and salt water, may give different reactions, and much more observation is called for. For example, I find it definitely stated in one of my notebooks that Harlequins never use their wings under water, but in subsequent observations a decided flip of their wings has been noted as they plunged under. Probably observation of healthy birds in a glass-sided tank will give the final solutions.

Okanagan Landing
British Columbia

BREEDING BIRDS OF THE PIGMY CONIFERS IN THE BOOK CLIFF REGION OF EASTERN UTAH

BY ROSS HARDY

Plates 23, 24

THE pigmy conifers of the west which are so characteristic of, and cover such extensive areas in, the Great Basin and the Colorado River drainage provide shelter for a number of interesting avian inhabitants. Between September 1, 1935, and May 21, 1938, the writer had the opportunity to make studies of the birds inhabiting sample areas of the extensive pigmy forests which skirt the base of the Book Cliffs in Carbon County, east-central Utah. These pigmy conifers, consisting principally of Utah juniper (*Juniperus utahensis*) and double-leaf piñon (*Pinus edulis*), cover large areas of the foothills which are in turn skirted by open flats and valleys of salty soil bearing stands of shadscale (*Atriplex confertifolia*) and greasewood (*Sarcobatus vermiculatus*) or similar saltbushes.

Two separate areas were selected for intensive study—one at Sunnyside, 6700 feet, near the upper altitudinal limits of the pigmy conifers (September 1, 1935 to June 7, 1936); the other near Price, 5567 feet, extending up over the foothills from 5800 feet to 6500 feet, nearer the lower limits of growth (August 25, 1936 to May, 1938).

The writer is indebted to Dr. A. M. Woodbury of the University of Utah and to Mr. Harold Higgins of Price, Utah, for assistance in connection with this study.

METHODS

Data were obtained by observation and collection of specimens upon frequent visits to and through the areas. Observations were facilitated by the use of eight-power binoculars. Of the specimens of skins, nests and eggs taken, the majority are in the writer's collection and a few at the University of Utah. A total of 1557 notes on field observa-

tions were filed in chronological order, and later transcribed and arranged in a separate systematic file.

CLIMATE

Considerable variation in climate can be tolerated by the pigmy conifers as shown by their vertical range of over 3000 feet. The U. S. Weather Bureau records (Alter, 1931: 18) show that there is little difference in annual mean temperature between Price and Sunnyside. Both places have a much greater precipitation in late summer and early fall than at any other time.

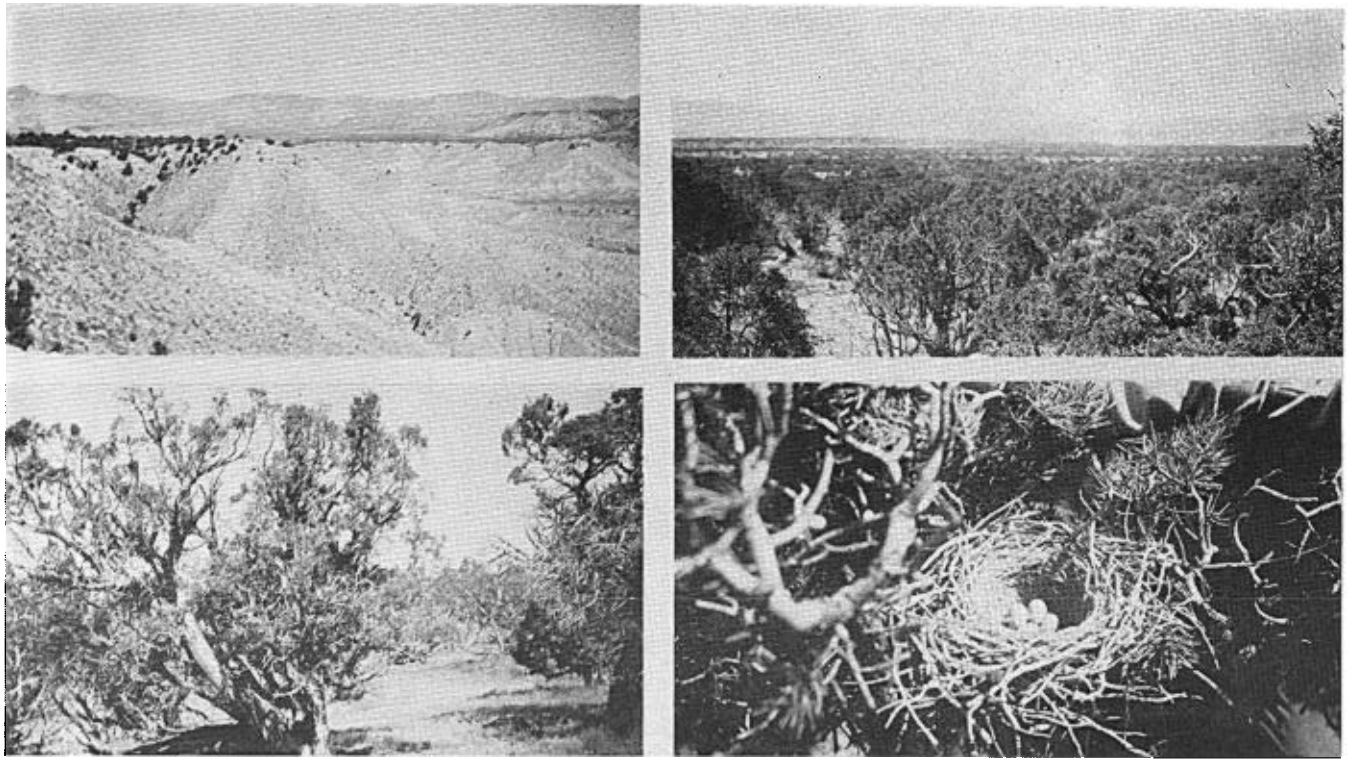
Comparative data show the mean annual rainfall at Sunnyside to be 13.5 inches; Price, 10.6 inches; and the Utah state average, 12.9 inches; the annual mean temperature at Sunnyside, 47.4° F.; Price, 47.8° F.; Utah, 48.0° F.; average maximum temperature at Sunnyside, 58.8° F.; Price, 63.5° F.; average minimum temperature at Sunnyside, 36° F.; Price, 32° F.; highest recorded temperature at Sunnyside, 96° F.; Price, 108° F.; lowest recorded temperature at Sunnyside, −10° F.; Price, −31° F.

Precipitation studies (Alter, 1931: 3) in the region show that precipitation increases with altitude at the rate of about one inch for each 328 feet. Alter further indicates that Price receives "relatively light precipitation because situated to the lee of the Wasatch Mountains. Sunnyside at the south edge of the Tavaputs Plateau of mountainous height, draws a good precipitation from summer thunder showers." "April, May and June are usually the driest months, June being most dependably driest. July, August, September and October are the wettest months at most places in the section, September being the most dependably wet everywhere."

THE PIGMY CONIFERS

The chief visual characteristic of the pigmy conifers is their scattering, squatty, bush-topped, stunted appearance. The junipers and piñons, which make up the bulk of the vegetation, usually run from ten to twenty feet in height and in general are widely spaced because their shallow root systems are relatively larger than their crowns. Within the limits of moisture tolerance of these plants, the ratio of root system to crown appears to vary inversely with soil moisture; the less the soil moisture, the more widely spaced are the crowns.

"The vegetation of this belt (Juniper-piñon) shows clearly that the small precipitation is one of the important factors limiting growth." (Tidestrom, 1925: 12). Sampson (in Tidestrom, 1925: 27) states "That limiting moisture, rather than excessive heat units or inferior



BOOK CLIFFS REGION, UTAH.—(*Upper left*) ROCKY SLOPES AND PIGMY-CONIFER-COVERED MESAS SKIRTING THE BOOK CLIFFS SEEN ABOUT TEN MILES IN THE DISTANCE. (*Upper right*) PIGMY CONIFERS, SHOWING STUNTED CHARACTER AND OPEN SPACING. (*Lower left*) JUNIPER (*left*) AND PIÑON TREES (*right foreground*) SHOWING TYPICAL SPACING IN DENSE AREA OF PIGMY CONIFERS. (*Lower right*) NEST AND EGGS OF PIÑON JAY IN A PIÑON TREE.

soil, is responsible for the limited growth of plants of this belt is made clear from the fact that all species which occur along watercourses grow more luxuriantly," and indicates that the second most important factor is the shallowness of the soil, a "factor which limits the density of the vegetative stand and its luxuriance of growth. Both precipitation and depth and fertility of soil increase as one goes to higher altitudes."

The lower limit of the pigmy conifers in the areas studied is usually marked by the line where the shallow, well-drained soils give way to the deeper salty soils of the valleys. The upper limit, however, appears to be set by increasing soil moisture where it permits a deciduous broadleaf chaparral type of vegetation to replace the pigmy conifers. This is indicated on the slope of the mountains near Sunnyside (at about 8000 feet) where, at the same altitude, the junipers and piñons occupy the drier south-facing slopes and the scrub oak (*Quercus gambeli*) and serviceberry (*Amelanchier alnifolia*) occupy the northerly slopes where snow persists longer and is deeper in winter.

Junipers are usually more numerous than piñons, although they vary from place to place. Counts on several small areas indicated a proportion of piñons running from 17% to 48%. The general average proportion in a transect about thirty feet wide and containing over a thousand trees was 26.4% piñon.

Interspersed in the spaces among the trees, sagebrush (*Artemisia tridentata*) is abundant and matchweed (*Gutierrezia* sp.), June grass (*Bromus tectorum*), and wheat grass (*Agropyron* spp.) are common. In certain areas, the cliff rose (*Cowania stansburiana*) occurs. Flowering herbs that are conspicuous include red skunkflower (*Gilia aggregata*), several *Penstemon*, a number of *Astragalus*, many species of *Eriogonum*, and numerous Cruciferae.

The pigmy conifers are found mostly upon the three- to five-mile-long, flat-topped mesas which extend from the Book Cliffs southward to the still more arid areas of the shadscale lowlands. The sloping sides of these mesas lead about 300 feet down to the saltbush flats. Price is situated at the southern edge of one of these mesas known as Woodhill, while Sunnyside is 26 miles northeast in the mouth of Whitmore Canyon of the Book Cliffs.

The edges of the mesas are often cut into pinnacles and ledges which provide shelter and nesting sites for birds. These may be from twenty to over a hundred feet high and are usually of a poor grade of loosely bound gravel conglomerate or crumbling blue slaty clay which makes it nearly impossible for one to climb them to study the avian inhabitants nesting there.

PROBLEMS OF THE ENVIRONMENT

The pigmy conifers place limitations upon the birds that can live under their influence through limitations in such necessities as space, food, water, shelter, protection, nesting material and nesting sites. The crops of juniper berries and pine nuts and the seeds of the interspersed plants are about the only products directly usable as food by the birds. Indirectly, however, the scanty resiniferous foliage, the tough wood, and the roots of the junipers and piñons, as well as similar parts of the minor plants, yield food for insects or rodents which in turn are used by the birds.

Most nesting birds choose junipers in preference to piñons for nesting trees, probably because natural cavities in trunks suitable for nesting sites occur much more frequently in junipers than in piñons. Woodpeckers can bore into juniper limbs which they often find decayed internally, but only occasionally find suitable places in dead piñons. The erect habit of growth of the piñons seems to offer few horizontal limbs to support the slovenly nests of such birds as Mourning Doves, whereas junipers frequently provide such nesting sites. The stringy, fibrous bark of the juniper seems to be the most characteristic nesting material furnished by the pigmy conifers although dried Russian thistle is often used.

Because of aridity, the pigmy forest and near-by areas support comparatively little plant life. Those plants which do grow are small-leaved desert forms which support a minimum of insect life. This means that birds nesting in such an area must claim a large territory to obtain enough food for their young. Territories of species nesting in near-by shadscale areas, however, were almost always larger than territories of the same or similar species of bird nesting in the somewhat more densely vegetated piñon and juniper areas.

Erosion, originally slow because of aridity, has been accelerated by overgrazing. Erosion is slowly wearing away the mesas to form cliffs and rocky slopes which serve as niches for birds nesting there. Fire often clears areas by destroying the pigmy forest. The succeeding growth of thistles and June grass is followed, after a great length of time, by wheat grass and sagebrush, which is later replaced by juniper and piñon.

Timidity seems to accompany this lack of cover, for the chief defense of these desert birds appears to be one of flight rather than one of concealment. Aridity affords less plant life to serve as cover than is provided by the greater amount of moisture higher in the mountains.

Waterfowl and similar birds are excluded from the pigmy forest by

absence of water, although they occasionally fly over such areas. Some birds such as swallows and Robins, which need mud for nests, are likewise excluded from breeding. Pheasants are excluded because of the lack of drinking water, but the Mourning Dove can and does fly great distances to obtain water.

Man's entrance has undoubtedly caused a diminution in number of those birds which are found only in natural arid areas. Such residents as the Piñon Jay and the Titmouse are obligate inhabitants in the pigmy forest. The destruction or changing of this area may cause hardship to them. The desert birds are reduced in numbers by irrigation. Such birds as the Desert Sparrow, the Piñon Jay, or the Titmouse are not found in cultivated regions, but they probably occupied such areas before irrigation began.

The excessive grazing of the area by livestock has, in many cases, reduced plant life to a minimum. This, without doubt, makes itself felt by a decreased yield of seeds and insects which serve as food for the birds. Undoubtedly the introduction of Russian thistle has changed the landscape to a tremendous degree and has probably changed the habits of birds. Horned Larks, Juncos and other seed eaters often, in winter, feed upon this plant instead of upon the seeds of grasses. Restoration of plant cover helps to restore some of the bird life, for birds seemed to be much more common in a large fenced, protected area on Woodhill than in the near-by overgrazed areas.

THE BIRDS OF THE PIGMY CONIFERS

A permanent home among the junipers and piñons can be found by some birds that are able to face the extremes of winter cold and storm and of summer heat and drouth, as well as the more optimal conditions of other times. This implies that they breed here and raise their young and are more or less obligate birds of the pigmy conifers.

Having a lesser degree of dependence upon this habitat, some birds breed here and migrate south for winter. Others merely pass through in migration and stop en route for resting and feeding. The pigmy trees give much more adequate protection and shelter than do the shadscales of the valleys and flats.

Some birds winter in the pigmy conifers and go elsewhere to breed. They migrate either to higher elevations (altitudinally) or to areas farther north (latitudinally). Other birds nest near by in other habitats and enter the area primarily to forage, while still others pass over the pigmy forest in migration without stopping.

Of the 125 species found in this and near-by areas, 79 have been observed in the pigmy conifers. Of these, eight may be classed as perma-

nent residents but only three of these are obligate birds of the piñons. The other five depend upon favorable nesting sites formed by the cliffs at the edge of the mesa. Fourteen summer residents and seventeen winter visitants have been recorded. All others are considered as migrants or foragers from near-by areas.

OBLIGATE PERMANENT RESIDENTS

Three species of birds are found throughout the year in the pigmy conifers and are known to nest in these trees, and hence may be called permanent residents. The Piñon Jay (*Cyanocephalus cyanocephalus*) and the Gray Titmouse (*Parus inornatus ridgwayi*) are not known to nest in the Book Cliffs Region, except in the trees, and thus are considered obligate birds of the pigmy conifers. The Lead-colored Bush-Tit (*Psaltriparus minimus plumbeus*) also nests in these trees but occasionally nests in ponderosa pines at higher elevations and thus is considered a semi-obligate bird of the pigmy conifers.

Nesting in colonies, but sometimes with one or two pairs nesting separately from the main flock, the Piñon Jay is one of the most conspicuous and noisiest inhabitants of this area. Varying in numbers at different seasons, a flock of over fifty jays occupied the pigmy conifer area near Price.

Courtship among the jays seemed to be under way on April 3, 1937, for many of the jays were pairing off, separate from the flock. One would often strut before another bird which would fly a short distance to settle down and again watch the demonstrating partner. On this day, one jay flew from a small, densely-leaved piñon which contained a half-built nest of sticks and juniper bark. This nest was never finished, although it bore the marks of recent work and did not resemble the weathered ramshackle nests remaining from previous years.

Near by, on April 17, 1937, two jays were carrying sticks and juniper bark to another nearly completed nest which was built next to the upper part of the trunk of a piñon. This nest was also later abandoned. Within fifty feet of it, on April 24, a third nest was found, well out on the end of a juniper limb. When discovered, an adult flew. The nest contained one egg. On each forenoon of three succeeding days, another egg was deposited. These four eggs were incubated until May 7, when they were deserted. The adults were not again seen in this place.

Young stubby-tailed jays were found in groups of three, four or five perched on limbs of trees about one and one-half miles northeast of this place on May 15. Recently-abandoned nests within a quarter-mile radius indicated that a large colony had nested. The jays nested

in this same area the following year and had nearly all left the nest by April 9, 1938. Of eight nests discovered, three contained young with pin feathers in tail and wings. By April 15, all but those in one nest had flown. After the mild winter of 1938, these young seemed to be more than three weeks earlier in their development than were the young hatched following the extremely severe winter of 1937.

The Piñon Jays nest on the limbs or in large branches while the Gray Titmouse prefers small cavities in the tree trunk or behind the bark. The Bush-Tit usually builds a pendent nest on the end of a limb. The two smaller birds are not colonial in their nesting habits. Thus there is likely no competition among these three species for nesting sites.

Competition between Titmice and white-footed mice for nesting sites possibly takes place. A Titmouse was heard chattering and scolding for nearly an hour as it hopped about in a juniper tree May 27, 1937. This incident was repeated in the same place two days later. In a crevice in the trunk of this tree was found a nest constructed almost entirely of juniper bark. A white-footed mouse (*Peromyscus maniculatus sonoriensis*) was captured in this nest on May 31. It is not known whether this was a mouse nest or a Titmouse nest, but the incident suggests the possibility of competition between these two animals for favorable nesting cavities.

Nesting of the Bush-Tit likely takes place between April 25 and July 15, for this species seemed nearly to disappear from the area at that time. On May 21, 1938, in a pigmy conifer area near the LaSal Natural Bridge south of LaSal Junction in San Juan County, a pendent nest of a Bush-Tit was found in the top of a piñon tree. It was made almost entirely of sheep's wool and contained five white eggs which, judging by their opaqueness, seemed ready to hatch. No nests were located in the area near Price, but the troops of parent and young were common during the latter part of July.

Titmice are found in a family group of a half dozen or so for a short time in the period after the young leave the nest. One immature titmouse was observed begging food from another, presumably a parent, on June 11, 1937. During most of the year, however, Titmice are found singly, in pairs, or a few with flocks of Bush-Tits or Chickadees. Bush-Tits, on the other hand, are commonly found in troops of six to thirty.

Among the Piñon Jays, in early June, each family seemed a separate unit within the larger social group—the flock. Each group of three or four young was accompanied by one or two adults to feed and guide them. The entire flock of Piñon Jays was seen to move down the

slopes to the shadscale flats on June 8, 1937. Here they spent much of their time during the following ten days. One morning I walked across the shadscale flats between one of these family groups and the rest of the flock. At once, this family arose from the ground where it had been feeding and flew to a distant lone juniper. The adult alighted in its sheltering branches but the young continued their flight beyond until a sharp squawk from the parent—almost a command, it seemed—caused them to wheel in mid-air and return to the juniper. Later, at another call from the parent, they flew very high overhead and returned to the main flock. In early July, these family lines were not so evident and the group seemed one large unit—the flock.

The population of this colony of jays appeared to more than double during the nesting season, but the total number prior to nesting seemed to remain about the same each year. Occasionally during the winter, dead jays were seen in the snow, but other than this no fatalities were observed. When a Horned Owl approached the nesting area just before sunset, May 15, 1937, thirteen adult jays, cawing loudly and flying constantly about its head, drove it for nearly a mile westward. Groups of jays seem to be able to repel one owl, but since the owl is nocturnal, it could likely prey upon jays if they were found at night. The remains of a Piñon Jay in the stomach of a Red-tailed Hawk was reported by Bent (1937: 172). This hawk is rather common in the area but it has never been seen to attack the jays, although the remains of Mourning Doves and Nighthawks were seen in a Red-tail nest.

The adult Piñon Jays are likely omnivorous in their habits. Usually because of individuals which seemed to act as sentries, it was impossible to approach closely enough to determine the exact nature of the food consumed. One young jay was observed to flutter its wings and beg food. An adult placed food in its mouth and flew to the top of a tree where it ate juniper berries. This may have been the kind of food previously fed to the young.

The small insects and similar food found on the leaves and small twigs by the Bush-Tits is likely largely unavailable to the much larger Piñon Jays. Bush-Tits spend much time feeding from the outer limbs and needles of the pigmy conifer trees. The Titmouse spends its time mostly in the larger branches and on the trunk of these same trees. Piñons seem to be more favored than junipers as feeding places. In December, the digestive organs of the Titmouse contained much gravel and bits of piñon leaves.

PERMANENT RESIDENTS NOT LIMITED TO THE PIGMY FOREST

Five species of birds are found nesting in the cliffs and high gravel banks around the edge of the mesa. Since all of these birds hunt for food over rather large areas, their presence in this area is attributed to the favorable nesting sites which are found along the edge of the mesas between the pigmy conifers and the lower-lying shadscale areas. It may be significant that all of these except the omnivorous American Raven (*Corvus corax sinuatus*) are birds of prey: the Western Red-tailed Hawk (*Buteo jamaicensis calurus*), the Eastern Sparrow Hawk (*Falco sparverius sparverius*), the Golden Eagle (*Aquila chrysaetos canadensis*), and the Montana Horned Owl (*Bubo virginianus occidentalis*).

The cliff-nesting birds are known to find different kinds of nesting sites but in the Price area they nested only on the ledges and cliffs. The Raven is said to nest elsewhere in Utah in piñon trees, but since cliffs are available in the pigmy conifer area of the Book Cliffs, it likely prefers the latter situation to tree nesting.

A Golden Eagle nest was located halfway up a hundred-foot ledge on a shelf below an overhanging bulge on April 10, 1937, in a pigmy conifer area of the Farnham Dome twelve miles east of Price. With some difficulty, a position was found upon the cliff where one could look with a binocular into a portion of the nest. One egg could be seen, but it was impossible to determine more. The parents were hunting the piñons and shadscale flats below. Golden Eagles are not common enough to be observed over the pigmy conifers at all times, but this species seems to be a permanent resident of the area.

Some competition for favorable nesting sites and for food may possibly exist between the Red-tailed Hawk and the Golden Eagle since their habits are very similar. In the Emma Park area of the Book Cliffs, about ten miles north of Price, on June 5, 1937, an eagle was observed as it was driven from what was likely the nesting area of Red-tailed Hawks. Two of these usually slow-flying birds were surprisingly agile as they flew at the head of the eagle which quickly left their territory.

The account of the nesting habits of the Red-tailed Hawk and its unusual nest upon an isolated pinnacle has been published separately (Hardy, 1939: 79). In the area studied, these birds were not found nesting other than on pinnacles or upon protruding shelves of cliffs.

Nest construction by a pair of American Ravens began March 20, 1937 when they were flying in and out of a crevice in the "Cracked Ledge" near Carbon High School. This ledge has a hollow just beneath the rim of the harder rock which covers Woodhill, and into this

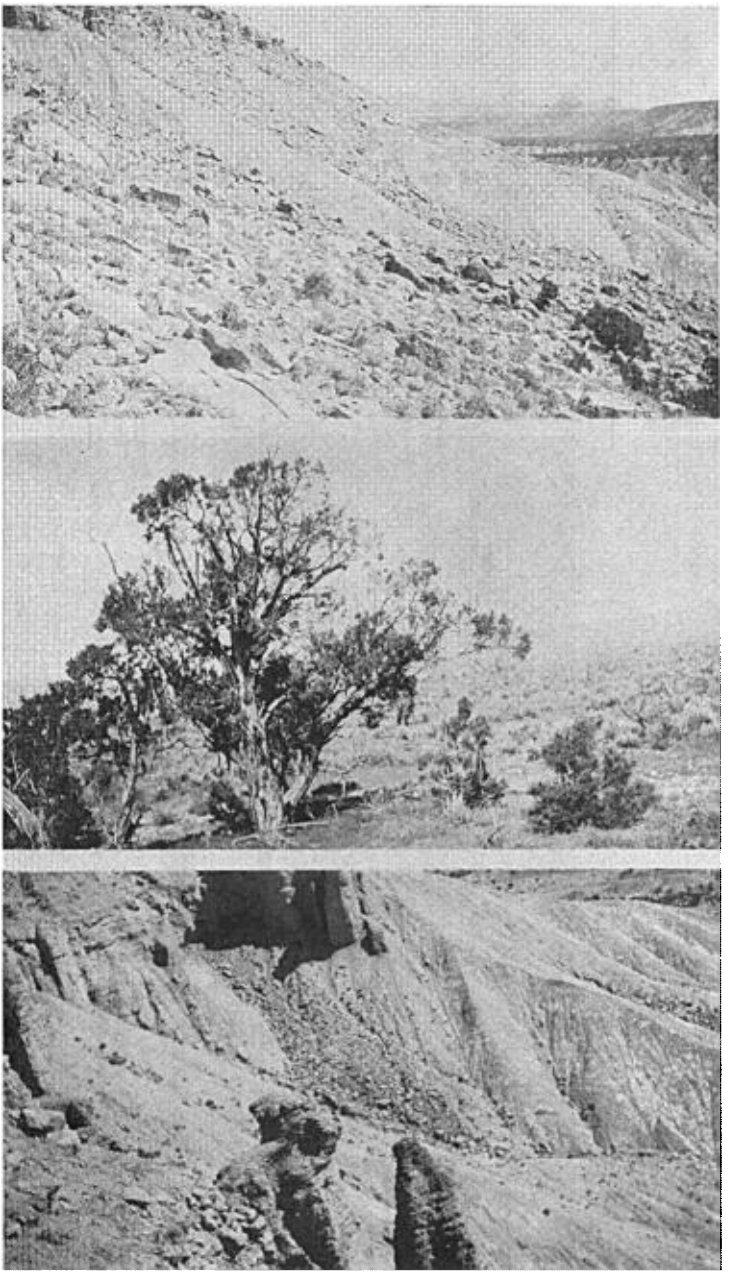
cavity the birds carried sticks, wool, and juniper bark. They usually flew in opposite directions on their foraging expeditions and returned about the same time, welcoming one another with hoarse caws.

The raven nest, lined with juniper bark and an inner lining of sheep's wool, contained no eggs on April 11. At 5 P. M. the following day, there was one pale blue egg. The nest was being incubated by one raven at dusk on April 15 at 7 P. M., while the other bird perched in a crevice about ten feet away. When disturbed, this bird flew straight out, paused in mid-air as it fanned its wings, and turned its head to look before circling around and flying away. A second egg was present April 19. At noon, April 23, the nest had been filled with stones. The ravens were not to be seen, but a near-by pile of empty shotgun shells carried its own suggestion. July 15, two ravens were seen flying about this ledge. No nest was built here during 1938, but during the spring of 1939, it was reported to me that another nest in the same place met a similar fate.

Nesting in small crevices of crumbling slate or gravel ledges at the mesa's edge, the Sparrow Hawk is common in the pigmy conifers throughout the year. During May, the young could be heard below the ledge. On July 9, about fifty feet from one of these pinnacles where they had likely been hatched, five young hawks were seeking shelter from a summer thunderstorm by crouching on the ground beneath a juniper. Inasmuch as these birds nest in small crevices and are mainly insectivorous in habit, they likely do not compete with the larger Red-tailed Hawk or Golden Eagle.

An adult and two young Horned Owls were hunting on Woodhill, June 24, 1937. When disturbed, they flew into a crevice back of a high blue-slate ledge where an adult had been frequently observed earlier in the year. Their nest was believed to have been in this dark crevice. During another daytime expedition, these owls flew down a small canyon when they were disturbed. House Finches and Bluebirds sent forth a continuous cry of alarm which rolled like a wave ahead of the owls, probably warning other inhabitants of the pigmy conifers. Because of nocturnal habits, these birds likely avoid competition with the other cliff-nesting species of this area.

The problem of avoiding excessive exposure to the sun was likely more difficult of solution for young Red-tailed Hawks than for the other cliff-nesting birds which were in crevices or otherwise located in shady niches. The hawks nesting on the top of a pinnacle were seen to move out of the nest at 33 days of age (June 19, 1937) and cling precariously to a few sticks on the edge of the pinnacle where they were on the north side, in the shade of the tall, bulky nest—the only



BOOK CLIFFS REGION, UTAH.—(*Top fig.*) ROCKY SLOPES AROUND BASE OF PIGMY CONIFER FOREST, OFTEN NEARLY BARREN; A TYPICAL NESTING AREA FOR THE ROCK WREN. (*Middle fig.*) JUNIPER TREE AT EDGE OF A SAGE-COVERED FLAT; A NESTING SITE FOR THE MOUNTAIN BLUEBIRD. (*Bottom fig.*) LEDGES AND PINNACLES AT EDGE OF MESA; BARE, ROCKY SLOPES IN BACKGROUND. A NEST OF THE RED-TAILED HAWK ON PINNACLE IN THE FOREGROUND.

shade on the pinnacle. This was repeated during June 22. A large branch of jointfir (*Ephedra nevadensis*), observed in the nest on June 24, may also have been placed there to help shade the young birds. On June 26, the young hawks were again in the nest, evidently enjoying the sunshine, because the weather was cooler after the rain of the previous night. The extreme heat of the previous week was over. On July 6, at 50 days of age, one young hawk had flown to a near-by dusty area and was seen taking a dust bath.

The food of the young hawks, in addition to numerous jackrabbits and blowsnakes, consisted of Nighthawks and Mourning Doves, remains of which were observed in the nest. No prairie-dogs (*Cynomys leucurus*) were seen in the nest, even though these rodents are abundant in the area near the nesting site. Red-tailed Hawks were observed feeding upon Uinta ground-squirrels (*Citellus armatus*) ten miles north, in the aspen area of Emma Park.

NESTING SUMMER RESIDENTS

Fourteen species may be classed as summer residents, nesting in the pigmy conifers. Four of these are not abundant. The Broad-tailed Hummingbird (*Selasphorus platycercus platycercus*) is encountered occasionally during the summer as it feeds from some of the numerous flowering annuals. One nest was found in a piñon in Huntington Canyon, Emery County, in 1932, but no nests were found near Price, although because of its habits it is presumed to nest there. The Ash-throated Flycatcher (*Myiarchus cinerascens cinerascens*) which usually nests in trees has been observed near Price two times. On July 10, 1937, two of them were seen in mating antics as they alighted in a juniper and then continued their flight northward, deeper into the pigmy conifers. Say's Phoebe (*Sayornis saya saya*) is sometimes found feeding in the conifers during the summer. It likely nests on the near-by ledges, but no nests were taken from this area. At higher altitudes, near the cliffs at Sunnyside, a few specimens of Cañon Wren (*Catherpes mexicanus conspersus*) were taken. They possibly nest in that area.

The ten other summer residents of the pigmy conifers may be divided into four groups upon the basis of their nesting habits. These are birds nesting in tree cavities, those nesting in or on limbs of trees, those nesting upon the ground, and those nesting in cavities in or beneath rocks.

Cavities made by winter-visiting woodpeckers in living junipers are commonly utilized by the Mountain Bluebird (*Sialia currucoides*) for its nests. Nest construction may not begin until April although the birds arrive between January 28 (as they did in 1938) and February 29 (as in 1936), depending upon weather conditions.

Nesting material was being carried into one of these juniper cavities on April 24. The hole was too small to allow one to feel the nest and it would have been impossible to move part of the trunk without great destruction—hence the exact condition of affairs in this tree could not always be ascertained. On May 13 the birds were incubating, but on May 28 they were carrying food into the nest. On June 1 the young were noisy when the entrance of the nest was touched. The young were outside the nest, June 14. Twelve days later the male was again incubating. On July 10 the second brood seemed to have hatched. No adults were seen near the nesting cavity after August 6. Large flocks of Bluebirds were foraging throughout the pigmy conifers after the first brood had left the nest.

All Bluebird nesting cavities studied were in living junipers from three to five feet above the ground and all but one were holes made the previous winter. Bluebirds nest in cultivated areas and higher in the mountains in the aspens but are unable to nest in the shadscale and greasewood areas because of the lack of cavities. They are thus confined to areas where there are plants large enough to furnish nesting cavities.

Likely both the Horned Owl and the Sparrow Hawk are enemies of the Bluebird for this species is alarmed when either of the two appears. The Red-tailed Hawk does not seem to alarm Bluebirds in the same way as do these birds of prey.

Six species of birds are known to nest in the foliage or on the limbs of trees in this scrub forest. The American Magpie (*Pica pica hudsonia*) often nests in colonies, but individual pairs may nest separately from others. Two groups of nests formerly used by Magpies but unoccupied at the time of this study were all that was left of a fairly large Magpie population, thanks to "sportsmen." A newly constructed nest in a piñon was found April 10, 1937, on the Farnham Dome, ten miles east of Price. The bottom of the large bundle of sticks was lined with mud and rootlets and contained three eggs of a brown-mottled, bluish color.

Four half-grown young Magpies were in a nest discovered in a cottonwood tree near an irrigation canal at the edge of the pigmy conifers four miles west of Price on May 28, 1937. These and a few stragglers observed between March 20 and November 11 seemed to comprise the remnants of a once fairly abundant Magpie population.

The Western Gnatcatcher (*Polioptila caerulea amoenissima*) is known to saddle its felt-like nest upon a small branch in the trees of the pigmy conifer areas of Tooele and Washington counties of Utah, but no nests were taken in the Price area. It is presumed to nest in this

area because twenty-six different entries on as many different days record different places where the species was observed between May 8, and August 6, 1937. It was not observed in any other habitat than in the pigmy conifer area.

A female Black-throated Gray Warbler (*Dendroica nigrescens*) was observed feeding a young just out of the nest on June 19, 1937, in the pigmy forest near Price. This female kept up a continual sharp chipping as she fidgeted about in a piñon tree; meanwhile she gathered soft-bodied insects, having layer after layer hanging from her bill at one time. A male that approached was repulsed by her, but a second male which came near a minute or so later and gave a few chirps of alarm was hardly noticed by the female. She busied herself gathering insects from the tufts of piñon needles and was seen to be without her food after a visit to one particularly thick cluster. In this piñon tuft was found a young bird just out of the nest.

When discovered, the young bird jumped to the ground and tried to escape by hopping through the thistles while the female set up a great fuss, chattering and fluttering her wings. She did not try to feign an injured wing. It is interesting to note that this bird did not try to conceal the presence of her young by swallowing her food in the presence of an observer as did female Mountain Bluebirds, Desert Sparrows, and Lark Sparrows.

This warbler was common from May 1 to late July and was observed in no other area than in the pigmy conifers.

The Common House Finch (*Carpodacus mexicanus frontalis*) occurs in the Price area throughout the entire year. However, it was not found in the pigmy conifers during the winter months—that is from September 1, 1936, until April 11, 1937. Large flocks of these finches congregated in the box elder trees around the town and farms where they fed upon the dried seeds during the cold weather. They were known to nest in the town as well as sparingly in the conifer area. Almost any tree which provides thick cover near the ground—within a few feet—seemed to be used for the nest.

A nest of the House Finch contained four eggs on April 25. The last of these hatched May 8. After the young had left, this nest was remodeled and contained three eggs on May 25, but the nest was empty the next day. A female finch was seen carrying a twig through the pigmy forest on June 29, but she dropped it after she had been watched for about ten minutes. This was believed to be intended to help repair a nest for a second brood. A male was observed feeding a young one which begged food by approaching him and fluttering its wings on July 13.

Western Chipping Sparrows (*Spizella passerina arizonae*) reappeared April 17, 1937, but the males were not distributed into territories and singing from their individual perches atop conifer trees until May 8. Occasionally Brewer's Sparrows (*Spizella breweri breweri*) were seen in the flocks, but they were not known as nesters in the pigmy conifers of this area, although they did nest in greasewoods on the more arid flats below.

Chipping Sparrows were carrying nesting material on May 24, while on the same day other individuals were seen copulating. Young were observed out of the nest on June 22 while near-by adults were copulating for a second brood. A nest containing two young sparrows was located where it was well hidden on the brushy tip of a piñon limb. This nest was made with an outer supporting framework of dried Russian thistles and was lined with vegetable fibers and horsehair, although it was built in a fenced area from which grazing had been excluded for over two years and horses had not been allowed within two miles. Eight days later the nest was empty. Flocks of young were seen in many places in the forest where they were being fed by adults.

The kinds of seeds and insects consumed by Chipping Sparrows are undoubtedly eaten by other species of birds, thus likely helping to reduce the numbers of birds living in any area. A Chipping Sparrow was seen chasing an insect from one sagebrush to another when a Mountain Bluebird flew down and caught the insect before the sparrow was able to overtake it. The sparrow pursued the bluebird through the air until the food had been swallowed, whereupon the sparrow returned to its original perch.

The Western Mourning Dove (*Zenaidura macroura marginella*) is very adaptable in its nesting habits. It has been found to nest beneath sagebrush on the ground, in cavities in cliffs, and on the upper surface of horizontal juniper limbs as well as in the thick, matted limbs of a greasewood. The majority of them in the Price area nested upon the large, horizontal branches of living junipers. No nests were found in piñons, probably because the more erect branching of this tree does not provide satisfactory sites for slovenly Mourning Dove nests.

The return from the south was noticed on April 19 when the doves reappeared on the shadscale flats near Price, but they were not seen in the pigmy conifers until a week later.

A Mourning Dove nest was discovered on a large horizontal branch of a juniper about four feet from the ground on May 8. It was made of a few dried grass stems and contained the usual two eggs. The

incubation period was determined to be equal to, or greater than, sixteen days. The two young hatch within two days of one another, indicating that incubation is continuous after the first egg is placed in the nest. At least two broods were raised during the season. Birds that hatched in one nest on May 29, 1937, flew after but a ten-day period. The last brood of doves found left its nest on August 5 and the doves were not observed in the pigmy conifers after September 1.

Protection of the young from sun and rain is provided by one of the adults which usually remains on the nest during a large part of the day. Despite this, one young was killed in its nest by a hailstorm. The adults seem to rely upon their protective coloration which greatly resembles the gray color of the dead limbs upon which they nest. They fly only when approached within a very few feet. The adult will try to distract attention by the pretense of having an injured wing. One individual that fluttered from the nest in extremely 'crippled' fashion was seen to approach the nest in a circuitous manner a few minutes later, but upon observing that the writer was still in the vicinity, immediately it again became 'crippled'. Red-tailed Hawks fed upon Mourning Doves. The antelope ground-squirrel (*Citellus leucurus pennipes*) destroyed eggs in one nest.

Ground-nesting birds, other than the ubiquitous Mourning Dove, include the Western Lark Sparrow (*Chondestes grammacus strigatus*) and Howell's Nighthawk (*Chordeiles minor howelli*). The latter can hardly be called a nester since it simply deposits its eggs upon the ground beneath a tree.

During the courtship period of early June, immediately after the arrival of the Howell's Nighthawk, these birds fly during the daytime. A *whirrzz* sound is made as the air rushes through their wings when they dip upward at the end of a long vertical dive and then give a sharp vocal *peep*. From early June until early July, two birds are often flushed from beneath the same tree during the daytime, but later in the summer only one bird is found in a given place. The neutral, broken pattern of the Nighthawks is a very effective protective device since they are very difficult to find unless they move.

One egg was found on the ground beneath a juniper on the morning of July 2, 1937. This one egg was incubated until July 15, after which the adult was no longer seen. Whenever this adult was flushed during the period of incubation, she flew very low, fluttering below the tops of the pigmy conifers as if to escape the notice of a near-by, omnipresent Sparrow Hawk. It is thought possible that she may have fallen victim to one of these small hawks or perhaps a Red-tailed Hawk since Nighthawk remains were observed in the nest of the latter.

Two newly hatched birds were found beneath a juniper on July 10. These baby Nighthawks remained in the same place until seven days later. They grew rapidly while the dark pin feathers pushed through the buff-colored down and when last seen they were able to walk with a queer, rolling motion, with wings held aloft. The last young observed in this area left the nest on July 21. Five nests were found. One contained one egg, two had one young each, and two had two young in each.

Sixteen or eighteen pairs of Nighthawks were usually visible at one time in the evenings, early in the summer, as they flew over the pigmy conifers. Later in the summer the birds were not observed to fly and hunt their food in pairs and the flock seemed to be larger, undoubtedly because of the addition of young. Very few Nighthawks were present after September 15, 1937.

Male Lark Sparrows appeared in the area on May 8, and selection of territories began soon after. From the top of a high sagebrush or a lone tree, they poured forth their songs from daylight until dark and occasionally even afterward. This species favored the area where sagebrush-covered flats adjoined the thick conifers.

The nest of the Lark Sparrow, sunken slightly in the ground and hidden beneath a pile of dried thistles or a matchbush, was made of small sticks and juniper bark and lined with horsehair and vegetable fibers. Usually the nest is placed at the edge of a clearing, but one was found in the thick conifers.

Eggs were deposited in the morning, one on each of consecutive days. One nest contained one egg on May 23 and its full clutch of four on May 26. All of these hatched on June 6 (incubation period: 11 days) suggesting that during the laying period they were not under constant incubation. However, each time this nest was visited during the laying period, an adult was flushed from the nest. Ten days after hatching, these young left the nest although they were not completely feathered.

The young sparrows hide in the sagebrush and thistles and are fed by the adults. Moths, grasshoppers, and caterpillars seem to comprise the main items of food carried by both parents to the young who quickly come out of concealment at their approach.

The nests observed were not used for a second brood although it seems that another brood is usually raised. On July 6 a nest contained two eggs and a third egg was added the next day. On July 17 two eggs hatched and the next day the remaining egg was missing from the nest. The nest was vacant after the young had been in the nest nine days.

After the young of the first brood have left the nest, all territorial areas seem to be broken down. Flocks, each comprising a family, wander at will. Occasionally a female will be courted by more than one male and there may be minor skirmishes for possession. This seems to take place until new boundaries are set up. The female may be entirely inattentive while she is engaged in carrying grasshoppers to the young, but this does not stop the male from singing and fluttering about her. While the young are in the nest, the male assists in the task of feeding, but when they can fly well, which is about fifteen days after they have left the nest, he no longer helps.

Small cavities beneath rocks and similar semi-underground situations are favored by the Common Rock Wren (*Salpinctes obsoletus obsoletus*) for its nesting activities. This bird returned April 10, 1937, after having been missing from the pigmy conifer area near Price since the previous November 7. Nest construction took place early, for some eggs hatched before May 18, 1937. Nests of Rock Wrens were found on rocky slopes near the pigmy conifers and on the near-by shadscale flats. Usually a tunnel from six to twenty inches in length leads to the nest. The numerous characteristic pebbles were placed at each nest entrance. One nest built on the near-by shadscale flat under a large, somewhat isolated rock had small lengths of broken shadscale stems substituted for the pebbles.

The nest which was decorated with sections of stems contained eight eggs on June 24. These all hatched the morning of July 8 after being incubated a few hours more than fourteen days. After the young had left, this nest was destroyed by an antelope ground-squirrel before it could be used for a second brood.

Six young Rock Wrens were in another nest when it was discovered May 18. These young left the nest May 26. This nest was not occupied by a second brood. Yet another nest discovered May 24 contained seven eggs which hatched June 6. The young left the nest June 20. A second brood occupied this nest; the first egg was deposited July 20 and one each day thereafter until the sixth on July 25. Incubation did not start until the last egg had been deposited and all eggs hatched the afternoon and evening of August 7 (incubation period: 14 days). The nest was again empty August 22.

The young wrens scatter through the rocks and conceal themselves after they leave the nest. When the second brood is being incubated and fed in the nest, the first brood passes into the pigmy forest to feed. Between mealtimes, the five to eight young return to the area near the nest.

Usually all of the wren eggs hatch, but one nest discovered June 26

contained an egg which failed to hatch. The other five eggs hatched July 2 and the wrens were feathered out when they left the nest July 13, leaving the unhatched egg which was still unbroken.

A pair of wrens raising two broods of six to eight per brood would increase the population fourteen or more so that the number of wrens is greatly increased by autumn. As far as can be determined, most of them leave the area in the autumn, but about the same number that inhabited the area the previous spring reappear the following spring, thus suggesting a high mortality rate during the autumn and winter.

Enemies of the Rock Wren possibly include the striped racer (*Masticophis taeniatus taeniatus*), which is common in the area, and possibly the desert wood rat (*Neotoma lepida*), which builds its nest beneath rocks in the same areas. The snake would likely prey upon such birds as it could obtain, while the rat would destroy or replace the nests with its own structures. The antelope ground squirrel probably is also destructive to these birds.

NICHES

In order to support a large number of species of birds, it is necessary that an environment supply a number of habitats so that each kind of bird may find its own particular niche where it can successfully rear its young. Should two species of birds be too similar in all their habits it is likely that one will be crowded out by the other. This is chiefly avoided by differences in nesting and feeding.

Each of the twenty-two kinds of breeding birds observed evidently has its own niche. It was impossible to delineate exactly all of the habits and factors which allow these many forms to inhabit successfully this desert area, but significant ones have been pointed out where possible.

Eight kinds of birds were able to live here throughout the year, of which five were attracted by the favorable nesting sites offered by cliffs. These five avoided competition with one another because they chose different sizes of cavities for nests, because one of them is nocturnal, because another is omnivorous in its feeding habits, because another feeds largely upon insects, because of differences in their size, and for many other less apparent reasons. The three obligate residents avoid competition by differences in food and feeding habits as well as differences in nesting.

Some birds, such as the hawks and owls, prey upon other birds, although birds evidently do not form the principal item in such diets.

Fourteen summer residents were able to find food such as flowers, seeds, and insect life, in spite of the harshness of this arid area. These

avoid competition by leaving the area during the winter when their kind of food is less abundant. They find at least four different kinds of nesting sites and avoid competition in food getting because one feeds from flowers, another catches its insects by flying with wide-open mouth in the higher levels, others feed upon insects caught on the wing in flycatcher fashion, some obtain caterpillars and similar forms from twigs, others get insects from the bark of trees, many find food upon the ground, while still others rely mostly upon seeds.

As an example: the Mountain Bluebird was seen to catch flying insects from the air much like a flycatcher. Thus it may rival the Phoebe. It was observed in active competition with the Chipping Sparrow. Even though there is this overlapping, this cavity-nesting thrush finds its own particular niche and is able to maintain itself in this area.

SUMMARY

1. This is a report upon the pigmy conifer forests of the arid Book Cliffs region of eastern Utah and some of the habits of the twenty-two species of birds which breed there.

2. Some birds favor a permanent home in the pigmy conifers and face extremes of aridity, heat, frost and other weather conditions throughout the year. These species breed here, raise young and can be called obligate birds of this plant association. These are the Piñon Jay, the Gray Titmouse, and the Lead-colored Bush-tit. These birds differ in their methods of feeding and nesting in the same area, and thus each finds its own particular niche.

3. Their presence determined more by rocks and cliffs for safety in nesting than by pigmy conifers, the Western Red-tailed Hawk, Golden Eagle, Eastern Sparrow Hawk, Montana Horned Owl, and American Raven are permanent residents in this area.

4. Fourteen other species of birds are summer residents of the pigmy conifers. Of these, four were scarce in the region. Most of these are passerine birds and are primarily insect and seed eaters that, in winter, are unable to find sufficient food of the proper kind and hence must migrate from here and return at the winter's end. They nest in cavities in trees, in the limbs of trees, on the ground, and beneath rocks upon the ground.

5. Each kind of bird has one or more characteristics which cause it to differ from the other birds in the area and hence it is able to survive with them because of this partial elimination of competition. Such habits as food getting, nesting, incubation periods, and similar adaptive activities are listed when observations permit.

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THE BARBETS

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THE Capitonidae or family of barbets is found throughout the tropical regions known as the Ethiopian in Africa, the Indian, including the Indian, Indo-Chinese and Indo-Malayan subregions in Asia, and the Neotropical region in the New World. The family is not easily defined. In general it may be said that the Capitonidae are zygodactylous perching birds with ten tail feathers. The wings and tail are rounded. The bill is stout and strong with the culmen having a tendency to curve and with the tip pointed.

In most cases these birds present rather a squat, stubby appearance. The perching position tends to be straight up and down. Almost all the species are found in areas of high trees, either deep forest or old gardens. Some forms range high into the mountains over seven thousand feet. Others are exclusively lowland dwellers. Barbets excavate their nests after the fashion of woodpeckers, usually in rotten parts of tree trunks. However, one genus, *Caloramphus*, is said to excavate nesting holes out of termite nests, and an African form is reported to nest in holes in the ground—(*T. margaritatus*) *vide* Friedmann (1930: 463). As in woodpeckers the bill is used in excavating, and the attitudes and climbing habits in trees often closely resemble those of the Picidae, even to the use of the tail as a support.

As with most tropical birds, the nesting season tends to be variable and drawn out. Barbet's eggs are white and rounded, thin-shelled and rather glossy. The flight of these birds is fluttering, often appearing clumsy, and not long sustained. Their calls are, for the most part, characteristic harsh monosyllables uttered over and over, *i. e.* the Asiatic "coppersmith," although other species utter low whistles or soft wailing notes.