

MURUK Volume 1 reprinted September 1990

MURUK

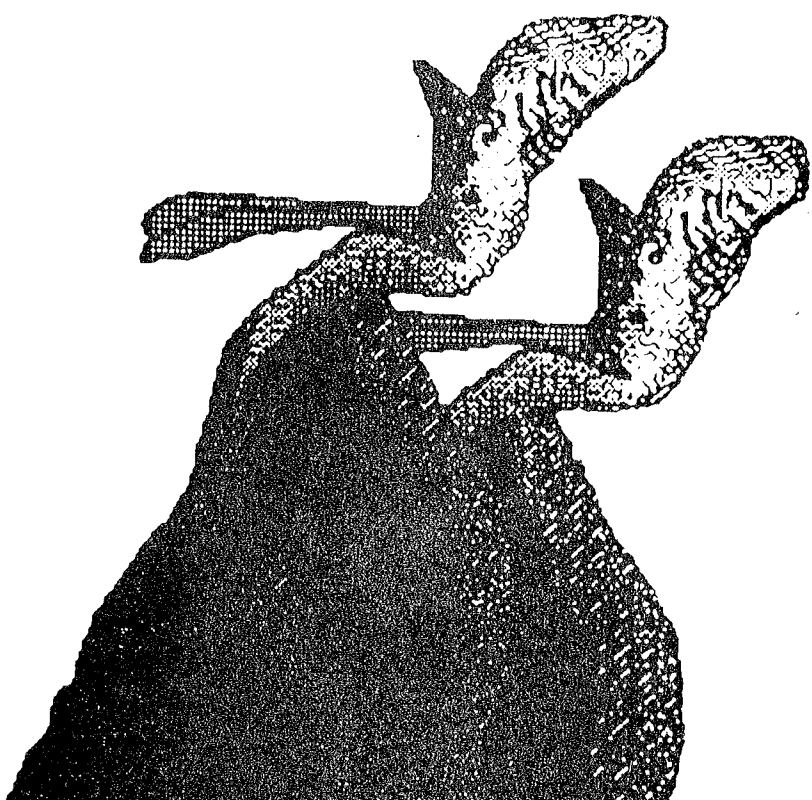
VOLUME 1 REPRINTED SEPTEMBER 1990

JOURNAL OF THE PAPUA NEW GUINEA BIRD SOCIETY

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EDITORIAL FOR REPRINT OF VOLUME 1

Volume One of MURUK first appeared in 1986, originally in an A4 format. Subsequently, the format of MURUK has changed to A5 and we have had lots of requests to reprint volume one in this style. We have, at last managed to comply with this request. All three parts of MURUK volume one are presented here in this special issue.

The order and content of the papers is largely unchanged from the original. I have omitted some of the PNG Bird Society announcements that are no longer relevant and corrected some typographical errors. I hope no others have crept in. Some bird names have been amended to agree with "Birds of New Guinea" by Beehler, Pratt and Zimmerman.

I have had a great deal of help in producing this reprint and would like to thank Mary George for typing in the papers, Mike Hopkins for technical assistance and editing and Elly Brown, Helen Fortune Hopkins, Will Glynn and Jenny Hicks for editing and proof reading.

Roger Hicks (editor)

MURUK

VOLUME 1 NUMBER 1 FEBRUARY 1986

THE JOURNAL OF THE PAPUA NEW GUINEA BIRD SOCIETY

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WELCOME TO MURUK

MURUK is the long-awaited ornithological journal, published by the Papua New Guinea Bird Society

MURUK is the only ornithological journal covering the Papua New Guinea region, Irian Jaya and the Solomon Islands.

MURUK could not exist without the support of the Department of Environment and Conservation, which takes an active interest in the Papua New Guinea Bird Society.

MURUK continues the tradition of naming journals after flightless birds. It is also has a Papua New Guinea flavour, in that it is named in the most widespread language of the region, Pidgin...Muruk is the pidgin word for Cassowary.

CONTRIBUTIONS for publication should be typed, double-spaced on one side of the paper only and submitted to the Editor in triplicate. Papers should be concise, original and should include a summary and appropriate references. Clarity and good organization of material will be required. Details of a appropriate format are outlined in Emu, Journal of the Royal Australasian Ornithologists Union.

EDITORIAL

The Papua New Guinea Bird Society, during the two decades of its existence, has published a great deal of ornithological information in its official Newsletter. Unfortunately, but understandably, many authors who could have contributed to that publication chose to place their papers in other more widely distributed journals overseas. The Society now feels that an effort should be made to bring together in one journal all Papua New Guinean ornithological papers, thus avoiding the frustration and inconvenience of having the material scattered widely and often obscurely throughout the world. This is the first issue of MURUK, a quarterly journal, to be published by the Papua New Guinea Bird Society. It has come into being because of the joint effort by the Society and the Department of Environment and Conservation who were also interested in consolidating papers on the birds of this region.

We hope that MURUK fulfils a need and encourage contributions of an academic or formal nature. It will be a journal dedicated to the sharing of knowledge about the unique birds of Papua New Guinea, as well as the other half of New Guinea, Irian Jaya, and the entire Solomon Islands region. Together they make up the 'New Guinea Region', an unique area, unsurpassed in its high percentage of endemics for such a relatively small part of the world.

This issue contains a paper questioning the current taxonomy of the *Aplonis* starlings, and a most interesting article on the co-operative breeding of Helmeted Friarbirds and Brown Orioles. The latter article raises many questions we hope to have answered in forthcoming issues of MURUK. Finally there is a report of a Black Tern at the Moitaka settling ponds near Port Moresby, the first record of this bird in the New Guinea region. We trust that you will find the articles interesting and topical, and hope that you will give this journal the support required for its success.

The Editorial Committee wishes to thank all authors who have contributed papers to date and we apologize for the delay in producing the first issue. We are optimistic that the next few issues will appear on schedule. For the long term the Society will continue to publish MURUK as regularly as possible when it receives appropriate papers. The continuing support of authors everywhere who have new material on the birds of the 'New Guinea Region' is needed.

The society Newsletter will henceforth become a bimonthly publication dealing solely with the activities of the Papua New Guinea Bird Society. Local members of the Society will receive both the Newsletter and MURUK as they are published. Overseas members will receive their Newsletters enclosed with MURUK on a quarterly basis.

Brian W. Finch, Editor

THE *APLONIS* STARLINGS OF THE SOLOMON ISLANDS

BRIAN W. FINCH

INTRODUCTION

The Solomon Islands are very well represented by the Starling family. There are only three genera present, one of which is introduced, but numerous species. The genus *Aplonis* has a greater abundance of species in the region than any other. Depending on the taxonomy followed there are no less than ten forms, which the author feels should all be recognised as individual species. This paper gives some unpublished data concerning these forms, and attempts to explain how so many different species can co-exist in these islands, whereas on the New Guinea mainland only two species occur over the major portion of the island with a very locally distributed third species confined to two major river basins.

THE GENUS *APLONIS*

The species of the genus *Aplonis* found in the Solomon Islands are as follows: *brunneicapilla*, *cantoroidea*, *dichrous*, *feadensis*, *grandis*, *insularis*, *malaitae*, *metallica*, *tabuensis* and *zelandica*. These last two named species only enter the political Solomon Islands in the Santa Cruz Islands and represent New Hebridean avifauna not Solomon Islands; as such they are not discussed further in this paper, which deals with the Solomon Islands as a faunal region. The inter-relationships amongst the *Aplonis* species may be described by establishing three groups.

PROBABLE RELATIONSHIP BETWEEN THE SPECIES

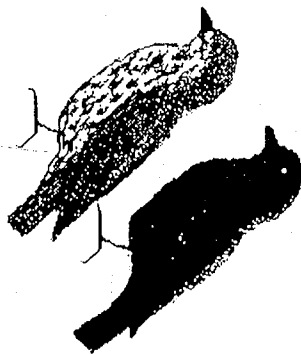
<i>cantoroidea</i>	<i>metallica</i>	<i>grandis</i>
<i>feadensis</i>	<i>brunneicapilla</i>	<i>malaitae</i>
<i>insularis</i>		
<i>tabuensis</i>		
<i>zelandica</i> ...	(?).....	<i>dichrous</i>

THE *CANTOROIDES* GROUP

Pump, stout-billed, short-tailed starlings are very widespread in the south-west Pacific. Two species are very widespread, *payanensis*, which extends into Malaysia from the Philippines and Borneo, and the familiar *cantoroidea* found from the Moluccas to the Solomons. Over most of its range, this adaptable species has colonised small islands without changing in form; on some very small islands, however, the birds have differentiated from the ancestral stock sufficiently to warrant full specific status.

cantoroides

Over most of its range *cantoroides* is the most abundant starling but on some islands *metallica* occurs in far greater numbers. *Cantoroides* always nests in holes, usually in trees, but now it commonly uses man-made structures in which to nest and to roost. No other native starling in the region has shown this adaptability, nor has any other so readily accepted the change to an urban existence. This last move has most certainly led to a great increase in numbers, particularly in the large coastal towns. Although mainly a coastal or lowland species on the Papua New Guinea mainland, the species has moved into the montane towns of Goroka and Mount Hagen, each over 1700 m.

*Aponis cantoroides*

Whilst the species has invaded small islands, it has not successfully re-invaded the islands which now have insular species that have evolved from it in earlier invasions. Four other species in the Solomons region have probably evolved from *cantoroides*, and all are restricted to small islands in the region.

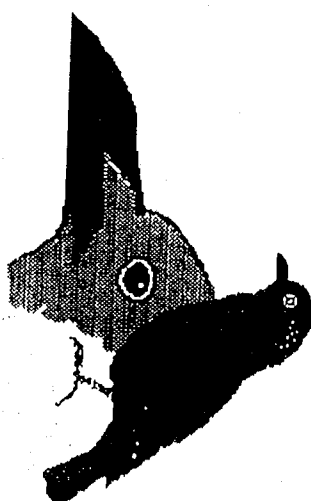
Typical *cantoroides* show a red iris in adult plumage, no coloured eye-ring; the immatures are heavily streaked on their undersides.

feadensis

Previously *feadensis* was considered to be more widespread, the reason being that one of the other races is now recognised as a separate isolated species. It is found only on the very small islands to the north-east of Bougainville and north of the south-eastern tip of New Ireland, and Ongtong Java off the north coast of Malaita. Although Rennell Island is given as part of the distribution for this species, there is another species endemic to that island, and this is discussed under *insularis*.

On Nissan Island where the author has had field experience with *feadensis* it was only noted in singles, pairs or small parties but not in flocks. Because there is no natural open country vegetation other than along the beach, the species has evolved into an arboreal forest inhabitant, feeding amongst the dense foliage of the trees.

A. feadensis is built much like *A. cantoroides*, from which it differs in being bulkier. The bill is more slender, almost thrush-like, with black feathering coming right down onto the culmen. The all dark iris is surrounded by a bright pale yellow eye-ring. Compared to *cantoroides* this species is almost totally without gloss, being a dull slaty-black. Immatures lack the heavily streaked underparts, and are merely a slightly duller version of the adult birds, with paler edgings to the breast feathers. In flight the species appears much broader winged, the beats are slower and the flight-pattern hesitant, nothing like the direct fast flight of *cantoroides*.

*Aponis feadensis*

On Nissan Island the most abundant species of bird is the Nissan White-eye *Zosterops greyiincta*, an abundant species found in all types of vegetation throughout the island. This species has louder calls than most species of white-eyes, and a very pleasant Whistler-like warble. The Atoll Starling *A. feadensis* instead of having the loud ringing, sharp metallic notes common to *cantoroides*, has soft notes very similar to those given by the white-eye. The reason for this apparent mimicry is unclear, but the repertoire of calls is atypical for this genus. The most commonly given call is a loud rising slur:

wweeeeee-eeeeee

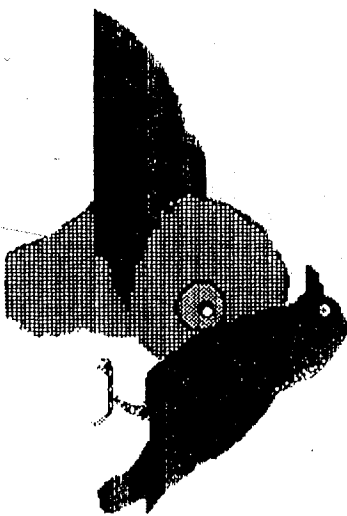
insularis

Confined to Rennell Island, south of the island of Guadalcanal, this species, for it is a species in its own right, was formerly treated as a race of *feadensis*. Reasons are given here why the author considers that it is not even related to that species.

On Rennell the bird was fairly common, usually encountered in pairs feeding in the forest canopy where it can be most silent and unobtrusive. It readily comes down low to feed in shrubs. In general appearance it is much like the previous species but has a very short tail, even for an *Aponis*. It is wholly slaty-black with a greenish gloss on the back and sides of the neck. Compared to *feadensis* the bill is heavy, more like *cantoroides*, possibly even heavier and lacking the conspicuous feathering on the

culmen of the former. The upperparts of adults are uniformly slaty-black; the under parts are dull grey-black; the flight feathers show as a duller black and contrast a little with the rest of the wing; the entire iris is orange-yellow and there is no trace of an eye-ring. Immatures are more uniformly browner, lacking any gloss, and have a pale brown iris.

The calls are most distinctive. In flight the notes are a sharp metallic clinking "chink-chink" very like that given by the Orange-breasted Fig-Parrot *Cyclopsitta guineaheriti* of the New Guinea mainland. The song however is a musical series of tinny notes like those of *cantorooides* but more varied. Some calls are similar to those of the Song Parrot *Geoffroyus heteroclitus*, also found on Rennell Island.



Aplonis insularis

Like *feadensis* this species is an obvious derivative of *cantorooides*, both having evolved independently following invasions of that species to the islands that they now occupy. Whether Nissau, Fead or Ongtong Java received the original invasion of *cantorooides* that evolved into *feadensis* is not certain, but from one of these islands the bird spread to the others as an already evolved *feadensis*. At some time *cantorooides* arrived on Rennell Island where a very insular form evolved into *insularis*. So sedentary is this species that it has not even managed to colonise nearby Bellona, which has no Starlings with which it would compete.

The lumping of these two forms under the umbrella *feadensis*, as Mayr (1954) and others have done, has surely been on the grounds that the two are similar in appearance, inhabit well off-shore islands and it was convenient to do so. Obviously no investigations were carried out in the field, and diagnostic features in both these species, such as eye-ring colour and iris colour, are lost in museum specimens. Mayr (1954), makes no mention of the yellow eye-ring on *feadensis* nor the orange-yellow iris of *insularis*. When *feadensis* was illustrated in Gould's monographs, the species was illustrated without a yellow eye-ring; nor did Rutgers make any mention of the fact, when he published his contributory text to Gould's paintings in *Birds of New Guinea*. The illustration, however, does show the thrush-like bill of *feadensis* as mentioned, whereas Mayr states that it has a heavier bill than *cantorooides*.

metallica

A. metallica is probably the most numerous and widespread Starling in the Solomon Islands, sharing the distribution of every other species apart from *insularis*. It is even present on the off-shore islands occupied by *feadensis*, although in much smaller numbers.

It is a highly social species, always in flocks, and nesting colonially in usually isolated trees, where the pairs build their woven pendant nests. No other species has a long graduated tail (but see *brunneicapilla*), nor the rich green-purple gloss.



Aplonis metallica

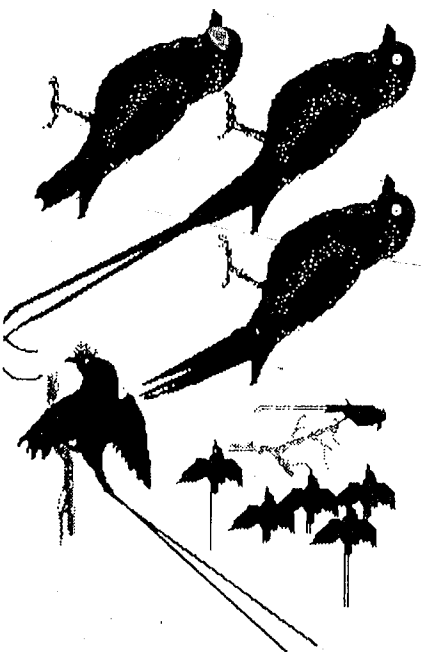
brunneicapilla

This species is undoubtedly the most striking of the whole genus, and the rarest starling in the Solomon Islands. It was previously known from only a few specimens from Rendova and Bougainville, and, until a breeding colony was discovered by Cain and Galbraith on Guadalcanal, the remarkable breeding plumage was completely unknown. They located breeding colonies in the hill-forest behind Honiara, where pairs had burrows in epiphytes attached to large rainforest trees. Birds with extraordinary long central tail feathers were then seen for the first time. The original birds that were collected were no-breeding individuals showing no trace of any elongated tail feathers; the most distinctive feature that they possessed was a pale iris. Thus the most diagnostic feature being unknown, the species was named the White-eyed Starling. To emphasise the obscurity of the species, Mayr states "...tail slightly elongated, bill highly arched. Iris white; bill and feet black. Differs from *metallicus* by the white eye, heavy bill, and short tail. Very rare and probably not colonial."

In early 1985 Peter Kaestner was most fortunate to find an active breeding colony on the Buin road, south of Aropa on Bougainville. This was in a logged area, and the colony of some ten pairs was located in a large completely isolated tree that had been left standing. The author was most fortunate in visiting this colony very shortly after its discovery and this provided a unique opportunity to study this virtually unknown species.

The adults were bluish-black with a strong purple gloss to the throat and a bottle-green gloss to the back. The black bill was short, stout, but with a strangely arched culmen quite unlike any other species. The iris was conspicuously whitish, although the immatures were not so striking, and in many it was not very obvious that the iris was so pale. The most outstanding feature was the curious elongated central tail feathers, which extended as two long and very flexible pins up to three times the length of the outer tail feathers. The rest of the tail showed a slight graduation. Birds with tail wires were assumed to be adult males; the presumed females and immatures lacked the pin feathers and had lanceolated tails, rather than graduated, this being less obvious in the younger birds. This species appeared to lack streaked immature plumages, the young being duller versions of the adults, and lacking gloss.

Some adult birds lacked the pins, and others had broken wires, or only one streamer. These are presumably broken in the confines of the nest burrow when the bird is turning around, but it is also likely that the wires are moulted when the bird is no longer in breeding condition or has completed nesting. This would also explain that whilst adults had been collected before Cain and Galbraith found the first breeding colony, they showed no trace of the pin feathers.



Aplonis brunneicapilla

The location was inundated lowland forest, which probably remains water-logged throughout the year, although the logging operations may have upset the local water table; however the nesting tree was above the water-line. It was 20 m from the nearest patch of forest, completely in the open. The tree was very tall; for the first 15 m the trunk rose straight up and had no arterial branches at all and the upper part of the tree spread out into several stout branches, terminating in a fairly open canopy. The upper portion of the trunk and the major branches were densely clothed in masses of epiphytes of many kinds. The epiphytes had created their own soil-like environment, as the vegetation withered, or wind-blown detritus collected in the tangles. Dense stem and root systems formed mats around the vegetation and on the branches. The

starlings' nests were burrowed either in the soil around the larger epiphytes such as 'Staghorns', or in the dense tangles of roots. Some of these tunnels must have been fairly deeply located inside of the mass as birds with very long tail streamers disappeared completely from view.

At first light the birds would awaken and emerge from the nest tunnels, where all of the birds had roosted during the night, and sit around on the tops of the branches of a dead neighbouring tree, or close to the nest, where they would preen in the first rays of the dawn sun. Some would sing in a subdued fashion. After a short while the birds would collect as a flock or a series of parties, and fly out to collect food from the nearby forest. The birds would be away for some twenty minutes, then return as a flock to the nest site carrying food, which appeared to be berries, and wisps of plant material for the nest. The birds carrying food entered the nest tunnels; some birds that appeared to carry nothing, or had already deposited their load and were waiting for their mates to finish feeding the young, would sit outside the nest and preen and warble softly. When the young had been fed, the birds would wait until all were ready, then fly off as a flock to the feeding site. One such feeding tree was only 30 m away, and there the birds collected berries. Around the nesting tree the birds were always seen flying to it or from it, but a few hundred metres away a couple of parties were observed flying at a tangent to the colony suggesting that another nesting colony was located in the forest not very far away.

In all the respect the species lives a colonial existence. It breeds as a colony, it flies out to feed as a group, it feeds as a group, returns to the nest as a group and feeds the young as a group. Connected with this is the most complex pair-bonding display which was demonstrated by several adult males at the same time, near the nesting tunnels on neighbouring branches. These males selected a horizontal branch, lowered their heads and backs by flexing their legs, raised a short tufted crest from the base of the bill to the back of the crown, spread. At the same time the tail was pointed at an upwards angle, and the long tail wires, which were completely flexible, waited up and down. For a starling this is a most unusual display. Some birds while performing would give a warble of sharp metallic notes, very loud and strong when compared to *metallica* which is what it most closely resembled. Many notes were very tiny, and now and again the birds would string the notes together into a rustling 'aluminium-foil-like' warble.

The birds showed no aggression when congeneric species either settled in their nesting tree or in a neighbouring tree, as was the case with a pair of Brown-winged Starlings *Aplonis grandis* which had their nest in a neighbouring tree and frequently used the white-eyed Starlings tree as a landing station when flying to or from their own nest. When a flock of *metallica* landed in the neighbouring tree there was likewise no aggression, and it was as if the *brunneicapilla* had not noticed them.

The affinities of this species are unclear. In the elongated tail feathers, colonial habits, metallic warblings and chinkings, it shows closest alliance with *metallica*. It is evidently not able to compete successfully, and has remained a very rare species wherever it is found. It is likely that it will eventually be found to occur on all of the major islands throughout the Solomons, and has so far been over looked when not in its striking nuptial plumage. That the Bougainville colony was only the second ever to be discovered, on an island has been fairly well covered ornithologically when compared to all of the other islands that make up the Solomon Islands, testifies to its rarity.

THE GRANDIS GROUP

The three starlings to make up this group are different from those so far dealt with in that they are larger and shaped more like a Myna and their primaries are brownish, contrasting with the rest of the wing. Two species build large stick nests placed openly in the branches of trees. The author is not sure about the nesting habits of *dichrous*. The last named is possibly not part of this group. The reasons for this conclusion are discussed under the section dealing with that species.

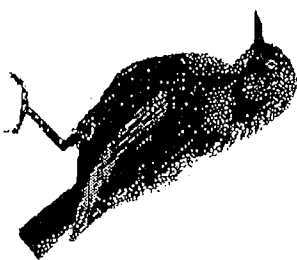
grandis

Grandis is a member of a group of the three larger species of starlings of the region. The other two related species (considered subspecies by some authors) are *malaitae* only found on the island of Malaita, and *dichrous*, only found on the island of Makira (previously known as San Cristobel). On all of the other islands apart from small offshore islets, Rennell island and the Santa Cruz group, it is *grandis* that will be found. It differs little on these islands, although its altitudinal distribution and social behaviour do appear to differ from location to location, but this may have seemed so only because of having a limited sample.

A large bulky starling lacking the crisp blackness in the plumage, or any noticeable gloss, in build it is shaped similar to the Eurasian Starling *Sturnus vulgaris* and like this species has a medium length slender bill, rather than the short, stout, almost crow-like bills of most *Aplonis* starlings. The throat has long dark lanceolate hackles with green/bluish gloss, and there are also some elongated feathers on the back of the neck and nape. In some lights the whole bird can appear streaky, in others the underparts look more dull dark brown than blackish. The outer primaries are obviously and diagnostically paler brown, contrasting with the rest of the wing. The iris is dark, the bill and feet blackish. Immatures appear as duller versions of the adults, but there is no streaked immature plumage in this group.

The birds on Bougainville travel in pairs, and would seem to pair for life. They like to perch openly in the very tops of trees, where they sit for long periods. They are sluggish in their movements, their flight is laboured and hesitant, more like a Myna's than a Starling's and it is in flight that the brown primaries are most obvious. The nest is also

placed in the small branches at the top of a tree, a very bulky nest woven out of small sticks into a dome-shaped mass with an entrance in the side. Possibly the nests are added to in successive seasons, as some observed were small, whilst others of much larger dimensions were in use at the same time.



Aplonis grandis

Most calls recorded were shrill and high pitched, "shreenk", "shrip", "seeet", and in flight the birds often gave an un-starling-like "tip-tip" similar to the flight calls of some Eurasian Buntings *Emberiza* sp. The protracted song consists of a continuous string of warbles, chips, squeaks and other shrill notes, interwoven with a chatter. This song is very like that given by the Eurasian Starling, a fact that has been commented on by other authors writing about this species. Some notes are soft but others, interspersed amongst the ramblings, cannot be heard at all even though the bill is opening and closing as if the refrain was still pouring forth. There is possibility that part of the song is beyond the range of human hearing as has been suggested by another author (Hadden, 1981).

On Bougainville *grandis* is mainly a lowland species, but occurs in small numbers as high as Panguna and probably extends even higher. It does not associate in flocks; parties up to four are regular, this probably representing an adult pair with two fledged offspring. The general rule is that this species is to be found in pairs, but undoubtedly more must gather at fruiting trees.

Birds of Kolombangara, in the central Solomon Islands, were in no way any different from the birds seen on Bougainville.

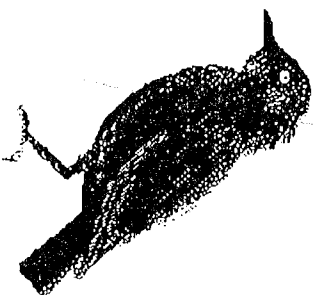
The birds on Guadalcanal in the far eastern and of the Solomon Islands chain were very similar to the birds encountered elsewhere, but in the field their appearance was slightly smaller overall, with a very slightly proportionately longer tail (not obvious), and the pale brown of the primaries more conspicuous. They were common from sea-level up to 1200 m at Vallecocha. As with other localities, the species was usually in pairs, but it showed a more ready inclination to gather socially into larger parties, and on one occasion over twenty were feeding at a fruiting bush. One call heard on

Guadalcanal but not noticed elsewhere was a high metallic and strident "zink" which was given frequently by birds as they fed, or remained perched on a branch. The call note was given with a convulsive jerk of the head, and had carrying power.

In appearance, the differences between *grandis* from the three parts of its range, western (Bougainville), central (Kolombangara), and eastern (Guadalcanal), were insignificant. There was no obvious difference in overall size or structure, no noticeable cline in plumage colour, characteristic, or texture, no appreciable variation in the shade or extent of the pale brown of the primaries, no differences in the bill size or structure, nor any variation away from a dark iris.

It is the unvarying characteristics of this species throughout its range that persuaded the author that the two forms, *malaitae* and *dichrous*, are not merely races of *grandis*, as they have been treated in the past. The former is an allied form but still a species in its own right, the latter is only doubtfully a close ally of *grandis*. The author's reasons for splitting these forms into separate species are given under their individual treatments.

malaitae



Aplonis malaitae

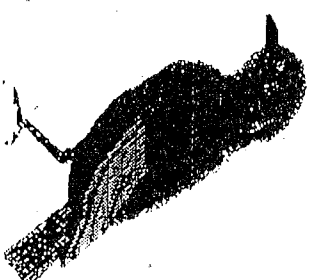
Malaitae is confined to the island of Malaita, lying roughly to the north of Guadalcanal, where it is and obvious representative of the *grandis* group, but differs from that species in several small but nevertheless important features, and one very important and conspicuous feature. This last difference, strangely not even mentioned by Mayr (1945), is that the iris, instead of being dark, is wholly whitish. Overall the bird is slighter than *grandis*, showing less brown on the primaries of the perched bird. The hackles on the back of the neck and the nape are longer, and hang as a shaggy beard from the throat, where the gloss is a shiny deep purple. The breast shows an oily green sheen, contrasting with the throat.

This species is often encountered in pairs, but readily gathers into parties. A feature not observed with *grandis* is that *malaitae* will readily associate with *metallica* at fruiting trees. It is common throughout the lowlands, extending up into the hills.

The song is similar to that of *grandis* being rich and varied, and it also shares the higher pitched notes, which may be beyond the human auditory range. Whilst very closely related to *grandis*, and a geographic replacement species, full species status for *malaitae* is warranted because the iris colour, smaller size, glossier, greener plumage, and long hackles on the neck and throat place *malaitae* apart from *grandis*, which has unvarying appearance throughout its distribution.

The fact that Mayr (1945) did not make any mention of the white iris on this species must mean that he was unaware of the fact. This is yet another example of taxonomic placements being decided on the basis of museum skins, with no field data. Museum skins lose features such as iris colour, eye-rings, bill and leg colour, or the original tone of any soft parts such as wattles, gape linings and bare patches of skin. So far in this paper *malaitae* is not the only casualty; we have seen it with *feadensis*, where there is no mention of any yellow eye-ring, and with *insularis*, where there is no mention of the complete lack of an eye-ring, nor any mention of the orange-yellow iris colour. Thus *feadensis* and *insularis* were lumped together as one form, and the same procedure has been applied to *malaitae* and *grandis*. In fact the entire treatment given in "Birds of the Southwest Pacific" (Mayr, 1945) is to be found in the section dealing with the Brown-winged Starling (*grandis*), where *malaitae* is treated as a race of that species. It reads, "...*malaitae* Mayr 1931 (malaita) smaller and with a greener breast".

dichrous



Aplonis dichrous

Dichrous is a very different bird from either *grandis* or *malaitae* in size, appearance, call, habits and bill structure. All of the features are treated in detail in the text that follows.

It is a much smaller bird than either of its so called close relatives, but treated here in the *grandis* group, for that is where it has been placed by other authors. It lacks that dull brownish cast, being a crisper black, with a shorter, stouter black bill, and a redder iris. In overall shape (but not posture), it more closely resembles *cantoroides* than *grandis*. There is a bright glossy spangling of purple on the breast and underparts. The

throat has short pointed hackles, not the long rangey lanceolate hackles of its "allies". The most distinctive single feature is that the entire flight feathers are pale brown, almost with a golden tinge in some lights, whereas in the last two species, the pale brown is confined to the outer primaries, leaving the inner primaries and secondaries blackish. This pale wing contrasts strikingly with the crisp blackness of the remainder of the plumage. The tail is also brownish rather than black (unlike the last two species) and noticeably squared and rather short.

The birds associate mainly in pairs, but also in small parties, and are found at all altitudes on the island. Unlike the other two species which move deliberately and somewhat clumsily, this species is very agile, coming right down in the foliage to feed within less than a metre of the ground, hopping nimbly amongst the slender twigs, or hanging by its feet to stretch itself out to reach an item of food. In great contrast to all other starlings, it showed no aversion towards joining mixed feeding assemblages, readily associating with such unlikely genera as *Monarcha*, *Rhipidura*, and *Pachycephala*. The calls recorded were high pitched squeaks and clinks like *cantorioides*, and a rising whistle!

Differences between *dichrous* and *grandis* are far more numerous than the resemblances, the only obvious feature that they share is the paler primaries, and even in this it is very different in the extent of the pale area, and the colour.

The inclusion of *dichrous* with *grandis* is certainly erroneous, and many current authors treat it as a full species. The fact is that it has probably not even evolved from *grandis* stock, but could have come from the east and not the west. Although the author has no field experience of *zelandica* from Santa Cruz and the New Hebrides, it would seem (based on descriptions) to be a far better contender as an ally of *dichrous*. In bill structure and body shape, this species is like a typical *Aplonis* starling.

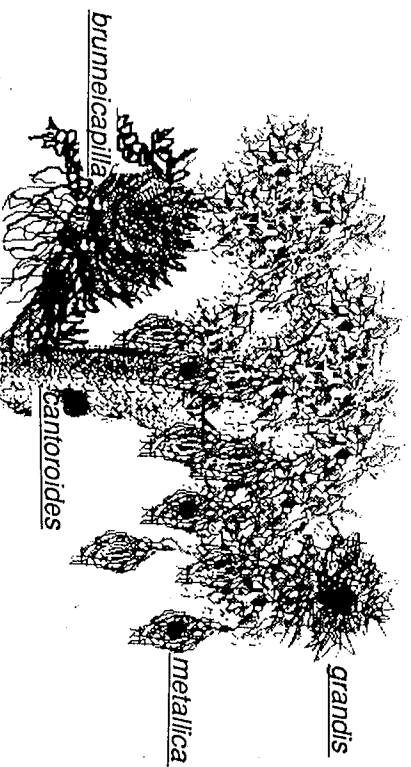
SUCCESSFUL SYMPATRY IN THE GENUS *APLONIS*

Through the greater part of the New Guinea mainland, two species of *Aplonis* are to be found. Both are common and they co-exist all around the coast, and along river systems. Both species require open country, but only the Singing Starling *A. cantorioides* is found in the dry savanna. Both are widespread and have colonised the major satellite islands, and a majority of the smaller vegetated islands. Whilst they may feed in the same trees, there is no competition when it comes to nesting, for the Singing Starling nests in already excavated holes or natural hollows in trees, and more recently in man-made structures. Whilst the species is solitary in its nesting habits, several pairs may nest in close proximity if there are a sufficient number of potential sites. The Metallic Starling *A. metallica* is a highly social species, and only nests in colonies, some of which are very large. Each pair constructs a neatly woven, pendant-shaped hanging nest, and the entire colony may have hundreds of these nests hanging from the higher branches all over the tree. Often the tree is an isolated individual in an otherwise fairly open area.

In view of the fact that the New Guinea mainland is the home for only two widespread species of *Aplonis*, it comes as a surprise to learn that some islands in the Solomon Islands, all of which have a fairly impoverished fauna typical of isolated island's host four species of *Aplonis* in complete sympatry. This presents a very interesting study for students interested in avian niches. Whilst a more detailed study for students interested in avian niches. Whilst a more detailed study of these birds is required, there is no doubt that a greater part of the success of their co-existence stems from their different nesting habits. It would be conceivable for all four species to nest in the same tree, without competing for sites. At the place along the road to Buin where the observations on the nesting colony of White-eyed Starlings were made, all four species of starlings were present, and all four were found nesting in close proximity.

There was no inter-specific aggression between the four species, even though they were at times present in the same vegetation; in fact there was a considerable tolerance. Perhaps they utilise different food resources, although all four were seen eating berries of the same appearance.

DIFFERENT NEST SITES UTILISED BY *APLONIS* STARLINGS



brunneicapilla

Only nests in holes which it must excavate itself at the bases of and amongst the packed root systems of arboreal epiphytes. Burrows are deep, and in most cases almost vertical. It would appear that this species favours isolated trees in which to nest, and will only do so as a small colony, as this is a highly sociable species.

cantorioides

Mainly a solitary breeder, though several pairs may nest in close proximity. Always nests in a hole, either in a tree or a man-made structure. The hollow issued as the nest site, but the species make no excavations itself apart from tidying up the hole.

grandis

A solitary breeder, which builds its bulky nest in exposed branches, usually in the top of a tree. The nest is a medium to very large (for the size of the bird), dome-shaped structure of small woven sticks and moss with a side entrance.

metallica

A colonial nester, favours isolated trees in which pairs weave their pendant hanging nest made from neatly woven strands of grass-like fibres.

CONCLUSION

Hopefully this paper, whilst it has not conclusively reformed the taxonomic placements of the species treated, nor given them the thorough coverage that they deserve, will kindle and interest in this most interesting and sorely neglected group. The suggestions of revising the taxonomy are ventured in the hopes that another will take up the task and work on the group in the field.

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SECOND RECORDED INSTANCE OF THE BROWN ORIOLE *ORIOLUS SZALAYI* NESTING IN THE SAME TREE AS THE HELMETED FRIARBIRD *PHILEMON BUCEROIDES*

GEORGE E. CLAPP

INTRODUCTION

The author reported the Brown Oriole *Oriolus szalayi* nesting in the same rain-tree *Samanea saman* as the Helmeted Friarbird *Philemon buceroides* in Popondetta in 1982 (Clapp 1982b). Between 2 May 1982 and 5 June 1982 more than eleven hours of observations were carried out. Nesting in each case was aborted by an unknown agency, in the case of the honeyeater at the nesting stage and in the case of the oriole still apparently at the incubation stage. Twenty-eight antiphonal duets by *Philemon buceroides* during the observation period confirmed the data in Clapp (1982a) on duetting in *Philemon buceroides* and confirmed that duetting in this species is performed by a mated pair. During the period in question not a single instance of direct aggression between the two species was observed. The possibility was raised of a dominance hierarchy between *Philemon buceroides* and *Oriolus szalayi* with the former being dominant. The bearing of the data on the striking similar appearance of

O. szalayi and *P. buceroides* was discussed and the conclusion reached that the data supported the rejection of Cody's (1974) proposal that interspecific aggression has caused the convergence in appearance. The present paper documents the second instance of Brown Orioles nesting in the same tree as a pair of Helmeted Friarbirds.

CIRCUMSTANCES

On 10 April 1983 Brown Orioles and Helmeted Friarbirds were noticed both nesting in the same tree, in the high covenant housing area in Popondetta, Oro Province, Papua New Guinea. It was evident from the state of the nests that the friarbirds must have commenced building first. The tree used for nesting was an Erima, *Ocoteles sumatana*.

The nests were typical for each species, the *Oriolus* nest was a medium shallow saucer suspended from a fork let from a lateral branch and situation near the very bottom of the canopy about one third of the way towards the bole; the *Philemon* nest was a deep cup suspended from a forklet from a lateral branch and situated approximately two-thirds of the way up the canopy and halfway in towards the bole. The *Oriolus* nest had a wispy tail of vegetable material hanging from the bottom and the *Philemon* nest, although not having one to start with, developed a wispy tail later. The two nests were both on the same side of the tree and were some eight or nine metres apart vertically.

OBSERVATIONS

The bulk of the observations was carried out on 28 separate days within the period 10 April 1983 to 25 May 1983 inclusive. There was a total of 31 hours and 22 minutes observations. Observations were made on 10-12 April inclusive, 16-18 April inclusive, 21-26 April inclusive, 1st May, 3-8 May inclusive, 10 May, 12 May, 14-15 May, 18-19 May, 21-23 May inclusive and 25 May.

NESTING OF WHITE-BELLIED CUCKOO-SHRIKE *CORACINA* *PAPUENSIS* IN SAME TREE

On 21 April the author noticed that a pair of White-bellied Cuckoo-shrikes *Coracina papuensis* was also nesting in the same tree used by the Friarbirds and Orioles. The author was not able, however, to follow the progress of this breeding attempt (two nests were difficult enough to watch simultaneously, three would have detracted from the value of the observations) and the last note was that on 21 May the *Coracinas* were observed sitting on the nest, which was situated near the top of the canopy, on the same side of the tree as the other two nests.

THE NESTING RECORD

The initial observations of nest building started on 10 April and both the Brown Oriole and the Helmeted Friarbird were building on this day. Both and definitely finished building by the end of 16 April; both were seen sitting on 17 April. The Friarbird was

first seen definitely feeding young on 5 May, and the Oriole was first seen definitely feeding young on 12 May. In both species, both male and female fed the young. The Oriole hatched two chicks as did the Friarbird. In each case the stronger chick emerged from the nest for the first time on 22 May, the Oriole chick being the first out of the nest at 12:41 and the Friarbird chick being out from the nest for the first time only a few minutes later. Each species definitely had one chick which was out of the nest and moving around fairly strongly on 22 May. On 23 May there was no sign of the Oriole chick but the Friarbirds were seen to be feeding one chick still in the nest while one chick was out and about.

Unfortunately it was not possible to carry out extensive observations on 23, 24 and 25 but on 25 May there was no activity from either the Orioles or the Friarbirds in the nest tree and it is assumed that by that time all four chicks had fledged. Certainly on 25 May two adult Friarbirds were seen with two fledgelings in the garden next to that in which the nest tree was situated and subsequently the adult Friarbirds were seen on later dates with their two juveniles. However it is not known what became of the Oriole chicks as they were not seen subsequent to the 22 May.

For the Helmeted Friarbird there is insufficient information to give the interval between finishing the nest and the laying of the eggs. It is however reasonable to assume that for the Friarbird incubation time is about 18 days and nesting time is about 18 days. As the Brown Oriole was seen to put the last touches to its nest on the 16 April, and as it was seen definitely sitting on 17 April, there may well be less than a day's interval between finishing the nest and laying the first egg. There is insufficient information in the case of the Brown Oriole to estimate the length of either the incubation or nesting time.

THE EVENTS OF 22 MAY 1983

There is no doubt this was the most significant day in the whole period of observations and it is worth recounting the events of this day in some detail.

First observations started at 11:45. Immediately it was noticed that one of the Brown Orioles was giving a different call; it was almost a double note, a slurred 'ischew' call. The similarity of this call to the Helmeted Friarbird's foraging/contact call was remarkable. The other Oriole was giving the usual rollicking call. The author considers it significant that this 'ischew' call had not been given by the Orioles during the whole period of observations, from 10 April, until it was heard for the first time on 22 May. This call has been heard from Brown Orioles in other localities and at other times but whether or not as part of a breeding situation is not known. The Oriole making the rollicking call approached to within one metre of the Friarbird's nest with no reaction from the perched Friarbird.

Observations ceased briefly at 11:50 and recommenced at 11:53. Then one Oriole came to the nest tree with food and another was calling continuously. One Oriole (whether the one with food or not is unfortunately unclear from the notes taken) approached to within one metre of the Friarbird nest. The other Oriole also came up to the vicinity of the nest but not as close. At 12:01 a Friarbird approached and chased the Oriole away from the nest. The Oriole with the food came down to another lower perch and the other Oriole went into a nearby tree. At 12:04 the Oriole with the food went to its nest and fed a chick. After some non-significant events it was noted at 12:13 that the Friarbird nest contained a chick moving around in it. Between 12:18 and 12:19 both the Oriole and the Friarbird fed their respective chicks. An Oriole which had arrived at the nest tree with food at 12:15 did not feed its chick at the nest until 12:36. At 12:22 the Friarbird came to its nest and fed its chick. At 12:27 the Friarbird chick was fluttering up on to the rim of the nest, it fluttered its wings and then went down into the nest again. At 12:36 the Friarbird came to its nest and fed a chick. At 12:41 an Oriole was calling and one Oriole chick was out of the nest, while the other stretched its neck up in the nest. Shortly afterwards (no more than three minutes at the most), the stronger of the two Friarbird chicks was up on the branch which held the suspended nest. At 12:53 the Friarbird came to the nest and fed its chick and at 12:58 both the Oriole and the Friarbird went to their respective nests and fed their chicks. Observations finished at 12:58.

Observations started again at 15:44 when it was noticed that an Oriole was moving all around the Friarbird nest at a distance of about two metres, uttering the previously described 'ischew' call note (harshly), and interspersing it with the normal Oriole rollicking call (medium strength). The Oriole fledgeling at this stage was sitting on a limb next to the Oriole nest, whilst the other adult Oriole was in the lower canopy of the nest tree. There was no sign of the adult Friarbirds or the Friarbird fledgeling. At 15:49 an Oriole was not far from the Friarbird nest when a Friarbird called and came to feed its young. The Oriole moved down level with its own nest while the Friarbird fed its chick. Then followed some non-significant events. At 15:51 a Friarbird adult usurped the perch where an adult Oriole was sitting, thus exhibiting Friarbird dominance over the Oriole.

At 15:58 the Oriole fledgeling was not visible and the parents, also invisible, were calling in a nearby tree. Both Orioles were seen near the Oriole chick just after 16:03 and the unusual 'ischew' call was being given.

After 16:15 a Friarbird came to the nest tree and fed its fledged chick. Shortly afterwards an Oriole came to the tree with food, the Friarbird fledgeling moved near to it and there was an encounter which the author did not observe clearly but which may have been the Oriole feeding the Friarbird chick. The Oriole then flew away and finally the Friarbird chick flew also. At 16:26 and again at 16:28 when the Friarbird came to

feed its chick in the nest there was an antiphonal duet with one bird on the nest rim and one in another tree.

At 16:40 the Friarbird fledgeling was seen on the top of the rain tree. The 'ischew' call was being uttered by an Oriole. The two Orioles were then seen very near to the Friarbird chick. Then one of the Orioles came and sat right next to the Friarbird chick. Only a Friarbird call in the vicinity made it move, but both Orioles still stayed nearby. At this stage it was clearly seen that it was an Oriole that was uttering the 'ischew' call - the Friarbird fledgeling was apparently silent. Shortly afterwards all the birds flew.

Between 16:47 and 17:00 the Oriole fed its chick at the nest twice and the Friarbird fed its chick at the nest once. Between 17:00 and 17:17 there was feeding of both chicks by Friarbird and Oriole, also some antiphonal duets by the Friarbirds, in this case just after feeding and leaving the nest area. At 17:16 it was noticed that there were definitely two Oriole chicks in the nest. Observations finished at 17:21 but at 17:27 there was an instance of vicious aggression by the two Friarbirds against an *Accipiter* spp.

POSSIBLE ANTIPHONAL DUET BY *ORIOLEUS SZALAYI*

On 21 April an instance was noted of possible antiphonal duetting by the two Orioles. The possible duet consisted of a pair of calls by Bird A - along clear upslurred and then downslurred whistled call with a shorter call at the end; this was followed instantaneously by a somewhat shorter pair of calls by Bird B - an upslurred call with an approximately equal duration downslurred call. This pattern was repeated several times perfectly. After that the calls were also given again but clashed. So perfect were the initial several instances of Bird B's calls following those of Bird A, and given the fact that on several other occasions the author heard possible duets in *Oriolus* (i.e. outside of the scope of this paper), that this is believed to be at least an incipient antiphonal duet.

ANTIPHONAL DUETTING BY *PHILEMON BUCEROIDES*

During the period of observations the author recorded 52 antiphonal duets by *Philemon*. Of these eight duets spread over four separate days, were initiated by the bird with the higher pitched tone (Clapp 1982b), whilst seven duets spread over six separate days, were started by the bird with lower pitched tone. One instance was noted of a bird changing its notes halfway through an antiphonal duet but still inter leaving them (Clapp 1982b). Several instances were noted of antiphonal duets being performed while one bird was on the nest and the other elsewhere (Clapp 1982b).

During the same period 150 bouts of solo calls were noted, but a bout here is only a term of convenience, as the field notes were never intended to indicate the exact number of solo calls, and a bout as used here could be anything from one call to many.

AGGRESSION

During the period of observations the following instances of definite aggression were recorded. Five instances of Willie Wagtails *Rhipidura leucophrys* pursuing Helmeted Friarbirds from nearby trees into the Friarbird/Oriole nest tree. One instance of two Willie Wagtails harassing a Helmeted Friarbird which was in its nest; eventually the *Philemon* left the nest and was chased by the wagtails into a nearby rain-tree (on the same day, 24 April, the author twice noted two wagtails fiercely attacking another small unidentified bird nearby). One instance on 16 April of a White-bellied Cuckoo-shrike *Coraciina papuensis* buzzing an Oriole in the nest tree; it is interesting to note that a Friarbird immediately came close to inspect the situation and that the Cuckoo-shrike did not persist with buzzing. One instance on 22 April of a Helmeted Friarbird attacking a large lizard near its nest; the second Friarbird came to the vicinity but did not join the attack and the lizard retreated. One instance on 22 May of two *Philemon* chasing off an *Accipiter* spp. so viciously that they beat it to the ground momentarily and then sent it off altogether. One instance of an *Accipiter* spp. chasing a Brown Oriole which had stolen nesting material from the hawk's nest in a nearby Kinkii Pine tree; the hawk desisted because of harassment by two Willie Wagtails. Two instances of aggressive posturing by the *Philemon* towards the *Oriolus*, both on 24 April and both shortly after the *Philemon* had been chased into the nest tree by the Willie Wagtails, indicating a possible spillover of aggression. Lastly one instance on 22 May of the *Philemon* aggressively chasing off an *Oriolus* from the vicinity of its nest.

In addition there were four clear-cut instances of dominance exhibited by the *Philemon* over the *Oriolus*, expressed by the simultaneous taking over by the *Philemon* of the perch that the *Oriolus* was on, as the *Oriolus* moved out submissively. One of these took place on 23 April, two on the 24 and one on the 22 May. There was also a less clear cut instance on 21 April.

FEEDING THE YOUNG

A) *Philemon buceroides*

Between 5 May and 23 May inclusive, covering nine separate days, there were 32 definite observations of adults feeding young. Of these most were merely noted as 'food', two were definitely large praying mantis, three were definitely large unidentified insects, one was listed as an insect, and one was almost certainly a cicada.

In addition there were nine presumed feeding instances observed. On two other occasions the adults were seen to catch a large green praying mantis but it is not known whether they were subsequently fed to the chicks. On one occasion an adult Friarbird hunted for eight minutes, ignoring small ripe figs near it, before it finally caught the presumed cicada and fed it to the chick.

Intervals between successive feedings varied widely and randomly ranging from one minute to 53 minutes, and in such a way that it would be quite misleading to quote any

average. Elapsed time between when the adult bird was first seen with the food and when it fed the chick was in most cases very brief and on only one occasion did it reach two minutes.

B) *Oriolus szalayi*

Between 12 May and 22 May inclusive, covering five separate days, there were 16 definite observations of adults feeding young. Of these, most were merely noted as food, three were almost certainly fruit (small globular, reddish objects held in the open beak), and two were probably small grubs or caterpillars. There were also four presumed feeding instances observed.

Intervals between successive feeding varied widely, ranging from one minute to 55 minutes, and in such a random way that it would be inappropriate to quote any average.

Of great interest was the elapsed time between when the adult bird was first seen with the food item and when it actually fed the chick. On twelve occasions these elapsed times were excessive: they were 15, 8, 19, 29, 45, 2, 1, 12, 21, 4, 13, and 10 minutes respectively. With the other feeding occasions there was no appreciable elapsed time. During these extraordinary intervals between arriving with food and feeding it to the young, the adult bird would continually shift from perch to perch, approach the nest, retreat, approach again, retreat, and so on. On several occasions the adult bird waited until the other oriole arrived in the vicinity again before feeding the chick. It is in fact worth noting one instance in detail.

At 07:48 on the 15 May an adult Oriole flew into the nest tree with food, apparently fruit, in its beak. At that stage the bird was on the same side of the tree as its nest. At 07:56 an Eclectus Parrot *Eclectus toratus* flew overhead and called, at which the Oriole shifted its perch over to the other side of the tree. At 08:01 a sneeze by a person going along the road also apparently startled the Oriole. At 08:15 the other adult oriole flew into the nest tree and perched below and to the right of the Oriole's nest (the nest being on the left hand side of the tree from the observer's viewpoint). At 08:32 the first Oriole with the food finally moved to the nest and at 08:32:15 it fed the chick, flying away at 08:33. There was a total elapsed time of 44 minutes during which the Oriole with the food was constantly shifting its perch, on a number of occasions moving nearer to the nest then away from it.

Another extraordinary incident worth noting in detail occurred on 22 May. At 16:15 an adult Friarbird came to the nest tree with food, fed the Friarbird chick and flew away. It should be noted here that the Friarbird chick was out of the nest. Then an Oriole came to the nest tree with food at approximately 16:16. The young Friarbird came near to the Oriole. There was a brief 'encounter' which the author did not see clearly because

it was so quick and unexpected, but the Oriole then flew away out of the tree. The encounter was not an aggressive move, the birds came together briefly. Later the young Friarbird also flew away. The 'ischew' call given by the Oriole was heard again at 16:20. After the 'encounter' the Oriole that had arrived in the nest tree with food in its beak should normally have gone to feed its young but did not do so, instead it flew away. The author is quite certain that the identification of the Friarbird chick was correct, as the Friarbird had fed it earlier. The balance of probabilities is therefore that the Oriole fed the Friarbird chick.

AMOUNT OF TIME SPENT IN THE NEST TREE

During 7% of the total observation period only an Oriole or Orioles were present in the nest tree, for 17% of the time there was only a Friarbird or Friarbirds in the nest tree, for 67% of the time individuals of both species were present and for 9% of the time neither adult Friarbirds nor adult Orioles were apparently present. The Oriole, however, did spend considerable time perched in a close neighbouring tree slightly below the level of its nest, so the stated time for the Oriole being present at the nest site may well be misleading.

DISCUSSION

The first point to be made about these observations of *P. buceroides* and *O. szalayi* in the proximity nesting situation is that they indicate a connection between the mimicry by *O. szalayi* of *P. buceroides*, not only with general feeding assembly advantages, but with anti-predator advantages for both species. They complement the feeding situation observations mentioned by Diamond (1982).

The fledging time appeared to be the significant event towards which everything was leading. Although hatching did not appear to be closely coordinated between the two species, the initial fledging of the stronger chick of each species occurred within minutes of each other on 22 May: at 12:41 for the Oriole and no more than a few minutes later for the Friarbird. This can be regarded as remarkable timing, particularly as it can be presumed there were at least several days between the hatching of the two species' eggs.

Also significant is the 'ischew' call, so similar to the foraging/contact call of the Friarbird, which the Oriole only started giving on 22 May, the day when the chicks of both species first fledged. It is possible that this mimicry is to accustom the young Friarbird to accepting the Oriole as another parent 'Friarbird' very early in its life. The normal rolling Oriole call was interspersed with the 'ischew' call. Subsequently the Friarbird chick which it grows up to be an adult might be inclined to accept the Oriole as an 'honorary conspecific' because of the auditory and visual conditioning. Certainly the 'ischew' is the closest Brown Oriole call to any call of the Helmeted Friarbird. Another Oriole call is a long drawn out whistle that recalls the general

quality and character of a Friarbird cell. Of course, in tone and volume the Brown Oriole songs are similar to those of the Helmeted Friarbird, even if the character of the songs are different.

Two of the favoured perches of the Friarbirds were: 1) on a level with the Oriole nest but at the rear of the nesting tree and 2) slightly above the level of the Oriole nest and four or five metres to the right. Both perches were considerably below the Friarbird nest. Proximity of the Friarbird to the Oriole's nest would be advantageous to the Oriole, giving better anti-predator insurance to the latter's nest, as the former would be alert to predators. As yet there is no explanation as to why the preferred Friarbird perch is below instead of level with its own nest. One may also consider the possibility that the Friarbird, by deliberately stationing itself near the Oriole nest and away from possibility that the Friarbird, by deliberately stationing itself near the Oriole nest and away from its own nest, may be using the Oriole nest as a 'sacrifice'. If a potential predator sees the Friarbird sitting close to the Oriole nest it may not notice the Friarbird nest and in any subsequent absence by the Friarbird such a predator might turn its unwelcome attention to the nest which the Friarbird was apparently guarding.

Increased protection for the Friarbird's nest could occur when only one bird, an Oriole, is present in the nest tree, and as that bird resembles a Friarbird, then both nests are apparently protected by a bird that has a pugnacious reputation. This would be advantageous to both species.

Both species would also derive greater protection from predators because there is greater immunity by being part of a group, in this case a loosely knit 'group' (see Bettram in Kress & Davies, 1978). The mimicry of the Friarbird by the Orioles makes it seem that there are more than two Friarbirds. Before hatching it would appear that there are not two but four 'Friarbirds', and after hatching it could conceivably appear that there were eight 'Friarbirds'. So potential predators which are aware of the Friarbirds' pugnacity would tend to leave the 'Friarbirds' alone when it sees an apparent 'group' of them. Vocal mimicry would further enhance this deception. Again both species would benefit.

In this context we should note that the *O. szalayi* mimicry of *P. buceroides* in New Guinea is not perfect (Diamond, 1982). Mimicry of *P. subcorinaculus* by *O. forsteri* on Ceram in the Moluccan Islands is almost perfect, so the group appearance argument would be more applicable there. Unfortunately we do not know whether these two species practice proximity nesting on Ceram.

The observed percentage of time spent at the nest by the two species would provide a distinct advantage to the Oriole if it nests in proximity to the Friarbird. If for 17% of the time there are only Friarbirds present in the tree, then for that amount of time there

Oriole's nest would gain protection that it would not otherwise have because if the Friarbirds were not present then there would be no birds guarding the nesting tree. For the same reason there is some advantage to the Friarbirds when only Orioles are present (7% of the time) and both species gain from the 'group' anti-predator deception during the 67% of the time that both Friarbirds and Orioles are in the nesting tree.

Diamond (1982) postulated that the advantages to the Oriole, in the Oriole/Friarbird mimicry situation in Australasia are first, that the mimic (Oriole) escapes attacks from the larger species (Friarbird) that might otherwise drive it off, and second, that the mimic, by resembling the larger bird, may derive higher status in the eyes of smaller species and may succeed in scaring them off with less effort because of its appearance.

However this appears to be only part of the solution. Anti-predator protection probably does play an important role in this mimicry situation, particularly with regard to protection of eggs and young. At the same time the author believes that there is an unsolved aspect to this puzzle, and that is the relationship between the young Friarbird and the adult Orioles, also possibly the relationship between the young Orioles and both the young and adult Friarbirds. We have observed that there is a relationship but we do not yet know enough about it nor can we formulate a theory as to its meaning.

Wallace (1863, 1969 in Diamond, 1982), may have been partially right when he theorized that mimicry was an answer to predation by birds of prey, but he should have used the more general term 'predators'. It is well known that nests in tropical areas are much less successful than nests in temperate areas in part because of the high level of predation by snakes, lizards, raptors and other birds and animals.

During these observations the Helmeted Friarbirds fended off at least two potentially serious predators: one *Accipiter* spp. and one large lizard. There can be no doubt that at least some potential predators would be wary of attacking either the bird itself or the nest of a bird that resembled a Helmeted Friarbird, if once that predator had been attacked by a Friarbird.

What is the overall significance of these observations? It is probable that we are looking at an evolving situation. The Brown Oriole does not always nest in close proximity to Helmeted Friarbirds but it appears we have a special proximity nesting arrangement in which there is both visual and vocal mimicry, and from which both species may derive some advantage. There appears to be an element of timing so that both species fledge their chicks at the same time.

The extreme nervousness displayed by the Orioles in feeding their chicks at the nest, as shown in the long elapsed time between the adult first appearing with food and subsequently feeding it to the chick, cannot be explained at this point. There was

define alternating behaviour, presumably caused by a conflict of underlying tendencies. Several times the Orioles would approach almost to the nest with the food and then retreat again. Certainly the phenomenon needs explanation. Could it be that the resemblance of the Oriole chick to the Friarbird chick induces an approach/fear conflict in the adult Oriole?

The data on antiphonal duetting by the Helmeted Friarbird reinforce data already collected (Clapp, 1982(a); Clapp 1982(b)). It is assumed that the higher, pitched and lower pitched birds are female and male respectively although there is no hard evidence to support this assertion. At any event it is clear that either male or female may initiate an antiphonal duet, as the number of instances of duets initiated by either lower or higher pitched calls were approximately equal (seven versus eight).

Last, the author agrees with Diamond (1982), that we need more data from field studies on the interactions of Friarbirds and Orioles. As well as general field studies on the *Oriolus/Philemon* complex, it would be particularly enlightening to have field data of species in places where the mimicry is almost perfect, such as on Ceram in the Moluccan Islands. Particular attention needs to be paid to nesting of the two species in circumstances where they practice proximity nesting. Crucial observations would be of the young just before and after fledging.

The author extends his thanks to Professor J.M. Diamond of UCLA for assistance.

Gratitude must be extended to Miss R. Tibo of Popondetta for typing the manuscript and to the Provincial Forest Officer, Popondetta, Mr. Nathan Siriga, for identifying the nest tree.

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BLACK TERN *CHLIDONIAS NIGER* AT MOITAKA SETTLING PONDS, CENTRAL PROVINCE - FIRST RECORD FOR THE NEW GUINEA REGION

BRIAN W. FINCH

On 18 May 1985 the author was accompanied by Tim Murphy (visiting from Brisbane), Eric Shackleton and David Cornac (visiting from Melbourne), and we were calling in at Moitaka at 16:00 hrs on the off-chance that something of interest might be there. In view of the date, nothing out of the ordinary was expected.

Immediately on getting out of the vehicle BWF checked a party of terns feeding at the in-flow pipe of one of the new ponds. Amongst the Whiskered Terns *Chlidonias hybrida*, and Gull-billed Terns *Sterna nilotica*, was bird that was immediately recognised as a black Tern *Chlidonias niger*, and BWF drew attention to it. The bird was in complete immaculate breeding plumage.

The other observers and the author were all familiar with this species in its usual range, and everyone agreed on the identification. After we had watched the bird for several minutes it flew off towards Waigani Swamp and did not reappear.

The following day (15:00 hrs), Tim Murphy and the author returned to Moitaka, this time accompanied by Paulene and Bob Kibble. The Black Tern was located amongst the other terns on the muddy spit which used to be the bank between the two larger tanks, but which has now been removed. This three-hundred metre long strip of muddy hummocks is very attractive to birds and they cannot be disturbed on foot. These ideal conditions have caused other palaearctic species to remain much later than normal: fifty Common *Sterna hirundo*, four Little Terns *Sterna albfornis*, five white-winged Black Terns *Chlidonias leucoptera*, one each of Black-tailed Godwit *Limosa limosa*, and Pectoral Sandpiper *Calidris melanotos*. The last named was particularly unusual for the time of year and the only individual member of all of the above-named that was in nuptial plumage (apart from the Black Tern).

After a short while the Black Tern flew from the spit with a party of Whiskered Terns to feed at the in-flow pipe at the place where it had first been discovered. After feeding for about fifteen minutes, the bird flew back towards and over us, and rested again on the spit.

DESCRIPTION

The head and entire underparts down to the lower belly are immaculate black; under tail coverts to vent, and a slight tracing on to the hind flanks are white. The mantle, entire

wing area, rump and tail are uniform pale slate. In the strong sunlight the bird showed a most attractive bluish cast when seen from some angles. The underwing was wholly greyish-white contrasting starkly with the black of the underparts in a straight line demarcation. The underwing coverts were very pale greyish-white, whilst the undersides of the flight feathers were darker. The undersides of the first few primaries were a much darker grey. When the bird was seen from front-on or nearly so, a narrow but very conspicuous white line could be seen along the leading edge of the wings from the body to the carpal. The blackish bill was long and slender, the feet reddish and the tail quite obviously forked.

HABITS

When feeding, the birds showed much more grace than the Whiskered Terns, dipping and swooping from a greater height, and when rising it traced more gentle arcs than that species. The wings, which appeared broader and fuller, seemed to enable a greater precision of movement. Sometimes the bird would dash about madly zigzagging all over the area, playfully diving at and being dived at by other terns for no apparent reason but in away that was typical of the *Chlidonias* terns. The whole effect was that of a more graceful flyer than all other terns present.

Although the White-winged Black Terns preferred to rest rather than feed and did not allow for a direct comparison, nuptial plumaged birds had been seen recently. Whilst they are more graceful "bouncier" flies that Whiskered Terns the author gained the impression their wing strokes are shallower than this Black Tern's and their swooping more abrupt. When resting the Black Tern favoured raised clods of mud rather than flat ground.

COMPARISONS WITH WHITE-WINGED BLACK TERN IN BREEDING PLUMAGE

In spite of the close relationships between *C. niger* and *C. leucoptera* and the difficulty in separating the two species (except in juvenile plumage, when *leucoptera* has a very dark saddle), the differences in breeding plumage are many.

BILL: The black bill of *niger* is longer and more slender than the short, almost Little Gull-like, red bill of *leucoptera*. It is the short bill of *leucoptera* that always reminds the author of a small gull (particularly Little Gull *Larus minutus*) when observing the resting bird. The winter head pattern only enhances the resemblance. The slender bill of *niger* combined with the solid black crown in winter plumage is in every way typical of terns.

WINGS: The underwing of *leucoptera* is extensively black on the coverts, showing as an extension of the black underparts; the line where the wings join the body is indistinct. The undersides of the flight feathers are stark whitish with grey tips. The underwing of *niger* is the reverse: there is no black on the underwings at all, and the contrast where the wings join the body is startling. The underwing

coverts are greyish white, whilst the undersides of the flight feathers are darker. From the upperside *leucoptera* has wholly white wings apart from some greyer edging to the flight feathers. This is sharply contrasted against the black back and mantle, which is as black as the head and underparts. This in turn contrasts with the pure white rump and tail. The entire upper surface of *niger* is bluish-slate, and the back of the head merges into the slaty grey of the upper back.

RUMP AND TAIL: The rump and tail of *leucoptera* are pure white, contrasting sharply against the black of the back and mantle. The tail is shallowly forked. Because the entire upper parts of *niger* are more or less uniform, the bird is subtle when compared with the arresting black and white of *leucoptera*. The tail of *niger* is more deeply forked.

DISCUSSION

Black Terns are a very long way out of their normal range when they visit the Australia Region. Their breeding range is widespread in North America, but in Eurasia is mainly confined to Europe and extending to the Upper Yenisei and Russian Turkestan (Yaurie, 1965). Records east of the line are very few. There is a single sight record from Delhi in India, which Ali & Ripley consider as doubtful (Ali & Ripley, 1968). There have been a few records in Japan, which could relate to the North American race *surinamensis*. There is also a record from Hong Kong, where yet again the author considers the record doubtful (Webster, 1976).

The entire North American population winters in South America, whilst the Western Palearctic population *niger* winters entirely in tropical and sub-tropical Africa. Up to the present, three individuals have found their way to the Australasian region, all to Australia. There are two records for New South Wales: Tuggerah Lakes, September 1958, and Kooragang Island, Newcastle, January to March 1968; and one for Western Australia at Lake Joondalup, December 1973. All of these records related to birds in non-breeding plumage, (Pizzey, 1980). This most attractive individual at Motika constitutes only the fourth record for the Australasian Region, and the first to be discovered in full breeding plumage. The extensive white on the vent and undertail coverts suggests that this individual is a member of the Western Palearctic race *niger*.

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BOOK REVIEW

The birds of Papua New Guinea including the Bismarck Archipelago and Bougainville. Volume 1: by Brian J. Coates. 1985. Adelaide: Dove Publications. Pp 464. ISSN 0 9590257. Price in P.N.G. K70.00.

This magnificently illustrated book treats the birds of political Papua New Guinea, the first to do so. Volume 1 takes us through the non-passerines, dealing with 377 species of the 740 which will be covered by both volumes. Volume 2 will also include summaries of the birds of Irian Jaya and the Solomons.

The opening chapters introduce the characteristics of the bird fauna of the Papuan subregion and its origins; the physical features, climate, and vegetation of Papua New Guinea; a listing of habitats with their representative bird species; and some miscellaneous notes of features of the avifauna. In the systematic section for each species there is a description, a summary of its distribution, notes on habitats, altitudinal range, ecology and breeding, and a listing of recorded subspecies. For nearly all species there is a map showing the probable distribution (shaded), with particular sightings or specimens shown by spots. Finally there are indices and a good bibliography. The whole is sumptuously illustrated with almost 500 colour photographs and a further 44 line drawings. There are maps on the front and back covers, showing places mentioned in the text. Topography of Papua New Guinea and the Port Moresby region.

I found the opening chapters useful, though the vegetation section is a direct summary from Paijiamans (1967). The species reports vary from short accounts to long discussions several pages in length. The depth of coverage varies with the extent of the author's experience with that species. The notes are uniformly well written and interesting. Of particular value are the distribution maps, not previously available in any book about PNG birds. Occasionally there are errors, for example the maps for the Slate-breasted Rail and that for the Bare-eyed Rail appear to be reversed.

A long standing irritation for non-professional birders is the lack of standardisation of English names. It seems a shame that the author has in some cases used names which will be different from those used in the forthcoming field guide (Beehler *et al.* 1986) which, it is to be hoped, will set the standard.

It is for the photographs that this book is most to be valued. The coverage varies, Port Moresby birds being generally better represented. Some species are given wide spreads, such as the Thick-billed Group Pigeon with nine pictures on pages 42, and 295-300. But one can see that the author would have found difficulty in leaving out any of his best shots. Some species photographs are disappointing, for example the

pictures of Brown and Black-billed ('Bar-tailed') Cuckoo-Doves on page 264 are not very useful in assisting identification. In all 232 species, about 60% are photographed, and it would be unreasonable to expect the author to delay publication while waiting for wider coverage. The bulk of the pictures are of excellent quality and are beautifully reproduced. However, I found the method of labelling the plates extremely irritating. The small reference numbers at the corners of pages mean that they eye has to travel to three different places and back to verify the caption and the picture.

The book is a little difficult to categorize. It remains a very personal account, relying heavily on the author's own experience. It is emphatically not a field guide. Few would be capable of carrying it out of doors, let alone rich enough to risk exposing it to the weather. I think that it succeeds in two ways, firstly as a 'coffee table' book for browsing through a beautiful record of Papua New Guinea's unique avifauna, and secondly as a comprehensive reference book for the region. It will certainly be a welcome addition to any ornithologist's library and I look forward avidly to Volume two.

M.J.G. HOPKINS

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MURUK

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EDITORIAL

This, the second issue of MURUK, contains one major article by Christopher Healey on the effects of hunting, gardening and other human activity on the Birds of Paradise of the Jimi Valley. Many hours of fieldwork were necessary during the preparation of this article and we welcome the care and professionalism that Mr. Healey has put into his contribution. Also included in this issue is a short note on nesting records in the Bulolo area which has been compiled by Lorraine Lamothe. Very little is known about the nesting and breeding habits of many Papua New Guinea birds and these brief notes are an important contribution to ornithological knowledge of the area.

Those of you who receive our Newsletter will know that Brian Finch, the founder and first Editor of MURUK, has left Papua New Guinea to take up an exciting new job with Abercrombie and Kent in Nairobi. We will miss his exceptional field abilities but know that he will soon be making birding news in Kenya.

Starting with this issue, MURUK will be produced by an editorial board. Each board member will be responsible for one issue a year. Members of the board are Michael and Helen Hopkins, Joan Oliver and Peter Storer. It is regrettable that the publication of our second issue has been delayed because of production difficulties but we hope to improve our performance when we obtain some profession secretarial help.

Once again we would like to thank those authors who have sent in manuscripts. Three or four of the shorter articles will be published in the next issue. As our expertise and credibility increase we hope that a greater number of authors will seriously consider placing their latest articles in MURUK. In the future we plan to create a panel of readers and make MURUK a refereed journal.

Joan Oliver, Editor

THE IMPACT OF MAN ON BIRDS OF PARADISE IN THE JIMI VALLEY

CHRISTOPHER J. HEALEY

INTRODUCTION

In this paper I discuss the impact of man on populations of several species of Birds of Paradise (Paradisaeidae) in the Jimi Valley, Western Highlands area of Papua New Guinea. Although the importance of Bird of Paradise plumes in the cultures of New Guinea people is well known, little systematic attention has been given to the effects of human alteration of habitat and predation on the birds. It is often supposed that the greatest single threat to the survival of Birds of Paradise is the clearing of forest for food gardens to support a growing rural population and to make way for commercial ventures. Some authorities assert that hunting pressure seems to have little impact on the numbers of birds (e.g. Schodde 1973).

Elsewhere (Healey 1980) I have documented in some detail the regions where Bird of Paradise plumes are most intensively used as items of decoration and ceremonial wealth, and also the extent of the area in which hunting occurs to supply plumes. Plumes are most intensively used in only a few major valleys of the central highlands of PNG, especially the densely populated Simbu and eastern Wahgi Valleys. Relatively little hunting occurs locally in these valleys, as much of the original forest has long given way to grassland and fallow re-growth. Most hunting for plumes occurs in less densely settled areas of the highlands, especially on the northern and southern fringes, and in the surrounding foothills. Complex and extensive trading networks, some hundreds of kilometres long, funnel plumes from numerous peripheral communities towards the limited region of ultimate consumption. There are two consequences of this trading system. First, central highlands can exert a high demand for plumes without intensifying predation locally. This tends to spread hunting pressure over a very wide area. Second, hunting in peripheral areas is stimulated in part by a demand for plumes in central areas of consumption, so that in these supply areas, hunting pressure may actually be increased above the requirements of local demand. In other words, the intensity of hunting in peripheral areas with relatively low human population density is not simply a function of local demographic conditions, but is influenced by demographic and economic factors in distant regions.

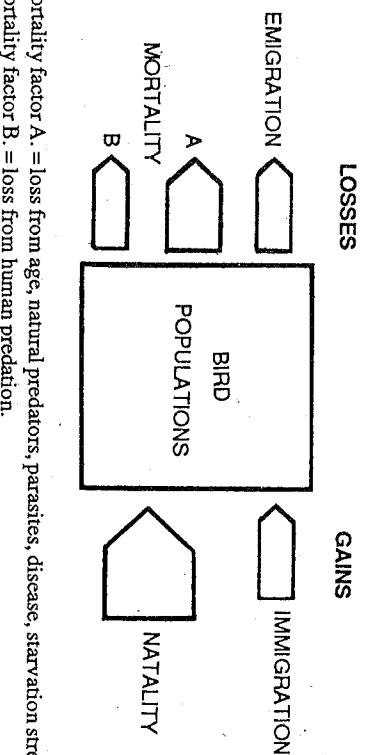
These conditions complicate analysis of Bird of Paradise population dynamics. Since man does not depend upon the birds even marginally for biological survival, one cannot treat man and birds as interdependent populations of predator and prey. Hunting by man, unlike other predators, is a cultural activity. As such, models of predator-prey relations developed by Errington (1934), Klein (1970), Kruuk (1972), Lack (1966), Mech (1970), Schaller (1967, 1972), Slobodkin (1961) and others are

clearly inadequate to describe predation by man on these birds. Nonetheless, such models may have some relevance to the response of bird populations to predation by man.

I adopt Slobodkin's (1961:134ff.) steady state or homeostatic model of populations, in which density-dependent factors tend to control populations around a steady (but not necessarily optimum density) figure. "The effect of predation on the size of the prey populations is either to substitute one cause of mortality for another or to lower the survival at some particular age in the population, or both". Sources cited in the preceding paragraph give empirical support to Slobodkin's model. That the model also applies to Birds of Paradise subjected to predation by man can only remain a working hypothesis in the absence of sufficient data on the ecology and population dynamics of Birds of Paradise.

Predation on the birds to supply the plume trade is both sex- and age-specific: adult males are selected by the hunter, even if females and immature males are taken incidentally for food or in uncontrolled traps. I propose that in populations of Birds of Paradise subjected to selective predation, recruitment and/or loss rates will be adjusted so as to maintain population densities around a steady state. These adjustments should be manifest by age and sex structures differing from those of populations free from human predation. Factors involved in the dynamics of Bird of Paradise populations are illustrated in Figure 1.

FIGURE 1: MODEL OF BIRD OF PARADISE POPULATIONS



Similar models applied to populations of large prey species, such as wildebeest (Kruuk 1972), buffalo (Sinclair 1977), and deer (Klein 1970; Mech 1970) can be tested by the reconstruction of age/sex composition over time by the examination of such factors as dentition, height and weight of living and dead animals. Similar analyses of bone and tooth remains have been used to examine the population dynamics of prey species

found in archeological remains of human hunters (Smith 1974; Davis and Wilson 1978).

Data on age-specific characteristics of Birds of Paradise are lacking, except for some fragmentary material on captive specimens. Thus there is no basic material to permit a study of the diachronic operation of the model by the examination of the birds themselves. However, one aspect of the model is amenable to diachronic analysis, and that is mortality from human predation.

Non-literate people commonly have impressive memories. Hunting successes told to me in detail provide a means of reconstructing an index of past hunting rates. Remembered kills can be compared for different time periods and be taken as indices of predation rates, using the assumption that standard proportions of actual kills are forgotten. Such comparison can be further refined by proposing that the proportion of forgotten kills increases with time. I hypothesize that human hunting success is partially density-dependent: where birds are common, the hunter is more likely to kill birds; where they are uncommon, he is less likely to exert himself or meet with success. Thus, reconstructions of past hunting rates based on these indices allow me to make inferences about the stability of actual hunting over time, and thus the approximate density of suitable prey (adult males birds).

The aims of this paper are:

1. To examine the present structure of Bird of Paradise populations in a defined area, and to relate this structure to empirically determined levels of human predation and alteration of habitat in the past.
2. To examine the diachronic operation of the model through a reconstruction of past levels of predation. The effects of this predation on past populations will be inferred in relation to the present relationship between man and birds, as outlined in 1 above.

Methods. This paper is based on 16 months fieldwork in the Jimi Valley. In 1972 I spent three months visiting 13 settlements, including a nine-day stay in Tsuwenkai. Twelve months fieldwork in 1973-74 and another month in 1978 were all spent in Tsuwenkai village. This research was directed towards formulating and testing the model outlined above. This was an anthropological study of the ecology and economics of a regional trade system (Healey 1977). An examination of the hunting of Birds of Paradise to provide plumes for trade provided a focus for the study. An attempt was made to discover the dynamic operation of the trade system and its local basis in the production of plumes, by adding a time dimension.

All quantitative data and ornithological material reported here were obtained during 1973-74. Data on human interaction with Birds of Paradise were obtained by observations and conversations on bird lore. In addition, I collected detailed histories

of hunting of valuable birds and mammals from 57 resident adult men. These records, which stretch back to the 1920s, provide data to reconstruct past predation rates. In addition, with the help of three local assistants, I kept a record of all kills of Birds of Paradise in Tsuwenkai during the year.

Eleven men were questioned in detail about their hunting of female-plumaged (i.e. adult females and immatures, either male or female) Birds of Paradise, since the 57 hunting histories concentrate mainly on adult males killed.

During 1973-1974 a record was kept of the location and altitude of all Birds of Paradise seen or heard. I also noted similar records provided by my three full-time field assistants, and selected other informants if I judged their reports to be reliable. Of particular value were the reports of one of my assistants, Lucien Yekwai, a local hunter of considerable skill, and an acknowledged village expert on natural history. All these records by age, sex, or plumage-type, were entered onto a map (scale 1:20000) which had been prepared from air photographs prior to my 1973-74 fieldwork. The map was divided into 400 m² grids which, in conjunction with a dense pattern of ridges and streams, allowed for fairly accurate placement of records in most cases.

Over the 12 month period of fieldwork I made numerous single day excursions to various parts of Tsuwenkai territory, as well as several extended drier-season trips lasting up to four days. For these latter, six forest camps were established (see Map 2 in Appendix).

The rugged terrain, poor visibility in the forest, and constraints of time and other duties prevented me from developing appropriate techniques for censuses along transects. However, I established three census areas (Map 2) within which I attempted to record all individuals of two species of Birds of Paradise. Area 1 was a strip 200 m wide and 800 m long, spanning the boundary between primary and secondary forest. Areas 2 and 3 were deep in the primary forest. Area 2 was 16 ha in extent and 400 m², located at the bottom of a major valley. Area 3 included Area 2, but extended 2000 m to the ridge-crest at about 2450 m, and was 80 ha in area.

I was unable to make a conclusive test of the model of bird populations as the amount of quantitative data gathered on birds remained limited. The necessity of gathering a broad range of ethnographic material to discover the cultural use and management of Birds of Paradise precluded more exhaustive censusing or the use of more time-consuming techniques for observing and recording ecological data on birds.

THE ENVIRONMENT

Location of the Study. This study was based in the village at Tsuwenkai, Western Highlands Province, PNG, which is inhabited by the Kumdagai people who speak the Maring language. The village centre lies at 5°25'S, 144°38'E, at an altitude of 1680 m

on the north wall of the Jimi Valley (see Map 1 in Appendix). The village is accessible only by foot track which connects to a mission airstrip several hours walk away. A vehicular road to link the village with major highland centres was being built with local labour in the 1970s. It is possible this project will never be completed.

Tsuwenkai lies close to the crest of the Bismark Range, extending westward from Mount Wilhelm (4509 m). The range forms the northern wall of the Jimi Valley, which is separated from the densely populated Wahgi Valley to the south by the Sepik-Wahgi Divide, which rises to over 3700 m in places. The Jimi River rises on the north-west slopes of Mount Wilhelm and flows roughly west-north-west in the northern part of the valley to drain into the Sepik River. The Jimi thus provides a corridor from the northern lowlands into the central highlands. The total area of Tsuwenkai territory is 25 km².

Climate. The average yearly rainfall, for a six year period, at Tablbugo government station south of the Jimi is 3124 mm. The Tsuwenkai rainfall is probably somewhat higher. Rain is rather seasonal, the wetter period lasting from November to April, the drier period from May to October.

Temperatures show no clear seasonal variation. The average daily maximum recorded during fieldwork at Tsuwenkai was 23°C, and the average minimum, 15°C.

Terrain. Tsuwenkai and environs are located in the valley of the Kant, a major feeder stream of the Jimi. The Kant Valley is narrow, with short, steep, lateral spurs and intervening streams. Tsuwenkai territory ranges in altitude from about 1220 m to about 2800 m. The loose shales and clays are prone to landslips, even in primary forest.

Vegetation and Ecological Zones. Four major ecological zones can be delineated, each characterized by particular floral communities.

1. The montane zone extends down from the mountain peaks to the forest edge, mainly between 1700 and 1850 m. Most of this zone is of mixed floristic composition, although *Castanopsis* and *Lithocarpus* oaks are common at the lower edge, and *Nothofagus* beech on some of the highest peaks. Informants stated that oak forest formerly extended to lower altitudes, before being cleared to make way for food gardens. Montane forest has a more or less continuous canopy about 30 m or more above the ground. One, usually two, substages are present. The ground level is fairly clear, except below openings in the canopy. The montane zone covers 16 km² or 64% of the Tsuwenkai area.

2. Below this zone lies the zone of human habitation. This is a patchwork of secondary forest in all stages of development, food gardens, small coffee plantations, home-steads, and groves of ornamental and shade trees. The following subzones can be identified.

Secondary forest: ranging from tall forest merging into primary montane forest to lower, more open-spaced woodland on drier sites. Secondary forest approaches the characteristics of montane forest in 40 to 70 years after initial clearing.

Bush fallow: composed of lower, scrubbier growth. This may reach a height of 18-20 m in six years, and if left uncleared will develop into secondary forest.

Homesteads: coffee and casuarina groves: these tend to be semi-permanent sites, dominated by planted vegetation. Tall secondary forest trees may also shade these areas, and provide attraction for birds when in fruit or flower. Tsuwenkai village consists of about forty home-steads or single house sites scattered for 2 km on the west flank of the Kant valley.

These three subzones together cover about 5.8 km² (23.2% of the total area).

Gardens: the Kundagai practise slash and burn agriculture, clearing gardens mainly from secondary forest. Gardens are kept in production from a little over one year to two years after planting. The average fallow period for garden sites is 15-16 years (range 6-16 years (range 6-22 years, mode 12 years). Excluding small homestead gardens, the total area under production in 1974 was about 0.5 km² or 2% the total area.

3. The third major zone is grassland, comprising some 2 to 2.5 km² or 9% of the total area. Grassland is interspersed in the zone of human habitation, and is more extensive in the southern part of the area, towards the Jimi. Oral traditions indicate that most of this grassland has been stable for 200 years.

4. A fourth zone is found in lower altitudes beyond Tsuwenkai territory. This is lower montane rainforest, which is extensive near the Jimi itself.

Birds of Paradise are found in all these zones except the grassland. Of the thirteen species recorded in Tsuwenkai, six are confined to the montane zone, five occur in both montane and human habitation zones, and two are confined to the latter, but extend to the lower montane zone beyond Tsuwenkai (Table 3). Narrow strips of grassland do not act as barriers to the movement of Birds of Paradise. However, extensive grasslands beyond Tsuwenkai's southern borders may have prevented the entry of the Lesser Bird of Paradise *Paradisaea minor* into the lower altitude secondary forest. This species is common elsewhere in the Jimi Valley (Healey 1978b).

Effect of Human Activity on the Environment. Under the present agricultural regime, there appears to be no expansion of the zone of human habitation. Until recently, there was probably some shrinkage following population decline through epidemics in the

1940's and 1950's. The collection of wild plants for building and other purposes, and foraging domestic pigs undoubtedly affect the speed of regeneration and the floristic composition of secondary forest, in more accessible parts of primary forest. Fires spreading from garden sites also damage the adjacent forest, and help maintain grassland communities.

This apparently stable situation may not continue long, as Kundagai population growth appears to be accelerating. Although reserves of secondary forest in excess of present needs will allow for the expansion of food gardens to feed the growing population, new clearing of primary forest may eventually become necessary. This situation may be hastened as increasing areas of land are lost to subsistence agriculture by the planting of semi-permanent groves of coffee as a cash crop in old garden sites.

The population of Tsuwenkai in 1974 was 304 people. The overall population density is 12 people per km², while the density of people to area of land currently under cultivation and fallow is 48. These densities are low by New Guinea highlands standards. I estimate that with present agricultural techniques, the Tsuwenkai area could support almost double the present population. My data are insufficient for suggesting when this growth might be achieved.

For the present, the Kundagai consider that they have sufficient agricultural land. They are generally reluctant to bring large areas of primary forest into production, as these are harder to clear and do not give such high yields as gardens cut in secondary forest. The clearing of some areas of forest, believed to be the abode of ancestral spirits, is specifically tabooed (see Healey 1977: 83-92 for a fuller discussion of these issues).

HUNTING AND ITS REGULATION

The Kundagai are divided into several clans. Clans and their sub-divisions are important land-owning groups. Three clans jointly own most of the land north of Remnapai Creek and east of the Kant River. The land between Remnapai and Punk Creek is owned by a fourth clan. All four clans have equal rights of access to the land south of Punk Creek.

The Kundagai use the plumes or skins of 53 species of birds in their head-dress, decorations on festive or ritual occasions. Nine of these species are Birds of Paradise, all but one of which occur in Tsuwenkai forests. Most plumes are obtained by gift or loan from friends and relatives, or by trade. Bird of Paradise plumes and other forest products are the only resource locally available to the Kundagai which are valuable trade items and in high demand elsewhere in the highlands. They are therefore heavily involved in both hunting to provide plumes for trade, and in importing plumes from their northern and western neighbours, and re-exporting them towards the central highlands to the southeast. In return they receive steel tools, decorative shells, live pigs, and money.

No one in Tsuwenkai owned a gun, and all hunting involved bow and arrow or trap. Birds of Paradise are shot or trapped at fruiting trees or at baits set by the hunter. Baits used are the fruit of the *Trichosanthes* vine or the wild banana (*Musa* sp). Hides are sometimes built in the branches of fruiting trees and beside baits. Birds are also shot from hides at forest pools and display trees.

Most hunting occurs in the drier season, mainly for reasons of comfort. Some men do not enjoy hunting, and many lack sufficient skill and knowledge to make it a rewarding pastime. Of the approximately 70 men of active hunting age (15 to 55 years), only 11 are considered by the Kundagai to be particularly skilful and successful.

A Kundagai may ideally hunt in any part of Tsuwenkai land, including areas not owned by his own clan. However, he may only kill valuable birds on land owned by his own clan. The species considered valuable are listed in Table 1.

TABLE 1. RESTRICTED GAME IN TSUWENKAI

Species which may be killed only on the clan land of the hunter.

<i>Casuarus bennetti</i>	Dwarf Cassowary
<i>Chamosyna papou</i>	Papuan Lorikeet
<i>Epimachus meyeri</i>	Brown Sicklebill
<i>Epimachus fastosus</i>	Black Sicklebill
<i>Astrapia stephaniae</i>	Stephanie's Astrapia
<i>Lophortyx superba</i>	Superb Bird of Paradise
<i>Pardisaea minor</i>	Lesser Bird of Paradise (Not present in Tsuwenkai)
<i>Pteridophora albertii</i>	King of Saxony Bird of Paradise

In addition to confining his hunting of these species to his own clan land, a man may lay personal claim of ownership to Birds of Paradise he discovers. Usually he claims such birds at their display trees. Consequently, some hunters inadvertently kill birds that have been claimed by others, and become involved in informal court cases.

Sites where generations of birds have displayed communally are a valuable resource for their finder, as birds can be killed over extended periods. Such sites may be passed on to sons on the death of the owner. The only species displaying communally in Tsuwenkai is Stephanie's Astrapia *Astrapia stephaniae* although display sites of the Lesser Bird of Paradise *Pardisaea minor* are widespread at lower altitudes.

Most highly successful hunters tend to concentrate their hunting in a favourite area that they know well. Such men owning *Astrapia* display sites, for example do much of their hunting for other species in the vicinity of display sites. These favoured areas are known to most other Kundagai, who rarely seek valuable birds there on the assumption that

they have already been discovered and claimed. Favoured hunting regions of successful hunters in effect become *de facto* personal hunting territories. In 1974 the Kundagai recongised six such territories, owned by eight men (two territories being jointly owned by two men each). Together, these territories comprised about one fifth of all montane forest.

Whilst territorial restrictions limit the number of hunters who may operate in some areas, various other restraints apply to all hunters. The fear that forest-dwelling spirits will be angered and send sickness on the hunter who kills too much game on any expedition possibly acts as a limit on the bag of hunters. Perhaps more importantly, the Kundagai adopt various restraints for reasons of conservation. Many hunters consider it unwise to kill all adult male Birds of Paradise in a region, and female-plumaged and immature male birds are often spared by hunters. These measures are to ensure a continued breeding stock to produce plumed males for the future.

The Jimi Local Government Council, established in 1966, has adopted traditional rights and restrictions as rules for hunting valuable birds. The Council has also endorsed the national law forbidding the killing of Birds of Paradise by other than traditional means.

EFFECTS OF HUNTING RESTRICTIONS ON INTENSITY OF PREDATION

The number of active hunters operating in an area must have some effect on hunting productivity. Where there are many hunters in a given area of hunting land their effects on prey populations will no doubt be greater than where there are few. Many hunters on prey populations will no doubt be greater than where there are few. Many hunters combining the area for game are more likely to secure a high total bag than a few, even where each individual has limited success as game becomes scarcer through intensive predation. By contrast, where the ratio of hunters to area of hunting land is low, individual hunters can achieve high productivity while the total bag of all hunters remains relatively low. In short, predation may be extensive rather than intensive.

These propositions can be examined by a comparison of hunter:land area ratios in several different Maring territories, using data set out in Table 2. This table compares ratios of males over 15 years of age to areas of primary forest in nine village territories (see Map 1 for locations). The actual ratio of hunters to forest land will be lower than indicated for two reasons. (1) population figures include small numbers of absentee males and (2) include old men who no longer hunt. I can correct for these factors only in the case of the Tsuwenkai population. Nonetheless, these ratios can serve as an index of the maximum potential hunting pressure expressed as the number of hunters operation in a given area.

Assuming game is equally dense in all territories listed, it is evident that game will be subjected to less intensive predation in Tsuwenkai because there are fewer hunters

there. The inference is that each hunter in Tsuwenkai, having a larger area in which to hunt, competes less with his fellow hunters, and thus may be able to secure more birds in a given time. Men of all settlements probably have roughly equal demands on their time to participate in social and subsistence activities. This places an upper limit on the amount of time they are able to devote to hunting. Tsuwenkai hunters may be more inclined to approach the maximum time available for hunting, because the returns will be greater, making hunting a more rewarding activity in economic, nutritional and psychological terms.

TABLE 2: Ratio of Hunters to hunting land in Maring communities¹

Population	Numbers of hunters	Area of primary forest in km ²	No of hunters/km ²
Tsuwenkai ²			
a.	58	16.0	3.8
b.	89	16.0	5.6
Tsenbaga	68	3.9	17.4
Mondo	81	5.9	13.7
Gai	125	4.4	28.4
Nimbra	97	4.3	22.6
Tsenggangp	57	5.6	10.2
Kompiai	315	c.2.7	c.116.7
Total	832	42.8	
Mean	118.9	6.1	19.5

Note: 1 For sources see Healey 1977:235

2 a. = resident population in November 1974;

2 b. = resident population plus absentee males. The latter to be compared with other populations.

Since the amount of hunting time is similarly limited in all settlements, it also follows that game is subjected to less hunting pressure where the density of hunters is low. For example, six Tsuwenkai per square kilometre of hunting land will have to work much harder to exert the same hunting pressure in the same period of time as 117 in Kompiai.

Aside from the time available for hunting and competition from other hunters, the efficiency of a hunter is further limited by his knowledge of game, skill in hunting techniques, and the efficiency of his weapons. Available time and other limitations set an upper limit on the productivity of hunting. Where the ratio of hunters to hunting land is high, these additional limitations become less significant in reducing hunting

pressure. Where the ratio of hunters to hunting land is low, as in Tsuwenkai, additional limitations become more important in reducing overall hunting success, so that while each hunter may be highly productive, the sum of all hunter's efforts is lower. This may be so even if the total number of prey killed by each hunter exceeds the total killed by each man in populations with a high hunter to area ratio, because prey species may remain more numerous, in turn sustaining continued high productivity.

The assumption of an even distribution of game is, however, false, and the preferred prey varies in relation to what is locally available. Feral pigs and large lower montane marsupials are especially sought in all territories other than Tsuwenkai listed in Table 2. These animals are absent from Tsuwenkai, where hunters concentrate on montane forest marsupials and birds. I have no good data on relative abundance of game animals in different territories. Informants' subjective opinions nonetheless offer a rough guide.

Kompiai men told me that Birds of Paradise were less numerous in their territory than in Tsuwenkai. In a survey of the contribution of game to the diet, Buchbinder (1973:132) found that those questioned had eaten little meat in the week prior to her investigation, and that all had been from small animals, rather than the preferred larger prey. Such small game appeared fairly common according to Nimbra and Tseggamp people, but the Gai people, with a higher ratio of hunters to land, said there was little game available and apparently had difficulty in locating it. By contrast, the Kundagai consider that their preferred prey species are mostly quite common, and while a hunter may not always find what he is searching for, he seldom has much difficulty in locating game of some sort. His problem, rather, is actually killing it.

This material is inconclusive but lends some support to the hypothesis that game is more plentiful, and individual's hunting productivity is greater, in those territories where there is a low ratio of hunters to land area.

Aside from these demographic effects on the intensity of predation, other factors serve to reduce hunting pressure in all territories. It is questionable whether fear of spirit anger actually inhibits a hunter enjoying good fortune. However, despite often considerable knowledge of his prey and skill in hunting techniques, the simple technology of hunting often leads to failure.

Since little hunting occurs in the wetter months, Birds of Paradise suffer little molestation from man during their breeding season, and annual recovery rates of their population are not directly affected by human activity.

I conclude that various hunting restrictions outlined in the preceding section tend to limit human predation. Joint rights held by members of a group to hunt valuable birds

in certain areas, the exclusive rights of individuals to hunt at certain sites or make use of hides or baits they have constructed, and *de facto* personal hunting territories, all limit the number of men who may hunt in certain areas or at specific sites. This results in a reduction of the intensity of hunting to which birds may be subjected.

Voluntary restraints on killing female and immature male birds, and the practice of leaving some adult males alive at a communal display site may have beneficial effects aside from limiting the number of birds shot. Sparring female-plumaged birds helps maintain the reproductive pool of females and the number of immature males to reach maturity.

There is no direct evidence for the benefits of hunting techniques and restrictions in limiting the intensity of predation. There is some inferential evidence for reduced hunting pressure at communal display sites of *Astrapia*, as noted below. However, in the absence of comparative material from human communities that do not observe the restrictions summarised here, it is not possible to demonstrate the conservatory benefits of these beliefs and practices.

DISTRIBUTION AND BREEDING BIOLOGY

Here I make some general remarks on the distribution of Birds of Paradise and aspects of nesting display and moult. More detailed species accounts are given in the section on effects of human predation on populations.

TABLE 3: Paradisaeidae of Tsuwenkai

Species	Habitat ¹	Altitudinal range (m)	Status	Hunting ²
<i>Loria loriae</i>	Second, montane	1660-2070	Common	-
<i>Loboparadisaea sericea</i>	Second, montane	1700+	?	-
<i>Manucodia chalybatus</i>	Second	1620-1640	Uncommon	-
<i>Paradigalla brevicauda</i>	Montane	1800-1900	?	-
<i>Epinachus fastuosus</i>	Montane	c2000+	Very rare	(+)
<i>Epinachus meyeri</i>	Montane	2060-2250	Rare	(+)
<i>Astrapia stephaniae</i>	Montane	1630-2250	Common	+
<i>Parotia carolae</i>	Second, montane	1730-2000	Common	(+)
<i>Parotia lawesii</i>	Second, montane	21730-2000	Uncommon	(+)
<i>Lophorina superba</i>	Second, montane	1450-2200	Common	(+)
<i>Diphyllodes magnificus</i>	Second	1450-1600	Common	(+)
<i>Pteridophora alberti</i>	Montane	2050-2400+	Common	+
<i>Paradisaea rufoliphi</i>	Second-montane edge	1700	Rare	(+)

Notes: 1. Second = second growth, montane = primary montane forest.; 2. Intensity of hunting pressure: + = adult males actively sought for plumes; (+) = plumes used by little deliberate hunting; - = plumes not used, no special hunting efforts.

Distribution and Biological Cycles of Birds of Paradise in Tsuwenkai. There are least 13 species of Birds of Paradise in Tsuwenkai land (Table 3). Like other birds, all may be killed for food. The plumes or skins of eight species are used in decorations, but only three species are deliberately sought for their plumes and subjected to intensive predation of adult males.

Only two of the locally represented Paradisaeidae are lower lowland montane species: *Manucodia chalybeatus* and *Diphyllodes magnificus*. Other low altitude forms are found in neighbouring areas: *Manucodia keraudreni*, *Cicinnurus regius*, and *Paradisaea minor*.

Diamond (1972) has noted some sorting by sex and age in the altitudinal range of the general *Loria*, *Loboparadisaea*, *Epimachus*, *Lophorina*, *Diphyllodes* and *Pteridophora*. Displaying males tend to be concentrated in the upper part of the range with females in the lower part. Immatures are often most common in the lowest reaches of the range. I noted similar segregation by sex in Tsuwenkai of *Lophorina* and, most clearly, in *Astrapia*, where adult males appear to be confined to the top 200 m of the range, females and immatures being found throughout the 630 m range of the species.

Birds of Paradise are largely frugivorous, although some species feed on invertebrates and small vertebrates also. My data on the diet of birds derives mainly from information provided by Kundagai hunters, who listed local names for trees and shrubs at which Birds Paradise fed (Table 4). The list is probably incomplete, especially for those species not hunted for their plumes. It is possible that there are significant differences (unknown to the Kundagai) in the diet of the two *Epimachus* and two *Parodia* species. Even given these shortcomings, the table suggests that *Pteridophora* has the most restricted diet (one recorded fruit food) and *Lophorina* the most diverse diet (fourteen fruit foods). In terms of the variety of fruits available, the food supply is roughly constant throughout the year, with perhaps a slight peak in supply with the onset of the drier season.

TABLE 4: Fruit eaten by paradisaeidae in Tsuwenkai¹

Bird Species	Fruit Family	Genus &/or Species	Form	Fruiting time ²
<i>Loria loriae</i>	Araceae		Wild taro	A
	Utricleae	<i>Cypholophus</i>	Tree	?
		<i>Maoulia</i>	Tree	A
<i>Paradisagallia brevicauda</i>	Araceae		Wild taro	A
	Musaceae	<i>Musa</i>	Wild banana	A
	Palmae	<i>Calamus</i>	Palm	A

TABLE 4 cont: Fruit eaten by paradisaeidae in Tsuwenkai¹

Bird Species	Fruit Family	Genus &/or Species	Form	Fruiting time ²
<i>Epimachus fastuosus/meyeri</i>	Araceae		Wild taro	A
	Araliaceae	<i>Schefflera</i>	Tree	D
	Cucurbitaceae	<i>Trichosanthes</i>	Climber	A
	Ericaceae	<i>Rhododendron</i>	Tree	D
		<i>macgregoriae</i>		
<i>Astrapia stephaniae</i>	Musaceae	<i>Musa</i>	Wild banana	A
	Pandanaceae	<i>Freycinetia</i>	Climber	A
		<i>Freycinetia</i>	Climber	?
	Rubiaceae	<i>Timonius</i>	Tree	A
<i>Parodia carolae/lawesii</i>	Araceae		Wild taro	A
	Araliaceae	<i>Schefflera</i>	Tree	D
	Cucurbitaceae	<i>Trichosanthes</i>	Climber	A
	Ericaceae	<i>Rhododendron</i>	Tree	D
		<i>macgregoriae</i>		
	Musaceae	<i>Musa</i>	Wild banana	A
	Pandanaceae	<i>Freycinetia</i>	Climber	A
	Rubiaceae	<i>Timonius</i>	Tree	A
	Ulmaceae	<i>Trema</i>	Tree	A
	Unident	<i>orientalis</i>	Tree	D
<i>Lophorina superba</i>	Araliaceae	<i>Schefflera</i>	Tree	D
	Cucurbitaceae	<i>Trichosanthes</i>	Climber	A
	Palmae	<i>Homolanthus</i>	Tree	W,I
	Pandanaceae	<i>Calamus</i>	Palm	A
	Piperaceae	<i>Freycinetia</i>	Climber	D
	Sapindaceae	<i>Piper</i>	Tree	A
	Ulmaceae	<i>Harpullia</i>	Tree	D
		<i>Trema</i>	Tree	
	Utricleae	<i>orientalis</i>	Tree	A
		<i>Maoulia</i>	Tree	A
<i>Lophorina superba</i>	Araceae		Wild taro	A
	Araliaceae	<i>Schefflera</i>	Tree	D
	Cucurbitaceae	<i>Trichosanthes</i>	Climber	A
	Ericaceae	<i>Rhododendron</i>	Tree	D
		<i>macgregoriae</i>		
	Euphorbiaceae	<i>Homolanthus</i>	Tree	W,I
	Musaceae	<i>Musa</i>	Wild banana	A
	Myrtaceae	<i>Decaspermum</i>	Tree	I,W
<i>Paradisagallia brevicauda</i>	Palmae	<i>Calamus</i>	Palm	A
	Rubiaceae	<i>Timonius</i>	Tree	A

TABLE 4 cont: Fruit eaten by paradisaeidae in Tsuwenkai¹

Bird Species	Fruit Family	Genus &/or Species	Form	Fruiting time ²
<i>Lophorina superba</i> cont:	Rutaceae	<i>Evodia crispula</i> (&/or Sapindaceae q.v.)	Tree	D
	Sapindaceae	<i>Arytera</i> (or Rutaceae q.v.)	Tree	?
	Ulmaceae	<i>Harpullia</i>	Tree	D
		<i>Trema orientalis</i>	Tree	A
	Urticaceae	<i>Maoutia</i>	Tree	A
<i>Diphyllodes magnificus</i>	Piperaceae	<i>Piper</i>	Tree	A
	Ulmaceae	<i>Trema orientalis</i>	Tree	A
<i>Pteridophora alberti</i>	Rubiaceae	<i>Timonius</i>	Tree	A
<i>Paradisaea rudolphi</i>	Araliaceae	<i>Schefflera</i>	Tree	A
	Musaceae	<i>Musa</i>	Wild banana	A
	Piperaceae	<i>Piper</i>	Tree	A
	Ulmaceae	<i>Trema orientalis</i>	Tree	A

Notes: 1 All identifications are tentative. No species were collected, but identifications were made by matching Kundagai names for plants to vernacular names listed against scientific determinations (by the National Division of Botany) provided by W. Clarke (personal communication and 1971), Manner (1977) and Rappaport (1968).

2 Symbols: A = at any time during the year; D = in drier season; W = in wetter season; I = between seasons.

Diamond (1972: 86) states "that breeding is almost entirely confined to times of local wet conditions in most (New Guinea) fruit-eating birds", including Birds of Paradise. I found no evidence of breeding during extended visits to the forest, which occurred mainly in the drier season. Informants claimed that all Birds of Paradise, along with most other birds, breed in the wetter season. Various men claim to have found nests, or seen juveniles being fed, of *Epinachus meyeri*, *Astrapia stephaniae*, *Parotia caroleae*, *Lophorina superba* and *Pteridophora alberti*. Only one egg, nestling or juvenile was seen in each case, and all sightings were confined to the wetter season, especially between November and February. Female birds are said to care for fledglings until about May or June. The few such records suggest that the Kundagai seldom encounter evidence of breeding, supporting the claim that the birds breed in the wetter season, when hunting activity is diminished.

Displays I have observed in five species (*A. stephaniae*, *P. caroleae*, *L. superba*, *D. magnificus* and, elsewhere in the Jimi, *Paradisaea minor*) all indicate that the behaviour may occur in the absence of females. Such displays may be territorial in solitary displaying species, and to determine a dominance hierarchy in communal displaying species, and perhaps also among those species occupying exploded arenas (display sites of solitary males in auditory contact, [Gilliard 1969]). The occurrence of display does not therefore necessarily indicate that breeding is imminent or in progress. The Kundagai claim that displays continue throughout the year. However, the intensity of display does seem to vary over the year. Several *Diphyllodes* males displaying within earshot of my house increased the vocal intensity and frequency of display with the onset of the wetter season. On the basis of limited observations of *Astrapia* in the drier season months of July, August and September, it appears that display activity declines in the latter month when the birds are in moult immediately preceding the wetter season. Draffan (1978) noted a similar decrease in display activity in *Paradisaea guillemoti* preceding the wet season on the Huon Peninsula.

Informants state that Birds of Paradise moult their ornamental plumes from about the winter solstice in June, and that moult is complete by the summer solstice. I have seen evidence of moult in *Astrapia* (missing central tail feathers in September), *Parotia* (missing a pair of occipital plumes in October) and *Pteridophora* (one occipital plume not reached full length in August). None of these records is conclusive, although made prior to breeding, when moult of ornamental plumes might be expected Figure 2 depicts the biological cycle of Birds of Paradise.

FIGURE 2: Timing of nesting, moult and display in Birds of Paradise at Tsuwenkai

MONTHS	J	F	M	A	M	J	J	A	S	O	N	D
DRIER SEASON	—	—	—	—	—	—	—	—	—	—	—	—
WETTER SEASON	—	—	—	—	—	—	—	—	—	—	—	—
MOULT	—	—	—	—	—	—	—	—	—	—	—	—
DISPLAY	—	—	—	—	—	—	—	—	—	—	—	—
NESTING	—	—	—	—	—	—	—	—	—	—	—	—

Effects of Forest Clearing on Distribution. Before Tsuwenkai was settled by pioneering immigrants about 50 years ago there was only a small human population and much of the present zone of human habitation was under primary forest. South of Danmark Creek clearing for food gardens on the western slopes of the Kant and Pint Valleys has destroyed all primary forest from near the valley bottoms up to 1700-1850 m. Prior to this clearing, various mid-montane Birds of Paradise probably occupied the more extensive forests.

Schodde (1973: 138) states that *Epimachus meyeri*, *Astrapia stephaniae* and *Pteridophaea* are largely confined by habitat preference to montane forests above the frostline, which he identifies at about 2200 m. He concludes that their habitat is seldom encroached upon by agriculture, and that habitat availability is therefore not a limiting factor in their distribution. While it is true that sharp ground frosts are a critical climatic factor in limiting the upward spread of subsistence agriculture, the actual level at which this occurs varies with climatic and topographic influences, from about 1980 m to almost 2600 m (Brookfield 1964). My own data indicate that the three species mentioned by Schodde extend well below 2200 m (see also Diamond 1972) and might therefore be in danger of encroachment by agriculture. Schodde's remark is based upon the present distributions of these species, which are best known from the mountain ranges flanking the densely populated Wahgi Valley. I would suggest that these birds are confined above the frostline not by habitat preference as Schodde argues, but because human interference in the form of agriculture and intensive hunting have forced them to retreat to the higher ranges.

Clearing of Tsuwenkai forests below 1800 m has undoubtedly reduced habitat availability. Thus, with the extensive destruction of oak forest in the Kant Valley *Paradisaea rudolphi* is now confined to a few remaining stands of oak at the edge of the montane zone. An increase in inter-specific competition may have attended the compression of the montane zone, with some species squeezed out of habitat occurring within their altitudinal range. This may explain the confinement of *Epimachus fastosus* to the highest ranges which support greater altitudinal belts of montane forest with sufficient habitat to support this species and its congener, *E. meyeri*. As the forest edge was extended upwards, and oak forest destroyed, *E. fastosus* may have been eliminated. This scheme is supported by informants' statements that both *Epimachus* species were formerly more common, and were found close to settlement areas and therefore at lower altitudes before forest clearing was so advanced.

Similar, but downward, compression of habitat may explain the absence of *Paradisaea minor* from Tsuwenkai, even though there are relict patches of advanced secondary forest within its altitudinal range.

L. superba, *D. magnificus* and, to a lesser extent, *Parotia carolae*, are well adapted to secondary growth, and may have benefited by the increase in disturbed habitat, as have *Paradisaea raggiana* and *P. minor* elsewhere (Diamond 1972; Healey 1978b). These three species are found in young fallow, and even visit taller trees shading homesteads and coffee groves, although they appear to require fairly well-advanced secondary forest for display and nesting sites.

There is little present need to clear additional primary forest, although this may become necessary in the future. I detected no obvious increase in forest clearing over the period

1974 to 1978. Encroachment of agriculture on montane forest is most liable to affect distribution of *Paradisaea*, *Loboparadisaea*, *Astrapia* and *Pteridophaea*. However, much of the montane zone has little or no agricultural potential under present Kundaigai methods of production, and unless disturbed by forestry or mining, extensive areas of habitat will remain. Under these conditions, hunting assumes importance as a possible limiting factor on bird population.

EFFECTS OF HUMAN PREDATION ON BIRD POPULATIONS

There are no published comparative data on the population ecology of Birds of Paradise. The effects of intensive age- and sex-selective human predation on population dynamics cannot therefore be assessed by comparison with unmolested control populations of the same species. However, comparison with other species of Birds of Paradise in Tsuwenkai give some indication of the effects of intensive and selective predation. None of these control species is totally free from human predation, although hunting pressure is low, and there is little if any selectivity of adult males over immatures and females in contrast to hunting of valuable birds. Since my data on control populations of Birds of Paradise are limited, I also use data on several species of Neotropical birds with apparently similar ecological requirements and behaviour patterns to Birds of Paradise.

Various studies have shown unequal sex ratios among Passerines. Tertiary sex ratios (among fledged birds) are generally unequal in favour of males (Dow 1973; Mayr 1939; Selander 1965). Dow (1973) and Selander (1965) note that sex ratios may vary between different locations and seasons for one species. Dow also reviews some of the problems in accurately determining tertiary sex ratios in the field, even in sexually dimorphic species. Both Dow (1973) and Selander (1960) conclude that, contrary to the general Passerine trend, unequal sex ratios in favour of females do occur, but that they are largely confined to polygynous or promiscuous breeding species. Gilliard (1969) considers that most of the sexually dimorphic species of Birds of Paradise are polygynous. It is not clear if he intends the restricted meaning for this term of the male forming a pair-bond with several females. Field observations suggest that at least one communally displaying species, *Paradisaea decora*, is actually promiscuous with no pair bonding, and a single female may copulate with several males (LeCroy *et al.* 1980), and this may be a general pattern among sexually dimorphic species with elaborate displays.

Selander (1965) notes that delayed maturation is common in non-monogamous breeding species, although females generally breed at a younger age than males. This is presumed to occur in Birds of Paradise (Gilliard 1969), where males are thought to take at least 5 years to attain full adult plumage. In captivity, males of *Paradisaea rubra* are known to take at least 6 years to attain adult plumage (Frith 1976), while G. George (per. comm.) suggests that 7 years may be a more realistic estimate for most species. There is evidence (reviewed below) that males are capable of breeding while

in sub-adult plumage. There are no indications of when females achieve sexual maturity. Since in their first few years immature males are indistinguishable in plumage from females, one cannot determine secondary or tertiary sex ratios in Birds of Paradise by sight. In the following discussion I therefore deal with plumage-type ratios (adult male-and-female-type plumage) as indices of tertiary sex ratios.

Clutch size is not known in many Birds of Paradise species. Most species seem to lay a single egg, but in the genera *Manucodia*, *Phonygammus*, *Phloris*, *Cicinnurus*, and *Diphyllodes* two eggs are laid, while at least three *Paradisaea* species lay one or two eggs (Cooper and Forshaw 1977). With the exceptions of *Diphyllodes magnificus* and *Paradisaea rudolphi*, all Birds of Paradise in Tsuwenkai probably lay a single egg, as Kundagai testimony also suggests. Informants were of the opinion that each female Kundagai testimony also suggests. Informants were of the opinion that each female lays only one egg each breeding season.

Populations Free from Intensive Predation. From these considerations a theoretical model of the structure of unmolested Bird of Paradise populations can be attempted. In a population of adult birds with an equal sex ratio the plumage-type ratio will also be equal. For purposes of model building I make a series of assumptions: 1). that there is an equal mortality of the sexes at all ages; 2). that each adult female rears one young each year, and 3). that the sex ratio of nestlings is equal from which it follows that the tertiary sex ratio will remain equal while the plumage-type ratio will be biased in favour of female-type because of delayed maturity in males. If females breed at younger ages than males, then the sex ratio for breeding birds will be biased in favour of females and unequal plumage-type ratios will be further accentuated by younger females producing chicks while their male age-mates are still in female-type plumage.

Clearly these assumptions are invalid for wild populations. In particular, mortality will tend to reduce the number of female-plumaged birds, as mortality in birds is commonly highest within the first year of life (Lack 1966). Destruction of unhatched eggs and nestlings is particularly high especially in the tropics where snakes are the major predators (Skutch 1966).

The following notes give details on sightings of species not subjected to intensive predation with particular attention to plumage-type ratios. Sight and call records include some birds noted only by assistants accompanying me on forest surveys. I also list reports of birds seen or heard by my assistants or others on other occasions. All records other than my own are included only if I could plot the birds onto a map of locations with reasonable accuracy. These records are compiled over the twelve months from November 1973. My own observations and opinions of Kundagai experts on bird lore indicate that individuals of most sexually dimorphic species are relatively sedentary. Birds repeatedly seen in the same locality were therefore treated as the same individual. Clearly there remains a danger of counting an individual more than once. I cannot claim to have eliminated this difficulty, except in areas visited only

once. If I was in any doubt that a bird was already recorded I omitted later records. I add some notes on the results of interviews with eleven hunters whose kills of adult male and female-plumaged birds were recorded.

The following abbreviations are used: PTR = plumage-type ratio; M = adult male(s); I = immature male(s); F = females(s); f = female-plumaged bird(s). Mating bird names are given after English vernaculars.

Loria lorae Loria's Bird of Paradise, *mambarno*.

Sight records: 1M in company of 1f at about 2070 m in primary forest; 1 possible 2 other f seen in secondary growth.

The Kundagai consider this a common bird, though I found it retiring. I have insufficient sightings to suggest a PTR or sex ratio, although in the nearby Kaironk Valley f probably greatly outnumber M (Majnep and Bulmer 1977:72).

Loboparadisaea sericea Yellow-breasted Bird of Paradise, *chengbanui*.

Sight records: One bird indistinctly seen in a tall primary forest tree, tentatively identified as a male.

Manucodia chalybatus Crinkle-collared Manucode, *munguni*.

Sight records: Four unsexed individuals on two different occasions in secondary growth. This species appears to be more common at lower altitudes beyond Tsuwenkai.

Paradigalla brevicauda Short-tailed Paradigalla, *balbalmai*

Call records: heard on two occasions in primary forest.

Epimachus fastosus Black Sicklebill, *Kalanah gi yondo*.

Sight records: None.

Call records: 1M

Reports: The specimen heard is said to range from Mounts Kumbant to Karenmai, and one man has laid claim of ownership to it. One I is known to live on the Kombaku range.

This is exclusively a bird of the montane forest, and is evidently rare, largely, it seems, replaced by the congener *E. meyeri*. Nowhere common in the Jimi, it seems to have a patchy distribution along the Bismark flanks. This may be partly due to declining areas of mixed oak forests, its preferred habitat (see also Majnep and Bulmer 1977: 57).

Calls of males are audible over long distance, and if more vocal males were present I would expect Kundagai hunters to know of them. The above two records therefore probably constitute the total resident population of males. The sex ratio may therefore approach equality. However, any hunting successes would have

a comparatively great effect on the population structure, and with a high mortality of young birds the potential for population increase would be low.

The hunting histories I collected of 57 men include only one record of an *E. fastosus* being killed, in about 1930-35. This species is said to have been more common in the early 1900s when one man is credited with killing two males in one day. Other birds may have been shot since then by men now dead, but the paucity of recorded kills suggests that the present rarity of this bird is not due to predation, at least over the last 30 or 40 years.

Epimachus meyeri Brown Sicklebill, *Kalanch gurunt*.

Sight records: 2f, 1l. 3 *Epimachus* f were seen by my assistants, but since the Maring do not distinguish between the two female-plumaged *Epimachus*, it is not certain that they were *E. meyeri*.

Reports: 1 possible 2M, in forests south and west of the Kant River. One male allegedly displays in the upper Anyen Valley.

These records and reports are all from about 2060 m (female-plumaged birds) to around 2250 m (adult males). This species is uncommon in Tsuwenkai. Where both *Epimachus* species are present elsewhere in New Guinea, *E. meyeri* is usually found at higher altitudes than *E. fastosus* (Diamond 1972: 328). Bulmer (1968: 634) notes that in the nearby Schrader Ranger *E. meyeri* is generally confined to *Nothofagus* beech forest above about 2300 m. In Tsuwenkai the species extends below this level into mixed forest, and where this occurs *E. fastosus* seems to be absent. Diamond (1972) has noted a similar pattern in the south-eastern highlands. It is possible that the expanded altitudinal range of *E. meyeri* has led to the exclusion of *E. fastosus*. Both species occur together only on the highest ranges of the flanks of the main Bismark Crest north of the Kant River where the wider altitudinal belt of forest may allow sufficient room for each species.

The above records suggest a PTR of 1 or 2M:6f. Informants state that individuals range widely, and the seven or eight birds recorded may represent the total population south and west of the Kant.

Hunting histories include only one adult male shot in Tsuwenkai.

Paroia carolae Carol's Paroia, *Klawoe*

Sight records: 3M, 3f.

Call records: 1M.

This is a fairly common bird of primary and secondary forest between about 1730 and 2000 m. Males clear display bowers on the forest floor (Healey 1980). Some informants claim that several males may display at the same bower (cf. Schodde and Mason 1974).

Call and sight records are too few to suggest a PTR or sex ratio. However, the PTRs of birds killed by three of the sample of eleven hunters are suggestive:

Hunter 1 killed 3M, 6f in various places at different times.

Hunter 2 trapped 1M, 3f at one display bower over a brief period.

Hunter 3 shot 1M, 3f at various times and places.

Other hunters had not killed the species or had killed only one or two birds of either plumage type. The PTR may thus be between 1M:1f and 1M:3f. The latter ratio may represent a sex ratio approaching equality.

Paroia lawesii Lawes' Paroia, *kizwi*

Sight records: 1f.

This was a bird that visited a bower of *P. carolae* (Healey 1976). The species is apparently uncommon.

Diphyllodes magnificus Magnificent Bird of Paradise, *pengaluo*

Sight records: a). At display bowers: 1M at each of 3 bowers: b) Away from bowers: 3M, 5f. Some of these may also have been seen at bowers.

This is a common bird in its restricted habitat of secondary forest and woodland below about 1600 m. Several males each maintain bowers within auditory contact, forming an exploded arena. Bowers are in dense thickets, and may even be located in narrow tongues of growth in steep gullies on grassy slopes.

Limited observations at bowers suggest a sex ratio of breeding birds of 1M:2f (cf. Thair 1977). One hunter told us that he had shot a male at a bower which was visited by three female-plumaged birds at one time. The PTR of birds seen away from bowers of 1M:1.6f suggests that the sex ratio in the population as a whole may be biased in favour of males, since some female-plumaged birds are likely to have been immature males.

Paradisaea rudolphi Blue Bird of Paradise, *aweng*.

Sight records: 1, possibly 2M, 1f.

Reports: 1l seen in an area away from where my own sightings were made.

Several birds which I did not locate to determine plumage-type were regularly heard calling from particular areas of the forest edge. Although one hears this species call almost every day on the edge of the settlement, there are only a few individuals, apparently occupying limited territories centred on relic stands of *Lihocarpus* and *Castanopsis* oak at the forest edge. I never saw or heard the species in the depths of montane forest, nor in secondary growth less than about twenty-five years old. The species appears to have a patchy distribution in the Jimi, Simbai and Kaironk Valleys, probably due to progressive destruction of habitat (cf. Mainep and Bulmer 1977:72). There are insufficient records to suggest the PTR or sex ratio.

These scanty data are clearly inconclusive. They are, however, comparable with data on valuable plumbe-bearing species in that at least *Paroita*, *Diphyllodes*, *Epimachus* and *Paradisaea* are highly sexually dimorphic, with cryptically coloured female-plumaged birds, and ornate, eye-catching adult males. One might expect the above relatively unmolested species to be as noticeable to the observer as the intensively hunted species to be discussed below.

For seldom-hunted species, the PTR seems generally to be only slightly unbalanced in favour of female-plumaged birds, suggesting a sex ratio of 1:1 or slightly favour males.

Non-Paradisaeidae Free from Human Predation. A consideration of the population structures of several other birds gives some comparative data to aid in the evaluation of the effects of predation on Bird of Paradise populations. Two species of Manakin (*Pipridae*) studied by Snow (1962a,b) on Trinidad can be compared with Birds of Paradise. These little birds are remarkably similar to Birds of Paradise in their habits and habitat.

Snow found an equal sex ratio in the Black-and-white Manakin *Manacus manacus* and assumes this is also true of the Golden-headed Manakin *Pipra erythrocephala*. In *Manacus* populations the PTR is about 1M:2f and in *Pipra* 1M:2.2 to 2.3f.

Manacus generally lays two eggs, and more than one brood may be laid in a season. In common with many other tropical forest species *Manacus* has a high nest failure rate (cf. Skutch 1966). Sixty percent of all nests started fail to produce hatched young. Of the 40% of successful nests, almost 50% failed to produce fledged young (81% of all nests started). The average number of fledglings per nest was 0.33. Snow estimates that each female lays an average of three broods per year, resulting in each female producing one surviving fledgling each year. Only one third of these subsequently reach breeding age, so that each female contributes 0.33 individuals to the next season's breeding population. About half of these are males which do not breed in their first year, and which may be unsuccessful in securing advantageous locations at leks, and so fail to breed in succeeding years.

Low reproductive success in tropical birds in general has been correlated with high adult survival rates (Skutch 1955; Snow and Lill 1974). While in *Manacus* the number of nests producing fledged young is only 19%, and two thirds of these young die in their first year, the adult survival rate is about 89% per annum. Snow and Lill (1974) have shown that *Manacus* males may survive at least 14 years, females for 12.5 years. Female *Manacus* breed until at least 10 years old, males possibly until 12 or more. *Pipra* breeding life appears to be almost as prolonged.

Data on the breeding success (numbers of fledged young to eggs laid) of seven tropical

lowland forest birds in Trinidad give an average of 25% (range 17-33%) (Snow and Snow 1963; 1973; Snow 1974). This is close to Skutch's (1966) figure of a 21% breeding success in lowland Panama. Skutch notes that in general breeding success increases with altitude in the tropics. He found that Central American birds nesting in disturbed habitats between about 1500 to 1800 m had breeding success of 53%, although those nesting between about 1980 to 2280 m had a success rate of only 44%. The average for both regions is 48.5%. Skutch goes on to show that Central American forest breeders generally have a lower nest success, probably because loss of eggs and young is higher.

In the absence of any satisfactory data on Birds of Paradise these data on Neotropical birds provide the basis for the following assumptions on breeding of Birds of Paradise in Tsuwenkai.

Paradisaeidae Species Subjected to Intensive Predation for Plumes. Most Birds of Paradise in Tsuwenkai breed in primary forest between the 1500 and 2280 m limits mentioned by Skutch. Snakes are the main nest predators implicated by Skutch (1966) and Snow (1952b), though these may be less numerous in Tsuwenkai than in Central America. Nonetheless, conclusion for the Americas cannot simply be applied to New Guinea, though they serve as a useful guide. I shall err on the side of caution and assume that Bird of Paradise breeding success is towards the lower limit indicated by Skutch for birds breeding at comparable altitudes in Central America. I assume that only one attempt is made to lay one egg, and that the sex ratio in unmolested birds is about equal or biased in favour of males. In fact, small clutch size and high nestling mortality may be compensated for by repeated nestings.

Survival of adult Birds of Paradise is probably high, but since nesting success is possibly higher than in lowland Manakins, adult survival may be lower than the almost 90% of Snow's (1962a) Manakins. Deferred maturity of males for 5 or more years would, on comparative evidence from tropical America, argue for a long life. Each bird therefore has a long reproductive life to compensate for low breeding success rates resulting from small clutch size and probably high mortality rates in at least the first year of life. My only evidence for the age of a wild Bird of Paradise is highly circumstantial. An adult male *Astrapia* was wounded by a hunter at a communal display site, and consequently deserted the site. The bird took up residence in a small area of forest where it had remained for 5 or 6 years prior to my sighting of it. If this bird was shot soon after assuming full adult plumage it must be at least 10 - 12 years old.

Two factors may operate among Birds of Paradise to maintain a steady-state population in the face of increased human predation. This first is that other birds may quickly compensate for heavy mortality by increased reproductive output or by predation

replacing other forms of mortality. The latter consequence is less likely in the case of human predation on birds for their plumes, as the hunter will tend to prefer well-plumed, active adults. Non-human predators, on the other hand, tend to select young or weak prey which might otherwise succumb to other forms of mortality (e.g. Mech 1970; Krunk 1972). Campbell *et al.* (1973) provide material on compensatory reproduction in response to predation. They found that human predation on one population of *Callipepla squamata* Scaled Quail in New Mexico was over 17 times more severe than the general level for all populations in the state. The harvest of quail bagged per square mile was eight times greater than the statewide harvest. Even when quail populations in their experimental area were greatly decreased through predation and other mortality factors, numbers built up to densities similar to those on a control, un hunted area, within a single season. Campbell *et al.* (1973: 26) conclude that it appears that proportionally more young quail were added to the treatment area (where hunting was encouraged) than to the control area (where hunting was prohibited), thus accounting for the relative increase on the former". Similar increases in reproductive success to compensate for increased mortality have been noted for other vertebrates, as noted in the introduction.

The particular relevance of the study by Campbell *et al.* is that it shows the response to massive predation can be fast. Since the predation on Birds of Paradise is biased to adult males, the reproductive population of females remains relatively unchanged. Because the species to be considered below are polygynous or promiscuous breeders, a large number of females can be fertilised by a small number of males. The reproductive rate, therefore, may be more dependant on the number of breeding females, so that levels of reproduction can be maintained with only a few breeding males (see e.g. Wynne-Edwards 1962). Even where tertiary sex ratios are equal, the effective sex ratio of breeding birds can be heavily skewed in favour of females through direct female selectivity of males, or indirectly, by exclusion of males from contact with females at leks or exploded areas.

The second factor which may operate in conjunction with, or in place of, the first to maintain a steady-state population is that in the partial or even complete absence of adult males, subadult males may breed. Schodde (1973: 139) notes that unplumed males in ten genera examined were sexually mature. Cooper and Forshaw (1977) report evidence of the capacity of subadult males, mostly captive specimens, to breed. Diamond (1972:340) suggests that subadult male *Paradisaea ragiana* regularly breed in the Karimui Basin where fully plumed males are rare. The most convincing evidence of the acceptability of unplumed males as mates is provided by LeCroy *et al.* (1980), who observed unplumed birds mounting females even in the presence of fully plumed displaying males.

With these considerations in mind, I turn to an examination of the effect of hunting on the population numbers and structures of individual species. The following calcula-

tions should be regarded as approximations only. Given the insufficiency of reliable data I have attempted to err on the side of under-estimation.

Astrapia stephaniae Stephanie's Astrapia, *Kombam*

Sight records:

a. At display sites:

Gachambo: 4M, 2f (maximum numbers during six observation periods).

Gandakai: 3M, 2f.

Bombong: 4M, 1f, 1f

b. Away from display sites:

i. Including known or suspected repeated sightings of some birds: 6M, 20f (PTR 1M: 3.3f).

ii. Single sightings excluding birds known or suspected to have been previously encountered at or away from display sites: 2M, 4f, 13f (PTR 1M: 8.5f).

Reports: Alyunk display site: 3M (subsequently abandoned the area).

This is a fairly common bird. Adult males are confined entirely to montane forest between 2050 m and 2250 m or higher. Females and immature males occupy this range and also occasionally visit the forest edge, exceptionally down to 1630 m.

Adult males display communally at traditional sites composed of one or more trees (Healey 1978a). The Kundagai know of four widely dispersed sites (Map 2): Gachambo, Gandakai, Bombong and Alyunk. I visited the first three. Birds ceased displaying at Gandakai shortly before I visited this site, allegedly because the owner of this area had wounded a bird there. However, males congregated near the display trees, and local experts considered that displays would recommence in time.

The Gachambo site was originally found, between 1944-49, close to the Kam River. Around the mid 1950s birds gathered in trees higher on the slopes of Mt. Gonggia. The Gandakai site has been in use since at least the late 1950s. *Astrapia* have been known in the Bombong area since the early to mid-1940s, but the display site was only discovered between 1962 and 1964.

The Alyunk site is owned by an old man, who found it between 1910 and 1915 when he was a boy. He has never shot birds there, although his relatives have. Poachers are also suspected to have taken many birds at the display area. One of my assistants, Lucien Yekwai, an acknowledged expert on *Astrapia*, spent two days searching for the birds associated with the Alyunk site with which he was familiar. Although birds had been seen displaying here early in 1974, all trace of them at the display trees and in the surrounding forest had vanished by the time of Yekwai's search in August. Yekwai concluded that the males had either wandered to another part of the rocky and treacherous Alyunk slopes or crossed the Bismark Crest into the Simbai.

Display sites may be visited by several generations of birds. The locations of sites may shift over time, and the actual trees used by displaying birds may also change. Allegedly, not all adult males display at communal sites. Yekwai claims that one male he once wounded at Gachambo deserted that site permanently, and now maintains a solitary existence at a lower level near the Kant River. During the day males associated with particular sites disperse loosely in the neighbouring forest. I am unsure how far birds wander. Some are found well away from known display areas, where they possibly display alone or not at all.

Sight and report records (at display sites and single sightings of category b, ii above) yield a total known population of 39 birds (16M, 23f, of which 5 are distinctive J), with a PTR of 1M:1.4f and a sex ratio of at least 1M:0.86f. These ratios include males seen at display trees which females seem to visit only occasionally and in small numbers. Thus the sex ratio is probably less biased in favour of males in the population as a whole. As indicated in entries for sight records above, the PTR's of birds seen away from display sites give different results. The ratio of about 1M:6f based on single sightings of 19 birds is probably the most reliable, though based on a small sample, and I use it to project estimates of the minimum total population.

Assuming this ratio holds for all 11M observed at display sites, then 88f are associated with them, giving a total population of some 100 birds. If the 3 Aiyunk males remain in Tsuwenkai, the total would be 142 birds. I will work on the smaller figure which can stand as the minimum population in land west of the lower Kant and Goinbang Creek.

Of the 19 birds seen away from display sites 4 were distinguishably I. Thus, 6 males and 13 apparently female birds were seen. Assuming an equal secondary sex ratio the 2M will be balanced by 2 adult F, and the 4I by 4 younger F which will be at least 2 years old (since immature male plumage is distinguishable from female plumage only in the second year (Gilliard 1969:157) and possibly capable of breeding. This leaves 7f of undetermined sex. Some of these will be young males. It is therefore likely that the actual sex ratio is about equal. This breakdown also implies a large proportion of young birds in the population which is at odds with comparative data suggesting a population composed mainly of older birds. In other words, a relatively large fraction of the 9 or 10 female birds in this sample should be capable of breeding. I will assume that 6 females (31.6%) of the sample fall into this category; this may be an underestimate. Projecting this proportion onto the estimated population of 100 birds, about 31 may be breeding females. With a 33.3% nesting success there will be 10 surviving young each season with an equal sex ratio.

Hunting histories at the Bombong and Gachambo display sites indicate that males are shot at the rate of one every 2 to 2.5 years. Hunting histories of 57 men include *Astrapia*

kills by 21 men. They had together shot 49 male *Astrapia* since 1930, at a rate of 1.1 per annum. Three of these men own display sites and have shot 6, 7 and 8 birds, not all at display sites. Men not owning display sites shoot birds less frequently. One such man had shot five, others only one or two. For the years 1965-73 for which records of kills are most reliable, a minimum of 17 birds (almost 2 per year) have been shot. Seven of these were shot at display sites, six at Bombong and Gachambo. Omitting the later, the predation rate away from display sites was about one male killed each year. During 12 months fieldwork two males were killed, one near a display site.

Rates of predation on males are therefore around two per year, but vary from about one away from display sites to one killed every 2 to 2.5 years at display sites. These rates are within estimated limits of the reproductive rate of the population.

However, these rates are calculated from kills everywhere in Tsuwenkai, while recruitment rates are based on the projected population of only part of the area. Actual breeding output may therefore be somewhat higher.

Of the eleven men questioned about their hunting of female-plumaged birds, six had killed from one to three *Astrapia* females each. Eight of them had killed from one to eight males. In all, they had killed 17 males and 11 female-plumaged birds, some of which would be immature males. Hunting of *Astrapias* therefore not as age- and sex-selective as might be expected of a species primarily sought for its plumes. Most hunters must shoot *Astrapia* away from display sites, where adult males are less commonly encountered than female-plumaged birds. On the other hand, predation rates on males are lower at display sites where mating presumably occurs. The reproductive potential of the species may therefore not be unduly affected.

Lophorina superba Superb Bird of Paradise, *yenandioik*.

Sight records: 13M, 11, 13f.

Call records: 4M, 4f, 19 unsexed. Assistants claimed to be able to determine the sex of a bird by its calls, and I have relied upon their opinion.

This is the most common of the valuable Birds of Paradise. It is numerous in the lower reaches of montane forest and at the forest edge. Female-plumaged birds and, less commonly, adult males, can be found in the zone of human habitation. I have encountered this species from the bottom of the Kant Valley at 1450 m up to 2200 m in the montane forest. This last record seems to be exceptional both for Tsuwenkai (one record) and for the eastern highlands in general (cf. Diamond 1972: 331). *Lophorina* mainly occurs between 1630 and 1940 m, that is, spanning the transition area between secondary and primary montane forest. Adult males are more common in the upper part of this range, being mainly found above 1830m.

Each male customarily calls and displays alone from the crowns of one or more trees within a confined territory. Males seem to be highly sedentary, spending much time in the vicinity of calling or display trees. Unlike *Asiurapa* display sites, *Lophorina* trees are usually loosely clustered within auditory range of one another.

Sight and call records indicate a PTR of 1M:1.08f, which suggests an unbalanced sex ratio in favour of males, but this may be influenced by a disproportionate recording of highly visible and very vocal males. Accounts of the eleven men whose hunting of M and f birds were recorded suggest that PTRs in five small areas where some men had trapped and shot birds varied from 1M:3f to 1M:8f (mean 1M:5f), suggesting a sex ratio close to 1:1. The eleven hunters had shot 38M and at least 43f in nine years, although some men said they could not remember all birds shot. Predation is thus not markedly sex selective. Assuming a PTR of 1M:5f, the 17M seen or heard are part of a total population of 102 birds. This is clearly an underestimate for Tsuwenkai as a whole, as parts of the territory were minimally surveyed.

Results of censuses in Areas 1 and 2 (Map 2) projected to the total available habitat give a higher estimate of the population. In the primary forest Area 2 there were 6 *Lophorina*, or a density of one bird per 2.7 ha. In the forest edge Area 1 there were 9 birds, for a density of one every 1.8 ha. Observations suggest that this greater density of *Lophorina* in such disturbed habitats as Area 1 is general in Tsuwenkai. I estimate the minimum total area of habitat for *Lophorina* at about 6 km². Over half of this area is primary forest with lower densities of birds. The overall average density will therefore be between one bird to 2.7 ha and one every 1.8 ha. I assume a density of one bird every 2.3 ha. The total area of available habitat would then support about 260 birds.

Of the conservative estimate of 102 birds, at least half the population will be females, assuming a near equal sex ratio. With high mortality of young birds, and high adult survival rates, most of these females would be adults capable of breeding (say 80% of all females). I will assume that about 40 females are in breeding condition (39.2% of the total population). With a 33.3% nesting success, these females produce about 13 fledged young each year, half of them males. Applying the same assumption to the estimated total of 260 birds, 120 breeding females produce 34 fledged young each year, including 17 males.

In the nine years 1965-73, at least 16M or almost 2 per year were killed. In the 12 months of fieldwork 8M were killed. This higher rate is within the recruitment rate of the larger estimated population. Since estimates of population densities and available habitat used to compute total numbers are deliberately conservative, annual recruitment rates may exceed variable predation rates of 2-8M by an even greater margin.

Pteridophora alberti King of Saxony Bird of Paradise, *balpan*.

Sight records: 7M, 6f, 16f.

Call records: 2M, 2f, 18f, 2 unsexed. Assistants claim that calls of adult and immature males and of females are distinguishable, and I have relied upon their opinion.

This common bird is found only in undisturbed primary forest mainly between 2050 and 2260 m. In the nearby Kaironk Valley it extends up to at least 2400 m (R. Bulmer pers. comm.) and Diamond (1972: 339) recorded males at 2740 m on Mt. Karimui. A record of an immature male and several female-plumaged females at 1860 m may have been due to particular conditions in a valley noted for its peculiarly low temperatures.

Pteridophora and *Lophorina* seem to displace one another altitudinally, with the former being most common in the lower part of its range.

Adult males maintain several customary calling trees within their individual territories (see also Majnepe and Bulmer 1977:74), although nuptial displays probably occur in the forest substage (Beach 1975; Healey 1975). Plumed males appear to be highly sedentary, spending long periods resting or calling in customary trees.

The PTR of sight records is 1M:3.1f (including I in the latter category). The sex ratio probably does not diverge markedly from equality.

In census Area 3, 15 *Pteridophora* were located (3M and 12f), at a density of one bird to 5.3 ha. No birds were recorded in the upper 16 ha of this area, which is probably above the altitudinal limit of the species. Omitting this section of the census strip raises the density to one bird every 4.3 ha. Approximately 8 to 9.5 km² of Tsuwenkai land is primary forest within the altitudinal range of *Pteridophora*. This area would support 160-190 birds at a density of one every 5 ha or 199-237 at a density of one every 4 ha. I shall work with a mean estimate of 200 birds.

Female-plumaged *Pteridophora* are rarely killed and the species is not attracted to fruit baits or caught in traps. Most birds killed are therefore the results of deliberate effort. Males are usually shot high in calling trees. Female-plumaged birds are seldom shot because hunters spare them, but also because they are seldom encountered in males' calling trees (cf. Beach 1975). Predation is therefore more sex- and age-selective than is apparent for other species, so one might expect greater skewing of the population in favour of female-plumaged birds.

Of the 53 birds seen or heard 17 were males (including 8 immatures), and 18, or 34% were females. A larger proportion may actually be capable of breeding, for some of the remaining 18 unsexed birds would have been adult females. Projecting these

figures to the estimated population of 200 birds there would be at least 68 adult females. With a 33.3% nesting success rate their reproductive output would be 22 birds, or 11 males each year.

Over the period 1965-73, 24 birds were killed at a rate of 2.7 per year. During the 12 months of fieldwork 5 males were killed. Both are within the projected annual reproductive rate of the species.

A nearly equal sex ratio in the face of more marked sex-selective predation than in any other species suggests that either *Pteridophora* has compensated for this predation, or that the tertiary sex ratio in unmolested populations is biased in favour of males.

PREDATION RATES AND HOMEOSTASIS OF THE BIRD POPULATIONS

Calculations for some individual species in the preceding section are based on rather few observations over a limited period. Predation rates, however, are based on records over longer periods, and show fluctuations between the periods 1965-73 and 1973-74. Annual rates appeared to be higher in the latter period, probably because some informants had forgotten kills in the earlier period. Predation rates of individual hunters vary considerably over time (Healey 1977: 254ff), but since the numbers of hunters and their identities and skills vary over time, any fluctuations in predation rates by individuals is not necessarily reflected in their combined rates. Nonetheless, one might expect the predation rates on Birds of Paradise of the Kundagai as a whole to vary somewhat over time, in response to the irregular occurrence of ceremonies requiring decorative plumes. Potentially this could mean that the reproductive capacity of the population would also fluctuate.

Trade in bird plumes has increased since 1956 when the Kundagai were first contacted by the government, and an imposed peace ensured greater safety for traders. One might expect hunting rates to have increased in this time to sustain intensified trading, and the Kundagai claim that this is so. Analysis of the hunting histories, which extend back to the 1920s, shows that there has been no appreciable increase in predation rates on the three most commonly killed Birds of Paradise.

Table 5 provides hunting rates pre and post 1956, as well as gross numbers killed in 1973-74. There is no way of knowing whether the latter figures are representative of average predation levels, nor whether the variation from year to year is accurate. It is not possible to reconstruct past absolute predation figures. Thus, the number of birds recorded as killed in the two earlier time periods are not gross figures but only the totals killed by men still living in 1973-74. Since most active living hunters have been operating mainly since 1955, the data are biased towards more recent hunting. Consequently, pre 1955 rates must have been somewhat higher, so that the slight increases in predation rates of *Astrapia* and *Lophorina* are more an artefact of the

method of analysis than a reflection of the real situation. The conclusion is that, whatever the actual levels of predation prior to my fieldwork, they do not appear to have increased since pacification and the attendant intensification of trade in the mid 1950s.

TABLE 5: Annual predation rates pre and post 1956, and 1973-74.

SPECIES	Pre 1956 (25 year period)		Post 1956 (19 year period)		1973-74
	No. of birds killed	Rate/year	No. of birds killed	Rate/year	No. of birds killed
<i>Astrapia stephaniae</i>	16	0.6	19	1.0	2
<i>Lophorina superba</i>	24	1.0	29	1.5	8
<i>Pteridophora alberti</i>	28	1.1	22	1.1	5

In fact it is probable that hunting rates prior to 1956 were actually higher than at present. Since that date the Kundagai have greatly increased their import of plumes. This has allowed them to export more plumes and consequently increase imports of pigs, shells and other valuables flowing in the reverse direction (see Healey 1977 for discussion of these changes). This presumed post-1956 decline in hunting may be simply because increasing import of plumes has made the Kundagai less reliant on local hunting to provide themselves with feathers for decoration and export. It may also be a response to an increasing scarcity of wild birds. Oral traditions indicate that there were fewer people living in Tsuwenkai two to three generations ago and that the forests were more extensive. It is therefore quite possible that there were larger populations of wild birds which could sustain higher rates of predation. It is also possible that these populations declined under pressure of hunting and forest clearing, although there is no evidence for this.

Present hunting rates appear to be within the rate of annual recruitment; that is, under its present organisation, hunting does not pose a threat to the survival of the birds in Tsuwenkai. However, there is no way of knowing if the present balance between recruitment and mortality in bird populations is representative of the past. Thus, while bird populations appear to be stable now there are no grounds for assuming that this circumstance can be projected into the past, much less into the future. Since the birds still exist, it is reasonable to conclude that hunting rates over time have remained within the limits of reproductive potential. This conclusion does not rule out the likelihood of past decline; that is, of periodic over-exploitation without a full recovery of population levels.

CONCLUSION

This study suggests that the Kundagai can maintain long-term production of feathers on a sustained-yield basis.

The model described in the introduction is based on an assumption of a steady state in population dynamics. In terms of this assumption, homeostasis in bird populations has been maintained, albeit with probable fluctuations, for several decades.

Clan and individual rights to territories and specific resources, as well as new, if informal, Council rules and personal restraints accepted by hunters, all limit the intensity of predation. Nonetheless, one cannot actually specify any positive links between these social and cultural constraints and the population ecology of the birds. However, as long as trade in bird plumes remain an important part of the local economy, hunters in Tsuwenkai will be motivated to observe restrictive rules of access to wild birds. This does not preclude the possibility that these rules will be subject to changes which may serve the short-term interests of some individuals or groups, but may be to the long-term detriment of Birds of Paradise. The "age old traditions" of preiterate tribal peoples are vulnerable to subtle changes and reinterpretations over time. The maintenance of customary rules regulating hunting partly depends on the continuing high demand for plumes in the central highlands, over which the Kundagai have no control, and on continuing lack of opportunity for the development ventures which might be highly destructive of the environment, such as large scale cash cropping, forestry or mining. Even if such developments do not directly lead to destruction of habitat, the attendant changes in social organisation and cultural conceptions of man's relationship to the environment may make Jimi people less inclined to conserve their forest resources.

I noted that there is little present incentive to clear additional areas of forest to meet subsistence needs. Additional clearing will almost certainly become necessary in the future as the population grows, and planting of cash crops increases. Much of the climax forest remains above the limits of agriculture, although the Kundagai entertain the hope they will be able to engage in some commercial logging when the road connecting them to Tabibuga and the Highlands Highway is completed. Even so, it is likely that large continuous tracts of forest should remain as retreats for Birds of Paradise. Further, some species, notably *Lophorina superba*, would seem to benefit by the creation of disturbed habitat.

Undoubtedly, the greatest threat to wildlife in the area is from mining. A national subsidiary of a major multinational company has recently taken out exploration permits for gold and other minerals in a large area of the Jimi and Simbai Valleys, and a particularly promising region is centred right on Tsuwenkai. Clearly, a large mining venture in such terrain would have radical effects on the local environment.

Whether mining will go ahead in the region is not yet known. Apart from this threat,

the future of most species of Birds of Paradise seems reasonably secure in Tsuwenkai. However, this conclusion cannot be drawn for the Jimi as a whole, other parts of which show a higher hunter to hunting land ratio, and higher overall human population densities. It is likely that bird populations in these areas are subject to more intensive predation, and are more liable to suffer from destruction of habitat than in Tsuwenkai. Local extinction of Birds of Paradise may occur in some of these areas if forest clearing increases to support a growing population, or if mining is developed. More detailed studies are still needed to determine the current and project status of Birds of Paradise in the Jimi and to assist in their conservation.

Field research in 1972 was supported by a grant from the University of PNG, and in 1973-74 by grants from the New York Zoological Society, The Myer Foundation, and the PNG Department of Natural Resources. The research was designed in consultation with officers, in particular Max Downes, of the PNG Wildlife Division (then in the Department of Agriculture, Stock and Fisheries, now in the Department of Environment and Conservation). The object was to provide basic data on the cultural significance of Birds of Paradise and to assist those responsible for the development of a programme for the conservation of Birds of Paradise.

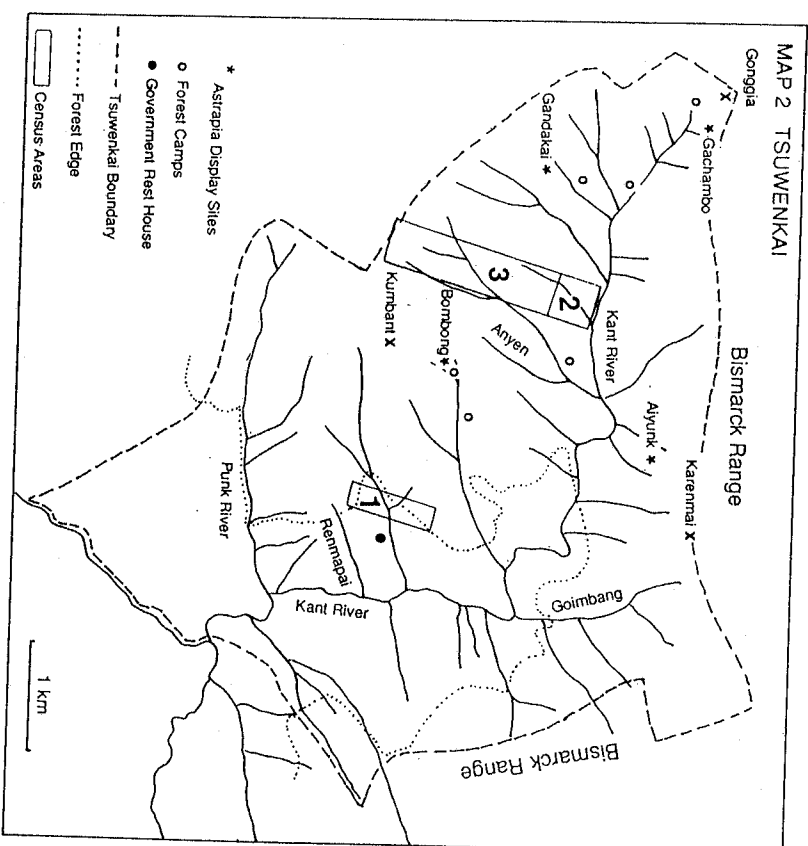
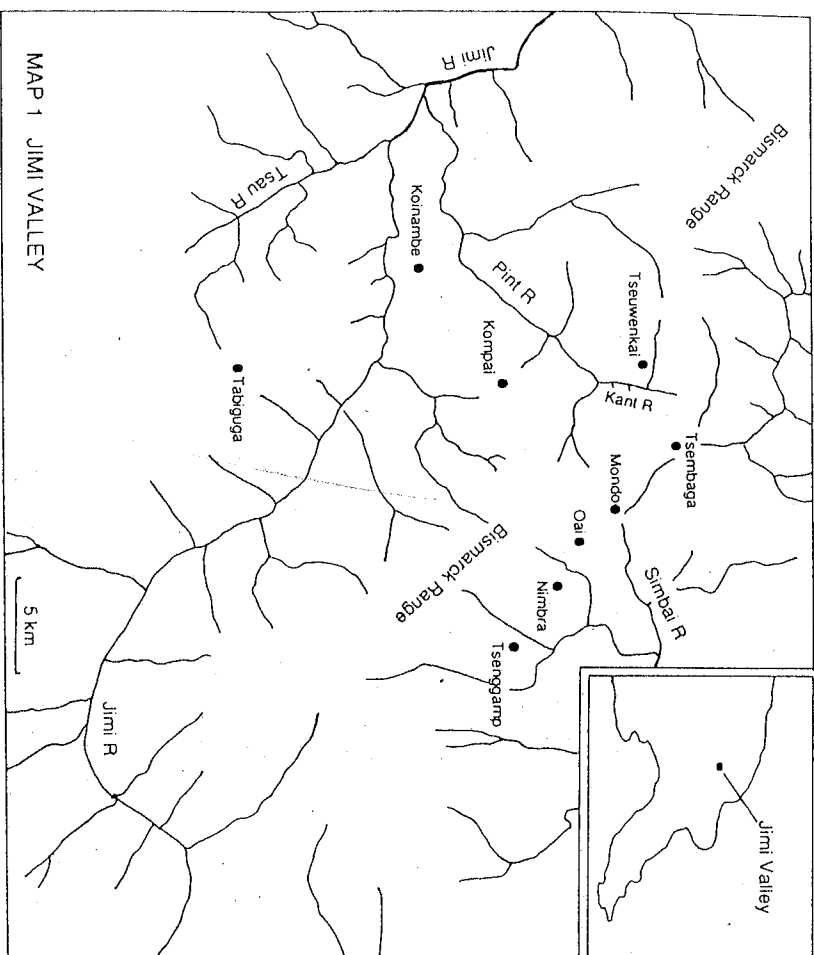
A number of people have given me assistance in the interpretation of data and preparation of this paper. Professor Bill Clarke gave tentative identifications of some plants, and Mr Graeme George provided information on various aspects of Bird of Paradise biology and ecology. Professor Ralph Bulmer was instrumental in the planning stages of my research, and commented generously and profusely on its results. Mary LeCroy and Dr Jim Menzies made very helpful comments on a draft of this paper.

For general assistance in the field, companionship, and help in pursuing birds through the forest I am indebted to Felicity Healey, Mathew Deimang Kuk of Kwitop, and Philip Amang and Lucien Tekwai of Tsuwenkai. Without the generous and amiable guidance and instruction in natural history by Lucien my results would have been much poorer.

My sincere thanks to all these individuals and institutions. Any errors or misrepresentations in this report are entirely of my own making.

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NEST RECORDS FROM NORTH OF THE CENTRAL CORDILLERA OF PAPUA NEW GUINEA

LORRAINE LAMOTHE

A perusal of Coates (1985) indicates that few nest records exist for Papua New Guinea, especially away from the Port Moresby and the Papuan area generally. I offer here a few nest records, collected opportunistically over the past several years, from the Bulolo area, Morobe Province.

Brown Cuckoo-Dove

Macropygia amboinensis

a) September 1977, in a young Kinkik Pine *Aracaria huntii* in Gesch's Seed Orchard, Bulolo.

b) 13 April 1980, rough structure of grass, pine needles and ferns built onto a road cut at Kaisenik Plantation (*Pinus patula*). c. 14 cm in diameter. Contained one egg.

c) 29 September 1980, a nest of pine needles (main and upper most material), dry ferns and a few *Pinus* twigs (at the bottom) inter woven with rooted grasses. c. 11 to 12.5 cm in diameter. Found in a different road cut at Kaisenik Plantation, c. 1.5 above road level. One egg.

d) 8 December 1982, nest high on road cut (over 2 m up) at Kaisenik Plantation. One egg.

Emerald Ground-Dove

Chalcophaps indica

2 May 1982. Female found dead in duck pen at a residence at the Forestry Station, Bulolo. Contained an enlarged ovum (c. 6 x 6 mm).

Superb Fruit-Dove

Ptilinopus superbis

8 October 1985, carrying nesting material, Manki logging area, Bulolo.

Pheasant Coucal

Centropus phasianus

15 April 1982, at the base of *Pinus caribaea* in a 4 year old plantation just outside Bulolo. Nest made of Kunai leaves. Two eggs.

Marbled Frogmouth

Podargus ocellatus

14 November 1980, netted and collected in *P. patula* plantation, Kaisenik, Morobe Province. Contained fully developed but unhardened egg c. 50 x 40 mm in dimension.

Shining Flycatcher

Myiagraeco

September 1977, Nest overhanging the creek at Gesch's Seed Orchard, Bulolo.

Yellow-bellied Sunbird

Nectarinia jugularis

a) 13 August 1982, nest (abandoned) c. 3 m off the ground in a young hoop pine *Aracaria cunninghamii* in the Forest Research Station nursery, Bulolo. The nest, especially the bottom and top, was made up of case-beater cases. The main body of the nest was bound primarily with grasses.

b) 21 August 1982. Nest found in a lemon tree c. 2.5 to 3.0 m above the ground. Located in a gully running through the Forestry Station housing area, Bulolo. Nest completely lined with fluffy seed material, probably *Parsonia*, Apocynaceae.

Mamakin sp.

Lonchura sp.

2 September 1981, Fallen nest with two dead nestlings. Below a *Pinus* tree at a residence at the PNG Forestry College, Bulolo.

Thanks go to the following people who brought nests/nesting birds to my attention. Frans Arentz, Ken Hart, Michael Howcroft and Jeffrey Cunningham, and Neville Howcroft.

Coates, B.J. 1985. *The Birds of Papua New Guinea*. Vol. 1 Non-passerines. Dove Publications.

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EDITORIAL

This issue of Muruk will be the final one for 1986 and our original, ambitious goal of four stimulated interest from several widely separated sources. One correspondent from Poland extended warm congratulations and in fact was surprised that we were attempting four issues in our first year. Other letters have expressed some doubt about the ability of the Papua New Guinea Bird Society to sustain two publications and have wondered about the basis on which articles will be placed in one or the other. These are, of course, some of the important concerns debated by both the editorial committee and the Society's executive. For Muruk we will be seeking research articles, reports of careful observations in the field, and short notes on vagrant or rare species, nesting records, display or other unusual bird behaviour. The Newsletter will continue with reports on meetings and outings and will include species lists from the various areas that members visit. Short notes on bird identification and 'jizz' or information on where to find particular birds or birdwatching anecdotes will be welcomed. Our policy will be open to review as Muruk becomes well established.

It is particular encouraging that we have had many promises of articles from people who have been doing research in Papua New Guinea. But not unexpectedly, they are slow to appear. Articles will also be forthcoming from some of our new members who have plans for netting and banding in the Port Moresby area. Their initial efforts at the Waigani setting ponds have already turned up a rare Gray's Grasshopper-Warbler. We look forward to all these contributions and ask the authors to submit their articles as soon as possible.

We now have access to a laser printer and hope that our senders appreciate the new format. Early in 1987 we will have a new cover design from students at the National Art School.

Joan A. Oliver, Editor.

BIRDS OF MOUNT SCRATCHLEY SUMMIT AND ENVIRONS: 3520 METRES ASL IN SOUTH-EASTERN NEW GUINEA

G.E. CLAPP

SUMMARY

Listed are 22 species of birds seen during a June 1984 visit to the summit of Mt. Scratchley, 3520 m in the Wharton Range of the central cordillera in south-eastern New Guinea. MacGregor's Bird of Paradise *Macgregoria pulchra* was not uncommon and specimens of a new food tree for this species were collected and subsequently identified as *Rapanea involucrea*. An active nest of the Island Thrush *Turdus poliocephalus* was found. Of exceptional interest was the sight record of the Logrunner *Orthonyx temminckii* at 3450 m the highest known record for this species on the island of New Guinea and the first known sighting by an ornithologist for many decades.

INTRODUCTION

I proceeded to Mt. Scratchley by helicopter from Kokoda on 9 June 1984 with one companion, T. Siravopa. We remained on the mountain until the morning of 18 June 1984 when we departed by helicopter for Kokoda. Whilst on the mountain we stayed in the Post and Telecommunication Corporation's microwave repeater station maintenance hut, sited on the summit. The weather was not good, several days being wasted because of thick cloud and rain and no bird observation was possible on 12 June. It was also quite cold and night temperatures may well have approached freezing. Wind varied between calm and quite high. Bird observation was thus rendered quite difficult, particularly because early clouding-in meant that we could not travel far from the hut with any safety.

Mt. Scratchley is one of the high mountain peaks in the central cordillera of the island of New Guinea, and is situated in the Wharton Mountain range. The site of the PTC tower is 3520 m (measured by altimeter) at ground level on the summit. Grid reference is EL472362 on the 1:100,000 scale topographic map EDITION 1 SERIES T683 SHEET 8380 WASA. Co-ordinates are 147°25'40"E and 08°43'10"S.

All altitudes quoted were measured by altimeter unless preceded by the letter 'C' which indicates an estimated altitude only.

The area visited was a patchwork of forest and natural grassland. The forest was largely dominated by *Dacrydium papuense*/*Libocedrus* but also with many areas of lighter, drier and in some cases scrubby forest. The forest was interspersed with large areas of grassland: tussock grassland with cushion herbs and other alpine plants and trees and shrubs on the ridges and drier slopes, and coarse grassland and sedges

on the wetter slopes and in the gullies. The coarse grassland and sedges degraded to mild bog and standing water near run-off areas and towards the flatter centres of the glaciated valleys. Parts of Mt. Scratchley were glacier eroded during the last major glacial event in the Pleistocene, with consequent formation of U-shaped valleys. For a more detailed technical description of the Mt. Scratchley area see Blake (1973), Pajmams (1973) and Loeffler (1977).

We saw no wild pigs, no wallabies and no larger animals of any description, although I twice heard New Guinea wild dogs howling from fairly nearby and I also saw wallaby droppings.

Judging by the number of remains of obviously burned trees in the open areas, the drier season brings man, and with him fire. The forest appears in places to be getting pushed farther back, isolated forested ridges and knolls being particularly vulnerable. Although not of immediate concern because of the generally wet conditions, the apparently restricted areas of forest in which MacGregor's Bird of Paradise is to be found and its rather restricted dietary preferences, coupled with the complete lack of knowledge of tree regeneration at high altitudes in New Guinea, it is desirable that parts of the habitat of *Macgregoria pulchra* should be protected by law and a patrolled high altitude National Park set up.

SYSTEMATIC LIST

Harrier *Circus* sp.

A pair of large, dark looking raptors was seen from the summit a fair distance out over the grassland/forest mosaic on the morning of 17 June, and were initially presumed to be *Circus approximans*. However after reference to Coates (1983) regarding the distribution of *C. aeruginosus* (= *C. approximans*) and the difficulties of distinguishing between juveniles of *Circus spilnotus* and adult and juvenile *C. aeruginosus*, it seems best to designate the birds I saw merely as *Circus* sp. in the absence of any detailed description. Coates (personal communication) has pointed out that *C. spilnotus* has been recorded at 3500 m in the Wharton Range.

Painted Tiger-Parrot *Psittacula picta*

Seen only on 17 June at 3500 m in forest not far from the edge, only 3 m up in a small tree. A pair, male and female, allowed a close approach. There was some gentle allopreening of the female's nape by the male but no other courtship activity. At one stage the male gave a slight 'chir' vocalisation. The birds are elusive and quiet, even when flying, so this one observation on the day before departure is probably not an indication of the species' true abundance.

Glossy Swiftlet *Collocalia esculenta*

Two individuals were seen at 1640 and 14 June after a day with much rain and cloud. They were about 20 m from the ground at 3500 m. On 17 June another two individuals were seen hawking low down over the grass at 3400 m. Evidently it is not common in the area.

Mountain Swiftlet *Collocalia hirundinacea*

At 1600 on 15 June numbers were seen near the communications tower at 3520 m hawking for insects high above and descending to within 3 or 4 m of the ground.

Alpine Pipit *Anthus gutturalis*

Not uncommon locally, these birds were clearly identifiable as the S.E. New Guinea race *A. g. gutturalis*, (c.f. Rand and Gilliard 1967). They were seen in twos and threes on 11 June at c. 3400 m and on 13 June at c. 3450 m. They seemed to prefer areas of alpine grassland, shrubs and

cushion herbs, where bare areas of rock or ground protruded, no matter how small these outcrops were. Diamond (1972) comes closest to describing the call of this endemic species, which I have noted as 'a thin tweet'. The birds were shy and not easy to observe for any length of time.

Island Thrush *Turdus poliocephalus*

Sighted on every day of the expedition's stay, this species was the commonest bird in the alpine grassland/shrubbery areas and was even seen a short distance into the forest edge. I recorded calls as a thin downslurred 'sweet', as well as repeated alarm call 'chup chup'. I often noticed a number of birds flying out from bushes and shrubbery but it was not until a nest was discovered on 17 June that I realised the reason. At c. 3400 m the nest was in the heart of the foliage of an alpine shrub or small tree on a slope and standing in tussock grassland. The tree was closely foliaged and about 2.5 m in height, and the nest, a bulky cup, was at a height of 1.75 m and contained either three or four nestlings. Unfortunately the loss of my notebook containing the precise data makes it unwise to make further comment. I am certain from the number of birds which flew from the hearts of trees that several pairs were breeding.

Logrunner *Orthonyx lewinickii*

To my great chagrin this species was only sighted on the day before we left, at 16:00 on 17 June down the slope from the summit of Mt. Scratchley at 3450 m. The bird, a male, was seen in very damp moss forest on a slope. There was fairly heavy undergrowth with a heavy layer of moss, humus and ground litter. I glimpsed the bird several times between 16:00 and 16:45. When first spotted the bird had a large yellowish insect in its beak. The bird was continually digging and scratching in the forest floor. When disturbed, it would either run or flutter short distances with a whirring of wings. When undisturbed and feeding it occasionally gave a quite soft 'peet' call - which was the only vocalisation I heard (cf. Mayr and Rand 1937). This call was similar to but not as high pitched as the call of the Spotted Quail-thrush *Cinclosoma punctatus* of Australia. Although I saw only the male I gained the distinct impression from calls that there may have been another bird in the vicinity.

A full description is given as I believe it possible this bird may represent an undescribed plumage. It is curious that I estimated the bird to be 5" or 6" (12.5 - 15.0 cm) in length, despite Rand and Gilliard (1967) giving the length as 7 1/4" (18.0 cm). That seems a large discrepancy, but may possibly be accounted for by the bird being on the ground in poor light. I noted a dark eye and brown or dark grey beak. The bird appeared brown on the head, brown on the back with darker streaking, the primaries appeared brown edged black. It had a white throat and upper breast and appeared to have an uninterrupted black band across the breast. The lower breast and abdomen appeared brown.

However, I must emphasise the lateness of the hour for observing birds in closed canopy tropical forest and with a cloud cover outside. Indeed it was very dim in the forest. Also it was a difficult bird to observe: it was continually moving, was cryptically coloured, tended to be obscured by vegetation and was a very nervous bird, the slightest movement by the observer sent it scurrying. However it seemed reluctant to leave the general area, because despite being disturbed several times and going off, it came back repeatedly before finally leaving altogether.

The Australian race of this species in southern Queensland appears to be a much noisier bird and definitely larger (personal observation).

Blue-Capped Iritia, *Iritia kowaldi*

Only one pair of this interesting species was sighted, at 3450 m on 15 June high in a large tree at the edge of the forest, near a stream where they were feeding. I noted that 'they also go upside down' and that they tended to avoid the patches of sunlight on the tree where they were feeding (presumably an anti-predator behaviour), quickly fluttering on to another shaded area when they came to a sunny patch in their foraging.

Tawny Grassbird *Megalurys timoriensis*

The Tawny Grassbird was seen only on 9 June and 16 June in tall, rank grass and shrubs in slightly swampy areas at c. 3400 m: it was not common.

New Guinea Thornbill *Acanthiza murina*

Two or three of these thornbills were seen gleaming four or five metres up in scrubby forest at 3400 m on 15 June. A very high pitched single 'tweet' was repeated several times. As these small warblers can pose identification problems, I include my field notes which state: the birds were approximately 10 cm with brown upperparts and off-white underparts, a clearly visible black sub-terminal band and 'whitish' tip to the tail. I have depicted the bird with a fine dark bill.

Large Scrubwren *Sericornis nouhuysi*

This was a plump looking warbler seen on 11 June at c. 3200 m. Field notes indicate: brown upperparts with light buffy underparts and no other distinguishing marks; about 12.5 cm in length. There were two calls: a 'tweet' and a chattering call. The birds were in a small glade in scrubby forest at the head of a gully. A fresh nest was found nearby, a very bulky enclosed structure composed of grass and moss with a front entrance, and situated about 3 m up in the hanging dead fronds of a tree fern. Although we waited the birds did not approach the nest while we were present, so we left. But I am convinced this was the nest belonging to the *S. nouhuysi* we saw nearby.

Mountain Mouse-Warbler *Crateroscelis robusta*

Fairly common and sighted on a number of occasions: 11 June (3200 m); 15 June (3360 m). These scrubwrens were seen in lighter, scrubby forest without a heavy moss covering, rather than the wet podocarp cloud forest.

On 17 June at 3400 m, one was seen close up, in more open, somewhat lighter forest without a thick ground cover and with considerable stony protrusions. It chattered and scolded for some considerable time and although I suspected a nest, I could not find one.

However, attracted to its scolding were Crested Berrypeckers, a Friendly Fantail and a juvenile White-winged Robin.

Friendly Fantail *Rhipidura albolimbata*

Fairly common, particularly inside the forest at the edge. Seen on 11, 15, 16 and 17 June. Altitudes noted were 3360 m. These birds would approach quite close to an observer and had a remarkable and pleasant tinkling song.

White-Winged Robin *Peneohello sigillatus*

Seen on 11, 15 and 17 June at c. 3200 m and 3400 m and 3420 m. Several of those seen were juveniles. This bird has a habit of clinging sideways to a stem or tree. The only call noted was a 'chup call' given by a juvenile that was seen on 17 June at 3400 m.

Regent Whistler *Pachycephala schlegelii*

This beautiful bird was apparently quite local in occurrence, being seen in one restricted area, in forest on or at the bottom of, two knolls which were covered on their lower slopes with a drier (but still relatively moist) forest in comparison with the heavily mossed podocarp forest. The crests of these knolls were covered with a more stunted and quite scrubby forest which had the superficial appearance in some parts of being secondary, but which I believe in fact was caused by the stony nature of the ground and a much reduced soil and litter cover.

The species was seen on 16 June at 3400 m and 3470 m and on 17 June at 3470. On 17 June a pair of Regent Whistlers were seen foraging and giving a soft 'pit' call (a single note repeated at intervals) as they searched for insects. This was presumably a contact call. Twice the female was seen to eat small caterpillars. The female frequently descended to within one or two metres of the ground on this occasion.

Crested Bird of Paradise *Cnemophilus macgregorii*

This species was seen once only at 3450 m on 16 June in a remarkable incident. I was slowly moving through somewhat dense and heavily mossed cloud forest, with heavy ground cover and on a slope, when an adult male flew so closely past my head with a swish of wings that it gave me a fright. The bird perched to low down only a few metres away. It had in its beak a yellowish looking thin twig or stick, quite straight and about 4 cm long. It moved down to ground level but unfortunately, out of sight. When I cautiously moved to try and see what it was doing it had gone.

I could see nothing to explain the twig. While the bird was out of sight but still in the vicinity, it called once - a remarkable loud parting call which I have noted as a deep, aspirated 'Whunh' (c.f. Beahler 1978). I had in fact heard the call in the canopy but had not known its source until then. Judging by the calls the bird was locally common in one small area in the deep cloud forest. The bird sighted had golden yellow upperparts, as would be expected of the South East New Guinea race *C. m. macgregorii*.

MacGregor's Bird of Paradise *Macgregoria pulchra*

This high mountain species was not uncommon locally, particularly in the forests west and south-west of the summit peak of Mt. Scratchley. It is still one of the least known of the birds of paradise despite having had several papers written on it, notably Rand (1940), Barker and Croft (1977) and Beahler (1983).

These birds frequented forest and forest edge and occasionally perched in low trees outside of the forest. On 15 June I saw one individual, probably a male, fly at least 150 m, from a tree to a shrub. After a pause it moved on. For the last several metres the bird glided. This bird was moving from the forest on the western side to the forest on the eastern side of the peak, the two stretches being separated by some two or three hundred metres of tussock grassland, rocky outcrops, shrubs and small trees. The two areas forest were quite discrete patches.

I never heard these birds utter anything except the very subdued 'yeet' call described by Rand (1940) and Beahler (1983). In the areas where *M. pulchra* was common the forest was cloud forest with large tall trees forming an even canopy 15 to 20 m in height. Presumably these were *Dacrycarpus*, *Libocedrus* and *Papuaedrus*, but I was not competent to distinguish between them. Where the character of the forest was different (and there are a number of different forest types in the area) *M. pulchra* it was not found, with one important exception which is detailed below. *M. pulchra* did not spend long periods in the open except at the edge of the forest in shrubbery. Sometimes it would sit on an exposed perch at the forest edge for some minutes. On 10 June I observed a pair of *M. pulchra*. The male had visibly more yellow in the wing. The birds moved into the shrub-like trees adjacent to the forest. The male, on its own was foraging wing flashing continually. Several times it probed into the shrubby tree (which had pink flowers) but if it obtained insects they must have been very small because I could not see them from thirty metres distance with binoculars. I watched the male continue this activity for several minutes and eventually both birds moved off in loose association, i.e. in the same general direction and within half a minute of each other. These birds gave the 'yeet' call several times.

The most interesting encounter with this bird was on 15 June at 3360 m in forest about 2 km from the hut. Markedly different from the heavy cloud forest near to the hut, this forest was more open, drier and with a lower canopy and few podocarp trees. There were bare rocks and rock ledges protruding in several places. I saw a pair of *M. pulchra* and actually watched one eating the fruit of a tree which was definitely not *Dacrycarpus*. The tree was 10 m high but slender rather than large, and the fruit was a pinky-mauve colour and not large. Specimens of the leaves, bark and fruit were taken and the tree was later identified as *Rapanea involucriata* Mez (Family Myrsinaceae). It was noted that the bird took several fruit while I was watching and would have continued feeding had I not disturbed it.

M. pulchra was recorded at the following altitudes:

9 June at 3520 m; 10 June c. 3500 m; 14 June c. 3500 m; 15 June 3450 m, 3360 m and c. 3500 m; 17 June 3400 m.

Red-Collared Myzomela *Myzomela rosebergii*

This is the only species listed which I did not personally sight. On 11 June T. Siravoga saw a small black bird with a bright red back in the canopy of scrubby edge forest at the head of a gully at c. 3200 m.

Sooty Melidectes *Melidectes fuscus*

This honeyeater was sighted only on 16 June at 3450 m, low down in shrubby undergrowth and small trees, gleaming for insects. It was much less common than Belford's Melidectes.

Belford's Melidectes belfordi

Belford's *Melidectes* was a very common, noisy bird of the forest and forest edge but rarely ventured outside. It was sighted on all days except 12 June when bad weather precluded any observations, but even on that day it could be plainly heard. It was present at a range of altitudes between 3300 and 3420 m. 'Dive bombing' of *Paranythia montium* by this species is described below the former. I noted the calls of this species on 9 June as 'whee whee whee whoa'. On 11 June a pair of Belford's *Melidectes* I was observing sometimes called together - apparently in a duet.

Crested Berrypecker Paranythia montium

The Crested Berrypecker was one of the commonest birds in the area. I sighted it on all days except 9 and 12 June between c. 3100 and 3500 m.

On 14 June in the late afternoon at c. 3500 m there were two Crested Berrypeckers in a small shrubby tree. One was dive bombed by a Belford's *Melidectes*. There was no apparent reason for this aggression.

My notes indicate that of the twelve sightings of this species, six were of pairs, two were of birds associated together, two were noted only as Crested Berrypeckers in the plural and two were of single individuals. It is evident that the pair bond was strong in these birds at this time and, judging by the remarks in Rand and Gilliard (1967) they may well have been breeding.

On 15 June near the edge of the forest on a ridge I saw a Crested Berrypecker which 'also had a pleasant whistled song'. This does not appear to have been previously reported.

Mountain Firetail Oreostrubus fuliginosus

Appeared uncommon. Although Rand and Gilliard (1967) say this species was not found in flocks, two of the three sightings I made were of small flocks. On 16 June at c. 3300 m, in shrub and small trees at the edge of the grassland, a small flock of c. 10 of this species was observed. They were clearly identifiable but shy and tended to stay out of sight and move off unobtrusively. Their calls were soft but otherwise mannikin-like. Again on 16 June at 3400 m at a different location I noted a small flock of this species but did not record the number. On 17 June, two were seen at 3450 m in forest near the edge. They moved off quickly when encountered.

Miscellaneous

Other than the species listed above there were some difficult to resolve sightings. Small parrots in a small flock were heard on 9 June but not identified. On 16 June at 3450 m a bird was seen which was black with white on the wings and whitish on the abdomen. It was noted as being a robin, smaller than *Petroica signatus*. It may well have been *P. bivittata* but no white was noted on the forehead. On several occasions quite small warblers were glimpsed as they left tree ferns in which they had been gleaming. They were shy and there was too much over in other tree ferns and they left before identification was possible. These warblers may have been *Gerygone ruficollis*. Another mystery bird, seen at 3200 m in scrubby edge forest, was small (10 cm) with a dark top to the head, a whitish supercilium and a black line through the eye greenish brown on the back and with a light coloured underside. The description fits *Phylloscopus trivirgatus*, but as this was far above its known altitudinal range Rand and Gilliard (1967; Diamond 1972; Beehler 1978), it requires confirmation.

DISCUSSION

The weather on Mt. Scratchley should have been better considering time of the year. The general clouded-in conditions prevented us from reaching the small alpine lakes near English Peaks and the rocky area above the timberline. Nevertheless I made some interesting and valuable sightings.

Although Mayr and Rand (1937) mention that *M. pulchra* eats some fruit other than

Podocarpus (= *Dacrycarpus*) the first positive scientific identification of such a food tree is of great interest. *Rapanea* spp. trees are widespread in the high mountains of eastern New Guinea (Barker and Croft 1977) and are common trees where the Star Mountains population of *M. pulchra* is found (Barker and Croft 1977). *Rapanea* spp. are also found commonly in the Lake Habbema area, and moreover go right to the timber line as stunted small trees (Brass 1941); Schodde et al. (1975) recorded *Rapanea* spp. on the Carstensz Massif at the Western edge of the range of *M. pulchra* in Irian Jaya.

When discussing to this bird's diet I believe Beehler's exposition to be an oversimplification and to contain some misinterpretation of the facts found in the literature (Beehler, 1983). Beehler states 'Rand (1940) hints that *Macgregoria* is a strict frugivore specialising on a single fruit tree listed as '*Podocarpus* (Podocarpaceae)'. However to understand the position precisely it is necessary to quote the various authors exactly.

Rand (1940) states the following:

- (a) 'Sometimes they poke among the moss on tree trunks, and pull off moss and bark as though searching for insects, but all the stomachs I have examined contained only fruit. When in forests where *Podocarpus* occurred the stomach contents consisted of their fruit exclusively.
- (b) 'In east New Guinea it favours especially *Podocarpus* fruits and when in that habitat feeds exclusively on their fruit. But when we went higher than Habbema, to 3600 and 3800 metre camps near Mt. Wilhelmina, and left the coniferous forests behind, *Macgregoria* continued to be a fairly common breeding bird'.

I interpret these remarks to imply that birds in areas outside of the *Podocarpus* forest fed on fruit other than *Podocarpus* (= *Dacrycarpus*), presumably unidentified fruit. If *M. pulchra* is fairly common breeding bird at altitudes above the coniferous forests, and if it is (at least at times) locally sedentary in habits (Beehler 1983) then its diet must largely consist of other than *Dacrycarpus* fruits, at those higher altitudes. I believe it is significant that in his summary Rand (1940) never stated that *M. pulchra* specialised on *Dacrycarpus* fruits, preferring to say merely 'it is a specialised species with no close relatives.'

Rand and Gilliard (1967) say: 'the fruit of a taxad, very common in the forest here was apparently their principal food...'. The word principal should be stressed, and it should also be noted that on that expedition only four stomachs were examined in the field, and that of those four stomachs, two contained fruit other than *Dacrycarpus* (Rand 1940). There is actually nothing in the published notes as to whether or not these stomachs contained *Dacrycarpus* fruits as well, but in one case it is unlikely as one bird whose stomach contained the fruit of an angiosperm, was taken at Murray Pass where, to quote Rand 'the same tree (i.e. *Dacrycarpus*) though present, was not fruiting.' Baker and Croft (1977) state that *M. pulchra* occurs commonly in areas in the Star

Mountains where *Dacrycarpus* is only low and scattered: "The upper altitudinal limit was on the summit ridges between Mrs. Capella and Scorpion in an open sub-alpine shrubland of *Vaccinium*, *Rapanea* and *Rhododendron* with scattered low *Dacrycarpus* and *Papuacedrus* where the bird was commonly seen."

I also noted *M. pulchra* poking and prying into the foliage of the shrubs, in a similar fashion to Rand's (1940) observations of the bird poking into moss and bark, but again as in my observations, no visible food was obtained. Nevertheless this behaviour must gain the bird something, and the most likely explanation is that the bird is obtaining food. I noticed on Mt. Scratchley that, particularly after the rain and cloud cleared and the sun emerged, the shrubbery was covered in small spider webs with minute spiders. It is possible that *M. pulchra* may be exploiting such minute soft-bodied arthropods, particularly as these would be unlikely to show up except in the most detailed stomach examinations.

I suggested that *M. pulchra* feeds principally on *Dacrycarpus* but that by necessity it will often feed on other fruits and perhaps on very small soft-bodied arthropods. Possibly these other fruits, such as *Rapanea involucreata*, may prove to be crucial in allowing *M. pulchra* to exist where and/or when *Dacrycarpus* is not present or not fruiting, particularly in view of the fact that *M. pulchra* may at times be quite sedentary.

The sighting of the Logrunner *Orthonyx temminckii* was the highlight of the expedition. There is a record of this species at 11,000 ft. (3354 m) on Mt. Scratchley and Mt. Knutsford in 1898 (Rothschild and Hartert 1903) but it is well known that these old records are notoriously unreliable with regard to altitude. My altimeter recorded Mt. Scratchley as 3520 m, in almost perfect agreement with the altitude indicated on the modern topographic map used. Yet in the 1896-1897 Annual Report for British New Guinea, MacGregor (1898) gave the altitude for the summit of Mt. Scratchley as 12,860 ft (3921 m). This is not a surprising error given that the methods used to obtain altitude were the boiling point of water and the aneroid barometer. At any rate my sighting is certainly the highest altitude at which *O. temminckii* has been recorded. Mt. Knutsford is not marked on modern maps, but sketch maps in the old British New Guinea annual reports show it about halfway along and slightly to the west of centre of a line between Mt. Scratchley and Mt. Victoria. Although only rarely recorded from only a few peaks in south-east New Guinea, it is probably that *O. temminckii* occurs on most peaks in the vicinity of Mt. Scratchley and Mt. Victoria which have high altitude moss forest. But because the bird is so retiring and the moss forest is such an uncomfortable place for prolonged bird observation, this species is rarely seen. Indeed this is the first known sighting by an ornithologist for many decades. Only specimens could establish whether an undescribed plumage type really does occur on Mt. Scratchley.

The active nest of the Island Thrush *Turdus poliocephalus* is believed to be one of the

very few recorded on the island of New Guinea. It is most regrettable that some notebooks and a case of slides were lost when the author moved from Papua New Guinea to Australia. Amongst these was the notebook containing the data on nest and nestlings. The observation is, however, a positive record for the time of year for active breeding by this species on the high mountains of southeast New Guinea.

The other sightings offer good historical continuity of recorded avifauna in this rarely visited high mountain area of outstanding geographical and zoological interest. A total of 22 species was recorded, one being identified to genus only and the remainder positively to species.

I am most grateful to Mr. B. J. Coates for his helpful criticism and discussion of an earlier version of this paper. I am indebted to Mr E.E. Henry, formerly Assistant Director, Division of Botany, Office of Forests, Lae, PNG, for identification of *Rapanea involucreata*. Thanks are due to Mr T. Stravopa who accompanied me to Mt. Scratchley at very short notice, and to Pacific Helicopters for transporting us on schedule to and from a remote location. I am grateful to the librarians at the Queensland Museum, Brisbane, Australia, for allowing me access to historical documents, and to Mr. B. W. Finch for helpful discussion.

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SOME OBSERVATIONS OF BIRDS FORAGING IN TREMA ORIENTALIS

D. McWINTER

From 15:00 to 16:00 on 28 May 1983, from 14:45 to 16:30 on 30 May, and from 15:15 to 15:45 on 31 May, I observed a variety of birds foraging in a *Trema orientalis* adjacent to the main office of the Wau Ecology Institute (W.E.I.). The identity of the two trees mentioned below, and information about them was kindly supplied by Allen Allison, Acting Director of W.E.I. Observations were obtained with 10x40 Leitz binoculars at 30 to 40 meters.

Trema orientalis is a fairly common tree on the grounds and in the coffee groves of W.E.I. It is not one of the trees planted to provide shade for coffee; rather, it springs up adventitiously and is allowed to persist. It's a fast-growing, short-lived tree with a broad, comparatively open crown. This particular tree was an estimated 13 m tall with a crown diameter of nearly the same. The tree was in fruit and was noticeably suffering leaf damage from insects, one of which, perhaps the main one, was a lepidopteran larva 5 to 7 cm long, coloured light green to brown. With one exception, the species of birds that foraged in the tree fed exclusively on fruit, caterpillars or small insects.

The following is a list of species seen in the tree, the number of each species seen when present, and what was eaten by that species, if anything:

Brown Cuckoo-Dove *Macropygia amboinensis*
 1 to 2, not seen eating.
 Black-billed Cuckoo-Dove *M. nigrirostris*
 1, ate fruit.
 Rainbow Lorikeet *Trichoglossus haematodus*
 3 to 15, ate fruit.
 Double-eyed Fig-Parrot *Cyclopsitta diophthalma*
 2 to 3, ate fruit.
 Chestnut-breasted Cuckoo *Cacomantis castaneiventris*
 1 to 2, ate caterpillars.
 Malay Bronze Cuckoo *Chrysococcyx minillius*
 1, not seen eating.
 White-crowned Koel *Caliechthrus leucolophus*
 1 to 2, ate caterpillars.

Sacred Kingfisher *Halcyon sancta*
 1, ate caterpillars.
 Dollarbird *Eurostomus orientalis*
 1, used the tree as a perch to forage from, did not forage within the tree's canopy.
 Black-shouldered Cuckoo-shrike *Coraciina minor*
 1 to 2, ate caterpillars.
 Northern Fantail *Rhipidura rufiventris*
 1, stayed only briefly, did not forage.
Pachycephala sp.,
 1, not seen eating.
 Hooded Pitohui *Pitohui dichrous*
 1 to 2, ate caterpillars and other, smaller insects.
 Brown Oriole *Oriolus szalay*
 1 to 2, ate caterpillars and other, smaller insects.
 Marbled Honeyeater *Pycnopygius cinereus*
 1, stayed briefly, did not forage.
 Helmeted Friarbird *Philemon buceroides*
 2 to 3, not seen eating.
 Papuan Flowerpecker *Dicaeum pectorale*
 1 to 4, ate small insects.

No species was in the tree for the entire observation period. Most came and fed for varying periods, then left. As a species, the Rainbow Lorikeet spent the most time in the tree. As individuals, the Chestnut-breasted Cuckoo spent the most time. The Rainbow Lorikeets spent a lot of time in the tree just climbing around and interacting with each other. Two Double-eyed Fig-Parrots sat and preened and allo-preened for 15 minutes. A White-crowned Koel sat and called for nearly 20 minutes after eating several large caterpillars.

The caterpillar eaters exhibited several ways of finding prey, several ways of manipulating prey once it was caught, and took varying time to manipulate the prey before consumption. The Chestnut-breasted Cuckoos hunted by walking along slender branches and peering about, or they sat in one place for at least five minutes while looking about. If a caterpillar was seen while hunting in the latter way, the bird would fly to the nearest branch and pick the insect off. After capture, the larvae was battered on a large branch and crunched between the bird's mandibles until pulped enough to swallow. This usually took between one and two minutes. White-crowned Koels hunted by walking on larger branches than the previous species. If a caterpillar was spotted, they leaped/flew and semi-crashed their way over to it, battered it on the nearest large branch, and consumed it in less than a minute.

The Sacred Kingfisher was a sit-and-wait hunter that flew to the prey, hovered briefly, and picked it off. The one time the kingfisher was seen handling the prey after capture, it so vigorously battered the insect on a branch that pieces of the insect were lost. Handling time before consumption was uncertain. Both the Black-shouldered Cuckoo-shrikes and the Brown Orioles moved frequently in the smaller branches while peering

around. One cuckoo-shrike hovered briefly in order to pick a caterpillar off a leaf. Both species battered their prey and ran it through their mandibles. Both averaged about a minute in handling time before consumption.

There seems to be a rough inverse correlation between the mass of the bird and handling time for similar sized prey.

The number of species present in the tree during the same time period varied from day to day. On 31 May, only three species were present, and during the same time on 30 May, seven or eight species were there. On 28 May, close track was not kept, but no more than four species were present in that time period. There was heavy rainfall for one hour prior to the 30 May observation period. This may have stimulated insect activity, or the birds may have been catching up on their feeding before retiring for the night.

Some incidental observations were made. Chestnut-breast Cuckoos and a Brown Oriole were seen taking caterpillars from other *Trema orientalis* on the W.E.I. grounds. A Rainbow Lory was seen drinking liquid from an upturned flower of a nearby African Tulip-Tree (*Spatodea campanulata*) after the rain on 30 May. Finally, as unequivocal proof that pure research pays off, I saw an unexpected lifer while making these observations - a Blue-faced Parrot-Finch *Erythrura trichroa*.

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BAIRD'S SANDPIPER *CAUDRIS BAIRDII* AT KANOSIA LAGOON - FIRST RECORD FOR THE NEW GUINEA REGION

BRIAN W. FINCH

LOCATION AND HABITAT

Four members of the Papua New Guinea Bird Society (myself, Roger Hicks, and Joan & Michael Oliver) were investigating Kanosia Lagoon, Central Province, on 24 November 1985, to see what migrant species were being attracted by the drying out process that was leaving extensive area of oozy mud with scattered drier islands and shallow pools.

Whilst the area had been too wet for the main passage of waders, and sadly most had passed over without stopping on the southward passage, the increasing suitability of habitat was attracting the later migrants, and there were over a hundred palaearctic waders present.

Species present consisted of approximately a hundred Sharp-tailed Sandpipers *Calidris acuminata*, one Marsh Sandpiper *Tringa stagnatilis*, five Wood Sandpipers *Tringa glareola*, one Eastern Golden Plover *Pluvialis dominica fulva*, and ten Japanese Snipe *Gallinago hardwickii*. A pair of Little Ringed Plovers *Charadrius dubius* turned out to be of the resident race *dubius*.

The observers had split up and were each checking out different parts of the lagoon. Whilst returning from the farther north-eastern portion, I saw a wader feeding in the company of a party of Sharp-tailed Sandpipers and one Marsh Sandpiper. The bird was obviously different and was thought to be a Baird's Sandpiper *Calidris bairdii*, although the species had not previously been recorded in the New Guinea region before. Two observers studied the wader for over twenty minutes taking detailed notes, and sketching the bird in the field.

Whilst the other two members of the PNGBS were making their way down the hill to the lagoon and heading towards the birds, the small flock startled, and flew further down the lagoon some 50 m away, and from this assemblage single birds and pairs peeled off and headed past us back down the lagoon towards the area in which the unusual sandpiper was first discovered. In spite of a thorough search by all four observers the bird could not be relocated amongst the thirty or more birds feeding in the shallow pools and on the dry mud with tangles of dead vegetation.

We later found the Baird's Sandpiper at the edge of a small pool. After a short time it, together with a dozen Sharp-tailed Sandpipers, flew up and after circling the far end of the lagoon, all flew out of sight.

DESCRIPTION

The bird stood up to a centimetre shorter than the accompanying Sharp-tailed Sandpipers, the body bulk was slimmer but the entire length was comparable, because of the very long wings which extended well beyond, and totally obscured the tail.

Head: Wholly brownish-grey (the field notes read as cold greeny-grey), slightly browner on the crown with no obvious supercilium, this being reduced to a pale line just above, and slightly beyond, the eye. There was no darkening around the ear coverts as in most *Calidris* waders.

Throat/breast: Although the chin was not observed while the bird fed, the throat appeared cold grey, and this continued on to the lower throat where there was narrow but obscure streaking although the background colour was uniform with head. This streaking broke off quite noticeably just in front of the bend of the wing, where the white of the underparts extended upwards.

Flanks: Along the sides of the breast and flanks was a line of irregularly shaped indistinct orange-brownish spots.

Underparts: The remainder of the underparts were white without any marking or suffusions.

Upperparts: From the nape extending on to lower back, there was a series of furrowed dark and pale stripes which shaded into the cold Dunlin-grey of the lower back. The wing-coverts and inner secondaries were grey with indications of darker centres and conspicuous buffy white edges to the feathers. The flight feathers were blackish and contrasted with the rest of the wings. The primaries were very long and extended well beyond the tail, and each wing tip crossed over totally obscuring the all grey tail.

Flight: In flight with the Sharp-tailed Sandpipers, this bird differed little except in being smaller, it shared the obscure indistinct whitish wing bar of the sharp-tails, and showed an all blackish rump.

Bill: The bill was shorter than a Sharp-tailed Sandpipers', and was straight with only a slightly perceptible droop at the tip when seen from some angles, but not nearly as pronounced a droop as in Sharp-tailed Sandpipers' bills. Unlike that species the bill was completely blackish, and did not show the olive cast to the basal third of the lower mandible. The width was even along the length, tapering at the tip.

Legs: Blackish although usually obscured by water as the bird fed with the Sharp-tailed Sandpipers in shallow muddy water. Although the two species were feeding in the same depth of water, the Baird's Sandpiper was up to its belly in water whilst the Sharp-tailed Sandpipers were still keeping their underparts dry, testifying to the *C. bairdi* having much shorter legs.

General Appearance: The bird was like a large stint in proportions, but more attenuated and with a head that appeared too small for the body. The neck was short compared to other medium sized *Calidris* and the bird had a very sleek profile with the long tapering back and wings protruding beyond the tail.

Feeding: Whilst feeding in the shallow water, the bird's habits were distinct enough to enable it to be picked out from the Sharp-tailed Sandpipers even if obscured bodily by that species. The jabbing motion was more like that exhibited by the Pectoral Sandpiper *Calidris melanotos* (a useful means of picking out that species from Sharp-tailed Sandpipers when plumage differences cannot be discerned). The head was held with the bill pointing vertically downwards, and inserted into the water with a series of rapid jabs, retracted, although the tip may still have remained in water, and the bird moved forward a little. Then the procedure was repeated. By contrast the Sharp-tailed Sandpipers' feeding actions were far less deliberate and more casual, the bill inserted into the water at an angle, not vertically, and with slower series of shallow jabs. The legs were slightly bent, whereas the Baird's Sandpiper seemed to keep its legs straight, although admittedly obscured by water.

DISCUSSION

All four observers had had previous experience with Baird's Sandpiper in the field, either in Canada or in the United Kingdom.

Like many vagrant birds, this individual exhibited variance from what is considered 'the norm' in its choice of feeding habitats. Instead of feeding on the dry mud it chose

to feed in water with the Sharp-tailed Sandpipers. It is quite likely that dry mud baking in an equatorial sun becomes quite sterile. Other Baird's Sandpipers that have turned up in Australia have also been found in wetter habitats than would be considered usual in the Nearctic where the bird is mainly a passage migrant through the central prairies rather than along the coasts.

The presence of obscure spotting along the flanks is suggestive of a adult bird coming out of breeding plumage, whilst the overall grey appearance with narrow but distinctive buffy white edges to coverts is more suggestive of a first winter bird.

The breeding range of this species extends from the Nearctic into western Siberia, and it is only to be expected that a few birds would wander southwards to the Australasian region. This record would constitute the first record for the New Guinea region, whilst Australian has had four and New Zealand one record.

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ACCIPITER NOVAEHOLLANDIAE ATTACKS CACOMANTIS CASTANEIVENTRIS

D. McWHIRTER

On 4 June 1983, at about 15:00 hours, while sitting in the lounge of the Wau Ecological Institute hostel, I heard a rush of wings outside, behind me. A hawk had hit another bird in flight, and the impact had carried them about 10 m further into a small hollow near a coffee bush. The hawk crouched with spread wings and tail over the struggling, crying bird. The hawk's head was up and its mouth open. When the victim cried and struggled harder, the hawk pressed closer, bent its head down, and may have bitten the bird. At this point, the hawk could be identified as an adult, coloured phase Grey Goshawk, *Accipiter novaehollandiae*.

When I went outside to try and determine the identity of the other bird, the hawk flew off, but, judging from the scolding by other birds, circled around behind some trees, and stayed in the vicinity. The victim was an adult *Cacomantis castaneiventris*. It did not fly and seemed to be in shock. It had a slight wound in the throat area, the left eye was punctured, and the adjacent orbital bone looked damaged, perhaps from a bite. After setting the cuckoo down a metre from where it had previously lain, I went into the hostel to see if the hawk would return.

About fifteen minutes later, it flew in and landed in the base of the nearest coffee bush. It seemed to inspect the area visually, staying within the cover of the bush. However,

it apparently failed to see the immobile cuckoo (from where it was perched, the bush may have obscured its view). After two minutes or so, the hawk flew up to a bare branch, ruffled and preened its feathers for a minute, then flew off. Towards dusk, I went out to see if the cuckoo, which still had not moved, was dead. When I reached to touch it, it scrambled to the shelter of the nearby coffee bush. It acted more alert, but seemed incapable of sustained flight. When I checked the next morning, the cuckoo was gone.

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BLACK-HEADED GULLS *LARUS RIDIBUNDUS* AT LAE AIRSTRIP, MOROBE PROVINCE. THIRD RECORD FOR MAINLAND PAPUA NEW GUINEA.

BRIAN W. FINCH

On 19 January 1985 a group of birdwatchers including myself, while waiting for a plane to be refuelled at Lae Airport, observed waders on the airstrip. Meanwhile, I walked to the sea at the end of the airfield and saw a bird, albeit at a great distance, that had dark underwings and white flashy forewings. I thought it was probably a Black-headed Gull *Larus ridibundus*.

The party hurried to the same point where a sewage outfall pipe was attracting numbers of terns, particularly White-winged Black Terns *Chlidonias leucopierus*. Amongst these terns was not one but three Black-headed Gulls. All three birds were in first winter plumage, with a black tipped orangy-brown bill, brown on the secondary coverts and a narrow black terminal tail band.

The other two mainland Papua New Guinea records, also discovered by the author, were both at Moitaka Settling Ponds in 1979 and 1982. These individuals were also in first-winter plumage.

Three records by one observer in six years would suggest that small numbers of Black-headed Gulls are annually visiting the coasts of Papua New Guinea. The species has yet to be recorded in Australia.

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FEMALE HOUSE SPARROW *PASSER DOMESTICUS* ON PAGA HILL, PORT MORESBY. A SECOND RECORD FOR PNG.

ROGER K. HICKS

On 10 June 1986 at 07:00 I was bird-watching on Paga Hill before going into work when I heard a familiar call, but was unable to identify the species. The source of the call was tracked down to a rubbish collection area. The bird was feeding amongst the rubbish but when disturbed flew up onto some nearby telephone wires where it was identified as a female House Sparrow *Passer domesticus*. I watched it for about two minutes before it flew into some trees and could not be relocated. I saw the sparrow once more, and again only briefly, on 12 June, when it was perched on some more overhead wires in the company of two White-breasted Wood-swallows *Artamus leucorhynchus*. Unfortunately no other bird-watchers managed to see the sparrow. I am familiar with this species and its congener, the Tree Sparrow *P. montanus* in Europe. The following description is taken from the notes I made shortly after each observation.

It was two thirds the size of a White-breasted Wood-Swallow, the only species present with which to compare it, and of a similar chunky build. It had a heavy pale seed-eaters bill. The underparts, from chin to vent, were a uniform brown-grey. The upperparts were a darker brown and heavily streaked with black on the mantle. Pale edgings to the wing coverts resulted in one obvious wing-bar and one less obvious. The most notable plumage feature was a broad pale supercilium which started behind the eye and went towards the back of the head.

The habitat on Paga Hill is mixed savanna (i.e. grassland with some trees and shrubs) with some houses and associated garden plants. This female House Sparrow first appeared after a month of continuous south-easterly winds. Assuming it was a true vagrant it would probably have originated in Australia where the nearest House Sparrows are at Cooktown, north Queensland (Pizzey 1980), some 700km SSW of Port Moresby. However the situation of Paga Hill less than 1km from Port Moresby's harbour, is probably more important than the habitat in which the sparrow was seen or the prevailing weather conditions prior to its arrival. As with the first record of this species in PNG, a party of four at Kila Kila (Ashford 1978), it is probably that this female arrived aboard ship.

Ashford, R. W. 1978. First record of House Sparrow for Papua New Guinea. *Emu* 78: 36

Pizzey, G. 1980. *A Field Guide to the Birds of Australia*. Collins. Sydney.

Address: National Computing Centre, Wards Strip, P.O., N.C.D., P.N.G.

EXTENSION OF RANGE OF *ALCEDO PUSILLA*

L. LAMOTHE

On 10 July 1985 a small kingfisher flew into one of the offices at the Forest Research Station, Bulolo, Morobe Province. It was photographed and identified as *Alcedo pusilla*. Beehler (1978) does not include it in his guide which covers birds above 500 m. Coates (1985) states that the species (which he calls *Ceyx pusilla*) is a lowlands one which has been recorded locally as high as 540 m on the Sogeri Plateau. The altitude at the Forest Research Station being approximately 750 m, this is a significant extension to the known range especially as higher points exist between Bulolo and the coastal lowlands.

Beehler, B. 1978. *Upland Birds of Northeastern New Guinea*. Wau Ecology Institute, Handbook No. 4 Wau, 156pp.

Coates, B.J. 1985. *The Birds of Papua New Guinea*. Dove Publications, Alderly, 464pp.

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