THE ENDEMIC AVIFAUNA OF SAIPAN, TINIAN, GUAM AND PALAU

By JOE T. MARSHALL, JR.

In the year from December, 1944, to December, 1945, I made a zoological collection, chiefly animals of medical interest, on the islands of Saipan, Tinian, Guam and Palau in Micronesia. These were obtained for the United States Army Medical Museum. Birds were collected incidentally to procuring a collection of mammals and their ectoparasites; they were turned over to the United States National Museum by the Army Medical Museum. Richard E. Genelly worked with me on Tinian and generously provided the photographs used in this paper. In my spare time I recorded field observations and prepared series of study skins, some skeletons and alcoholics of birds which were sent to the Museum of Vertebrate Zoology. Through the courtesy of Herbert Friedmann of the United States National Museum the first-mentioned bird skins were loaned to the Museum of Vertebrate Zoology where the following account of the endemic land and fresh-water species was prepared. It is based upon the 579 specimens collected by Genelly and myself and upon my field notes. An effort was made to obtain the maximum information possible from each bird specimen. Color of soft parts, degree of completion of the skull roof, size of gonads, stomach contents, amount of fat and stage in the molt sequence were recorded. I searched also for blood parasites in the species taken on Saipan and Tinian. Further information was obtained, though not reported here. Samuel A. Edgar identified intestinal parasites and Henry S. Dybas identified arthropods in the stomachs and collected ectoparasites, which were sent to the National Museum.

HABITATS

The native land and fresh-water birds of these islands are either confined entirely to natural environment or achieve their maximum abundance in it, with one exception. On Tinian, rows of acacia trees have been planted as windbreaks through the farm lands, and the resulting "edge" habitat is particularly suitable for the Bridled White-eye, which occurs therefore in disproportionately large numbers on Tinian as compared with the other islands.

The untouched natural environment may be divided into several kinds of habitat as follows. (1) Mangrove lagoons occur over vast areas in the Palau group. They provide a stand of vegetation suitable for many land birds, consisting of two sizes of trees, spaced several yards apart, growing in three to six feet of salt water. One is an erect tree with a single straight trunk 30 to 50 feet high, the other forms dense clumps of multiple stems only 10 to 15 feet tall.

(2) Coastal shrubbery occurs on Saipan, Tinian, and Guam (fig. 35). It often is wind-controlled, and forms a dense, continuous cover of broad-leaved plants three to six feet tall in a band along the coast in places with too little soil and too rocky to support trees.

(3) An entirely different kind of coastal vegetation occurs on all the islands at the edge of sandy beaches where there is ample soil on gently sloping ground. It consists of a row or two of magnificent Casuarina trees, often more than 100 feet tall.

(4) Fresh-water marshes are found on Saipan, Tinian and Guam. At Lake Susupe (actually brackish), Saipan, and Lake Hagoi, Tinian, the marsh vegetation consists of alternating pure expanses of cane about 10 feet tall, tules about six feet tall, and fern-like plants whose fronds interlock to form an impenetrable mass extending from six to ten feet above the water level.

(5) Savannah is found near the airstrip on Babelthuap, Palau, and consists of bunch grasses and ferns two or three feet high separated from each other by bare soil.

(6) Woodland covers the major portion of the islands (fig. 36). A rich assortment of broad-leaved trees, differing somewhat as to component species on each island, grow close together and provide a continuous leafy canopy 30 to 100 feet above the ground. On Palau this forest is densest, and there is only a sparse understory vegetation. Here the forest is composed of two elements: gigantic multiple-stemmed trees with widely spreading dense crowns, growing about 100 yards apart and extending high above the level of the surrounding vegetation; and shorter trees forming a more or less interrupted canopy between the former, depending on the irregularities and steepness of the terrain.

ENDEMIC SPECIES

The little Pied Cormorant (*Phalacrocorax melanoleucus*) is found on Palau in mangrove lagoons and small fresh-water ponds inland where they spend much time sitting upright on dead branches. Individuals or small groups are often seen in flight over the inland forests. A specimen taken from a tree at the edge of a stream on Babelthuap had eaten a crayfish.

Fig. 35. Coastal shrubbery at Marpo Point, Tinian Island.

The Reef Heron (*Demigretta sacra*) was seen only once on Saipan (gray phase). It was found nesting in April on Tinian by Genelly (birds were gray-colored; fig. 37) and was watched foraging in lagoons on Guam. Here the birds had been spending the heat of the day standing singly or in pairs on the sandy beach. Later in the afternoon until almost dark they actively stalked small fish in water a foot deep, keeping always on the move and working out to 100 yards from shore. On Palau the Reef Heron forages also in mangrove lagoons, where a white individual with black shaft spots on the back and wings was found creeping about in shallow water, keeping the body horizontal, low, and with the neck hunched up. It would strike at a fish by "releasing" the head, as if by trigger action, in a forward and downward direction. Of nine birds seen on Palau, five were gray, two pure white and two were white with black spots on the back.

The Rufous Night Heron (*Nycticorax caledonicus*) was noted in mangrove lagoons on Palau. At dusk they fly for long distances over the forest to their feeding grounds. In view of the surpassing beauty of the plumage of this species, it might be of interest to note the equal delicacy of color of the soft parts: iris yellow, skin on face lettuce green, bill black and feet creamy yellow.

The Chinese Least Bittern (*Ixobrychus sinensis*) is an abundant and conspicuous inhabitant of fresh-water marshes on Saipan, Tinian and Guam. Only two were seen on Palau. On Guam these bitterns appear in the evenings in lagoons and feed in company

Fig. 36. Cane field and broken forest, in vicinity of coral caves near northwest end of Tinian Island.

with the Reef Herons, pursuing small fish in a manner identical to that species, while they wade in water up to their bellies. They also feed on grasshoppers in moist grassland near marshes and are frequently seen during the day making long flights over the farm lands. A more characteristic forage behavior is noted in the tule beds around the lakes on Saipan and Tinian. The bird grasps a tule stem in each foot and moves from stem to stem about a foot above the water level. It comes to the edge of the tules to feed, where it sits absolutely motionless in a compact ball with the head drawn in against the body. The feet extend almost horizontally to each side because of the bending of the two stems which it grasps. With a movement of extreme rapidity it suddenly extends its long neck to grasp a small fish in its bill. It can retire into the inner tules and back again with such a fluid easy grace that one does not suspect the bird to be in motion until it vanishes. The call, frequently uttered, is a harsh *craak*.

The Marianas Mallard (*Anas oustaleti*) is found in fresh-water marshes at Lake Susupe, Saipan and Lake Hagoi, Tinian (fig. 38). Twelve was the greatest number seen together at any one time. They were never found on both the lakes during any one month, and it is probable that the same birds fly from one island to the other. An adult male taken in April and another in October were both in breeding condition. A family of ducklings was seen in April. They are frequently found in pairs, not out on open water but in little ponds completely surrounded by tules. When flushed, they circle the lake and land in

concealed ponds at the other end. This mallard feeds on green vegetation and seeds by plucking away at the grass in very shallow water. No "tip-up" feeding was seen.

The Incubator Bird (*Megapodius lapérouse*) was found only on Palau. There was no trace of them on Saipan, Tinian or Guam; they were once abundant on at least the first two islands. Genelly and I searched every bit of the remaining natural forest on Tinian, the type locality of the race *lapérouse*, including some particularly fine timber

Fig. 37. Reef Heron (gray phase) on nest, Tinian Island.

on the northeast side (fig. 39). In considering the habitat of the Incubator Bird (as well as the Palau Ground Dove) on Palau, a distinction must be made between two kinds of woodland. Particularly luxurious stands of timber grow on the rich deep soil of the gently sloping mountains of Babelthuap. I found neither of these bird species there although a careful search was made. On the smaller islets adjacent to Babelthuap, such as Koror, the forest grows on knife-edged steep ridges which are rocky, are practically without soil, and are dissected by fissures, potholes, narrow ravines and caves. A little soil and leaf mold collects on the tops of flat boulders and in the bottoms of the ravines, thus providing the sole niche for foraging by megapodes and ground doves. Incubator birds are abundant in this kind of forest, scratching in the leaf litter on the ground for their food of small fruits and snails. Their ease of locomotion on the rocks is uncanny. In the gloom under the forest canopy, a bird walking in a horizontal direction, say along the jagged wall of a ravine, appears to progress rapidly, steadily and gracefully as if a smooth trail had been hewn from the rock for his accommodation. Judging from tracks, they go under and among boulders. The principal sign of their activity is the kicked-up soil and leaf litter found on every flat bench or ravine bottom. They roam singly or in small groups, but the chicks appear to be solitary and independent. Both adults and chicks fly rapidly and perch quietly in trees when flushed. Two kinds of loud call-notes are uttered by this species, either separately by the same individual or as a duet. One bird

gives six staccato notes on the same pitch (*cuk-cuk-cuk-cuk-cuk-cuk*) while the other chimes in with three long cries, each with a downward inflection and lower in pitch than the preceding (*keer, keer, keer*).

The Banded Rail (*Rallus philippensis*) is abundant on Palau in savannah vegetatation, around the edges of mangrove lagoons and in grassland of abandoned farms, where it feeds on green vegetation and snails. In the evening, dozens of birds can be heard as they call with a piercing *kreek, kreek, kreek*. I have never seen this bird fly. It forages on the ground, walking and moving the head back and forth with each step. When surprised, it scoots along rapidly with the head hunched down.

The Guam Rail (*Rallus owstoni*) is found in grass and ferns on damp ground on the edges of clearings in the woodland on Guam. Downy young utter a single light *"tsip"* note which sounds like the call of the Orange-crowned Warbler in California. The only food item I have noted is a kind of leathery land slug.

Fig. 38. Marianas Mallard, a sick individual in a fresh-water lake on Tinian Island.

The Gallinule (*Gallinula chloropus*) is abundant in the fresh-water marshes on Saipan, Tinian and Guam. One was picked up dead on Palau. They feed in the water by swimming and sticking the head under the surface to grasp green vegetation, or they pick seeds and insects from the ground as they walk through the cane, with tail up and flashing the white feathers constantly. I did not visit the fresh- and brackish-water marshes on Palau and so failed to find these birds alive there. Rollin H. Baker (Smithsonian Misc. Coll. 107, no. 15, 1948:49) provides evidence that they breed on this island group.

A Palau resident which I happened not to find is the Purple Swamphen, *Porphyrio porphyrio,* included here for the sake of completeness. Baker (*loc. cit.*) has recorded it and reliable observers at Peliliu noted it during my stay there.

Fruit doves of the genus *Ptilinopus* are exceedingly abundant, strictly arboreal inhabitants of the woodland environment on Saipan, Tinian, Guam and Palau. They usually feed in the upper parts of the trees and procure their food of fruit, berries, small figs and flowers by walking along horizontal twigs and reaching up and to the side to pick fruit. Each time a fruit is plucked, the foliage shakes a little, and this is practically the only indication of the presence of the doves. They are almost invisible in the trees by virtue of their light green coloration. Their short fleshy tarsi appear to equip them admirably for locomotion along horizontal twigs and branches. The birds generally alight perching crosswise on a twig, then turn and move off along it. They can turn entirely

around with singular grace and economy of motion and move in the opposite direction. They have two equally baffling tricks to avoid detection when first entering a tree. Either they freeze for 15 minutes upon alighting, which amounts to vanishing because of their concealing coloration, or they alight and repair, in the same continuity of motion, to further concealment in the foliage, then freeze.

When a group has once started feeding in a very tall tree the birds are no longer wary. In lower trees they leave silently out the back side of the tree as the observer approaches. They fly at great speed and very straight, always at tree-top level. There appears to be no particular flocking tendency but because of the great numbers of individuals, any food tree, especially those on Palau whose spreading crowns project high above the general forest level, will have up to a dozen birds in it.

Fig. 39. View of part of largest area of undisturbed forest (right center) on Tinian Island.

On Palau the fruit doves share this particular forage niche with the Micronesian Pigeon, but the two species tackle the food problem in different ways. The former work from within, the latter from the periphery of the tree. Groups of the two species often feed in the same tree, but they pay no attention to each other. Fruit doves frequent not only the woodland but also, on Saipan, the *Casuarina* trees at the shore of Lake Susupe, and on Palau, the larger trees in the mangrove lagoons. Birds ply back and forth constantly between woodland and lagoon.

In the foregoing discussion I have combined information on the Marianas Fruit Dove (*Ptilinopus roseicapilla*) of Saipan, Tinian and Guam and the Crimson-crowned Fruit Dove (*Ptilinopus porphyraceus pelewensis*) of Palau because I think they are practically identical in ecology and behavior. The only difference in behavior discerned is in their songs, which differ in tempo and inflection although not in quality. In *roseicapilla* the sequence of mellow "coo's," all beginning on the same pitch, starts with two or three long notes, definitely separated from each other, each inflected upward in the middle. This inflection imparts to the opening notes a particularly "demanding" or

"insistent" character. They are followed by a rolling series of notes becoming faster, then slower toward the end, followed by three or four longer notes with rising inflection. This song, heard all day long, can be represented thus (commas indicate pauses): *cooo, cooo, cooo, cu-cucucucu-cu-cu coo coo coo.* On the other hand, all the notes in the song of *pelewensis* have a downward inflection, are distinct and separate from each other, with hesitations in the first part of the song and a descent in pitch in the last part (an asterisk denotes a hesitation): *coo, coo,* coo-cu,* coo, coo-cu,* coo* (now an even descent in pitch) *cu, cu, cu, cu, cu.* This song, on Koror in the Palau group, is heard all day and all night. I would guess that nocturnal singing is not spontaneous but is provoked by outside agencies, namely imitated calls by myself or the opening notes of the song of the Palau Owl, which are of similar pitch and quality to those of the dove. This provocation is always forthcoming from the owls, which abound in the same habitat occupied by the doves. The fruit dove can then be regarded as being irresistibly impelled to answer notes similar to its own. One dove will answer the first owl, then the whole island is in an uproar. Each dove gives only one sequence, then is silent until a new outbreak is initiated.

The Micronesian Pigeon (*Ducula oceanica*) is also strictly arboreal and is abundant in woodland on Palau. Unlike the Crimson-crowned Fruit Dove and the fruit bat (*Pteropus mariannus*) it does not forage both in the woodland and mangrove lagoons. It eats much larger fruit than does *Ptilinopus* although small berries are also taken. Each fruit is swallowed whole; the pits, 23 mm. in diameter, are to be found in the stomach and intestine. These birds commonly gobble fruit while they cling to little twigs on the periphery of the tree, often hanging upside down; or by fluttering the wings they maintain the body in a vertical position. They are evenly distributed through the forest and were not flocking in November and December. They prefer to sing from the tops of ridges; therefore there is usually a great concentration of birds along the forested crests. Adults are wary and call from concealment in the higher parts of the trees, whereas the young birds, lacking the knob on the bill, are tame and are more frequently collected. The song, resembling the barking of sea-lions, is a rasping, deep-throated *arrooo, arrooo, arooo, aroo, aroo,* consisting of three to seven notes each lower in pitch, shorter and of less intensity than the preceding. At close range a superimposed tone of rising inflection can be heard accompanying each bark; it is a high-pitched rasp similar to the song of a tree frog (*Hyla*) and can be represented as *kreek, kreek.* Another song heard less frequently is a series of mellow hoots all on the same pitch and in tempo identical with the barking song.

The White-throated Dove (*Gallicolumba xanthonura*) is strictly arboreal and is abundant on Saipan, Tinian and Guam, although less numerous than *Ptilinopus.* One's first introduction to this species is the sight of lone males flying for long distances high over valleys and ridges with a peculiar labored effort, very slow in spite of the vigorous deep strokes of the wings. The body is inclined upward from the horizontal, and the whole performance gives the impression of a bird fighting a tremendous head-wind. This dove feeds on fruits, seeds and berries which it swallows whole, although at times it picks at the pulp and seeds of papaya. Its habitat is woodland, where it forages in the higher parts of tall trees, often in the company of *Ptilinopus.* They are frequently found in fresh-water marshes, where they perch, apparently to sun themselves, on the fronds of the fern-like plant which grows there. They appear not to feed in this environment, however. At dawn a chorus of hooting is heard, in which all the adult males take part. This song is a low moan, *ooooo,* uttered at intervals of 10 to 20 seconds. It is heard much less frequently during the rest of the day. Pairs are found as a rule, but the females

usually remain concealed in the foliage whereas the males take up conspicuous positions. The mating performance usually takes place on bare, horizontal limbs of tall trees. The female alights on the limb and begins to walk along it toward concealment in the leafy part of the tree. The male then flies to the same branch and utters as he alights a long snarl which can be represented as *crrrrreeeeeek*. He walks rapidly after the female and follows her leaps from one branch to another whereupon she escapes to another tree and the performance may begin again.

Like the Incubator Bird, the tiny solitary Palau Ground Dove (*Gallicolumba canifrons*) inhabits only woodland growing on rocky ridges. It was commonly found in this situation on Peliliu and Koror in the Palau group. This elegant bird forages only on the ground for its food of hard berry pits which are ground up in its stomach. It prefers the few available accumulations of soil and leaf mold on saddles between ridges, on flat rocks or in the bottoms of ravines, although it occasionally walks among the jagged boulders, where, like the Incubator Bird, it proceeds as smoothly as if walking along a paved road. When startled, it leaps from the ground with an audible clap of the wings, flies very swiftly for a short distance, alights and retires behind a tree-trunk for a few minutes, then continues feeding. It walks swiftly and gracefully, here and there picking up seeds from the ground. The head moves back and forth with each step, and the legs twinkle with their rapidity of progression. Each male has a fixed song-perch about ten feet above ground on a horizontal twig screened by vines, where it can be found daily. On Peliliu two adjacent males sang from perches only 30 yards apart. The song is not the moan of *G. xanthonura,* but is a series of seven or eight gentle coo's, each with an upward "questioning" inflection, and very soft. This charming dove fascinated me more than any other Micronesian bird. Its graceful movements, soft plumage colors and the splendor of its brilliant pink feet and eye-ring made each glimpse of it a thrill.

Of the strictly land-dwelling birds the Nicobar Pigeon (*Caloenas nicobarica*) of Palau is the only one for which I do not have series of specimens from each island of occurrence. I saw only two individuals during my stay on Palau from November 1 to December 6, 1945. One was seen in flight over Bloody-nose Ridge, Peliliu; the other was flushed from the ground on the top of the forested ridge on Koror.

In the Palau group of islands the Palau Owl (*Pyrroglaux podargina*) occurs in pairs spaced at 100-yard intervals through the woodland and portions of the mangrove lagoons adjacent to it. I observed 33 pairs on Koror, representing about half the total population there, and four pairs in a patch of natural woodland remaining on Peliliu. Although no defense of territory or trespassing across supposed territorial boundaries was noted, I think that the species is territorial because each pair stays within a limited area all night long (they spend hours in the same group of trees), there are seldom more than two birds in such an area, and the males advertise their presence at a high perch in the center of this area by incessant loud singing during the first few hours of the evening and by sporadic singing through the rest of the night. Most of my observations on this species were conducted at the northwest end of the steep forested ridge on Koror. This portion of the ridge is about 200 feet high and is surrounded by mangrove swamps to the north and west. Each owl territory on the north side comprises a strip about 100 yards wide extending from the summit to a point about 100 yards out into the lagoon. Other territories exist farther out in the mangrove lagoon and are occupied by pairs which appear to be permanently stationed, judging from the fact that some are heard there soon after sunset, long before any owls begin to fly from their roosting trees. Only a few pairs begin to sing this early, but the same ones do it every evening, at the same time and from the same tree, where presumably they have been roosting during the day. The

majority of the birds begin to call as it is getting dark. They frequent the middle and upper parts of the woodland trees and the tall trees in the lagoon. Food consists of large orthopterans and centipedes.

The voice of the Palau Owl does not remotely resemble that of the screech owls and scops owls of North America; it is identical in pitch, quality and delivery (but not tempo) with the note of the Ferruginous Pygmy Owl of Central America. Each note is a sharp whistled *quirt*. Singing involves a duet by the members of the pair and a flight on the part of the male. This apparent mating performance lasts three minutes and is repeated at fifteen minute intervals during the early evening. While the female is perched silently in a tree 25 to 50 yards away, the male begins to call with low mellow notes which rapidly rise in pitch and intensity of the *quirt* call, repeated at two-second intervals, and carried along at the same pitch for about a minute. As the intensity, tempo and "insistence" of these notes is increased, the intervals become irregular and double notes are frequent. At the end of the second minute he changes to double notes, the second part of each being a minor third lower than the first, and at this point the female begins to call. These double notes, representing the climax in intensity of the song, are uttered every second and the series lasts for a half minute or more, at which point the male, without interruption in the song, flies toward the female. From the moment he takes wing the notes are again single and they rapidly subside in pitch and volume, then cease. The female may or may not join in this flight. If she does, both birds go to a new tree. In any event, the male next calls from near the spot at which the last notes of the flight song were heard.

The song of the female is lower in pitch and mellower than the harsh cries of the male and is condensed in time so that while the male is in flight, both songs correspond. I have noted a somewhat similar duet in the Screech Owl of California, but in that species the male is stationary, the female joins him at the conclusion of his "bouncing ball" song, then they both give the series of double trills.

The skull of the Palau Owl bears fundamental resemblances to those of North American species of the genus *Otus,* although it differs in proportions and in several details which might prove to be important in generic classification if enough species of *Otus* were represented by skeletons to permit a thorough comparison of the two genera. Otherwise, the Palau Owl seems very unlike North American *Otus*. It lacks "ear" tufts, has a white bill, light gray cere and whitish feet (pale gray above and cream color below). The iris is brown.

The Jungle Nightjar (*Caprimulgus indicus*) is a common nocturnal bird of the woodlands and adjacent mangrove lagoons on Palau. They are first seen as darkness approaches and forage in the early evening on June beetles, grasshoppers and other large insects. As in other caprimulgids, the first specimens taken at dusk are already crammed with food, recently captured and undigested. One such stomach contained ten beetles, each two centimeters long. They take insects on the wing, either during continuous swift erratic flight about the periphery of the forest trees and the large trees in the mangrove swamp, or by making repeated sallies from a bare twig which commands an unobstructed view for 50 yards or more horizontally within or at the edge of the forest. Such fixed forage perches can be either at the top of a tree, on a dead projecting branch at middle height, or from a stake a foot from the ground. The bird returns to this perch after the capture of each insect, which may take it out 30 yards or more. I have never seen them on the ground.

The legend that *Caprimulgus* and its relatives invariably perch lengthwise on horizontal branches doubtless stems from the fact that when sleeping during the day and

when dozing late at night (while digesting the food that they succeed in procuring during a very short and efficient forage period in the evening), they *do* recline in this manner. Such quiescent birds are difficult to detect by eye reflection because their eyes are closed or open just a trifle. It is my experience with the Jungle Nightjar as well as with the Poor-will, Whippoorwill and Chuck-will's-widow of North America that the birds perch crosswise on small twigs or at the tip of vertical stems while engaged in insect foraging from a fixed perch in vegetation.

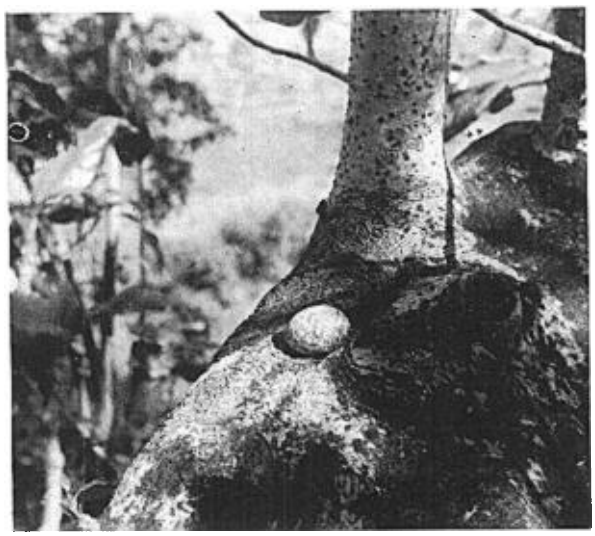

Fig. 40. Egg of the Fairy Tern (*Gygis alba*) placed on a thick branch of a breadfruit tree 20 feet above the ground.

The Jungle Nightjar is solitary while foraging, but groups up to a half dozen sometimes engage in community singing at dusk in the tops of some of the largest trees, and two or more may frequently be seen chasing each other through the forest. During November and part of December the birds were erratic in their distribution, covered very extensive areas in foraging, and were not found in the same places on successive evenings. A call, given in flight, especially when birds are chasing each other, is a rasping snore of one syllable. The song uttered by a single perched bird is a long succession of harsh percussive whistles, each with a downward inflection, two or three per second. In group singing this song is mellower and is speeded up into a roll which is uninterrupted for minutes at a time. These hammerings, together with the notes of the Palau Owl and Crimson-crowned Fruit Dove, the incessant snarling and bickering of fruit bats, the "stomach rumblings" uttered by gecko lizards, the rasping of the Common Noddy (in flight along the crest of the ridge all night long) and the piping of tree frogs, make up the pandemonium of nocturnal sounds to be heard on Koror ridge.

The Edible Nest Swiftlet (*Collocalia inexpectata*) is abundant on Saipan, Guam and Palau, but is not continuously present on Tinian. Large flocks of these tiny birds forage during the day over ridges and along the steep sides of canyons where there is little vegetation. They avoid the dense forest. Smaller flocks of about a dozen birds spend all day foraging within a circumscribed area, for instance a bare hillside, a road bank, or the circumference of a large tree standing in the open. They are also found in pairs in similar situations, apparently at any time of year. Pairs and small flocks are found daily

at the same spot. The members of a pair spend hours foraging in a fixed circuit only 25 to 30 yards in diameter and execute the same maneuvers each time around, staying within one to five yards of the ground. During the day they take no part in the activities of large flocks which may be directly overhead. Sometimes they chase each other and utter slight chirps and twitterings. The flight is very slow, consisting of smooth glides interspersed with flutterings to regain altitude. The pitch of the wings is changed constantly during the glide; in another characteristic mannerism the bird rolls sharply at the end of a flutter so that for an instant one wing is pointing up, the other straight down. The food consists of a variety of tiny arthropods, gathered, of course, in flight.

At dusk all the swiftlets from a large area congregate at one place. For instance, at the northeast end of the ridge on Koror the swiftlets begin to gather each evening along a road between the woodland and the mangrove swamp, augmenting the number represented by the local groups and pairs there, until several hundred are present. They all continue foraging close to the ground, even after the sheath-tailed bats (*Emballonura*) are out (the two species operate together in very similar style), then they begin to ascend as they mill around in a loose cloud. By the time it is dark, the cloud of swiftlets has disappeared over the top of the ridge.

An indication either of seasonal cycles of activity or of nomadism on the part of the large flocks of swiftlets is the fact that on Saipan the evening congregations are found only for a few consecutive weeks at any one part of the island. On Tinian there was a flock at Marpo Valley during the first half of October, 1945. By the twentieth, there were only four birds, and from October 22 until at least the middle of November there was not a single swiftlet on the entire island. Geographic variation is exhibited in this species. Twenty-five specimens of the race *bartschi* from Saipan, Tinian and Guam are of uniform dorsal coloration and possess a wing-length average of 107.6 mm., whereas the six examples of the Palau race, *pelewensis,* have a light rump patch, are grayer, less brown ventrally, blacker and glossy above, and average 110.9 mm. in wing-length, all exceeding the average for *bartschi.*

On Guam the Micronesian Kingfisher (*Halcyon cinnamomina*) is abundant in woodlands, although it is rarely seen or heard unless looked for. Almost invariably a pair can be found if one goes to the largest tree in the vicinity and looks among the bare horizontal branches on the underside of the crown canopy which command a view of the ground beneath. The birds will be sitting there perfectly still. They harry unmercifully the flocks of Bridled White-eyes, which set up a confusion chorus at each appearance of a kingfisher. Stomachs contained only small and large insects, a large annelid and fish scales, and I have never witnessed the actual capture of a white-eye. A nest was found in a hole 20 feet up in a tree trunk. On Palau this bird is still more secretive. Most of the few pairs that I saw there were encountered face-to-face as I groped along trails or clambered about the rocks in the woodland trying to retrieve specimens. They do not fly until one attempts to grab them. They perch silently and absolutely motionless on horizontal vine stems a yard or two from the ground. Stomachs contained large cicadas and large grasshoppers swallowed whole.

The White-collared Kingfisher (*Halcyon chloris*) is the most conspicuous bird to be seen and heard on Saipan and Tinian, and it also is abundant on Palau. It prefers the shoreline vegetation for its foraging. Usually it perches on a prominant branch or at the top of a *Casuarina* tree, from which it glides swiftly to the ground to capture its prey of large insects (grasshoppers, beetles, wasps), spiders, crabs, lizards and house mice. Smaller insects are occasionally taken. The prey is swallowed whole, and if it is large, such as a lizard, the tail sticks out of the kingfisher's mouth. I saw one killing a mouse

by whacking the skull repeatedly with its bill. At dusk this kingfisher feeds like a motmot, making rapid flights from a fixed perch to hover and catch insects about the peripheral foliage of low trees.

On Saipan and Tinian the White-collared Kingfisher is an unrelenting assailant of the Bridled White-eye, although I have never seen one make a successful capture. It flies at great speed into a tree, scattering white-eyes like leaves before the wind, then perches and sits very still for a long time, before making another foray. An occupied nest was found in a road bank on Saipan in August. It was a tunnel, three inches in diameter, burrowed out of the earth, which slanted upward slightly and opened into a larger cavity.

White-collared Kingfishers are frequently found sleeping at night on horizontal twigs or vine stems situated on the underside of the crown of the larger woodland trees. This species is found usually in pairs, but often three to five will gather to fly in large circles at a great height, keeping up a veritable din of call notes, then parting to fly in opposite directions high over the canyons and ridges. In fighting, they endeavor to grasp bills and wrest each other from their perch. The loser hangs, shrieking and fluttering,

Table 1

Geographic Variation in the Genus *Halcyon*

	Halcyon cinnamomina		*Halcyon chloris*	
Race	*cinnamomina*	*pelewensis*	*albicilla*	*teraokai*
endemic on	Guam	Palau	Saipan, Tinian	Palau
habitat	woodland (secretive)	woodland (secretive)	beach forest, coastal shrubbery (conspicuous)	beach forest, edge of mangrove swamps (conspicuous)
call notes	crrreeee; haw-hée, haw-hée (usually silent)	clip-a clip-a clip-a; crrreeee, crrreeee, crrreeee (usually silent)	clip-clip-clip, clip-clip-clip; haw-hée, haw-hée, haw-hée (vociferous)	crrreeee; clip-clip, clip-clip, clip-clip (less vociferous)
back color ♂	bluish-green	bluish-green	bluish-green	bluish-green
ventral color ♂	cinnamon	white	white	narrow black tips on white ventral feathers
crown ♂	cinnamon	cinnamon	white	bluish-green
collar ♂	cinnamon	white	white	white
♀ differs from ♂ in:	back dusky olive-green, belly white	back and several streaks on crown, dusky olive-green	back and rarely one or two streaks on crown, dusky olive-green	back and crown dusky olive-green
juvenile differs from adult ♂ in:	cinnamon edges on wing coverts, narrow diffuse black tips on collar and chest, crown heavily streaked with dusky green edged with cinnamon; belly: ♂ light cinnamon, ♀ cream	same	white edges on wing coverts, narrow black tips on white chest feathers, crown heavily streaked with dusky-green edged with buff	same
average measurements				
wing	100 (7 adults)	89 (3 adults)	111 (25 adults)	109 (7 adults)
tail	75	68	80	72
tarsus	16.4	13.7	16.9	15.3
bill (from nostril)	37.5	39.1	46.1	45.7
bill depth	12.6	11.6	14.4	13.7

from the other's bill. A peculiar posturing display seen on Saipan begins with a bird uttering loud calls as it approaches a tree where another is sitting. As it alights, it assumes a rigid posture with the back vertical, the tail up at a 90 degree angle to the back, and the head and neck extended at an equal angle forward. This position is held for several minutes, even after both birds stop calling.

The marked geographic variation exhibited in the genus *Halcyon* from these islands is summarized in table 1. Each of the four forms (two races for each of the two species) uses only two of the three available kinds of call notes and modifies them somewhat in tempo and quality. The juvenal plumage of one race may suggest the adult plumage of another. The two species do not approach each other in wing and bill length. The races of *cinnamomina* show no overlap in wing, tail and tarsus, and the forms of *chloris* do not overlap in the tail dimensions.

In appearance and forage behavior the Cicada Bird (*Edolisoma tenuirostre*) of Palau resembles a solitaire. Family groups are found in November; they are always on the move, not found daily in the same area, and the individuals stay close together, often in the same bush. They forage at the edge of the woodland, catching insects on the wing by straight flights from a high perch, or they eat berries, other vegetable matter and insects as they hop in the small twigs. They are not common; generally only one group is found in a day's search. The call is a soft mellow whistle with upward inflection like the call of the Swainson Thrush. When chasing each other the birds utter a series of these followed by whistles of downward inflection and a twanging quality. The adult plumage in this species is not attained by the postjuvenal molt, at least one additional molt being required to produce the slate blue of the male and the dark head and back of the female.

The song of the Palau Warbler (*Psamathia annae*) is heard continuously during the day from the vine tangles within woodlands on the islets of the Palau group. It resembles the song of the Varied Thrush, that is, each long whistle is uttered at a different pitch and the higher ones are of two simultaneous tones. They lack the vibrant trill of the high notes of the thrush and differ also in that each tone swells gradually then diminishes in volume, thus enhancing its eerie effect. The notes are remarkably full and penetrating in quality, although not loud. From the higher tones the bird may slur upward then give a warbled phrase of five notes (used as a call note by the female) which may be repeated rapidly or in the early morning may be extended into a lengthy song. Ratchety wren-like calls are also uttered. This species is very abundant, but the individuals are spaced separately or in pairs at regular intervals through the woodland. Singing and foraging take place within the concealment of vine tangles, either high in the trees or close to the ground. A male will spend hours in the same vines, alternately singing and foraging. Food of large or small insects and snails is picked from the vines as the bird hops in leisurely fashion through this growth. I have not found them actually on the ground.

The song and call note of the Nightingale Reed Warbler (*Acrocephalus luscinia*), of Saipan and Guam, are identical with those of the California Thrasher, making allowances for the smaller body size and consequent lesser volume of the song in the Marianas bird. The body proportions and bill are also similar to those of the thrasher, as well as the habit of mounting to a tree top to sing in the evening. All the males sing in a chorus at dawn but singing is less frequent during the day. If one bird begins, the others join in. They sing constantly throughout moonlit nights. Midday singing is from concealment in the cane. This species gathers its prey of lizards, snails, spiders and large insects from the ground. Its distribution on Saipan is most peculiar. There is a large dense population in the marsh lands surrounding Lake Susupe, where the birds prefer

dense vegetation, avoiding only the trules growing in the water. It is absent from extensive marshes elsewhere on the island, except for a few pairs at Tanapag Harbor. There are four other small colonies at widely separated points, differing greatly in habitat. One is in tall grass in moist gullies at the top of the mountains in the center of the island, another in dense low forest on rocky ground on the shore of Magicienne Bay, another at the edge of woodland in the central eastern part of the island, and the last, also on the east side, a mile south of the previous, inhabits vegetation along a stream which flows through a wooded canyon. This is the only Saipan bird which is not found uniformly throughout a given kind of environment.

The Rufous-fronted Fantail (*Rhipidura rufifrons*) is abundant in the woodland understory vegetation on Saipan, Tinian and Guam. It feeds on small insects caught on the wing or picked from the surface of tree trunks, branches and foliage. In either case the food is taken while the bird progresses swiftly forward, by zig-zag darting flights or rapid hopping. It does not return to a fixed perch after capturing each insect. Flights are usually in a horizontal plane, and several insects are taken before the bird again alights. Because of the small size of the bird, it can dart rapidly through dense growth with amazing agility. The body is maintained in a horizontal position and the tail is kept spread during this activity. Also the wings are never tightly folded. These birds forage singly and are often hostile to each other. Because of their great numbers they are constantly meeting and do much chasing, calling and singing, all of which suggests a marked territoriality. They indulge in a dawn chorus of singing. The delightful song consists of a descending cascade of thin piping notes, often preceded by the longer high-pitched notes used separately as sequestration calls. Thus the song resembles that of the Golden-crowned Kinglet, but being at somewhat lower pitch, is tinkling in quality rather than squeaky.

A geographic representative of the Rufous-fronted Fantail is found on Palau (*Rhipidura lepida*). Like the former species it is found in the understory vegetation of the woodland habitat and forages in the same way on small insects, but because of its much larger size it appears to lack the nimbleness of *rufifrons*. It occasionally feeds, half flying and half hopping, on rocks and along fallen tree-trunks. Its voice is entirely different from that of *rufifrons*, and I heard no singing from the birds during November and December. The call notes are lower in pitch and consist of loud harsh scolding notes as well as a succession of syllables on the same pitch, each with a downward inflection. A display was noted in this species, which appears to be lacking in the Marianas bird. The tail is fully spread and cocked up over the back while the bird parades in front of his perched companion. In foraging the tail is closed, in contrast to the medium spread at all times maintained by *rufifrons*.

The following remarks on variation in the geographically complementary forms of the genus *Rhipidura* from these islands is based upon my series of 31 specimens of *Rhipidura rufifrons saipanensis* from Saipan (12) and Tinian (19), 15 *Rhipidura rufifrons uraniae* from Guam, and 12 *Rhipidura lepida* from Palau. The wing, tail, tarsus and bill from nostril are longer in males than in females. There is no statistically significant difference in these dimensions among the Saipan, Tinian and Guam populations. Setting the measurements of *rufifrons* at 100 per cent, we find that *lepida* exceeds it by 15 per cent in wing, 14 per cent in tail length, 32 per cent for the tarsus and 35 per cent for the bill length. There is no overlap between the two species in these characters. In coloration the Saipan and Tinian populations are identical. Geographic variation in color is summarized in table 2.

The juvenal plumage of the two species is practically identical, and dorsally it is

intermediate between the two adult plumages. The feathers of the dorsal surface are brown with narrow rufous tips on the body feathers and wide rufous margins on the wing coverts. The major difference is the tail tip, which is white in *rufifrons,* rufous in *lepida.* When the rufous tips wear off of the body feathers and the black throat patch begins to appear (the postjuvenal molt begins on the forehead, chin and throat) juvenal *rufifrons* are indistinguishable in the field from the adults, whereas in *lepida* they are different from the adults and look more like *rufifrons.*

Table 2
Geographic Variation in Adult Plumage of the Genus *Rhipidura*

	saipanensis	*uraniae*	*lepida*
dorsal color	brown; forehead, superciliary and rump rufous	same, but back possibly more olive	rufous
extent of white on chin	wide	very narrow	wide
white-tipped feathers on posterior part of black throat	wide zone	narrow zone	none (all black)
light chest spot	none	buffy white	white
belly and flanks	buffy medially, grading to rufous laterally	buffy medially, grading through cinnamon to olive-brown	concolor, rufous
tip of tail	white	white	rufous

The Tinian Monarch (*Monarcha takatsukasae*), endemic on Tinian, is present in about equal numbers with *Rhipidura* in woodland, but it reaches the peak of its abundance in a kind of arborescent marsh vegetation found in Marpo Valley. *Rhipidura* is absent from this growth. *Monarcha* is a phlegmatic bird compared with the fantail; it moves slowly through the foliage, occasionally flying after insects and hovering at the peripheral foliage of the tree. The food is entirely composed of small insects. The most frequent type of foraging consists of repeated flights from an exposed perch in the understory of the woodland, where the bird sits erect, inspecting the air for passing insects. They occur in pairs, and their harsh wren-like calls are uttered when they chase each other. The song, heard especially in the evening, is remarkable for its clarity and purity of tone. It consists of three notes: two grace notes followed by a beautiful *wheeeooo* of descending inflection.

Age variation in color of bill, but not in plumage, is revealed by the 35 specimens. The bill of the youngest birds, with skulls entirely of one layer, is black on the upper mandible and tip of the lower mandible and yellow on the rest of the lower mandible. A female with a black and yellow bill was photographed by Genelly as it brooded its eggs. None of the specimens with this kind of bill was in breeding condition, however. After a period during which the supposed juvenal plumage may become somewhat abraded, the bill gradually becomes blue, beginning at the base of the upper mandible, at which time the base of the lower mandible is olive. The skull at this stage has "windows." The bill then becomes blue except for a small black line near the tip of the upper mandible. The males (three examples) still have small skull windows at this stage, have reached full breeding condition, and are again in fresh plumage. Later the skull is completed and the bill is entirely blue. Females retain the black tip for a while after the skull is completed; two of three such specimens are in breeding condition, one with a brood patch.

Micronesian Broadbills (*Myiagra oceanica*), found in pairs on Guam and Palau,

relentlessly chase other birds, especially kingfishers, out of their small territories. The song is a series of seven clear whistles, inflected slightly by the Guam birds. Scolding call notes are also uttered. On Guam they are found in woodland, and on Palau they are very abundant both in the woodland and the mangrove lagoons. They sit upright on an exposed perch in the middle or lower parts of trees and dart rapidly after flying insects,

Table 3
Geographic Variation in *Myiagra oceanica*

	freycineti		*erythrops*	
	male	female	male	female
Dorsal coloration				
forehead	concolor with head	concolor with head	orange	orange
head and neck	dark shiny steel-blue	dark dull blue, not shiny	light blue-gray, not shiny	light dull blue-gray, not shiny
back, wings and tail	blue	dark brownish-gray, orange edges on coverts and inner secondaries	brownish-gray, a few brown edges on wing coverts and inner secondaries	brownish-gray, brown edges on wing coverts and inner secondaries
Ventral coloration				
extent of white	chin, under tail coverts and most of underparts usually white	median posterior region	half or none of underparts; under tail coverts usually orange	median posterior region more salmon
tone of orange	yellower, more golden		pinker, more salmon	

returning to the same perch and quivering the tail after each capture. They also take insects from the foliage as they hop among the higher twigs. This species is a powerful flyer, seen to advantage as it streaks over the water from one mangrove to another. The male is larger than the female, and the two races (*freycineti* of Guam, 10 specimens; *erythrops* of Palau, 8 specimens) differ greatly in tail length, width of bill and coloration. They do not overlap or approach each other in these characters. Average measurements of six Guam and five Palau adult males are, respectively, wing 70, 69; tail 59, 53; tarsus 19.9, 20.1; bill from nostril 8.7, 8.9; bill width at nostril 6.5, 7.3 mm. The extra width of the bill in the Palau race is made up lateral to the nostril, so that the nostrils of the two forms are the same distance apart. There is great individual variation among the males in the extent of the orange areas and in the amount of white tips to the orange feathers. The females lack the white tips and do not vary. Table 3 summarizes the outstanding points of dissimilarity in color between the two races, from which it can be seen that there is a more noticeable sexual dimorphism in *freycineti* than in *erythrops*.

The Morning Bird (*Colluricincla tenebrosa*) inhabits the dark woodlands of Palau, where it forages at middle tree height on insects, berries, fruit and snails by hopping through the branches and vines in the manner of a jay. It is common but not evenly dispersed. Groups of two to eight individuals roam through the woods, each bird staying within hearing distance of its companions. In behavior they resemble the Gray Jay; that is, they have no fixed postures or stereotyped forage method, rather they peer about, apparently keeping track of everything that goes on, and are ready to utilize any food source. They are inquisitive to an astounding degree. They used to gather around me to sit quietly and stare from a distance of only two or three feet with their bills wide open. They have a great variety of conversational notes and a wide vocal range difficult to characterize except for quality, which is decidedly "tinny." The song has the quality and structure of the Black-headed Grosbeak's song, but is more rushed and of shorter

duration. An impressive pre-dawn chorus is a further unforgettable attribute of this remarkable species.

The Micronesian Starling (*Aplonis opacus*) frequents the woodlands of Saipan, Tinian and Palau in roaming flocks of a dozen to fifty birds, but on Guam they drift through the timber in great loosely organized hordes. Sometimes the juveniles are found in flocks by themselves. Food consists mostly of fruit, but seeds and insects are also eaten. Foraging takes place at varying heights in the trees. They congregate in bare branches of trees and are particularly numerous around cliffs, where, on Saipan, they nest in potholes in the rock. Long flights, high overhead, are frequent. The song consists of gurgling and bubbling notes with whistles interspersed. There are many conversational variations in the loud calls. The measurements of 33 specimens of the race *guami* from Saipan, Tinian and Guam agree with the findings of Baker (*op. cit.*: 70) that the Saipan and Tinian birds have a slightly longer wing and deeper bill than those from Guam. I have only six specimens of the race *orii* from Palau, but their bills are decidedly less deep than *guami,* with no overlap. In coloration, the two races are identical. In adult plumage, the feathers of the male have larger glossy areas than do those of the females. There is considerable individual variation in the juvenal plumage, the ventral ground color of which varies from white to dark brown.

The Guam Crow (*Corvus kubaryi*) inhabits, under natural conditions at least, the deepest forests on Guam. Foraging takes place on the ground beneath the dense woodland canopy, where the birds are secretive and noiseless. Stomachs of five specimens contained grasshoppers and other insects, lizards, buds, flowers and other vegetable matter. Crows are found in two's or small groups but the individuals do not forage close together. Their "caw" has conversational variations.

The beautiful Golden Honey-eater (*Cleptornis marchei*) is numerous in the understory of the Saipan woodlands; it is the only species on that island which cannot be found in the Lake Susupe marshes. Its large eye appears to be an adaptation for life in the shade. In spite of its long legs, and thrush-like build, it does not feed on the ground. It eats mostly berries with hard pits, which are swallowed whole; it also takes seeds, insects and spiders, the latter being captured as it flits rapidly from twig to twig. When perched, it stands high, with the body nearly horizontal and flicks the wings like a Hermit Thrush. Although not strictly a flocking species, there are usually three or four birds in the same group of trees, and they chase each other, uttering strident wren-like notes during their swift flight. They also have a twanging call similar to that of the Varied Thrush. I have frequently seen congregations of ten or a dozen birds, all clamoring loudly, and have never been able to find a reason for the commotion. The food call of the juvenile is a plaintive mellow whistle. This species appears not to sing at all.

The Cardinal Honey-eater (*Myzomela cardinalis*) is common in woodland on all the islands visited. I have little to add to Mayr's account (Birds of the Southwest Pacific, 1945:100-102) of this bird except that the male appears to be strongly aggressive, chasing other species, especially white-eyes, away from his flowering trees. Pairs seem to have a fixed foraging circuit which includes widely separated, selected trees, and around which the male is preceded by the female. Snails are sometimes eaten. The "song" is just a loud wheezy whistle. The two races (*saffordi,* 18 specimens from the Marianas; *kobayashii,* 8 specimens from Palau) differ in the hue of red color (shown in juveniles and adults of both sexes). *Saffordi* is orange-red whereas *kobayashii* is a deep pure scarlet. The ground color of the adult female is, respectively, olive-brown and dusky-brown. The calls of *kobayashii* are lower in pitch than those of *saffordi* and are easily confused with notes uttered by *Aplonis.*

The Bridled White-eye (*Zosterops conspicillata*) is a non-territorial species which is found in flocks of a dozen to 50 individuals at all months of the year, even when some pairs are nesting. They feed among the small twigs in all kinds of habitat, showing a marked preference for trees and bushes which have small leaves or leaflets. Each flock makes the rounds of a fixed forage circuit. On Palau, one such circuit included the edge

Table 4

Number of Specimens Exhibiting Certain Colors of Soft Parts in *Zosterops conspicillata*

	Iris			Base of Lower Mandible		Upper Mandible		Feet	
Population	brown	light gray	white	gray	yellow	blackish	olive	bluish-gray	olive
Saipan									
ad (11)	10	1		11		11		11	
im (15)	9	6		15		15		15	
Tinian									
ad (21)	21			21		21		21	
im (21)	21			13		21		21	
Guam									
ad (6)	2	4			6		6		6
im (7)	1	6			7		7		7
Palau									
ad (7)			7	7		7		7	
im (5)			5	5		5		5	

of the woodland, bushes in gardens, and taller trees in an adjacent mangrove swamp. The flock made the rounds here about once every hour, but at one time the birds interrupted their foraging to rest silently for a half hour in a large tree in the swamp. A neighboring flock of Gray-brown White-eyes had about the same circuit, but the two species remained independent, their paths crossing occasionally as if by accident, at which times they would both forage in the same tree at the same time. The principal food is berries (with hard pits 4.5 mm. in diameter) swallowed whole. Seeds, fruit, caterpillars, ants and other small insects are taken; grasshopper parts and small snails are found in their stomachs rarely. Insects are taken as the birds move rapidly through the foliage, occasionally making short flights into the air or hovering in front of a leaf spray. A common attitude in foraging is a horizontal position of the body, with bill, body and tail in line, like a nuthatch. They flick the wings constantly.

Their high-pitched location notes are constantly uttered, apparently serving to keep members of the flock together, and are intensified by the stragglers. When flying across open spaces from one forage tree to the next, they stay within three to six feet of the ground. On only one occasion did I notice a bird actually singing. It was an adult male collected on Tinian, whose song had been merely an extended series of the usual siskin-like call notes. The "confusion chorus," invariably heard upon the dramatic arrival of a kingfisher, consists of the ordinary call notes delivered at maximum intensity and frequency by all members of the flock. It lasts for a minute or so, during which time the birds remain stationary. They respond in this manner only to the kingfisher in flight. After he has alighted the confusion chorus dies down and they resume foraging, only to be thrown again into consternation at the next attack of the kingfisher, who may have been sitting in the same tree with them all this time.

Measurements of the 95 specimens from Saipan (27), Tinian (43), Guam (13) and Palau (12) reveal that the adults are slightly larger than the immatures, but that the two sexes are practically identical and that the Tinian population is indistinguishable from the one on Saipan. Slight differences in average measurements of adults among the three races (*saipanensis* of Saipan and Tinian, *conspicillata* of Guam, *semperi* of Palau)

range from 2 to 5 per cent in magnitude, with *conspicillata* possessing the longest tarsus and largest bill, and *semperi* possessing the longest wing. Striking differences in coloration are found, however, as summarized on tables 4 and 5. The Saipan and Tinian populations differ somewhat in color of iris and bill. There are marked differences in voice among the three races. *Saipanensis* utters high-pitched plaintive siskin-like calls and a rough *chilp chilp* like an English Sparrow. The high-pitched calls are absent from the repertoire of *conspicillata*. The notes of *semperi* are high clear whistles: *tee dee, tee dee, tee dee-dee-dee.*

The Bridled White-eye is the only species in which blood parasites were found. Those on Saipan and Tinian were almost universally infected with *Haemoproteus* and had microfilariae in an incidence of about 15 per cent. Neither parasite was found in the Guam white-eyes.

Table 5

Geographic Variation in Plumage Color of *Zosterops conspicillata*

	saipanensis	*conspicillata*	*semperi*
back	dull green	dull green, rump yellowish, crown feathers gray basally	bright yellow-green
lores	cream (narrow)	white, yellowish in 3 (wide)	yellow (medium width)
white eye-ring	medium	large	small
black border below eye-ring	conspicuous	small	inconspicuous
auriculars	same color as back	gray (greenish in 3)	same color as back
chin and throat	same color or slightly lighter than belly	whitish, in contrast to rest of underparts (yellow in 2)	yellow, same as rest of underparts or brighter
rest of underparts	dull yellow; yellowest posteriorly	pale pure yellow; yellowest posteriorly	intense yellow; yellowest anteriorly

The Gray-brown White-eye (*Zosterops cinerea*) of Palau is much more abundant in deep woodland than is the Bridled White-eye. It differs further in that pairs are found as frequently as flocks, foraging takes place in the crown foliage of the larger trees, and the flight is powerful; individuals and small groups are often seen on long flights, high in the air. Like its relative, it frequents all kinds of vegetation in addition to woodland. The food of this bird consists mainly of berries and fruit, although insects are occasionally taken. Its call notes are not as sweet and clear as those of *semperi* but are of the same pattern.

In appearance, habits and voice the Large Palau White-eye (*Rukia palauensis*) does not even suggest, let alone resemble, the other species of white-eyes on these islands. It does not travel in flocks, and a male will chase starlings and kingfishers away from the tree in which he happens to be singing. Individuals chase each other from time to time, uttering loud grating calls. When one male begins to sing, others in the vicinity do likewise and a chorus ensues. After a time they suddenly stop and streak away into the vine tangles, bursting into song again one-quarter to a half hour later from a different group of trees. This species prefers the upper parts of tall, vine-draped trees, where it sings either from concealment in the vines or from bare branches, and forages on caterpillars, ants and fruit. They feed also in vine tangles close to the ground. The remarkable song consists of high-pitched loud whistles and trills. Several opening whistles have a marked downward inflection and a strained quality as if uttered in extreme agony. These are followed by a long trill which surges in intensity, and there are whistles of upward inflection uttered polyphonically while the trills continue as a background. The

song therefore sounds somewhat like two canaries singing at the same time. A further peculiarity in this species is that it is abundant on Peliliu and absent from similar environment on the neighboring islands of the Palau group.

BREEDING AND MOLTING SEASONS

It is perhaps not too early to advance some tentative inferences concerning the presence or absence of an annual cycle of breeding activity in the endemic species. Combining my information on breeding with that presented by Baker (*op. cit.*: 35-74) we find that 13 species, for which sufficient specimens and records are available, appear to breed the year around. Not every month is represented for any one species, nor is there enough information to determine if nesting is more frequent in some months than others; however, in these species series of specimens from any time of year show that all the adult males (with exceptions noted below) have testes of maximum size, and in passerines the accompanying enlargement of cloacal tubules is noted. Some of the adult females are laying, others may have a brood patch. The few records of nests and downy young for these species are from widely separated months. It is of particular interest that in those marked with an asterisk (to which *Cleptornis marchei* must be added) some immature individuals (in partial or complete adult plumage) are in full breeding condition before their skulls are fully matured. In passerines, this means that they breed when they are only about six months old. The species assumed to breed all year are the following: *Ixobrychus sinensis, Anas oustaleti, Rallus owstoni, Gallinula chloropus, *Ptilinopus porphyraceus* (including the Marianas form), **Gallicolumba xanthonura, Halcyon chloris, *Acrocephalus luscinia, *Rhipidura rufifrons, *Monarcha takatsukasae, *Aplonis opacus, *Myzomela cardinalis* and **Zosterops conspicillata*. In the following species some adult males are not in breeding condition in the same months when others of the same island population do breed: *Halcyon chloris, Psamathia annae, Myiagra oceanica* on Guam, *Aplonis opacus,* and *Zosterops conspicillata* on Palau.

Other species, represented by fewer specimens, at least definitely breed in the months noted: *Demigretta sacra* in April on Tinian; *Nycticorax caledonicus* in August, September and December; *Rallus philippensis* in September and November; *Porphyrio porphyrio* in September; *Gallicolumba canifrons* in November and December; *Collocalia inexpectata* on Guam in February and May; *Halcyon cinnamomina* on Guam in March to July; *Psamathia annae* in November and December; *Myiagra oceanica* in May and June on Guam, and November on Palau; *Cleptornis marchei* in January, February and April; and *Rukia palauensis* in November and December.

Scanty evidence of a seasonal cycle is provided by species in which none of the individuals (number of specimens indicated in parentheses) are in breeding condition at a certain time of year. *Pyrroglaux podargina* (4) and *Caprimulgus indicus* (5) are not breeding in November and the first week of December, although they have slightly enlarged gonads and sing in these months. *Edolisoma tenuirostre* (8), *Rhipidura lepida* (12), *Colluricincla tenebrosa* (11) and *Zosterops cinerea* (7) appear not to breed in November. *Corvus kubaryi* (5, in addition to others listed by Baker) does not breed in May, June and July.

In only three species are the individuals taken in a given month all at the same stage of molt. *Pyrroglaux podargina* (4) are in worn plumage in November. Four specimens of *Acrocephalus luscinia* are in new plumage in February, one is worn in June, and seven, one of which is beginning to molt, are in extremely abraded plumage in September. All five specimens of *Corvus kubaryi* taken in May and June are in the middle of a complete molt. These species are in marked contrast to the remaining forms, most of which show no correspondence among individuals in the molt program, few individ-

uals being either in entirely fresh or entirely abraded plumage and most showing a mixture of old and new feathers at any time of year. Even the postjuvenal molt appears to be a leisurely affair spread over several months, except in *Aplonis opacus*. In this species the juvenal plumage is carried for a considerable period until it is uniformly abraded and the skull has small windows. Then the entire plumage is replaced by the glossy black adult feathers before the completion of the double skull roof.

COMMENTS ON DISTRIBUTION AND ECOLOGY

Certain conspicuous points of difference between island populations of the geographically variable species have been mentioned in order to emphasize the grossness of the differences and lack of overlap in many characters between these isolated populations as contrasted with the situation among continental polytypic species. Under these circumstances the difficulty of determining which populations are species and which are races is at once apparent. Ecologic criteria are much less useful for island forms than for those on continents because on islands the niches in the environment are not all filled and in the absence of marked interspecific competition the land birds generally show great versatility in utilizing different habitats, as discussed below. There is only one clear-cut case, in the avifauna of the islands which I studied, of geographically complementary forms which could, if necessary, safely be determined as different species on the basis of ecology. This involves the restriction to one or the other of two markedly different kinds of habitat by forms of the genus *Halcyon* on islands where both habitats occur. On Saipan and Tinian, *Halcyon chloris* is found along the shore-line (*Casuarina* trees and coastal shrubbery) and avoids the interior of continuous woodlands. On Guam, *Halcyon cinnamomina* is absent from the shore habitats and is restricted to dense woodland. Therefore each species, where it occurs alone on an island, fills out only its appropriate habitat, in the same manner as when both occur together, as on Palau.

Incipient race formation seems to be taking place in *Zosterops conspicillata* on Saipan, where the population differs in proportion of bill color and iris color types from the population on Tinian, only three miles removed. Otherwise, there is no racial difference to be found between large series of doves, kingfishers, flycatchers and starlings on the two islands. There is a marked difference in composition of their avifaunas, however, which points to the effectiveness of an ocean barrier for some species at least. *Monarcha takatsukasae* of Tinian is not found on Saipan, nor are *Cleptornis marchei* and *Acrocephalus luscinia* of Saipan found on Tinian, although suitable environments for these species are available on both islands.

Four species exhibit a strange sort of discontinuous distribution within the limits of a single island (or group of closely adjoining islets, as on Palau). *Megapodius lapérouse* and *Gallicolumba canifrons* of Palau appear to be restricted to woodland on steep rocky ridges on the outlying islets and are absent from forests growing on deep soil on the large island of Babelthuap. Discontinuities in distribution of *Rukia palauensis* and *Acrocephalus luscinia* are not correlated with differences in habitat. *Rukia* on Palau was found only at Peliliu, and was absent at Arakabesan, Koror and Babelthuap. *Acrocephalus* on Saipan was abundant in the marshes around Lake Susupe, absent from other similar marshes and present elsewhere only in five small colonies in different kinds of environment.

Owing to the vagaries of colonization of these remote islands, their endemic land avifauna is impoverished both as to number of species and ecologic types. As a result, there are many niches for which no species are exclusively adapted. (For instance, there are no birds which forage by picking insects from crevices in the bark, like creepers and woodpeckers, and no birds which crack seeds in their bills.) Correlated with this is a

marked versatility on the part of the passerine species in kind of food eaten and the habitat and substrate on which it is obtained. The swiftlets, nightjars and small flycatchers are the only strictly insectivorous birds found. The doves are strictly frugivorous; the owl, kingfishers, Palau Warbler and Nightingale Rëed Warbler are carnivorous (or take larger invertebrates). The rest of the species, most of them possessing bills which one thinks of as "insect-eating," take invertebrate and vegetable food indiscriminately, and in a variety of habitats.

MIGRANTS AND INTRODUCED SPECIES

Brief mention may be made of wintering, migrant or introduced land and fresh-water forms which were found, inasmuch as some records are new for Micronesia. The Egret (*Egretta intermedia*) is a winter visitant to all these islands and is absent only from April to the first part of August. (A lone individual was seen on Guam, June 1.) It is found in flocks of a dozen to 100 birds which forage exclusively in fresh-water marshes and moist grassland, eating house mice, grasshoppers and dragonfly nymphs. They often feed under and around cattle. Specimens were taken on Saipan and Tinian. A migrant flock of six Black-crowned Night Herons (*Nycticorax nycticorax*) was flushed on April 4 at Lake Hagoi, Tinian, where the birds were concealed and sleeping in tall vegetation at noon. One was collected. A wintering Black-crowned Night Heron was seen on several evenings in November on Palau and was collected. A pair of Garganey (*Anas querquedula*) was seen daily in April on Lake Hagoi, and one was collected. They fed as they swam at the edge of the marsh vegetation and flew when alarmed. A flock of 15 Pintails (*Anas acuta*) was seen at Lake Susupe, Saipan, on February 7. A pair of Shovellers (*Anas clypeata*) was collected on Lake Hagoi on October 12. Two Scaups (*Aythya fuligula*) were seen daily at Lake Hagoi in April.

Three kinds of hawks are winter residents on Palau and were seen almost daily in November: a large *Accipiter* the size of a Goshawk, a small *Accipiter* and a medium-sized *Buteo*. Domestic Fowl (*Gallus gallus*) were seen on all the islands, but I was impressed by the wildness of those on Koror, in the Palau group. A small chick in juvenal plumage was collected there in deep natural woodland, far from human habitation.

Two migrating Least Terns (*Sterna albifrons*) were diving for gambusia fish in Lake Susupe, Saipan, on September 26. One was collected. One Domestic Pigeon (*Columba livia*) was seen in natural forest on Tinian in April. The introduced Turtle Dove (*Streptopelia bitorquata*) is an abundant resident which breeds on Saipan, Tinian, and Guam. Specimens were taken on all three islands. It forages only in clearings, roads and farm lands and therefore does not compete nor come into close contact with the native doves, which stay in the natural forest vegetation. A flock of 15 large Cockatoos (*Cacatua*), probably introduced, was seen in November at each visit to a small inland body of salt water in the middle of the steep, heavily forested hills on Koror in the Palaus. Single wintering Cuckoos (*Cuculus*) were seen several times in November on Palau.

Lone migrating adult Barn Swallows (*Hirundo rustica*) were seen by Genelly in March and by myself in April on Tinian. Only immature birds were found to spend the winter on Saipan, Tinian and Palau. Seventeen specimens taken on these islands from October to February are in predominantly juvenal plumage and with skull "windows" indicating immaturity. Apparently it takes all winter for these birds to acquire the adult plumage and at least until December for them to form a two-layered skull. These wintering immatures foraged around Lake Susupe at Saipan where they were accompanied by an unidentified species of swallow. On Tinian they foraged along the edge of a cliff and along the lanes of acacia trees planted in farming country. On Palau, they were found in open farm land.

Two wintering adult Gray-spotted Flycatchers (*Muscicapa griseisticta*; identified by Herbert Friedmann) were taken on Palau on November 6 and December 2, respectively.

Weaver-finches (*Lonchura punctulata* nearest *cabanisi*; identified by Friedmann) were found in grassland on a farm on Babelthuap in the Palaus. Twelve specimens were collected from the flock of fifty at this spot. Adults (determined by skull) were in breeding condition; one female was laying and had a brood patch. The immatures had small gonads and were in various stages of the postjuvenal molt, except one, which had full adult plumage. This species has evidently been introduced recently on the island; they are successfully reproducing there and they occupy a habitat not shared with any native bird.

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