AVIFAUNA OF THE EASTERN HIGHLANDS OF NEW GUINEA

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Dedicated
in admiration and friendship
to
Robert MacArthur

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INTRODUCTION

This monograph is a study of the avifauna of that part of New Guinea known as the Eastern Highlands, i.e. the Central Range between longitudes 143°E and 146°E and above an altitude of 1,350 ft. The discussion is based initially on my collections and studies made during four expeditions to New Guinea between 1964 and 1969, but the records of other workers in the Eastern Highlands are also summarized. The first part of the text (I, pp. 3-15) gives a brief synopsis of the ornithological exploration of the Eastern Highlands and describes my collecting itineraries, methods, and localities. The second part (II, pp. 17-94) analyses some features of general ecological and evolutionary interest in the avifauna of the Eastern Highlands: patchiness of distribution, ecological sorting mechanisms (niche differences between congeners), a speciation mechanism in montane birds, zoogeographical affinities, altitudinal distribution, the breeding non-forest avifauna, migration, bird assemblages in fruiting and flowering trees, breeding patterns, and bird classification by New Guinea natives. A summary of this second part is given on pp. 92-94. The third part (III, pp. 95-412) consists of individual accounts of the 354 species recorded to date from the Eastern Highlands. This is followed by a list of relevant literature (IV, pp. 413-419) and an index (V, pp. 421-438).

The manuscript was accepted by the Nuttall Ornithological Club on 20 September 1971.

I

ORNITHOLOGICAL STUDIES IN THE EASTERN HIGHLANDS

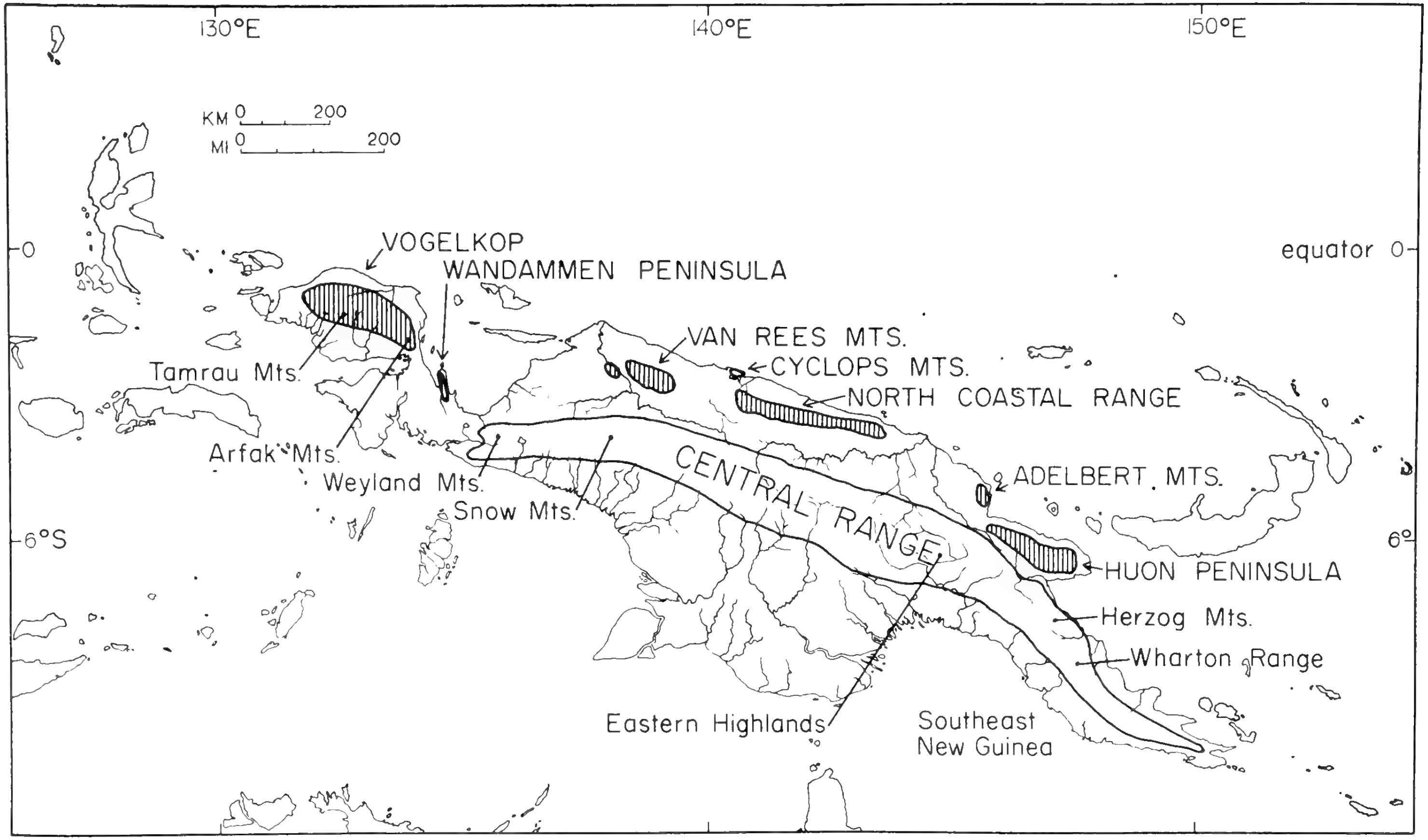
Sources of Information

The backbone of the island of New Guinea (Maps 1 and 2) is formed by a central mountain range which rises to nearly 17,000 ft and which runs uninterrupted for about 1,000 miles from near the southeastern tip of New Guinea west to the head of Geelvink Bay (longitude 135°E). There are no known north-south passes under 5,000 ft in the Central Range. In two areas, namely, in the Eastern Highlands and in the Baliem and Ilaga Valleys of the Snow Mountains of western New Guinea, the Central Range broadens into a system of valleys with dense human populations. New Guinea's remaining mountains are the mountains of the Vogelkop Peninsula in the far west, and a series of isolated ranges or "mountain islands" along the north coast (Van Rees Mountains, Cyclops Mountains, North Coastal Range, Adelbert Mountains, and mountains of the Huon Peninsula) which are separated from the Central Range by lowland basins. In this monograph the term "Eastern Highlands" is arbitrarily taken to mean that portion of the Central Range between longitudes 143°E and 146°E. These limits are chosen partly for practical reasons arising from availability of information, but they also correspond approximately to a natural zoogeographic unit which is weakly distinct from the portions of the Central Range farther to the west and to the east, as discussed on pp. 46-48. Coverage in this monograph is further restricted to elevations above 1,350 ft, my lowest collecting station.

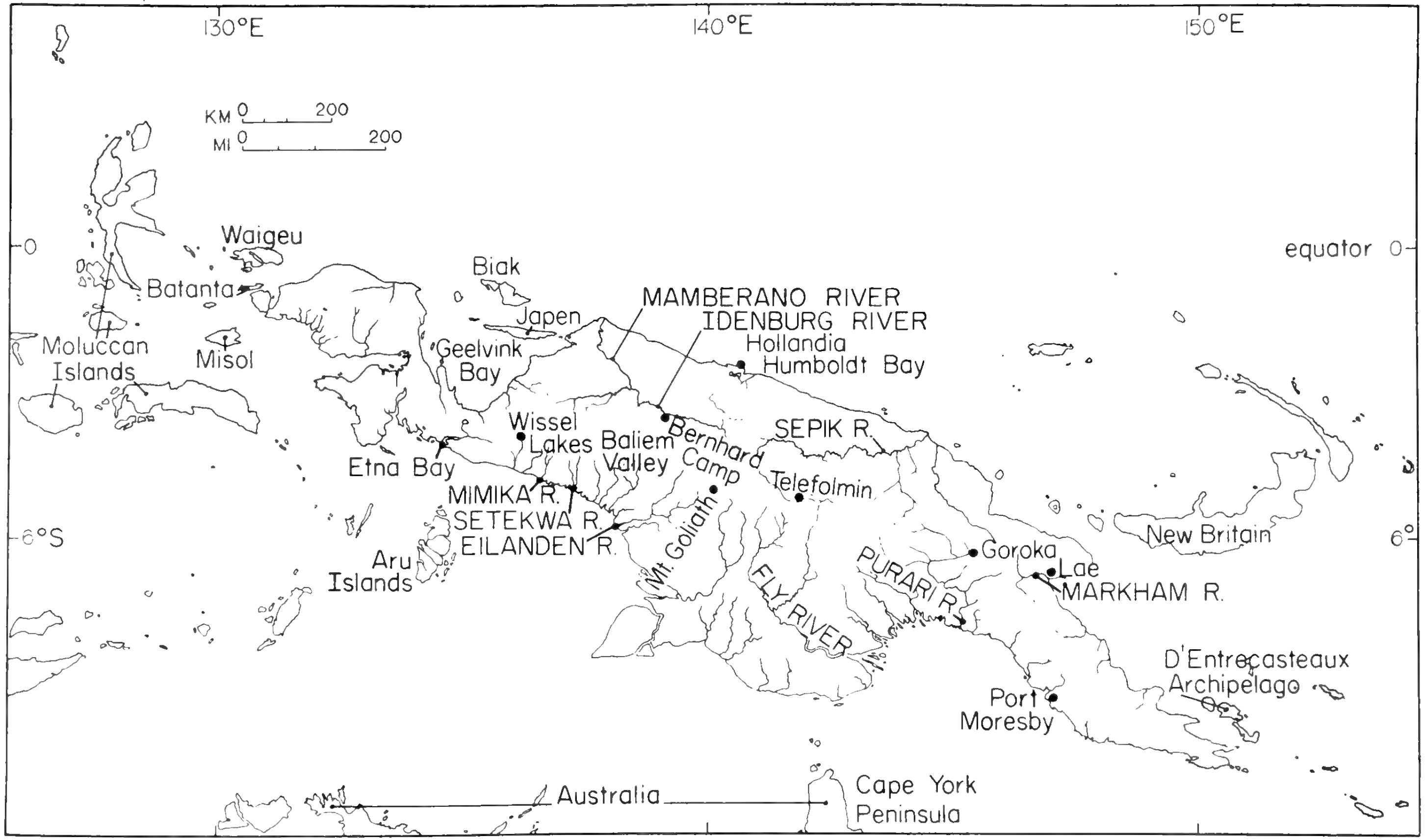
The area of New Guinea covered (Map 3) thus extends approximately from Tari in the west to Kainantu 200 miles farther east, and from the Schrader Range in the north to Lake Kutubu and Mt. Karimui 120 miles farther south. The highest peak of this area is Mt. Wilhelm (ca. 15,000 ft), with numerous other peaks exceeding 12,000 ft (e.g., Mt. Hagen, Mt. Giluwe, and Mt. Michael). The drainage is by tributaries of the Sepik and Ramu Rivers in the north, and by tributaries of the Purari and Kikori Rivers in the south. The principal towns include Goroka, Mt. Hagen, Kainantu, Kundiawa, Mendi, Minj, and Wabag. The zoogeographical area which I call "Eastern Highlands" includes, but is larger than, the political subdivision of the Territory of Papua and New Guinea called the "Eastern Highlands District."

The following sources of information concerning the avifauna of the Eastern Highlands were available to me:

The first systematic collections of birds in the Eastern Highlands



MAP 1. Principal mountain ranges of New Guinea. The Central Range extends uninterrupted from the southeastern tip to the head of Geelvink Bay in the west. To the north of the Central Range and separated from it by areas of lower elevation are several isolated ranges or "mountain islands": the Vogelkop, Wandammen Peninsula, Van Rees Mountains, Cyclops Mountains, North Coastal Range, Adelbert Mountains, and Huon Peninsula. Some arbitrarily named regions of the Central Range (Weyland Mountains, Snow Mountains, Eastern Highlands, southeastern New Guinea, Herzog Mountains, Wharton Range) and of the Vogelkop (Tamrau Mountains, Arfak Mountains) are also indicated.



MAP 2. Locations of some of the principal rivers, towns, islands, and collecting localities mentioned in the text.

were carried out independently by three workers in the early 1950's in the Wahgi Valley and surrounding mountains (see Map 3 for these and other collecting stations in the Eastern Highlands). E. T. Gilliard of the American Museum of Natural History led expeditions in 1950 and 1952, the results of which were reported by Mayr and Gilliard (1954). Gyldenstolpe (1955) described the collections he made for the Stockholm Museum in 1951. Sims (1956) analysed birds collected by Shaw-Mayer for the British Museum (Natural History) in 1950 and 1951. Almost all the material of these three collectors was obtained at elevations above 5,000 ft. Their surveys of the forest at higher elevations were sufficiently exhaustive that subsequent workers have been able to add only two species to the forest avifauna breeding in the Eastern Highlands above 6,000 ft.

In the Schrader Range on the northern rim of the Eastern Highlands a small but important early collection on the 6,700-foot Schraderberg was made in 1913 by Bürgers as part of the Sepik River Expedition of the German colonial administration. It was studied by Stresemann (1923). The remaining collections of this large expedition were obtained at low elevations along the Sepik River and on mountains (Hunsteinspitze, Lordberg, Etappenberg, Mäanderberg) farther to the west, which fall outside the area covered by this monograph. Another collection in the Schrader Range was obtained by E. T. Gilliard in 1964 at 5,000-8,600 ft and was discussed by Gilliard and LeCroy (1968).

Collections for the Commonwealth Scientific and Industrial Research Organization of Australia (C.S.I.R.O.) were made by Schodde in 1961 at Lake Kutubu (2,450 ft) and Mt. Giluwe (ca. 5,900-11,500 ft) and by Hitchcock in 1963 in the Kubor Range (ca. 6,400-12,000 ft). The Lake Kutubu collection was described by Schodde and Hitchcock (1968), while the Kubor collection was briefly discussed by Hitchcock (1964), who kindly provided me with further unpublished records based on it.

Unpublished information from other observers was also available during the preparation of this report. Dr. R. N. H. Bulmer generously provided detailed summaries of his extensive unpublished observations between ca. 3,000 and 12,000 ft, principally from two areas: the Kaironk Valley of the Schrader Range, and the Kyaka area from Baiyer River to the northern slopes of Mt. Hagen. Major H. L. Bell furnished records from several localities. The New Guinea Bird Society Newsletter, published monthly since 1965, was the source of some additional records by other naturalists resident in New Guinea.

My studies were carried out in the course of four expeditions (1964, 1965, 1966, 1969) to the southeastern part of the Eastern Highlands at elevations between 1,350 and 12,300 ft. Most of the new distributional records and material of taxonomic interest were obtained below 5,000 ft, because the nearest localities at which the hill forest (2,000-

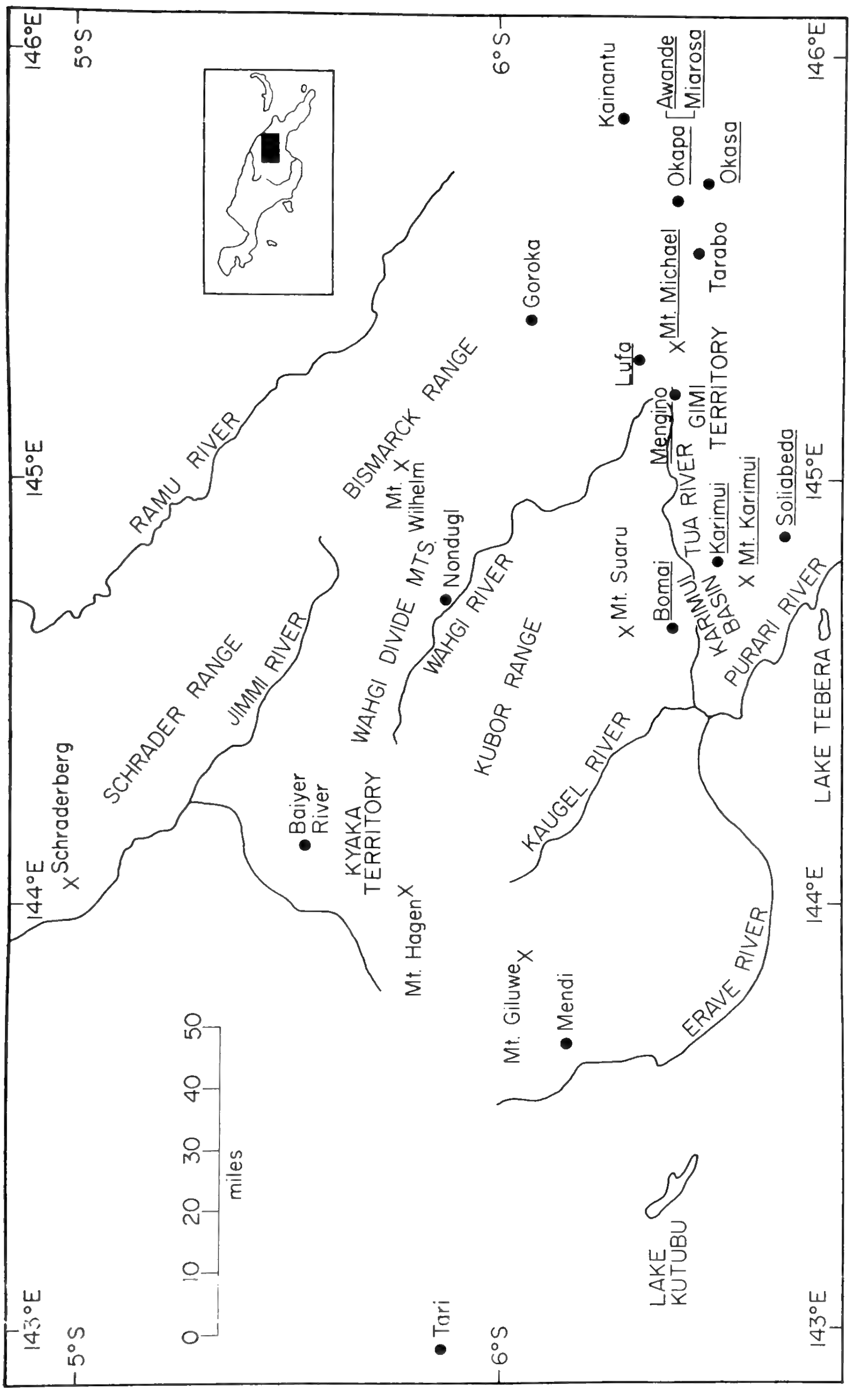
5,000 ft) avifauna of the southern watershed of the Central Range had been exhaustively surveyed were 400 miles to the west (Snow Mountains) and 150 miles to the east (Wharton Range). Also, previous taxonomic publications on Eastern Highlands material discussed little material under 5,000 ft, except for the report of Schodde and Hitchcock (1968). A summary of my itineraries, methods, and collecting stations follows.

Itineraries

The 1964 expedition was conducted jointly with Dr. John W. Terborgh. From 9 June to 28 June we worked in the vicinity of Okapa, principally at the villages of Miarosa and Awande (Map 3). Between 29 June and 19 July we surveyed the avifauna of Mt. Michael, including the collecting stations of Lufa and Mengino. On 20 July we set out overland from Mengino through the territory of the Gimi people for the Karimui Basin, which Terborgh reached on 27 July. I stopped en route to observe at a campsite on the Sena River between 25 and 28 July, and arrived at Karimui on 29 July. From then until 17 August we remained at Karimui Patrol Post, surveying the avifauna of the Karimui Basin. We returned to Okapa for the period 18-27 August, spending part of this period at the nearby Okasa forest.

In 1965 I began observing in the Okapa area on 13 June and worked there until 27 June, dividing the time between the village of Awande and the Okasa forest. The remainder of the expedition, which lasted until 15 September, was spent in the Karimui area. Studies were carried out at Karimui Patrol Post itself 1-5 July, 10-18 July, 2-7 August, and 11-15 September. Bomai was reached by Cessna airplane and observations made there between 6 and 9 July. My lowest-altitude collecting station was Soliabeda, which I reached overland in two and one-half days and where I worked from 19 July to 1 August. The period from 8 August to 9 September was devoted to altitudinal censuses on the west peak of Mt. Karimui.

The 1966 expedition was mainly concerned with exploring the North Coastal Range (Diamond, 1967b, 1968, 1969) and falls outside the scope of this monograph. No collections were obtained in the Eastern Highlands, but some observations were made at Karimui, Okapa, and Goroka on 20-24 June and 14-15 September. During the 1969 expedition, studies were made at Astrolabe Bay, Karkar and Bagabag Islands, New Britain, and Mt. Albert-Edward in southeastern New Guinea, all lying outside the Eastern Highlands. However, the avifauna of Mt. Albert-Edward is very similar at the species level to that of the Eastern Highlands, and analyses of stomach contents and some behavioral observations from Mt. Albert-Edward are cited in this monograph.



MAP 3. The Eastern Highlands of New Guinea, with the locations of the principal villages, rivers, mountains, and collecting localities mentioned in the text. The names of my study localities are underlined.

Methods

In order to leave much of my time free for field observations, virtually all specimens were collected and prepared by Eastern Highlands natives: Paran, Koreko, and Esa of the Fore people, Gumini and Uro of the Gimi people, and Kariniga and Omwai of the Karimui people. Collecting was carried out with shotguns and with mistnets. I examined many additional specimens that had been obtained by local people with bow and arrow, snares, sticks, and other less conventional means. In the afternoon or evening I supervised the preparation of specimens by Highlands assistants, sexing each specimen by dissection and noting the condition of the gonads. In 1965, but not in 1964, specimens were weighed prior to preparation. Most specimens were prepared as skins, but some were made into skeletons or preserved in formalin. Collections of frogs, lizards, snakes, and mammals (mostly rodents and mistnetted bats, but also some marsupials) were brought back in formalin. The bird skins are divided between the American Museum of Natural History, the Harvard Museum of Comparative Zoology, and the Los Angeles County Museum of Natural History; all mammals are at the first-named institution, all birds in formalin at Harvard; the frogs, lizards, and snakes are divided between the American Museum of Natural History and Harvard; and the bird skeletons are divided between these two institutions and the United States National Museum. Taxonomic evaluation of all the collected bird material was undertaken in the Bird Department of the American Museum of Natural History, where the most extensive collection of New Guinea birds is located. Some comparisons were also undertaken at the Museum of Comparative Zoology.

Most mornings and parts of the afternoons were used for field observations. My observations were mainly devoted to determining, as accurately as possible, the altitudinal ranges in undisturbed forest, to identifying songs and calls, and to estimating relative abundances of species by crude censusing techniques. The most exact altitudinal records were obtained on the west ridge of Mt. Karimui, which was completely covered by undisturbed forest. There were no man-made clearings within two miles of this ridge. Visible evidence and reports of local informants indicated that the summit of the ridge had not been climbed previously and that the lower parts of the ridge were visited only infrequently by native hunters. We made a footpath along the crest of the ridge from its base at 4,000 ft to the summit at 8,165 ft; made horizontal paths to divide the mountain into eight altitudinal zones of about 500 vertical feet each; selected convenient reference marks to divide each zone into subzones ranging in vertical extension from 60 to 200 ft; and placed camps at the top of Zone 1 (4,200 ft), at the junction of Zones 2 and 3 (4,750 ft), at the junction of Zones

3 and 4 (5,390 ft), and at the junction of Zones 5 and 6 (6,500 ft). The altitude of each reference point was read to ± 5 ft on an aviation altimeter on which the standard barometric pressure was set to 29.92 inches. The average of numerous readings on different days under varying atmospheric conditions was calculated for each point, since daily standard barometer readings on Mt. Karimui were, of course, unavailable. Upon retrieving a bird the collectors numbered the wrapping paper of each specimen to indicate the subzone in which it had been taken. By frequently noting the contents of the nets before my assistants later came to empty them, I was able to determine that their subzone assignments were completely reliable. I conducted daily censuses of each subzone in turn, and recorded exact elevations whenever a bird was encountered near a limit of its species range. An average of four days was devoted to collecting and censusing in each of the eight zones, and an average of a week was spent living at each of the four camps. Thus, the relative abundance at vertical intervals of 60 to 200 ft was estimated for all species present on Mt. Karimui, and the limits of some species (cf., *Crateroscelis murina* and *C. robusta,* p. 27) were determined exactly.

Crude censuses of relative abundance (*not* of absolute abundance per acre) were conducted by counting each bird heard or seen within a horizontal distance of about 50 yards during several hours of observations each day. If a song was heard several times from the same locus, suggesting that it came from the same individual, it was counted only once. Individuals apparently more than about 50 yards away were not counted, in order to reduce the extent to which the abundance of conspicuous or noisy species might be overestimated. The number of individuals of a given species censused was divided by the total number of individuals of all species censused in order to obtain one estimate of the species' relative abundance, expressed as a percentage of the whole avifauna. A second estimate was derived from collected specimens, by dividing the number of individuals of a given species collected by the total number of all birds collected. These two estimates were then averaged, for each species and for each subzone or collecting locality, to yield the relative abundances which will be cited in the individual species accounts. For instance, the statement that a given species "accounts for 2% of the local avifauna" means that two of every 100 birds locally present are estimated to be of that species. The relative abundances of the commonest species at a locality were rarely above 10%, and were generally in the range 4-10%. There were about 21 species at Karimui Patrol Post (3,650 ft), and about 15 in Zone 3 of Mt. Karimui (4,750-5,390 ft), with relative abundances greater than 1%.

These crude estimates of local relative abundance are obviously subject to systematic errors because of the methods used to derive them. Species which rarely sing, or whose songs I failed to determine, or which tend to stay out of sight, were underestimated in field censuses. Middlestory and upperstory species which are infrequently or never caught in mistnets were underestimated in the collections. Some protected species which my assistants were instructed not to collect beyond a certain number (birds of paradise, bowerbirds, and the large cockatoos) were underestimated in shotgun collections, but many of these, fortunately, are noisy birds which were inevitably overestimated in my field censuses. However, the combined estimate from censuses and collecting should provide at least tentative first estimates of relative abundance. Comparisons of the relative abundance of the same species at two different localities or altitudes should be freer from distortion, since the same systematic errors would affect the species at both localities.

Descriptions of Collecting Localities

General Remarks

Botanical descriptions of parts of the Eastern Highlands have been given by Brass (1959), Hitchcock (1964), and Schodde and Hitchcock (1968), and of montane vegetation in other parts of New Guinea by Brass (1941), Archbold, Rand, and Brass (1942), and Gilliard and LeCroy (1961). Briefly, the original vegetation over almost the whole area of the Eastern Highlands was forest up to timberline at about 11,500 ft, above which alpine grassland takes over. The total area occupied by natural non-forest habitats between 1,000 ft and timberline is extremely small. It consists only of strips along the few lakes (Lake Kutubu, Lake Tebera, Lake Kandep) and numerous small rivers and streams in this altitudinal range, plus occasional landslide, earthquake, and tree-fall areas on mountain slopes. The clearing of the forest for agricultural purposes has greatly expanded these open habitats. Today, because of dense native population, the Eastern Highlands contain the most extensive areas of (secondary) midmontane grassland in New Guinea.

The forest itself gradually changes in composition with altitude, the general succession being lowland rainforest at the lowest elevations, midmontane forest dominated by oaks (*Castanopsis, Quercus*), forests dominated by southern beeches (*Nothofagus*) at higher elevations, and subalpine forest and shrubbery with numerous conifers (*Podocarpus, Libocedrus*). Perhaps the most striking change in forest physiognomy occurs at what may conveniently be termed the moss level. The upper elevations of New Guinea mountains are shrouded much of the time in standing banks of clouds. Within this moist and poorly lit zone the forest is stunted, and thick layers of moss cover much of the ground, trunks, and branches. The lower limit of this heavily mossed zone, which is said to coincide with the lower limit of the cloud banks, is sometimes sufficiently distinct that it can be meaningfully defined to within 50 vertical feet. Its elevation varies considerably from mountain to mountain, depending upon local cloud conditions. This moss level occurs at about 6,500 ft on Mt. Karimui's west ridge, at 4,500 ft on Mt. Karimui's east ridge, at 8,700 ft on Mt. Michael, and at some undetermined altitude about 7,500 ft in the Okapa area. Several birds, such as *Ptiloprora guisei, Oreocharis arfaki, Peneothello sigillatus,* and *Lophorina* (*Pteridophora*) *alberti,* have lower altitudinal limits which correlate approximately with the moss level, while some other species (p. 67) have ceilings at the moss level.

Specific Localities

Okapa area.—Collecting localities were Okapa Patrol Post (6,600 ft); Awande (6,000 ft), a native village two miles east of Okapa; Miarosa (5,800 ft), a native village two miles east of Okapa and one mile south of Awande; and Okasa, a forestry camp near a village of the same name, nine miles south of Okapa. The highest collecting elevation in this area was at 7,500 ft on the ridge separating Miarosa from Awande, and the lowest was at 3,550 ft on a small river below Okasa. This area is inhabited by the Fore people, who have achieved medical prominence through *kuru* or "laughing sickness" (Gajdusek and Zigas, 1957), an incurable and invariably fatal neurological disease which is largely restricted to the Fore and accounts for a high percentage of their deaths. Much of the area around Okapa, Awande, and Miarosa has been cleared for agriculture and exists as gardens, grassland, or second-growth, but the hill slopes behind Miarosa and Awande remain with their original cover of midmontane forest. At 7,500 ft there is still little moss in the forest. Correlated with this, *Oreocharis arfaki* and *Peneothello sigillatus* are absent, and *Ptiloprora guisei* is very rare in the Okapa area. Most collecting at Okasa was done between 3,550 and 4,250 ft in a forest with magnificent tall *Araucaria* pines. This forest is a reservoir of cerebral malaria and is presently uninhabited, but large expanses of grassland around it testify to a formerly dense native population.

Mt. Michael area.—Collecting localities were Mt. Michael itself, an isolated 12,300-foot peak forested above 7,000 ft, below which altitude the forest has been largely cleared; Lufa Patrol Post at 6,300 ft on the north slope of Mt. Michael, situated in an area which has been largely cleared; and Mengino, a village at 6,150 ft on the west slope of Mt. Michael. Our principal camp was located in tall forest at 8,000 ft on the northwest side of Mt. Michael, with a subsidiary camp in stunted subalpine forest at 10,200 ft. Heavily mossed conditions are first encountered at 8,700 ft, and alpine grassland at 11,200 ft, but patches and tongues of shrubbery in the alpine grassland are still found near the summit at 12,300 ft. Terborgh and I reached alpine grassland and the summit only on one day (10 July 1964), so that my experience of alpine grassland in the Eastern Highlands is limited. Collecting at

Mengino extended from the village at 6,150 ft down to a river at 4,600 ft, in partly cut forest interspersed with second-growth and gardens.

Gimi territory.—The area between Mengino and the east rim of the Karimui Basin is hilly and lies between 4,200 and 6,500 ft. Second-growth and gardens are found around several small villages of the Gimi people, but most of the area is still forested. Little time was available for collecting in this area. However, in passing through a small patch of mossy forest at about 6,000 ft we met *Ptiloprora guisei* again, which was absent at the same and even higher elevations elsewhere in areas with little mossing.

Karimui Basin.—Most of the Eastern Highlands consists of rugged and steep ridges and mountains. The Karimui Basin, a volcanic plain on the north side of Mt. Karimui, is of interest as one of the few large flat expanses within the Eastern Highlands. The basin floor is at about 3,500 ft, has no hills, and is flat except for a few narrow stream gorges. As shown by several aerial reconnaissance flights, which I undertook in 1965, the basin is effectively sealed off from the rest of the Eastern Highlands by a ring of mountains which rises to about 8,400 ft in the central peak of Mt. Karimui and which stands at least 1,000 ft (in most places much higher) above the basin floor on all sides except where pierced by narrow river gorges. Thus, the Karimui Basin is an island of tropical habitat isolated within the Eastern Highlands, a fact which is reflected both in its endemic bird forms and in the unusual composition of its avifauna (pp. 53-56). At the time of my studies most of the basin floor was still covered by rainforest, which unfortunately is rapidly being cleared in the vicinity of villages. In its vegetational structure this basin forest is typical of the rainforest of the flat lowlands near sea level, e.g., in the presence of emergent trees up to 200 ft tall ("A story" in the sense of Richards (1952)), and differs from the hill forest encountered at the same elevation at most other localities in New Guinea. Collecting localities on the basin floor were Karimui Patrol Post at 3,650 ft, henceforth simply called Karimui; and Bomai, a small airstrip and native village at 3,250 ft about 12 miles west of Karimui. The locality "Sena River" refers to a camp I made in undisturbed forest beside a small stream at 4,500 ft. This camp lay 15 miles east of Karimui and within the basin but part way up its eastern wall. Soliabeda is a native village at 2,000 ft, nine miles southeast of Karimui and beyond Mt. Karimui, i.e., outside of the basin. The village of Soliabeda was only a few years old, so that the area of land which had been cleared for gardens was still small. The terrain around Soliabeda is hilly, in contrast to the nearby Karimui Basin. Below the village of Soliabeda the Wi River, flowing at 1,350 ft, represented the lowest altitude I reached in the Eastern Highlands. Finally, collections were made on the west ridge of Mt. Karimui itself, which was reached from the village of Iogoramalu, about six miles west of Karimui Patrol Post. As described on p. 9, the ridge was divided into eight altitudinal zones with the following limits: Zone 1, 4,000-4,200 ft; Zone 2, 4,400-4,750 ft; Zone 3, 4,750-5,390 ft; Zone 4, 5,390-5,960 ft; Zone 5, 5,960-6,500 ft; Zone 6, 6,500-7,080 ft; Zone 7, 7,080-7,620 ft; Zone 8, 7,620 ft to the summit of the ridge at 8,165 ft. The highest peak of Mt. Karimui is a few hundred feet higher than the summit of this west ridge but is separated from it by a narrow vertical-walled chasm several thousand feet deep and hence was inaccessible to me. Zone 1 was still on the gently sloping edge of the basin floor, while Zones 2 through 8 were on the ridge which rises continuously and steeply from the top of Zone 1 to the summit. A well-defined moss level occurrs at 6,500 ft, above which the stunted summit forest is a three-dimensional maze of fallen branches, low trees, and bushes, all overgrown with cold, wet moss.

Goroka.—A few observations were made at this town, which is one of the principal commercial centers in the Eastern Highlands, but no specimens were collected. The elevation is 5,140 ft. All land in the vicinity has been cleared, and no primary forest remains.

Acknowledgments

These studies were made possible and were facilitated by generous cooperation from many individuals and groups at all stages in the work. It is a pleasure to record my debt to:

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To these and many other individuals and groups, I am grateful.

II

SOME GENERAL FEATURES OF THE EASTERN HIGHLANDS AVIFAUNA

Patchiness of Distribution

"Drop-outs" in the Eastern Highlands

The breeding avifauna of montane forest and alpine grassland of the Eastern Highlands must now be considered well-explored ornithologically. Since the surveys of Gilliard, Gyldenstolpe, and Shaw-Mayer in the years 1950-1952, only two forest species appear to have been added to the list of birds breeding or presumed breeding at elevations above 6,000 ft, viz., the honeyeater *Ptiloprora meekiana* and the mannikin *Erythrura papuana*. Most species breeding above 6,000 ft in the Eastern Highlands have been recorded or collected there on at least two separate instances, the sole exceptions being *Pachycephala tenebrosa* and *Ptiloprora meekiana,* which are known in the Eastern Highlands from a single specimen each. There are undoubtedly further breeding species to be recorded from the hill forests below 6,000 ft and from grassland and disturbed areas above this elevation. More nonbreeding migrants and vagrants from the lowlands also remain to be discovered. However, the addition of more than one or two species to the breeding avifauna of undisturbed forest above 6,000 ft is unlikely.

For these reasons it is significant that there are nine species that have been recorded from the Central Range to the east and west of the Eastern Highlands but not in the Eastern Highlands, even though the Eastern Highlands provide suitable habitats. A few of these apparent "drop-outs" may still turn up, but most of them will probably prove to be absent. These absences, and several related phenomena involving distributional patchiness in New Guinea, require detailed discussion because of their evolutionary and zoogeographical significance. The nine apparent "drop-outs" are:

Hieraaetus morphnoides, Little Eagle (Accipitridae); a rare species in New Guinea, recorded to date from the Central Range in western New Guinea (Utakwa River, Baliem Valley, Idenburg River), the Central Range in southeastern New Guinea (Aroa River, Hydrographer Range, Sogeri District, Wau), two of the "north mountain islands" (Adelbert Mountains, Huon Peninsula), and the lowlands near Lae. Most of these records are from between 2,000 and 6,000 ft.

Coracina lineata, Barred Graybird (Campephagidae); a patchily distributed but locally common inhabitant of hill forest between 2,000 and 4,000 ft in the mountains of the Vogelkop, southeastern New

Guinea, and three of the "north mountain islands" (North Coastal Range, Adelbert Mountains, Huon Peninsula).

Amalocichla sclateriana, Greater New Guinea Thrush (Turdinae); forests of the Central Range between 8,000 and 12,000 ft in western and southeastern New Guinea.

Orthonyx temminckii, Logrunner (Orthonychinae); forest at 4,000-10,000 ft on the Central Range in western and southeastern New Guinea and on the Vogelkop.

Macgregoria pulchra, MacGregor's Bird of Paradise (Paradisaeidae); conspicuous and fairly common in high altitude forest (9,000-13,000 ft) of the Central Range in west New Guinea, probably at Telefolmin, and in southeastern New Guinea. It strains one's credulity to suppose that *Macgregoria pulchra* could have escaped detection if it occurred in the Eastern Highlands. Not only is it conspicuous, but most New Guinea ornithologists have paid particular attention to birds of paradise. Gilliard, Bulmer, I, and others made a habit of exhaustively quizzing local natives and would surely have learned of *Macgregoria* in this fashion, as Gilliard did at Telefolmin (Gilliard and LeCroy, 1961, p. 16 and p. 64).

Climacteris leucophaea,[1] White-throated Tree Creeper (Climacteridae or (?) Certhiidae); the sole species of creeper in New Guinea; forest from 5,000 to 10,000 ft on the Central Range (western and southeastern New Guinea, Telefolmin) and the Vogelkop.

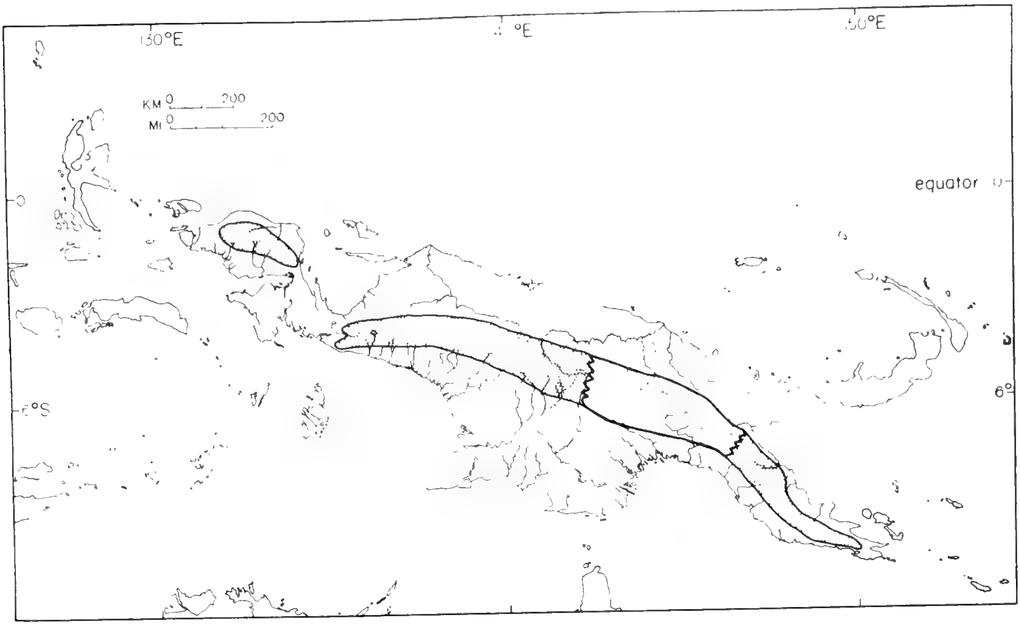
Ptiloprora plumbea, Leaden Honeyeater (Meliphagidae); a rare inhabitant of the Central Range in forest at 4,000-6,000 ft (Utakwa River of western New Guinea, Telefolmin, and southeastern New Guinea).

Melanocharis arfakiana, Obscure Berrypecker (Dicaeidae); the second rarest New Guinea bird, known from two specimens, one taken on the Vogelkop at the western tip of New Guinea in 1867, and the other taken 1,000 miles to the east in 1933 at 3,000 ft in southeastern New Guinea.

Lonchura monticola and *L. montana,* Alpine Mannikin (Estrildidae), a superspecies; alpine grassland at 9,000-14,000 ft in western and southeastern New Guinea, where it is common and occurs in flocks of up to 50 birds. The only other ecologically related estrildid in New Guinea, *Oreostruthus fuliginosus,* is uncommon and restricted to the edge between forest and alpine grassland. The alpine grasslands of Mts. Hagen, Wilhelm, and Giluwe have been explored by several collectors, and this conspicuous species could hardly have been missed if present.

Of these nine "drop-outs," the evidence is strongest for the absence of *Macgregoria pulchra* and *Lonchura monticola;* nearly as strong for *Amalocichla sclateriana, Orthonyx temminckii,* and *Climacteris leucophaea;* less strong for *Hieraaetus morphnoides, Coracina lineata,* and *Ptiloprora plumbea;* and inadequate concerning the mysterious *Me-*

1 Listed as *Climacteris placens* in Rand and Gilliard (1967).



MAP 4. *Distribution of Climacteris leucophaea,* the White-throated Tree Creeper. This species is present on the Vogelkop and on the western and southeastern portions of the Central Range but is absent from the Eastern Highlands, so that its distribution is discontinuous despite the continuous expanse of montane habitat on the Central Range.

lanocharis arfakiana. Since some of these drop-outs are uncommon or rare, the obvious first question to ask is whether there has been enough work in the Eastern Highlands to justify attaching significance to the apparent absences. The following comparison shows that the ornithological exploration of the Eastern Highlands would have been more than adequate to detect their presence in most cases. In southeastern New Guinea the First Archbold Expedition collected 3,200 birds in 1933-1934; the collection included eight of the nine species that drop out in the Eastern Highlands. In western New Guinea the Third Archbold Expedition collected 4,846 birds in 1938-1939; the collection included six of the nine Eastern Highlands drop-outs. The total number of bird specimens collected to date in the Eastern Highlands is considerably larger, viz., about 7,500, of which a higher proportion came from medium and high altitudes (where most of the drop-outs would be found) than in the case of the Archbold Expeditions. In addition, workers in the Eastern Highlands have been able to supplement their own observations with far more information gathered from local natives than did the Archbold Expeditions. For instance, my Fore and Daribi assistants gave me detailed descriptions of all the birds that they or their relatives had at some time seen or heard of but which I failed to collect (pp. 90-91). These descriptions included even inconspicuous, undistinctive, and rare warblers, and species of which one individual had been caught 10 years ago but which had never been seen since. Most of these descriptions are identifiable, and none resembles any of the drop-outs. The Fore and Daribi are unlikely to have overlooked birds with habits as distinctive as those of *Orthonyx temminckii* and *Climacteris leucophaea* while distinguishing sibling species in the warbler genera *Sericornis* and *Crateroscelis*. Thus, I consider it highly probable that most of the apparent drop-outs are actually missing in the Eastern Highlands.

One must still ask whether the absences could be related to replacement by closely similar competing species or to the absence of suitable habitat. The former explanation applies to a tenth species, *Melidectes ochromelas,* which is also absent in the Eastern Highlands while present to the east and west. As discussed (pp. 388-389), there is an unusual competitive situation involving three congeneric species in genus *Melidectes,* and the absence of *M. ochromelas* is correlated with the presence of two of its congeners. *Coracina lineata, Ptiloprora plumbea,* and *Melanocharis arfakiana* are members of large genera, and competition may also play a role in their absence, though not in any simple fashion—i.e., their distributions are not complementary to the distribution of congeners, as in the *Melidectes* case. No such factors suggest themselves in the remaining cases. Elsewhere in New Guinea *Lonchura monticola* is the common and sole alpine grassland mannikin; *Macgregoria,* a very distinct monotypic genus, is the common and sole bird of paradise above 11,000 ft; the creeper *Climacteris leucophaea* is the only representative of its family in New Guinea; *Orthonyx temminckii* has distinctive habits and no congeners in New Guinea; and the thrush *Amalocichla sclateriana* lives at altitudes above its only congener and overlaps altitudinally only one other thrush (*Turdus poliocephalus*), which has a quite different diet (mainly fruit instead of insects). In the Eastern Highlands the niches of these drop-outs remain unfilled in their absence.

Thus, as illustrated in Map 4 (p. 19) for *Climacteris leucophaea,* the distribution of these drop-outs on the Central Range shows a gap of about 250 miles in the Eastern Highlands. For the alpine species *Lonchura monticola* and *Macgregoria pulchra* the available habitat is discontinuous, but for the remaining drop-outs the Central Range presents a 1,000-mile stretch of habitat with no major barriers. One is accustomed to encountering drop-outs in the avifaunas of isolated mountain ranges, but the finding of drop-outs in sections of a continuous habitat may come initially as a surprise. However, the other parts of the Central Range also have drop-outs (pp. 46-47). Southeastern New Guinea "inexplicably" lacks five or six montane species that are present on the Central Range both in western New Guinea and in the Eastern Highlands. These are *Porzana tabuensis, Pachycephala tenebrosa,* the *Paradigalla* superspecies, *Lophorina (Pteridophora) alberti,* and *Archboldia papuensis;* the *Melidectes nouhuysi-M. princeps* superspecies is also missing but may be excluded by competing congeners, as discussed on p. 391. The western part of the Central Range also "inexplicably" lacks four montane species present both to the east on the Central Range and to the west on the Vogelkop, viz., *Myzomela adolphinae, Erythrura papuana, Coracina lineata,* and *Melanocharis arfakiana.* These lists exclude species which are absent because their distribution complements that of a congener, or which appear to have split off recently from a close relative and to be in the process of expanding their range (cf., pp. 33-34). To set these numbers in perspective, New Guinea has about 170 widespread montane species or superspecies, so that the proportion of drop-outs in any given part of the Central Range is only 3-5%. The proportion of widespread species that drop out is much higher on the isolated mountain ranges of the Vogelkop and "north mountain islands": Vogelkop, ca. 8%; Huon Peninsula, 8%; North Coastal Range, 58%; Cyclops Mountains, 77%; Adelbert Mountains, 82%.

The drop-out phenomenon within New Guinea may be interpreted along the lines developed by MacArthur and Wilson (1967) for island faunas. To explain the fact that the number of species on an island is observed to increase with increasing island size and decreasing distance from the mainland, these authors postulated that the number of species in an island fauna represents an equilibrium between extinction rates and immigration rates. Extinction rates are highest on the smallest islands, where populations consist of the fewest individuals and run the highest risk of being wiped out by random fluctuation in numbers due to transiently poor conditions, such as disease, accidents, failure in food supply, etc. Immigration rates increase with island size and proximity to the mainland. The same principles find immediate application to the avifaunas of New Guinea's isolated mountain ranges, which for montane birds represent distributional islands of suitable habitat in a "sea" of lowland. These principles apply equally well to any portion of the continuous Central Range, and the only differences from the situation on the isolated ranges are quantitative. A species is more likely to be eliminated by chance, and extinction rates are therefore higher, on a small mountain range with a small total population than on a large mountain mass such as the Eastern Highlands. When a species does disappear, immigration rates are higher on the Central Range, where recolonization occurs from immediately adjacent portions of the range, than on the isolated mountain ranges. Thus, the percentage of drop-outs is lowest on the various parts of the Central Range, higher on the large but isolated ranges of the Vogelkop and Huon Peninsula, and highest on the smallest isolated ranges (Cyclops Mountains and Adelbert Mountains). A similar phenomenon is encountered in the distribution of New Guinea lowland birds, because mountain ranges divide up the New Guinea lowlands into habitat islands of various sizes. For instance, the flat lowland strip hemmed in by mountains along the north coast of southeastern

New Guinea lacks several species, e.g., *Pitohui kirhocephalus, Mino anais, Goura victoria,* which are otherwise ubiquitous and common in the New Guinea lowlands.

The drop-out phenomenon on the Central Range may provide one of the keys to how the New Guinea montane avifauna evolved. Speciation involves the breakup of what was originally one species into two geographically isolated daughter populations, which may diverge in isolation to the point where they are reproductively isolated and ecologically distinct when they come into contact again. One may therefore ask, "What provided the necessary isolation for speciations in the mountains of New Guinea?" A glance at a map of New Guinea (Map 1), with its continuous Central Range and isolated smaller ranges, might suggest that divergences took place between populations on the Central Range and populations on the isolated ranges, with the latter then reinvading the former to generate new species on the Central Range. If this were the case, one would expect to find distributional patterns reflecting early stages in the development of sympatry after reinvasion, such that one montane species occurrs on the Central Range and a different but closely related species occurrs on an isolated range plus the nearest portion of the Central Range. However, there is not a single such pattern involving any of the "north mountain islands," and even the Vogelkop provides only a few possible examples, viz., *Peneothello cryptoleucus* and *P. cyanus; Pachycephalopsis hattamensis* and *P. poliosoma; Ptiloprora erythropleura* and *P. perstriata.* This suggests that the isolates of the small detached ranges have rarely succeeded in reinvading the large Central Range. In contrast, there are numerous examples of pairs of forms that clearly represent every possible intermediate stage in speciation involving eastern and western isolates on the Central Range. These examples include: pairs of allopatric semispecies with one member in the western part and the other in the eastern part of the Central Range (e.g., *Lophorina* (*Parotia*) *carolae* and *L.* (*Parotia*) *lawesi, Melidectes princeps* and *M. nouhuysi, Lophorina* (*Astrapia*) *splendissima* and *L.* (*Astrapia*) *mayeri* and *L.* (*Astrapia*) *stephaniae*); pairs of closely related species that are sympatric over much of the middle of the Central Range but only one of which reaches the western tip and the other the eastern tip (e.g., *Rallicula rubra* and *R. forbesi, Psittacella modesta* and *P. madaraszi, Epimachus fastosus* and *E. meyeri, Toxorhamphus novaeguineae* and *T. poliopterus*); and pairs of closely related species, one of which is confined to the eastern part of the Central Range and the other of which is distributed over the whole length of the Central Range (e.g., *Ptiloprora guisei* and *P. perstriata, Paradisaea rudolphi* and the *P. raggiana* superspecies, *Amblyornis subalaris* and *A. macgregoriae,* and probably *Cnemophilus macgregoriae* and *C.* (*Loria*) *loriae*).

These cases suggest that montane speciation in New Guinea can take place, and in most cases has taken place, on the Central Range alone, despite the absence of major east-west geographical barriers on this range. The apparent paradox of speciation on a continuous mountain range may be resolved by the drop-out phenomenon, which provides the necessary isolation. Evidently the first stage in speciation is the development of east-west clines and subspeciation on the Central Range, as illustrated by the subspecies of most midmontane birds (pp. 00-00). In the second stage an intermediate population dies out, as illustrated by the Eastern Highlands drop-outs. These local extinctions may have higher probabilities of occurring at times when the area of suitable habitat has been reduced by climatic or vegetational fluctuations, e.g., when a general cooling compresses forest altitudinal bands or when dry conditions restrict the forest. In the third stage the now-isolated eastern and western populations diverge to the point where they become well-marked subspecies or distinct members of a superspecies. This stage is represented by the Alpine Mannikin, *Lonchura monticola,* which occurs in southeastern New Guinea, has no population in the Eastern Highlands and is represented in western New Guinea by the semispecies, or very distinct subspecies *L. montana* (= *L. monticola montana*). The fourth stage is reached when these isolates come into contact again (e.g., the *Parotia, Melidectes,* and *Astrapia* superspecies cited above). In some cases the rejoined western and eastern populations will not have acquired reproductive isolation and will hybridize, leading to very distinct but interbreeding western and eastern subspecies (e.g., *Crateroscelis robusta robusta* and *C. r. sanfordi, Rallicula forbesi forbesi* and *R. f. steini*). In other cases, however, such as those cited in the previous paragraph, reproductive isolation will be perfected, and as the final stage in speciation the two forms will gradually reinvade each other's ranges, or else one will reinvade the entire range of the other. The ecological correlates of these east-west reinvasions follow a consistent pattern and are discussed on pp. 00-00. These considerations may be relevant to speciation problems in continuous habitats in other parts of the world, such as the problems posed by the rich montane avifauna of the Andean chain of South America.

Local "Drop-outs," and Rare or Localized Species

If in New Guinea one surveys the avifaunas of different mountains a few miles apart in the same range, one finds that a given mountain does not support the entire montane avifauna of the region but rather that some species are missing. Stein (1936) was struck by this point in comparing Mt. Kunupi and Mt. Sumuri, adjacent peaks in the Weyland Mountains, and many examples turned up during my 1966 survey of four peaks in the North Coastal Range (Diamond, 1968). The pattern of this effect is that the smaller the mountain, the more species are found to be missing at a given altitude. That is, a mountain 5,000 ft high obviously lacks all species restricted to elevations above 5,000 ft, but it also lacks some of the species found at 3,000-5,000 ft on larger mountains. The explanation is presumably the relation between species diversity and area: the smaller the mountain, the less the area at a given altitude, hence the fewer individuals in the local populations and the greater the likelihood of temporary local extinctions. In the Eastern Highlands this tendency is illustrated by Mt. Karimui, a peak 8,400 ft high rising above the Karimui Basin (3,500 ft) and about 10 miles from the nearest peak over 8,000 ft. We collected and netted many specimens on Mt. Karimui, and my field observations there for a month were supplemented by those of seven Fore assistants, three Gimi assistants, and five Daribi assistants who were intimately familiar with the New Guinea midmontane avifauna. Thus, our survey was probably complete, and most of the expected midmontane forest species including rare ones turned up. However, four species that are widespread elsewhere in the Eastern Highlands were not found and may be assumed to be absent on Mt. Karimui, viz., *Ducula chalconota, Melampitta lugubris, Heteromyias albispecularis,* and *Melanocharis longicauda.*

A related phenomenon involves birds whose distribution is patchy to an extreme degree, such that well-established populations have been found at a few widely scattered localities but the species is absent in similar habitats over most of New Guinea. For instance, the Yellow-breasted Bird of Paradise, *Loboparadisea sericea,* was found to be fairly common at 3,000-6,000 ft at three far-flung localities (Mt. Kunupi at the western end of the Central Range, the Utakwa River in southwestern New Guinea, and Dawong in eastern New Guinea), and was otherwise known only from a few specimens at five other scattered localities until it turned up in numbers on the west ridge of Mt. Karimui. *Archboldia papuensis sanfordi,* a striking race of Archbold's Bowerbird endemic to the Eastern Highlands, is known only from two very local populations, one on the southwestern side of Mt. Hagen and the other on Mt. Giluwe, despite extensive searches and inquiries among hundreds of natives by several ornithologists. The Yellow Thicket Flycatcher, *Poecilodryas placens,* is present in six scattered areas and common in most of these (Batanta Island off the western end of New Guinea, the Menoo Valley of the Weyland Mountains, Astrolabe Bay in southeastern New Guinea, Lake Kutubu, and Karimui) but has been reported nowhere else. All three of these species have been missed in exhaustive collections involving thousands of specimens in numerous other areas.

These and other rare or patchily distributed birds in New Guinea appear to fall into two categories. Some (e.g., *Megatriorchis doriae, Rhamphomantis megarhynchus, Uroglaux dimorpha, Campochaera sloetii, Androphobus viridis, Macgregoria pulchra, Loboparadisea sericea, Archboldia papuensis,* and *Daphoenositta miranda*) belong to distinct monotypic genera without close relatives. Others (e.g., *Ptilinopus nanus, Charmosyna wilhelminae, Charmosyna multistriata, Tanysiptera nympha, Coracina lineata, Crateroscelis nigrorufa, Sericornis nigroviridis, Gerygone chloronota, Poecilodryas placens, Pachycephala aurea, Pachycephala tenebrosa, Meliphaga flavirictus, Ptiloprora plumbea, Ptiloprora meekiana, Pycnopygius stictocephalus,* and *Melanocharis arfakiana*) belong to large genera with many ecologically similar species. In many cases the habits of these local or rare species are sufficiently well known to rule out the suggestion that they have narrow ecological requirements uniquely met by only a few far-flung localities in New Guinea. Their fragmented, relict distributions suggest that more likely they are slowly becoming extinct, either because they are the last survivors of unsuccessful evolutionary lines (monotypic genera) or because they are being out-competed by ecologically similar close relatives in the same genus.

Thus, a tendency to distributional patchiness expresses itself at several levels in the New Guinea avifauna: in differences between the avifaunas of nearby mountains; in large geographical gaps in the distribution of otherwise widespread species; and in the highly fragmented, relict-like distributions of other species. Examples of any of these phenomena may also be found in the temperate zones, but they are more prominent in New Guinea and perhaps in the tropics in general. The tendency to drop out or to be patchily distributed is as much a characteristic of a given species as its abundance, and is distinct from abundance. For instance, the cuckoo *Chrysococcyx meyerii,* the thrush *Drymodes superciliaris,* and the honeyeater *Meliphaga polygramma* are always uncommon. Nevertheless, they turn up in low numbers at almost any hill forest collecting station on the Central Range and on most of the "north mountain islands" as well, on most of which some much commoner Central Range species (*Pachycephala soror,* the *Melidectes* honeyeaters) are absent. If one views local species diversity as an equilibrium between local extinction rates and immigration rates, the greater patchiness of bird distribution in New Guinea as compared to the temperate zones is most readily explained by postulating lower dispersal rates in New Guinea. This postulate is almost certainly valid, since there is little migration in New Guinea forests and hence recolonization after local extinctions should be slow, whereas each year in the temperate zones the annual migrations and seasonal dispersals generate a flood of potential new colonists. Species vary in their dispersive tendencies and abilities, and these differences may partly underlie the tendency toward patchy distribution that is characteristic of certain species. An additional contributing factor may be the closer niche packing and increased interspecific competition resulting from higher species diversity in the tropics, such that the local survival of each species becomes more precarious (MacArthur, 1972, chapter 2).

In short, the distributional patchiness of many New Guinea birds comes initially as a surprise to some temperate zone ornithologists, whose first reaction may be to dismiss the phenomenon with a trivial explanation such as that the patchiness is due to inadequate exploration or highly specialized habits. Enough is known about distribution in most cases, and about habits in many cases, to dismiss these explanations. In fact, distributional patchiness is seen on reflection to be an expected consequence of low dispersal rates and high species diversity in the New Guinea forest and of the continuing occurrence of speciation. In a saturated fauna an automatic corollary of the fact that new species are constantly arising is that other species must constantly be becoming extinct. The New Guinea avifauna provides clear examples of intermediate stages both in speciation and in extinction.

Ecological Sorting Mechanisms

If two formerly conspecific forms have succeeded in perfecting reproductive isolating mechanisms by the time contact is reestablished after a period of geographic isolation and evolutionary divergence, they then fulfill the definition of species. For the forms to succeed in reinvading each other's ranges and to become sympatric, they must in addition develop ecological differences sufficient to permit coexistence. That the development of reproductive isolating mechanisms and of these ecological sorting mechanisms may proceed at different rates is shown by the existence of superspecies, comprised of forms which are perfectly, or nearly perfectly, isolated reproductively but which are strictly allopatric in distribution, presumably because ecological differences are still insufficient to permit reinvasion. Examples are: *Chalcopsitta; Psittaculirostris; Micropsitta keiensis* and *M. pusio; Lalage; Parotia; Melipotes;* the *Melidectes ruforissalis* group; and *Melidectes nouhuysi* and *M. princeps.* In addition to being a prerequisite for completion of the speciation process, ecological sorting mechanisms also underlie the problem of species diversity, viz., the question of what makes it possible for many species to coexist at a locality (Lack, 1971).

Lack (1944) has analysed the avifauna of Great Britain, and Moreau (1948) the avifauna of Tanganyika, by determining the ecological sorting mechanisms between the members of all pairs of species in a given family. In the present analysis of ecological sorting mechanisms in the Eastern Highlands of New Guinea I shall adopt a narrower choice of material for analysis and shall largely confine discussion to pairs of congeneric rather than merely confamilial species. Confamilial species of different genera presumably have been distinct longer, and might be expected to have diverged ecologically from each other in more ways, than have congeneric species. One, in fact, finds that most congeneric pairs of species in New Guinea differ ecologically mainly in one or two simple respects. These ecological sorting mechanisms may be classified under three headings: spatial differences (altitudinal segregation, habitat preference, vertical segregation, allopatry, and checkerboard allopatry) which lead to pairs of congeners having mutually exclusive territories; differences in feeding or foraging behavior; and temporal differences (occupation of the same habitat at different times). These categories will be considered in turn.

1. Spatial Segregation

Altitude.—The most important ecological sorting mechanism in the New Guinea avifauna as a whole, and in the Eastern Highlands in particular, is segregation by altitude. That is, more pairs of congeners segregate by living at different altitudes than by any other means. The Eastern Highlands provide about 37 instances of pairs of similar and congeneric species which live in the same gross habitat type but have altitudinal ranges which are largely or completely mutually exclusive. Some examples (citing the low-altitude form first in each case) are the pigeons *Ducula rufigaster* and *D. chalconota,* the kingfishers *Halcyon torotoro* and *H. megarhyncha,* the flycatchers *Peltops blainvillii* and *P. montanus,* the flycatchers *Machaerirhynchus flaviventer* and *M. nigripectus,* the bowerbirds *Ailuroedus buccoides* and *A. crassirostris,* and the honeyeaters *Ptiloprora guisei* and *P. perstriata.* In about 12 additional cases there are three similar congeners which replace each other with altitude. Examples include the logrunners *Eupetes caerulescens, E. castanonotus,* and *E. leucostictus* and the flowerpeckers *Melanocharis nigra, M. longicauda,* and *M. versteri.* Four congeneric species replace each other successively in two cases (the warbler genus *Sericornis* and the bird of paradise *Lophorina*), and in the whistler genus *Pachycephala* there is a sequence of five species. Many similar cases have been discovered by Terborgh (1971) in the avifauna of the Peruvian Andes.

In a considerable portion of these cases the altitudinal transition is sharp, mutual exclusion of each species from the other's range is complete, there are no significant ecological differences between the species except for those associated with altitudinal range, and the species are quite similar to each other morphologically and apparently are the product of a recent speciation. One case (p. 230) is provided by the warblers *Crateroscelis murina* and *C. robusta,* which are the commonest insectivorous gleaners of the understory, resemble each other in color, pattern, size, and song, and forage in virtually identical manners between ground level and five feet above the ground. As we ascended the west ridge of Mt. Karimui from its base, *C. murina* progressively increased in abundance with increasing altitude until it was the second most abundant bird in Zone 3b (5,080 to 5,390 ft). It abruptly disappeared at 5,390 ft. At 5,400 ft *C. robusta* abruptly appeared at its maximum abundance and progressively decreased in abundance with increasing altitude towards the summit at 8,165 ft (Fig. 1). No individual of either species was ever found within the other's altitudinal zone. There was no vegetational discontinuity in the forest at the transition altitude, and the ecotone at the lower level of the moss forest lay at 6,500 ft, which is 1,100 ft higher. As shown in Figure 2, which depicts the altitudinal ranges of the *Crateroscelis* warblers at various localities at different longitudes on the Central Range, the transition altitude varies locally between 4,500 and 5,500 ft, but there is no consistent difference between eastern and western New Guinea. Additional instances of similarly sharp transitions are discussed

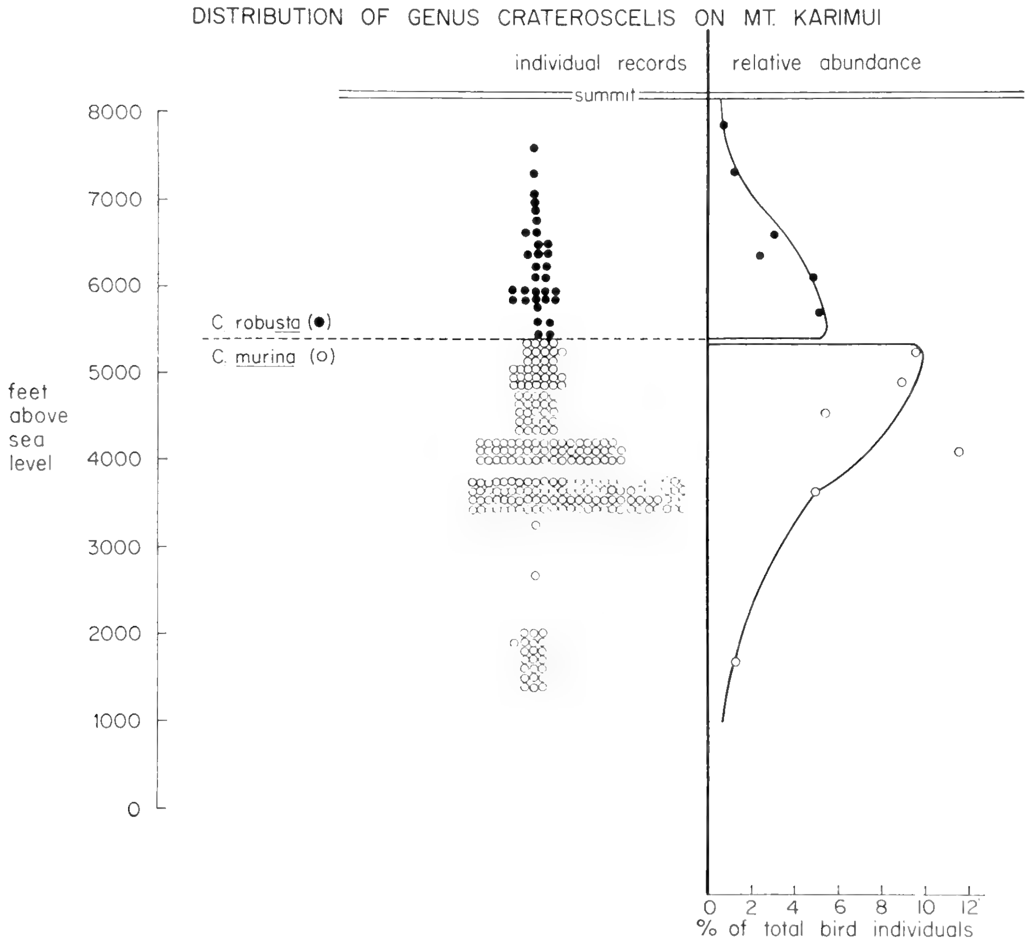


FIG. 1. Distribution of the warblers *Crateroscelis robusta* (●) and *C. murina* (○) on Mt. Karimui as a function of altitude. On the left side each mark represents one individual heard, seen, or collected at the given altitude (the relative paucity of records between 2,000 and 3,000 ft is due to my having spent only a brief time at this altitude). The right side gives the relative abundance in the whole avifauna, i.e., the percentage of bird individuals of all species estimated as being *C. robusta* or *C. murina* (see p. 10). Note that the two species replace each other sharply at 5,400 ft, and that each species reaches its maximum population density just above or just below this altitude.

in the text (cf., *Melanocharis nigra* and *M. versteri, Coracina montana* and *C. schisticeps, Rhipidura hyperythra* and *R. albolimbata,* and the genera *Eupetes, Sericornis, Peltops,* and *Ailuroedus*).

To varying degrees in other instances the altitudinal transition is not sharp, ecological sorting mechanisms in addition to altitudinal distribution are apparent, and the two or more species, while congeneric, show sufficient morphological differences to suggest that speciation occurred less recently. For instance, the pigeons *Ptilinopus ornatus* and *P. perlatus* have similar color patterns suggesting recent divergence, and in general represent each other altitudinally, *P. perlatus* being found at lower elevations. However, *P. perlatus* is less common, and the altitudinal ranges of the two species overlapped at Karimui, an overlap made possible by *P. perlatus's* larger size and its preference for the forest edge over the forest interior. On the southern slopes of the Eastern Highlands live three congeneric parrots, *Charmosyna placentis* occurring at low elevations, *C. pulchella* at medium elevations, and *C. papou* at higher elevations. The altitudinal ranges are largely mutually exclusive, but each overlaps the next by up to several hundred feet. *C. placentis* is more closely related to other species in the genus than to *C. pulchella* or to *C. papou;* the latter two share the same distinctive color pattern with each other but differ by a factor of 2.6 in weight. The five whistlers *Pachycephala griseiceps, P. hyperythra, P. soror, P. schlegelii,* and *P. modesta* are encountered from sea level to timberline in that sequence, but their altitudinal

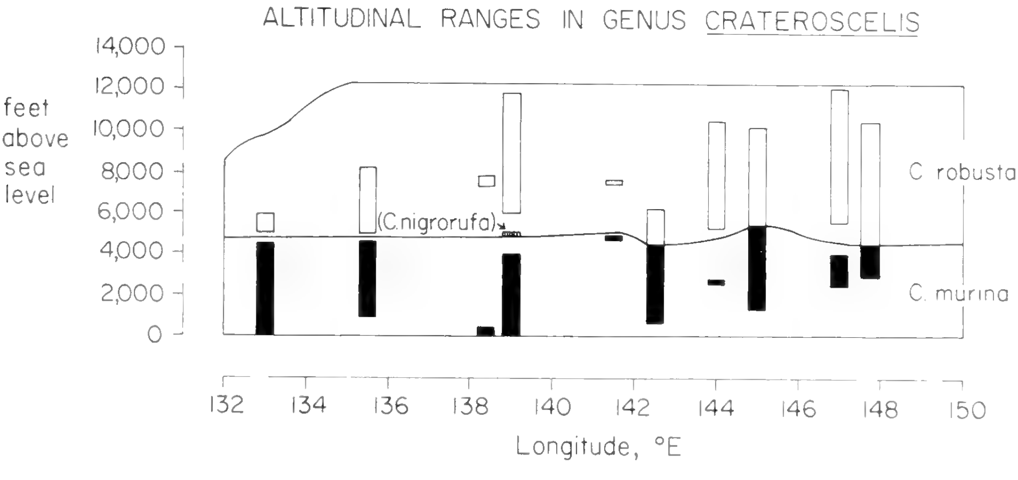


FIG. 2. Altitudinal ranges of *Crateroscelis* warblers as a function of longitude, based on the records of collections at ten localities. Note that the altitudinal ranges of *C. murina* and *C. robusta* are mutually exclusive, and that the transition altitude varies locally between 4,500 and 5,500 ft but shows no systematic variation with longitude. Where the rare *C. nigrorufa* is present, its range lies between those of the other two species. None of the 10 expeditions on whose records the figure is based collected continuously from sea level to timberline, so that the apparent gaps in altitudinal distribution at some localities are artifacts caused by discontinuous collecting transects.

ranges overlap broadly: *P. soror* straddles the ranges of *P. hyperythra* and *P. schlegelii,* which nearly meet; the range of *P. schlegelii* includes much or most of that of *P. modesta;* and that of *P. griseiceps* includes most or all of that of *P. hyperythra.* No two of these five species are as immediately derived from each other as are *Crateroscelis murina* and *C. robusta,* or *Ptilinopus ornatus* and *P. perlatus.* The additional ecological sorting mechanism making altitudinal overlap possible is a tendency towards vertical segregation: on the average *P. griseiceps* forages higher in the vegetational column than does *P. hyperythra, P. hyperythra* higher than *P. soror, P. soror* perhaps higher than *P. schlegelii,* and *P. schlegelii* lower than *P. modesta.* The correlation between degree of morphological similarity and strictness of altitudinal segregation in bird altitudinal sequences in New Guinea suggests that strict altitudinal segregation was the first sorting mechanism to develop in these cases, and that some degree of altitudinal overlap became possible only as further evolution and morphological divergence led to other ecological differences. This interpretation is supported by the evidence presented on pp. 33-34.

Certain high-altitude species appear to take over the combined niches of several low-altitude congeners. For instance, in the cuckoo genus *Cacomantis* the single species found above 6,000 ft is *C. pyrrhophanus,* which inhabits the forest interior as well as second-growth and gardens. Below this elevation it is replaced by two species, *C. castaneiventris* in the forest interior and *C. variolosus* in second-growth and gardens. Up to six species of *Ptilinopus* pigeons may be found locally sympatric at low elevations, differing in size and preference for the forest interior versus the forest edge. These yield to one medium-sized species, *P. rivoli,* at higher elevations.

I found that individuals collected outside a species' usual altitudinal range and in the range of a congener generally proved to be immatures. A typical example arose on Mt. Karimui in the warbler genus *Sericornis,* four species of which divided up the mountain into mutually exclusive altitudinal bands; *S. spilodera* up to 4,240 ft, *S. arfakianus* from 4,400 to 5,000 ft, *S. perspicillatus* from 5,100 to 6,350 ft, and *S. papuensis* from 6,450 ft to the summit at 8,165 ft. The only violation of these limits detected came when two immature individuals of *S. spilodera* were collected at 4,950 ft, near the upper limit of the next higher species.

This tendency of immatures to be found at the peripheries of the altitudinal range characterizes most species of the New Guinea montane avifauna, and not just those which belong to altitudinal sequences. The change in population structure with increasing altitude is typically that immatures are found at the bottom of the altitudinal range; somewhat higher one meets immatures plus birds in adult plumage but in nonbreeding condition, with females usually appearing at lower altitudes than males; next comes the optimal part of the species' range, with singing males and adults of both sexes in breeding condition; and, finally, another band of immatures but of few adults appears at the upper altitudinal limit in some species. Examples of this population structure discussed in detail in the species accounts include *Pachycephala leucostigma, Pachycephala schlegelii, Myzomela rosenbergii, Melipotes fumigatus,* and *Ptiloprora guisei.* This tendency is manifest to an extreme degree in some species of birds of paradise, in which displaying adult males may be compressed into the top 600 ft of the altitudinal range, with adult females and especially immatures continuing to be found several thousand feet below the level at which the lowest adult male is encountered (cf. *Lophorina superba; Lophorina (Diphyllodes) magnifica; Lophorina (Cicinnurus) regia;* and *Loboparadisea sericea*). Stein (1936) explicitly remarked on the same population structure for the birds of paradise *Cnemophilus (Loria) loriae, Lophorina (Pteridophora) alberti, Epimachus fastosus,* and *Epimachus meyeri* in the Weyland Mountains.

Two explanations suggest themselves for the sharp transitions in sequences of altitudinally segregating congeners. On the one hand, the actual altitudinal limits of a species might be directly determined by its adaptations, either to altitude itself, or else, probably more importantly, to variables correlated with altitude, notably vegetation and temperature. On this hypothesis each member of an altitudinal sequence would be adapted only to a certain range of altitudes (or forest types or temperatures) and would be unable to maintain stable populations beyond its actual limits, even if the other species in the sequence were absent. By this interpretation the actual altitudinal limits and the physiologically possible altitudinal limits of a species would be identical, and would be sharp only if there were a sharp change in an adaptively critical environmental variable. The alternative hypothesis is that the actual altitudinal limits of a species depend upon competition with other species. Each species would be intrinsically capable of establishing itself over a broader altitudinal range than that which it actually inhabits. However, in the presence of ecologically very similar species each form would be limited to that altitudinal range (or temperature range or vegetational type) over which it was competitively superior, and would be excluded from adjacent altitudinal bands in which the related species were competitively superior.

While the first hypothesis (intrinsic survival ability) may prove valid in some instances, competition is clearly the explanation in many cases. To begin with, competition appears the only reasonable interpretation when the population density of one species changes from maximal to zero and the abundance of a closely related congener changes from zero to maximal within the same 10 vertical feet in a gradually changing forested habitat. Had sharp species transitions in altitudinal sequences been due to a sharp vegetational discontinuity rather than to competition, then the bird transitions should have coincided with vegetational ecotones, and many bird transitions should have clustered around the same altitude. These expectations are not fulfilled, as illustrated by Figure 3, which plots those transition altitudes between congeneric birds on Mt. Karimui's west ridge that I was able to determine most accurately. The sharpest ecotone was that at 6,500 ft at the lower limit of the heavily mossed zone. No bird transition coincided with this ecotone, and the nearest transition was the one about 100 vertical feet below between *Sericornis papuensis*

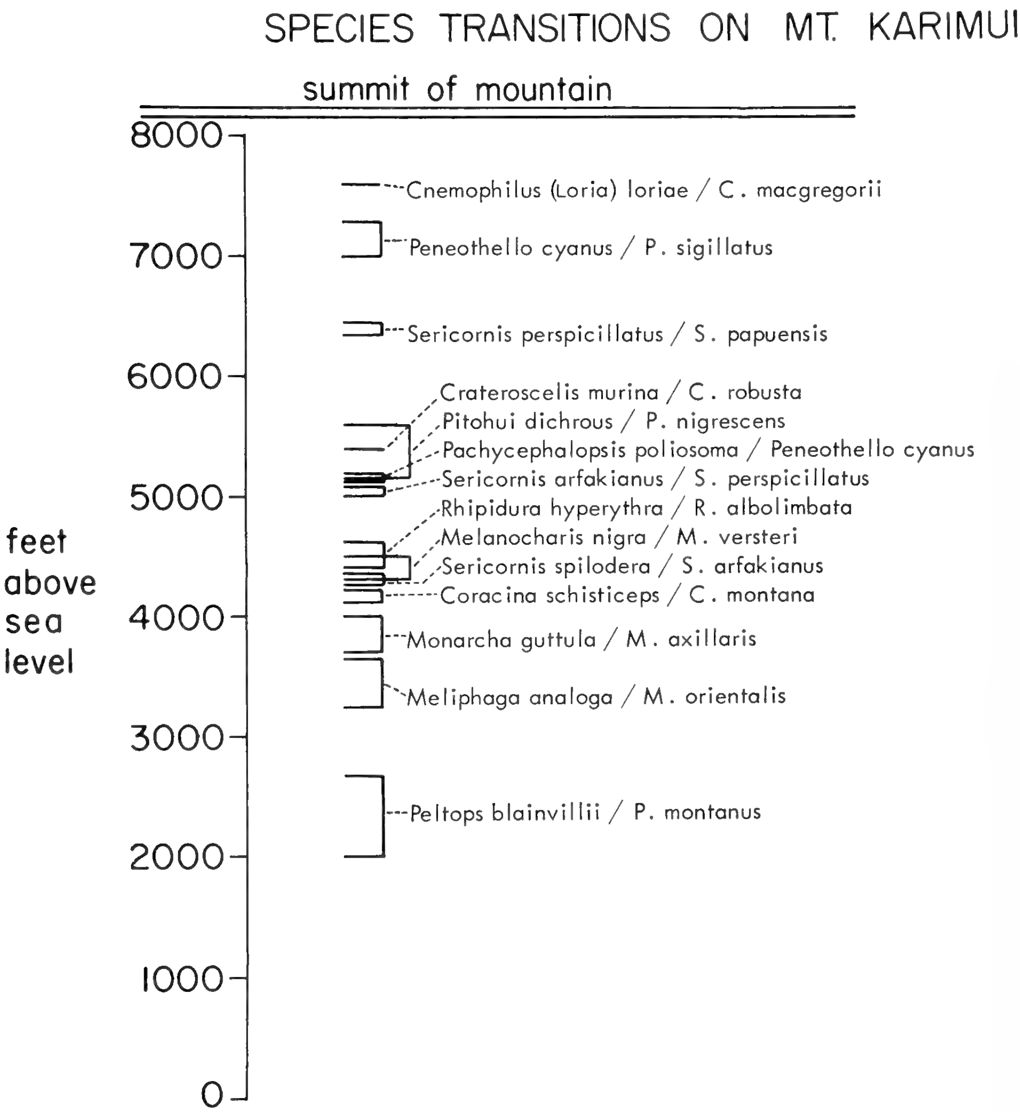


FIG. 3. Some altitudes on Mt. Karimui's west ridge at which pairs of congeneric or closely related species replaced each other abruptly. In each case the first-named species is the low-altitude form, the last-named species the high-altitude form. A sharp line means that the transition altitude was identified exactly, while a bracket means that the transition occurred at some altitude within the indicated band but was not determined more exactly.

and *S. perspicillatus*. Figure 3 also shows that different bird transitions occur at different altitudes, and that at least one transition is encountered every 600 feet in the well-studied region between 3,650 and 8,165 ft. Few transitions were identified between 3,250 and 2,000 ft, partly for the trivial reason that no collecting was carried out in this band, partly because in the Karimui area this altitudinal band constitutes part of a relatively well-defined tropical "zone" with few species limits (pp. 67-70).

The facts that few or no vegetational ecotones in the New Guinea forest are as sharp as many bird transitions in altitudinal sequences, and that these sharp transitions do not coincide with ecotones, imply that sharp transitions involve competition. To test this hypothesis, one would like to find situations in which one member of a sequence has been locally eliminated, and to examine whether its congener, freed of the competition, expands into the missing species' altitudinal range. This test is made possible by two different circumstances: the drop-out phenomenon and the reinvasion situation.

As discussed on pp. 21-24, small mountains and mountain ranges have fewer bird species than large ones because localized populations are most likely to become extinct. Under these circumstances one often finds that congeners expand their altitudinal range at the expense of the missing species (Diamond, 1970a, 1970b). For instance, in the Okapa area the altitudinal ranges of the low-altitude flowerpecker *Melanocharis nigra* and its high-altitude congener *M. versteri* were separated by several thousand feet, and the intervening altitudes were monopolized by the middle-altitude congener *M. longicauda*. On isolated and small Mt. Karimui, *M. longicauda* was one of the species that dropped out, and *M. nigra* expanded upwards and *M. versteri* downwards to meet somewhere between 4,300 and 4,500 ft. In the North Coastal Range the cuckoo-shrike *Coracina schisticeps* occurred at most localities up to about 2,900 ft, above which altitude it was replaced by *C. montana*. However, on Mt. Turu, an isolated peak only 3,650 ft high, *C. montana* was absent, presumably because it could not maintain a stable population within a band of only 750 vertical feet; and *C. schisticeps*, freed of the competition, occurred up to Mt. Turu's summit. Similar instances arise among altitudinally representative species in *Rallicula, Charmosyna, Psittacella, Crateroscelis, Pachycephala,* and *Melidectes*.

The second kind of test for competition occurs during speciation, when one form begins to reinvade the geographical range of another to which it was formerly allopatric. As discussed on pp. 22-23, speciation in the New Guinea mountains usually begins with the formation of eastern and western isolates. There are 13 cases in which allied eastern and western species are sympatric only over part of the geographical range, indicating that reinvasion is at an early stage. In 11 of these cases the two species have mutually exclusive altitudinal ranges in the area of sympatry, and each has a broader altitudinal range outside the area of sympatry. For instance, the honeyeater *Ptiloprora guisei* occurs on the Central Range in eastern New Guinea and on one "north mountain island," the Huon Peninsula. The similar *P. perstriata* occurs on the Central Range in both western and eastern New Guinea. In western New Guinea, where *P. perstriata* occurs alone, it lives from about 5,000 to 12,000 ft. In the area of sympatry, eastern New Guinea, *P. perstriata* lives from about 9,000 to 12,000 ft, *P. guisei* from 5,000 to 9,000 ft, and the altitudinal ranges are mutually exclusive. On the Huon Peninsula, where *P. guisei* occurs alone, it lives from 5,000 to apparently at least 10,500 ft. Thus, in the area of sympatry the altitudinal ranges of both species are apparently compressed by competition as compared to the range each can inhabit when by itself. A clear example of the development of an ecological sorting mechanism in the earliest stage of speciation is presented by the birds of paradise *Lophorina* (*Astrapia*) *mayeri* and *L.* (*Astrapia*) *stephaniae,* between which reproductive isolation is not yet complete and whose ranges are still largely allopatric. Sympatry has been reported only from two mountains, Mts. Giluwe and Hagen, where the two forms segregate altitudinally, *L.* (*Astrapia*) *mayeri* being found at higher elevations. Similar instances in the Eastern Highlands arise in the bird of paradise genus *Epimachus,* in the honeyeater genus *Toxorhamphus,* and apparently in the megapode genus *Talegalla.*

Thus, the principal (but not the only) speciation mechanism in the mountains of New Guinea appears to be the formation of western and eastern isolates, followed by mutual reinvasion with altitudinal displacement, until the two species occur sympatrically over all New Guinea with mutually exclusive altitudinal ranges. In most cases altitudinal segregation is the first ecological sorting mechanism to develop, and other differences develop only later, after broad sympatry has been achieved (cf. pp. 29-30).

In some genera this process has occurred two or three successive times to give rise to three-species and four-species altitudinal sequences. However, two-species sequences are much commoner in New Guinea. The larger sequences tend to be unstable and to lead to elimination of the middle birds, whose narrow altitudinal ranges due to competition from both above and below make them particularly prone to drop out locally. The narrowest altitudinal ranges in the New Guinea mountains prove to be those of middle birds in three- and four-species sequences. For instance, on Mt. Karimui the warbler *Sericornis arfakianus,* the second bird in a four-species sequence, was compressed into a band of only 600 feet, while *Melanocharis longicauda,* middle bird in a three-species sequence, was missing entirely, having been squeezed out between its congeners. In the Cyclops Mountains and North Coastal Range the whistler *Pachycephala soror,* third in a five-species sequence, has similarly been squeezed out between *P. hyperythra* and *P. schlegelii*. The warbler *Crateroscelis nigrorufa*, middle bird in a three-species sequence, is very rare and local, presumably because it has been eliminated at most localities. The instability of three-species sequences also appears responsible for the unique and complex distributional pattern of compound checkerboard allopatry in the *Melidectes rufocrissalis-M. belfordi-M. ochromelas* complex (pp. 388-389; 393-396).

To recapitulate, sharp altitudinal transitions between congeners are due to competition, as shown by the facts that most vegetational ecotones are much less sharp; that the transitions do not coincide with ecotones or with each other; that the component species expand their ranges when one member drops out locally; and that they compress their ranges in the zone of sympatry during reinvasion. In the Andes of Peru Terborgh (1971) has described essentially identical phenomena exemplified by numerous altitudinal sequences of two to five species. It is worth restating explicitly that the bearing of adaptations to altitude, vegetation, and temperature on the sequences is not denied. The fact that *Crateroscelis murina* lives below *C. robusta*, and not vice versa, can only mean that the former is better adapted to low altitude, rainforest, and warm temperatures and that the latter is better adapted to high altitude, *Nothofagus* forest, and cool temperatures. It is the sharpness of the transitions, and the mutually exclusive altitudinal ranges, in the absence of equally sharp changes in temperature and forest composition, which must be explained in terms of competition.

Habitat.—Congeners that live at the same altitude may differ in respect to the gross habitat type preferred (forest, second-growth and forest edge, grassland, savanna, swamp, or water). Since the fractional area occupied by gross habitat types other than forest is small in undisturbed areas in most parts of New Guinea (especially in the mountains) except in a low-rainfall band on the south coast, the proportion the nonforest avifauna bears to the total avifauna in New Guinea is low. The nonforest avifauna of the Eastern Highlands is discussed on pp. 70-79.

In the following 18 pairs or groups of species which occur in the Eastern Highlands, the first member lives mainly at the forest edge, in second-growth, or in gardens, while the second member or members live mainly in the forest, but the birds are otherwise fairly similar ecologically. Details are given under individual species accounts:

Accipiter fasciatus; A. melanochlamys and *A. poliocephalus*
Falco berigora; F. severus
Macropygia amboinensis; M. nigrirostris (difference valid only above 5,000 ft)
Cacomantis variolosus; C. castaneiventris

Centropus phasianinus (grassland); *C. menbeki* (forest)
Tyto capensis (grassland); *T. alba* (open wooded country); *T. tenebricosa* (forest)
Halcyon sancta, H. macleayii (Australian wintering visitors); *H. torotoro, H. megarhyncha* (residents)
Coracina papuensis, C. tenuirostris; C. schisticeps, C. melaena, and *C. boyeri*
Gerygone ruficollis; G. cinerea
Gerygone chloronota, G. magnirostris; G. chrysogaster
Rhipidura leucothorax; R. threnothorax
Rhipidura leucophrys (open country); *R. rufiventris* (forest edge); *R. hyperythra* (forest interior)
Pachycephala rufiventris; several other species of *Pachycephala*
Colluricincla harmonica; C. megarhyncha
Cracticus cassicus; C. quoyi
Myzomela adolphinae; M. rosenbergii
Melidectes torquatus; M. rufocrissalis-M. belfordi
Meliphaga auga; M. mimikae

The rail *Rallus pectoralis* occurs in dry grassland, while the similar *Rallus philippensis* is found in wet and swampy grassland.

In the hills the swiftlet *Collocalia esculenta* is confined to the air space above small streams and forest glades, while *C. hirundinacea* forages over extensively cleared areas.

Vertical distribution.—Many New Guinea forest species show strict preferences for the height in the vegetational column at which they forage. For example, the warblers *Crateroscelis robusta* and *C. murina* are almost always seen within five feet of the ground, the thicket flycatcher *Pachycephalopsis poliosoma* within three feet of the ground, and the logrunners *Eupetes castanonotus* and *E. leucostictus* remain on the ground or on fallen branches. Conversely, the warbler *Gerygone palpebrosa* and the flycatcher *Monarcha frater* often forage down to within about 12 ft of the ground but never within five feet of the ground. These vertical preferences are well illustrated by results of mistnetting, since our mistnets generally extended from near the ground to six feet above the ground. Despite intensive use of mistnets (about 30 in operation simultaneously) many common forest species were never netted, and some species (e.g., the thicket flycatcher *Peneothello cyanus* and the honeyeater *Toxorhamphus poliopterus*) were netted much more often in proportion to their censused abundance than others. I shall frequently cite netting results in the individual species accounts as an indication of vertical foraging preference. While temperate zone species, of course, also have vertical preferences, these are less strict and absolute than in species-rich areas of the tropics. For instance, if one operates mistnets for a long time, one eventually catches every species of bird present in New Zealand forest or in eastern North American forest, but little more than half of the species present in New Guinea (in my experience) or in Peru (Terborgh, pers. comm.).

The following 19 forest species in the Eastern Highlands apparently forage strictly or almost strictly on the ground: the cassowaries *Casuarius bennettii* and *C. casuarius,* the megapodes *Megapodius freycinet, Talegalla* sp., and *Aepypodius arfakianus,* the rail *Rallicula forbesi,* the woodcock *Scolopax saturata,* the ground doves *Gallicolumba beccarii, G. rufigula, G. jobiensis,* and *Chalcophaps stephani,* the pittas *Pitta erythrogaster* and *P. sordida,* the thrushes *Zoothera dauma, Amalocichla incerta,* and *Drymodes superciliaris,* and the logrunners *Eupetes castanonotus, E. leucostictus,* and *Melampitta lugubris.*

Three additional forest species apparently forage on the ground and in undergrowth within a few feet of the ground: the thicket flycatchers *Heteromyias albispecularis* and *Pachycephalopsis poliosoma,* and the whistler *Pitohui cristatus.*

Eight species forage in the understory within five feet, or in a few cases ten feet, of the ground but usually not on the ground itself: the warblers *Crateroscelis murina, C. nigrorufa,* and *C. robusta,* the flycatcher *Rhipidura threnothorax,* and the thicket flycatchers *Peneothello sigillatus, P. cyanus, P. bimaculatus,* and *Poecilodryas placens.*

At the other extreme are the numerous forest species which keep to the middle and upper stories and rarely descend to the lower story. To quantitate this phenomenon by mistnet results, let us exclude from consideration birds weighing over 250 g (hence possibly strong enough to break out of the mistnets I was using, although a few larger birds were in fact netted), and consider only species of which I saw, heard, or collected at least 10 individuals. This leaves 137 forest species. Of these 137 species, 77 (56%) were netted at least once, while 60 (44%) were never netted. The list of 60 species not netted includes most pigeons except for the four small ground doves of the genera *Gallicolumba* and *Chalcophaps;* most parrots except *Psittacella;* the cuckoo *Eudynamis scolopacea;* all campephagids without exception; the warblers *Phylloscopus trivirgatus* and *Gerygone ruficollis;* the flycatchers *Peltops montanus* and *P. blainvillii,* and *Monarcha frater* and *M. chrysomela;* the whistler *Pachycephala hyperythra;* the oriole *Oriolus szalayi;* the birds of paradise *Manucodia* (including *"Phonygammus"*), *Epimachus* (including *"Drepanornis"*), *Paradisaea,* and *Loboparadisea,* and *Lophorina* (*Parotia*) *lawesi* (despite the male's terrestrial display court) and *Lophorina* (*Ptiloris*) *magnifica;* the honeyeaters *Myzomela eques, M. nigrita, M. cruentata, Oedistoma pygmaeum, Meliphaga subfrenata* and *M. analoga,* and *Pycnopygius ixoides;* and the dicaeids *Dicaeum geelvinkianum* and *Oreocharis arfaki.* In addition, I netted females but never males of the honeyeater *Meliphaga obscura,* although males were collected by other means. There are a couple of these species that I netted elsewhere in New Guinea or observed in the understory despite my failure to net them. Most of them, however, are species that I saw dozens or hundreds of times and which simply do not descend to the understory, unless under the unusual conditions noted below.

Of the 77 species netted, seven rarely use the understory and were netted only under one of three unusual conditions. First, birds flying from one side of a ridge to another often prefer to fly through a notch or dip in the ridge, and if one sets up nets in such a notch, anything may turn up. For instance, one such net on Mt. Menawa in the North Coastal Range caught a flock of 25 *Charmosyna* parrots, which feed in the crowns of flowering trees. Secondly, at high elevations where the forest becomes stunted, species that remain in the middle- and upper-stories of tall forest turn up in nets, simply because the middle- and upperstories disappear at high elevations. For instance, the parrot *Oreopsittacus arfaki* and the honeyeater *Myzomela rosenbergii* were netted in the stunted summit forests of Mt. Michael and Mt. Karimui but not in the taller forest at lower elevations. Finally, some species present both in the forest interior and at the edge are netted much less often in the interior than at the edge (e.g., the honeyeaters *Melipotes fumigatus, Melidectes rufocrissalis,* and *Meliphaga orientalis*).

Thus, almost half of the forest species in the Eastern Highlands have sufficiently marked middle- and upperstory preferences that they are rarely or never netted in the forest.

There are about eight pairs or groups of congeneric forest species in the Eastern Highlands for which differences in vertical preference provide an important or the most important ecological sorting mechanism, one species foraging largely in the lower story and the other largely in the middle- and upperstories. All eight cases involve small passerines. In four of these cases the upperstory species was never taken in mist-nets, but even in these four instances the vertical segregation was not absolute because the lowerstory species was occasionally or often seen in the middlestory. The eight cases, listing the lowerstory bird or birds first in each case, are:

Sericornis nouhuysi; S. arfakianus, S. perspicillatus, S. papuensis
Rhipidura threnothorax; R. hyperythra
Rhipidura atra, R. brachyrhyncha; R. albolimbata
Monarcha axillaris; M. frater
Monarcha guttula; M. chrysomela
Pachycephala soror; P. hyperythra
Pachycephala schlegelii; P. modesta
Meliphaga mimikae, M. aruensis; M. orientalis, M. analoga

Allopatry.—New Guinea provides numerous examples of superspecies, i.e., pairs or groups of forms that already are, or may be assumed to be, reproductively isolated but whose distributions are still largely or strictly allopatric. Superspecies consist of isolates ("semispecies") between which geographical contact may have been reestablished but which are presumably still too similar ecologically to reinvade each other's ranges. The Eastern Highlands contain about eight pairs of allopatric semispecies, which fall into two categories.

The first category consists of lowland or hill forest species to which the Central Range, running east-west, presents a major barrier, so that one form has been isolated on the northern slopes of the Central Range and the other on the southern slopes. Four examples, listing the northern form first and the southern form second in each case, are the crowned pigeons *Goura victoria* and *G. scheepmakeri;* the fig parrots *Psittaculirostris edwardsii* and *P. desmarestii;* the trillers *Lalage atrovirens* and *L. leucomela;* and the red birds of paradise *Paradisaea minor* and *P. raggiana.* In one additional case, the cassowary *Casuarius casuarius,* one member of a superspecies has been found on the southern slopes, while the corresponding form of the northern slopes (*Casuarius unappendiculatus*) has not yet been reported from the Eastern Highlands but will undoubtedly turn up when the northern slopes are explored at low altitudes.

The other category consists of midmontane species for which the Central Range does not provide a distributional barrier but which have formed eastern and western semispecies by the mechanism discussed on pp. 22-23. In this category fall two pairs of birds of paradise, *Lophorina* (*Astrapia*) *mayeri* and *L.* (*Astrapia*) *stephaniae,* and *Lophorina* (*Parotia*) *carolae* and *L.* (*Parotia*) *lawesi* (the western form is listed first in each case). The astrapias provide a fascinating example of the development of ecological sorting mechanisms in the early stages of reinvasion, and are discussed further on p. 34 and pp. 338-339.

Finally, the megapodes *Talegalla jobiensis* and *T. fuscirostris* provide at first glance another pair of northern and southern semispecies which are still allopatric, but the evidence discussed on p. 000 suggests that the development of sympatry and ecological sorting may actually be far advanced in this instance.

Checkerboard allopatry.—In the previously cited examples of allopatry, each member of the superspecies has a coherent and exclusive range, and a continuous geographical line running north-south or east-west divides it from its relative. There are in addition five puzzling cases of forms whose distributions appear to be largely or wholly allopatric but which replace each other in checkerboard fashion. Thus, the range of each species is broken into discrete geographical areas separated from each other by areas inhabited by the other species. Three of these cases involve pairs of forms: the fruit doves *Ptilinopus pulchellus* and *P. coronulatus,* the owlet-nightjars *Aegotheles albertisii* and *A. archboldi,* and the mannikins *Erythrura trichroa* and *E. papuana.* A fourth case (pp. 388-389) consists of three honeyeaters (*Melidectes rufocrissalis, M. belfordi,* and *M. ochromelas*) and is more complex: most New Guinea mountains support two of these three species, and the identity of the locally missing species varies geographically in checkerboard fashion. The last case involves eight mannikins of the genus *Lonchura,* which have colonized the midmontane grasslands in an irregular checkerboard, each area usually supporting only one species but the same species recurring in widely separated areas. Further details of all these cases are given under the individual species accounts. At least three different phenomena (habitat differences, colonization, and recent range expansion) appear to be involved, as discussed in the following paragraphs.

The geographical ranges of the fruit doves *Ptilinopus pulchellus* and *P. coronulatus* (pp. 124-125) both include essentially the whole of New Guinea. In some cases they replace each other over large areas. For instance, *P. coronulatus* is apparently found over the whole lower and middle Fly Rivers, while *P. pulchellus* is found on the upper Fly River; and *P. coronulatus* is on the northern slopes of the Eastern Highlands, *P. pulchellus* on the southern slopes. However, there are also areas, as on the Vogelkop, where these species replace each other over much shorter distances and inhabit smaller patches. One suspects that these two species recognize some consistent difference in the environment or habitat and that a competitive equilibrium has been reached, each species being able indefinitely to exclude the other from the type of habitat in which it is competitively superior. However, the basis of this postulated habitat difference is unknown, and I cannot detect any feature which consistently characterizes the areas chosen by *P. pulchellus* and distinguishes them from the areas chosen by *P. coronulatus.*

The checkerboard colonization of the midmontane grasslands by the eight *Lonchura* mannikins appears to have been settled on a "first come first serve" basis, and the diversity of habitats colonized by each species makes it unlikely that superior adaptations to subtle habitat differences determined the local winner. For instance, *L. spectabilis* is the sole mannikin for a distance of at least 150 miles in the midmontane grassland of the Eastern Highlands over a considerable range of altitudes, climatic conditions, and grass types and heights; *L. caniceps* is equally well entrenched in midmontane grassland of southeastern New Guinea presenting a similar but equally varied range of conditions; and *L. tristissima* fills this niche on several of the "north mountain islands" (see pp. 409-410 for details). The midmontane grasslands in their present form are recent by-products of native agriculture, and much of their grassland avifauna consists of colonists from the lowlands. The *Lonchura* mannikins appear to colonize only with difficulty, so that for them the colonization of these grassland islands is a slow and random process. Once a given species arrives, it becomes established over the whole area and excludes potential future colonists. The identity of the locally successful colonist is usually as unpredictable as trying to guess which of several related species will become established on a particular oceanic island or on a particular mountain.

The remaining three cases appear to involve recent range expansions due to invasions or speciations. In the genus *Erythrura* the species *E. papuana* is endemic to New Guinea, where it is known only from a handful of scattered localities. The very similar *E. trichroa* occurs from Celebes to Australia, the Solomon Islands, and Micronesia, and has been found at most midmontane localities in New Guinea except those where *E. papuana* occurs (p. 000). Presumably *E. papuana* is the older species in New Guinea and has been eliminated at all but a few localities by *E. trichroa,* a recent invader from the outside. The other two cases (*Aegotheles* and *Melidectes*) suggest recent speciations within New Guinea itself. *Aegotheles archboldi* and *A. albertisii* replace each other in checkerboard fashion in western New Guinea, while *A. albertisii* has the Vogelkop and eastern New Guinea to itself (p. 177). Sympatry has been demonstrated at one locality and may depend on different altitudinal preferences. Sympatry between those two of the three *Melidectes* forms present at a given locality depends also upon altitudinal exclusion. Apparently two successive speciations produced three honeyeaters, and since altitudinal sequences of three species tend to be unstable in New Guinea (p. 34), one of the three species (but not always the same one) disappeared at each locality.

Thus, the *Erythrura* case suggests a speciation and on-going reinvasion during which an ecological sorting mechanism adequate to permit sympatry has not developed and the older form has been reduced to a fragmented and possibly shrinking range. In the *Aegotheles* and *Melidectes* instances a sorting mechanism, viz., altitudinal segregation, has developed in at least a few areas, but either has failed to develop in most areas, or else was inadequate to guarantee stable sympatric populations of both forms and resulted in local elimination of one.

2. Nonspatial Sorting Mechanisms (Food and Foraging Differences)

The sorting mechanisms discussed so far (altitude, habitat, vertical distribution, allopatry, and checkerboard allopatry) have as their usual result that the spatial overlap between territories of congeners is minimal or nonexistent. We shall now consider those factors, mainly related to food consumed and the means of obtaining it, that permit congeneric species to occupy spatially overlapping territories. It should at once be mentioned that it requires careful observation to decide in some cases whether segregation is mainly spatial or nonspatial. For instance, even when two congeners occur at the same locality, at the same altitude, and in the same gross habitat type and forage at the same height, they may still be interspecifically territorial due to their recognizing finer habitat categories, such as denser and less dense forest. This is likely to prove true, for example, of the two ground doves *Gallicolumba jobiensis* and *G. rufigula.* Conversely, in the Eastern Highlands those congeners which have markedly different vertical foraging preferences appear in no case to have foraging spheres which completely exclude each other vertically, and other factors also contribute to niche differences. For instance, the honeyeater *Meliphaga aruensis* spends more time in the lowerstory than does *M. analoga* but also has a stouter bill; and the warbler *Sericornis nouhuysi* spends more time in the lowerstory than do its congeners but is also a larger bird.

The commonest type of nonspatial segregation among congeners in the Eastern Highlands depends upon a difference in body size, implying an average difference in size of food taken or in places food is sought (a large bird can take larger food, but a light bird can forage on smaller twigs and perches). There are 15 genera containing two or more species that overlap broadly in habitat and altitudinal preference but differ in size. The prize instance of segregation by size in New Guinea is provided by the pigeon genus *Ptilinopus,* which is represented on the New Guinea mainland by 11 species, all of them fruit eaters, arboreal, and colored largely green. The five that occur sympatrically at Karimui form a graded size series, each about 1.5 times heavier than the next: *P. nanus* (average weight 49 g), *P. pulchellus* (76 g), *P. superbus* (123 g), *P. ornatus* (163 g), and *P. perlatus* (245 g). A sequence of three arises in the hawk genus *Accipiter* at Karimui; *A. poliocephalus* $<$ *A. novahollandiae* $<$ *A. buergersi.* The other cases are listed in Table 1.

It will be seen from Table 1 that the weight ratio averages 1.9 and always falls between 1.33 and 2.73, usually between 1.5 and 2.5. The fact that the values show only this limited spread about the optimal ratio is due to a balance of selective pressures. Birds with a lower weight ratio would be too similar to coexist and would have to segregate by some other means (altitude, habitat, allopatry, etc). Birds with a higher weight ratio would leave an intermediate niche empty: i.e., a medium-sized bird could evolve or invade and not be too close in size to either the heavier or the lighter bird. For instance, if there were two otherwise similar birds with relative weights of 3.0 and 1.0, both could also coexist with a medium-sized bird whose relative weight was $\sqrt{3.0} = 1.7$.

Several pairs of congeners differ in other simple and obvious respects related to obtaining food. The whistler *Pachycephala leucostigma* eats mainly fruit, while its congeners are largely insectivorous. The various species of honeyeaters of the *Meliphaga analoga* complex differ in the extent to which they use flowering trees.

There remain several groups of congeners that share largely or in part the same gross habitat and are of similar sizes but between which

TABLE 1
WEIGHTS OF CONGENERS WHICH SORT OUT BY SIZE

Family	Heavier Species		Lighter Species		Weight Ratio,
	Name	Weight	Name	Weight	(Heavier Species / Lighter Species)
Accipitridae	*Accipiter buergersi*	[575]	*A. novaehollandiae*	[348]	1.65
Accipitridae	*Accipiter novaehollandiae*	[348]	*A. poliocephalus*	?	?
Columbidae	*Ptilinopus perlatus*	[245]	*P. ornatus*	(163)	1.50
Columbidae	*Ptilinopus ornatus*	(163)	*P. superbus*	(123)	1.33
Columbidae	*Ptilinopus superbus*	(123)	*P. pulchellus*	(76)	1.62
Columbidae	*Ptilinopus pulchellus*	(76)	*P. nanus*	(49)	1.55
Columbidae	*Macropygia amboinensis*	(141)	*M. nigrirostris*	(89)	1.58
Psittacidae	*Psittacella brehmii*	(99)	*P. madaraszi*	(39)	2.54
Podargidae	*Podargus papuensis*	(385)	*P. ocellatus*	(141)	2.73
Aegothelidae	*Aegotheles insignis*	(78)	*A. albertisii*	(37)	2.11
Apodidae	*Collocalia whiteheadi*	?	*C. hirundinacea*	(8)	?
Apodidae	*Collocalia whiteheadi*	?	*C. esculenta*	(9)	?
Campephagidae	*Coracina caeruleogrisea*	(138)	*C. montana*	(63)	2.19
Campephagidae	*Coracina caeruleogrisea*	(138)	*C. schisticeps*	(52)	2.65
Campephagidae	*Coracina caeruleogrisea*	(138)	*C. morio*	(57)	2.42
Malurinae	*Sericornis nouhuysi*	(15)	*S. perspicillatus*	(9)	1.67
Malurinae	*Sericornis nouhuysi*	(15)	*S. papuensis*	(11)	1.36
Pachycephalinae	*Pachycephala rufinucha*	(39)	*P. modesta*	(20)	1.95

TABLE 1 (*Continued*)

Family	Heavier Species: Name	Heavier Species: Weight	Lighter Species: Name	Lighter Species: Weight	Weight Ratio, (Heavier Species / Lighter Species)
Pachycephalinae	*Pachycephala rufinucha*	(39)	*P. schlegelii*	(22)	1.77
Pachycephalinae	*Pachycephala rufinucha*	(39)	*P. soror*	(25)	1.56
Paradisaeidae	*Lophorina (Parotia) lawesi*	(158)	*L. superba*	(78)	2.03
Paradisaeidae	*Lophorina (Parotia) lawesi*	(158)	*L. (Diphyllodes) magnifica*	(86)	1.84
Paradisaeidae	*Lophorina (Diphyllodes) magnifica*	(86)	*L. (Cicinnurus) regia*	(53)	1.62
Meliphagidae	*Myzomela eques*	(18)	*M. nigrita*	(10)	1.80
Meliphagidae	*Oedistoma iliolophum*	(12)	*O. pygmaeum*	(6)	2.00
Meliphagidae	*Meliphaga flaviventer*	(45)	*M. aruensis*	(26)	1.73
Meliphagidae	*Meliphaga flaviventer*	(45)	*M. auga*	(28)	1.61
Meliphagidae	*Meliphaga flaviventer*	(45)	*M. mimikae*	(27)	1.67
Meliphagidae	*Meliphaga flaviventer*	(45)	*M. orientalis*	(18)	2.50
Meliphagidae	*Meliphaga flaviventer*	(45)	*M. analoga*	(24)	1.88
Meliphagidae	*Philemon novaeguineae*	(133)	*P. meyeri*	(57)	2.37
				Average	1.90

The congeners compared overlap broadly in habitat and altitudinal preference, and niche differences depend in large part (though not necessarily exclusively) on size differences. Numbers in parentheses are average weights (in grams) of my specimens from the Eastern Highlands. For those species of which I collected or weighed no specimens, the average of weights reported by other collectors in other parts of New Guinea is given in square brackets. Where several lighter species are compared with one heavier species, the lighter birds sort out ecologically among themselves by some other means, usually by altitudinal or vertical preference.

the ecological sorting mechanisms cannot be adequately defined at present. Presumably foraging differences remain to be identified in most of these cases, while interspecific territoriality based on fine habitat distinctions may be operative in a few: the hawks *Accipiter novaehollandiae* and *A. fasciatus*, the pigeons *Ducula zoeae* and *D. rufigaster*, the ground doves *Gallicolumba jobiensis* and *G. rufigula*, the cuckoo-shrikes *Coracina boyeri*, *C. melaena*, *C. schisticeps*, and *C. morio*, the whistlers *Pitohui kirhocephalus*, *P. dichrous*, and *P. ferrugineus*, the honeyeaters *Melidectes fuscus* and *M. princeps*, and the flowerpeckers *Melanocharis striativentris* and *M. longicauda* or *M. versteri*.

3. Temporal Segregation

In principle, two species could forage in similar manners in the same habitat if they occupied the habitat at different times of the year (or, conceivably, of the day). In practice, there are few cases suggestive of temporal segregation among New Guinea birds, since seasonal variation is so limited. The pigeon *Ptilinopus superbus* was breeding in the Eastern Highlands at a time when its congeners were not breeding. In the south coastal savanna at Merauke, where seasonal changes may be more marked than in rainforest, the harrier *Circus spilonotus* is present in the wet season, *Circus approximans* in the dry season (Hoogerwerf, 1964). The postulated local migrations of some montane lories (p. 80), if they really do take place, may result in temporal replacement. The kingfisher *Melidora macrorhina* is partly or mainly nocturnal, whereas other kingfishers are diurnal. It would be worth noting whether those few New Guinea forest species (e.g., *Halcyon megarhyncha*, *Eurystomus orientalis waigiouensis*) which are congeneric or conspecific with an Australian form wintering in open habitats in New Guinea spend more time in open habitats after the migrants leave.

Some General Features of Ecological Sorting Mechanisms

Two general remarks are appropriate at this point.

There are systematic changes with altitude in the fineness of niche differences and in the relative importance of differing sorting mechanisms. Species diversity decreases with increasing altitude, and niche differences become correspondingly coarser. At altitudes above 8,500 ft, even in tall *Nothofagus* forest, most species in the impoverished avifauna belong to different genera or even families; no genus is represented by three species living at the same altitude; and only seven genera (*Psittacella*, *Aegotheles*, *Collocalia*, *Sericornis*, *Rhipidura*, *Pachycephala*, *Melidectes*) are represented by two species at the same altitude. In contrast, below 3,000 ft there are nine genera in which one may find between four and eight congeners occurring sympatrically at the same altitude. While altitude provides the most important sorting mechanism for the New Guinea avifauna taken as a whole, it is obviously of no importance in the avifauna of the flat lowlands, where there are no differences in altitude. A different picture of the relative importance of various sorting mechanisms might also be obtained if one compared all species pairs in the same family, as Lack (1944) did for England and as Moreau (1948) did for Tanganyika, rather than just pairs in the same genus, as done here for the Eastern Highlands.

The discussion of strict altitudinal segregation applies only to large areas of extensive virgin forest undisturbed by man, where ecological interrelationships are characterized by a beauty and simplicity lost in disturbed areas. Near human settlement one will look in vain for congeners replacing each other within 10 vertical feet. For instance, the whistlers *Pitohui nigrescens* and *P. dichrous* had mutually exclusive altitudinal ranges on Mt. Karimui but were netted at the same altitude at the forest edge behind Awande. Vertical stratification also breaks down in ecologically disturbed areas. For instance, the honeyeater *Meliphaga orientalis* remains in the middle- and upperstories in undisturbed forest and was never caught in mistnets on Mt. Karimui but was netted twice at Awande. Finally, even reproductive isolating mechanisms may break down in disturbed areas, as has occurred on a large scale in the case of the honeyeaters *Melidectes belfordi* and *M. rufocrissalis*.

Zoogeographical Affinities of the Eastern Highlands Avifauna

The affinities of the Eastern Highlands nongrassland avifauna will be discussed, first at the species level, then at the subspecies level. This section extends a previous analysis by Mayr and Gilliard (1954, pp. 328-329), which was based on Gilliard's collections in the Wahgi region.

As already mentioned, the Central Range provides an uninterrupted expanse of montane habitat with no known major east-west barriers between about longitudes 135°E and 150°E. Most montane species are distributed over the whole extent of the Central Range. Within the Central Range three lesser subdivisions may be recognized, most unequivocally on the basis of species ranges (presence of a few endemic species, absence of a few widespread species) but also on the basis of subspecies:

1. *Southeastern New Guinea,* extending from long. 150°E west to the Herzog Mountains (long. 146°30′E). This region is characterized by six drop-outs, i.e., by the absence of six widespread species (*Porzana tabuensis, Pachycephala tenebrosa,* the *Paradigalla* superspecies, *Lophorina (Pteridophora) alberti, Archboldia papuensis,* and the *Melidectes nouhuysi-M. princeps* superspecies); by the absence of

Epimachus fastosus, a western product of a recent speciation that has yet to reach the southeast; by the presence of an endemic species, *Amblyornis subalaris,* the product of a recent speciation; and by the presence of five other species or semispecies resulting from recent speciations, shared with the Eastern Highlands and discussed in the next paragraph.

2. *Eastern Highlands,* extending east at least to the Okapa area (long. 145°30′E) and west at least to Tari (long. 143°E) and probably at least to long. 142°30′E. This region is characterized by the absence of the nine drop-outs listed on pp. 00-00, and by the absence of *Melidectes ochromelas,* which is kept out by competitive exclusion (pp. 388-389); by the presence of two endemic semispecies, *Lophorina* (*Astrapia*) *mayeri* and *Melidectes princeps;* by the presence of two endemic semispecies shared with southeastern New Guinea, *Lophorina* (*Parotia*) *lawesi* and *Lophorina* (*Astrapia*) *stephaniae;* and by the presense of three endemic species shared with southeastern New Guinea, all products of recent speciation (*Cnemophilus macgregorii, Paradisaea rudolphi,* and *Ptiloprora guisei*).

3. *Western New Guinea,* extending from long. 135°E east at least to the Telefolmin region (long. 141°30′E). This region contains the highest mountains of New Guinea and has the most distinctive and numerous endemic species. There are three endemic species in monotypic genera, two of them alpine birds: *Anurophasis monorthonyx* (alpine), *Androphobus viridis,* and *Oreornis chrysogenys* (alpine). There are four other endemic species, *Aegotheles archboldi, Petroica archboldi* (alpine), *Pachycephala lorentzi,* and *Lonchura teerinki,* and two endemic semispecies, *Lophorina* (*Astrapia*) *splendissima* and *Melidectes nouhuysi.* Seven other species, five of them apparently products of recent speciation, are shared with the Vogelkop but are absent from the Eastern Highlands and southeastern New Guinea: *Rallicula rubra, Charmosyna josefinae, Melampitta gigantea, Peneothello cryptoleucus, Pachycephalopsis hattamensis, Ptiloprora erythropleura,* and *Zosterops fuscicapilla.* There are five drop-outs present on the Vogelkop and in eastern New Guinea but not on the western part of the Central Range (*Coracina lineata, Myzomela adolphinae, Melanocharis arfakiana, Erythrura papuana,* and *Zosterops novaeguineae;* the absence of the last-named species may be correlated with the presence of *Zosterops fuscicapilla*). *Accipiter buergersi* should perhaps also be considered a drop-out, since it occurs in southeastern New Guinea, the Eastern Highlands, and the Huon Peninsula but not in western New Guinea, has no close relatives, and must be a relatively old species.

No systematic collecting has been done between long. 141°30′E and long. 143°E, or between long. 145°30′E and long 146°30′E. It remains to be seen how sharp these transition zones are, i.e., whether a region's endemic species will disappear and its drop-outs reappear within a short distance in these uncollected gaps. These two transition areas are apparently less than 70-100 miles in extent, while the three regions are 200-440 miles in extent.

The Eastern Highlands appear to be a fairly uniform region with respect to species and subspecies distributions above 5,000 ft. The exceptions to this statement are sufficiently few to be worth detailing. The only well-established limit of a midmontane species within the Eastern Highlands is that of the semispecies *Lophorina* (*Astrapia*) *mayeri* and *Lophorina* (*Astrapia*) *stephaniae* which replace each other around long. 144°E (Mts. Hagen and Giluwe). Mts. Hagen and Giluwe also have the easternmost known colonies of *Archboldia papuensis,* which then apparently disappears again for 350 miles to the west until Mt. Wilhelmina is reached. The eastern and western semispecies *Lophorina* (*Parotia*) *lawesi* and *Lophorina* (*Parotia*) *carolae* also probably meet in the Eastern Highlands, but the details are still unknown. The only midmontane species which appears to be represented in the Eastern Highlands by well-marked eastern and western races is *Peneothello sigillatus.* Three other midmontane species (*Coracina caeruleogrisea, Sericornis nouhuysi,* and *Paradisaea rudolphi*) are represented in the Eastern Highlands by thinly differentiated eastern and western races which intergrade clinally. In the cases of three species (*Lophorina* (*Astrapia*) *stephaniae, Melidectes rufocrissalis,* and *Melidectes belfordi*) the race on the outlying Schrader Range differs from that in the remainder of the Eastern Highlands.

For analysis of subspecific affinities the Eastern Highlands avifauna will be broken down into five somewhat arbitrary categories based on altitude, since several different patterns emerge:

1. *Alpine species:* species confined to alpine grassland or the adjacent forest edge, rarely descending below 10,000 ft in the Eastern Highlands. These species live only on the highest mountains in New Guinea and show the highest degree of endemism, as expected from the broken and isolated nature of their habitat. Of the seven alpine species in the Eastern Highlands, one (*Melidectes princeps*) is an endemic semispecies; three (*Megalurus timoriensis montanus, Turdus poliocephalus erebus, Oreostruthus fuliginosus hagenensis*) are represented by endemic subspecies, the latter two nearest the southeastern New Guinea forms; two (*Petroica bivattata bivittata* and *Melidectes fuscus fuscus*) belong to the southeastern New Guinea race, while the western New Guinea race differs; and one (*Anthus gutturalis rhododendri*) belongs to the Huon Peninsula race, which is nearer the southeastern New Guinea race than the western New Guinea race. The reason for these southeastern affinities of the alpine avifauna of the Eastern Highlands is probably that the alpine grasslands of southeastern New Guinea are less distant than those of the Snow Mountains of western New Guinea.

2. *Midmontane species:* birds that do not descend below 5,000 ft.

excepting alpine species, which have already been considered. Grassland and swamp species will also be considered separately (pp. 71-72).

Twenty-seven midmontane species provide no indication of zoogeographical affinities, either because all New Guinea populations belong to one race, or else because all Central Range populations belong to one race and differentiation occurs only on isolated mountain "islands" (Vogelkop, Huon Peninsula, etc.). Of the remaining species, ten (*Psittacella picta excelsa, Psittacella madaraszi hallstromi, Epimachus meyeri bloodi, Cnemophilus* (*Loria*) *loriae amethystina, Cnemophilus macgregorii sanguineus, Archboldia papuensis sanfordi, Daphnoenositta miranda kuboriensis, Melidectes rufocrissalis thomasi, Ptiloprora guisei umbrosa, Zosterops novaeguineae wahgiensis*) are represented by valid endemic subspecies, with two additional endemic subspecies on the Schrader Range (*Lophorina* (*Astrapia*) *stephaniae feminina* and *Melidectes belfordi schraderensis*). In the cases of 19 species of which there are two races, a western and an eastern race, on the Central Range, racial determinations are available for the populations of the Snow Mountains (about 400 miles west of the Eastern Highlands), Telefolmin (about 200 miles west of the Eastern Highlands), the Eastern Highlands, and the Wharton Range of southeastern New Guinea (about 200 miles east of the Eastern Highlands). In eight of these 19 cases the racial division falls between southeastern New Guinea and the Eastern Highlands; in five cases, between the Eastern Highlands and Telefolmin; and in six cases, between Telefolmin and the Snow Mountains. In the four additional cases mentioned on p. 48, western and eastern races divide within the Eastern Highlands. The Eastern Highlands population of *Pachycephala modesta* belongs to the race of the Huon Peninsula mountain "island," and the southeastern and Telefolmin populations on the Central Range are both racially distinct.

Thus, almost all geographic variation of midmontane species on the Central Range is east-west variation, and affinity decreases with increasing distance. There are somewhat closer affinities with the populations to the east in southeastern New Guinea than with the more distant Snow Mountains of western New Guinea, as concluded previously by Mayr and Gilliard (1954, p. 329) and as also true of the alpine avifauna. Except for the three isolates of the Schrader Range (p. 48), there are no racial differences between the northern and southern slopes. This is as one would expect, since the Central Range extends much further east-to-west than north-to-south and presents no major barriers to a midmontane species. The dissected terrain consists of mountains separated by valleys which provide minor barriers and whose floors along the watershed divide lie at 5,000 ft or higher. A species will therefore find suitable habitat patchier the higher its altitudinal range lies, and the group with the highest percentage of differentiated forms is the alpine avifauna.

3. *Tropical species:* birds ranging from sea level up to a ceiling which is lower than 5,000 ft. Since the Central Range has no passes under 5,000 ft, it acts as a barrier which completely stops direct contact between populations in the northern New Guinea lowlands and southern New Guinea lowlands. Two lengthy indirect paths are available for north-to-south gene flow: around the tip of southeastern New Guinea in the extreme east, and across the Geelvink Gap or around the Vogelkop in the extreme west. Thus, the populations of tropical species form a continuous or broken ring in the lowlands around the periphery of New Guinea. The tropical avifauna on the southern slopes of the Eastern Highlands is well known taxonomically as a result of my collections and those of Schodde and Hitchcock, whereas little material from below 5,000 ft on the northern slopes has been evaluated taxonomically. The following comments therefore apply only to the southern slopes unless stated otherwise, and mainly to my material from the Karimui area and Okasa. The conclusions reached by Schodde and Hitchcock concerning Lake Kutubu will be cited separately for comparison.

The races of 42 tropical species replace each other consecutively in simple fashion as one proceeds around the lowlands periphery of New Guinea. There are, of course, other species in which all New Guinea lowlands populations belong to the same race. Regarding east-west differences, there are 24 of these 42 cases in which the southeastern, Eastern Highlands, and southwestern populations belong to the same race; 11 cases in which one race occurs in southwestern New Guinea, the Fly River, and Eastern Highlands and a different race in southeastern New Guinea; five cases in which one race occurs in southwestern New Guinea and on the Fly River and a different one in the Eastern Highlands and southeastern New Guinea; and two cases in which one race occurs in southeastern New Guinea, the Eastern Highlands, and part of the Fly River, while a different race occurs on another part of the Fly River and in western New Guinea. Thus, the Karimui-Okasa avifauna is slightly closer to that of the Fly River to the west than to that of southeastern New Guinea to the east, as Schodde and Hitchcock (1968, p. 11) also showed for the Lake Kutubu avifauna. Regarding north-south differences, there are four instances (the *Goura* superspecies, the *Chalcopsitta* superspecies, the *Psittaculirostris* superspecies, and the *Paradisaea raggiana-P. minor* superspecies) in which one semispecies occurs in southern New Guinea and the Eastern Highlands, a different semispecies in northern New Guinea; 34 cases in which one subspecies occurs in southeastern New Guinea and the Eastern Highlands, a different subspecies in northern New Guinea; only five cases where the southern New Guinea, northern New Guinea, and Eastern Highlands populations all belong to the same subspecies; and no instance in which the Eastern Highlands population belongs to a northern New Guinea race and differs from a southern

New Guinea race. Thus, the affinities of the avifauna on the southern slopes of the Eastern Highlands are exclusively southern, as expected. That north-south differentiation is more frequent than east-west differentiation is also as expected, since the distances within the southern New Guinea lowlands or northern New Guinea lowlands are less (and the opportunities for gene flow therefore greater) than between northern and southern New Guinea around the eastern and western tips of the Central Range.

Gilliard, Gyldenstolpe, and Shaw-Mayer obtained specimens of seven tropical species from the northern slopes of the Eastern Highlands. These all belong to northern semispecies (*Goura victoria, Psittaculirostris edwardsi, Paradisaea minor*) or subspecies (*Gallicolumba rufigula septentrionalis, Ceyx azureus ochrogaster, Lophorina (Cicinnurus) regia similis,* and *Ailuroedus buccoides geislerorum*).

Four tropical species are represented by endemic subspecies which probably have narrow ranges on the southern slopes of the Eastern Highlands (*Domicella lory somu, Aegotheles bennettii terborghi, Rhipidura leucothorax clamosa, Myzomela eques karimuiensis*).

A different pattern of variation appears in four other tropical species: one race is widespread over most of New Guinea, and a different race is confined to the Fly River lowlands. The Eastern Highlands population belongs to the widespread race in three cases (*Crateroscelis murina murina, Microeca flavovirescens cuicui, Myzomela nigrita meyeri*) and to the Fly River race in one case (*Amaurornis olivaceus ruficrissum*).

Finally, there are three cases in which the racial affinities of the Eastern Highlands population are neither with southeastern New Guinea directly to the east nor with the Fly River directly to the west, but with the southern slopes of the Snow Mountains farther to the west, giving a checkerboard distribution (*Coracina melaena melaena, Pitohui ferrugineus ferrugineus, Meliphaga flaviventer rubiensis*).

4. *Hill forest species:* birds whose ceilings lie below 5,000 ft but which do not descend as far as sea level. Just as for tropical species, the Central Range is a complete barrier, except at its ends, to the north-south movement of birds in this category. Consideration is again limited to forms on the southern slopes of the Eastern Highlands unless stated otherwise.

Eleven hill forest species show no geographical variation on the Central Range. In nine species variation fits a simple east-west and/or north-south pattern. Regarding east-west differences, the southeastern, Eastern Highlands, and southwestern (i.e., southern slopes of the Snow Mountains) populations belong to the same race in three cases; in five cases the southeastern and Eastern Highlands populations belong to one race, the southwestern population to another; and in one case (*Pachycephala hyperythra*) the southeastern and Eastern Highlands populations belong to the same race, but the species is absent from southwest New Guinea. The hill forests at the head of the Fly

River cannot be included in this comparison because they are virtually unexplored ornithologically. Regarding north-south differences, the Eastern Highlands and southeastern (or southern) populations belong to the same race in all nine cases, while the species is absent from northern New Guinea in one case (*Meliphaga auga*) and is represented by a different population in northern New Guinea in all eight other cases. In three instances (*Manucodia* (*Phonygammus*) *keraudrenii, Lophorina* (*Diphyllodes*) *magnifica, Ailuroedus crassirostris*) Gilliard or Gyldenstolpe took specimens from the northern slopes of the Eastern Highlands and found them to belong to the northern race. Thus, the main pattern of geographic variation for hill forest species in the Eastern Highlands is identical to that for tropical species.

More complex patterns are met in four hill forest species. *Pachycare flavogrisea* shows clinal east to west variation, and it proves convenient to recognize the boundary between two races as occurring in the Eastern Highlands. *Peneothello bimaculatus* is represented by one race in the northwestern, southwestern, Eastern Highlands, and southern slopes of southeastern New Guinea, by another race on the northern slopes of southeastern New Guinea and on the Huon and Adelbert "north mountain islands." The situation is reversed for *Zosterops atrifrons,* of which the populations of the Eastern Highlands (southern slopes) and the northern slopes of southeastern New Guinea are conracial, while the populations of the southern slopes of southeastern New Guinea and the southwest are racially distinct. Finally, *Pachycephalopsis poliosoma* from the Eastern Highlands (southern slopes) proves, surprisingly, to belong to the race *albigularis* from the northern slopes at the western extremity of the Central Range, with distinct races intervening in southeastern, southwestern, and northeastern New Guinea. There are no endemic hill forest subspecies in the Eastern Highlands.

5. *Birds ranging both above and below 5,000 ft.* Only five species in this category exhibit north-south racial differences in eastern New Guinea. Three populations (*Cacomantis variolosus oreophilus, Meliphaga orientalis facialis, Melanocharis striativentris striativentris*) belong to the southern race, two (*Opopsitta diophthalma festetichi, Trichoglossus haematodus intermedius*) to the northern race. The ceilings of these five species vary locally between about 5,500 and 6,800 ft, and the number of north-south passes at these altitudes is limited, so that the Central Range, although not a complete barrier to north-south gene flow, is still somewhat of a barrier.

Simple east-to-west variation involving two races on the Central Range is encountered in six cases. The division falls between southeastern New Guinea and the Eastern Highlands in three cases (*Rallicula forbesi, Alisterus chloropterus, Pachycephala soror*), between the Eastern Highlands and Telefolmin in one case (*Dicaeum geelvinkianum*), and between Telefolmin and the Snow Mountains in two cases (*Cacomantis castaneiventris, Amblyornis macgregoriae*). In two instances (*Coracina caeruleogrisea, Paradisaea rudolphi*) eastern and western races meet within the Eastern Highlands.

The Eastern Highlands populations of three species belong to endemic subspecies (*Casuarius bennettii shawmayeri, Tregellasia leucops wahgiensis, Paradisaea rudolphi margaritae,* plus *Lophorina superba pseudoparotia* on the Schrader Range).

In two instances (*Lophorina superba latipennis, Melanocharis longicauda captata*) Eastern Highlands populations belong to the subspecies of the Huon Peninsula mountain "island" and differ racially from the Central Range populations to the east and west. These patterns almost surely arose from populations differentiating in the Eastern Highlands and then invading the Huon Peninsula, not vice versa (cf., also, *Pachycephala modesta,* p. 49).

The Eastern Highlands population of *Meliphaga orientalis* is derived from the southern slopes of western New Guinea (*facialis*) rather than the southern slopes of southeastern New Guinea (*orientalis*) and differs from the northwestern (*citreola*) and northeastern (*becki*) populations.

Colluricincla megarhyncha is represented in the Wahgi Valley by the northeastern New Guinea race *tappenbecki* and on the southern slopes of the Eastern Highlands by the Herzog Mountains race *nea.* The populations from southeastern New Guinea and the Fly River differ.

Summary of zoogeographic affinities. The hindrances to gene flow implicit in geographic variation result in New Guinea either from geographical barriers, hence a discontinuity in the distribution of a species, or else simply from distance. The Central Range runs east-west and lacks passes under 5,000 ft. For tropical and hill forest species, which are absent above 5,000 ft, the Central Range functions as a complete or nearly complete barrier, so that there are marked differences between northern and southern populations, as well as east-west variation resulting from distance. For midmontane species, which do not descend below 5,000 ft, north-south population differences are virtually nonexistent, and variation is east-to-west. The higher a species' altitudinal lower limit, the patchier the environment becomes to the species, so that the highest proportion of endemic forms is encountered among alpine birds. Eastern and western distributional limits of species and semispecies can be used to divide the Central Range into three sections, of which the Eastern Highlands as defined in this monograph is one.

Avifauna of the Karimui Basin

The unusual bird distribution patterns in the Karimui Basin require separate discussion. As already mentioned, Karimui is a flat basin with a floor lying at about 3,500 ft, and is effectively sealed off from the outside by a ring of mountains. The Karimui avifauna is marked by the presence of many lowland species whose altitudinal ceiling elsewhere lies considerably below 3,500 ft; by the absence or rarity of some hill forest species normally encountered at this altitude; and by the presence of three strikingly distinct endemic forms. The avifauna we found at Karimui Patrol Post (3,650 ft) contrasted with that of the Okasa forest (3,550-4,250 ft), which is at the same altitude but in hilly terrain typical for this altitude in most of New Guinea.

The following 26 or 27 lowland forest species were present at Karimui but rarely reach this altitude elsewhere in New Guinea. Some of these species, in fact, normally disappear as soon as one leaves the flat lowlands at sea level. None was present at the same elevation at Okasa, and Schodde and Hitchcock met only 11 at Lake Kutubu despite the elevation there (2,450 ft) being 1,200 ft lower than at Karimui Patrol Post: *Aviceda subcristata, Rallina tricolor, Ptilinopus nanus, Megaloprepia magnifica, Chalcophaps stephani, Charmosyna placentis, Psittaculirostris desmarestii, Opopsitta gulielmitertii, Geoffroyus geoffroyi, Eudynamis scolopacea, Centropus menbeki, Aegotheles bennettii, Halcyon torotoro, Campochaera sloetii, Coracina boyeri, Sericornis spilodera, Rhipidura threnothorax, Monarcha chrysomela, Microeca flavovirescens, Poecilodryas placens, Pitohui kirhocephalus, Pitohui ferrugineus, Lophorina (Cicinnurus) regia, Ailuroedus buccoides, Myzomela eques, Pycnopygius ixoides,* and probably *Casuarius casuarius.*

The following nine lowland species of the forest edge, second-growth, and open country were present at Karimui somewhat above their normal altitudinal ceiling. All were absent at Okasa, but Schodde and Hitchcock found all except *Circus approximans* at Lake Kutubu (2,450 ft): *Circus approximans, Amaurornis olivaceus, Ptilinopus perlatus, Dacelo gaudichaud, Rhipidura leucothorax, Mino dumontii, Cracticus cassicus, Dicrurus hottentottus,* and *Nectarinia sericea.*

The following ten hill forest species which would normally be encountered at the elevation of Karimui were absent: *Casuarius bennettii, Charmosyna pulchella, Halcyon megarhyncha, Sericornis arfakianus, Phylloscopus trivirgatus, Rhipidura atra, Microeca griseoceps, Lophorina (Parotia) lawesi, Lophorina superba,* and *Ailuroedus crassirostris.* In the case of three additional hill forest species expected at 3,500 ft, one or more immatures were taken at Karimui but no adults: *Monarcha axillaris, Pachycephala soror,* and *Manucodia (Phonygammus) keraudrenii.* Adults of five additional hill forest species were taken at Karimui but were much rarer than expected at 3,500 ft: *Tregellasia leucops, Pachycephalopsis poliosoma, Pachycephala leucostigma, Melidectes torquatus,* and *Meliphaga orientalis.* Fifteen of these 18 hill forest species were present at Okasa and include all of the commonest Okasa birds.

In seven of these cases a species unexpectedly present and a species unexpectedly absent at Karimui are successive members of an altitudinal sequence (p. 27), so that the "wrong" member of the sequence was present: *Charmosyna placentis* vs. *C. pulchella*, *Halcyon torotoro* vs. *H. megarhyncha*, *Sericornis spilodera* vs. *S. arfakianus*, *Rhipidura threnothorax* vs. *R. atra*, *Microeca flavovirescens* vs. *M. griseoceps*, *Ailuroedus buccoides* vs. *A. crassirostris*, and probably *Casuarius casuarius* vs. *C. bennettii*.

Two kinds of evidence indicate that the distributional anomalies at Karimui are ultimately due to the flatness of the basin floor. The first line of evidence is based on the changes in the avifauna on the lower slopes of Mt. Karimui, which rises out of the basin. Near the base of Mt. Karimui's west ridge the basin floor begins to slope gently upward as one goes towards the mountain, until at an elevation of 4,200 ft the foot of the west ridge is encountered and the mountain abruptly rises at a steeper angle. Of the eight altitudinal zones into which I arbitrarily divided Mt. Karimui, the lowest, Zone 1, was on the sloping basin edge just at the foot of the ridge and spanned an altitude range from 4,000 to 4,200 ft. Although Zone 1 began at an altitude only 350 ft above Karimui Patrol Post (3,650 ft), my main collecting station on the flat basin floor, all but six of the 26 or 27 lowland forest species present at Karimui above their normal ceiling were absent from Zone 1, and five of these six disappeared as soon as the west ridge was reached, i.e., in Zone 2. Conversely, of the 18 hill forest species absent or rare on the basin floor, 10 were present and generally common already in Zone 1, and seven of the remaining eight appeared in Zone 2. Thus, the distributional anomalies of the flat basin floor were reversed as soon as sloping terrain was encountered even though there had been only a small change in altitude itself.

The second and more striking line of evidence that the anomalous lowlands avifauna of the Karimui Basin is due to its flatness was provided by the discontinuous altitudinal ranges of at least three hill forest species. The flycatcher *Rhipidura atra* was present on the slopes of Mt. Karimui from 4,090 ft upward and was absent on the basin floor. When I crossed the mountain wall ringing the basin and descended into hilly country en route to Soliabeda, *Rhipidura atra* reappeared at 3,230 and 2,770 ft. On the slopes of Mt. Karimui the parrot *Charmosyna pulchella* was present from 4,400 ft upward, and the bird of paradise *Loboparadisea sericea* from 4,000 ft upwards. Both were absent on the basin floor but reappeared at Soliabeda, which is at 2,000 ft in hilly country. The absence of these three species in the basin thus could not have been due to altitude, since they were present at both lower and higher altitudes in hilly terrain, and must have been due to the flatness. Had more time been spent en route between Karimui and Soliabeda, and had the difficulty and circumstances of the route not been so unconducive to bird-watching, I suspect that similar instances of discontinuous altitudinal distributions would have been unmasked in some other hill forest species.

The explanation these facts suggest for the anomalous avifauna of Karimui is that the flatness of the basin floor has caused it to fill up with the rainforest, and hence many of the birds, characteristic of the flat lowlands rather than of the hill slopes. This interpretation seems reasonable, since the slope governs the effectiveness of drainage and hence the plant communities, and since quite a few New Guinea bird species (e.g., *Otidiphaps nobilis, Gymnophaps albertisii, Lophorina* (*Diphyllodes*) *magnifica*), are absent from the flat lowlands but present in hilly terrain even near sea level. What makes Karimui unique is the general ruggedness of New Guinea's hills and mountains, so that one rarely, or nowhere else, finds a flat area at 3,500 ft as extensive as at Karimui.

Three of these isolated populations trapped within the Karimui Basin have differentiated to yield strikingly distinct endemic forms, all tending towards melanism (Diamond, 1967a). The unique type of the owlet-nightjar, *Aegotheles bennettii terborghi,* not only represents an altitudinal record for this lowland rainforest species but also is 25% larger in linear dimensions than the other races (hence presumably twice as heavy) and much darker. The goshawk *Accipiter novaehollandiae* exists elsewhere in two color phases, one pure white, the other gray and rufous, while the Karimui population is melanistic, being uniform dark gray-brown. The mannikin *Lonchura spectabilis gajduseki* has buff underparts as opposed to white in other races. The distinctness of these endemic forms suggests that strong selective pressures are operative at Karimui and that the mountain ring is an effective barrier to gene flow for some species. For such species the Karimui Basin represents an isolated island of tropical habitat, analogous to the evolutionary significance of isolated high mountain summits for alpine species.

Altitudinal Distribution

In this section the results of my altitudinal censuses in the Karimui area (Soliabeda, Bomai, Karimui, Mt. Karimui) will be analysed. Previous analyses of the altitudinal distribution of New Guinea birds include those by Stresemann (1923, pp. 7-15), Archbold and Rand (1935, pp. 535-543), and Archbold, Rand, and Brass (1942, p. 285).

I identified 242 bird species in the Karimui area. Of these, 36 were nonforest species, strictly confined to grassland, second-growth, or water. Such habitats do not exist on Mt. Karimui, and these 36 species are therefore excluded from consideration in the present analysis. Of the 206 forest species, there were 40 of which I obtained too few records to work out the altitudinal range satisfactorily.

Figure 4 presents the altitudinal ranges of the 166 forest species for which my data are adequate. All altitudinal ranges were assumed to be continuous; if a bird was recorded above and below but not at a certain elevation, it was assumed to be present at that elevation but to have been overlooked. This assumption is probably valid except in the cases of a few hill forest species present above and below but not in the Karimui Basin (pp. 55-56). Birds present at Soliabeda, my lowest station (1,350-2,000 ft), are arbitrarily depicted in Figure 4 either as continuing down to sea level or else as having their lower limits at Soliabeda, the decision being made on the basis of my experience elsewhere in New Guinea or on the basis of published information. On Mt. Karimui, Zone 1 (4,000-4,200 ft), Zone 2 (4,400-4,750 ft), Zone 3a (4,750-5,080 ft), Zone 3b (5,080-5,390 ft), Zone 4a (5,390-5,780 ft), Zone 4b (5,780-5,960 ft), Zone 5a (5,960-6,250 ft), Zone 5b (6,250-6,500 ft), Zone 6a (6,500-6,770 ft), Zone 6b (6,770-7,080 ft), Zone 7a (7,080-7,280 ft), Zone 7b and 8a (7,280-7,620 ft), and Zone 8b (7,620-8,165 ft, the summit) were each considered as units in constructing Figure 4: i.e., if a species was recorded anywhere within the unit, it is depicted as being present throughout the unit.

The following conclusions may be extracted from Figure 4:

1. *Species diversity* (Fig. 5). The number of forest species recorded at a given altitude is relatively constant at about 100 species from 3,650 ft (Karimui) and 3,250 ft (Bomai) down to at least 1,350 ft (the lower limit of collecting at Soliabeda). On Mt. Karimui the number of species decreases regularly with increasing altitude, from 77 at 4,000-4,200 ft (Zone 1) to 16 in the summit zone (7,620-8,165 ft). Possibly some of the difference between the species totals for the lowest elevation on Mt. Karamui (77 species) and the three village locations at lower elevations (ca. 100 species) is because larger and more diverse areas of forest were surveyed at a given elevation at the village locations than on Mt. Karimui. The apparent slight maximum in Figure 5 at 3,650 ft (Karimui) is probably an artifact of more time spent collecting at Karimui than at other localities. It should be mentioned again that the actual number of forest species is about 25% higher than depicted in Figure 5, since ranges for only 166 of the 206 forest species in the area were used to construct Figure 5.

Three factors contribute to the decrease in species diversity with altitude depicted in Figure 5. First, with increasing elevation the forest becomes more stunted, and MacArthur, Recher, and Cody (1966) have shown that bird species diversity among different habitats in the same area correlates well with the foliage profile diversity. Second, the total area in New Guinea at a given altitude decreases with increasing altitude. Over long times, the total number of species that can evolve to utilize a given type of habitat should be larger, the greater the available area of the habitat, and one would therefore expect fewer high-altitude than low-altitude species in New Guinea even if the foliage did not change. For example, there is a much greater area of alpine grassland, and consequently much greater variety of alpine grassland bird species, in the South American Andes than in New

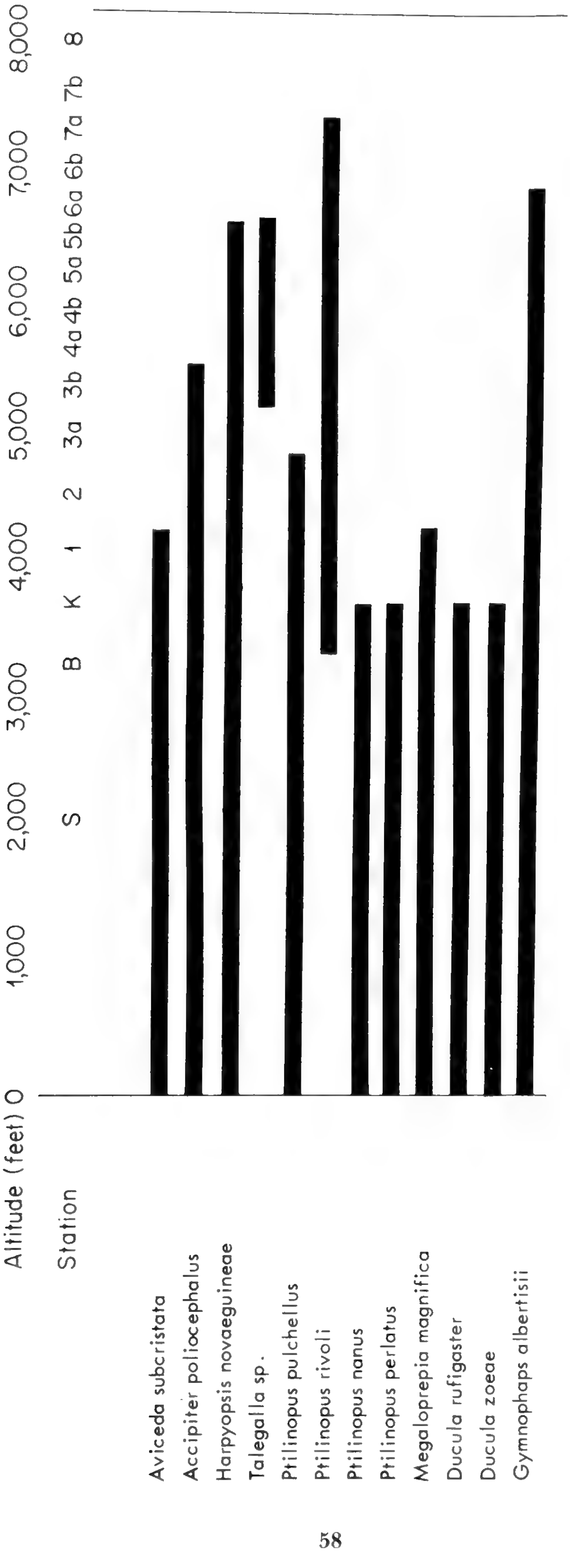


FIG. 4. Altitudinal ranges of 166 species in the Karimui area.

See text, page 56, for discussion of how this figure was constructed. Collecting stations are abbreviated by the letters S (Soliabeda), B (Bomai), and K (Karimui Patrol Post) and by the zone numbers of the census zones on Mt. Karimui between 4,000 ft. and the summit at 8,165 ft.

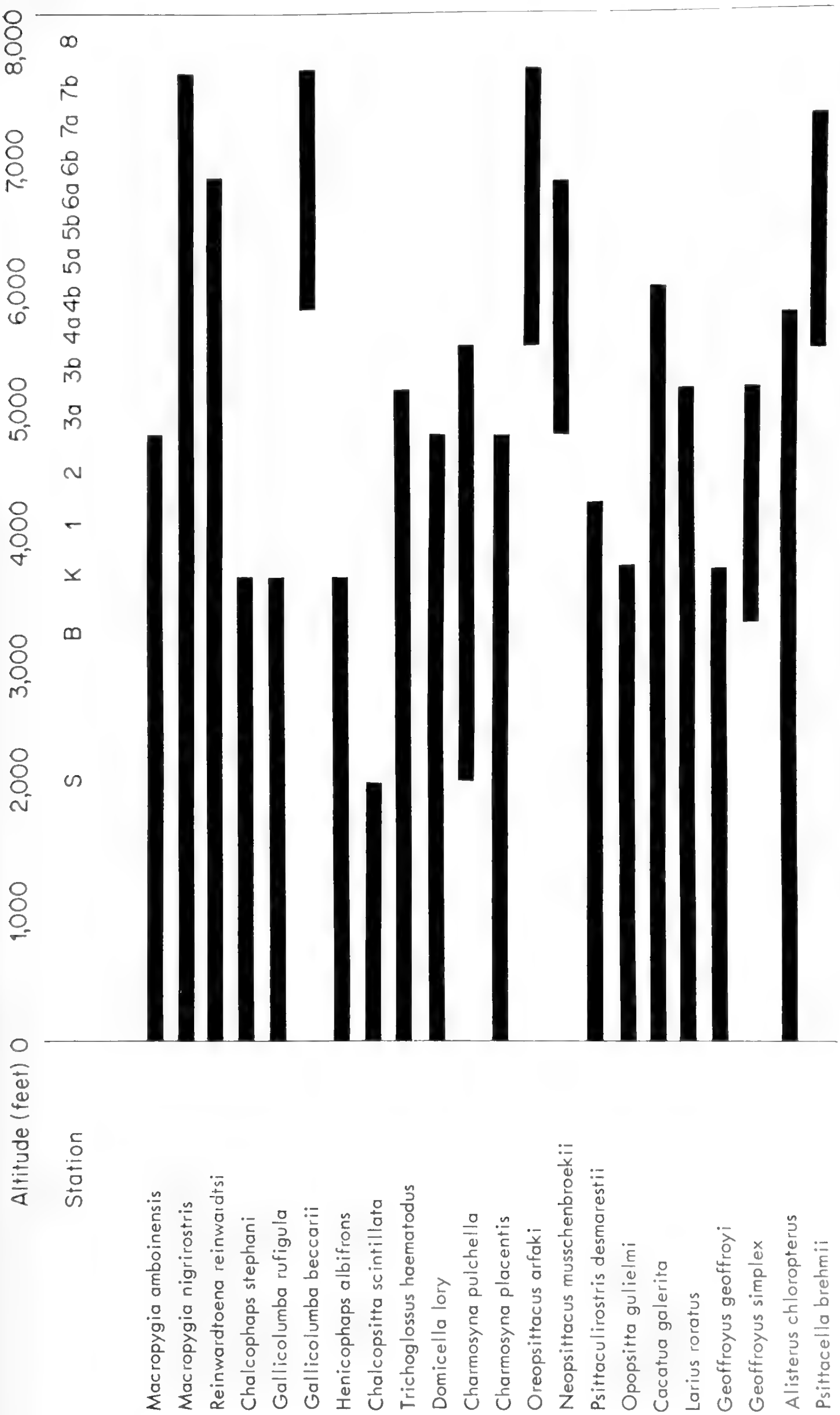


Fig. 4 (cont.). Altitudinal ranges of 166 species in the Karimui area.

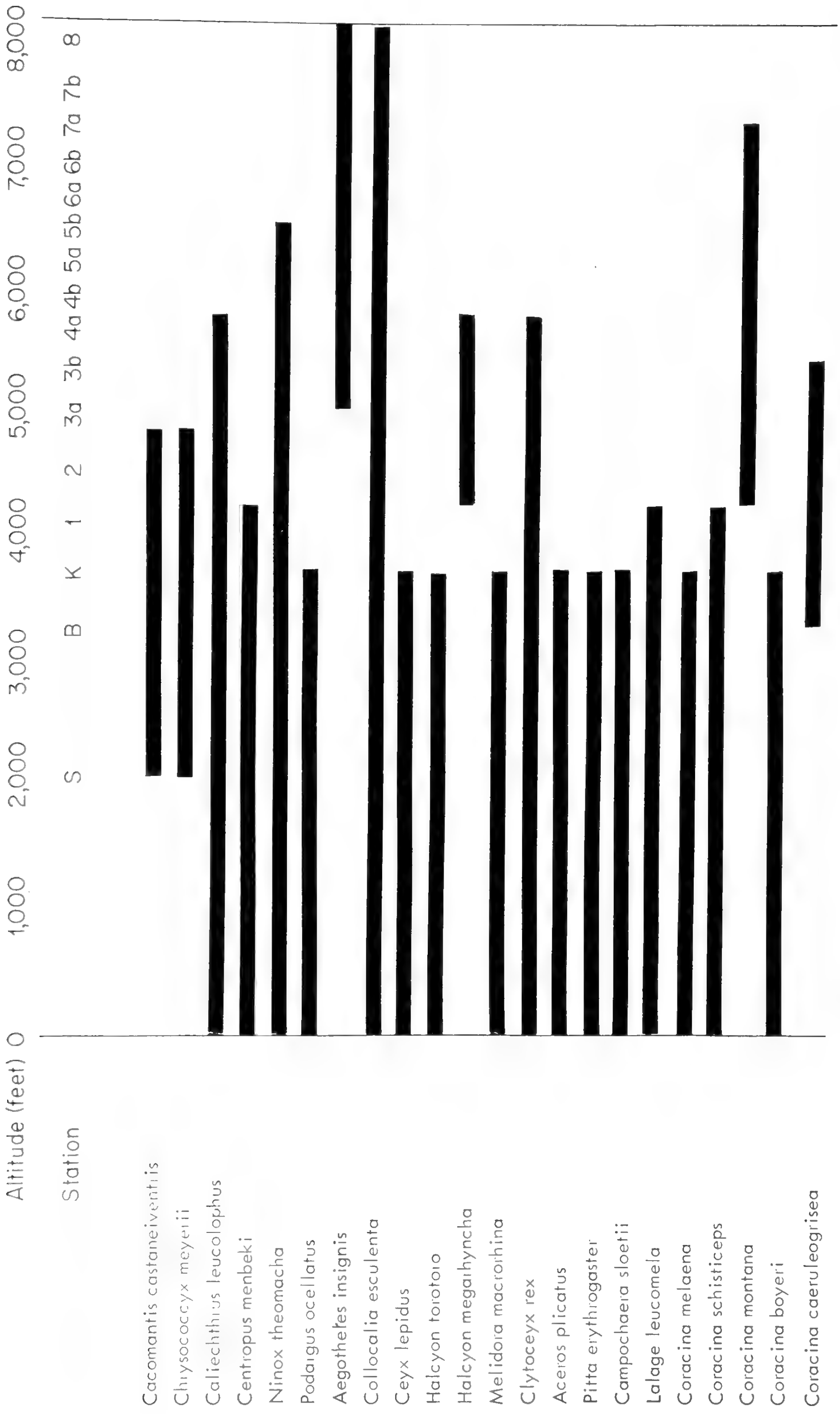


FIG. 4 (cont.). Altitudinal ranges of 166 species in the Karimui area.

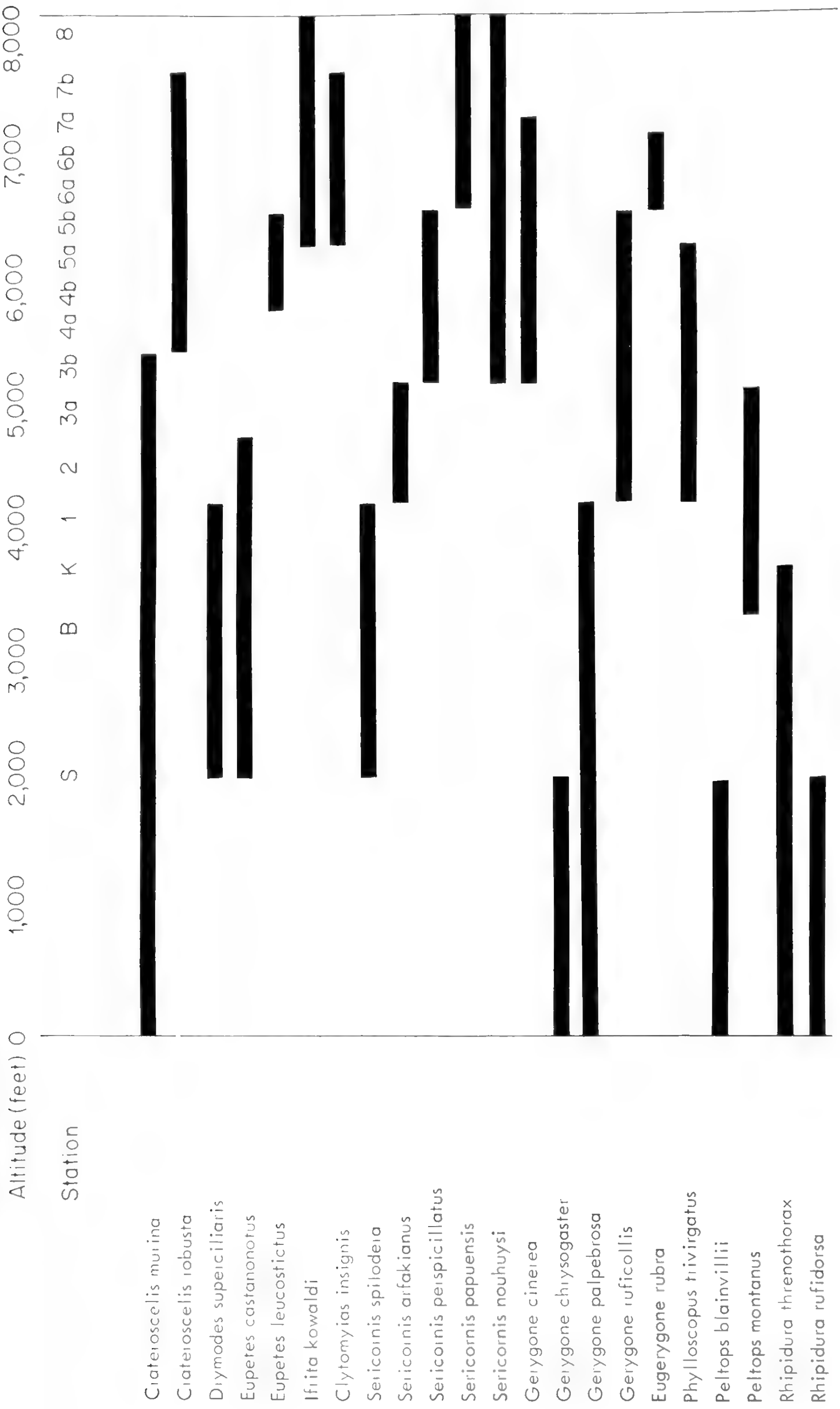


FIG. 4 (cont.). Altitudinal ranges of 166 species in the Karimui area.

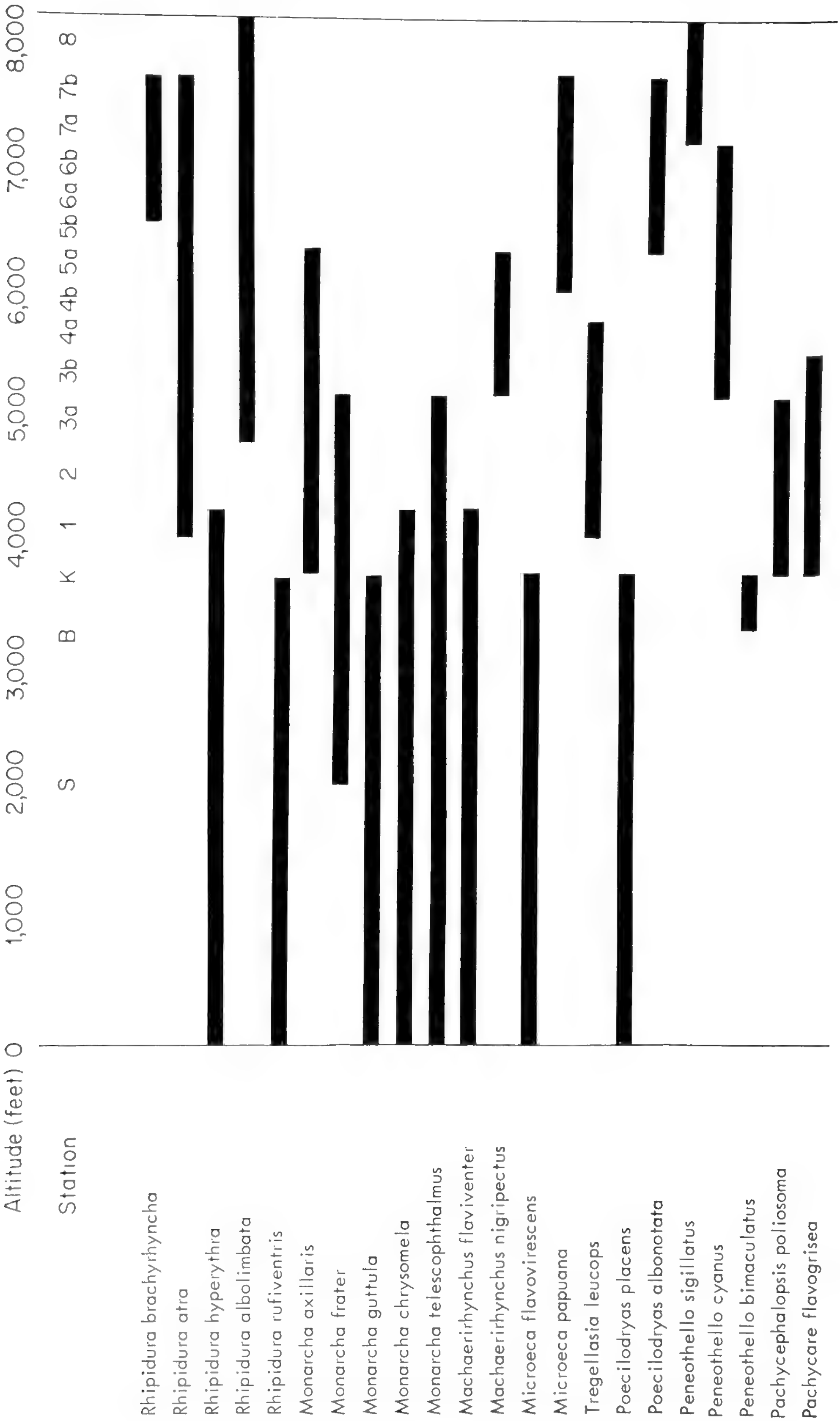


FIG. 4 (cont.). Altitudinal ranges of 166 species in the Karimui area.

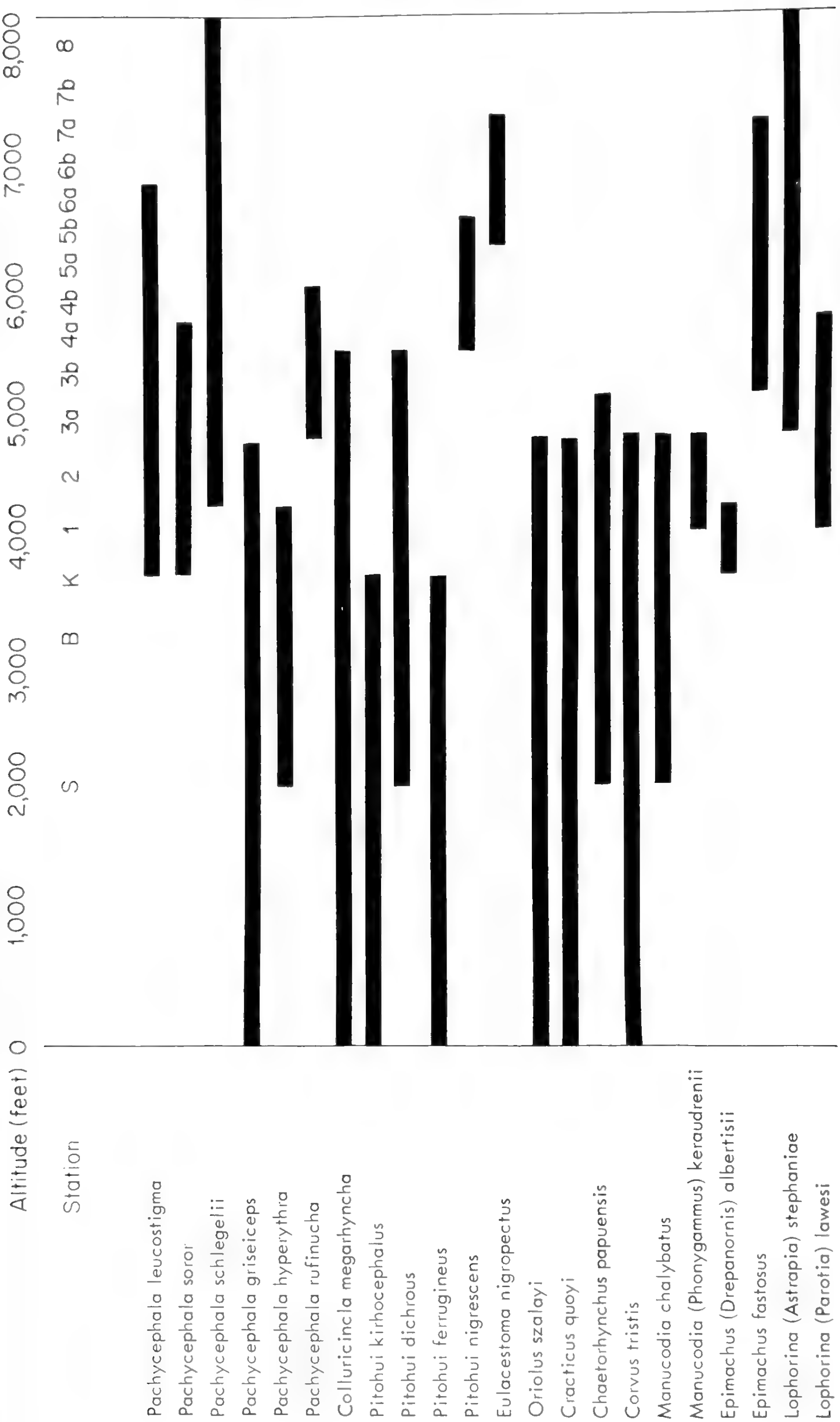


FIG. 4 (cont.). Altitudinal ranges of 166 species in the Karimui area.

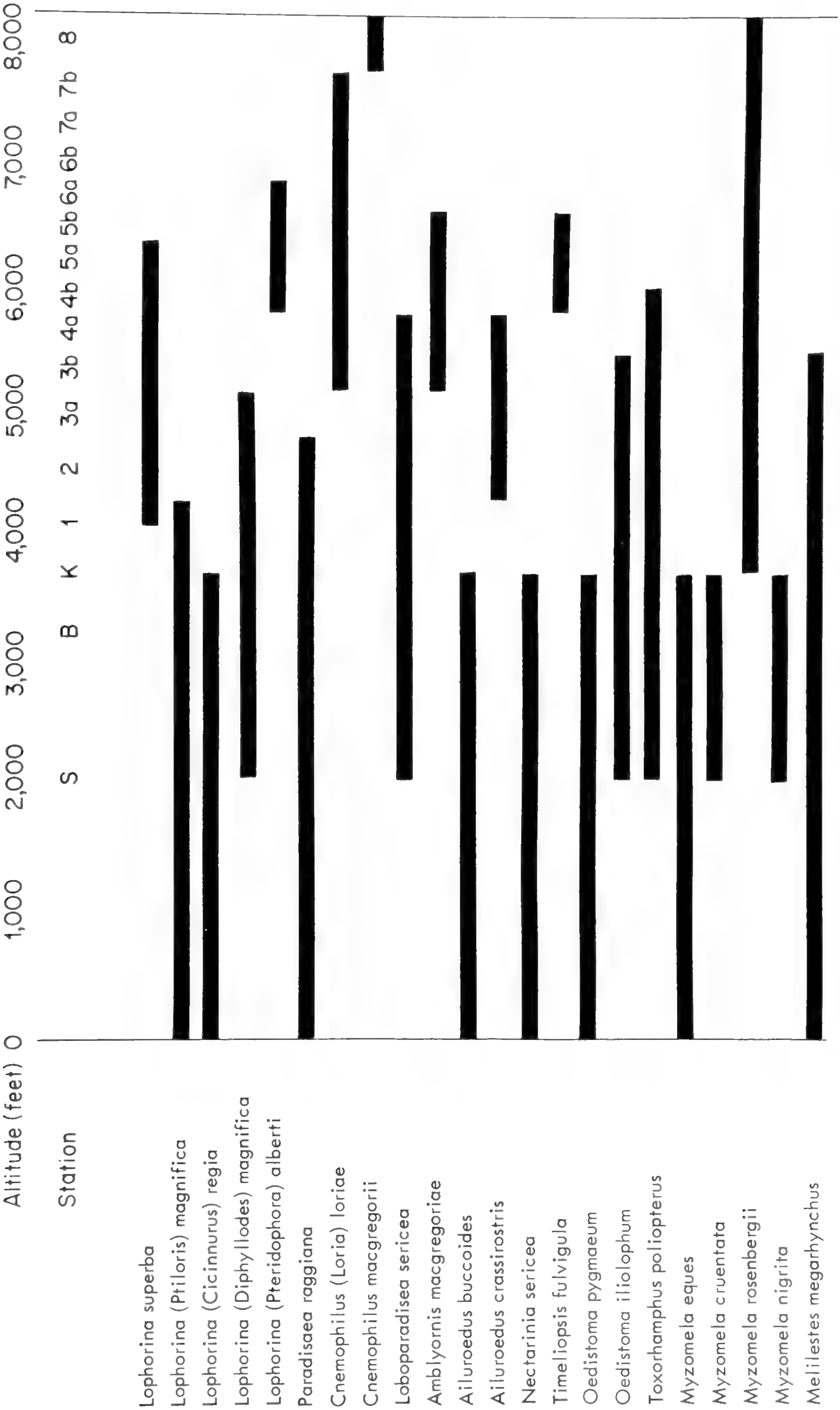


FIG. 4 (cont.). Altitudinal ranges of 166 species in the Karimui area.

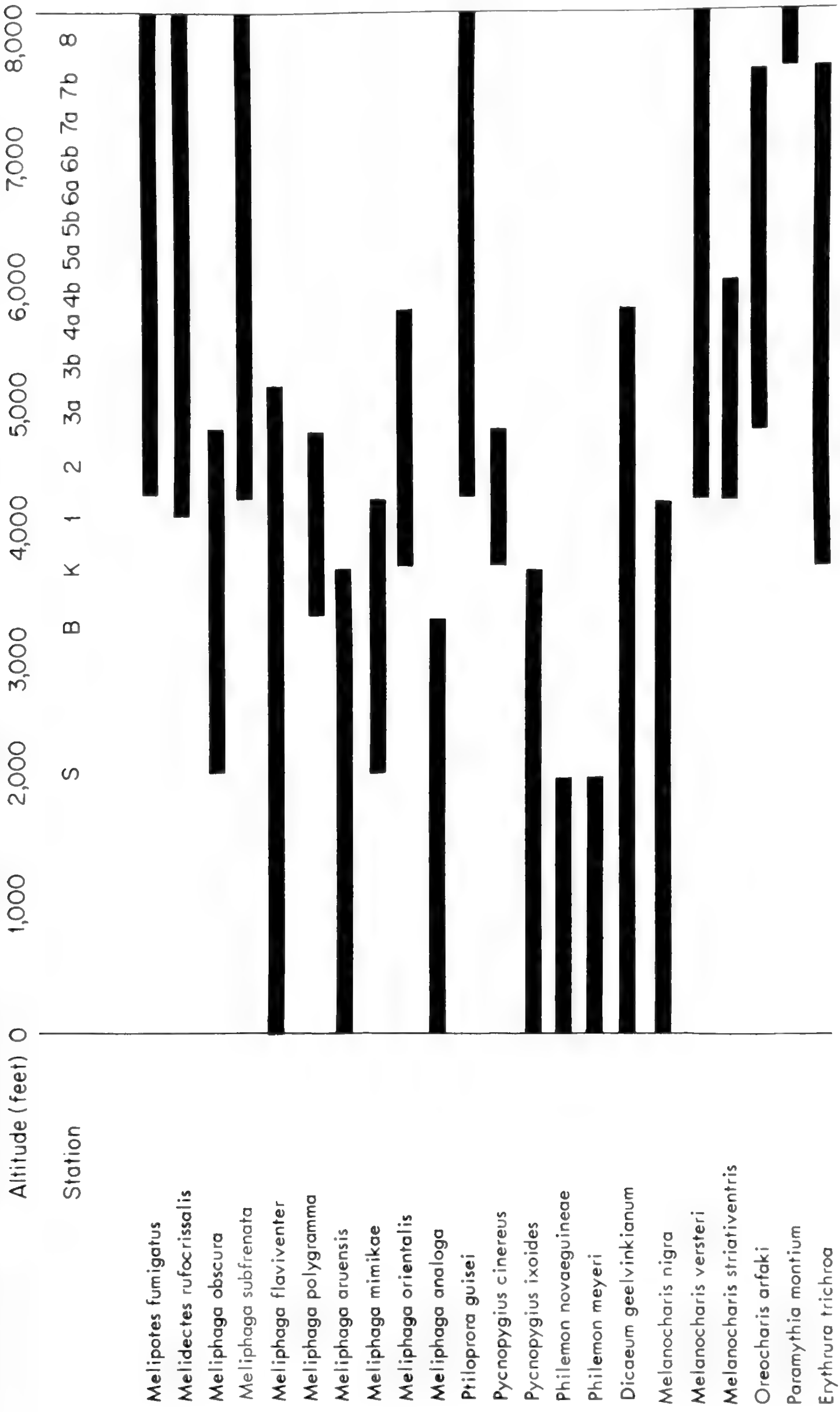


FIG. 4 (cont.). Altitudinal ranges of 166 species in the Karimui area.

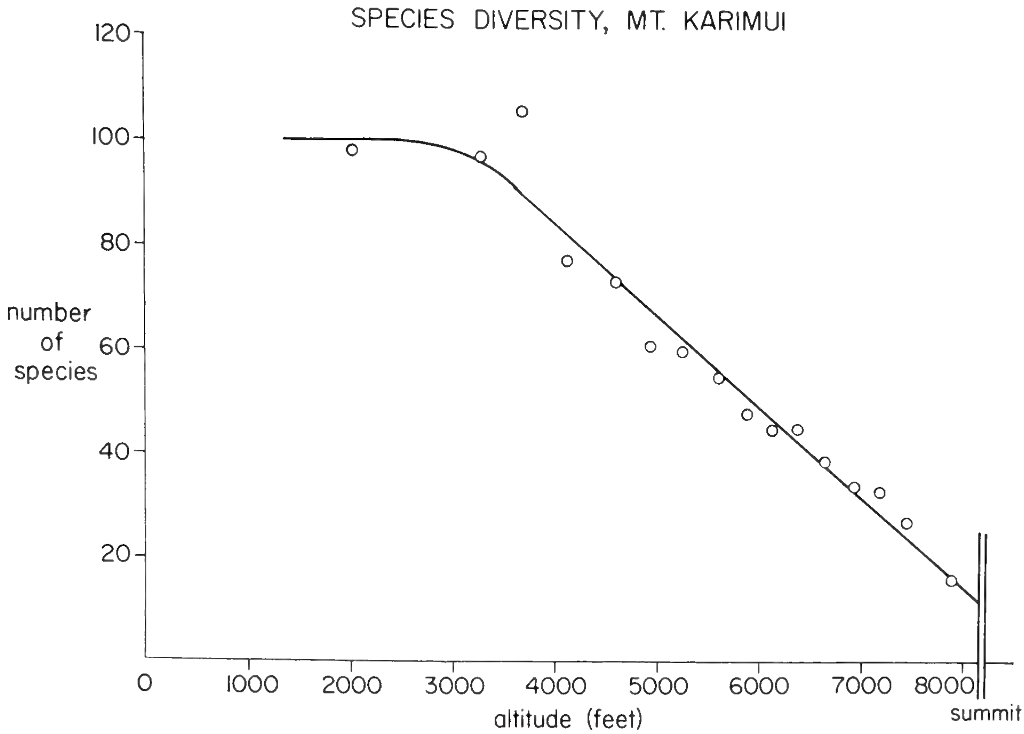


FIG. 5. Species diversity on Mt. Karimui. Each point gives the number of forest species recorded at the given elevation. Species diversity decreases with increasing altitude.

Guinea. Third, as discussed previously (p. 24), Mt. Karimui is a small, isolated mountain and does not have all the species present on larger New Guinea mountains due to drop-outs. Mt. Karimui supports the smallest fraction of the available species pool at the highest elevations, where the effects of isolation and small land mass are most pronounced.

2. *Species with broad altitudinal ranges.* Figure 4 shows that most species have ranges of less than 5,000 but more than 1,000 feet. Only 19 species have ranges greater than 5,000 ft, and only six of these exceed 6,500 ft. All 19 of these wide-ranging species descend to sea level. No montane species (i.e., a species that fails to descend to sea level) has a range greater than 4,200 ft.

Of the 19 wide-ranging species, 12 have no congeners in the Eastern Highlands, either because they belong to monotypic genera or else have congeners restricted to other islands or other parts of New Guinea. This correlation is another expression of the fact that altitudinal segregation is the most important ecological sorting mechanism in New Guinea that permits sympatry between congeners. Hence species without congeners are the ones most likely to have a broad altitudinal range.

3. *Species with narrow altitudinal ranges.* There are two classes of species with ranges narrower than 1,000 feet. One of these consists of

high altitude species for which Mt. Karimui is barely high enough and which can exist only near the summit. For instance, the bird of paradise *Cnemophilus macgregorii* was confined to the top 545 ft, and the flowerpecker *Paramythia montium* was not seen more than 40 ft below the summit. The other class consists of species whose ranges fall in the middle of the mountain and in some cases are compressed by congeners living at higher or lower altitudes. For instance, the total range of the warbler *Sericornis arfakianus* is 600 feet, the whistler *Pitohui nigrescens* is 900 feet, and the bird of paradise *Manucodia (Phonygammus) keraudrenii* is 750 feet. These narrow altitudinal bands imply excessively small populations which might easily be eliminated by an unusual environmental fluctuation (a poor breeding season, disease, expansion of another species, etc.). Such species are most like to drop out on Mt. Karimui or to have difficulty becoming established in the first place.

4. *Altitudinal "zones."* If the altitudinal limits of many species tended to coincide, this fact could be expressed by recognizing altitudinal zones of faunal distribution. If limits of many species did not coincide, zones would be arbitrary and not worth recognizing. This question is examined in Figures 6-9.

Figure 6 plots, as a function of altitude, the absolute number of species per 100 feet reaching their upper altitudinal limit in a given zone. Figure 7 reexpresses the same numbers as the percentage of the species in a given zone which reach their upper limit in each 100 feet of the zone. It is apparent that few species (only seven) reach their ceilings below Karimui (3,650 ft). There would, of course, be some further species present at sea level whose ceilings lie below Soliabeda and which were therefore not observed in these studies. Species ceilings are well distributed from 3,650 ft to the summit, with some concentration at three maxima: viz., between the flat basin floor at Karimui (3,650 ft) and the lowest slopes of Mt. Karimui (4,000 ft), where 35 species drop out; at the moss level (6,500 ft), where nine species (20% of the avifauna at 6,350-6,500 ft) drop out; and above 7,280 ft, where 13 species drop out before the summit is reached and 16 species continue up to the summit and necessarily drop out there. Seventy-two species have ceilings between 4,000 ft and the moss level on Mt. Karimui, but there are no well-defined maxima in this range.

Figures 8 and 9 are the corresponding figures for the absolute and relative numbers of species reaching their lower limits per 100 feet. Below Bomai (3,250 ft) species drop out at a low rate (24 species, or somewhat less than one species or 1% of all species present dropping out per 100 vertical feet). Above Bomai the frequency of species lower limits, whether expressed absolutely or relatively, first increases and then decreases with increasing elevation and has a very broad maximum around 5,000 ft. The apparent increase again at the highest altitude (farthest right-hand point of Figures 8 and 9) reflects the

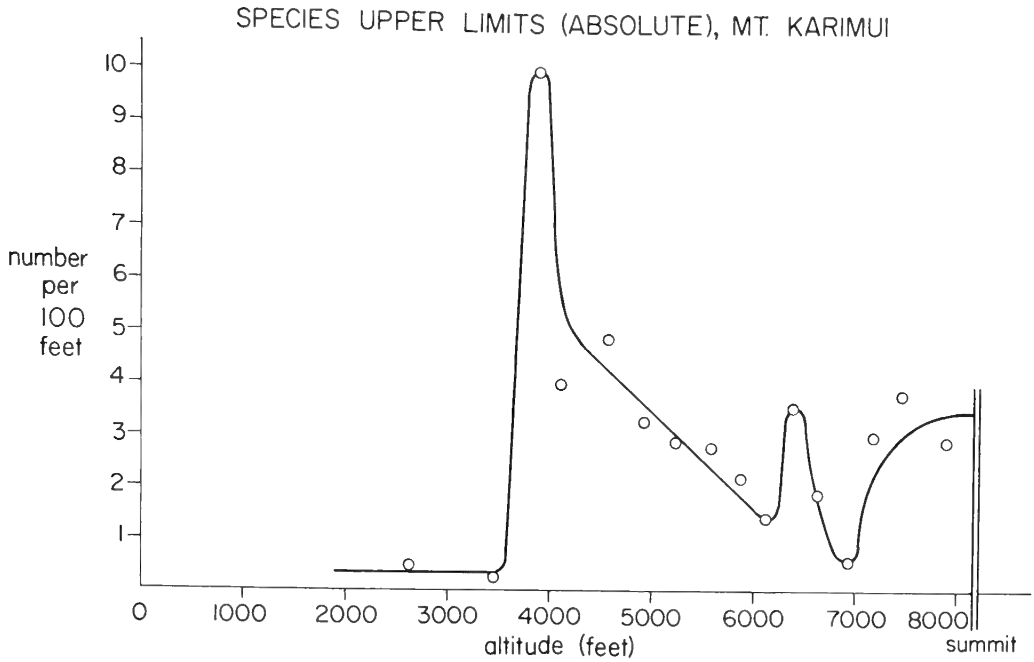


FIG. 6. Absolute frequencies of the upper altitudinal limits of forest species on Mt. Karimui, as a function of altitude. The ordinate gives the number of species whose upper altitudinal limits lay in a vertical band of 100 feet centered about the altitude given on the abscissa. Species ceilings are well distributed over the whole mountain above about 3,500 ft, with an accumulation at 4,000 ft (transition between flat basin floor and hill slopes) and a lesser accumulation at 6,500 ft (the moss level).

appearance of only two new species in the depauperate avifauna of Zone 8.

One could therefore speak of a relatively uniform tropical zone extending from the Karimui Basin (3,650 ft) down to Soliabeda (1,350-2,000 ft) and (by extrapolation) to sea level, where the total number of species remains quite constant and few species have their ceilings or lower limits. Subdivision of Mt. Karimui (>4,000 ft), which lies above this tropical zone but still contains a majority of tropical species for some distance above 4,000 ft, into several zones is not possible. Instead, new species gradually come in with increasing altitude, with a very broad maximum around 5,000 ft, and species gradually reach their ceilings, with a slight maximum at the moss level and an acceleration towards the summit.

Previous authors have discussed a "sharp avifaunal break which occurs at about 4,500-5,000 ft in the altitudinal zonation of New Guinea birds" (Gilliard and LeCroy, 1961, p. 22; cf., also, Stresemann, 1923, who places the break at 1,500 m = 4,920 ft, and Archbold and Rand, 1935, who place it at 1,700 m = 5,580 ft). In the field I had the strong impression that such a sharp break did exist. This impression was due partly to the rapid species turnover on Mt. Karimui (e.g., only 12 species are found at both 3,650 and 6,000 ft); and partly because

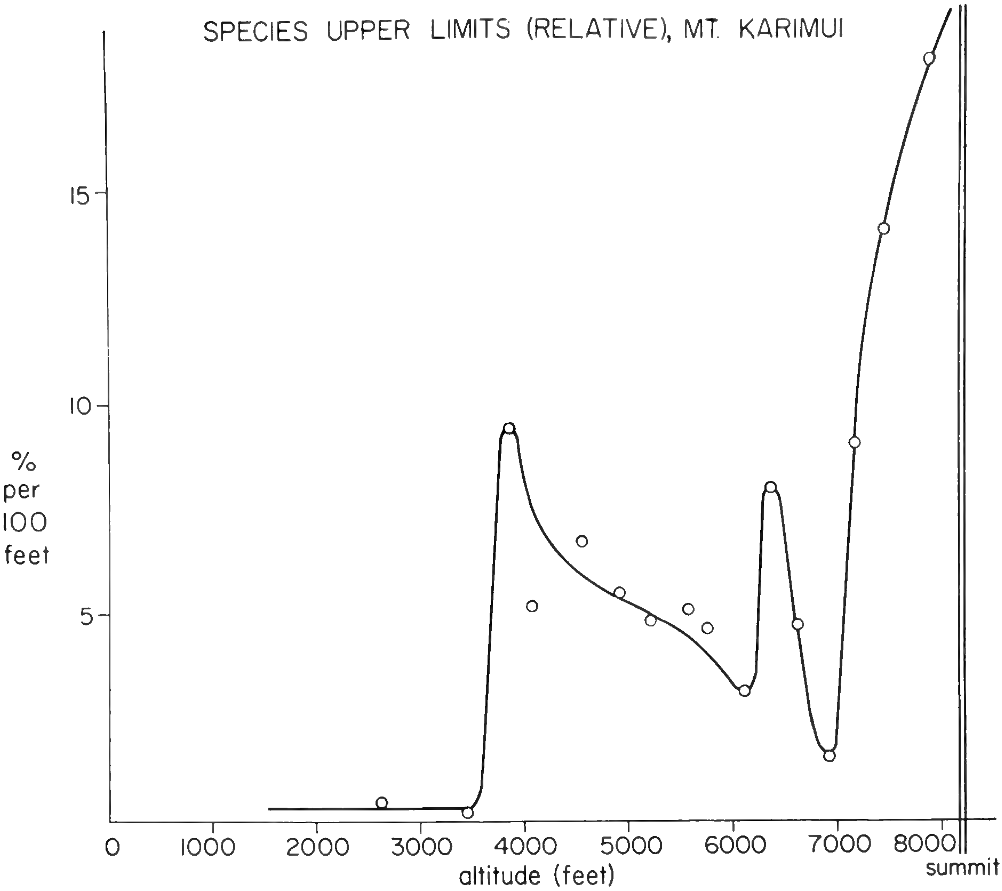


FIG. 7. Relative frequencies of the upper altitudinal limits of forest species on Mt. Karimui, as a function of altitude. The ordinate gives the percentage of species present at a given elevation whose upper altitudinal limits lay in a vertical band of 100 feet centered about the altitude given on the abscissa.

some common and conspicuous species reached their upper limit (*Crateroscelis murina, Pachycephalopsis poliosoma, Meliphaga flaviventer*) or lower limit (*Crateroscelis robusta, Sericornis perspicillatus, Rhipidura albolimbata, Peneothello cyanus*) near 5,000 ft. However, the detailed results presented in Figures 6-9 show that one cannot speak of a sharp break at 5,000 ft on Mt. Karimui: there is no increased frequency of ceilings and only a gentle maximum in frequency of lower limits. If one had to designate any break on Mt. Karimui, it would be at 3,650-4,000 ft, and even that one would involve only a minority of the species present.

These findings concerning Mt. Karimui cannot be assumed valid for other New Guinea mountains without further testing, since distributional patterns on Mt. Karimui are unusual in three respects. First, the intrusion of the flat basin has caused a conspicuous tropical element to persist in undisturbed forest up to 3,650 ft to a degree for which I know of no parallel elsewhere in New Guinea. Elsewhere I

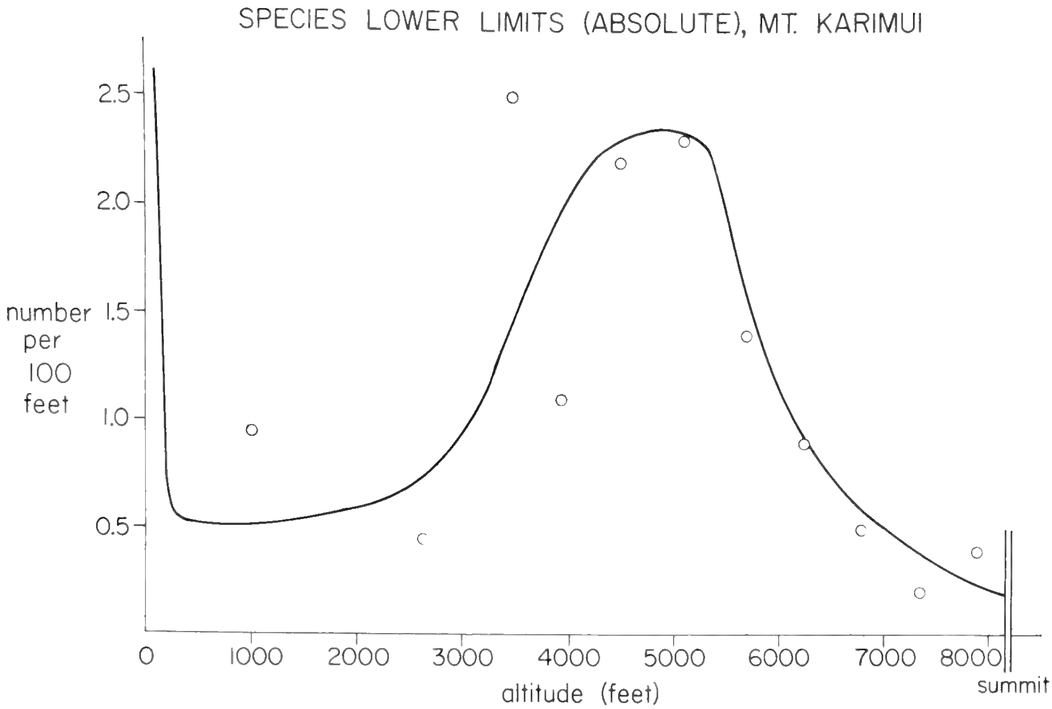


FIG. 8. Absolute frequencies of the lower altitudinal limits of forest species on Mt. Karimui, as a function of altitude. The ordinate gives the number of species whose lower altitudinal limits lay in a vertical band of 100 feet centered about the altitude given on the abscissa. The frequency of lower limits reaches a very broad maximum around 5,000 ft.

would not expect so little change in the avifauna between 1,350 and 3,650 ft and so marked an accumulation of species ceilings at 3,650-4,000 ft, i.e., so marked a tropical "zone." Second, moss forest descends lower on Mt. Karimui than on the highest central peaks of New Guinea, though it descends still lower on isolated peaks nearer the sea. The avifauna at 7,500 ft on Mt. Karimui is similar to that at 10,000 ft on Mt. Michael, and birds compressed between 4,000 ft and 6,500 ft on Mt. Karimui would range from 3,000 to 8,500 ft on larger mountains. Finally, Mt. Karimui is too low to support the depauperate New Guinea alpine grassland and timberline avifauna.

Breeding Non-Forest Avifauna

Species Composition

In areas undisturbed by man the original vegetation is forest over most of New Guinea. The only extensive area in which the climax vegetation is not forest is the low-rainfall savanna strip on the south coast, where most birds are Australian rather than typical New Guinea species. Elsewhere original non-forest vegetation consists of alpine grassland, naturally disturbed areas (due to landslides, earthquakes, or fallen trees), swamps and marshes, and the edges of streams and rivers.

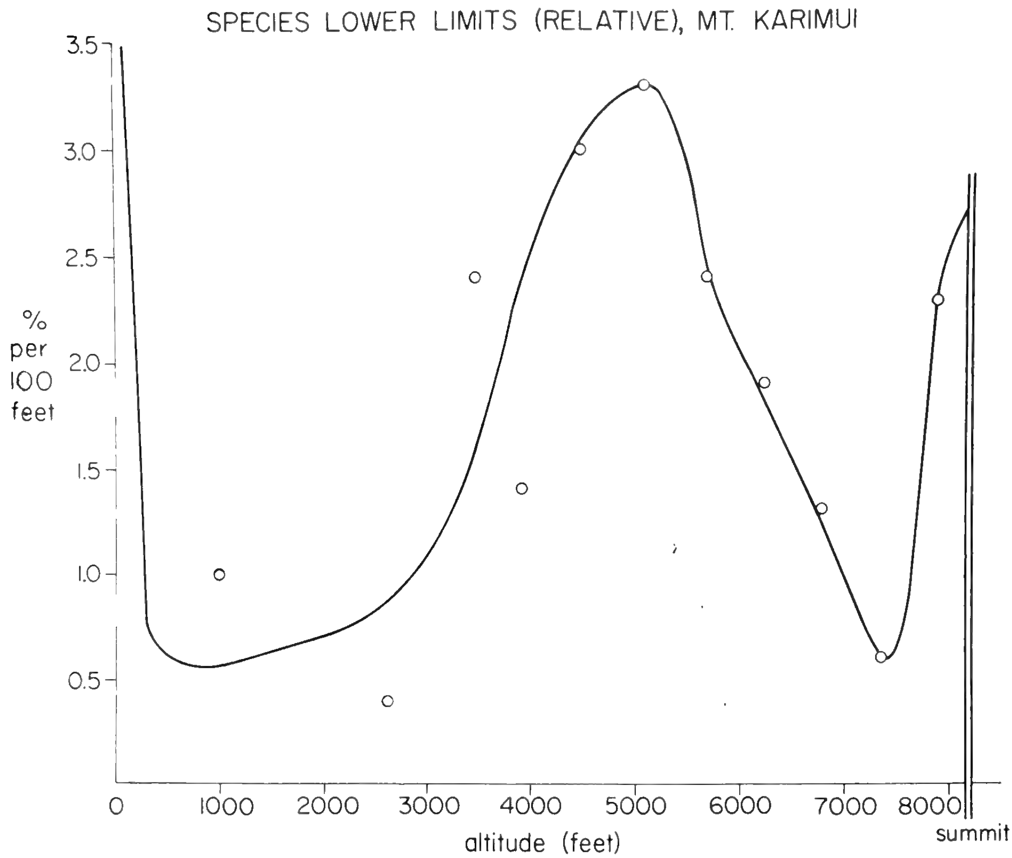


FIG. 9. Relative frequencies of the lower altitudinal limits of forest species on Mt. Karimui, as a function of altitude. The ordinate gives the percentage of species present at a given elevation whose lower altitudinal limits lay in a vertical band of 100 feet centered about the altitude given on the abscissa.

The total unforested area in undisturbed regions at middle elevations is minute. As a result the breeding non-forest avifauna of the Eastern Highlands is limited in variety (about 80 species in all types of non-forest habitats at all elevations above 1,350 ft). In areas settled by man non-forest habitat is greatly increased. It is of interest to examine the list of breeding bird species characteristic of each of six types of non-forest habitat in the Eastern Highlands. It should be remembered (see pp. 79-80) that migrants from outside New Guinea make a conspicuous but nonbreeding contribution to the non-forest avifauna, especially to category 6 (open country and forest edge).

1. *Alpine grassland.*—Alpine grassland occurs naturally above about 11,500 ft and is separated by a forest belt from the man-made mid-montane grassland, whose upper limit varies locally up to about 8,000 ft. Only four species occur in the alpine grassland, all represented by endemic subspecies: the pipit *Anthus gutturalis*, which is strictly confined to the grassland; the thrush *Turdus poliocephalus* and the grass finch *Oreostruthus fuliginosus*, which live in the grass-

land and adjacent forest edge (*Oreostruthus* barely gets into the grassland and is mainly in the forest edge); and the grass warbler *Megalurus timorensis,* which has isolated and racially distinct populations in lowland, midmontane, and alpine grassland.

2. *Water.*—Bodies of water consist of a few lakes (Kutubu, Tebera, Kandep, and the small alpine lakes on Mt. Wilhelm), a few small rivers, and numerous brooks and small streams. The breeding water birds are the grebe *Podiceps novaehollandiae,* the ducks *Anas superciliosa* and *Salvadorina waigiuensis,* and the kingfisher *Ceyx azureus.* All occur in the much more extensive waterways of the lowlands except for *Salvadorina.* There are two strictly riparian passerines, both absent from the lowlands: the flycatcher *Monachella muelleriana* and the Torrent Lark, *Grallina bruijni.* The duck *Nettapus coromandelianus* has been reported from Lake Kandep, the duck *Anas gibberifrons* from the Wahgi River and Mt. Giluwe, and several cormorants and herons at Lake Kutubu, but I do not know if these species breed. The cormorant *Phalacrocorax melanoleucos* has been found breeding on the Baiyer River. *Salvadorina waigiuensis* is apparently the sole aquatic bird in the alpine lakes of Mt. Wilhelm.

3. *Swamps.*—Small swamps border watercourses and harbor up to five rails: *Rallus philippensis, Porzana tabuensis, Porzana pusilla* (one locality), *Porphyrio porphyrio,* and *Gallinula tenebrosa* (one record). All five species have wide ranges outside New Guinea. *P. pusilla* is confined to middle elevations in New Guinea, and *Rallus phillippensis* and *Porzana tabuensis* are represented in the Eastern Highlands by thinly differentiated endemic subspecies.

4. *Air.*—In the air, remote from forest, are 14 species, of which six swifts and swallows take aerial food, while eight hawks merely hunt from the air. Six of these 14 species—the hawk *Henicopernis longicauda,* the swifts *Collocalia esculenta, C. hirundinacea,* and *C. whiteheadi,* the crested swift *Hemiprocne mystacea,* and the wood swallow *Artamus maximus*—also occur over hill or montane forest and streams in areas undisturbed by man; *Henicopernis* also hunts inside the forest. I suspect that seven of the other species have begun to appear in the Eastern Highlands from the lowlands only since man began extensive clearing of the forest, viz., the hawks *Milvus migrans, Haliastur indus, Accipiter fasciatus, Circus spilonotus, Circus approximans* (only Karimui), and *Falco berigora* and the swallow *Hirundo tahitica.* The hawk *Elanus caeruleus,* whose range includes much of Africa and Eurasia, is confined in New Guinea to extensively deforested areas at midmontane elevations. The New Guinea population is subspecifically distinct (*E. c. wahgiensis*) but has never been found in areas of New Guinea undisturbed by man, so that its origins are obscure.

5. *Midmontane grasslands.*—Midmontane grasslands in their present extent are a product of native agriculture. If one defines grassland species as those that live in the grass and do not require other elements

(trees, fences, bushes) for perches, then 16 grassland species occur in the Eastern Highlands. Most of these 16 species are confined in the Eastern Highlands to areas with extensive destruction of forest by man. Seven of these also occur in the lowlands and do not have endemic midmontane races: the cuckoo *Centropus phasianinus,* the nightjar *Caprimulgus macrurus,* the lark *Mirafra javanica,* the grass warblers *Acrocephalus arundinaceus* and *Cisticola exilis,* the bowerbird *Chlamydera lauterbachi,* and the mannikin *Lonchura grandis* (only at Okasa). While *Chlamydera lauterbachi* is widespread, the other six species are each known only from a few localities or areas in the Eastern Highlands, making one suspect that they have just begun to colonize the midmontane grasslands. Six grassland species also occur in the lowlands, but the midmontane population is subspecifically distinct: the quail *Synoicus ypsilophorus* and *Coturnix chinensis,* the bustard-quail *Turnix maculosa,* the wren-warbler *Malurus alboscapulatus* (two races), the grass warbler *Megalurus timoriensis,* and the mannikin *Lonchura spectabilis* (two races). The races *Synoicus ypsilophorus lamonti, Turnix maculosa giluwensis, Megalurus timoriensis wahgiensis, Malurus alboscapulatus kutubu,* and *Lonchura spectabilis gajduseki* are endemic to the Eastern Highlands, while *Coturnix chinensis novaeguineae* is shared with the midmontane grasslands of western New Guinea, *Malurus alboscapulatus mafulu* is shared with the midmontane grasslands of southeastern New Guinea, and *Lonchura spectabilis wahgiensis* is shared with the midmontane grasslands of the Huon Peninsula. The remaining three species—the rail *Rallus pectoralis,* the owl *Tyto capensis,* and the pipit *Anthus novaeseelandiae*—have wide geographic ranges outside New Guinea, but the New Guinea populations are subspecifically distinct and confined to the midmontane grasslands (absent from the lowlands, except for one localized population of the pipit).

6. *Open country and forest edge.*—"Open country and forest edge" may be used as the name for a category that excludes swamps and pure grassland but includes native gardens, grassland with occasional trees or fences to provide perches, open vegetation around villages and towns, planted groves of trees remote from forest, regenerating vegetation in a cleared and fallow area, and the forest edge. Many forest species may, of course, also be found at the forest edge, but if discussion is restricted to birds regularly found remote from forest and to birds which are much commoner at the forest edge than in the forest interior, then one arrives at a somewhat arbitrary list of 33 species. About 17 of these species are encountered above 5,000 ft, 16 only below 5,000 ft, and 24 at sea level. This list is probably not exhaustive, since I spent little time in towns remote from forest.

Two of these 33 species (the cuckoo *Cacomantis pyrrhophanus* and the warbler *Gerygone ruficollis*) occur only above 5,000 ft. Both may be found in the interior of undisturbed forest but have become much commoner in trees of towns and gardens, perhaps because they have so few competitors in these habitats.

Five species are absent from the lowlands and live mainly between about 3,000 and 7,000 ft: the flycatcher *Peltops montanus,* the shrike *Lanius schach,* and the honeyeaters *Myzomela adolphinae, Melidectes torquatus,* and *Meliphaga auga.* Four of these five species (*Peltops montanus* and the three honeyeaters) are endemic to New Guinea and also live in forest or in natural forest edge habitats, so that their origin poses no problems. *Lanius schach* is confined to man-made habitats (gardens and grassland with perches) and is represented in New Guinea by an endemic race of a species with a widespread extralimital range.

Ten species (the pigeon *Macropygia amboinensis,* the parrot *Trichoglossus haematodus,* the cuckoo *Cacomantis variolosus,* the Barn Owl, *Tyto alba,* the chat *Saxicola caprata,* the flycatchers *Rhipidura rufiventris* and *Rhipidura leucophrys,* the whistlers *Pachycephala rufiventris* and *Colluricincla harmonica,* and the bird of paradise superspecies *Paradisaea minor-P. raggiana*) occur in the lowlands and are found only below 5,000 ft in undisturbed areas but have ceilings, depending on the species, between 5,500 and 7,000 ft in settled areas. Four of these species (the pigeon, the parrot, the bird of paradise, and *Rhipidura rufiventris*) are regularly found in forest up to about 4,500 ft, so that only a small upwards step was required to colonize the settled areas above 5,000 ft. The cuckoo is mainly, the other five species are strictly, forest edge and open country birds, and all six are absent at elevations above a few thousand feet in undisturbed areas.

The remaining 16 species range from the lowlands up to ceilings varying between about 2,000 and 4,000 ft: the rail *Amaurornis olivaceus,* the kingfisher *Dacelo guadichaud,* the roller *Eurystomus orientalis waigiouensis,* the cuckoo-shrikes *Coracina papuensis* and *C. tenuirostris,* the wren-warbler *Todopsis cyanocephala,* the warbler *Gerygone magnirostris,* the flycatchers *Peltops blainvillii, Rhipidura leucothorax,* and *Myiagra alecto,* the starling *Mino dumontii,* the oriole *Oriolus szalayi,* the butcherbird *Cracticus cassicus,* the drongo *Dicrurus hottentottus,* the sunbird *Nectarinia sericea,* and the honeyeater *Philemon novaeguineae.* Three if these species (*Dacelo gaudichaud, Oriolus szalayi, Philemon novaeguineae*) also live in the forest interior, while *Amaurornis olivaceus* lives in garden edges and grass and the remaining species live at the forest edge or in partly cut forest. For most of these species the ceilings in the disturbed areas of the Eastern Highlands (2,000-4,000 ft) are somewhat above the ceilings in undisturbed areas.

Origin of the Non-Forest Avifauna of the Eastern Highlands

There appear to have been five sources of the nonforest bird species in the Eastern Highlands.

1. *Evolution in pre-existing specialized habitats.*—Three types of

specialized habitats, inhabited by specialized birds already listed, must always have existed in the Eastern Highlands: alpine grassland, bodies of water, and swamps. The total areas occupied by these specialized habitats are very small now, have been little affected by man, and probably have not been significantly larger in recent geological history, except for expansion of alpine grassland during cooler parts of the Pleistocene. The endemic montane species and subspecies now living in these habitats have had an indefinite amount of time to evolve in them. The very small number of such endemic montane forms (four in alpine grassland, three on waterways, two in swamps) is what one would expect from the small area of such habitats in the New Guinea mountains. Some of the water and swamp species also live in the lowlands and are not represented by endemic montane races. They probably evolved mainly in the lowlands, where the area occupied by waterways and swamps is larger.

2. *Evolution in pre-existing forest edge habitats.*—Even in montane areas undisturbed by man, natural forest edge habitats adjacent to open spaces exist, notably in permanent form along streams, but also transiently on steep slopes with landslides, as a result of trees falling in the forest, and as a result of earthquakes. The total area of forest edge habitat in undisturbed montane areas is very small and increases vastly in regions disturbed by man. The population densities of forest edge species in settled regions are now high in many cases, but before native agriculture these species must have evolved and eked out "a precarious existence in the shifting bits of habitat suitable for them" (Rand and Brass, 1940, p. 377). As illustrations I shall cite several instances in which I obtained records in montane areas remote from human disturbance for birds which are completely absent from the interior of closed forest. At the Sena River the Crested Swift, *Hemiprocne mystacea,* perched in riverside trees and sallied into the open space over the stream. In the river gorges below Karimui, Bomai, and Soliabeda and on the Sena River I met the swift *Collocalia esculenta* hawking over the streams, and I have seen both *C. esculenta* and *C. hirundinacea* over ravines and the sides of forested ridges on Mts. Karimui, Michael, Menawa, and Turu. On Mt. Menawa I saw the wood swallow *Artamus maximus* perched in trees on the crest of a steep forested ridge. The butcherbird *Cracticus cassicus* was present in the river gorges below Soliabeda and Bomai. The flycatcher *Peltops montanus* sallied over the Sena River from trees on the banks, and I have regularly found it in trees on the crests of steep mountain ridges (Mts. Karimui, Somoro, Nibo, Menawa). Once I saw the sunbird *Nectarinia sericea* in the tree canopy on the steep slopes of the Nami Gorge in the Karimui Basin. I found a nest of the honeyeater *Meliphaga auga* in a bamboo thicket near a small stream below Soliabeda.

3. *Evolution in forest.*—Five of the seven montane species that occur in open country and forest edge habitats and do not descend to

sea level also occur in the interior of montane forest, where they undoubtedly evolved. These are *Cacomantis pyrrhophanus, Gerygone ruficollis, Pitohui dichrous, Myzomela adolphinae,* and *Melidectes torquatus. Gerygone ruficollis* and *Melidectes torquatus* are very uncommon in the forest interior but are the two most abundant species in trees in open country around 5,000 ft, and their numbers must have undergone an enormous explosion as a result of native agriculture.

4. *Recent expansion from the lowlands.*—Because there are many more rivers, marshes, and swamps in the lowlands than in the mountains, more species of forest edge and grassland birds have evolved in the lowlands than in the mountains. With the recent spread of open country in the mountains, some lowlands species may have begun to colonize the midmontane open country only recently. Though it is, of course, impossible to be certain about the time of arrival, a recent arrival must be suspected for species whose midmontane populations are not subspecifically distinct and which are absent from the mountains in areas undisturbed by man, particularly if their distribution in midmontane open country is very local. In this category probably fall the swallow and six hawks listed on p. 72, most of the seven grassland birds listed on p. 73, and most of the 26 open country and forest edge birds listed on pp. 73-74 which are shared with the lowlands and are not subspecifically distinct.

5. *Rapid recent evolution?*—The evolution of non-forest lowland species poses no problems because there is a modest amount of non-forest habitat in the lowlands and these species can be seen in these natural habitats. The evolution of the few montane forest edge species also poses no problems because, although the amount of such natural habitat is small, one can find these species in natural forest edge habitats in undisturbed areas, as illustrated on p. 75. The main problem arises in connection with the evolution of the endemic midmontane grassland populations, because the amount of natural midmontane grassland (along streams, in landslide and earthquake areas) is minute, and because most of the endemic forms have never been recorded in these natural habitats in which they might be postulated to have evolved. Specifically, for the following 10 species with endemic midmontane races every midmontane record that has come to my attention is from a man-made habitat: *Synoicus ypsilophorus, Coturnix chinensis, Turnix maculosa, Tyto capensis, Anthus novaeseelandiae, Saxicola caprata, Malurus alboscapulatus, Megalurus timoriensis, Lanius schach,* and *Lonchura spectabilis.* Most of the species to which these endemic races belong range through the Indonesian Archipelago or as far as Asia and are presumably of non-Papuan origin, the exceptions being *Malurus alboscapulatus* (confined to New Guinea) and *Lonchura spectabilis* (New Guinea and New Britain). The only New Guinea midmontane grassland forms that are endemic to this habitat

at the species level are *Lonchura teerinki* of western New Guinea and *Lonchura vana* of the Vogelkop.

There are two possible explanations for these cases. First, some of these species may have been present for a long time in the tiny amount of natural midmontane grassland habitat, may have evolved there into endemic races, and may simply not have been detected yet in such habitats. In other words, they would have the same history as midmontane forest edge species, which had to eke out a precarious existence before the advent of agriculture. Second, they may have evolved in the short time since native agriculture began to create significant areas of secondary midmontane grassland. Present evidence suggests that agriculture on a limited scale may have become possible in New Guinea about five millenia ago (Bulmer, 1964). However, extensive clearing of land began with the introduction of the sweet potato, which appears to have reached the Eastern Highlands only a few centuries ago. Thus, the time scale for evolution of the midmontane grassland races would be of the order of several centuries up to a few millenia. Until recently such a short time scale for subspeciation would have appeared unlikely, but the demonstration by Johnston and Selander (1964) of geographical differentiation in the House Sparrow *Passer domesticus* since its introduction into the New World 137 years ago shows that this is perfectly feasible in some cases. It is important to remember that population changes will occur much more rapidly when breeding stock is transplanted into a new type of environment and isolated from the parent population than in the cases of established populations; and, also, that severe selection pressures may operate on new colonists of the New Guinea midmontane grasslands, whether they arrive from the New Guinea lowlands or from outside New Guinea.

Probably some of the 10 races listed on p. 76 have the first type of history, some the second. Midmontane grassland forms that surely have a long history include the sole two endemic species, the distinct mannikin species *Lonchura teerinki* of western New Guinea and the semispecies *Lonchura vana* of the Vogelkop, which probably evolved in the marshes of the Baliem River and the Anggi Lakes, respectively. I would not be surprised to see the midmontane race of *Malurus alboscapulatus* eventually turn up in a marsh beside some Eastern Highlands stream remote from areas of human influence. At the other extreme, the mannikin *Lonchura spectabilis gajduseki* requires large expanses of grassland and is confined to the Karimui Basin, whose topography and history of human settlement are sufficiently well known to make it unlikely that this mannikin population could have existed anywhere in the Basin before the present century. *Lonchura spectabilis gajduseki* is, accordingly, a likely candidate to have differentiated rapidly and recently.

Pioneering by Non-Forest Species

When natives clear a new village and garden area in the middle of the forest, an island of habitat is created for grassland and second-growth birds, surrounded by a barrier of unsuitable forest habitat. The colonization of these grassland islands poses the same problems as those involved in the zoogeography of oceanic islands. One of my collecting stations, Soliabeda, was just such a non-forest island that had been cleared by natives a few years previously and lay several miles from the next such island. Consideration of the non-forest avifauna at Soliabeda is interesting because of its relevance to the question of what makes a good colonist.

Although Soliabeda and Karimui shared most forest species in common, Soliabeda had only part of the non-forest avifauna of Karimui. All four of the small aerial species of Karimui (*Hemiprocne mystacea, Collocalia esculenta, C. hirundinacea, Artamus maximus*) were present at Soliabeda. These species are strong fliers, and the first two would have been present along forest streams even before the village site was cleared. Of the four large aerial species of Karimui (the open country hawks *Haliastur indus, Accipiter fasciatus, Circus approximans, Falco berigora*), only the first was present, perhaps because the cleared area at Soliabeda was marginally small to provide even a single feeding territory. Of the 16 species in the category "open country and forest edge" at Karimui which also utilized the forest edge or forest interior (*Macropygia amboinensis, Trichoglossus haematodus, Cacomantis variolosus, Dacelo gaudichaud, Eurystomus orientalis waigiouensis, Rhipidura leucothorax, Rhipidura rufiventris, Pachycephala rufiventris, Pitohui dichrous, Oriolus szalayi, Mino dumontii, Cracticus cassicus, Dicrurus hottentottus, Paradisaea raggiana, Nectarinia sericea, Meliphaga auga*), all except two (*Eurystomus orientalis waigiouensis, Pachycephala rufiventris*) were present at Soliabeda. Of the three species of "open country and forest edge" at Karimui which could not utilize the forest interior or forest edge (*Amaurornis olivaceus, Saxicola caprata, Rhipidura leucophrys*), only the rail *Amaurornis olivaceus* was present at Soliabeda. Of the four grassland species at Karimui (*Synoicus ypsilophorus, Malurus alboscapulatus, Megalurus timoriensis, Lonchura spectabilis*), only the wren-warbler *Malurus alboscapulatus* was at Soliabeda.

Generalizing, one can say that open country species that can also use the forest and forest edge make the best colonists, partly because they can disperse most easily (through the forest or by using forest edge habitats along rivers as stepping stones), partly because more habitat is available to them for building up a stable population than to a bird restricted to grassland and open country. At a disadvantage are species with a large territory requirement, a category including not only hawks but perhaps also the *Lonchura* mannikins, which normally associate in large flocks. Of the species restricted to grassland and open country, the rail and the wren-warbler are apparently good colonists. The superior dispersal ability of the rail is in keeping with the ability of rails to reach the most remote oceanic islands.

Migrants

Eleven species that breed in the palearctic region have been recorded from the Eastern Highlands as winter visitors, with most of the records between September and April. Eight of these 11 species are shorebirds (Charadriidae, Scolopacidae): *Pluvialis dominica fulva, Numenius minutus, Tringa hypoleucos, Tringa brevipes, Gallinago megala, Gallinago hardwickii, Calidris ruficollis,* and *Calidris acuminata.* The other three are the duck *Anas querquedula,* the cuckoo *Cuculus saturatus horsfieldi,* and the wagtail *Motacilla cinerea caspica.*

Thirteen species that breed in Australia have been recorded from the Eastern Highlands as winter visitors, with most of the records between April and October: the spoonbill *Platalea regia,* the falcon *Falco cenchroides cenchroides,* the pratincole *Glareola isabella,* the cuckoos *Cacomantis pyrrhophanus prionurus* and *Chrysococcyx lucidus plagosus,* the nightjar *Eurostopodus albogularis albogularis,* the kingfishers *Halcyon macleayii incincta* and *Halcyon sancta sancta,* the bee-eater *Merops ornatus,* the dollarbird *Eurystomus orientalis pacificus,* the swallow *Hirundo nigricans nigricans,* the cuckoo-shrike *Coracina novaehollandiae melanops,* and the flycatcher *Myiagra cyanoleuca.*

The most striking fact about these 24 palearctic and Australian migrants in New Guinea is that their distribution is strictly confined to open habitats, second-growth, and the forest edge. I am unaware of a single record of a palearctic or Australian migrant taken inside undisturbed forest anywhere in the Eastern Highlands. There is no record above 9,000 ft, where there is little cleared land except natural alpine grassland, which the migrants evidently do not utilize. The implication is that migrants have been coming to the Eastern Highlands in significant numbers only since the advent of extensive native agriculture, i.e., probably within the last millennium (p. 77). The palearctic migrants wintering in Africa similarly avoid the interior of the rainforest (Moreau, 1966). By contrast, wintering North American species comprise a significant percentage of bird individuals inside the tropical rainforest of Central America.

Because of New Guinea's equatorial position New Guinea breeding species do not migrate from the island. However, there is evidence for local seasonal migration within New Guinea in the cases of a few species. Four categories may be distinguished. (1) Some species which breed in the lowlands may undertake postbreeding migrations to the Eastern Highlands. For instance, large postbreeding flocks of the starling *Aplonis cantoroides* have been recorded at Nondugl in the

Wahgi Valley. Records of the starling *Aplonis metallica,* of cormorants, anhingas, and herons, and possibly of some hawks (*Milvus migrans, Circus approximans, Haliastur indus ?*) may also represent postbreeding stragglers from the lowlands. As in the case of palearctic and Australian migrants, these lowland migrants are found mainly in cleared and second-growth areas in the Eastern Highlands. (2) Some species, particularly lories and myzomelid honeyeaters, which breed in the Eastern Highlands and which depend for food on transient sources of flowers and fruit, may undertake local seasonal migrations in search of food. For instance, Fore native informants told me that the parrots *Pseudeos fuscata, Psitteuteles goldiei,* and *Geoffroyus simplex* breed and are conspicuous at Okapa in the wet season, but I found them uncommon or absent in the dry season. The erratic distribution of the honeyeater *Myzomela adolphinae,* which depends upon flowering trees for food, also suggests local migration. (3) The open country shrike *Lanius schach* breeds at Okapa in the dry season, but native informants said that it disappears during the wet season. Similarly, at Lake Kutubu, Schodde and Hitchcock were told by native informants that the open country honeyeater *Philemon novaeguineae* is absent during the wet season. The cuckoo *Eudynamis scolopacea* was apparently absent from Karimui during the driest months of 1965. (4) Some stragglers may be driven into the Eastern Highlands by storms, an example being the appearance of Sooty Terns, *Sterna fuscata,* at Mt. Hagen township in June 1967.

Little or nothing is known about the details of these local migrations. Further examples of palearctic, Australian, and New Guinea lowland species which migrate or straggle to the Eastern Highlands undoubtedly will be uncovered and probably will provide most of the future additions to the list of species recorded from the Eastern Highlands.

Bird Feeding Assemblages in Fruiting and Flowering Trees

The gathering of birds of many species to feed on trees bearing fruit or flowers are a spectacular feature of the tropics. Several species of New Guinea parrots, pigeons, and honeyeaters are mainly to be found at these ephemeral food sources. In 1964 Terborgh and I made a study of these feeding assemblages which has been reported in detail elsewhere (Terborgh and Diamond, 1970), but will be summarized briefly here along with some subsequent observations.

Our method was to station ourselves at a fruiting or flowering tree and, at two-minute intervals, to record the number of individuals of each species in the tree. One individual recorded in one two-minute period was taken as an arbitrary unit of "bird-usage" of the tree. In the individual species accounts it occasionally will be stated that a given species accounted for a certain percentage of the bird-usage of a particular tree; this refers to the bird-usage units of that species as a percentage of the total bird-usage units of all species in that tree.

Usage of flowering trees was dominated by honeyeaters (notably of the genera *Oedistoma, Myzomela,* and *Meliphaga*) and by lorikeets (*Chalcopsitta, Pseudeos, Trichoglossus, Domicella, Charmosyna, Oreopsittacus,* and *Neopsittacus*). Ten to 16 species were regularly seen in one tree. Most of these species presumably were obtaining nectar and insects from the flowers, but the parrot *Trichoglossus haematodus* ate the flower receptacles as well. At a given locality essentially the same group of bird species reappeared in different species of flowering trees. Within a given tree there was some vertical segregation of the honeyeaters, with *Oedistoma pygmaeum* and the several species of *Myzomela* mainly in the canopy and the species of *Meliphaga* mainly in the lower branches. While the honeyeaters moved in and out as individuals, the lorikeets often arrived and departed as flocks. Several of the lories have crimson upperparts, and of those which have green upperparts, several have a crimson or blue rump. This striking dorsal coloration must make them conspicuous when viewed from above against the green jungle, and may serve to attract the attention of other members of the species to a flock flying towards a tree which it has located.

Trees bearing small fruits (up to 5 mm in diameter) were utilized by representatives of more bird families (Columbidae, Campephagidae, Pachycephalinae, Sturnidae, Paradisaeidae, Meliphagidae, Dicaeidae, a few Psittacidae) than were flowering trees. Nine to 16 species were regularly seen in one tree. Trees with larger fruits (greater than 10 mm in diameter) were virtually monopolized by pigeons, particularly those of the genus *Ptilinopus. Ficus* trees with large fruits several inches in diameter surrounded by a woody rind were monopolized initially by parrots (*Trichoglossus haematodus, Psittaculirostris desmarestii*), which chipped holes in the rind with their strong bills. Later, members of other families, particularly Campephagidae, Paradisaeidae, and long-billed species of Meliphagidae, inserted their weak bills into the hole to obtain pulp which the shorter-billed parrots had been unable to reach.

These transient assemblages of birds that gather in fruiting or flowering trees should not be confused with the mixed-species, itinerant, mainly insectivorous flocks which forage through tropical forests in many parts of the world. It is worth mentioning explicitly that I never encountered such itinerant flocks in the Eastern Highlands. Furthermore, when I brought four of my Eastern Highlands assistants with me to the North Coastal Range in 1966 and we met itinerant flocks for the first time, they related to me their amazement and were emphatic that their own birds at home didn't behave that way! In contrast, Gilliard (in Gilliard and LeCroy, 1968) observed mixed flocks in the Schrader Range of the Eastern Highlands; Schodde and Hitchcock (1968, p. 40) mentioned their presence at Lake Kutubu;

Rand (Mayr and Rand, 1937, pp. 114, 132, 159, 161; Archbold, Rand and Brass, 1942, p. 246) encountered them in western New Guinea and southeastern New Guinea; and I found them on Mt. Albert-Edward, and at certain localities and altitudes but not at others in the North Coastal Range. I have no explanation for this apparent unpredictability.

Rainfall

Rainfall patterns in the Eastern Highlands are relevant to the problem of bird breeding seasons discussed in the next section.

Tables 2 and 3 give rainfall records for Okapa Patrol Post and for Karimui Patrol Post, respectively, kindly supplied by the patrol officers at these stations. Rainfall records for some other stations, including Lufa and Goroka, have been published by Brass (1964), and records for the Kubor Range and Lake Kutubu have been summarized by Hitchcock (1964) and by Schodde and Hitchcock (1968).

For much of the Eastern Highlands the annual rainfall averages between 70 and 180 inches, and there is a weakly differentiated dry season between May and September and rainy season between November and April. However, the distinctness of wet and dry seasons varies from year to year and varies among neighboring localities in the same year.

At Okapa the annual rainfall averages 91 inches and varies in different years between 65 and 136 inches. The wettest month, March, has on the average 3.4 times as much rain as the driest month, June. In at least five of the eight years up to 1965 for which there are records, May, June, July, August, and September were drier than the average month of that year, and December, February, March and April were wetter than the average month. The June-July dry season was quite pronounced in 1956, 1964, and 1965. However, normally dry September was the wettest month in 1963, and May was the third wettest month in 1962, while normally wet February was the third driest month in 1963 (drier than June-October) and December was the third driest month in 1964.

At Karimui the pattern is qualitatively similar but wetter overall and less distinct. Annual rainfall averages 131 inches and varies from 113 to 158 inches, with January, February, March, April, and September on the average the wettest months and June, July, August, and November the driest months. The June-August dry season was fairly pronounced in 1964, and more pronounced in 1965. However, the wettest month, March, has on the average only 2.3 times as much rain as the driest month, June. In 1961 normally dry July was the wettest month. These statements are based on rainfall records taken at Karimui Patrol Post. The situation on Mt. Karimui, for which no records are available, is patently different. The mountain is usually

TABLE 2

MONTHLY AND ANNUAL RAINFALL AT OKAPA PATROL POST (in inches)

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1956	9.82	8.54	8.33	5.57	2.86	1.43	0.96	4.68	6.25	4.87	5.04	12.81	71.16
1959	6.83	9.08	13.82	8.58	5.96	2.54	6.15	5.16	4.78	5.60	3.43	8.56	80.49
1960	—	—	9.63	7.78	1.58	6.36	1.40	4.05	3.77	8.02	4.49	6.86	ca. 64.70
1961	8.56	12.85	7.06	13.42	10.50	7.26	—	9.05	7.88	10.70	11.81	8.18	ca. 117.10
1962	4.33	10.28	6.04	12.98	11.25	3.97	7.51	6.18	9.75	11.02	—	12.45	ca. 135.90
1963	4.18	3.14	9.61	5.92	1.77	6.43	3.39	6.13	16.09	5.54	2.87	5.70	70.77
1964	14.40	8.75	9.84	7.64	7.45	1.86	1.44	5.52	9.38	5.84	13.15	5.06	90.33
1965	11.65	9.37	19.18	6.47	7.17	4.55	1.22	2.68	7.37	4.77	6.86	14.74	96.03
1966	5.72	13.16	13.17	7.08	7.93								
Average	8.19	9.40	10.74	8.38	6.29	4.30	3.15	5.43	8.16	7.05	6.81	9.30	90.81

TABLE 3

MONTHLY AND ANNUAL RAINFALL AT KARIMUI PATROL POST (in inches)

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1960											9.67	6.63	
1961	9.21	11.58	14.78	17.64	12.73	7.03	16.87	12.25	11.62	14.97	10.14	10.02	148.84
1962	9.33	12.97	19.73	18.04	11.21	7.16	14.47	9.05	19.71	11.54	8.09	16.27	157.57
1963	7.06	5.21	13.62	11.24	5.97	11.87	4.68	18.79	10.89	12.66	4.36	8.96	115.31
1964	14.41	12.67	16.01	9.19	6.10	4.57	3.97	7.17	11.78	8.78	19.35	6.90	120.90
1965	15.11	11.42	17.12	8.71	14.25	6.25	1.72	2.37	6.69	6.25	1.85	21.42	113.16
1966	19.20	19.80	19.59	9.03	13.13								
Average	12.39	12.28	16.81	12.31	10.57	7.38	8.34	9.93	12.14	10.84	8.91	11.70	131.18

shrouded in cloud even when it is fair at Karimui Patrol Post. I was told after descending from Mt. Karimui in August 1965 that the month I spent on the mountain had been the driest period on record since a rain gauge was set up at Karimui Patrol Post. On Mt. Karimui this irreducible minimum of precipitation meant that it rained day and night without interruption for half of the days on the mountain, and only seven of the days we spent on it were without any rain.

At Lake Kutubu (Schodde and Hitchcock, 1968) May to October is the wettest season, rather than the driest season as in the Wahgi Valley and my study areas.

To summarize, during the particular months and years of my studies (June-September 1964 and 1965) the particular localities I visited were experiencing a relatively dry season. This would have been true in these months at these localities in most but not all other years, and at many other but not all localities in the same years.

Breeding Seasons in the Eastern Highlands

Breeding patterns in the Eastern Highlands are complex in that they differ among birds of different habitats, vertical strata, altitudes, or food habits. Hence, analysis of breeding activity in separate segments of the avifauna is more informative than analysis of the avifauna as a whole. The following categories, which overlap to some extent, will be considered: grassland birds; birds of second-growth and the forest edge; hawks; birds that frequent fruiting trees; birds that frequent flowering trees; meliphagids generally; forest birds of the ground and lowerstory; forest warblers; other forest species. Since my records are most detailed for the Karimui area (Karimui, Bomai, Soliabeda, Mt. Karimui), all remarks refer to this area unless it is specifically stated otherwise. Breeding patterns on Mt. Karimui differed from those at lower elevations and will be cited separately, but those from the three stations at lower elevations (Karimui, Bomai, Soliabeda) were similar to each other and will be referred to without distinction simply as the pattern at Karimui. Most information is based on examination of gonad size, but some is derived from actual nests or nestlings. It will be recalled that this information comes from the relatively dry months of June, July, and August of 1964 and 1965. Although several patterns emerge from my results, they must be considered preliminary for three reasons: (a) they are based on extrapolation from a fraction of the year; (b) a condition of enlarged testis size may be maintained for longer than the actual nesting seasons; and (c) I have no information on peak seasons of fruit, flower, seed, and insect production.

Grassland birds.—Adequate information to judge breeding condition was obtained at Karimui for three species that live in grassland: the rail *Amaurornis olivaceus,* the wren-warbler *Malurus alboscapu-*

latus, and the mannikin *Lonchura spectabilis.* All adults collected of all three species had gonads in breeding condition, and nestlings of all three species were obtained. Thus, there was a highly synchronous breeding peak in the dry season. In addition, the cuckoo *Cacomantis variolosus,* which lives in garden trees rather than in the grass itself but uses *Malurus abolscapulatus* as its principal foster parent, was breeding. Information was obtained for more grassland species at Okapa, and all were breeding: *Malurus alboscapulatus* and *Lonchura spectabilis,* plus the quail *Synoicus ypsilophorus,* the rail *Porzana tabuensis,* the grass-warbler *Megalurus timoriensis,* and the shrike *Lanius schach. Lanius schach* actually appears to leave the Okapa region in wet seasons.

Birds of second-growth, the forest edge, and open spaces (excepting hawks).—All adults taken at Karimui of 11 species in this category were found not to be in breeding condition: the crested swift *Hemiprocne mystacea,* the swifts *Collocalia hirundinacea* and *C. esculenta,* the kingfisher *Dacelo gaudichaud,* the dollarbird *Eurystomus orientalis,* the flycatchers *Peltops blainvillii* and *P. montanus,* the oriole *Oriolus szalayi,* the drongo *Dicrurus hottentottus,* the starling *Mino dumontii,* and the sunbird *Nectarinia sericea.* Some but not all adults of the flycatchers *Rhipidura leucothorax* and *Pachycephala rufiventris* and the butcherbird *Cracticus cassicus* were breeding. There was some breeding in the wood swallow *Artamus maximus,* and most individuals of the honeyeater *Meliphaga auga* were breeding, in 1964, but there was no breeding in either species in 1965, which was drier. Evidently breeding of most forest edge species ceases completely when it becomes sufficiently dry. The situation is thus exactly opposite to the case of grassland birds.

Hawks.—No individual in breeding condition was encountered among the six species of hawks whose gonads were examined (*Accipiter novaehollandiae* and *Falco berigora,* in open country; *Aviceda subcristata, Accipiter poliocephalus,* and *Megatriorchis doriae,* in lowland forest; and *Accipiter melanochlamys,* in montane forest).

Frugivores (except meliphagids).—Under this category are lumped 42 forest species that feed to a large extent on fruit: all species of arboreal pigeons about which evidence was obtained, totaling 12; the parrot *Psittaculirostris desmarestii;* the hornbill *Aceros plicatus;* all species of campephagids, totaling seven; the whistler *Pachycephala leucostigma;* all species of birds of paradise and bowerbirds, 14 in all; and all dicaeids, six in all. Of the 29 frugivores at Karimui, there were 19 species in which all individuals were uniformly in nonbreeding condition; five species in which some individuals were breeding in 1964 but none in 1965 (the pigeon *Ducula zoeae,* the parrot *Psittaculirostris desmarestii,* the birds of paradise *Manucodia chalybatus* and *Lophorina (Diphyllodes) magnifica,* and the bowerbird *Ailuroedus buccoides*); two species in which some but not all individuals were breeding in 1965 (the bird of paradise *Lophorina* (*Ptiloris*) *magnifica* and the flowerpecker *Dicaeum geelvinkianum*); one species which was not breeding in July and August 1965 but entered breeding condition in September 1965 (the pigeon *Megaloprepia magnifica*); and two species in which virtually all individuals were breeding (the pigeon *Ptilinopus superbus* and the bird of paradise *Lophorina* (*Cicinnurus*) *regia*). The situation was quite different on Mt. Karimui: out of 15 frugivores, only five species showed no signs of breeding, while in ten species some (but generally not all) individuals were breeding. In the case of two species, the pigeon *Macropygia nigrirostris* and the bird of paradise *Lophorina* (*Diphyllodes*) *magnifica,* present both on Mt. Karimui and in the Karimui Basin, the montane population was breeding, but the lowland population was not, although numerous adults were present.

The simplest interpretation to cover most of these facts is that breeding is almost entirely confined to times of local wet conditions in most fruit-eating birds. The systematic difference between Mt. Karimui and the lower elevations is to be expected from the fact that conditions were considerably drier at the lower elevations during my studies. The fewer breeding records from 1965 than 1964 reflect the differences in rainfall.

Birds that depend upon flowering trees.—Thirteen species feed mainly or almost exclusively in flowering trees: seven parrots of the subfamily Loriinae, and six honeyeaters (*Oedistoma iliolophum, O. pygmaeum,* and four species of *Myzomela*). Of the nine species at Karimui, five were not breeding, one (*Trichoglossus haematodus*) was breeding in 1964 but not 1965, and some but not all individuals were breeding in three cases (*Charmosyna placentis, Myzomela cruentata, Oedistoma iliolophum*). Of the four species on Mt. Karimui, two (*Oreopsittacus arfaki* and *Myzomela rosenbergii*) were breeding, and two (*Charmosyna papou* and *C. pulchella*) were not. At Okapa natives and Europeans said that the several species of lories there had young in the wet months from November on.

Honeyeaters (Meliphagidae).—There are 18 additional species of meliphagids which are not so strikingly tied to flowering trees, though most visit flowering and/or fruiting trees. Of the 12 species at Karimui, eight were uniformly not breeding, two were represented by some breeders in 1964 but none in 1965, and two had breeding individuals in both 1964 and 1965 but fewer in 1965. Thus, breeding is suppressed partly or completely in all these species in a dry spell. In the wetter conditions on Mt. Karimui only one species (*Meliphaga orientalis*) was uniformly nonbreeding, four species had some or most individuals breeding, and in two species (*Melidectes rufocrissalis* and *Ptiloprora guisei*) all males had greatly enlarged testes.

Forest birds of the ground and lowerstory.—This category consists of nine forest species that feed on the ground (four pigeons of the genera *Chalcophaps, Henicophaps,* and *Gallicolumba,* the pitta *Pitta erythrogaster,* the thrushes *Amalocichla incerta* and *Drymodes superciliaris,* and two logrunners of the genus *Eupetes*), plus 18 forest warblers, flycatchers, whistlers, and honeyeaters which forage largely or exclusively in the lower story. At Karimui many, but not all, individuals of eight species were breeding, virtually all individuals of one (the flycatcher *Poecilodryas placens*) were breeding, three species had some breeding individuals in 1964 but not in 1965, and three were not breeding. On Mt. Karimui there were breeding individuals of six species but none of eight species. In two of these six species (the warbler *Sericornis nouhuysi* and the flycatcher *Peneothello cyanus*) all or most individuals were breeding. Two species present both on Mt. Karimui and at lower elevations (the warbler *Crateroscelis murina* and the whistler *Colluricincla megarhyncha*) had breeding individuals at low elevations but not on the mountain. Thus, the pattern in forest lowerstory birds is the opposite of the pattern among arboreal fruit eaters, in that there is more breeding activity at Karimui than at higher elevations. Evidently there is some tendency in lowerstory birds to nest in the dry season, and more were therefore nesting at Karimui, where the dry period was more pronounced.

Forest warblers.—Eleven species of forest warblers occur at Karimui or on Mt. Karimui (*Clytomyias insignis,* five species of *Sericornis,* two species of *Crateroscelis,* and three species of *Gerygone*). Most, but not all, individuals of four species were in breeding condition, all individuals of five species were breeding, *Clytomyias insignis* was not breeding, and *Crateroscelis murina* was breeding at Karimui but not on Mt. Karimui. Two of these 11 species (*Crateroscelis*) were confined to the lowerstory, while most of the others are often but not exclusively found in the lowerstory. This might suggest that the breeding of warblers is just another expression of the tendency of lowerstory species to be breeding in June-August. However, the warbler *Gerygone palpebrosa,* which I have never seen in the lowerstory, was breeding at Karimui; and six out of the eight warblers on Mt. Karimui were breeding, although the majority of lowerstory species generally on Mt. Karimui were not breeding. Thus, lowerstory habits are not necessarily the explanation for breeding patterns in forest warblers.

Other forest species.—Among forest flycatchers (Muscicapinae and Pachycephalinae) not confined to the lower story, breeding individuals were encountered among seven of 14 species at Karimui and among three of 10 species at Mt. Karimui. In only two cases (*Microeca flavovirescens* at Karimui, and *Tregellasia leucops* on Mt. Karimui) was there evidence that the whole adult population had come uniformly into breeding condition. Finally, one may consider a "wastebasket" category consisting of all forest species not belonging to the categories considered so far—three parrots, five cuckoos, four nocturnal species, three kingfishers, one logrunner, one drongo, one crow, and one mannikin. Only two of the 15 species at Karimui in this "wastebasket" category were breeding, and only two of six on Mt. Karimui.

Summary of breeding patterns.—During the dry months of July-August 1964 and 1965 at Karimui, breeding was taking place among all grassland birds, most lowerstory forest birds, and most warblers, but was not occurring among most second-growth birds, frugivores, flower feeders, meliphagids, or most other middlestory and upperstory forest species. On Mt. Karimui during these same months, where conditions were wetter, breeding was taking place among most frugivores, meliphagids, and warblers, but not among most other species. "Breeding" in these statements is taken to mean that a significant fraction of individuals of a given species were in breeding condition.

In addition, it is worth considering in which species there appeared to be a highly synchronized pattern, such that virtually all individuals either were or were not breeding. Synchronous breeding peaks were found among all species of grassland birds, two frugivores at Karimui, three meliphagids on Mt. Karimui, one lowerstory species at Karimui and two on Mt. Karimui, two warblers at Karimui and three on Mt. Karimui, and one flycatcher at Karimui and one on Mt. Karimui. Breeding was completely suppressed in all hawks, most second-growth species, most frugivores, flower feeders, and meliphagids at Karimui, and many other forest species of the middle- and upperstories.

There were three species (the pigeon *Ptilinopus superbus,* the warbler *Sericornis papuensis,* and the honeyeater *Myzomela rosenbergii*) of which most or all specimens collected proved to be males, all in breeding condition. All nine specimens collected of the pigeon *Ptilinopus pulchellus* proved to be males and all were not breeding. Only males of the swiftlet *Collocalia hirundinacea* were collected in early July, only females in late July. The explanation for these unbalanced sex ratios is unclear.

For comparison with the Karimui results, incidental information about breeding patterns has been obtained in four other parts of New Guinea. The peak breeding months for most species are September-November in the Wharton Range of southeastern New Guinea (Mayr and Rand, 1937; Schodde, cited in Schodde and Hitchcock, 1968, p. 17; my experience on Mt. Albert-Edward), November-March in northwestern New Guinea (Rand, 1942b; Ripley (1964), however, reports May-October), October-January in the western Papuan islands (Ripley, 1964), and September-October at Lake Kutubu (Schodde and Hitchcock, 1968). These peaks fall in the austral spring and summer. At these localities, as at Karimui, the rainy season is November to April and the dry season June to August, except at Lake Kutubu, where May-October are the wettest months.

Factors related to breeding patterns.—Rainfall patterns probably have a significant effect on breeding, with dry weather suppressing breeding in most species but eliciting synchronized breeding peaks in grassland and forest understory or ground-dwelling birds. The suppressing effect of very dry weather is illustrated by a comparison of the 1964-1965 results. The following ten species were in breeding condition at Karimui in July-August 1964 (July 30 to August 17) but were not breeding (although resident) in the much drier months July-August 1965 (July 1 to August 6): *Trichoglossus haematodus, Psittaculirostris desmarestii, Monarcha guttula, Pachycephalopsis poliosoma, Artamus maximus, Manucodia chalybatus, Lophorina (Diphyllodes) magnifica, Ailuroedus buccoides, Meliphaga flaviventer,* and *Meliphaga auga.* In the cases of four additional species, breeding occurred in July-August of both years, but the percentage of the local population breeding was considerably higher in 1964: *Ducula zoeae, Colluricincla megarhyncha, Toxorhamphus poliopterus,* and *Melilestes megarhynchus.* Similarly, a suspension of breeding by some bird species in the dry season and a sudden resumption with the onset of rains has been described in Trinidad by Snow and Snow (1964) and in Venezuela by Gilliard (1959a).

Grassland birds evidently reverse the normal trend, wait for a dry spell, and then come into breeding condition rapidly and synchronously. A possible explanation is that nests in grassland, whether on the ground or in grass, receive nearly the full force of a downpour and are more susceptible to damage by rain than are nests in trees or the forest. Similar considerations may apply to ground-dwelling forest species. An analogy is provided by the duck *Salvadorina waigiuensis,* which breeds in the Karimui area at the height of the dry season: it nests on low boulders beside streams subject to flash floods after heavy rains in the foothills, and such nests would have little chance of success in wet periods.

It is interesting that the peak breeding season is the austral spring and summer (October-March) in New Guinea and at most southern hemisphere tropical as well as temperate localities, even within a few degrees of the equator, while the peak breeding season at tropical as well as temperate localities north of the equator is generally in the boreal spring and summer, March-June (Moreau, 1966; Snow and Snow, 1964). Part of the reason may be that the months of peak rain correspondingly reverse near the equator. However, local rainfall patterns may not be the sole determinant of breeding, since peak breeding still occurs in the austral spring at Lake Kutubu even though the rainfall pattern is locally reversed there, the spring being the end of the rainy season rather than the beginning, as in much of the rest of New Guinea. In the New World, Snow and Snow (1964, p. 32) tentatively interpret a similar situation to mean that "natural selection has led to complexes of closely knit seasonal changes, affecting both animal and plant life, which may prevail over large areas and be adapted to the general climatic conditions of the region but not perfectly adapted to special local conditions."

Factors which one might *a priori* postulate to integrate breeding seasons over large areas at the same latitude despite local differences in rainfall patterns include the annual cycles of daylength, light intensity, and temperature. Another consideration is whether resident birds time their breeding to avoid competition from the influx of wintering and postbreeding birds from Australia, the palearctic zone, and the New Guinea lowlands. As discussed on p. 00, these visitors are strictly confined to open habitats and seem unlikely to influence the breeding of forest species. Only four resident species of open country in the Eastern Highlands appear to face an influx of conspecific or congeneric Australian or palearctic visitors: citing the resident first and the vistor second, these are the falcons *Falco berigora novaeguineae* and *F. cenchroides cenchroides,* the cuckoos *Cacomantis pyrrhophanus excitus* and *C. p. prionurus,* the dollarbirds *Eurystomus orientalis waigiouensis* and *E. o. pacificus,* and the swallows *Hirundo tahitica frontalis* and *H. nigricans nigricans.* All four of these visiting species are uncommon or local in the Eastern Highlands. The resident *Eurystomus* and *Falco* were not breeding during the season of the visitors' presence in my study areas, while I have no information concerning the breeding season in the other two cases.

Further progress in understanding breeding seasons of New Guinea birds will require information about seasonal variations in food abundance, combined with year-round records of bird cycles based on nests and juveniles rather than on gonad condition.

Native Classifications and Knowledge of Birds

My introduction to the systems of zoological classification developed by New Guinea natives came during the first week of my first season in the Eastern Highlands, when I was staying at the Fore village of Miarosa and was trying to learn some words of the Fore language. As I was washing at the village spring one evening and a frog began calling nearby, a small Fore boy explained, "Dákwo wanípindi mindíe." I had already learned that "wanípindi" was the word for "water" in the locative case, and that "mindíe" was the form of the verb "to be" used for living things, so that I assumed that the sentence meant "There's a frog in the water" and that "dákwo" meant "frog." The next day a man caught and brought me a frog while we were in the forest, and I pointed to it and said "dákwo" to practice the new word. "No, no," I was told, "This isn't dákwo. Dákwo is another fellow. This one is ibisaráya." Evidently different species of frogs had different names.

Thereafter I made a systematic effort to learn Fore names for animals, by asking individual natives to identify collected specimens, to name bird calls we heard, to name birds we saw in the field, and to describe animals they knew about but had not yet been able to show me. In this way I obtained Fore names and identifications or descriptions of 110 birds, 15 small mammals, 20 large mammals, 16 frogs, and 17 lizards and snakes. These names have been discussed elsewhere (Diamond, 1966). Detailed analyses of zoological classification by the Karam people of the Schrader Range have been published by Bulmer (1967a, 1968) and Bulmer and Tyler (1968). I made no attempt to get names for plants but am sure that these were also classified, since Paran and Esa responded to an idle remark I once made about mushrooms with a long lecture naming and describing 31 kinds of mushrooms in the vicinity of Awande, whether each was edible, and on what each was likely to be found growing.

It turned out that the Fore had a name for every bird that occurred regularly in the area. Usually each species had a separate name, and even sibling species as similar as two *Sericornis* warblers or the two *Macropygia* cuckoo-doves were distinguished. In a few cases (*Gerygone* warblers, *Halcyon* kingfishers, *Melanocharis* berrypeckers) related species were lumped under the same name but might then be distinguished by an added epithet. For instance, the kingfisher *Halcyon sancta* was named "patóroba bilong place" (the "patóroba" of settled areas), while *Halcyon megarhyncha* was "patóroba bilong bush" (the "patóroba" of the forest). In the cases of some birds of paradise and bowerbirds with marked sexual dimorphism, such as *Lophorina superba* and *Amblyornis macgregoriae,* the name for the adult male differed from that for the female or immature male.

Towards the end of my first season, Paran, my best Fore informant at Awande village, gave me names and descriptions of 30 birds which he knew but which I had not yet collected. All of these were eventually identified tentatively or definitely in 1965 and 1966. Many of the birds he described were not only rare but small and undistinctive (e.g., *Crateroscelis nigrorufa* or the "fúntara", *Cisticola exilis* or the "ikonantúbe", *Clytomyias insignis* or the "tabugíri"). Some of the birds he discussed had been seen only once or twice in recent memory at Awande. For instance, Paran had seen the "óa" (*Talegalla* sp.) only twice; the "topa" (apparently a white heron) had last been seen in 1964, when one individual appeared at Awande; and no one had seen the "kwi-kwípa" (*Gallinula tenebrosa* or *Porphyrio porphyrio*) since one had been captured 10 years earlier during Paran's boyhood. These names and descriptions proved useful in tracking down missing species. Correspondingly, Fore knowledge of local birds was sufficiently exhaustive that in cases where I showed the Fore a specimen of a bird and they stated that it did not occur at Awande, I feel that this information can be relied upon.

The purpose behind Fore animal names appears to be utilitarian. The only large animals to serve as sources of meat are the pig, the cassowary, and (formerly) man, so that even the smallest birds are hunted and eaten, as are mice, lizards, bats, and beetles. In addition, the feathers of many birds (birds of paradise, bowerbirds, and some parrots and hawks) are prized for decoration. As a result, many Fore, particularly boys and men, possess an incredibly detailed knowledge of the habits and voices of birds and other animals in their area. It should be realized that Fore natives vary individually in their knowledge, reliability, and powers of observation, just as do Europeans. Some of the younger generation of Fore, who are going to schools, have acquired little knowledge of the local fauna. It should also be realized that linguistic difficulties, misunderstandings, and inadequate interviewing techniques can easily result in wrong information when one is quizzing natives. Information elicited from primitive peoples is systematically discounted by some ornithologists who have found such information unreliable in their experience, as a result of working with poorly informed groups or poorly informed individuals, or employing inadequate interviewing techniques. However, an undifferentiated rejection or acceptance of all information supplied by natives is no more justifiable than would be the undifferentiated rejection or acceptance of all information supplied by professional ornithologists. Some observations on bird distribution, behavior, or song by Paran and several of my other New Guinea associates will be discussed in this monograph under the species accounts, because I found these individuals equal to the best European observers I have known in their powers of species recognition, knowledge of birds, and care in separating fact from opinion or hearsay.

The species accounts in the remainder of this book give the Fore name for each bird wherever identified with certainty. In some cases the names in the North Fore dialect spoken at Awande and the South Fore dialect spoken at Miarosa differ and are given separately. I have also listed some names obtained from my Gimi assistants. The Gimi and Fore languages are related but mutually unintelligible, and Gimi and Fore names occasionally coincide but usually differ. Finally, I have given the Daribi names given by my assistants from the Karimui basin. Two supposedly unrelated languages, Daribi and Tudawhe, are spoken at Karimui, and comparison of lists of names from a Daribi village (Bomai), a Tudawhe village (Soliabeda), and a border village (Yudo) shows that there have been some word borrowings, so that some Daribi names I cite may actually be derived from Tudawhe. Many more species of birds occur at Karimui than at Awande, and I found that the Daribi apply the same name to several related birds more often than do the Fore.

Summary

1. *Patchiness of distribution.*—The distribution of some bird species on the Central Range is discontinuous, in that they are absent from the Eastern Highlands but present on other parts of the chain

farther west and farther east. Numerous intermediate cases show that speciation in the mountains of New Guinea usually involves the formation of western and eastern isolates on the Central Range, which then reinvade each other's ranges. The formation of such isolates on a continuous mountain chain is made possible by distributional discontinuities resulting from local extinctions. This distributional patchiness in New Guinea forest birds is probably due to low dispersal rates and high species diversity, and also expresses itself in differences between the avifaunas of nearby mountains and in fragmented, relict-like distributions of some species.

2. *Ecological sorting mechanims.*—Completed speciation requires not only the development of reproductive isolation but also of ecological segregation. The principal ecological sorting mechanism among congeners in the mountains of New Guinea, and usually the first one to develop, is altitudinal, such that two to five bird species replace each other abruptly with altitude. The sharpness of these transitions is due to competition, as shown by compression of altitudinal ranges during speciation and reinvasion and by expansion when one species is locally eliminated. Congeners may also sort out spatially by occupying different habitat types; by foraging at different vertical levels in the vegetational column; by allopatry; and by "checkerboard allopatry." Nonspatial sorting related to food and foraging differences frequently depends upon a difference in body size. The ratio of body weights of two congeners which sort out by size averages 1.90 and usually falls between 1.5 and 2.5, due to a balance of selective pressures. Instances of temporal segregation are rare in New Guinea.

3. *Zoogeography.*—The Central Range may be divided into three weakly defined regions, based on presence of endemic forms and absences of otherwise widespread forms. Most geographic variation in montane birds on the Central Range is east-to-west and results simply from distance. In birds confined to elevations below 5,000 ft variation is mainly north-south because of the barrier posed by the Central Range.

4. *Avifauna of the Karimui Basin.*—Karimui, a flat mountain-ringed basin at 3,500 ft, has an avifauna typical of the sea level lowlands rather than of the hill slopes. Several lowlands birds isolated in this tropical "island" within the highlands have differentiated to yield melanistic endemic forms.

5. *Altitudinal distribution.*—Analysis of the altitudinal ranges of 166 forest bird species on Mt. Karimui, derived from altitudinal censuses along the west ridge from 1,350 ft to the summit at 8,165 ft, shows that species diversity decreases with increasing altitude; and that definition of altitudinal montane "zones" of bird distribution would be arbitrary, since species turnover is a fairly smooth function of altitude except for the local anomalies introduced by the flat floor of the Karimui Basin. The population structure of most species

changes in a characteristic way with altitude: at the bottom of the altitudinal range are immatures, nonbreeding adults appear somewhat higher, breeding adults still higher, and another band of immatures may exist at the upper limit of the altitudinal range. This population structure is present to an exaggerated degree in birds of paradise.

6. *The breeding nonforest avifauna.*—In the mountains of New Guinea the breeding nonforest avifauna is limited in variety because there is little natural nonforest habitat in the mountains. Some of these nonforest species evolved in specialized habitats, at the forest edge, or in forest; others have recently begun to spread upward from the lowlands as native agriculture creates increasing expanses of open country; and still others may have differentiated rapidly and recently.

7. *Migrants.*—Palearctic and Australian wintering migrants to the Eastern Highlands are absolutely confined to nonforest habitats. There are a few cases of local migration of New Guinea species in the Eastern Highlands, involving postbreeding lowlands birds, species depending upon fruiting and flowering trees, and species escaping wet or dry conditions.

8. *Patterns of breeding activity.*—In the Eastern Highlands the patterns of breeding activity are very complex and vary among different groups of birds, at different localities, at different elevations, and in different years. In general, grassland species have a highly synchronized breeding peak in the dry season; birds of second-growth, meliphagids, and other species dependent upon fruiting and flowering trees tend to breed in the wet season; and lowerstory birds and warblers tend to breed in the dry season.

9. *Assemblages in fruiting and flowering trees, rainfall, and native classification.*—Bird feeding assemblages in fruiting and flowering trees, rainfall patterns, and classifications of birds by New Guinea natives are summarized.

III
SPECIES ACCOUNTS

Measurements and weights.—All measurements are given in millimeters, and all weights in grams. Wing measurements are of the wing straightened against a ruler, while tail measurements are from the insertion of the central pair of rectrices to the tip of the longest rectrix. In cases of large series I omit individual values and cite instead the range, average value, and standard deviation in the form illustrated by the example "8 ♂: 15.2-19.4 (17.4 ± 1.2)," where 15.2-19.4 is the range, 17.4 the average value, and 1.2 the standard deviation. In the lists of specimens, a number followed by a question mark (e.g., "2 ♂, 1 ♀, 1 imm. ♂, 1 ?") always means that the sex was not determined and does not mean that the species identification is in question.

Specimens examined.—Under "specimens examined" I list not only birds prepared and brought back as skins, skeletons, or in formalin, but also a large number of birds examined and often measured, weighed, and sexed in the field but not retained as specimens. This latter category includes some specimens collected and offered for sale by local natives, and some mistnetted birds that were subsequently released, and consists principally of individuals of excessively common species and of protected species.

Localities.—The names and elevations of my collecting localities may be summarized again here for convenient reference. Okapa area: Awande (6,000 ft), Miarosa (5,800 ft), Okasa (3,550-4,250 ft). Mt. Michael area: Lufa (6,300 ft), Mt. Michael (7,000-12,300 ft), Mengino (4,600-6,150 ft). Karimui area: Karimui (3,650 ft), Bomai (3,250 ft), Soliabeda (1,350-2,000 ft), Sena River (4,500 ft); Mt. Karimui Zone 1 (4,000-4,200 ft), Zone 2 (4,400-4,750 ft), Zone 3 (4,750-5,390 ft), Zone 4 (5,390-5,960 ft), Zone 5 (5,960-6,500 ft), Zone 6 (6,500-7,080 ft), Zone 7 (7,080-7,620 ft), Zone 8 (7,620-8,165 ft).

Stomach contents, voice, and abundance.—Because I did not examine stomach contents of my Eastern Highlands specimens, the stomach contents analyses reported in the text are all from specimens I collected on Mt. Albert-Edward in southeastern New Guinea in 1969. All other remarks about specimens, behavior, and voice are based on the Eastern Highlands unless specifically stated otherwise.

Figures 10-15, 17-35, and 37-42 depict vocalizations in simplified, diagrammatic fashion by representing relative pitch vertically and relative duration horizontally, with syllables and sound quality specified in some cases.

Estimates of relative abundances, obtained by the method described on p. 10, are frequently stated, using the expression "At locality X, species Y accounted for Z% of the local avifauna."

Frequently cited references.—The major previous collections in the Eastern Highlands are cited so frequently in the text that full references are omitted to save space. The relevant references are: Mayr and Gilliard (1954), for Gilliard's collections; Gyldenstolpe (1955), for Gyldenstolpe's collections; Sims (1956), for Shaw-Mayer's collections; Schodde and Hitchcock (1968), for Schodde's collection at Lake Kutubu; and unpublished manuscripts of R.N.H. Bulmer (1962, 1967a) summarizing his studies in Kyaka territory and in the Schrader Range. "N.G.B.S. Newsletter" will be used as an abbreviation for the *New Guinea Bird Society Newsletter,* published monthly at Port Moresby since 1965.

Taxonomy and nomenclature. Scientific nomenclature in general follows that used by Rand and Gilliard (1967) in their *Handbook of New Guinea Birds.* Most of the deviations involve overdue or generally accepted lumping of monotypic or small genera.

Most vernacular names follow the current practice of the New Guinea Bird Society, viz., to use current Australian names (*An Index of Australian Bird Names,* CSIRO Division of Wildlife Research, Technical Paper No. 20, 1969) for those New Guinea birds also found in Australia, and to use names proposed by Rand and Gilliard (1967) for other species. For species of New Guinea origin with a restricted distribution in Australia, I have preferred the name proposed by Rand and Gilliard if it differs from the Australian name and if the Australian name is less appropriate to the New Guinea population. For example, the Australian name of *Ptilinopus superbus,* Purple-crowned Pigeon, would be confusing in New Guinea, where there are several additional species of pigeons with purple crowns, whereas the name used by Rand and Gilliard, Superb Fruit Dove, had already been applied to this species in several previous books and monographs on New Guinea birds or southwest Pacific birds. Some names proposed by Rand and Gilliard present problems of consistency or suitability. For instance, *Eugerygone rubra,* Red-backed Warbler, is no longer considered a warbler; *Ifrita kowaldi,* Blue-capped Babbler, and the three species of *Crateroscelis,* Mouse-babblers, are no longer considered babblers; *Gerygone ruficollis,* Tree-fern Gerygone Warbler, is much more characteristic of other habitats than of treefern fields; and *Acanthiza murina,* De Vis Tree Warbler, is the sole New Guinea representative of a genus of which the other twelve species live in Australia and are all called thornbills (Western Thornbills, Tasmanian Thornbill, Brown Thornbill, etc.). In these cases I have either modified the name proposed by Rand and Gilliard or else substituted a name proposed by Schodde and Hitchcock (1968 and pers. comm.).

Seven new races based on my collections have been described previously (Diamond, 1967a), and no new names are introduced in this monograph.

In evaluating the validity of proposed subspecies, I used as a standard the admirably thorough, sound, and consistent taxonomic analyses of Mayr and Rand (1935, 1937) and of Rand (1936, 1938a, 1938b, 1938c, 1941a, 1941b, 1942a, 1942b) based on the collections of the first three Archbold expeditions. Of the 99 New Guinea bird forms described by Rand, there is no instance in which I was unable to discern the characters cited in the diagnoses in the Archbold reports. Conversely, I have found no population of which Rand had adequate material and in which I could detect reliable taxonomic characters warranting naming but which Rand had refrained from naming. A uniform and consistent taxonomic treatment for different groups of birds and for different parts of New Guinea is an obvious prerequisite for drawing undistorted conclusions about evolution, zoogeography, and other biological problems of general interest, and the opportunity to extract such conclusions seems to me to furnish the only significant justification for concerning oneself with subspecies. In reviewing races proposed since 1942, I have, accordingly, synonymized those races which would not be considered distinct by the standards of the Archbold reports.

CASUARIIDAE: CASSOWARIES

Casuarius bennettii shawmayeri Rothschild

Dwarf Cassowary

NATIVE NAMES. Fore: ámanani. Gimi: ámananic. Daribi: képi. Pidgin English: moruk.

TAXONOMY. Apparently only one specimen of this species known to have originated from a definite locality in the Eastern Highlands has been taxonomically analysed. This was a female from the Hagen Range, assigned by Sims to *shawmayeri*, a race originally described from the Kratke Mountains at the eastern end of the Eastern Highlands.

BREEDING. Gimi natives told me that eggs are found in March and April, suggesting breeding towards the end of the rainy season.

DISCUSSION. Dwarf Cassowaries live in virgin forest of hills and mountains up to about 7,000 ft, apparently in low numbers. They are shy and rarely seen but betray their presence by their droppings, consisting of pits of large fruit which evidently represent their principal food. When cornered, they defend themselves with powerful kicks: Paran's dog had been killed by a cassowary, and Gilliard (Mayr & Gilliard, 1954) saw a human attacked and nearly killed. From native accounts the adults are solitary and may be accompanied by one young bird. The meat is dark and said to be not unlike human flesh; the large green eggs are eaten; and the feathers are used as brooms and as decorations at native sing-sings. Captured young birds are kept as pets in villages until large enough to eat.

Casuarius casuarius subsp.

Double-wattled Cassowary

Native informants at Karimui stated that two cassowaries occur there. One was said to be a smaller bird, living on the mountain slopes; I have seen captives kept by natives, and it is *Casuarius bennettii,* the widespread montane cassowary. The cassowary on the floor of the Karimui Basin itself was said to be much larger (about the height of a man); this description was confirmed by a European resident who saw one that had been killed. This second species can only be *C. casuarius,* the large cassowary of the lowlands, whose altitudinal range generally appears to exclude that of *C. bennettii.* If confirmed, the occurrence at Karimui would represent an altitudinal record for this species, but it would not be surprising in view of the many other lowlands species that have colonized the flat basin floor.

PODICIPEDIDAE: GREBES

Podiceps novaehollandiae novaehollandiae Stephens

Little Grebe

NATIVE NAME. Fore: noshó.

DISCUSSION. Gyldenstolpe collected one specimen on the Wahgi River; Bulmer saw a pair and inspected a nest in the Baiyer Valley; and natives report grebes as present in the Fore area.

PHALACROCORACIDAE: CORMORANTS

Phalacrocorax sulcirostris (Brandt)

Little Black Cormorant

Observed by Schodde and Hitchcock at Lake Kutubu, and reported from Baiyer River (N.G.B.S. Newsletter, No. 54, p. 1, June 1970).

Phalacrocorax melanoleucos melanoleucos (Vieillot)

Little Pied Cormorant

Observed by Schodde and Hitchcock at Lake Kutubu, and found breeding at Baiyer River (3,900 ft) by Bulmer.

ANHINGIDAE: ANHINGAS

Anhinga rufa papua Rand

Australian Darter

Observed by Schodde and Hitchcock at Lake Kutubu.

ARDEIDAE: HERONS and BITTERNS

Notophoyx picata (Gould)

Pied Heron

SPECIMENS EXAMINED. Karimui: 1 ♀ (26 Aug. 1965).
WING. 224.
EXPOSED CULMEN. 64.

DISCUSSION. The above specimen was collected by a native, who said that he had shot it out of the top of a tree. A single bird stayed for 10 days around a tea plantation at Mt. Hagen in June 1967 (N.G.B.S. Newsletter, No. 23, p. 2, Sept. 1967).

Egretta alba modesta (Gray)

Great White Heron

Bulmer collected one at 3,900 ft in the Baiyer Valley (18 Jan. 1956), and Schodde and Hitchcock observed individuals at Lake Kutubu.

Egretta intermedia plumifera (Gould)

Plumed Egret

Observed at Lake Kutubu by Schodde and Hitchcock.

Nycticorax caledonicus hilli Mathews

Nankeen Night Heron

Gyldenstolpe obtained two from a swampy patch in the Wahgi Valley. Schodde and Hitchcock found the species common at Lake Kutubu.

Zonerodius heliosylus (Lesson)

Forest Bittern

Bulmer collected one at 4,700 ft on the Lai River (23 Nov. 1955).

Dupetor flavicollis gouldi (Bonaparte)

Black Bittern

Shaw-Mayer secured one at 7,300 ft on Mt. Giluwe.

THRESKIORNITHIDAE: IBISES and SPOONBILLS

Platalea regia Gould

Royal Spoonbill

One was collected by Gyldenstolpe in a boggy area near Nondugl.

ANATIDAE: GEESE and DUCKS

Anas superciliosa rogersi Mathews $\leqslant$ *A. s. pelewensis* Hartlaub and Finsch

Black Duck

In the Eastern Highlands the Black Duck has been collected in the Wahgi River and near Mt. Giluwe, and observed at Lake Kutubu and in a marsh near Okapa. The two New Guinea races differ only in size; Gilliard's specimen agreed with the smaller *pelewensis,* while specimens taken by Gyldenstolpe and Shaw-Mayer agreed with *rogersi.*

Anas querquedula Linnaeus

Garganey Teal

One female of this rare palaearctic visitor is cited as having been collected at Lake Kandep (N.G.B.S. Newsletter, No. 12, p. 2, Oct. 1966).

Anas gibberifrons gracilis Buller

Gray Teal

Gyldenstolpe collected one female in the Wahgi River.

Salvadorina waigiuensis Rothschild and Hartert

Salvadori's Teal

NATIVE NAMES. Fore: noshó. Gimi: nosó. Daribi: gédi.
SPECIMENS EXAMINED. Soliabeda: 2 ♂, 1 ♀ (24-28 July 1965).
WING. 2 ♂: 186, 189. 1 ♀: 180.
EXPOSED CULMEN. 2 ♂: 36, 38. 1 ♀: 35.
STOMACH CONTENTS. Insects and much gravel.

TAXONOMY. The species may increase in size with altitude. Six males that I measured, collected at altitudes above 10,000 ft on Mt. Wilhelm, in the Snow Mountains, and in southeastern New Guinea, have wings of 195-201 (197 $\pm$ 3) mm, larger than either of the Soliabeda males (from 1,350 ft, at the lower altitudinal limit of the species).

BREEDING. Both males had enlarged testes. One of the males was shot with the female, which contained an egg nearly ready to lay as well as several other enlarged ova. On 27 July 1965 Paran found a nest, a depression in a rock next to the Wi River, lined with grass and containing three pale coffee-colored eggs. Thus, *Salvadorina's* breeding at Soliabeda falls in the dry season, which is teleologically understandable: after rains in their watersheds, small highlands streams are subject to sudden flash floods, which would immediately destroy a nest like the one Paran found. Van Deusen (pers. comm.) discovered the first known nest, in vegetation near the alpine lakes on Mt. Wilhelm.

DISCUSSION. Of the 13 species of Anatidae reported from New Guinea, this is the only endemic species, and the only one that fails to descend to the lowlands. Most of the remaining 12 species are largely or entirely confined to the lowlands. The poor representation of Anatidae in the mountains is what one would expect from the very small number and size of New Guinea's montane lakes.

Single individuals of *Salvadorina* were seen several times on the Wi River (1,350 ft) and Sena River (4,500 ft), which are rocky, turbulent, and narrow mountain streams. In some cases the bird was perched on boulders in the middle of the torrent, while in other cases it was first noticed as it took flight, taxiing low over the surface of the water instead of bounding straight up with a spring (cf., also, Mayr and Rand, 1937, p. 11). To judge from reports of native informants, *Salvadorina* is a regular but uncommon inhabitant of rushing torrents on mountain slopes in the Eastern Highlands. The unusually low elevation of Soliabeda records is probably attributable to the fact that the Wi River was still turbulent and in mountainous terrain. In addition, *Salvadorina* occurs in another quite different habitat, namely, the alpine lakes between 10,000 and 13,000 ft in the Snow Mountains, Eastern Highlands, and southeastern New Guinea. Gilliard and Van Deusen both observed it in the twin alpine lakes on Mt. Wilhelm.

Nettapus coromandelianus coromandelianus (Gmelin)

White-quilled Pygmy Goose

H. L. Bell (pers. comm.) states that L. W. C. Filewood found this species abundant at Lake Kandep (7,000 ft).

ACCIPITRIDAE: HAWKS and EAGLES

Elanus caeruleus wahgiensis Mayr and Gilliard

Black-winged Kite

On 29 June 1965 I observed one individual over grassland at Tarabo airstrip (6,000 ft) near Okapa. It flew back and forth 10-30 ft above the ground, periodically stopping to hover in one spot. The manner of hovering was distinctive: the axis of the body was inclined to the horizontal at about 45°, head upwards, and the wing strokes were entirely in a plane above that of the body. This behavior is essentially the same as that of *Elanus leucurus* (sometimes considered conspecific with *E. caeruleus*) which I have observed in South America.

Gilliard collected the type specimen and observed others in the Wahgi Valley. There are also sight records by Bulmer and Bell at Baiyer River (3,600 ft) and from Pureni in the western part of the Eastern Highlands (N.G.B.S. Newsletter, No. 23, p. 4, Sept. 1967). The expanses of the Eastern Highlands cleared by man seem ideal habitat for this species, and it is surprising that it should be so local and uncommon.

Aviceda subcristata stenozona (Gray)

Crested Lizard Hawk

SPECIMENS EXAMINED. Soliabeda: 1 ♂ (26 July 1965). Karimui: 1 ♂ (4 Aug. 1965). Mt. Karimui zone 1: 1 ♂, 1 ♀ (11 Aug. 1965).

WING. 3 ♂: 284, 294, 308. 1 ♀: 307.

CULMEN FROM CERE. 3 ♂: 21, 22, 22.

STOMACH CONTENTS. Insects.

TAXONOMY. The races *stenozona* of western New Guinea and *megala* of eastern New Guinea differ only in size. Wing measurements of comparative material yielded 272-305 (284 ± 14) for five *stenozona* males, 306 and 311 for two *megala* males. Values given by Rand and Gilliard (1968) are: *stenozona,* ♂ 290-303, ♀ 296-314; *megala,* ♂ 298-316, ♀ 314-334. The present material is thus closer to *stenozona.* A single immature female taken at Lake Kutubu by Schodde and Hitchcock had a wing of 294 mm and was also assigned to *stenozona.* The barring on the underparts of my four specimens is darker than in most other material, nearly charcoal.

BREEDING. Although the male and female from Mt. Karimui were together as a pair, the gonads of these four specimens were small.

DISCUSSION. Individuals or groups of up to five were seen soaring high or else perched in tall trees overlooking open spaces. Once I saw a bird attacked and driven off by the flycatcher *Peltops montanus.*

The two specimens from the lower slopes of Mt. Karimui may constitute an altitudinal record (4,100 ft) for this lowland species.

Henicopernis longicauda longicauda (Garnot)

Long-tailed Buzzard

While hawks in general are not numerous in the Eastern Highlands, this species is among the less uncommon. Until one learns to recognize it in flight, however, *Henicopernis* is easy to overlook entirely, since it is usually seen soaring rather high. The wings are long, rounded, and broad, the head is small, and the tail is long, rounded, and slender, so that the silhouette suggests three long loops and one short loop attached at a point and radiating at right angles. The pattern of the undersurface is also distinctive, the head, upper breast, wings, and tail appearing dark, the lower breast and belly light. The primaries are often held outstretched. With practice the combination of the distinctive shape and undersurface pattern enables one to recognize *Henicopernis* at a moderate distance. It is rarely seen sufficiently close for the barring of the wings and tail to be visible. I saw it regularly in all parts of the Eastern Highlands over both cleared country and forest, usually soaring without flapping, sometimes alternately soaring and flapping. About half of my observations were of pairs or of groups of three birds. One pair was seen to chase off an individual of the kite *Haliastur indus*.

Milvus migrans affinis Gould

Black Kite

NATIVE NAME. Fore: kékepa.

DISCUSSION. In the Eastern Highlands this species is widespread in districts with large expanses of man-made grasslands (but is absent at Karimui, where grassland is limited and probably recent in origin). It gathers in large numbers at the leeward side of grassland fires in wait for fleeing grasshoppers, and searches the ground for burnt prey once the fire has passed. Elsewhere in New Guinea *Milvus migrans* is a lowlands species and has not been recorded even from the extensive man-made grasslands of the Baliem Valley of western New Guinea. I do not know whether it breeds in the Eastern Highlands or whether it is a seasonal nonbreeding visitor from the lowlands. The birds I watched were always soaring low over the ground in the manner of a harrier (*Circus*). The indented tail, unique among New Guinea hawks, facilitates identification in silhouette.

Haliastur indus girrenera (Vieillot)

Brahminy Kite or Red-backed Sea Eagle

NATIVE NAMES. North Fore: pirinámu. South Fore: pílam.
SPECIMENS EXAMINED. Karimui: 1 imm. ♀ (17 July 1965).
WING. 357.
EXPOSED CULMEN. 24.
STOMACH CONTENTS. Grasshoppers.

DISCUSSION. This species, *Henicopernis longicauda,* and *Milvus migrans* are perhaps the commonest hawks of the Eastern Highlands. The chestnut and white adults are unmistakable, while the immatures may be recognized in flight by the light "window" in the distal half of the wing. I found *Haliastur indus* widespread (Okapa, Lufa, Karimui) up to 6,600 ft, and Bulmer found a nest at 4,000 ft. It was usually seen soaring over open country, generally singly but sometimes in groups of up to four. About once a month it came to eat spiders out of their webs near the European houses at Okapa, and one individual was seen with a rat, but much of the diet is insects caught on the wing. A soaring individual was chased off by a pair of *Henicopernis longicauda.* While this is mainly a lowlands species, the Third Archbold Expedition (Rand, 1942b) and Ripley (1964) found that it has also colonized the man-made grassland of the Baliem Valley of western New Guinea.

VOICE. A weak, somewhat nasal, high-pitched downslur, suggestive of the bleating of a lamb and incongruously faint for so large a bird.

Accipiter buergersi (Reichenow)

Buerger's Goshawk

SPECIMENS EXAMINED. Karimui: 1 ? (probably ♀ from measurements) (13 July 1965).
WING. 316.
TAIL. 228.
CULMEN FROM CERE. 26.
SOFT PARTS. Iris: light yellow. Legs: light yellow-green. Cere: light green. Bill: dark gray.

TAXONOMY. The feathers of the back have black centers and chestnut edges, the impression of black predominating on the upper back and of chestnut on the lower back. The head is black, with a few white feathers; the upper tail charcoal with nine thin lighter bars; and the upper wings charcoal brown, with faint light bars on the inner edges of the primaries. The underparts from the chin through the undertail coverts are white unevenly washed with light chestnut, the chestnut being darker on the flanks and shanks and absent on the throat. There are small black streaks on the throat, bold black streaks on the breast, flanks, and shanks, and black spots on the lower belly and undertail coverts. The axillaries are rufous with black centers, and the undersurface of the primaries and tail alternately barred black and white.

Only about seven other specimens exist, of which two were available for comparison: the type of *Accipiter eudiabolus* Rothschild and Hartert, an unsexed adult (presumed male from its measurements) from Babooni at 3,000 ft in the mountains of southeastern New Guinea; and an immature, also presumed to be male, from the Hydrographer Range of southeastern New Guinea. The Babooni adult has the head and upperparts black, the underparts white with bold black streaks, and the feathers of the upperwing coverts black with broad chestnut edges; wing 295, tail 201, exposed culmen 22 mm. The Hydrographer Range immature has the head, upperparts, axillaries, and underparts of the body mainly rich chestnut, with bold black streaks below and black centers to the feathers of the upperparts; wing 292, tail 206, exposed culmen 21 mm. In both of these specimens, as in the Karimui bird, the undersurface of the wings and tail is barred black and white. The Karimui specimen is thus not fully adult but more nearly so than the Hydrographer Range specimen, from which it differs in that the chestnut wash of the axillaries and underparts is paler, the ground color of the throat and a few patches on the breast and undertail coverts are already pure white, and the black centers of the back feathers have increased at the expense of the chestnut peripheries, especially on the upper back.

DISCUSSION. *Accipiter buergersi,* the rarest species of hawk endemic to New Guinea, is apparently confined to low altitudes (1,900-5,200 ft) in the mountains of eastern New Guinea. Besides Karimui and two or three localities in southeastern New Guinea, the other localities where it has been taken are Junzaing on the Huon Peninsula, the type locality of Maeanderberg and the Lordberg in the mountains south of the Sepik River, and the Sau Valley of the Eastern Highlands, where Bulmer collected one specimen at 5,200 ft (5 Dec. 1955).

In the upper part of the altitudinal range of *Accipiter buergersi* there is no other forest *Accipiter,* but in the lower part of its range it is one of three forest species in its genus. The three species differ in size, each being about 50% heavier than the next: *A. buergersi* > *A. novaehollandiae* > *A. poliocephalus.*

Accipiter novaehollandiae leucosomus (Sharpe)

Gray Goshawk or White Goshawk

NATIVE NAMES. Daribi: kemoráge (melanistic phase), penágo (white phase).

SPECIMENS EXAMINED. Karimui: one specimen preserved in alcohol (presumed ♂ from measurements) (28 July 1964); 1 ♂ (3 Aug. 1965).

WING. 1 ♂: 217. 1 ♂?: 215.

TAIL. 1 ♂: 162. 1 ♂?: 159.

CULMEN FROM CERE. 1♂: 17. 1♂?: 17.
STOMACH CONTENTS. A small bird.

TAXONOMY. These specimens have been described previously (Diamond, 1967a). *Accipiter novaehollandiae* has been known to exist in two color phases, an all-white phase and a colored (russet and gray) phase, whose frequencies vary geographically. Thus, the white phase is characteristic of Tasmania; only the colored phase occurs in the D'Entrecasteaux Archipelago (subspecies *pallidimas*) and the Louisiade Archipelago (subspecies *misulae*); and both phases occur on New Guinea in roughly equal proportions or with the colored bird slightly more common. In New Guinea *Accipiter novaehollandiae* is mainly a lowland species, although it does reach the Baliem Valley of the western New Guinea mountains. In the Eastern Highlands it is not known to occur outside of the Karimui Basin; it was even absent at Soliabeda (2,000 ft) nine miles southeast of Karimui Patrol Post but beyond the mountains ringing the basin. This isolated Karimui population is remarkable in that both of the above specimens, and all individuals seen by me in 1964 and 1965, were melanistic, i.e., a uniform dark gray-brown. The only other record of melanism in this species is a single female from the Hydrographer Mountains of southeastern New Guinea. According to Karimui natives, the dark phase ("kemoráge") is resident at Karimui throughout the year and nests at the tops of very tall trees, while individuals of the white phase ("penágo") appear only infrequently and disappear after a few days. The occurrence of geographically localized melanistic, white, and colored phases is of interest, as is the extremely limited range of the melanistic form in an ecological island surrounded by areas where only the other two forms occur.

BREEDING. The gonads of the 1965 males were small.

DISCUSSION. I found solitary individuals at Karimui and Bomai in trees overlooking gardens and cleared areas.

VOICE. (see Fig. 10). An unhurried series of 8-10 thin, high, upslurred notes, surprisingly weak for a bird its size, and similar to the call described for the species in Australia (Cayley, 1959).

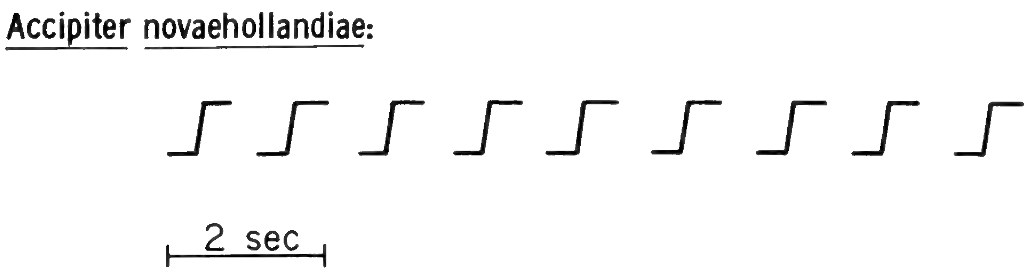


FIG. 10. Voice of *Accipiter novaehollandiae*.

SPECIES ACCOUNTS

Accipiter fasciatus polycryptus Rothschild and Hartert

Australian Goshawk

SPECIMENS EXAMINED. Karimui: 1 ♀ (2 Aug. 1965). Bomai: 1 imm. ♀ (7 July 1965).
WING. 1 ♀: 260. 1 imm. ♀: 204.
TAIL. 1 ♀: 199. 1 imm. ♀: 142.
CULMEN FROM CERE. 1 ♀: 18. 1 imm. ♀: 17.

TAXONOMY. This material agrees with the eastern New Guinea race *polycryptus.* The race *dogwa* of the Fly River bulge of southern New Guinea differs in being considerably paler below, especially on the abdomen, and in having the brown bars on the breast narrower than the intervening white areas (vice versa in *polycryptus*).

BREEDING. The Karimui adult female had two ovaries.

DISCUSSION. At Karimui the habitat preference and behavior of *Accipiter fasciatus* appeared similar to those of *Accipiter novaehollandiae,* i.e., solitary individuals were seen perched in trees overlooking native gardens and open spaces. A perched immature was repeatedly attacked by the flycatcher *Rhipidura leucophrys* and finally flew off with the flycatcher in pursuit. Other Eastern Highlands records are from the Wahgi Valley, where Gilliard and Gyldenstolpe found it "not common" to "fairly rare," and from Kyaka territory, where Bulmer reported it as common.

VOICE. A series of about a dozen or more thin notes, progressively rising in pitch.

Accipiter poliocephalus Gray

New Guinea Gray-headed Goshawk

SPECIMENS EXAMINED. Karimui: 1 ♀ (13 July 1965). Bomai: 1 ♀ (8 July 1965). Soliabeda: 1 ♂, 1 ♀ (24 and 30 July 1965). Mt. Karimui Zone 3: 1 ♀ (20 Aug. 1965).
WING. 1 ♂: 195. 4 ♀: 209, 215, 221, 227.
CULMEN FROM CERE. 1 ♂: 17. 4 ♀: 19, 20, 20, 21.
STOMACH CONTENTS. A lizard.

BREEDING. The gonads of all specimens were small.

DISCUSSION. My few observations of this lowlands hawk at Karimui and Bomai were of solitary individuals perched in trees in native gardens, a habitat description which could apply equally well to the other two *Accipiter* species in the Karimui Basin (*A. novaehollandiae* and *A. fasciatus*). However, *A. poliocephalus* also lives within the forest: the Mt. Karimui (5,000 ft) and Soliabeda females were both taken while diving for netted or wounded flycatchers in the forest. In addition to its greater preference for the forest interior, *A. polioceph-*

alus may sort out ecologically from its congeners *A. novaehollandiae* and *A. fasciatus* on the basis of its smaller size (the two congeners weigh 50% more), suggesting different prey.

Accipiter melanochlamys schistacinus (Rothschild and Hartert)

Black-mantled Goshawk

NATIVE NAME. Fore: amaipána.
SPECIMENS EXAMINED. Awande: 1 ♂ (15 June 1965). Mt. Karimui Zone 6: 1 ♂ (5 Sept. 1965).
WING. 2 ♂: 213, 220.
CULMEN FROM CERE. 2 ♂: 16, 17.
STOMACH CONTENTS. A small bird.

TAXONOMY. The single available specimen of the nominate race, which is confined to the Vogelkop, is blacker above, especially on the head, and darker below than my two specimens or other *schistacinus* material.

BREEDING. Testes of both specimens were small.

DISCUSSION. Both specimens were obtained in the interior of virgin montane forest, remote from human disturbance. The Awande specimen was shot while perched at the top of a tree; the Mt. Karimui specimen (ca. 6,800 ft) was driven into a mistnet by my Fore assistants while it was trying to eat a small dicaeid *Melanocharis versteri* trapped in the net. Another specimen that subsequently escaped was netted at 8,500 ft inside the forest on Mt. Michael, where it too had presumably been after a netted bird and become trapped of its own efforts. One individual was surprised on the ground in the forest and flew into the treetops. The habit of preying on other birds is responsible for its Fore name, "amaipána", which means "killer of one's brother."

This species has generally been considered rare although widespread, and less than 30 specimens exist. It nevertheless occurs regularly in the Eastern Highlands, even if at a low density, from at least 5,500 ft to 8,700 ft wherever there are large expanses of forest undisturbed by man. Thus, I obtained one specimen each at my three midmontane stations; and Gilliard, Gyldenstolpe, Shaw-Mayer, and Bulmer each collected one to three specimens in the Wahgi Mountains, Kubor Mountains, Schrader Range, Mt. Hagen, and Mt. Giluwe. It is the only forest *Accipiter* in this altitudinal range and is replaced in the forest at lower elevations by *A. poliocephalus* and *A. novaehollandiae* (and the very rare and geographically limited *A. buergersi*). On Mt. Karimui a vertical distance of 1,800 ft separated the sites where *A. melanochlamys* and *A. poliocephalus* were netted. Records elsewhere also suggest that altitudinal segregation of *A. melanochlamys* from its forest congeners is complete.

Megatriorchis doriae Salvadori and D'Albertis

Doria's Hawk

SPECIMENS EXAMINED. Soliabeda: 1 ♂ (29 July 1965).
WING. 287.
TAIL. 250.
CULMEN FROM CERE. 25.

BREEDING. The testes were small.

DISCUSSION. The monotypic genus *Megatriorchis* is one of the rarest endemic New Guinea hawks. The above specimen was brought in by a Soliabeda native, who spotted it perched in a tree inside the forest. He hid in the undergrowth, made noises imitating a small bird, and shot the hawk with bow and arrow when it came down to investigate. The previous day I had seen probably the same individual perched inside the forest in the crown of a flowering tree, which had attracted many small birds and butterflies. During the 15 minutes that I watched the hawk, it remained stationary. *Megatriorchis doriae* has been recorded from forest at altitudes up to 3,000 ft at a number of localities scattered over New Guinea.

Harpyopsis novaeguineae Salvadori

New Guinea Eagle

NATIVE NAMES. Fore: tiyó. Gimi: luípa.

DISCUSSION. *Harpyopsis,* the largest endemic New Guinea hawk, is quite uncommon but widely distributed in the Eastern Highlands, inhabiting forest up to about 9,500 ft. The individuals I observed were either soaring just over the top of the forest or else perched inconspicuously inside the forest in the crowns of trees. The most remarkable feature of this eagle's habits is that it hunts by night as well as by day, and at one camp the calls of a pair of *Harpyopsis* awakened me repeatedly throughout the night. In life the feathers around the eye form a distinct facial disc, as in owls, and may play some role in night vision or hearing. The prey consists of large marsupials and birds and small pigs.

VOICE. A single note with a quality like the sound made by a taut bowstring being released, followed by a hollow note repeated one to four times and like the foraging call of a domestic chicken: bung! —buk-buk-buk-buk.

Circus spilonotus spilothorax Salvadori and D'Albertis

Spotted Marsh Harrier

My only observation was of a black-and-white male soaring low over grassland near Okasa (4,250 ft) in June 1965. The other Eastern Highlands records are from grassland at Nondugl, where Gilliard and Gyldenstolpe each saw it a few times, from grassland near Mt. Giluwe, where Shaw-Mayer observed it often, and from gardens and grassland in the Baiyer Valley and Schrader Range, where it was found by Bulmer. Its distribution is evidently quite local, and I interpret my failure to find it in the grasslands at Okapa, Lufa, and Karimui as probably indicating its being actually absent from those localities, since the distinctive male is easy to recognize even at a distance.

Circus approximans gouldi Bonaparte

Swamp Harrier

SPECIMENS EXAMINED. Karimui: 1 ? (12 July 1965).
WING. 400.
TAIL. 234.
CULMEN FROM CERE. 24.
SOFT PARTS. Iris: brown. Legs: yellow. Cere: yellow. Bill: black.

TAXONOMY. This specimen is a nearly solid and uniform dark brown below, except for a paler chin and some inconspicuous dark shaft streaks. The upperparts are also uniform dark brown, except that there are a few white patches on the lower back, the nape is largely white, and the forehead and area around the base of the bill light gray.

DISCUSSION. This Australian and New Zealand race was previously known in New Guinea mainly or only from sea level on the southern coast, and provides yet another example of a lowland species reaching the Karimui Basin. The Second Archbold Expedition (Rand, 1941a) found both this form and *Circus spilonotus spilothorax* at Lake Daviumbu in the same month, strengthening the case for considering them as separate species. At Merauke *C. approximans* is present only in the dry season and *C. spilonotus* only in the wet season (Hoogerwerf, 1964).

FALCONIDAE: FALCONS

Falco peregrinus ernesti Sharpe

Peregrine Falcon

DISCUSSION. Few Eastern Highlands records exist: a male collected by Shaw-Mayer at 7,300 ft on Mt. Giluwe; one seen by Van Deusen (Sixth Archbold Expedition) at 11,400 ft over the summit grassland of Mt. Michael; and possible sight records by Bulmer in Kyaka territory.

VOICE. A fairly high-pitched, slightly hoarse, weak, upslurred screech "ka-ah," repeated about seven times in 5 sec.

Falco severus papuanus Meyer and Wiglesworth

Oriental Hobby

NATIVE NAME. Fore: akík.
SPECIMENS EXAMINED. Soliabeda: 1 ♀ (25 July 1965).
WING. 233.
TAIL. 101.
CULMEN FROM CERE. 15.
SOFT PARTS. Iris: brown. Legs: yellow. Cere: yellow. Bill: black.

BREEDING. The specimen had two ovaries.

DISCUSSION. This is apparently the only specimen collected to date in the Eastern Highlands and was one of a pair that circled over the village of Soliabeda. The following day one individual, presumably the surviving mate, appeared over the village. In addition, on several occasions at Miarosa (5,800 ft) in June 1964 I observed a pair repeatedly alight in the top of a tall dead tree, take off, circle, and return to the same perch. Finally, I saw one individual in Gimi territory (5,000 ft) in July, 1964. Thus, *Falco severus* may be regarded as local and uncommon in the Eastern Highlands in open country with tall trees.

VOICE. A rapid series of typically falcon-like notes, descending in pitch.

Falco cenchroides cenchroides Vigors and Horsfield

Nankeen Kestrel

SPECIMENS EXAMINED. Karimui: 5 ♀ (1-17 July 1965). Bomai: 1 ♀ (7 July 1965).
WING. 240-264 (255 ± 9).
TAIL. 145-160 (154 ± 6).
CULMEN FROM CERE. 14.5-15.0 (14.9 ± 0.2).
WEIGHT. 154-189 (167 ± 16).
SOFT PARTS. Iris: brown. Legs: yellow. Bill: light grey.

DISCUSSION. *Falco c. cenchroides* is an Australian bird for which there were no New Guinea records until recent years, when it began to turn up as a winter visitor (March to September) in southern New Guinea (N.G.B.S. Newsletter, No. 10, p. 2, Aug. 1966; No. 14, p. 3, Dec. 1966; No. 43, p. 1, May 1969; No. 44, p. 1, July 1969; van den Assem, 1960). As discussed previously (Diamond, 1967a), my specimens were collected in June and July of 1965, when I frequently saw this falcon flying over the Karimui and Bomai airstrips. In addition, I saw an individual over Karimui airstrip in June 1966 and in April 1969, and a photograph of a falcon shot by the patrol officer at Karimui in 1964 establishes it as this species. The fact that all specimens were females with small ovaries suggests that they were nonbreeding vagrants. Stresemann (1914a) pointed out earlier that the records of *Falco c. cenchroides* outside of Australia (from New Zealand, Java, Babbar, Ceram, and the Aru Islands) are nearly all females.

Falco berigora novaeguineae (Meyer)

Brown Hawk or Brown Falcon

SPECIMENS EXAMINED. Karimui: 1 ♂ (13 Sept. 1965).
WING. 310+.
TAIL. 180.
CULMEN FROM CERE. 21.
STOMACH CONTENTS. Hair and jaws of a small mammal.
SOFT PARTS. Iris: light brown. Legs: whitish. Cere: lemon to white. Bill: gray.

BREEDING. The testes were small.

DISCUSSION. In addition to the specimen collected, I observed this falcon several times at Karimui and Iogoramalu in the Karimui Basin, near Okapa, and in Gimi territory. Individuals were seen perched in trees in gardens or open country, and twice I saw pairs chasing each other, diving and twisting rapidly and calling. Gyldenstolpe and Bulmer also collected specimens. Thus, this falcon may be widespread, but uncommon, in the Eastern Highlands in open country (never in the forest interior).

VOICE. The pairs chasing each other uttered a very rapid series of harsh notes on one pitch delivered at machine-gun rate; this could alternatively be described as a crackling scream. This series was sometimes punctuated by two more emphatic notes.

MEGAPODIIDAE: MEGAPODES or BRUSH TURKEYS

Megapodius freycinet subsp.

Common Scrub Hen or Scrub Fowl

NATIVE NAMES. Fore: kaúba. Gimi: oedóc. Daribi: neyó.
STOMACH CONTENTS. Insects, centipedes, snails, pebbles, and sand.

DISCUSSION. According to native reports, *Megapodius freycinet* is at Soliabeda (2,000 ft), Karimui (3,650 ft), on Mt. Karimui itself (above 4,000 ft), and at Awande (6,000 ft), where Paran collected it. It also occurs in Kyaka territory, where natives brought eggs to Bulmer on several occasions. In much of its range this is a lowland species, but the Third Archbold Expedition (Rand, 1942b) found it up to 4,000 ft in the Snow Mountains, and Greenway (1935) recorded it up to 5,700 ft in the Herzog Mountains.

Talegalla sp.

(*Talegalla jobiensis,* Brown-collared Brush Turkey, and/or *Talegalla fuscirostris,* Black-billed Brush Turkey)

NATIVE NAMES. Fore: óa. Gimi: aloíya. Daribi: wádi.

DISCUSSION. Some species of *Talegalla* is widespread in the Eastern Highlands. On Mt. Karimui, between 5,000 and 6,500 ft, I heard calls virtually identical to the calls of *Talegalla jobiensis* that I heard on the north coast. My native assistants reported *Talegalla* in the Okapa area below 6,000 ft, and down to at least 2,000 ft in the Karimui area. At Lake Kutubu Schodde and Hitchcock observed a *Talegalla* which they assumed was *T. fuscirostris,* but they did not obtain specimens.

The species of *Talegalla* involved is uncertain, and its identification will answer a question of considerable interest. There are three species of *Talegalla,* which are very similar morphologically and nearly but not quite allopatric: *T. cuvieri* of far western New Guinea, *T. fuscirostris* of southern New Guinea, and *T. jobiensis* of northern, northeastern, and southeastern New Guinea. *T. fuscirostris* is a lowland species, apparently not recorded at elevations higher than a few hundred feet, whereas *T. cuvieri* and *T. jobiensis* occur up to 3,000-5,000 ft. *T. fuscirostris* and *T. cuvieri* overlap for a distance of at least 150 miles in southwestern New Guinea around long. 136° E, and in this area they appear to segregate altitudinally, with *T. cuvieri* confined to higher elevations. *T. fuscirostris* and *T. jobiensis* overlap for at least 50, perhaps 250, miles in southeastern New Guinea around long. 147° E. I would guess that the *Talegalla* at Okapa and Karimui will prove to be *T. jobiensis* rather than *T. fuscirostris,* because the altitude would be typical of the former and unprecedented for the latter, and because the calls of the Karimui *Talegalla* were indistinguishable from those of *T. jobiensis.* The evolutionary history implied by these distributions is that genus *Talegalla* once consisted of a superspecies ring of three allopatric forms; and that the range of the southern form, *T. fuscirostris,* is being reinvaded by *T. cuvieri* from the west and by *T. jobiensis* from the east, with the forms segregating altitudinally in each overlap zone.

VOICE. A nasal, unhurried, and very loud call which may be rendered "wa-wa-wa", suggestive of a child wailing but more nasal and deeper, and consisting of two detached upslurs followed by a steady note (Fig. 11).

Aepypodius arfakianus arfakianus (Salvadori)

Wattled Brush Turkey

NATIVE NAMES. Fore: íya. Daribi: dasiári.
STOMACH CONTENTS. A broken fruit pit, and much gravel.

DISCUSSION. This species of megapode appears to be generally distributed, though quite uncommon, in primary forest between 3,000 and 9,000 ft, having been observed or collected at several localities by Gilliard, Shaw-Mayer, and me. According to natives, *Aepypodius* flies

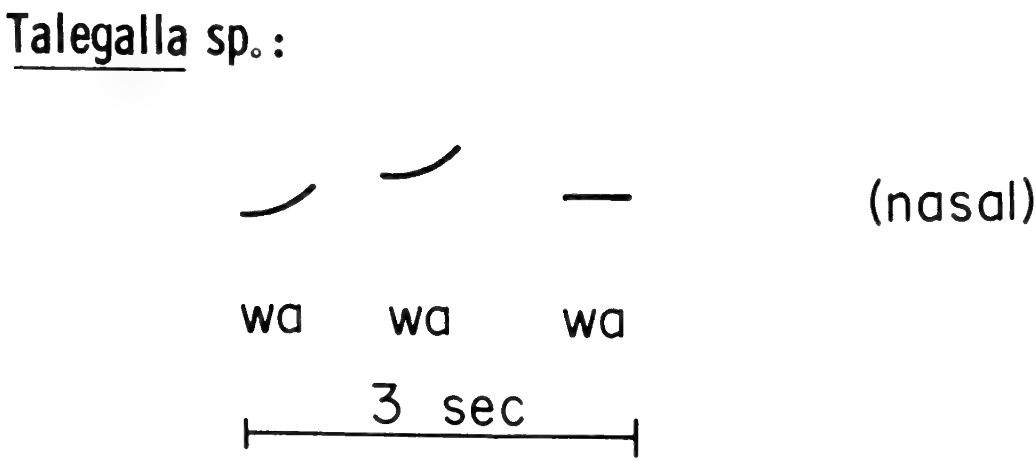


FIG. 11. Voice of *Talegalla* sp.

up into trees when disturbed, whereas *Talegalla* prefers to remain on the ground. This is in accord with our observations: an *Aepypodius* seen by Terborgh at Okasa was in a tree, and those that I saw on the Sena River were birds which burst up from the ground at my approach and alighted heavily in trees.

PHASIANIDAE: QUAIL and PHEASANTS

Synoicus ypsilophorus lamonti Mayr and Gilliard

Brown Quail

NATIVE NAME. Fore: yókayó.
SPECIMENS EXAMINED. Awande: 1 ♂ (20 June 1965).
WEIGHT. 83.
WING. 91.

TAXONOMY. This specimen agrees with topotypical *lamonti* males. Its upperparts are more chestnut and richly colored than those of *mafulu,* while *dogwa* and *plumbeus* differ in the tendency towards uniform gray coloration of the underparts.

BREEDING. The testes of the specimen (collected in June) were enlarged. On 18 August 1964 a Fore man at Awande showed me a nest on the ground in grass containing five eggs (one 33 x 24 mm) colored very pale tan with dark brown speckles. The "yókayó" was said to be generally nesting then at Awande, which implies that breeding is in the dry season, as true of most other grassland birds as well.

DISCUSSION. I found small groups of this quail not uncommon in grassland and native gardens at Miarosa, Awande, and Okasa. Other collectors have also encountered it regularly in the Eastern Highlands wherever there are substantial expanses of midmontane grassland and gardens. In southeastern New Guinea, but not in the Eastern Highlands, it also occurs in alpine grassland.

VOICE. A two-note nasal whistled call, the second note a questioning upslur at a higher pitch (Fig. 12).

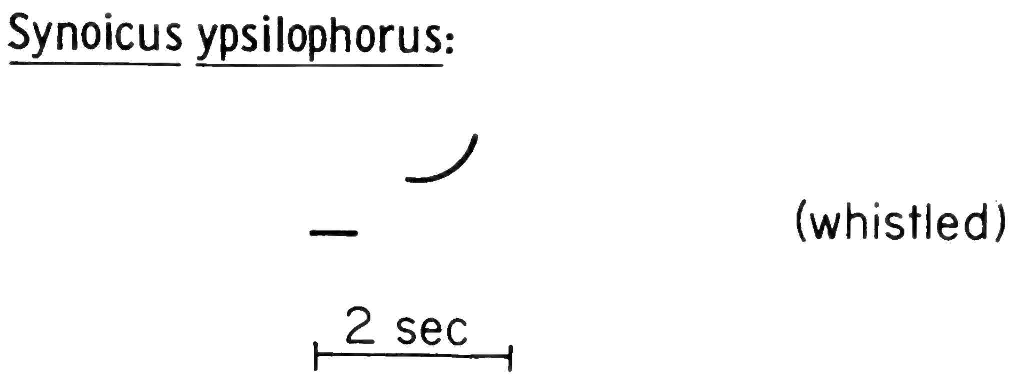


FIG. 12. Voice of *Synoicus ypsilophorus*.

Coturnix chinensis novaeguineae (Rand)[1]

Chinese Quail or King Quail

Other collectors have found this small quail to occur, but in considerably lower numbers than *Synoicus ypsilophorus,* in the grassland of the central part of the Eastern Highlands (Mts. Wilhelm, Hagen, and Giluwe, and the Wahgi Valley). At Okapa and the Karimui Basin it is apparently absent.

TURNICIDAE: BUSTARD QUAIL

Turnix maculosa subsp. and *T. m. giluwensis* Sims

Black-backed Bustard Quail or Red-backed Quail

NATIVE NAME. Fore: mu.
SPECIMENS EXAMINED. Okasa: 1 ♂ (23 June 1965).
WEIGHT. 26.
WING. 67.
EXPOSED CULMEN. 11.

TAXONOMY. The race *giluwensis,* described from Mt. Giluwe (Sims, 1954), was characterized as lacking the chestnut collar of *horsbrughi,* smaller than *furva,* and paler below than *furva* or *horsbrughi.* Only one specimen each (both females) of *giluwensis* and *horsbrughi* was available for comparison. The Okasa male agrees with *giluwensis* in lacking the chestnut collar of *horsbrughi;* the orange-brown color of the breast is richer than that of *giluwensis* but less rich than that of *horsbrughi;* the color of the lower belly is pale buff as in *horsbrughi,*

1 Listed as *Excalfactoria chinensis* in Rand and Gilliard (1967).

not white as in *giluwensis.* The wing length is close to that of the two known males of *giluwensis,* given as 65 mm by Sims (1956). (Rand (1942a) gives the wing of one male *horsbrughi* as 72 mm, and the male of *furva* is unknown). This meagre material is insufficient to assign the Okasa population racially but suggests that it is intermediate between *giluwensis* and *horsbrughi.*

DISCUSSION. The Okasa specimen, which apparently is the fourth known New Guinea male of this rare species, was captured by hand by a Fore man in grassland. The other Eastern Highlands records of this somewhat local species are from Awande, Mt. Giluwe, and Nondugl.

RALLIDAE: RAILS

Rallus pectoralis captus Mayr and Gilliard

Slate-breasted Rail or Lewin Rail

NATIVE NAME. Fore: inónpa.
SPECIMENS EXAMINED. Awande. 1 ♂, 3 ♀ (27 Aug. 1964; 18-20 June 1965).
WEIGHT. 1 ♂: 73. 2 ♀: 69, 77.
WING. 1 ♂: 100. 3 ♀: 95, 96, 100.
EXPOSED CULMEN. 1 ♂: 27. 3 ♀: 27, 28, 31.

TAXONOMY. These Awande specimens agree with topotypical *captus* from Mt. Hagen in size and in the rich brown coloration of the top of the head and neck. The male specimen has the crown dark olive-brown rather than chestnut.

DISCUSSION. All four specimens were trapped in grassland by natives. Most other collectors in the Eastern Highlands have also obtained trapped specimens. The species is evidently fairly common but secretive in grassland from 5,000 to 8,000 ft. It is absent at Karimui, probably because of the low altitude.

Rallus philippensis wahgiensis Mayr and Gilliard

Banded Land Rail

Gilliard, Gyldenstolpe, Shaw-Mayer, and Bulmer all found this larger relative of *Rallus pectoralis* fairly common in swampy grassland in the Wahgi Valley, at Mt. Giluwe, and in Kyaka territory. *Rallus pectoralis* and *R. philippensis* differ ecologically in that the former prefers dry grassland, the latter swampy areas. I never encountered *Rallus philippensis,* and Awande natives appeared not to know it, probably because the grassland at Awande was all dry.

Porzana pusilla palustris Gould

Marsh Crake

Three specimens collected at Mt. Giluwe by Shaw-Mayer provide the only Eastern Highlands record. The species has been taken at only one other locality in New Guinea, the Wissel Lakes (Junge, 1953).

Porzana tabuensis edwardi Gyldenstolpe

Spotless Crake

NATIVE NAME. Fore: olólinta.
SPECIMENS EXAMINED. Awande: 1 ♂, 1 ♀ (18-20 June 1965).
WEIGHT. 1 ♂: 47. 1 ♀: 44.
WING. 1 ♂: 84. 1 ♀: 81.
EXPOSED CULMEN. 1 ♂: 20. 1 ♀: 17.

TAXONOMY. The Awande material belongs to *edwardi,* a thinly differentiated race characterized by having the upperparts slightly darker and the bill slightly longer than in nominate *tabuensis* or *richardsoni.*

BREEDING. The gonads of both specimens were enlarged.

DISCUSSION. Both specimens were trapped in grassland by natives. The species was also collected by Gilliard, Gyldenstolpe, Shaw-Mayer, and Bulmer and is fairly common but secretive in grassland, mainly between 5,000 and 8,000 ft. It is absent at Karimui.

Poliolimnas cinereus leucophrys (Gould)

White-browed Crake

SPECIMENS EXAMINED. Awande: 1?
WING. 94.

TAXONOMY. The race *minimus* is considered inseparable from *leucophrys.*

DISCUSSION. *Poliolimnas cinereus* has a spotty distribution in the New Guinea lowlands. The Awande specimen (6,000 ft), taken by Paran in 1967, constitutes an altitudinal record, with the next highest record being a specimen taken at 1,350 ft in the Astrolabe Range by Tate after the Second Archbold Expedition. The Awande record may indicate a straggler rather than a resident population.

VOICE. A squeaky two-note call, the second note one-half second after the first.

Rallicula forbesi cf. *steini* Rothschild

Forbes's Chestnut Rail

NATIVE NAMES. Fore: ko-átna. Daribi: kóma.
SPECIMENS EXAMINED. Awande: 1 ♀ (20 June 1965). Mt. Michael: 1 ♂ (6 July 1964).
WEIGHT. 1 ♀: 91.
WING. 1 ♂: 103. 1 ♀: 107.
TAIL. 1 ♂: 59. 1 ♀: 63.

EXPOSED CULMEN. 1 ♂: 28. 1 ♀: 23.
STOMACH CONTENTS. Insects.

TAXONOMY. These two specimens differ from nominate *forbesi* of southeastern New Guinea in the much shorter tail, and in this respect agree with *steini,* originally described on the basis of a single female from the Weyland Mountains in far western New Guinea. The larger series obtained by Gilliard, Gyldenstolpe, and Shaw-Mayer all showed great variation in plumage. In addition, specimens from Mt. Giluwe had tails as long as those of nominate *forbesi,* while those from various locations in the Wahgi Valley had short tails. The suggestion of Sims (1956) that this variability of *Rallicula forbesi* in the Eastern Highlands is due to recent reestablishment of breeding contact between the western race *steini* and the eastern race *R. f. forbesi* following a period of isolation is a plausible one, since the details of distribution in the genus *Rallicula* suggest that these rails have become isolated, differentiated, and reinvaded each other's ranges often (Diamond, 1969).

DISCUSSION. *Rallicula forbesi* goes about on the ground in parties of a few individuals inside primary midmontane forest between 4,200 and 9,500 ft. It is secretive and uncommon but nevertheless widespread, and has turned up at almost all forest collecting stations in the Eastern Highlands within these altitudinal limits.

Rallina tricolor tricolor Gray

Red-necked Rail

SPECIMENS EXAMINED. Karimui: 1 ♀ (12 August 1964).
WING. 146.

TAXONOMY. The specimen agrees with the New Guinea race *R. t. tricolor,* and differs from the Australian race *robinsoni* (Cape York Peninsula) in the darker brown belly and lower back and in the fainter barring on the abdomen.

DISCUSSION. The specimen provides the sole record for the Eastern Highlands, and also represents an altitudinal record for this lowland species, rarely found more than a few hundred feet above sea level.

Amaurornis olivaceus ruficrissum (Gould)

Rufous-tailed Moorhen

NATIVE NAME. Daribi: kába.
SPECIMENS EXAMINED. Karimui: 1 ♂, 3 ♀, 1 juv. ? (9 and 11 Aug. 1964; 1 July-6 Aug. 1965).
WEIGHT. 2 ♀: 175, 180.
WING. 1 ♂: 148. 3 ♀: 137, 139, 139.
EXPOSED CULMEN. 1 ♂: 35. 3 ♀: 28, 28, 30.
STOMACH CONTENTS. Insects.

TAXONOMY. *A. o. ruficrissum* of northern Australia and southern New Guinea differs from *A. o. moluccanus* of the remainder of New Guinea in the lighter belly and more rufous, less dull undertail coverts, and in that the male has a red base to the culmen, lacking in *moluccanus*. The Karimui material is somewhat intermediate but nearer *ruficrissum* in the color of the belly and undertail coverts; the male has a red-orange base to the culmen. The juvenile is uniformly black.

BREEDING. All four adults had enlarged gonads. This fact, plus the record of the juvenile not more than a few days old taken in early July, implies that breeding is in the dry season, as true for most grassland birds.

DISCUSSION. This moorhen was present at Soliabeda as well as at Karimui and was also collected by Schodde and Hitchcock at Lake Kutubu. In the Karimui area and in other parts of New Guinea where I encountered it, it lived in the tall grass that had grown up around gardens and cleared land, remote from any swamp. It was far more often heard than seen and proved impossible to flush; it merely remained out of sight in the grass when disturbed.

VOICE. As described in detail elsewhere (Diamond and Terborgh, 1968), the commonest vocalization in this species is a duet, in which each bird of a pair alternately utters a cat-like wail lasting about a second and beginning just as the wail of its partner concludes. During the performance the birds move about in the tall dense grass, several feet apart, and remain out of sight of each other. The duet is often given at night as well as during the day. Solo calls consisting of a low irregular, hen-like "chuck-chuck-chuck" or "kuk-kuk" or "bk-bk-bk" are heard infrequently.

Gallinula tenebrosa subsp.

Dusky Moorhen

In 1951 a European resident at Nondugl showed Gyldenstolpe colored photographs of two moorhens which had been shot near the Wahgi River and which Gyldenstolpe identified as this species. There is no other record from the Eastern Highlands and only a few scattered records from other parts of New Guinea.

Porphyrio porphyrio subsp.

Purple Swamp Hen

Gilliard and Gyldenstolpe found evidence of the presence of swamp hens in swampy grass near the Wahgi River, and Gilliard secured one specimen. Bulmer obtained a sight record at Wabag (6,000 ft) in January 1956. The species occurs mainly in the lowlands but has also been found at higher altitudes in western New Guinea (Wissel Lakes, Baliem Valley).

CHARADRIIDAE: PLOVERS

Pluvialis dominica fulva (Gmelin)

Golden Plover

Gilliard, Gyldenstolpe, and Shaw-Mayer met small flocks at Nondugl in March and April and in September and October. Bulmer noted large flocks present for short periods of the austral summer in Kyaka territory, and Bell recorded the species at Baiyer River in December 1965. The Golden Plover is common in other parts of New Guinea in migration and as a winter visitor.

SCOLOPACIDAE: SANDPIPERS, CURLEW, and SNIPE

Except for *Scolopax saturata,* all members of this family recorded in New Guinea are nonbreeding visitors from the Palearctic and Nearctic.

Numenius minutus Gould

Little Whimbrel

Bell (1968) observed a flock at Baiyer River airstrip from 12 to 16 Dec. 1965.

Tringa hypoleucos Linnaeus[1]

Common Sandpiper

This is one of the most widespread wintering shorebirds in the Eastern Highlands. There are records from Nondugl in April and October by Gilliard and by Gyldenstolpe; from Lake Kutubu in September by Schodde and Hitchcock; from Mt. Hagen district and Baiyer River in December by Bell; from Lanim River in September by Bulmer; and from Baiyer River in December, January, April, August, and October by Bulmer.

Tringa brevipes (Vieillot)[2]

Gray-tailed Tattler

Observed by Schodde and Hitchcock at Lake Kutubu after 20 Sept.

1 Listed as *Actitis hypoleucos* in Rand and Gilliard (1967).
2 Listed as *Heteroscelus incanus brevipes* in Rand and Gilliard (1967).

Gallinago megala Swinhoe[1]

Marsh Snipe

Gyldenstolpe found large numbers suddenly appearing in the Nondugl grasslands for a few days in late September 1951.

Gallinago hardwickii (Gray)[2]

Japanese Snipe

Gyldenstolpe collected two specimens at Nondugl in September 1951. There is one older New Guinea record (Mt. Wilhelmina: Rand, 1942b) and several more recent ones. A few sight records of snipe of this or the preceding species have been reported from elsewhere in the Eastern Highlands.

Scolopax saturata rosenbergii Schlegel

East Indian Woodcock

Gilliard, Gyldenstolpe, Shaw-Mayer, and Bulmer found woodcock uncommon in deep forest at high altitudes (8,500-10,000 ft) on several peaks (Mt. Wilhelm, Mt. Giluwe, Lamende Range, Wahgi Divide Mountains, Schrader Range).

Calidris ruficollis (Pallas)[3]

Red-necked Stint

One was collected by Schodde and Hitchcock at Lake Kutubu on 30 Sept.

Calidris acuminata (Horsfield)[4]

Sharp-tailed Sandpiper

One specimen was collected by Schodde and Hitchcock at Lake Kutubu on 30 Sept.

GLAREOLIDAE: PRATINCOLES

Glareola isabella Vieillot[5]

Australian Pratincole

SPECIMENS EXAMINED. Soliabeda: 1 ♀ (25 July 1965).

1 Listed as *Capella megala* in Rand and Gilliard (1967).
2 Listed as *Capella hardwickii* in Rand and Gilliard (1967).
3 Listed as *Erolia ruficollis* in Rand and Gilliard (1967).
4 Listed as *Erolia acuminata* in Rand and Gilliard (1967).
5 Listed as *Stiltia isabella* in Rand and Gilliard (1967).

WEIGHT. 48.
WING. 187.

DISCUSSION. The bird collected had landed on bare ground after circling Soliabeda village shortly after sunrise. Schodde and Hitchcock regularly saw small groups of this Australian wintering visitor on playing fields and the airstrip at Lake Kutubu until at least 4 Oct. Bell observed 20 at Tari airstrip on 4 Aug.

LARIDAE: GULLS and TERNS

Sterna fuscata subsp.

Sooty Tern

Single individuals were picked up at Wapenamanda and Mt. Hagen on the morning of 29 June 1967, evidently members of a flock lost while flying across New Guinea the previous night (N.G.B.S. Newsletter, No. 23, p. 2, Sept. 1967).

COLUMBIDAE: PIGEONS

Diets of New Guinea Pigeons

The genera of New Guinea pigeons differ in diet. *Ptilinopus, Megaloprepia,* and *Ducula* take only fruit whose flesh is soft enough to crush between one's fingers, and the stomachs of these genera never contain gravel. The size of fruit eaten varies with the size of the bird, from 6 mm in diameter for the smallest *Ptilinopus* to 50 mm for the largest *Ducula.* In *Columba, Macropygia, Reinwardtoena, Chalcophaps, Gallicolumba, Caloenas,* and *Otidiphaps* the stomach often or usually contains gravel, sand, or stones (up to 10 mm in diameter in *Caloenas* and *Otidiphaps*). Correspondingly, the diet of these genera consists of hard fruit, nuts, and seeds, occasionally supplemented by insects in *Chalcophaps* and *Gallicolumba.* The stomach wall of *Caloenas* is especially thick and muscular.

Niche Differences in Genus *Ptilinopus*

In the Papuan region there occur 13 species of *Ptilinopus,* of which nine range virtually over the entire island of New Guinea, one is confined to the north coast (*P. viridis*), and three fail to reach, or else barely reach, the main island of New Guinea. All are mainly green in color, medium-sized to small, arboreal, and live on soft fruit. The vocalizations of all 10 species with which I am familiar are a confusingly similar series of low "coo's" or "hoo's". Above 5,000 ft one encounters only one species (*P. rivoli*) or occasionally two (*P. rivoli* plus *P.*

ornatus). At lower elevations it is the rule to find several species locally sympatric. For instance, combining results from the three prewar Archbold Expeditions and my three expeditions, species lists were available for a total of 29 localities at elevations of 4,000 ft or less. At three localities, six *Ptilinopus* species were present; at four localities, five species; at five localities, four species; at nine localities, three species; at seven localities, two species; and at one locality, one species. Several species are regularly seen in a single fruit tree. Table 4 indicates the species present at each of my eight best-studied collecting localities in the Eastern Highlands.

Size differences are a major factor that make this degree of local sympatry possible. Thus, approximate average weights of the 10 New Guinea mainland species are: *P. nanus,* 50; *P. pulchellus,* 75; *P. coronulatus,* 75; *P. iozonus,* 110; *P. superbus,* 125; *P. viridis,* 125; *P. aurantiifrons,* 140; *P. rivoli,* 155; *P. ornatus,* 165; and *P. perlatus,* 240. The five species that occur regularly at Karimui (*P. nanus, P. pulchellus, P. superbus, P. ornatus, P. perlatus*) have weights that successively increase by a factor of about 1.5 (50, 75, 125, 165, 240). Two small species with the same weight, *P. pulchellus* and *P. coronulatus,* have locally complementary distributions so that both rarely occur at the same locality. Other ecological differences are that *P. ornatus* and *P. perlatus* have altitudinal distributions which largely exclude each other; that the local distributions of *P. ornatus* and *P. superbus* in hill forest (below *P. rivoli,* above most of the other species) tend to be complementary; that *P. iozonus* and *P. perlatus* are more characteristic of second-growth and the forest edge than the other species; and that *P. superbus* had a synchronized peak of breeding in my study areas at a time when all its congeners at the same elevation were in nonbreeding condition. However, much remains to be learned about ecological sorting within this genus.

TABLE 4

LOCAL DISTRIBUTION OF SPECIES OF *Ptilinopus* FRUIT DOVES[1]

	P. superbus	*P. pulchellus*	*P. rivoli*	*P. nanus*	*P. ornatus*	*P. perlatus*
Awande (6,000 ft)			x			
Mt. Michael (ca. 8,000 ft)			x			
Mt. Karimui (5,000-7,000 ft)			x		x	
Okasa (ca. 4,000 ft)	x		x (rare)		x	
Sena River (4,500 ft)	x					
Karimui (3,650 ft)	x	x	x (rare)	x	x	x
Bomai (3,250 ft)		x	x (rare)			
Soliabeda (2,000 ft)		x		x	x	

[1] The table indicates which *Ptilinopus* species were present at each of my eight best-studied collecting localities in the Eastern Highlands.

Ptilinopus superbus superbus (Temminck)

Superb Fruit Dove

NATIVE NAME. Daribi: ai.
SPECIMENS EXAMINED. Karimui: 2 ♂ (29 July 1964; 3 July 1965). Okasa: 7 ♂ (22-25 June 1965).
WEIGHT. 6 ♂: 114, 119, 122, 124, 128, 132.
WING. 4 ♂: 123, 127, 130, 135.
STOMACH CONTENTS. Fruit, 7-26 mm. in diameter.

BREEDING. All of the specimens were males, and all had greatly enlarged gonads. One female was observed at Karimui and another at the Sena River but none at Okasa, where males were particularly numerous. Perhaps the females at Okasa were remaining out of sight on nests, unless the males arrive before the females.

At the Sena River in 1964 I found a nest 3 ft off the ground in a low bush 30 ft from the river. It was a flimsy stick construction containing one white egg measuring 29 x 18 mm. This nest and the enlarged testes of the specimens suggest that the peak of breeding occurred in the dry season at Okasa, Karimui, and the Sena River both in 1964 and 1965. Most other fruit eating species were not breeding at this time (p. 85).

DISCUSSION. *Ptilinopus superbus* was the commonest *Ptilinopus* at Okasa and the only one on the Sena River, but was quite uncommon at Karimui and absent at Soliabeda and on Mt. Karimui. In general, I have found *P. superbus* characteristic of forest on hill slopes up to about 4,500 ft, largely below the altitudinal range of *P. rivoli*. Its main competitor on the hill slopes is *P. ornatus*, which is more rigidly tied to this habitat but is usually found in localities where *P. superbus* is absent or uncommon. *P. superbus* occurs irregularly in second-growth and agricultural areas up to about 5,000 ft. It also extends to sea level, where it comes into competition with other *Ptilinopus* species.

The male displays to the female while standing on a branch, by puffing up his breast feathers and orange collar, spreading the wings, flaring the tail to show the light terminal band, and uttering a rasping sound.

VOICE. The distinctive slow call consists of a single note with an "m" sound, followed after a 2-sec pause by a series of three to six identical upslurs at 1-sec intervals.

Ptilinopus pulchellus pulchellus (Temminck)

Beautiful Fruit Dove

SPECIMENS EXAMINED. Karimui: 2 ♂, 1 ? (29 July 1964; 1 and 17 July 1965). Bomai: 1 ♂ (7 July 1965). Soliabeda: 4 ♂ (22-27 July 1965). Mt. Karimui Zone

1: 1 ♂ (11 Aug. 1965); Zone 2: 1 ♂ (14 Aug. 1965).
WEIGHT. 8 ♂: 55-85 (76 ± 11).
WING. 9 ♂: 105-109 (108 ± 2).
STOMACH CONTENTS. Fruit, 7-16 mm in diameter.

TAXONOMY. Of the nine specimens sexed, seven had the testes small, while two (Mt. Karimui Zone 2 and Karimui 17 July 1965) had the testes somewhat enlarged. It is remarkable that only males were collected (females are indistinguishable from males in the field).

DISCUSSION. *Ptilinopus pulchellus* was fairly common at Karimui and Soliabeda in trees of forest, second-growth, and gardens, and Schodde and Hitchcock also found it at Lake Kutubu. It is generally distributed elsewhere in New Guinea in forest up to about 2,000 ft, occasionally (as at Karimui) somewhat higher. Its ability to coexist with several other species of *Ptilinopus* in this range is probably associated with its smaller size.

One other New Guinea species of *Ptilinopus, P. coronulatus,* has approximately the same size (weight and wing length) as *P. pulchellus.* The local distributions of these two species complement each other to a striking degree. Thus, on the southern slopes of the Eastern Highlands and on the upper Fly River *P. pulchellus* is present, *P. coronulatus* absent, while on the northern slopes of the Eastern Highlands, on the Sepik River, and on the lower Fly River *P. coronulatus* is present, *P. pulchellus* absent. Out of 23 low-altitude collecting stations of the three prewar Archbold Expeditions, 13 supported only *P. coronulatus,* six only *P. pulchellus,* and only four supported both species. On the Vogelkop the Denison-Crockett expedition took *P. pulchellus* at three localities, took *P. coronulatus* at five different localities, and found no locality supporting both species, although all these camps were within 100 miles of each other and most were within 10 miles. There must be some common denominator to the localities supporting one species rather than the other, but I cannot discern what it is.

Ptilinopus coronulatus subsp.

Little Coroneted Fruit Dove

In Baiyer and Lai Gorges on the northern slopes of the Eastern Highlands, Bulmer collected three specimens of this species at 2,000-3,000 ft in October 1955. As discussed under the previous species, its local distribution largely complements that of the similar sized *P. pulchellus.*

Ptilinopus rivoli bellus Sclater

White-breasted Fruit Dove

NATIVE NAMES. Fore: túbi. Gimi: túbi. Daribi: birísigi.

SPECIMENS EXAMINED. Awande: 1 ♂ (26 June 1964). Okasa: 1 ♂ (23 June 1965). Mt. Michael: 1 ♂, 2 ♀, 1 imm. ♂ (4-8 July 1964). Karimui: 1 imm. ♂, 1 ♀ (3 and 5 Aug. 1965). Mt. Karimui Zone 3: 3 ♀; Zone 4: 1 ♂, 1 ♀ (16-28 Aug. 1965).

WEIGHT. 3 ♂: 134, 145, 188. 5 ♀: 139, 141, 142, 152, 166.

WING. 2 ♂: 143, 148. 4 ♀: 133, 134, 136, 137.

STOMACH CONTENTS. Fruit, 6-20 mm in diameter.

BREEDING. The Okasa male, and one male and one female from Mt. Karimui Zone 4, had enlarged gonads. The nest is a flimsy stick construction with one egg.

DISCUSSION. This is the characteristic *Ptilinopus* of mountain forest from about 4,500 to 8,000 ft, occasionally to 9,000 ft, and was fairly common at all my montane collecting stations. In addition, I obtained four records from lower elevations: one collected at 4,200 ft at Okasa, two collected at Karimui (3,650 ft), and an adult male seen at Bomai (3,250 ft). In most of its altitudinal range *P. rivoli* is the sole species of its genus except for occasional localities where *P. ornatus* is present. Only the lowest part of its normal range is shared with *P. superbus*. The few individuals that straggle below 4,000 ft (e.g., to Karimui and Bomai) are greatly outnumbered by several species of congeners at these localities.

Single individuals or pairs frequent the middle- and upperstories of the forest interior, infrequently venturing into trees of second-growth. Up to four birds may be seen simultaneously in a fruit tree. When perched motionless and silently, which is to say most of the time, their green plumage renders them hard to locate in the leafy crowns of tall trees.

VOICE. A series of upslurred "hoo's," falling in pitch and greatly accelerating as the series progresses. Other species of *Ptilinopus* (*P. perlatus, P. aurantiifrons, P. iozonus*) have calls to which this same description applies, but in no other species is the acceleration so marked. Also, softer and slower single "hoo's" or pairs of "hoo's," each "hoo" initially rising, then usually falling, in pitch.

Ptilinopus nanus nanus (Temminck)

Least Fruit Dove

SPECIMENS EXAMINED. Soliabeda: 1 ♀ (25 July 1965).

WEIGHT. 48.5.

WING. 85.

TAXONOMY. The length of the wing agrees with that of the few other available females of *P. n. nanus*, the New Guinea race (84-88 mm). Females of *minimus* from the western Papuan islands have a wing length of 80-81 mm.

DISCUSSION. On two occasions I observed one or several individuals in a tall fruit tree also frequented by *P. ornatus* and *Megalo-*

prepia magnifica in the forest at Soliabeda. I also saw a pair in a tall tree at the edge of the forest at Karimui on 11 Sept. 1965. There are no other Eastern Highlands records. This is the smallest and rarest wide-ranging New Guinea *Ptilinopus,* known only from a handful of scattered localities and specimens in the lowlands.

VOICE. A slow, repeated, disyllabic upslur "koo-uh."

Ptilinopus ornatus kaporensis Rothschild and Hartert

Ornate Fruit Dove

NATIVE NAME. Daribi: búma.

SPECIMENS EXAMINED. Soliabeda: 3 ♂, 1 ♀ (25 and 26 July 1965). Karimui: 4 ♂, 1 ♀, 1 ? (2 and 3 Aug. 1965).

WEIGHT. 7 ♂: 142, 157, 162, 166, 169, 178, 185. 2 ♀: 161, 165. 1 ?: 149.

WING. 6 ♂: 144, 145, 151, 151, 154, 155. 1 ♀: 146. 1 ?: 149.

STOMACH CONTENTS. Fruit, 13-19 mm in diameter.

TAXONOMY. Racial differences in populations of this species from the main body of New Guinea (exclusive of the Vogelkop) form a cline around the periphery of the island, broken in the west at the Vogelkop, where the nominate race *ornatus* is quite distinct in possessing a purple crown. The opposite extremes in this cline fall in northern New Guinea (assigned to *P. o. gestroi*) and in southwestern New Guinea (*P. o. kaporensis*), birds from the southeast (topotypical *gestroi*) being intermediate but closer to the northern populations. The distinguishing characters are the color of the breast (darker and browner in *kaporensis,* lighter and more orange in *gestroi*) and the color of the band on the upper back and neck (darker, browner, and more richly colored, nearly chocolate, in *kaporensis;* lighter and more olive suffused with orange in *gestroi*). Material available for comparison included *gestroi* from the northern slope of the Snow Mountains, topotypical *gestroi* from southeastern New Guinea, and *kaporensis* from the upper Fly River and from Mt. Goliath (southern slope of Snow Mountains) but no topotypical *kaporensis* (Onin Peninsula, southwestern New Guinea). The specimens from the southern slope of the Eastern Highlands, which geographically are intermediate between southeastern New Guinea and the Fly River or Mt. Goliath, have the breast darker and browner than any of the comparative material, and this probably means darker and browner even than the type of *kaporensis,* which Rand (1942b) found to compare well with the Fly River specimen and most of the Mt. Goliath specimens. In the color of the band on the back and neck, however, the Eastern Highlands birds agree well with Mt. Goliath and Fly River *kaporensis.* The affinities of the Eastern Highlands birds are thus with *kaporensis* to the west, not with *gestroi* to the east.

BREEDING. The gonads of all specimens were small.

DISCUSSION. The characteristic habitat of *P. ornatus* is forest of the hill slopes up to 4,500 ft, ranging down occasionally to the base of the hills and infrequently reaching the flat country at sea level. The slightly smaller *P. superbus* is also characteristic of hill forest but, in contrast to *P. ornatus,* is also found frequently in the flat lowlands. The distributions of *P. superbus* and *P. ornatus* in the hill forest may to some extent complement each other, as do those of the smaller *P. pulchellus* and *P. coronulatus* in the lowlands. For instance, *P. ornatus* was common at Soliabeda and Karimui, quite uncommon at Okasa, and absent at the Sena River, while *P. superbus* was absent at Soliabeda, quite uncommon at Karimui, and common at the Sena River and Okasa.

In addition, I saw *P. ornatus* once at 6,500 ft in moss forest on Mt. Karimui, separated by 3,000 vertical feet from the population on the floor of the Karimui Basin. There are at least five other instances of detached populations of *P. ornatus* at altitudes well above its usual upper limit (ca. 4,500 ft): 7,100 ft in heavily mossed forest on the northern slope of the Snow Mountains (Rand, 1942b), 5,200 ft in moss forest on Mt. Menawa in the North Coastal Range (my 1966 expedition), Bijenkorf on the southern slope of the Snow Mountains (Junge, 1937), and the camps of Lord Rothschild's collector, A. S. Meek, on Mt. Goliath in the Snow Mountains and on the upper Angabunga River in southeastern New Guinea. The only other species of *Ptilinopus* at all six of these high-altitude localities was *P. rivoli,* which weighs approximately the same as *P. ornatus.* How *P. ornatus* and *P. rivoli* sort out ecologically in these high-altitude areas of local sympatry is unknown.

VOICE. A low, repeated, soft "mm."

Ptilinopus perlatus zonurus Salvadori

Pink-spotted Fruit Dove

SPECIMENS EXAMINED. Karimui: 4 ♂, 3 ♀ (2-5 Aug. 1965).
WEIGHT. All specimens weighed more than 210 g.
WING. 3 ♂: 154, 157, 157. 3 ♀: 150, 152, 155.

BREEDING. All specimens had small gonads.

DISCUSSION. At Karimui this species and its smaller relative *P. ornatus* were the two commonest species of *Ptilinopus* and fed together in the same fruit trees. The two species are very similar in pattern and are more closely related to each other than either is to any other species. However, their typical altitudinal and habitat preferences are totally distinct, and their occurrence together at Karimui is exceptional. Whereas *P. ornatus* is usually found on the hill slopes and rarely reaches sea level, *P. perlatus* is usually confined to the lowlands, and Karimui represents an altitudinal record for it. At the lower elevation of Lake Kutubu (2,450 ft) Schodde and Hitchcock found *P. perlatus* very common but did not obtain *P. ornatus*. In my experience, *P. perlatus* is characteristic of second-growth trees and the forest edge rather than the interior of primary forest. Its occurrence in the lowlands is quite local, and it must be considered the least common widespread New Guinea *Ptilinopus,* except for *P. nanus.*

VOICE. A series of low, downslurred "hoo's," delivered at a rate slightly less than one per second. The rate is either constant, or else accelerates slightly but by much less than does the similar call of *P. rivoli.* Also, a very soft single "hoo" dropping in pitch at the end, with or without an initial rise in pitch.

Megaloprepia magnifica interposita Hartert

Magnificent Fruit Dove or Wompoo Pigeon

NATIVE NAME. Daribi: somagoí.

SPECIMENS EXAMINED. Karimui: 5 ♂, 5 ♀ (10 July, 15 July, 3-5 Aug., 11 Sept. 1965); 1 ? (15 Aug. 1964). Soliabeda: 1 ♂, 1 ♀ (22 and 28 July 1965).

WEIGHT. 6 ♂: 180, 192, 201, $>$210, $>$210, $>$210. 5 ♀: 175, 177, 182, 182, $>$210.

WING. 6 ♂: 163-175 (167 $\pm$ 5). 6 ♀: 158-171 (163 $\pm$ 4).

STOMACH CONTENTS. Fruit, 9-22 mm in diameter.

TAXONOMY. The races to which this Eastern Highlands material is related are *poliura* (southeastern New Guinea), *assimilis* (Cape York Peninsula, Australia), and *interposita* (type locality the Wandammen Peninsula of northwestern New Guinea, also southwestern New Guinea from the Onin Peninsula to the Fly River). In the deep, bright yellow color of the undertail coverts the Eastern Highlands specimens resemble the type of *interposita* and Fly River birds, whereas the undertail coverts of *poliura* from southeastern New Guinea are paler and duller. The wing spots of *poliura* are brighter yellow, those of *interposita* from the Wandammen Peninsula, Weyland Mountains, and southern slopes of the Snow Mountains are more whitish; Fly River and Eastern Highlands birds are intermediate in this respect. The breast is lightest and reddest in *poliura,* deeper and more purple in *interposita* from southwestern New Guinea and the type of *interposita,* and still deeper and more purple in Fly River and Eastern Highlands birds. In Australia *Megaloprepia magnifica* becomes more purple ventrally and larger as one proceeds from the Cape York Peninsula (*assimilis*) through northern Queensland (*keri*) to southern Queensland and New South Wales (*magnifica*). The race *assimilis* is close to Fly River and Eastern Highlands birds in the purple color of the breast but is larger. My measurements of the wing yield 4 ♂ 172-188 (182 $\pm$ 7), 3 ♀ 176-181 (179 $\pm$ 3) for *assimilis,* whereas Fly River birds are the same size as Eastern Highlands birds: 5 ♂ 162-173 (167 $\pm$ 5), 5 ♀ 158-162 (162 $\pm$ 4).

In explanation of these characters, it may be recalled that lower sea levels during parts of the Pleistocene created a land bridge, now covered by the shallow Torres Straits, between the Cape York Peninsula of Australia and the Fly River bulge of southern New Guinea. The distributions of numerous New Guinea birds and mammals attest to the earlier existence of this bridge (Tate, 1952; Keast, 1961). Across this bridge the New Guinea and Australian populations of *Megaloprepia* would have been continuous, and the Fly River bulge would have been a meeting point not only of *poliura* and *interposita* but of *assimilis* as well. It seems unwise to dismember these clines further, and the Eastern Highlands population is therefore best assigned to *interposita,* since it agrees most closely with this race. The details are however of zoogeographical interest and may be briefly summarized: Fly River and Eastern Highlands birds are rather different from the southeastern race *poliura* and stand closest to the western race *interposita,* from which they deviate in having a darker, more purple breast (*assimilis* genes) and yellower wing spots (*poliura* genes).

BREEDING. Two specimens taken on 11 Sept. 1965, both males, had enlarged testes, and one female, taken on 4 Aug. 1965, had somewhat enlarged ovaries. The other nine specimens sexed (five taken in July, four in early August 1965) had small gonads. This seems to suggest breeding recommencing at the end of the dry season. The nest is a flimsy stick construction on a branch 6-15 ft above the ground, with one white egg.

DISCUSSION. At Karimui and Soliabeda *Megaloprepia* was less common than the commoner species of *Ptilinopus,* with which it shared use of fruit trees in the shaded forest interior while avoiding trees of the forest edge and second-growth. It remained within the shaded lower half of the crowns, whereas species of *Ptilinopus* often chose exposed perches at the tops of trees after feeding. In addition, we heard it once on the lowest part of Mt. Karimui (4,000 ft). It is basically a lowland species, and the only other Eastern Highlands records are from Lake Kutubu (2,450 ft).

VOICE. Three deep, equally-spaced notes on virtually the same pitch, the whole call lasting about 1 sec. So well are the sounds approximated by the syllables "hoo-wa-hoo" that I initially assumed that a man was calling in the forest, and it did not even occur to me to consider the possibility that it might be a bird.

Ducula pinon jobiensis (Schlegel)

Pinon Imperial Pigeon

DISCUSSION. Bulmer collected one specimen of this lowland species at 2,000-3,000 ft in the Baiyer Gorge.

VOICE. Very low-pitched notes, in either of the two patterns depicted in Figure 13 (p. 133).

Ducula rufigaster rufigaster (Quoy and Gaimard)

Purple-tailed Imperial Pigeon

SPECIMENS EXAMINED. Karimui: 1 ? (30 July 1964). Soliabeda: 1 ♂ (30 July 1965).
WING. 1 ♂: 193. 1 ?: 202.
STOMACH CONTENTS. Fruit.

TAXONOMY. The race *pallida* was separated on the grounds that "birds from the south slopes of the Oranje Mountains differ from all other populations by the decidedly paler breast and abdomen" (Junge, 1952, p. 248) and was also characterized as larger than nominate *rufigaster* (Rand and Gilliard, 1968, p. 173). Five specimens collected by Meek on the Setekwa River, 50 miles west of the type locality of *pallida* (Noord River), do not appear to me paler ventrally than other New Guinea populations. The average wing lengths of 11 populations from various parts of New Guinea, including the population from the Setekwa River, all fall between 192 and 199 mm, with a spread of 10 to 25 mm in each population. Thus, the distinctness of *pallida* from *rufigaster* seems doubtful.

BREEDING. The testes of the male were small.

DISCUSSION. At Karimui and Soliabeda this pigeon was quite uncommon, solitary, and usually seen perched motionless in the middlestory of the shaded forest interior, occasionally at the forest edge.

Ducula chalconota smaragdina Mayr

Red-breasted Imperial Pigeon

NATIVE NAMES. North Fore: kintánamu. South Fore: mímpi. Gimi: mípi.
SPECIMENS EXAMINED. Miarosa: 1 ♀ (17 June 1964). Awande: 1 ♂ (19 June 1965). Mt. Michael: 1 ♂, 2 ♀ (2-12 July 1964).
WING. 2 ♂: 214, 217. 3 ♀: 199, 205, 210.
STOMACH CONTENTS. Fruit.

TAXONOMY. These specimens agree with the race *smaragdina* from the main body of New Guinea, which differs from *D. c. chalconota* of the Vogelkop in having a longer wing and a greener, less purple back. There is some individual variation in the back color, which is particularly green in the Miarosa female, more purple in the Awande male.

DISCUSSION. *Ducula chalconota,* the largest montane pigeon, is the high altitude representative of *D. rufigaster,* occurring uncommonly and as solitary individuals in the middle- and upperstory of forest at about 6,000-8,500 ft. I observed it on Mt. Michael and in the Okapa area, while Gilliard and Bulmer collected it on Mt. Hagen. It was absent on Mt. Karimui.

VOICE. A low quiet, unhurried note "hmmm," either constant in pitch or else upward inflected, given either twice in succession or just once.

Ducula zoeae (Lesson)

Zoe Imperial Pigeon

NATIVE NAME. Daribi: hee.
SPECIMENS EXAMINED. Karimui: 6 ♂, 3 ♀ (11 and 13 Aug. 1964; 9 July-5 Aug. 1965). Soliabeda: 1 ♂, 1 ♀ (21 July 1965).
WING. 6 ♂: 213, 216, 218, 220, 220, 221. 4 ♀: 214, 222, 223, 225.
STOMACH CONTENTS. Fruit, 19-45 mm in diameter.

BREEDING. The 11 Aug. and 13 Aug. males had enlarged testes, and the 5 Aug. female had an enlarged ovary, while the July specimens had small gonads. Thus, breeding may have been commencing towards the end of the dry season, as with *Megaloprepia magnifica*.

DISCUSSION. At all my low-altitude stations up to a ceiling varying locally between 4,000 and 4,700 ft, *Ducula zoeae* was a common species whose characteristic calls were heard daily. Most of its altitudinal range, which extends down to sea level, is shared with its less common congener *D. rufigaster,* but *D. rufigaster* does not extend to quite so high altitudes as does *D. zoeae*. Other records of *D. zoeae* in the Eastern Highlands are at Lake Kutubu (2,450 ft) and at 4,000 ft in the Baiyer Valley.

D. zoeae was usually seen singly or in small numbers, from the middlestory up to the crowns of the tallest trees. Unlike *D. rufigaster* and *D. chalconota* it seemed equally at home at the edge of the forest as in the forest interior. The flight is heavy, and the wing beat slow.

VOICE. A low but resonant series of broken "hoo's." Each "hoo" rises slightly in pitch, lasts somewhat more than 1 sec, and is broken into usually five separate notes: hoo, h-h-h-h-hoo, h-h-h-h-hoo, h-h-h-h-hoo, etc. (Fig. 13).

Gymnophaps albertisii albertisii Salvadori

D'Albertis' Pigeon

NATIVE NAME. Fore: pupúnte. Daribi: búruma.
SPECIMENS EXAMINED. Okasa: 3 ♂ (23 and 24 June 1965). Mt. Michael: 1 ♀ (4 July 1964). Karimui: 1 ♂, 1 ♀ (5 Aug. 1965). Soliabeda: 1 ♀ (22 July 1965).
WING. 4 ♂: 180, 187, 197, 204. 1 ♀: 191.

BREEDING. The Okasa specimens had enlarged gonads, while those from other localities did not.

DISCUSSION. D'Albertis' Pigeon is widely but erratically distributed in the Eastern Highlands, and was present at all my collecting stations except Mengino and Bomai, ranging up to 11,000 ft in stunted moss forest on the summit ridge of Mt. Michael. In the vicinity of mountains it sometimes descends to sea level, but it is usually absent

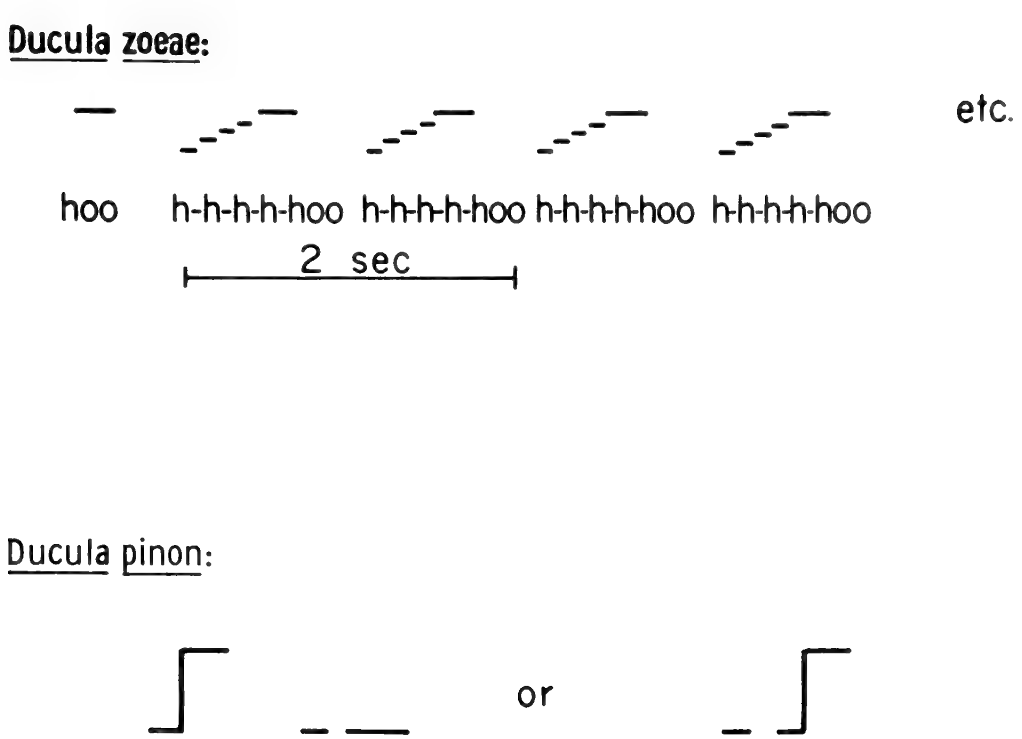


FIG. 13. Voices of *Ducula zoeae* and *D. pinon*.

from the flat lowlands. In contrast to most other pigeons in the hills and mountains of New Guinea, this is a social bird par excellence. I rarely saw a solitary individual, occasionally met pairs, but usually found it in groups of three to 30, the average size being about a dozen. Flocks perch in tall trees of the forest interior, and if disturbed, swiftly circle high over the forest before realighting. In fruit trees they keep to themselves and do not mix with other species of pigeons. A characteristic habit or display is for flocks to fly down a mountain at high speeds along the crest of a steep ridge, dropping thousands of feet in a single dive.

VOICE. I never heard a vocalization.

Columba vitiensis halmaheira (Bonaparte)

White-throated Pigeon

In New Guinea this appears to be a scarce species; the only Eastern Highlands record comes from Nondugl, where Gyldenstolpe collected one specimen from a small flock.

Macropygia amboinensis kerstingi Reichenow

Amboina Cuckoo-dove

NATIVE NAMES. Fore: kubótya. Gimi: kubófa. Daribi: búbe.
SPECIMENS EXAMINED. Awande: 2 ♀ (16 and 18 June 1965). Okasa: 3 ♂, 3

♀ (23-25 June 1965). Mt. Michael: 1 ♀ (13 July 1964). Karimui: 3 ♂, 1 ♀ (9 July-3 Aug. 1965). Soliabeda: 1 ♂, 2 ♀, 1 ? (21-25 July 1965). Mt. Karimui Zone 1: 3 ♂ (9-11 Aug. 1965).

WEIGHT. 9 ♂: 131-179 (149 ± 17). 8 ♀: 107-158 (136 ± 17).

WING. 7 ♂: 158-170 (167 ± 4). 7 ♀: 143-171 (161 ± 10).

STOMACH CONTENTS. Gravel and ground-up fruit.

TAXONOMY. As previous observers have noted, series of this species from the same locality show great individual variation. The legs are bright purple, bright red-purple, bright carmine, or bright pink in most adult males, dull dark brick-brown in one adult male and in immature males, and dull purple, dull brick-red, or dull dark brick-brown in females. The bill is pale flesh, light horn-colored, dark horn-colored, gray-brown, dark gray, or completely black, and this variation does not correlate with sex or other characters. The amount of barring on the back, neck, cheeks, and breast of adult females and immature males is variable. There is no consistent variation in size or in weight with altitude. This large and inadequately understood individual variability reinforces the doubts expressed by previous authors (Gyldenstolpe, 1955; Gilliard and LeCroy, 1961) whether the race *kerstingi* can be maintained as distinct from *cinereiceps*. When comparison is restricted to adult males, specimens from northern New Guinea (*kerstingi*) have slightly darker backs than material from the D'Entrecasteaux Archipelago, the type locality of *cinereiceps*. My Eastern Highlands series is nearer *kerstingi,* less dark dorsally, but darker ventrally, as Rand (1942a) noted for Fly River *kerstingi*. Southeastern New Guinea specimens are nearer *cinereiceps*.

BREEDING. Gonads were small in most specimens, except that they were slightly enlarged in two females and one male from Okasa, and in one male each from Karimui and Mt. Karimui.

DISCUSSION. *Macropygia amboinensis* occurred at all of my Eastern Highlands collecting stations except Bomai and the higher elevations on Mts. Michael and Karimui, and has also been collected by most other workers in the Eastern Highlands. The ecological diferenecs between *M. amboinensis* and *M. nigrirostris* are complex. Both species may be found from the mountains down to sea level, and the habitat of both has been recorded as forest or second-growth, depending upon the locality. Their local distributions tend to be, but are not strictly, complementary, such that only one of the two is common at a particular location. Detailed consideration of my distributional records and the published records of others suggests the following correlations: (1) The most clear-cut difference is that there are practically no records of *M. amboinensis* in deep primary forest above about 5,000 ft, whereas *M. nigrirostris* occurs in forest up to altitudes varying between 7,000 and 9,000 ft, frequently into the mossy zone. For instance, *M. nigrirostris* is the only species in forest above 5,000 ft on Mt. Karimui in my experience and on Mts. Wilhelm, Kubor, and Hagen (Mayr and

Gilliard, 1954). (2) *M. amboinensis* is the dominant species in trees of open country cleared by man (native gardens, isolated casuarina stands in grassland, edge of the forest) above 5,000 ft. This is the case at Miarosa and the base of Mt. Michael (present study) in the Wahgi Valley of the Eastern Highlands (Mayr and Gilliard, 1954), and in the Baliem Valley of western New Guinea (Rand, 1942b). Thus, like many other lowland species, *M. amboinensis* has been able to spread upward into areas cleared by man. (3) Below 5,000 ft *M. amboinensis* is the dominant species of the forest, as at Okasa, Soliabeda, the lower slopes of Mt. Karimui up to 4,500 ft, and many other localities. The exclusion of *M. nigrirostris* from the forest at low altitudes is certainly not complete, but where *M. nigrirostris* is common below 5,000 ft, it seems generally to be in second-growth, as around Karimui station (3,650 ft) and at Lake Kutubu (2,450 ft). The size difference may play a role in making possible the local sympatry at lower elevations, since *M. amboinensis* is about 1.7 times as heavy as *M. nigrirostris.*

M. amboinensis was generally seen as solitary individuals or pairs in the middlestory of trees, not in the crown. Some practice is required to distinguish it in the field from *M. nigrirostris.* The green-naped, light-breasted males of *M. amboinensis* are easily identified in good light. Females and immatures are more difficult to recognize, but *M. nigrirostris* is smaller and its brown of a richer hue. The vocalizations of the two species are very distinct.

VOICE. A series of doubled-noted hoots delivered at the rate of one to two per second. The two notes of each hoot are connected; the second note is about a major third in pitch higher than the first and is accented. Successive hoots do not vary at all in pitch (Fig. 14). Some calls of *Reinwardtoena reinwardtsi* are nearly indistinguishable.

Macropygia nigrirostris nigrirostris Salvadori

Black-billed Cuckoo-dove

NATIVE NAMES. Fore: píripíri. Daribi: búbe.

SPECIMENS EXAMINED. Awande: 3 ♂, 2 ♀ (16-18 June 1965). Okasa: 1 ♀ (24 June 1965). Karimui: 7 ♂, 3 ♀ (3 July-5 Aug. 1965). Mt. Karimui Zone 1: 2 ♂ (11 and 12 Aug. 1965); Zone 2: 1 ♂ (5 Sept. 1965).

WEIGHT. 13 ♂: 68-104 (91 ± 11). 6 ♀: 66-104 (88 ± 14).

WING. 8 ♂: 139-153 (145 ± 5). 4 ♀: 144, 145 (3).

STOMACH CONTENTS. Gravel and ground-up fruit.

TAXONOMY. While both *Macropygia amboinensis* and *M. nigrirostris* have quite variable plumage, two features by which they may be distinguished in any plumage are that the uppertail is always barred in *M. nigrirostris,* never in *M. amboinensis;* and that the bill of *M. nigrirostris* is stouter.

In the present series the pattern of variation is as follows. Adult males have the dorsal surface of the tail barred, the lower back some-

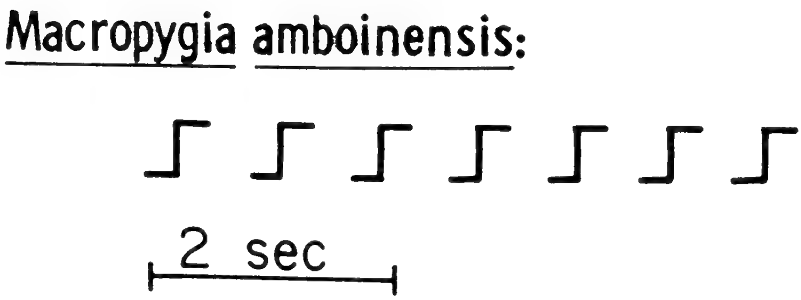


FIG. 14. Voice of *Macropygia amboinensis,* and one of the two common calls of *Reinwardtoena reinwardtsi* (virtually indistinguishable from call of *Macropygia amboinensis*).

times faintly barred, the remainder of the plumage totally unbarred. Adult females have not only the uppertail but also the whole back and breast barred. Barring in immatures of both sexes is distributed as in the adult female but is heavier, and Gilliard and LeCroy, (1967, p. 194) have pointed out detailed differences in barring patterns between adult females and immatures. The legs are bright pink or bright reddish purple in adult males, dull brick-red in adult females and immatures. The bill is black in adult males, a horn-color of varying depth in adult females and immatures.

BREEDING. The gonads were enlarged in two of the three Mt. Karimui specimens but in no other material.

DISCUSSION. The ecological differences between this species and *M. amboinensis* have been discussed under *M. amboinensis.* In the ecologically disturbed area around Karimui Patrol Post (3,650 ft) *M. nigrirostris* was commoner than *M. amboinensis.* It was absent from the primary forest of Mt. Karimui between 4,500 and 6,500 ft but reappeared in the moss forest at 6,500-7,600 ft.

VOICE. Quite different from *M. amboinensis,* and more reminiscent of *Ptilinopus:* a quiet series of about a dozen muted "coo's" at the rate of three or four per second, initially rising and then dropping in pitch, slightly decreasing in volume, and with no change in tempo (unlike most species of *Ptilinopus,* which accelerate).

Reinwardtoena reinwardtsi griseotincta Hartert

Great Cuckoo-dove

NATIVE NAMES. Fore: ébiye. Gimi: yukiba. Daribi: yúguri.

SPECIMENS EXAMINED. Karimui: 1 ? (12 July 1965). Bomai: 1 ♀ (6 July 1965). Mt. Karimui Zone 1: 1 ♀ (9 Aug. 1965); Zone 3: 1 ♂ (16 Aug. 1965).

WEIGHT. 1 ♀: 208. 1 ♂, 1 ♀, 1 ?: >210.

WING. 1 ♂: 242. 2 ♀: 214, 236. 1 ?: 228.

BREEDING. The gonads of all specimens were small. A male was collected on a nest of sticks 15 ft above the ground, containing a single white egg measuring 40×25 mm.

DISCUSSION. This species is fairly widespread at almost all elevations in the Eastern Highlands but is everywhere uncommon. A sighting in Zone 6 of Mt. Karimui was in moss forest, and Gilliard found *Reinwardtoena* up to 11,000 ft in moss forest on Mt. Hagen. All my sightings were of solitary individuals 10-40 ft above the ground; some were in deep forest, some at the edge of forest, and one in second-growth. The long tail and notably slow wing beat make the flight of this graceful pigeon a joy to watch.

VOICE. There are two distinct calls: a series of disyllabic hoots virtually identical to the call of *Macropygia amboinensis* (Fig. 14, p. 136); and a single note followed by a rapid series of a dozen notes dropping in pitch, suggesting laughter.

Chalcophaps stephani stephani Pucheran

Stephan's Ground Dove

SPECIMENS EXAMINED. Karimui: 1 ♂, 1 ♀ (16 July and 3 Aug. 1965).
WEIGHT. 1 ♂: 126. 1 ♀: 120.
WING. 1 ♂: 144. 1 ♀:138.
STOMACH CONTENTS. Fruit, seeds, and gravel.

TAXONOMY. These two specimens are darker, more lavender-gray, and less brown on the breast than other New Guinea material. The darkness is in conformity with the general trend at Karimui.

BREEDING. The gonads of the male were much enlarged. A nest was located 30 ft above the ground in a fork of a tree.

DISCUSSION. I have no other records than the two specimens. At Lake Kutubu (2,450 ft) Schodde and Hitchcock found this species to be the common ground dove of second-growth and the forest edge, while *Gallicolumba jobiensis* was common in primary forest. Elsewhere in New Guinea *Chalcophaps stephani* mainly occurs near sea level.

VOICE. A series of faint notes delivered at a rate of 3-4 notes per second and lasting 8-15 sec. Towards the end of the series the notes rise slightly in pitch and become slightly louder.

Gallicolumba rufigula alaris Rand and *G. r. septentrionalis* Rand

Red-throated Ground Dove

NATIVE NAME. Daribi: pómo.
SPECIMENS EXAMINED. Karimui: 1 ♂ (11 Aug. 1964); 1 ♀ (6 Aug. 1965).
WEIGHT. 1 ♀: 121.
WING. 1 ♂: 136. 1 ♀: 132.
STOMACH CONTENTS. Fruit and some insects.

TAXONOMY. When compared with *alaris* from the Fly River (including the type) and Setekwa River, the two Karimui specimens differ somewhat in being darker on the back and especially darker on the nape, but they share the most distinctive character of the race, the absence of the gray area on the side of the head. The gray edges of the upperwing coverts are comparable to those in Setekwa River birds, and broader and grayer than in Fly River birds. The races *orientalis* (southeastern New Guinea), *septentrionalis* (northern New Guinea), and nominate *rufigula* (Vogelkop) all differ in possessing a gray area on the head. In addition, the gray edges of the wing coverts are narrower in *septentrionalis,* broader in nominate *rufigula,* and duller and less distinct in *orientalis* than in the Karimui birds. The race *helviventris* of the Aru Islands agrees in lacking the head patch but has the covert edgings much more vinaceous. Northern watershed specimens from the Jimmi Valley were assigned to the northern race *septentrionalis* by Gilliard and Gyldenstolpe, and Gyldenstolpe (1955) specifically mentioned the presence of a well-defined gray area on the side of the head.

When examined in March 1966, the two Karimui specimens still had the breast quite distinctly washed with yellow-orange, but this wash was completely absent in prewar material. Rand (1941a) commented previously on the rapid postmortem fading of this wash.

BREEDING. The gonads of the male were much enlarged.

DISCUSSION. Both specimens were collected while on the ground in forest. Karimui natives are familiar with the species, but it is evidently quite uncommon and shy. Like *G. beccarii, G. rufigula* becomes locally abundant when wild bamboo produces seeds.

VOICE. A very faint, upwards inflected "br-r-r-r-r," easily overlooked or mistaken for a frog.

Gallicolumba beccarii beccarii (Salvadori)

Beccari's Ground Dove

NATIVE NAME. Fore: mánumu.

SPECIMENS EXAMINED. Awande: 2 ? (21 June 1964, and 19 June 1965). Mengino: 1 ♂ (16 July 1964). Mt. Karimui Zone 4: 1 ♀ (30 Aug. 1965); Zone 8: 1 ♂ (10 Sept. 1965).

WEIGHT. 1 ♀: 59. 1 ?: 56.

WING. 1 ♀: 105. 2 ?: 105, 109.

STOMACH CONTENTS. Gravel and seeds.

DISCUSSION. This species is widespread but usually uncommon in montane forest between about 5,000 and 9,000 ft, and is generally the sole species of ground dove at these altitudes. It lives on the ground in the forest and is quite shy (all my specimens were netted). Paran told me that about once a decade, when the wild bamboo produces seeds, *G. beccarii* appears in enormous numbers at Awande to eat the seeds and to nest.

Gallicolumba jobiensis jobiensis (Meyer)

White-breasted Ground Dove

SPECIMENS EXAMINED. Karimui. 2 ♂, 2 ♀, 1 ? (3 July-5 Aug. 1965).
WEIGHT. 2 ♂: 132, 158. 2 ♀: 126, 131. 1 ?: 154.
WING. 2 ♂: 147, 149. 2 ♀: 140, 141.
STOMACH CONTENTS. Fruit, gravel, and insects.

BREEDING. The testes of the two males were slightly enlarged.

DISCUSSION. All the specimens were solitary and on the ground inside the forest.

The distribution of this species seems highly erratic. The five specimens from Karimui suggest that it was uncommon but not rare there. At Lake Kutubu Schodde and Hitchcock found this species to be the common ground dove of the forest interior. Bulmer collected one specimen at 6,700 ft, the Fore said that it occurred at Awande, and a single trapped specimen was brought to Gilliard at Kup at some elevation about 4,000 ft. Most other New Guinea records are from low elevations.

Henicophaps albifrons albifrons Gray

White-capped Ground Pigeon

NATIVE NAME. Daribi: odu.
SPECIMENS EXAMINED. Karimui: 1 ♂ (3 Aug. 1965), 2 ♀ (14 Aug. 1964). Soliebeda: 1 ♀ (23 July 1965).
WING. 1 ♂: 187. 2 ♀: 185, 185.

BREEDING. One of the two 1964 females had an enlarged ovary, but the gonads of the other specimens were small.

DISCUSSION. The two Karimui females were collected together. The Soliabeda female was alone at the top of a tree, and the Karimui male was one of a pair on the ground. My only experience with this uncommon species in the field was with a solitary individual at Soliabeda, flying 10 ft above the ground in partly cut forest with tall trees.

VOICE. The call, delivered from a perch in a tree, is a rapid series of "hoo's" at the rate of 5 per second for 20 sec. The series slightly rises in pitch, and has a hollow quality similar to the voice of *Macropygia nigrirostris* or *Centropus menbeki*.

Otidiphaps nobilis cervicalis Ramsay

Magnificent Ground Pigeon

NATIVE NAMES. Fore: wáibo. Gimi: kwéyo. Daribi: wágari.
SPECIMENS EXAMINED. Awande: 1 ♀ (19 Oct. 1967).
WING. 199.
STOMACH CONTENTS. Ground-up fruit, and pebbles 10 mm in diameter.

TAXONOMY. This specimen agrees with *cervicalis* of southeastern New Guinea, and differs from nominate *nobilis* of western New Guinea, in the light gray rather than iridescent green-purple nape, the dark green rather than dull purple rump, and the deep green rather than deep purple underparts. A native-produced specimen from the Jimmi Valley on the northern slope of the Eastern Highlands was also assigned to *cervicalis* by Mayr and Gilliard (1954).

DISCUSSION. This is a rare and local inhabitant of the forested hill slopes in the Eastern Highlands, ranging occasionally up to 6,000 ft. My only field record was of a call heard at 5,100 ft on Mt. Karimui.

VOICE. A plaintive tremulous, descending whistle lasting 2 sec.

Goura scheepmakeri subsp.

Scheepmaker's Crowned Pigeon

Crowned Pigeons, presumably of this semispecies, were reported to Schodde and Hitchcock as occurring in the Lake Kutubu district.

Goura victoria beccarii Salvadori

Victoria Crowned Pigeon

DISCUSSION. Gyldenstolpe mentions individuals of this northern *Goura* semispecies at Nondugl aviary, captured somewhere on the northern slopes of the Eastern Highlands. Both semispecies of *Goura* are to be expected only at low elevations.

VOICE. A very low "buk-buk-buk."

PSITTACIDAE: PARROTS

Chalcopsitta scintillata chloroptera (Salvadori)

Yellow-streaked Lory

SPECIMENS EXAMINED. Soliabeda: 1 ♂, 1 ♀ (25 July 1965).
WEIGHT. 1 ♂: >210. 1 ♀: 195.
WING. 1 ♂: 170, 1 ♀: 163.

TAXONOMY. Both specimens lack the yellow area in the underwing which is always present in nominate *scintillata* and often reduced or lacking in *chloroptera*. The underwing coverts are entirely green in the Soliabeda male, while in the female they are green for the proximal two-thirds and red for the distal third. This character also places the Soliabeda birds with *chloroptera* and differentiates them from nominate *scintillata*, in which the underwing coverts are largely red.

BREEDING. The testes of the adult male were slightly enlarged.

DISCUSSION. I encountered no individuals of this lowland species besides this pair, and there are no other records from the Eastern Highlands.

The fact that the Soliabeda birds are *chloroptera* reinforces earlier indications that *chloroptera,* originally described from the southeastern coast, may extend in the foothills far west of the easternmost coastal population of *C. s. scintillata* (originally described from the southwest). The localities from which these two races have now been recorded are as follows: nominate *scintillata,* along the southwestern coast from Triton Bay (long. 134°E) east to at least the mouth of the Fly River (long. 143°E); *chloroptera,* on the southeastern coast between long. 146°E and 148°E, and apparently extending westward in the foothills and on the upper reaches of the south coast rivers to Soliabeda (upper Purari drainage, long. 145°E), upper Fly River (one specimen collected by the Second Archbold Expedition, long. 142°E), upper Eilanden River (ca. long. 139°E), and upper Noord River (ca. long. 138°E). Both races show much individual variation (e.g., variable amounts of yellow in the primaries of *chloroptera,* of red in the predominantly green underwing coverts of *chloroptera,* and of green in the predominantly red underwing coverts of nominate *scintillata*). The Noord River population includes typical *chloroptera,* typical nominate *scintillata,* and intermediates. Probably hybridization of the two races is now occurring after a prolonged break in contact at the Fly River, as also seems to be the case with *Psittaculirostris desmarestii.* This would be in keeping with the obvious evolutionary history of the genus *Chalcopsitta* as a superspecies ring in the New Guinea lowlands, with contact between populations having been broken and reestablished a number of times. The genus consists of three virtually allopatric semispecies, whose distributions now form an incomplete circle (broken in the east between Astrolabe Bay and the Kemp Welch River) around the periphery of New Guinea: *C. duivenbodei* on the north coast, *C. atra* in the far west, and *C. scintillata* on the south coast and Aru Islands. The unique type of *C. atra spectabilis* (intermediate between *C. a. insignis* and *C. s. scintillata*) also suggests hybridization between former isolates at at least one other point in the ring besides the Fly River.

Pseudeos fuscata incondita (Meyer)

Dusky-orange Lory

NATIVE NAMES. Fore: páila. Daribi: bú-kínikíni.
SPECIMENS EXAMINED. Karimui: 1 ♂, 1 ♀ (5 Aug. and 11 Sept. 1965).
WEIGHT. 1 ♂: 143.
WING. 1 ♂: 159. 1 ♀: 161.

TAXONOMY. The male is in the red phase, while the female is in an intermediate red-orange phase.

BREEDING. The testes of the male were enlarged.

DISCUSSION. The erratic distribution of this lory in the Eastern Highlands suggests seasonal migration within New Guinea. On none of my visits to the Okapa area (June and August 1964; June 1965; June 1966) did I see it in the field. Yet the Fore were familiar with the "páila" and said that it was numerous in the rainy season (November onward). Several Europeans at Okapa had captive specimens in both the orange and the yellow phases, which the Fore had captured as nestlings. Similarly, the Daribi were familiar with the Dusky Lory under the name of "bú-kínikíni," but I found it rare at Karimui and absent at Soliabeda, Bomai, and Mt. Karimui. In the Wahgi Valley, Gilliard never encountered it on his two visits (both March or April to August), and Gyldenstolpe between August and early November collected only one specimen (late October). Apparently the Eastern Highlands population breeds during the rains and then leaves before the onset of the dry season, perhaps retreating to the coastal lowlands. Other Eastern Highlands records include Lake Kutubu, the Schrader Range, and Kyaka territory. This lory gathers in flocks in flowering trees.

VOICE. A loud, shrill cry quite similar to that of *Trichoglossus haematodus,* but shorter, hoarser, and even more grating.

Trichoglossus haematodus intermedius Rothschild and Hartert

Rainbow Lory

NATIVE NAMES. Fore: k're-'k're. Gimi: k're-k're. Daribi: kínikíni.
SPECIMENS EXAMINED. Mengino: 1 ♂, 2 ♀ (15 July 1964). Karimui: 6 ♂, 6 ♀ (4-15 Aug. 1964; 3 July-11 Sept. 1965). Soliabeda: 2 ♂, 2 ♀ (25-29 July 1965).
WEIGHT. 5 ♂: 127, 129, 135, 137, 142. 4 ♀: 116, 120, 122, 124.
WING. 6 ♂: 143, 143, 144, 144, 145, 146. 7 ♀: 135, 136, 137, 138, 138, 142, 144.
STOMACH CONTENTS. Flowers.

TAXONOMY. This is a variable species, in which each local population shows some distinct features (Cain, 1955). My specimens are closest to *intermedius* from the Wahgi Valley except that the upper belly is less dark green. The race *berauensis* from western New Guinea differs in the more extensive blue on the face and forehead; *berauensis* from the Fly River, in having the dark green of the upper belly spottier; and *micropteryx* of southeastern New Guinea, in the paler breast and back, browner nape and cheeks, and narrower green edges to the red of the breast. *T. h. caeruleiceps* of the lower Fly River is very distinct in its much darker green belly, pronounced orange wash on the abdomen, reduced green edges to the red of the breast, and more extensive blue on the forehead and sides of the head. The material of Gyldenstolpe and Gilliard from the Wahgi Valley was also assigned to *intermedius,* while Schodde and Hitchcock placed one specimen from Lake Kutubu with *micropteryx.*

BREEDING. The testes of both males collected at Karimui in

1964 were enlarged. In 1965 the gonads were enlarged only in a Soliabeda male. According to the Fore this lory, like many others, breeds at Okapa during the rainy season.

DISCUSSION. I encountered *Trichoglossus haematodus,* one of the most widespread and conspicuous lories in the Eastern Highlands, at all my collecting stations except Mt. Michael, up to 4,500-5,000 ft in primary forest and up to 6,500 ft in the casuarina groves and trees of villages and open country. It usually occurs in small, noisy groups of up to half a dozen individuals perched in the middlestory and canopy of trees or calling loudly in flight. Unlike *Pseudeos fuscata,* to which it is otherwise rather similar in voice and habits, *T. haematodus* does not leave the Eastern Highlands during the dry season.

Pairs of birds that were perched facing each other 1 ft apart displayed by opening and rapidly fluttering the wings to reveal the strikingly colored pattern of the underwing. Many species of lories have patterned underwings that may function in species-specific displays.

Terborgh's observations on feeding trees indicate that the main food source of *T. haemotodus* is flowers and that it takes fruit less frequently. At Karimui it was the second commonest parrot in flowering trees, accounting for about 10% of the bird-usage, and it actually fed on the blossoms by biting off the receptacles and allowing the petals to fall to the ground. However, Terborgh also encountered an unusual relation between this species and honeyeaters in *Ficus* trees at Karimui and Miarosa. The fruits of these *Ficus* were about 8 cm long and 4 cm in diameter and protected by a thick, woody pericarp which precluded any direct assault on the soft pulp inside. Underneath the trees were lying fallen fruits with neatly cut holes about 1 cm in diameter at the blossom ends. Observation of the feeding birds showed that these holes were being made by *Trichoglossus haematodus* and another parrot, *Psittaculirostris desmarestii,* which tossed aside chips with a shake of their heads and gained access to the pulp within five minutes. Not even these parrots, though, could penetrate the side walls of the pericarp, and they always had to abandon the fruit with most of the pulp remaining because of their short bills. Honeyeaters such as *Melilestes megarhynchus, Melidectes torquatus, Meliphaga flaviventer,* and several other species of *Meliphaga* then inserted their long, delicate bills, which would have been useless for opening the fruit, and ate more of the pulp. Initially, when most of the fruits were still unopened, 99% of the bird-usage in these *Ficus* trees was by *Trichoglossus* and *Psittaculirostris,* and 1% by honeyeaters, Later, when most of the fruits had been opened and the parrots had obtained as much pulp as their bills could reach, honeyeaters accounted for up to 93% of the usage, and parrots only for 7%.

VOICE. A high, short, very grating shriek, louder than that of

Neopsittacus musschenbroekii but less hoarse and grating than that of *Pseudeos fuscata.*

Psitteuteles goldiei (Sharpe)

Red-capped Streaked Lory

NATIVE NAME. Fore: yáni.

DISCUSSION. This is the least common of the midmontane lories, known from eight scattered localities in the Eastern Highlands between about 5,500 and 8,500 ft. My only field observation was of a noisy flock flying over the forest at 6,900 ft above Miarosa. According to the Fore it breeds at Okapa during the rainy season as do other lories, and several caged birds which had been brought in as nestlings were kept as pets by Europeans at Okapa. In Kyaka territory Bulmer commonly noted flocks of up to 40 in December and January but only occasionally saw the species during the rest of the year, implying local migration.

Domicella lory somu Diamond and *D. l. erythrothorax* (Salvadori)

Western Black-capped Lory

NATIVE NAMES. Fore: korió. Gimi: korió. Daribi: sómu.

SPECIMENS EXAMINED. *D. l. somu:* Karimui, 1 ♂, 2 ♀; Bomai, 2 ♂, 2 ♀; Soliabeda, 2 ♂, 2 ♀; Mt. Karimui Zone 1, 1 ♂ (7 July-11 Aug. 1965). *D. l. erythrothorax:* Sena River, 1 ♂ (26 July 1964).

WING. *D. l. erythrothorax:* 1 ♂, 167 (see Diamond, 1967a, for weights and wing measurements of *D. l. somu*).

TAXONOMY. As discussed elsewhere (Diamond, 1967a), the race *somu,* with a restricted range in the Karimui Basin and Purari River drainage, is unique in lacking the neck band present in all other races of *D. lory* but absent in *D. hypoinochrous.* Surprisingly, the single specimen which Terborgh and I collected 15 miles east of Karimui at the Sena River, on the slopes of the mountain walls ringing the Karimui Basin but still within the basin, definitely belongs to the southeastern New Guinea race *erythrothorax* because of the presence of the neck band (and slightly larger size). Schodde and Hitchcock assigned the Kutubu population to *D. l. rubiensis,* but their description implies that it actually belongs to *D. l. somu,* since they mention the absence of the neck band.

BREEDING. The gonads were small in 11 specimens, slightly enlarged in the two others, suggesting that breeding was suspended in the dry season, as with other lories.

DISCUSSION. *Domicella lory* is generally distributed along the southern edge of the Eastern Highlands up to about 4,500 ft, being uncommon above 3,000 ft but numerous at Soliabeda (2,000 ft). In virgin forest the lories *Domicella lory, Trichoglossus haematodus,* and

Pseudeos fuscata all extend up to nearly the same altitude (the latter two consistently several hundred feet higher), but *Domicella lory* has failed entirely to follow the other two species in colonizing the man-made second-growth habitats of the Eastern Highlands at 5,000-6,500 ft. The social behavior is also different. *Trichoglossus haematodus* and *Pseudeos fuscata* are often seen in small flocks, both when in flight and when in feeding trees. All my sightings of *Domicella lory* in flight were of individuals or pairs, and the largest number that I saw together in a feeding tree was three. To judge from the trees it frequents, it feeds principally on flowers, secondarily on fruits.

VOICE. More varied and more musical than that of *Trichoglossus haematodus* or of *Pseudeos fuscata*. The commonest vocalization consists of two identical squeals in immediate succession, with a quality as of sleigh-bells when heard in the distance; this double squeal cannot be confused with the voice of other New Guinea parrots. In addition, a variety of high piercing squeaks and loud whistles may be emitted, particularly when the birds are perched.

[*Domicella hypoinochroa devittatus* (Hartert)]

Eastern Black-capped Lory

DISCUSSION. This species has never been found west of Hall Sound in southeastern New Guinea. Mayr and Gilliard (1954) list it from the Eastern Highlands on the basis of a captive bird photographed by Gilliard at Kup and said to have been caught south of the Kubor Range. This captive was probably a misidentified individual of *Domicella lory somu,* the common *Domicella* of the Eastern Highlands. At the time when Gilliard examined the Kup pet in 1952, the race *D. l. somu* was still unknown, and the best way of distinguishing *D. hypoinochroa* and *D. lory* was thought to be the neck band present in the former and absent in the latter. However, *somu* lacks the neck band, and must be distinguished from *D. hypoinochroa* by subtler points easily overlooked or invisible in a photograph.

Charmosyna papou goliathina Rothschild and Hartert

Papuan Lory

NATIVE NAMES. Fore: waiyá. Gimi: waiyá. Daribi: háde.

SPECIMENS EXAMINED. Mt. Michael: 1 ♀ (4 July 1964). Mt. Karimui Zone 5: 1 ♂, 2 ♀ (27-28 Aug. 1965).

WING. 1 ♂: 150. 3 ♀: 145 (2), 147.

STOMACH CONTENTS. A paste of flowers.

TAXONOMY. The Mt. Michael female and Mt. Karimui male are in the black phase, while the Mt. Karimui females are in the red phase. The black phase seems several times more numerous than the red phase in the Eastern Highlands. The specimens agree with *golia-*

thina of western New Guinea and differ from *stellae* of southeastern New Guinea in that the longest rectrices are yellow-green rather than reddish yellow, and in that the red of the longest uppertail coverts is tipped with green.

BREEDING. The Mt. Karimui male and female were a pair with enlarged gonads.

DISCUSSION. *Charmosyna papou* is a regular inhabitant of the forest interior from 5,500 to about 9,000 ft and has turned up at virtually all collecting stations in this habitat. It is locally common, but its abundance depends upon the presence of the flowering trees on which it feeds. Unlike some other lories, *C. papou* remains within the forest, and I never saw it in open country.

The altitudinal range of *C. papou* lies above those of all its congeners, except that *C. pulchella* occasionally overlaps *C. papou. C. papou* shares its range with four other lories, but these five high-altitude lories sort out largely on the basis of size: *Oreopsittacus arfaki,* ca. 20 g; *Neopsittacus pullicauda,* 38 g; *Neopsittacus musschenbroekii,* 50 g; *Psitteuteles goldiei,* 60 g; *Charmosyna papou,* 85 g.

VOICE. A shrill, somewhat grating cry, more grating than that of *Oreopsittacus arfaki* or *Neopsittacus pullicauda* but much weaker than that of *Trichoglosslsus haematodus.* A loud wing beat which I heard frequently on Mt. Karimui was attributed to this species by the Fore.

Charmosyna pulchella bella (De Vis)

Little Red Lory

NATIVE NAMES. Fore: súshuke. Gimi: áni.

SPECIMENS EXAMINED. Mt. Karimui Zone 2: 2 ♂, 1 ♀; Zone 3: 1 ♂, 2 ♀ (14-17 Aug. 1965).

WEIGHT. 1 ♂: 37. 3 ♀: 31.0, 32.3, 34.5.

WING. 3 ♂: 93, 94, 95. 3 ♀: 87, 91, 92.

TAXONOMY. The specimens are indistinguishable from *bella* of southeastern New Guinea and Telefolmin.

BREEDING. The testes were slightly enlarged.

DISCUSSION. This lory is sparsely distributed in hill forest along the slopes of the Eastern Highlands between about 2,000 and 5,800 ft. Its altitudinal range lies largely but not entirely below that of *C. papou.* Elsewhere in New Guinea its range lies entirely above that of *C. placentis,* but in the Karimui area, where *C. placentis* extended up to 4,750 ft, *C. pulchella* and *C. placentis* overlapped considerably and fed in the same flowering trees at the Sena River and on Mt. Karimui.

C. pulchella is one of several hill forest species with a discontinuous altitudinal range at Karimui because the tropical flat basin floor divides its normal range on the hill slopes (p. 55). On Mt. Karimui all the specimens and observations of *C. pulchella* fell between 4,400 and 5,290 ft. The species was also present at the Sena River, (4,500 ft) on the eastern wall of the Karimui Basin. I never encountered it on the flat basin floor (3,650 ft), and Yudo natives confirmed that it was absent there and to be found only on the mountain. A few individuals were seen again when we went down to Soliabeda (2,000 ft) beyond the basin walls.

Like other lories, *C. pulchella* congregates noisily in flowering trees. Like *C. papou* and unlike *C. placentis* or *Trichoglossus haematodus*, it remains within the forest and rarely ventures into open country.

VOICE. A short note similar to that of *C. placentis* but sweeter, less shrill or staccato.

Charmosyna wilhelminae (Meyer)

Pygmy Streaked Lory

One specimen collected by Bulmer at 4,500 ft in the Lanim Valley is the sole Eastern Highlands record of this rare lory. A flock that I observed at 5,000 ft on Mt. Albert-Edward in southeastern New Guinea was feeding at flowers of the oak *Castanopsis*.

Charmosyna placentis placentis (Temminck)

Yellow-fronted Blue-eared Lory

NATIVE NAME. Daribi: abubáge.

SPECIMENS EXAMINED. Karimui: 4 ♂ (2-10 July 1965). Soliabeda: 4 ♂, 5 ♀ (23-30 July 1965). Mt. Karimui Zone 2: 2 ♂, 1 ♀ (14-15 Aug. 1965).

WEIGHT. 9 ♂: Soliabeda, 33.0, 36.5, 39.0, 42.0; Karimui, 31.0, 33.0, 40.0; Mt. Karimui, 30.5, 32.0 (overall average 35.5 ± 4.3). 8 ♀: Soliabeda, 26.5, 29.0, 29.3, 30.3, 33.5; Karimui, 33.0, 36.3; Mt. Karimui, 35.7 (overall average 31.7 ± 3.5).

WING. 9 ♂: Soliabeda, 84, 86, 86, 87; Karimui, 86, 86, 90; Mt. Karimui, 88, 91 (overall average 87 ± 2). 11 ♀: Soliabeda, 81, 82, 83, 84, 84; Karimui, 85, 86, 88, 89; Mt. Karimui, 88, 91 (overall average 86 ± 3).

STOMACH CONTENTS. Flowers, seeds, and a paste of flowers.

TAXONOMY. These specimens have a blue rump patch of the same size as in nominate *placentis* from the Fly and Oriomo Rivers, Kei Islands, and Aru Islands (the patch is much larger in *ornata* and absent in *subplacens* of southeastern New Guinea). My females average slightly darker above, and my males deeper red on the flanks, than the comparative material of *placentis*, in line with the general trend towards darkness at Karimui. The measurements (wings of males and females, and weights of females but not of males) suggest an increase in size with altitude.

BREEDING. The gonads were considerably enlarged in one male and one female from Karimui and in two males from Soliabeda, and slightly enlarged in both males from Mt. Karimui.

DISCUSSION. This species has hitherto been considered a characteristic bird of the New Guinea lowlands at elevations near sea level. Its presence in abundance at Karimui (3,650 ft) may constitute an altitudinal record. It remained numerous on the lower slopes of the basin walls and finally disappeared at 4,750 ft on Mt. Karimui. At Soliabeda (2,000 ft) it was even more abundant. There are no other Eastern Highlands records, and its distribution or area of abundance in the Eastern Highlands may prove to be confined to the Karimui area.

C. placentis congregated to feed in flowering trees, where it was the most numerous species in the Karimui area and provided from 15% to as much as 65% of the bird-usage. We had no records of it in the many fruiting trees kept under observation. In the flowering trees it distributed itself uniformly throughout the crown. At any time a given tree might hold up to 25 individuals of *C. placentis,* which came and went in groups of two to 10, kept up an incessant chatter, and often paused from feeding to chase each other.

VOICE. A single short note "tsss"—crisp, shrill, high, and staccato, and considerably less substantial than the notes of *Neopsittacus musschenbroekii, Trichoglossus haematodus,* or *Pseudeos fuscata.*

Oreopsittacus arfaki grandis Ogilvie-Grant

Plum-faced Mountain Lory

NATIVE NAMES. Fore: túshuke. Gimi: gígi.

SPECIMENS EXAMINED. Mt. Michael: 2 ♂, 3 ♀ (1-11 July 1964). Mt. Karimui Zone 4: 1 ♂, 1 ♀; Zone 5: 1 ♂, 2 ♀; Zone 6: 1 ♀ (28 Aug.-5 Sept. 1965).

WEIGHT. 2 ♂: 22.3, 22.5. 4 ♀: 21.7, 21.8, 22.0, 22.3.

WING. 2 ♂: 81, 81. 5 ♀: 81, 82, 82, 84, 84.

STOMACH CONTENTS. Flower paste.

TAXONOMY. Eastern Highlands birds lack the red abdominal spot present in *major* and nominate *arfaki.*

BREEDING. The testes were enlarged in birds from Mt. Karimui.

DISCUSSION. This small, high-altitude lory is characteristic of moss forest, and its vertical distribution on a given mountain seems to correlate with the distribution of this vegetational type. On Mt. Karimui, where the cloud level is lower than in most other parts of the Eastern Highlands, *Oreopsittacus* descended to 5,600 ft. On Mt. Michael, where the trees were heavily mossed only above 8,700 ft, *Oreopsittacus* was found only above this altitude and occurred up to about 10,500 ft in the moss forest. At Okapa I collected up to 7,500 ft and found neither heavy moss nor this parrot, but the Fore were familiar with the "túshuke" and said that it lived somewhere on top. It occurs in flocks of two to six and frequents flowering trees.

VOICE. A short, weak, unvoiced, repeated note "ts," weaker than that of other montane lories and more suggestive of a warbler than of a parrot.

Neopsittacus musschenbroekii major Neumann

Yellow-billed Mountain Lory

NATIVE NAMES. Fore: kása. Gimi: kása.
SPECIMENS EXAMINED. Awande: 7 ♂, 5 ♀ (14-20 June 1965). Mengino: 1 ♂ (15 July 1965). Mt. Karimui Zone 3: 2 ♀ (17 Aug. 1965).
WEIGHT. 6 ♂: 50-62 (52 ± 2). 7 ♀: 49-53 (50 ± 1).
WING. 8 ♂: 109-117 (113 ± 3). 7 ♀: 111-116 (113 ± 2).
STOMACH CONTENTS. Dry and granular flower remains.

BREEDING. All specimens, except one Awande female, had small gonads. According to the Fore, the "kása" breeds in the rainy season.

DISCUSSION. *Neopsittacus musschenbroekii* is widespread at about 5,000-8,500 ft throughout the Eastern Highlands. It is one of the few midmontane forest birds that have profited greatly from human activities, most of the other species in man-made habitats in the Eastern Highlands being originally lowland birds. For example, it was numerous in partly cut forest around Okapa, Lufa, and Mengino, and was the commonest parrot at Miarosa village (5,800 ft), congregating in casuarina stands along the gardens and roads in flocks of up to 50. On the other hand, it seems to require at least the close proximity of forest and is absent in areas (such as Goroka) where the forest has been largely or completely eliminated for miles around to leave just isolated groves. *N. musschenbroekii* is invariably seen in pairs or larger groups, not as individuals.

VOICE. A shrill "ss", "ks", or "ts", somewhat staccato and hoarse, and moderately high in pitch. In comparison with the notes of other lories that may be found in its altitudinal range, the note of *N. musschenbroekii* is harsher, shorter, and more grating than that of *N. pullicauda,* more staccato and considerably stronger than that of *Oreopsittacus arfaki,* and less harsh and somewhat weaker than the notes of *Pseudeos fuscata* or *Trichoglossus haematodus.* The note is heard frequently whether the birds are perched or in flight.

Neopsittacus pullicauda pullicauda Hartert

Orange-billed Mountain Lory

SPECIMENS EXAMINED. Mt. Michael: 1 ♂ (5 July 1964).
WING. 100.
STOMACH CONTENTS. Dry and granular flower remains. This species and *N. musschenbroekii* may actually eat flowers, whereas *Oreopsittacus arfaki* and *Charmosyna papou,* whose stomachs contain soft paste, perhaps only take nectar.

BREEDING. The gonads were very small.

DISCUSSION. To my surprise, the specimen was caught in a mist-net a few feet above the ground in tall forest on level ground at 8,000 ft (*Neopsittacus* generally stays in the canopy).

This is the high-altitude *Neopsittacus* species, living in moss forest throughout the Eastern Highlands at about 7,500-10,000 ft. Its altitudinal range overlaps that of *N. musschenbroekii* by 500 or 1,000 ft, and in the intermediate zone both species can be found in the same flowering tree. This overlap may be made possible by the fact that *N. musschenbroekii* is about 40% heavier than *N. pullicauda*. The main plumage differences between these two sibling species are that *N. musschenbroekii* has a yellow bill, yellow undertail, and light shaft streaks on the crown, while *N. pullicauda* has a more orange bill, olive undertail, and lacks light shaft streaks on the crown.

VOICE. A gentle sibilant note, harsher than that of *Oreopsittacus arfaki* but weaker and less shrill than that of *Neopsittacus musschenbroekii.*

Psittaculirostris desmarestii cervicalis (Salvadori and D'Albertis)

Large Fig Parrot

NATIVE NAME. Daribi: shúashúa.

SPECIMENS EXAMINED. Karimui: 4 ♂ (12 Aug. 1964; 4-5 Aug. 1965). Bomai: 1 ♂ (9 July 1965). Mt. Karimui Zone 1: 1 ♀ (11 Aug. 1965).

WEIGHT. 2 ♂: 108, 118. 1 ♀: 126.

WING. 4 ♂: 112, 115, 116, 121. 1 ♀: 116.

TAXONOMY. When compared with specimens of *cervicalis* (the southeastern New Guinea race) from the Brown River, Kumusi River, Hydrographer Mountains, and Holnicote Bay, Karimui specimens differ only in that the throat and cheeks are paler, more yellow and less orange, and in that the ear coverts are even deeper red-orange. From Fly River material collected by the Second Archbold Expedition and classified as *godmani* × *cervicalis* (Rand, 1942a), Karimui specimens differ in that the breast band is deeper blue and in that the ear coverts are darker and deeper orange, but they agree in the color of the throat and cheeks. The Karimui population is thus intermediate between southeastern New Guinea birds and the variable Fly River population but is nearer the former.

BREEDING. The gonads of the 1964 male were considerably enlarged, but those of the 1965 males were only slightly enlarged.

DISCUSSION. The three semispecies of genus *Psittaculirostris* constitute a superspecies ring in the lowlands around the periphery of New Guinea. As discussed by Rothschild (1920), Fly River birds appear to be hybrids between the distinct races *P. d. godmani* of the southwest and *P. d. cervicalis* of the southeast. Evidently the Fly River was one of four major points (the other three being Huon Gulf, Humboldt Bay, and Geelvink Bay) where distribution in the *Psittaculirostris* ring was formerly broken, but reestablishment of contact at the Fly River between populations on either side of the break evidently occurred before differences had developed to the point of reproductive isolation. The evolutionary history of the genus *Chalcopsitta* must have been similar.

The presence at Karimui (3,250-4,200 ft) constitutes an altitudinal record for this lowland genus, and other records of *P. desmarestii* for the Eastern Highlands are lacking. As in the case of several other lowland species, so for *P. desmarestii* the Karimui population represents an isolated island of distribution, since I did not find the species at Soliabeda (2,000 ft) immediately to the south of the Karimui Basin, nor did Schodde and Hitchcock report it from Lake Kutubu (2,450 ft). At Karimui this parrot was uncommon, was seen in groups of two to six, and occurred much more often in fruit trees than in flowering trees, where it might be seen at any height from the lowest to the highest branches. Together with *Trichoglossus haematodus* it cut holes with its heavy bill through the woody pericarp of *Ficus* fruits, most of whose pulp was then eaten out by long-billed honeyeaters (see p. 143). One pair was seen coming out of a hole in a tree.

VOICE. A high, thin, downslurred note quite unlike that of the other parrots in feeding trees at Karimui.

Psittaculirostris edwardsii (Oustalet)

Edward's Fig Parrot

DISCUSSION. Mayr and Gilliard recorded two specimens collected by N. B. Blood in the Jimmi River region, and another specimen at Nondugl aviary from unknown locality. Gyldenstolpe mentioned four further Nondugl aviary birds originating from the Jimmi River. This is the *Psittaculirostris* form of northeastern New Guinea and presumably confined in the Eastern Highlands to low elevations on the northern slopes.

VOICE. A very short, metallic note "ks" with a sharp attack, as the sound of coins falling on concrete.

Opopsitta gulielmitertii suavissima (Sclater)

King William's Fig Parrot

SPECIMENS EXAMINED. Bomai: 2 ♂ (a and b), 1 ♀ (6 July 1965).
WEIGHT. 2 ♂: 33 (a), 27 (b). 1 ♀: 33.
WING. 2 ♂: 77 (a), 70 (b). 1 ♀: 79.

TAXONOMY. All three specimens agree with *suavissima* of southeastern New Guinea in having the forehead blue, whereas it is brown in *fuscifrons,* the race of southwestern New Guinea from the Fly River westward. The inner edges of the innermost primaries are yellow, a character shared by both these races and by *melanogenia* of the Aru Islands. The small male labelled "b" resembles the adult female in plumage and is presumably a second-year bird (Mayr and Rand, 1937).

DISCUSSION. In addition to collecting this lowland species at Bomai, I observed it at Karimui and Soliabeda as well, but there are no other Eastern Highlands records outside of the Karimui area. It was uncommon and was seen in groups of two to four, containing birds of both sexes. We had a few observations of it in flowering trees.

VOICE. There are two call notes: a short, unmusical, staccato "ks"; and a short, more musical, less staccato "ts" with a sweet quality. Both notes are less sharp, shrill, or grating than those of *Charmosyna placentis.*

Opopsitta diophthalma festetichi (Madarasz)

Two-eyed Fig Parrot

NATIVE NAMES. Fore: ninti or isoateo.
SPECIMENS EXAMINED. Okasa: 1 ♀ (24 June 1965).
WEIGHT. 56.
WING. 94.

TAXONOMY. The races of this parrot have been reviewed recently by Forshaw (1967). I reassessed the New Guinea mainland and Aru Islands populations in the light of 51 specimens at the American Museum of Natural History: 11 from southeastern New Guinea (7 ♂, 3 ♀, 1 imm. ♂), four from the Eastern Highlands (1 ♂, 2 ♀, 1 imm. ♀), one (♂) from the Huon Peninsula, one (♂) from the Ramu River, two (♀) from Astrolabe Bay, five from the North Coastal Range (2 ♂, 3 ♀), 19 from western New Guinea and the western Papuan islands (10 ♂, 7 ♀, 2 imm. ♂), one (♂) from the Fly River, and seven (3 ♂, 2 ♀, 2 imm. ♂) from the Aru Islands. The material from eastern and northeastern New Guinea (Eastern Highlands, Huon Peninsula, North Coastal Range, Huon Peninsula, Ramu River, Astrolabe Bay) differs from the southestern and western populations in having a wider yellow band across the crown of the male and in that the backs of the females are slightly darker. The name *festetichi* (type locality Astrolable Bay) is available for this eastern and northeastern population to distinguish it from nominate *diophthalma* (type locality Triton Bay, western New Guinea). In both the male and female characters the southeastern population is not separable from the western population and is separable from *festetichi,* so that the race *coccineifrons* from southeastern New Guinea must be considered synonymous with nominate *diophthalma* (not with *festetichi,* as Forshaw had suspected). Neither Forshaw nor I could detect the alleged variation in the depth of the red color of the forehead and cheeks, sometimes cited as a racial character. In the race *aruensis* the yellow crown band of the male is either lacking (Aru Islands) or very narrow (Fly River), and the female of *aruensis* is quite distinct.

BREEDING. The Okasa female was one of a pair coming out of a hole in a tree and may have been preparing to breed, as suggested by the enlargement of the ovary.

DISCUSSION. This fig parrot has a very spotty distribution at lower elevations (i.e., up to about 5,000 ft), and apparently lives in second-growth trees, in partly cut forest, and at the forest edge rather than in primary forest. In 1964 Terborgh saw the species several times at Okasa (3,500-4,250 ft) in stranglers bearing fruits about 5 mm in diameter. Gilliard reported it as "not uncommon up to 5,000 feet in the riverine forests near Kup" (Mayr and Gilliard, 1954, p. 339); Gyldenstolpe collected 10 specimens near Nondugl but met it nowhere else; Bulmer obtained one specimen about 6,000 ft in Kyaka territory; and there are sight observations from Baiyer Valley (N.G.B.S. Newsletter, No. 54, p. 1, June 1970). Birds that I saw were usually solitary, and perched at the tops of dead trees or else probed bark while hanging upside down.

VOICE. A sharp, sweet, somewhat metallic "ks," similar to the call of *Psittaculirostris edwardsii* but weaker and with a less sharp attack.

Micropsitta bruijnii bruijnii Salvadori

Mountain Pygmy Parrot

This locally distributed species of mountain forest is known in the Eastern Highlands from one specimen taken at 7,500 ft in the Kubor Mountains by Gilliard, six taken on the Schraderberg by Bürgers, one collected at 6,700 ft at Minj by N. B. Blood, sightings by Bulmer in the Jimmi Valley, and sightings at 5,500 ft in the Hagen area (N.G.B.S. Newsletter, No. 54, p. 1, June 1970). It works along and around branches in nuthatch-like fashion. The very similar *Micropsitta pusio* may turn up at lower elevations.

Probosciger aterrimus goliath (Kuhl)

Palm Cockatoo

NATIVE NAMES. South Fore: pakitóra. Daribi: boriaú.
SPECIMENS EXAMINED. Okasa: 1 ? (26 June 1965).
WING. 390.

TAXONOMY. From the large size I presume that this specimen belongs to the race *goliath*, inhabiting the foothills of southern New Guinea, rather than to nominate *aterrimus*, an Australian race which reaches the coastal lowlands of southern New Guinea. Schodde and Hitchcock also identified the Lake Kutubu population as *goliath*. The race *stenolophus* of northern New Guinea has much narrower crown feathers.

DISCUSSION. The specimen was collected while eating fruit at the top of a tree in the Okasa forest at about 4,200 ft. According to Fore natives living near this forest, the "pakitóra" is quite uncommon there. My Daribi assistants also knew the "boriaú" but said that it appears only very infrequently at Karimui (3,650 ft).

VOICE. A rapid series of alternate upslurs and downslurs "whik-whik-whik . . ." at a rate of 4 per second. Occasionally, a melodious, whistled, jumbled call with a quality similar to *Domicella lory*.

Cacatua galerita triton Temminck
Sulphur-crested Cockatoo

NATIVE NAMES. Fore: wai. Gimi: óde. Daribi: nára. Pidgin English: koki.

DISCUSSION. In the areas of the Eastern Highlands which I visited and which are still little disturbed by man, *C. galerita* is a ubiquitous and conspicuous inhabitant of primary forest up to about 5,000 ft, locally (Awande, Mt. Michael, Mt. Karimui) up to 7,000 ft, and was present at all my Eastern Highlands collecting stations. In areas with moderate human population densities, particularly those where shotguns are permitted, this cockatoo tends to disappear because its yellow crest plumes are prized for decoration. Gyldenstolpe and Gilliard did not meet cockatoos in the central parts of the Eastern Highlands in the wild state. Their studies were confined to altitudes above 4,000 ft, largely above 5,000 ft, but at these elevations cockatoos should merely be uncommon rather than absent, and I suspect that the species has already been extermniated by the higher human population densities in these areas.

The Sulphur-crested Cockatoo was usually seen in small groups of from a few to a dozen individuals. It is most conspicuous when soaring, somewhat hawk-like, high over the forest and calling loudly. This behavior seems to constitute a social display, for a few birds will land screaming in a tree, to be followed by several others which can be seen and heard as they come flying in from a mile away. A perched bird that is alarmed bends its head and sways, raising its yellow crest, to observe a human intruder from various angles.

VOICE. The call is the loudest of any New Guinea bird: a familiar, ear-splitting, harsh scream, delivered perched or in flight. A very different and infrequent vocalization, given only when perched, consists of a virtually continuous sound which goes on for several minutes, interrupted briefly every 1½ sec while the bird catches its breath. The pitch is nearly constant but rises slightly before each catching of breath. The sound is not loud and is difficult to localize if one does not happen to see the singer. The quality is totally unmusical, somewhat rasping, invites confusion with an insect, but most closely resembles the voice of a dog whose vocal cords have been damaged.

Psittrichas fulgidus (Lesson)

Vulturine Parrot

NATIVE NAMES. Fore, Gimi, and Daribi: kábare.

DISCUSSION. My sole field observation of this remarkable parrot in the Eastern Highlands came at Soliabeda, in an area of very low human population density, where one bird perched at the top of a tall tree in a native garden and then flew off. The distinctive flight consists of alternate rapid flaps and soaring, reminiscent of the Black Vulture *Coragyps atratus* of the New World. To judge from native reports, it is present but rare at lower elevations in Fore, Gimi, Daribi, and Tudawhe areas. Schodde and Hitchcock saw groups of up to 20 at Lake Kutubu.

The red feathers of the "kábare" are prized by natives far more than the plumage of any other bird, including any bird of paradise. Even in a poor area like Karimui, a *Psittrichas* commanded the relatively enormous sum of twenty dollars, equal to the price of a large pig and not much less than the price of a wife. Despite this popularity I saw or heard of only three captive *Psittrichas* in the Karimui area, an indication of its rareness even in areas with sparse human population. This is one of the few montane species whose existence is threatened directly (i.e., as opposed to being threatened indirectly through destruction of habitat) by man.

VOICE. Very harsh, rasping, drawn-out screams. Often the screams are in pairs, the first at constant pitch and hoarse, the second upslurred, nasal, and squeaky as the sound of a rusty gate.

Larius roratus pectoralis (Muller)

Red-sided Eclectus Parrot

NATIVE NAMES. Gimi: nóra. Daribi: ánari (male), tógali (female).

SPECIMENS EXAMINED. Karimui: 1 ♂ (12 Aug. 1964). Mt. Karimui Zone 1: 1 ♂ (11 Aug. 1965).

WING. 2 ♂: 256, 263.

BREEDING. The testes of the Mt. Karimui specimen were large, while those of the Karimui bird were very small.

DISCUSSION. The Red-sided Eclectus Parrot was found up to 4,800 ft throughout the Karimui area, where my census figures showed that it was consistently about one-third as numerous as *Cacatua galerita*. In the lowlands this species is more numerous and sometimes assembles in considerable numbers, circling conspicuously high overhead at sunset like the *Nestor* parrots of New Zealand. However, in the Karimui area it was invariably solitary. It is probably widespread at the lower elevations in the Eastern Highlands, since my Gimi assistants were familiar with it and my Awande assistants knew it from low elevations in Fore territory. It was found common at Lake Kutubu

(2,450 ft) by Schodde and Hitchcock and up to at least 5,000 ft in Kyaka territory by Bulmer.

VOICE. A loud harsh scream, quite similar to that of *Cacatua galerita,* but with a more croaking quality and less deafening.

Geoffroyus geoffroyi aruensis (Gray)

Red-cheeked Parrot

SPECIMENS EXAMINED. Soliabeda: 1 ♀ (22 July 1965).
WEIGHT. 169.
WING. 155.

TAXONOMY. The single specimen agrees with *aruensis,* e.g., in that the rump is green rather than red.

DISCUSSION. At Soliabeda (2,000 ft) this was the fourth commonest parrot, and Schodde and Hitchcock found it widespread at Lake Kutubu (2,450 ft), but I saw it only a few times at Karimui (3,650 ft). This is a lowland species with an altitudinal range only marginally overlapping that of its congener *G. simplex,* which was absent at Soliabeda but common at Karimui and higher elevations. *G. geoffroyi* occurred singly or in groups of a few birds, and most often attracted attention when calling loudly in flight.

VOICE. A series of identical notes repeated at the rate of two to three per second for 5 to 10 sec. The notes are high and fairly loud, and have a bright, piercing, ringing quality as of a metal surface being struck. Each note is upslurred, virtually disyllabic. Only two other species have calls with which the call of *Geoffroyus geoffroyi* can be confused. At a great distance and when not heard clearly, the call of *G. simplex* may sound similar. Some calls of the drongo *Dicrurus hottentottus,* which also consist of a series of ringing, metallic, disyllabic notes, are very similar and at times virtually indistinguishable. With practice the drongo calls can usually be distinguished by the facts that the series in the drongo usually consists of fewer notes; that the drongo's notes are sometimes downslurred, whereas they are always upslurred in *G. geoffroyi* in the Eastern Highlands (though not in other parts of New Guinea); and in that the call is usually delivered in flight by *G. geoffroyi* but when perched by the drongo. The quality of the voice of *G. geoffroyi* shows considerable geographical variation.

Geoffroyus simplex subsp.

Blue-collared Parrot

NATIVE NAMES. Fore: k'ri-k'ro. Daribi: síbunane.

BREEDING. Said by natives to breed in the rainy season at Okapa.

DISCUSSION. Although I found this parrot widespread and fairly common throughout the Eastern Highlands at 3,000-6,500 ft, it is so incredibly shy that a specimen with locality data has yet to be collected. Usually I saw it in flocks flying overhead at a great height and calling, and neither I nor my native assistants were able to approach it more closely than 200 feet when it was perched in flowering trees, without its panicking and bolting. It is said to eat acorns of the oak *Castanopsis.* A nestling reared in captivity learned to speak a few words.

VOICE. In pattern, similar to the voice of *G. geoffroyi,* i.e., a series of piercing high notes delivered at the rate of about two per second. The successive notes are at nearly, but not exactly, the same pitch and vary slightly in quality, whereas successive notes of *G. geoffroyi* are identical. The sounds are well represented by a repetition of the Fore name: *k'ri-k'ro-k'ri-k'ro-* etc. As usually heard, i.e., at a great height, the quality is appealing and somewhat musical, as of sleigh-bells in the distance or of a rusty gate swinging back and forth. Under these circumstances confusion with the voice of *G. geoffroyi* is possible. The charm of the call disappears when heard nearby, and it becomes loud, harsh, piercing, and unmusical.

Alisterus chloropterus callopterus (D'Albertis and Salvadori)

Papuan King Parrot

NATIVE NAMES. Fore: úwe. Gimi: kâfe. Daribi: tánabo.

SPECIMENS EXAMINED. Awande: 1 ♂, 2 ♀ (16 June 1965). Okasa: 2 ♀, 1 ? (22-23 June 1965). Karimui: 1 ♂, 1 imm. ♂ (5 Aug. 1965).

WEIGHT. 2 ♂: 167, 173. 2 ♀: 155, 170. 1 ?: 148.

WING. 2 ♂: 184, 195. 2 ♀: 190, 197.

TAXONOMY. In the narrowness of the blue band on the upper back, the two adult males agree with *callopterus,* the form of central New Guinea, rather than with nominate *chloropterus,* the southeastern New Guinea race. The band is slightly broader in the male from Awande than in the male from Karimui (100 miles west of Awande), possibly suggesting an approach to nominate *chloropterus.*

BREEDING. The gonads were enlarged in the Okasa specimens, small in Karimui specimens.

DISCUSSION. The Papuan King Parrot was present in low numbers at all my forested collecting localities below 6,500 ft in the southern parts of the Eastern Highlands and probably occurs down to the foot of the hills. Apart from a Nondugl aviary bird and a pet bird of uncertain origin recorded by Gilliard and Gyldenstolpe, and probably taken at lower elevations in the Jimmi Valley, records of this forest species from the central parts of the Eastern Highlands seem to be lacking, possibly because of the extensive deforestation there below 6,500 ft. It is virtually confined to the shaded forest interior, occurs singly or in groups of two or three, remains unobtrusively in the lower branches and middlestory, moves deliberately, and flies only short distances and without calling when disturbed. Because of its retiring behavior it is heard more often than seen.

VOICE. Two distinctive calls: (a), a single, low-pitched, fairly loud, hoarse, harsh, very short and staccato note. (b) The commoner call is a series of five or six similar notes at 1½ sec intervals, at medium pitch, with a somewhat piercing quality, and each note being slightly downslurred. The pitch usually drops slightly with successive notes in the series (Fig. 15).

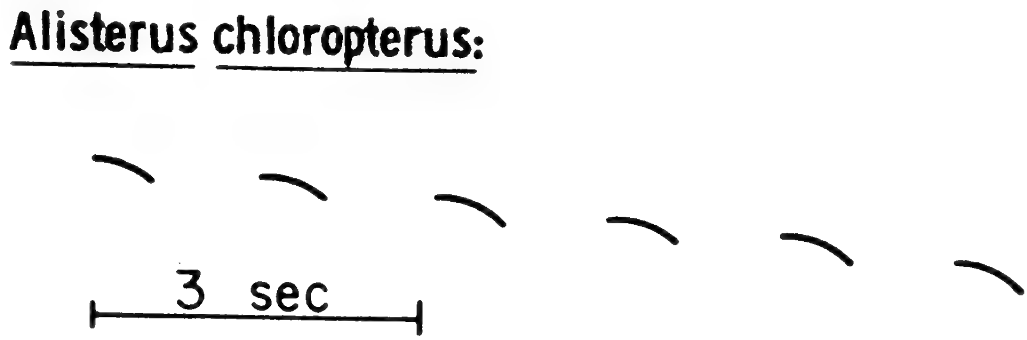


FIG. 15. Voice of *Alisterus chloropterus.*

Niche Differences in the Genus *Psittacella*

The four species of this genus apparently sort out ecologically in a simple fashion. There are two large species, *P. brehmii* and *P. picta,* and two small species, *P. madaraszi* and *P. modesta.* At a given altitude one may find one large species and one small species, but the two large species have nearly mutually exclusive altitudinal ranges, as do the two small species. Details of plumage and distribution suggest that, of the three speciations in this genus, the first was the split between a large form and a small form, the second produced the second large species, and the most recent produced the second small species (Fig. 16).

Psittacella brehmii pallida Meyer

Brehm's Tiger Parrot

NATIVE NAMES. Fore: tánge. Gimi: ákoi.
SPECIMENS EXAMINED. Mt. Michael: 2 ♀ (1 and 4 July 1964). Mt. Karimui Zone 4: 1 ♂ (31 Aug. 1965).
WEIGHT. 1 ♂: 99.
WING. 1 ♂: 116. 1 ♀: 121.
TAIL. 1 ♀: 85.
STOMACH CONTENTS. Small seeds and ground-up fruit.

TAXONOMY. This species shows much individual variation in plumage, but within the limits of this variation Eastern Highlands

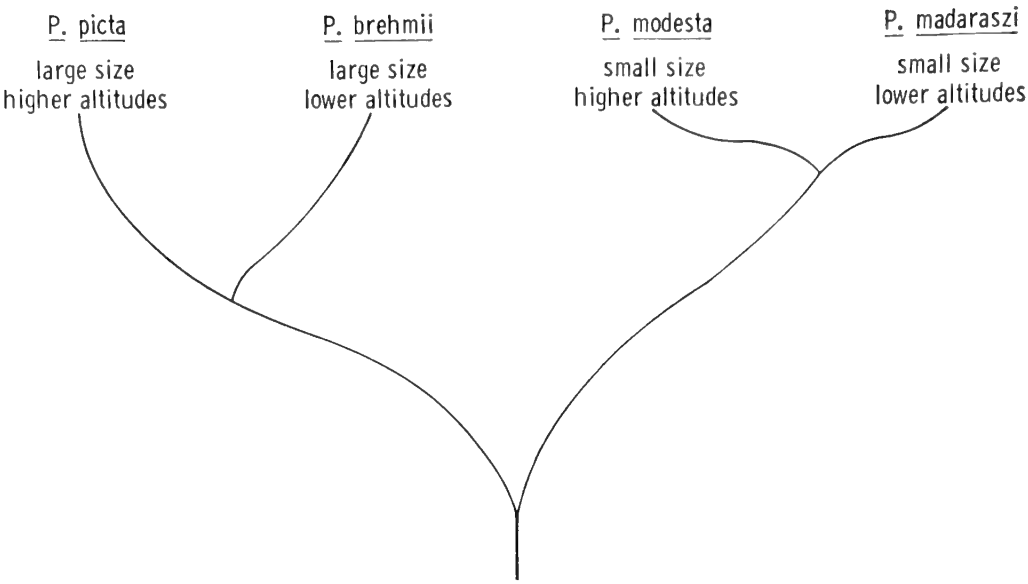


FIG. 16. Reconstructed evolutionary history of *Psittacella*. An ancestral form speciated to yield one large form and one small form, each of which again speciated to yield a pair of similar-sized forms with mutually exclusive altitudinal ranges.

material is closest to the southeastern New Guinea race *pallida*. The Mt. Karimui male has the head and upper breast darker than in any other specimen available for comparison, but this character is subject to postmortem fading (Rand, 1942b, p. 452) and varies individually. The western race *intermixta* differs in that it is considerably larger, while *harterti* females (Huon Peninsula) have a slightly paler head and less extensive barring on the breast and flanks. The race *buergersi* from the Schraderberg is probably synonymous with *pallida* (Gilliard and LeCroy, 1968).

BREEDING. The testes of the Mt. Karimui male were slightly enlarged.

DISCUSSION. *Psittacella brehmii* is an uncommon and solitary but widespread inhabitant of montane forest between about 5,300 ft and 9,000 ft, and has been encountered sparingly by most collectors at most localities within this zone (the claim of Gyldenstolpe, 1955, p. 57, that "it inhabited grassland and shrub country" appears unique). The individuals that I saw were 10 to 50 ft above the ground, slowly walked along a branch supporting themselves by the legs and bill without using the wings, and periodically stopped to bite at something. They spent at least 10 minutes in the same tree and often remained motionless for several minutes.

Records from the Eastern Highlands and other parts of New Guinea indicate that the altitudinal ranges of *P. brehmii* and its similar-sized high-altitude relative *P. picta* are nearly mutually exclusive, with the transition altitude varying locally between 8,000 and 10,000 ft. On the

Huon Peninsula, where *P. picta* is absent, *P. brehmii* may extend up to 3,800 meters (= 12,500 ft), as suggested by altitudes on labels of specimens collected by Keysser and examined in the American Museum of Natural History. In plumage *P. brehmii* and *P. picta* are more similar to each other than to their smaller relatives *P. modesta* and *P. madaraszi* but the two large species differ more from each other than do the two small species, suggesting that the former speciation occurred earlier. In addition, the races of *P. picta* are quite distinct, also indicating that it is a relatively old species.

VOICE. *P. brehmii* is generally silent, but on a single occasion I saw it give a two-note call (Fig. 17). The first note was short and harsh, and was followed at a ½-sec interval by a nasal note which first rose and then fell in pitch.

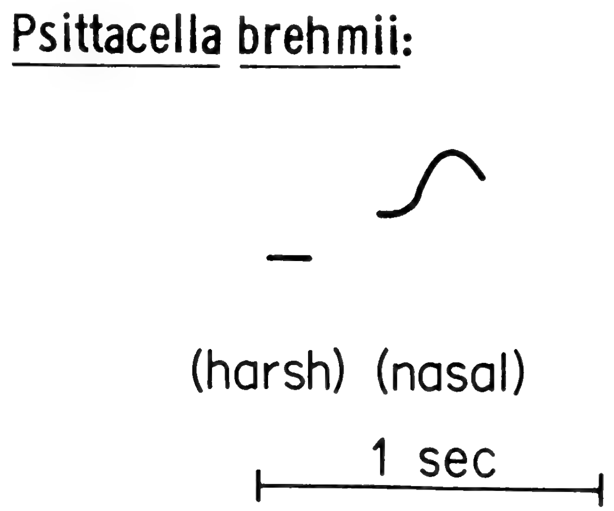


FIG. 17. Voice of *Psittacella brehmii.*

Psittacella picta excelsa Mayr and Gilliard

Painted Tiger Parrot

NATIVE NAMES. Fore: tánge.
SPECIMENS EXAMINED. Mt. Michael: 1 ? (9 July 1964).
WING. 109.
TAIL. 70.
STOMACH CONTENTS. Fruit and granular vegetable matter.

TAXONOMY. The Mt. Michael specimen has the crown, breast, and edges of the primaries somewhat lighter and more brightly colored than in *excelsa* from Mts. Hagen, Wilhelm, and Kubor, but these differences are minor. It differs most obviously from nominate *picta* in the olive-brown (instead of red-brown) crown and from *lorentzi* in the olive-brown (instead of blue-green) throat and in the red (instead of barred yellow) upper tail coverts.

DISCUSSION. The specimen was netted at 10,200 ft in stunted moss forest. The two individuals that I saw in the field were perched 15 or 20 ft above the ground in small trees. Paran said that this "tánge" (as opposed to *P. brehmii,* the other "tánge") was absent from the mountain behind Awande (about 7,500 ft high) but was present on a higher mountain behind Okapa (somewhat over 8,000 ft high). Combining this information with the collections of Gilliard and of Shaw-Mayer, one can say that this parrot is a regular inhabitant of forest on high mountains from elevations of about 8,000 ft up to at least 11,000 ft, and probably higher.

Relations of *Psittacella madaraszi* and *P. modesta*

Psittacella madaraszi and *P. modesta* were formerly considered conspecific. Since the available evidence indicates that they are distinct and since some specimens have been misidentified in the literature of the last 15 years, the material in the American Museum of Natural History and the British Museum (Natural History) was reviewed. Table 5 summarizes measurements.

The morphological differences are as follow. *P. modesta* is in general larger (Table 5), but *P. madaraszi* increases in size from east to west, so that the westernmost population, *P. madaraszi major,* is as large as *P. modesta. P. madaraszi* has a stouter bill (culmen from cere 15 mm, as opposed to 13 mm in *P. modesta*). The female plumages are distinct: *P. modesta* females have orange-and-black barred breasts and brown heads, while *P. madaraszi* females have no or only obscure barring on the breast and have a green head with a blue forehead and a barred crown and hindneck. Adult males of the two species are very similar and have brown heads with yellow centers to the feathers and unbarred breasts. A yellow collar is present in adult males of *P. modesta* except for the nominate race, and is lacking in adult males of *P. madaraszi.* In each species the immature male resembles the adult female. There are no morphologically intergrading specimens, although an intergrade would be easy to recognize in the female.

Regarding recently collected material, all four of my Eastern Highlands specimens are *P. madarszi hallstromi.* Gilliard collected four specimens in the Eastern Highlands which he described as "*P. modesta hallstromi*" (= *P. madaraszi hallstromi*). Examination of these specimens shows that three of them, including the type of *hallstromi,* belong to *P. madaraszi.* The fourth, an immature male collected at 7,000 ft on Mt. Hagen and mentioned by Mayr and Gilliard (1954, p. 340), is unmistakably *P. modesta* and has a barred breast, green-washed brown head without yellow centers to the feathers, long wing (typical of *P. modesta,* longer than any known specimen of *P. madaraszi*), and lacks a yellow collar (present in adult males but lacking in females and immature males of *P. modesta*). At Telefolmin, Gilliard collected

TABLE 5
MEASUREMENTS OF *Psittacella modesta* AND *Psittacella madaraszi*

	Wing (♂)	Wing (♀)	Altitude (ft)
P. modesta modesta			
Vogelkop (2♂, 2♀)	95, 96	93, 95	5,500-5,900
P. modesta collaris			
Snow Mountains, southern slopes	[94, 96, 97, 98(3), 99, 102][a]	[98, 98][a]	5,500-8,000
P. modesta subcollaris			
Snow Mountains, northern slopes (10♂, 10♀)[b]	[94-100][a]	[92-102][a]	5,900-9,200
Telefolmin (1♂)	95		7,300
P. modesta subsp.			
Eastern Highlands (4♂, 1♀)	98, 99, 100, 101	102	7,000-9,500
P. madaraszi madaraszi			
Southeastern New Guinea (18♂, 6♀)	87(4), 88(2), 89, 90(2), 91(3), 92(2), 93(3), 94	82, 85, 86, 87, 88, 90	6,000-7,900
P. madaraszi huonensis			
Huon Peninsula (1♂, 1♀)[b]	93	92	4,000-5,000
P. madaraszi hallstromi			
Eastern Highlands (4♂, 4♀)[b]	91, [91][a], 92, [93][a], 94(2), [95][a], 96	88, 93, 96	5,200-8,000
P. madaraszi subsp.			
Telefolmin (2♀)		93, 93	5,850
P. madaraszi major			
Snow Mountains, northern slopes (1♀)		95	5,300
Weyland Mountains (2♂, 2♀)[b]	97, 97	[90][a], 94, 97	4,300-5,600

[a] From published measurements of other authors.
[b] Including type.

one male and two females, which he listed as *P. modesta subcollaris* (Gilliard and LeCroy, 1961, p. 41). Examination shows that the male is *P. modesta subcollaris* and that the females are *P. madaraszi*. In the Wahgi Valley Gyldenstolpe collected three males which I have not examined but which were evidently *P. madaraszi hallstromi*. At 8,000-9,500 ft in the Eastern Highlands Shaw-Mayer collected five specimens which Sims (1956, p. 404) assigned to *hallstromi*. Examination of these specimens in the British Museum (Natural History) shows that one is a juvenile *P. madaraszi hallstromi* (♂, wing 91, collected at 8,000 ft in the Kubor Range, specimen number B.M. 1953.17.88) and that the other four are *P. modesta* (♂, wing 100, 8,500 ft, Mt. Giluwe, B.M. 1953.17.85; ♂, wing 99, 8,000 ft, Mt. Giluwe, B.M. 1953.17.86; ♀, wing 102, 8,000 ft, Mt. Giluwe, B.M. 1953.17.87; ♂, wing 101, 9,500 ft, Hagen Range, B.M. 1953.17.89). Shaw-Mayer collected an additional, unreported specimen of *P. madaraszi* at 7,500 ft at Baiyanka on the Purari-Ramu Divide (♂, wing 94, B.M. 1942.1.6.7).

The distributional details are as follows. *P. modesta,* consisting of the races *collaris, subcollaris,* and nominate *modesta,* occurs from the Vogelkop in the extreme west to long. 145°E in the Eastern Highlands but is absent farther east in the Herzog Mountains, southeastern New Guinea, and the Huon Peninsula. *P. madaraszi,* consisting of the races *huonensis, hallstromi, major,* and nominate *madaraszi,* occurs from eastern New Guinea (southeastern New Guinea, Herzog Mountains, Huon Peninsula) west along the Central Range to the Weyland Mountains but is absent on the Vogelkop in the far west. The two species are sympatric for a distance of at least 400 miles on the Central Range. Their altitudinal ranges appear to be mutually exclusive, with *P. modesta* living at higher altitudes than *P. madaraszi.* Thus, in the Snow Mountains the Third Archbold Expedition took *P. modesta* at 5,900-9,200 ft, *P. madaraszi* at 5,300 ft. At Telefolmin *P. modesta* was taken at 7,300 ft, *P. madaraszi* at 5,850 ft. In the Eastern Highlands *P. modesta* has been taken at 7,000-9,500 ft, *P. madaraszi* at 5,200-8,000 ft.

The reconstructed evolutionary history is that *P. modesta* arose as a western isolate, *P. madaraszi* as an eastern isolate, of what was originally one small-sized *Psittacella* species. Each form has reinvaded most of the other's geographical range, with altitudinal segregation as the ecological sorting mechanism, but *P. modesta* has not yet reached the eastern tip of New Guinea, and *P. madaraszi* has not yet reached the western tip. The birds of paradise *Epimachus fastosus* and *E. meyeri* have the same distribution and presumably the same history.

Psittacella modesta subsp.

Modest Tiger Parrot

As discussed above, this species was taken at 7,000 ft on Mt. Hagen by Gilliard, and at 8,000-9,500 ft on Mt. Giluwe and the Hagen Range by Shaw-Mayer.

Psittacella madaraszi hallstromi Mayr and Gilliard

Madarasz's Tiger Parrot

NATIVE NAME. Fore: ánko.
SPECIMENS EXAMINED. Awande: 2 ♂, 1 ♀ (16-20 June 1965). Mt. Karimui zone 5: 1 ♀ (30 Aug. 1965).
WEIGHT. 2 ♂: 41.5, 43.0. 2 ♀: 35.3, 36.0.
WING. 2 ♂: 94, 96. 2 ♀: 89, 92.

CULMEN FROM CERE. 2 ♂: 15, 15. 1 ♀: 14.
STOMACH CONTENTS. Granular vegetable remains.

TAXONOMY. The Eastern Highlands race *hallstromi* differs from nominate *madaraszi* of southeastern New Guinea in its slightly larger size, in the slightly darker brown head and throat of the male, and in the slightly darker green back and brighter red and darker black on the nape of the female.

BREEDING. The gonads were small in all specimens.

DISCUSSION. I have no observations of this parrot in life. All were taken singly in forest between 6,000 and 6,500 ft, and one was netted. As mentioned previously, Gilliard and Gyldenstolpe each obtained three specimens, and Shaw-Mayer two.

Loriculus aurantiifrons meeki Hartert

Bat Lorikeet

STOMACH CONTENTS. A white paste or powder (sap?), and fruit.

DISCUSSION. The Eastern Highlands records for this rare little parrot are one female taken at Lake Kutubu (2,450 ft) and assigned to *meeki* by Schodde and Hitchcock; one specimen collected at 4,000 ft in the Lanim Valley by Bulmer; two Nondugl aviary birds examined by Gyldenstolpe, said to be from the Jimmi River; and possible sightings by Terborgh at Karimui in August 1964. The wing beat is rapid, fluttering, and atypical for a parrot.

CUCULIDAE: CUCKOOS

Cuculus saturatus horsfieldi Horsfield and Moore

Oriental Cuckoo

Gilliard collected an adult male of this palearctic migrant at 5,200 ft near Nondugl on 10 May, Bulmer had a possible sighting in Kyaka territory at 4,600 ft in October, and there is one sighting from Baiyer River (N.G.B.S. Newsletter, No. 54, p. 1, June 1970).

Cacomantis variolosus oreophilus Hartert

Gray-breasted Brush Cuckoo

NATIVE NAMES. Fore: petetóbeye. Daribi: sádewe bilong place (= "sádewe of the village": cf. *Cacomantis castaneiventris*).
SPECIMENS EXAMINED. Awande: 1 ♂ (17 June 1965). Karimui: 6 ♂, 2 ♀, 1 imm. ♂, 1 imm. ♀, 1 imm. ? (11 Aug. 1964; 3 July-4 Aug. 1965). Bomai: 1 ♂ (6 July 1965).
WEIGHT. 7 ♂: 32, 33, 35 (3), 36 (2). 2 ♀: 35, 40. 1 imm. ♂: 33. 1 imm. ♂: 35. 1 imm. ?: 39.
WING. 7 ♂: 117 (2), 120, 121 (2), 122, 125. 2 ♀: 112, 121. 1 imm. ♂: 121. 1 imm. ♀: 117. 1 imm. ?: 116.

EXPOSED CULMEN. 6 ♂: 15.5, 16.5, 17.0, 17.5, 18.5, 19.0. 2 ♀: 18.0, 19.0. 1 imm. ♂: 18.5. 1 imm. ?: 14.5.

STOMACH CONTENTS. Insects; less often, insects and fruit.

TAXONOMY. These specimens agree with *oreophilus* in that the bill is stouter than in *infaustus*. Of the three immature Karimui specimens, the male is in nearly adult plumage, with barring remaining only on the belly; the female is more immature, being entirely barred below and barred in a few patches above; while the specimen of indeterminate sex is entirely barred above and below.

BREEDING. Of the eight adult males, the Bomai specimen, the Awande specimen, and three Karimui specimens had small testes, while the other three Karimui specimens had the testes slightly enlarged. Both adult females (from Karimui) contained large eggs nearly ready to lay.

Paran shot the immature Karimui specimen of indeterminate sex while it was being fed by two wren-warblers *Malurus alboscapulatus*, which were also collected and proved to be two immature males. He said that at Awande, too, "asasaba's" (*Malurus alboscapulatus*) were the species that raised "petetóbeye's" (*Cacomantis* cuckoos). *Malurus alboscapulatus* was clearly breeding in the dry season both at Awande and at Karimui (p. 216). The two laying females and the young immature suggest that *Cacomantis variolosus* also breeds in the dry season and has synchronized its breeding to that of its principal host.

DISCUSSION. This cuckoo is conspicuous because of its song, fairly common, and nearly ubiquitous in gardens, second-growth, trees in open country, and towns, ranging up to about 6,300 ft in this habitat. It has surely increased greatly in numbers and spread upward somewhat as a result of clearing of the forest in the Eastern Highlands. The preferred perches of *C. variolosus* are in the middlestory of trees overlooking open spaces. It is most frequently seen at heights of 15-60 ft above the ground, rarely down to 10 ft or up into the crowns of tall trees.

Ecological relationships among the three species of genus *Cacomantis* in New Guinea seem to me simple. *C. variolosus* inhabits open country from sea level up to about 4,000-6,300 ft, the upper limit depending upon the extent of ecological disturbance caused by man. *C. castaneiventris* inhabits the forest interior over much of this same altitudinal range and is found regularly at the upper part of this range in the absence of man but is rare at sea level. *C. pyrrhophanus* inhabits both second-growth and the forest interior from about 5,000 ft upward and in effect takes over the niches of both its congeners at higher elevations. In undisturbed areas altitudinal exclusion of the other two species by *C. pyrrhophanus* seems complete, though there may be marginal overlap in disturbed areas.

VOICE. There are two songs, both unmistakable (Fig. 18). The first is a series of a half dozen similar three-note phrases, the series progressively rising in pitch, accelerating, and becoming louder, as if the singer were becoming progressively more excited. Each three-note phrase is in dotted rhythm and can be represented by the syllables "pe- - -te-to", giving rise to the Fore name "petetóbeye". The whole series consists of four to six repetitions of this basic phrase and lasts up to 5 sec. The other song, which is similar in form to the songs of several species of *Chrysococcyx,* has the same quality but consists of a series of nearly identical notes delivered at the rate of one per second, each note dropping in pitch at the end. The series may remain at constant volume and on constant pitch. It may also progressively drop slightly in pitch and grow louder without accelerating. A bird delivering the second song may break into the "pe- - -te-to" song and then return to the second song, giving the impression of an idling engine occasionally being set into motion. Both songs have the same whistled, shrill quality, carry well in open country, and are among the most characteristic sounds of Karimui station. Once I heard the "pe- - -te-to" song from a bird still in immature plumage.

Cacomantis pyrrhophanus prionurus (Lichtenstein) and *C. p. excitus* Rothschild and Hartert

Fan-tailed Brush Cuckoo

SPECIMENS EXAMINED. Awande: 1 ♀ (17 June 1965).
WEIGHT. 50.
WING. 138.
TAIL. 140.
STOMACH CONTENTS. Insects.

TAXONOMY. The Awande specimen belongs to the Australian race *prionurus,* recognized by its pale cinnamon underparts and dull gray back. It had a small ovary and must have been a winter visitor. Three specimens collected at Nondugl by Gyldenstolpe in August and September 1950 provided the first, and only other, record of this race from New Guinea. It has also been found on migration to the Aru Islands. The resident New Guinea race *excitus* is quite distinct in its dark rufous-brown underparts and dark shining slaty dorsal coloration.

BREEDING. Bulmer recorded one egg in a nest of the wren-warbler *Malurus alboscapulatus,* which is the principal host of *Cacomantis variolosus* at lower elevations; and I observed a juvenile being fed by the warbler *Sericornis nouhuysi.*

DISCUSSION. Gilliard, Gyldenstolpe, Shaw-Mayer, and Bulmer each collected one or two specimens of *C. p. excitus,* and Gilliard reported it "very common," but this is probably true only very locally, as I did not find it either on Mt. Michael or on Mt. Karimui and other observers have generally found it rare. In the Eastern Highlands its altitudinal range is about 5,000 to 9,500 ft, largely above that of the

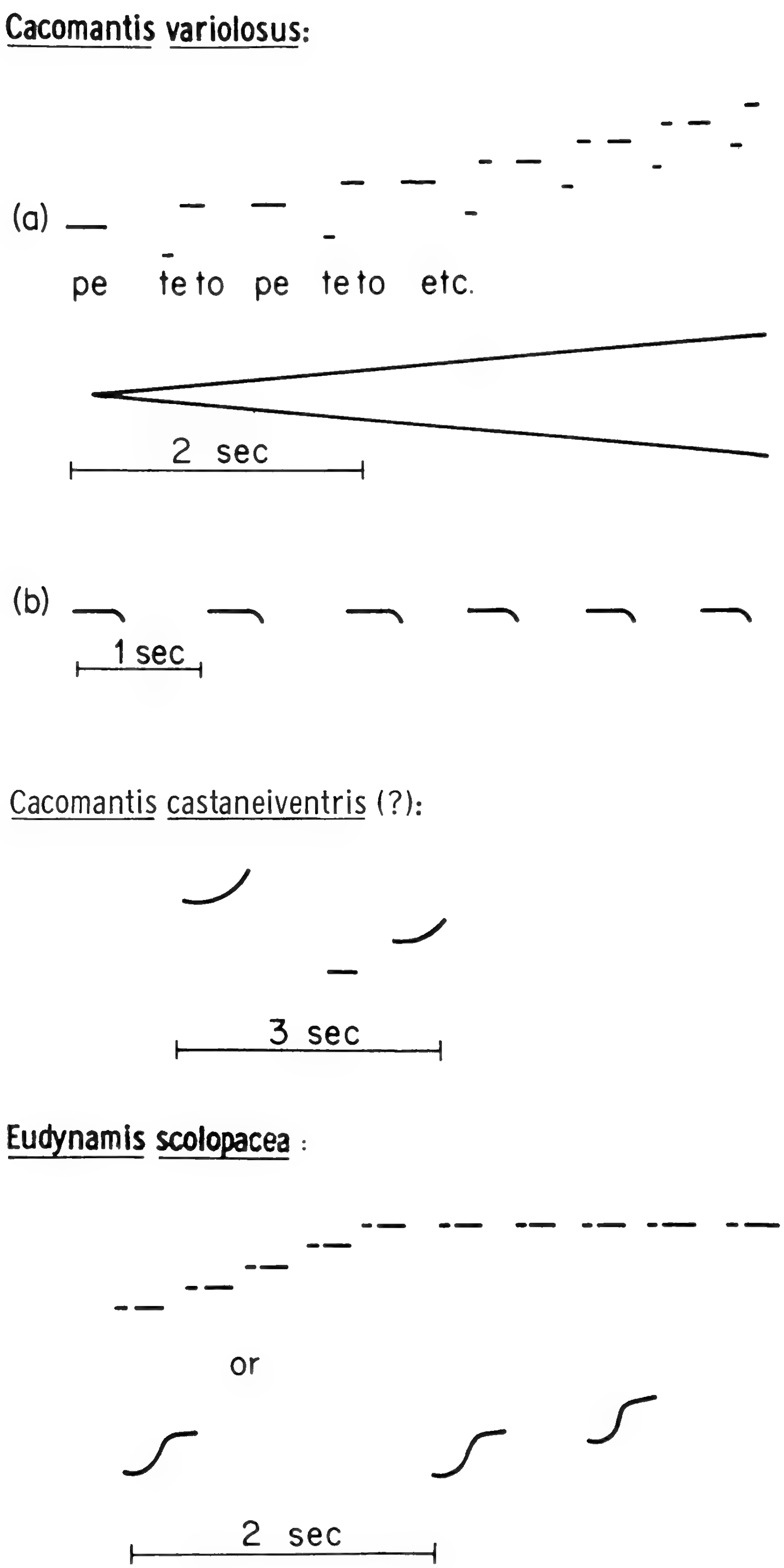


FIG. 18. Voices of three New Guinea cuckoos.

other two *Cacomantis* species. Individuals that I observed were solitary and perched either on the ground or on stumps in forest clearings, or else on large branches up to 50 ft above the ground in open forest. Most of the time they were motionless and perched upright in a thrush-like posture, but one hovered for a few seconds to pluck something from the foliage.

VOICE. A rapid, plaintive trill, descending slightly in pitch, and similar to some calls of the kingfishers *Halcyon megarhyncha* and *H. torotoro* but weaker.

Cacomantis castaneiventris weiskei Reichenow

Chestnut-breasted Brush Cuckoo

NATIVE NAMES. Fore: petetóbeye. Gimi: fétote. Daribi: sádewe bilong bush (= "sádewe of the forest": cf. *Cacomantis variolosus*).

SPECIMENS EXAMINED. Mengino: 1 ♂ (15 July 1964). Karimui: 3 ♂, 3 ♀, 1 imm. ♂ (2 Aug. 1964; 3 July-4 Aug. 1965). Soliabeda: 1 ♂, 1 imm. ♀ (24 and 30 July 1965). Mt. Karimui Zone 1: 1 ♂ (12 Aug. 1965).

WEIGHT. 4 ♂: 32, 36, 37, 38. 3 ♀: 35, 37, 38. 1 imm. ♂: 27. 1 imm. ♀: 34.

WING. 4 ♂: 110, 111, 117, 119. 3 ♀: 107, 112, 114. 1 imm. ♂: 104. 1 imm. ♀: 101.

TAXONOMY. The wing measurements place this series with *weiskei,* which differs from *arfakianus* only in its slightly larger size.

BREEDING. The gonads were small except in the Soliabeda male and a Karimui male and female, which had the gonads slightly enlarged.

DISCUSSION. All 11 specimens were obtained inside the forest, and seven of them were netted, suggesting that this cuckoo spends much time in the understory. One immature male and subadult female were found together in the same net. I never saw the species in life, but song records and reports of natives indicate that it is uncommon, local, and shy, and lives in forest up to about 6,000 ft.

VOICE. Natives attribute a mournful, slow, three-note song at medium-low pitch to this species. The pattern is distinctive: the first and third notes are leisurely and upslurred, the second note shorter, and the first note is higher in pitch and separated by a longer time interval from the second and third (Fig. 18, p. 167). The identification is consistent with the three-note songs described for this species by Stein (1936, p. 49) and by Ripley (1964, p. 36). On the north coast of New Guinea I heard the same song differing only in that the final note was trilled, so that the identification may still be compatible with Rand's description (Mayr and Rand, 1937, p. 63) of the song of *C. castaneiventris* as a "full rich trill."

Genus *Chrysococcyx*[1]

The three resident New Guinea species form an altitudinal sequence in forest, with *C. ruficollis* at the highest elevations, *C. meyerii* at middle elevations, and *C. malayanus* (not yet reported from the Eastern Highlands) at the lowest elevations. An additional species, *C. lucidus,* occurs in open country in the Eastern Highlands as a winter visitor from Australia.

Chrysococcyx lucidus plagosus (Latham)

Golden Bronze Cuckoo

SPECIMEN EXAMINED. Lufa: 1 ♀ (29 June 1964).

DISCUSSION. My sole specimen of this Australian winter visitor was shot from a perch 20 ft above the ground in a lawn casuarina at Lufa Patrol Post (6,300 ft). A modest number of specimens have been obtained by others (four at Nondugl by Gyldenstolpe, one each at Nondugl and in the Kubor Mountains by Gilliard, four in Kyaka territory by Bulmer), suggesting that the species' appearances in the Eastern Highlands are regular.

Chrysococcyx ruficollis (Salvadori)

Mountain Bronze Cuckoo

I did not encounter this cuckoo, which appears to be rare and local in mountain forest between 6,000 and 8,500 ft. The known records in the Eastern Highlands are two specimens collected in the Kubor Range (one each by Gilliard at 7,000 ft and by Hitchcock at 6,400 ft), one on Mt. Wilhelm at 8,500 ft by Gilliard, and one at 6,000 ft on the north slope of Mt. Hagen by Bulmer.

Chrysococcyx meyerii Salvadori

Meyer's Bronze Cuckoo

SPECIMENS EXAMINED. Awande: 1 ♀ (19 June 1965). Soliabeda: 1 ♂ (23 July 1965).

WEIGHT. 1 ♂: 19.3. 1 ♀: 20.7.

WING. 1 ♂: 90. 1 ♀: 92.

DISCUSSION. Meyer's Bronze Cuckoo is solitary and uncommon but widespread up to 5,000 ft, rarely up to 6,000 ft, and has been encountered by most collectors. It is found in the forest or at the forest edge but seems to prefer the latter. In the field this cuckoo suggests a sluggish flycatcher in its behavior. It moves slowly in the middlestory, usually 15 to 40 ft above the ground, catching insects.

[1] Listed as *Chalcites* in Rand and Gilliard (1967).

VOICE. A series of six or seven identical notes at intervals of about 1 sec or less, each note dropping slightly in pitch at the end. The pitch is high, the quality plaintive and clear, the volume soft. In pattern this resembles the second song of *Cacomantis variolosus* but is much weaker in volume and slightly more leisurely in tempo, precluding the possibility of confusion. The song of *Chrysococcyx lucidus lucidus,* which I heard in New Zealand, is similar in pattern. Published descriptions of the songs of *C. ruficollis* (Stein, 1936), *C. basalis* (Cayley, 1959), and *C. lucidus plagosus* of Australia (Cayley, 1959) are also similar, but that of *C. malayanus* (Cayley, 1959) is apparently quite different.

Eudynamis parva parva Salvadori[1]

Black-capped Koel

SPECIMENS EXAMINED. Mengino: 1 imm. ♂ (15 July 1964). Okasa: 1 ♂, 1 ♀ (a) (24 June 1965). Karimui: 1 ♀ (b) (4 Aug. 1965).
WEIGHT. 1 ♂: 40. 2 ♀: 49 (a), 40 (b).
WING. 1 ♂: 102. 2 ♀: 104 (a), 100 (b). 1 imm. ♂: 105.
STOMACH CONTENTS. Fruit.

TAXONOMY. The coloration of these birds is not gray but instead is rufous, placing them with the race nominate *parva* (*grisescens* is restricted to northern New Guinea). The iris was red. The immature male from Mengino has the throat already orange-brown, as in the adult male, rather than gray, as in the female and immature male; the mustache stripe is charcoal but not yet the steely blue of the adult male; the gray stripe between the eye and mustache is already ochraceous posteriorly; the crown is still dark brown, with just a few scattered steely blue feathers.

BREEDING. The Okasa male and female, a pair shot from the same tree, both had enlarged gonads.

DISCUSSION. The above specimens constitute the sole Eastern Highlands records of this very uncommon cuckoo. The Mengino specimen was shot 50 ft above the ground in a fruit tree at 4,600 ft in open second-growth forest near a river, at the upper limit of the species' altitudinal range. In addition to these specimens, a pair was seen in the middlestory of a tree at Karimui.

VOICE. The song, delivered from a treetop perch, is similar to the common song of *Eudynamis scolopacea* (Fig. 18, p. 167) but weaker: a series of pairs of notes, each pair louder and on a higher pitch than the previous pair. The elements are sometimes three repeated notes or else single downslurs rather than a pair of notes. Another variant is a series of identical upslurs at 1½-sec intervals, similar to the voice of *Cacomantis variolosus* in quality.

1 Listed as *Microdynamis parva* in Rand and Gilliard (1967); see Mayr (1944).

Eudynamis scolopacea rufiventer (Lesson)

Indian Koel

SPECIMENS EXAMINED. Karimui: 1 ♂ (11 Sept. 1965).
WING. 185.
STOMACH CONTENTS. Fruit, 9-11 mm in diameter.

TAXONOMY. The small size places the specimen with *rufiventer,* the breeding race of most of New Guinea, rather than with *subcyanocephala,* which is in southern New Guinea as a wintering visitor from Australia and as a resident (Rand, 1941). Females of these two races are quite distinct in plumage. Cuckoos agreeing closely with the female of *rufiventer* were seen but not collected at Karimui.

BREEDING. The testes were somewhat enlarged.

DISCUSSION. The Indian Koel was heard or seen nine times at Karimui in August 1964. In 1965 the only records were of the specimen (11 Sept.) and of a song heard on 15 Sept. I was particularly interested in tracing the unmistakable song and am certain that I did not hear it in the dry months of June, July, or August 1965. Probably local migration within New Guinea is involved. All Koels seen were solitary, and were either feeding in the middlestory of fruit trees, or else singing from commanding perches at the tops of very tall trees overlooking open spaces. Eastern Highlands records of this tropical species are lacking except at Karimui.

VOICE. There are four types of vocalizations, all loud. The common song is a series of about a dozen pairs of notes, the first note of each pair on the same pitch as the second but shorter (Fig. 18, p. 167). Successive pairs rise in pitch and increase slightly in volume. The whole song lasts about 5 sec. Another song consists of three upslurs, the second following 2 sec after the first and on the same pitch, the third 1 sec after the second and on a slightly higher pitch (Fig. 18). Each upslur has a sense of forward momentum and sounds as if it came from a bird much larger than the Koel. A single such slur is sometimes given as a call. The common alarm note is a rapidly repeated, musical, emphatic, staccato note "whik-whik-whik . . ." reminescent of *Paradisaea minor.* An alternative alarm note is a disagreeable upslur.

Caliechthrus leucolophus (Müller)

White-crowned Koel

NATIVE NAME: Daribi: poíba.
SPECIMENS EXAMINED: Karimui: 1 ♂ (17 July 1965). Mt. Karimui Zone 4: 1 ♂ (28 Aug., 1965).
WEIGHT: 2 ♂: 113, 125.
WING. 2 ♂: 169, 175.
STOMACH CONTENTS. Large insects.

BREEDING. Both specimens had small testes.

DISCUSSION. These two specimens provide the sole records for this low-altitude treetop cuckoo in the Eastern Highlands. Elsewhere in New Guinea, too, the species is local, being common in a few areas and absent in others. The Karimui bird was perched alone in a tree at the edge of a clearing. The Mt. Karimui bird, one of two in adjacent trees in primary forest, was collected at 5,700 ft, which is unusually high for the species. Daribi natives said that it occurs regularly in the Karimui area.

VOICE. According to natives, three or four loud rapid notes on the same pitch.

Centropus menbeki menbeki Lesson

Greater Coucal

NATIVE NAME. Daribi: píni.

SPECIMENS EXAMINED. Karimui: 2 ♂, 1 ♀ (13 and 14 July 1965). Bomai: 1 ♀ (7 July 1965). Soliabeda: 1 ? (22 July 1965).

WING. 2 ♂: 212, 243. 2 ♀: 230, 235.

TAIL. 2 ♂: 343, 366. 2 ♀: 340, 345.

EXPOSED CULMEN. 2 ♂: 46, 47. 2 ♀: 49, 51.

CULMEN FROM BASE. 2 ♂: 49, 52. 2 ♀: 57, 58.

STOMACH CONTENTS. Insects.

TAXONOMY. All specimens have the plumage unbarred. The iris was red, and the bill whitish.

BREEDING. Both males had two testes, which were small.

DISCUSSION. There are no Eastern Highlands records for the Greater Coucal other than from the Karimui area, where it was uncommon. The presence at Karimui (3,650 ft) and on the lower slopes of Mt. Karimui (up to 4,200 ft) is somewhat above the normal altitudinal range of the species. It ranges from the ground to about 50 ft above the ground, and has a characteristic habit of clumsily hopping up the trunk of a small tree, switching its long tail from side to side as it goes. The Soliabeda specimen was surprised while trying to eat two small birds out of our mistnets.

Although *C. menbeki* and *C. phasianinus* both may be found in second-growth, their average habitat preferences are different: *C. phasianinus* is mainly found in grassland, while *C. menbeki* (but never *C. phasianinus*) occurs in the forest. In addition to these differences in habitat preference, it is surprising how infrequently the two species even occur in the same locality.

VOICE. The common call is a series of about four hollow, booming, sometimes disyllabic notes "hoo" or "coo-a", similar in quality to the calls of *Macropygia nigrirostris* or species of *Ptilinopus*. This call may be heard for some time after sunset. Less frequently heard is a peculiar and totally unmusical call consisting of a staccato upslurred grunt like the croak of a bullfrog, followed by a dry, rapid, rattled series of notes rising in pitch.

Centropus phasianinus propinquus Mayr

Pheasant Coucal

DISCUSSION. The only definite Eastern Highlands records of this grassland coucal are from the grassland of the Baiyer Valley, where Gilliard and Bulmer collected it and Bell found it common up to about 5,000 ft. In addition, native informants told Bulmer that it occurs in the Kaironk Valley of the Schrader Range up to 5,500 ft and near Banz. Elsewhere in New Guinea *C. phasianinus* is confined to altitudes generally below 2,500 ft, and it has not colonized the Baliem Valley grasslands of western New Guinea. However, the large expanses of grassland in the Eastern Highlands appear to be ideal habitat for it, and it will be interesting to see whether it succeeds in colonizing other parts of the Eastern Highlands besides the Baiyer Valley.

VOICE. A series of dull, hollow, booming notes which accelerate in tempo, similar in quality to the call of *C. menbeki.*

TYTONIDAE: BARN OWLS

Niche Differences in the Genus *Tyto*

The three species of *Tyto* in the Eastern Highlands sort out by habitat: *T. tenebricosa* in forest (and alpine grassland), *T. alba* in disturbed habitats, *T. capensis* in midmontane grassland.

Tyto alba meeki (Rothschild and Hartert)

Barn Owl

NATIVE NAME. Fore: waiyimpómpo.
SPECIMENS EXAMINED. Awande: 2 ♂ (1 and 4 July 1967).
WING. 276, 278.

DISCUSSION. The specimens were collected from second-growth trees in the Okapa area where I also saw an individual at sunset flying at the edge of the forest and uttering monosyllabic screams. The Barn Owl is generally distributed in low numbers through the Eastern Highlands (other records by Gilliard, Gyldenstolpe, and Bulmer).

Tyto tenebricosa arfaki (Schlegel)

Sooty Owl

NATIVE NAME. Fore: ósi.
STOMACH CONTENTS. A ball of hair with skulls of small mammals.

DISCUSSION. The Fore knew of only one pair of this little-known forest barn owl living within a wide radius of Okapa. Shaw-Mayer collected one individual each at 8,500 ft in the Hagen Range and the Lamende Range, Gilliard collected a young bird at 7,000 ft in the Kubor Range, and there are records of two birds brought into Nondugl aviaries. On Mt. Albert-Edward I found an individual sleeping during the day in a hole under the roots of a forest tree.

Van Deusen (pers. comm.) analysed bones in the regurgitated pellets of two individuals of *Tyto tenebricosa* and kindly provided the following details, which offer valuable insight into its diet. The first set of pellets was found under a boulder in alpine grassland on Mt. Wilhelm at 12,000 ft. The three major prey species were the rats *Rattus niobe* and *Pogonomelomys* sp., and, to a lesser extent, the bandicoot *Peroryctes longicauda*. All three live in alpine grassland. There were also a few bones of the small marsupial *Eudromicia caudata* from the adjacent subalpine forest, the rats *Neohydromys* sp. and *Pogonomys* sp., the large wallaby *Thylogale bruijni* (probably taken as carrion from wild dog kills), and an unidentified bird. The second set of pellets came from a boulder roost at the edge between forest and grassland at 7,800 ft in the Cromwell Mountains. The dominant prey species proved to be the common arboreal forest marsupial *Pseudocheirus forbesi*. Other prey included the giant rats *Hyomys* sp. and *Mallomys* sp., the small forest rat *Anisomys* sp., the rat *Rattus exulans,* three forest marsupials (the bandicoot *Peroryctes raffrayanus,* the flying phalanger *Petaurus breviceps,* the wallaby *Dorcopsulus vanheurni*), the large wallaby *Thylogale bruijni* (probably taken as carrion), the forest bats *Nyctimene* sp. and *Syconycteris* sp., and unidentified birds.

VOICE. According to natives, a long, high-pitched, slightly downslurred note, suggestive of the neighing of a horse.

Tyto capensis papuensis Hartert

Grass Owl

Of the three barn owls occurring in the Eastern Highlands, this seems to be the least uncommon. Gilliard, Gyldenstolpe, and Shaw-Mayer all observed it over grassland and obtained two specimens each. It has also been discovered in western New Guinea in the grassland of the Baliem Valley by Ripley (1964).

STRIGIDAE: OWLS

Ninox theomacha theomacha (Bonaparte)

Papuan Boobook Owl

NATIVE NAME. Fore: atóku.
SPECIMENS EXAMINED. Karimui: 1 ♂ (12 July 1965).

WING. 186.
STOMACH CONTENTS. Insects 25 mm long, and a few mammal hairs.

BREEDING. The testes were small.

DISCUSSION. The specimen was caught in a mistnet inside the forest at Karimui. I heard the call of this owl, which is the commonest nocturnal bird call in New Guinea forests, from the forest and forest edge up to 6,450 ft on Mt. Karimui. Other Eastern Highlands records are from Lake Kutubu (Schodde and Hitchcock), the Baiyer Valley (Bulmer), Kup (Gilliard), and 8,200 ft in the Hagen Range (Shaw-Mayer).

VOICE. Two identical downslurred notes at an interval of slightly less than 1 sec, resembling the call of *Ninox novaeseelandiae* which I heard in New Zealand. On different occasions I recorded the call as "kyew kyew" or "hyew-ew hyew-ew" or "kru kru."

PODARGIDAE: FROGMOUTHS

Podargus papuensis Quoy and Gaimard

Great Papuan Frogmouth

NATIVE NAMES. Fore: yása. Daribi: úni.

DISCUSSION. *Podargus papuensis* is rarely seen but is widespread through the Eastern Highlands in low numbers in forest and in isolated trees up to about 7,000 ft. My sole observation was in daylight at Karimui, when my Fore assistants pointed out to me a bird which had been disturbed by their approach. It was perched motionless and upright, with its head turned towards us, 30 ft above the ground in a tall tree at the edge of a clearing. This frogmouth sometimes sits with its mouth wide open for long periods, with a sticky substance on its palate that might serve to attract or trap insects.

Podargus ocellatus ocellatus Quoy and Gaimard

Little Papuan Frogmouth

NATIVE NAME. Fore: atóku.
SPECIMENS EXAMINED. Okasa: 1 ♂ (22 June 1965). Karimui: 4 ♀ (15 Aug. 1964; 3-16 July 1965). Bomai: 1 ♀ (9 July 1965).
WEIGHT. 2 ♀: 140, 141.
WING. 1 ♂: 184. 5 ♀: 173, 176, 178, 179, 187.

TAXONOMY. All specimens are in the red-brown phase.

BREEDING. All had small gonads, suggesting that breeding is limited to the wet season.

DISCUSSION. Two of the specimens were netted in the forest; one was caught by hand while sleeping on a branch during the day; and three were shot also while sleeping on branches during the day, one of these being in a group of three. I never observed this frogmouth in the field, but, to judge from the number of specimens, it may be the least uncommon nocturnal bird in forest up to about 5,000 ft. Bulmer and Gyldenstolpe secured one specimen each.

AEGOTHELIDAE: OWLET-NIGHTJARS

Aegotheles bennettii terborghi Diamond

Collared Owlet-nightjar

SPECIMENS EXAMINED. Karimui: 1 ♂ (16 Aug. 1964).
WING. 154.
TAIL. 122.

DISCUSSION. The unique type of this very distinct race was caught by hand by a Karimui native, who found it sleeping in a tree during the day. It differs from other races most notably in its larger size (wing and tail 25% longer than in nominate *bennettii,* the other southern New Guinea race) and in its much darker, blacker upperparts (see Diamond, 1967a, p. 6 for diagnosis). It represents an altitudinal record for this lowland species, and is of interest in illustrating evolutionary divergence in lowland birds isolated in the Karimui Basin as well as the tendency of these populations towards darker plumage (p. 56).

Aegotheles wallacii wallacii Gray

Wallace's Owlet-nightjar

SPECIMENS EXAMINED. Karimui: 1 ♂ (1 July 1965).
WEIGHT. 48.5.
WING. 122.
TAIL. 109.

TAXONOMY. Comparative measurements of all 23 specimens known of this species have been summarized elsewhere (Diamond, 1969). The Karimui specimen completely lacks a light collar on the hindneck, of which there are suggestions in some *gigas* and *manni* specimens. The light buffy V-shaped mark on the forehead is about as distinct as in the one available specimen of nominate *wallacii* from the Vogelkop and more distinct than in the one available *wallacii* specimen from the Aru Islands. The lower belly is palest and has the fewest markings in the Vogelkop specimen. The loose arrangement of white dots on the undersurface of the tail into bands is least distinct in the Karimui specimen.

DISCUSSION. This is a rare species with a very local distribution, recorded near sea level in the Aru Islands, southwestern New Guinea, and the Vogelkop and at medium elevations in the Weyland Mountains, North Coastal Range, and Karimui. The Karimui specimen represents a range extension to the east.

Aegotheles albertisii salvadorii Hartert

Mountain Owlet-nightjar

NATIVE NAMES. Fore: atóku. Gimi: maúla.

SPECIMENS EXAMINED. Awande: 1 ♀, 1 juv. ? (15 and 18 June 1965). Okasa: 2 ♂ (22 and 25 June 1965).

WEIGHT. 2 ♂: 36, 39. 1 ♀: 37. 1 juv. ?: 25.

WING. 2 ♂: 112, 114. 1 ♀: 123. 1 juv. ?: 106.

TAIL. 2 ♂: 93 +, 96. 1 juv. ?: 66.

STOMACH CONTENTS. Insects.

TAXONOMY. The type of *Aegotheles archboldi* differs in its richer dorsal coloration, coarser white spots on the back, and coarser and darker breast markings. Since both *A. albertisii* and *A. archboldi* exist in two color phases and show much individual variation and since the complex plumage patterns defy simple description, identification in the absence of comparative material is impossible.

BREEDING. The testes were large in one Okasa male, small in the other.

DISCUSSION. This aegothelid was also collected by Gilliard, Gyldenstolpe, and Shaw-Meyer, and is common but secretive in forest from about 4,500 to 8,500 ft. Two of the adults were netted, two others were seen flying out of holes in trees when disturbed during the day, and the juvenile was caught by hand in a garden.

The relations among the small midmontane forest aegothelids of the *albertisii-archboldi* complex remain to be clarified. *A. archboldi* was originally described as a race of *A. albertisii.* Proceeding from west to east in the mountains of New Guinea, the distribution of the populations is as follows: *A. albertisii albertisii,* Vogelkop; *A. albertisii wondiwoi,* Wandammen Peninsula; *A. albertisii salvadorii,* Weyland Mountains to Wissel Lakes; *A. archboldi,* Wissel Lakes to Mt. Wilhelmina; *A. albertisii salvadorii,* Mt. Goliath; *A. archboldi,* Telefolmin; and *A. albertisii salvadorii,* Eastern Highlands, Huon Peninsula, and southeast New Guinea. The only locality where both *A. albertissi* and *A. archboldi* have been taken is the Wissel Lakes. As Ripley (1964) points out, the altitudinal range of *A. albertisii* (ca. 3,800-8,600 ft, combining various records in the literature) is on the average lower than that of *A. archboldi* (ca. 7,000-12,000 ft, except for a native-procured Telefolmin specimen listed (Gilliard and LeCroy, 1961, p. 43) as from 4,800 ft but probably from an unknown elevation. Thus, the geographical distributions are disjunct and largely but not completely complementary ("checkerboard allopatry," p. 39), and the altitudinal ranges are possibly complementary in the areas of local overlap.

Aegotheles insignis insignis Salvadori

Large Owlet-nightjar

NATIVE NAMES. Fore: atóku. Gimi: maúla.
SPECIMENS EXAMINED. Mt. Karimui Zone 3: 1 ♀; Zone 4: 1 ♂; Zone 8: 1 ♂, 1 ♀ (17 Aug.-6 Sept. 1965).
WEIGHT. 2 ♂: 75, 79. 2 ♀: 77, 82.
WING. 2 ♂: 157, 163. 2 ♀: 160, 165.
STOMACH CONTENTS. Insects.

TAXONOMY. Three of the specimens are in the dark phase, while the Zone 8 male is intermediate between the dark phase and light phase. Gilliard and LeCroy (1961, p. 43) point out that dark phase plumage probably succeeds light phase plumage in the same individual.

BREEDING. Both males had the testes slightly enlarged.

DISCUSSION. All four specimens were caught in mistnets between 5,000 and 7,900 ft. Other collectors in the Eastern Highlands have also found the species at most collecting stations in forest between about 4,000 and 8,500 ft, a range which *A. insignis* shares with *A. albertisii*. Niche differences probably are related to size, since *A. insignis* is twice as heavy as *A. albertisii*.

CAPRIMULGIDAE: GOATSUCKERS

Caprimulgus macrurus yorki Mathews

White-tailed Nightjar

NATIVE NAMES. Fore: k'ru-k'rúnta.
STOMACH CONTENTS. Insects.

BREEDING. Three "nests" were found: sets of two coffee-colored eggs with sparse, small, light grey-brown blotches, measuring 30-34 × 22-23 mm, laid directly on the ground.

DISCUSSION. This goatsucker was heard calling from grassland and gardens at Miarosa (5,800 ft), Okapa (6,600 ft), and Mengino (6,150 ft), but not at my other stations. In particular, despite the vast expanses of grassland at Okasa, and despite the number of lowland species that have colonized Karimui, I found it at neither locality and presume it to be absent because its distinctive, frequently-given call could not have been missed. The experience of other observers in the Eastern Highlands indicates an equally spotty distribution. The clearing of the forest has permitted this lowland species to spread up to the newly created midmontane grassland not only in the Eastern Highlands but also at Telefolmin (Gilliard and LeCroy, 1961, p. 43) and in the Baliem Valley of western New Guinea (Rand, 1942b, p. 457; Ripley, 1964, p. 40). It emerges just after sunset to hawk for insects in cleared areas.

VOICE. Several (usually two or three) identical metallic notes "tuck" separated by intervals of slightly less than 1 sec. The quality may be compared to a human clicking the tongue against the palate, or to an anvil being struck with a hammer. The call carries a half mile across the grassland on a still night.

Eurostopodus mystacalis mystacalis (Temminck)[1]

White-throated Nightjar

SPECIMENS EXAMINED. Soliabeda: 1 ♂ (21 July 1965).
WEIGHT. 145.
WING. 234.
TAIL. 148.

BREEDING. The testes were small.

DISCUSSION. The specimen was shot while hawking over Soliabeda village at dusk. The only other Eastern Highlands record of this Australian migrant is of a single individual taken at Kup (5,000 ft) on 15 May 1952 (Mayr and Gilliard, 1954). All New Guinea records are from the eastern half of the island except for one bird taken at the Idenburg River by the Third Archbold Expedition. At Lake Kutubu Schodde and Hitchcock observed *Eurostopodus* nightjars without large white marks in the tail or wing and tentatively identified them as *E. papuensis,* but this description might also fit *E. mystacalis.*

Eurostopodus archboldi (Mayr and Rand)

Archbold's Nightjar

STOMACH CONTENTS. Large insects, including a cicada.

DISCUSSION. Four specimens of this rare high-altitude nightjar have been taken in the Eastern Highlands: one at 10,000 ft in moss forest on Mt. Hagen (Mayr and Gilliard, 1954, p. 342), one at 8,000 ft on Mt. Hagen, and two at 7,300-7,500 ft on Mt. Giluwe (Sims, 1956, 407). In 1964 the Seventh Archbold Expedition obtained a single specimen on the Huon Peninsula, whence the species had not previously been recorded. Only eight other specimens have been reported: the type series of three from 7,900 ft on Mt. Tafa, southeastern New Guinea (Mayr and Rand, 1935, p. 4); a specimen I collected at 8,200 ft on Mt. Albert-Edward, southeastern New Guinea; three from about 10,600 ft in the Lake Habbema area of western New Guinea (Rand, 1942b, p. 457); and one from 7,500 ft in the Ilaga Valley of western New Guinea (Ripley, 1964, p. 40). The geographical range is thus extensive, but the distribution is extremely spotty. My Mt. Albert-Edward specimen was one of a pair hawking silently in a forest clearing at dusk, flying from just above the treetops to about 30 ft above the ground and periodically perching on a dead tree.

[1] Listed as *Eurostopodus albogularis* in Rand and Gilliard (1967).

APODIDAE: SWIFTS

[*Chaetura novaeguineae* subsp.]

New Guinea Spine-tailed Swift

Gyldenstolpe (1955, p. 69) included this species in the Eastern Highlands avifauna on the strength of seeing "numbers of large swifts—presumably representing the above-mentioned species" along with the smaller *Collocalia esculenta* at Nondugl. *Chaetura novaeguineae* has apparently been collected only in the lowlands, whereas another large swift, *Collocalia whiteheadi,* has been collected in the Wahgi Valley. The sight record of *Chaetura novaeguineae* based on size is therefore presumed to be a case of misidentification.

Collocalia esculenta esculenta (Linnaeus)

Glossy Swiftlet

NATIVE NAME. Fore: kísabe.
SPECIMENS EXAMINED. Awande (6,000 ft): 1 ♂ (25 Aug., 1964). Sena River (4,500 ft): 1 ♀ (27 July 1964). Soliabeda (1,350 ft): 1 ? (26 July 1965). Mt. Karimui Zone 5 (6,400 ft): 1 ♂ (28, Aug. 1965).
WEIGHT. 1 ♂ (6,400 ft): 8.0. 1 ? (1,350 ft): 7.3.
WING. 2 ♂: 106 (6,000 ft), 109 (6,400 ft). 1 ♀: 102 (4,500 ft). 1 ?: 98 (1,500 ft).
STOMACH CONTENTS. Insects.

TAXONOMY. This small series illustrates the clinal increase in size with altitude which emerges more clearly from larger series (e.g., Archbold, Rand, and Brass, 1942, p. 285).

BREEDING. The gonads were small in these specimens. Three nests were found under overhanging boulders beside streams. The nests were crude cups of moss 10 cm in diameter and 8 cm deep, and contained two young. An adult gathered moss for one of these nests by repeatedly hovering to pick it off the bark of a tree.

DISCUSSION. The habitat preferences of this swiftlet depend upon altitude. Above 5,000 ft *C. esculenta* may be seen over almost any kind of habitat (midmontane grassland, gardens, second-growth, primary forest, alpine grassland) up to 12,000 ft. At these higher elevations it sometimes forms mixed flocks with *C. hirundinacea,* but on the average *C. esculenta* forages nearer the ground and closer to vegetation, *C. hirundinacea* usually higher and more in the open, though under misty conditions *C. hirundinacea* may also forage within a few feet of the ground. *C. esculenta* generally flies below the level of the treetops, occasionally even inside the forest in more open areas, and circles and skims close to the foliage. In the hill forest below 4,500 ft in the parts of the Eastern Highlands I studied, *C. esculenta* is strikingly and absolutely confined to river gorges. Thus, in the vicinity of Karimui (3,650 ft) and Bomai (3,250 ft) airstrips *C. hirundinacea* was present daily in flocks of dozens, sometimes over a hundred birds, at any height down to nearly ground level, but not once did I see *C. esculenta* in these flat cleared areas. A few hundred feet away *C. esculenta* reappeared as the only swift in the river gorges at the edge of these two airstrips. Similarly, *C. esculenta* was the only swift at our 4,500 ft camp on the Sena River, in the river gorges between Karimui and Soliabeda, and in the Wi River gorge at 1,350 ft below Soliabeda, where the one Soliabeda specimen was collected, but the species was absent from the rolling terrain 500 ft above the Wi River, where Soliabeda village itself was located. At Lake Kutubu (2,450 ft) Schodde and Hitchcock (1968, p. 35) also noted ecological segregation between *C. esculenta* and the other swiftlet present (*C. vanikorensis* or *C. hirundinacea*), with the former confined to a river and nearby forest glades, the latter over cleared areas distant from primary forest.

Collocalia hirundinacea hirundinacea Stresemann

Mountain Swiftlet

NATIVE NAME. Daribi: hawáiyabo.

SPECIMENS EXAMINED. Karimui: 7 ♂, 10 ♀, 4 ? (2-16 July 1965). Bomai: 1 ♂ (7 July 1965).

WEIGHT. 7 ♂: 8.7, 9.0 (3), 9.3 (2), 10.0. 9 ♀: 8.0, 9.0 (7), 9.3. 2 ?: 9.0 (2).

WING. 8 ♂: 105-113 (109 ± 3). 10 ♀: 105-111 (109 ± 2). 4 ?: 110, 111, 111, 113.

STOMACH CONTENTS. Insects.

TAXONOMY. *Collocalia hirundinacea* and *C. vanikorensis* are impossible to distinguish in the field and very difficult in the hand. Characters that I found useful are that *C. vanikorensis* has a slightly larger (wider and longer) bill; most but not all *C. hirundinacea* have feathered tarsi, and most but not all *C. vanikorensis* have unfeathered tarsi; *C. vanikorensis* tends to be more brown on the uppersurface and undersurface, while *C. hirundinacea* tends to have more of a blue sheen above (especially on the head) and to be more gray and paler below; and *C. hirundinacea* shows more white at the base of the dorsal feathers when the back is ruffled. All specimens collected at Karimui and Bomai proved to be *C. hirundinacea.*

DISCUSSION. The sex ratio changed progressively throughout July 1965. Only males were taken on 2, 3, 4, and 7 July. On 10 July one male and three females were taken; on 11 July one male and one unsexed bird. Only females were taken on 12, 14, 15, and 16 July.

Flocks of brown swiftlets which must have been either this species or *C. vanikorensis* (as opposed to the blue *C. esculenta*) were observed daily over airstrips, grassland, and cleared land from 2,000 ft up to alpine grassland at 11,000 ft. In general, *C. hirundinacea* is found at higher elevations, *C. vanikorensis* at lower elevations. Since my Karimui and Bomai specimens were all *C. hirundinacea,* I presume that those from the higher stations, where no specimens were taken, were also *C. hirundinacea.* As discussed under the preceding species, habitat segregation between *C. hirundinacea* and *C. esculenta* was strict at lower elevations, but mixed flocks occurred at higher elevations.

VOICE. A high-pitched twittering.

Collocalia whiteheadi nuditarsus Salomonsen

Whitehead's Swiftlet

The only Eastern Highlands records are four specimens collected by Gilliard at 5,000-6,000 ft in the Kubor Mountains, plus breeding records at 6,000 ft in the Kaironk Valley of the Schrader Range (Bulmer, pers. comm.). Somadikarta (1967) was the first to recognize that the Idenburg River swiftlets, formerly placed in the same subspecies as the populations now known as *nuditarsus,* actually belong to a distinct species, *C. papuensis.* Whether *nuditarsus* is actually conspecific with *C. whiteheadi* of the Philippines is uncertain.

HEMIPROCNIDAE: CRESTED SWIFTS

Hemiprocne mystacea mystacea (Lesson)

Mustached Swift

NATIVE NAMES. Gimi: arakáda. Daribi: gébisige.

SPECIMENS EXAMINED. Karimui: 1 ♀ (4 Aug. 1965). Bomai: 2 ♂, 2 ♀ (6-8 July 1965).

WEIGHT. 2 ♂: 69, 73. 3 ♀: 72, 73, 74.

WING. 2 ♂: 225, 240. 3 ♀: 229, 232, 234.

STOMACH CONTENTS. Insects.

BREEDING. All the Bomai specimens (collected in July) were in nonbreeding condition, while the Karimui female (collected in August) had enlarged ovaries.

DISCUSSION. I found this striking bird only in the Karimui region, up to 4,500 ft (Soliabeda, Bomai, Karimui, Sena River), where its distribution seemed local—i.e., it was uncommon and seen irregularly except at Bomai, where several were seen every day in a particular garden. Group of two to four birds, occasionally solitary individuals, occupied conspicuous perches in open areas in the crowns of tall trees with little foliage, from which they sallied out, circled briefly with strong, falcon-like flight, and returned to the same perch. The Soliabeda, Bomai, and Karimui birds were in highly disturbed habitats (gardens and other areas which had been extensively cleared but had a few tall trees remaining). The Sena River record was in undisturbed forest, where a pair used a tall tree on the bank overlooking the open space over the river as a perch. Gyldenstolpe (1955, p. 72) once saw one individual of *H. mystacea* over Nondugl (5,200 ft), and Bulmer mentions it as present below 5,000 ft in the Schrader Range.

H. mystacea is worth citing as an example of a low-elevation species that has failed to colonize Eastern Highlands garden areas above 5,000 ft, although the nature of the habitat seems to correspond well to its normal lowland habitat and although the colonization would have necessitated only a small step above its normal altitudinal range, which extends to ca. 4,000 or 4,500 ft.

VOICE. The call is a high downslur, nearly a squeal.

ALCEDINIDAE: KINGFISHERS

Ceyx azureus lessonii (Cassin) and *C. a. ochrogaster* (Reichenow)[1]

Azure Kingfisher

SPECIMENS EXAMINED. Sena River: 1 ♂, 1 ♀ (26 and 27 July 1964).
WING. 1 ♂: 73.
STOMACH CONTENTS. Insects.

TAXONOMY. The darker ochraecous wash of the underparts places the specimens with the southern New Guinea race *lessonii,* to which the Lake Kutubu population also belongs. Sims (1956) assigned a female taken at Minj (5,000 ft) in the Wahgi Valley by Shaw-Mayer to the northern New Guinea race *ochrogaster.*

DISCUSSION. This kingfisher lives near small streams, including brooks as little as 2 ft across, or in the understory of the forest. All individuals that I saw were solitary and perched within 5 ft of the ground. Periodically a perched bird quickly raises and lowers its whole body while holding its legs in place, an action comparable to a man on horseback "posting" in the saddle when the horse is in the trotting gait, and similar to the "posting" of *Salpinctes obsoletus* (Troglodytidae) of North America and *Xenicus gilviventris* (Acanthisittidae) of New Zealand. The purpose of the action is probably to assist vision by obtaining a different perspective or estimating distance by parallax.

Ceyx lepidus solitarius Temminck

Dwarf Kingfisher

SPECIMENS EXAMINED. Karimui: 1 ♂, 2 ? (6 Aug. 1964; 9 July-3 Aug. 1965). Soliabeda: 1 ♂, 1 ♀ (25 July, 1965).
WEIGHT. 2 ♂: 13.3, 14.5. 1 ♀: 14.0. 1 ?: 13.0.
WING. 3 ♂: 52, 53, 53. 1 ♀: 55. 1 ?: 52.
STOMACH CONTENTS. Insects.

BREEDING. The gonads were small in all specimens, implying that breeding is not in the dry season.

DISCUSSION. There seem to be no other Eastern Highlands records yet of this tiny kingfisher, but it will undoubtedly turn up

1 Listed as *Alcyone azurea* in Rand in Gilliard (1967).

elsewhere below 4,000 ft. In the Karimui region it was uncommon and solitary in the understory of the forest interior and forest edge, up to about 15 ft above the ground. Often it occurs away from water, but I saw one pair perched on a branch above a small brook, periodically plunging into the water directly beneath them and immediately returning to the same perch. Like *Ceyx azureus, C. lepidus* periodically "posts" up and down on its legs.

Melidora macrorhina macrorhina (Lesson)

Hook-billed Kingfisher

NATIVE NAME. Daribi: sugabá.
SPECIMENS EXAMINED. Karimui: 2 ♂, 1 ? (6 and 8 Aug. 1964; 3 July 1965). Bomai: 1 ♂, 1 ♀ (6 and 7 July 1965). Soliabeda: 2 ♀ (26 and 29 July 1965).
WEIGHT. 2 ♂: 91, 102. 3 ♀: 93, 97, 110.
WING. 3 ♂: 116, 118, 119. 3 ♀: 111, 119, 120.

TAXONOMY. The light highlights on the black crown of the female place this series with nominate *macrorhina,* as expected on geographical grounds, rather than with the north coast form *jobiensis.* The 29 July Soliabeda female, but not the other specimens, is buffy below, a character of immatures and some adults.

BREEDING. The gonads were slightly enlarged in the 26 July Soliabeda female, not enlarged in the other specimens.

DISCUSSION. Five of the seven specimens were netted. In the Karimui area this is evidently a not uncommon species in the lower- and middlestory of the forest interior. Elsewhere in New Guinea *M. macrorhina* is regularly encountered only at elevations below 3,000 or 2,000 ft, and the only other Eastern Highlands record is a single female taken at Lake Kutubu. This kingfisher is nocturnal, and is unobtrusive, solitary, and silent during the day, so that my sole sighting was of a bird 20 ft above the ground in dense foliage.

VOICE. The call (Fig. 19, p. 186) is heard only at night. It consists usually of two whistled notes, the second conspicuously shorter than the first, a half-tone higher, sometimes trilled, and following the first by slightly less than 1 sec. Occasionally two additional shorter notes are added at a higher pitch. The kingfishers *Melidora macrorhina, Clytoceyx rex, Halcyon torotoro, H. megarhyncha, H. macleayii,* and *Tanysiptera galatea* betray their relationship in the similar whistled qualities of their calls.

Clytoceyx rex rex Sharpe

Shovel-billed Kingfisher

NATIVE NAMES. Fore: userépo. Gimi: mégofo. Daribi: idadanógo.
SPECIMENS EXAMINED. Awande: 1 ♂ (11 July 1967).
WING. 165.

EXPOSED CULMEN. 37.
WHOLE CULMEN. 46.

TAXONOMY. In dorsal coloration the specimen is darker than Fly River, Bernhard Camp, and Jimmi River specimens, comparable to Mt. Tafa specimens, and paler than Telefolmin specimens. Since variation in darkness follows a checkerboard geographical pattern, the race *septentrionalis* is not recognized.

DISCUSSION. The only other Eastern Highlands specimens of this uncommon and sparsely distributed species are three from the Jimmi River presented to Gilliard, and one shot at 6,000 ft on Mt. Wilhelm by Shaw-Mayer. I heard its song at eight localities between 2,000 and 6,500 ft, from the forest or forest edge. The specimen was surprised on the ground while eating a snake. According to Paran, *Clytoceyx* is solitary, and most in evidence at Awande in the rainy season, when it perches on trees or fences overlooking gardens and flies down to the ground to locate its food of large insects, grubs, and small mice.

VOICE. An unmistakable, clear, liquid, ventriloquial three- or four-note, whistled call that is delivered from the crown of a tall tree and carries well. The whole call takes not quite 1 sec. The commonest pattern is of three notes in descending pitch, the first two separated in pitch by an interval of a second or minor third, the second two by a fourth or major third (Fig. 19). Less often there is a fourth note, giving rise onomatopoetically to the name "u-se-ré-po". At each note of the call the tail is jerked. Another call consists of three or four louder, rapid, muscal notes on the same pitch. I have heard the call only in the morning, and most often shortly after dawn.

Dacelo gaudichaud Quoy and Gaimard

Gaudichaud's Kookaburra

NATIVE NAME. Daribi: ánuai.
SPECIMENS EXAMINED. Karimui: 2 ♂, 2 ♀ (13-18 July, 1965). Bomai: 1 ♂ (8 July 1965). Soliabeda: 1 ♂, 4 ♀ (22-29 July 1965).
WEIGHT. 4 ♂: 132, 138, 139, 161. 6 ♀: 144, 146, 146, 146, 149, 156.
WING. 4 ♂: 129, 134, 135, 137. 6 ♀: 133, 137, 137, 138, 138, 139.
STOMACH CONTENTS. Insects, often large ones such as grasshoppers.

BREEDING. All specimens had small gonads, hence breeding is not in the dry season.

DISCUSSION. The Karimui population of this noisy, conspicuous, and belligerent lowland kingfisher was considerably above its normal altitudinal ceiling, and elsewhere in the Eastern Highlands it has been recorded only at Lake Kutubu (2,450 ft). It was usually seen perched singly in the middlestory, occasionally in the understory or crown, of second-growth, gardens, forest edge, and occasionally forest. The tail is often cocked up when perched or when fighting. I have observed fights with others of its species and with *Coracina papuensis.*

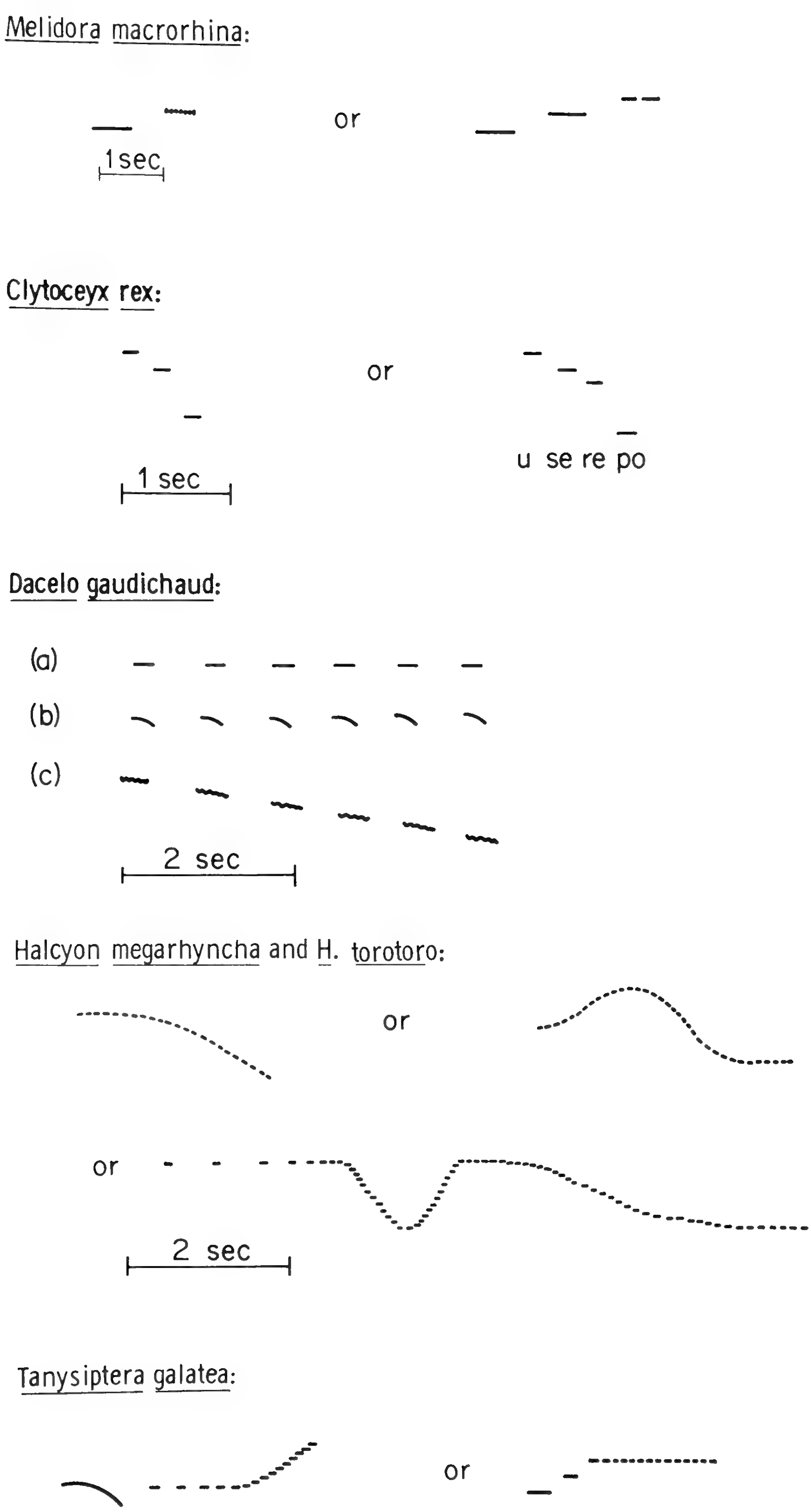


FIG. 19. Voices of six New Guinea kingfishers.

VOICE. Loud, and exercised from conspicuous perches. Most vocalizations consist of a series of a half dozen or more separate notes at intervals of 1 sec. The quality is either: (a) clear barking notes as of a small but noisy dog, all barks being on the same pitch; (b) more squealing, downslurred barking notes, all again being on the same pitch; or (c) barking notes, each of which is trilled; in this case successive notes are on lower pitches (Fig. 19, p. 186). As with *Dacelo leachii* and *D. novaeguineae,* two nearby individuals of *D. gaudichaud* often bark simultaneously; this may represent male-female duetting.

Halcyon torotoro meeki Rothschild and Hartert

Lowland Yellow-billed Kingfisher

SPECIMENS EXAMINED. Karimui: 1 ♀ (14 July 1965).
WEIGHT. 38.
WING. 73.
CULMEN FROM ANTERIOR EDGE OF NOSTRIL. 33.
STOMACH CONTENTS. Insects.

TAXONOMY. The underparts of the Karimui specimen are as pale as in *meeki* and *brevirostris,* and paler than in *pseustes.* The length of the culmen from the anterior edge of the nostril to the tip was measured in four females each of four races: *tentelare,* 32, 33, 33, 33; *pseustes,* 30, 32, 32, 34; *brevirostris,* 28, 29, 31, 31; *meeki,* 31, 33, 34, 34. The short bill of *brevirostris* eliminates it, and the Karimui specimen must be assigned to *meeki,* a slight westward range extension. The ranges of southern New Guinea races given by Rand (1938, pp. 11-12) may thus be reformulated as follows: *meeki,* southeastern New Guinea, west to Karimui (Purari drainage, long. 145°E); *pseustes,* southern New Guinea from the mouth of the Fly River (long. 143°E) west to the Mimika River (long. 136°E) except for the range of *brevirostris;* nominate *torotoro,* northern and western New Guinea, on the south coast east to Etna Bay (long. 135°E); *brevirostris,* near the coast at long. 142°E in the bulge of southern New Guinea.

BREEDING. The ovary was small.

DISCUSSION. This was quite an uncommon species in the Karimui Basin, and has not been recorded elsewhere in the Eastern Highlands. On the three occasions I saw it, solitary individuals were perched 2-15 ft above the ground in open second-growth, and jerked or cocked the tail at frequent intervals. The altitudinal range of *H. torotoro* excludes that of its higher-altitude sibling *H. megarhyncha.* In the Karimui Basin the transition takes place at some altitude between 3,650 ft, the highest *H. torotoro* record, and 4,400 ft, the lowest *H. megarhyncha* record (the transition usually takes place somewhat below 3,000 ft in the rest of New Guinea). Although *H. torotoro* and *H. megarhyncha* are very similar in appearance as well as in voice, they are evidently distinct species: their sizes do not overlap if individuals of the same sex are compared, the bill is generally pure yellow in adult *H. torotoro* but has some black in adult *H. megarhyncha* of all races except *sellamontis,* neither species approaches the other morphologically with altitude, and the two forms show independent geographic variation in subspecific traits.

VOICE. A lengthy "police whistle" identical to the call of *H. megarhyncha* (Fig. 19, p. 186), as also noted by Stein (1936, p. 47). The whole body shakes as the bird calls.

Halcyon megarhyncha subsp.

Mountain Yellow-billed Kingfisher

NATIVE NAMES. Fore: patoróba bilong bush (= "patoróba of the forest": cf. *Halcyon sancta*). Gimi: gúralo. Daribi: wiyokolólo.

SPECIMENS EXAMINED. Awande: 1 ♀ (19 June 1965).

WEIGHT. 63.

WING. 90.

EXPOSED CULMEN. To margin of lateral feathering, 38; to margin of medial dorsal feathering, 41.

TAXONOMY. The Eastern Highlands population may eventually require separation as a new race nearest nominate *megarhyncha* but larger, but the material available at present is too limited to warrant doing so now. Only two other Eastern Highlands specimens have been measured: a male, wing given as 96 mm by Mayr and Gilliard (1954, p. 343); and male, wing given as 89 mm by Gyldenstolpe (1955, p. 72). My measurements of female specimens in the American Museum of Natural History yield: nominate *megarhyncha,* 8 ♀ from southeastern New Guinea, wing 81-88 (83 ± 2; seven values fall between 81 and 83), exposed culmen to margin of medial feathering 36-40 (38.5); *wellsi,* 2 ♀ from the Weyland Mountains, wing 86 and 87. The Awande female thus has a longer wing than any other female measured, and this is probably also true of the male listed by Mayr and Gilliard. The bill of the Awande specimen is yellow except that the upper surface of the upper mandible is black. The bills of *H. m. megarhyncha* and *wellsi* are similar, but *sellamontis* of the Huon Peninsula has the whole bill yellow. The race *wellsi* differs from nominate *megarhyncha* in the buffier, less white underparts and the darker (bluer) back, in which respects the Awande bird agrees with *megarhyncha.*

BREEDING. The gonads were small, as also true of my sole *H. torotoro* specimen, so that these two resident species presumably breed when the migrants *H. sancta* and *H. macleayii* are gone.

DISCUSSION. *Halcyon megarhyncha* is found strictly in the forest interior, from about 4,000 to 6,500 ft. Its altitudinal range is completely exclusive of that of its low-altitude sibling *H. torotoro.* From April to September the Australian migrants *H. sancta* and *H. macleayii* share its altitudinal range but are confined to open country, so that habitat exclusion is complete. It would be interesting to know if *H. megarhyncha* comes out to the forest edge and second-growth when the migrant flood departs.

H. megarhyncha is locally not uncommon, and calls often and loudly while perched in the middlestory of forest trees. It must remain motionless inside the foliage, for I found the singers exasperatingly impossible to see, and Stein (1936, p. 48) and Rand (1942b, p. 460) report similar experience. The minimal number of specimens collected in the Eastern Highlands reflects this invisibility rather than true rareness.

VOICE. A long call identical to the call of *H. torotoro*, closely similar to a police whistle in quality, and consisting of a series of rapid notes lasting a total of several seconds. The pitch may continuously drop throughout the series; may initially rise before dropping; or may drop, then rise, and sometimes drop again (Fig. 19, p. 186). How *H. torotoro* and *H. megarhyncha*, which are so similar both in appearance and in voice, distinguish each other near the transitional altitude is unknown.

Halcyon macleayii incincta Gould and *H. m. elisabeth* (Heine)

Forest Kingfisher

SPECIMENS EXAMINED. Karimui: 4 ♂, 1 ♀ (3 July-3 Aug. 1965). Soliabeda: 2 ♂, 1 ♀ (26-29 July 1965).

WEIGHT. 6 ♂: 41, 41, 42, 42, 43, 48. 2 ♀: 41, 48.

WING. 6 ♂: 86, 89, 90, 90, 91, 91. 2 ♀: 87, 88.

STOMACH CONTENTS. Insects and a frog.

TAXONOMY. All eight specimens have the blue-green backs of the race *incincta*, a migrant from eastern Australia. At Nondugl, Gyldenstolpe took two specimens, one of *incincta* and one of the resident eastern New Guinea race *elisabeth*. In addition, I saw but did not collect the species at Okasa (4,250 ft), and Schodde and Hitchcock met *incincta* at Lake Kutubu (2,450 ft).

BREEDING. All specimens had small gonads.

DISCUSSION. Of the two *Halcyon* species that migrate to New Guinea during the Australian winter, *H. sancta* is common up to 7,500 ft, whereas *H. macleayii* becomes uncommon above 5,000 ft and apparently disappears above 5,500 ft. Below 5,000 ft both may be found at the same locality, but *H. sancta* is up to twice as common. I can discern no differences in wintering habitat preferences where they overlap at these lower altitudes. Both species choose open habitats with trees in which they perch 5-40 ft above the ground, most often in native gardens, and eschew the forest and even the forest edge. In flight I find the white wing patches of *H. macleayii* a useful field mark.

VOICE. The migrant *incincta* was silent during the time I observed it in the Eastern Highlands. The call of the resident *elisabeth* is a short, descending, musical, rattled trill, like a shorter, slower, louder version of the call of *H. torotoro* and *H. megarhyncha*.

Halcyon sancta sancta Vigors and Horsfield

Sacred Kingfisher

NATIVE NAMES. Fore: patóroba bilong place (= "patóroba of the village": cf. *Halcyon megarhyncha*). Gimi: gúralo.

SPECIMENS EXAMINED. Awande: 6 ♂, 1 ♀ (19 Aug. 1964; 15-20 June 1965). Karimui: 6 ♂, 2 ♀ (10 Aug. 1964; 4 July-3 Aug. 1965). Bomai: 1 ♀ (6 July 1965). Soliabeda: 3 ♂ (25-29 July 1965).

WEIGHT. 12 ♂: 39-50 (44 ± 3). 3 ♀: 37, 45, 49.

WING. 12 ♂: 89-98 (92 ± 3). 3 ♀: 85, 92, 92.

STOMACH CONTENTS. Insects, including large grasshoppers.

BREEDING. All specimens had small gonads.

DISCUSSION. The sex ratio of the specimens (15 ♂, 4 ♀) is quite disparate in this Australian wintering visitor. Other collections have often shown equally disparate ratios. For instances, Gyldenstolpe (1955, p. 75) obtained 0 ♂, 8 ♀ at Nondugl; the Second Archbold Expedition (Rand, 1942a, p. 321) had a total of 0 ♂, 6 ♀ at three localities, 2 ♂, 0 ♀ at a fourth; the Third Archbold Expedition (Rand, 1942b, p. 461) had 10 ♂, 3 ♀. It appears that males and females may have different local preferences in their wintering grounds.

Of the migrants that visit the Eastern Highlands during the Australian winter, this is the commonest species above 5,000 ft, and one of the commonest below this elevation. All observers have found it at most localities in suitable habitats up to 7,500 ft from April through October. As stated under *H. macleayii,* it is to be found in open habitats with trees, such as native gardens, around human habitations, and in casuarina stands, never inside the forest. Much smaller numbers must have reached the Eastern Highlands before the spread of native agriculture. Insects are caught by pouncing, occasionally in midair by sallying, and are killed by being pounded against a surface.

VOICE. Usually silent; occasionally, a soft rasped note.

Tanysiptera galatea subsp.

Common Paradise Kingfisher

STOMACH CONTENTS. Insects.

DISCUSSION. Dr. Bulmer has kindly informed me that natives reported racket-tailed kingfishers, probably of this species, as not uncommon in the Jimmi Valley, that he examined plumes procured by natives, and that N. Camps collected one specimen. The species is to be expected at the lowest elevations along the edges of the Eastern Highlands.

New Guinea has two common lowland forest kingfishers which are in related genera and ecologically somewhat similar: *Tanysiptera galatea* and *Halcyon torotoro.* They differ ecologically in size (average weight of the former 56 g, the latter 41 g), vertical preference (the former more confined to the understory), and upper altitudinal limit (the latter extending to higher altitudes).

VOICE. The call is a slow, soft, upslurred, mournful whistle lasting 2-3 sec and repeated at intervals. The song is a loud, rising, accelerating, whistled trill usually preceded by a longer, more nasal note (Fig. 19, p. 186).

MEROPIDAE: BEE-EATERS

Merops ornatus Latham

Rainbow Bee-eater

NATIVE NAME. Daribi: síbudili.

SPECIMENS EXAMINED. Okasa: 1 ♂, 2 ♀ (24 June 1965). Karimui: 1 ♂, 4 ♀ (3 July-4 Aug. 1965). Bomai: 2 ♀, 1 ? (5-7 July 1965).

WEIGHT. 2 ♂: 32, 33. 7 ♀: 26, 27 (2), 28 (2), 29 (2). 1 ?: 29.

WING. 2 ♂: 104, 109. 7 ♀: 104, 105 (4), 107 (2). 1 ?: 106.

STOMACH CONTENTS. Insects.

TAXONOMY. Five specimens have black throats (an adult character), five do not (an immature character); four have elongated tail feathers (an adult character), six do not (an immature character). There seems to be no fixed sequence for acquisition of the black throat and long tail: four specimens with black throats have short tails, three with long tails lack black throats, one has both a black throat and long tail, and two have neither.

BREEDING. All specimens had small gonads.

DISCUSSION. As in the case of *Halcyon sancta,* the sex ratio is quite disparate (2 ♂, 7 ♀). This has also been true for the specimens collected by some other expeditions in New Guinea, suggesting some segregation of the sexes on the wintering grounds.

This Australian wintering visitor has also been recorded from April through at least August by Gilliard in the Wahgi Valley and by Bulmer in Kyaka territory and in the Schrader Range. Schodde and Hitchcock found it appearing at Lake Kutubu in early October and following the Soro River, evidently at the beginning of the return migration to Australia. In suitable habitats *M. ornatus* is not uncommon below 4,500 ft and locally up to 5,200 ft, above which altitude it seems rare or absent. It apparently may gather in roosts, since flocks regularly fly in one direction just after sunrise and return in the opposite direction towards sunset. Its habitat preference is large expanses of open country with a scattering of trees to provide exposed perches (never in the forest interior). From these exposed perches it sallies out like a flycatcher, or soars and floats like a swallow, in a short flight, before returning to the perch. The flights in a smooth arc remind me of the motion of a model airplane attached to a fixed length of cord. *Merops ornatus* sometimes circles in a breeze with spread wings for several seconds without flapping, and may be one of the smallest birds that actually soars.

VOICE. A single musical note ("bk"); or three or four such notes run together in very rapid succession.

CORACIIDAE: ROLLERS

Eurystomus orientalis pacificus (Latham) and *E. o. waigiouensis* Elliot

Dollarbird

SPECIMENS EXAMINED. *E. o. pacificus:* Karimui: 1 ♀ (12 July 1965); Soliabeda: 1 ♀ (22 July 1965). *E. o. waigiouensis:* Karimui: 5 ♂, 6 ♀ (11-12 Aug. 1964, 3 July-11 Sept. 1965).

WEIGHT. *E. o. pacificus:* 2 ♀: 132, 135. *E. o. waigiouensis:* 4 ♂: 148, 153, 167, 190; 5 ♀: 157, 163, 166, 174, 192.

WING. *E. o. pacificus:* 2 ♀: 190, 194. *E. o. waigiouensis:* 5 ♂: 191, 192, 192, 196, 201; 5 ♀: 190, 193, 196, 203, 204.

STOMACH CONTENTS. Insects up to several centimeters in length.

TAXONOMY. At Karimui both the resident breeding form *waigiouensis* and the Australian wintering visitor *pacificus* occurred, with the former far more numerous. The sole specimen obtained at Soliabeda was *pacificus,* as was the sole bird Schodde and Hitchcock collected at Lake Kutubu. Bulmer collected both races in Kyaka territory. With practice these two races can be distinguished in the field by the darker and richer coloration, bluer underparts, and greener upperparts of *waigiouensis* and by the paler, browner color of *pacificus.* The larger size of *waigiouensis* appears most clearly in the weights.

BREEDING. All specimens of both races had small gonads. As discussed by Mayr (1942, p. 253), crossing of these races is prevented because *pacificus* remains in nonbreeding condition while in New Guinea. The small gonads of all my *waigiouensis* specimens as well suggest that *waigiouensis* is also in nonbreeding condition (like most species of second-growth in the Karimui area) when *pacificus* arrives, and breeds in the rainy season after the latter's departure. A November-December breeding season of *waigiouensis* in southeastern New Guinea is also suggested by the records of the First Archbold Expedition (Mayr and Rand, 1937, p. 88). In addition, although both races do sometimes occur at the same locality, usually one or the other race vastly predominates.

DISCUSSION. The Dollarbird was generally solitary and selected exposed perches in the tops of tall, dead or leafless trees overlooking open spaces, in partly cleared forest or near the edge of the forest, in the manner of a giant flycatcher. From these perches it periodically sallied out and circled around with a floppy, caprimulgid-like flight before returning to the perch. Once a display was observed between two birds perched in a tree, which bowed to each other rhythmically for a minute before flying off together. Circling flights observed in the morning at considerable heights may also constitute a display.

VOICE. A short, low-pitched, monosyllabic croak or snapping sound reminiscent of a frog or insect, and somewhat suggestive in quality of the disyllabic call of *Mino dumontii*.

BUCEROTIDAE: HORNBILLS

Aceros plicatus ruficollis (Vieillot)

Papuan Hornbill

NATIVE NAMES. Fore: áne. Gimi: áhana. Daribi: wézi.

SPECIMENS EXAMINED. Karimui: 1 ♂ (a) (15 Aug. 1964). Soliabeda: 1 ♂ (b) (24 July 1965).

WING. 2 ♂: 437 (a), 415 (b).

TAIL. 1 ♂: 232 (b).

TAXONOMY. The race *jungei* from eastern New Guinea was separated from *ruficollis* of western New Guinea on the basis of larger average size apparent in long series, but there is a good deal of overlap (Mayr, 1937, p. 13). Since the wing length of males averages 424 mm in *ruficollis* but 442 mm in *jungei,* the present scanty material (average 426 mm) must be assigned to the smaller *ruficollis.* A male from Lake Kutubu had a wing of 420 mm and was also assigned to *ruficollis* by Schodde and Hitchcock.

BREEDING. Both specimens had small testes.

DISCUSSION. In the Karimui area this species was uncommon and was usually seen singly or in pairs in the forest. Hornbills probably are widely distributed at low elevations (below ca. 3,500 ft) at the edges of the Eastern Highlands.

VOICE. A series of grunts, "uh----uh----uh----uh"; in flight, a thumping or chugging sound made with the wings at each beat, as of a steam locomotive slowly starting up.

PITTIDAE: PITTAS

Pitta erythrogaster macklotii Temminck

Blue-breasted Pitta

NATIVE NAME. Daribi: towagá.

SPECIMENS EXAMINED. Okasa: 1 ♀, 1 imm. ♀ (24 and 25 June 1965). Karimui: 1 ♂, 4 ♀, 2 ?, 1 imm. ♂, 1 imm. ♀, 1 imm. ? (3-12 Aug. 1964; 3 July-3 Aug. 1965). Bomai: 1 imm. ♂ (7 July 1965). Soliabeda: 1 ♂, 1 ♀ (28 July 1965).

WEIGHT. 1 ♂: 98. 5 ♀: 79, 80, 85, 89, 95. 1 ?: 86. 2 imm. ♂: 76, 85. 1

imm. ♀: 72.

WING. 1 ♂: 106. 6 ♀: 105, 105, 106, 107, 107, 108. 2 imm. ♂: 105, 108. 2 imm. ♀: 104, 108. 1 imm. ?: 111.

STOMACH CONTENTS. Insects.

TAXONOMY. The New Guinea races are quite distinct, and the present series agrees well with *macklotii* from southeastern New Guinea and the Fly River. The race *habenichti* differs in the brighter, redder, less brown nape; *loriae* in the very dull brown nape which hardly contrasts with the darker brown of the crown; and *oblita* in the paler, less bright nape and the bluer, less green back. The five young birds have the belly lighter and more rose-orange in color, the throat and breast mottled brown, and only scattered bright feathers on the nape.

BREEDING. The gonads were enlarged in the Soliabeda pair but small in all other specimens. This fact, combined with the number of young birds, suggests that (except at Soliabeda) breeding was recently completed, i.e., before the dry season.

DISCUSSION. *Pitta erythrogaster* is widely distributed in forest on the hill slopes up to 3,500 or 4,000 ft. Natives said that it lived on the ground in the forest interior, and Paran encountered it in small parties of about three birds on the forest floor.

VOICE. According to Daribi natives, the call consists of two low-pitched, slow, tremulous whistles, the first rising in pitch, the second falling in pitch.

Pitta sordida novaeguineae Müller and Schlegel

Black-headed Pitta

This pitta, whose altitudinal spread upwards from the lowlands is much more limited than that of *P. erythrogaster,* is known in the Eastern Highlands only from the Jimmi Valley of the northern watershed, where Mayr and Gilliard (1954, p. 343) recorded one specimen and Bulmer (pers. comm.) collected three more.

ALAUDIDAE: LARKS

Mirafra javanica subsp.

Singing Bush Lark

DISCUSSION. This grassland species was collected in the Baiyer Valley by J. Kikkawa. It has been recorded at only four other localities in New Guinea.

VOICE. The call note has the quality of the sound produced by running one's finger along the teeth of a comb, as does the call of *Peltops montanus.*

HIRUNDINIDAE: SWALLOWS

Hirundo tahitica frontalis Quoy and Gaimard

Pacific Swallow

NATIVE NAME. Fore: onuguteyábi.
STOMACH CONTENTS. Insects.

DISCUSSION. This swallow is common in open country, particularly around villages and settlements, but there may be major gaps in its distribution within the Eastern Highlands (e.g., it was absent from the entire Karimui area).

Hirundo nigricans nigricans Vieillot

Tree Martin

The sole Eastern Highlands records to date are sight records at Tari Airstrip on 4 August 1965, by H. L. Bell, and in the Hagen area in March 1970 (N.G.B.S. Newsletter, No. 54, p. 2, June 1970).

CAMPEPHAGIDAE: CUCKOO-SHRIKES

This whole family appears to share a common breeding cycle, since all or almost all individuals of all species I met in the Eastern Highlands were in nonbreeding condition at the times of my visits.

Campochaera sloetii flaviceps Salvadori

Golden Cuckoo-shrike

NATIVE NAME. Daribi: yómmu.
SPECIMENS EXAMINED. Karimui: 1 ♂ (6 July 1965). Bomai: 1 ♂, 1 ♀, 1 ? (6 July 1965).
WEIGHT. 2 ♂: 41, 46. 1 ♀: 41. 1 ?: 36.
WING. 2 ♂: 109, 110. 1 ♀: 104. 1 ?: 97.

TAXONOMY. These specimens differ from nominate *sloetii* of the Vogelkop and Idenburg River in having the posterior half or two-thirds of the crown washed with yellow-green.

BREEDING. The gonads were small in all specimens, suggesting breeding in the rainy season, as with most other campephagids.

DISCUSSION. *Campochaera,* a monotypic and endemic New Guinea genus, has a very spotty distribution on the lower hill slopes and near the foot of the hills. The population in the Karimui area is at present the only one known in the Eastern Highlands, and is about 1,000 ft higher than the usual altitudinal ceiling of the species. Besides collecting it at Karimui and Bomai, I observed it at Soliabeda. Its habitat in the Karimui area was tall trees in forest and at the edge of forest, especially trees bearing fruit, while the duetting displays were carried out in the crowns of the tallest trees emerging above the canopy. Ogilvie-Grant (1915, p. 121) remarked that "it appeared to have the habits of a Flycatcher, darting out to catch some passing insect and returning again to the same perch", but this description could well have been based on the conspicuous duetting display and it may not have been catching insects at all.

VOICE. A duet which has been described in detail elsewhere (Diamond and Terborgh, 1968). Briefly, one individual delivers a rapid series of a half dozen high, musical notes, all on the same pitch. Simultaneously with the last several notes, a second individual gives a whistled upslur, downslur, or two or three slurs. In groups of two to four the brightly colored singers move through the canopy, repeating the performance from the tops of trees successively several hundred feet apart. This display is similar to that of *Coracina montana* and *C. schisticeps*.

Lalage atrovirens subsp.

Black-browed Triller

STOMACH CONTENTS. Fruit up to 4 mm in diameter, and insects.

DISCUSSION. Bulmer collected two specimens in the Jimmi Valley. The species will probably turn up elsewhere at low elevations on the northern watershed. It lives singly or paired in the treetops, more often in light forest or at the forest edge than in primary forest.

VOICE. Emphatic upslurs or groups of 5-7 notes reminiscent of laughter, repeated 3-9 times (Fig. 20, p. 207).

Lalage leucomela polygrammica (Gray)

Varied Triller

SPECIMENS EXAMINED. Karimui: 1 ♂, 1 ? (1 and 3 July 1965). Bomai: 1 ♀ (8 July 1965). Soliabeda: 1 ♂, 2 ♀ (22-27 July 1965).

WEIGHT. 2 ♂: 28, 29. 3 ♀: 25, 26, 27. 1 ?: 24.

WING. 2 ♂: 93, 94. 3 ♀: 88, 88, 94.

TAXONOMY. Rand (1942a, p. 324) has discussed individual variation in this race. My two adult males resemble southeastern New Guinea birds in their gray, distinctly barred underparts and are slightly more barred than one topotypical *polygrammica* male from the Aru Islands. Eleven out of 14 males from the Fly River area are nearly whitish below with the barring very obscure, and the remaining ones are comparable to southeastern New Guinea males.

BREEDING. The gonads were small in all specimens.

DISCUSSION. This is the triller of the southern watershed, occurring up to 4,500 ft. Besides collecting it in the Karimui area, I observed it once at Okasa. Its habitat was the middle- and upperstories (20-100 ft above the ground) of trees at the edge of forest, in partly cut forest, and in isolated tall trees, not in the well-shaded forest interior. It was usually seen in pairs and moved about in leisurely fashion.

VOICE. The only sound I heard was, on one occasion, a scolding downslurred note similar to that of the honeyeater *Melilestes megarhynchus.*

Niche Differences in the Genus *Coracina*

This large genus is represented in New Guinea by 11 species, of which 10 have been reported from the Eastern Highlands. All live in the middle- and upperstories (I have yet to take any member of the genus in a mistnet). All species take both insects and fruit, but *C. schisticeps, C. montana, C. boyeri,* and perhaps *C. lineata* take mainly fruit, while *C. tenuirostris, C. caeruleogrisea, C. papuensis, C. longicauda,* and perhaps *C. melaena* and *C. morio,* take mainly insects.

Three of the species are large (weights 95-150). One of these, *C. novaehollandiae,* is an Australian winter visitor of which only stragglers reach the Eastern Highlands and remain in open habitats. The other two are forest species whose altitudinal ranges are nearly mutually exclusive: *C. longicauda* at higher elevations, where it encounters only the somewhat larger *C. caeruleogrisea* and the considerably smaller *C. montana* near the lower limit of its range; and *C. caeruleogrisea* at lower elevations, where it overlaps several congeners half its size.

The remaining seven species are small (50-70). Two of these (*C. tenuirostris* and *C. papuensis*) are low-altitude species which are usually found in open and forest edge habitats. Of the five small forest species (*C. montana, C. schisticeps, C. morio, C. melaena, C. boyeri*) two have mutually exclusive altitudinal ranges: *C. montana* at higher elevations, above not only *C. schisticeps* but also above the three other small forest species; and *C. schisticeps* at lower elevations. The distributions of *C. schisticeps* and *C. morio* in the hill forests (ca. 1,500-4,500 ft) tend to be locally complementary, and both are uncommon at sea level, where the common forest species are *C. melaena* in the middlestory and *C. boyeri* in the crowns. *C. melaena* and *C. boyeri* have altitudinal ceilings lower than the ceilings of *C. schisticeps* and *C. morio* but overlap these two hill forest species to a considerable extent. Unsolved problems are how these four small forest species sort out on the lower hill slopes, and what habitat differences *C. schisticeps* and *C. morio* recognize to achieve partly complementary local distributions.

Coracina melaena melaena (Lesson)

Black Graybird

SPECIMENS EXAMINED. Karimui: 1 ♂, 2 ♀ (1 July-4 Aug. 1965). Bomai: 3 ♂, 1 ♀ ? (6-9 July 1965). Soliabeda: 1 ♂, 1 ♀, 1 imm. ♂ (24-27 July 1965).

WEIGHT. 4 ♂: 56, 57, 60, 63. 2 ♀: 55, 57. 1 ♀ ?: 53. 1 imm. ♂: 54.

WING. 5 ♂: 123, 124, 124, 126, 126. 3 ♀: 118, 118, 120. 1 ♀ ?: 116. 1 imm. ♂: 121.

STOMACH CONTENTS. Insects and fruit.

TAXONOMY. The races *C. m. melaena* of western New Guinea and *meeki* of eastern New Guinea differ in darkness of the female and intergrade clinally, *melaena* being the darker race. The backs of my females are quite richly colored and compare well with nominate *melaena* from the Vogelkop and Idenburg River. The undersurfaces of *meeki* females from southeastern New Guinea are paler, more cinnamon, less richly colored than in nominate *melaena*. In this respect Fly River birds (assigned to *meeki*) are intermediate; my females are on the average more richly colored than the Fly River birds and are nearly as richly colored as Vogelkop and Idenburg River females. This gives a checkerboard distribution as one proceeds from west to east on the south coast: *melaena* from the Vogelkop to the Eilanden River, *meeki* at the Fly River, *melaena* at Karimui, and *meeki* in the southeast.

BREEDING. One Karimui female had enlarged ovaries, but the gonads were small in all other specimens.

DISCUSSION. In the Karimui region *Coracina melaena* is somewhat above its usual altitudinal ceiling and was nearly as common as its much noisier close relative *Coracina schisticeps*, with which it sometimes occurred in the same tree. *C. schisticeps* and *C. melaena* differ somewhat in altitudinal preference, *C. schisticeps* having a higher ceiling, and *C. melaena* being common in the flat lowlands where *C. schisticeps* is uncommon or absent. At Lake Kutubu (2,450 ft) Schodde and Hitchcock found *C. melaena* common and did not obtain *C. schisticeps*. *C. melaena* spends more time in the middlestory (15-40 ft above the ground), *C. schisticeps* and *C. boyeri* in the crowns.

Coracina schisticeps poliopsa (Sharpe)

Gray's Graybird

NATIVE NAME. Daribi: désin.

SPECIMENS EXAMINED. Karimui: 2 ♂ (12 July 1965). Soliabeda: 7 ♂, 4 ♀, 1 imm. ♂ (21-29 July 1965).

WEIGHT. 9 ♂: 48-57 (53 ± 3). 4 ♀: 49, 53, 53, 54. 1 imm. ♂: 46.

WING. 9 ♂: 110-120 (115 ± 3). 4 ♀: 108, 112, 113, 114. 1 imm. ♂: 109.

TAXONOMY. Subspecific differences are largely confined to the female. The races *C. s. schisticeps*, *reichenowi*, and *moskowskii* of western and northern New Guinea differ from my material in that the female's chin is rufous rather than gray; in addition, in *reichenowi* the male's chin is darker. Compared to *poliopsa* females from southeastern New Guinea, the Fly River, and the southern slope of the Snow Mountains, Soliabeda females differ in the deeper and richer rufous of the underparts, and in the greater extent of gray on the chin. It seems desirable to await more material from the Eastern Highlands to decide whether the chin color is sufficiently consistent to warrant racial separation. The deep rufous underparts of Soliabeda females are unlikely to be a racially significant character, since comparison of recent and older collected material from the same locality shows that this ventral color is subject to postmortem fading.

BREEDING. The gonads were small in all specimens.

DISCUSSION. *Coracina schisticeps* has not yet been recorded from the northern watershed of the Eastern Highlands and is "inexplicably" missing from the Huon Peninsula and most of the southeastern New Guinea. At Karimui and Soliabeda it was common and conspicuous in the treetops, accounting for about 5% of bird individuals.

VOICE. As described elsewhere (Diamond and Terborgh, 1968) groups of two to four *C. schisticeps* carry out treetop displays similar to those of *C. montana* and *Campochaera sloetii,* except that the female does not reply to the male's vocalizations and there is therefore no duet. The male's call is a series of loud, nasal, whistled slurs similar to those of *C. montana* males, the first one upslurred, later notes downslurred. This conspicuous performance is repeated from the tops of different tall trees.

Coracina tenuirostris subsp.

Cicada Bird

STOMACH CONTENTS. Insects in most stomachs, fruit in half the stomachs examined.

DISCUSSION. Bulmer collected two specimens (one each at 4,200 and 5,000 ft) in the Baiyer Valley and one at 5,000 ft in the Jimmi Valley. This species lives at the forest edge and in gardens and second-growth.

VOICE. The song is a series of identical clear notes repeated at 3 times per second for 10-30 sec and crescendoing slightly. One or two other birds may fly into a treetop with a singer and give musical chirps, but the group display is less ritualized than in the case of *C. schisticeps* and *C. montana.*

Coracina morio incerta (Meyer)

Müller's Graybird

SPECIMENS EXAMINED. Okasa: 1 ♀ (22 June 1965). Mengino: 1 ? (15 July 1964). Bomai: 1 ♂, 1 ♀ (6 July 1965).

WEIGHT. 1 ♂: 57. 2 ♀: 53, 60.
WING. 1 ♂: 118. 2 ♀: 113, 114. 1 ?: 115.
EXPOSED CULMEN. 1 ♂: 17. 2 ♀: 16, 17. 1 ?: 17.

TAXONOMY. The Okasa female, presumably a young bird, has the axillaries nearly white with gray barring, a condition that can be matched in some specimens available for comparison. It also has very faint suggestions of barring on the belly.

BREEDING. All specimens had small gonads.

DISCUSSION. There is some tendency, though not a strict one, for the local distributions of *Coracina morio* and *C. schisticeps* in the hill forest to complement each other, just as the distributions of *C. montana* and *C. schisticeps* complement each other altitudinally. This is reflected in the fact that I collected no *C. schisticeps* at the three localities where I took *C. morio,* and no *C. morio* at the two localities where I took *C. schisticeps.*

VOICE. *C. morio* is apparently the author of a song consisting of a buzzy note repeated at 5 times per second for about 4 sec, suggestive of the song of *C. tenuirostris.*

Coracina montana montana (Meyer)

Black-bellied Graybird

NATIVE NAMES. Fore: onténti. Gimi: ínane.

SPECIMENS EXAMINED. Awande: 1 ? (18 June, 1965). Okasa: 1 imm. ♂ (23 June 1965). Mt. Michael: 2 ♂ 1 and 13 July, 1964). Mt. Karimui Zone 2: 3 ♂, 2 ♀; Zone 3: 3 ♂, 4 ♀; Zone 4: 3 ♂, 3 ♀ (13 Aug.-1 Sept. 1965).

WEIGHT. 10 ♂: 59-70 (66 ± 4). 9 ♀: 57-70 (63 ± 4). 1 imm. ♂: 59. 1 ?: 56.

WING. 10 ♂: 127-135 (131 ± 3). 6 ♀: 124, 126, 126, 127, 127, 131. 1 imm. ♂: 123. 1 ?: 124.

STOMACH CONTENTS. Fruit 2-3 mm in diameter (four stomachs); fruit and insects (two stomachs).

TAXONOMY. Birds from eastern New Guinea were formerly separated in the race *minus* from those of western New Guinea on the basis of their shorter wing (ca. 126-135 ♂, 124-131 ♀, vs. 134-140 ♂, 127-137 ♀). The present series belongs to the smaller eastern population, but *minus* is now not recognized because size decreases clinally from west to east on the Central Range (Diamond, 1969; Rand and Gilliard, 1967). The two largest males (wing 135) came from 8,000 ft on Mt. Michael, whereas all other measured males came from altitudes of 4,000-6,000 ft. Other than this I cannot discern an increase in size with altitude. In the Snow Mountains, Rand (1942b, p. 463) also found that birds from 9,200 ft were distinctly larger but that there was no correlation between size and altitude between 4,000 and 7,200 ft. The Okasa immature male, which has the shortest wing of the series and a low weight, has the tail, primaries, and lores, but not the chin, throat, or breast, black; there are scattered black and white barred feathers (dark subterminally, white terminally) on the head, cheeks, and belly, and the tips of the secondaries and undertail coverts are barred black and white. The unsexed Awande specimen, which also has a short wing and low weight, is similar except that the tail in addition has white tips and the barring on the body is more limited. Rand (1942b, p. 463) describes an immature male in similar plumage, and the American Museum of Natural History has a few other similar specimens.

BREEDING. The gonads were small in most specimens but were slightly enlarged in four males and one female from Mt. Karimui.

DISCUSSION. This is a conspicuous and widespread species in mountain forest between about 4,000 and 9,000 ft, living in the crown of the forest (not in second-growth). The lower limit to its range is fixed by competition with its low-altitude congener, *C. schisticeps:* the altitudinal ranges of these two species are mutually exclusive, and I have not detected either species penetrating the other's altitudinal zone by more than 100 vertical feet. Thus, in the Karimui area *C. schisticeps* was common up to 4,200 ft, above which it disappeared completely, while *C. montana* was common above 4,230 ft, with a single observation at 4,140 ft. In contrast to the sharp lower limit, *C. montana* becomes gradually less common at higher altitudes depending locally on the elevations at which the forest becomes stunted and tall trees disappear. On Mt. Karimui, where the forest became heavily mossed at 6,500 ft and progressively more stunted thereafter, *C. montana* accounted for about 10% of all bird individuals at 4,200-5,800 ft, about 5% at 5,800-7,280 ft, and was absent above 7,280 ft. On Mt. Michael, where heavy moss and stunting set in only at 8,700 ft, *C. montana* was still common around our camp at 8,000 ft. but was only encountered once above 8,700 ft.

VOICE. A loud and precisely synchronized duet which is delivered in the treetops by parties of two to four birds and has been described elsewhere (Diamond and Terborgh, 1968). The female delivers several harsh notes on the same pitch in synchrony with slurred whistles from the male. Each day the singers follow apparently the same route, selecting display trees several hundred feet apart.

Coracina boyeri subalaris (Sharpe)

Rufous-underwing Graybird

SPECIMENS EXAMINED. Karimui: 7 ♂, 8 ♀ (11 Aug. 1964; 2 July-5 Aug. 1965). Soliabeda: 2 ♂, 1 ♀ (22-26 July 1965).

WEIGHT. 9 ♂: 62-74 (68 ± 4). 6 ♀: 61-68 (64 ± 3).

WING. 8 ♂: 127-137 (133 ± 3). 7 ♀: 120-135 (128 ± 5).

STOMACH CONTENTS. Fruit.

TAXONOMY. These agree with *subalaris* of southern New Guinea in the gray (rather than white) lores of the female, in the pale rufous underwing coverts, and in the long wing.

BREEDING. All specimens had small gonads.

DISCUSSION. This graybird lives in small parties of three to five birds in the treetops. The Karimui population may represent an altitudinal record for this lowland species, and the only other Eastern Highlands record is provided by one specimen from Lake Kutubu (2,450 ft).

VOICE. *C. boyeri* has a display similar to that of *C. montana* and *C. schisticeps,* in which a group of birds flies among the tops of tall trees, stopping in each to call. The display vocalizations consist of single or paired, high, sweet, whistled slurs "tsyew," more often upslurred than downslurred, repeated at intervals of several seconds. Other quieter calls are a low clucking, a cat-like "mew," and repeated chirping notes "chuck."

Coracina caeruleogrisea strenua (Schlegel) and *C. c. adamsoni* (Mayr and Rand)

Stout-billed Graybird

NATIVE NAMES. North Fore: kabagége. South Fore: kaíyowaíyowa. Gimi: kudiye.

SPECIMENS EXAMINED. Awande: 2 ♂, 3 ♀ (26 June 1964; 17-19 June 1965). Okasa: 1 ♀ (22 June 1965). Karimui: 5 ♂, 1 ♀, 1 imm. ♂ (11-15 Aug. 1964; 10 July-4 Aug. 1965). Bomai: 1 ♂, 1 ♀ (6 July 1965). Mt. Karimui Zone 1: 2 ♀; Zone 2: 1 ♂, 1 ♀; Zone 3: 1 ♀ (9-21 Aug. 1965).

WEIGHT. Okapa area (Awande and Okasa): 1 ♂, 151; 4 ♀, 120, 126, 130, 136. Karimui area (Karimui, Bomai, Mt. Karimui): 5 ♂, 127, 138, 144, 152, 158; 4 ♀, 135, 137, 139, 142; 1 imm. ♂, 151.

WING. Okapa area: 2 ♂, 173, 182 (178 ± 6); 2 ♀, 167, 170 (169 ± 2), Karimui area: 5 ♂, 168, 169, 171, 173, 174 (171 ± 3); 5 ♀, 158, 165, 167, 167, 168 (165 ± 4); 1 imm. ♂ 172.

CULMEN FROM NOSTRIL. Okapa area: 1 ♂, 29; 2 ♀, 26, 27. Karimui area: 5 ♂, 26, 27, 27, 28, 29; 5 ♀, 25, 27, 27, 28, 31; 1 imm. ♂, 26.

STOMACH CONTENTS. Large insects (two stomachs); 17 mm fruits (one stomach).

TAXONOMY. The race *adamsoni* of southeastern New Guinea differs from *strenua* of western New Guinea in its larger average size, slightly darker ochraceous axillaries, and slightly paler gray general coloration. My measurements of wing length give: for *adamsoni* from southeastern New Guinea, 5 ♂, 171-180 (177 ± 4), 4 ♀, 163-170 (167 ± 3); *strenua* from the Vogelkop to Telefolmin, 8 ♂, 165-179 (171 ± 5), 6 ♀, 161-166 (165 ± 2); nominate *caeruleogrisea* from the Fly River, 2 ♂, 169 and 170 (170 ± 1), 2 ♀, 160 and 164 (162 ± 3). My limited material suggests that the Awande-Okasa population averages as large as *adamsoni* while the material from the Karimui area (100 miles to the west) is as small as *strenua.* The Awande-Okasa material approaches *strenua* in the paleness of the underwing coverts. Gilliard and Gyldenstolpe assigned their Wahgi Valley material to *strenua.*

Evidently the populations of this species are nearer *adamsoni* in the easternmost part of the Eastern Highlands and are nearer *strenua* farther west. *C. c. caeruleogrisea* of the Fly River and Aru Islands is generally paler.

BREEDING. All specimens had the gonads small.

DISCUSSION. This large cuckoo-shrike is widespread but not numerous throughout the Eastern Highlands from about 3,000 ft to a ceiling varying locally between 5,200 ft (Mt. Karimui) and 8,000 ft (Mt. Michael), and has been met by most observers. The other large New Guinea cuckoo-shrike, *C. longicauda,* has an altitudinal range lying mostly above that of *C. caeruleogrisea* but not completely exclusive of it. Like other *Coracina* species, *C. caeruleogrisea* lives in the upperstory of the forest in small groups of about three birds. It walks along tree limbs in a manner reminiscent of a crow.

VOICE. Varied, with both quiet and louder calls: a harsh, grating scream, fairly but not very loud; a soft "chirp"; and a soft slurred note first dropping then rising again in pitch, with a mewing quality, like the call of the bowerbird *Ailuroedus crassirostris.*

Coracina novaehollandiae melanops (Latham)

Australian Graybird

SPECIMENS EXAMINED. Awande: 1 ♀ (16 June 1965). Karimui: 3 ♂, 1 imm. ♂, 2 imm. ♀ (14 Aug. 1964; 9-11 July 1965).

WEIGHT. 3 ♂: 121, 123, 126. 1 ♀: 113. 1 imm. ♂: 120. 1 imm. ♀: 118.

WING. 3 ♂: 196, 197, 200. 1 ♀: 199. 1 imm. ♂: 192. 2 imm. ♀: 181, 196.

CULMEN FROM BASE. 3 ♂: 27, 28, 29. 1 ♀: 30. 1 imm. ♂: 29. 2 imm. ♀: 28, 28.5.

TAXONOMY. These Australian migrants belong to the eastern and southern Australian race *melanops,* not to the Tasmanian race *novaehollandiae* or the northern Australian race *didima,* which have also been recorded from New Guinea. *C. n. didima* differs in its shorter wing and paler color, *C. n. novaehollandiae* in its shorter bill.

BREEDING. The gonads were small in all specimens.

DISCUSSION. This is the first record of this Australian migrant for the Eastern Highlands or for such high altitudes anywhere in New Guinea. Small flocks of two to six birds were seen on six occasions at Awande, Karimui, and Bomai in isolated tall trees in open country, i.e., in gardens and near Karimui airstrip, a habitat in which no species of *Coracina* resident at Karimui or Awande was ever seen. These may have been itinerant groups which remained for short periods, since all my sightings in the Karimui Basin fell in the periods 4-14 Aug. 1964, and 8-11 July 1965.

Coracina papuensis subsp.

Papuan Graybird

STOMACH CONTENTS. Insects (no fruit).

DISCUSSION. This non-forest campephagid is generally a lowland species in New Guinea but has colonized two widely separated areas of the Eastern Highlands. At Lake Kutubu (2,450 ft) Schodde and Hitchcock found it common in flocks at the forest edge and in second-growth along the lake. Bulmer found it breeding commonly in gardens and open country of the Baiyer Valley up to 5,500 ft. The flight is distinctively undulating; the bird alternately flaps to gain altitude, then glides down with the wings held stiffly vertically downwards.

VOICE. A weak, high-pitched, disyllabic note "chee-yu" or "whechew," the first note higher than the second, with a squealing or breezy quality more like the voice of a parrot (e.g., *Domicella lory*) than of most graybirds.

Coracina longicauda grisea Junge

Black-hooded Graybird

SPECIMENS EXAMINED. Agotu (Gimi territory): 1 ♂ (22 July 1964).
WING. 176.
STOMACH CONTENTS. Large insects (four stomachs); insects and fruit (five).

TAXONOMY. The races *grisea* of western New Guinea and nominate *longicauda* of southeastern New Guinea differ only in size. I measured wings of males of both races, with the following results, proceeding from west to east: Snow Mountains (*grisea*), 171, 172, 173; Telefolmin, 170, 173; Mts. Hagen and Wilhelm, 172, 173, 174; Agotu, 176; Huon Peninsula, 176; southeastern New Guinea (*C. l. longicauda*), 177, 179, 180, 180, 186 (180 ± 3). There is obviously a clinal increase in size from west to east, as shown previously by the more extensive measurements of Gilliard and LeCroy (1961, p. 46). Five males from the Wahgi region, slightly farther west than Agotu, measured by Gilliard and LeCroy (1961, p. 47) and by Gyldenstolpe (1955, p. 77), gave 169, 172, 172, 174, 176, yielding an average of 173 for all six Eastern Highlands males. On this basis I refer the whole Eastern Highlands population to *grisea*. More specimens would be required to decide if birds at the eastern end of the Eastern Highlands really are nearer nominate *longicauda*.

DISCUSSION. My sole encounter with this species was in forest near Agotu, where a tongue of moss forest descended to about 5,800 ft, giving this unusually low record for the species. The specimen was one of a flock of six hopping slowly along branches in the tree crowns. Most other observers in the Eastern Highlands have encountered *C. longi-*

cauda but at altitudes above 7,000 ft and ranging in the moss forest up to 10,500 or even 12,000 ft.

VOICE. A high parrot-like slur similar to the note of *Coracina papuensis,* and a short low-pitched chirp.

MOTACILLIDAE: PIPITS and WAGTAILS

Motacilla cinerea caspica (Gmelin)

Gray Wagtail

Gyldenstolpe met this palearctic wintering visitor a few times in August in boggy grassland at Nondugl. Bulmer observed and collected it near streams in Kyaka territory during December through February at 4,000-5,500 ft and also commonly in the Schrader Range up to 7,500 ft.

Anthus gutturalis rhododendri Mayr

Alpine Pipit

SPECIMENS EXAMINED. Mt. Michael: 3 ? (10 July 1964).
WING. 2 ?: 92, 95.
STOMACH CONTENTS. Insects (five stomachs), grass seeds (two), insects and seeds (three).

TAXONOMY. The Mt. Michael specimens are smaller than nominate *gutturalis* of southeastern New Guinea and have the abdomen slightly darker; *wollastoni* of western New Guinea has the black markings on the side of the throat reduced or absent.

DISCUSSION. This high-altitude pipit was met only in alpine grassland at 12,000 ft near the summit of Mt. Michael where, during our brief experience in this habitat, it was the only conspicuous bird. It walked on the ground with a waddling gait, and perched in bushes in the grassland and in 40-ft trees at the forest edge. Alpine grassland has now been surveyed ornithologically on four high peaks of the Eastern Highlands (Mts. Michael, Wilhelm, Hagen, and Giluwe), and *Anthus gutturalis* has been found on all four.

VOICE. The varied song consists of high, thin, clear notes, each repeated several times before repeating a different type of note. The call is a faint, high-pitched "tsip" or "tsee," sometimes repeated.

Anthus novaeseelandiae exiguus Greenway

Richard's Pipit

NATIVE NAME. Fore: iboróto.

DISCUSSION. I met this pipit in twos and threes on the lawns of European houses at Okapa (6,600 ft) and on the nearby grass airstrip at Tarabo (6,000 ft), but nowhere else. Other observers have found it numerous at a number of Eastern Highlands localities between 4,000 and 7,000 ft in very close-cropped grass, such as on sheep pastures, football fields, airstrips, and lawns. The grassland on grown-over native gardens seems too tall for it. Elsewhere in New Guinea it has been recorded only near Wau and Port Moresby.

MUSCICAPIDAE: OLD WORLD INSECT EATERS

Turdinae: Thrushes

Drymodes superciliaris brevirostris De Vis

Northern Scrub Robin

NATIVE NAME. Daribi: gisonábo.

SPECIMENS EXAMINED. Karimui: 1 ♂?, 3 ♀, 1 ? (4-7 Aug. 1964; 2 July-6 Aug. 1965). Bomai: 1 ♂ (7 July 1965).

WEIGHT. 1 ♂: 58. 1 ♂?: 52. 2 ♀: 36, 41.

WING. 1 ♂: 95. 1 ♂?: 90. 3 ♀: 80, 82, 82.

CULMEN FROM NOSTRIL. 1 ♂: 13.0. 1 ♂?: 11.5. 3 ♀: 9.5, 9.5, 10.0.

TAXONOMY. These specimens are closest to *brevirostris,* from which they differ only in the darker, blacker crown (tendency towards *nigriceps*). In the pale color of the underparts they are closer to *brevirostris* from southeastern New Guinea than from the Fly River; the latter are browner below. The races *nigriceps* and *beccarii* have duller and darker backs, and *nigriceps* in addition is darker and grayer below.

DISCUSSION. *D. superciliaris* is a shy and uncommon, but widespread, inhabitant of the forest floor from about 1,800 to 4,200 ft. I never saw it in life but heard its song several dozen times at Okasa, Soliabeda, Karimui, and on the lower slopes of Mt. Karimui.

VOICE. An unmistakable series of clear, very slow, chromatically descending, somewhat plaintive, whistled notes. The quality and the medium pitch are similar to those of *Crateroscelis murina.* In the Eastern Highlands the song consists typically of five notes, each lasting 1½ sec and separated by an equal pause from the next note, so that the whole song lasts about 15 sec. The first note is initially downslurred. Successive notes each remain on constant pitch, and each is about a half-tone lower than the next (Fig. 20). The downslurred first note is sometimes given alone as a call, and takes more practice to identify but is still diagnostic.

Saxicola caprata wahgiensis Mayr and Gilliard

Pied Chat

NATIVE NAMES. Fore: pobogíle. Gimi: médi. Daribi: dódi.

SPECIMENS EXAMINED. Awande: 1 ? (17 June 1965).

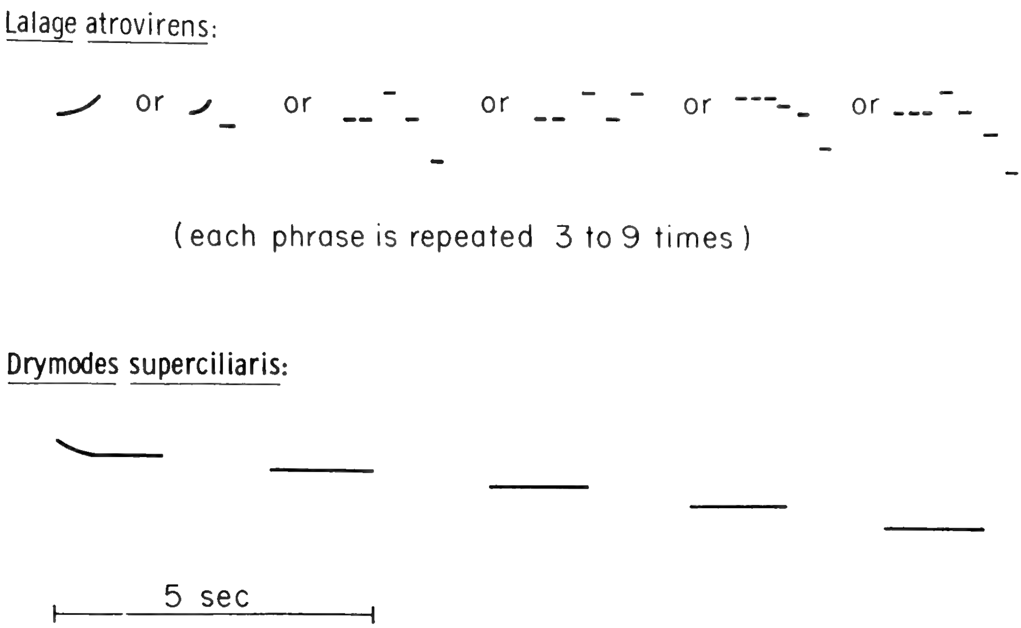


FIG. 20. Voices of *Lalage atrovirens* and *Drymodes superciliaris*.

WEIGHT. 19.5.
WING. 78.

DISCUSSION. This is a common species in cleared country (native gardens, or grassland with perches such as fences or trees, but not pure grassland) almost anywhere in the Eastern Highlands. Solitary individuals or pairs perched on fences, dead branches, the ground, and at the tops of isolated trees, whence they periodically sallied out in flycatcher fashion. One was seen with a berry in its bill. Males showed territorial behavior, frequently singing from conspicuous perches generally 10 to 30 ft, sometimes as much as 70 ft, high.

VOICE. A weak, somewhat hoarse, high-pitched, whistled song of four to eight notes in irregular rhythm. Each singer has several patterns, each of which is delivered several times in succession (with moderate pauses between repetitions) before proceeding to the next pattern. One of these four-note patterns is the source of the Fore name "pobogíle."

Zoothera dauma papuensis (Seebohm)[1]

White's Ground Thrush

SPECIMENS EXAMINED. Okasa: 1 ♂ ? (a) (23 June 1965). Sena River: 1 ? (b) (28 July 1964). Mt. Karimui Zone 3: 1 ♂ (c) (19 Aug. 1965).
WING. 1 ♂ (c): 114. 1 ♂ ? (a): 117.

DISCUSSION. This thrush is one of the rarest species of the New

[1] Listed as *Oreocincla dauma* in Rand and Gilliard (1967).

Guinea hill forest and has been taken in New Guinea only in five areas. The 12 specimens known to me are as follows: Huon Peninsula, one each collected by Wahnes and Keysser on the Sattelberg; Adelbert Mountains, one taken by Ziegler (3,800 ft); southeastern New Guinea, one collected by the First Archbold Expedition at Mafulu (4,000 ft), three collected at 4,000 ft on the Aroa River by Weiske, and the type specimen taken by Goldie; southern slope of the Eastern Highlands, my three specimens; southern slope of the Snow Mountains, one taken by Meek at 4,000 ft. All three of my specimens came from primary forest: the Okasa specimen was shot on the ground at 3,550 ft, the Sena River one netted at 4,500 ft, and the Mt. Karimui one netted at 5,100 ft. The species has a wide extralimital range (Asia to the Solomon Islands) and is among the minority of hill forest species that "hopped" directly into the New Guinea mountains from the outside, instead of evolving from a lowland ancestor.

Amalocichla incerta olivascentior Hartert

Lesser New Guinea Thrush

NATIVE NAME. Gimi: kábiya-agóra.
SPECIMENS EXAMINED. Mt. Karimui Zone 4: 1 ♂ (30 Aug. 1965).
WEIGHT. 30.7.
WING. 76.
TAIL. 51.
EXPOSED CULMEN. 16.
STOMACH CONTENTS. Insects.

TAXONOMY. The Mt. Karimui specimen was compared with *brevicauda* of southeastern New Guinea, *olivascentior* of the Snow Mountains and Weyland Mountains and North Coastal Range, nominate *incerta* of the Vogelkop, and one Mt. Goliath specimen referred to *brevicauda*. The color of the underparts is grayest and dingiest, least brown, in *olivascentior* from the Weyland Mountains and North Coastal Range, followed by Snow Mountains *olivascentior;* southeastern New Guinea *brevicauda* is browner, and Vogelkop *A. i. incerta* brownest, least gray. The Mt. Karimui specimen is intermediate between Weyland Mountains and Snow Mountains birds. The Mt. Goliath specimen is slightly browner than the Mt. Karimui specimen but still much less brown than southeastern *brevicauda*. The white feathers on the side of the throat are conspicuously tipped with dark in Weyland Mountains and Snow Mountains birds and the Mt. Karimui specimen but not in southeastern birds or the Mt. Goliath specimen. The Mt. Karimui specimen is therefore assigned to *olivascentior* on the basis of the ventral coloration and throat feathers. Its wing and tail lengths are shorter than those of 10 male *olivascentior* measured (wing 77-84, tail 55-61). Gyldenstolpe assigned his seven specimens from the Wahgi Valley to *brevicauda,* apparently on geographical grounds and without comparison of material. He specifically mentions, however, the dark margins of the throat feathers, so that they undoubtedly belong to *olivascentior*. The measurements he reports (e.g., wing 79-82 in males) are comparable to Snow Mountains and Weyland Mountains *olivascentior*. The allocation of the single Mt. Goliath adult is uncertain. In his check list Mayr (1941) includes the Sepik Mountains in the range of *brevicauda,* presumably on the basis of one specimen which Bürgers collected on the Schraderberg and which I was not able to examine.

The revised ranges of the subspecies are therefore: *brevicauda,* southeastern New Guinea, Huon Peninsula, and (requires confirmation) Schraderberg; *olivascentior,* Eastern Highlands, North Coastal Range, Snow Mountains, and Weyland Mountains; Mt. Goliath (eastern extremity of Snow Mountains), allocation uncertain; and nominate *incerta,* Vogelkop.

BREEDING. The testes of the Karimui specimen were greatly enlarged.

DISCUSSION. My specimen was netted at 5,960 ft, while Gyldenstolpe's specimens were all trapped at 8,000 ft. The only other Eastern Highlands records are from the Schrader Mountains (specimens obtained by Bürgers and Bulmer). This is evidently a rare and local thrush of the forest floor.

Turdus poliocephalus erebus Mayr and Gilliard

Island Thrush or New Guinea Blackbird

STOMACH CONTENTS. Fruit (two stomachs), insects (one), fruit and insects (one).

The Island Thrush was found in alpine grassland above 1,000 ft on the summits of Mts. Hagen, Wilhelm, and Giluwe by Gilliard and by Shaw-Mayer. On Mt. Albert-Edward I found it characteristic of the edge between forest and alpine grassland, hopping on the ground and perching in low bushes or up to 40 ft high in forest edge trees, sometimes feeding in grassland several hundred feet from the forest edge but retreating to the forest when alarmed.

VOICE. The call-notes are typical for the genus *Turdus:* a repeated buzzy alarm note with the tail flicked at each note, a squawk, and a weak, high, slightly downslurred "tsr" or "sss."

Orthonychinae: Logrunners

As constituted by Deignan (1964) in Peters' *Check-list,* Vol. 10, this family consists of nine genera, restricted to Australia and New Guinea except for the species *Eupetes macrocerus* from Malaya, Sumatra, and Borneo. The members of this family were formerly considered to be babblers (Timaliinae). The genera *Drymodes* and *Crateroscelis,* also previously considered babblers, have been transferred to Turdinae and Malurinae, respectively, so that the Timaliinae are now considered to be represented in New Guinea only by *Pomatostomus isidori* and *P. temporalis* of the lowlands.

Eupetes castanonotus pulcher Sharpe

Midmountain Eupetes

NATIVE NAMES. Gimi: liyóta. Daribi: gíwibo.

SPECIMENS EXAMINED. Sena River: 1 ♂ (29 July 1964). Karimui: 3 ♂, 1 ♀, 2 ? (8-15 Aug. 1964; 5 Aug.-11 Sept. 1965). Bomai: 1 ♂ (9 July 1965). Soliabeda: 1 ♂, 1 ♀ (27-29 July 1965). Mt. Karimui Zone 1: 2 ♀, 1 imm. ♂ (11-12 Aug. 1965).

WEIGHT. 3 ♂: 70, 72, 74. 2 ♀: 70, 74. 1 imm. ♂: 61. 1 ?: 58.

WING. 6 ♂: 94, 96, 97, 97, 99, 99. 4 ♀: 89, 89, 91, 93. 1 imm. ♂: 96. 1 ?: 89.

TAXONOMY. In two of my females the eye stripe is completely blue, while in the other two and in one of the unsexed Karimui specimens the stripe becomes paler or whitish blue posterior to the eye. Two of the females have white spots on the undertail coverts, while this cannot be checked in the other two due to loss of feathers. The immature male has scattered chestnut feathers on the blue of the lower back and rump.

Material available for comparison consisted of nominate *castanonotus* from the Vogelkop, *saturatus* from the southern slope of the Snow Mountains, *uropygialis* from the northern slope of the Snow Mountains, specimens from the Adelbert Mountains assigned to *buergersi,* two males of uncertain affiliation (perhaps *buergersi* or *par*) from Keku in the Finisterre Mountains of the Huon Peninsula, and *pulcher* from southeastern New Guinea. Topotypical material of *buergersi* (Sepik Mountains) and *par* (Saruwaged Mountains) was lacking. Females of the races *E. c. castanonotus, saturatus, uropygialis,* and from the Adelberts differ from mine in having the eye stripe blue in all specimens. The general color of *E. c. castanonotus* is quite similar, but its blue is slightly paler and less purple, and the chestnut of its back is very slightly paler. *E. c. saturatus* differs conspicuously in its much deeper blue ventral coloration and its slightly darker chestnut back. *E. c. uropygialis* differs conspicuously in that the lower back of the female is blue, not chestnut, and differs slightly in the generally paler coloration. The Adelbert series and the Keku males differ in the lighter tone both of their chestnut and blue parts. *E. c. pulcher* is quite close in its general coloration; the blue of *pulcher* averages slightly lighter and less purple, but many specimens can be matched with mine; the chestnut averages lighter in *pulcher.* Females of *pulcher* have the eye stripe pale blue or whitish, often mixed with rusty (none of my females has this rusty). From the description (Mayr, 1931, p. 691), *buergersi* is eliminated by the blue eye stripe of all three known females and perhaps by its darker general coloration. *E. c. par* (Meise, 1930, p. 17) apparently agrees with my specimens in that the eye stripe of the female may be either solid blue, or else pale blue behind the eye; it apparently differs in its longer wing (the original description cited 2 ♂ 101, 101; 2 ♀ 98, 99); Meise said that males of *par* were indistinguishable from *saturatus*, which would make them much darker blue than my specimens; Mayr said that females of *par* had a lighter chestnut back than *E. c. castanonotus*, which would make them lighter chestnut than my specimens.

The Eastern Highlands series thus shares the variably light eye stripe of females of the eastern populations *pulcher* and *par*. The small differences in general coloration between it and the slightly lighter *pulcher* to the east are what one would expect of a clinal east-to-west darkening along the southern watershed that would culminate in *saturatus* of the Snow Mountains. The incidence of light female eye stripes seems also to decrease clinally east-to-west on the southern watershed from *pulcher* through the Eastern Highlands to *saturatus*. The Eastern Highlands population is therefore best assigned to the most similar end of the cline, *pulcher*.

BREEDING. The gonads were enlarged in all adult males and half the females. Evidently this ground nesting species (Rand, 1942a, p. 327) breeds in the dry season.

DISCUSSION. *E. castanonotus* lives strictly in the forest interior on the ground. Single birds or pairs were occasionally seen walking with bobbing head and fairly long, leisurely strides on the forest floor. When disturbed, the birds flew just above (i.e., less than 1 ft above) the ground and realighted 10-20 ft away, in a manner reminiscent of South American tapaculos (*Pteroptochos megapodius*, Rhinocryptidae). They were much more often heard than seen.

While *E. castanonotus* has yet to be recorded away from the Karimui area, it is likely to turn up at most stations in hill forest between about 1,500 and 4,500 ft. The genus *Eupetes* provides an instance of perfect triple exclusion, in that the altitudinal range of *E. castanonotus* lies strictly above that of *E. caerulescens* (transition at ca. 1,000-2,000 ft, *E. caerulescens* from there down to sea level) and strictly below that of *E. leucostictus* (transition at ca. 4,100-5,000 ft). The evolution of the genus is particularly easy to trace, since each species shows considerable subspecific variation in color pattern and some race of each species can be found which approaches in its color pattern some race of the species above or below it.

VOICE. The song (Fig. 21a) consists of three to six clear, bell-like, whistled notes at moderate pitch, all on the same pitch and identical except for dramatically increasing in volume, and concluded by a very loud downslurred "chew!" Sometimes a short, unmusical, fainter, downslurred "ksew" comes between the whistled notes and the "chew!" The whole song takes about 2 sec. On paper this looks like the song of several *Pachycephala* species (*P. soror*, *P. hyperythra*, *P. rufiventris*), but in practice I felt no danger of confusion, possibly because the final "chew!" is so distinctive. Heard more often is the common call (Fig. 21b), three very loud, identical, explosive notes "chew! chew! chew!" in rapid succession. When heard at a distance, this call can easily be confused with a similar call of the whistler *Pachycare flavogrisea,* but that of *Eupetes castanonotus* is louder, somewhat more rapid, and comes from the ground, not from the trees.

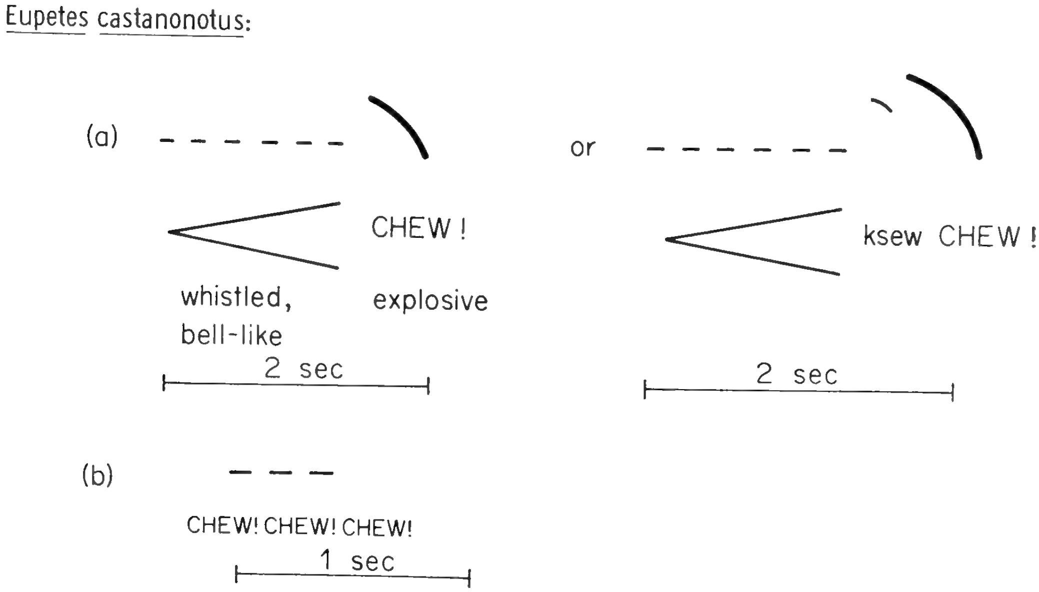


FIG. 21. Voice of *Eupetes castanonotus.*

Eupetes leucostictus loriae Salvadori

High Mountain Eupetes

NATIVE NAME. Fore: iré.

SPECIMENS EXAMINED. Miarosa: 1 ? (17 June 164). Mt. Michael: 1 ♀, 1 ? (4 and 7 July 1964). Mt. Karimui Zone 4: 1 ♂, 1 ♀ (30 Aug. and 1 Sept. 1965).

WEIGHT. 1 ♂, 49. 1 ♀, 51.

WING. 1 ♂, 85. 2 ♀, 77, 83.

TAXONOMY. This series is closest to *loriae* of southeastern New Guinea and *amabilis* of the Huon Peninsula. The latter is blue below with very little olive, while the former has an olive wash on the breast and flanks. My specimens have a lesser extent of olive wash than the average amount for *loriae* but can be matched by some southeastern New Guinea birds and are therefore assigned to *loriae,* as Mayr and Gilliard (1954, p. 345) similarly concluded for their Wahgi Valley series.

BREEDING. The male had somewhat enlarged gonads.

DISCUSSION. This eupetes is inconspicuous and uncommon but nevertheless widespread on the forest floor from ca. 5,000 to 8,500 ft, having been encountered by most collectors in the Eastern Highlands. Its habits are generally similar to those of *E. castanonotus*, i.e., it walks on the ground singly or in pairs, but it differs conspicuously in not possessing or frequently exercising a loud voice.

VOICE. The only sound that I heard was, on one occasion, a faint "tsip" from one bird of a pair, like the call of a young chick.

Melampitta lugubris longicauda Mayr and Gilliard

Lesser Melampitta

STOMACH CONTENTS. Insects (one stomach), insects and seeds (one).

DISCUSSION. In the central and northern parts of the Eastern Highlands Gilliard, Gyldenstolpe, Shaw-Mayer, Hitchcock, and Bulmer recorded this species in dense undergrowth on the forest floor at higher elevations (ca. 7,000-10,000 ft). Despite intensive netting in apparently suitable habitats at Okapa, Mt. Michael, and Mt. Karimui I never obtained it.

Ifrita kowaldi kowaldi (DeVis)

Blue-capped Ifrit

SPECIMENS EXAMINED. Miarosa: 2 ♂ (17 and 24 June 1964). Mt. Michael: 1 ♀ (5 July 1964). Mt. Karimui Zone 5: 1 ♂, 1 ♀; Zone 6: 1 ♂, 2 ♀: Zone 7: 2 ♂, 1 ♀; Zone 8: 1 ♂, 2 ♀ (28 Aug.-8 Sept. 1965).

WEIGHT. 4 ♂: 33, 34, 35, 36. 6 ♀: 30, 32, 33(4).

WING. 7 ♂: 86, 86, 87, 88, 89, 90, 92. 6 ♀: 82, 84, 86, 86, 86, 87.

STOMACH CONTENTS. Insects.

TAXONOMY. These belong to the eastern race; *brunnea* of western New Guinea differs by being more brown and less olive above and by having the remiges and rectrices more rufous. The ear stripe is white in males but not in females.

BREEDING. The gonads were slightly enlarged in two Mt. Karimui males but were small in other specimens.

DISCUSSION. Virtually all collectors in the Eastern Highlands have found the Ifrit fairly common in primary midmontane forest up to about 9,500 ft. Its lower limit is not more than 1,000 ft below the lower limit of the mossy zone, at an altitude depending upon local conditions (usually 6,500 or 7,000 ft). It feeds nuthatch-like in moss-covered trees, probing in moss, pounding at the bark, often bending over a branch head downwards to probe the undersurface while still gripping the uppersurface with its legs, and bracing itself stiffly on its tail. The tip of the tail consequently becomes abraded, as in the case of the New Zealand warbler *Mohoua ochrocephala*, which has similar habits. The Blue-capped Ifrit forages from the understory to the crowns and is often seen in pairs or groups of three, calling frequently and loudly.

VOICE. A rapid series of a half dozen rasped, scratchy, identical notes, similar to the call of *Machaerirhynchus nigripectus* or that of *Mohoua ochrocephala*.

Malurinae: Wren Warblers

The warblers of New Guinea and Australia fall into four groups whose relationships are unclear. One group, represented in New Guinea by five species in the genera *Malurus, Todopsis, Chenorhamphus,* and *Clytomyias,* is confined to Australia and New Guinea. A second, represented in New Guinea by 19 species in the genera *Sericornis, Acanthiza, Gerygone,* and perhaps *Crateroscelis,* is centered on New Guinea and Australia but has a few representatives on islands to the east and west. A third consists of grass warblers of predominantly Eurasian and African genera, of which *Acrocephalus, Megalurus,* and *Cisticola* have breeding representatives (five species) in New Guinea. The fourth consists of the Eurasian and African tree warblers, of which only *Phylloscopus trivirgatus* reaches New Guinea. The third and fourth groups comprise the subfamily Sylviinae. While earlier authors (and Rand and Gilliard, 1967) placed the second group (*Sericornis* and its allies) with the Sylviinae and kept the first group as a separate subfamily Malurinae, Mayr and Amadon (1951) and Keast (1961) tentatively combine the second group with the Malurinae. The latter arrangement is arbitrarily adopted here.

Malurus alboscapulatus mafulu Mayr and Rand and *M. a. kutubu* Schodde and Hitchcock

Black and White Wren Warbler

NATIVE NAMES. Fore: asasába. Gimi: férotóro.

SPECIMENS EXAMINED. Awande: 3 ♂, 2 juv. ? (15-20 June 1965). Karimui: 5 ♂, 1 ♀, 3 imm. ♂, 1 juv. ♂ (12 Aug. 1964; 12-17 July 1965). Bomai: 1 ♀ (5 July 1965). Soliabeda: 2 ♂, 2 ♀ (24-29 July 1965).

WEIGHT. 10 ♂: 9.3-12.3 (11.1 $\pm$ 1.0). 4 ♀: 9.7, 10.5, 11.0, 11.0. 3 imm. ♂: 10.0, 10.0, 11.0. 1 juv. ♂: 10.5.

WING. 10 ♂: 48-52 (50 $\pm$ 1). 4 ♀: 49 (4). 3 imm. ♂: 48, 49, 49. 1 juv. ♂: 46.

STOMACH CONTENTS. Insects.

TAXONOMY. All four females have white lores and scapulars and are charcoal brown to black above but vary in the color of the underparts. One, with enlarged ovaries, is white below except for a faint breast band (Soliabeda); a second, caught on the nest, is entirely white below (Bomai); a third has a white chin and belly but blackish throat and breast (Karimui); and the fourth is largely charcoal brown below with scattered white feathers and a whitish chin (Soliabeda). Of the three immature males (all from Karimui), one has white lores, scapulars, and underparts, and the upperparts are black except for scattered brown feathers; a second is similar except that the upperparts are charcoal brown; the third is gray-brown above including the scapulars, and dirty white below with a darker breast band. The juvenile male is charcoal brown above including the scapulars, while the underparts and lores are white (Karimui). Both Awande juveniles are gray-brown except for a white chin. Adult males are black except for white scapulars; one has a few feathers of the belly white but still has enlarged testes. The many female and immature *Malurus* (i.e., those apart from the black adult males with white scapulars) seen in the field at Karimui were equally variable; some were pure white below, others had a dark breast band, and still others were largely dark below except for a light throat.

The color of the females and the large size place this series with *mafulu,* a race described from the midmontane grasslands of southeastern New Guinea and later found in those of the Wahgi Valley. *M. a. naimii,* the lowland race of southeastern New Guinea to the west of Port Moresby, differs by its smaller size and on the average by the smaller extent of dark areas on the flanks and breast of the female. *M. a. dogwa* of the Fly River lowlands differs markedly in the much smaller size, brown upperparts, buffy flanks, and whitish underparts without a breast band. Only the Bomai female and the Karimui juvenile have any buff on the flanks, and these small amounts can be matched in *mafulu.* It is interesting that in the case of *Malurus alboscapulatus* the newly created grasslands of the Karimui Basin have been colonized by the midmontane race (*mafulu*) rather than by the lowland races (*naimii* or *dogwa*).

The Wahgi Valley population was also assigned to *mafulu* by Mayr and Gilliard. Surprisingly, Schodde and Hitchcock (1968, p. 42) state that the population at Lake Kutubu (2,450 ft) and Mendi (5,900-7,000 ft) is very different and they describe it as a new race *kutubu,* since the female is uniformly sooty black. This pattern is shared by three other spatially isolated populations: *moretoni* in the southeastern New Guinea lowland to the east of Port Moresby, *aida* in the northwestern New Guinea lowland and midmontane grasslands of the Weyland Mountains, and *randi* in the midmontane grasslands at the Wissel Lakes. The *mafulu* group (female white ventrally) also has an interrupted distribution in the midmontane grasslands of southeastern New Guinea and the eastern part of the Eastern Highlands (*mafulu*), the lowlands of southeastern New Guinea (*naimii*), the lowlands of northeastern New Guinea (*tappenbecki*), and the Vogelkop (nominate *alboscapulatus*). The third group, in which females are brown and white, occurs in the lowlands of southern New Guinea (*dogwa*) and southwestern New Guinea (*lorentzi*) and the midmontane grasslands of the Baliem Valley (*balim*). An explanation for the checkerboard distributions of the three female plumage types is lacking.

BREEDING. Natives brought in two nests, bowls of dry grass which were said to have been on the ground in grassland. One contained one fledgling, the other two. All adult males taken at all my collecting localities had greatly enlarged testes. Evidently breeding is concentrated in the dry season. According to Fore informants nests of *Malurus* are those most often victimized by the cuckoo *Cacomantis variolosus.*

DISCUSSION. *Malurus alboscapulatus* is probably the most abundant and ubiquitous Eastern Highlands bird in grassland and gardens, up to about 7,000 ft. At Soliabeda, where a few years before my arrival two small gardens had been cleared in the middle of a large area of undisturbed forest, *M. alboscapulatus* was already common and breeding though the other characteristic species of the midmontane grasslands had not yet been able to colonize this tiny island of suitable habitat. It is usually seen in small groups, perhaps family groups, of two to six birds. The birds can readily be called out of the depths of the grassland to perches on tall stalks of grass, but I have never seen them perched more than 6 ft above the ground. Their flights are jerky, brief, and give every impression of being weak, despite which they must have crossed nine miles of unbroken forest, including a mountain ridge 1,000 ft high, to have reached Soliabeda from the nearest grassland.

VOICE. A rapidly spitted twitter or jumble of notes full of sibilants, inspiring the Fore name "a-sa-sa-ba."

Todopsis cyanocephala bonapartii Gray

Blue Wren Warbler

DISCUSSION. Schodde and Hitchcock found this low-altitude wren warbler at Lake Kutubu in dense second-growth and at the forest edge.

VOICE. A rapid series of spitted notes very similar to the call of *Malurus alboscapulatus.*

Clytomyias insignis oorti Rothschild and Hartert

Rufous Wren Warbler

NATIVE NAME. Fore: tabugíri, or asasába bilong bush(= "asasába of the forest": cf. *Malurus alboscapulatus*).

SPECIMENS EXAMINED. Awande: 1 ♀ (a) (14 June 1965). Mt. Karimui Zone 5: 1 ♀; Zone 6: 1 ♂; Zone 8: 1 ♂.

WEIGHT. 2 ♂: 12.0, 12.7. 2 ♀: 15.2 (a), 13.0.

WING. 2 ♂: 56, 58. 2 ♀: 59 (a), 57.

STOMACH CONTENTS. Insects.

TAXONOMY. These agree with *oorti* in the underparts being buffier than in nominate *insignis* of the Vogelkop, which has a nearly white throat.

BREEDING. The Awande female (marked "a") contained two nearly formed eggs, while the gonads of the Mt. Karimui specimens were small.

DISCUSSION. *Clytomyias insignis* seems to be local and uncommon in midmontane forest. All four of my specimens were netted, indicating preference for the understory. The Fore said that *Clytomyias* is very similar in behavior to *Malurus alboscapulatus* and that it goes about near the ground and around fallen trees with cocked tail.

Sylviinae: Warblers

Niche Differences in the Genus *Sericornis*

This genus presents not only difficult taxonomic problems but also some of the most complicated altitudinal relationships in New Guinea, including parallel four-species and two-species altitudinal sequences (Diamond, 1969). Four of the species (*S. spilodera, S. arfakianus, S. perspicillatus, S. papuensis*) are small (weight ca. 9-12), have small bills (culmen from base 12-13), forage both in the lower- and middle-stories, and constitute a four-species altitudinal sequence. The remaining two widespread species, *S. virgatus* (absent in the Eastern Highlands) and *S. nouhuysi,* are large (weight ca. 11-18), have large bills (culmen from base 15-16), forage mainly in the lower story, and exclude each other altitudinally, but each overlaps several of the small species. *S. beccarii* is related to *S. virgatus* but is confined to the flat lowlands of southern New Guinea and the Cape York Peninsula of Australia, while *S. nigroviridis* is a mystery bird of distinct appearance, known from one specimen.

The altitudinal ranges of the abundant four small *Sericornis* species on Mt. Karimui were:

S. spilodera	1,350 ft or below	—4,240 ft
S. arfakianus	4,400 ft	—5,000 ft
S. perspicillatus	—6,350 ft	5,100 ft
S. papuensis	—summit (8,165 ft)	6,450 ft

All transitions were sharp, i.e., no individual of any species was caught, seen, or heard in another's altitudinal band, except for two *S. spilodera* shot together at 4,950 ft, far into *S. arfakianus*'s band. These two were young birds with short wings, low weights, and gonads not discernible, and conform to the general rule (p. 00) that normal altitudinal limits are most likely to be violated by young birds.

Sericornis spilodera guttatus (Sharpe)

Pale-billed Sericornis

NATIVE NAME. Daribi: sabobá.

SPECIMENS EXAMINED. Karimui: 9 ♂, 1 ♀ (31 July-17 Aug. 1964; 3-17 July

1965). Bomai: 1 ♂ (8 July 1965). Soliabeda: 2 ♂ (22 and 27 July 1965). Mt. Karimui Zone 1: 4 ♂, 2 ♀; Zone 2: 1 ♂; Zone 3: 2 ? (10-16 Aug. 1965).

WEIGHT. 10 ♂: 10.3-13.2 (11.9 $\pm$ 0.8). 3 ♀: 10.5, 11.0, 11.0.

WING. 10 ♂: 56-63 (60 $\pm$ 2). 2 ♀: 57, 58.

TAXONOMY. This series is closest to *guttatus* of southeastern New Guinea and agrees with it in size but differs in the darker throat spots, deeper yellow color below, darker upper tail, and darker, brighter, and more olive back. *S. spilodera* thus follows the general trend at Karimui towards dark coloration. However, these differences seem not sufficiently marked to justify naming a new race. The race *wuroi* of the Fly River is paler and greener below, paler and less bright above, slightly smaller, and the throat spotting is paler; *granti* of the southern slope of the Snow Mountains is paler below, paler, browner, and less olive on the back, tail, and crown, and with paler, browner, less gray and less clear throat spotting; nominate *spilodera* of northern New Guinea is paler and less yellow below, darker on the crown, and the throat spotting is less dark; *ferrugineus* of Waigeu is much paler above and below and has the throat spotting nearly obsolete. The whole culmen measures 13 to 14 in my specimens.

BREEDING. At Karimui both in 1964 and 1965, and at Bomai and Soliabeda, most males and the one female obtained had greatly enlarged gonads, suggesting breeding in the dry season for this species of the understory. The sex ratio of specimens for those localities was very unequal in favor of males (12:1), as in the case of *S. papuensis* on Mt. Karimui (possibly because females were staying on nests?). In contrast, all specimens obtained on Mt. Karimui had very small gonads. These individuals near the upper limit of the altitudinal range must be young birds or nonbreeding adults, a pattern observed in other species as well (cf. p. 30).

DISCUSSION. *S. spilodera* is the *Sericornis* species with the lowest altitudinal range and is present in hill forest on all major mountain ranges of New Guinea, becoming rare or absent at sea level. The altitude of 4,240-4,400 ft for the *S. spilodera*-*S. arfakianus* transition on Mt. Karimui is somewhat higher than usually found elsewhere in New Guinea, probably due to the effect of the tropical Karimin Basin shifting most hill forest ranges upwards.

In the field *S. spilodera* is most easily distinguished from other species of *Sericornis* by its pale, horn-colored bill.

Sericornis arfakianus (Salvadori)

Gray-green Sericornis

SPECIMENS EXAMINED. Okasa: 2 ♂, 1 ? (22-24 June 1965). Sena River: 1 ? (26 July 1964). Mt. Karimui Zone 2: 1 ♂, 1 ♀, 2 ?; Zone 3: 1 ♂ (13-18 Aug. 1965).

WEIGHT. 4 ♂: 9.0, 9.0, 9.0, 10.3. 1 ♀: 7.5. 2 ?: 6.5, 9.3.

WING. 4 ♂: 48, 52, 55, 56. 1 ♀: 48. 2 ?: 51, 51.

CULMEN FROM BASE. 4 ♂: 12.0, 12.5, 12.5, 13.0. 1 ♀: 12.0. 2 ?: 12.0, 12.0.

TAXONOMY. The slight geographical variation in this species follows an irregular checkerboard that renders impossible the definition of subspecies with coherent ranges. In dorsal coloration, populations from the Weyland Mountains, Cyclops Mountains, North Coastal Range, and southeastern New Guinea are brighter than birds from the Idenburg slopes, Adelbert Mountains, and Telefolmin, with Vogelkop birds still duller. The underparts range from yellowish with slight streaking to grayer with more streaking, the sequence of populations from yellower to grayer being Cyclops > Weyland > North Coastal Range > southeastern New Guinea > Adelbert Mountains > Telefolmin, Vogelkop, Idenburg slopes.

BREEDING. Testes were large in both Okasa males and one of the Mt. Karimui males.

DISCUSSION. This is the second member in the altitudinal sequence of small *Sericornis,* living above *S. spilodera* and below *S. perspicillatus* between ca. 4,000 and 5,000 ft. On most New Guinea mountains, in my experience and to judge from records of the First and the Third Archbold Expeditions (Mayr & Rand, 1937; Rand, 1942b), its total vertical range is only about 1,500 ft, but even with respect to this narrow band its Mt. Karimui range is compressed (to 600 ft).

VOICE. Dry scolding notes, and a dry call note "chip."

Sericornis perspicillatus Salvadori

Buff-faced Sericornis

NATIVE NAME. Fore: pasagekiyábi.

SPECIMENS EXAMINED. Awande: 2 ♂, 1 ♀ (20 June 1964; 15 June 1965). Mt. Michael: 1 ♂ (2 July 1964). Mt. Karimui Zone 3: 2 ?; Zone 4: 2 ♂, 1 ♀; Zone 5: 2 ♂, 1 ? (16 Aug.-1 Sept. 1965).

WEIGHT. 5 ♂: 8.0, 8.8, 9.0, 10.0, 10.2. 1 ♀: 8.0.

WING. 7 ♂: 51, 54, 55 (5). 2 ♀: 50, 51.

CULMEN FROM BASE. 7 ♂: 12.0 (3), 12.5, 13.0 (3).

STOMACH CONTENTS. Insects.

BREEDING. Three of the four Mt. Karimui males had greatly enlarged testes, suggesting breeding at the same time as other species of *Sericornis* at Karimui.

DISCUSSION. *S. perspicillatus* and *S. nouhuysi* are superficially rather similar because of the yellowish underparts and orange face in both species. The iris is generally dull brown in *S. perspicillatus,* whereas it is often red-brown in *S. nouhuysi.*

S. perspicillatus is the third in the altitudinal sequence of small *Sericornis.* As with many other birds of midmontane forest, the descent of stunted moss forest to 6,500 ft on Mt. Karimui resulted in an unusually low upper limit for *S. perspicillatus* (6,350 ft), and its upper limit on most other mountains (e.g., Mt. Michael) is around 8,000 ft.

It flits nervously in small groups of a few to eight birds in the understory and in trees up to about 40 ft above the ground, not only in the forest interior but also at the forest edge, in partly cut forest, and even in casuarina groves which have no bushes in the understory.

VOICE. The common call is a dry "chip," recognizable with practice. A more distinctive vocalization, perhaps the song, is a rapid series of "chip's" which progressively rise in pitch and grow thinner in quality; the series may be preceded by a more substantial "chip" at a higher pitch (Fig. 22). There are also scolding and chattering notes.

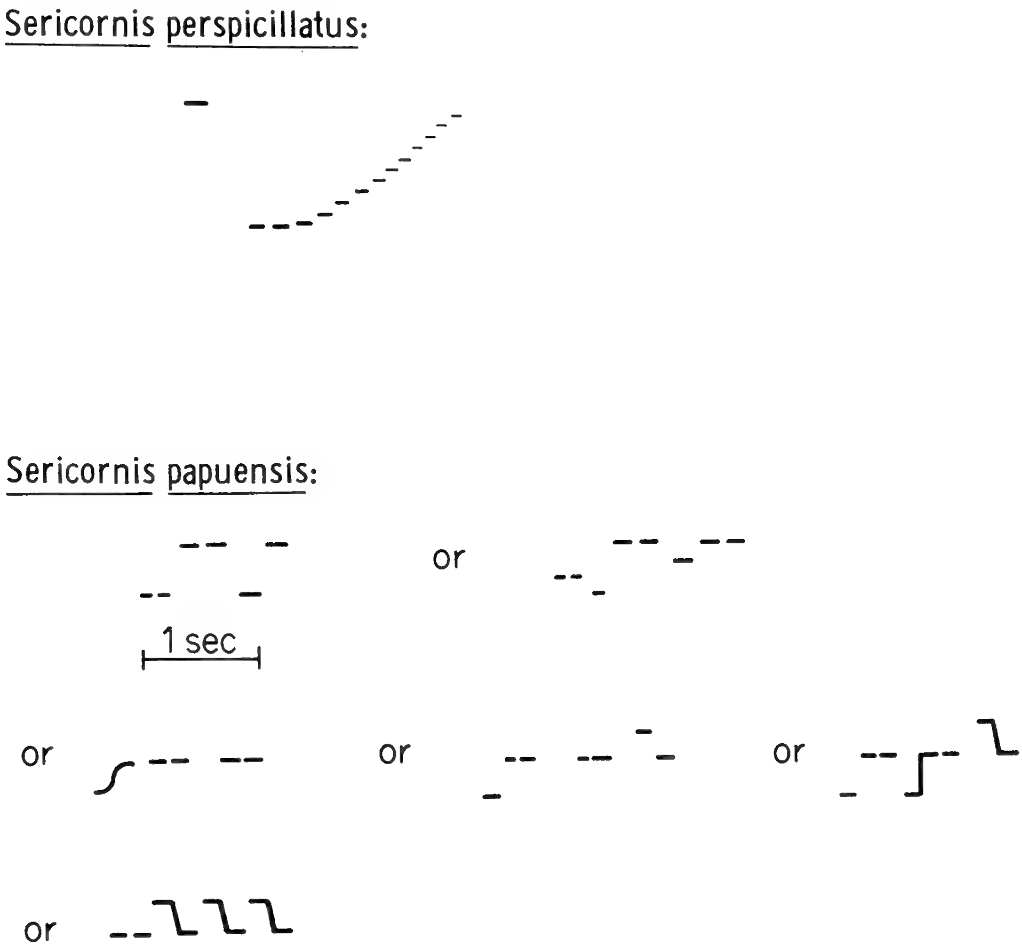


FIG. 22. Voices of *Sericornis perspicillatus* and *S. papuensis.*

Sericornis papuensis papuensis (De Vis) and (?) *S. p. buergersi* Stresemann

Papuan Sericornis

SPECIMENS EXAMINED. Mt. Michael: 1 ? (6 July 1964). Mt. Karimui Zone 5: 1 ♀, 1 imm. ?; Zone 6: 9 ♂, 2 ♀; Zone 7: 2 ♂; Zone 8, 9 ♂ (28 Aug.-8 Sept. 1965).

WEIGHT. 10 ♂: 9.8-11.7 (10.7 ± 0.5). 3 ♀: 10.0, 10.3, 10.7. 1 imm. ?: 9.5.
WING. 10 ♂: 55-61 (58 ± 1). 3 ♀: 52, 53, 53. 1 imm. ?: 52.
CULMEN FROM BASE. 10 ♂: 12.0-14.0 (12.8 ± 0.5). 3 ♀: 12.5 (3). 1 imm. ?: 13.
STOMACH CONTENTS. Insects.

TAXONOMY. The mark which I find most useful in the hand for distinguishing specimens of this difficult and variable species from other *Sericornis* and from *Acanthiza murina* is on the forehead: for 2-3 mm from the base of the bill the forehead has the same light orange color as the face, with dark tips to the feathers; this contrasts with the darker color of the more posterior parts of the forehead and the crown. From *S. perspicillatus, S. papuensis* is distinguished by this forehead mark, the subterminal tail band, longer wing, and usually by the browner, less olive, coloration, especially on the wings and tail. Marks I find useful, besides the forehead, for separating the superficially similar *Acanthiza murina* are: the color of the tail (dull gray or gray-olive, especially near the tip, in *A. murina,* brownish-olive in *S. papuensis;* the subterminal tail band (much more distinct in the former); the light orange eye ring of the latter, absent in the former; the edges of the primaries (olive in the former, often brownish-olive in the latter); the whitish chin, speckled with black on the sides, in *A. murina;* and, in life, the dull brown iris of *S. papuensis,* as opposed to the whitish or pale tan iris of *A. murina.*

All of my males prepared as skins, and two of my three females, form a quite uniform series, showing little variation. The Mt. Karimui Zone 5 female from the lower limit of the altitudinal range differs in its darker wings and underparts. The Zone 5 immature taken with this female is quite yellow below, a feature which can be matched in young birds from other parts of New Guinea. Elsewhere in New Guinea this is a highly variable species, with plumage varying from brownish to greenish. On the average the brownest series are those assigned to the race *buergersi* from the Snow Mountains and Telefolmin (topotypical *buergersi* from the Schraderberg were unavailable); nominate *papuensis* from southeastern New Guinea averages more olive, and *meeki* from Mt. Goliath is much greener. The present series is intermediate between nominate *papuensis* and *buergersi* but closer to *papuensis,* from which it differs mainly in that *papuensis* averages less dark above. Both the more brownish and the more greenish individuals from the Snow Mountains have darker underparts than the Mt. Karimui series, and no Mt. Karimui specimen is really brown as are many from the Snow Mountains.

The two specimens collected by Gilliard on Mt. Wilhelm and Mt. Hagen, which Mayr and Gilliard (1954, p. 347) assigned to *buergersi,* are browner below and duller above than Mt. Karimui specimens. I have not seen Gyldenstolpe's five adults from the Wahgi Valley, which he described (1955, p. 93) as being variably browner or greener above and which he assigned to *buergersi.* More specimens of this variable species would be needed to decide whether Wilhelm-Hagen-Wahgi birds really do average browner than those from Mt. Karimui 50 miles to the south.

BREEDING. The disparate sex ratio is notable (20 ♂, 3 ♀). Without exception all males had greatly enlarged testes. Of the two Zone 6 females, one had the ovaries enlarged, while I did not record ovary size in the other. The two Zone 5 specimens (6,450 ft) were an immature with undiscernible gonads and a female with small ovaries, conforming to the general pattern of nonbreeding birds being found at the extremes of the altitudinal range. From 6,550 ft up to the summit of Mt. Karimui (8,165 ft) *S. papuensis* was singing often and loudly.

DISCUSSION. *S. papuensis* is the fourth and highest in the altitudinal sequence of small *Sericornis*. It foraged from near the ground to about 30 ft above the ground in groups of up to four birds, gleaning mainly on branches and twigs, rarely on main trunks.

When I discussed *Sericornis* ecology previously (Diamond, 1969, pp. 26-30), I had not had an opportunity to study *S. papuensis* in the presence of *Acanthiza murina*. The published records of the First Archbold Expedition from Mt. Albert-Edward appeared to suggest that interaction with *A. murina* altered the niche of *S. papuensis* so that the latter and *S. perspicillatus* overlapped in altitudinal range. This proves not to be the case, as shown by more recent field work I carried out on Mt. Albert-Edward. Despite the presence of *A. murina*, the ranges of *S. papuensis* and *S. perspicillatus* there are still nearly mutually exclusive, as on Mt. Karimui in the absence of *A. murina*, and overlap is confined to a few immature individuals.

VOICE. The song (Fig. 22, p. 220) is a loud, rapid, unmusical outburst with a somewhat harsh and unclear quality, consisting of five to eight notes, all of which are on one of two (occasionally one of three) pitches. The song is sometimes prefixed by two or three faint notes. The call is a dry "chip" similar to that of other *Sericornis* species.

Sericornis nouhuysi stresemanni Mayr and *S. n. oorti* Rothschild and Hartert

Large Mountain Sericornis

NATIVE NAME. Fore: mabiséna.

SPECIMENS EXAMINED. Awande: 3 ♂, 2 ♀ (20-28 June 1964; 15-20 June 1965). Mt. Michael: 2 ♂, 1 ♀ (4-10 July 1964). Mt. Karimui Zone 3: 1 ♂, 1 ♀; Zone 4: 2 ♂; Zone 5: 2 ♂, 2 ♀; Zone 6: 2 ♀; Zone 8: 1 ♂ (16 Aug.-7 Sept. 1965).

WEIGHT. 9 ♂: 13.0-17.7 (16.2 ± 1.7). 7 ♀: 14.0-15.8 (14.6 ± 0.6).

WING. 10 ♂: 61-67 (64 ± 2). 10 ♀: 58-64 (61 ± 2).

CULMEN FROM BASE. 10 ♂: 14.0-17.0 (15.3 ± 1.1). 10 ♀: 14.0-16.0 (15.4 ± 0.8).

STOMACH CONTENTS. Insects.

TAXONOMY. The Awande and Mt. Karimui series differ in color, though not in size. Awande specimens have quite olive backs, rather yellow underparts, not dingy on the breast, and are closest to *oorti* of southeastern New Guinea. Mt. Karimui specimens are more rufous above, less yellow below, dingier on the breast, and closer to the description of *stresemanni* from the Schraderberg and to the series collected by Gilliard in the Wahgi region and assigned to *stresemanni*. The race *S. n. nouhuysi* of western New Guinea is even more rufous, while Telefolmin birds were assigned to *stresemanni*. Evidently there is a west-to-east color cline in *S. nouhuysi,* from more rufous in the west to more olive in the east. It seems most convenient to place the *stresemanni-oorti* transition between the Wahgi-Karimui area and the Okapa area 100 miles to the east.

The iris is either brown, orange-brown, or red-brown in both males and females.

BREEDING. Gonads were enlarged in only two Awande specimens, but were greatly enlarged in all Mt. Karimui males and two of the females. All five *Sericornis* species taken in the Karimui area were evidently breeding in July, August, and September. At 10,200 ft on Mt. Michael an adult was captured on its nest on 10 July 1964. The nest was 4 ft above the ground in a bunch of moss hanging from a tree limb, and contained two eggs.

DISCUSSION. *S. nouhuysi* has been found common by most collectors at most localities in the Eastern Highlands from about 4,500 to 11,000 ft or more, in forest and dense second-growth. Compared to the four smaller species of *Sericornis, S. nouhuysi* spends a greater fraction of its time in the understory, forages more on main branches and trunks than on twigs and small branches, and often works vertically up a trunk in the manner of a creeper or nuthatch, probing at the bark and moss. The altitudinal range of *S. nouhuysi* takes in the entire ranges of *S. perspicillatus* and *S. papuensis* on Mt. Karimui and overlaps *S. arfakianus* at the Sena River and *Acanthiza murina* on Mt. Michael. The independence of its distribution from that of these other small warblers confirms that it occupies a different type of niche, associated with its more marked preference for the understory, different foraging technique, and larger size and longer bill (all but one of my *S. nouhuysi* specimens weigh more than all specimens of all other *Sericornis* species I took).

VOICE. The Fore pointed out to me a song said to come from this species: a thin, slightly sibilant, rambling warble of only modest length, dropping in pitch towards the end. The call notes are a dry "chip", a spitted note unlike that of *S. perspicillatus,* and a rasped scolding note.

Sericornis beccarii subsp.

Beccari's Sericornis

or

Sericornis virgatus subsp.

Perplexing Sericornis

These two species include a confusing group of populations among which the species lines are not fully clear. As discussed elsewhere (Diamond, 1969), *S. virgatus* is apparently a hill forest species living at 2,000-4,500 ft on the Vogelkop, the northern slopes of the Central Range west of long. 143°E, and several of the "north mountain islands." *S. beccarii* is apparently confined to the flat lowlands of southern New Guinea and the Aru Islands near sea level, and to the Cape York Peninsula of Australia. At Lake Kutubu (2,450 ft) Schodde and Hitchcock (1968, p. 45) took one specimen of this complex, the first record from the southern hill slopes of the Central Range. They tentatively related it to the population *idenburgi* of northwestern New Guinea, based on the published description of that race, but they lacked comparative material, without which racial assignment of *Sericornis* forms is practically impossible, and they recognized that the affiliation with *idenburgi* was improbable on geographical grounds. Further speculation as to the race and species represented must await taxonomic comparison of the specimen.

Acanthiza murina (De Vis)

New Guinea Mountain Thornbill

SPECIMENS EXAMINED. Mt. Michael: 1 ♀, 4 ? (10 July 1964).
WING. 1 ♀: 62. 1 ?: 61.
CULMEN FROM BASE. 1 ♀: 12.5. 1 ?: 11.0.
STOMACH CONTENTS. Insects.

TAXONOMY. *Acanthiza murina* is confusingly similar superficially to the smaller species of *Sericornis*. It has a distinct, dark, subterminal band on the tail, a whitish iris, an absolutely even, dingy, ventral coloration (no orange on the throat or cheeks), and a dull, even, olive color above. Differences between it and *Sericornis papuensis* are summarized under *S. papuensis*. It may be recognized in the field by the very short tail and the whitish underparts.

DISCUSSION. Of the small warblers, *Acanthiza murina* has the highest altitudinal range, being confined to moss forest above 8,000 ft, mainly above 10,000 ft. Its altitudinal range is shared with *Sericornis papuensis* and *S. nouhuysi,* from which it differs ecologically in that it forages from the treetops down to 15 ft above the ground, never lower. The ecologically equivalent warbler at lower elevations is

Gerygone cinerea. Acanthiza murina is usually seen in loose flocks of 3-10 individuals spread out over several adjacent trees, gleaning (not sallying or hovering) on leaves and small twigs, rarely on larger branches. It moves by short hops of several inches up to a foot, and the flocks feed systematically for several minutes in one tree before moving on to the next tree.

VOICE. The song consists of four similar pairs of notes, the first member of each pair being on a higher pitch than the second. Members of flocks continually give faint, sweet, almost tinkling contact calls, by which the flock is easily located.

Songs of the Genus *Gerygone*

There are five species of *Gerygone* whose songs I have had the opportunity to hear at various localities: *G. ruficollis* in the Eastern Highlands and a recording from the Baliem Valley of western New Guinea, *G. chrysogaster* in the Eastern Highlands and North Coastal Range, *G. magnirostris* in the North Coastal Range and on Karkar, *G. olivacea* in southeastern New Guinea and in Queensland (Australia), and *G. igata* in New Zealand. The songs of all five are high-pitched, have a thin and somewhat plaintive quality, are delivered fairly fast, and are based on machine-gun patterns of about a half dozen notes which are repeated two to nine times in immediate succession. Figure 23 illustrates the songs of *G. ruficollis* and *G. chrysogaster* in the Eastern Highlands, and of *G. olivacea, G. magnirostris,* and *G. igata* for comparison. I did not hear songs from *G. cinerea, G. chloronota,* or *G. palpebrosa.*

Gerygone cinerea Salvadori

Gray Gerygone Warbler

SPECIMENS EXAMINED. Awande: 1 ♂, 1 ♀ (14 and 20 June 1965). Miarosa: 1 ? (24 June 1964). Mt. Karimui Zone 3: 1 ♂; Zone 7: 2 ♂ (21 Aug.-3 Sept. 1965).
WEIGHT. 4 ♂: 7.0, 7.7, 7.7, 8.0. 1 ♀: 7.2.
WING. 4 ♂: 51, 52, 53, 54. 1 ♀: 52. 1 ?: 51.
STOMACH CONTENTS. Insects.

BREEDING. All three Mt. Karimui specimens had the testes much enlarged.

DISCUSSION. This tiny, inconspicuous warbler occupies between about 5,400 and 8,500 ft in forest the niche that *Acanthiza murina* does at higher altitudes. Flocks of 2-10 individuals spread out over several trees, forage from the treetops down to 15 ft above the ground, gleaning leaves, twigs, and small branches. Unlike *Acanthiza murina, Gerygone cinerea* occasionally hovers and makes short sallies, its behavior is more nervous, and its foraging less systematic. At the forest edge it also gleans in the understory. The transition altitude between

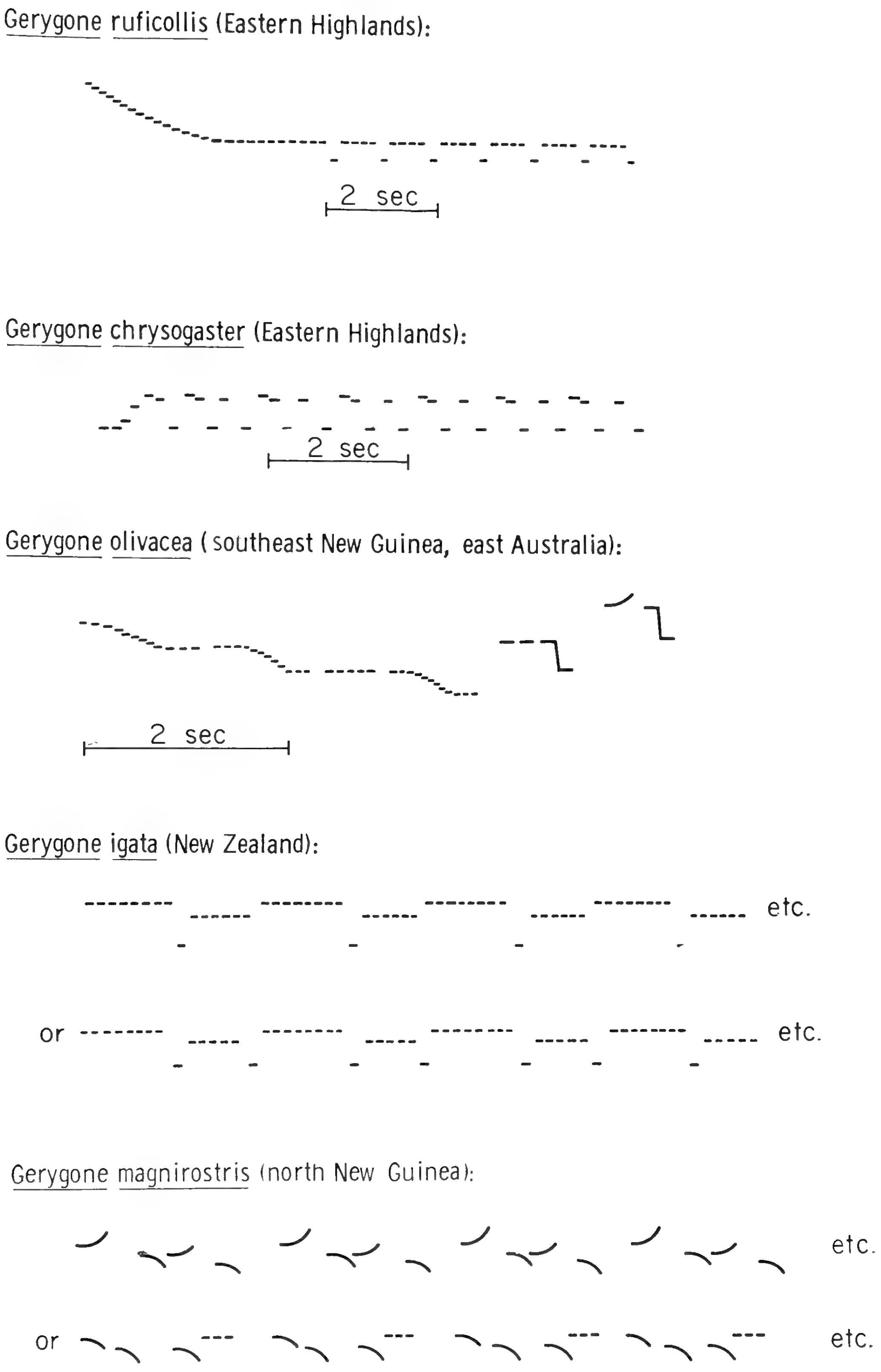


FIG. 23. Voices of five *Gerygone* warblers.

Gerygone cinerea and *Acanthiza murina* varies locally between 7,800 and 9,300 ft. This is one of the few instances of sharp altitudinal replacement among non-congeneric species in New Guinea.

VOICE. Members of flocks give faint, sibilant contact calls.

Gerygone chrysogaster chrysogaster Grey
Yellow-bellied Gerygone Warbler

SPECIMENS EXAMINED. Soliabeda: 1 ♂ (25 July 1965).
WEIGHT. 9.5.
WING. 55.
STOMACH CONTENTS. Insects.

TAXONOMY. The black bill and the brownish-olive upperparts place this specimen with nominate *chrysogaster* (*notata* and *dohertyi* have olive upperparts and a horn-colored bill).

BREEDING. The greatly enlarged testes of the specimen and the frequent songs indicate that *G. chrysogaster* was in breeding condition at Soliabeda.

DISCUSSION. At Soliabeda this low-altitude warbler was common, accounting for 6% of bird individuals. One song was heard at 2,150 ft between Soliabeda and Karimui, but the species was absent at Karimui, and there are no other Eastern Highlands records. Single individuals or small groups were seen moving rapidly in forest and in second-growth trees, generally in the middlestory but sometimes descending to within a few feet of the ground. *G. palpebrosa* was also present at Soliabeda but apparently did not descend into the lower story.

VOICE. A typical weak *Gerygone* song consisting of a repeated five-note pattern introduced by three or four extra notes (Fig. 23, p. 226). If one discharges a gun and *G. chrysogaster* is in the vicinity, it immediately sharts up its song. A continuous dry chirping may also be heard occasionally.

Gerygone chloronota subsp.
Gray-headed Gerygone Warbler

I have no specimens but do have sight records of birds observed at such close quarters as to preclude the possibility of misidentification. Between 6 and 9 July 1965 I saw one individual daily at Bomai, flitting 10-60 ft above the ground in a tree at the edge of a ravine. In August 1964, Terborgh studied some groups of 2-6 in a small flowering tree at Karimui, standing at the edge of a garden several hundred yards from forest. They were the only bird species exploiting this tree and kept up a nearly continuous flow of soft vocalizations as they probed between the petals. The species evidently prefers trees in open habitats. In New Guinea *G. chloronota* is a rare species, known from few and scattered localities.

Gerygone palpebrosa inconspicua Ramsay

Black-headed Gerygone Warbler

SPECIMENS EXAMINED. Karimui: 2 ♂ (1 and 2 July 1965).
WEIGHT. 2 ♂: 8, 9.
WING. 2 ♂: 52, 54.
STOMACH CONTENTS. Insects.

TAXONOMY. These belong to the southeastern New Guinea race. The race *tarara* from coastal parts of the southern New Guinea bulge west of the Fly River differs in the male most obviously in the brownish tinge of the black parts of the throat and head; *wahnesi* of northern and northeastern New Guinea differs in the black crown (olive in the Karimui specimens); and nominate *palpebrosa* of the Vogelkop differs in the brighter and more yellow-green back. The dorsal coloration of museum specimens foxes with age.

BREEDING. The testes were greatly enlarged in both specimens.

DISCUSSION. In the Karimui region *G. palpebrosa* was present from 4,200 ft down to at least 1,350 ft. There seem to be no other Eastern Highlands records yet, but it will doubtless turn up at other hill forest stations. Pairs or small groups flit rapidly in trees of the forest and at the forest edge. I never netted this warbler or saw it less than 10 ft from the ground.

Gerygone magnirostris subsp.

Swamp Gerygone Warbler

STOMACH CONTENTS. Insects.

DISCUSSION. This lowland warbler has been observed in stream-side vegetation at 3,500 ft near Baiyer River, an altitudinal record for the species (J. Kikkawa, pers. comm.; N.G.B.S. Newsletter, No. 54, p. 2, June 1970).

VOICE. A repeated four-to-six-note pattern of slurs (Fig. 23), with a slightly nasal quality and a substantial volume, suggestive of a species of *Lalage* rather than *Gerygone*.

Gerygone ruficollis insperata De Vis

Red-necked Gerygone Warbler

NATIVE NAME. Fore: enemesílo.
SPECIMENS EXAMINED. Awande: 1 juv. ? (18 June 1965). Miarosa: 1 ? (17 June 1964). Lufa: 2 ? (29 June and 13 July 1964).
WEIGHT. 1 juv. ?: 7.
WING. 1 juv. ?: 48.
STOMACH CONTENTS. Insects.

TAXONOMY. The Awande juvenile is pale lemon below, becoming paler towards the lower belly, dark brown with an olive tinge on the back, and dingy dark olive on the head. The tail feathers have the characteristic white spots.

DISCUSSION. With the possible exception of the honeyeater *Melidectes torquatus*, no other midmontane species has profited so spectacularly from native agriculture as *G. ruficollis*. In primary forest it is hard to see but easy to locate by song. These songs indicate that it was not uncommon in primary forest on Mt. Karimui between 4,500 and 6,500 ft, and present but uncommon around 8,000 ft on Mt. Michael. However, in trees in open habitats cleared by man in the Eastern Highlands, and especially in casuarina groves, this nervous warbler is often the most abundant bird, occurring in flocks of up to 20 and even up to 50 birds. It has similarly colonized the open habitats, again casuarina groves in particular (Rand, 1942b, p. 476), in the Baliem Valley of western New Guinea. In southeastern New Guinea, but apparently not elsewhere, it is common in treeferns in alpine grassland.

VOICE. An unmistakable, high pitched, plaintive, fairly rapid (ca. six notes per second), and lengthy song. The first 10 to 30 notes gradually descend in pitch, eventually level out at a constant pitch, and thereafter every fifth note is lower in pitch by an interval of a third or a fourth, forming a five-note pattern which is the origin of the Fore nace "e-ne-me-sí-lo". The "enemesilo" phrase is repeated three to nine times to conclude the song (Fig. 23, p. 226). Sometimes all the "enemesilo" phrases are omitted, and the song terminates after the initial 10 to 30 notes. Voice recordings from the Baliem Valley which I have heard are essentially the same.

Ripley (1964, p. 59) gives the following description of the song of the warbler *Phylloscopus trivirgatus* in the Baliem Valley: "These warblers have a long, drawn-out series of single whistling notes on a descending scale, rather pretty but mournful. The notes remind me of the song of a North American White-throated Sparrow, *Zonotrichia*." This is an accurate description of the *Gerygone ruficollis* song. The song of *Phylloscopus trivirgatus* is also high but completely different in form and pattern, and the attribution of the *Gerygone* song to *Phylloscopus* is surely an error, one, however, which could arise easily, as both are small and nervous tree warblers.

Niche Differences in the Genus *Crateroscelis*

This genus of three species, which was formerly placed with the babblers but is now assigned to the warblers, illustrates the course of altitudinal sequences of more than two congeners in New Guinea. All three species are quite similar in appearance and habits. In a few areas all three are present and replace each other subsequentially: *C. murina* at low altitudes, *C. nigrorufa* at middle altitudes, *C. robusta* at higher altitudes. In many or most areas, however, *C. nigrorufa* is absent, and there is a sharp boundary between the altitudinal ranges of *C. murina* and *C. robusta.* This "squeezing-out" of the middle species seems to be a common result of multiple altitudinal replacement in other genera as well (p. 34).

Crateroscelis murina murina (Sclater)

Lowland Mouse-Warbler

NATIVE NAMES. Gimi: sikaíde. Daribi: kírili or píroni.

SPECIMENS EXAMINED. Okasa: 3 ♂ (23 and 26 June 1965). Karimui: 4 ♂, 2 ♀, (31 July-16 Aug. 1964; 1-14 July 1965). Soliabeda: 2 ♀ (23-30 July 1965). Mt. Karimui Zone 1: 3 ♂, 5 ♀; Zone 2: 1 ♂; Zone 3: 1 ♂, 1 ♀ (9-19 Aug. 1965).

WEIGHT. 9 ♂: 13.0-17.0 (15.0 ±1.1). 8 ♀: 14.3-16.0 (15.0 ± 0.7).

WING. 10 ♂: 59-63 (61 ±1). 10 ♀: 55-61 (57 ± 2).

TAXONOMY. The races *monacha, pallida, fumosa,* and *capitalis* are paler, especially on the underparts, while *fumosa* and *capitalis* are also smaller. The Eastern Highland series belongs to the dark-bodied, dark-crowned, widespread New Guinea race *C. m. murina.* Birds from the Karimui area average darker than those from Okasa, as is often the case at Karimui.

BREEDING. Gonad condition was as follows: Okasa, testes small in all males examined; Karimui, testes enlarged in most but not all males, one nestling brought in on 16 July; Mt. Karimui, testes small in three males, slightly enlarged in a fourth, ovaries small in all females. This suggests that breeding of this lowerstory species is in the dry season at Karimui but not at Okasa or on Mt. Karimui.

DISCUSSION. *C. murina* is the commonest bird in the understory of hill forest. In the flat coastal plains and near sea level it is quite sparsely distributed, sometimes even absent. At Soliabeda (1,500-2,000 ft) it still accounted for only 1.2% of all birds. This figure had risen to 4.9% at Karimui (3,650 ft), and thereafter *C. murina* became progressively more abundant as we worked our way up Mt. Karimui, accounting for 9.2% of all birds in Zone 3, until it abruptly disappeared between 5,390 and 5,400 ft, where it was replaced by *C. robusta.* One of our campsites was near this transition altitude, and I had frequent opportunity to check the strictness of the transition by noting that *C. murina* songs always came from below this altitude, *C. robusta* from above.

C. murina remains within the forest and is seen as solitary individuals or as small parties of two or three birds, on the ground, on fallen logs, in low bushes, and in thickets. I have not seen it more than 5 ft above the ground. Singers are difficult to locate, and the species is far more often heard than seen.

VOICE. A beautiful whistled song characterized by the distinctness of its notes, the simplicity of its patterns, and the very clear quality suggestive of a flute in the higher registers, and, like a flute, with a "breathy" quality when heard close. Patterns consist of 2-10 notes, most commonly of either three or four notes. Frequently each note has the same time value; sometimes a dotted rhythm is used, the first note may be detached, or a subsequent note may be held longer than the others. An average length for the song is 1-1½ sec, but 3 sec is not unusual. The pitch range of the whole song may be encompassed within a fourth or major third, and intervals between successive notes are close to half-tones, whole tones, or thirds. A given individual uses at least eight to 10 different patterns. Each pattern is repeated three to six, sometimes up to 16, times, with pauses between repetitions, before the singer goes on to the next pattern. Figure 24 illustrates many of the *C. murina* patterns I have heard in the Eastern Highlands (patterns 1 through 10 were used successively by one singer, 11 through 18 by another). The call is a dry "chip" or a squawk.

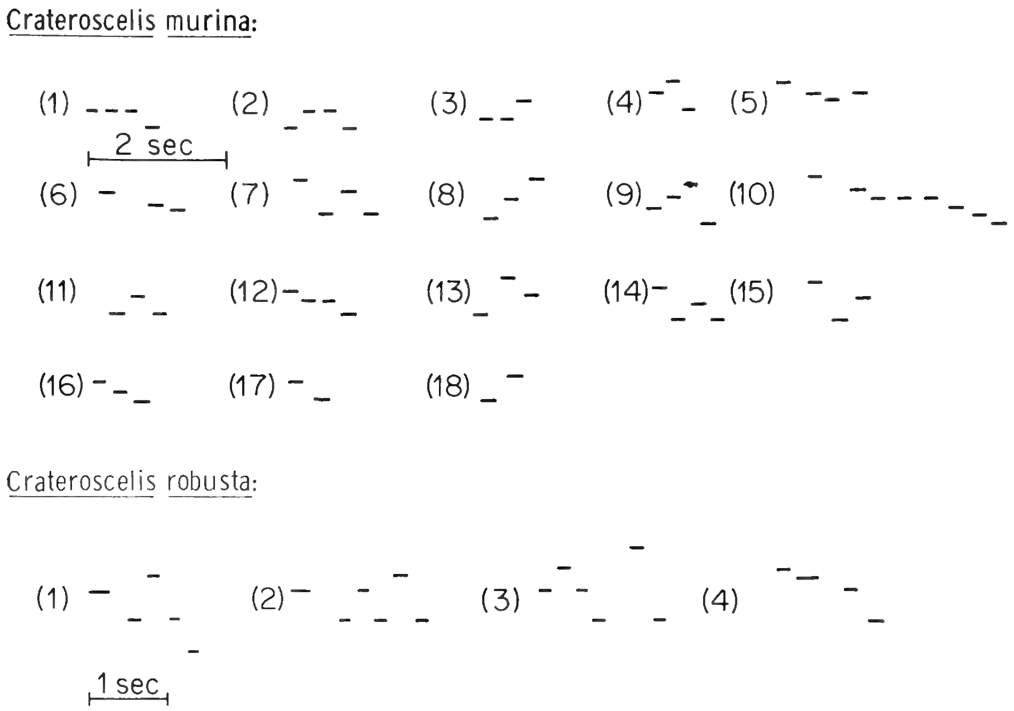


FIG. 24. Song patterns of *Crateroscelis murina* and *C. robusta*.

Crateroscelis nigrorufa nigrorufa (Salvadori)

Midmountain Mouse-Warbler

NATIVE NAME. Fore: fúntara.
SPECIMENS EXAMINED. Awande: 1 ♂ (12 July 1967).
WING. 61.

TAXONOMY. In the coloration of the lower flanks, belly, and undertail coverts my specimen agrees with nominate *nigrorufa* of southeastern New Guinea rather than with *blissi* of the Snow Mountains and Weyland Mountains, which is darker and blacker. Compared to my specimen, southeastern New Guinea birds are slightly browner, less black, dorsally, but this may be due to foxing, since they were collected in 1903-1906.

DISCUSSION. The only other Eastern Highlands specimen of this rare species was taken by Gyldenstolpe in the Wahgi Mountains.

Crateroscelis robusta robusta (De Vis)

Mountain Mouse-Warbler

NATIVE NAME. Fore: séka.

SPECIMENS EXAMINED. Awande: 2 ♂, 2 ♀ (28 June 1964; 16-18 June 1965). Mt. Michael: 2 ♂, 2 ♀ (4-12 July 1964). Mt. Karimui Zone 4: 1 ♂, 1 ♀, 1 imm. ♀; Zone 6: 1 ♂, 2 ♀, 1 imm. ♂; Zone 7: 1 ♀; Zone 8: 1 ♂ (17 Aug.-8 Sept. 1965).

WEIGHT. 5 ♂: 16.0, 16.0, 16.8, 17.3, 17.5. 5 ♀: 14.3, 16.0, 16.3, 16.8, 18.0. 1 imm. ♂: 17.0 1 imm. ♀: 18.0.

WING. 5 ♂: 60, 61, 62, 62, 63. 5 ♀: 56, 57, 61, 61, 64. 1 imm. ♂: 59. 1 imm. ♀: 53.

STOMACH CONTENTS. Insects.

TAXONOMY. As already noted by Gyldenstolpe (1955, p. 84) and by Mayr and Gilliard (1954, p. 345), there is much individual variation in the color of the underparts (brown or gray). The present series suggests that this is to some extent, though probably not entirely, a matter of age, the brownest underparts being in the younger birds. The color of the throat also varies, and is whitest in specimens with the least brown underparts. Gyldenstolpe's series also suggests a correlation with age: all nine of his gray males have longer wings than four of his five brown males, and four of his six gray females are larger than three of his four brown ones. However, one of his brown males had enlarged testes. Eye color also varies individually, as noted previously by Mayr and Rand (1937, p. 107). In adult males the iris is orange, straw-colored, or light straw-orange; brown or orange-brown in adult females; and dull brown or gray-brown in immatures of both sexes.

The race *sanfordi* differs in its much buffier underparts, *deficiens* in the absence of the gray breast-band.

BREEDING. Testes were enlarged in all three adult males from Mt. Karimui and in one of the two adult males from Awande.

DISCUSSION. *C. robusta* is nearly as ubiquitous and common in forest at higher altitudes as *C. murina* is at lower altitudes. It appeared abruptly on Mt. Karimui at its maximum abundance at 5,400 ft, and accounted for about 5% of the local avifauna in the zones from 5,400 to 6,250 ft, about 3% in the zones of stunted moss forest from 6,250 to 7,280 ft, about 1% up to 7,610 ft, and was not encountered on the top 500 ft of the mountain. On Mt. Michael it was present from the base of the forest (7,000 ft), commonest around 8,000 ft where the forest was still tall, and still present up through the progressively more stunted moss forest until at least 10,200 ft. Its behavior is similar to that of *C. murina,* i.e., it remains in the lowest story of the forest or searches in leaf litter on the ground, singly or in pairs, and is much more often seen than heard.

VOICE. A whistled song similar to that of *C. murina* but with a less flute-like, thinner, and more tinkling quality, more irregular rhythm, more hurried delivery, and consisting on the average of more notes (five or six is typical). As does *C. murina, C. robusta* alternates patterns, a few of which are given in Figure 24 (p. 231). Its call is a short, dry, very buzzy note similar to that of *Sericornis nouhuysi.*

Sylviinae: Warblers

Acrocephalus arundinaceus subsp.

Great Reed Warbler

DISCUSSION. According to Bell (1968) this warbler is very numerous in dense "pit-pit" (tall cane grass) and tall elephant grass in the Baiyer River Valley of the northern watershed (3,600 ft) and on the Sepik-Wahgi Divide at 6,600 ft. One specimen has been collected near Mt. Hagen, and there is a sight record from Pureni (N.G.B.S. Newsletter, No. 28, p. 3, Feb. 1968). Its distribution throughout New Guinea is spotty.

VOICE. A lengthy, rich song composed of single and paired notes of varied qualities, each repeated 3-5 times before going on to the next note. The form suggests New World mimic thrushes (Mimidae) or the European Song Thrush (*Turdus philomelos*).

Megalurus timoriensis wahgiensis Mayr and Gilliard, *M. t. montanus* Mayr and Gilliard, and *M. t. macrurus* (Salvadori)

Tawny Grassbird

NATIVE NAME. Fore: kásaru.

SPECIMENS EXAMINED. Awande: 1 ♂, 2 ♀, 1 juv. ♂ (19-20 June 1965). Miarosa: 1 ? (15 June 1964). Karimui: 2 ♀ (3 July 1965).

WEIGHT. 1 ♂: 26. 3 ♀: 23, 25, 27.

WING. 1 ♂: 68. 4 ♀: 64, 66, 66, 70. 1 ?: 63. 1 juv. ♂: 51.

TAIL. 1 ♂: 119. 3 ♀: 97, 102, 105. 1 ?: 101.

STOMACH CONTENTS. Insects (three stomachs), insects and seeds (one).

TAXONOMY. This species is subject to both altitudinal and local geographical variation. The first high-altitude form discovered was *alpinus* from the alpine grasslands of southeastern New Guinea, which differed from *macrurus* of the southeastern midmontane and low-altitude grasslands in its longer wing, grayer underparts, and darker back. The midmontane and alpine forms of the Snow Mountains differed in the same way and were also assigned to *macrurus* and *alpinus*. Mayr and Gilliard (1951, p. 9) then described two analogous forms from the Wahgi region of the Eastern Highlands: *wahgiensis* of the midmontane grasslands, fairly close to *alpinus* in color but with a longer tail and shorter wing; and *montanus* of the alpine grasslands, with the short *alpinus* tail but darker color. The situation subsequently became more complicated when Sims (1956, p. 415) analysed Shaw-Mayer's material from Mt. Giluwe and showed that the color patterns there were "upside-down," i.e., the alpine form was the paler one, although it had the shorter tail as in the Wahgi Valley. More recently Gilliard and LeCroy (1961, p. 48) assigned Telefolmin midmontane birds to neither *macrurus* nor *wahgiensis* but to *alpinus* on the basis of the longer wing, and Schodde and Hitchcock assigned one specimen each from Lake Kutubu (2,450 ft) and Mendi (6,900 ft), between Telefolmin and the Wahgi Valley, to *macrurus*. Wing and tail measurements and color may vary independently, and future collectors should state all three; Mayr and Gilliard gave no wing measurements in their descriptions of *wahgiensis* and *montanus*, and Gilliard and LeCroy gave no tail measurements for the Telefolmin series.

In dorsal color the Awande and Karimui specimens are close to *wahgiensis* from Mt. Hagen (Tomba) and Mt. Kubor, and differ from each other only in the darker crown of Karimui birds. The race *macrurus* of southeastern New Guinea is shorter winged, shorter tailed, and less dark above. *M. t. muscalis* of the Fly River differs in its streaked crown, shorter wing, and paler, less brown dorsal coloration. My measurements of Hagen and Kubor *wahgiensis* give: Hagen, 3 ♀, wing 64, 66, 68, tail 97, 95, 98; Kubor, 1 ♀, wing 63, tail 104. While the number of specimens is small, there seems to be local variation in measurements even in midmontane *wahgiensis* of the Eastern Highlands. Combining my measurements of females with Gyldenstolpe's measurements (1955, p. 90) of Nondugl females, one finds wing length decreasing in the order Karimui > Hagen = Awande > Kubor = Nondugl; tail length decreases in the order Awande = Kubor > Hagen = Karimui > > Nondugl. This local variability, plus the upside-down and checkerboard racial distributions mentioned in the previous paragraph, makes reassessment of the New Guinea races of this species desirable.

BREEDING. One of the Karimui females had enlarged ovaries. This, plus the capture of the juveniles, suggests some breeding in the dry season, but perhaps not the uniformly synchronized breeding seen in *Malurus alboscapulatus*.

DISCUSSION. All observers have found this warbler common and widespread in the midmontane grassland of the Eastern Highlands. Its habitat is grass several feet high, from which it is harder to flush than *Malurus alboscapulatus*. Bell (1968) found in the Baiyer Valley that *Acrocephalus arundinaceus* has colonized tall, ungrazed grass, whereas *Megalurus timoriensis* is in grass grazed down by cattle to balls about three feet high. Gilliard, Shaw-Mayer, and Bulmer also found *Megalurus timoriensis* in alpine grassland. This warbler is thus of interest in having a discontinuous altitudinal range in alpine grassland (> 11,000 ft), man-made midmontane grassland (ca. 3,000-7,500 ft), and grassland of the lowlands.

VOICE. The call is a single dry note "tsip" or "tsick" or "chip", which often sounds disyllabic. There is also a repeated scolding note "buk-buk-buk . . ." like the clucking of a chicken

Cisticola exilis diminuta Mathews

Golden-headed Fantail Warbler

NATIVE NAME. Fore: ikonantúbe.
SPECIMENS EXAMINED. Okasa: 1 ♂, 1 ♀ (26 June 1965).
WEIGHT. 1 ♂: 8.5. 1 ♀: 8.2.
WING. 1 ♂: 50. 1 ♀: 43.
STOMACH CONTENTS. Insects.

BREEDING. Neither specimen had the gonads enlarged, suggesting that this species may be exceptional among grassland birds in not breeding during the dry season.

DISCUSSION. The distribution of *Cisticola exilis* in the Eastern Highlands is local. Besides collecting it in the grasslands at Okasa in June 1965 and observing it there in August 1946, I was told that it occurred at Awande, but I found it nowhere else, and it was certainly absent at Karimui. Neither Gilliard nor Gyldenstolpe met it in the Wahgi Valley. Bell (1968, and pers. comm.) found it near Mt. Hagen "quite numerous but strictly localized to areas of short blady grass"; Shaw-Mayer collected one at 7,300 ft on Mt. Giluwe; and Bulmer reports it as common in the Baiyer Valley around 4,000 ft and in the Kaironk Valley of the Schrader Range up to 5,000 ft.

VOICE. The very distinctive song consists of two very faint notes "hoo-hoo" ½-1 sec apart, followed by a disyllabic musical note of bell-like absolute clarity (Fig. 25). So different are the qualities of the two halves of the song that they give the impression of coming from two different species. The song is given from the top of a bush, or even of a tree, if any is in the vicinity. The dry, drawn-out call note suggest a sneeze or an insect.

Phylloscopus trivirgatus giulanettii (Salvadori)

Leaf Warbler

NATIVE NAME. Fore: pasésule.
SPECIMENS EXAMINED. Miarosa: 2 ? (11 and 17 June 1964). Mt. Michael: 1 ? (13 July 1964). Mengino: 1 ♂ (15 July 1964). Mt. Karimui Zone 3: 1 ? (16 Aug. 1965).

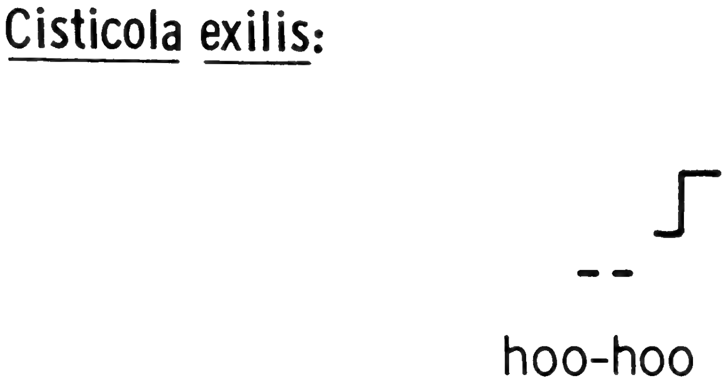


FIG. 25. Voice of *Cisticola exilis.*

WEIGHT. 1 ?: 8.3.
STOMACH CONTENTS. Insects.

TAXONOMY. These specimens were prepared as skeletons or preserved in formalin and hence cannot be analysed racially. Mayr and Gilliard (1954, p. 347) and Gyldenstolpe (1955, p. 96) assigned specimens from the Wahgi region to *giulanettii.*

DISCUSSION. *P. trivirgatus* is one of the half dozen commonest forest birds in its altitudinal range (ca. 4,300-7,000 ft, in the forest interior, forest edge, and trees of second-growth and gardens). On Mt. Karimui it first appeared around 4,300 ft, was commonest between 5,100 and 5,900 ft where it accounted for 5-10% of all birds, and disappeared around 6,100 ft. On some outlying mountain ranges of New Guinea (e.g., the North Coastal Range and Vogelkop) it is largely confined to altitudes below 5,000 ft. While it sometimes descends to within 10 ft of the ground, it usually remains in the treetops where it is more easily identified by voice than by sight. As it gleans, it moves by short hops of a few inches to a foot and occasional flights of several feet.

VOICE. A high, brief, patternless warble, often concluding with a very high upslur apparently continuing to go up out of the human auditory range.

MUSCICAPINAE: FLYCATCHERS

Peltops blainvillii (Lesson and Garnot)

Lowland Peltops Flycatcher

SPECIMENS EXAMINED. Soliabeda: 2 ♂, 2 ♀ (25-30 July 1965).
WEIGHT. 2 ♂: 29.7, 30.5. 2 ♀: 28.0, 30.3.
WING. 2 ♂: 96, 96. 2 ♀: 93, 100.
CULMEN FROM BASE. 2 ♂: 25, 26. 2 ♀: 22, 23.
SOFT PARTS. Iris deep red or dull red.
STOMACH CONTENTS. Insects.

BREEDING. All specimens had small gonads.

DISCUSSION. The genus *Peltops* is endemic to New Guinea, has no close relatives, and consists of two monotypic species. *P. blainvillii* is so exceedingly similar morphologically to its higher-altitude sibling species *P. montanus* that it was not until 1921 that *montanus* was described even as a subspecies of *P. blainvillii*. The careful comparisons of Stresemann (1923, p. 92) and Gilliard and LeCroy (1961, p. 52) revealed only two diagnostic characters. First, *P. montanus* has a longer wing and tail than *P. blainvillii;* this suffices to separate most but not all specimens, because there is some overlap and also because *P. montanus* decreases in size with decreasing altitude (Bergmann effect) and approaches the size of the low-altitude form *P. blainvillii*. The second diagnostic character is the larger white patches on the back and on the cheek of *P. montanus;* this is also a good but not perfect distinguishing character, since there is some overlap with *P. blainvillii*. Both species behave similarly and inhabit the same kinds of habitats; I have been unable to detect ecological differences except in altitudinal range. In the field, however, the two species are easily distinguishable by their dissimilar and frequently given calls.

The altitudinal ranges of *P. blainvillii* and *P. montanus* are mutually exclusive. I found *P. blainvillii* only between 1,500 and 2,000 ft at my lowest-altitude locality, Soliabeda. My lowest record of *P. montanus* was at 2,680 ft between Yudo and Soliabeda, leaving a gap of 680 ft in which no *Peltops* was found. There appeared to me to be a similar gap in the North Coastal Range distributions, and I cannot find a published record of *P. montanus* under 2,500 ft, nor of *P. blainvillii* above 2,000 ft except for a specimen taken by Schodde and Hitchcock at Lake Kutubu (2,450 ft). Hence the apparent gap could be real.

At Soliabeda *P. blainvillii* was uncommon. Groups of up to four perched in the crowns of tall trees overlooking small clearings in the forest. From these perches they sallied after insects often at considerable distances from the crown, sometimes to within a few feet of the ground. The territory must be large, since successive treetop perches may be several hundred feet apart.

VOICE. Unique among New Guinea birds in that the notes are very sharply sucked in. The rhythm is usually iambic, e.g., three rapid pairs of notes, all on the same pitch, the first member of each pair short and unaccented (Fig. 26). At each pair of notes the head is thrown violently up and down. Sometimes three or four sucked-in notes in rapid succession on the same pitch are given in uniform rhythm. The quality is totally unmusical, i.e., clicked or snapped. Once I heard a faint call of three rapid unmusical notes on successively lower pitches, like a weak, abbreviated fragment of the usual *Peltops montanus* call.

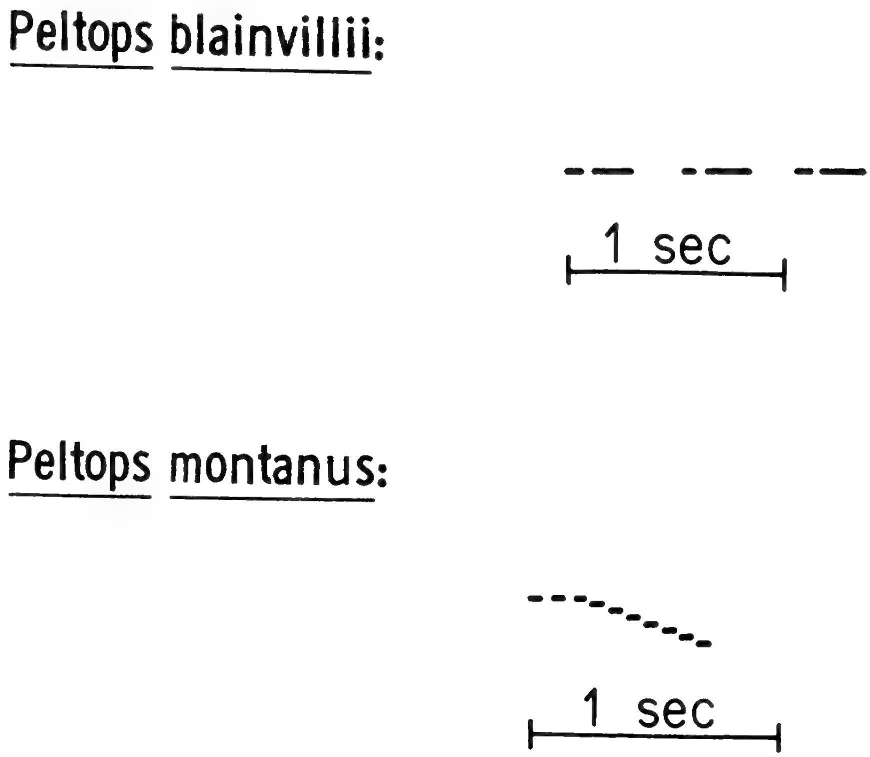


FIG. 26. Voices of *Peltops blainvillii* and *P. montanus.*

Peltops montanus Stresemann

Mountain Peltops Flycatcher

NATIVE NAME. Gimi: ilémukokóya.

SPECIMENS EXAMINED. Okasa (4,250 ft); 2 ? (22 and 25 June 1965). Mt. Michael (7,000 ft): 1 ♂ (13 July 1964). Mengino (4,600-5,100 ft): 1 ♀, 2 ? (16 July 1964). Karimui (3,650 ft): 4 ♂, 4 ♀ (2 July-3 Aug. 1965). Bomai (3,250 ft): 1 ? (6 July 1965).

WEIGHT. 4 ♂: 33.3, 34.0 (2), 36.0. 4 ♀: 29.0, 29.7, 30.5, 32.0. 3 ?: 27.0, 31.0, 31.5.

WING. 5 ♂: 109, 110 (3), 114. 4 ♀: 101, 104 (2), 107. 4 ?: 104, 107, 110, 113.

CULMEN FROM BASE. 5 ♂: 23 (4), 25. 4 ♀: 20, 21, 22, 23. 2 ?: 23, 24.

SOFT PARTS. Iris: red, orange, or orange-brown.

BREEDING. Gonads of all specimens were small.

DISCUSSION. *P. montanus* is erratically distributed in the Eastern Highlands from 2,600 ft to 5,100 ft (Mt. Karimui) or to 7,200 ft (Mt. Michael). It was present at most of my stations in this altitudinal range but was definitely absent at Okapa (6,600 ft), Awande (6,000 ft), and Miarosa (5,800 ft), both in my experience and in the much more extensive experience of my Fore assistants. It was not found in the Wahgi Valley by Gilliard or Gyldenstolpe. Bulmer found it breeding in Kyaka territory in 1955, when he collected five specimens and recorded one nest between 4,300 and 5,300 ft, but he did not encounter it in the four months he spent there in 1959.

The habitat of this species may be easily summed up as tall forest trees at the edge of open spaces. From conspicuous perches which are rarely less than 40 ft above the ground, *P. montanus* sallies into the open space to catch insects and returns to its perch or to a neighboring tree, sitting stationary between sallies. On the Sena River the trees chosen were on the river bank, and the open space exploited was that over the river. In the virgin forest on Mt. Karimui the perches were initially in tall trees emerging above the canopy or on a ridge. When we had cleared small campsites in the forest, trees at the edge of these were also used. At Karimui, where many gardens and roads had been cleared, trees at the border between these clearings and the forest furnished perches. It is surprising that this species, which concentrates at natural open spaces in the forest, is not far more abundant and widely distributed in settled areas of the Eastern Highlands. Like *P. blainvillii, P. montanus* is a social species, seen usually in groups of 2-5, though sometimes singly. Once I saw a *P. montanus* attack a perched hawk *Aviceda subcristata* and force it to take flight.

VOICE. A very rapid series of a half dozen to a dozen notes lasting in all less than 1 sec, and descending slightly in pitch (Fig. 26, p. 238). The volume is soft, and the quality quite similar to that of the sound produced by running one's finger along the teeth of a comb. Infrequently one hears a hoarse upslurred "wheep."

Songs and Niche Differences in the Genus *Rhipidura*

It is interesting to attempt to deduce species relationships within this genus from songs, since the 12 species I have encountered fall into three distinct groups on this basis. *R. leucothorax* and *R. threnothorax* resemble each other in their loud, explosive songs very unlike those of the other 10 species. The harsh song of *R. leucophrys* places it by itself in another group. The songs of the remaining nine species (*R. atra, R. brachyrhyncha, R. albolimbata, R. hyperythra, R. rufiventris, R. rufidorsa,* plus *R. fuliginosa* which I heard in New Zealand, Australia, and Espiritu Santo, *R. dahli* of New Britain, and *R. nebulosa* of Samoa) are all weak and high-pitched, and consist of either or both of two kinds of notes: clear whistled notes and jumbled twitters. *R. albolimbata* and *R. hyperythra,* in whose songs clear whistled notes predominate, are particularly close to each other, and *R. brachyrhyncha* and *R. atra* are close to each other in their squeaky, tinkling, jumbled songs. The songs of *R. fuliginosa* and *R. dahli* are similar to those of *R. brachyrhyncha* and *R. atra.* This vocal "classification" is in reasonable accord with a grouping based solely on morphology.

Niche differences among the nine species of *Rhipidura* in the Eastern Highlands may be summarized in oversimplified form as follows. *R. leucophrys* is confined to open country such as gardens and villages, whereas the other species all live in the forest or dense second-growth.

Three species live mainly in the forest understory and have mutually exclusive altitudinal ranges: *R. threnothorax* at low altitudes (to ca. 3,000 ft), *R. atra* at middle altitudes (3,000 to ca. 7,000 ft), *R. brachyrhyncha* at high altitudes (above ca. 7,000 ft). The latter two venture into the middlestory, which *R. threnothorax* rarely does. The altitudinal range and the lowerstory preference of *R. leucothorax* are similar to those of its close relative *R. threnothorax,* but *R. leucothorax* lives in thickets at the forest edge and in dense second-growth, *R. threnothorax* in the forest interior. *R. hyperythra* and *R. albolimbata* are forest species that forage from the crowns to the understory, most often in the middlestory or crown, and have mutually exclusive altitudinal ranges, *R. albolimbata* living at higher elevations (above 4,500 ft) than *R. hyperythra* (below 4,500 ft). *R. rufiventris* lives in more open parts of the forest and is commonest at the forest edge or adjacent to open spaces (not in the thickets utililized by *R. leucothorax*), occurs from sea level to ca. 5,000 ft, forages from the crowns to the understory, and is larger than *R. hyperythra* or *R. albolimbata. R. rufidorsa* is a forest species of the lower- and middlestories, confined in the Eastern Highlands to elevations below 2,000 ft, where *R. hyperythra* is uncommon.

Rhipidura threnothorax threnothorax Müller

Sooty Thicket Fantail

NATIVE NAME. Daribi: tusadá.

SPECIMENS EXAMINED. Karimui: 9 ♂, 2 ♀, 1 nestling (1-15 Aug. 1964; 2-12 July 1965). Bomai: 2 ♂, 1 ♀ (6 July 1965). Soliabeda: 1 ♂, 1 ♀ (28-30 July 1965).

WEIGHT. 6 ♂: 15.7, 17.0, 18.5, 19.0, 19.5, 20.0. 4 ♀: 14.7, 16.3, 16.5, 19.0.

WING. 9 ♂: 75-85 (81 ± 3). 3 ♀: 71, 74, 75.

TAIL. 9 ♂: 96-101 (98 ± 2). 3 ♀: 89, 92, 94.

STOMACH CONTENTS. Insects.

TAXONOMY. Three males and one female have pale rufous tips to the upperwing coverts, a character subject to individual variation in other areas as well (Rand, 1942a, p. 333; 1942b, p. 477).

BREEDING. One female at Karimui was captured on a nest from which the nestling was secured. Testes were large in both Bomai males; enlarged in half of the Karimui males, small in the others; and small in the sole Soliabeda male. Evidently many, but not all, individuals of this understory species were breeding in the dry season.

DISCUSSION. *R. threnothorax* has not yet been recorded in the Eastern Highlands outside the Karimui area, where it is somewhat above its usual ceiling. It is shy, solitary, and infrequently seen but not uncommon. Of the forest fantails this is the most sharply restricted to the understory, the few that I saw being at most 3 ft above the ground and sometimes on the ground. It favors those parts of the forest or forest edge that have particularly dense undergrowth.

VOICE. The song is of five notes, the first upslurred, the first two softer, the last three a loud "chew-chew-chew" (Fig. 27, p. 242). The call is a loud, spitted "pik! pik! pik!" The vocalizations are reminiscent of *Eupetes castanonotus* or *Pachycare flavogrisea*.

Rhipidura leucothorax clamosa Diamond

White-breasted Thicket Fantail

SPECIMENS EXAMINED. Karimui: 1 ♂ (10 July 1965). Soliabeda: 2 ♂ (25-28 July 1965).
WEIGHT. 2 ♂: 19.0, 19.7.
WING. 3 ♂: 78, 79, 79.
TAIL. 3 ♂: 86, 89, 91.
STOMACH CONTENTS. Insects.

TAXONOMY. In accord with the general trend at Karimui this race differs in its darker, blacker plumage (Diamond, 1967a).

BREEDING. Testes were small in one Soliabeda male; enlarged in the second Soliabeda male, which had been consistently singing from the same thicket for several days; and enlarged in the Karimui male.

DISCUSSION. *R. leucothorax* is not a forest bird but remains inside the densest and most tangled thickets and in second-growth and at the forest edge, not necessarily in the shade of taller trees. While it was a noisy singer and moved about within these thickets, it stayed largely concealed and was difficult to observe. The unbalanced sex ratio in my series (3 ♂, 0 ♀) and in the American Museum of Natural History's collection (21 ♂, 6 ♀) is probably because females of this skulking bird are much more likely to escape detection than singing males. It adopts an exaggerated fantail posture, with the tail fully spread.

This fantail was uncommon and local in the Karimui area, where it was considerably above its normal altitudinal range. In the Karimui Basin itself my only records were of a song heard in a thicket near Iogoramalu (3,700 ft) and of the specimen brought in at Karimui by a native. The species was also taken by Schodde and Hitchcock at Lake Kutubu (2,450 ft) and has been observed in the Baiyer Valley (3,500 ft: N.G.B.S. Newsletter, No. 54, p. 2, June 1970).

VOICE. The song consists of a short series of rapid, spitted or staccato, initially faint notes which accelerate and rise in pitch, to terminate in a loud, explosive, slurred note suggestive of a *Pachycephala* (Fig. 27).

Rhipidura rufidorsa subsp.

Gray-breasted Rufous Fantail

SPECIMENS EXAMINED. Soliabeda: 1 ♂ (27 July 1965).
WEIGHT. 10.

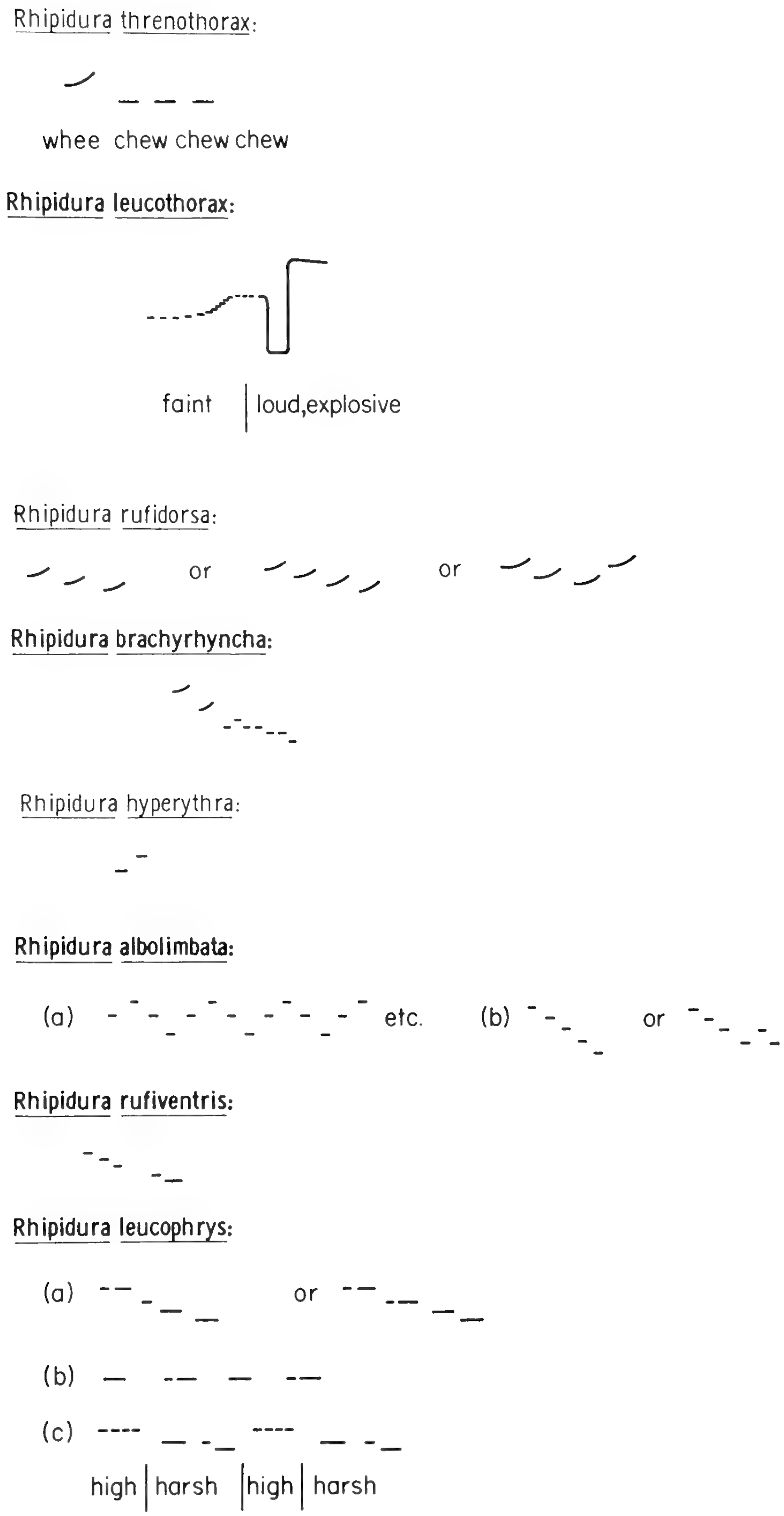


FIG. 27. Voices of *Rhipidura* flycatchers.

WING. 66.
STOMACH CONTENTS. Insects.

TAXONOMY. The rufous of the back in *Rhipidura rufidorsa* becomes gradually paler as one proceeds counter-clockwise around the periphery of New Guinea: *kumusi* on the north coast of southeastern New Guinea is the brightest, *kubuna* on the south coast of southeastern New Guinea is the dullest, and nominate *rufidorsa* of the rest of New Guinea is intermediate. *R. r. kubuna* is also the palest form. The Soliabeda male is somewhat brighter than *kubuna*, duller and darker than nominate *rufidorsa* from the Fly River, and considerably darker than *rufidorsa* from the Weyland Mountains and south slope of the Snow Mountains. It is closest to Fly River *rufidorsa*, but a definite racial assignment requires more material.

BREEDING. The testes were enlarged.

DISCUSSION. The sole specimen was netted, and no other was seen or heard.

VOICE. Three or four high, whistled notes, suggestive of *Crateroscelis murina* in quality but slightly upslurred. The notes either move progressively down the scale, or else the last note returns to the pitch of the first (Fig. 27, p. 242).

Rhipidura brachyrhyncha devisi North

Dimorphic Rufous Fantail

SPECIMENS EXAMINED. Mt. Michael: 1 ♀, 1 ? (5 and 13 July 1964). Mt. Karimui Zone 6: 1 ♀; Zone 7: 1 ♂; Zone 8: 1 ♂, 1 ♀ (2-7 Sept. 1965).
WEIGHT. 2 ♂: 10.3, 10.7. 2 ♀: 8.3, 9.7.
WING. 2 ♂: 71, 74. 3 ♀: 66, 67, 68.
STOMACH CONTENTS. Insects.

TAXONOMY. *Rhipidura brachyrhyncha* exists in two color phases, as discussed by Mayr and Rand (1937, p. 164): a darker phase with much black in the tail (Type I of Mayr and Rand) and a paler phase with no black in the tail (Type II of Mayr and Rand). All of my specimens are Type I except the Mt. Karimui Zone 7 male, which is Type II. The five specimens which Gyldenstolpe (1955, p. 97) collected in the Wahgi Mountains and the three which Bürgers took in the Schrader Range (Stresemann, 1923, p. 8) were all Type I. Mayr and Gilliard (1954) do not state the proportions in Gilliard's specimens, but four of these are present in the American Museum of Natural History, and all are Type I. In the Snow Mountains the Third Archbold Expedition (Rand, 1942b, p. 478) obtained 15 of Type I and 4 of Type II, Ripley (1964, p. 60) 3 and 1, and the Lorentz expedition (Junge, 1939, p. 29) 2 and 0. In southeastern New Guinea I found Type I twice as common as Type II. However, Mayr and Rand (1937, p. 167) state that the proportions are nearly equal in the Vogelkop and the Huon Peninsula. Evidently there is some geographic variation in the proportions, with Type I predominant in the central body of New Guinea. The related fantail *R. fuliginosa* of New Zealand also has two color phases whose relative abundances vary geographically.

BREEDING. Gonads were small.

DISCUSSION. Three species of *Rhipidura—R. brachyrhyncha, R. atra,* and *R. albolimbata*—occur in the forest interior at higher elevations and are usually not in second growth. Niche differences involve altitudinal distribution, and vertical distribution within the forest:

As regards altitudinal distribution, all three species may coexist in an overlap zone around 7,000 ft, where *R. atra* and *R. brachyrhyncha* overlap by about 500 feet, but for the most part *R. brachyrhyncha* lives from this altitude up to about 11,000 ft, *R. atra* from this altitude down to 3,000 or 4,000 ft. These two species are much more closely related to each other than to other New Guinea *Rhipidura* species, as indicated by their songs, their lowerstory preferences, and the similar plumage of *R. atra females* and *R. brachyrhyncha* Type I. They may have originated as an altitudinal pair and eventually developed enough differences in foraging behavior (see Mayr and Rand, 1937, p. 161) to permit modest altitudinal overlap. *R. albolimbata* shares the whole altitudinal range of *R. brachyrhyncha* and much of the range of *R. atra,* extending from 11,000 down to 4,500 ft, where it is replaced by *R. hyperythra.*

As regards vertical distribution within the forest, *R. albolimbata* and *R. hyperythra* are characteristic of the middlestory (5-60 ft above the ground, occasionally lower or higher). *R. atra* and *R. brachyrhyncha* are most often seen in the understory (ca. 2-8 ft above the ground, sometimes to 20 ft) and favor denser thickets than do *R. albolimbata* and *R. hyperythra.* The characteristic habitat of *R. brachyrhyncha* is stunted moss forest, and it has turned up at most Eastern Highlands collecting stations in this habitat. Thus, the lower altitudinal limit of *R. brachyrhyncha* and the upper limit of *R. atra* are strongly dependent upon local conditions. In the Okapa area, where we ascended to 7,500 ft without reaching moss forest, *R. brachyrhyncha* was absent, and *R. atra* went up to at least this altitude. On Mt. Michael, where moss forest began at 8,700 ft, *R. brachyrhyncha* descended to 8,000 ft, and *R. atra* ascended at least to 8,100 ft. On Mt. Karimui, where moss forest began rather abruptly at 6,500 ft, *R. brachyrhyncha* descended only to this altitude, and *R. atra* disappeared at it except for two records at 7,620 ft.

VOICE. The high-pitched song has a tinkling quality when heard nearby but sounds squeaky at a distance. It consists of a run-together descending cascade of about seven fast notes, introduced by a couple of detached, higher-pitched, slower, upslurred notes (Fig. 27, p. 242). The call note is slightly upslurred, high-pitched, and squeaky.

Rhipidura atra atra Salvadori

Black Fantail

NATIVE NAME. Fore: t're-t're.

SPECIMENS EXAMINED. Awande: 2 ♂, 1 ♀, 2 imm. ♂ (19 June 1964; 15-17 June 1965). Okasa: 1 ♂ (23 Aug. 1964). Mt. Michael: 1 ♀ (4 July 1964) Sena River: 1 ♂ (27 July 1965). Mt. Karimui Zone 1: 4 ♂, 1 ♀; Zone 2: 1 ♂, 1 ♀; Zone 3: 1 ♂; Zone 4: 2 ♂, 1 ♀; Zone 8: 1 ♂ (9 Aug.-7 Sept. 1965).

WEIGHT. 10 ♂: 11.0-14.0 (12.6 ± 1.0). 4 ♀: 10.5, 10.7, 12.0, 12.3. 2 imm. ♂: 10.3, 12.3.

WING. 10 ♂: 76-81 (79 ± 2). 3 ♀: 73, 74, 77 (74.7). 2 imm. ♂: 73, 74.

STOMACH CONTENTS. Insects.

TAXONOMY. The two immature males are in a brown plumage resembling that of the adult female. The other males are in a fully adult black plumage except for a few brown feathers on one.

BREEDING. The gonads were slightly enlarged in one Mt. Karimui male and one Awande male and were small in all other specimens.

DISCUSSION. *Rhipidura atra* was present at all my forest collecting stations between about 2,800 and 8,000 ft, with the conspicuous exception of Karimui (3,650 ft) and Bomai (3,250 ft). The possibility that it was present but overlooked at Karimui and Bomai is negligible, because both my Fore assistants and I knew its song, and it is readily netted, conspicuous, and common where present. The most surprising discovery of my walk from Karimui down to Soliabeda and vice versa was the observation of four *R. atra* at 2,770 ft and of one at 3,230 ft in hill forest on the outer side of the Karimui Basin's mountain wall. As we went up from the Karimui Basin onto the slopes of Mt. Karimui, *R. atra* reappeared at 4,090 ft and continued up to 6,500 ft, with two records at 7,620 ft. This hill and mountain forest species thus has a discontinuous altitudinal range at Karimui (present at 2,770-3,230 ft and 4,090-7,620 ft, absent in between), as a result of the intrusion of tropical conditions and flora on the basin floor. It is usually solitary and has a typical *Rhipidura* behavior, displaying with fanned tail and spinning about 180 degrees on its perch.

VOICE. There are three kinds of vocalizations: (1) the call note, a loud metallic "pink!"; (2) a very faint twittering progressing upscale; and (3) a tinkling high-pitched jumble of a song similar to that of *R. brachyrhyncha,* with a sweet and piercing quality. Once I heard this song from an individual in brown plumage (a female or immature male).

Rhipidura hyperythra muelleri Meyer

Chestnut-bellied Fantail

SPECIMENS EXAMINED. Okasa: 1 ♂, 1 ♀, 2 ? (23-26 June 1965). Guwasa (Gimi territory): 1 ♀ (24 July 1964). Karimui: 1 ♂, 2 ♀, 1 ? (1 July-4 Aug. 1965). Bomai: 1 ? (6 July 1965).

WEIGHT. 1 ♂: 11.5. 2 ♀: 10.0, 10.7. 3 ?: 11.0, 11.0, 11.5.
WING. 1 ♂: 73. 2 ♀: 66, 71. 3 ?: 72, 75, 78.

TAXONOMY. The distinguishing racial feature is the extent of white on the tips of the outer tail feathers: 15-20 mm in *castaneothorax* of southeastern New Guinea, 6-14 mm in *muelleri* from the remainder of New Guinea. The figures for my series place it with *muelleri:* Okasa, 1 ♂ 12 mm, 2 ? 14 and 14 mm; Bomai, 1 ? 11 mm; Guwasa, 1 ♀ 9 mm. The greater extent in the specimens from Okasa, lying farther to the east, suggests an approach to *castaneothorax.* A specimen from Lake Kutubu examined by Schodde and Hitchcock also belonged to *muelleri.*

BREEDING. The gonads were enlarged in one Karimui male but not in the other specimens.

DISCUSSION. *R. hyperythra* is the middlestory forest fantail of lower altitudes up to about 4,500 ft and was collected or observed at all my stations in this range, above which it is replaced by *R. albolimbata.* Its maximum abundance is in hill forest near the upper limit of its altitudinal range: i.e., it was common at Okasa (3,500-4,250 ft), and in Zone 1 of Mt. Karimui it accounted for 4% of census totals. At Bomai and Soliabeda it was quite uncommon. To judge from published records and my own experience, it is rare and often absent in the flat floodplains of the lowlands (Sepik Basin, southwestern New Guinea floodplain, Fly River). Its habit of tipping forward, nervously fluttering its wings and fanning its tail, then spinning around 180 degrees to repeat the performance, resembles *R. albolimbata.*

VOICE. The quality is as in the song of *R. albolimbata,* the pattern is drastically abbreviated, as if *R. albolimbata* were sparing itself its usual *ad nauseam* repetitions: two short and detached, high-pitched, faint but clear and tinkling notes, the second following the first by less than 1 sec and a minor third higher in pitch (Fig. 27, p. 242). An even fainter twittering similar to that of *R. albolimbata, R. rufiventris,* and *R. atra* was heard once.

Rhipidura albolimbata Salvadori

White-eared Fantail

NATIVE NAMES. Fore: ninikésu.
SPECIMENS EXAMINED. Awande: 1 ♂ (a), 3 ? (b, c, d) (28 June 1964; 14-19 June 1965). Mt. Karimui Zone 3: 1 ? (e); Zone 5: 1 ♂ (f), 1 ♀ (g), 1 ? (h); Zone 6: 2 ? (i, j); Zone 7: 1 ♂ (k), 1 ? (l); Zone 8: 1 ? (m) (16 Aug.-5 Sept. 1965).
WEIGHT. 3 ♂: 9.9 (a), 10.7 (f), 11.4 (k). 1 ♀: 9.5 (g). 1 ?: 9.0 (h), 9.3 (c), 9.3 (i), 10.0 (e), 10.3 (d), 10.7 (j), 11.0 (m).
WING. 3 ♂: 79 (a), 80 (f), 82 (k). 1 ♀: 71 (g). 6 ?: 72 (b), 72 (e), 74 (h), 80 (c), 84 (l), 84 (m).
STOMACH CONTENTS. Insects.

TAXONOMY. In the Snow Mountains (Rand, 1942b, p. 479), at Telefolmin (Gilliard and LeCroy, 1961, p. 53), and in the Wahgi

Valley (Mayr and Gilliard, 1954, p. 348; Gyldenstolpe, 1955, p. 99) this species increases in size and darkness with increasing altitude. Of the specimens measured in my series from the southern parts of the Eastern Highlands, those with the longest wings ("k", "l", "m") are the three from the highest altitude. Specimens "k" and "m" are also the darkest (on the back and flanks) and heaviest specimens ("l" was not weighed or available for color comparison). The large, dark, high-altitude birds have been separated as *lorentzi*. However, this altitudinal cline is gradual and has now been found over a stretch of 600 miles in the Central Range. As suggested by Gilliard and LeCroy (1961, p. 53; 1968, p. 19), it therefore seems undesirable to recognize altitudinal subspecies in this case.

DISCUSSION. *R. albolimbata* is the high-altitude forest fantail of the middlestory, replacing *R. hyperythra* above about 4,500 ft. On Mt. Karimui's west peak (the one I studied in detail) the lowest sighting of *R. albolimbata* was at 4,630 ft, and the highest of *R. hyperythra* was at 4,360 ft. On Mt. Karimui's east ridge, where moss forest descended lower and which we crossed at 4,420 ft en route from Soliabeda back to Karimui, it was *R. albolimbata* which we found at this altitude. However, at 4,500 ft on the Sena River and at 4,250 ft in the Okasa forest it was *R. hyperythra* that was present. *R. albolimbata* extends abundantly upward throughout the stunted moss forest to above timberline, where it forages on tree ferns in alpine grassland several hundred feet from the forest edge.

VOICE. The song is a sequence of clear, detached, short, and high notes spaced at intervals of about ½ sec, giving the impression of water droplets falling at regular intervals. In the commonest pitch arrangement the first and third notes are on the same pitch, the second note a minor third higher, the fourth note a minor third lower. This four-note pattern is the origin of the Fore name "ni-ni-ke-su" and is repeated *ad nauseam* without pause (Fig. 27a, p. 242). Less often the song consists of a five- or six-note phrase which has the same quality and high pitch but is not repeated (Fig. 27b). One of these latter patterns, consisting of five notes each one tone lower than the preceding and concluding with faint twittering, is close to the song of *R. rufiventris*.

Rhipidura rufiventris gularis Muller

White-throated Fantail

SPECIMENS EXAMINED. Karimui: 1 ♂ (4 Aug. 1965). Bomai: 1 ♂ (7 July 1965). Soliabeda: 2 ♂ (28 and 29 July 1965).

WEIGHT. 4 ♂: 14.5, 15.0, 15.0, 16.0.

WING. 4 ♂: 85, 86, 88, 89.

STOMACH CONTENTS. Insects.

BREEDING. Testes were enlarged in all four specimens and greatly enlarged in two of them.

DISCUSSION. Whereas *R. hyperythra* is virtually confined to the forest interior, *R. rufiventris* may be found in the forest interior but more often occurs in natural forest clearings produced by fallen trees, and in open parts of the forest, the forest edge, and second-growth, at any height from the ground to the treetops. I observed or collected it at all my collecting stations below 5,000 ft that included some second-growth, but only up to 4,000 ft in primary forest. As one proceeds from 4,000 ft downward, *R. rufiventris* becomes more common, *R. hyperythra* less common. For instance, *R. rufiventris* reached its maximum abundance at my lowest station, Soliabeda, where *R. hyperythra* was quite uncommon. *R. rufiventris* still occurs regularly in the flat floodplains of the lowlands, where *R. hyperythra* is quite uncommon or absent. There are also differences in behavior: larger *R. rufiventris* does not indulge in the pronounced tail-fanning of *R. hyperythra* and *R. albolimbata,* and is somewhat less nervous.

VOICE. The song consists of five descending notes in syncopated rhythm, the whole song lasting slightly less than 2 sec (Fig. 27, p. 242). The pitch is fairly high, and the successive pitch intervals are somewhat less than a whole note. The quality is a thin whistle similar to the voice of *Crateroscelis murina* but less substantial and clear, and more substantial than the songs of *R. hyperythra* or *R. albolimbata.* The pattern is similar to that of some *R. leucophrys* songs and to a rare *R. albolimbata* song (Fig. 27b), but the very different quality precludes confusion. A repeated faint "whik" was once heard as a call note.

Rhipidura leucophrys melaleuca (Quoy and Gaimard)

Willie Wagtail

NATIVE NAMES. Fore: kétori. Gimi: bídii. Daribi: gódigódi.

SPECIMENS EXAMINED. Awande: 1 ♂, 2 ♀, 2 ? (17-20 June 1965). Karimui: 1 ♀ (15 July 1965).

WEIGHT. 1 ♂: 25.5. 3 ♀: 23.0, 24.0, 29.5. 2 ?: 24.0, 25.0.

WING. 1 ♂: 101. 3 ♀: 95, 95, 98. 2 ?: 97, 103.

STOMACH CONTENTS. Insects.

BREEDING. The Awande male had enlarged testes.

DISCUSSION. The Willie Wagtail is one of the principal avian beneficiaries of man-made ecological changes in the Eastern Highlands. Whereas it is a lowland species elsewhere in New Guinea, in the Eastern Highlands it is common and ubiquitous up to 6,500 ft in open country offering perches (but not in pure grassland). Strangely, it is only from the Eastern Highlands to Telefolmin that *R. leucophrys* has succeeded in colonizing the midmontane grassland. To judge from published records, it is absent from the midmontane grassland of the Huon Peninsula, southeastern New Guinea, and the Baliem Valley, Ilaga Valley, and Wissel Lakes region of western New Guinea. Its perches range from the tops of casuarina groves and of trees overlooking roads and gardens to the ground. Perhaps it is the only widespread breeding bird in the Eastern Highlands, apart from the more locally distributed *Anthus novaeseelandiae*, which spends a high proportion of its time on open bare ground (i.e., roads and closely cut lawns). Much of its food is obtained by flycatching in midair. Willie Wagtails fly up to and repeatedly attack perched large birds, like *Accipiter fasciatus* and *Corvus orru*, and continue to chase them when they take off, partly in order to pluck feathers to line the nest. They also chase dogs. In some areas Willie Wagtails leave during the dry season and return to breed during the rains.

VOICE. Quite unlike the quality of other New Guinea species of *Rhipidura*. There are two kinds of songs, which may involve notes of two sharply different qualities: harsh or grating, low-pitched, louder notes, somewhat like *Monarcha axillaris* in quality, and higher-pitched, weaker, whistled notes. Each note has a sharp attack, is staccato, and is at constant pitch. One of the two songs is a five- or six-note phrase in uneven rhythm and with progressively dropping pitch (Fig. 27a, p. 242); the phrase may immediately be repeated. The other song (Fig. 27b) consists either of a three-note phrase in dotted rhythm, in the harsh quality, and at nearly the same pitch, the phrase being immediately repeated; or else (Fig. 27c) consists of this same phrase alternating with a phrase in the weaker, higher quality and consisting of four rapid-fire notes on the same pitch. These songs are occasionally heard at night.

Monarcha axillaris fallax (Ramsay)

Black Monarch

NATIVE NAME. Gimi. luserepiyába.

SPECIMENS EXAMINED. Awande: 1 imm. ♂, 1 ? (19 June 1964; 19 June 1965). Okasa: 2 ♂, 1 ♀, 2 imm. ? (20 Aug. 1964; 22-26 June 1965). Karimui: 2 imm. ♂, 1 imm. ♀, 1 imm. ? (10 Aug. 1964; 2-15 July 1965). Mt. Karimui Zone 1: 4 ♂, 3 ♀, Zone 2: 2 ♂; Zone 3: 1 ♂; Zone 5: 1 ♂ (9 Aug.-2 Sept. 1965).

WEIGHT. 10 ♂: 15.0-17.0 (15.7 ± 0.6). 4 ♀: 14.3, 14.7, 16.0, 16.0. 3 imm. ♂: 13.5, 14.0, 15.5. 1 imm. ♀: 17.0. 1 imm. ?: 12.7.

WING. 10 ♂: 74-82 (77 ± 2). 3 ♀: 73, 74, 75. 3 imm. ♂: 73, 74, 77. 1 imm. ♀: 75. 3 imm. ?: 74, 75, 75.

STOMACH CONTENTS. Insects.

TAXONOMY. The nominate race of the Vogelkop, Weyland Mountains, and North Coastal Range has much larger white pectoral tufts. Immatures of both sexes are uniform dull slate gray, lacking the blue-black sheen of adults. They also have browner primaries, and one specimen has a few brown feathers on the back. Adult females have the blue-black sheen slightly less pronounced than in adult males but are still readily distinguished from immatures.

BREEDING. The gonads of the whole series were small, usually very small, except for being slightly enlarged in two of the Mt. Karimui males.

DISCUSSION. *Monarcha axillaris* is a forest species with an altitudinal range from about 3,000 to 6,000 ft. In my study areas it reached its maximum abundance in Zone 1 of Mt. Karimui (4,000-4,200 ft), where it accounted for 7% of the local avifauna, and in the Okasa forest (3,550-4,250 ft). The contrast between its abundance on the lower slopes of Mt. Karimui and its rareness (0.2% of the local avifauna) on the flat basin floor at Karimui Patrol Post (3,650 ft) was striking and in agreement with the rareness of many other hill forest species in the Basin. Stragglers of *M. axillaris* turn up irregularly and in low numbers at 6,000 ft (e.g., Awande), occasionally higher. This flycatcher provides an excellent example of the tendency of immature birds to be found at the extremes of a species' altitudinal range: no immature was collected or seen in the species' "heartland" (Zones 1 and 2) on Mt. Karimui, whereas all birds collected and seen at Karimui Patrol Post were the gray immatures, as was one of the two Awande specimens.

Of the New Guinea representatives of genus *Monarcha, M. axillaris* is the closest to the *Rhipidura* fantails in its habits. It flits in the lower- or middlestory up to ca. 20 ft above the ground, holding its body horizontal and fanning its tail, sometimes in groups of up to four birds. Superficially *Monarcha axillaris* resembles male *Rhipidura atra,* so that the Fore called the former by the latter's name ("t're-t're"). Distinguishing features are the white pectoral tufts of the former and white superciliary spot of the latter (not always obvious); the lower mandible, blue-black in the former and orange in the latter; the voice; and behavioral differences.

VOICE. Three or four identical notes in rapid succession on the same pitch, all three or four being completed within ½ sec. The quality is distinctive: dry, buzzy, rasping, fairly loud, totally unmusical, and like an insect or the scolding of a wren (Troglodytidae).

Monarcha frater periophthalmicus Sharpe

Black-winged Monarch

SPECIMENS EXAMINED. Okasa: 4 ♂, 2 ♀ (22-25 June 1965). Karimui: 2 ♂, 2 ♀ (1 July-5 Aug. 1965). Mt. Karimui Zone 1: 1 ♀; Zone 2: 1 ♂ (10 and 15 Aug. 1965).

WEIGHT. 7 ♂: 21.0, 21.0, 22.3, 22.5, 23.0, 23.0, 24.0. 4 ♀: 20.8, 21.0, 21.5, 21.5.

WING. 6 ♂: 85, 85, 87, 88, 90, 91. 5 ♀: 83, 84, 84, 85, 85.

TAXONOMY. The black of the face extends behind the eye, whereas it does not do so in the nominate race. In color my series is comparable to southeastern New Guinea birds, whereas Telefolmin birds average darker gray than either on the breast and back.

BREEDING. Gonads were large in one Karimui male, somewhat enlarged in the other, and small in all other specimens.

DISCUSSION. This is a solitary species of the middle- and upper-stories (20-80 ft above the ground) of hill forest, between ca. 1,800 and 5,100 ft in my study areas, varying locally from common to absent. There is no straggling to higher altitudes, and there seem to be no records above 5,100 ft anywhere in New Guinea. Bulmer collected *M. frater* at 4,000-4,500 ft in the Baiyer Valley. *M. frater* does not descend to the understory and was not netted, differing in this respect from its congener *M. axillaris*, much of whose altitudinal range it shares.

VOICE. The song (Fig. 28, p. 255) is a fairly loud, mellow, cheerful, whistled note repeated several times at intervals of about 1 sec. Each note is initially upslurred and then downslurred and may be preceded by a much shorter note. The quality is reminiscent of *Pitohui dichrous* or *Meliphaga flaviventer*. The call is a dry, buzzy "chuck-chuck-chuck."

Monarcha guttula (Garnot)

Spot-winged Monarch

SPECIMENS EXAMINED. Karimui: 4 ♂, 3 ♀ (7-13 Aug. 1964; 3-16 July 1965). Bomai: 3 ♂ (6-9 July 1965). Soliabeda: 6 ♂, 2 ♀ (22-28 July 1965).

WEIGHT. 10 ♂: 14.0-18.3 (16.6 ± 1.3). 4 ♀: 14.5, 16.0, 16.5, 17.0.

WING. 10 ♂: 77-83 (80 ± 2). 3 ♀: 78, 80, 80.

STOMACH CONTENTS. Insects.

TAXONOMY. The series shows no change in wing length with altitude.

BREEDING. In August 1964 one male and one female at Karimui were sexed, and both were found to have enlarged gonads. Out of seven males and five females sexed in July 1965 at Karimui, Bomai, and Soliabeda, two males and one female at Soliabeda had somewhat enlarged gonads, and the other specimens had small gonads. This suggests that the dry weather of July-August 1965 suppressed breeding, as also noted for some other species at Karimui (p. 00).

DISCUSSION. Other localities where this tropical monarch has been found in the Eastern Highlands are Lake Kutubu (2,450 ft) and Baiyer River (N.G.B.S. Newsletter, No. 54, p. 2, June 1970). It did not even get into Zone 1 of Mt. Karimui, and was commonest at my lowest station, Soliabeda, where it accounted for 2% of the local avifauna. It was an active and solitary forest understory species, foraging up to 30 ft above the ground.

VOICE. The call is a dry squawk on constant pitch or slightly upslurred; or else a dry rasped scolding difficult to distinguish from that of *Monarcha telescophthalmus* or *Toxorhamphus poliopterus*.

Monarcha chrysomela aruensis Salvadori

Black and Yellow Monarch

SPECIMENS EXAMINED. Karimui: 2 ♀ (14 July and 4 Aug. 1965). Soliabeda: 1 ♂ (24 July 1965).
WEIGHT. 1 ♂: 15.0. 2 ♀: 13.0, 15.5.
WING. 1 ♂: 67. 2 ♀: 66, 68.
STOMACH CONTENTS. Insects.

TAXONOMY. There are clinal west-to-east color variations in both males and females as one proceeds from the Aru Islands and the Fly River (race *aruensis*) to the Karimui area to southeastern New Guinea and the D'Entrecasteaux Archipelago (race *praerepta*). In the males, D'Entrecasteaux birds differ from the others by being generally more yellow and less orange. The crown of males is most orange in Aru Islands and Fly River birds, least so in D'Entrecasteaux birds; Soliabeda and southeastern New Guinea birds are intermediate, with the Soliabeda male closer to Aru Islands-Fly River birds and southeastern New Guinea specimens closer to D'Entrecasteaux birds. In the females the breast is more olive on the Fly River than in the D'Entrecasteaux Archipelago, with southeastern New Guinea birds intermediate and variable. Karimui females are somewhat nearer D'Entrecasteaux than Fly River females in this respect but are deeper yellow below than these or other *praerepta* or *aruensis*. Fly River females are more olive, darker, and less yellow dorsally than D'Entrecasteaux or southeastern New Guinea females, and in this respect the Karimui females agree much better with Fly River females, from which they differ in being somewhat more yellow. Thus, the three specimens from the Karimui area are on the whole closer to the *aruensis* than to the *praerepta* end of the cline.

BREEDING. Gonads were not enlarged in the females and only slightly enlarged in the male.

DISCUSSION. At Karimui and Soliabeda this tropical species was very uncommon (ca. 0.2% of the local avifauna). My highest record was a single sighting at 4,120 ft on Mt. Karimui. Except for a male and female seen chirping at each other, the species was solitary. Its habitat is the forest and the forest edge, particularly trees with some open space around them. It is even more nervous and active than other species of *Monarcha* and works around the tops and outside of the crowns of trees, generally at least 30 ft above the ground, so that it was never netted.

VOICE. The song is a loud musical jumble of mellow notes, spitted notes, "cheep's", and squawks, accompanied by frequent snapping of the bill.

SPECIES ACCOUNTS

Monarcha telescophthalmus harterti van Oort $\lesseqgtr$ *M. t. henkei* Meyer[1]

Frilled Monarch

SPECIMENS EXAMINED. Okasa: 1 ♂ (23 June 1965). Karimui: 5 ♂, 1 imm. ♂ (1 July-5 Aug. 1965). Bomai: 3 ♂, 1 ♀ (7-9 July 1965). Soliabeda: 1 ♂, 1 ♀, 1 imm. ♂ (25-29 July 1965). Mt. Karimui Zone 2: 1 ♀; Zone 3: 1 ♀ (14 and 16 Aug. 1965).

WEIGHT. 8 ♂: 16.0-19.0 (17.1 ± 1.0). 3 ♀: 15.7, 16.0, 18.5. 1 imm. ♂: 18.3.

WING. 10 ♂: 78-87 (82 ± 2). 3 ♀: 74, 78, 79. 2 imm. ♂: 79, 81.

STOMACH CONTENTS. Insects.

TAXONOMY. The taxonomic analysis of this species is of interest in that my series is geographically intermediate between *harteri* of south-central New Guinea and *henkei* of southeastern New Guinea, and in that my females are close to the former race and my males to the latter. In the male *henkei* is best distinguished from *harterti* by the (on the average) smaller extent of black on the chin, and in this respect my males are closest to *henkei*. In the female *henkei* often has a paler and more rufous back and faint rufous wash on the abdomen, while *harterti* has a darker, browner, nonrufous back and a pure white abdomen; my females agree in both respects with *harterti*. There is also a slight size difference, *henkei* being larger than *harterti*. Mayr and Rand (1937, p. 154) give as average wing length ♂ 80.9, ♀ 78.7 for *henkei* from southeastern New Guinea, ♂ 78.5, ♀ 75.4 for *harterti* from the Oriomo River, while Rand (1942a, p. 338) gives ♂ 79.5, ♀ 77.0 for *harterti* from the Fly River. The average values for my series (♂ 81.8, ♀ 77.0) are nearer *henkei* in the male, *harterti* in the female, as are the color characteristics.

BREEDING. Gonads were very small in all specimens except for one Karimui male, in which they were slightly enlarged.

DISCUSSION. I agree with Ripley (1964, p. 61) that separation of this monarch and its Australian relatives in a genus *Arses* is undesirable.

Monarcha telescophthalmus was seen fairly often at Soliadeda and Karimui, where it accounted for about 1% of the local avifauna. It was much less common on Mt. Karimui, and the highest record was at 4,900 ft on Mt. Karimui and approximately the same altitude below Mengino. Its habitat is the forest, edge of the forest, and second-growth, where it is usually found 5-40 ft above the ground. A distinctive habit of *M. telescophthalmus* not shared with its New Guinea congeners is one of standing on or coming down the sides of large vertical tree trunks, either right-side-up or upside-down. Whether pursuing these nuthatch-like habits or chasing flying insects, it moves actively.

VOICE. The call is a thin, buzzy, upwards-inflected squawk. The

[1] Listed as *Arses telescophthalmus* in Rand and Gilliard (1967).

song is a dry, slow, rattled, ringing trill which progressively drops in pitch.

Myiagra alecto subsp[1]

Shining Flycatcher

STOMACH CONTENTS. Insects.

DISCUSSION. Bulmer collected a specimen beside a stream at 4,200 ft in Kyaka territory, Schodde and Hitchcock report the species in riverside shrubbery near Lake Kutubu (2,450 ft), and Kikkawa found it in the Baiyer Valley. This lowland species of the forest edge and second-growth may spread upward to similar habitats elsewhere in ecologically disturbed areas of the hill slopes in the Eastern Highlands. I follow Schodde and Hitchcock (1968) in treating the species as a *Myiagra,* not as a *Monarcha.*

VOICE. The call is a harsh rasp that crescendoes greatly. The song is a rapid trill of clear whistled notes, crescendoing somewhat, and either all on the same pitch or else slightly rising.

Myiagra cyanoleuca (Vieillot)

Satin Flycatcher

Bulmer collected one specimen of this winter visitor from Australia at 4,400 ft in the Baiyer Valley on 12 July 1955. Apparently the only other records from northern New Guinea are a male collected at Hollandia on 4 July 1938, by the Third Archbold Expedition, a male taken by Gilliard at Aiome at the foot of the Schrader Range in May or late April 1964, and records from Karkar (March 1914; June 1969) and Manam (December 1913; January 1914) islands.

Machaerirhynchus flaviventer xanthogenys Gray

Yellow-breasted Flatbill Flycatcher

SPECIMENS EXAMINED. Karimui: 2 ♂, 1 ♀ (2-16 July 1965).
WEIGHT. 2 ♂: 11.0, 11.5. 1 ♀: 12.0.
WING. 2 ♂: 61, 62. 1 ♀: 60.

TAXONOMY. The forehead and eye stripes of the males are yellow rather than white, a character unique to the southern New Guinea race *xanthogenys.* The upper backs of the two males are black with but little olive; the amount of olive in larger series of *xanthogenys* is quite variable.

BREEDING. The gonads were greatly enlarged.

DISCUSSION. This tropical flycatcher was seen and heard regu-

1 Listed as *Monarcha alecto* in Rand and Gilliard (1967).

larly at Soliabeda (2% of the local avifauna) and infrequently at Karimui, Bomai, and up to 4,100 ft on Mt. Karimui. It was solitary, active, and usually seen 10-50 ft above the ground, but one of the specimens was netted in the understory. It seems commoner at the forest edge and in open parts of the forest than in the shaded forest interior.

VOICE. The quality of the song is distinctive, a weak, high, buzzy, unmusical and dry run-together trill. The pattern is usually that depicted in Figure 28: two connected notes, the first dropping in

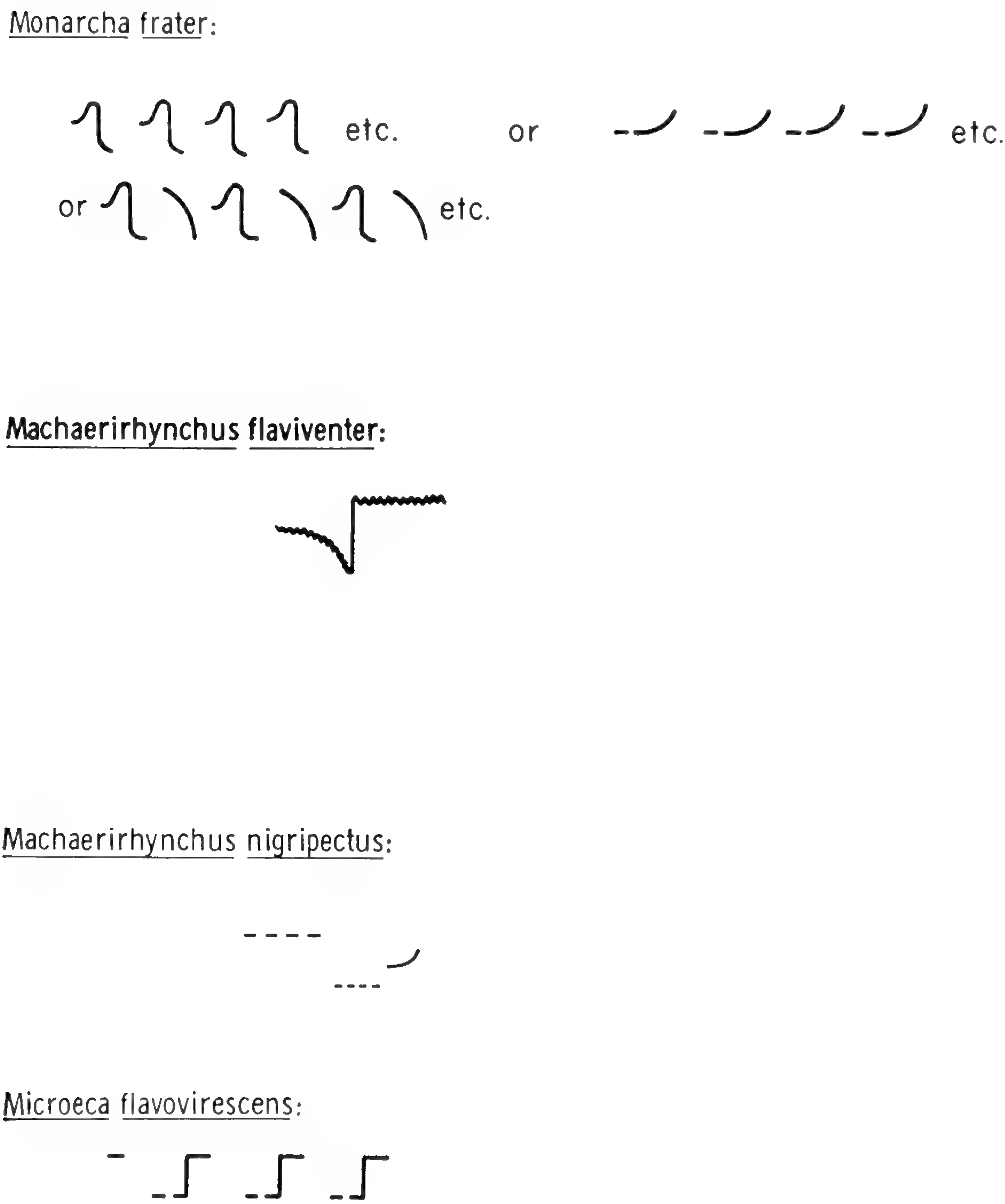


FIG. 28. Voices of four New Guinea flycatchers.

pitch, the second steady at a higher pitch. Sometimes the trill rises straight up the scale instead.

Machaerirhynchus nigripectus saturatus Rothschild and Hartert

Black-breasted Flatbill Flycatcher

NATIVE NAME. Fore: yaragiyéta.
SPECIMENS EXAMINED. Awande: 1 ♂ (17 June 1965). Agotu (Gimi territory): 1 ♂ (22 July 1964). Maiba (Gimi territory): 1 ♀ (23 July 1964). Mt Karimui Zone 3: 1 ♀ (18 Aug. 1965; Zone 4: 1 ? (23 Aug. 1965).
WEIGHT. 1 ♂: 12.0.
WING. 1 ♂: 61. 2 ♀: 60, 60.
STOMACH CONTENTS. Insects.

TAXONOMY. The blackish backs of the females separate these from *harterti* of southeastern New Guinea and the Huon Peninsula, in which females are dark gray-brown above.

DISCUSSION. *Machaerirhynchus nigripectus* is the high-altitude equivalent of *M. flaviventer,* foraging rapidly from the understory to the treetops while calling loudly. On Mt. Karimui I found the former from 5,210 to 6,100 ft, and the latter up to 4,100 ft. Other collectors in the Eastern Highlands have encountered *M. nigripectus* regularly between 5,000 and 8,000 ft, in forest, second-growth, or at the forest edge.

VOICE. The call consists of a loud, rapid series of musical but buzzy notes, similar to *Ifrita kowaldi* or to *Mohoua ochrocephala* of New Zealand. The song has a similar quality (Fig. 28).

Eugerygone rubra saturatior Mayr

Red-backed Flycatcher

SPECIMENS EXAMINED. Mt. Karimui Zone 6: 1 ? (3 Sept. 1965).
WEIGHT. 9.
WING. 58.
STOMACH CONTENTS. Insects.

TAXONOMY. The specimen is presumed a female because of its plumage. The female of the nominate *rubra* of the Vogelkop differs in its browner, less olive, back.

DISCUSSION. I found this rare flycatcher only between 6,100 and 7,170 ft on Mt. Karimui. The few other Eastern Highlands records are also mainly from forest at higher elevations (7,000-8,000 ft in the Kubor Mountains, Wahgi Mountains, Schrader Range, and Mt. Hagen). Songs came from solitary individuals 6-10 ft above the ground in the stunted trees of the moss forest. Their behavior was nervous; the tail was flicked from side to side, and the wings were continuously fluttered. The white eyelids and white in the undertail are good field marks. The other species with which confusion may arise in the field because of appearance, behavior, and habitat are *Gerygone cinerea, Gerygone ruficollis,* and *Melanocharis versteri.*

Mayr and Gilliard (1954, p. 349) have argued that this bird is a flycatcher, rather than a warbler, as previously held.

VOICE. A very high-pitched, faint, tinkling song fluctuating alternately above and below the same pitch.

Niche Differences in the Genera *Microeca* and *Tregellasia*

New Guinea has four widespread species of *Microeca* (*M. flavigaster, M. flavovirescens, M. griseoceps,* and *M. papuana*) and one species of *Tregellasia* (*T. leucops*). *Tregellasia* resembles New Guinea *Microeca* species in the color of the plumage and in the orange legs, has often been considered congeneric with *Microeca,* and the two genera obviously share a common derivation. Of these five species, all but *M. flavigaster* have been found in the Eastern Highlands. The following discussion of their ecological differences is based partly on my field observations in the Eastern Highlands and North Coastal Range and partly on the basis of published locality records from other parts of New Guinea.

While the other four species are birds of the forest, the habitat of *M. flavigaster* is savanna and open country with scattered trees, from the lowlands up to about 2,500 ft, with one record at 4,800 ft (Telefolmin).

Of the four forest species, *M. flavovirescens* is in the lowlands and lower hill slopes, dropping out at an altitude which varies locally between 2,000 and 4,000 ft; *M. griseoceps* and *T. leucops* are on the middle hill slopes from about 3,000 to 5,000 ft; and *M. papuana* is in the mountains above 5,000 or 6,000 ft. Examining local variations of the limits in more detail, one finds that the range of *M. flavovirescens* and the range shared by *M. griseoceps* and *T. leucops* are mutually exclusive, and that the latter range and that of *M. papuana* are not only mutually exclusive but probably separated by a gap of 700-800 ft. Local variations in the altitudinal limits of the four species are therefore intercorrelated. For instance, the intrusion of tropical conditions at Karimui gives *M. flavovirescens* a higher upper limit, and *T. leucops* a higher lower limit (somewhere between 3,650 and 4,000 ft), than usual. Similarly, the descent of moss forest to low elevations in the North Coastal Range gives *T. leucops* a lower upper limit, and *M. papuana* a lower lower limit (somewhere between 4,200 and 5,000 ft), than usual. The occasional records of *M. flavovirescens* above 2,000 ft are from localities where *M. griseoceps* is absent. While this triple altitudinal sequence seems to hold for virtually all the explored high mountains of New Guinea, it does not apply to the zoogeographically distinct Fly River delta region of southern New Guinea or to the Cape York Peninsula of Australia, where 21 species which are confined to the mountains elsewhere in New Guinea, including *M. griseoceps* and *T. leucops,* descend to sea level.

The differences between *M. griseoceps* and *T. leucops,* the only two of the five species sharing the same altitudinal range and habitat, are behavioral. The four *Microeca* species all behave in essentially the same manner: they are social birds, usually seen in groups of three or four, and perch upright and motionless, sallying out from their perches to catch insects. *T. leucops* sometimes adopts the same behavior, but it seems to spend proportionately more time in the understory; it is often solitary, whereas I have yet to see any of the other four species as solitary individuals; and it often perches sideways on the bark of trees, a behavior I have never seen in the four New Guinea *Microeca* but which is characteristic of *T. leucops*'s Australian relatives and of the New Guinea thicket flycatchers (p. 262). In their shared altitudinal range *T. leucops* is a common and ubiquitous species, whereas *M. griseoceps* is uncommon and local. The uncommoness of *M. griseoceps,* the middle species in the three-fold sequence *M. flavovirescens-M. griseoceps-M. papuana,* with habits similar to its higher and lower relatives, is typical of the fate of the middle species in many three-species altitudinal sequences (p. 34). The numerous *T. leucops* has evidently succeeded in avoiding this "curse of the middle species" by adding some different habits to its behavioral repertoire. However, the fact that *T. leucops* has not been able to invade the altitudinal ranges of the successful *M. papuana* and *M. flavovirescens,* although it has completely overrun the range of *M. griseoceps,* may imply that many of the habits of *T. leucops* are still those of the *flavovirescens-griseoceps-papuana* group.

Microeca flavovirescens cuicui (De Vis)

Olive Microeca Flycatcher

SPECIMENS EXAMINED. Karimui: 6 ♂, 1 ♀, 3 ? (8 and 9 Aug. 1964; 12 July-5 Aug. 1965). Bomai: 2 ♂, 2 ? (6 July 1965). Soliabeda: 3 ♂ (27 and 28 July 1965).

WEIGHT. 10 ♂: 14.0-17.0 (15.6 ± 1.1). 1 ♀: 14.0. 3 ?: 13.0, 13.0, 13.5.

WING. 9 ♂: 76-83 (80 ± 2). 1 ♀: 73. 2 ?: 69, 72.

STOMACH CONTENTS. Insects.

TAXONOMY. Specimens from southeastern New Guinea and the southern slope of the Snow Mountains, and my specimens, belong to the barely distinguishable race *cuicui* of most of New Guinea, and have the yellow of the underparts just detectably less dull than in nominate *flavovirescens* of the Fly River and Aru Islands. The dorsal coloration appears to be subject to postmortem changes.

BREEDING. Testes were much enlarged in all three Soliabeda males, in both Bomai males, and in three of the six Karimui males. The three Karimui males with small testes had relatively shorter wings (76, 78, 81 mm) and may have been subadult.

DISCUSSION. At Karimui, Bomai, and Soliabeda this lowland forest species accounted for about 0.5-1.0% of the local avifauna. Its upper limit at Karimui (3,650 ft) is somewhat higher than usual elsewhere in New Guinea, in agreement with the general Karimui trend and probably related to the absence of *M. griseoceps*. Groups of two or three birds sat motionless on perches within about 15 ft of each other. Periodically a bird sallied out and darted around after insects, returning to the same or a nearby perch. Eventually the whole group moved on to a new set of perches. On three occasions my collectors brought in two birds shot together, and on one occasion three birds. The composition of these groups was: 1 ♂, 2?; 1 ♂, 1?; 2 ♂; 2 ♂. The specimens of uncertain sex were probably females or young birds because of their short wings (69 mm) or low weights (13.0 and 13.5 g).

VOICE. A faint song based on a repeated phrase (Fig. 28, p. 255).

Microeca griseoceps subsp.

Yellow-footed Microeca Flycatcher

SPECIMENS EXAMINED. Okasa: 1 ♀.
WEIGHT. 12.
WING. 70.

TAXONOMY. Reassessment of the races of this species, to be reported in connection with my North Coastal Range collections, indicates that *poliocephala* is synonymous with *occidentalis* and that the Cape York race *kempi* (type examined), described by Mathews as a new species and genus, is not separable even subspecifically from nominate *griseoceps*. Analysis of color differences in this species is complicated by marked postmortem changes, as also noted by Rand (1942b, p. 483). My Okasa specimen has the wing longer than in nominate *griseoceps* and the back brighter and more yellow than in comparative material. More material would be necessary to place the Eastern Highlands population racially. The legs are bright orange, the upper mandible black, and the lower mandible orange.

BREEDING. The gonads were small.

DISCUSSION. The specimen was collected at 3,550 ft and is the sole one reported to date in the Eastern Highlands.

Microeca papuana Meyer

Yellow Microeca Flycatcher

NATIVE NAME. Fore: kenantágure.

SPECIMENS EXAMINED. Mt. Michael: 1 ♂, 1 ♀, 1 imm. ♂ (4-12 July 1964). Mt. Karimui Zone 5: 2 ♂, 3 ♀, 1 ?; Zone 6: 1 ♂, 1 ♀; Zone 7: 1 ♂, 1 ♀; Zone 8: 3 ♂, 2 ♀, (27 Aug.-8 Sept. 1965).

WEIGHT. 7 ♂: 13.5-15.0 (14.3 ± 0.6). 7 ♀: 13.0-16.0 (13.9 ± 1.1).

WING. 7 ♂: 72-79 (75 ± 2). 5 ♀: 70, 71, 72, 74 (2). 1 ?: 69.

STOMACH CONTENTS. Insects.

TAXONOMY. The immature bird from Mt. Michael has the legs brownish orange (only the toes bright orange), the lower mandible orange, and the upper mandible grayish orange, whereas the whole leg is bright orange and the bill black in adults. The uppertail of the immature is brownish, and the underparts a dirty lemon-green instead of the bright yellow of adults.

BREEDING. Gonads were small in all Mt. Karimui specimens.

DISCUSSION. *Microeca papuana* is widespread in montane forest of the Eastern Highlands up to about 8,500 ft. In the Okapa area *M. papuana* descended to 6,600 ft and *T. leucops* occurred up to 5,800 ft, while the corresponding altitudes for Mt. Karimui were 6,100 and 5,400 ft. Thus, there is a gap of 700-800 ft between the two species. The transition takes place 400-500 ft higher in the Okapa area than on Mt. Karimui, in agreement with the general trend for these areas. *M. papuana* ranges from the understory to about 60 ft above the ground in groups of three or four birds which may be in several different trees spread over a distance of 50 ft and which fly to a new perch at intervals of 5-15 sec. On four occasions two birds out of a group were collected. Three of these pairs proved to be a male and a female, while the fourth was a female plus a bird of uncertain sex, probably another female or an immature because of its short wing (69 mm).

VOICE. The song is a high, brief, tinkling, formless warble reminiscent of *Malurus alboscapulatus* and descending in pitch. The calls are a high-pitched "tsee"; a very faint, sibilant upslur; and five to eight repetitions of a dry, scolding note on the same pitch.

Tregellasia leucops wahgiensis Mayr and Gilliard

White-faced Flycatcher

NATIVE NAME. Gimi: sabarotoíya.

SPECIMENS EXAMINED. Miarosa: 1 imm. ♀ (13 June 1964). Okasa: 2 ♂, 2 ♀, 1 imm. ♂ (21 Aug. 1964; 22-26 June 1965). Karimui: 1 ♂ (15 July 1965). Mt. Karimui Zone 1: 2 ♂; Zone 2: 5 ♂, 2 ♀; Zone 3: 3 ♂, 2 ♀ (10-21 Aug. 1965).

WEIGHT. 10 ♂: 15.3-19.4 (17.4 ± 1.0). 7 ♀: 14.0-18.0 (15.4 ± 1.4). 2 imm. ♂: 15.3, 18.0.

WING. 10 ♂: 75-79 (77 ± 1), 5 ♀: 69 (2), 70, 71 (2). 2 imm. ♂: 73, 74.

TAXONOMY. The Okasa series compares well with a topotypical *wahgiensis* female from the Kubor Mountains and with *wahgiensis* from Mafulu and the Mambare River, in the white chin and yellow throat, the white forehead, and the color of the bill, which is pale straw-orange except for a black tip to the upper mandible. The Mt. Karimui specimens agree in these respects but have the crown blacker, less washed with olive. There is no size difference between the Okasa and Mt. Karimui series.

BREEDING. The gonads were greatly enlarged in all Mt. Karimui males, in the sole Karimui male, and in two males and one female from Okasa.

DISCUSSION. *Tregellasia leucops* is common and widely distributed in hill forest between about 3,000 and 5,500 ft. Its maximum abundance was reached in the Okasa forest (3,550-4,250 ft) and in Zone 2 of Mt. Karimui (4,400-4,750 ft), where it accounted for about 2% of the local avifauna. On Mt. Karimui it dropped out at 5,400 ft, and the sole Miarosa specimen (5,800 ft) was an immature. It was virtually absent at Karimui (3,650 ft) despite the favorable altitude but in line with the general tropical pattern there. The sole Karimui specimen was not the expected immature at the limit of the species' range but an adult male with large testes. The habits of this flycatcher were mentioned on p. 258.

VOICE. Whereas the four widespread New Guinea species of *Microeca* have weak but musical warbled songs, I heard no song or musical notes from *Tregellasia leucops* despite most of the males being in breeding condition. The call is a dry, nasal "chew" or a thin, nasal series of about nine scolding notes dropping somewhat in pitch toward the end of the series.

Monachella muelleriana muelleriana (Schlegel)

River Flycatcher

NATIVE NAME. Fore: níntere.

SPECIMENS EXAMINED. Okasa: 1 ♂, 1 ♀ (22 and 26 June 1965). Sena River: 1 ♂, 1 ? (26 July 1964). Soliabeda: 1 ♂, 1 ♀ (23 and 26 July 1965).

WEIGHT. 2 ♂: 24.0, 27.5. 2 ♀: 23.0 and 23.5.

WING. 2 ♂: 96, 98. 2 ♀: 94, 96.

BREEDING. Gonads were small in all specimens.

DISCUSSION. *Monachella muelleriana* is one of the two strictly riparian species of passerines in New Guinea, the other being *Grallina bruijnii*. Its habitat is streams which (a) are rushing, (b) have many protruding boulders, and (c) are sufficiently broad to have an air space free of vegetation over them. In practice, I encountered *Monachella muelleriana* on all Eastern Highlands streams I visited between 1,350 and 4,500 ft with beds at least 15 ft broad, but not on brooks completely covered by forest. It disappears from lowland rivers below the fall line, where the streams start to meander and the banks and bed are no longer strewn with boulders.

In this habitat *Monachella* is uncommon but widespread, perching motionless on boulders, fallen logs, and driftwood in the torrent or else on an overhanging branch, occasionally flicking its tail or sallying out after insects. It is a social species, usually seen in groups of three or four, sometimes up to eight, infrequently singly. After each member of the group has made a few sallies, the group flies a short distance along the river with a characteristic undulating flight, just a few feet above the water. In both its social habits and its pattern of alternating periods of sallying with periods of perching motionlessly, *Monachella muelleriana* resembles the species of the genus *Microeca.*

VOICE. A high-pitched, sweet, piping note "pink" given singly or rapidly repeated five to eight times.

Petroica bivittata bivittata De Vis

Forest Robin

STOMACH CONTENTS. Insects.

DISCUSSION. Five specimens of this uncommon high altitude robin have been taken in the Eastern Highlands: one collected by Bulmer at 11,500 ft on Mt. Hagen in bushes of the alpine grassland; and two at 11,000 ft in the Lamende Range, plus two more at 10,000-11,000 ft on Mt. Giluwe, obtained by Shaw-Mayer. I did not find it on Mt. Michael, nor did Gilliard on Mt. Wilhelm.

Niche Differences Among Thicket Flycatchers

For convenience the name thicket flycatcher may be applied to muscicapids of the genera *Poecilodryas, Peneothello, Heteromyias,* and *Pachycephalopsis,* which link *Petroica* to *Pachycephala.* Most thicket flycatchers have similar habits, size (20-40g), and body form; the generic lines among them are not entirely clear (Mayr, 1941a). Eight species have been found to date in the Eastern Highlands: *Poecilodryas hypoleuca, Poecilodryas placens, Poecilodryas albonotata, Peneothello sigillatus, Peneothello cyanus, Peneothello bimaculatus, Heteromyias albispecularis,* and *Pachycephalopsis poliosoma. Poecilodryas albonotata* lives in the middle- and upperstories, but the other species live mainly in the understory and are rarely seen more than 6 ft above the ground, so that mistnets have proved a boon to studying their distributions. At least six (*Poecilodryas hypoleuca, P. placens, P. albonotata, Peneothello sigillatus, P. cyanus, Heteromyias albispecularis*), and probably all, have the distinctive habit of perching sideways on the bark or stems of vertical saplings or tree trunks with the body held horizontal, a habit shared by some other related muscicapids of the genera *Tregellasia, Eopsaltria, Quoyornis,* and *Petroica.* Like flycatchers of genus *Petroica,* the thicket flycatchers move in a characteristic fashion: they remain perched motionlessly for long periods, sometimes holding apparently awkward postures and appearing tense and ready to pounce, then abruptly fly several yards further to a new perch. Flycatchers of genus *Pachycephala,* to which the thicket flycatchers show some resemblance and in which a few of the species were formerly placed, may also perch motionless for short times but have less abrupt transitions between motion and rest.

The three commonest species sort out on the basis of altitude, apparently with sharp transitions and no overlap: *Pachycephalopsis poliosoma* at low altitudes (ca. 3,000-5,000 ft), *Peneothello cyanus* at middle altitudes (ca. 5,000-8,000 ft), and *Peneothello sigillatus* at high altitudes (ca. 8,000-11,000 ft). The *Pachycephalopsis poliosoma-Peneothello cyanus* transition provides one of the few cases in New Guinea of strict altitudinal exclusion between two species which are not immediately derived from a common ancestor. *Poecilodryas hypoleuca* is widely distributed in the lowlands and could be considered a fourth, low-altitude equivalent of the triple sequence *Pachycephalopsis poliosoma-Peneothello cyanus-Peneothello sigillatus,* but its altitudinal ceiling is well below the lower limit of *Pachycephalopsis poliosoma.*

Poecilodryas albonotata shares most of the altitudinal range of *Peneothello cyanus* and the lower part of the range of *P. sigillatus,* but differs from both in its preference for the middle- and upperstories. *Heteromyias albispecularis* has an altitudinal range similar to that of *Peneothello cyanus* but is less common and spends more of its time actually on the ground. *Peneothello bimaculatus* is local in its distribution, is largely (but not entirely) confined to the southern watershed, and is found in hill forest in the lower part of the altitudinal range of the heavier and commoner *Pachycephalopsis poliosoma. Poecilodryas placens* has an extremely local distribution (only six localities in New Guinea) below the altitudinal ranges of the other species, except for *Poecilodryas hypoleuca.*

Poecilodryas hypoleuca hypoleuca (Gray)

Black and White Thicket Flycatcher

STOMACH CONTENTS. Insects.

DISCUSSION. This lowland species of the forest understory, second-growth, and thickets has been recorded in the Eastern Highlands only at Lake Kutubu (2,450 ft) and the Baiyer River (3,500 ft: N.G.B.S. Newsletter, No. 54, p. 2, June 1970).

VOICE. A loud, disyllabic slur "whi-chew," the first note staccato and at a higher pitch, the second note more explosive.

Poecilodryas placens (Ramsay)

Yellow Thicket Flycatcher

SPECIMENS EXAMINED. Karimui: 1 ♂, 1 imm. ? (10 Aug. 1964; 4 July 1965). Bomai: 2 ♀, 2 ? (6-9 July 1965). Soliabeda: 3 ♂, 1 ♀ (25-30 July 1965).

WEIGHT. 2 ♂: 26, 28. 3 ♀: 23, 24, 25. 1 ?: 28.

WING. 4 ♂: 90, 92, 93, 95. 3 ♀: 83, 84, 84. 2 ?: 84, 91. 1 imm. ?: 81.

TAXONOMY. The legs are orange or pale orange. The immature has brown on the upperwing coverts. Comparative measurements are summarized in Table 6, from which it appears that some minor geographical size variation exists.

TABLE 6
WING OF *Poecilodryas placens*

Locality	♂	♀
Batanta Island: 4♂, 3♀	92-98 mm (96)[1]	87-91 (89)
Weyland Mountains: 8♂, 2♀	90-100 (97)	86, 88 (87)
Lake Kutubu: 1♂[2]	96.5	
Karimui: 4♂, 3♀	90-95 (92.5)	83-84 (83.7)
Southeastern New Guinea: 4♂, 2♀	92-94 (93)	85, 85 (85)
Astrolabe Bay: 1♂, 1♀	95	92

[1] Average values are given in parentheses.
[2] From Schodde and Hitchcock (1968).

BREEDING. Gonads were greatly enlarged in all males and in one female.

DISCUSSION. Of the passerines with a wide geographical range on the lower hill slopes of New Guinea, few have a patchier distribution than *Poecilodryas placens.* It is known from six far-flung localities: the summit of Mt. Besar on the island of Batanta off the western tip of New Guinea, at 2,800-2,900 ft; the Menoo Valley in the Weyland Mountains of western New Guinea, at 1,000-3,300 ft; Keku on Astrolabe Bay in northeastern New Guinea; southeastern New Guinea (Kubuna, Brown River, Goldie River, Mt. Cameron, and mountains of the Kotoi District); Lake Kutubu (2,450 ft); and the Karimui area, at 2,000-3,650 ft. At some of these localities *P. placens* is apparently not uncommon, although quite unobtrusive. For example, it accounted for 0.9% of the local avifauna at Soliabeda; Stein took 18 specimens in the Weyland Mountains; and Gilliard collected eight on Batanta. It is highly improbable that these six localities uniquely possess some habitat feature required by *P. placens:* its habits are similar to those of several other thicket flycatchers which are numerous, widespread in their altitudinal ranges, and among the dominant lowerstory flycatchers. The only guess I can hazard is that *P. placens* may be too similar ecologically to the more successful *P. hypoleuca* to coexist with it and is in the process of becoming extinct. This is suggested by the fact that at four of the six localities where *P. placens* has been found, *P. hypoleuca* is missing (Batanta, Karimui, most of southeastern New Guinea) or else present but much rarer than *P. placens* (Menoo Valley).

In the Karimui area *P. placens* was found only in the most shaded parts of the forest, where the understory was relatively open. Here it remained strictly within 6 ft of the ground. Even more frequently than other thicket flycatchers it perched on the vertical stems of small trees, one leg an inch above the other, gripping the stem, holding the body horizontal and leaning outward on the extended legs, and giving an impression of intense concentration as it peered ahead. It held these uncomfortable-looking perches without moving for long times, but when it finally moved it did so abruptly and flew on to another stem a few yards away or occasionally alit on the ground. I saw only solitary individuals, though a male and a female were once collected together. Apparently the only other published field observations of *P. placens* are those of Stein (1936, p. 39).

VOICE. The call is a buzzy squawk, but the song is one of the loveliest in New Guinea. The pitch is moderately low, the volume subdued, and the quality mellow and flute-like. Notes begin with a clear and sharp attack, like a bell or like the pipes of a good Baroque organ. The pattern consists of one to three connected pairs of notes with a brief pause between each pair, delivered at a rate of about three pairs in 2 sec (Fig. 29). The first note of each pair is higher than the second by an interval that may be up to a major third, particularly for the second and third pairs of a song, while the pitch interval in the first pair is often so small as to give the impression of one longer note on the same pitch. Usually the lower members of all two or three pairs are on the same pitch, but in one case the third pair was entirely below the pitch of the second pair. Once I heard a song consisting of five single notes on progressively lower pitches but with the usual quality.

Poecilodryas albonotata griseiventris (Rothschild and Hartert)

Black-throated Thicket Flycatcher

SPECIMENS EXAMINED. Awande: 1 ♂ (a) (26 June 1964). Mt. Michael: 1 ♂ (b) (5 July 1964). Mt. Karimui Zone 5: 3 ♂, 2 ♀; Zone 8: 1 ♀ (28 Aug.-4 Sept. 1965).

WEIGHT. 3 ♂: 38.3, 40.7, 43.0. 3 ♀: 34.7, 36.3, 39.7.

WING. 5 ♂: 98 (a), 101 (b), 106, 110, 112. 3 ♀: 102, 104, 109.

STOMACH CONTENTS. Insects.

TAXONOMY. The race *correcta* of southeastern New Guinea and the Huon Peninsula differs from this series in being paler above, having the white of the underparts more extensive and buffy, and the black of the throat paler. The Awande specimen, from my farthest east station, approaches *correcta* in having the greatest extent of white on the underparts of my series, more than any *griseiventris* specimen available for comparison and more than some *correcta*. However, it lacks the buffy tinged underparts and paler upperparts of *correcta*. The Mt. Michael and Mt. Karimui specimens agree in color with *griseiventris* except in having the throat blacker and less brown, possibly because of foxing in the older material. *P. a. correcta* averages slightly smaller than *griseiventris* from western New Guinea, but the Awande and Mt. Michael males (listed as "a" and "b" above) plus one male taken at Nondugl by Gyldenstolpe (1955, p. 107: wing given as 97 mm) are smaller than the Mt. Karimui birds or any other specimen of *griseiventris* and smaller than most *correcta*.

BREEDING. Gonads were small in all specimens.

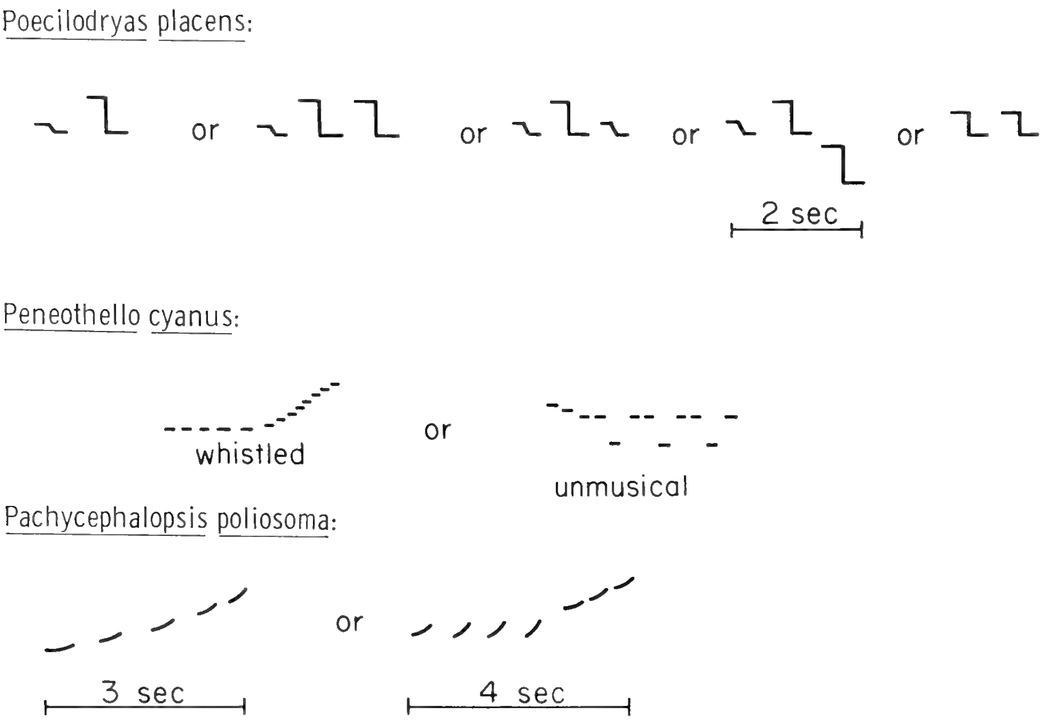


FIG. 29. Voices of three species of thicket flycatchers.

DISCUSSION. *Poecilodryas albonotata* is widely distributed but uncommon in forest at 6,000-9,000 ft. It perches upright and motionless at 20-70 ft above the ground, sometimes in the understory, holding the perch for 10-60 sec before flying with a loud fluttering of wings to the next perch 20 ft or more away. Occasionally it slowly raises and lowers its tail. Its insect food is either captured in midair or plucked off the vegetation.

VOICE. The song is at the highest pitch of any New Guinea bird song: two to four identical, thin, drawn-out downslurs, repeated at ½ sec intervals (Fig. 29).

Peneothello sigillatus sigillatus (De Vis) and *P. s. hagenensis* Mayr and Gilliard

White-winged Thicket Flycatcher

SPECIMENS EXAMINED. Mt. Michael: 1 ♂, 1 ♀, 1 imm. ? (8-11 July 1964). Mt. Karimui Zone 7: 1 ♂, 1 ♀, 1 ? (4-7 Sept. 1965).
WEIGHT. 1 ♂, 24.0. 1 ♀: 21.3. 1 ?: 21.5
WING. 2 ♂: 90, 95. 2 ♀: 87, 88. 1 ?: 93. 1 imm. ?: 87.
TAIL. 1 ♂: 62. 1 ♀: 62. 1 imm. ?: 61.
STOMACH CONTENTS. Insects.

TAXONOMY. The race *quadrimaculatus* of western New Guinea differs in having white patches on the sides of the breast; *hagenensis* from Mt. Hagen differs in that the white patch in the secondaries is much more extensive and in that the innermost secondary lacks a black tip. The Mt. Michael and Mt. Karimui series show no differences in the wing patch, with white being confined to three secondaries, which have extensive black tips. The wing patch is of the same size in nominate *sigillatus* from southeastern New Guinea, Mts. Wilhelm and Kubor, and the Schrader Range, but the one available specimen of *saruwagedi* from the Huon Peninsula has somewhat more extensive black tips. Measurements of wing length gave: *saruwagedi,* 1 ♀ 88; *P. s. sigillatus,* Mts. Wilhelm and Kubor, 4 ♂, 92, 93, 94 and 96, 5 ♀, 89, 92, 94, 95, and 96 mm. Smaller size was cited as a characteristic of *saruwagedi* compared to *sigillatus* in the original diagnosis (Mayr, 1931, p. 680), but use of this as a racial characteristic is complicated by an increase of size with altitude at the same location (Mayr and Rand, 1937, p. 139; Rand, 1942b, p. 485). My series may, therefore, be assigned to *sigillatus* and is quite distinct from *hagenensis.* It is surprising that these two subspecies occur 30 miles apart (the distance between Mt. Hagen and Mt. Kubor), since most other high altitude species are represented by the same subspecies on different peaks of the Eastern Highlands.

The immature has the uppertail largely black, the upperparts largely black but mixed with increasing numbers of rufous feathers towards the head, and the underparts mottled rufous and dark gray, with rufous predominating.

DISCUSSION. *Peneothello sigillatus* is the thicket flycatcher of the moss forest and seems to be the high-altitude equivalent of *P. cyanus.* On Mt. Michael, where moss forest begins at 8,700 ft, *P. cyanus* went up at least to 8,100 ft, and *P. sigillatus* extended from 11,000 ft, near timberline, down to at least 9,500 ft. On Mt. Karimui, where moss forest descends to 6,500 ft, the transition between *P. cyanus* and *P. sigillatus* took place around 7,000-7,300 ft. *P. sigillatus* usually remains within a few yards of the ground or on the ground itself, changes perches at intervals of 5-20 sec, and often perches sideways on saplings. Once I saw it in a tree fern in alpine grassland 40 ft from the forest edge.

Peneothello cyanus subcyaneus (De Vis)

Slaty Thicket Flycatcher

NATIVE NAMES. Fore: ápari. Gimi: lólori. Daribi: karoábo.

SPECIMENS EXAMINED. Awande: 3 ♂, 1 ♀, 1 imm. ♂ (19-27 June 1964; 15-19 June 1965). Mt. Karimui Zone 3: 1 ♂; Zone 4: 2 ♂, 3 ♀; Zone 5: 4 ♂, 2 ♀; Zone 6: 2 ♂, 2 ♀ (17 Aug.-7 Sept. 1965).

WEIGHT. 10 ♂: 24.0-30.0 (26.9 ± 1.5). 10 ♀: 20.7-26.0 (23.2 ± 1.7). 1 imm. ♂: 29.0.

WING. 10 ♂: 93-99 (95.5 ± 1.8). 10 ♀: 80-90 (86.2 ± 2.4). 1 imm. ♂: 95.

STOMACH CONTENTS. Insects.

TAXONOMY. The color of the crown is close to that of southeastern New Guinea birds, and paler than in specimens from Telefolmin, the Cyclops Mountains, or the Snow Mountains. Mt. Karimui specimens are darker in general coloration than those from Awande. These and other Eastern Highlands series of *P. cyanus* are slightly larger than *subcyaneus* from southeastern New Guinea. There is no size difference between Awande and Mt. Karimui birds, nor is there a change of size with altitude on Mt. Karimui.

BREEDING. Gonads were enlarged, usually greatly, in almost all Mt. Karimui adult males and in two of the three adult males taken at Awande in 1965. No immature birds were taken on Mt. Karimui.

DISCUSSION. *Peneothello cyanus* is the thicket flycatcher of forest from about 5,000 ft up to the level at which heavy mossing appears. Its abundance shows puzzling variability. On Mt. Karimui (west peak), where it occurred from 5,200 to about 7,000 ft, it was the commonest flycatcher and the fourth most abundant bird in this zone, accounting for about 6% of the local avifauna. At some other localities it is uncommon or even absent.

Its behavior is similar to that of *Poecilodryas placens,* i.e., it generally remains within 5 ft of the ground (though I have also seen it as much as 15 ft up) and remains motionless at a perch, appearing to peer intently, before abruptly flying on to another perch.

VOICE. The song is similar to that of *Myiagra alecto:* a series of a dozen clear, musical, whistled notes at medium pitch, the first few of which are on the same pitch, but they then progressively rise in pitch and accelerate (Fig. 29, left, p. 266). The volume remains unchanged or else progressively increases only slightly. A less common song with a very different quality is a loud, unmusical, three-note phrase repeated several times and preceded by one or two other notes (Fig. 29, right).

Peneothello bimaculatus bimaculatus (Salvadori)

White-rumped Thicket Flycatcher

SPECIMENS EXAMINED. Karimui: 5 ♂, 4 ?, 1 imm. ♂, 1 imm. ? (9-12 Aug. 1964; 1 July-6 Aug. 1965). Bomai. 3 ♂, 2 ♀ (6-8 July 1965).

WEIGHT. 7 ♂: 25 (2), 26 (2), 27 (2), 28. 2 ♀: 21, 22. 1 imm. ♂: 24.

WING. 7 ♂: 84, 86, 87 (3), 88, 89. 2 ♀: 77, 79. 1 imm. ♂: 86. 1 imm. ?: 84.

TAXONOMY. Material available for comparison consisted of *vicarius* from the Huon Peninsula, Adelbert Mountains, and the northern slopes of southeastern New Guinea, and nominate *bimaculatus* from the Vogelkop, the Weyland Mountains, the southern slopes of the Snow Mountains, and the southern slope of southeastern New Guinea. The race *vicarius* is distinguished by having almost no white on the belly. Snow Mountains birds assigned to *bimaculatus* have the next least amount of white on the belly. The other series of *bimacu-*

latus (including mine) show individual variation in the amount of white but no average differences between series. The extent of white in the breast patch also shows individual variation but not average variation between series. The depth of blackness of most of the body plumage varies; this color has a brownish tinge in all comparative material and in my females and immatures, but my males stand out at once as being fully black. Foxing may be part or most of the explanation in this case, since one male collected by Gilliard in the Tamrau Mountains of the Vogelkop in 1964 is as black as my males and blacker than prewar Vogelkop males. The two immatures have brown tips to the upperwing coverts. Table 7 shows that there is little size variation, except that Snow Mountains birds are distinctly smaller. The Snow Mountains population may eventually require naming on the basis of small size and reduced extent of white on the belly, but a larger series is required to confirm these differences.

TABLE 7
WING OF *Peneothello bimaculatus bimaculatus*

Locality	♂	♀
Vogelkop	85, 85, 86, 91, 91, 92 (av., 88)	79, 80, 81, 84, 85 (av., 82)
Weyland Mountains	89	
Snow Mountains	78, 80, 80, 85 (av., 81)	
Karimui	84, 86, 87, 87, 87, 88, 89 (av., 87)	77, 79
South slopes of southeastern New Guinea	84, 84, 85, 85, 86, 88, 89, 90 (av., 86)	81, 81

BREEDING. Of the eight adult males, the testes were somewhat or much enlarged in five, small in three.

DISCUSSION. *Peneothello bimaculatus* resembles *Poecilodryas placens* in being an "unsuccessful" thicket flycatcher with a patchy distribution, though it is not so extreme a case. It has turned up at about 15 scattered localities in southern New Guinea extending around to the Adelbert Mountains in the northeast and the Weyland Mountains in the northwest, but it is apparently absent in most of northern New Guinea (i.e., no records from the northern slopes of the Central Range, the Cyclops Mountains, or the North Coastal Range). In the Eastern Highlands I met *P. bimaculatus* only at Karimui and Bomai. When seen, it was perched a few feet above the ground in underbrush in forest or at the edge of forest, sitting motionless except for occasionally flicking its wings.

Heteromyias albispecularis centralis Rand

Ground Thicket Flycatcher

NATIVE NAME. Fore: yobágo.
SPECIMENS EXAMINED. Awande: 2 ♂, 1 ♀ (15-18 June 1965). Miarosa: 1 ♂, 2 ? (17-24 June 1964). Mt. Michael: 2 ? (4 July 1964).
WEIGHT. 2 ♂: 32, 36. 1 ♀: 31.
WING. 3 ♂: 96, 100, 101. 1 ♀: 91. 1 ?: 103.
STOMACH CONTENTS. Insects.

TAXONOMY. My specimens differ from examples of *centralis* from the Wahgi region only in having the breast whiter, less gray. Despite their intermediate geographical position they show no approach to the brownish black crown of *armiti* of the Herzog Mountains and southeastern New Guinea (the crown is black instead), but the Awande and Miarosa specimens do approach slightly the brighter and more olive back of *armiti*.

BREEDING. Gonads were large in the female and one male from Awande, small in the other Awande male.

DISCUSSION. *Heteromyias albispecularis* is present, though uncommon, at most forest localities in the Eastern Highlands between 5,500 and 8,500 ft, but was absent on Mt. Karimui. It frequently perches on the ground.

VOICE. A ringing, bell-like note repeated 4-8 times per second for up to 15 sec without change of pitch or volume. A fragment of this song two to five notes long is often given as a call. The call of *Climacteris leucophaea,* a midmontane species which is absent from the Eastern Highlands, is quite similar but crescendoes slightly. Another song of *H. albispecularis* consists of three or four clear, high-pitched, whistled notes going up the scale and is the origin of the Fore name "yo-ba-go".

Pachycephalopsis poliosoma albigularis Rothschild

White-throated Thicket Flycatcher

NATIVE NAMES. Gimi: soy. Daribi: karoábo.
SPECIMENS EXAMINED. Okasa: 2 ♂, 1 ♀ (20 Aug. 1964; 22 and 26 June 1965). Sena River: 1 ♂, 1 ♀ (26 and 29 July 1964). Karimui: 2 ♂, 2 ♀ (7 Aug. 1964; 11 July and 6 Aug. 1965). Mt. Karimui Zone 1: 4 ♂, 5 ♀; Zone 2: 1 ♂, 2 ♀; Zone 3: 1 ♂, 2 ♀ (9-19 Aug. 1965).
WEIGHT. 10 ♂: 35-42 (40.5 $\pm$ 2.6). 10 ♀: 32-40 (35.6 $\pm$ 2.7).
WING. 10 ♂: 100-110 (105 $\pm$ 3). 10 ♀: 93-103 (98 $\pm$ 2).

TAXONOMY. The Eastern Highlands series was compared with *albigularis* (type and two other topotypical specimens from the Weyland Mountains, plus two from Telefolmin), *approximans* (southern slope of the Snow Mountains, four specimens), *balim* (the type from the northern slope of the Snow Mountains at higher altitudes), *idenburgi* (northern slope of the Snow Mountains, lower altitudes, four specimens), *hypopolia* (Huon Peninsula, one specimen), and nominate *poliosoma* (southeastern New Guinea and Herzog Mountains, many specimens). Eastern Highlands birds are close to topotypical *albigularis,* particularly in the dorsal coloration, and differ mainly in the bluer, less gray underparts and the darker uppertails, in both of which deviations they resemble Teleformin birds. It was initially surprising when Telefolmin birds, separated from the Weyland Mountains by 300 miles and the populations of *idenburgi* and *balim,* had to be assigned to *albigularis* (Gilliard and LeCroy, 1961, p. 59). It is even more surprising that birds from the southern slope of the Eastern Highlands, 500 miles to the east of the Weyland Mountains and on the opposite watershed, are also *albigularis.* Of the two other southern watershed races, *approximans* differs in the more gray-brown and less blue upperparts, the grayer and less blue underparts, and the much lighter and browner uppertail, while nominate *poliosoma* is duller, more gray-brown and less blue above (especially on the crown), lighter on the exposed parts of the upperwing and tail, more gray-brown and less blue below (especially on the breast), and has the white of the throat more restricted in extent and more washed with gray-brown posteriorly. Compared to Mt. Karimui specimens, Okasa specimens show a slight tendency towards nominate *poliosoma* in the buffier and less extensive throat patch, but they are still much nearer *albigularis.* The race *balim* differs in having the back, crown, and breast more gray-brown and the undertail coverts buffy, not gray; *idenburgi* is smaller, grayer below, has the extent of white on the throat more reduced, and the margins of the remiges browner; and *hypopolia* is smaller, paler, and grayer on the back and crown, more gray-brown below, and the extent of white on the throat is more restricted. No specimens of the race *hunsteini* (mountains on the upper Sepik River) were available, but from the description it must differ in the reduced extent of white on the throat and in other respects.

BREEDING. Gonads were small in Okasa specimens except one male, which had greatly enlarged testes. At Karimui gonads were greatly enlarged in males and in one female. On Mt. Karimui testes were moderately enlarged in one male, slightly in two, not at all in three; and ovaries were enlarged in only two females.

DISCUSSION. *P. poliosoma* is the common thicket flycatcher of the hill forest (3,000-5,000 ft). However, it is so shy and hard to see that it may be overlooked completely unless one learns its song or sets up mistnets. Song censuses and netting returns show that it reached its maximum density in Zone 1 of Mt. Karimui (4,000-4,200 ft), where it was the most abundant bird and accounted for 12% of the local avifauna. Between 5,100 and 5,200 ft in Zone 3 of Mt. Karimui it was abruptly replaced by *Peneothello cyanus,* altitudinal exclusion between the two species being strict. (In the Daribi language spoken at Karimui *Peneothello cyanus* and *Pachycephalopsis poliosoma* go by the same name, "karoábo"). At Karimui, on the floor of the Karimui Basin, *Pachycephalopsis poliosoma* was much less common (0.7% of the local avifauna), and the lowest record of it was at 3,230 ft en route to Soliabeda. When seen, it was always solitary, in the forest interior, and perched stationary for relatively long times within a few feet of the forest floor.

VOICE. The call is a single whistled note, often slightly upslurred, rather loud, and with considerable carrying power and a clear, piercing quality, like the sound produced by blowing across the open end of an expended shotgun cartridge. The song (Fig. 29, p. 266) consists of four to seven, usually four or five, notes with a very buzzy quality. Each note is upwards inflected and about half a tone higher than the previous note. The time intervals are slightly less than 1 sec between the first few notes and distinctly shorter between the last two or the last three notes. Both the song and the call are heard often, and particularly the song is easily recognized.

PACHYCEPHALINAE: WHISTLERS

Pachycare flavogrisea subaurantia Rothschild and Hartert and *P. f. subpallida* Hartert

Dwarf Whistler

NATIVE NAMES. Fore: yágigusaréa. Gimi: labiliyágo. Daribi: bobidaú.

SPECIMENS EXAMINED. Okasa: 5 ♂, 2♀ (23 Aug. 1964; 22-26 June 1965). Karimui: 2 ♂, 4 ♀ (13 Aug. 1964; 15 July-6 Aug. 1965). Mt. Karimui Zone 1: 1 ♂; Zone 2: 3 ♂, 1 ♀; Zone 3: 2 ♂ (10-17 Aug. 1965).

WEIGHT. 10 ♂: 14.0-19.0 (16.6 ± 1.3). 7 ♀: 12.5-18.3 (15.7 ± 2.5).

WING. 10 ♂: 62-68 (65 ± 2). 4 ♀: 62, 63, 63, 64.

TAXONOMY. *Pachycare flavogrisea* shows considerable geographical variation in the depth of its yellow ventral color. The race *randi* of the northern slope of the Snow Mountains has the deepest and most orange color, followed by *subaurantia* of Telefolmin and the southern slope of the Snow Mountains, followed by nominate *flavogrisea* of the Vogelkop, followed by *subpallida* of southeastern New Guinea, the palest and most yellow race. Where *subaurantia* grades into *subpallida* in the Sepik Mountains, birds resembling nominate *flavogrisea* are found. Unfortunately, the color fades markedly within the first ten years postmortem, so that subspecific assignment of fresh specimens involves an educated guess as to what their appearance will be in ten years. For instance, Weyland Mountains birds collected by Stein in 1931 "agreed completely" with topotypical *subaurantia* in 1935 (Hartert, Paludan, Rothschild, and Stresemann, 1936, p. 202) but "agreed perfectly" with topotypical *P. f. flavogrisea* when reexamined in 1940 (Rand, 1942b, p. 487). When I examined my specimens (collected in 1964 and 1965) in March of 1966, I found that the Karimui series was approximately as orange as *subaurantia* from Telefolmin (collected in 1954, so that fading was probably completed) and was considerably more orange than the Okasa series which agreed with nominate *flavogrisea*. In February 1967 I reexamined the specimens and found that Karimui birds were still *subaurantia* but that Okasa birds were intermediate between *flavogrisea* and *subpallida*. It seems a safe guess that the Okasa series will finally fade into *subpallida*. I am provisionally listing the Karimui birds as *subaurantia*, but it remains to be seen whether they will reach the level of *flavogrisea* by the time they finish fading. In any case, the general increase in orange color from east to west (exclusive of the Vogelkop) is reflected in the difference between Okasa and Karimui, 100 miles west of Okasa.

BREEDING. Gonads were small in all Okasa specimens except one male; large in both Karimui males; and small on Mt. Karimui except for being quite large in one male and slightly enlarged in another.

DISCUSSION. *Pachycare flavogrisea* is a characteristic, vocal, and common species of hill forest from about 2,800 to 5,400 ft, reaching its maximum abundance in Zones 1, 2, and 3 of Mt. Karimui (4,000-5,400 ft, 6% of the local avifauna). There seems to be no tendency to stray above its local altitudinal ceiling, although the level of the ceiling shows minor local differences. While *P. flavogrisea* is sometimes found in low trees in open second-growth if there is forest nearby, it is commonest in forest. It can be seen at almost any height in the vegetational column from a few feet above the ground to the crowns of trees but is found most often in the middlestory. It is usually solitary, fairly active, and much more often heard than seen.

VOICE. The loud, melodious, whistled, and explosive calls and songs are among the characteristic sounds of hill forest and support the suspected relationship of *Pachycare* with *Pachycephala* and *Colluricincla*. These calls involve two kinds of notes: an upslurred "wheep!" and a nonslurred "chew!" The patterns permute a rapid series of 2-4 "wheep's" on the same pitch with rapid series of 2-4 "chew's" on some other pitch, usually several notes lower. Each series of "wheep's" or "chew's" progressively increases in volume. One of the commonest patterns is: "wheep-wheep! chew-chew-chew! wheep-wheep! chew-chew-chew! wheep-wheep! chew-chew-chew!" Figure 30 (p. 278) gives other patterns. The rapid tempo and the repeated crescendoes are distinctive, but confusion with the even louder and more explosive call of *Eupetes castanonotus* is possible.

Niche Differences in the Genera *Pachycephala*, *Colluricincla*, and *Pitohui*

The species of these three closely related genera may conveniently be discussed together as regards niche differences.

Nine species of *Pachycephala* have been found in the Eastern Highlands. Five of these are ecologically similar, similar-sized (weight ca. 20-25 g), rather common, forest-dwelling, insectivorous species which form a broadly overlapping altitudinal sequence: *P. griseiceps* (0-4,500 ft), *P. hyperythra* (1,500-4,200 ft), *P. soror* (3,500-6,000 ft), *P. schlegelii* (5,000-10,000 ft), and *P. modesta* (6,000-11,000 ft). As discussed on p. 00, each species partly overlaps the altitudinal range of the species above and below it, and the altitudinal overlap is apparently made possible by differences in preferred vertical foraging level within the vegetational column. *P. leucostigma,* an uncommon forest species, has an altitudinal range that brings it into contact with all eight other *Pachycephala* species, and is similar in size to the preceding five, but differs in that it takes considerably more fruit than insects, while the other species take mainly insects and rarely fruit. *P. rufinucha* lives in the forest and overlaps the altitudinal ranges of six of its congeners (all those found in the Eastern Highlands except *P. griseiceps* and *P. hyperythra*), but differs in that it is 70% heavier (weight ca. 40 g), has a more powerful bill and legs, lives mainly on the forest floor, and takes larger prey than its congeners as well as fruit. *P. tenebrosa,* a large (weight ca. 45 g) midmontane bird of the forest floor, is rare and known in the Eastern Highlands from only one locality. *P. rufiventris* overlaps all its congeners altitudinally but lives in very open groves, e.g., gardens or casuarinas, a habitat shared by no other member of the genus in New Guinea.

Colluricincla megarhyncha is common, similar in proportions to the first five *Pachycephala* species discussed, overlaps most of them altitudinally (ca. 0-6,000 ft), and forages for insects in the lower- and middle-stories of the forest and second-growth, but is larger (weight ca. 35-40 g) and more sluggish. *C. harmonica* is twice as large as *C. megarhyncha,* comparable in size to the species of *Pitohui,* and lives in open groves, a habitat in which the only other whistler is the much smaller *Pachycephala rufiventris.*

The species of the endemic New Guinea genus *Pitohui* are about twice as large (70-100 g) as *Colluricincla megarhyncha* and take both insects and fruit. All five widespread members of this genus have been found in the Eastern Highlands. One member sorts out on the basis of altitude: *P. nigrescens* is found only above 5,500 ft, where its congeners are all absent. All four of the other species were able to coexist at Karimui (3,650 ft). *P. cristatus* is a rare species of hill forest apparently living mainly on the ground, whereas the other four species seem similar to each other in their habits and occupy both the understory and middlestory. *P. kirhocephalus, P. dichrous,* and *P. nigrescens* apparently form a three-species altitudinal sequence with much overlap between the first two and a sharp transition between the second two. The altitudinal ranges of *P. ferrugineus* and *P. kirhocephalus* coincided in the Karimui area, though *P. ferrugineus* has a slightly lower ceiling elsewhere in New Guinea, and the ecological differences between these two species are not clear to me. The species *"Pitohui" tenebrosus* of Palau in the Caroline Islands, initially described in the genus *Rectes* (= *Pitohui*), subsequently placed in a monotypic genus *Malacolestes*, sometimes placed in *Colluricincla*, and transferred back to *Pitohui* by Mayr (1967) in Peters' *Check-list*, Vol. 12, appears to me to belong to *Colluricincla* and not to *Pitohui*.

Pachycephala leucostigma obscura (Rand)[1]

Mottled Whistler

SPECIMENS EXAMINED. Awande: 1 ♂ (28 June 1964). Okasa: 2 ♀, 1 ?, 1 imm. ♂ (22-26 June 1965). Mt. Michael: 1 imm. ♂ (5 July 1964). Mengino: 1 ♂ (16 July 1964). Karimui: 1 ♀ (17 July 1965). Mt. Karimui Zone 2: 1 ♀; Zone 5: 1 ♂, 1 imm. ♂; Zone 6: 1 ♂, 1 ♀ (13 Aug.-4 Sept. 1965).

WEIGHT. 2 ♂: 25.0, 28.3. 5 ♀: 23.0, 24.5, 28.0, 29.0, 29.5. 2 imm. ♂: 25.0, 28.0. 1 ? (♀ or imm.), 24.0.

WING. 4 ♂: 85, 88, 89, 90. 5 ♀: 84, 84, 85, 87, 87. 3 imm. ♂: 85, 85, 86. 1 ?: 83.

STOMACH CONTENTS. Fruit only, ranging in diameter from 1 to 9 mm (3 ♂, 3 ♀); fruit and insects (3 ♂); insects only (1 ♂).

TAXONOMY. In the western races *nova* and nominate *leucostigma* the adult male has a mottled pattern approaching that of the female. Compared to five adult males of *obscura* (one from Mt. Goliath and four from southeastern New Guinea), my males are darker above and darker and more olive below. The Mt. Goliath male is the next darkest and also has obscure barring on the underparts, which is present but less marked in my specimens and virtually absent in southeastern New Guinea males. The iris was olive in the one adult male whose eye color I noted, brown in the females and immature males.

BREEDING. Testes were greatly enlarged in the Mengino adult and slightly enlarged in the Mt. Karimui Zone 5 adult and the Okasa immature. In all other specimens gonads were small.

DISCUSSION. The series clearly illustrates a tendency towards altitudinal specialization according to age and sex. All four adult males were taken above 6,000 ft (at 6,500 and 6,770 ft on Mt. Karimui, and at 6,100 ft at Mengino and near Awande). At Okasa (3,550-4,250 ft), Karimui (3,650 ft), and Mt. Karimui Zone 2 (4,700 ft) only females and immature males were taken. The highest specimen was the immature male from 8,000 ft on Mt. Michael. Gilliard obtained one specimen on Mt. Hagen and another at 8,300 ft in the Schrader Range.

I have no field observations of this whistler, whose stomach contents consist of both fruit and insects but mainly fruit. The statement by Rand and Gilliard (1967, p. 422) and by Stein (1936, p. 36) that its

1 Listed as *Rhagologus leucostigma* in Rand and Gilliard (1967).

diet is exclusively fruit is incorrect, as already noted by Gilliard and LeCroy (1968, p. 21). Presumably its diet is what enables it to coexist at the same altitudes and in the same habitats as six other whistlers (*P. soror, P. schlegelii, P. griseiceps, P. hyperythra, P. modesta,* and *P. rufinucha*), which take fruit infrequently. All of my specimens were obtained in forest, and 11 of the 13 were netted, suggesting lowerstory habits.

P. leucostigma was originally described in the genus *Pachycephala*, and its close affinity to the other species of this genus has never been questioned. Although it has a distinctive color pattern and diet, I see no reason to conceal its relationships by recognizing the monotypic genus *Rhagologus* for it. Even my Fore assistants referred to *P. leucostigma* simply as "pítna", the Fore name for all species of genus *Pachycephala* (but not of the genera *Colluricincla* or *Pitohui*).

Pachycephala soror klossi Ogilvie-Grant

Sclater's Whistler

NATIVE NAMES. Fore: pítna. Gimi. óbuhai.

SPECIMENS EXAMINED. Awande: 2 ♂, 2 ♀ (28 June 1964; 15 June 1965). Okasa: 1 ♂, 1 ♀ (22 Aug. 1964; 22 June 1965). Mt. Michael: 1 ♂, 1 ♀ (5 and 13 July 1964). Karimui: 1 ?, 1 imm. ♂, 2 imm. ? (13 Aug. 1964; 1 July-3 Aug. 1965). Mt. Karimui Zone 1: 2 ♂; Zone 2: 3 ♂; Zone 3: 1 ♂, 1 ♀; Zone 4: 2 ♂, 1 ♀ (11 Aug.-1 Sept. 1965).

WEIGHT. 10 ♂: 22.5-27.2 (24.8 ± 1.3). 8 ♀: 23.0-27.0 (24.9 ± 1.5). 2 imm. ♂: 23.5, 25.5. 2 imm. ?: 20.5, 22.0.

WING. 10 ♂: 88-93 (90 ± 2). 7 ♀: 86-89 (88 ± 1). 1 imm. ♂: 89. 1 imm. ?: 85.

TAXONOMY. Adult males have the tail blackish (as in the western race *klossi*) rather than strongly washed with olive (as in *bartoni* of southeastern New Guinea and the Herzog Mountains). The more eastward-lying Awande and Okasa birds are indistinguishable from Karimui birds in this respect and thus show no approach to *bartoni*. Immatures have brown on the head and wings.

BREEDING. At Awande in 1965 most specimens had the gonads much enlarged, and one female contained a nearly full-sized egg. On Mt. Karimui one adult male had the testes somewhat enlarged, another slightly, and the others not at all.

DISCUSSION. *P. soror* has a lower altitudinal limit around 3,500 ft and a ceiling at an altitude varying locally between 5,800 ft (Mt. Karimui) and 8,000 ft (Mt. Michael). It shares the lower part of its range with *P. hyperythra,* the upper part with *P. schlegelii* and *P. modesta*. It is similar in habits to these other species except that it spends less time in the understory than *P. schlegelii* and more time in the understory than *P. hyperythra* or *P. modesta*. Three of the four specimens at Karimui (3,650 ft), the lower limit of its altitudinal range in this area, were immatures, in agreement with the usual pattern of immature birds setting the lower limit of a species. Within its altitudinal range *P. soror* is fairly common (1-2% of the local avifauna).

VOICE. I never identified the song with certainty. However, between 4,750 and 5,680 ft on Mt. Karimui, a zone in which *P. soror, P. schlegelii,* and *P. rufinucha* were the only species of *Pachycephala,* I frequently heard a distinctive song which could only have been a *Pachycephala* and which was attributed by the Fore to a *pítna,* their name for all species of *Pachycephala.* Since the song of *P. schlegelii* is distinctly different and I am familiar with it, and since *P. rufinucha* was considerably less common, I tentatively assume that this unidentified song was *P. soror* and describe it here. The commonest pattern (Fig. 30) consists of a fairly rapid series (ca. three notes per second) of 8-10 very clear, whistled, high-pitched notes, all on the same pitch and progressively increasing in volume, and usually concluding in a loud slur, either upslurred or downslurred, which is occasionally omitted. Variants are that the individual notes in the series of 8-10 notes may all be explosively upslurred, or else explosively downslurred, or else disyllabic. The crescendo and the bell-like clarity of the whole song are distinctive.

Pachycephala schlegelii obscurior Hartert

Schlegel's Whistler

NATIVE NAMES. Fore: pítna. Gimi: óbuhai.

SPECIMENS EXAMINED. Awande: 1 ♂ (17 July 1965). Mt. Michael: 1 ♂ (2 July 1964). Mt. Karimui Zone 2: 1 imm. ♂, 1 imm. ?; Zone 3: 1 ♂, 1 ♀, 1 ? (♀ or imm.); Zone 4: 1 ♂, 4 ♀; Zone 5: 5 ♂, 3 ♀, 1 imm. ♂; Zone 6: 4 ♂, 1 ♀, 1 imm. ♂; Zone 7: 1 ♂; Zone 8: 3 ♂, 2 ♀, 1 imm. ♂ (13 Aug.-10 Sept. 1965).

WEIGHT. 10 ♂: 20.5-24.5 (22.4 ± 1.2). 10 ♀: 19.4-24.8 (22.4 ± 1.4). 1 ?: 23.3. 4 imm. ♂: 20.5, 21.0, 23.0, 24.7. 1 imm. ?: 22.3.

WING. 10 ♂: 81-89 (86 ± 2). 10 ♀: 81-86 (84 ± 1). 1 ?: 85. 5 imm. ♂: 84, 84, 85, 86, 87. 1 imm. ♀: 86. 2 imm. ?: 83, 85.

STOMACH CONTENTS. Most stomachs contained only insects; one adult female, only seeds; two juveniles, seeds and insects.

TAXONOMY. Analysis of wing length shows no change with altitude between 4,400 and 8,165 ft, although birds from 9,000 ft upward have been shown to be larger (Mayr and Rand, 1937, p. 173; Rand, 1942b, p. 488).

The subspecific color differences cited by Hartert in defining the races *obscurior, viridipectus,* and *cyclopum* are very slight. In adult males the abdomen is somewhat more ochraceous in *obscurior* of southeastern New Guinea than in other races. My males are intermediate but nearer *obscurior.*

BREEDING. Testes were greatly enlarged in the one male from Awande and in seven from Mt. Karimui; and moderately enlarged in six, slightly in four, and not at all in five adult males from Mt. Karimui.

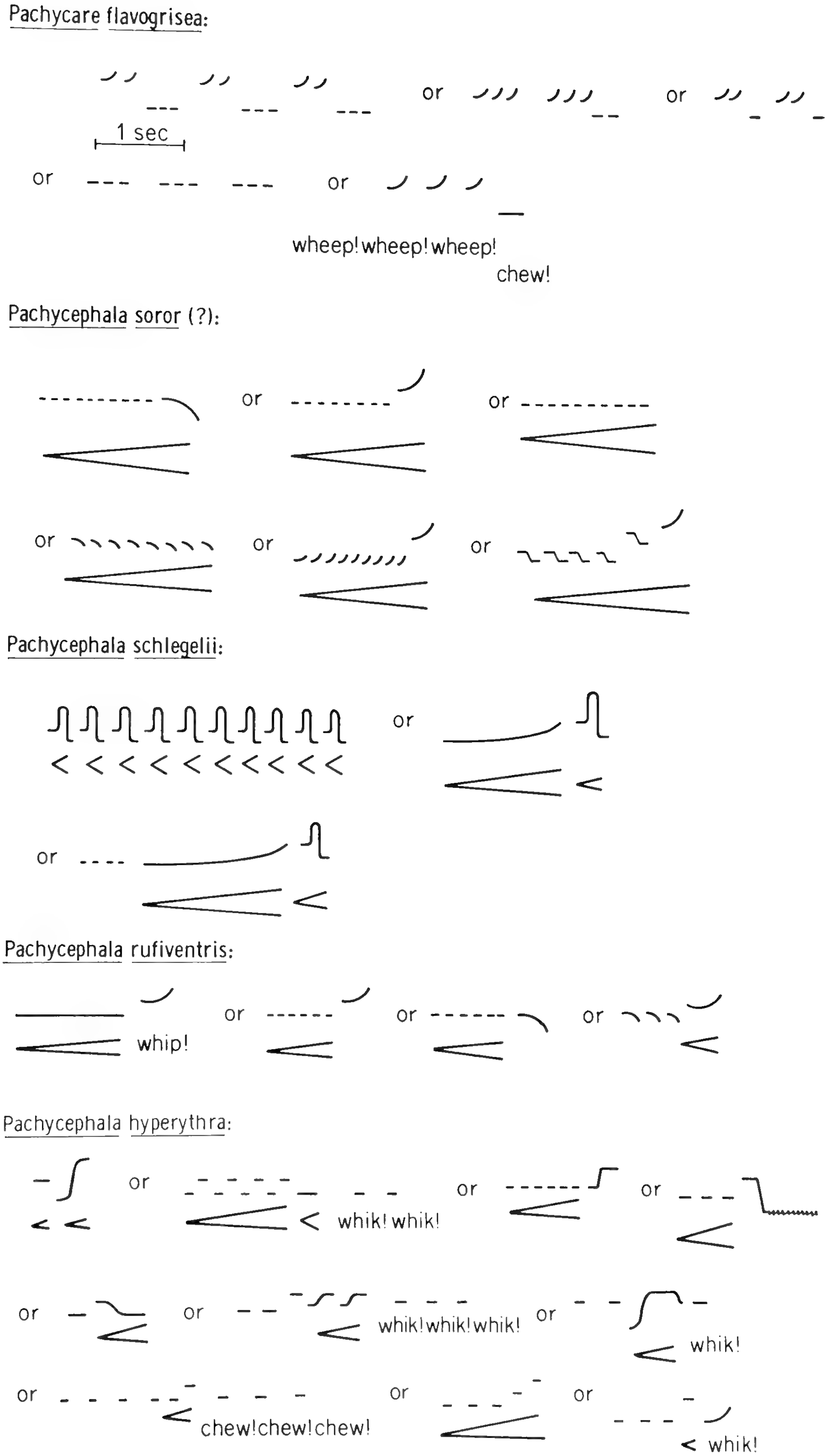


FIG. 30. Voices of five New Guinea whistlers.

DISCUSSION. The change in population composition with altitude as we went up Mt. Karimui was striking. In Zone 2 (4,400-4,750 ft) my only records were of the two immatures collected, a male in female-like plumage and with tiny testes, and an unsexed immature with many scattered rufous feathers (a carryover from the nestling plumage). In Zone 3 an unsexed bird in female plumage was collected at 5,080 ft, an adult male with small testes at 5,180 ft, and an adult female at 5,210 ft. In Zone 4 (5,390-5,960 ft) one singing male was seen and heard around 5,900 ft, adult females were collected at 5,700, 5,865, 5,870, and 5,960 ft, and the first adult male with enlarged testes was collected at 5,960 ft on the boundary between Zones 4 and 5. In Zone 5 an adult female was taken at 6,100 ft and two at 6,450 ft, an adult male with enlarged testes at 6,100 ft and another at 6,400 ft, three adult males with small testes at 6,100 ft, 6,430 ft, and 6,530 ft, a male in nearly adult plumage with tiny testes at 6,500 ft; and singing males began to be encountered regularly above 6,250 ft. In Zone 6 through 8 (6,500 ft up to the summit at 8,165 ft) males with enlarged testes accounted for more than half the population, and singing males were common. The contribution of *P. schlegelii* to the total avifauna was below 1% up to 5,780 ft but thereafter rose progressively from 4% in the upper half of Zone 4 (5,780-5,960 ft) to 11% in the upper half of Zone 8 (7,610-8,165 ft), where it was the second commonest bird (after *Ptiloprora guisei*).

P. schlegelii is abundant and widespread in the Eastern Highlands in forest between about 4,400 and 9,700 ft, the exact limits varying locally. Whereas it descended to 4,400 ft on Mt. Karimui, in the Okapa area it was still very uncommon at 6,000 ft. It ranges from the understory to the crowns, shifts perches every few seconds while foraging, and obtains its food by plucking it from surfaces rather than by sallying.

VOICE. Varied, but readily recognized as a *Pachycephala* by the crescendoes, and distinguished from other species of *Pachycephala* by the frequent use of a characteristic slurred note and of unmusical sounds resembling the sound of smacking one's lips, kissing, or a cat meowing. The characteristic slur is an explosive whistled note which suddenly rises in pitch and then immediately returns to the original pitch, increasing in volume as it does so (Fig. 30, p. 278). This resembles somewhat a call of *Monarcha frater*. A typical song consists of 10 such slurs repeated identically at intervals of slightly less than 1 sec. Another song is a prolonged cat-like meow which increases in volume, rises slightly in pitch, and is terminated by the explosive slur. Sometimes this song consisting of the meow and the slur is prefixed by four detached, identical, bell-like notes. Countersinging males snap their bills and flare and erect the yellow nape patch.

Pachycephala griseiceps perneglecta Hartert

Gray-headed Whistler

SPECIMENS EXAMINED. Okasa: 1 ♂, 3 ♀ (22-26 June 1965). Karimui: 4 ♂, 4 ♀, 1 imm. ♀ (7-11 Aug. 1964; 1-17 July 1965). Bomai: 1 ♀ (7 July 1965). Soliabeda: 5 ♂, 2 ♀ (22-28 July 1965).

WEIGHT. 10 ♂: 20.0-24.0 (21.7 $\pm$ 1.2). 10 ♀: 20.5-24.3 (22.0 $\pm$ 1.2). 1 imm. ♀: 20.7.

WING. 10 ♂: 82-86 (84 $\pm$ 1). 10 ♀: 79-85 (82 $\pm$ 2). 1 imm. ♀: 76.

STOMACH CONTENTS. Insects.

TAXONOMY. The series is close to *perneglecta* from the Fly River and from southeastern New Guinea west of Port Moresby, differing slightly in that the olive back is brighter and greener and in that the gray of the head contrasts more with the olive back. Okasa and Karimui specimens are virtually the same. The race *dubia* of southeastern New Guinea east of Port Moresby is very distinct in its brown back and lack of yellow on the underparts. The Lake Kutubu population also belongs to *perneglecta* (Schodde and Hitchcock, 1968).

BREEDING. Gonads were small in all females and in the Okasa male. At Soliabeda the testes were slightly enlarged in three males, small in two; at Karimui, large in two males, small in two others.

DISCUSSION. *Pachycephala griseiceps* will probably be found in most areas of the Eastern Highlands from about 4,500 ft down to sea level. It occurs in forest but is more numerous at the forest edge and comes out into partly cut forest and dense second-growth. Its altitudinal range includes the lowest part of *P. soror*'s range, the entirety of *P. hyperythra*'s range, and the lowlands, where no other member of the genus is present. Whereas *P. hyperythra, P. soror,* and *P. schlegelii* spend much of their time in the understory, *P. griseiceps* is usually found at least 15 ft above the ground in the middlestory or in the crowns, descends less frequently to the understory, and is rarely taken in mistnets.

VOICE. A melodious chirping which is unmistakable once learned. The pattern consists of a strict alternation between a monosyllabic, slightly upslurred chirp and a disyllabic chirp. Each kind of chirp is given alternately a few to a half dozen times and returns at intervals of between ½ sec and 1 sec. The most distinctive and charming feature is the flexibility both of tempo and volume, reminiscent to an exaggerated degree of a Chopin waltz played *rubato*. The singer unpredictably and irregularly doubles his rate of delivery while increasing the volume. At the same time the disyllabic chirp, which is at a lower pitch than the monosyllabic chirp at a slow rate of delivery, moves to a pitch higher than that of the monosyllabic chirp. The song is ventriloquial, and the singer often hard to identify even when in open view. Only when I succeeded in observing the throat of a *P. griseiceps* moving in synchrony with the song could I finally prove that it was the author. Among other species of *Pachycephala* the only foreshadowing

I have found of this unusual delivery is an occasional slight and temporary hesitation in the middle of the song of *P. hyperythra*.

Pachycephala hyperythra salvadorii Rothschild

Rufous-breasted Whistler

SPECIMENS EXAMINED. Karimui: 1 ♀, 4 ? (2-10 Aug. 1964; 12 July and 5 Aug. 1965). Bomai: 1 ♀ (6 July 1965). Soliabeda: 4 ♂, 1 ♀ (27-30 July 1965). Mt. Karimui Zone 1: 1 ♂, 1 ♀ (9 and 10 Aug. 1965).

WEIGHT. 5 ♂: 25.5, 28.0, 28.5, 29.0, 29.0. 3 ♀: 25.5, 27.0, 29.0.

WING. 4 ♂: 89, 90 (2), 92. 4 ♀: 83, 85, 88, 89. 1 ?: 87.

TAXONOMY. Compared with *salvadorii* of southeastern New Guinea, these specimens agree in the pale, dull ochraceous underparts, the gray throat, and the dark and slightly brown-tinged olive back, and differ only in the slightly brighter color of the belly. The races *sepikiana* and nominate *hyperythra* differ in the brighter and more orange underparts; *reichenowi* in the brighter underparts, browner back, and whiter, less gray, throat. The Lake Kutubu population also belongs to *salvadorii* (Schodde and Hitchcock, 1968). A single specimen, in poor condition, obtained by the Second Archbold Expedition on Mt. Mabiom at the headwaters of the Fly River, is brighter olive above and somewhat brighter ochraceous below than my series. Thus, there appears to be a cline on the southern watershed, with increasing brightness from southeastern New Guinea to the Karimui area to the Fly River to nominate *hyperythra* of the Vogelkop.

BREEDING. Gonads were enlarged in one Soliabeda male but small in all other specimens.

DISCUSSION. *P. hyperythra* is the whistler corresponding to *P. soror* and *P. schlegelii* in the lower hill forest, with an altitudinal range of about 1,500-4,200 ft. From Soliabeda it extended up on Mt. Karimui only to 4,200 ft and failed to overlap *P. schlegelii* (found above 4,400 ft) but did overlap *P. soror* (found above 3,650 ft). In the Eastern Highlands it remained at 10-30 ft above the ground, and I never netted it. In the North Coastal Range, where *P. soror* was missing, *P. hyperythra* was frequently seen in the understory and was netted.

While *P. hyperythra*'s geographical range covers most of New Guinea, its local distribution has the curious patchiness which one comes to associate in New Guinea with genera containing many ecologically similar species (p. 25). I failed to find it at Okasa (3,550-4,250 ft), although the altitudinal range would appear suitable. In southeastern New Guinea it is known from few localities; it is not included in the exhaustive collections of the First Archbold Expedition, and neither Mayr nor Stevens encountered it in the Herzog Mountains. There are no records at all from the southern slope of the Snow Mountains, although the hill forest zone there has been explored at many points by six large expeditions. At several localities where *P. hyperythra* is absent, *P. soror,* whose lower limit in the presence of *P. hyperythra* is around 3,500 ft, ranges down to 2,000 ft or lower and appears to take over *P. hyperythra*'s altitudinal range.

VOICE. A typical *Pachycephala* song, beginning with 1-8 clear, faint, bell-like or whistled notes that crescendo and terminate in loud, usually repeated slurs "whik! whik!" (Fig. 30, p. 278).

Pachycephala modesta hypoleuca Reichenow

Brown-backed Whistler

SPECIMENS EXAMINED. Awande: 1 ? (19 June 1964). Mt. Michael: 1 ♂, 1 ♀ (30 June and 8 July 1964). Mt. Karimui: Zone 5: 1 ♀ (2 Sept. 1965).

WEIGHT. 1 ♀: 19.7.

WING. 2 ♀: 82, 89, 1 ?: 83.

STOMACH CONTENTS. Solely insects in most stomachs, insects and a fruit pit in one.

TAXONOMY. Specimens from my three localities are very similar to each other and to birds collected on Mt. Kubor by Gilliard. The nominate race is more olive and generally lighter on the back, while *telefolminensis* is grayer below and darker and grayer on the back.

BREEDING. The Mt. Karimui female contained a nearly full-sized egg.

DISCUSSION. In the areas where I collected, *P. modesta* was the least common *Pachycephala* and the one with the highest altitudinal range, extending from 6,000 ft to timberline at 11,000 ft. While occasionally seen in the understory, it usually remained in the crowns 40 or more feet above the ground, where it foraged both by plucking and sallying and moved by frequent short hops of a few feet alternating with short flights. At at least two localities in southeastern New Guinea *P. modesta* descends to considerably lower altitudes: to ca. 3,500 ft in the Herzog Mountains (Mayr, 1931, p. 716) and to 4,200 ft in the Owen Stanley Range inland from Port Moresby (Gilliard, 1950, p. 30). The only guess I can hazard for an explanation is that, since this is an area where *P. hyperythra* is missing, the remaining *Pachycephala* species may have expanded their niches and altitudinal ranges.

P. modesta is one of only five species of montane birds confined to eastern New Guinea and lacking a western New Guinea representative in the same superspecies. However, there is a close relative of *P. schlegelii, P. lorentzi,* which is confined to western New Guinea, occupies there a high altitudinal range (ca. 6,000-12,500 ft) similar to that of *P. modesta* in eastern New Guinea, and may fill an analogous niche. *P. modesta* and *P. lorentzi* to date have been found sympatric only at Telefolmin.

Pachycephala rufiventris dorsalis Ogilvie-Grant[1]

White-bellied Whistler

SPECIMENS EXAMINED. Okasa: 2 ♂, 2 ♀ (22-26 June 1965). Lufa: 2 ♂, 1 ♀, 1 imm. ♂, 2 ? (29 June-14 July 1964). Karimui: 3 ♂, 1 ♀ (13-15 July 1965). Bomai: 1 ♂, 1 ♀ (8 July 1965).

WEIGHT. 5 ♂: 24.5, 2.05, 26.3, 27.5, 28.0. 3 ♀: 24.0, 25.5, 27.0.

WING. 5 ♂: 88, 89, 90, 92, 93. 4 ♀: 83, 88, 89, 89.

TAXONOMY. Although Rand and Gilliard (1967, p. 429) keep as distinct species *P. rufiventris* of Australia, southeastern New Guinea, and the Louisiade Archipelago and *P. monacha* of the rest of New Guinea and the Aru Islands, the evidence summarized by Mayr and Gilliard (1954, p. 352) for considering them conspecific seems convincing. The two "species" intergrade in the vicinity of Port Moresby.

DISCUSSION. Prior to the ornithological exploration of the Eastern Highlands *P. r. dorsalis* had been considered a rare bird, known only from seven scattered localities. In the Eastern Highlands it is common, loud, and conspicuous in tall casuarina trees growing on lawns in European settlements. It may also be found, but more erratically, in trees at the edge of the forest or trees in native gardens and villages. Possibly it is a very recent arrival in the Eastern Highlands and is spreading rapidly; Paran told me that it had settled at Awande for the first time in 1963. It has also colonized (or is colonizing) settled areas in the Baliem Valley, at Teleformin, and in the Torricelli Mountains.

The perches of *P. rufiventris* range from 15 ft above the ground to the tops of tall casuarinas. I have seen it catching insects on the wing and also eating a caterpillar.

VOICE. The song is a typical whistled *Pachycephala* song but more explosive than that of other New Guinea species. Most songs end in an explosive, slurred (either up or down), whistled "whoop" or "wheep" or "chew". This is preceded either by a single long note on constant pitch, by a rapid series of staccato notes on the same pitch separated by identical brief time intervals, or by a rapid series of identical slurs. Whichever is the case, this introductory note, notes, or slurs increase dramatically in volume to terminate in the final explosive slur. All notes are clear and whistled; there are no unmusical notes such as occur in the songs of *P. hyperythra* and *P. schlegelii* (Fig. 30, p. 278).

Pachycephala rufinucha niveifrons Hartert

Rufous-naped Whistler

NATIVE NAME. G'mi: kiriferiye.

SPECIMENS EXAMINED. Awande: 1 ♀, 1 ? (16 and 19 June 1965). Mt.

[1] Listed as *P. monacha* in Rand and Gilliard (1967).

Michael: 1 ♂, 1 ♂ (4 and 8 July 1964). Mt. Karimui Zone 3: 1 ♂; Zone 4: 1 ♂ (17 and 30 Aug. 1965).

WEIGHT. 2 ♂: 38.0, 42.5. 1 ? 37.5.

WING. 3 ♂: 86, 88, 90. 2 ♀: 84, 88. 1 ?: 84.

STOMACH CONTENTS. Insects (three stomachs); insects and seeds (two); a 5 cm worm (one). Natives credit this species with the ability to take large prey.

TAXONOMY. These agree with *niveifrons* in the whitish forehead and the olive back which has no tinge of brown. Not even my most easterly specimens (from Awande) show an approach to *gamblei* of southeastern New Guinea. The males show an increase in wing length with altitude, as also found by the First and the Third Archbold Expeditions.

BREEDING. Gonads were small.

DISCUSSION. This distinctive *Pachycephala,* which has a very heavy bill and long and powerful legs, spends much time on the ground and in the understory, and five of the six specimens were netted. Its habitat is forest from 4,800 to at least 8,000 ft.

Pachycephala tenebrosa tenebrosa Rothschild

Sooty Whistler

The only Eastern Highlands record of this rare western New Guinea *Pachycephala* is a single female collected by Bürgers on the Schraderberg during the German Sepik Expedition.

Colluricincla megarhyncha nea (Mayr) and *C. m. tappenbecki* Reichenow[1]

Rufous Shrike-thrush

NATIVE NAMES. North Fore: kupési. South Fore: kokopílo. Gimi: okopído. Daribi: hogobiyá.

SPECIMENS EXAMINED. Awande: 2 ♂, 3 ♀ (28 June 1964; 16-20 June 1965). Okasa: 3 ♂, 4 ♀ (21 and 23 Aug. 1964; 22-26 June 1965). Karimui: 2 ♂, 1 ♀ (16 Aug. 1964; 1 July and 3 Aug. 1965). Bomai: 2 ♂, 1 ♀ (6-9 July 1965). Soliabeda: 2 ♂, 1 ♀ (22-30 July 1965). Mt. Karimui Zone 1: 1 ♂, 2 ♀; Zone 2: 1 ♂, 2 ♀; Zone 3: 1 ♂, 1 ♀ (9-31 Aug. 1965).

WEIGHT. Awande-Okasa: 5 ♂, 33-41 (37.4 ± 2.8); 5 ♀, 34-40 (36.2 ± 2.0). Karimui-Bomai-Soliabeda-Mt. Karimui: 5 ♂, 29-41 (35.7 ± 2.7); 5 ♀, 30-41 (34.7 ± 3.1).

WING. Awande-Okasa: 5 ♂, 92-100 (98 ± 3); 5 ♀, 87-95 (92 ± 3). Karimui-Bomai-Soliabeda-Mt. Karimui: 5 ♂, 89-99 (93 ± 3); 5 ♀, 83-96 (90 ± 3).

STOMACH CONTENTS. Insects.

TAXONOMY. The series was compared with *goodsoni* (including the type) from the Merauke District of southern New Guinea, *wuroi* (including the type) from southern New Guinea, *palmeri* (including the type) from the Fly River, *despectus* (including the type) from the

1 Listed as *Myiolestes megarhynchus* in Rand and Gilliard (1967).

south coast of southeastern New Guinea, *superfluus* (including the type) from the north coast of southeastern New Guinea, *nea* from the Herzog Mountains, *madaraszi* from the Huon Peninsula, and *tappenbecki* from northeastern New Guinea and the Kubor Range of the Eastern Highlands. My specimens are closest to *nea,* with which they agree in the dark gray bill and the gray throat, and from which they differ only in having slightly darker upperparts and brighter underparts. The race *palmeri* from the Fly River is also close but differs in the buffier and less gray throat, the more straw-colored bill, and the slightly more distinct breast streaks. Awande-Okasa birds average very slightly brighter olive above, less heavily streaked on the breast, and less dull or gray below than birds from the Karimui area when large series are viewed side by side. There is no convincing change of weight or wing length with altitude in either the Awande-Okasa area or the Karimui-Bomai-Soliabeda-Mt. Karimui area, but birds from the former area are slightly heavier and have longer wings than birds from the latter area. The race *goodsoni* is much paler and duller above, particularly on the crown, and much less olive above; *wuroi* is paler above and less gray on the chin; *despectus* is paler above and below and slightly more olive above; *superfluus* is paler, duller, and less ochraceous below; *madaraszi* is less olive above; *tappenbecki* is browner, duller, and less olive above, and the throat and upper breast are grayer and contrast more with the belly. Birds from the Wahgi Valley and Mt. Giluwe, collected by Gilliard, Gyldenstolpe, and Shaw-Mayer, are *tappenbecki.*

BREEDING. Gonads of most specimens were large at Awande but small at other localities.

DISCUSSION. *Colluricincla megarhyncha* is inconspicuous and solitary but nevertheless common and ubiquitous from sea level up to a ceiling which varies locally between 5,400 and 6,500 ft. On Mt. Karimui it dropped out at 5,400 ft, but it was still common around 6,100 ft at Mengino and 6,200 ft at Awande, while Bulmer found it up to at least 6,500 ft in Kyaka territory. Its habitat is the lower- and middlestories (to ca. 10-15 ft above the ground) in the forest interior, at the forest edge, and in second-growth which is sufficiently dense for the understory to be well shaded. In these habitats it accounts for about 3-5% of the local avifauna.

In behavior, posture, appearance, and voice *C. megarhyncha* is simply a big and sluggish *Pachycephala.* Some specimens had to be examined carefully to distinguish them from the dull race of *Pachycephala hyperythra* living in the Karimui area.

VOICE. The song is the origin of the South Fore and Gimi name "kokopílo" and consists usually of four notes, the last two of which are joined in an upslur or downslur (Fig. 31). There is a strong but not explosive increase in volume in the last two notes. The first note is approximately a major sixth in pitch above the second. Sometimes an extra note is added at the beginning, creating a five-note song. The total length is about 1½ sec, the quality is mellow, and the pitch somewhat lower than that of *Pachycephala rufiventris.* It was amusing to hear hidden individuals give their song after every gunshot, a useful attribute that made it easy to determine the altitudinal range of the species.

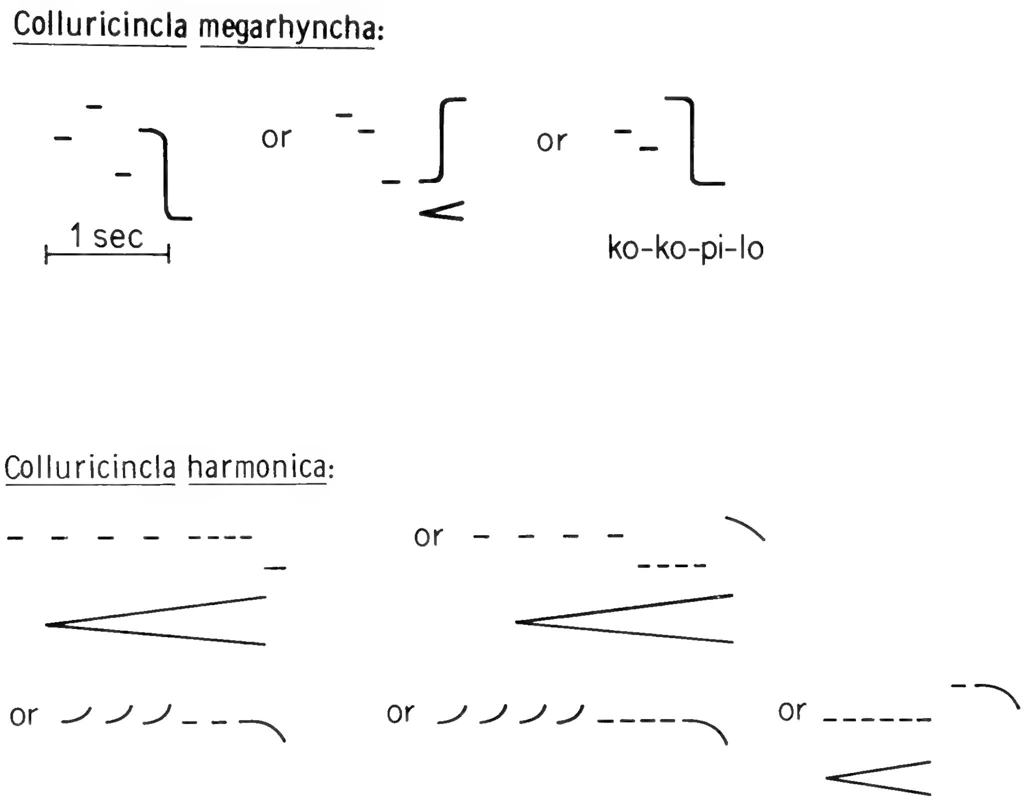


FIG. 31. Voices of *Colluricincla megarhyncha* and *C. harmonica*.

Colluricincla harmonica tachycrypta Rothschild and Hartert

Gray Shrike-thrush

DISCUSSION. This large whistler of scattered trees in open country is common in the lowlands of eastern New Guinea and has recently been recorded in two Eastern Highlands towns, Goroka and Kainantu (N.G.B.S. Newsletter, No. 59, p. 1, Oct. 1970).

VOICE. A loud, full, mellow, *Pachycephala*-like song at medium pitch, beginning with repeated notes or upslurs which are on the same pitch but crescendo, and usually ending with a downslur (Fig. 31).

Pitohui kirhocephalus brunneiceps (D'Albertis and Salvadori)

Variable Pitohui

NATIVE NAME. Daribi: húa.
SPECIMENS EXAMINED. Karimui: 6 ♂, 1 ♀ (3 July-4 Aug. 1965). Bomai:

4 ♀, 1 ? (6 and 7 July 1965). Soliabeda: 6 ♂, 1 ♀ (22-29 July 1965).
WEIGHT and MEASUREMENTS. See Table 8.

TAXONOMY. *Pitohui kirhocephalus* shows more striking geographical variation than any other New Guinea bird and encompasses among its subspecies most of the color patterns occurring in the other members of the genus. Some races (*brunneivertex, jobiensis,* and *meyeri*) are fairly uniform brown and resemble *P. ferrugineus* or *P. cristatus.* Males of other races (*meridionalis, nigripectus*) have a black and maroon pattern like *P. dichrous.* In addition, most populations, including mine, show much individual variation. On the average, my specimens are much closer to a topotypical and uniform series of *brunneiceps* collected on the Fly River by the Second Archbold Expedition than to the 14 other races with which they were compared.

The variation among my specimens concerns six features: (1) The darkness of the fulvous, somewhat orange color of the breast and belly. All Soliabeda birds are darker than all except one of the Karimui and Bomai birds. (2) The darkness of the head, which is dark brown in most specimens but is nearly black in the Soliabeda specimen labelled "b" in Table 8. (3) The distinctness of the hood, which depends upon how marked is the contrast between the throat and breast. In the Bomai specimen "1", probably an immature, the throat and breast are the same color, and there is no hood. The contrast is slight in four Karimui specimens and one from Soliabeda. In three Soliabeda specimens the throat is nearly as dark as the crown, so that the throat: breast contrast forms a very distinct hood. (4) The color of the upper tail, which is a rich brown to olive-brown in some specimens but nearly black in specimen "b", while the tail feathers of some other specimens are blackish around the shaft. (5) The color of the wings, varying from brown to nearly black. (6) The color of the back, which is a slightly deeper and richer brown in Soliabeda and Bomai specimens than in Karimui specimens, which agree in this respect with Fly River *brunneiceps.* Table 8 scores all my specimens and three related populations or individuals on the first four of these points. In my specimens there is no consistent difference between the sexes in these characters. All my specimens have the bill black.

As summarized in Table 8, most Karimui and Bomai birds are somewhat paler below and have less distinct hoods than Fly River *brunneiceps,* while some Soliabeda birds have darker underparts and most have darker heads than *brunneiceps.* In addition, the wings of Fly River birds average 3-4 mm shorter. These differences are minor in view of the considerable individual and local variation and the much more marked differences compared to other races. Males of *meridionalis,* the next race to the east (in southeastern New Guinea), are distinct in the really black hood, wings, and tail, while females have the head paler than in my series. As seen in Table 8, two males from Deva Deva collected by Hamlin, which come the closest of the

TABLE 8

COLOR VARIATION IN *Pitohui kirhocephalus*

Locality	Specimen Number	Sex	Weight (g)	Wing (mm)	Distinctness of Hood	Darkness of Ventral Coloration	Darkness of Head	Amount of Black in Uppertail
Soliabeda	a	♂	91	124	4	5	3	2
Soliabeda	b	♂	98	124	4	4	5	3
Soliabeda	c	♂	95	122	1	3	1	1
Soliabeda	d	♂	92	125	2	3	2	1
Soliabeda	e	♂	92	124	3	3	2	—
Soliabeda	f	♂	91	126	2	4	2	1
Soliabeda	g	♀	85	129	4	3	2	1
Bomai	h	♀	100	123	2	2	1	1
Bomai	i	♀	95	120	2	2	1	1
Bomai	j	♀	93	125	2	2	2	2
Bomai	k	♀	91	121	2	2	1	1
Bomai	l	?	85	115	0	1	1	0
Karimui	m	♂	98	123	1	2	1	0
Karimui	n	♂	—	129	(prepared as skeleton)			
Karimui	o	♂	92	126	3	2	1	1
Karimui	p	♂	92	124	1	2	1	0
Karimui	q	♂	91	123	1	2	1	1
Karimui	r	♂	97	125	3	2	2	2
Karimui	s	♀	94	123	1	3	1	1
Fly River, *brunneiceps* ♂ ♀					3	3	1	1
Deva Deva, *meridionalis* 2♂					5, 5	2, 2	3, 5	3, 3
Southwestern New Guinea, *nigripectus* 1♂, A.M.N.H. No. 656,361					3	2	1	1

The distinctness of the hood is scored 0 to 5: 0, the throat and breast are of the same color; higher scores, the throat is increasingly darker than the breast. The darkness of the breast and belly is scored 1 to 5; higher scores mean darker color. The darkness of the head is scored 1 to 5, 1 being brown, 5 nearly black. The amount of black in the uppertail is scored 0 to 3: 0, no black; 1 and 2, increasing amounts of black around the central shaft; 3, largely black. An average score is assigned to the fairly uniform series of *brunneiceps* collected on the Fly River by the Second Archbold Expedition. All my Soliabeda, Karimui, and Bomai birds are scored individually, as are one aberrant *nigripectus* male similar to my specimens and two *meridionalis* males from Deva Deva, southeastern New Guinea.

available *meridionalis* specimens to *brunneiceps,* are approached by two of the darkest Soliabeda specimens but still differ in having the throat tipped with black. Most specimens of *nigripectus* (south-western New Guinea) have the head and tail even blacker than my specimen "b", and in addition *nigripectus* males usually have a black breast. One aberrant *nigripectus* male collected by Meek on the southern slope of the Snow Mountains (A.M.N.H. No. 656,361) resembles my series and is scored separately in Table 8.

BREEDING. Gonads were slightly enlarged in seven males but were small in the remaining males and all females.

DISCUSSION. I found this tropical species common (ca. 2% of the local avifauna) at Soliabeda, Bomai, and Karimui but nowhere else, not even in Zone 1 of Mt. Karimui. While it might be found in the forest and in dense second-growth at any level from the understory to the treetops, sometimes in fruiting trees, it preferred dense thickets near the forest edge, where it kept out of sight. A jumble of calls would emerge from a thicket, leaves would shake and shapes dart about, and finally three or four *P. kirhocephalus* would emerge and chase each other into a nearby thicket. In flight it had a loud, fluttering wingbeat, as do *P. dichrous* and *P. nigrescens.* Its habits and sometimes its voice and appearance resemble *P. dichrous,* of which it may be considered the low-altitude representative, though there is a broad overlap.

VOICE. Loud, liquid, and melodious whistles at medium pitch, somewhat harsher than those of *P. dichrous.* A common element is a connected pair of notes, the first note a fourth in pitch below the second note. A typical song begins with one such pair, followed a second later by two more such pairs in immediate succession, after which the song degenerates into an irregular but melodious jumble. Often two singers will deliver their jumbles simultaneously from adjacent thickets, one starting after the other. This may involve rival males singing competitively (countersong). Other instances of one bird calling in response to another bird's call occur frequently. A common call note is an upslurred whistle. Elsewhere in New Guinea this species sings duets and trios (Diamond and Terborgh, 1968, p. 73).

Pitohui dichrous (Bonaparte)

Black-headed Pitohui

NATIVE NAMES. Fore: obo. Gimi: okofo.

SPECIMENS EXAMINED. Awande: 1 ♂, 1 ♀ (28 June 1964; 17 June 1965). Okasa: 1 ♀ (26 June 1965). Karimui: 4 ♂, 2 ♀ (12 Aug. 1964; 3 July-11 Sept. 1965). Soliabeda: 2 ♀ (28 and 30 July 1965). Mt. Karimui Zone 1: 1 ♂, 1 ♀; Zone 2: 3 ♂, 3 ♀, 1 ?: Zone 3: 1 ♂ (9-16 Aug. 1965).

WEIGHT. 10 ♂: 67-76 (72 ± 2). 10 ♀: 67-79 (72 ± 4).

WING. 10 ♂: 106-116 (110 ± 3). 10 ♀: 102-113 (107 ± 3).

STOMACH CONTENTS. Fruit.

BREEDING. The only specimens with enlarged gonads were the 1964 Karimui male, collected 12 Aug., and the last male collected at Karimui in 1965, on 11 Sept. This may suggest that the breeding season is toward the end of the calendar year or is suppressed in dry periods.

DISCUSSION. *P. dichrous* is the middle bird in an altitudinal sequence in genus *Pitohui,* occurring between the ranges of *P. kirhocephalus* and *P. nigrescens.* It descends regularly to 1,500 ft and reaches sea level in a few parts of New Guinea, so that it overlaps the upper half of *P. kirhocephalus's* range. Its ceiling varies between about 5,000 and 6,000 ft, and at this ceiling it excludes *P. nigrescens,* probably strictly in undisturbed forest. In the ecologically disturbed forest edge at Awande both species were netted at approximately the same altitude (6,200 ft). The following figures for the contribution of *P. dichrous* to the avifauna show that it is most numerous in hill forest above the range of *P. kirhocephalus:* Soliabeda, 1,350-2,000 ft, 0.3%; Karimui, 3,650 ft, 0.7% (*P. kirhocephalus* present at both Soliabeda and Karimui); Mt. Karimui Zone 1, 4,000-4,200 ft, 2% (*P. kirhocephalus* absent at this and higher altitudes); Zone 2, 4,400-4,750 ft, 5.6%; Zone 3a, 4,750-5,080 ft, 2.6%; Zone 3b, 5,080-5,150 ft, 0.7%; not observed above 5,150 ft.

Like *P. kirhocephalus, P. dichrous* may be seen at any height in the vegetational column in the forest or in dense second-growth, from the understory up to the crowns of tall trees, as solitary individuals or in groups of three or four. Terborgh observed it in trees with small fruits.

VOICE. Loud and mellow whistles at medium pitch, similar to those of *P. kirhocephalus* but with no harsh quality. Two common types of vocalizations are: a rapid series of a half dozen identical upslurs delivered at the rate of 4 per second; and a song consisting of whistled notes, upslurs, and downslurs in an interestingly irregular and hesitating rhythm, and usually beginning with two notes on the same pitch followed by an upslur (Fig. 32).

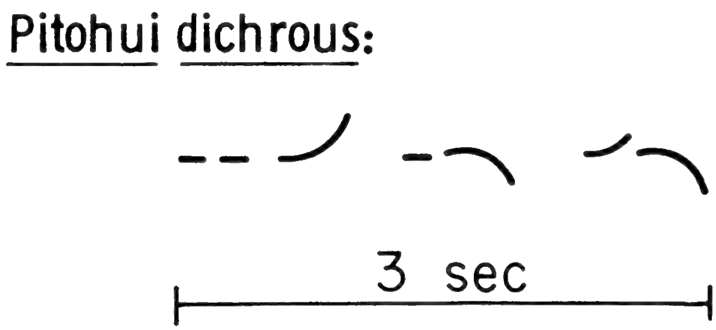


FIG. 32. Voice of *Pitohui dichrous.*

Pitohui nigrescens subsp.

Black Pitohui

NATIVE NAME. Fore: kóroli.

SPECIMENS EXAMINED. Awande: 4 ♂, 1 ? (28 June 1964; 17-20 June 1965). Mt. Michael: 1 ? (5 July 1964). Mt. Karimui Zone 4: 1 ♂; Zone 5: 3 ♂ (27 Aug.-5 Sept. 1965).

WEIGHT. Awande: 2 ♂, 73, 78; 1 ?, 78. Mt. Karimui: 4 ♂, 74, 76, 82, 86.

WING. Awande: 4 ♂, 131, 135, 135, 137; 1 ?, 138. Mt. Karimui: 4 ♂, 130, 130, 131, 133.

STOMACH CONTENTS. Insects (four stomachs), insects and seeds (two), 4 mm fruit (one).

TAXONOMY. Both unsexed birds are black and probably males, though black females are known (Gilliard and LeCroy, 1970, p. 17). As subspecific characters are based mainly on the female, I cannot make a racial assignment of this series, which was compared with males of nominate *nigrescens* (Vogelkop), *wandamensis* (Wandammen Peninsula), *meeki* (Weyland and Snow Mountains), and *schistaceus* (southeastern New Guinea). Males were found to differ in wing length, hue (blacker or browner), and depth of color (darker or lighter). As shown in Table 9, males from Awande, lying to the east of Mt. Karimui, have the longest wings, whereas birds from southeastern New Guinea, still farther to the east, have the shortest wings. Both Awande and Mt. Karimui birds are more black, less brown, than any other available for comparison. The possibility of foxing cannot be excluded, as all other material was at least 28 years old. The races *schistaceus* and nominate *nigrescens* are lighter than *meeki* or *wandamensis*. Mt. Karimui birds are comparable to *meeki* in this respect and are darker than four of the five Awande specimens, which are in turn darker than *schistaceus*. On the basis of color Mayr and Gilliard assigned their only specimen, a long-winged female from Mt. Hagen,

TABLE 9
WING LENGTH OF *Pitohui nigrescens* MALES

schistaceus,	
southeastern New Guinea	124 (2), 125 (4), 126 (4), 127, 128, 129 mm (av., 125.8)
subsp. ?, Awande	131, 135 (2), 137, 138 (av., 135.2)
subsp. ?, Mt. Karimui	130 (2), 131, 133 (av., 131.0)
meeki,	
Snow Mountains	133
Weyland Mountains	129, 130 (3), 131, 136, 138 (av., 132.0)
wandamensis,	
Wandammen Peninsula	132
nigrescens,	
Vogelkop	123, 126 (2), 128, 130, 131 (2), 132, 133 (av., 128.9)

to *buergersi,* which was described from the Schraderberg but was unavailable for comparison and is doubtfully distinct from *meeki.* More females from the Eastern Highlands, including topotypical females from the Schraderberg, are necessary to assess the validity of *buergersi* and the status of the Eastern Highlands population, but it is definitely closer to *meeki* than to *schistaceus.*

BREEDING. Gonads were small in all specimens.

DISCUSSION. *P. nigrescens* is an uncommon forest species between about 5,600 and 8,200 ft, ranging from the understory to about 35 ft above the ground. The few that I saw were solitary and flew with a loud wing beat like *P. kirkocephalus* and *P. dichrous.*

VOICE. An unmusical, buzzy "cher-wee" repeated two or three times in succession. The syllable "cher" is at a lower pitch than "wee". Also, a musical chirp "kyew", repeated eight times at ½ sec intervals.

Pitohui ferrugineus ferrugineus (Bonaparte)

Rusty Pitohui

NATIVE NAME. Daribi: húa.

SPECIMENS EXAMINED. Karimui: 5 ♂, 2 ♀ (11 and 14 Aug. 1964; 3 July-4 Aug. 1965). Bomai: 3 ♂, 2 ♀ (6-7 July 1965). Soliabeda: 4 ♂, 4 ♀ (22-29 July 1965).

WEIGHT. 10 ♂: 86-110 (98 $\pm$ 8). 7 ♀: 77-99 (90 $\pm$ 7).

WING. 10 ♂: 138-147 (141 $\pm$ 3). 8 ♀: 124-138 (133 $\pm$ 4).

STOMACH CONTENTS. Insects and fruit.

TAXONOMY. Specimens from the Karimui area are closest in depth of color to nominate *ferrugineus* from the Vogelkop and upper Fly River, and are also close to birds from the Idenburg River and southern slope of the Snow Mountains. The race *leucorhynchus* is much darker and has a whitish bill; *clarus* of southeastern New Guinea and the lower Fly River is paler; *holerythrus* of Japen and the Weyland Mountains is darker; and *brevipennis* of the Aru Islands has the black slightly darker. *P. f. ferrugineus* thus has a checkerboard distribution. The bill was black and the iris straw-colored in my specimens.

BREEDING. Gonads were moderately enlarged in one Soliabeda male, greatly enlarged in another, slightly enlarged in one Karimui male, and small in other specimens.

DISCUSSION. To date, this low altitude species has been found in the Eastern Highlands only in the Karimui area and at Lake Kutubu. Although the number of specimens indicate that it was fairly common (1.7% of the local avifauna at Soliabeda and Bomai, 0.5% at Karimui), I observed it only infrequently, from the understory to 40 ft above the ground in the forest interior. The altitudinal ranges of *P. ferrugineus* and *P. kirhocephalus* are coincident in the Karimui area (0-3,650 ft). *P. ferrugineus* is slightly larger, more sluggish in its movements, quieter, and more limited to the forest interior, whereas

P. kirhocephalus is noisy and often seen at the forest edge and in dense second-growth as well as in the forest interior.

Pitohui cristatus arthuri Hartert and *P. c. kodonophonos* Mayr

Crested Pitohui

NATIVE NAME. Daribi: sígo (?).
SPECIMENS EXAMINED. Karimui: 1 ? (6 Aug. 1964).
WING. 108.
TAIL. 85.
EXPOSED CULMEN. 24.

TAXONOMY. The short wing, tiny gonads, and rufous edges to the upperwing coverts suggest that this specimen was an immature. The bill was dark gray.

The Karimui specimen is closest to the type and another topotypical specimen of *arthuri* from the Cyclops Mountains and is equally olive on the back but differs in being generally slightly darker, distinctly darker on the crown, and more rufous on the uppertail. The race *kodonophonos* of southeastern New Guinea, to which Schodde and Hitchcock referred a Lake Kutubu specimen, approaches the Karimui specimen in the darkness of the crown but is considerably paler below. The nominate race from the Vogelkop and southern slope of the Snow Mountains is darker below, more brown and less olive above. When the crest lies flat, *P. cristatus* is superficially similar to *P. ferrugineus* but may be distinguished by the rufous uppertail, the darkened breast band, and the brown instead of straw-colored or whitish iris.

DISCUSSION. *Pitohui cristatus* is a rare hill forest species known in the Eastern Highlands only in the Karimui area and at Lake Kutubu. I heard its suspected song a dozen times in the understory at Karimui and in hill forest between 2,600 and 4,300 ft.

VOICE. If the statements of several natives on this matter are correct, then *P. cristatus* is the author of the most extraordinary bird song in New Guinea.

The song consists of a long series of identical notes which are initially all on the same pitch and at equal time intervals. The pitch lies approximately an octave above middle C. One of the two remarkable features of the song is its length. One song which I timed and which seemed to be of average length lasted 175 sec without interruption. As the song proceeds, the notes gradually accelerate and also gradually drop in pitch. Thus, the rate of delivery was timed at five notes per second at the start of the song, 13 notes per second at the end; and the final pitch may be about half an octave below the initial pitch. The song ends more or less abruptly in the middle of the series, and may then be given again after a pause.

The other and more remarkable feaure is the unusual, throbbing quality, suggestive of either the "singing" sound produced by high-voltage transmission lines or else of the sound produced by blowing across the narrow mouth of a large open vessel. As a result of this quality, the song blends so well into the surroundings and is so unlike any other bird song that it does not catch one's attention, least of all if one is listening for bird calls. Although the song is muted and not loud, it carries for long distances of up to half a mile that are impossible to estimate unless the singer happens to be very close.

Eulacestoma nigropectus De Vis

Wattled Shrike-tit

SPECIMENS EXAMINED. Mt. Karimui Zone 5: 2 ♂; Zone 6: 2 ♂, 1 ♀; Zone 7: 1 ♂ (28 Aug.-7 Sept. 1965).

WEIGHT. 5 ♂: 19.7, 20.5, 20.5, 21.7, 22.0. 1 ♀: 21.3.

WING. 5 ♂: 69, 70, 70, 71, 71. 1 ♀: 72.

STOMACH CONTENTS. Insects.

TAXONOMY. The males are blacker and less brown on the breast than nominate "*nigropectus*" from the Mambare River and Wharton Range or "*clara*" from Mt. Goliath and the Kubor Mountains, with the exception of one male from Mt. Tafa (Wharton Range), which is equally black. The female has the underparts yellow-olive with obscure barring on the throat and breast. A juvenile has the back and upperwing coverts rufous. With the description of *clara* (Stresemann and Paludan, 1935, p. 44), topotypical specimens of *clara* from the Weyland Mountains, and southeastern New Guinea birds before me, I was unable to detect the differences cited in the description of *clara,* which had already been suspected as being synonymous with the nominate race by Mayr and Gilliard (1954, p. 354) and Rand and Gilliard (1967, p. 438).

BREEDING. The gonads of all specimens were small.

DISCUSSION. *Eulacestoma nigropectus* belongs to a monotypic, distinctive, poorly-known, endemic New Guinea genus. Though common in southeastern New Guinea, it is uncommon and local in the Eastern Highlands at 6,400-8,000 ft, and I met it only on Mt. Karimul. It obtains its food from limbs and branches, particularly from the broken-off tips of dry dead branches, between the understory and 30 ft above the ground. In searching, every few seconds it hops a few inches (in dense vegetation) up to four feet (on leafless branches) along a limb, frequently leaning over the limb head downwards and nuthatch-like to inspect the underside but never hanging upside-down from the underside. The ends of twigs bend down under its weight, so that it must be weight limited in its choice of feeding station. Occasionally it stops to pry, pound, or dig vigorously at a branch, and chips of wood and pieces of moss fly as it works. I judge its heavy bill to be extremely powerful, having been bitten by it.

LANIIDAE: SHRIKES

Lanius schach stresemanni Mertens

Schach Shrike

NATIVE NAME. Fore: kaíto.
SPECIMENS EXAMINED. Awande: 1 ♂, 1 ♀, 1 ? (15-20 June 1965).
WEIGHT. 1 ♂: 46. 1 ♀: 48. 1 ?: 46.
WING. 1 ♀: 96.

BREEDING. The male, taken in June, had small gonads, but on 18 Aug. 1964, two nestlings were shown to me at Awande. I was told that the *kaíto* disappeared from the Okapa area during the wet months of Janury, February, and March. Perhaps it breeds in the dry season, like many grassland birds, and then undertakes a local migration in the wet season.

DISCUSSION. The Schach Shrike has a peculiar geographical range, namely, midmontane grassland of eastern New Guinea as far west as Telofolmin but not farther west. There is no obvious reason why it should be missing from the midmontane grassland of the Baliem Valley of western New Guinea. It is fairly widespread in the Eastern Highlands (but is absent at Karimui) and perches on trees and fences in grassland, gardens, and villages, quickly flicking its tail as it waits to pounce.

VOICE. According to the Fore, this shrike mimics the voices of other birds.

ARTAMIDAE: WOOD SWALLOWS

Artamus maximus Meyer

Greater Wood Swallow

NATIVE NAMES. Fore: éseyabi. Daribi: támani.
SPECIMENS EXAMINED. Mengino: 1 ♂, 2 ♀ (14 July 1964). Karimui: 4 ♂, 2 ♀ (10-15 Aug. 1964; 16 July-4 Aug. 1965). Bomai: 2 ♂, 1 ♀ (6-7 July 1965). Soliabeda: 3 ♂, 4 ♀ (23-29 July 1965).
WEIGHT. 7 ♂: 54-64 (59 ± 4). 5 ♀: 52-59 (57 ± 3).
WING. 7 ♂: 152-163 (158 ± 4). 7 ♀: 154-164 (158 ± 4).
STOMACH CONTENTS. Medium-sized insects.

TAXONOMY. The wing averages shorter and the weight averages lower than in a series from the Wahgi Valley and other parts of New Guinea, perhaps because of the low altitude. The race *wahgiensis* described by Gyldenstolpe is invalid, as pointed out by Sims (1956, p. 422) and by Gilliard and LeCroy (1961, p. 63).

BREEDING. Gonads were small in all specimens except for the latest one collected, a male taken at Karimui on 15 Aug. 1964, which had greatly enlarged testes.

DISCUSSION. *A. maximus* was present at all my Eastern Highlands stations that offered some cleared land, up to 8,500 ft. Its original habitat was hill forest and midmontane forest, and one still sees it occasionally at an exposed perch on a protruding branch or at the top of a dead tree in primary forest. It is far more common, however, in settled areas and must have enjoyed a great increase in population since the advent of agriculture. It is usually seen soaring without flapping, sometimes quite high, or else perched on a branch in tightly packed rows of two to six birds, each apparently touching its neighbors.

VOICE. The call of *A. maximus* is a pleasant chirp which I cannot distinguish from the call of its low-altitude equivalent, *A. leucorhynchus.* The rarely heard song, delivered perched from the crown of a tall tree, is a prolonged soft jumble including imitations of other birds and very similar to the songs of New World mockingbirds (Mimidae). Elements include squawks, chirps, and short trills, each repeated 2-5 times.

STURNIDAE: STARLINGS

Aplonis cantoroides (Gray)

Singing Starling

STOMACH CONTENTS. Fruit.

DISCUSSION. Gilliard and Gyldenstolpe were surprised independently to find large flocks of this lowland species at Nondugl (5,200 ft), evidently in the same grove of trees but in different years. Specimens taken in April and May were not in breeding condition, while those taken in late August and September were entering breeding condition and beginning courtship activities. I observed groups of four at Goroka on 14 Sept. 1966 and 31 July 1969. According to Bell (pers. comm.), this starling breeds in the vicinity of Port Moresby in the rainy season (January-May). Perhaps *A. cantoroides* is undertaking postbreeding migrations from the lowlands to the Eastern Highlands in increasing numbers.

VOICE. A clear, sweet downslur.

Aplonis metallica metallica (Temminck)

Metallic Starling

STOMACH CONTENTS. Fruit up to 12 mm in diameter; rarely, insects.

DISCUSSION. Shaw-Mayer collected a female of this lowland starling in May 1951, at 7,000 ft on Mt. Giluwe and found it plentiful there at 5,300 ft. No other Eastern Highlands records are known to me.

VOICE. A harsh downslur readily distinguished from the call of *A. cantoroides.*

Mino dumontii dumontii Lesson

Yellow-faced Myna

NATIVE NAMES. Fore: yaúta. Gimi: káho.
SPECIMENS EXAMINED. Karimui: 5 ♂, 8 ♀ (3 July-5 Aug. 1965). Soliabeda: 1 ♂, 2 ♀ (25-27 July 1965).
WEIGHT. 4 ♂: 197, 198, 209, 235. 10 ♀: 140-198 (176 ± 21).
WING. 6 ♂: 146-157 (152 ± 4). 10 ♀: 136-153 (145 ± 5).
STOMACH CONTENTS. Fruit, 6-19 mm in diameter.

TAXONOMY. The iridescent color is green in eight females, purple in two, and green in two males, blue-green in two, and purple in two. Differences in the iridescent color were among the characters used to separate a north coast race *violaceus,* but Mayr and Rand (1937, p. 187) and Junge (1939, p. 72) showed that the various colors can all be found in a single population (as also true at Karimui) and probably change with wear.

BREEDING. The gonads were small in all specimens.

DISCUSSION. This lowland species has been found in the Eastern Highlands at Lake Kutubu and in the Karimui area (Soliabeda, Bomai, and Karimui). At Karimui (3,650 ft) it was fairly common (1.2-1.5% of the local avifauna), and its presence there constitutes an altitudinal record. It was usually seen in small groups of several (up to four) birds, and often in pairs, on conspicuous perches in the tops of tall trees (either leafy or dead) at the edge of forest and in second-growth. Terborgh found up to 10 *M. dumontii* eating small fruits in a strangling fig.

VOICE. A disyllabic, low-pitched, penetrating, totally unmusical croak, with the second syllable on the lower pitch. There are also several other equally weird and unmusical notes. If one hears what sounds like a bullfrog at the top of a tall tree, either *M. dumontii* or *Eurystomus orientalis* is in the vicinity.

ORIOLIDAE: ORIOLES

Oriolus szalayi (Madarasz)

New Guinea Oriole

NATIVE NAMES. Gimi: itakurófo. Daribi: unanáburo.
SPECIMENS EXAMINED. Okasa: 3 ♂ (red bill); 1 ♂, 1 ♀ (black bill) (22-26 June 1965). Karimui: 4 ♂, 2 ♀ (red bill); 4 ♂, 1 ♀ (black bill) (12 and 15 Aug. 1964; 1-18 July 1965). Bomai: 1 ♂ (red bill); 1 ♀ (black bill) (22 July 1965). Soliabeda: 1 ♂ (red bill); 1 ♂ (black bill) (22 July 1965).
WEIGHT. 8 ♂: 91, 92, 93, 93, 98, 98, 101, 106; 2 ♀: 101, 115 (red bill). 6 ♂: 79, 84, 90, 95, 99, 100; 2 ♀: 88, 91 (black bill).
WING. 10 ♂: 134 (2), 136, 137, 138 (2), 140 (2), 142, 144; 2 ♀: 138 (2) (red bill). 6 ♂: 128, 129, 132, 133, 134, 135; 3 ♀: 129, 129, 132 (black bill).
STOMACH CONTENTS. Fruit.

TAXONOMY. The bill is either black or else very dull blood-red. Because the wing is longer in all females with red bills than in any with a black bill, and is also longer in all but two of the red-billed males than in any back-billed male, I presume that a black bill is a sign of immaturity. Three of the red-billed males have the underparts buffier than the rest.

BREEDING. The only specimen with enlarged gonads was a red-billed male from Okasa.

DISCUSSION. *Oriolus szalayi* is present in many ecologically disturbed areas at the edge of the Eastern Highlands up to about 4,000 or 5,000 ft and is particularly common at Karimui, but occurs in primary forest only at much lower altitudes. Its habitat is the upperstory and middlestory of tall trees at the edge of the forest, in second-growth, gardens, and in partly cut forest, i.e., wherever it finds perches in tall trees adjacent to open spaces. Usually several individuals were seen together.

Plumage convergence of *Philemon novaeguineae* and *O. szalayi* is discussed on pp. 382-383.

VOICE. There are three kinds of vocalizations. The commonest is the song, a liquid, medium-pitched, fairly loud, run-together series of pairs of notes or slurs. The second note is the lower note in the first few pairs but is usually the higher note in the last pair (Fig. 33). The second vocalization is a call with the same liquid quality, consisting of a single note which is initially slurred downward and then upward,

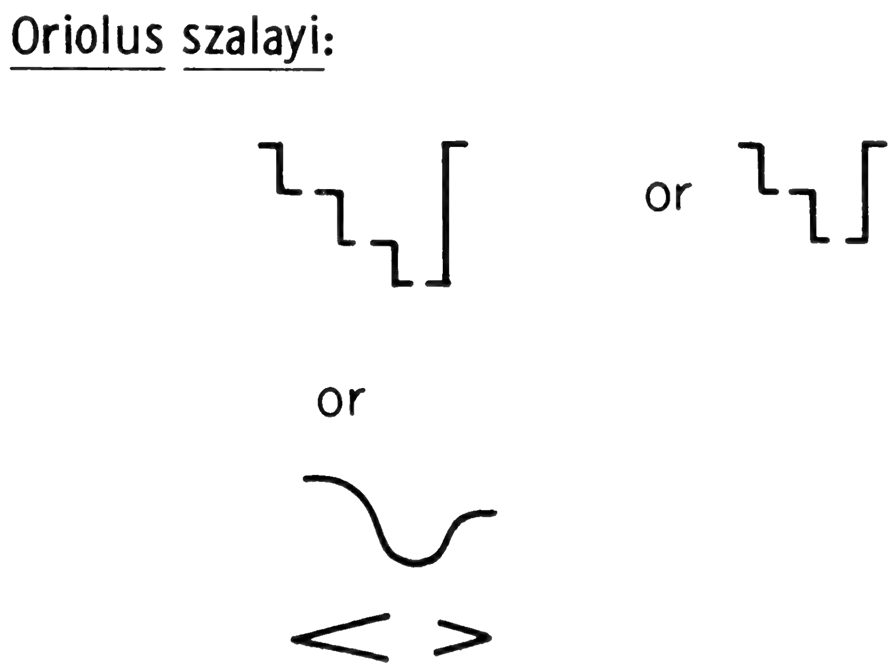


FIG. 33. Voice of *Oriolus szalayi.*

and at the same time undergoes a crescendo and decrescendo, with the maximum volume on the lowest pitch (Fig. 33). The third call is a single harsh, hoarse, downslurred "chew".

GRALLINIDAE: MUDNEST BUILDERS

Grallina bruijni Salvadori[1]

Torrent Lark

NATIVE NAMES. Fore: níntere. Gimi: neterewíya. Daribi: sénili.

SPECIMENS EXAMINED. Awande: 1 ♀, 1 ? (18 and 19 Aug. 1964). Sena River: 1 ♂, 1 ? (26 and 28 July 1964). Mt. Karimui Zone 3: 1 ♂ (17 Aug. 1965).

WEIGHT. 1 ♂: 38.4.

WING. 2 ♂: 102, 107. 1 ♀: 100.

TAXONOMY. I follow Amadon (1950) in considering the Torrent Lark congeneric with the Magpie Lark, *Grallina cyanoleuca,* of Australia, rather than meriting recognition in the monotypic genus *Pomareopsis.*

Both unsexed birds were in female plumage.

DISCUSSION. This is one of the two strictly riparian passerines in New Guinea, the other being the less uncommon *Monachella muelleriana.* Both species require rushing, rocky, mountain torrents, may often be found on the same stretch of the same stream, and are absent from the flat lowlands. I found *G. bruijni* in these montane streamside habitats from 2,700 to 5,150 ft, and Shaw-Mayer and Bulmer observed it at 6,500 ft or higher. A male with small testes was shot by one of my assistants at 5,150 ft in forest on the crest of a ridge of Mt. Karimui and many hundred feet above the streams on either side of the ridge, a habitat in which I never saw *G. bruijni* myself and where my assistant was equally surprised to find it. The bird was probably crossing the ridge from one stream to the other.

G. bruijni is a striking and active bird which alights on boulders in torrents and walks (not hops) up the sides of or along the boulders, wagging its seemingly loosely-hinged tail from side to side. It spins about, turns, and displays like a fantail (*Rhipidura*). Once while I was watching a group of three that had alighted on a large boulder, one bird faced the other two, reared up on its legs, raised its head and body towards the vertical position, and opened its wings wide to show to its partners the striking black and white pattern of the underparts. The sexes differ markedly with respect to this pattern.

VOICE. The call is a penetrating, buzzy, harsh upslur or upwards-inflected squawk, quite different from the sweet, high-pitched note of *Monachella muelleriana.*

[1] Listed as *Pomareopsis bruijni* in Rand and Gilliard (1967).

CRACTICIDAE: BUTCHERBIRDS and BELL-MAGPIES

Cracticus cassicus cassicus (Boddaert)

Black-headed Butcherbird

NATIVE NAMES. Gimi: koíki. Daribi: hórabe.

SPECIMENS EXAMINED. Karimui: 1 ♂, 2 ♀, 1 imm. ♂, 3 juv. ? (12-16 Aug. 1964; 12 July 1965). Bomai: 1 ♂, 1 ♀ (6 and 9 July 1965). Soliabeda: 3 ♂, 3 ♀ (23-30 July 1965).

WEIGHT. 3 ♂: 140, 145, 155. 4 ♀: 130, 136, 141, 147.

WING. 5 ♂: 159, 162, 164 (2), 166. 3 ♀: 156, 158, 159.

STOMACH CONTENTS. Fruit and insects.

TAXONOMY. The immature male from Karimui has some brown striations on the black of the head and back.

BREEDING. In 1964 at Karimui two of the three sexed adults had greatly enlarged gonads. On 13 Aug. 1964 I found a nest containing one nestling, located on a horizontal tree branch 40 ft above the ground in second-growth forest and constructed of sticks. On the same day a native brought in two nestlings from another nest. Testes were greatly enlarged in the Bomai male and in one of the three Soliabeda males, small in the two others. Evidently breeding is concentrated in the dry season.

DISCUSSION. The preferred habitat is the crowns of trees bordering open spaces (never the interior of primary forest), so that this butcherbird is much less common in undisturbed forested regions than in areas occupied by man. In the areas of primary forest at Bomai and Soliabeda small groups of *C. cassicus* concentrated in river gorges at the forest edge. The black and white pattern of the upperparts as it flew across the gorges, and the loud calls echoing back and forth across the gorge, made it conspicuous. Other Eastern Highlands records are from the Schrader Range, up to 4,500 ft in cultivated areas of Kyaka territory (Bulmer), at 3,500 ft in Baiyer Valley (N.G. B.S. Newsletter, No. 54, p. 2, June 1970), and Lake Kutubu (2,700 ft). All these locality records in the Eastern Highlands are rather high for *C. cassicus,* which seldom ranges above 2,000 ft elsewhere in New Guinea.

VOICE. A loud, jumbled bugling and yodeling, which combines bell-like notes and liquid and rollicking phrases with hoarse notes, gurgles, and musical croaks. The song of the Australian cracticid *Gymnorhina tibicen* is somewhat similar, and the only New Guinea song with a comparable volume and combination of different qualities is that of *Cracticus quoyi,* which differs in having a more consistent and organized pattern. Once I heard a particularly long (several minutes in duration) and varied jumble, including imitations of other birds, in typical *C. cassicus* habitat (edge of a gorge) and with the quality of the *C. cassicus* song, so that I think it probably came from *C.*

cassicus even though I did not see the singer. Among the species imitated were *Cracticus quoyi, Paradisaea raggiana,* and *Meliphaga* spp. The closely related *Cracticus nigrogularis* of Australia is known to be a mimic.

Cracticus quoyi quoyi (Lesson)

Black Butcherbird

NATIVE NAME. Daribi: gaúwadi.
SPECIMENS EXAMINED. Karimui: 4 ♂, 3 ♀, 2 ? (6-14 Aug. 1964; 1 July-6 Aug. 1965). Bomai: 1 ♂ (8 July 1965). Soliabeda: 3 ♀ (26-29 July 1965).
WEIGHT. 3 ♂: 158, 164, 166. 5 ♀: 131, 145, 151, 161, 170.
WING. 5 ♂: 165, 170 (2), 173, 178. 6 ♀: 158, 166, 168, 170, 171, 181.

TAXONOMY. These specimens agree with the widespread New Guinea race *C. q. quoyi* in the short wing and in the breadth of the bill at the base as viewed from above. The Australian race *spaldingi* reaches the Aru Islands, and possibly the Digul River and Fly River bulge of southern New Guinea (Mees, 1964, p. 32). Other Eastern Highlands records are from the Jimmi Valley of the northern watershed (Gyldenstolpe) and from Lake Kutubu (Schodde and Hitchcock).

BREEDING. The gonads were very small in all specimens of *C. quoyi,* whereas *C. cassicus* was breeding at this time (August 1964, July-August 1965).

DISCUSSION. *C. quoyi* differs ecologically from *C. cassicus* in being (1) found in the forest interior, (2) solitary, (3) much less common in most parts of New Guinea, and in (4) spending much of its time in the lower story. The latter difference is illustrated by netting results: *C. cassicus* was never netted, whereas four of the 13 specimens of *C. quoyi* were collected with nets.

C. quoyi was more common and conspicuous at Karimui than at any other locality in New Guinea I have visited. Occasionally an individual would come out of the forest, perch up to 20 ft above the ground in a roadside tree, and give its distinctive call, to be answered by a couple of other individuals in the distance. More often it skulked and was glimpsed only briefly as it flew through the undergrowth a few feet above the ground. On Mt. Karimui it was heard occasionally in Zones 1 and 2 between 4,030 and 4,370 ft; this probably represents its altitudinal ceiling.

VOICE. The call and the song are equally loud, ringing, and distinctive and carry considerable distances. The call consists of four notes within a time span of 1 sec (Fig. 34). The first of these four notes is a hoarse upslur, while the second, third, and fourth notes are ringing. The time interval between the first and second notes is twice as long as the other intervals. The second and fourth notes are on the same pitch, and near the pitch of the first note, while the third is a fourth lower in pitch. The bold and ringing song has a striking rhythm and interval pattern (Fig. 34). It begins with three notes in a dotted rhythm, followed by a series of three to six three-note phrases. The second note of all the phrases is on the same pitch, and the third note is always on another pitch a third below the second note. The first note of the phrase is alternately a third and a fourth higher than the second note. The time interval between the first and second note equals that between the second and third note when the pitch interval is a third, and is twice as long when the pitch interval is a fourth. The whole song lasts 5 sec. While these descriptions may sound complicated, both the call and the song are in practice "catchy", unmistakable, and consistent, and may be made clearer by Figure 34. An additional call consists of pairs or longer series of hoarse, harsh, and more or less musical upslurred croaks.

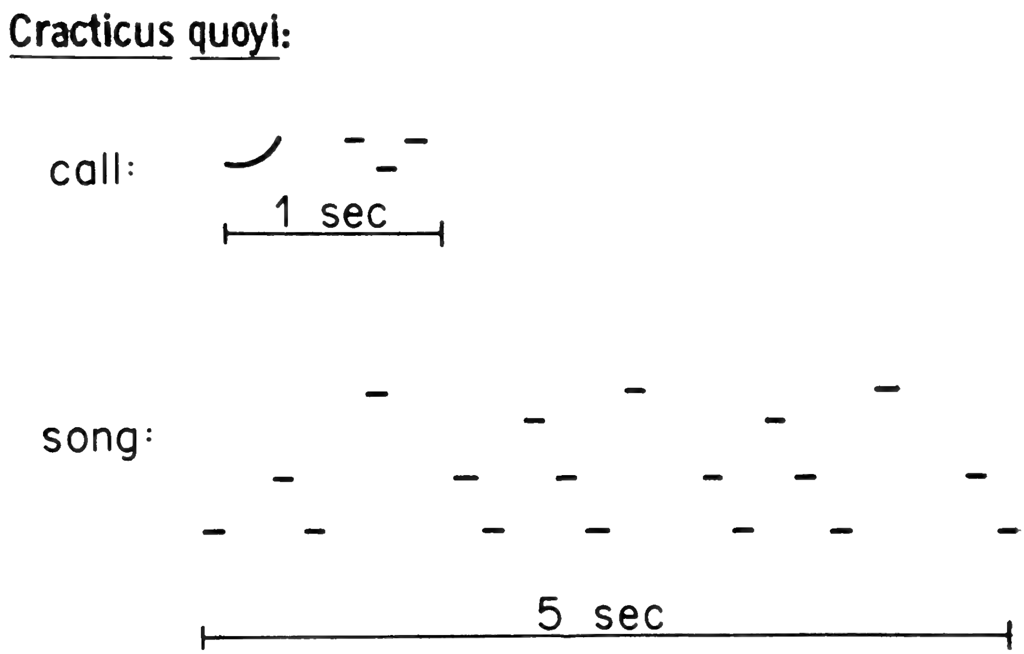


FIG. 34. Voice of *Cracticus quoyi.*

DICRURIDAE: DRONGOS

Dicrurus hottentottus carbonarius Bonaparte

Spangled Drongo

NATIVE NAME. Daribi: sígiyarasáre.

SPECIMENS EXAMINED. Karimui: 4 ♂ (7 Aug. 1964; 18 July-5 Aug. 1965). Bomai: 1 ♂, 3 ♀ (5-9 July 1965). Soliabeda: 2 ♀ (23 and 24 July 1965).

WEIGHT. 3 ♂: 76, 80, 80. 4 ♀: 64, 65, 68, 73.

WING. 5 ♂: 145, 145, 153, 154, 155. 4 ♀: 138, 142, 143, 143.

EXPOSED CULMEN TO EDGE OF FEATHERING ON DORSAL MIDLINE. 5 ♂: 18, 21, 22, 23, 27. 4 ♀: 20, 22, 22, 24.

CULMEN FROM BASE. 4 ♂: 30, 32, 33, 35. 4 ♀: 31, 31, 32, 33.
STOMACH CONTENTS. Insects.

TAXONOMY. The specimens all belong to the resident New Guinea race *carbonarius,* not to the Australian race (possibly a separate species) *bracteatus,* which winters and possibly may breed (Rand, 1938c) in southern New Guinea. *D. h. bracteatus* has a green instead of purple gloss and has less of the bill covered by feathering at the base than does *carbonarius.* My measurements of the exposed culmen give: *carbonarius* (Fly River and Idenburg River, collected by the Second and the Third Archbold Expeditions), ♂ 22-25, ♀, 20-22; *bracteatus* (Fly River, collected by the Second Archbold Expedition, and Cape York Peninsula of Australia), ♂ 26-33; ♀ 27-30. For the whole culmen from the base: *carbonarius* (Fly River), ♂ 31-33, ♀ 30-32; *bracteatus* (Fly River and Cape York), ♂ 33-38, ♀ 32-34 mm.

BREEDING. One Bomai female had enlarged ovaries, but gonads in all other specimens were small.

DISCUSSION. In the Eastern Highlands the Spangled Drongo has been recorded from the Karimui area (to 3,650 ft), and from 3,500 ft in the Baiyer Valley (N.G.B.S. Newsletter, No. 54, p. 2, June 1970), where it is above its normal altitudinal range, and also at Lake Kutubu (2,450 ft). In habits it was solitary and to be found in the middlestory of trees at the edge of the forest and in second-growth but not (or rarely) in the forest interior. It held its perches for relatively long times, frequently flaring its tail and flicking the tail with each call.

VOICE. The call consists typically of three ringing disyllabic notes "k-sing", the second and third notes on the same pitch and the first on a higher pitch. The first syllable is very brief, virtually a grace note to the second syllable, and has a sharp and explosive attack. The longer second syllable is more nasal. Each note lasts not quite ½ sec. This call is surprisingly similar to the usual call of the parrot *Geoffroyus geoffroyi* and sometimes not safely distinguishable from it. Other calls are a rapid series of nasal notes on the same pitch, and notes with a strange quality as a siren or creaking door.

Chaetorhynchus papuensis Meyer

Mountain Drongo

SPECIMENS EXAMINED. Okasa: 2 ♂, 2 ♀ (22-26 June 1965). Sena River: 1 ♀, (6 July 1964). Karimui: 3 ♂, 1 ♀, 1 imm. ? (1 July-5 Aug. 1965). Bomai: 1 ♂, 3 ♀ (6-8 July 1965). Soliabeda: 1 ♀, 1 imm. ? (22 July 1965). Mt. Karimui Zone 1: 3 ♂, 2 ♀; Zone 2: 1 ♂; Zone 3: 1 ♂ (9-16 Aug. 1965).
WEIGHT. 10 ♂: 36-45 (42 ± 2), 10 ♀: 27-39 (33 ± 4). 1 imm. ?: 34.
WING. 10 ♂: 109-122 (115 ± 3), 10 ♀: 102-110 (106 ± 2).

TAXONOMY. The iris is brown, whereas it is orange in *Dicrurus hottentottus,* the other drongo in New Guinea. Most but not all specimens have a well-concealed white patch at the base of the scapulars.

BREEDING. Gonads of all specimens were small, often very small.

DISCUSSION. *Chaetorhynchus papuensis,* a monotypic genus endemic to New Guinea, is a solitary and inconspicuous but ubiquitous species confined to the interior of hill forest. It reached its maximum abundance in Zone 1 of Mt. Karimui (4,000-4,200 ft, 3.5% of the local avifauna). At Soliabeda (2,000 ft), which is probably at the lower limit of its altitudinal range, it was quite uncommon, and its ceiling on Mt. Karimui was around 4,800 ft. There is no tendency for individuals to stray above the ceiling in this species. As usual, only or mainly males are present near the ceiling, while the lowest stations (Soliabeda and Bomai) had mainly females and immatures. I generally found *C. papuensis* perched stationary and upright, like a large flycatcher, on a horizontal branch in the understory or up to 40 ft above the ground. On one occasion I saw the usually-concealed white scapular patch on a bird in the field, suggesting that it may be used for display or recognition purposes.

VOICE. The calls are a strong, explosive "pik" or "peep", given either once or five to seven times in rapid-fire succession; and a down-slurred, whistled "pi-yew". The song is a loud, prolonged jumble.

CORVIDAE: CROWS

Corvus tristis Lesson and Garnot[1]

Bare-faced Crow

NATIVE NAMES. Fore: kai. Gimi: láta. Daribi: tádi.

SPECIMENS EXAMINED. Okasa: 1 ♂ (a) (22 June 1965). Karimui: 3 ♂ (b, c, d), 2 ♀ (e, f) (15 July-5 Aug. 1965). Bomai: 2 ♀ (g, h) (7 and 9 July 1965).

WING. 4 ♂: 320(b), 327 (a), 338 (c), 352 (d). 3 ♀: 325 (e), 334 (f), 334 (g).

TAXONOMY. The males "a", "c", and "d" are colored dark brown, glossy above, and had large or greatly enlarged testes. The female "g" is slightly less dark and glossy. The male "b", which had small testes, and the females "e" and "f", are paler brown with little or no gloss. In each sex the dark birds have longer wings than the pale birds. Taken alone, this might suggest that darkness is correlated with age, but other larger series taken by other collectors have suggested that it is a matter of individual variation.

DISCUSSION. Up to 5,000 ft, rarely higher, this crow is present in low numbers in most forested areas. I met it in flocks of four to six individuals, perched in trees in the forest or else flying slowly near the forest edge. Several sightings were in river gorges. Terborgh found it feeding on small fruits in a strangling fig at Okasa.

VOICE. A hollow, short, and nasal "ka", rather weak and high-pitched for a crow.

[1] Listed as *Gymnocorvus tristis* in Rand and Gilliard (1967).

PARADISAEIDAE: BIRDS OF PARADISE

Generic Revision of the Paradisaeidae

The family Paradisaeidae consists of 25 species or superspecies. Virtually all recent classifications, e.g., the ones by Mayr (1962) in Peters' *Check-list,* Vol. 15, and in the book by Gilliard (1969), distribute these 25 species and superspecies among 20 (sometimes 21) genera, of which 11 are monotypic in the strictest sense, six are monotypic in the sense of consisting of a single superspecies, and only three (15% of the genera) contain more than a single species or superspecies. While this degree of generic splitting and this low species-to-genus ratio (1.25) is unparalleled among bird families of comparable size, there are even more finely split alternative classifications of the Paradisaeidae, such as that of Iredale (1948), who lists many subspecies and hybrids as separate species and genera and thereby arrives at 40 genera.

These classifications deprive the genus taxon of meaning. While the species taxon corresponds to a biological reality, namely, a group of interbreeding populations, the genus taxon and other higher categories are arbitrary groupings erected for taxonomic convenience in indicating relationships. The higher categories are *based* on a biological reality insofar as the distances between species of a phylogenetic tree are not equal. However, these interspecies distances vary continuously, while the number of levels of higher categories is finite and small. Hence delineation of higher categories always involves some degree of arbitrariness and is dictated by practical considerations (see Mayr, 1942, pp. 275-291, especially his Fig. 29, for further discussion). A monotypic genus tells nothing about the relationship of the species in it, and the adding of the genus name to the species name conveys no new information. A practical justification for a monotypic genus nevertheless arises in two cases: if the affinities of a species are unknown; or if a species differs much more markedly in several independent characters from its relatives than its relatives differ from each other.

On neither of these two grounds is the recognition of many monotypic genera among the Paradisaeidae justified. There are only three species in the family about whose affinities not enough is known to place them near some other species. Except in respect to one class of characters (the ornamental plumes of adult males), most paradisaeid species fall into compact groups. Females and immature males of different "genera" are often so similar that even experts such as Stresemann have misidentified specimens as to "genus" (cf. *Lophorina superba pseudoparotia,* p. 312, and the nest attributed to *Loria loriae,* p. 000). Intergeneric hybrids are known from 10 of the 20 "general".

The historical reason for the high degree of generic splitting in the Paradisaeidae has been the ornamental feathers of adult males, which are more bizarre and diverse than in any other family. These ornaments include wire-like feathers growing out of the tail or head, central rectrices several times as long as the rest of the bird, scalloped occipital plumes twice as long as the rest of the bird, wattles, dorsal capes, breast shields, and pectoral fans. However, these ornaments are poor generic characters, because species whose adult males appear at first glance so drastically dissimilar as to suggest they belong to different families may prove to be closely related in most other respects (e.g., *Cicinnurus regius* and *Diphyllodes magnificus; Lophorina superba* and the *Parotia* superspecies). Marked variation in these ornaments occurs even within the same superspecies and was used by Iredale to place members of the same superspecies in different genera. For instance, *Diphyllodes respublica* has a bare crown of naked blue skin, *D. magnificus* does not; *Parotia wahnesi* has a tail twice as long as the other three members of its superspecies; and *Paradigalla carunculata* has a tail three times as long as that of *Paradigalla brevicauda*. Adult male displays can be equally divergent. For instance, *Paradisaea rudolphi* and *P. guilielmi* display upside-down, which the other *Paradisaea* forms do infrequently or never; *Parotia* constructs dance areas on the ground, while the closely related *Lophorina* displays in trees; and *Diphyllodes* similarly constructs ground courts, unlike the arboreally displaying but related *Cicinnurus*.

A generic classification of the Paradisaeidae that indicated relationships more effectively than the oversplit one in current use would be desirable for several reasons. No New Guinea bird family offers such clear and numerous examples of intermediate stages in speciation. As noted by Bock (1963, p. 100), the Paradisaeidae "could provide an excellent example of adaptive radiation in feeding habits", but this has been "one of the least discussed features of the birds of paradise. . . ." They could also illustrate clearly the types of niche differences which make coexistence among closely related species possible. The parallel geographic variation in females of *Lophorina superba* and the *Parotia* superspecies is remarkable but has never been discussed. The acceptance of predominantly monotypic genera has been an important reason why the illuminating examples provided by birds of paradise with respect to these ecological and evolutionary questions of general interest have not received more attention. A prerequisite for exploitation of the Paradisaeidae in this sense is a better understanding of relationships among paradisaeid species, as expressed in generic grouping.

An adequate generic classification should be broadly based rather than relying on single characters. In the following tentative revision I have taken into account the following types of characters: female plumage; similarities rather than differences in adult male plumage; the anatomical studies of Bock (1963) and Stonor (1938); altitudinal range, voice, and observations of behavior and diet derived from my field experience of 17 of the 20 currently recognized genera; geographical distribution; hybridization; and displays. Preliminary efforts also to draw conclusions from eggs were not productive because the variation within the whole family seemed not much greater than the variation within one genus or superspecies. The point of considering altitudinal range is that, in other New Guinea families, species with mutually exclusive altitudinal ranges and similar habits almost always prove to be closely related and congeneric (p. 27). *It is explicitly assumed that no differences in male ornamental plumage, no matter how exaggerated, should disqualify two birds of paradise from being considered congeneric if this is the conclusion indicated by other kinds of evidence. In this family in which morphological divergence has spectacularly outpaced the development of reproductive isolation, it is important to realize that one must accept genera exhibiting a much greater range of morphological variation among adult males than in morphologically more conservative families.*

The starting point for this revision is Bock's (1963) discovery that the Paradisaeidae can be divided into two or three groups by anatomical criteria: the subfamily *Cnemophilinae,* consisting of the "genera" *Cnemophilus, Loria,* and *Loboparadisea;* the subfamily Paradisaeinae, with 16 of the 17 remaining "genera"; and the monotypic genus *Macgregoria,* which appears in several respects intermediate. I consider in turn the following problems: (1) The relation between *Manucodia* and *Phonygammus.* (2) The relation between *Epimachus* and *Drepanornis.* (3) The relation between *Cicinnurus* and *Diphyllodes.* (4) The relations between *Lophorina, Parotia,* and *Ptiloris.* (5) The affinities of groups 3 and 4 to each other, and of *Astrapia, Pteridophora,* and *Seleucidis.* (6) The affinities of the remaining groups of Paradisaeinae (*Paradisaea, Paradigalla, Semioptera, Lycocorax,* and *Macgregoria*). (7) Evaluation of genera of Paradisaeinae. (8) The relations among the three genera of the Cnemophilinae.

1. Relation between *Manucodia* and *Phonygammus.*

The birds of paradise, popularly known as manucodes, comprise four closely related species or superspecies, currently called *M. chalybatus* and *M. comrii* (probably constituting a superspecies), *Manucodia ater, M. jobiensis,* and *Phonygammus keraudrenii.* Apparently all are monogamous and form stable pair bonds, unlike most other birds of paradise. Correlated with this, no hybrids involving these species are known. All are medium-sized (wing 160-240 mm), nearly uniform glossy black, and sexually monomorphic, and have heavy, crow-like bills. All live in the middle- and upperstories of the forest. Probably all have a peculiarity called a convoluted trachea, namely, a loop of windpipe in adults extending onto the breast between the skin and muscles, although the erroneous assumption is sometimes made that this is peculiar to *keraudrenii.* Definitive information about the presence of a convoluted trachea seems to be unavailable for the semispecies *comrii,* but I have dissected specimens of *chalybatus, jobiensis,* and *keraudrenii* with convoluted tracheas, and van Oort (1909, p. 105) published a drawing of the convoluted trachea of *ater.* The description of the call of *jobiensis* by Ogilvie-Grant (1915, p. 9) is similar to the calls I have heard from *keraudrenii,* and Rand (1938d, p. 1) suggested similarity of the call of *jobiensis* to that of *ater.*

In the areas where I have collected, there has been a three-fold altitudinal sequence, with *keraudrenii* at the highest elevations, *chalybatus* at medium elevations, and *ater* and *jobiensis* sharing the lowest elevations. Among the many normally montane species of New Guinea birds that descend to sea level at the mouth of the Fly River are *chalybatus* and *keraudrenii.* The five forms differ in the adult mainly in some details of the ornamentation, which is little developed in manucodes compared to most other paradisaeids. Perhaps the most distinct form is *comrii,* which has twisted central tail feathers, a raised mat of feathers on the crown, and very curled and crinkled feathering of the neck and underparts. Crinkling is present but less marked in *chalybatus* and *jobiensis,* which are difficult to distinguish even as adults. In *keraudrenii* there are elongated head and neck feathers and a tuft of feathers on the crown whose length varies subspecifically, being longest in the races *hunsteini* and in *jamesii* of the Eastern Highlands and shortest in the race *neumanni* and the nominate race. The breast feathers of *ater* are slightly curled and pointed. Immatures and subadults of all species are very similar and have occasionally been misidentified. The most similar species are *chalybatus* and its lowland sibling *jobiensis,* which appears to be the product of a recent speciation and is still largely confined to the north coast of New Guinea but has had its whole geographical range reinvaded by *chalybatus,* the altitudinal ranges of the two species being mutually exclusive.

The monotypic genus *Phonygammus* has long been accepted for the species *keraudrenii.* No other currently used paradisaeid genus seems to me so devoid of justification. The manucodes form a compact group very similar to each other and distinct from other birds of paradise, and constitute an ideal genus. The head tufts of *Manucodia keraudrenii* are greatly reduced in some subspecies, could not be considered a character of generic value even if long and constant, and are much less distinctive than the ornamental feathering of the semispecies *M. comrii.* Even such keen observers of birds of paradise as my Daribi native assistants used the same name, "pagonabo", for *M. keraudrenii* and the other species of manucode in their native valley, *M. chalybatus.*

2. *Epimachus* and *Drepanornis.*

Eleven species or superspecies of the Paradisaeinae (10 currently recognized genera) constitute a related group eight of whose members hybridize with at least one and sometimes with as many as four other members of this group. The females are all brown dorsally, with bars or else markings derived from bars ventrally. The males share to varying degrees the features of a glossy black coloration, a soft velvet texture to the dorsal feathers due to a distinctive feather structure, and a green iridescent crown. This group consists of the "genera" *Epimachus, Drepanornis, Lophorina, Parotia, Ptiloris, Diphyllodes, Cicinnurus, Astrapia, Pteridophora,* and *Seleucidis.* Within this association the most specialized and strikingly distinct forms as regards a functionally significant character are the related genera *Epimachus* and *Drepanornis.*

The genus *Epimachus* consists of two similar species, *E. fastosus* of western New Guinea and *E. meyeri* of eastern New Guinea. They are sympatric in most of central New Guinea with mutually exclusive altitudinal ranges (*E. fastosus,* ca. 4,500-7,500 ft; *E. meyeri,* ca. 7,500-9,500 ft) and are probably products of a recent speciation and reinvasion according to the mechanism discussed on p. 34. The genus *Drepanornis* consists of two similar species whose geographical ranges are still allopatric and which may therefore be considered a superspecies: *D. bruijnii* of the western New Guinea lowlands north of the Central Range between long. 136 and 141°E, and *D. albertisii,* which lives in much of New Guinea except for the area inhabited by *D. bruijnii* and ranges from 2,000 ft up to a ceiling varying geographically between ca. 5,000 and 7,000 ft. The most distinctive features of all four forms is the long and slender sickle-shaped bill (culmen from base 65-80 mm), a feature possessed by no other paradisaeid. *Epimachus* and *Drepanornis* are superficially similar and have always been placed next to each other in classifications.

The similarity appears to be more than superficial. Bock (1963, p. 101) stated that the skulls of the two genera were virtually identical except for the lacrymal being larger in *Epimachus.* Stonor (1938, pp. 468-472) noted that details of the feather tracts were similar, e.g., the extreme narrowing of the terminal portion of the ventral tract. The four forms are of similar sizes (wing 150-210 mm) and share the following features of plumage, several of which distinguish them from such related genera as *Lophorina, Parotia,* and *Astrapia;* a solid gray-brown (*E. meyeri* and both *Drepanornis* forms) or black (*E. fastosus*) breast in adult males; similar lateral tufts and pectoral tufts in adult males (cf. Stonor, 1938), but not the distinct breast shields of *Lophorina* or *Parotia* or the different shield of *Astrapia;* a solid velvet-black chin in adult males; a brown unstriped head in *Epimachus* males and in both sexes of *Drepanornis,* unlike the black striped head of *Lophorina* and *Parotia;* and barred underparts in the females. The most marked plumage differences between *Drepanornis* and *Epimachus* concern the much longer tail of *Epimachus,* and the upperparts of adult males, which are brown in *Drepanornis* (as in females of all four forms) but velvet-black on the back and iridescent blue-green on the crown in *Epimachus,* as in *Lophorina, Parotia,* and *Astrapia.*

Little is known about the habits of *D. bruijnii,* but the other three forms live in the forest crown and use their long bills to probe for insects and pick berries. The stomach contents given on labels of Shaw-Mayer's specimens of these three forms in the American Museum of Natural History include grasshoppers, other insects, berries, and fruit; the stomach contents of *E. meyeri* which I dissected included insects, grubs, and fruit; and van Heurn found fruit and seeds in the stomach contents of *D. bruijnii* (Hartert, 1932). The two genera together may provide a threefold altitudinal sequence, *D. albertisii-E. fastosus-E. meyeri.* On Mt. Karimui I found that the range of *D. albertisii* was wholly below that of *E. fastosus,* and this is also suggested by Stein's (1936) records for the Weyland Mountains, with the transition altitude around 4,200-5,000 ft. In southeastern New Guinea, where the middle-altitude *E. fastosus* is absent and only the high-altitude *E. meyeri* remains, and on the Huon Peninsula, where both species of *Epimachus* are absent, labels of specimens taken by Anthony and Shaw-Mayer show *D. albertisii* as high as 7,000 ft, suggesting that it may range higher in the absence of competition from *E. fastosus.*

Since the four sicklebills are closer to each other than to other paradisaeids and share the most specialized bills of the family, they form a natural genus, with the name *Epimachus* having priority and *Drepanornis* available as a subgeneric name. Presumably the common ancestor speciated to form the two lines or subgenera, with each line speciating again to yield the present four forms.

3. Relation between *Cicinnurus* and *Diphyllodes.*

The genus *Diphyllodes* consists of a superspecies, *D. magnificus* on the New Guinea mainland and *D. respublica* on the islands of Waigeu and Batanta. *Cicinnurus* is monotypic (*C. regius*). At first glance one is struck by dissimilarities in the adult males, *Cicinnurus* being scarlet and white, *Diphyllodes* green, velvet, red, and yellow. The displays are also different, *Diphyllodes* clearing courts on the ground, *Cicinnurus* displaying in the trees. However, the two genera are similar in most other respects and have been placed next to each other in recent classifications. The affinity is attested by the fact that more hybrid specimens of the *D. magnificus* $\times$ *C. regius* cross are known than for any other paradisaeid hybridization.

The morphological resemblances include the following. Adult males of both genera have two slender, greatly elongated central rectrices, which cross at the base (as in no other paradisaeid), are curved at the tip, and have barbs restricted to one side of the shaft. The feather tracts are similar (Stonor, 1938). The skulls are very similar in most respects (Bock, 1963). In both genera the back of the adult male has scarlet areas, and lacks black areas, whereas the other related paradisaeids in which the female also has barred underparts (*Lophorina, Parotia, Astrapia,* etc.) have the back largely velvet-black in the adult male and lack scarlet areas. The females are similar generally, and particularly in having brown unstriped heads, unlike the blacker striped heads of *Lophorina, Parotia,* and *Ptiloris. Cicinnurus regius* is closer to *D. respublica* than to *D. magnificus,* e.g., in size (wing ca. 110 mm in *D. magnificus,* 95 mm in the other two species), in the ventral coloration of the female (the barring is closer and the ground color less ochraceous in *D. magnificus* than in the other two species), and in the red dorsal coloration of the male (least extensive and dullest in *D. magnificus*).

Both *Cicinnurus* and *Diphyllodes* eat mainly fruit and have relatively short bills. Both spend much time in the lowerstory and are regularly trapped in mistnets but also range up to the forest crown. I have not heard the call of *Cicinnurus regius* adult males, but the description of it by Gilliard (1969) is similar in pattern to the calls I heard from *D. magnificus* adult males, a series of loud, harsh notes on the same pitch. Most of the altitudinal range of *D. magnificus* (5,000 ft down to the lower hill slopes, adult males generally uncommon below 2,000 ft) lies above that of *Cicinnurus regius* (the flat lowlands up to about 2,000 ft in most areas). The ecological differences between these two similar species in the zone of altitudinal overlap are probably related in large part to size, since *D. magnificus* is 60% heavier than *C. regius.*

Consideration of the taxonomic status of *Diphyllodes* and *Cicinnurus* is postponed until the remaining species of Paradisaeidae have been discussed.

4. Relations between *Lophorina, Parotia,* and *Ptiloris.*

The genus *Lophorina* is monotypic (*L. superba*), while *Parotia* consists of a superspecies (*P. sefilata, P. carolae, P. lawesi,* and *P. wahnesi*) and *Ptiloris* also consists of a superspecies (*P. magnificus, P. victoriae, P. paradiseus*). *Parotia* is distinct in that adult males clear display courts on the ground and have six wire-like plumes on the head. There are also some differences in the bills and hence in the feeding habits and skulls of these three groups. *Parotia* has a bill similar to that of *Cicinnurus* or *Diphyllodes* and feeds largely on fruit. *Lophorina* has a more slender bill and takes not only fruit but also beetles, grasshoppers, and other insects. The bill is somewhat longer in *Ptiloris* (more so in *P. magnificus* than in the other two semispecies) and is used to obtain insects from bark and crevices as well as to take fruit. In plumage, however, both in the female and in some ornaments of the adult males, these three groups are extremely similar. So detailed is the resemblance that Stresemann (1923, p. 31) initially listed the *Lophorina* females collected by Bürgers on the Hunsteinspitze as

Parotia carolae, and only 10 years later did he recognize them as a (thinly differentiated) new race of *Lophorina superba,* which he accordingly named *L. s. pseudoparotia.* Hybrids are known between *Lophorina* and *Parotia,* and between *Lophorina* and *Ptiloris.*

The plumages of the adult males are basically similar except for the wire-like plumes of *Parotia.* The coloration is mainly black, with glosses of various shades. The dorsal feathers have a soft, velvet-like texture and, in *Lophorina,* are laterally prolonged into a cape. The crown is iridescent blue-green (in *Parotia* this is true only distally). All three species or superspecies possess a distinctive ventral ornament shared by no other paradisaeid, an iridescent blue-green breast shield of flattened, stiff feathers which have black central dots in some populations of each group (e.g., the dots are present in *Parotia, Ptiloris magnificus,* and the *Lophorina superba* races from the Central Range, but they are absent in *Ptiloris victoriae, Ptiloris paradiseus,* and the races *Lophorina s. superba* and *L. s. niedda* of the Vogelkop and Wandammen Peninsula). The shield is markedly prolonged laterally in *Lophorina* and slightly in two of the three *Ptiloris* semispecies. The iridescence of the shield varies from green to purplish among the *Parotia* semispecies. The feather tracts in the three "genera" are similar (Stonor, 1938).

The females share a basic color pattern (brown back, blackish head and moustache with whitish superciliary and gape stripes, close black and white ventral barring on an ochraceous background), and similar types of marked geographic variation are encountered in the three groups. The upperparts vary from rufous (*Ptiloris magnificus, Parotia wahnesi* and *P. lawesi*) to olive-brown (*Ptiloris paradiseus* and *P. victoriae, Parotia carolae, Lophorina superba latipennis*). Rufous edges are present on the remiges of *Ptiloris magnificus, Parotia wahnesi* and *P. carolae,* and the *Lophorina* races of the Central Range; reduced in *Ptiloris paradiseus, Ptiloris victoriae* and *Parotia lawesi;* and nearly absent in *Parotia sefilata* and the *Lophorina* races *superba* and *niedda.* The underparts have a pronounced ochraceous wash in *Ptiloris victoriae* and *Parotia lawesi* and *P. wahnesi,* less of a wash in *Ptiloris paradiseus, Parotia carolae,* and *Lophorina s. feminina,* still less of a wash in *Parotia sefilata* and *Lophorina s. minor,* and the ground color is virtually white in *Ptiloris magnificus.* The light superciliary stripe is conspicuous in *Ptiloris, Parotia carolae,* and the *Lophorina* races from the Snow Mountains (*feminina*) eastwards; reduced to a narrow streak posterior to the eye in *Parotia wahnesi;* and completely or nearly absent in *Parotia sefilata* and *P. lawesi* and the *Lophorina* races *L. s. niedda* and *L. s. superba.* The crown is black in the *Parotia* semispecies *sefilata, lawesi,* and *wahnesi* and in the *Lophorina* races *L. s. superba* and *L. s. niedda,* brown in *Ptiloris magnificus, Parotia carolae,* and *Lophorina s. feminina.* In the area immediately below the eye the light gape stripe is absent in the

Lophorina races *L. s. superba* and *L. s. niedda,* while the dark moustache is conspicuous in the *Parotia* semispecies *sefilata, lawesi,* and *carolae,* reduced in *Ptiloris magnificus* and *Parotia wahnesi,* virtually absent in *Ptiloris paradiseus,* and entirely absent in the *Lophorina* races of the Central Range. The markings of the underparts are bars in *Parotia, Lophorina,* and *Ptiloris magnificus,* crescent-shaped in *Ptiloris paradiseus,* and reduced to sparse dots in *P. victoriae.*

One of the most remarkable and overlooked features of this geographic variation of the females is that it runs parallel in some populations of *Parotia* and *Lophorina.* Thus, *Parotia sefilata* is confined to the Vogelkop and Wandammen Peninsula. The *Lophorina* races in this region (nominate *superba* on the Vogelkop, *niedda* on the Wandammen Peninsula) resemble a small version of this *Parotia* semispecies in the black head, dark back, reduction of the rufous edges of the remiges, and obliteration of the superciliary stripe, and differ only in the absence of the gape stripe. In the Snow Mountains the crown is brown and the superciliary conspicuous both in the *Parotia* semispecies (*carolae,* the one for which Stresemann and van Heurn independently mistook *Lophorina*) and the *Lophorina* race (*feminina*), and the olive back, the rufous edges of the remiges, and the color of the underparts match well. In eastern New Guinea the species deviate, since the underparts are much less ochraceous, and the superciliary is much more conspicuous, in *Lophorina* than in *Parotia* (*P. lawesi* and *P. wahnesi*).

The altitudinal ranges of *Lophorina* and *Parotia* largely coincide with each other (usually ca. 3,500-6,500 ft), and largely exclude that of *Ptiloris magnificus* (sea level to ca. 3,000 or 4,000 ft). Ecological segregation between *Parotia* and *Lophorina* probably depends on *Parotia*'s greater size (nearly twice as heavy as *Lophorina*) and *Lophorina*'s longer bill and greater consumption of insects.

5. Affinities of groups 3 and 4, and of *Astrapia, Pteridophora,* and *Seleucidis.*

While *Cicinnurus* and *Diphyllodes* are particularly close, and *Ptiloris, Lophorina,* and *Parotia* are very close, these two groups are also related to each other. This is illustrated by the basically similar pattern of the females (brown dorsally, barred underparts; remiges edged rufous in *Diphyllodes respublica* and in *Cicinnurus* but not in *D. magnificus*) and by the resemblances between the skull and bill of *Parotia* on the one hand and of *Diphyllodes* and *Cicinnurus* on the other (Bock, 1963). Field observations suggest that *Diphyllodes magnificus* and *Lophorina* are close. Adult males of these two common species have mutually exclusive altitudinal ranges: on Mt. Karimui I found that the lowest adult males of *Lophorina* appeared about 35 ft above the highest males of *Diphyllodes.* While *Lophorina* females and immature males penetrated 1,000 ft into the range of *Diphyllodes,* the abundances of the two species varied complementarily in the overlap zone so that the sum of their abundances remained relatively constant. The calls of adult males are quite similar. The species differ only by 13% in weight, and both spend much time in the understory but also range into the forest crown. Hybrids are known.

There are three other birds of paradise whose relationship to the *Lophorina* and *Cicinnurus* groups is indicated by female plumage, and whose relationship to the *Lophorina* group is further indicated by male plumage. These are the *Astrapia* superspecies, *Pteridophora alberti*, and *Seleucidis melanoleuca:*

Astrapia consists of five midmontane and high-altitude semispecies (*A. nigra, A. splendissima, A. mayeri, A. stephaniae,* and *A. rothschildi*). The adult male plumage conforms closely to the *Lophorina-Parotia-Ptiloris* type (black with various glosses, the crown iridescent blue-green, the back with a soft velvet-like texture). The central rectrices of the adult male are greatly elongated as in *Epimachus* and (less markedly) in *Parotia wahnesi,* and the feathers of the nape are lengthened to varying degrees in different subspecies. However, *Astrapia* lacks specially modified ornamental feathers. The females are brown dorsally, barred ventrally, and brownish-black on the head and upper breast. Most of the altitudinal range of *Astrapia* is shared by the smaller *Pteridophora,* which weighs only half as much, and by the sicklebilled *Epimachus meyeri.* The lower part of *Astrapia*'s range is shared with *Lophorina* and *Parotia.* Hybrids with *Epimachus fastosus* are known. Although *Astrapia* would be regarded as wildly aberrant in any other family, by the standards of the Paradisaeidae it must be considered as having few distinctive features of significance. The long tail of the adult male cannot be regarded as a good generic trait within this family, because of the marked variation in tail length among the semispecies of *Parotia* or *Paradigalla* and between the related *Epimachus* and *Drepanornis. Astrapia* has generally been placed next to *Epimachus* in classifications because of the long tail, but lengthened tails have apparently been acquired independently in four groups (*Parotia, Paradigalla, Astrapia, Epimachus*) among the 11 species or superspecies of the brown-female complex (listed on p. 309). There is no other reason to suspect that *Astrapia* is closer to *Epimachus* than to other members of the complex.

The monotypic genus *Pteridophora* (*P. alberti*) has particularly bizarre ornamental feathers in the adult male, a pair of long and scalloped occipital plumes. As in *Lophorina,* the upperparts are black with a soft velvet texture, and the feathers of the upper back are lengthened into a *Lophorina*-like cape, but the lower breast and belly differ from *Lophorina* in being yellowish. Females are brown dorsally, lack stripes on the head (cf. *Cicinnurus*), and are whitish ventrally with dark curved bars similar to those of *Ptiloris paradiseus* females but less deeply curved. The weight of *Pteridophora* is approximately the same as that of *Lophorina.* The altitudinal range is almost entirely above that of *Lophorina,* both in my experience and in that of Gilliard (1969). The only competing species of Paradisaeinae at these altitudes are the heavier *Astrapia* and the sicklebilled *Epimachus.* As gauged from stomach contents, the diet is largely fruit, with seeds reported once. *Pteridophora* may be thought of as the high altitude member of the four-species altitudinal sequence *Pteridophora-Lophorina-Diphyllodes-Cicinnurus.* The bill and skull are much as in *Cicinnurus* or *Parotia* (Bock, 1963). *Pteridophora* may be less close to the *Lophorina* group, particularly in the colored underparts of the male, than is *Astrapia,* but it is still a relatively undistinctive form (apart from the occipital plumes).

The monotypic genus *Seleucidis* (*S. melanoleuca*) lives in lowland swamp forest, has an elongated bill, is medium-sized (160-200 g), and feeds on seeds, fruit, insects, and nectar. The female plumage conforms extremely closely to the *Lophorina-Parotia-Ptiloris* pattern: the back and wings are rufous (cf. *Ptiloris magnificus, Parotia wahnesi*), the head solid black (cf. *Lophorina s. superba* and *L. s. niedda*), the underparts pale ochraceous with close barring (as close as in *Ptiloris magnificus* and *Diphyllodes,* somewhat closer than in *Lophorina* or *Parotia*). The male shares with *Lophorina* and its allies the glossy black upperparts with a soft velvet texture. The breast shields of *Seleucidis, Ptiloris, Lophorina,* and *Parotia* males form a series: all feathers are stiff and flattened in *Lophorina* and *Parotia,* fewer are stiff and flattened in *Ptiloris magnificus,* still fewer in *Ptiloris paradiseus,* fewer again in *Ptiloris victoriae,* and none in *Seleucidis,* in which the whole shield is composed of soft feathers. The male of *Seleucidis* differs from *Lophorina* in its yellow belly which fades to white postmortem and in its lengthened white flank plumes with 12 wire-like feathers, but these features are paralleled by the yellowish belly of *Pteridophora* and the lengthened purple flank plumes of *Ptiloris magnificus.* Hybrids with *Ptiloris* and *Paradisaea* are known. The bill is somewhat more specialized than in other forms of groups 3, 4 and 5 but is not nearly so specialized as in *Epimachus* and is quite like that of *Ptiloris,* especially *Ptiloris magnificus.* The skull is undistinctive and typical of the Paradisaeinae (Bock, 1963). Particularly the female plumage, but also the above-mentioned features of the male plumage and the bill, place *Seleucidis* near its allies *Ptiloris* and *Lophorina.*

The taxonomic status of these three "genera" is considered later.

6. Remaining species of Paradisaeinae.

Five genera of Paradisaeinae remain to be considered. The first three of these are "good" monotypic genera whose affinities are obscure.

Macgregoria pulchra is a high-altitude, monogamous, sexually monomorphic species of particularly obscure affinities, in that it is not even clear whether it belongs to the subfamily Cnemophilinae or Paradisaeinae (Bock, 1963).

Lycocorax pyrrhopterus is confined to the Molucca Islands, where the only other paradisaeid is *Semioptera*. Like the manucodes, which it suggests superficially in its bill, size, and uniform glossy dark brown color, *Lycocorax* is monogamous and sexually monomorphic. There is no reason to suspect a particular affinity of *Lycocorax* to any other member of the Paradisaeinae, unless *Manucodia*. Whether its superficial similarity to *Manucodia* represents true relationship or convergence is unclear (Bock, 1963).

Semioptera wallacei is the other paradisaeid of the Moluccas. The female is uniform brown. The male differs only in having a pair of long white plumes arising from each shoulder, and a green, laterally-expanded breast shield superficially reminiscent of *Diphyllodes magnificus* but basically quite dissimilar (Stonor, 1938). The form of the ventral feather tract is shared with no other paradisaeid (Stonor, 1938). The bill is elongated and heavy. Bock (1963) states that the skull is typical of the Paradisaeinae and especially resembles that of *Seleucidis*. Clear indications of a particular affinity of *Semioptera* to some other paradisaeine genus are lacking, and the female plumage is distinct.

The *Paradigalla* superspecies (*P. carunculata* and *P. brevicauda*) is sexually monomorphic, uniformly black, and adorned only by facial wattles. This plumage is distinctive for a paradisaeid female (superficially suggested only by *Macgregoria*). However, the crown has stiffened blue-green feathers as in *Lophorina, Ptiloris, Epimachus,* and *Astrapia* males. Hybrids with *Lophorina, Parotia* and *Epimachus* further imply affinities to this large group of paradisaeines. The skull is apparently typical of the Paradisaeinae (Bock, 1963).

The last genus, *Paradisaea,* consists of a superspecies (*P. apoda, P. rubra, P. raggiana, P. minor, P. decora*) plus *P. rudolphi* of eastern New Guinea and *P. guilielmi* of the Huon Peninsula. The latter two are sympatric with the superspecies and inhabit altitudinal ranges that lie largely or entirely above that of the superspecies. Some affinities to the large group of Paradisaeinae with barred females are suggested by the distinctly barred underparts of *P. rudolphi* females and the obscurely barred underparts of *P. decora* females, as well as by hybrids with *Ptiloris, Diphyllodes,* and *Seleucidis*. *Diphyllodes* and *Cicinnurus* may be the members of this group to which *Paradisaea* is nearest, as suggested by the following shared features: elongated wire-like central rectrices with barbs reduced or absent, the presence of red or yellow and absence of black on the back of males (except in *P. rudolphi*), and the upside-down displays of males of *P. guilielmi, P. rudolphi,* and occasionally *Cicinnurus regius* and *P. raggiana*.

7. Evaluation of genera of Paradisaeinae.

Having surveyed the 22 species or superspecies of Paradisaeinae, we may now consider how best to draw generic lines.

Macgregoria pulchra, Lycocorax pyrrhopterus, and *Semioptera wallacei* are each isolated forms without clear affinities to another species. These three, and only these three, members of the Paradisaeinae fulfill the criteria of good monotypic genera. *Manucodia* is an isolated and very homogeneous group of four species (one a superspecies). In the case of *Paradisaea* (three species, one a superspecies) there seem to be clear affinities with *"Diphyllodes"* and *"Cicinnurus"*, but *Paradisaea* is still sufficiently distinct and compact that its right to stand as a genus is unlikely to be disputed. Similarly, the *Paradigalla* superspecies is related to the *Lophorina* complex but constitutes a distinctive and acceptable genus.

The remaining 11 species or superspecies form a related group, as indicated by the female plumage of all members, the male plumage of most, and hybridization. From this group *Epimachus* (including *Drepanornis;* three species, one a superspecies) deserves to be subtracted as a separate genus, because its species share the most strikingly distinct bill in the family and form a compact group which has radiated in three easily reconstructed speciations.

The assignment of the other eight species or superspecies of the group provides the most recalcitrant obstacle to a satisfactory generic revision of the Paradisaeidae. It may be recalled that within this group *"Diphyllodes"* and *"Cicinnurus"* form one closely-knit subgroup, *"Lophorina"*, *"Parotia"*, and *"Ptiloris"* form another subgroup, and *"Astrapia"*, *"Seleucidis"*, and *"Pteridophora"* are each separate. One solution would therefore be to recognize five genera, two polytypic and three monotypic. Against this solution one may object that it fails to express taxonomically the interrelationships within the group, that it exaggerates the distinctness of the members by comparison with the other much more distinct paradisaeid genera, and that neither *Astrapia, Pteridophora,* nor *Seleucidis* has characters warranting erection of a monotypic genus, if one rejects ornamental plumes as a proper basis for monotypic genera. Alternatively, the eight species could be placed in a single genus (*Lophorina*) of five subgenera (*Cicinnurus, Lophorina, Astrapia, Seleucidis,* and *Pteriodophora*), as illustrated in Table 10 (p. 321). This has the disadvantage that eight of the 22 members of the subfamily Paradisaeinae would be placed in one rather large genus, and that the differences between some of the species in this genus would be greater than the differences among congeneric species in the other polytypic genera (*Manucodia, Paradisaea, Epimachus*). The former point is less a disadvantage than simply a recognition of a biological reality, that the subfamily does consist of a group of eight species plus several more isolated groups or species. The latter difficulty is inevitable in translating a phylogenetic tree into hierarchical nomenclature with a finite number of levels: the possible distances between species of the tree vary continuously, and it is therefore impossible to attain a nomenclature in which the distances between all units on the same level are equal. On the whole the arrangement of Table 10 appears to me the least unsatisfactory one I can devise at present, in expressing relationships and in minimizing variation in differences between taxonomic units on a given level.

8. Subfamily Cnemophilinae.

As presently construed, this subfamily consists of three monotypic genera, *Cnemophilus* (*macgregorii*), *Loria* (*loriae*), and *Loboparadisea* (*sericea*). Bock (1963) showed that these three species resemble each other, and differ from the species of Paradisaeinae, in several features of skull construction sufficiently distinctive to warrant placing these three birds in a separate subfamily.

Among these three species *Loria loriae,* which De Vis initially described in the genus *Cnemophilus,* and *Cnemophilus macgregorii* resemble each other, and differ from *Loboparadisea,* in several morphological respects. *Loboparadisea* is a smaller bird (weight 62-77 g vs. 80-100 g for the other two species). The underparts of the adult male are yellow in *Loboparadisea,* velvet-black (*Loria*) or brownish velvet-black (*Cnemophilus*) in the other two. The females of *Cnemophilus* and *Loria* are unpatterned and rather uniform-colored birds: *Cnemophilus,* olive-brown, slightly paler below; *Loria,* olive, paler and more yellow below, olive-brown on the wings and tail. Both *Cnemophilus* and *Loria* females present a slightly scaled appearance due to obscure dark feather margins. *Loboparadisea* females have a distinct pattern dorsally, in that the head and upper back are olive-brown, the lower back and rump yellow, and the tail rufous-brown; the underparts are yellow. *Loboparadisea* has a distinct immature plumage which is streaked ventrally and which is otherwise more like adult females of *Cnemophilus* than of *Loboparadisea,* whereas in the cases of *Loria* and *Cnemophilus* immatures resemble the adult female. *Cnemophilus* and *Loria* females are sufficiently similar that when Shaw-Mayer and Loke Wan Tho discovered the nest of *Cnemophilus* and obtained a high quality close-up photograph of the female at the nest in sharp focus, the bird was misidentified as *Loria,* Sims (1956, p. 426) described the nest under *Loria,* Gyldenstolpe (1955, Pl. XI) published a 7″ × 5″ reproduction of the photo labeled as *Loria* in his report on his collections, and the misidentification was still not recognized until years later. In dorsal coloration adult males of *Loria* and *Cnemophilus* differ, since *Loria* is velvet black dorsally as ventrally, while *Cnemophilus* is yellow-orange anteriorly becoming browner posteriorly and on the wings. In addition, *Cnemophilus* has a short, slender crest of six feathers. *Loboparadisea* adult males are distinctively patterned as the adult females but with brighter colors, and have pale blue-green wattles at the base of the bill.

Ecological and distributional evidence alone would suffice to indicate a close relation between *Cnemophilus* and *Loria*. Both species live mainly in the understory (unlike the more arboreal *Loboparadisea*) and feed on fruit. The local altitudinal ranges of the two species appear to be mutually exclusive, with the transition altitude around 7,600 ft on Mt. Karimui (*Cnemophilus* at higher altitudes, *Loria* lower). The geographical range of *Cnemophilus* is confined to southeastern New Guinea and the Eastern Highlands, a distribution shared by only five other montane species, all products of a recent speciation. One of these, the semispecies *Parotia lawesi,* is still allopatric to its relatives; *Astrapia stephaniae* is largely allopatric to its relatives but overlaps *A. mayeri* at the western extremity of its range, the two forms living in mutually exclusive altitudinal bands; while the geographical ranges of the other three, *Ptiloprora guisei, Amblyornis subalaris,* and *Paradisaea rudolphi,* are shared completely with their more widespread congeners *Ptiloprora perstriata, Amblyornis macgregoriae,* and *Paradisaea raggiana,* with the two forms segregating altitudinally in each case. These five cases represent stages in a shared speciation pattern, in which the range of a southeastern New Guinea isolate of a superspecies is reinvaded and completely overrun by the next isolate to the west, the southeastern isolate also gradually extends westward, and sympatry is made possible by altitudinal segregation. By analogy *Cnemophilus* probably evolved as a southeastern New Guinea isolate of a superspecies including *Loria*. The course of speciation seems to have proceeded equally far in the cases of *Cnemophilus macgregorii, Ptiloprora guisei,* and *Paradisaea rudolphi,* all three of which now share their entire geographical ranges with the sister species and have extended westward to somewhere between long. 143°30′ E and 142°E.

For these reasons the species *loriae* and *macgregorii* should again be considered congeneric, as De Vis did initially. *Cnemophilus* has priority as the genus name, and *Loria* becomes a synonym. *Loboparadisea* remains as an allied but monotypic genus.

Conclusions.

The classification tentatively arrived at is summarized in Table 10. The 25 species or superspecies are now distributed among 10 rather than 20 genera, yielding a species-to-genus ratio of 2.5. Of the 10 genera, five are monotypic, one contains two species, two contain three species, one contains four species, and one contains eight species. All of the 10 discarded genera are monotypic, five in the strictest sense, five in the sense of consisting of a single superspecies.

Nomenclatural problems which would result from this classification are that the species name of *"Ptiloris" magnificus* (described as *Falcinellus magnificus* by Vieillot in 1819) would become preoccupied by that of *"Diphyllodes" magnificus* (described as *Paradisaea magnifica* by Pennant in 1781) as a result of both being transferred to the genus *Lophorina;* and that the species name of *"Pteridophora" alberti* (described under the same name by Meyer in 1894) would become preoccupied by the race *"Ptiloris" magnificus alberti* (described as *Ptiloris alberti* by Elliot in 1871) as a result of both being transferred to *Lophorina.* However, coining of new names seems unwise, and likely to lead only to confusion, until these and perhaps other proposals for generic reclassification of birds of paradise have been more widely discussed and until more evidence has accumulated. For the present, in referring to paradisaeid species whose familiar generic names I proposed to discard, I shall continue to cite this discarded name in parentheses: e.g., *Lophorina (Ptiloris) magnifica, Lophorina (Diphyllodes) magnifica, Epimachus (Drepanornis) albertisii,* and *Cnemophilus (Loria) loriae.*

Cnemophilus macgregorii sanguineus Iredale

Multi-crested Bird of Paradise

SPECIMENS EXAMINED. Mt. Karimui Zone 8: 1 ♂, 1 subadult ♂ (2 and 6 Sept. 1965).
WEIGHT. 1 ♂: 94. 1 subadult ♂: 86.
WING. 1 ♂: 114. 1 subadult ♂: 112.
STOMACH CONTENTS. Fruit, 3-12 mm in diameter.

TAXONOMY. The subadult male has the deep velvet underparts of the adult, with only two small olive patches, and has a full-sized crest, but the upperparts are olive-brown as in the female, with areas of orange on the crown and upper back.

The Eastern Highlands race *sanguineus* is quite distinct from nominate *macgregorii* of southeastern New Guinea in the orange rather than yellow back. The race *kuboriensis* described from the Kubor Mountains was characterized as having paler upperparts and blacker underparts than *sanguineus* (Mayr and Gilliard, 1954, p. 361). Since examination of the type of *kuboriensis* showed that it was extremely similar to *sanguineus,* and since only one other species (*Peneothello sigillatus*) exhibits subspecific differences between Mt. Hagen and the Kubor Range (50 miles from Mt. Hagen), detailed comparison of the following material was undertaken: two adult males (including the type of *kuboriensis*) from the Kubor Mountains, the two Mt. Karimui specimens, and seven topotypical adult males of *sanguineus* from Mt. Hagen. Average wing lengths from the three localities are the same within 1 mm. Two Mt. Hagen specimens and the Mt. Karimui adult are either as dark and black ventrally or slightly more so than the two Kubor birds, five Mt. Hagen birds are slightly paler, and the Mt. Karimui subadult is the blackest. The back and uppertail coverts are slightly paler and less orange in the Kubor specimens, the Mt. Karimui

TABLE 10
GENERIC CLASSIFICATION OF THE PARADISAEIDAE

Proposed Classification	Usual Classification
Subfamily Cnemophilinae	
Cnemophilus macgregorii	*Cnemophilus macgregorii*
Cnemophilus loriae	*Loria loriae*
Loboparadisea sericea	*Loboparadisea sericea*
Subfamily Paradisaeinae	
Macgregoria pulchra	*Macgregoria pulchra*
Lycocorax pyrrhopterus	*Lycocorax pyrrhopterus*
Manucodia ater	*Manucodia ater*
Manucodia chalybatus[1]*-comrii*	*Manucodia chalybatus-comrii*
Manucodia jobiensis	*Manucodia jobiensis*
Manucodia keraudrenii	*Phonygammus keraudrenii*
Semioptera wallacei	*Semioptera wallacei*
Paradigalla carunculata-brevicauda	*Paradigalla carunculata-brevicauda*
Epimachus fastosus	*Epimachus fastosus*
Epimachus meyeri	*Epimachus meyeri*
Epimachus [Drepanornis][2] *albertisii-bruijnii*	*Drepanornis albertisii-bruijnii*
Lophorina superba	*Lophorina superba*
Lophorina sefilata-carolae-lawesi-wahnesi	*Parotia sefilata-carolae-lawesi-wahnesi*
Lophorina magnifica-paradisea-victoriae	*Ptiloris magnificus-paradiseus-victoriae*
Lophorina [Cicinnurus] magnifica-respublica	*Diphyllodes magnificus-respublica*
Lophorina [Cicinnurus] regia	*Cicinnurus regius*
Lophorina [Astrapia] nigra-splendissima-mayeri-stephaniae-rothschildi	*Astrapia nigra-splendissima-mayeri-stephaniae-rothschildi*
Lophorina [Pteridophora] alberti	*Pteridophora alberti*
Lophorina [Seleucidis] melanoleuca	*Seleucidis melanoleuca*
Paradisaea rubra-apoda-raggiana-minor-decora	*Paradisaea rubra-apoda-raggiana-minor-decora*
Paradisaea guilielmi	*Paradisaea guilielmi*
Paradisaea rudolphi	*Paradisaea rudolphi*

[1] Names of members of a superspecies are connected by hyphens for purposes of brevity.
[2] Subgeneric names are given in brackets.

adult, and one Mt. Hagen bird than in the other six Mt. Hagen birds, and the Mt. Karimui adult is slightly deeper orange on the head than the Mt. Hagen birds, but these differences are also trivial. Hence, *kuboriensis* must be synonymized with *sanguineus*.

BREEDING. The testes of the subadult male were moderately large.

DISCUSSION. *Cnemophilus macgregorii* occurred from 7,620 ft to the summit (8,165 ft) on Mt. Karimui, and has also been collected by Gilliard, Shaw-Mayer, Bulmer, and Hitchcock between 8,000 and 11,000 ft on Mt. Giluwe, Mt. Hagen, and the Kubor Range in moss forest. The western limit of its range must lie somewhere between Mt.

Giluwe and Telefolmin but remains to be determined. It is usually seen in fruit trees, sometimes up to 60 ft above the ground but more often in the understory. Its movements are characteristically abrupt, its wingbeat loud. Once I watched a group of two adult males and two birds in female plumage, moving singly or together 3-40 ft above the ground, often with all four birds within 3 ft of each other, periodically stopping to eat berries. They occasionally gave low harsh calls, and the wings whirred loudly in flight, but the two males appeared not to react to each other, and there was no suggestion of a display. Southeastern New Guinea natives on Mt. Albert-Edward told me that *C. macgregorii* does not carry out a display ("he no sing-sing, he walkabout nothing that's-all"), and Gilliard was given the same information in the Eastern Highlands.

VOICE. Quiet harsh and rasping sounds.

Cnemophilus (Loria) loriae amethystinus (Stresemann)[1]

Loria's Bird of Paradise

NATIVE NAME. Gimi: arudími.

SPECIMENS EXAMINED. Awande: 1 ♂ (19 June 1965). Mt. Karimui Zone 3: 1 ♂; Zone 4: 1 ♂; Zone 5: 2 ♀; Zone 7: 1 ♂; Zone 8: 1 ♂, 1 ♀ (17 Aug.-8 Sept. 1965).

WEIGHT. 5 ♂: 80-101 (90 ± 8). 3 ♀: 91, 94, 95.

WING. 5 ♂: 99-107 (102 ± 3). 3 ♀: 96, 99, 100.

TAXONOMY. Subspecies are founded on the iridescent color of the inner secondaries of adult males viewed in good light: solid violet in *amethystinus,* blue-green in *inexpectatus,* between violet and blue-green in nominate *loriae.* Eastern Highlands specimens are unmistakably *amethystinus.* Gyldenstolpe's (1955, p. 142) suggestion, advanced without comparative material being available, that Eastern Highlands birds might be *C. l. loriae* is untenable. The gape is white.

BREEDING. The testes were moderately enlarged in four of the males, small in the other three.

DISCUSSION. Although *Cnemophilus loriae* was apparently not uncommon between 5,300 and 7,600 ft on Mt. Karimui, I never saw it in the field and obtained no evidence of its presence on Mt. Michael. The frequency of netted individuals indicates lowerstory habits. Gilliard, Gyldenstolpe, Shaw-Mayer, Bulmer, and Hitchcock all collected *Cnemophilus loriae* at various altitudes in forest between 6,000 and 9,000 ft. My highest record of it on Mt. Karimui came 20 ft below the lowest record of *Cnemophilus macgregorii,* and the altitudinal distributions of these congeners also appear to complement each other at other localities, with little overlap.

[1] Listed as *Loria loriae* in Rand and Gilliard (1967).

Loboparadisea sericea sericea Rothschild

Yellow-breasted Bird of Paradise

SPECIMENS EXAMINED. Soliabeda: 1 imm. ? (22 July 1965). Mt. Karimui Zone 1: 1 imm. ♂; Zone 2: 3 ♂; Zone 3: 1 ♂, 1 imm. ♂; Zone 4: 1 ♂, 1 ♀ (10-31 Aug. 1965).

WEIGHT. 5 ♂: 70, 72, 72, 73, 75. 1 ♀: 77. 1 imm. ♂: 63. 1 imm. ♂: 75. 1 imm. ?; 66.

WING. 5 ♂: 94 (3), 95, 96. 1 ♀: 93. 1 imm. ♂: 96. 1 imm. ♀: 93. 1 imm. ?: 98.

TAIL. 2 ♂: 61, 63.

TAXONOMY. Material available for comparison was as follows. *L. s. aurora:* Herzog Mountains, 1 ♂. *L. s. sericea:* type, 1 ♂ (probably from the Weyland Mountains); Weyland Mountains, 7 ♂, 1 ♀, 1 imm. ♂, 3 imm. ♀; Mt. Goliath, 2 ♀; Utakwa River, 1 imm. ♀; Telefolmin, 1 imm. ♂; unknown locality in Dutch New Guinea, 1 ♂. In color the adult males from Mt. Karimui are indistinguishable from nominate *sericea*. They differ from *aurora* in that the top of the head is olive-brown darker than the back, rather than olive scarcely darker than the back; in that the back is less pale and less yellow; and in that the primaries are darker. In the initial diagnosis of *aurora,* Mayr (1930, p. 147) also cited paler yellower underparts with a green instead of orange tone. The underparts of the one *aurora* specimen available to me are paler than the Mt. Karimui males or two Weyland Mountains males but can be matched exactly by other Weyland Mountains males, five of which have a green tone.

Measurements of wing length are given in Table 11. There is obvious variation, but it is too irregular to use as a subspecific character. In the Weyland Mountains females are larger than males, but this is not the case on Mt. Karimui. A single adult male which was received by Gyldenstolpe from the Jimmi River and which was described as closer to nominate *sericea* in color has a wing length equal to the average value for Mt. Karimui males (Table 11).

What Rand and Gilliard (1967, p. 505) describe as the adult female is actually the immature plumage. Adult females have the same pattern as adult males but duller colors. The wattles of the male are very pale blue-green in life.

BREEDING. Gonads were enlarged in three of the five adult males, small in all other specimens.

DISCUSSION. *Loboparadisea sericea* exemplifies to an extreme degree the patchiness of distribution characteristic of numerous New Guinea birds, especially some birds of paradise. It was common on the west ridge of Mt. Karimui, but Gyldenstolpe's Jimmi River specimen is the only other Eastern Highlands record. It appears from published records to be common on Mt. Kunupi of the Weyland Mountains, on the Utakwa River of southwestern New Guinea, and at

TABLE 11
COMPARATIVE WING LENGTH OF *Loboparadisea sericea*

	♂	♀	imm. ♂	imm. ♀
aurora				
Herzog Mountains[1]	96			
	95 (2), 96 (2)[2]			
sericea				
Mt. Karimui	94 (3), 95, 96	93	96	93
Jimmi River	95[3]			
Telefolmin			99	
Mt. Goliath		97, 98		
Weyland Mountains	89, 90, 91 (type), 91, 92, 93 (3)	98	96	94, 96, 98
unknown locality	100			

[1] Localities listed successively from east to west.
[2] From Mayr (1930, p. 147).
[3] From Gyldenstolpe (1955, p. 145).

Dawong in the Herzog Mountains, but to be absent at some nearby localities and in many large and well-explored areas. In all, it is known from only about nine localities (Wau and Dawong in the Herzog Mountains, Mt. Karimui and Jimmi Valley in the Eastern Highlands, Telefolmin, Utakwa River and Mt. Goliath in the Snow Mountains, and Mt. Kunupi and the Gebroeders Range in the Weyland Mountains).

I never observed *Loboparadisea* in the field and can offer only the statement of my native assistants that they found it in the treetops, which is consistent with no specimens having been netted. As with some other hill forest species like *Charmosyna pulchella* and *Rhipidura atra,* the intrusion of the flat Karimui Basin has given it a discontinuous altitudinal range: present at Soliabeda (2,000 ft), absent at Bomai (3,250 ft) and Karimui (3,650 ft), present between 4,000 and 5,890 ft on Mt. Karimui. The population structure follows the usual pattern, with two of the three immatures coming from lower altitudes than any of the adults, and the Soliabeda immature (2,000 ft) a full 2,400 vertical feet below the lowest adult (4,400 ft).

Manucodia chalybatus (Pennant)

Crinkle-collared Manucode

NATIVE NAMES. Daribi: pagonábo (adults), tágari (immatures).
SPECIMENS EXAMINED. Karimui: 4 ♂, 5 ♀ (10-13 Aug. 1964; 2 July-5 Aug. 1965). Soliabeda: 1 imm. ♂ (28 July 1965). Mt. Karimui Zone 1: 1 ♂ (9 Aug. 1965).
WEIGHT. 5 ♂: 158->210. 5 ♀: 167-181 (175 ± 5).
WING. 5 ♂: 154-174 (162 ± 7). 5 ♀: 150-164 (155 ± 4).
TAIL. 5 ♂: 121-138 (131 ± 5). 5 ♀: 119-133 (125 ± 5).
EXPOSED CULMEN. 5 ♂: 34-39 (37 ± 1). 5 ♀: 33-36 (34 ± 1).

TAXONOMY. Apparently iris color changes from brown to red-orange with age: the iris was orange to red in adult males (with crinkled breast and throat feathers) and in most females examined, two of which were in breeding condition, but was orange-brown or brown in subadult and immature specimens. A convoluted trachea was present in adult males.

Subadults and immatures of *M. chalybatus* can be very difficult to distinguish from subadults and immatures of *M. ater,* because the distinctive glosses and feather shapes of the adults are lacking. Hence measurements were made of both species in southern New Guinea (Fly River) and southeastern New Guinea, with the results tabulated in Table 12. The most consistent difference is the longer tail of *M. ater.* In southeastern New Guinea *M. ater* has a longer wing than *M. chalybatus,* but on the Fly River there is much overlap. On the Fly River the dorsal sheen is a useful character except in immatures, since the sheen is consistently more green in *M. ater* there and more purple in *M. chalybatus.* This character is of less use in southeastern New Guinea, where *M. ater* is more purple. *M. ater* is mainly a lowlands species, *M. chalybatus* a hill forest species.

BREEDING. The two females examined at Karimui in 1964 had greatly enlarged ovaries with a nearly full-sized egg, and one crinkled Karimui male in 1965 had the testes slightly enlarged, but the gonads were small in other specimens.

DISCUSSION. Single individuals or pairs of *M. chalybatus* were

TABLE 12
COMPARATIVE MEASUREMENTS OF *Manucodia chalybatus* AND *Manucodia ater* IN SOUTHERN AND SOUTHEASTERN NEW GUINEA

	Exposed Culmen	Wing	Tail
Manucodia chalybatus			
southeastern New Guinea, 3 ♂	39.5-41.0 (40.0)[1]	169-177 (173)	138-142 (140)
southeastern New Guinea, 5 ♀	34.5-37.0 (35.5)	154-167 (158)	120-137 (130)
Fly River, 2 ♂	37.0-38.0 (37.5)	166-177 (172)	138-139 (139)
Fly River, 3 ♀	34.0-35.0 (34.5)	160-162 (161)	123-128 (126)
Karimui, 5 ♂	34.0-39.0 (36.5)	154-174 (164)	121-138 (130)
Karimui, 5 ♀	33.0-36.0 (34.5)	150-164 (158)	119-133 (124)
Manucodia ater subalter			
southeastern New Guinea, 5 ♂	38.0-40.0 (39.0)	192-205 (198)	162-174 (167)
southeastern New Guinea, 5 ♀	36.0-38.0 (37.5)	182-197 (189)	158-164 (160)
Manucodia ater ater			
Fly River, 4 ♂	35.5-36.0 (36.0)	169-182 (176)	144-153 (149)
Fly River, 6 ♀	35.0-36.0 (35.5)	168-178 (174)	144-155 (149)

[1] Average values are given in parentheses.

not uncommon at Karimui and in Zone 1 of Mt. Karimui (1% of the local avifauna) but were inconspicuous, quiet, and remained in the middle- and upperstories. At Soliabeda, which was probably near the bottom of the altitudinal range, the sole record was an immature brought in by natives, and the ceiling on Mt. Karimui was around 4,750 ft. Bulmer also found the species present but very inconspicuous in Kyaka territory up to at least 5,500 ft, and collected a pair of breeding birds at a nest at 5,000 ft. Schodde and Hitchcock obtained it at Lake Kutubu (2,450 ft). The silhouette in flight is similar to that of *Paradisaea raggiana,* and the flight movements are also similar: several quick, convulsive flaps while jerking the tail, then a short glide.

VOICE. The only call I heard was a staccato "tuk" like a raindrop falling in a shallow pan of water.

Manucodia keraudrenii jamesii (Sharpe), *M. k. purpureoviolaceus* (Meyer), and *M. k. neumanni* (Reichenow)[1]

Trumpetbird

NATIVE NAMES. North Fore: kaukábara. South Fore: kautyába. Daribi: pagonábo (adults), tágari (immatures).

SPECIMENS EXAMINED. Awande: 1 ♂, 1 ♀ (15 and 17 June 1965). Okasa: 2 ♂, 1 ♀ (24 Aug. 1964; 23 and 24 June 1965). Karimui: 1 imm. ♂ (4 Aug. 1965). Mt. Karimui Zone 1: 1 ♂, 1 ♀, 1 imm. ♂; Zone 2: 1 ♀ (9-16 Aug. 1965).

WEIGHT. Awande-Okasa: 2 ♂, 168, 174; 2 ♀, 131, 171. Karimui-Mt. Karimui: 1 ♂, 190; 2 ♀, 147, 172; 2 imm. ♂, 174, 175.

WING. Awande-Okasa: 2 ♂, 164, 167; 2 ♀, 151, 161. Karimui-Mt. Karimui: 1 ♂, 164; 2 ♀, 153, 156; 2 imm. ♂, 152, 159.

EXPOSED CULMEN. Awande-Okasa: 3 ♂, 29, 32, 33; 2 ♀, 30, 32. Karimui-Mt. Karimui: 1 ♂, 31; 2 ♀, 29, 30; 2 imm. ♂, 30, 30.

TAXONOMY. The series was compared with *purpureoviolaceus* of southeastern New Guinea, *jamesii* of the Fly River, Aru Islands, and Baroka (southeastern New Guinea lowlands west of Hall Sound), *neumanni* from the Wahgi and Sepik Mountains, and nominate *keraudrenii* from the Weyland Mountains and Vogelkop. Awande-Okasa birds have rather green underparts and blue-violet wings, tail, and back and are closest to Fly River *jamesii,* from which they differ in having the underparts, wings, and tail slightly, and the back considerably, more purple and less green. However, in the color of the back they are only slightly more purple than Aru Islands *jamesii.* Of the Karimui-Mt. Karimui birds, two are quite green above, as are most from the Fly River; one is more blue-violet above and can still be matched exactly by some Fly River birds; and the remaining two are still more blue-violet, both on the back and on the wings, like Awande-Okasa birds. These differences indicate that my series is intermediate morphologically, as it is geographically, between the Fly River

1 Listed as *Phonygammus keraudrenii* in Rand and Gilliard (1967).

(*jamesii*) and southeastern New Guinea (*purpureoviolaceus*); and that the more westerly-lying Karimui series is nearer *jamesii,* as one would expect. The differences are more marked compared to *purpureoviolaceus,* which is much more purple on the underparts, back, wings, and tail. One specimen collected by the Sixth Archbold Expedition in the Kassam Pass belongs to *purpureoviolaceus.* The head plumes in my series are unusually long. *M. k. neumanni* is a very deep dull violet on the lower back, wings, and tail and is the race to which belongs one Nondugl aviary specimen (given to Gilliard) of unknown provenance but presumably from the northern watershed of the Eastern Highlands. Thus, birds in the southern, northern, and eastern parts of the Eastern Highlands are distinct and referrable to three races: *jamesii, neumanni,* and *purpureoviolaceus.*

The immature has less gloss and a smaller crest and beard.

BREEDING. The 1964 Okasa male had greatly enlarged testes, but gonads were small in all other specimens examined.

DISCUSSION. Although in some other parts of New Guinea (notably the mouth of the Fly River) *Manucodia keraudrenii* regularly reaches sea level, it is a hill forest species in the Eastern Highlands, ranging from 3,500 ft up to a variable ceiling at 6,200 ft (Okapa area) or less (4,600 ft on Mt. Karimui). The only record at Karimui (3,650 ft), near the bottom of its range, was of the one immature male. Most of the altitudinal range of *M. keraudrenii* lies above that of *M. chalybatus.* Sightings were of solitary individuals in the middle- or upperstory of the forest, except for a pair at Miarosa in a casuarina grove a few hundred yards from the forest edge. One was seen in a fruiting tree at Miarosa.

VOICE. A prolonged, hoarse, harsh note with a peculiar quality, similar to the sound humans produce in response to a doctor's request, "Open your mouth and say a-a-ah." Also, a musical, downslurred, slightly nasal "kyew", similar in quality to the call of *Philemon novaequineae.*

Paradigalla brevicauda Rothschild and Hartert

Short-tailed Paradigalla

NATIVE NAME. Gimi: íbinimi.
SPECIMENS EXAMINED. Mt. Karimui Zone 3: 1 ♀ (18 Aug. 1965).
WING. 151.
TAIL. 89.

DISCUSSION. This is one of the birds of paradise with a very local distribution. The specimen, collected at 5,160 ft in the forest middlestory, was the only representative of this species I saw. Gilliard collected three in the Hagen and Bismarck Mountains and reported it as "common in the forest crown between 6,500 and 8,000 ft but difficult to collect" (Mayr and Gilliard, 1954, p. 355). In Kyaka territory

Bulmer (pers. comm.) found it "common at forest edge and in forest from below 6,000 to at least 7,000 ft".

Epimachus fastosus stresemanni Hartert

Black Sicklebill

NATIVE NAMES. Fore: kúmpi. Gimi: kúrikúri. Daribi: padukwá.

DISCUSSION. Like several other birds of paradise, *Epimachus fastosus* is at some localities common and at other similar localities absent. On Mt. Karimui, I heard *E. fastosus* males calling most days from about 5,200 to 7,300 ft and saw a female or immature male at the top of a tree at 5,400 ft. Neither Shaw-Mayer nor Gyldenstolpe collected it; Gilliard encountered only one male at 7,500 ft on Mt. Hagen; in Kyaka territory Bulmer (pers. comm.) found it "fairly common at forest edge and in forest 6,000-7,000 ft"; and Bürgers found it common on the Schraderberg.

VOICE. The male's call consists of two identical, sharp, liquid notes in immediate succession, with considerable carrying power: "buk-buk", like the call of a foraging domestic chicken but much sharper and louder. On Mt. Karimui males never called on the ridge crest but only from the steep flanks of the ridge, which I also found to be the case with the isolated population of *Epimachus fastosus ultimus* on Mt. Menawa in the North Coastal Range (Diamond, 1969) and with *Epimachus meyeri*.

Epimachus meyeri bloodi Mayr and Gilliard

Brown Sicklebill

STOMACH CONTENTS. Two mm fruits (two stomachs); insects and 9 mm fruit (one); 7 mm fruit pits and two 40 mm grubs (one).

DISCUSSION. This sicklebill occurs at 8,000-9,500 ft on Mts. Hagen, Kubor, and Wilhelm, the Wahgi Mountains, and the Schrader Range. Its altitudinal range and that of its lower-altitude congener *E. fastosus* are mutually exclusive. In southeastern New Guinea, where *E. fastosus* is absent, I have found *E. meyeri* down to 5,000 ft. It ranges from 10 ft above the ground to the crowns, and congregates in fruiting trees.

VOICE. Adult males call from the steep flanks of ridges, two or three individuals within earshot of each other. The reverberating, totally unmusical call lasts 2 sec, is repeated at intervals of about 2 min, and consists of three double notes. The quality may be compared to the sound of a pneumatic drill, a burst from a machine gun, or a trash can lid being slammed on the pavement and its sound being quickly damped out.

Epimachus (*Drepanornis*) *albertisii cervinicaudus* (Sclater)[1]

Black-billed Sicklebill

NATIVE NAME. Daribi: sodadi.
SPECIMENS EXAMINED. Karimui: 2 imm. ♂ (15 Aug. 1964; 5 Aug. 1965). Mt. Karimui Zone 1: 1 ♂ (10 Aug. 1965).
WEIGHT. 1 ♂: 119.
WING. 1 ♂: 154. 2 imm. ♂: 147, 148.
TAIL. 1 ♂: 130, 2 imm. ♂: 122, 130.
CULMEN FROM BASE: 1 ♂: 75. 1 imm. ♂: 77.

TAXONOMY. Reexamination of available material indicates that only two thinly differentiated races are worth recognizing: nominate *albertisii* (including *geisleri*) from the Vogelkop, Wandammen Peninsula, and Huon Peninsula; and *cervinicaudus* (including *inversus*) from the Central Range. In the adult male, adult female, and immature male *cervinicaudus* has a slightly paler upper tail and slightly lighter, duller, more olive back than *albertisii.* I cannot detect the alleged slight color differences between the populations of the Huon Peninsula ("*geisleri*") and the Vogelkop (nominate *albertisii*) after comparing adult males, adult females, and immature males from both areas. The Karimui population is slightly darker on the back than *cervinicaudus* of southeastern New Guinea but otherwise matches.

DISCUSSION. *Epimachus albertisii* is an uncommon and local species, especially in the main body of New Guinea, where the Karimui series provides the first record for the southern watershed. There appear to be three locality records for the northern watershed (Mt. Kunupi in the Weyland Mountains at long. 135°30′E, the Lordberg in the Sepik Mountains at long. 143°E, and the Herzog Mountains at long. 147°E), in addition to records for four peripheral areas (the Vogelkop, Wandammen Peninsula, Huon Peninsula, and southeastern New Guinea). Rand and Gilliard (1967, p. 470) and Mayr (1941b, p. 170, and in Mayr and Greenway, 1962, p. 189) state that the range includes the northern slopes of the Central Range from the Weyland Mountains to the Lordberg, but this is an incorrect assumption: there are no records at all between the Weyland Mountains and the Lordberg. This area includes the entire range of the closely related and equally uncommon *Epimachus* (*Drepanornis*) *bruijnii* (ca. long. 136-141°E in the lowlands of the northern watershed). The hill slopes in this area have been intensively surveyed by the Third Archbold Expedition around long. 139°E (northern slope of the Snow Mountains), by Mayr around long. 140°30′E (Cyclops Mountains) and by me between long. 141°30′E and 143°30′E in the North Coastal Range, and (less intensively) by van Heurn on the Doormanpad (long. 138°30′E) and by Gilliard at Telefolmin (long. 141°30′E), so that the apparent

[1] Listed as *Drepanornis albertisii* in Rand and Gilliard (1967).

absence of *E. albertisii* in this area is probably real, and it and *E. bruijnii* are probably still allopatric and constitute a superspecies. In addition, their altitudinal ranges are different, since *E. bruijnii* is known only near sea level and *E. albertisii* only in the hills and mountains (3,650-4,200 ft in the Karimui area). On Mt. Karimui the highest record of *E. albertisii* was 1,000 ft below the lowest record of *E. fastosus,* so that the altitudinal ranges of these two similar species are mutually exclusive.

VOICE. Karimui natives pointed out to me a call from the treetops which they said belonged to this species. It consisted of a rapid and loud series of over a dozen musical notes which progressively increased in volume and dropped slightly in pitch. This call is similar to the description of the call of this species by Stein (1936, p. 26) and of *E. bruijnii* by Ripley (1964, p. 48).

Lophorina superba latipennis Rothschild

Superb Bird of Paradise

NATIVE NAMES. Fore: néni (male), piyó (female and immature male). Gimi: nine-óba (male), araro (female and immature male).

SPECIMENS EXAMINED. Awande: 3 ♂, 2 imm. ♂ (14-20 June 1965). Mt. Karimui Zone 1: 1 imm. ♂; Zone 3: 2 ♀; Zone 4: 2 ♀; Zone 5: 1 ♂ (10 Aug.-1 Sept. 1965).

WEIGHT. 4 ♂: 80-93 (89 ± 5). 4 ♀: 60-75 (67 ± 5). 3 imm. ♂: 76, 78, 81.

WING. 4 ♂: 133-138 (136 ± 2). 4 ♀: 113-123 (119 ± 3). 3 imm. ♂: 123, 124, 129.

STOMACH CONTENTS. Fruit, 6-8 mm in diameter.

TAXONOMY. Iredale (1948) founded a race *addenda* on a single adult male from the Hagen district, citing apparently striking differences in the cape, the frontal shield, and the breast feathers. Mayr and Gilliard (1954, p. 358) and Gyldenstolpe (1955, p. 133) did not recognize *addenda,* because adult males from the Hagen district and other parts of the Eastern Highlands proved indistinguishable from males from other parts of the Central Range. However, there has been no agreement as to the correct assignment of the Eastern Highlands population, which has been variously placed with *feminina* (Mayr and Gilliard, 1954; Mayr, in Mayr and Greenway, 1962, p. 193; Rand and Gilliard, 1967), with *pseudoparotia* (Gilliard and LeCroy, 1961), or with a resuscitated *addenda* (Gilliard, 1969) on the basis of female characters. In fact, comparison of Eastern Highlands females with those of other races shows that they are clearly closest to *latipennis* of the Huon Peninsula, from which they differ only in being slightly darker above. From *feminina* they differ obviously in the crown being blacker and less brown, and in having much less white speckling, the underparts having much less ochraceous wash, and the back being darker and more olive. The race *minor* of southeastern New Guinea differs in the crown being slightly more blackish and the back much warmer brown; nominate *superba* (Vogelkop) and *niedda* (Wandammen Peninsula) in the crown being an unspeckled black and the superciliary stripe greatly reduced. Topotypical specimens of *pseudoparotia* (Sepik Mountains), which were not available to me for comparison, were noted by Stresemann (in Gyldenstolpe, 1955, p. 132) and by Mayr and Gilliard (1954, p. 358) to be browner and less olive dorsally than Eastern Highlands females. The race *connectens* of the Herzog Mountains is virtually indistinguishable from *latipennis* and must be considered a synonym. Eastern Highlands males have distinct black centers to the feathers of the breast shield, as do males of all other populations except nominate *superba* and *niedda*.

BREEDING. The gonads were much enlarged in one female, small in the others; small in immature males, and enlarged in most adult males.

DISCUSSION. In my study areas *Lophorina superba* was the commonest bird of paradise within its altitudinal range (ca. 3,500-7,000 ft), and accounted for 3% of the local avifauna at 5,400-6,000 ft on Mt. Karimui. There was marked change in population composition with altitude on Mt. Karimui. Zone 1 yielded only an immature male, and Zone 2 two females or immature males. Zone 3 yielded females, and the first adult male was heard calling at 5,115 ft. Adult males were commonest in Zone 4, where females remained until 5,700 ft. Above 5,700 ft few *Lophorina superba* were encountered, all adult males. At the bottom of the forest on Mt. Michael (ca. 7,000 ft) there were a few *Lophorina superba,* all adult males. This change in sex ratio with altitude, though true of many other species, is particularly marked in birds of paradise, as initially reported by Stein (1936).

There are also some differences in the habits of adult males as opposed to immatures and females. Adult males call and display high in the crowns, though not at the very tops, of leafy trees. In ecologically disturbed areas these display trees are often at the forest edge or in partly cut areas, to a greater extent than with the other midmontane birds of paradise. Females and immatures spend proportionately twice as much time in the understory as adult males. Females and adult males were never seen together, and Paran said that nestlings were fed solely by the female. Terborgh found *Lophorina superba* feeding in fruit trees at Okasa and Miarosa. It is generally solitary and moves slowly.

VOICE. The call of the adult male is a series of seven to ten very harsh, raucous, utterly unmusical notes within a span of 5 sec. Successive notes in the series become lengthened and louder and decelerate greatly. A given individual repeats the series from the same perch at intervals of about 10 min.

Lophorina (Parotia) carolae subsp.[1]

Queen Carola's Six-wired Bird of Paradise

To date there are three Eastern Highlands records, all from the northern watershed: a single female at the Nondugl aviary, possible from the Jimmi River region, which Mayr and Gilliard (1954, p. 358) assigned to the race *chrysenia* despite some differences; a male and a female from the Jimmi Valley, which Gyldenstolpe was unable to assign to an existing subspecies; and one native-prepared skin Bulmer obtained in the Schrader Range, where he also obtained *Lophorina (Parotia) lawesi.*

The four semispecies of *"Parotia"* form a superspecies, with two members (*L. sefilata* of the Vogelkop and *L. wahnesi* of the Huon Peninsula) confined to peripheral mountain "islands". In the main body of New Guinea, *L. carolae* is the western semispecies and *L. lawesi* the eastern semispecies. From present distributional information it appears that the ranges of the two forms meet around long. 144-145°E. The details of the transition may prove as interesting as in the case of the *Lophorina (Astrapia) mayeri-L. (Astrapia) stephaniae* transition.

Lophorina (Parotia) lawesi lawesi (Ramsay)[2]

Lawes's Six-wired Bird of Paradise

NATIVE NAMES. Fore: kíara. Gimi: kíara. Daribi: pápa.

SPECIMENS EXAMINED. Awande: 1 ♂, 1 ♀ (15 and 19 June 1965). Okasa: 1 ♂ (22 June 1965). Mt. Karimui Zone 1: 1 imm. ♂; Zone 2: 2 ♀, 1 imm. ♂; Zone 3: 1 ♀; Zone 4: 1 ♀ (11-27 Aug. 1965).

WEIGHT. 1 ♂: 175. 5 ♀: 139-166 (151 ± 9). 2 imm. ♂: 168, 178.

WING. 2 ♂: 157, 158. 5 ♀: 142-149 (144 ± 1). 2 imm. ♂: 149 (2).

TAXONOMY. Iredale (1948, p. 162) founded the race *exhibita* on a single female from the Mt. Hagen district, remarking that a single male was indistinguishable from nominate *lawesi.* His diagnosis reads: "But the female shows valid colour differences in the marking of the under-surface, the whole being rather deep rufous, closely crossbanded throughout from chin to under tail-coverts, while the upper surface is also a deeper red brown." Since subsequent collectors obtained no females, the validity of *exhibita* has remained unchecked. The above series from the Eastern Highlands was carefully compared with nominate *lawesi* from southeastern New Guinea. Adult males were found to be indistinguishable except, apparently, for a slightly longer wing in Eastern Highlands birds. The females showed no difference in the closeness of the barring of the underparts nor in the color of the upperparts. Of seven Eastern Highlands females examined, three

1 Listed as *Parotia carolae* in Rand and Gilliard (1967).

2 Listed as *Parotia lawesi* in Rand and Gilliard (1967).

agreed in the color of the underparts with most southeastern New Guinea females, while the other four were slightly duller and less rufous below. Hence *exhibita* cannot be recognized. An adult male collected by the Sixth Archbold Expedition at Purosa near Okapa has a wing of 158 mm, and Gyldenstolpe (1955, p. 131) gives 150 mm and 154 mm for the wings of two males from the Jimmi Valley (northern watershed). My measurements of southeastern New Guinea *lawesi* give average wing lengths of 151.6 mm for adult males and 142.3 mm for females, so that birds from the southern watershed of the Eastern Highlands average slightly larger.

I examined the color of the iris in eight individuals from the Eastern Highlands (1 ad. ♂, 2 imm. ♂, 5 ♀), and in all cases it was blue. Eye color is indicated on the labels of 40 specimens from southeast New Guinea in the American Museum of Natural History (21 ad. ♂, 12 imm. ♂, 6 ♀, 1 ?). In 27 cases (13 ad. ♂, 8 imm. ♂, 5 ♀, 1 ?) it is listed as blue; in 10 cases (7 ad. ♂, 3 imm. ♂) there is a blue inner ring and yellow outer ring, or the label simply states yellow and blue; in two cases (1 imm. ♂ ?, 1 ♀) the label states yellow; and in one case (1 imm. ♂), brown. In *Lophorina* (*Parotia*) *carolae* (3 ad. ♂, 8 imm. ♂, 6 ♀) the iris color is given as yellow-green, yellow, or whitish. The statement by Rand and Gilliard (1967, p. 483) that the iris is yellow in the adult male of *L. lawesi* and pale blue in the female of *L. carolae* is therefore incorrect and reversed. The gape in the specimens I examined was yellow.

BREEDING. Gonads of all specimens were small.

DISCUSSION. On Mt. Karimui *Lophorina lawesi* occurred between 4,000 and 5,700 ft, while it occurred up to at least 6,000 ft in the Okapa area. There are at least three locality records from the northern watershed: (1) Bulmer collected it in Kyaka territory in forest and at the forest edge, at 5,300 and 6,000 ft; (2) Bulmer collected two females or immatures in the Schrader Range; (3) Gyldenstolpe was given two males from somewhere in the Jimmi Valley. As discussed under *L. carolae,* these records are of interest in making it likely that the ranges of *L. carolae* and *L. lawesi* meet.

Lophorina (*Ptiloris*) *magnifica* subsp. and *L. m. magnifica* (Vieillot)[1]

Magnificent Riflebird

NATIVE NAME. Daribi: to-owa.

SPECIMENS EXAMINED. Karimui: 1 ♀ (a), 1 imm. ♂ (14 July 1965). Soliabeda: 1 ♀ (b) (29 July 1965).

WEIGHT. 2 ♀: 120 (a), 147 (b). 1 imm. ♂: 168.

WING. 2 ♀: 142 (a), 151 (b). 1 imm. ♂: 173.

EXPOSED CULMEN. 2 ♀: 46 (a), 50 (b). 1 imm. ♂: 57.

[1] Listed as *Craspedophora magnifica* in Rand and Gilliard (1967) and as *Ptiloris magnificus* by Mayr (1962) in Peters' *Check-list,* Vol. 15.

TAXONOMY. My measurements of females give: the eastern race *intercedens*, 9 ♀ from southeastern New Guinea, exposed culmen 37-41 (39.9), wing 141-155 (148.8); the western race *magnifica*, 8 ♀ (Fly River, southern slope of Snow Mountains, Weyland Mountains, Humboldt Bay, Idenburg River), exposed culmen 50-53 (51.6), wing 148-157 (151.8). The Soliabeda adult female is nearer *magnifica*, but a firm racial assignment will have to await examination of adult males. Schodde and Hitchcock assigned the Lake Kutubu population to nominate *magnifica*.

BREEDING. The Soliabeda female examined was an adult with enlarged ovaries, whereas the smaller Karimui female had very small ovaries.

DISCUSSION. The Magnificent Riflebird was uncommon in the Karimui area (0.2-0.3% of the local avifauna) up to about 4,000 ft on the lowest slopes of Mt. Karimui. Females or immature males were observed singly a few times in the middlestory of the forest. Adult males were never seen, but their powerful calls showed that they had a regular but very sparse distribution at intervals of about one-half mile to a mile.

On two occasions at Karimui I observed a display between two birds in female-like plumage (probably one a female and the other an immature male. The immature male and the female with small ovaries were collected together at Karimui with bow and arrow by a native and may also have been displaying). In the first case (7 Aug. 1964) the two birds alighted next to each other on a branch 15 ft above the ground at the top of a bush at the edge of the forest. One bird faced the other, reared up on its legs, spread out its wings and bent them backwards, threw back its head, and remained in this uncomfortable posture for some time. The second bird then assumed this posture, and finally both assumed it simultaneously before flying off. No calls had been given. On the second occasion (12 Sept. 1965) two birds perched facing each other on a branch 30 ft above the ground in forest. One tilted its body up until it was vertical, held the tail back at right angles to the body so that it was horizontal, opened the wings and bent them at the shoulder so that they nearly met behind the back and the breast was arched towards the partner, and then rose up and down on its legs like a horseman posting on a trotting horse. The pair flew off to a branch of another tree and repeated the display. A less powerful version of the usual adult male call was periodically given. The display of a captive adult male is apparently similar (Rand and Gilliard, 1967, p. 487).

VOICE. The colossal whistles of the adult male are among the most powerful and beautiful bird songs in New Guinea. These calls consist of either two or three upslurred whistles, each lasting nearly 1 sec and followed by the next at an interval of less than 1 sec. Each note starts at approximately the same pitch (an octave or less above middle C). The first slur sweeps a full octave upscale, the second slur has a smaller sweep (of a sixth or a seventh), and the third note (if there is one) a still smaller sweep. When the singer is close, one can hear that the beginning of each slur is slightly hoarse, but the quality is otherwise full and mellow. The singer remains hidden in the crown of a tall tree and calls every few minutes. In Zone 2 of Mt. Karimui, 700 feet above the last riflebird, these whistles were still readily audible coming up from below, and each singer probably hears his next rival a half mile or more distant.

Lophorina (*Diphyllodes*) *magnifica hunsteini* (Meyer) and *L. m. chrysoptera* (Elliot)[1]

Magnificent Bird of Paradise

NATIVE NAMES. Fore: tárotáro (male). Gimi: yáro. Daribi: móbudali.
SPECIMENS EXAMINED. Karimui: 4 ♀, 4 imm. ♂ (1 July-6 Aug. 1965). Mt. Karimui Zone 1: 1 ♂; Zone 2: 1 ♂ (11 and 14 Aug. 1965).
WEIGHT. 2 ♂: 88, 94. 4 ♀: 66-93 (77 ± 7). 4 imm. ♂: 77-108 (90 ± 7).
WING. 2 ♂: 115, 116. 4 ♀: 105-113 (108 ± 2). 4 imm. ♂: 107-114 (111 ± 2).
STOMACH CONTENTS. Fruit.

TAXONOMY. The adult males are closest to *hunsteini* of southeastern New Guinea, from which they differ only in that the back is brighter and lighter red than most (but matched by some) *hunsteini*. They differ from *chrysoptera* in the brighter brick-red midback, and the brighter, more orange, less brown crown; and from nominate *magnifica* and *intermedia* in the brighter orange scapulars and inner secondaries. Gyldenstolpe found that birds from south of the Wahgi-Sepik Divide were *hunsteini* and those north of the Divide were *chrysoptera,* which seems reasonable, since the passes all lie above the altitudinal ceiling of the Magnificent Bird of Paradise and it has no tendency to wander above this ceiling. There are few or no racial differences in the females.

BREEDING. The two adult males had large testes. Gonads were small in most females and in immature males in female-like plumage.

DISCUSSION. The Magnificent Bird of Paradise is the commonest bird of paradise and one of the most abundant birds in hill forest, even in ecologically disturbed areas, dropping out towards sea level and with a ceiling around 4,000-5,000 ft. In the Karimui area the population composition and abundance were as follows: Soliabeda (2,000 ft), 1.7% of the local avifauna, immature males twice as numerous as females, few adult males; Karimui (3,650 ft), 2.7%, females slightly more common than immature males, few adult males; Mt. Karimui Zone 1 (4,000-4,200 ft), 2.4%, and Zone 2 (4,400-4,750 ft),

[1] Listed as *Diphyllodes magnificus* in Rand and Gilliard (1967).

2.3%, adult males increasingly common; lower half of Zone 3 (4,750-5,080 ft), 1.3%, mainly adult males; no higher records.

In my experience the variations in the altitudinal limits of *Lophorina (Diphyllodes) magnifica* are correlated with those of *Lophorina superba,* and the two species seem to represent each other altitudinally, a conclusion consistent with records of expeditions in other parts of New Guinea. On Mt. Karimui the lowest adult males of *L. superba* appeared (5,115 ft) just above the altitude where the highest males of *L. (Diphyllodes) magnifica* dropped out (5,080 ft). Some females and immatures of *L. superba* extended 1,000 feet downward into the range of *L. (Diphyllodes) magnifica.* From 2,000 to 6,000 ft in the Karimui area the sum of the contributions of these two species to the avifauna was approximately constant (1.6-3.7%), with only *L. (Diphyllodes) magnifica* below 4,000 ft, only *L. superba* above 5,000 ft, and their abundances in the overlap zone changing in complementary fashion. The absence of *L. (Diphyllodes) magnifica* at Okasa was correlated with the downwards extension of *L. superba's* range at Okasa to well below 4,000 ft. Although the plumage and mating display of the adult males are quite different, the calls of the adult males, the plumage of the females, and the behavior of these two species are very similar and reinforce the impression of close relationship drawn from the altitudinal distribution.

Females and immature males are solitary and move about sluggishly in the middle- and lowerstory. Adult males were much less often seen than heard, but also seemed to spend a good deal of their feeding time in the understory. As with *L. superba,* females and adult males were rarely or never seen together and may meet only to mate. An adult female was once seen feeding a juvenile male. Individuals sometimes perch sidewise on the trunks of saplings in the manner of thicket flycatchers, and often hang upsidedown to feed.

Natives showed me two display areas maintained by adult males, one at the Sena River (4,500 ft) and one at 4,350 ft on Mt. Karimui. In each case an area of ground 6-8 ft in diameter had been cleared completely of leaves and twigs. In this area stood two or three dead saplings with their leaves removed. According to natives, the resident male displays on these saplings.

VOICE. The call of the adult male, given from high concealed perches in trees, is similar to that of *L. superba* and consists of a half-dozen loud, harsh, buzzy, downslurred, low-pitched notes on the same pitch, progressively increasing in volume. The *L. superba* call is harsher and decelerates much more markedly. Several males may be heard calling in the same general vicinity. I heard one calling near one of the two display courts I visited. The females and immature males call one to three harsh, downslurred, and quiet "chew's", i.e. a shortened and soft version of the male's call.

Lophorina (*Cicinnurus*) *regia rex* (Scopoli) and *L. r. similis* (Stresemann)[1]

King Bird of Paradise

NATIVE NAME. Daribi: náburo.
SPECIMENS EXAMINED. Karimui: 2 ♂, 2 ♀ (9 and 11 Aug. 1964; 1 July and 11 Sept. 1965). Soliabeda: 1 ♂ (22 July 1965).
WEIGHT. 3 ♂: 48, 55, 57. 1 ♀: 51.5.
WING. 3 ♂: 95, 96, 97. 2 ♀: 94, 96.
STOMACH CONTENTS. Fruit, 6-12 mm in diameter.

TAXONOMY. These belong to the widespread race *rex* (possibly synonymous with *regius*; Mees, 1964). One immature male with enlarged testes was largely in female-like plumage but had the head largely red and some red on the primaries and uppertail coverts. Gyldenstolpe received a specimen of *L. r. similis* from the Jimmi Valley of the northern watershed, Schodde and Hitchcock took two *rex* at Lake Kutubu (2,450 ft), and Bulmer collected one specimen at 2,000-3,000 ft in the Baiyer Valley of the northern watershed.

BREEDING. All adult males had enlarged testes.

DISCUSSION. The King Bird of Paradise was fairly common at Soliabeda (ca. 1.3% of the local avifauna) but very uncommon at Karimui (ca. 0.1%), where it was above its usual altitudinal ceiling. The population structure shows the usual change with altitude: immature males made up about half of the Soliabeda population, with adult males and females also present, whereas only adults were found at Karimui. My limited observations were of single individuals, male-female pairs, or pairs in female-like plumage (females and/or immature male) 10-60 ft above the ground in the forest and at forest edge. Schodde and Hitchcock (1968, p. 61) remark that at Lake Kutubu *L.* (*Cicinnurus*) *regia* frequented second-growth and the forest edge, while *L.* (*Diphyllodes*) *magnifica* lived in primary forest.

Lophorina (*Astrapia*) *stephaniae ducalis* (Mayr) and *L. s. feminina* (Neumann)[1]

Princess Stephanie's Astrapia

NATIVE NAMES. Fore: tawánta (male), ókai (female and immature male). Gimi: mélo. Daribi: kwekwe.
SPECIMENS EXAMINED. Mt. Michael: 1 ♀ (9 July 1964). Mt. Karimui Zone 3: 1 ♂; Zone 5: 1 ♀ (16-27 Aug. 1965).
WEIGHT. 1 ♂: 153. 1 ♀: 145.
WING. 1 ♂: 162. 2 ♀: 148, 161.
TAIL. 1 ♂: 550. 2 ♀: 294, 329.
STOMACH CONTENTS. Fruit 3-14 mm in diameter (five stomachs); fruit and a large, hard insect (two); a 2 cm insect (one).

1 Listed as *Cicinnurus regius* in Rand and Gilliard (1967).

1 Listed as *Astrapia stephaniae* in Rand and Gilliard (1967).

TAXONOMY. *Lophorina* (*Astrapia*) *stephaniae* occurs from Mt. Giluwe (long. 144°E) eastwards, with birds from Mts. Giluwe, Hagen, Kubor, Karimui, and Michael referrable to the race *ducalis* and those from the Wahgi Mountains, Mt. Wilhelm, and the Schraderberg to *feminina*. The validity of *ducalis* as distinct from nominate *stephaniae* of southeastern New Guinea is doubtful and has also been questioned by Gilliard and LeCroy (1968, p. 25). The supposed difference in blackness may be due to foxing, and the difference in wing length is slight.

DISCUSSION. *L. stephaniae* has been encountered by all collectors at virtually all forested localities in its altitudinal (5,000-8,000 ft) and geographical range, but its abundance is subject to marked local variation. I found it uncommon on Mt. Karimui (5,100-8,100 ft) and Mt. Michael (7,000-8,000 ft) and never saw it in the Okapa area, whereas Bulmer found it very common on Mt. Hagen and the Schraderberg. I observed individuals or groups of two or three 10-70 ft above the ground, prying in thick moss on trunks, or abruptly hopping up branches and vertical trunks, remaining stationary between hops. The long tail is flicked to the side as the bird turns, and looks as if it is about to fall off. The convulsive flight consists of rapid flaps alternating with a glide.

VOICE. I heard only a single quiet, harsh, frog-like note. In Gilliard's experience as well it seems to have been one of the quieter birds of paradise.

Lophorina (*Astrapia*) *mayeri* (Stonor)[1]

Ribbon-tailed Astrapia

The range of *L. mayeri* extends eastward to Mt. Hagen and Giluwe, where Gilliard, Shaw-Mayer, and Bulmer found it plentiful to abundant at 8,000-10,000 ft. As discussed by Mayr and Gilliard (1952a), its geographical range overlaps that of *L. stephaniae* on Mts. Hagen and Giluwe, where hybridization occurs to a limited extent (Shaw-Mayer, in Sims, 1956, p. 425).

A point of particular interest is that on both Mts. Hagen and Giluwe, astrapias at lower altitudes are apparently pure *L. stephaniae* or hybrids closest to it, while those at higher altitudes are pure *L. mayeri* or hybrids closest to it. The transition altitude is at 8,000-8,500 ft, as shown by Shaw-Mayer's observations on Mt. Giluwe and Bulmer's and Gilliard's on Mt. Hagen. The geographical ranges of *L. mayeri* and *L. stephaniae* are still largely allopatric and overlap only in this limited area. These two species thus illustrate the earliest stage in the evolution of two allopatric members of a superspecies group into sympatric species with mutually exclusive altitudinal ranges (p. 22,

1 Listed as *Astrapia mayeri* in Rand and Gilliard (1967).

p. 34). The western limit of *L. mayeri,* where it is replaced by *L. splendissima,* must lie somewhere between Mt. Giluwe and Telefolmin and provides one of the major unsolved distributional problems in the western part of the Eastern Highlands. As at the eastern limit, the details of the transition may prove of interest.

Lophorina (Pteridophora) alberti (Meyer)[1]

King of Saxony Bird of Paradise

NATIVE NAME. Fore: wárale.
SPECIMENS EXAMINED. Miarosa: 1 imm. ♂ (24 June 1964).
WING. 119.

TAXONOMY. The specimen is largely in female-like plumage but has scattered velvet-black patches on the crown and orange on the breast.

BREEDING. The testes were enlarged.

DISCUSSION. Although two races of this species (*buergersi* and *hallstromi*) have been named on the basis of differences in female plumage, reexamination of available material, including the type and three paratypes of *hallstromi* (Mt. Hagen) and two nearly topotypical specimens of *buergersi* (Schrader Range, 50 miles from Mt. Hagen) shows that the variation is irregular and probably too slight to warrant taxonomic recognition. The only differences worth mentioning are that the ventral barring is slightly heavier in the Snow Mountains, and slightly more widely spaced in the Eastern Highlands, than in the Weyland Mountains (*alberti*), and that the measurements are slightly larger for the Wahgi population (average wing length of females: Wahgi region, 116.0 mm (range, 8 ♀, 107-122.5); Schrader Range, 111.3 (4 ♀, 109-113); Snow Mountains, 113.2 (9 ♀, 110-115); Weyland Mountains, 112.2 (6 ♀, 110-114)). Gilliard and LeCroy (1968, p. 26) already noted that the female which Gilliard collected in the Schrader Range (the type locality of Rothschild's race *buergersi*) is indistinguishable from some Wahgi specimens, which had been separated from *buergersi* as *hallstromi.* The trivial differences on which collectors have often founded subspecies of birds of paradise have obscured a biologically important and still unexplained fact, namely, that geographical variation within many species of birds of paradise is remarkably slight compared to the striking differences between different semispecies or species.

The King of Saxony Bird of Paradise is widely but unevenly distributed in forest between about 6,000 and 9,000 ft. On Mt. Michael an adult male was observed "singing" from a perch 30 ft above the ground at 7,800 ft. On Mt. Karimui two adult males "sang" regularly

1 Listed as *Pteridophora alberti* in Rand and Gilliard (1967).

within hearing distance of each other, one at 6,500 ft. and the other at 6,200 ft.

VOICE. The "song" lasts about 3 sec, gradually increases in volume, and has such a weird quality that one is unlikely to suspect a bird as the author. It is a very dry rattling, a spitted jumble of insect-like notes poured out at a machinegun pace and suggestive of bad static on the radio, which briefly turns into a twittering at the climax of the crescendo.

Paradisaea raggiana salvadorii Mayr and Rand

Raggiana Bird of Paradise

NATIVE NAMES. Fore: to. Gimi: óromo. Daribi: púri.
SPECIMENS EXAMINED. Karimui: 1 ♂, 4 ♀, 4 imm. ♂ (3 July-5 Aug. 1965).
WEIGHT. 4 ♀: 164-203 (182 ± 14).
WING. 1 ♂: 177. 4 ♀: 147-169 (158 ± 8). 4 imm. ♂: 159-179 (171 ± 6).

TAXONOMY. The male specimen is not yet fully adult and has tail wires 410 mm long but no flank plumes. Birds from the Karimui-Okapa area as well as those from the Wahgi Valley are pure *P. ragginan salvadorii* and show no approach to *P. apoda novaeguineae* of the middle Fly River (whitish flank plumes, nape maroon rather than yellow) nor to *P. r. raggiana* of southeastern New Guinea (upper back yellow).

BREEDING. Gonads were small in almost all birds examined.

DISCUSSION. *Paradisaea raggiana* is common in the Eastern Highlands up to a ceiling varying locally between about 4,500 and 5,600 ft. At the so-called Hybrid Gap at the western end of the Wahgi Valley, where the pass between the Baiyer River drainage of the northern watershed and the Wahgi drainage of the southern watershed has been deforested, *Paradisaea raggiana* has been able to cross into the Baiyer Valley and hybridize with *P. minor,* according to Blood (cited by Mayr and Gilliard, 1954, p. 321) and information given to Bulmer by native informants. It is considerably more numerous in ecologically disturbed areas (casuarina groves, second-growth, and the forest edge) than in the forest interior, and its unusually high ceiling in the Eastern Highlands and its invasion of the northern watershed have probably resulted from native agriculture.

Fully plumed adult males were very rare in my study areas, undoubtedly due to native hunting pressure. Even subadults with tail wires but no flank plumes were encountered only twice. That the species nevertheless remains common in settled areas is probably due to subadult males with none of the prized ornamental plumage regularly mating with females in the absence of fully adult males. The birds remain in the middle- and upperstory (none was netted), and were often associated in noisy groups of a half-dozen. Terborgh recorded *P. raggiana* both in fruiting trees and flowering trees in the

Karimui area. The characteristic flight consists of several convulsive flaps followed by a brief soar.

VOICE. The common call is a series of a dozen or more loud "caw's" which progressively rise in pitch and decelerate. Often this series concludes with two more "caw's" at lower pitches and longer intervals (Fig. 35).

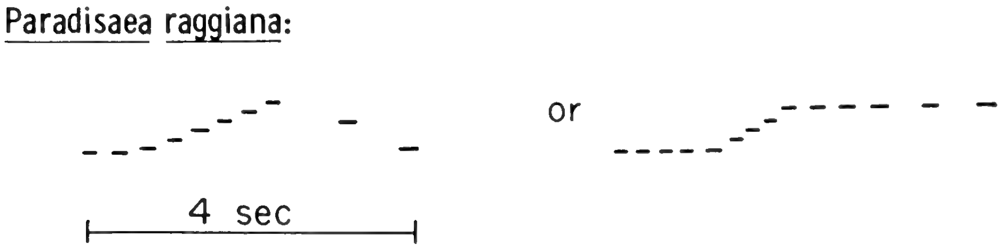


FIG. 35. Voice of *Paradisaea raggiana.*

Paradisaea minor finschi Meyer

Lesser Bird of Paradise

STOMACH CONTENTS. Fruit.

DISCUSSION. This is the northern watershed equivalent of *P. raggiana,* hybridizing with it in the upper Baiyer Valley. Bulmer found *P. minor* common in settled areas of Kyaka territory up to 5,500 ft, though fully adult males were as seldom seen as in the case of *P. raggiana* and presumably for the same reason.

VOICE. A series of loud "caw's" very similar to the call of *Paradisaea raggiana.*

Paradisaea rudolphi margaritae Mayr and Gilliard, and *P. r. rudolphi* (Finsch)

Blue Bird of Paradise

NATIVE NAMES. Fore: kongonámu. Daribi: barimoi.

SPECIMENS EXAMINED. Awande: 1 ♂, 2 imm. ♂, 1 ♀ (16-20 June 1965). Karimui: 1 ♀ (4 Aug. 1965).

WEIGHT. 1 ♂: 178. 2 imm. ♂: 156, 172. 2 ♀: 138, 175.

WING. 1 ♂: 156, 2 imm. ♂: 149, 152. 2 ♀: 138, 150.

TAXONOMY. In females and immature males of the race *margaritae,* originally described from the Wahgi Valley, the underparts, including the central belly and flanks, have black barring, whereas *rudolphi* of southeastern New Guinea has only the lower belly distinctly barred and the chest only faintly barred. The Karimui specimen is as barred as *margaritae* and is assigned to it. One of the Awande immature males is barred but more obscurely, and the other Awande immature and the unsexed bird have as little barring as *rudolphi,* so that the more easterly Awande population is nearer *rudolphi.* The adult male from Awande is indistinguishable from *rudolphi.*

DISCUSSION. The Blue Bird of Paradise lives in forest between about 3,600 and 6,500 ft and is generally uncommon. The population structure apparently follows the usual pattern, with adult males seen and calls heard only in the upper parts of the altitudinal range. Unlike *P. raggiana* and *P. minor,* it has not been able to colonize second-growth extensively and hence has been driven from much of its range by native agriculture (some of Bulmer's records, however, came from the forest edge and nearby garden areas). In undisturbed forest the altitudinal range of *P. rudolphi* lies largely or wholly above that of *P. raggiana,* as also true for *P. guilielmi* vis-a-vis *P. minor* on the Huon Peninsula. The western limit of the geographical range of *P. rudolphi* in the western part of the Eastern Highlands remains to be determined.

VOICE. The call pointed out to me by natives consisted of a series of notes somewhat similar to the call of *Paradisaea raggiana,* but with longer intervals between the notes, successively lower pitches, and a bell-like quality. The resemblance of each note to the syllable "kong" is the origin of the Fore name "kongonámu".

PTILONORHYNCHIDAE: BOWERBIRDS

Archboldia papuensis sanfordi Mayr and Gilliard
Archbold's Bowerbird

This extremely local bowerbird is known only from a small area between 8,500 and 9,000 ft on the southwestern slope of Mt. Hagen, where Gilliard and Shaw-Mayer collected it, and between 8,500 and 9,000 ft on Mt. Giluwe, where Shaw-Mayer collected it. Neither Bulmer nor Gilliard found it on the northern slopes of Mt. Hagen, and Bulmer's native informants from the southeastern slopes said that it occurred only farther west.

Amblyornis macgregoriae macgregoriae De Vis

MacGregor's Bowerbird

NATIVE NAMES. Fore: ónkena (male), antáu (female). Gimi: ósc.

SPECIMENS EXAMINED. Awande: 1 ♂, 1 ♀ (15 and 19 June 1965). Okasa: 2 imm. ♂ (22 and 25 June 1965). Mt. Karimui Zone 4: 1 ♂, 1 imm. ♂; Zone 5: 1 imm. ♂ (19 Aug.-2 Sept. 1965).

WEIGHT. 2 ♂: 110, 123. 1 ♀: 113. 4 imm. ♂: 116-132 (124 ± 7).

WING. 2 ♂: 137, 139. 1 ♀: 126. 2 imm. ♂: 128, 129.

TAIL. 2 ♂: 83, 90. 1 ♀: 73. 2 imm. ♂: 84, 88.

STOMACH CONTENTS. Fruit, 4-7 mm in diameter.

TAXONOMY. Gilliard and LeCroy (1961, p. 74) showed that the eastern race *macgregoriae* differs from the western race *mayri* in possessing a slightly shorter crest and tail. They measured the crest length from the posterior base, while Table 13 summarizes measurements of crest lengths I obtained from the anterior margin of orange feathering laid flat. The conclusion is still that western birds have longer crests, though there is some overlap.

TABLE 13
CREST LENGTH OF ADULT MALES OF *Amblyornis macgregoriae*

mayri	
Weyland Mountains, 5 ♂	90-103 mm (av., 96.2)[1]
Lake Habbema, 2 ♂	90, 102 (av., 96)
Mt. Goliath, 1 ♂	100
macgregoriae	
Mt. Hagen, 5 ♂	74-94 (av., 88.8)
Kubor Mountains, 3 ♂	80, 81 (av., 80.7)
Nondugl, 1 ♂	76
Mt. Karimui, 1 ♂	83
Awande, 1 ♂	92
Southeastern New Guinea, 7 ♂	71-93 (av., 82.4)

[1] Measurements are from the anterior margin of orange feathering.

The crests of both my adult male specimens are a deep orange comparable to that of the much shorter crest of *A. subalaris,* and darker than in any of the available museum specimens of *A. macgregoriae,* which have a paler and yellow-orange crest.

DISCUSSION. *Amblyornis macgregoriae* is widespread, though uncommon, in forest from 9,000 ft down to a lower limit varying locally between 3,500 ft (Okasa) and 5,200 ft (Mt. Karimui). One bower was found at about 6,800 ft in forest in the Okapa area, while there were four bowers on the west ridge of Mt. Karimui, all on the flat crest of the ridge: two within a few feet of each other at 5,390 ft, one at 5,820 ft, and one at 6,060 ft. An immature male in female plumage, with tiny testes and no trace of a crest, was collected while working on a bower.

I spent two mornings observing from a blind at one of these bowers (Fig. 36). It was located on a broad, flat, ridge crest, and was constructed around a sapling 16 ft tall and 3/4 inches in diameter. Sticks were criss-crossed about the trunk of the sapling to 8 ft above the ground, subtending for the most part 1 ft, occasionally up to 2 ft. Above 8 ft the sapling had branches with leaves, but below this height, where the sticks were criss-crossed, there was only one leafless branch (the bird probably having stripped the leaves) and a vine from an adjacent tree with a few leaves. About the base of the sapling the bird had constructed a circular moss platform 54 inches in diameter, with a raised rim around the periphery surrounding a moss basin 5 in deep and 30 inches in diameter. In the center of the basin a moss base 10 inches in diameter rose immediately about the sapling. Outside the platform was a small pile of chips of black, burnt wood. The surrounding forest was tall and open, with some particularly large *Araucaria cunninghamii*. Most of the bower was in shade, though some sunlight reached the bower floor.

On the first day both a crested adult male and a bird in female plumage were in the vicinity when I arrived at 10:20, and the birds moved about within 30 ft of the bower. The female never actually came to the bower nor within 10 ft of the male and perched between 12 and 35 ft above the ground. The male appeared squat and short-tailed with his center of gravity and much of his body apparently well forward of his legs. His orange crest remained inconspicuous, the base concealed, only the distal part visible. While perched, he seemed to peer intently, and his movements as he suddenly turned on his perch or suddenly flew off with a loud wing beat were ludicrously abrupt. Until 10:40 he assumed various perches 4-15 ft above the ground but not at the bower and was silent except for some kissing and scolding notes. Eventually he approached the bower, giving soft, downslurred, whining notes and rapidly repeated scolding notes. From 10:40 to 10:46 he stood around the base of the bower and continued to make whining and scolding sounds. Until 11:01 he periodically appeared and reappeared 20 ft from the bower, perched 4-15 ft above the ground, and once hopped vigorously up the trunk of a 2 inch sapling to a height of 15 ft. Between 11:01 and 11:06 A.M., when observations were terminated, no birds were visible.

On the next day I arrived at 09:28, placed 20 dead leaves on the moss basin to see what the bird would do with them, and went into the blind. At 09:30 the male appeared with a rustle of wings, and remained in the vicinity until 10:58 without the female. At first he took up various perches 15 ft or more from the bower, once perching sideways on a vertical sapling like a thicket flycatcher. At 09:47 he gave nasal downslurred calls like a *Melidectes* honeyeater; at 09:49, neighed like a horse; and at 09:51 gave a call like the crack of a bushknife striking a tree. Finally, at 09:57 he alighted on the rim of the bower with white moss or lichens in his bill, occasionally turning his head. After a minute he picked up one of the dead leaves I had left in the basin and dropped it on the rim, carried another leaf 3 ft off, and threw two over the rim with a toss of his head. He then spent a minute on the ground just outside the rim, during which he briefly raised, flared, and exposed his whole orange crest, which was otherwise held flat, furled, and basally concealed. At 10:01 he flew off and returned to the bower at 10:06. This time he threw out the leaf he had previously dropped on the rim, then threw out some smaller leaves by carrying them to the rim and tossing them several inches outside,

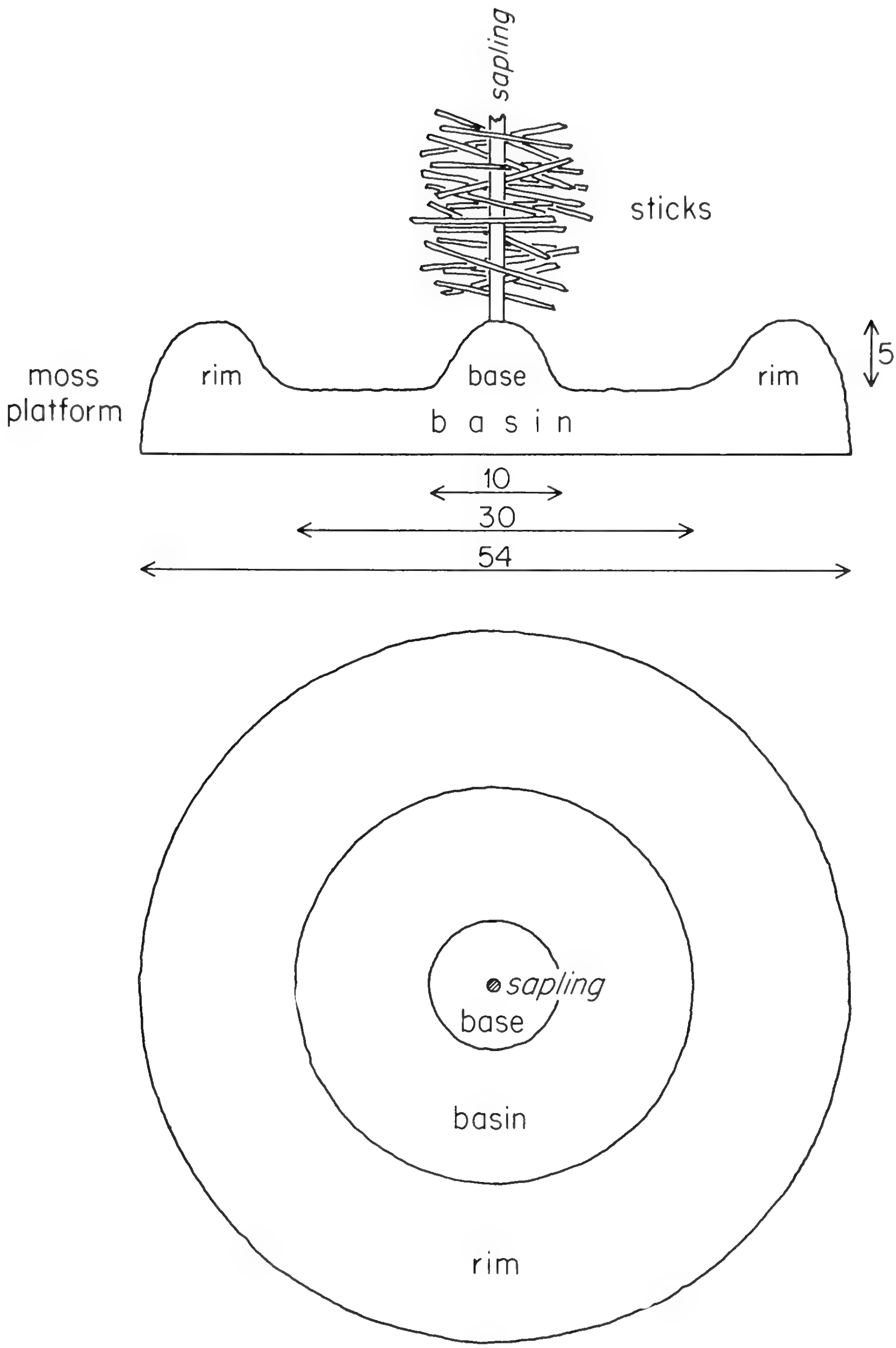


FIG. 36. Bower of *Amblyornis macgregoriae* (dimensions in inches). Above: cross-section in vertical plane through the central sapling. Below: cross-section in horizontal plane through the moss platform. See text, p. 343, for details.

and at 10:07 picked up the largest leaf and flew off with it. In 26 min he appeared again briefly, and at 10:40 reappeared with a whirring of the wings and perched 2 ft up on a vertical sapling behind the bower. He rapidly shifted perches to different saplings several times, quickly opening and closing his wings while perched. At 10:44 he flew off 15 ft to a perch 7 ft up and remained stationary for 3 min, during which he once again raised and flared his crest. After another shift of perch he began quiet, broken, nasal downslurs, coughing sounds, and chirps for 5 min. The sounds stopped at 10:58, and he remained away until at least 11:30, when I left. There were still 12 dead leaves remaining in the bower.

Paran found a nest with one nestling near the bower, 7 ft up in a pandanus. It was a bowl 5 inches deep and 5½ inches in diameter, lined with small twigs, and woven of strips of dry blades ¾ inch broad and 1-2 ft long brought from the adjacent grassland, plus a few dry pandanus leaves and *Castanopsis* leaves. In Paran's experience, the nests of *Amblyornis macgregoriae* generally contain one nestling, which is fed by the female alone.

[*Sericulus aureus ardens* (D'Albertis and Salvadori)[1]]

Golden Bowerbird

Iredale (1948) lists a skin from an unspecified locality in the Mt. Hagen district. This probably originated from somewhere in the Fly-Strickland-Kikori drainages and reached the Mt. Hagen district by native trade routes. There are no authentic records from the Eastern Highlands.

Chlamydera lauterbachi uniformis Rothschild

Lauterbach's Bowerbird

NATIVE NAME. Fore: kaíro.

TAXONOMY. The ranges of the subspecies have been reevaluated by Gilliard (1969).

BREEDING. A female brought in at Okasa by a native had enlarged ovaries.

DISCUSSION. This grassland bowerbird was present at Okasa and Miarosa but absent at Karimui. Gilliard, Gyldenstolpe, Shaw-Mayer, Bell, Bulmer, and Hitchcock all found it common in grassland at various localities in the Wahgi Valley and neighboring areas.

1 Listed as *Xanthomelus aureus* in Rand and Gilliard (1967).

SPECIES ACCOUNTS

Ailuroedus crassirostris melanocephalus Ramsay and *A. c. guttaticollis* Stresemann

Green Catbird

NATIVE NAMES. Gimi: waralóa. Daribi: buzibá.
SPECIMENS EXAMINED. Mt. Karimui Zone 2: 1 ♂ (14 Aug. 1965).
WEIGHT. 205.
WING. 152.

TAXONOMY. Specimens of *melanocephalus* from southeastern New Guinea vary somewhat in the darkness of the underparts, and the Mt. Karimui bird agrees with the darker specimens. The race *melanotis* of southern New Guinea is paler and greener below, while *guttaticollis* of the Sepik Mountains, to which Gyldenstolpe assigned with reservations a single specimen from the Jimmi River (northern watershed), has buffier spotting on the crown and nape.

BREEDING. The testes of the specimen were very small.

DISCUSSION. The altitudinal ranges of *A. crassirostris* and *A. buccoides* are mutually exclusive. In most areas of New Guinea the transition takes place around 2,500 ft, but in the Karimui area it is around 4,000 ft because of tropical conditions in the Karimui Basin. I found *A. crassirostris* between 4,300 and 5,450 ft on Mt. Karimui and also at Okasa. My observations were of solitary individuals in the middlestory of the forest (at least 20 ft above the ground), where their movements were easily traced by the calls. However, the single specimen was netted, probably a victim of its habit of eating birds and bats trapped in nets.

VOICE. A peculiar, not loud, mewing sound "wa-a-a-a-a-a" which lasts 1½ to 2 sec and is repeated at 10- to 15-sec intervals. Each note fluctuates up and down in pitch a few times within a span of about two whole tones.

Ailuroedus buccoides stonii Sharpe, *A. b. geislerorum* Meyer, and *A. b. cinnamomeus* Mees

White-eared Catbird

NATIVE NAME. Daribi: buzibá.
SPECIMENS EXAMINED. Karimui: 2 ♂, 3 ♀ (8-12 Aug. 1964; 1-15 July 1965). Bomai: 2 ♂, 1 ♀ (6-8 July 1965). Soliabeda: 2 ♀ (23 and 29 July 1965).
WEIGHT. 3 ♂: 134, 142, 146. 4 ♀: 126, 136, 140, 150.
WING. 4 ♂: 135, 135, 138, 142. 6 ♀: 126, 127, 130, 130, 133, 134.
STOMACH CONTENTS. Fruit.

TAXONOMY. The series agrees most closely though not perfectly with *stonii* of southeastern New Guinea. The crown averages darker in my specimens, though the darkest *stonii* and darkest Karimui birds are similar. The underparts also average darker in the Karimui area, though the darkest *stonii* are comparable. There is good agreement in the small size of the spots on the underparts and their sparseness on the abdomen. The races *oorti, geislerorum,* and *buccoides* all have much paler crowns, *geislerorum* and *oorti* have much paler underparts, and the spots on the underparts are larger in *oorti* and *buccoides.* Gyldenstolpe assigned a single specimen from the northern watershed to *geislerorum,* while Schodde and Hitchcock placed the Lake Kutubu population with *cinnamomeus.*

BREEDING. Gonads were small in all individuals examined in 1965, and were enlarged in one male and one female and small in the other male in 1964.

DISCUSSION. In the Karimui region *Ailuroedus buccoides* was rarely seen but frequently netted because of its habit, shared with *A. crassirostris,* of eating birds trapped in mistnets. The head of the victim was always eaten, and sometimes other parts as well.

NEOSITTIDAE: AUSTRALIAN NUTHATCHES

Daphoenositta miranda kuboriensis Mayr and Gilliard

Pink-faced Nuthatch

DISCUSSION. This nuthatch of high-altitude moss forest has been recorded four times in the Eastern Highlands at 8,000-10,000 ft: in the Kubor Mountains by Gilliard, in the Lamende Range by Shaw-Mayer, and in the Schrader Range by Gilliard and by Bulmer. Its habits, and those of *Neositta chrysoptera,* seem to me more like those of a warbler than of *Sitta.* Its progress is neither systematic nor slow; it spends only a few minutes in a tree before flying off, usually out of sight. It hops rapidly along a branch of either a dead or a leafy tree at about 1 ft per sec, leaning over and peering first to one side then another, and flits off to another branch. While it occasionally clings to the underside of a horizontal branch or goes up a vertical one, much more often it remains on the upper side of horizontal branches. I watched one digging and pounding repeatedly in bark, another shaking and eating a 3 cm grub. It was always in flocks, of three to five birds.

VOICE. Faint, sweet, *sucked-in,* slightly squeaky contact calls which are louder in flight than when perched; and a faint chatter when two individuals came together.

Neositta chrysoptera subsp.[1]

Papuan Sittella

NATIVE NAME. Fore: yalóto.

SPECIMENS EXAMINED. Miarosa: 1 ? (24 June 1964). Awande: 1 ♂, 1 ♀ (4 July 1967).

[1] Listed as *N. papuensis* in Rand and Gilliard (1967), see Mayr (1950).

WING. 1 ♂: 77. 1 ♀: 78.
STOMACH CONTENTS. Insects.

TAXONOMY. My three specimens have the whole head and upper breast pure white except for a few brown streaks on the chin and crown of the male, and the white markings on the inner edge of the primaries are more prominent than in any other New Guinea examples of the species available for comparison. Four birds which I observed in the Karimui area also had the whole head white.

The three geographically nearest races are *alba* of the Idenburg slopes (male with the whole head white, female unknown), *toxopeusi* of the Snow Mountains (male with the head and neck streaked, female apparently with the head and neck white), and *albifrons* of southeastern New Guinea (male with more dark areas and streaking on the head, female with a whitish head with brown shaft streaks). White spotting as on the primaries of the Miarosa specimen is present but reduced in *albifrons, toxopeusi,* and *papuensis* and is nearly absent in *alba.* Descriptions of three other Eastern Highlands adults have been published: a single white headed adult male collected by Shaw-Mayer at 8,000 ft on Mt. Giluwe, which Sims (1956, p. 430) found to match *alba;* a single adult male collected by Gilliard at 8,300 ft on Mt. Hagen, which is in general intermediate between *albifrons* and *toxopeusi* except for lacking the primary spots, and which Mayr and Gilliard refrained from identifying subspecifically; and a single adult female collected by Gyldenstolpe at Nondugl, which was nearest *toxopeusi* but had more dark areas on the head and which he described as a new race, *wahgiensis.* Descriptions of one specimen collected by Bulmer at Tari, one collected by Blood at Wabag, and five collected by Hitchcock in the Kubor Range had not been published at the time of writing. In view of the individual variation among the Eastern Highlands specimens collected to date, it is not possible to assign the material or to evaluate the validity of *wahgiensis* until an adequate series can be compared with adequate series of the other races (*alba* and *toxopeusi* are each known from only four specimens).

DISCUSSION. This species may be the middle-altitude equivalent of *Daphoenositta miranda.* I observed small flocks at 8,000 ft on Mt. Michael, at 6,000 ft in Gimi territory, and at Iogoramalu (3,630 ft) in the Karimui Basin, in addition to collecting the Miarosa (6,800 ft) and Awande (6,000 ft) specimens. These flocks were in tall trees with little foliage in forest clearings and gardens. Each flock spent a few minutes at one tree and then moved on as a group with undulating flight to a neighboring tree or else out of sight. As they worked actively over a tree, they frequently crawled on the undersides of branches, hung upside-down from branches, or else assumed upside-down positions on vertical trunks. Paran said that *Neositta chrysoptera* disappears from the Okapa area during the rainy season.

NECTARINIIDAE: SUNBIRDS

Nectarinia sericea sericea (Lesson)

Black Sunbird

SPECIMENS EXAMINED. Soliabeda: 1 ♂, 1 ♀ (26 and 29 July 1965).
WEIGHT. 1 ♂: 9.7. 1 ♀: 9.0.
WING. 1 ♂: 61. 1 ♀: 57.
STOMACH CONTENTS. Principally insects, occasionally fruit.

DISCUSSION. The Black Sunbird was common at Soliabeda, and rare at Karimui, at the forest edge and in gardens and second-growth. The Karimui records are much higher than the species normally occurs elsewhere in New Guinea. Schodde and Hitchcock also found the Black Sunbird at Lake Kutubu (2,450 ft). It perched in treetops, hovered in hummingbird fashion at flowers, probed while hanging upsidedown, or alighted on fallen logs and fences in gardens, moving rapidly and seldom remaining in one place for long. It fed on the surface of vegetation, never inside the forest.

VOICE. There are a variety of common calls, all very high-pitched, thin, sibilant, and rather faint. Common patterns are a rapid series of identical upslurs; one or several upslurs followed by a slow trill at a lower pitch; a breezy, slower upslur like North American goldfinches (*Carduelis* sp.); and a rapid series of notes alternating between two different pitches (Fig. 37). Some of these calls are similar to those of the honeyeater *Conopophila albogularis,* and others to the calls of the flowerpecker *Dicaeum geelvinkianum,* another tiny black bird of the treetops.

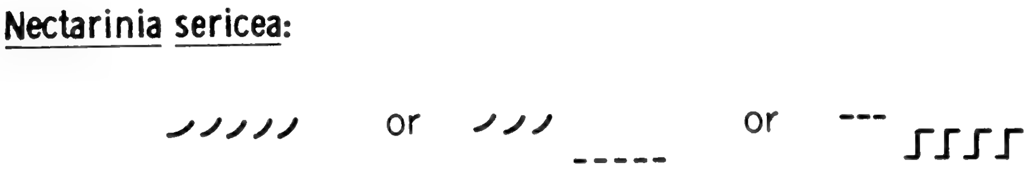


FIG. 37. Voice of *Nectarinia sericea*.

MELIPHAGIDAE: HONEYEATERS

Timeliopsis fulvigula meyeri (Salvadori)

Mountain Straight-billed Honeyeater

SPECIMENS EXAMINED. Awande: 1 ♀ (14 June 1965). Mt. Michael: 1 ♂, 1 ♀ (6 and 7 July 1964). Mt. Karimui Zone 4: 2 ♂; Zone 5: 1 ♀ (28 Aug.-1 Sept. 1965).
WEIGHT. 2 ♂: 20, 20. 2 ♀: 16, 19.
WING. 3 ♂: 78, 81, 82. 2 ♀: 73, 77.
STOMACH CONTENTS. Insects.

TAXONOMY. The four races of this species were separated on the basis of trivial differences in color shades. The Vogelkop population (nominate *fulvigula*) has the olive of the back slightly duller and darker, and the throat and breast browner, than the population of the Central Range (*meyeri*). The population of the Snow Mountains is much too similar to the southeastern New Guinea population to warrant the name *montana* (type and two paratypes from Mt. Goliath examined). The fourth race, *fuscicapilla,* is also probably a synonym of *meyeri.*

The iris was orange in all specimens.

BREEDING. Testes were enlarged in the Mt. Karimui males.

DISCUSSION. The Awande specimen came from 6,200 ft, the Mt. Michael ones from 8,000 ft, and the Mt. Karimui ones from 5,780 to 6,500 ft. Four of the six specimens were netted, suggesting understory habits, in agreement with the observations of Stein (1936, p. 30). This species does not use flowering trees. Other Eastern Highlands records are one specimen each from the Wahgi Region (Gilliard) and the Schrader Range (Bulmer).

Melilestes megarhynchus megarhynchus (Gray)

Long-billed Honeyeater

NATIVE NAMES. Fore: éro. Gimi: koyáge. Daribi: yoborusuábe.

SPECIMENS EXAMINED. Awande: 1 ♂ (28 June 1964). Karimui: 4 ♂, 2 ♀ (30 July-14 Aug. 1964; 2 July-5 Aug. 1965). Bomai: 1 ♂, 3 ♀ (7-9 July 1965). Soliabeda: 1 ♂, 4 ♀ (22-29 July 1965). Mt. Karimui Zone 1: 1 ♂; Zone 2: 1 ♂; Zone 3: 1 ♂, 1 ♀ (9-17 Aug. 1965).

WEIGHT. 10 ♂: 43.0-49.5 (46.6 ± 1.7). 10 ♀: 36.3-47.5 (41.1 ± 3.3).

WING. 10 ♂: 94-106 (100 ± 3). 10 ♀: 87-94 (91 ± 2).

STOMACH CONTENTS. Insects.

TAXONOMY. These specimens belong to the widespread nominate race, and differ obviously from *stresemanni* of northern New Guinea in the more olive, less gray underparts. The iris was orange.

There may be a very slight increase in size with altitude: average wing lengths on Mt. Karimui and at Awande (4,000-6,200 ft) are ♂ 101.8, ♀ 93.0; at Karimui (3,650 ft), ♂ 101.2, ♀ 90.6; at Soliabeda (2,000 ft), ♂ 100.0, ♀ 91.0.

A yellow eye ring, a sign of immaturity, is present in several specimens. Two of these specimens also have streaked throats, short wings (96 and 97 mm), and tiny testes and must be younger birds. Of the males with eye rings but without streaked throats, two had the testes somewhat, one considerably, enlarged.

BREEDING. One Karimui female in 1964 had greatly enlarged ovaries. Testis size ranged from small to large, with a higher proportion of enlarged testes on Mt. Karimui.

DISCUSSION. *Melilestes megarhynchus* is a common but unobtrusive tropical species ranging up to 5,000, rarely 6,000 ft. In the Karimui area, where it accounted for 1-2% of the local avifauna, the usual change in sex ratio with altitude is apparent: females predominate at the two lower stations (Soliabeda and Bomai), males at the two higher stations (Karimui, Mt. Karimui). In habits this is a solitary, shy, slow-moving, and silent bird of the lower- and middlestory (up to about 30 ft above the ground) in forest and second-growth. Proportionately more of the specimens were taken in nets at Soliabeda and Bomai than at Karimui, and still fewer were netted on Mt. Karimui. Since the Mt. Karimui specimens were mostly males in breeding condition, they may spend less time in the lowerstory. *M. megarhynchus* tended to feed by working its way up a tree, gleaning (presumably for insects) close to the trunk and branches. It also came to flowering trees. Terborgh observed a few individuals in a tree with small fruits at Mengino and in the tree at Miarosa with hard-shelled fruits chipped open by parrots (see under *Trichoglossus haematodus,* p. 143).

VOICE. A harsh but quiet downslur "chur-r-r" or mewing sound is occasionally given.

Niche Differences in the Genera *Toxorhamphus* and *Oedistoma*

The genus *Toxorhamphus* has usually been considered to consist of three very similar species, *T. poliopterus, T. novaeguineae,* and *T. iliolophus.* However, I concur with the decision of Salomonsen (1967, p. 342) to remove *iliolophus* to the genus *Oedistoma,* formerly considered monotypic (*O. pygmaeum*).

The niche differences among these ecologically similar honeyeaters are as follows. *T. poliopterus* and the very similar *T. novaeguineae* live mainly in the understory and do not visit flowering trees. Their altitudinal ranges are mutually exclusive (*T. poliopterus* at higher altitudes than *T. novaeguineae*) where both occur, and the former descends much lower in the absence of the latter. *T. novaeguineae* has not been recorded from the Eastern Highlands and is probably absent on the southern watershed east of the Fly River but should turn up below 4,000 ft on the northern watershed, where Gilliard collected it at the foot of the Schrader Range. The similar-sized *O. iliolophum,* in addition to foraging in the understory, also ranges into the treetops and visits flowering trees, which *T. poliopterus* and *T. novaeguineae* never do in my experience. *O. pygmaeum* is similar in habits to *O. iliolophum* but spends even more time in flowering trees and less time in the understory, weighs slightly less than half as much, and has a relatively shorter bill. *O. pygmaeum* and *O. iliolophum* range infrequently down to sea level, *T. poliopterus* never. *O. pygmaeum* has the lowest altitudinal ceiling, *O. iliolophum* higher, and *T. poliopterus* the highest.

SPECIES ACCOUNTS

Toxorhamphus poliopterus poliopterus (Sharpe)

Slaty-chinned Longbill

NATIVE NAMES. Fore: antábo. Daribi: tuniábe.

SPECIMENS EXAMINED. Awande: 2 ♂, 2 ♀ (20-21 June 1964; 14-18 June 1965). Karimui: 2 ♂, 3 ♀ (31 July-15 Aug. 1964; 1 July-3 Aug. 1965). Bomai: 1 ♂ (6 July 1965). Soliabeda: 2 ♂, 1 ♀ (24-30 July 1965). Mt. Karimui Zone 1: 1 ♂; Zone 2: 1 ♂, 2 ♀; Zone 3: 1 ♂, 2 ♀ (11-16 Aug. 1965).

WEIGHT. 10 ♂: 10.5-14.3 (12.4 ± 1.0). 10 ♀: 9.3-11.5 (10.4 ± 0.7).

WING. 10 ♂: 63-73(69 ± 3). 10 ♀: 61-68 (64 ± 3).

CULMEN FROM BASE. 10 ♂: 29-35 (32.0 ± 1.5). 10 ♀: 27-35 (29.9 ± 1.7).

STOMACH CONTENTS. Insects.

TAXONOMY. Table 14 summarizes measurements for populations from the eastern half of New Guinea. The first four entries, pertaining to my Eastern Highlands specimens, or else the second through fourth, pertaining only to the Karimui area, show a significant increase in bill length and wing length with altitude. There also appears to be some local variation in the bill-to-wing ratio (compare ratios for Nondugl, Mt. Karimui, and Awande, within 80 miles of each other and at similar altitudes). Greenway (1935, p. 98) pointed out that there is a wide range of variation in bill length and crown color (more gray or more green) in specimens from a given locality. Huon Peninsula birds were separated from southeastern New Guinea birds (nominate *poliopterus*) as *septentrionalis* on the basis of a shorter bill, slightly longer wing, lower bill-to-wing ratio, and more greenish, less pure gray crown (Mayr and Rand, 1935, p. 14). This race may be insufficiently distinct to merit recognition. The average difference in the color of the crown is slight, though detectable; the average difference in the culmen shown by Table 14 is slight; and the difference in wing length shown in Table 14 is difficult to evaluate without better knowledge of the altitudes at which the specimens were collected, since both the Huon Peninsula and southeastern New Guinea series fall within the range of averages for Eastern Highlands populations at various altitudes. On the basis of the average color of the crown (virtually the same as in southeastern New Guinea) and the bill-to-wing ratio, Eastern Highlands birds would have to be considered nominate *poliopterus* rather than *septentrionalis,* if *septentrionalis* were recognized. The race *maximus* of western New Guinea has a darker crown, and perhaps larger dimensions.

BREEDING. All ovaries were small, but testes at most localities were enlarged. The main exception was the small testes of Soliabeda males, suggesting that, as usual, immatures or nonbreeding birds are concentrated at the bottom of the species' altitudinal range.

DISCUSSION. The altitudinal range of *T. poliopterus* is roughly 1,500-6,000 ft, but both the lower limit and the ceiling show marked variation. The variations in the lower limit are correlated with the presence or absence of the related *T. novaeguineae,* which occurs from

TABLE 14

AVERAGE MEASUREMENTS OF *Toxorhamphus poliopterus*

	♂			♀		
	Culmen (from base)	Wing	Culmen/Wing	Culmen (from base)	Wing	Culmen/Wing
Awande (6,000 ft), 2♂, 2♀	32.8	70.6	0.465	32.3	67.3	0.480
Mt. Karimui (4,000-5,370 ft), 3♂, 2♀	32.7	71.7	0.456	28.5	64.0	0.448
Karimui and Bomai (3,250-3,650 ft), 3♂, 3♀	31.8	68.0	0.468	29.0	64.3	0.451
Soliabeda (2,000 ft) 2♂, 1♀	31.1	66.0	0.471	28.0	61.0	0.459
Nondugl (5,200 ft), 2♂	31.0	71.0	0.437			
Telefolmin (4,800 ft), 2♀				29.5	60.0	0.492
Huon Peninsula (mostly unknown altitudes) 1♂ (type of *septentrionalis*), 2♀	30.0	71.0	0.423	27.0	63.0	0.429
Southeastern New Guinea (mostly unknown altitudes) 5♂, 9♀	31.6	67.2	0.470	27.7	60.9	0.455

sea level to about 4,000 ft in western New Guinea, extending east through the Sepik Basin on the northern watershed but only as far as the Fly River on the southern watershed. Where the two species are sympatric, *T. poliopterus* does not descend below 4,000 or 5,000 ft (Sepik Mountains, Snow Mountains, Weyland Mountains, and possibly the northern watershed of the Eastern Highlands). Where *T. novaeguineae* is absent, *T. poliopterus* descends to about 1,500 ft (southeastern New Guinea, southern watershed of the Eastern Highlands at Soliabeda, and possibly Herzog Mountains and Huon Peninsula). The variations in the ceiling depend upon the local elevation of the moss level, so that the ceiling was lower on Mt. Karimui (5,800 ft) than in the Okapa area (up to at least 6,800 ft) and still higher on Mt. Michael (8,100 ft).

Within its altitudinal range, particularly in the upper part of its range, *T. poliopterus* is among the most abundant forest birds, sometimes the most abundant species (e.g., 9% of the local population at 4,000-5,600 ft on Mt. Karimui). One would never guess this, however, without nets or knowledge of the song, since the bird is infrequently seen. Its habitat is the forest interior, forest edge, or second-growth. It may be seen up to 30 ft above the ground but concentrates in the lowerstory, as evidenced by the numbers in which it saturated our mistnets (see under *Oedistoma pygmaeum* for further discussion of its habits). It darts about rapidly in the undergrowth, pecking at branches and sometimes hanging upside-down.

VOICE. Vocalizations are varied, frequent, weak, similar in quality to the calls of the sunbirds *Nectarinia sericea* and *N. jugularis,* and fall into two categories. Some calls have a dry quality, such as a dry squawk, a dry scolding, and a disyllabic sneeze-like note; but most have a sweet quality. The commonest call is a sweet "tsip"; another is "tsee-tsee-tsee-tsee-tsee". The songs with sweet quality consist of slurs, disyllabic notes, and repeated notes (Fig. 38). One of these songs resembles a weak version of the song of *Meliphaga auga* and may be confused with it.

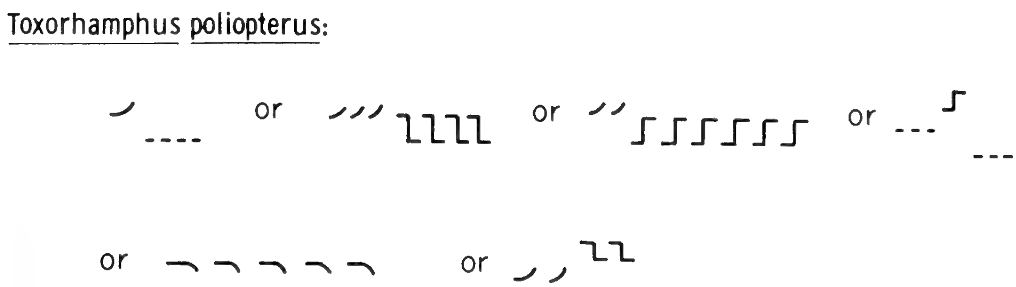


FIG. 38. Voice of *Toxorhamphus poliopterus.*

Oedistoma iliolophum flavum (Mayr and Rand)[1]

Gray-bellied Honeyeater

NATIVE NAME. Daribi: piye.

SPECIMENS EXAMINED. Okasa: 1 ♂ (22 June 1965). Karimui: 5 ♂, 2 ♀ (30 July-13 Aug. 1964; 1 July-5 Aug. 1965). Bomai: 1 ♀ (6 July 1965). Soliabeda: 1 ♂ (23 July 1965). Mt. Karimui Zone 1: 1 ♀; Zone 2: 3 ♂, 3 ♀; Zone 3: 1 ♀ (10-16 Aug. 1965).

WEIGHT. 10 ♂: 13.0-15.7 (14.2 ± 0.9). 7 ♀: 11.0-12.0 (11.5 ± 0.3).

WING. 10 ♂: 65-72 (68 ± 2). 6 ♀: 61-65 (63 ± 2).

TAXONOMY. The flanks are more brightly lemon-colored than in nominate *iliolophus.* The wing lengths of both the Okasa specimens (2 ♂, 68 and 70) and of the remainder from the Karimui area agree with southeastern New Guinea birds (♂ 66-70, ♀ 62-64) and are larger than on the Fly River (♂ 63-67, ♀ 58-62).

BREEDING. Gonad condition varied from small to moderately enlarged.

DISCUSSION. *O. iliolophum* was present at all my collecting stations up to 5,125 ft, and at none above this altitude. It was commonest at Karimui (3,650 ft), much less common at Soliabeda (2,000 ft), and is either absent or quite uncommon in flat country at sea level (as with many hill forest species, this last statement does not apply to the flat lowlands of the Fly River basin).

O. iliolophum and *Toxorhamphus poliopterus* have nearly the same wing length; *O. iliolophum* weighs slightly more; and *T. poliopterus* has a considerably longer bill (culmen from base ca. 30 vs. ca. 20 for *O. iliolophum*). T. *poliopterus* has brighter colors, but the coloration of *O. iliolophum* is sufficiently similar that field identification is usually difficult. There is broad altitudinal overlap from 1,500 to 5,000 ft, with *T. poliopterus* extending above and *O. iliolophum* below these limits. However, there are two striking niche differences. First, in flowering trees we never saw *T. poliopterus* but regularly saw *O. iliopholum,* which accounted for 1.3% of the bird-usage in flowering trees at Karimui. The other difference involves netting returns: nets accounted for 57% of our specimens of *O. iliolophum* but 88% of our specimens of *T. poliopterus.* Evidently both species spend much time in the understory, but the tendency is developed to an extreme degree in *T. poliopterus.* In flowering trees *O. iliolophum* was seen as often in the upper half of the tree (including the canopy) as in the lower half. It was also frequently seen within 10 ft of the ground (as one would suspect from the netting returns) and had a particular affinity for the clusters of small wild bananas at Karimui. Its behavior was often nuthatch-like, feeding close to branches and perching upside down on tree trunks and banana

1 Listed as *Toxorhamphus iliolophus* in Rand and Gilliard (1967); see p. 352.

clusters. However, it also hovered at the banana clusters, like a sunbird (to which it bears a striking superficial resemblance) or a hummingbird.

Oedistoma pygmaeum pygmaeum (Salvadori)

Pygmy Honeyeater

SPECIMENS EXAMINED. Karimui: 1 ♂, 1 ♀ (1 and 17 July 1965).
WEIGHT. 1 ♂: 6.0. 1 ♀: 5.7.
WING. 1 ♂: 48. 1 ♀: 47.

TAXONOMY. In a paper preliminarily naming a total of 28 races of meliphagids, based on reexamination of older material, Salomonsen (1966) described three new races of *O. pygmaeum*. The birds collected by Stevens on the Watut River in 1932 and already analysed by Greenway were described as *olivascens:* "Very similar to nominate *pygmaeum* but under parts with a conspicuous grayish olivaceous tinge and upper parts slightly darker" (Salomonsen, 1966, p. 2). Examination of the type series shows that the type (a male) stands out obviously among the eight males collected by Stevens as having the least yellow belly and lower flanks. Apart from this individual variant, Stevens' series is not distinguishable from other New Guinea populations. The name *flavipectus* was proposed for southern New Guinea birds, with the type a bird collected by Rand in 1934 on the First Archbold Expedition and already analysed by Mayr and Rand. Southern New Guinea birds do average a shade paler above and yellower below than the Vogelkop and northwestern New Guinea population, but many specimens can be matched, and the average difference is too slight for recognition.

DISCUSSION. The Pygmy Honeyeater occurred from about 2,000 to 4,500 ft. It was commoner than the two specimens indicate, and gathered in flowering trees, where it often accounted for 10 to 30% of bird-usage and was twice as common in the upper half as in the lower half of the crowns. In flocks of up to 10 it called incessantly and was in constant motion. One was seen to hover. The tailless silhouette (the tail extends no farther than the wings) is confusable only with *Gerygone* warblers, from which the hypernervous and social behavior and the voice serve to identify it.

VOICE. A constant, weak, rapid train of spitted notes on the same pitch.

Niche Differences in the Genus *Myzomela*

The five members of this genus contribute heavily to the bird-usage of flowering trees in New Guinea (Terborgh and Diamond, 1970). Apart from the erratically distributed second-growth species *M.*

adolphinae, the only form above 5,000 ft is *M. rosenbergii.* Three species (*M. cruentata, M. nigrita,* and *M. eques*) occur at lower altitudes, and at Karimui these three plus *M. rosenbergii* were present and often seen in the same tree. At Soliabeda *M. nigrita, M. cruentata,* and *M. eques* fed in the same tree, while *M. nigrita, M. cruentata,* and *M. rosenbergii* fed together at the Sena River. *M. nigrita, M. cruentata,* and *M. rosenbergii* are very similar in size and habits, confining themselves to the top of the canopy to an even more marked degree than does *Oedistoma pygmaeum.* Among the three species of myzomelids at lower altitudes, *M. eques* sorts out ecologically on the basis of its larger size (twice as heavy as *M. nigrita* and *M. cruentata*), presence at sea level (where *M. nigrita* and *M. cruentata* are rare or absent), and less extreme tendency to stay in the treetops. *M. nigrita* and *M. cruentata* are very similar ecologically, and the only difference I have noticed is that the altitudinal range of *M. cruentata* lies on the average higher.

Myzomela eques karimuiensis Diamond

Red-spotted Myzomela

SPECIMENS EXAMINED. Karimui: 1 ♂ (3 July 1965).
WEIGHT. 18.
WING. 75.
TAIL. 63.
CULMEN FROM BASE. 21.
STOMACH CONTENTS. Insects.

TAXONOMY. This is another of the dark races from Karimui (Diamond, 1967a, p. 9).

BREEDING. The gonads of the unique type were somewhat enlarged.

DISCUSSION. Of the five myzomelids in the Eastern Highlands. *M. eques* is the largest (in the male) and is the only one to extend regularly down to sea level. It was present at Soliabeda (2,000 ft) as well as Karimui (3,650 ft) but not at any higher station. Terborgh's observations at Karimui show that it accounted for 1-7% of the bird-usage in flowering trees and was consistently several times less numerous than *M. nigrita* but more numerous than *M. cruentata* or *M. rosenbergii.* A possible indication of niche specialization among myzomelids is provided by Terborgh's observation that *M. eques,* although mainly a canopy species, spent about one-third of its time in the lower half of the crown, whereas *M. cruentata* and *M. nigrita* were virtually confined to the upper half of the crown. In addition, the larger *M. eques* is somewhat slower moving than *M. cruentata, M. nigrita,* or *M. rosenbergii.*

Myzomela adolphinae Salvadori

Mountain Red-headed Myzomela

DISCUSSION. This myzomelid of second-growth, open country, and gardens between 4,000 and 6,400 ft varies radically and unpredictably in its abundance from place to place and from time to time, perhaps due to local movements associated with flowering of trees. Eastern Highlands records are from Kyaka territory and the Baiyer Valley (Bulmer), Nondugl (Gyldenstolpe, Shaw-Mayer), and the Kubor Mountains (Gilliard, Hitchcock). This species is present in the Vogelkop and Eastern Highlands but absent in the entire western half of New Guinea outside the Vogelkop, a distribution shared only by *Zosterops novaeguineae.* I have seen a singing male *M. adolphinae* and a male *M. rosenbergii* in the same tree.

VOICE. The song, repeated at 4 sec intervals, is suggestive of an *Empidonax* flycatcher (Tyrannidae, North America). It consists of two high-pitched notes, the first higher than the second, the first often upslurred, the second often trilled. The song of *Myzomela sclateri* is very similar.

Myzomela cruentata cruentata Meyer

Red Myzomela

SPECIMENS EXAMINED. Karimui: 4 ♂, 2 ♀ (2-12 July 1965).
WEIGHT. 3 ♂: 9.0 (3). 2 ♀: 7.0, 7.3.
WING. 3 ♂: 56, 57, 59.

BREEDING. The gonads were greatly enlarged in three of the males, very small in the fourth.

DISCUSSION. The Red Myzomela was observed at Soliabeda (2,000 ft), Karimui (3,650 ft), and the Sena River (4,500 ft). In flowering trees at Karimui and Soliabeda it accounted for 1-4% of the bird-usage and was much less numerous than *M. nigrita* or *M. eques.* At the higher altitude of the Sena River *M. eques* was absent, *M. nigrita* very uncommon, and *M. cruentata* and *M. rosenbergii* equally common (16% of the bird-usage each). Like *M. nigrita, M. cruentata* is virtually confined to the top of the canopy. The only ecological difference I can observe between these two species is that the altitudinal range of *M. cruentata* is centered slightly higher (*M. nigrita* commonest at 1,500-3,500 ft, *M. cruentata* commonest at 2,500-4,500 ft).

Myzomela nigrita meyeri Salvadori

Black Honeyeater

SPECIMENS EXAMINED. Karimui: 4 ♂, 1 ♀, 2 imm. ♂, 2 ? (3 July-5 Aug. 1965). Soliabeda: 2 ♂ (23-27 July 1965).

WEIGHT. 6 ♂: 9.8, 10.0 (4), 10.5. 1 ♀: 8.3. 2 imm. ♂: 8.3, 10.0. 2 ?: 9.0 (2).
WING. 6 ♂: 58 (4), 59, 61. 1 ♀: 54. 2 imm. ♂: 57 (2).

TAXONOMY. In size these are near the borderline between the widespread race *meyeri* (wing, ♂, 58-64) and the smaller Aru Islands and southern New Guinea race *nigrita* (wing, ♂, 55-58), but are within the range of *meyeri*. The female and one of the unsexed birds are olive-brown to gray-brown, with a rose chin and forehead, while the adult males are all black. The two immature males are black except for a small rose area on the chin.

BREEDING. Testes were greatly enlarged in one adult male, somewhat in two, at Karimui (3,650 ft); not enlarged in the two from Soliabeda (2,000 ft); and somewhat enlarged in one of the two immature males, not in the other, at Karimui.

DISCUSSION. In flowering trees at Karimui and Soliabeda this was the commonest myzomelid, nearly three times as common as the other three species combined. On the average, it accounted for 10% of the bird-usage. At the Sena River it was much less common than *M. cruentata* and *M. rosenbergii* and accounted for only 1% of the bird-usage. Like *M. cruentata, M. nigrita* is a canopy species: out of 77 individuals whose position in the upper or lower half of the tree was noted, 73 were in the upper half.

Myzomela rosenbergii rosenbergii Schlegel

Red-collared Myzomela

NATIVE NAME. Fore: páni.
SPECIMENS EXAMINED. Mt. Michael: 1 ♂ (3 July 1964). Karimui: 2 ♀ (3 July 1965). Mt. Karimui Zone 2: 6 ♂, 1 ♀, 2 imm. ♂; Zone 3: 1 imm. ♂; Zone 4: 1 ♂; Zone 5: 5 ♂, 1 imm. ♂; Zone 7: 1 ♀; Zone 8: 2 ♂ (13 Aug.-8 Sept. 1965).
WEIGHT. 15 ♂: 9.3-12.7 (11.0 ± 2.5). 4 ♀: 9.0-10.7 (9.7 ± 0.6).
WING. 15 ♂: 61-67 (64 ± 1). 4 ♀: 58-61 (59 ± 1).
STOMACH CONTENTS. Insects.

TAXONOMY. Gyldenstolpe (1955, p. 155) separated Eastern Highlands birds (*wahgiensis*) from nominate *rosenbergii* of the Vogelkop. However, comparison of my adult males with adult males collected in the Vogelkop (topotypical *rosenbergii*), Wahgi Valley (topotypical *wahgiensis*), southeastern New Guinea, and at Telefolmin shows that all series are identical except for the more recently collected specimens being slightly more pure black, less blackish-brown below, due presumably to foxing. The race *wahgiensis* accordingly must be considered synonymous with *rosenbergii*, as concluded by Gilliard and LeCroy (1961, p. 75).

BREEDING. In the Karimui area gonads were greatly enlarged in all the many adult males examined, but not in the females.

DISCUSSION. The sex ratio on Mt. Karimui is very unbalanced (males outnumber females 7:1), as is frequently true in museum collections of myzomelids. Two factors may contribute, in addition to the possibility that the ratio really is unbalanced in nature. (1) Rand and Gilliard (1967, p. 533) suggest that "males and females have different habitat preferences; the females instead of visiting flowering trees more often feed singly among the foliage, and perhaps lower in the forest." Most myzomelids are, in fact, collected in flowering trees where they congregate in large numbers and are easily secured, so that a preference of males for such trees might explain the unbalanced ratio in museums. I found that on Mt. Karimui males outnumbered females 12:1 in flowering trees but only 5:3 away from flowering trees. Corresponding figures on Mt. Albert Edward were 3:2 and 1:1, as on Mt. Karimui and in agreement with the suggestion of Rand and Gilliard. (2) Males and females may have different altitudinal preferences. Bulmer found that the proportion of adult males was much lower at 4,000-5,000 ft than at the higher altitudes up to 10,000 ft. At Karimui (3,650 ft) both specimens and most birds seen were females (or immatures).

Myzomela rosenbergii is fairly common from about 4,000 to at least 10,000 ft in forest and second-growth. Its local abundance appears to vary enormously in time and space according to the presence of flowering trees. On Mt. Karimui's west ridge during the month we were there, there were four such trees: at 4,250 ft, just above Zone 1 and beyond collecting and censusing limits; at 4,450 ft in Zone 2; at 6,490 ft in the upper half of Zone 5; and a fourth in Zone 3 on the side of the ridge, where we collected only very briefly. This is reflected in the relative abundance figures: Zone 1, 0.0% of the local avifauna; Zone 2, 13%; Zone 3, 1%; Zone 4, 0.2%; lower half of Zone 5, 0.0%; upper half of Zone 5, 9%; Zone 6, 0.0%; Zone 7, 2%; Zone 8, 1.2%. *M. rosenbergii* reached the bottom of its altitudinal range at Karimui and was the rarest of the four myzomelids there.

M. rosenbergii was netted frequently in high-altitude moss forest on Mts. Karimui and Michael, but not at lower altitudes, indicating that it stays mainly in the treetops until the forest becomes stunted.

VOICE. The call is a high-pitched upslurred "tswi" or a high "ts-ts". The song is an energetic, breathless, high-pitched sibilant trill or rapid alternation between two notes on different pitches.

Meliphaga analoga group

Anyone who has had to work with the nine exceedingly similar honeyeaters of the *Meliphaga analoga* group on mainland New Guinea will agree that they pose the most difficult problems of taxonomy, field identification, and niche definition in the New Guinea avifauna. All can be briefly described as small honeyeaters with olive upper parts, gray underparts, and a yellowish or whitish auricular spot. Six of these nine species occurred sympatrically and abundantly in the Karimui area. My general observations on taxonomy, voice, ecology, and field identification are summarized here and are followed by the individual species accounts.

Taxonomy.—One's first impression on starting to work with this group is that the forms of New Guinea *Meliphaga* are a hoax perpetrated by previous workers and constitute just a single form showing continuous and minor individual and geographical variation. With practice, however, it becomes possible to identify many specimens in the hand without measurements and to identify most (but not all!) of the rest by measurements (cf., Table 15). The grouping of populations in different areas into species was long a subject of controversy and confusion until clarified in a fine review by Rand (1936), the validity of most of whose conclusions has survived subsequent discoveries of new populations. Rand's classification appears to me at present to require modification in only two or three respects: the southern New Guinea populations *auga* and *setekwa,* which Rand grouped under *M. montana,* constitute a distinct species, *M. auga* (p. 368); the population *citreola* of northern New Guinea belongs to *M. orientalis,* not to *M. analoga* (Diamond, 1969, pp. 38-46); and *M. auga* may be a synonym of the form known as *M. albonotata.* The characters by which I distinguished the forms of the six species occurring in my study areas are listed below. It is necessary to realize that the minor differences between different species at one place are often less marked than the minor differences between different populations of the same species, so that this list will not necessarily be adequate in other parts of New Guinea.

1. *M. auga auga.* Readily identified by the whitish auricular spot of the adult, contrasting with the yellow spot of other species. The only possible sources of confusion are that the spot is pale lemon to yellowish in immatures, and that it is pale lemon to whitish in the uncommon *M. flavirictus.* The underparts are a dull, uniform, rather dark olive, very similar to the other species except *M. flavirictus.* The underwing coverts are olive-ochraceous, slightly more yellow and paler than in *M. mimikae,* averaging more olive than in *M. orientalis,* and distinct from the yellower coverts of the other three species. The inner edges of the primaries are pale olive, sometimes olive-ochraceous. The size (wing, tail, and weight) is similar to *M. mimikae* and *M. aruensis,* and larger than the other three species (Table 15).

2. *M. flavirictus flavirictus.* The rarest of the six species. Best distinguished by the auricular spot, which is pale lemon to nearly white (more yellow anteriorly); the marked and bright yellow rictal streak (a streak extending from the base of the bill to below the eye), better developed than in the other species; the distinctly yellow chin, more so than in *M. aurensis* or *M. analoga;* the lower mandible, which is not black, as in adults of the other species, but horn-colored; and the legs, which are less dark than in the other species, orange on the rear sur-

TABLE 15

MEASUREMENTS AND WEIGHTS OF SPECIES OF THE *Meliphaga analoga* COMPLEX ON THE SOUTH SLOPES OF THE EASTERN HIGHLANDS

		Weight	Wing	Tail	Culmen (from base)	Exposed Culmen
M. aruensis aruensis	3 ♂	27.0-28.7 (27.8)[1]	87-94 (90.3)	67-77 (72.7)	19.0-20.5 (19.8)	14.5-16.5 (15.3)
	3 ♀	23.0-26.5 (24.7)	83-88 (86.0)	67-74 (70.7)	18.5-19.5 (19.0)	14.0-15.0 (14.7)
M. auga auga	23 ♂	27.0-34.0 (30.7)	84-91 (86.9)	66-78 (71.8)	20.0-22.5 (21.1)	16.5-19.0 (17.6)
	23 ♀	22.3-28.5 (25.6)	77-83 (79.5)	63-70 (67.1)	18.0-22.0 (19.9)	15.0-18.0 (16.0)
M. mimikae bastille	34 ♂	24.0-32.5 (28.5)	82-91 (86.4)	67-75 (71.0)	20.0-23.0 (21.7)	17.0-20.0 (18.1)
	43 ♀	22.0-29.0 (25.4)	75-82 (79.4)	61-68 (65.2)	18.5-21.5 (20.1)	15.0-18.5 (16.7)
M. orientalis facialis	10 ♂	15.7-20.4 (18.6)	71-78 (74.8)	56-62 (59.9)	20.5-23.0 (21.6)	17.5-19.5 (18.4)
	11 ♀	15.5-19.5 (17.6)	66-71 (68.8)	52-58 (56.4)	19.0-21.0 (20.2)	16.0-18.5 (17.5)
M. analoga analoga	3 ♂	24.0-25.5 (25.9)	80-83 (82.0)	64-70 (66.3)	23.0-24.0 (23.5)	18.0-18.5 (18.3)
	4 ♀	21.0-22.0 (21.3)	75-78 (76.2)	60-64 (62.0)	21.0-22.0 (21.5)	16.0-18.5 (17.3)
M. flavirictus flavirictus	3 ♂	20.3	77, 79 (78.0)	65, 67 (66.0)	21.0, 21.5 (21.3)	17.0, 17.5 (17.3)

[1] Average values are given in parentheses.

face and dull olive on the front surface. None of these characters is infallible taken alone (e.g., immatures of other species may duplicate the bill and leg color), but the combination is distinctive. The upperparts are pale, dull, and gray and fairly distinct from the more olive and brighter color of the other species. The underwing coverts are whitish to yellow, not at all olive or ochraceous. The inner edges of the primaries are pale yellow. The underparts are pale, clear, and rather lemon as in *M. analoga* and *M. aruensis* and unlike the other three species. The size (wing, tail, bill, weight) is nearly as small as *M. orientalis,* somewhat smaller than *M. analoga,* and significantly smaller than the other three species.

3. *M. mimikae bastille.* The underparts are darker and more uneven (more spotted) than in the other species but are approached by *M. orientalis.* The underwing coverts are olive-ochraceous (occasionally more olive-yellow), and the inner edges of the primaries are near ochraceous (sometimes olive-buff to ochraceous). The auricular spot is yellow and of medium size. The bill is stout. The size is large, as in *M. auga* and *M. aruensis.* No single mark of this species is infallible, but the spotted underparts are the best mark, and the combination of the above traits is generally diagnostic. The most similar species is *M. orientalis,* from which *M. mimikae* may be recognized by the significantly larger size and stout bill.

4. *M. aruensis aruensis.* The auricular spot is yellow, and averages larger than in the other species. The feathers of the rump form a blackish tuft which stands up somewhat. This offers the best, though not an infallible, mark. The underparts are pale and evenly colored with a yellowish chin, and resemble *M. analoga* and *M. flavirictus.* The underwing coverts are yellow or yellow-orange, not ochraceous or olive. The inner edges of the primaries are yellow, sometimes yellow-buff. The size is large, as in *M. auga* and *M. mimikae,* and the length of the wing and tail averages greatest in *M. aruensis.* However, the stout bill is shorter than in the other five species, including the three smaller ones (*M. analoga, M. orientalis, M. flavirictus*). The face is rather blackish between the eye and the auricular spot. The most similar species is *M. analoga,* from which the combination of the rump tuft, stout bill, longer wing and tail, and larger auricular spot separate it.

5. *M. orientalis facialis.* The combination of small size, spotted underparts, long and slender bill, and somewhat ochraceous underwing are useful characters. The wing and tail are shorter, and the weight less, than in other species except *M. flavirictus* (those attempting to use this key in other areas should be warned that *M. gracilis,* which did not occur in my study areas, is equally small, and that some populations of *M. orientalis* in other parts of New Guinea are not so small). The slender bill is as long as in the large *M. auga* and *M. mimikae,* and more slender than in these or *M. aruensis.* The under-

parts are darker and more uneven (more spotted) than in other species except *M. mimikae,* which is slightly darker and more spotted. The auricular spot is smaller than in most other species and bright yellow. The underwing coverts are variable, and usually rather orange, generally ochraceous olive to ochraceous yellow, occasionally more yellow. The inner edges of the primaries are generally ochraceous olive. The most similar species are *M. mimikae,* which has similar underparts but is larger and has a stouter bill; *M. analoga,* which is somewhat larger and differs in the underparts and underwing; and *M. gracilis,* which has considerably paler and duller upperparts and paler and even-colored underparts.

6. *M. analoga analoga.* This species has no single feature that could be called distinctive, and must be recognized by a combination of characters, each shared individually with other species. The underparts are pale, even, and somewhat yellowish on the chin, as *M. aruensis* and *M. flavirictus* and unlike the other three species. The size is somewhat smaller than *M. auga, M. mimikae,* and *M. aruensis* and somewhat larger than *M. orientalis* and *M. flavirictus.* The underwing coverts are yellow, similar to *M. aruensis* but slightly paler. The inner edges of the primaries are yellow, as *M. aruensis.* The yellow auricular spot is slightly smaller than in *M. aruensis* and larger than in *M. orientalis.* The bill is slender and averages longer than in all the other species. The most similar species are *M. aruensis, M. orientalis,* and *M. flavirictus,* under which the distinguishing marks are listed.

Voice.—Regretably, meliphagas are as similar and undistinctive in voice as in appearance. Meliphagas call frequently. With one exception, all the calls I heard were a single, short, and musical note which can be rendered as "chip", "chup", "tup", or "tuck" and is either on constant pitch, slightly upslurred, or slightly downslurred. In the Eastern Highlands I identified this call positively from *M. auga* and *M. orientalis,* with high probability from *M. mimikae,* and elsewhere in New Guinea from *M. montana* and probably from *M. aruensis* and *M. analoga.* The one good vocal field mark is that *M. auga* has in addition a distinctive song.

Ecology.—Of the six meliphagas in the Karimui area, five coexisted at Karimui, four at Soliabeda, and three at Bomai. Niche differences involve habitat preference, altitudinal range, vertical distribution in the vegetational column, and probably feeding habits. (1) *M. auga* was strikingly confined to second-growth and the forest edge and was completely absent from the forest interior. (2) Much of the altitudinal range of *M. orientalis* lies above that of all other meliphagas, though it meets four other species at the lower extremity of its range (Karimui). *M. orientalis* and *M. analoga* are ecologically similar and have mutually exclusive altitudinal ranges. *M. mimikae* and *M. auga* are also hill forest species which rarely reach sea level and have a higher ceiling than the other species except for *M. orientalis.* Of the three species which reach sea level, *M. analoga* has a slightly lower ceiling than *M. aruensis* or *M. flavirictus,* and the ceiling of *M. gracilis* is so low that it failed to reach Soliabeda, my lowest station. (3) Netting returns suggest some differences in vertical preferences. *M. auga, M. mimikae,* and *M. aruensis* were often netted, *M. orientalis* much less often, and *M. analoga* and *M. flavirictus* never. (4) The differences in the bills suggest differences in feeding habits. The bills of the three lowerstory species (*M. auga, M. mimikae,* and *M. aruensis*) are stout, those of the three middlestory species (*M. orientalis, M. analoga,* and *M. flavirictus*) slender. Meliphagas in general glean for insects, visit flowering trees, and visit fruit trees, but deciding just which species is doing what is usually difficult. At Karimui Terborgh found meliphagas accounting for 7-30% of bird-usage in flowering trees, 66-76% in trees with small fruits, and 44% in trees with woody fruits opened by parrots. *M. flavirictus* was shot both in a flowering tree and in a tree with small fruits, and *M. orientalis* was shot in a flowering tree and observed at Miarosa in fruiting trees. The white-eared *M. auga* was also recognized in flowering trees. Far more information on stomach contents and on what specimens were doing when shot is necessary.

Field identification.—*M. auga* can usually be identified by its white ear and by its song, though not by its call. Field identification of the yellow-eared meliphagas is at present impossible unless one has carefully compared specimens of the forms known actually to be present in the study area, and then only after much practice and under the most favorable conditions of light and proximity imaginable. On two such occasions I felt confident that I was watching *M. mimikae* because of the uneven underparts. On one occasion I felt that I was watching *M. aruensis* because of the large and bright yellow auricular spot and dark face. The small and bright yellow auricular spot of *M. orientalis* might prove of some use as a field mark. Identification of yellow-eared meliphagas held in the hand, or prepared as study skins, should not be attempted without comparative material.

Meliphaga aruensis aruensis (Sharpe)

Puff-backed Meliphaga

NATIVE NAMES. North Fore: augarió. South Fore: agerabíte. Gimi: lóho. Daribi: sobadáge. (The same native names are applied to all species of the *Meliphaga analoga* complex).

SPECIMENS EXAMINED. Karimui: 2 ♂, 1 ♀ (8 Aug. 1964; 1 and 11 July 1965). Soliabeda: 1 ♂, 2 ♀ (22 July 1965).

WEIGHT. 2 ♂: 27, 29. 3 ♀: 23, 25, 27.

WING. 3 ♂: 87, 90, 94. 3 ♀: 83, 87, 88.

TAIL. 3 ♂: 67, 74, 77. 3 ♀: 67, 71, 74.

CULMEN FROM BASE. 3 ♂: 19.0, 20.0, 20.5. 3 ♀: 18.5, 19.0, 19.5.

EXOSED CULMEN. 3 ♂: 14.5, 15.0, 16.5. 3 ♀: 14.0, 15.0 (2).

TAXONOMY. The yellow auricular patch is square, rather than elongated as in the race *sharpei.*

BREEDING. The testes were small in one male, somewhat enlarged in another.

DISCUSSION. Three of the specimens were netted. This large, stout-billed meliphaga of the lowerstory reached its altitudinal ceiling at Karimui (3,650 ft).

Meliphaga auga auga Rand

Southern White-eared Meliphaga

SPECIMENS EXAMINED. Karimui: 19 ♂, 17 ♀, 1 imm. ♀, 1 imm. ? 1-16 Aug. 1964; 1-17 July 1965). Bomai: 3 ♂, 2 ♀ (6-8 July 1965). Soliabeda: 1 ♂, 4 ♀ (23-28 July 1965).

WEIGHT. 14 ♂: 27-34 (30.7 ± 2.3). 13 ♀: 22-29 (25.6 ± 1.8).

WING. 17 ♂: 84-91 (86.9 ± 1.8). 18 ♀: 77-83 (79.5 ± 1.6).

TAIL. 17 ♂: 66-78 (71.8 ± 3.0). 17 ♀: 63-70 (67.1 ± 1.9).

CULMEN FROM BASE. 17 ♂: 20.0-22.5 (21.1 ± 0.7). 18 ♀: 18.0-22.0 (19.9 ± 0.8).

EXPOSED CULMEN. 17 ♂: 16.5-19.0 (17.6 ± 0.7). 18 ♀: 15.0-18.0 (16.0 ± 0.8).

CULMEN FROM ANTERIOR EDGE OF LATERAL FEATHERING. 13 ♂: 15.5-17.0 (16.1 ± 0.5). 16 ♀: 14.0-16.5 (14.7 ± 0.8).

TAXONOMY. The range and average values of measurements for five males (including the type) and four females of nominate *auga* from southeastern New Guinea are: wing, ♂ 82-88 (86.0), ♀ 75-80 (77.8); tail, ♂ 68-75 (72.4), ♀ 65-67 (66.0); culmen (from base), ♂ 20-22 (21.3), ♀ 19-20 (19.3). Birds from the Karimui area thus average a trifle larger, and are very slightly duller and darker above, but otherwise match *auga* well. The type and paratype of *setekwa* differ in the slightly more orange axillaries, dirtier breast, and smaller size. Wahgi birds were separated by Gyldenstolpe and Gilliard (Gyldenstolpe, 1955, p. 166) as *gretae,* on the basis of having "a longer tail and somewhat longer wing; general coloration above and on the chest richer green". Specimens of *gretae* were not available for comparison, but average sizes calculated from the measurements cited in the original diagnosis (wing ♂ 89.7, ♀ 81.0; tail ♂ 72.4, ♀ 68.0 in *gretae*) are only slightly larger than in Karimui or southeastern New Guinea birds, and I doubt that *gretae* differs from *auga*. Gilliard and LeCroy (1967, p. 78) tentatively referred 14 white-eared meliphagas from the Adelbert Mountains to *gretae,* but examination shows that these specimens are close to the distinct and heavily spotted form *M. montana huonensis* (of which Gilliard and LeCroy lacked comparative material) and could not belong to the unspotted gretae (= *auga*?).

BREEDING. At Karimui testes were moderately or greatly enlarged in 1964, slightly or moderately enlarged in 1965. Ovaries were generally small except for being enlarged in one 1964 Karimui female. One nesting female was collected at Soliabeda. The nest was 15 ft above the ground in a bamboo thicket at 1,400 ft near a small river and held two young. In shape it was a cup 2½ inches high and with an inside diameter of 2 inches. The outside was constructed of green moss; the inside, of dry strands of grass arranged concentrically, with a few paper-thin chips of dry bark; and there was a lining of an unidentified, fine, soft, white, cotton-like material (possibly the same as the material Rand (1942a, p. 362) found in a nest of this species and identified as "plant down from the silk cotton tree").

DISCUSSION. In my study areas *Meliphaga a. auga* differed strikingly in its ecology from other species of *Meliphaga* in being strictly confined to second-growth and the forest edge and completely absent from forest interior remote from the edge. It was common in the Karimui area from 1,350 to 4,000 ft but absent at Okasa (3,550-4,250 ft), despite suitable habitat. Gilliard collected one specimen, and Gyldenstolpe 14, at Nondugl (5,200 ft). Gyldenstolpe's (1955, p. 167) comments on habitat duplicate my experience: ". . . . . rather common in patches of second-growth around Nondugl. Never observed in the forests of the Wahgi Divide." Schodde and Hitchcock (1968, p. 66) met *M. auga* in similar habitat at Lake Kutubu ("in the lower stages of tall secondary and marginal primary forest"). In the feeding trees studied by Terborgh he found white-eared meliphagas (*M. auga*) outnumbering yellow-eared individuals (four species) by about two-to-one. Solitary individuals of *M. auga* were also common in shrubbery 3-15 ft above the ground, where one was seen eating an insect, and were frequently netted.

In his review of the meliphagas Rand (1936) assembled eight white-eared forms, viz., *auga, setekwa, montana, sepik, steini, germanorum, huonensis,* and *aicora,* to which must be added a subsequently discovered form *margaretae* (Greenway, 1966, p. 22), into the single species *M. montana.* Rand noted, however, that the resulting "species" showed more geographic variation than any other in the *Meliphaga analoga* complex. More recent evidence suggests that two species are involved which are largely allopatric but overlap at Huon Gulf and possibly on the Huon Peninsula and in the Vogelkop and Weyland Mountains: a second-growth species with a more yellow-olive underwing in southern New Guinea, *M. auga* (races *auga* and *setekwa,* the former possibly a synonym of *albonotata;* see next paragraph); and a forest species with a more ochraceous underwing in northern New Guinea, *M. montana* (races *montana, margaretae, steini, sepik, germanorum, huonensis,* and *aicora*). The evidence is as follows. (1) Of the two forms of which I have field experience, *auga* (southern slopes of Eastern Highlands) and *sepik* (North Coastal Range), *auga* is confined to the forest edge and second-growth, while *sepik* lives in the forest interior. The taxa *auga* and *sepik* have very distinct calls, unlike each other's or that of any other meliphaga. Ecologically, *sepik* appears closer to the yellow-eared species *M. mimikae* of southern New Guinea. Except for its yellow ear, the large, stout-billed, spotted *M. mimikae* suggests (and is allopatric to) the northern New Guinea populations grouped under *M. montana* and is suspiciously similar to *margaretae*, as already noted by its describer, Greenway. However, *M. mimikae bastille* also lacks the distinctive call of *sepik*, so that I do not think that *sepik* and *M. mimikae bastille* are actually conspecific. (2) The inner edges of the primaries are ochraceous in the populations I group under *M. montana*, predominantly yellow-olive in *auga* and *setekwa*. (3) A white-eared meliphaga collected at Wau (Territory of Papua and New Guinea Museum. No. B 334) belongs unmistakably to *auga*. Wau lies halfway between the type localities of the quite different, ochraceous-underwinged races *aicora* (85 miles to the south) and *huonensis* (80 miles to the north). Thus, *M. montana* and *M. auga* are probably sympatric at Huon Gulf. If *auga* is a synonym of *albonotata* (see next paragraph), then the two species are also sympatric on the Huon Peninsula and in the Vogelkop and Weyland Mountains. Field observations of voice and habitat preference of the other populations besides *auga* and *sepik* will be necessary to test this proposed grouping.

The remaining white-eared meliphaga is the form known as *M. albonotata*, described in 1876 by Salvadori from D'Albertis' collection on the southern slope of southeastern New Guinea and subsequently reported from the Vogelkop and Weyland Mountains by many collectors, from southwestern New Guinea by Ogilvie-Grant (1915), and from the Huon Peninsula by Mayr (1931). I have examined Ogilvie-Grant's specimens, which are in the British Museum of Natural History and are close to *M. auga setekwa;* and I have also examined 13 specimens from the Vogelkop and Weyland Mountains in the American Museum of Natural History, which are also close to *M. auga setekwa*, differing only in the slightly brighter olive back and very slightly shorter wing and more slender bill. The type of *M. albonotata* from southeastern New Guinea was not available to Rand when he described *auga* from southeastern New Guinea, nor was it available to me, but Salvadori's (1881, Vol. 2, p. 333) description of *M. albonotata* fits the type of *auga* well. All white-eared meliphaga specimens in the American Museum of Natural History and in the Territory of Papua and New Guinea Museum from the southern slope of southeastern New Guinea apparently belong to the same population as the type of *auga*. It may turn out that *auga* is a synonym of *albonotata*, and that the Vogelkop-Weyland population is conspecific with *auga* (= ? *albonotata*) and *setekwa* and requires naming.

VOICE. Since white-eared meliphagas were identifiable by sight in the field, the vocalizations of this species could be identified with certainty. There are two call notes: a short, cheerful, musical, and fairly loud "chip" or "tup" with a sucked-in quality (perhaps more sucked-in than the call of *M. orientalis*?); and a very similar disyllabic note. These calls are not distinguishable from the calls of the yellow-eared meliphagas. The song is a series of 10-12 thin and quieter notes at the rate of about 5 per second, dropping in pitch towards the end and often rising slightly in pitch at the beginning. No yellow-eared meliphaga gave this song.

Meliphaga mimikae bastille Diamond

Large Spot-breasted Meliphaga

SPECIMENS EXAMINED. Okasa: 1 ♂, 1 ♀ (22 and 24 June 1965). Sena River: 4 ♂, 1 ♀ (26 and 27 July 1965). Karimui: 18 ♂, 17 ♀ (10-14 Aug. 1964; 1 July-6 Aug. 1965). Bomai: 1 ♂, 14 ♀ (6-9 July 1965). Soliabeda: 6 ♂, 9 ♀ 22-30 July 1965). Mt. Karimui Zone 1: 4 ♂, 1 ♀ (9-12 Aug. 1965).

WEIGHT. 25 ♂: 24-33 (28.5 ± 2.0). 41 ♀: 22-29 (25.4 ± 1.7).

WING. 30 ♂: 82-91 (86.4 ± 2.7). 42 ♀: 75-82 (79.4 ± 1.9).

TAIL. 31 ♂: 67-75 (71.0 ± 2.6). 43 ♀: 61-68 (65.2 ± 1.8).

CULMEN FROM BASE. 27 ♂: 20.0-23.0 (21.7 ± 0.7). 42 ♀: 18.5-21.5 (20.1 ± 0.8).

EXPOSED CULMEN. 26 ♂: 17.0-20.0 (18.1 ± 0.8). 39 ♀: 15.0-18.5 (16.7 ± 0.9).

TAXONOMY. The diagnosis of this race has been given previously (Diamond, 1967a, p. 12).

BREEDING. Testes were large in males taken in 1964 (Sena River and Karimui). In 1965 testes were slightly enlarged in three out of four males on Mt. Karimui and in two males at Soliabeda but were small in most males from Karimui and Bomai.

DISCUSSION. *M. mimikae* was the commonest forest meliphaga, and the commonest yellow-eared meliphaga, in my study areas up to 4,200-4,500 ft, above which altitude it disappeared. Netting figures suggest that it spends much time in the lowerstory, since 48% of the specimens were netted. The species is confined to the hills of southern New Guinea, mainly between 500 and 4,500 ft, and consists of three races known from the following localities. *M. m. mimikae,* southwestern New Guinea: Mimika, Kapare, Wataikwa, Iwaka, Setekwa, and Utakwa Rivers, from sea level to 2,500 ft but with the great majority of the specimens collected in the hills (Ogilvie-Grant, 1915, p. 67); upper Setekwa River and southern slopes of the Snow Mountains, 3,000 ft (collected by A. S. Meek); Alkmaar on the Noord River, unspecified but probably low elevation, one specimen reported (Junge, 1939, p. 60); Fly River, only on the hilly upper reaches at elevations above 260 ft (collected by Rand, Second Archbold Expedition). *M. m. bastille,* southern slopes of the Eastern Highlands, 1,350-4,500 ft: Karimui and Okapa areas (my collections). *M. m. granti,* southeastern New Guinea, no records below 2,500 ft: Mafulu, 4,100 ft (collected by Rand, First Archbold Expedition); Aroa River, 4,000-6,000 ft (collected by A. S. Meek); Hydrographer Range, 2,500 ft.

An adult male yellow-eared meliphaga (A.M.N.H. 342,965) collected by Rand at Bernhard Camp (elevation, 160 ft) in the northern New Guinea lowlands during the Third Archbold Expedition has been used by Salomonsen (1966, p. 4) as the unique type of a new race, *M. mimikae rara.* Rand (1942, p. 508) identified this specimen as *M. analoga flavida* and pointed out that it differed in color from the 28 other specimens he collected of this form but that it was virtually identical to *M. a. analoga* from the upper Fly River. Examination of this specimen shows that it is darker-backed than other *M. a. flavida* specimens and superficially not unlike but also not closely similar to the known races of *M. mimikae.* My measurements of it yield: wing, 83; tail, 69; exposed culmen, 18.5; culmen from base, 22.0. These measurements lie towards the upper limit for *M. analoga* and at the extreme lower limit for *M. mimikae* (only three of 31 males of *M. mimikae* measured have shorter wings). Against the attribution of this specimen to *M. mimikae* are the additional facts that the type locality would provide the sole northern New Guinea record; the locality is 300 miles along the hill slopes from the nearest place of known occurrence of *M. mimikae;* the elevation would be unusually low, though not unprecedented, for *M. mimikae;* and only a single specimen was taken although Rand's collection was exhaustive and *M. mimikae* has proved abundant at most localities where it occurs. Given these facts, the difficulty of identifying even large series of New Guinea meliphagas, and the likelihood that this specimen is merely an individual variant of another species, it seems inadvisable to take a single specimen as evidence for a new race and large range extension of *M. mimikae.*

VOICE. Since *M. mimikae* could rarely be distinguished from other yellow-eared meliphagas in the field, the call specifically of this species was not identified with certainty. However, at localities in the Karimui region where *M. mimikae* and other yellow-eared meliphagas were present, all vocalizations of yellow-eared meliphagas consisted of a single very similar call note, described on p. 365. Since 60-95% of the yellow-eared meliphagas were *M. mimikae,* I assume that it was responsible for most of these vocalizations.

Meliphaga orientalis facialis Rand

Small Spot-breasted Meliphaga

SPECIMENS EXAMINED. Awande: 3 ? (20 June 1964). Miarosa: 1 ? (28 June 1964). Okasa: 2 ♂, 1 ♀ (24-26 June 1965). Karimui: 5 ♂, 6 ♀ (8 Aug. 1964; 1 July-5 Aug. 1965). Mt. Karimui Zone 1: 1 ♀; Zone 2: 1 ♂, 2 ♀; Zone 3: 2 ♂, 1 ♀ (11-17 Aug. 1965).

WEIGHT. 9 ♂: 16-20 (18.6 ± 1.7). 11 ♀: 16-20 (17.6 ± 1.2).

WING. 10 ♂: 71-78 (74.8 ± 2.0). 12 ♀: 66-71 (68.8 ± 1.5).

TAIL. 10 ♂: 56-62 (59.9 ± 1.9). 12 ♀: 52-58 (56.4 ± 1.9).

CULMEN FROM BASE. 10 ♂: 20.5-23.0 (21.6 ± 0.8). 11 ♀: 19.0-21.0 (20.2 ± 0.7).

EXPOSED CULMEN. 10 ♂: 17.5-19.5 (18.4 ± 0.8). 11 ♀: 16.0-18.5 (17.5 ± 0.9).

CULMEN FROM ANTERIOR EDGE OF LATERAL FEATHERING. 3 ♂: 16.0, 17.0, 18.5. 4 ♀: 16.5, 17.0, 17.5, 17.5.

TAXONOMY. The various populations grouped under *facialis* are not identical, but the differences are not sufficiently marked or well-established to justify naming of new races. The principal differences are that birds from the Vogelkop (3 ♀, including the type: wing, 71, 75, 77; tail, 56, 59, 61; culmen from base, 21.5, 22.0) and the Weyland Mountains (2 ♂, wing, 78, 79; tail 63, 66; culmen from base, 22, 22) have longer wings and tails than those from the southern slope of the Snow Mountains (wing, 1 ♂ 74, 2 ♀ 69 and 71; tail, 1 ♂ 58, 2 ♀ 56 and 57; culmen from base, 1 ♂ 22.0, 2 ♀ 20.0 and 20.0) or my series. In addition, my birds show some approach to nominate *orientalis* of southeastern New Guinea in that the underparts are less spotted, and the upperparts darker, grayer, and less bright, than in other *facialis* populations, but they are still nearer *facialis* than *orientalis* in these respects. The nearly black postocular stripe of *orientalis* is greatly reduced in *facialis,* including my specimens. The race *becki* is considerably larger and still less spotted below, while *citreola* (formerly considered a race of *M. analoga;* Diamond, 1969) is yellower.

BREEDING. Gonads were small in all specimens.

DISCUSSION. In my study areas the altitudinal range of *M. orientalis* lay for the most part above those of its congeners. In the Okapa area it was the only meliphaga at Awande (up to 6,200 ft) and Miarosa (5,800 ft), and shared Okasa (3,550-4,250 ft) only with *M. mimikae.* In the Karimui area it descended to Karimui (3,650 ft), where four other species were present, but not to Bomai (3,250 ft); it shared Zone 1 of Mt. Karimui (4,000-4,200 ft) only with *M. mimikae;* and it was the only meliphaga on Mt. Karimui above 4,400 ft until it dropped out around 5,600 ft. Its maximum abundance (5-7% of the local avifauna) was at 4,400-5,600 ft. The fairly abrupt disappearance above this limit may have been correlated with the increase in abundance of *Ptiloprora guisei,* while the decline in abundance at lower altitudes may have been correlated with the appearance of the other meliphagas, particularly the similar *M. analoga.*

Two of the specimens on Mt. Karimui were shot in the flowering tree at 4,450 ft. The habitat appears mainly to be the forest interior, though one was collected and another seen in a tree in a garden at Miarosa. Only four specimens were taken in nets. Of these four netted birds, three were obtained on a single day at Awande near the forest edge, the fourth at Karimui, and none was netted in the undisturbed forest of Mt. Karimui. Six specimens were in trees or the tops of trees when shot. Probably *M. orientalis* is more of a middlestory and upperstory than lowerstory species in the forest interior, and utilizes the lowerstory mainly at the forest edge. Its altitudinal range excludes that of the similar *M. analoga,* the slender-billed middlestory forest meliphaga of lower elevations (cf., also, Diamond, 1969).

VOICE. Since this was the only member of the genus in Zones 2, 3, and 4 of Mt. Karimui, calls of meliphagas in these zones are assumed to be of this species. There are three similar call notes: a bright, short, monosyllabic "tuck"; a bright, short, slightly disyllabic (or else slightly upslurred) note, with the second syllable slightly higher; and a similar disyllabic call except with a thinner quality and with the second note lower. These calls were indistinguishable from calls of yellow-eared meliphagas at Karimui, Bomai, and Soliabeda, assumed to come mostly from *M. mimikae.*

Meliphaga analoga analoga (Reichenbach)

Mimic Meliphaga

SPECIMENS EXAMINED. Bomai: 1 ? (8 July 1965). Soliabeda: 3 ♂, 4 ♀ (23-30 July 1965).

WEIGHT. 3 ♂: 24, 25, 26. 4 ♀: 21 (3), 22. 1 ?: 21.

WING. 3 ♂: 80, 83, 83. 4 ♀: 75, 75, 77, 78. 1 ?: 80.

TAIL. 3 ♂: 64, 65, 70. 4 ♀: 60, 61, 63, 64. 1 ?: 65.

CULMEN FROM BASE. 3 ♂: 23.0, 23.5, 24.0. 3 ♀: 21.0, 21.5, 22.0. 1 ?: 21.5.

EXPOSED CULMEN. 3 ♂: 18.0, 18.5, 18.5. 3 ♀: 16.0, 17.5, 18.5. 1 ?: 18.0.

STOMACH CONTENTS. Fruit.

TAXONOMY. In his review of the meliphagas Rand (1936, p. 14) pointed out, "All of the populations included in this race [*analoga*] are not identical but the differences between various groups of individuals are not sufficient to be used in separating races." Two new races, *connectens* (from Beck's Madang series) and *papuae* (from Rand's Wuroi series) have been described by Salomonsen (1966, p. 5) from the material already discussed by Rand. Gilliard and LeCroy (1968, p. 36) reaffirmed that *connectens* is not separable from *flavida.* The type of *flavida* (type locality Japen) is the yellowest of the 15 Japen specimens I examined, and the average color differences among *flavida* populations from Japen, Madang, Wewak, Hollandia, and the Idenburg River are irregular and trivial. Several of the characters used to separate *papuae* (type and paratypes examined) from *analoga* had already been pointed out by Rand and are equally irregular and trivial.

BREEDING. Gonads were small in all specimens.

DISCUSSION. None of the specimens was netted. This meliphaga appears to replace *M. orientalis* as the slender-billed meliphaga of the forest middlestory at lower elevations. In the Karimui area the transition lay somewhere between 3,250 ft (highest record of *M. analoga*) and 3,650 ft (lowest record of *M. orientalis*).

Meliphaga flavirictus flavirictus (Salvadori)

Yellow-gaped Meliphaga

SPECIMENS EXAMINED. Mengino: 2 ♂ (16 July 1964). Karimui: 1 ♀, 1 ? (3 July and 3 Aug. 1965).

WEIGHT. 1 ♂: 20. 1 ?: 17.
WING. 2 ♂: 77, 79. 1 ?: 73.
TAIL. 2 ♂: 65, 67. 1 ?: 65.
CULMEN FROM BASE. 2 ♂: 21.0, 21.5. 1 ?: 19.0.
EXPOSED CULMEN. 2 ♂: 17.0, 17.5. 1 ?: 14.0.

TAXONOMY. The main difference between the three available specimens of *crockettorum* (Idenburg River, Sepik River, and southern slope of Snow Mountains) and six specimens of nominate *flavirictus* (southeastern New Guinea and Fly River) is the yellow auricular spot of the former as opposed to the paler, lemon-whitish spot of the latter. On the basis of this character my specimens are unequivocally *flavirictus*, as expected on geographical grounds.

DISCUSSION. None of these specimens was netted. The Mengino specimens were among many meliphagas and other honeyeaters feeding in a tree with small berries at 4,600 ft.

Meliphaga flaviventer rubiensis (Meyer)[1]

Tawny-breasted Honeyeater

NATIVE NAMES. Gimi: abigómu. Daribi: kesoábo.

SPECIMENS EXAMINED. Okasa: 1 ♂, 1 juv. ♂ (22 and 26 June 1965). Karimui: 6 ♂, 3 ♀ (4-14 Aug. 1964; 2 July-3 Aug. 1965). Bomai: 1 ♂, 1 ♀ (6-8 July 1965). Soliabeda: 3 ♂, 2 ♀ (22-30 July 1965). Mt. Karimui Zone 1: 1 ♀; Zone 2: 1 ♂, 2 ♀: Zone 3: 1 ♀ (10-17 Aug. 1965).

WEIGHT. 12 ♂: 40-55 (47.3 ± 4.2). 10 ♀: 38-49 (42.7 ± 3.1). 1 juv. ♂: 28.
WING. 12 ♂: 96-108 (101.8 ± 2.5). 10 ♀: 90-99 (96.0 ± 3.5). 1 juv. ♂: 66.
STOMACH CONTENTS. Mainly fruit, some insects.

TAXONOMY. Comparison with specimens of all nine races from the New Guinea mainland yielded the unexpected result that birds from both the Karimui area and Okasa are closest to *rubiensis*, the Weyland Mountains race, from which they differ only in having slightly darker upperparts. One might have expected them to be *giulianettii*, the southern watershed race both to the east and to the west, to which Mayr and Gilliard (1954, p. 369) assigned their two specimens (from an unstated locality) without comment and to which Schodde and Hitchcock also assigned Lake Kutubu birds. However, specimens of *giulianettii* from Mafulu, Baroka, and Kubuna in southeastern New Guinea and from Palmer Junction on the upper Fly River are paler above, much paler below, and duller brown on the breast than the Karimui and Okasa series. Specimens of *saturatior* from the lower Fly River and Aru Islands are also paler and duller below and have the edges of the wing coverts less bright rufous. Birds from the Setekwa River on the southern slope of the Snow Mountains,

[1] Listed as *Xanthotis chrysotis* in Rand and Gilliard (1967). This and the next three species, placed in the genera *Xanthotis* and *Oreornis* by Rand and Gilliard, are included in *Meliphaga* by Salomonsen (1967, pp. 386-391) in Peters' *Check-list*, Vol. 12, but do not belong to the *Meliphaga analoga* complex.

assigned to *saturatior,* are slightly darker below than Fly River and Aru Islands specimens and show a tendency towards *rubiensis* in this respect. The races *chrysotis, madaraszi, spilogaster, kumusii, philemon,* and *visi* all show marked differences.

BREEDING. Gonads were small in most specimens except in 1964 at Karimui, where most testes were enlarged.

DISCUSSION. *Meliphaga flaviventer* is one of the most abundant bird species in the lowlands, becoming less common with increasing altitude until it disappears completely around 5,000 ft. Its contribution to the avifauna in the Karimui area was 7% of the local avifauna at Soliabeda, 5% at Karimui, and 1.8% on Mt. Karimui, where the highest record was at 4,850 ft.

Both flowering and fruiting trees were utilized. *Meliphaga flaviventer* accounted for 5-25% of the bird-usage in flowering trees at Karimui, 10-40% in trees with fruits smaller than 5 mm at Karimui, Okasa, and Mengino, and 23% in the tree at Karimui with hard-shelled fruit opened by parrots. It was absent in trees with soft fruits larger than 10 mm. In these feeding trees it could be seen in both the upper and lower half of the tree but was twice as numerous in the lower half. Outside of fruit trees it was commonest from 5 to 50 ft above the ground, so that relatively few specimens were netted. Chases of one individual by another took place occasionally, and one pair was observed attempting copulation in flight.

VOICE. The song is a phrase of usually three notes, repeated five to 10 times in succession and reminiscent of the songs of caprimulgids. In the commonest version all notes are somewhat upslurred, particularly the first; the first note is highest and the third lowest in pitch; and the interval between the first and second note is twice as long as that between the second and third note or between repetitions of the pattern (Fig. 39). The pitch is in the lower middle registers, the quality clear, and the volume loud. When one individual starts singing, others nearby may begin after a few repetitions of the pattern and continue more or less in synchrony. The song is suggestive of that of the honeyeater *Philemon novaeguineae* in the use of a repeated pattern, in the pattern itself, and in quality. Songs I heard near Port Morebsy and Lae were very similar to those in the Eastern Highlands, but songs in the North Coastal Range differed by being delivered nearly twice as fast, suggesting that a comparison of songs and morphological subspecific characters at different localities might prove interesting.

Meliphaga polygramma lophotis (Mayr)[1]
Spotted Honeyeater

NATIVE NAME. Daribi: bulugági.
SPECIMENS EXAMINED. Karimui: 2 ♂, 2 ♀ (10 July-4 Aug. 1965). Bomai:

1 Listed as *Xanthotis polygramma* in Rand and Gilliard (1967).

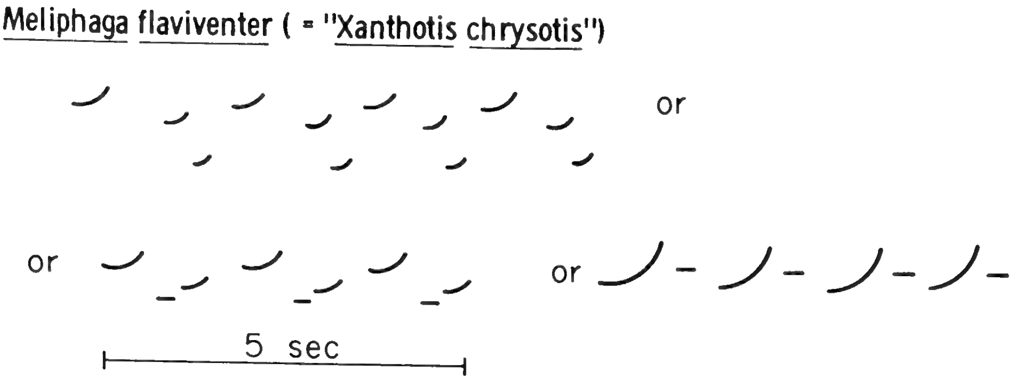


FIG. 39. Voice of *Meliphaga flaviventer.*

1 ♂ (9 July 1965). Mt. Karimui Zone 1: 1 ♀; Zone 2: 2 ♂ (10-15 Aug. 1965).
WEIGHT. 3 ♂: 19.7, 20.0, 23.5. 3 ♀: 18.0, 19.5, 19.5.
WING. 5 ♂: 75 (3), 76, 78. 3 ♀: 70, 73 (2).

TAXONOMY. These specimens agree with *lophotis* of the Huon Peninsula and southeastern New Guinea, which has a large yellow ear patch. The patch is smaller in *poikilosternos* and nearly lacking in *septentrionalis,* while *candidior* has smaller black spots on the underparts.

BREEDING. The latest male collected at Karimui (4 Aug.) and one of the two males on Mt. Karimui (15 Aug.) had slightly enlarged testes, while gonads were small in the other specimens.

DISCUSSION. This hill forest species was present up to 4,500-4,600 ft but did not occur as low as Soliabeda (2,000 ft). It was also recorded from Lake Kutubu (2,450 ft).

In the Karimui area *Meliphaga polygramma* occurred regularly but usually singly in feeding trees. It was observed in all seven flowering trees studied at Karimui and in the one at 4,400 ft on Mt. Karimui, where it made up 5-10% of the bird-usage. It accounted for 1-2% of the bird-usage in trees with small fruits at Karimui and Mengino, and 16% in the Karimui fruit tree with hard-shelled fruits opened by parrots. Its vertical distribution through the feeding trees appeared nearly uniform, but it was rarely seen in the understory or netted. In behavior it is silent and unobtrusive, and easily overlooked if one does not seek it in feeding trees.

VOICE. Neither Stein (1936, p. 32) nor I ever heard a sound from this honeyeater.

Meliphaga subfrenata salvadorii (Hartert)[1]

Black-throated Honeyeater

SPECIMENS EXAMINED. Mt. Karimui Zone 2: 1 ♂, 1 ♀; Zone 3: 1 ?; Zone 4: 1 ♂, 1 ♀; Zone 5: 1 ♂, 3 ♀; Zone 7: 1 ♂ (14 Aug.-7 Sept. 1965).

[1] Listed as *Oreornis subfrenatus* in Rand and Gilliard (1967).

WEIGHT. 4 ♂: 32, 32, 34, 37. 5 ♀: 26, 26, 27, 28, 28. 1 ?: 27.
WING. 4 ♂: 100, 101, 102, 104. 5 ♀: 89, 91, 91, 92, 93. 1 ?: 92.
STOMACH CONTENTS. Usually insects, but 3% of stomachs examined contained fruit.

TAXONOMY. These are nearer to the dark southeastern New Guinea race *salvadorii* than to *melanolaema*.

BREEDING. Testes were slightly enlarged in two males, considerably enlarged in the other two. One female had an enlarged ovary. Birds in song were heard from the top to the bottom of the altitudinal range.

DISCUSSION. At higher altitudes *Meliphaga subfrenata* is the medium-sized honeyeater in flowering trees, which it shares with the small *Myzomela rosenbergii* and the large *Melidectes rufocrissalis* (or *M. belfordi*). It occurs up to timberline, where it sometimes perches in tree ferns in alpine grassland near the forest edge. Its lower limit is usually about 7,000 ft, but it ranged down to 4,400 ft on Mt. Karimui, where it was fairly common (1.5% of the local avifauna). Its vertical distribution is mainly from 10 ft above the ground to the crowns, infrequently in the understory, once seen on the ground. Away from flowering trees I have seen it flycatching, and also clumsily hopping up a large vertical trunk like a would-be woodpecker, probing the bark, slipping a couple of times, then flying to the base of another trunk and ascending it in the same fashion. Males and females are equally common in flowering trees and away from them and do not differ in altitudinal distribution nor in vertical distribution through the vegetational column.

VOICE. As described elsewhere (Diamond and Terborgh, 1968, p. 74), the song is "a rapid, loud, bubbling, and cheerful series of notes which first rises and then falls in pitch, progressively decelerating and sometimes concluding in three slurs on the same pitch, after which the pattern is immediately repeated one or two times." The quality and pattern of the song as well as the frequency of countersinging are quite similar to the song of *Meliphaga versicolor*.

Meliphaga obscura (De Vis)[1]

Obscure Honeyeater

SPECIMENS EXAMINED. Karimui: 6 ♀ (2 and 7 Aug. 1964; 4 July-5 Aug. 1965). Soliabeda: 4 ♂, 1 ♀ (23-27 July 1965). Mt. Karimui Zone 2: 1 ♂, 1 ? (13 and 14 Aug. 1965).
WEIGHT. 5 ♂: 24, 25, 28, 29, 31. 5 ♀: 24 (2), 25, 26, 27. 1 ?: 27.
WING. 5 ♂: 85, 92 (3), 93. 7 ♀: 80 (2), 83, 85 (2), 86 (2). 1 ?: 92.

TAXONOMY. Due to the lack of Vogelkop material I am unable to assess the proposed race *viridifrons* (Salomonsen, 1966).

[1] Listed as *Oreornis obscurus* in Rand and Gilliard (1967).

BREEDING. Gonads were small in all specimens.

DISCUSSION. The unsexed Mt. Karimui specimen is probably male, from its wing length. The local sex ratios are very unbalanced (only females at Karimui, mainly males at Soliabeda).

I found this uncommon honeyeater of the hill forest only at the three above-cited localities where specimens were collected (2,000-4,630 ft). It was regularly seen in low numbers in trees with small fruits and in flowering trees, which it shared with up to 11 other species of meliphagids and where it accounted for 2-5% of the bird-usage. *Meliphaga obscura* was silent, slower in its actions than members of the *Meliphaga analoga* complex, and fed strictly in the lower branches and middlestory, never ascending into the upper half of the vegetational column. In addition, I have a few sightings of single individuals 5-10 ft above the ground in second-growth and gardens. Males frequented flowering trees and were never netted, while females were netted in the understory away from flowering trees.

VOICE. No vocalization was heard.

Pycnopygius cinereus marmoratus (Sharpe)

Marbled Honeyeater

NATIVE NAME. Fore: osára.

SPECIMENS EXAMINED. Awande: 1 ♂ (20 June 1964). Okasa: 6 ♂ (22-26 June 1965). Mengino: 1 ♂, 2 ? (16 July 1964). Karimui: 3 ♂, 3 ♀ (1-17 July 1965). Mt. Karimui Zone 2: 1 ♀ (13 Aug. 1965).

WEIGHT. 7 ♂: 40-58 (48.8 $\pm$ 3.9). 4 ♀: 36, 38, 45, 46.

WING. 10 ♂: 96-112 (106.6 $\pm$ 5.3). 4 ♀: 96, 101, 102, 105.

STOMACH CONTENTS. Fruit, 2-7 mm in diameter (seven stomachs); insects (seven); fruit and insects (one); flower remains (one).

TAXONOMY. The races *cinereus* and *dorsalis* are less heavily spotted below. There may be an increase in size with altitude, since the two birds with the longest wings (111 and 112) were from the highest altitudes (Awande, 6,200 ft, and Mengino, 5,800 ft) and since the Mt. Karimui female (4,750 ft, wing 105) was larger than the three Karimui females (3,650 ft, wing 96, 101, 102).

BREEDING. The testes of one Karimui male were slightly enlarged, but gonads in all other specimens were small.

DISCUSSION. *Pycnopygius cinereus* occurs in the forest interior but most often at the forest edge and in second-growth between about 3,500 and 6,500 ft, and is commonest in the lower part of its altitudinal range. The only record in the undisturbed forest of Mt. Karimui was the single specimen at 4,750 ft. In behavior it was a silent, solitary, sluggish, and inconspicuous bird of the upperstory, frequenting trees with flowers or small fruits. Only one specimen was netted. At a Miarosa fruit tree it was repeatedly driven off by another honeyeater, *Melidectes torquatus,* which is nearly the same size. Besides similar sizes, *Pycnopygius cinereus* and *Melidectes torquatus* have somewhat similar habits (upperstory, commonest in ecologically disturbed areas, attracted to fruit trees), but generally *Melidectes torquatus* is far more abundant. At the two localities where I found *Pycnopygius cinereus* common, *Melidectes torquatus* was either uncommon (Okasa) or absent (Mengino), suggesting that the more aggressive *Melidectes torquatus* may limit its distribution.

VOICE. As with its congener *P. ixoides,* I never heard any vocalization from *P. cinereus,* nor did Stein (1936, p. 32).

Pycnopygius ixoides ixoides (Salvadori)

Brown Honeyeater

SPECIMENS EXAMINED. Mengino: 1 ? (15 July 1964). Karimui: 5 ♂, 6 ♀ (10 Aug. 1964; 1 July-5 Aug. 1965). Bomai: 3 ♀ (6-9 July 1965). Soliabeda: 2 ♂, 2 ♀ (23-27 July 1965).

WEIGHT. 4 ♂: 28, 28, 29, 33. 8 ♀: 22, 22, 24, 24, 26, 28, 29, 31.

WING. 4 ♂: 86, 86, 87, 90. 3 ♀: 79, 79, 80.

TAXONOMY. These agree well with nominate *ixoides* from the upper Fly River and Mimika River except in having the edges of the primaries more olive and the ventral coloration averaging slightly brigher and richer. The underwing coverts are bright ochraceous, and the feathers of the crown are edged gray. The race *finschi* from the north coast of southeastern New Guinea is so much brighter rufous below that at first glance one might not have placed it in the same species. There appears to be only one record from the south coast of southeastern New Guinea (N.G.B.S. Newsletter, No. 35, p. 2, Sept. 1968). I have no Vogelkop material (topotypical *ixoides*) by which to assess the proposed southern New Guinea race *cinereifrons* (Salomonsen, 1966).

BREEDING. Gonads were slightly enlarged in one Karimui male, small in other specimens.

DISCUSSION. *Pycnopygius ixoides* is the low-altitude representative of the somewhat larger *P. cinereus,* to which it is very similar in behavior. The altitudinal ranges of the two species overlap around 3,500-4,500 ft. *P. ixoides* was fairly common in the Karimui area up to 3,900 ft, while *P. cinereus* extended down to 3,650 ft. The only other Eastern Highlands record to date is the Mengino specimen, taken at 4,600 ft within the vertical range of *P. cinereus.* Like *P. cinereus, P. ixoides* is solitary, slow-moving, inconspicuous, and silent, and frequents the middle- and upperstories. It was never netted. At Karimui there were a few observations in flowering trees and in trees with small fruits.

VOICE. No vocalizations were heard.

Philemon meyeri Salvadori

Meyer's Friarbird

SPECIMEN EXAMINED. Soliabeda: 1 ♂ (30 July 1965).
WEIGHT. 57.
WING. 111.
STOMACH CONTENTS. Mainly fruit, some insects.

BREEDING. The testes were moderately enlarged.

DISCUSSION. I met this small friarbird, which is much less conspicuous than its noisy congener *Philemon novaeguineae,* only at Soliabeda, where a pair was seen in the treetops on two occasions. The specimen was collected at the top of a flowering tree inside the forest.

Philemon novaeguineae novaeguineae (Müller)

New Guinea Friarbird

SPECIMEN EXAMINED. Soliabeda: 1 ♀ (23 July 1965).
WEIGHT. 133.
WING. 144.
STOMACH CONTENTS. Fruit.

TAXONOMY. The color is darker, and the knob on the culmen smaller, than in most but not all Fly River specimens.

While the race *jobiensis* from the north coast is fairly distinct, differences among the populations of the Vogelkop and south coast are minor and complicated by individual variation and effects of wear on color. Birds in this area have been variously distributed among three races, nominate *novaeguineae, brevipennis,* and *aruensis,* on the basis of differences in wing length, bill, and depth of color, without any agreement being reached among authors (Rothschild and Hartert (1913, p. 513), Ogilvie-Grant (1915, p. 78), Mayr and Rand (1937, p. 234), Rand (1942a, p. 364), and Junge (1939, p. 66; 1953, p. 73)). Recently Salomonsen (1966, p. 9) described the southeastern population, which Mayr (1941b, p. 211) had refrained from naming, as *fretensis,* on the basis of material already reviewed by Mayr and Rand and using the same characters (*fretensis* described as slightly paler and much larger) extensively discussed previously. I have therefore reviewed the material in the American Museum of Natural History from the western Papuan Islands, Vogelkop, Setekwa River, Fly River and southeastern New Guinea.

Within this area differences in slenderness of the bill and the size of the knob on the culmen seem as inconsistent and slight to me as they did to Ogilvie-Grant, Mayr and Rand, and Junge. As noted previously, average differences in color are of little help as subspecific characters in this species due to nongenetic variation: "Wear and fading produce such great changes in the color of the plumage of this species that it is difficult to compare any but specimens which are actually molting" (Mayr and Rand, 1937, p. 234). Rand (1942a, p. 364) found that birds from more arid areas were paler, due apparently to more pronounced wear. Table 16 assembles measurements of wing length in 43 males available to me (including the types of *brevipennis* and *fretensis*) and from measurements of other authors. It appears from these figures that birds from the Vogelkop and western Papuan islands average the largest, with Junge's specimens standing out as especially large; those from Etna Bay, 35 miles from the type locality of *novaeguineae* (Lobo on Triton Bay), average about 4 mm smaller; those from southeastern New Guinea (including the type of *fretensis*) average 1 mm shorter; Fly River birds average 1-4 mm shorter; and those from southwestern New Guinea exclusive of Etna Bay average another several millimeters shorter. Thus, wing length decreases clinally eastward from the Vogelkop to Etna Bay to the southwestern New Guinea coastal plain and then increases clinally further eastward to the Fly River and to south-

TABLE 16
WING LENGTH OF *Philemon novaeguineae* MALES

Vogelkop and western Papuan islands	
5 ♂	151-164 (av. 155)
3 ♂ [1]	151, 155, 158
4 ♂ [2]	145-158
7 ♂ [3]	160-164
2 ♂ [4]	154-156
Southwestern New Guinea	
Etna Bay, 3 ♂ [5]	150, 154, 155 (av. 153)
Noord River, 14 ♂ [3]	144-151
Mimika, Wataikwa, Setekwa Rivers, 13 ♂ [2]	139-150
Setekwa River, 3 ♂	142, 143*, 144 (av. 143)
Fly River	
27 ♂	139-156 (av. 148)
10 ♂ [6]	146-157 (av. 151)
1 ♂ [7]	153
Southeastern New Guinea	
8 ♂	149-158 (av. 152)**
3 ♂ [6]	152, 156, 158
2 ♂ [8]	147, 153

[1] From Gyldenstolpe (1955b).
[2] From Ogilvie-Grant (1915).
[3] From Junge (1939).
[4] From Mayr and De Schauensee (1939).
[5] From Junge (1953).
[6] From Mayr and Rand (1937).
[7] From Rand (1942a).
[8] From Rothschild and Hartert (1913).
* Type of *brevipennis*.
** Including type of *fretensis*.

eastern New Guinea. In separating *fretensis* from *brevipennis* Salomonsen cited the longer wing of the former, but the specimen selected as the type of *fretensis* is the largest specimen from southeastern New Guinea, while the type of *brevipennis* is the second smallest specimen from southwestern New Guinea. The smallest population (southwestern New Guinea) overlaps somewhat with the largest population (Vogelkop) and extensively with the intermediate populations.

There seem to be only two reasonable alternatives: to consider southwestern New Guinea riverplain birds as *brevipennis* and the rest as nominate *novaeguineae,* or else to consider all the Vogelkop and south coast populations as *novaeguineae.* Because the former procedure gives *novaeguineae* a discontinuous range and the sizes overlap, the latter procedure may be preferable. In either case *fretensis* must be considered a synonym of *novaeguineae.*

DISCUSSION. I met *Philemon novaeguineae,* one of the noisiest, most conspicuous, and characteristic species of the New Guinea lowlands, only at Soliabeda, where several individuals frequented the crowns of isolated trees. It was surprising not to find it in the Karimui Basin, which so many other lowlands species had reached. On the northern watershed the race *jobiensis* seems to have been much more successful at colonizing midmontane cultivated areas: Bulmer found it to be present in the upper Wahgi Valley and common in the Baiyer, Jimmi, and Kaironk valleys up to about 6,000 ft. Possibly this colonization is actively underway, since Ripley (1964, p. 72) found *P. n. jobiensis* in the Baliem Valley of western New Guinea in 1960, where the Third Archbold Expedition had not found it in 1938 and 1939 despite exhaustive collections. Schodde and Hitchcock (1968, p. 67) report that the population of *Philemon novaeguineae* at Lake Kutubu is migratory, disappearing during the wet season there (May to September).

The problem of the parallel geographical variation in the forms of *Philemon* and of the oriole genus *Oriolus* through the Molucca-Timor-New Guinea area has attracted attention ever since Alfred Russel Wallace described this variation a century ago in his classic *The Malay Archipelago* (1962) as a case of mimicry. Briefly, the *Philemon* populations inhabiting seven islands in this area (Ceram, Buru, Tenimber, Halmahera, Wetar, Timor, and New Guinea) show great inter-island variation, and the *Oriolus* populations show equally great variation, but on each island the *Oriolus* form and the *Philemon* form resemble each other, often to such a stunning degree that specimens in the hand can be distinguished only with difficulty. In the field I have frequently confused the New Guinea forms, *Philemon novaeguineae* and *Oriolus szalayi,* even though the morphological resemblance is less close than on the other six islands (both forms largely brown, the bare black facial skin in *Philemon* paralleled by heavy black streaking on the face and sides of the throat in *Oriolus, Oriolus* more distinctly streaked below). The morphological similarity on New Guinea is reinforced by similarity in habits, viz., in that both forms inhabit the middle- and upperstory of second-growth and rarely the forest interior, have approximately the same altitudinal range, and are social. On the island of Ceram *Oriolus forsteni* and *Philemon subcorniculatus* are virtually indistinguishable (large birds, mostly unstreaked brown, with a yellow-olive wash on the breast, gray collar on the nape, dark ear coverts). *Oriolus b. bouroensis* and *Philemon m. moluccensis* on Buru, and *Oriolus b. dicipiens* and *Philemon m. timorlaoensis* on Tenimber are largely brown without a yellow breast wash, with a reduced pale nape collar, and with a bare black facial patch of *Philemon* duplicated by a similar area of black feathering in *Oriolus*. On Halmahera *Philemon fuscicapillus* and *Oriolus phaeochromus* are entirely dark brown, the bare black facial patch of *Philemon* much reduced and the black facial feathering of *Oriolus* absent. *Philemon buceroides pallidiceps* and *Oriolus viridifuscus finschi* of Wetar, and *Philemon b. buceroides* and female (but not male) *Oriolus v. viridifuscus* of Timor, are pale below, unlike the previously mentioned forms, and a bare black facial patch contiguous with a bare black patch on the side of the neck in *Philemon* is duplicated by similar areas of black feathering in *Oriolus*. Further details of plumage are given by Wallace (1962, pp. 305-307) and by Stresemann (1914b, pp. 395-400).

Wallace (1962) attributed this remarkable parallel variation to Batesian mimicry of *Philemon* by *Oriolus*, arguing that hawks avoid the noisy, pugnacious *Philemon* with its strong claws and beak. Stresemann (1914b) rejected this interpretation on the grounds that selection by hawk predation was probably insignificant, and argued instead that the convergence was a coincidence due to common selective forces acting on both forms and that the appearance of either *Oriolus* or *Philemon* on an island would have been the same even if the other form had been absent. However, the resemblances in pattern are so detailed and striking that Stresemann's interpretation appears to me thoroughly implausible. A more promising approach to the problem stems from recent discussions by Moynihan (1968) and by Cody (1969), who have pointed out numerous similar cases of convergence in plumage between two unrelated bird species, usually ones which utilize similar food resources. Cody suggests that the convergence facilitates interspecific territoriality, while Moynihan refers to the convergence as "social mimicry", e.g., to facilitate interspecific flocking. The selective forces for convergence in the *Philemon-Oriolus* case remain unknown.

VOICE. The songs are the most characteristic bird sounds of the New Guinea lowlands. They consist of a somewhat nasal pattern of three or four slurred notes, repeated several times with pauses of less than a second between repetitions and with successive repetitions somewhat louder (Fig. 40).

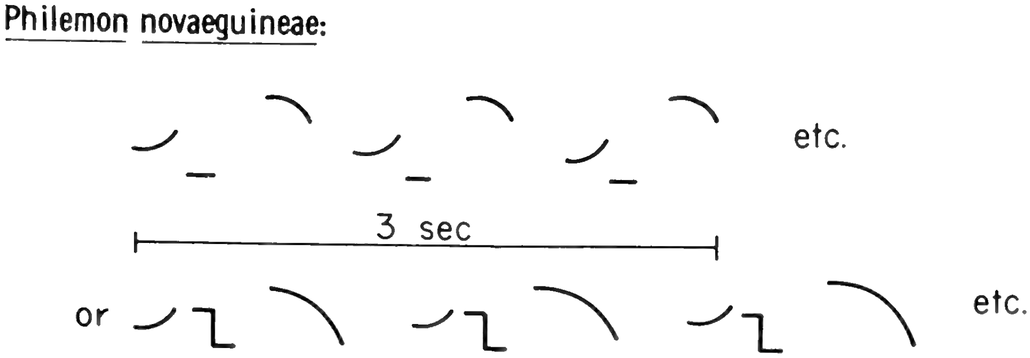


FIG. 40. Voice of *Philemon novaeguineae.*

Ptiloprora meekiana subsp.

Meek's Streaked Honeyeater

SPECIMENS EXAMINED. Mt. Michael: 1 ♀ (7 July 1964).
WING. 75.
TAIL. 67.

TAXONOMY. In color this specimen is intermediate between the western race *occidentalis* and the eastern race *meekiana.* It is nearer *occidentalis* in the brighter and greener upperparts and in the brighter yellow underparts and equidistant from the two races in the throat (slightly darker gray in *occidentalis*). Wing measurements for nine *occidentalis* females from the north slope of the Snow Mountains are 78-84 (79.9), and for two females of *meekiana* from the Huon Peninsula and southeastern New Guinea, 73 and 75. Since my specimen is nearer *occidentalis* in color but matches *meekiana* in size, racial assignment will have to await further material.

DISCUSSION. The specimen, which represents the sole record for the Eastern Highlands, was netted at 8,000 ft on Mt. Michael, where *P. guisei* was common. Except on the northern slopes of the Snow Mountains, this is a rare and local species throughout its wide range. The two races have very different altitudinal ranges: *meekiana* of southeastern New Guinea lives at 4,600-7,500 ft (mainly 5,000-7,000 ft), while *occidentalis* of western New Guinea lives at 7,200-9,200 ft.

Ptiloprora guisei umbrosa Mayr

Brown-backed Streaked Honeyeater

NATIVE NAMES. Gimi: habí. Daribi: kwe.

SPECIMENS EXAMINED. Awande: 1 ♂, 1 ? (14 and 15 June 1965). Mt. Karimui Zone 2: 1 ♂, 3 ♀; Zone 3: 1 ♀; Zone 4: 5 ♀; Zone 5: 3 ♂, 4 ♀; Zone 6: 4 ♂, 5 ♀; Zone 7: 4 ♂, 3 ♀; Zone 8: 3 ♂, 4 ♀ (13 Aug.-8 Sept. 1965).

WEIGHT. 10 ♂: 21.3-27.7 (24.2 ± 1.7). 10 ♀: 17.6-24.0 (20.4 ± 1.4).

WING. 10 ♂: 85-94 (89.3 ± 2.2). 10 ♀: 76-84 (79.2 ± 1.6).

STOMACH CONTENTS. Usually insects, very rarely fruit seeds.

DISCUSSION. Relations in the *Ptiloprora guisei-perstriata* complex, formerly considered a single species, were clarified by Mayr and Gilliard (1954, p. 369; Gilliard and LeCroy, 1961, p. 80). *P. guisei* is present at medium altitudes in eastern New Guinea and reaches its western limit somewhere between Mt. Giluwe and Telefolmin. *P. perstriata* occurs at medium and high altitudes in western New Guinea but lives in eastern New Guinea only at high altitudes above *P. guisei.* I take this situation to mean that *P. perstriata* originated in western New Guinea as a form allopatric to *P. guisei* and reinvaded the latter's range relatively recently. *P. mayri,* a member of the same complex, lives on two of the north mountain "islands" (Cyclops Mountains and North Coastal Range). The very similar *P. erythropleura* may constitute the Vogelkop representative (Diamond, 1969).

On Mt. Michael the transition between *P. guisei* and *P. perstriata* took place around 9,500-10,500 ft. Our records suggest that the two species might overlap by several hundred feet, but this is uncertain. Gilliard found that the transition on Mts. Hagen, Kubor, and Wilhelm was around 8,000 ft.

P. guisei is the most abundant and characteristic bird of moss forest, and is tied sufficiently strongly to this vegetational structure or the associated climatic conditions that the lower limit of its altitudinal range shows marked and predictable local variation. On Mt. Michael, where heavy mossing began at 8,700 ft, *P. guisei* was common from 8,000 ft upwards but not at lower altitudes. On our walk from Mt. Michael to Karimui we passed through a very local tongue of moss forest which descended to 6,000 ft between Agotu and Maiba, and immediately encountered *P. guisei,* after not having found it at the same and higher elevations during a week at Mengino. In the Okapa area, where we failed to encounter mossy conditions in our study zone (5,800-7,000 ft), the two specimens at Awande (6,000 ft) constituted the sole record. On Mt. Karimui, where the moss level was at 6,500 ft, *P. guisei* became common a few hundred feet below that altitude, remained common up to the summit at 8,165 ft, and trickled down to 4,400 ft in low numbers.

Census figures for *P. guisei* on Mt. Karimui clearly illustrate its association with mossy conditions: Zone 2 (4,400-4,750 ft), 1.6% of the local avifauna; Zone 3 (4,750-5,390 ft), 0.5%; Zone 4 (5,390-5,960 ft), 2.3%; lower half of Zone 5 (5,960-6,250 ft), 1.4%; upper half of Zone 5 (6,250-6,500 ft), 9.2%; Zone 6 (6,500-7,080 ft), 14.4%; Zone 7 (7,080-7,620 ft), 24.4%; Zone 8 (7,610-8,165 ft), 27%.

The abundance of *P. guisei* on Mt. Karimui made it possible to determine its population structure in detail. Zone 2 yielded three females and a male with tiny testes; Zone 3, one female; Zone 4, five females, one of them (netted at the border of Zones 4 and 5) with somewhat enlarged ovaries; and the lower half of Zone 5, a short-winged young male with tiny testes. In the upper half of Zone 5, near the moss level, songs were heard commonly, none at all having been heard at lower altitudes; and the sex ratio suddenly approached equality, with the testes of all males but one enlarged. Songs remained common, and the sex ratio remained near equality, in Zones 6 through 8. All males in Zone 6 had enlarged testes. In Zones 7 and 8, testes were much enlarged in half of the males, small or tiny in the others. Thus, nonbreeding birds show some accumulation at the top of the range in addition to descending 1,500 ft below breeding birds.

P. guisei seems to take over the niche filled by the genus *Meliphaga* at lower altitudes, as the common meliphagid gleaning for insects in the lower and middle stories. It is occasionally seen in flowering trees but does not concentrate in them. In behavior it is solitary and moves rapidly (1-3 ft every second or every few seconds), often hanging upside-down to probe.

VOICE. A variety of simple and quiet two- or three-note calls, the individual notes of which usually contrast in quality with each other. The characteristic elements include: a plaintive whistled slur, which may be upslurred, downslurred, or more complex; a staccato "chip"; and a short buzzy note. The commonest combination is for a short staccato or buzzy note to be followed by a slur, or vice versa. A call is given every 2-3 sec for 1 min or more (Fig. 41). The voices of *P. mayri* and probably of *P. perstriata* and *P. erythropleura* are quite similar.

Ptiloprora perstriata perstriata (De Vis)

Black-backed Streaked Honeyeater

SPECIMENS EXAMINED. Mt. Michael: 2 ♂, 1 ♀, 6 ?, 1 imm. ? (30 June-10 July 1964).

WING. 2 ♂: 100, 101. 1 ♀: 91. 1 imm. ?: 89.

STOMACH CONTENTS. Insects.

TAXONOMY. As discussed elsewhere in a review of the genus *Ptiloprora* (Diamond, 1969), the Snow Mountains population is so

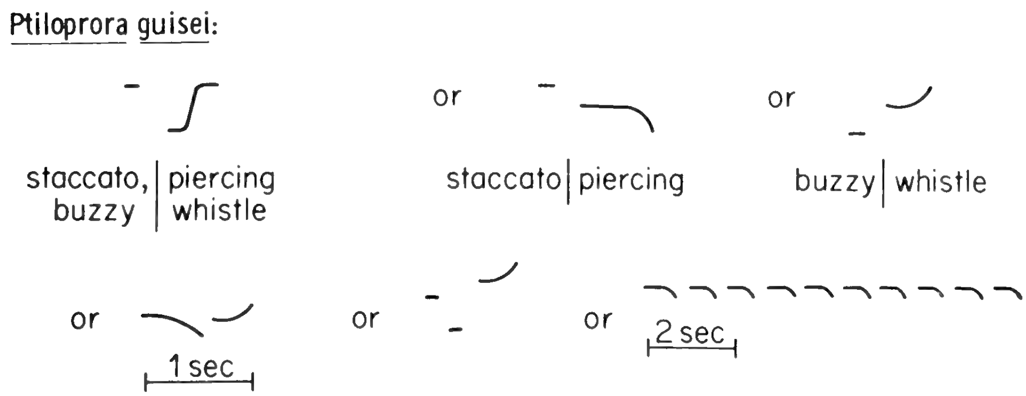


FIG. 41. Voice of *Ptiloprora guisei.*

close to nominate *perstriata* of southeastern New Guinea that the race *lorentzi* cannot be recognized. The race *perstriata* must be considered as encompassing the entire continuous 900-mile range of the species on the Central Range, with the second race *praedicta* isolated on the Wandammen Peninsula.

BREEDING. One of the males had enlarged testes.

DISCUSSION. Most of the specimens were netted.

P. perstriata lives at altitudes just above its sibling *P. guisei* on the higher peaks of the Eastern Highlands. On Mt. Michael I found it down to 9,500-10,000 ft in forest and all the way up to the summit at 12,300 ft, where it was common in the tongues of stunted trees and bushes reaching onto the summit cap of alpine grassland. Gilliard reported it above 8,000 ft (but apparently most commonly at 10,000 to 11,000 ft, judging from the altitudes given on his specimen labels) on Mts. Wilhelm, Hagen, and Kubor. On Mt. Karimui (8,165 ft) it was absent.

VOICE. Calls of *P. perstriata* that I heard on the summit of Mt. Michael were very similar to the calls of *P. guisei*. *Halcyon torotoro* and *H. megarhyncha* provide an additional example of congeners which replace each other altitudinally and are very similar vocally as well as morphologically.

Niche Differences in the Genus *Melidectes*

A review of interrelationships among the 10 species (all but *M. whitemanensis* confined to New Guinea) of the genus *Melidectes* is necessary as background for discussion of two questions under the species accounts: Why is the range of *Melidectes princeps* restricted to the Eastern Highlands? How did the unusual patterns of distribution and hybridization in the *M. belfordi-M. rufocrissalis* group arise?

On the basis of song, plumage, and bill form the species fall into two groups. The six members of the first group (*M. torquatus, M. ochromelas, M. rufocrissalis, M. leucostephes, M. foersteri,* and *M. belfordi*) have throat and/or gape wattles, a large bare patch of facial skin, pale edges on the back, are large (40-105 g), have relatively stout bills, and have similar loud nasal songs which frequently involve duets. The first four of these forms are confined to middle elevations (ca. 3,000-8,000 ft); *M. foersteri* occurs both at middle elevations and in the alpine zone; and *M. belfordi* occurs at middle elevations throughout its range, and also in the alpine zone in some parts of its range but not in others. *M. rufocrissalis, M. leucostephes,* and *M. foersteri* constitute a superspecies. The four members of the second group (*M. fuscus, M. nouhuysi, M. princeps,* and *M. whitemanensis*) lack throat or gape wattles, have a very small bare patch of facial skin, lack pale edges on the back, are medium-sized (25-60 g), have relatively slender bills, and have similar soft songs which do not involve duetting. *M. fuscus* and the *M. nouhuysi-M. princeps* superspecies are restricted to the New Guinea alpine zone. *M. whitemanensis* is confined to the island of New Britain, and was originally described as a monotypic genus *Vosea,* but its song, behavior, and morphology suggest that it is a *Melidectes* nearest *M. fuscus* (Diamond, 1971).

Only at alpine elevations does one find more than one species numerous in a given habitat. The details of distribution are such that each alpine area on the Central Range supports two species, no more and no less ("compound checkerboard allopatry"). Southeastern New Guinea has *M. fuscus* and an alpine race of *M. belfordi:* the Eastern Highlands have *M. fuscus* and *M. princeps* but no alpine *M. belfordi;* the northern slope of the Snow Mountains has *M. nouhuysi* and another alpine population of *M. belfordi* (*M. fuscus* is known on the northern slope only from a single specimen); and the southern slope of the Snow Mountains has *M. nouhuysi* and *M. fuscus,* but not *M. belfordi,* which apparently remains below 8,000 ft, from published reports of Ogilvie-Grant (1915, p. 61) and Junge (1939, p. 57). The isolated mountains of the Huon Peninsula, on which the area at alpine elevations is very small, have only *M. foersteri* at these elevations. Niche differences in the alpine zone are probably behavioral. *M. belfordi* frequents flowering trees and remains in the crowns; *M. fuscus* is half as large and gleans throughout the vegetational column, not in flowering trees; *M. nouhuysi* remains in alpine shrubbery at and above timberline, often on the ground; and the behavior of *M. princeps* has not been reported.

Niche differences between the species of the first group at middle elevations involve spatial segregation, in the sense that all the species occupy the same kind of niche in different habitats or geographical areas or at different altitudes. *M. torquatus* occurs on all the main mountain ranges of New Guinea in open second-growth, whereas the remaining midmontane species are mainly forest birds. The geographical ranges of *M. ochromelas,* the *M. rufocrissalis* superspecies, and *M. belfordi* are all peculiar when considered individually, in that each extends widely over New Guinea but is missing from large areas of the total range. When considered together, however, these ranges are found to provide a peculiar case of checkerboard allopatry, in that most areas have two species, never more and usually no less, and the altitudinal ranges of the two species in a given area are mutually exclusive. The details are as follows: southeastern New Guinea, *M. belfordi* at higher elevations, *M. ochromelas* at lower elevations (my observations on Mt. Albert-Edward); Huon Peninsula, *M. foersteri* (*rufocrissalis* superspecies) at higher elevations, *M. ochromelas* at lower elevations (Mayr, 1931; Mayr, 1941b, p. 198; labels of specimens collected by Beck); Schrader Range and Star Mountains, *M. belfordi* at higher elevations, *M. rufocrissalis* at lower elevations in ecologically undisturbed areas (Bulmer, personal communication; Diamond, 1967,

p. 12; Gilliard and LeCroy, 1968, pp. 33-35; Mees, 1964, p. 27); Weyland Mountains and southern slope of the Snow Mountains, *M. belfordi* at higher elevations, *M. ochromelas* at lower elevations (Ogilvie-Grant, 1915, p. 61; Stein, 1936, pp. 30-31); Vogelkop, *M. ochromelas* apparently at higher elevations, *M. leucostephes* (*rufocrissalis* superspecies) apparently at lower elevations. The Herzog Mountains, most of the Eastern Highlands, the eastern Snow Mountains (Mt. Goliath), and the northern slope of the Snow Mountains may have initially supported *M. belfordi* and *M. rufocrissalis,* but what one now finds is a hybrid population in the Herzog Mountains (*"M. b. stresemanni"*), most of the Eastern Highlands, and Mt. Goliath (*"M. b. griseirostris"*) (Mayr and Gilliard, 1952c), and nearly pure *M. belfordi* with only a few signs of *rufocrissalis* genes on the northern slopes of the Snow Mountains (Gilliard, 1959b, p. 8). Only *M. belfordi* was reported from the Wissel Lakes (Junge, 1963, p. 70), and only *M. ochromelas* from the Wandammen Peninsula (Hartert, 1930, p. 46), but in both cases the ornithological survey was not intensive and an additional species might have been present but overlooked. Wherever *M. belfordi* coexists with either of the other two species, it occupies the higher elevations. *M. ochromelas* lives below the representative of the *rufocrissalis* superspecies on the Huon Peninsula but possibly above the Vogelkop representative.

While there are other examples of checkerboard allopatry and of altitudinal exclusion among New Guinea birds, the case of the mid-montane forest *Melidectes* is unique in two respects. First, there is no other instance of a species pair in which the altitudinal sequence in one area is inverted with respect to another area, comparable to the apparent relations of *M. ochromelas* and the *rufocrissalis* superspecies on the Huon Peninsula and Vogelkop. Second, except among the alpine *Melidectes* I am unaware of another instance of compound checkerboard allopatry such that each area supports two species of a group of three, with the identity of the missing species showing irregular geographical variation. This situation stems ultimately from the facts that the forest *Melidectes* are too similar ecologically to coexist except by altitudinal exclusion; and that altitudinal series of three species in New Guinea are unstable and often lead to the elimination of one bird (cf., p. 34). The unique complexity of the *Melidectes* situation may be in part responsible for its providing the only instance of hybridization in a New Guinea altitudinal sequence outside the family Paradisaeidae.

Melidectes fuscus fuscus (De Vis)

Sooty Honeyeater

STOMACH CONTENTS. Insects.

TAXONOMY. Salomonsen (1966) described the Eastern Highlands population as a new race *gilliardi,* based on size characters of material collected by Gilliard. Mayr and Gilliard (1954, p. 367, Table 7) had already published critical comparative measurements of this material and concluded that it did not warrant separation from nominate *fuscus,* a decision also adopted by Sims (1956, p. 432) in treating Shaw-Mayer's material. The western population *occidentalis* is smaller than the southeastern population *fuscus,* and the geographically intermediate Eastern Highlands population is intermediate in wing, tail, culmen, and tarsus measurements. Since *gilliardi* overlaps *fuscus* in all four measurements in both sexes except apparently in the culmen of males, and since no differences other than size separate the populations, *gilliardi* should be considered synonymous with *fuscus.*

DISCUSSION. Gilliard, Shaw-Mayer, and Schodde collected this honeyeater at 10,000-11,000 ft on Mts. Hagen, Wilhelm, Giluwe, and Kubor in moss forest below timberline, but I failed to find it on Mt. Michael. It gleans, darting rapidly and hopping along branches, from the crowns to the understory, is frequently netted, and does not congregate in flowering trees.

VOICE. The long, monotonous song is based on a pair of high-pitched notes, the second either trilled or slurred and at a lower pitch than the first. The pair is repeated 90 times per minute for 1 min or more. The song of *Melidectes* ("*Vosea*") *whitemanensis* is similar but involves only 3-8 repetitions.

Melidectes princeps Mayr and Gilliard

Long-bearded Honeyeater

NATIVE NAME. Labagai (the language spoken at Lufa): abayó.
SPECIMENS EXAMINED. Mt. Michael: 1 ♀, 2 ? (10 July 1964).
MEASUREMENTS. See Table 17.

TAXONOMY. There is a naked area of skin about the eye, with the eye at its anterior edge. In life the upper half of this area is yellow-orange, the posterior lower quadrant yellow, and the anterior lower quadrant light gray-green. The chin and throat whiskers are white. Table 17 gives dimensions of the one Mt. Michael specimen prepared as a skin and of Gilliard's material. There are no plumage differences between birds from different mountains.

DISCUSSION. This is one of the two semispecies endemic to the Eastern Highlands (the other being *Lophorina* (*Astrapia*) *mayeri*) and occurs in high-altitude moss forest up to timberline, between 10,000 and 12,000 ft. The existing material consists of specimens collected on Mts. Wilhelm, Kubor, and Hagen by Gilliard, on Mt. Hagen and the Kubor Range by Shaw-Mayer, on Mt. Kinkain and the Minj-Nona Divide of the Kubor Range by Hitchcock, and on Mt. Michael by Terborgh and me. One of my three specimens was netted.

TABLE 17
MEASUREMENTS OF *Melidectes princeps*

		Wing	Culmen (from base)	Exposed Culmen
Mt. Michael,	1 ♀	114	44	39
Mt. Hagen,	3 ♂	120, 120, 121	49, 49, 51	44, 44, 45
	1 ♀?	113	49	45
Mt. Wilhelm,	2 ♀	111, 111	43, 45	38, 39
	1 ♂[1]	104	40	35
Mt. Orata (Kubor Range),	3 ♂	103, 110, 125	41, 41, 44	45, 45, 48
	1 ♀	108	41	46

[1] Probably immature.

In the Snow Mountains *M. princeps* is represented by *M. nouhuysi,* but there is no member of the superspecies in southeastern New Guinea. Only four other species and superspecies (p. 46) are known from elevations above 5,000 ft in the Snow Mountains and the Eastern Highlands but not from southeastern New Guinea. Rand and Gilliard (1967, p. 546) suggest that the absence of the *M. princeps-M. nouhuysi* superspecies from southeastern New Guinea might be due to "perhaps the annual burning of the alpine grasslands there, which has destroyed the alpine shrubbery and has eaten into the forest, artificially lowering the timberline". This or other explanations involving some general ecological condition seem to me improbable because no other wide-spread timberline species or superspecies is missing in southeastern New Guinea, whereas three are missing in the Eastern Highlands. The alternative interpretation I suggest is that the alpine zone in New Guinea provides only two *Melidectes* niches, as shown by the distributional evidence (p. 388); and that the establishment of *M. fuscus* and *M. belfordi* in southeastern New Guinea therefore left no room for *M. princeps.*

Melidectes belfordi subsp. and *M. b. schraderensis* Gilliard and LeCroy

Belford's Melidectes

STOMACH CONTENTS. Usually insects. Of the stomachs examined 14% also contained fruit.

DISCUSSION. *M. belfordi* remains in the crowns, is rarely netted, and congregates in flowering trees. It feeds by hopping along the branches or up the trunk, often leaning head downwards. Its distribution is discussed on pp. 388-389 and pp. 393-396.

VOICE. On Mt. Albert-Edward in southeastern New Guinea *M. belfordi's* loud repeated calls included hoarse rasps, nasal "caw's", and clear, high, piping notes. Frequently two birds facing each other on a branch duetted by calling "caw" in rapid and perfect alternation up to 34 times. I heard similar duets from the related *M. ochromelas* in southeastern New Guinea and *M. rufocrissalis* in the Eastern Highlands. The similarity of these antiphonal duets of three *Melidectes* species to the antiphonal duet of the Giant Fijian Honeyeater, *Gymnomyza viridis* (Diamond, 1972) supports the postulated relationship of these two genera (Mayr, 1944).

Melidectes rufocrissalis thomasi Diamond and *M. r. rufocrissalis* (Reichenow)

Reichenow's Melidectes

NATIVE NAMES. Fore: wai. Gimi: waiyó. Daribi: kírigo.

TAXONOMY. A previous report (Diamond, 1967a, p. 9; 1969, p. 55) lists specimens examined, weights, and measurements of this race from the southern slopes of the Eastern Highlands. The nominate race lives in the Schrader Range.

DISCUSSION. On Mt. Karimui population structure varied with altitude in the usual fashion. Zone 2 yielded females and one male with tiny testes, and Zone 3 yielded only females. From Zone 4 upward males were common, and all without exception had enlarged testes. One of the females in Zone 5, and both in Zone 6, had enlarged ovaries.

In my collecting areas *M. r. thomasi* ranged up to 8,000 ft and down to a lower limit varying locally between 4,000 ft (Mt. Karimui) and 6,000 ft (Mt. Michael). Bulmer found *M. rufocrissalis* × *M. belfordi* hybrids down to about 5,000 ft in Kyaka territory, Bulmer and Gilliard found *M. rufocrissalis* down to 5,000 ft in the Schrader Range, and Mackay (N.G.B.S. Newsletter, No. 28, p. 3, Feb. 1968) found it common at Pureni near Tari.

The habitat of *M. r. thomasi* is the forest and the forest edge, including partly cut forest with small gardens intruding, but not isolated groves in open areas, a niche left to *M. torquatus*. Within this habitat and altitudinal range it is not only one of the noisiest but also one of the most abundant birds, as the following census figures on Mt. Karimui show: Zone 2, 2.3% of the local avifauna; Zone 3, 3.9%; Zone 4, 8.4%; Zone 5, 27%; Zone 6, 15.5%; Zone 7, no records; Zone 8, 1%. It remains in the middle- and upperstory, with the result that only two of the specimens were collected with nets. Noisy chases between several birds in the treetops were a common occurrence. It was the largest of the several kinds of honeyeaters attracted to the flowering trees at 4,450, 4,700, and 6,430 ft on Mt. Karimui.

VOICE. The loud vocalizations include: a series of hoarse "caws" on the same pitch, similar to *Lophorina superba* but with no deceleration; and a series of two kinds of notes strictly alternating with each other, one note clear and on a slightly higher pitch, the note immediately preceding and following it more complex. This latter call is so similar to the common call of *M. torquatus* as to be not safely distinguishable. There is also a duet of alternating caws (Diamond and Terborgh, 1968, p. 74), similar to that of *M. belfordi.*

Melidectes belfordi × *Melidectes rufocrissalis* hybrids

The problem of hybridization between these two species in the Eastern Highlands was recognized and greatly clarified in the studies of Mayr and Gilliard (1952c) and of Gilliard (1959b). Additional discoveries since Gilliard's 1959 paper shed new light on the problem.

The starting point of Mayr and Gilliard's studies was that one finds in the Wahgi region hybrid swarms containing individuals close to pure *M. rufocrissalis,* others close to *M. belfordi,* and a whole spectrum of intermediates. At higher elevations (> 8,000 ft) these hybrid populations gradually yield to typical *M. belfordi.* Material collected earlier in the Herzog Mountains (*"M. b. stresemanni"*) and on Mt. Goliath (*"M. b. griseirostris"*) was also very variable and evidently represented hybrid populations with a preponderance of *belfordi* genes. Subsequently (in 1954) Gilliard obtained 12 specimens at Telefolmin (northern watershed), of which seven were nearly pure *belfordi,* three nearly pure *rufocrissalis,* and two hybrids. Pure *M. rufocrissalis* had previously been known only from the type locality of the Schraderberg on the northern watershed.

The four newer findings are as follows:

1. *Melidectes* honeyeaters on Mt. Karimui, at Okapa, and on Mt. Michael (all in the southern watershed) proved to belong to a new race of *M. rufocrissalis, M. r. thomasi* (Diamond, 1967a, p. 9; 1969, p. 55), identical to *M. r. rufocrissalis* except that the forehead was black, not white. Since a black forehead is a *belfordi* character that tends to predominate in the hybrid swarms, the origin of *M. r. thomasi* was probably a hybrid one. However, *M. r. thomasi* differed from the other hybrid swarms and hybrid races in being uniform and showing no other *belfordi* traits, suggesting that the hybridization leading to *M. r. thomasi* had occurred considerably earlier and that other *belfordi* genes had been eliminated. Since the southern watershed of the Eastern Highlands remains little explored ornithologically above 3,000 ft from Mt. Karimui for 300 miles westwards to the Star Mountains, and since *M. rufocrissalis* has been observed near Tari 140 miles west of Mt. Karimui, the new race may have an extensive range.

2. Two specimens collected in the Star Mountains on the southern watershed were discussed by Mees (1964, pp. 26-27). Of the one collected at the lower elevation (ca. 4,000 ft), he reported, "This specimen has all the characters of *M. rufocrissalis,* except that the supercilium is yellow." Of the one collected near 6,000 ft: "This bird agrees with *M.*

belfordi, except that the bill is much larger and grayish in color. The feathers over the eye are white. These two characters point to hybridization with the next species [*M. rufocrissalis*]." Actually, the supercilium is yellow in pure *rufocrissalis* and white in pure *belfordi,* so that the *rufocrissalis* specimen was in fact pure and the *belfordi* one nearly so.

3. In 1966 I found that no species of genus *Melidectes* was present in the North Coastal Range (Prince Alexander Mountains, Torricelli Mountains, Bewani Mountains) although the maximum altitudes in the North Coastal Range (up to 6,200 ft) were high enough for several of the species. In 1959 Gilliard had found no *Melidectes* species in the Adelbert Mountains, perhaps because they rise only to ca. 4,500 ft. Mayr had also found no *Melidectes* in the Cyclops Mountains, which rise to 7,100 ft.

4. In 1963 and 1964 Bulmer (pers. comm.) and Gilliard (Gilliard and LeCroy, 1968, pp. 33-35) discovered a population of *M. belfordi* in the Schrader Range of the northern watershed, the type locality of *M. r. rufocrissalis. M. belfordi* lived alone in the beech forest above 7,500 ft, *M. rufocrissalis* lived alone in the forest and disturbed areas below 7,000 ft, and the two species overlapped only in a narrow band at 7,500-8,000 ft. Most specimens were pure, but a few showed signs of hybridization.

Two major problems, in addition to a host of minor ones, remain unsolved. Why and how long has hybridization been occurring? Where did *M. rufocrissalis* and *M. belfordi* originate?

Regarding the origin of hybridization, Gilliard (1959b) suggested that it might stem from the extensive habitat disturbance caused by native agriculture. The evidence for altitudinal exclusion in undisturbed habitats, and the wholesale hybridization in the extensively disturbed Wahgi Region, are in general accord with this suggestion. If this hypothesis is correct, massive hybridization may have started only a few centuries ago. Information as to whether any hybridization at all takes place where both species occur together in completely undisturbed areas is sorely lacking. I would guess that some hybridization has been going on for a long time in undisturbed areas in the very narrow band of altitudinal overlap, since *M. r. thomasi* is a uniform and presumably not recent race even in the virgin forest of Mt. Karimui; and that habitat disturbance has drastically accelerated hybridization by creating much larger zones of contact.

Regarding the evolution of the group, Gilliard suggested "that wattle birds [the *M. rufocrissalis* superspecies] are essentially forest-edge birds of the northern watershed and that the black bills [*M. belfordi*] are essentially pure forest birds of the central range and southern watershed" (Gilliard, 1959b, p. 24). In particular, he suggested, the *M. rufocrissalis* group might have originated on the "north mountain islands" (Huon Peninsula, Adelbert Mountains, North Coastal

Range, Cyclops Mountains, and Van Rees Mountains) north of the Mamberano-Sepik-Ramu-Markham gulch and might have reinvaded the central range. While this hypothesis accounted for the facts available before 1959, it is untenable in the light of the more recent evidence. *M. rufocrissalis* has at least as extensive a range on the southern watershed (Okapa to the Star Mountains) as on the northern watershed (Huon Peninsula to Telefolmin); *M. belfordi* coexists with *M. rufocrissalis* at its type locality on the northern watershed; and three of the four "north mountain islands" explored to date (Adelbert Mountains, North Coastal Range, and Cyclops Mountains) lack not only *M. rufocrissalis* but any member of genus *Melidectes*. *M. rufocrissalis*'s habitat is primarily the lower altitudes and only incidentally the forest edge; it simply happens that the forest edge habitats created by native agriculture lie mainly in its altitudinal range because the range of *M. belfordi* is mostly too high for agriculture. Finally, analysis of New Guinea bird distributions suggests that colonization across the Mamberano-Sepik-Ramu-Markham gulch by midmontane birds has been practically a one-way affair, i.e., that the large Central Range has provided many midmontane species to colonize the small "north mountain islands" but that reverse movement of midmontane birds has been almost nonexistent.

Most pairs of New Guinea montane birds with mutually exclusive altitudinal ranges seem to have originated as eastern and western populations of a polytypic species on the Central Range (p. 34), and this was presumably the case in the *M. ochromelas-M. belfordi-M. rufocrissalis* group as well. There are more marked differences among the semispecies of the *rufocrissalis* superspecies than among the subspecies of *M. ochromelas* or among the subspecies of *M. belfordi,* but the differences between *M. belfordi, M. rufocrissalis,* and *M. ochromelas* are greater than those within the *rufocrissalis* superspecies. Morphologically, *M. rufocrissalis* is no closer to *M. belfordi* than *M. ochromelas* is to either, and one probably could not have predicted a priori in which of the three cases (*M. ochromelas-M. belfordi, M. ochromelas-M. rufocrissalis, M. belfordi-M. rufocrissalis*) isolating mechanisms were most likely to break down. While reconstruction of the evolutionary history inevitably involves some guesswork, the simplest explanation of these facts is that the common ancestor first broke up into three allopatric populations, the ancestors of *M. belfordi, M. rufocrissalis,* and *M. ochromelas;* and that *M. rufocrissalis* was the first to expand, reinvaded the ranges of the other two species by displacing them altitudinally, and then differentiated geographically. The peripheral distribution today of *M. ochromelas* may indicate that it was the second to expand, reaching the mountains of the Huon Peninsula and Vogelkop, which *M. belfordi* as the last species to expand may not have had time yet to colonize. Present-day distributions would owe their final form to the instability of three-species altitudinal sequences, causing the extinction of *M. rufocrissalis* in some areas (southeastern New Guinea, Weyland Mountains, southern slope of the Snow Mountains) and of *M. ochromelas* in others (Eastern Highlands and northern slope of the Snow Mountains).

Melidectes torquatus polyphonus Mayr

Cinnamon-breasted Wattlebird

NATIVE NAMES. Fore: ikitora. Gimi: kogidódo.

SPECIMENS EXAMINED. Awande: 4 ♂, 1 ♀ (16-20 June 1965). Okasa: 3 ♂ (24-26 June 1965). Mt. Karimui Zone 2: 2 ♀ (13 and 15 Aug. 1965).

WEIGHT. 7 ♂: 47, 50, 51, 53, 53, 55, 58. 3 ♀: 34, 37, 44.

WING. 7 ♂: 110, 111, 114, 115, 117, 119, 119. 3 ♀: 105, 107, 107.

TAXONOMY. In color these match a single male of *M. t. polyphonus* from Wau (Herzog Mountains), which has a wing of 116 mm. Mayr's (1931, p. 660) measurements of his type series of *polyphonus* (2 ♂, 123 and 125, 1 ♀, 113) are larger than my series, six males which I measured from Gilliard's Wahgi series (115, 116, 117, 117, 119, and 123), or Gyldenstolpe's (1955, p. 164) Wahgi series (6 ♂, 110-121, 8 ♀, 103-111, according to his measurements). The races *torquatus, nuchalis, mixtus,* and *cahni* are all paler and less ochraceous below, while *emilii* is more ochraceous below, has larger throat wattles, and the white throat patch reduced in size.

DISCUSSION. This species and *Gerygone ruficollis* are probably the midmontane birds which have profited most greatly from the activities of man. My only records from undisturbed forest were of the two Mt. Karimui specimens (4,400 ft) and of several seen at the Sena River (4,500 ft). In undisturbed forest in other parts of New Guinea as well (e.g., southern slopes of the Snow Mountains, Idenburg slopes) it seems rare, to judge from other expedition reports. In settled and cleared midmontane areas, however, both in the Eastern Highlands and in the Baliem Valley of western New Guinea it is very common in trees of gardens, the forest edge, open second-growth, and casuarina groves up to 5,500 or 6,000 ft. The lower limit may be somewhere around 3,500 ft, since it was uncommon at Okasa (3,550-4,250 ft) and sighted only a few times at Karimui (3,650 ft), despite plenty of forest edge habitat in both areas. Testes were large in three Awande males but tiny in all three Okasa males, suggesting that Okasa may be supporting immatures at the lower fringe of the range.

Melidectes torquatus is usually seen in trees 15 ft or more above the ground, though two were netted at the forest edge. The Karimui, Sena River, and Mt. Karimui records were all from flowering trees. At Miarosa Terborgh found *M. torquatus* accounting for 90% of the bird-usage in a tree with a hard-shelled fruit that had been chipped open by the parrot *Trichoglossus haematodus* (cf., p. 143).

VOICE. Loud, raucous, and very similar to some calls of *Melidectes* *rufocrissalis.* The pattern is difficult to describe but consists of a complex disyllabic gurgle with the first syllable on the higher pitch.

Melipotes fumigatus goliathi Rothschild and Hartert

Common Melipotes

NATIVE NAMES. Fore: obéti. Gimi: órai. Daribi: yáre.

SPECIMENS EXAMINED. Awande: 2 ♂ (14 and 20 June 1965). Okasa: 1 ♂ (22 June 1965). Karimui: 2 ? (1 and 11 July 1965). Mt. Karimui Zone 2: 3 ♂, 1 ♀; Zone 3: 1 ♂, 1 ♀; Zone 4: 1 ♂, 1 ♀: Zone 5: 2 ♂, 1 ♀; Zone 6: 1 ♂, 1 ♀; Zone 7: 2 ♀; Zone 8: 1 ♂, 3 ♀ (13 Aug.-8 Sept. 1965).

WEIGHT. 10 ♂: 46-68 (56.1 ± 5.7). 10 ♀: 44-57 (49.9 ± 3.7).

WING. 10 ♂: 100, 102, 108-119 (113 ± 4). 10 ♀: 101-108 (105 ± 2).

STOMACH CONTENTS. Fruit, 2-8 mm in diameter (14 stomachs); fruit and insects (four); insects (one).

TAXONOMY. Among the adults there is no more than a slight increase of wing length with altitude on Mt. Karimui. There are no average differences in the darkness of the underparts or upperparts between birds from the lowest zones of Mt. Karimui, from the highest zones of Mt. Karimui, and from Awande. These Eastern Highlands birds average slightly darker and blacker above than topotypical *goliathi* from Mt. Goliath or from the northern slopes of the Snow Mountains, and more so compared to nominate *fumigatus* of southeastern New Guinea, though the difference in blackness may involve foxing (Gilliard and LeCroy, 1961, p. 76). Birds from higher altitudes (> 8,000 ft) on Mt. Hagen and in the Snow Mountains have considerably longer wings (♂ 120-128, ♀ 108-117) and, at least on Mt. Hagen, have darker breasts and lighter bellies.

DISCUSSION. The population structure deduced from details of gonad condition and from weights and wing lengths is as follows. At the bottom of the altitudinal range are immatures: a male with tiny testes at Okasa, two specimens with very short wings (102) and undiscernible gonads at Karimui, and three males with short wings (100, 102), low weights (46, 49), or tiny testes in Zone 2 of Mt. Karimui. The first adult males and females appear in Zone 2, but males with enlarged testes do not appear until Zones 5 and 6 (ca. 6,000-7,000 ft) of Mt. Karimui and at Awande (6,000 ft). Zones 7 and 8 (7,080-8,165 ft) contain largely or solely females.

Melipotes fumigatus is one of the commonest Eastern Highlands forest birds from about 4,000 to 11,200 ft. Below 4,500 or 5,000 ft one usually finds only immatures in low numbers, but in the main part of its altitudinal range (e.g., Zones 2 through 8 of Mt. Karimui) it accounts for about 3.5% of the local avifauna. It remained common through the stunted moss forest both on Mt. Karimui (6,500-8,165 ft) and on Mt. Michael (8,700-11,200 ft), and disappeared on Mt. Michael only where the moss forest gave way to alpine grassland. It also extends to timberline in western New Guinea, but not in southeastern

New Guinea. In behavior *Melipotes fumigatus* is silent, slow-moving, and solitary, and observed much less often than one might have expected from its abundance. In the forest interior it remains mainly in the middle- and upperstories, but it often descends to the understory at the forest edge. It is the only forest honeyeater at higher elevations whose diet is mainly (but not solely) fruit. Several individuals were collected in the flowering tree at 6,500 ft on Mt. Karimui, but these were probably seeking insects attracted to the flowers rather than the flowers themselves (Mayr and Rand, 1937, p. 221).

VOICE. On only one occasion during four expeditions to areas where *Melipotes fumigatus* was abundant have I heard a sound from it: a series of a half dozen identical, rather slow, high-pitched, not loud notes, upslurred at the end and with a quality as of sleighbells or some parrots (e.g., *Domicella lory*).

DICAEIDAE: FLOWERPECKERS

Dicaeum geelvinkianum rubrocoronatum Sharpe

Red-capped Flowerpecker

NATIVE NAMES. Fore: ísawánotába. Gimi: férete. Daribi: dínai.

SPECIMENS EXAMINED. Okasa: 2 ♂ (23 and 25 June 1965). Karimui: 7 ♂, 4 ♀ (10 Aug. 1964; 1 July-5 Aug. 1965). Bomai: 2 ♀ (6 July 1965).

WEIGHT. 6 ♂: 6.0, 7.0 (3), 7.2, 7.3. 6 ♀: 5.3, 6.5, 6.5, 7.0, 7.3, 7.5.

WING. 6 ♂: 51, 51, 54, 54, 57, 57. 3 ♀: 47, 49, 49.

STOMACH CONTENTS. Insects (two stomachs); fruit (two).

TAXONOMY. The dorsal coloration is deep glossy violet. The races *rubrigulare* and *albopunctatum* on the Fly River have the red throat patch of the male larger.

BREEDING. Testes were enlarged in four males, not enlarged in three others.

DISCUSSION. This inconspicuous, tiny flowerpecker occurred at all my collecting localities up to 5,700 ft in forest and up to 6,200 ft in cultivated areas. Single individuals, occasionally pairs, ranged from the treetops to 10 ft above the ground. I never netted the species.

VOICE. The two inconspicuous and quite different calls usually provide the only evidence for the presence of the species in forest. One is a short, dry, buzzy, insect-like note. The other is a high, sibilant upslur confusingly similar to the call of the sunbird *Nectarinia sericea*. However, the sunbird's call is usually repeated, whereas that of *Dicaeum* is given once.

Melanocharis nigra chloroptera Salvadori

Black Berrypecker

NATIVE NAME. Daribi: sísitabi.

SPECIMENS EXAMINED. Karimui: 5 ♂, 3 ♀, 5 imm. ♂ (30 July-15 Aug. 1964;

1 July-3 Aug. 1965). Bomai: 1 ♂, 1 ♀, 1 imm. ♂ (6 and 7 July 1965). Soliabeda: 2 ♂, 1 ♀, 1 imm. ♂ (22-30 July 1965). Mt. Karimui Zone 1: 1 ♂ (12 Aug. 1965).

WEIGHT. 9 ♂: 11.5-14.7 (13.2 ± 1.1). 5 ♀: 14.0-16.5 (15.2 ± 0.7). 6 imm. ♂: 13.5-15.3 (14.3 ± 0.8).

WING. 9 ♂: 64-69 (66.6 ± 1.6). 5 ♀: 63-69 (67.0 ± 2.4). 6 imm. ♂: 62-69 (65.1 ± 1.7).

TAIL. 9 ♂: 43-49 (46.3 ± 2.0). 8 ♀: 41-47 (44.7 ± 2.1). 6 imm. ♂: 41-47 (43.6 ± 1.5).

TAXONOMY. There appears to be a slight increase in size with altitude, as suggested by the following measurements of adult males. In each case the average wing length is given first, then the average tail length, then the weight: Soliabeda (1,350-2,000 ft), 65.6 mm, 45.8 mm, 12.2 g; Karimui (3,650 ft), 67.0 mm, 46.9 mm, 13.7 g.

As in the case of *M. versteri*, females and immature males are heavier than adult males, though the difference is less marked in the case of *M. nigra*.

The race *unicolor* of northern and southeastern New Guinea is entirely blue-black in the adult male and differs strikingly from the races *chloroptera* and nominate *nigra* of southern and western New Guinea and from my series, in which the male's underparts are gray. *Nigra* lacks the olive edges on the remiges of the male, present in my series and in *chloroptera*. The only color difference between my series and *chloroptera* from the Aru Islands, Fly River, and southwestern New Guinea is that Karimui males average very slightly darker below and that this is somewhat more pronounced at Soliabeda. As seen in Table 18, my specimens have wings and tails as long as in southeastern New Guinea *unicolor*, slightly longer (particularly in the female) than

TABLE 18
MEASUREMENTS OF *Melanocharis nigra* ADULTS

	Males		Females	
	Wing	Tail	Wing	Tail
M. n. chloroptera				
Karimui area, 9♂, 5♀	64-69 (66.7)[1]	43-49 (46.4)	63-69 (67.0)	41-47 (44.6)
Fly River, 14♂, 17♀	62-66 (63.7)	40-45 (43.1)	59-64 (61.2)	37-41 (40.8)
Aru Islands, 3♂, 2♀	65-66 (65.7)	45	63, 65 (64)	40, 43 (41.5)
Aru Islands[2]	64-66	42-46	60-65	36-42
Setekwa River (southwestern New Guinea), 5♂, 2♀	62-64 (63.0)	40-44 (41.6)	61, 63 (62.0)	37, 39 (38.0)
Southwestern New Guinea[2]	62-66 (63)	40-42 (41)	60-64 (62)	39-41 (40)
M. n. unicolor				
Southeastern New Guinea[3]	63-69 (65.7)	45-49 (47.3)	56-58 (65.9)	39-41 (40)

[1] Average values are given in parentheses.
[2] From Junge (1939).
[3] From Mayr and Rand (1937).

topotypical *chloroptera* from the Aru Islands, which are in turn slightly larger than the Fly River and southwest New Guinea populations. The Lake Kutubu population also belongs to *chloroptera* and has essentially the same measurements as the Karimui series.

The racial assignment of the Karimui population is of interest from an evolutionary point of view. The genus *Melanocharis* contains a triple altitudinal sequence: *M. nigra* in the lowlands to 3,000 or 4,000 ft, *M. longicauda* from the upper limit of *M. nigra* to about 5,000 ft, and *M. versteri* from the upper limit of *M. longicauda* to near timberline. Subspecific variation is much less marked in *M. longicauda* and *M. versteri* than in *M. nigra,* suggesting that *M. nigra* is the oldest form, isolates of which have in the past reinvaded each other's ranges with altitudinal displacement to give rise to the other two species. The color difference between the black-bellied males of *M. nigra unicolor* and the gray-bellied males of the other *M. nigra* races is more striking than the differences between these gray-bellied races and the other two species. The songs of the black-bellied and gray-bellied races are detectably different to my ear. The black-bellied and gray-bellied populations must meet somewhere on the eastern shore of Geelvink Bay on the north coast and somewhere on the Gulf of Papua on the south coast.

On the north coast the gray-bellied race *M. n. nigra* has been taken as far east as the Wanggar River at the head of Geelvink Bay, while the black-bellied race *unicolor* has been taken as far west as Pionierbivak on the Mamberano River, leaving an uncollected gap of 180 miles between these two localities on the New Guinea mainland. Japen Island, which lies about 15 miles offshore in this gap, is the type locality of *unicolor.* On the south coast *unicolor* is known as far west as Hall Sound, and *chloroptera* was previously known as far east as Sturt Island on the Fly River. The finding of *chloroptera* at Karimui extends its range 200 miles farther east to within 100 miles of *unicolor.* When further ornithological exploration closes these two gaps, it will be interesting to examine whether the black-bellied and gray-bellied races finally intergrade in the short remaining unexplored distance or whether they behave as good species, furnishing a model for the evolution of *M. longicauda* and *M. versteri.*

BREEDING. Gonads were small in almost all specimens.

DISCUSSION. *M. nigra* is a common but inconspicuous species (about 2% of the local avifauna in the Karimui area) which is heard or netted much more often than it is seen. Individuals, pairs, or groups of up to six flit rapidly through the forest or second growth 2-20 ft above the ground. Adult males, adult females, and immature males spend the same proportion of the time in the understory, as judged by netting results. On Mt. Karimui, where *M. longicauda* was absent, *M. nigra* occurred up to 4,300 ft, above which elevation it was replaced by *M. versteri.* At Okasa, where *M. longicauda* was present, collections down to 3,550 ft failed to yield *M. nigra.*

VOICE. The distinctive song is a very rapid series of thin twittering notes whose pitch describes a perfect sine wave (Fig. 42). There are up to two waves per second and more than a half dozen waves per song. The call is a weak, brief, formless, slightly buzzy twittering somewhat reminiscent of *Peltops montanus* in quality.

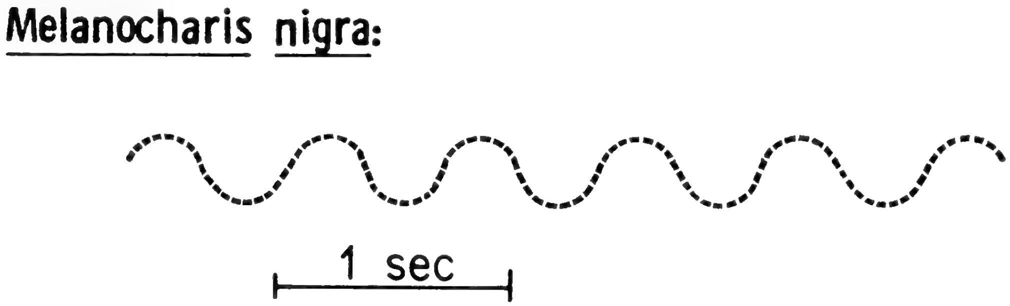


FIG. 42. Voice of *Melanocharis nigra.*

Melanocharis longicauda captata Mayr

Midmountain Berrypecker

SPECIMENS EXAMINED. Awande: 2 ♂, 1 ♀ (15 and 16 June 1965). Okasa: 2 ♂, 2 ♀ (23 Aug. 1964; 23-26 June 1965). Mengino: 1 ♂, 2 ? (15 July 1964). Bomai: 1 ♂, 1 imm. ♂ (6 July 1965).

WEIGHT. 4 ♂: 14.0, 15.0, 15.5, 17.0. 3 ♀: 15.0, 15.5, 15.5. 1 imm. ♂: 16.0.

WING. 4 ♂: 65, 65, 66, 66. 3 ♀: 64, 66, 67. 1 imm. ♂: 65.

TAIL. 4 ♂: 55, 56, 57, 58. 2 ♀: 53, 54. 1 imm. ♂: 51.

TAXONOMY. My specimens as well as three collected by Gilliard in the Wahgi Valley clearly belong to the race *captata* of the Huon Peninsula, with which they agree in the pattern of white on the tail; the outer edge of the outermost tail feathers is white, broadened distally into a bar, as illustrated by Salomonsen (1960). The race *orientalis* of southeastern New Guinea, to which previous collectors tentatively assigned their more limited material, differs in having a smaller white spot distally.

BREEDING. Gonads were small in all specimens.

DISCUSSION. This species is best distinguished from its congeners by the yellowish wash of the underparts, the lemon pectoral tufts, and the tail length (longer than *M. nigra,* shorter than *M. versteri*). It forms the middle member of a three-species altitudinal series with *M. nigra* and *M. versteri,* both of whose altitudinal ranges it overlaps slightly, and is local and uncommon, as are the middle members of other series. The only localities where it was common were Okasa and Mengino, where the other two species were absent. It was outnumbered by *M. nigra* at Bomai and by *M. versteri* at Awande, and was missing (squeezed out—see p. 34) on Mt. Karimui. *M. longicauda* and *Coracina morio* were the only two bird species (both of them characteristic of hill forest) which were present at Bomai (3,250 ft) but absent at Karimui Patrol Post (3,650 ft).

Both at Okasa and at Mengino Terborgh observed *M. longicauda* in trees bearing small fruits.

VOICE. At Okasa Terborgh heard this species delivering a "sine-wave" song similar to that of *M. nigra* (Fig. 42), suggesting that voice is not the isolating mechanism between these two sibling species. The calls include a high-pitched twittering, and incessant sibilant notes.

Melanocharis versteri virago (Stresemann)

Fan-tailed Berrypecker

NATIVE NAMES. Fore: oowakí. Gimi: útupi.

SPECIMENS EXAMINED. Awande: 2 ♂, 1 ♀, 1 imm. ♂ (15-19 June 1965). Mt. Michael: 1 ♂, 1 ♀, 1 imm. ♂ (2-12 July 1964). Mt. Karimui Zone 2: 1 ♂; Zone 3: 1 ♀, 2 imm. ♂; Zone 4: 1 ♂; Zone 5: 1 ♂, 2 ♀; Zone 6: 1 ♂, 2 ♀, 1 imm. ♂; Zone 7: 1 ♂, 2 ♀; Zone 8: 2 ♂, 2 ♀, 1 imm. ♂ (13 Aug.-8 Sept. 1965).

WEIGHT. 10 ad. ♂: 9.7-13.7 (11.9 $\pm$ 1.0). 10 ♀: 16.7-20.0 (18.1 $\pm$ 0.8). 6 imm. ♂: 12.0-16.0 (13.5 $\pm$ 1.3).

WING. 10 ad. ♂: 59-64 (60.6 $\pm$ 1.6). 10 ♀: 63-72 (68.1 $\pm$ 1.8). 6 imm. ♂: 61-67 (63.8 $\pm$ 1.9).

TAIL. 10 ad. ♂: 66-78 (73.5 $\pm$ 3.3). 10 ♀: 57-70 (65.4 $\pm$ 3.1). 6 imm. ♂: 55-72 (64.6 $\pm$ 5.6).

STOMACH CONTENTS. Fruit 2-5 mm in diameter (11 stomachs), fruit and insects (two), insects (one). Most stomachs of netted birds were empty, suggesting that digestion is rapid.

TAXONOMY. This is one of the few passerine species in which the female is larger than the male. All females I examined have heavier weights, and all but one have longer wings, than all adult males examined, though the males have longer tails. Immature males in female-like plumage are intermediate in weight and wing length between adult males and females but have the short tails of the females. As they mature, not only must males lose weight, but also their wings must become shorter, as also true of *Sericulus aureus* (Diamond, 1969). The four immature males with the longest tails (70-72) have nearly acquired the clear gray underparts of the adult male, though they still have female-like olive upperparts.

Eastern Highlands males are slightly darker gray below than *maculiceps* from southeastern New Guinea, less dark than nominate *versteri* of the Vogelkop or Cyclops specimens included in *virago*, and still less dark than *meeki* of the Weyland and Snow Mountains. Eastern Highlands females are darker and grayer below, less yellow, than *maculiceps* and are close to a single topotypical female *virago* from the Schraderberg.

BREEDING. On Mt. Karimui testes were somewhat enlarged in almost all adult males and in half of the immature males in female-like plumage but were not greatly enlarged in any specimen.

DISCUSSION. *Melanocharis versteri,* the highest species in the *M. nigra-M. longicauda-M. versteri* altitudinal sequence, is common but quite inconspicuous within its altitudinal range in forest and dense second-growth. On Mt. Karimui, where *M. longicauda* was absent, *M. versteri* descended to 4,500 ft and was common (4% of the local avifauna) up to the summit at 8,165 ft. At timberline it goes out to tree ferns in alpine grassland near the forest edge. Much of its time was spent in the lowerstory, but in fruit trees it occasionally ranged up to 40 ft above the ground. Females, adult males, and immature males were netted with the same frequency. Once I saw an adult male hovering at flowers.

VOICE. A variety of faint and high-pitched notes, such as a thin, rapidly repeated "ts-ts. . . ."; a scratchy and complaining "dee-dee-dee"; a high-pitched nasal "ee"; and an upslurred inquiring "chee-chee-chee". All these notes are faint, unlikely to catch one's attention, and not distinctive.

Melanocharis striativentris striativentris Salvadori

Streaked Berrypecker

NATIVE NAME. Fore: oowakí.

SPECIMENS EXAMINED. Awande: 8 ♂, 4 ♀ (19-21 June 1964; 14-20 June 1965). Miarosa: 1 ♂ (13 June 1964). Okasa: 2 ♂, 1 ♀ (23 and 24 June 1965). Mt. Karimui Zone 2: 1 ♀; Zone 4: 1 ♂, 2 ♀ (13 Aug.-2 Sept. 1965).

WEIGHT. 12 ♂: 16.3-20.0 (17.9 ± 1.1). 8 ♀: 16.5-22.0 (19.8 ± 1.7).

WING. 12 ♂: 69-75 (72.2 ± 1.5). 8 ♀: 71-75 (72.9 ± 1.1).

TAXONOMY. Females have slightly heavier weights and longer wings than males, but the difference is much less marked than in the case of *M. versteri.*

These specimens agree well with topotypical *striativentris* from the southern side of southeastern New Guinea. The race *prasina* of the northern side of southeastern New Guinea differs in having the basal portion of the tail white, while *chrysocome* of the Huon Peninsula is larger, darker ventrally, and more obscurely streaked.

BREEDING. Gonads were small in most specimens but were slightly enlarged in one male and three females.

DISCUSSION. The most noteworthy feature of this species is the extreme local variability of its abundance despite its wide geographical range. The American Museum of Natural History has a total of 14 specimens. The exhaustive collections of the three prewar Archbold expeditions included only two specimens of this species. Gilliard found it uncommon, Shaw-Mayer missed it, and I found it uncommon at Mt. Karimui, Okasa, and Miarosa. At Awande, however, one mile from Miarosa and 10 miles from Okasa, it proved to be the most abundant bird both in 1964 and 1965, and saturated our nets located at 6,100 ft just inside the forest near its edge and adjacent to gardens. Gyldenstolpe also found it abundant near Nondugl. The altitudinal range was 4,750-5,960 ft on Mt. Karimui and about 4,000-6,800 ft in the Okapa area, overlapping both *M. longicauda* and *M. versteri* (but not *M. nigra*).

Rhamphocharis crassirostris piperata (De Vis)

Spotted Berrypecker

SPECIMENS EXAMINED. Miarosa: 2 ? (13 and 17 June 1964). Mt. Michael: 1 ? (13 July 1964). Mengino: 1 imm. ♂ (15 July 1964). Mt. Karimui Zone 4: 1 ? (28 Aug. 1965). Mt. Karimui Zone 4: 1 ? (28 Aug. 1965).

WING. 1 imm. ♂: 71. 1 ?: 71.

TAIL. 1 imm. ♂: 71. 1 ?: 48.

EXPOSED CULMEN. 1 imm. ♂: 16.5. 1 ?: 16.0.

TAXONOMY. All specimens are in the spotted female or female-like plumage.

DISCUSSION. This is a rare species, but it nevertheless turned up at all of my midmontane collecting localities between 4,600 and 7,000 ft except Awande, albeit in minimal numbers. Three specimens were in the forest, one in second-growth at the forest edge, one in a fruiting tree in second-growth, and all were shot between 7 and 50 ft above the ground. No specimens were netted, whereas all four species of the closely related genus *Melanocharis* were often netted.

Oreocharis arfaki (Meyer)

Tit Berrypecker

NATIVE NAME. Gimi: mégino.

SPECIMENS EXAMINED. Mt. Michael: 1 ♂, 2 ♀ (5-12 July 1964). Agotu (Gimi territory): 1 ♀ (22 July 1964). Mt. Karimui Zone 2: 1 ♂; Zone 3: 2 ♀; Zone 8: 7 ♂, 2 ♀, 3 imm. ♂ (17 Aug.-3 Sept. 1965).

WEIGHT. 7 ♂: 18.0, 20.0 (2), 20.7, 21.4, 21.5, 21.7. 3 ♀: 18.0, 18.8, 21.0. 3 imm. ♂: 18.5, 19.7, 20.0.

WING. 6 ♂: 69, 71 (4), 75. 2 ♀: 70, 71. 2 imm. ♂: 69, 71.

STOMACH CONTENTS. Fruit 1-7 mm in diameter.

TAXONOMY. After comparing my material with specimens from other parts of New Guinea, including six topotypical males and two females from the Vogelkop, I agree with Salomonsen (1960, p. 3) and Gilliard and LeCroy (1970, p. 24) that there is too much individual variation to recognize the race *bloodi*.

BREEDING. All adult males on Mt. Karimui, and one of the immature males in female-like plumage, had the testes considerably or greatly enlarged.

DISCUSSION. This is one of the midmontane species whose altitudinal range shows local variations apparently correlated with the presence of mossy conditions (cf., *Ptiloprora guisei*). On Mt. Michael, where heavy mossing set in at 8,700 ft, *Oreocharis* was collected at 8,000 ft. En route from Mt. Michael to Karimui we passed through a tongue of moss forest at about 6,000 ft near Agotu and immediately re-encountered *Oreocharis*. On Mt. Karimui, where heavy mossing began at 6,500 ft, *Oreocharis* descended to 4,720 ft but became common only above 7,600 ft. In the Okapa area, where no heavy moss was encountered as high as we collected (up to 7,000 ft), *Oreocharis* was absent. It was generally in the middle- or upperstory of the forest, in flocks, and was rarely netted. Although stomachs contained solely fruit, I once saw an individual hanging upside-down to probe a flower.

VOICE. A very high, drawn-out note "sss" or "z-z-z", repeated incessantly by flocks and similar to the note of the Cedar Waxwing (*Bombycilla cedrorum,* Bombycillidae) in North America.

Paramythia montium montium De Vis

Crested Berrypecker

SPECIMENS EXAMINED. Mt. Michael: 1 ♂, 1 ♀ (30 June and 8 July 1964). Mt. Karimui Zone 8: 1 ♂, 1 ♀ (5 Sept. 1965).
WEIGHT. 1 ♂: 41. 1 ♀: 43.
WING. 2 ♂: 97, 103. 1 ♀: 97.
TAIL. 2 ♂: 92, 94.
STOMACH CONTENTS. Fruit, 2-8 mm in diameter.

DISCUSSION. This flowerpecker is common and widespread in high altitude stunted mossy forest, from timberline down to 9,500 ft (Mt. Michael) and on the very summit (8,165 ft) of Mt. Karimui. Most of its altitudinal range lies above that of its smaller relative *Oreocharis arfaki*. *Paramythia montium* feeds unsystematically on berries: it flies into a tree with a loud wing beat, hops around vigorously, plucks a few berries, and flies off again, leaving the tree full of uneaten berries. It spends more time in the crowns than in the understory.

VOICE. A faint squeaky note, suggestive of the sounds made by birdwatchers squeaking or sucking on the back of their hands to attract birds.

ZOSTEROPIDAE: WHITE-EYES

Zosterops atrifrons tenuifrons Greenway[1]

Black-fronted White-eye

SPECIMENS EXAMINED. Karimui: 1 ♂, 1 ? (12 Aug. 1964). Bomai: 1 ♀, 1 ? (6 July 1965).

[1] Listed as *Zosterops minor* in Rand and Gilliard (1967).

WEIGHT. 1 ♀: 11.0. 1 ?: 11.5.
WING. 1 ♀: 58. 1 ?: 57.

TAXONOMY. The black of the forehead is restricted to a small area at the base of the bill and is much more limited than in *delicatula* of the southern slopes of southeastern New Guinea, in which the black extends beyond the eyes. In this respect my specimens agree with the description of *tenuifrons* (Greenway, 1935, p. 105; perhaps synonymous with *chrysolaema*) from the northern slopes of southeastern New Guinea, of which I have seen no topotypical material.

BREEDING. The male had the testes greatly enlarged.

DISCUSSION. At Karimui and Bomai this hill forest white-eye was uncommon (ca. 0.2% of the local avifauna) and was encountered in groups of up to four birds in the upperstory of forest and second-growth, sometimes in flowering trees. *Z. novaeguineae* lives at higher altitudes, but the ranges may overlap slightly, since Bulmer collected both species around 5,000 ft in Kyaka territory.

VOICE. A lengthy song with a sweet quality. The call is a high-pitched, inquiring, sweet, upslurred "tswee."

Zosterops novaeguineae wahgiensis Mayr and Gilliard

Mountain White-eye

NATIVE NAMES. Fore: tiorióba. Gimi: líyu.

SPECIMENS EXAMINED. Awande: 1 ♂, 1 ♀, 1 ? (17 and 18 June 1965). Mt. Michael: 1 ♀ (30 June 1964).

WEIGHT. 1 ♂: 12.0. 1 ♀: 12.0. 1 ?: 13.5.

WING. 1 ♂: 64. 1 ♀: 64. 1 ?: 61.

STOMACH CONTENTS. Fruit 1-3 mm in diameter (nine stomachs); insects (four); insects and fruit (two).

TAXONOMY. Mayr and Gilliard (1951, pp. 14-15) and Gyldenstolpe (1955, p. 176) recognized three races of *Z. novaeguineae,* two of them (*wahgiensis* and *shawmayeri*) new, within an area 45 miles in extent containing no distributional barriers to the species. Examination of the unique type of *shawmayeri* shows that it is indistinguishable from *wahgiensis,* as Mees (1961) suspected and as Rand and Gilliard (1967, p. 591) and Mayr (1967, p. 309) recently agreed. All Eastern Highlands material collected to date belongs to a single thinly differentiated race *wahgiensis,* which differs from *crissalis* in the slightly darker, more green, less yellow back and the more gray, less powder-brown abdomen. My specimens differ from Nondugl *wahgiensis* mainly in having a slightly brighter yellow throat.

BREEDING. The gonads of all specimens were small.

DISCUSSION. *Zosterops novaeguineae* occurs in flocks in the crowns and middlestory, occasionally the understory, of forest at about 5,000-7,500 ft. It is somewhat commoner in disturbed habitats (casuarina stands, bushes of second-growth).

VOICE. The common call note is a sweet, down-slurred "tsyew" with a sharp attack and suggestive of a *Lonchura* mannikin. This note is faint, but the pooled sound of many members of a flock calling at once is loud. There is also a short, dry, upslurred, trilled call note similar to that of *Zosterops lateralis* of New Zealand and *Z. hypoxantha* of New Britain. The lengthy, sweet song of whistles and upslurs suggests the song of *Saxicola caprata* in quality.

ESTRILDIDAE: WAXBILLS and MANNIKINS

Erythrura trichroa sigillifera (De Vis)

Blue-faced Parrot-Mannikin

SPECIMENS EXAMINED. Karimui: 1 ♂ (6 Aug. 1965). Mt. Karimui Zone 8: 1 ♂ (7 Sept. 1965).
WEIGHT. 2 ♂: 13.8, 15.0.
WING. 2 ♂: 62, 62.
TAIL. 2 ♂: 47, 48.
EXPOSED CULMEN. 2 ♂: 11.5, 12.0.
STOMACH CONTENTS. Dry granular vegetable matter, possibly bamboo seeds.

BREEDING. Testes were considerably enlarged in both specimens.

DISCUSSION. This mannikin lives in forest and second-growth at 3,500-9,200 ft and is solitary and uncommon, except in thickets of wild bamboo, where it is numerous. Like *Gallicolumba beccarii,* it becomes locally superabundant when the bamboo produces seed. When disturbed, it flies up with a loud whirring of the wings.

VOICE. The call is a very rapid descending series of 2-5 thin, unvoiced notes, similar in quality to the song of *Peltops montanus* or to light spiccato playing on the violin.

Erythrura papuana Hartert

Papuan Parrot-Mannikin

NATIVE NAME. Fore: kukusía.
SPECIMENS EXAMINED. Awande: 1 ♂, 1 ♀, 2 ? (19 June 1964; June 14-17, 1965). Okasa: 1 ♀ ? (22 June 1965).
WEIGHT. 1 ♂: 18.5. 1 ♀: 17.3. 1 ♀ ?: 17.0. 1 ?: 18.5.
WING. 1 ♂: 68. 1 ♀: 67. 1 ♀ ?: 67. 2 ?: 65, 68.
TAIL. 1 ♂: 48. 1 ♀: 50. 1 ♀ ?: 37. 2 ?: 37, 49.
EXPOSED CULMEN. 1 ♂: 14.5. 1 ♀: 12.5, 1 ♀ ?; 13.0. 2 ?: 13.0, 13.0.
STOMACH CONTENTS. Dry, granular vegetable matter.

TAXONOMY. These five specimens, plus two specimens from the Vogelkop (including the type) and 10 from southeastern New Guinea in the American Museum of Natural History, were compared critically with the available large series of the very similar *E. trichroa sigillifera* to evaluate diagnostic differences. The only difference in color is that the chin has a blue patch of significant extent in adult males of *E.*

papuana, lacking (usually) or present but very small (infrequently) in adult males of *E. trichroa sigillifera* (and in females of both species). The stouter bill of adult males of *E. papuana* is visible at a glance. Measurements (Table 19) show that all or almost all *E. papuana* have longer wings, longer bills, and heavier weights than all or almost all *E. trichroa sigillifera.* Colors of the soft parts in life were the same for my specimens of both species (bill black, eye brown, legs pale flesh-brown).

DISCUSSION. Three specimens were netted in second-growth near the forest edge and one shot in the forest at 6,200 ft near Awande. The fifth specimen was shot at 4,000 ft in the Okasa forest nine miles from Awande.

The only other records of this rare species are from four localities in southeastern New Guinea (Aroa River, Kotoi, Mt. Tafa, Mt. Albert-Edward), from the Wissel Lakes of western New Guinea, and from the Arfak and Tamrau Mountains of the Vogelkop. The distributional relationship with the widespread and much commoner *E. trichroa sigillifera* can be described approximately as checkerboard allopatry. In the Okapa area (4,000 and 6,200 ft) I obtained only *E. papuana,* while elsewhere in the Eastern Highlands (3,500-9,200 ft: Karimui, Mt. Karimui, Mt. Kubor, Mt. Wilhelm, Mt. Hagen, Mt. Giluwe, Wahgi Divide Mountains, Weiga, Schraderberg, Baiyer Valley, Kaironk Valley) other collectors and I obtained only *E. trichroa.* In southeastern New Guinea the First Archbold Expedition collected *E. papuana* on the east slope of Mt. Tafa, *E. trichroa* on the west slope of Mt. Tafa and at three other localities. At the Wissel Lakes and at Bon Kourangen in the Tamrau Mountains only *E. papuana* was taken. There are only two instances of local sympatry: both species were recorded at Mayr's

TABLE 19

MEASUREMENTS AND WEIGHTS OF *Erythrura papuana* AND *E. trichroa sigillifera*

	Wing	Exposed Culmen	Weight
E. trichroa sigillifera			
17 ♂	59 (2), 61 (2), 62 (7), 63 (4), 64	11.0 (2), 11.5 (8), 12.0 (7)	11 (1), 12 (2), 13 (3), 14 (2), 15 (3), 16 (2), 17 (2), 18 (1)
13 ♀	60 (5), 61, 62 (4), 63, 64 (2)	11.0 (3), 11.5 (2), 12.0 (7)	12 (1), 13 (3), 14 (3), 15 (2), 16 (1), 17 (2), 18 (1)
E. papuana			
9 ♂	65, 66, 67 (5), 68, 69	12.5, 13.0, 13.5 (2), 14.0 (2), 14.5 (2)	18.0, 18.5, 19.0, 21.0, 24.0
4 ♀	67 (2), 68 (2)	12.5 (2), 13.0, 13.5	17.3, 18.0, 20.0, 21.0
4 ?	65, 66, 67, 68	13.0 (4)	17.0, 18.5, 19.0, 21.0

locality of Siwi in the Arfak Mountains of the Vogelkop; and on Mt. Albert-Edward in southeastern New Guinea I found *E. trichroa* abundant at 6,000-9,200 ft, *E. papuana* at 5,000-6,000 ft. No differences in habitat preference, altitudinal preference, or behavior have been noted, except for the altitudinal segregation on Mt. Albert-Edward. Both forms inhabit forest and the forest edge from about 3,000 to 7,000 ft (*E. papuana*) or 9,000 ft (*E. trichroa*). Unlike the situation among the *Geospiza* finches of the Galapagos Islands, the difference in bill size of these mannikins is evidently not sufficient to permit local overlap. *E. papuana* is endemic to New Guinea and presumably is the older invader, while *E. trichroa* extends from Celebes to Micronesia. The relict distribution of *E. papuana* suggests that its congener is in the process of replacing it and that it has been able to hold out only at a few scattered localities.

Lonchura grandis grandis (Sharpe)

Great-billed Mannikin

SPECIMENS EXAMINED. Okasa: 1 ♀ (26 June 1965).
WEIGHT. 16.
WING. 56.

TAXONOMY. The specimen has a duller back, a duller and more yellow-edged tail, and paler brown flanks than nominate *grandis* from southeastern New Guinea. However, it can be matched by some specimens of *grandis* in the first two respects and is approached by some *grandis* in the third respect. The race *ernesti* has the edges of the rectrices still paler, duller, yellower, and less ochraceous, while *heurni* has the back richer chestnut.

DISCUSSION. In 1964 I observed a flock of five of this species at 4,200 ft in the extensive grasslands surrounding the Okasa forest. In 1965 *L. spectabilis,* the widespread *Lonchura* of the midmontane grasslands in the Eastern Highlands, was the common form at Okasa, and only the single specimen of *L. grandis* was obtained. Mixed flocks containing both species were never observed.

Examination of the distribution of *Lonchura* mannikins in the midmontane grasslands of New Guinea proves interesting. Extensive midmontane grasslands probably came into existence only within the past millenium, as a result of native agriculture, and must originally have been confined to very narrow strips along a few of the larger lakes and rivers, and perhaps landslide areas. A total of eight species of *Lonchura* may now be found in the midmontane grasslands in various parts of New Guinea. Of these eight, two are localized species (*L. vana* and *L. teerinki*) endemic to this habitat; five are lowland species (one, *L. caniceps,* confined to southeastern New Guinea; the other four—*L. tristissima, L. grandis, L. castaneothorax,* and *L. spectabilis*—widespread) that appear to have spread upwards to the new habitats as they were created; and the eighth, *L. montana*, an alpine species that has spread downward. Apart from Okasa in the Eastern Highlands (*L. grandis* and *L. spectabilis*) and Mafalu in southeastern New Guinea (*L. grandis* and *L. caniceps*), each midmontane locality supports only a single species, but the identity of the locally successful colonist varies in an unpredictable checkerboard fashion over New Guinea. An extreme example of this irregularity occurs in the Herzog Mountains, where four different colonists occur at four different localities within 35 miles: *L. tristissima* in the Snake River Valley, *L. castaneothorax* at Mumena Creek, *L. grandis* at Biolowat, and *L. spectabilis* at Wau. The details for the rest of New Guinea, proceeding east to west, are as follows: southeastern New Guinea, *L. caniceps* (plus *L. grandis* at Mafulu); Herzog Mountains, cited in previous sentence; Huon Peninsula, *L. tristissima* at some localities, *L. spectabilis* at others; Adelbert Mountains, *L. tristissima;* Eastern Highlands, *L. spectabilis* (plus *L. grandis* at Okasa); Torricelli Mountains, *L. tristissima;* Baliem Valley of the Snow Mountains, *L. teerinki;* Ilaga Valley of the Snow Mountains, *L. montana;* Wissel Lakes, *L. castaneothorax;* Weyland Mountains, *L. tristissima;* Anggi Lakes of the Vogelkop, *L. vana;* other localities in the Vogelkop, *L. tristissima*. As discussed on p. 40, this checkerboard pattern probably reflects the facts that the midmontane grasslands provide islands of suitable habitat for the *Lonchura* mannikins, that establishment of the first successful colonist prevents the establishment of later potential colonists, and that it is in part a random matter which species arrives first.

Lonchura spectabilis wahgiensis Mayr and Gilliard and *L. s. gajduseki* Diamond

New Britain Mannikin

NATIVE NAMES. Fore: shúi. Daribi: búba.

SPECIMENS EXAMINED. *L. s. wahgiensis:* Awande, 1 ♀, 1 imm. ♂ (19 Aug. 1964; June 17, 1965); Mengino, 1 ? (16 July 1964). *L. s. gajduseki:* Karimui, 8 ♂, 4 ♀, 4 imm. ?, 1 juv. ? (3-17 July 1965).

WEIGHT. *L. s. wahgiensis:* 1 imm. ♂, 9.3. *L. s. gajduseki:* 8 ♂, 10.5-12.7 (11.7 $\pm$ 0.7); 3 ♀, 10.3, 11.0, 11.5; 4 imm. ?, 9.5, 11.0 (2), 11.5; 1 juv. ?, 7.0.

WING. *L. s. wahgiensis:* 1 imm. ♂, 50. *L. s. gajduseki:* 6 ♂, 49, 50, 51 (3), 52; 4 ♀, 49, 50 (2), 51; 1 imm. ?, 51.

TAXONOMY. *L. s. wahgiensis* is the widespread *Lonchura* of the midmontane grasslands west at least to Tari and east at least to the Okapa area, with the underparts whitish (sometimes pale buff in adults and medium buff in immatures). *L. s. gajduseki* is a distinctive form confined to the Karimui Basin, with the underparts medium buff in both adults and immatures (see Diamond, 1967a, p. 15, for diagnosis).

BREEDING. The testes of all adult *L. s. gajduseki* were much enlarged, indicating synchronized breeding activity in the dry season.

DISCUSSION. Flocks of up to 30 individuals are seen between 3,000 and 8,000 ft in the Eastern Highlands at any locality where there are large expanses of medium-tall grassland. Unlike *L. tristissima,* which sometimes perches in bushes and trees at the forest edge or in second-growth, *L. spectabilis* seems quite unable to utilize forest edge habitats. My general impression of New Guinea *Lonchura* species (with the possible exception of *L. tristissima*) is that they are among the last grassland birds to colonize a new garden or airstrip carved out of the forest and appear only when the available area of grassland is substantial, possibly because of their inability to use the forest edge and their need to associate in large flocks.

The presence of two endemic midmontane races of *Lonchura spectabilis* raises some evolutionary problems (see pp. 76-77). These problems are less acute in the case of *L. s. wahgiensis,* which differs only slightly from *L. s. mayri* of the lowlands and now has a large midmontane range, extensive parts of which have probably been under cultivation for at least several centuries. This timespan and the slight racial differences make it plausible that *wahgiensis* could have evolved in the last few centuries. An alternative hypothesis is that it may be much older and may have eeked out a precarious existence along the edge of the Wahgi and other rivers prior to extensive native agriculture (cf., Rand and Brass, 1940, p. 377; Rand, 1941b).

L. s. gajduseki is more distinct and inhabits a much smaller range with a well-known recent history. Information given by natives suggests that the Karimui Basin has been inhabited somewhat less than a century. Originally the natives' diet was mainly sago, and dependence on gardens began only with the termination of intertribal warfare and the introduction of the sweet potato in the 1950's. Having flown and walked over much of the basin, I find it impossible to imagine where *L. s. gajduseki* could have maintained itself before garden agriculture. The streams traversing the basin are confined to narrow gorges. Although I have been in 10 of these gorges, I have yet to meet a *Lonchura* or to see riparian vegetation that seemed to offer promise of supporting *L. s. gajduseki*. Either this race must have slowly evolved in some part of the basin not yet discovered—an unattractive possibility because of the circumscribed size of the basin and the large areas of grassland necessary for *L. spectabilis*—or else it must have evolved in a very short time, perhaps as little as 15 years. This latter possibility cannot be dismissed. The studies of Johnston and Selander (1964) on *Passer domesticus* in North America show that rapid morphological changes can occur in populations of species colonizing new habitats. The variants of *wahgiensis* in which the adult has pale buff underparts may have served as the starting material. Finally, the selection pressures at Karimui (due to heavy rainfall throughout the year) may have been unusually severe, as seen by the general tendency towards dark plumage expressed most strikingly in the melanistic population of *Accipiter novaehollandiae.*

VOICE. A faint, sweet upslur.

Oreostruthus fuliginosus hagenensis Mayr and Gilliard

Crimson-sided Mountain Grass Finch

STOMACH CONTENTS. Seeds (two stomachs), fruit (one), insects (one).

DISCUSSION. This uncommon high-altitude grass finch was collected in a forest glade on Mt. Hagen by Gilliard and in alpine grassland on Mt. Giluwe by Shaw-Mayer, at 8,500-11,500 ft.

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Citations of all significant page references for each New Guinea bird discussed are provided both under the generic name and under the specific name. Boldface type is used for the first page of the main account of a bird that occurs in the Eastern Highlands. Birds occurring in the Eastern Highlands are also cited under the English name, the subspecific name, and any scientific name used by Rand and Gilliard (1967) but replaced in the present work. Such citations refer only to the first page of the main account.

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