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THE ATTRACTION OF PURPLE MARTINS TO AN URBAN LOCATION IN WESTERN OREGON

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The Purple Martin (*Progne subis*) has been decreasing in numbers for many years and has practically disappeared from some sections of the North American continent where it formerly was an abundant summer resident, utilizing man-made nesting sites. Wherever the Purple Martin has nested on farms or in urban localities, it has been appreciated because of its many interesting and valuable qualities.

A recent regional report (Griscom, 1952:274) gives welcome news of the re-establishment of two Purple Martin colonies in Massachusetts, the first in the state since a disastrous, prolonged cold spell wiped out the martins early in the spring, half a century ago (Forbush, 1903).

"Often difficult to lure to a nesting box. Its presence justifies the effort." These views of William Vogt, entered in the caption under plate 22, The Purple Martin, in Audubon's "The Birds of America," may be taken as the theme of the project carried on in the southern Willamette Valley in Oregon during the past five years. Starting in 1948, the writer began to consider by what means the Purple Martin could be induced to nest in bird boxes at an urban location in western North America. The city of Eugene is at the southern end of the Willamette valley in west-central Oregon, about fifty miles from the Pacific coast and an equal distance from the Cascade mountain range. Gullion (1951) has adequately described the climatic and topographical features of the region.

The urban location is a residence plot on flat terrain, facing a busy cross street near the edge of Eugene. The rear of the property is adjacent to a one-acre expanse of gravel parking space utilized by school busses; adjoining this is an undeveloped city park area of several hundred acres drained by a sluggish creek which comes from nearby foothills. There are few trees in the immediate vicinity but a number of insulated telephone and electric wires extend across both the rear and front of the lot between the cross-arms of large telephone poles.

Seven species of swallow, including the Purple Martin, are summer residents in the region, but the Purple Martin occurs in small numbers relative to the others. It nests so remotely and flies at such heights that it is absent as far as the general public is concerned and rare or uncommon in the experience of the majority of those interested in birds. To one who has formerly spent pleasant hours watching and listening to Purple Martins in his yard, the martin's status in the west seems unfortunate, for the species represents an undeveloped avian resource which would likely respond favorably to active human assistance such as the erection of suitable nesting sites and action taken against its enemies and competitors.

ESTABLISHED COLONIES

In the major portion of the continent east of the Rocky Mountains, the Purple Martin is a dooryard bird, nesting almost exclusively in houses erected by man, and the observation of a wild nesting site is so uncommon that it merits a published field note. In the west coast states, the reverse is true. At the present time, as far as I can ascer-

tain, the only house colonies of Purple Martins in Oregon are those occupying bird houses on the Southern Pacific railroad drawbridges near the mouths of the Umpqua and Siuslaw rivers. In coastal cities of both Washington and California, Purple Martins nest on business buildings and around other structures. Doubtless, house colonies exist at scattered points in these two states, especially in California, but most reports of Purple Martins' utilizing bird boxes in areas west of the Rocky Mountains were made ten or more years ago.

For the past nine years, martins have been returning to the Umpqua River drawbridge. The bird houses they occupy thereon are under the eaves of the small yellow house containing the drawbridge machinery, high over the water atop the center of the bridge. There is great noise and vibration when the heavy engine is operating to revolve the center span 90 degrees as river traffic approaches. These gyrations, that occur from ten to fifteen times daily, as well as the passing of numerous steam and Diesel trains directly under the martin houses apparently disturb the martins but little. Except for incubating females, the birds fly out and circle nearby during the disturbances.

The bridge-control men first put up small houses for swallows about ten years ago. These were constructed of unpainted plywood and soon began to disintegrate. The original 1½-inch opening in one of the boxes became enlarged, and in 1944 a pair of Purple Martins took the box. Other crude boxes with larger openings were then put up, and, although the largest of these was only 5×5×6 inches, some successful nesting took place in the next few years according to the bridge tenders. Before the return of the martins in 1952, the old houses were taken down and new, weather-resistant houses totaling 17 apartments were installed under the eaves. The old houses were found to be leaky and filled with a ten years' accumulation of damp debris; mites and lice were abundant under the nesting material. Dead nestlings and adult birds as well as old eggs were noted. One triple-unit house had a nest of an English Sparrow (*Passer domesticus*) in one end and a martin nest in the other; a group of small bumblebees flew in and out of the middle unit. These boxes had been placed well back against the building under a widely overhanging eave and bore no resemblance to the traditional martin house on a pole; in fact they were little more than holes in part of the building. The new units, painted yellow, were 7×8×8 inches with 2¼-inch doorways within one inch of the floor. Six of the new units were utilized by martins in 1952, including two apartments on the west side of the bridge, where no houses had been previously. These two faced the direction of prevailing, stormy winds from the ocean.

The second artificially established colony of Purple Martins in Oregon is on a similar drawbridge over the Siuslaw River, 15 miles north of the Umpqua. Six adequate units were placed on this bridge powerhouse, 60 feet above the river, in the spring of 1952, and three of the units were shortly occupied by martins. This establishment was an unexpected success and may indicate a shortage of wild nesting sites as well as a preference for nesting in colonies. In Connecticut, where the paucity of Purple Martins is lamented by those interested in birds, an unsuccessful attempt has been made over a seventeen year period to spread a colony to other nearby boxes placed from one-half to fifteen miles away from the still existing colony at Westport. Apparently, the population in this colony is dwindling, according to Michael Oboiko, the sponsor of the colony.

WILD NESTING SITES

In the West, the Purple Martin is perhaps most often noted by former residents of the eastern, midwestern, or southern United States. On a quiet day, the high-flying martin's song may be heard at a great distance and for this reason one familiar with this species often knows the martin is overhead, even though he cannot locate it. Gabriel-

son and Jewett (1940) said, "We consider the beautiful and companionable purple martin a decidedly uncommon bird in Oregon." But Gullion (1951) later listed this species as a common summer resident while Mr. Ben Pruitt has seen and heard martins high over the southern Willamette Valley almost daily in summer. He first noticed them ten years ago and found a nesting site in 1945.

In 1950, after considerable search, Pruitt and I found numbers of martins feeding and perching about an urban location on the fringe of the Eugene-Springfield area, and we later ascertained that most of these birds took off each evening up Camp Creek canyon in the direction of Mount Nebo, one of the higher foothills (2500 feet) of the Cascade Range, twenty miles northeast of the spot where they perched each afternoon. A few martins were observed homing in other directions into the surrounding foothills. At one time, Pruitt counted sixty of these martins perching on the high, dead tree they frequented. One summer passed with numerous field trips made in an unsuccessful effort to locate nests of these birds.

In the second year of search I finally located a number of nesting sites near the top of Mount Nebo at about 2000 feet elevation. On a flat promontory of several acres, in a burned-over area, there were close groups of magnificent, gray, coniferous snags almost devoid of limbs and from 150 to 200 feet in height. Thirteen holes were noted high in the tops or sides of the snags by watching martins enter and leave. The spot had a commanding view of many miles, and it was interesting to note that from here the perching and feeding area in the urban district where Purple Martins were originally found could be identified through binoculars.

Because the most valuable resource of the Northwest is timber, the prevention and control of fire in the forests is of foremost importance; it is unfortunate for hole-nesting species that on Oregon's 9,987,000 acres of privately owned forests, the major lumber interests have embarked on an intensive program of systematically felling snags and dead trees which, due to their height, are frequently struck, splintered, and ignited by lightning. The fire-control crews have a special dislike for tall snags since fire may quickly go out of reach to the tops and be scattered beyond control lines by the wind. On the 15,251,000 federally owned or managed acres, the Forest Service rules require the felling of all snags within and for an additional 200 feet about all logging areas. The state also has regulations regarding the felling of snags on 1,101,000 acres of state-owned timber, according to Ross (1950).

The huge snags in the Mount Nebo location, supporting what appeared to be the major Purple Martin colony for this part of the county, were all torn down in the winter of 1951, as was the favorite perching tree 20 miles away, in the valley, on the edge of town. I have been unable to find any new loafing site where the birds perch in the afternoon, but I assume that in the mountains the martins have taken over other snags for nesting. It should be kept in mind, however, that these relatively soft-beaked birds require a special type of snag—one that has been extensively processed by woodpeckers. For such a snag there will be considerable competition.

Another factor that will no doubt affect the welfare of the Purple Martin in its primitive nesting sites is the campaign currently waged against the spruce budworm (*Choristoneura fumiferana*) in this region. The especially deleterious DDT-oil mixture is sprayed by plane over certain infested areas designated by field men or airborne spotters. One pound of DDT to a gallon of fuel oil with one pint of hydrocarbon solvent added is used in a concentration of one gallon of spray to the acre. A half million acres are scheduled to be sprayed in the spring of 1953; some three and a half million acres already have been sprayed in the present three-year program. In 1952 the spraying of DDT took place in May. The Douglas fir beetle (*Dendroctonus pseudotsuga*) started

an alarming epidemic of infested, living trees in the fir forests of western Oregon in 1950 and is now receiving specific attention. The only known way to combat this pest is to clear forests of windfalls, fire-scorched trees and infested timber as soon as possible. These clean-up programs will no doubt materially reduce the number of old snags in the forests of the West, for loggers in many instances are laying aside their normal logging plans in order to salvage merchantable windfalls, infested timber, and fire-scorched trees; even the very old, dead snags often contain considerable sound lumber.

The data from Ross (1950) indicate the extent of Oregon's forests wherein a perpetual supply of dead trees might be expected but for the clean-up program. The pests will receive increasing attention, for today insects and disease destroy more trees than fire. Officials of the Willamette National Forest are cooperating in a new project to erect boxes of simple construction in the forest to replace the destroyed homes of hole-nesting species and possibly to augment the swallow populations. Imagoes of both the spruce budworm and the Douglas fir beetle fly about during the mid-summer when swallows are most active.

In the coastal area adjacent to the Umpqua and Siuslaw rivers, a number of wild nesting sites have been found in old pilings used in log-rafting operations on the coastal streams and lakes. Apparently the Purple Martin is more abundant here than in the Willamette Valley, for many inland residents reported having seen martins only along the coast. The Oregon coast is heavily forested, but the martins seem to prefer old piling well surrounded by water. Most of these tree trunks protrude less than ten feet above the water. One nest was found at only five feet above the lake level, which is within ten feet of sea level. This finding, considered with Huey's (1936:125) report of Purple Martins nesting in Arizona at an elevation of 8600 feet, further indicates that this species must nest wherever it can find suitable sites, even where the general surroundings are not ideal. The scarcity of nesting sites both on the coast of Oregon and inland prevents martins from nesting in colonies as they would no doubt prefer to do. A large number of holes in trees and piling were examined by means of ladders, climbing irons, and the use of boats when necessary. Fully fifty per cent of the openings which appeared to be sites of hole-nesting species when seen from a distance terminated blindly within a few inches or ended in fist-sized cavities where woodpeckers had ceased excavation for one reason or another.

APPARENT NEED FOR CALCIUM

When martins were first found at their perching and feeding areas locally, it was noted that they settled on the ground surprisingly often. They were seen to be searching for and picking up small, light-colored particles most of which they flipped away as they continued walking about. Several areas where I saw martins fly down more than once were inspected. The spots were either dark, top soil in cultivated fields or expanses of grayish, black gravel made from crushed, basaltic rock. The cultivated fields had been fertilized with chicken-house sweepings which coincidentally contained small amounts of crushed oyster shell and a trace of granite grit.

Beal (1918:5), in listing stomach contents of Purple Martins, expressed curiosity when he found the vertebra of a fish and a small piece of mollusk shell. Seibert (1942) reported martins landing and picking up something from light-colored soil on the side of a steep bank in the San Francisco Bay region. Bent (1942:498) reported correspondence with Farley who had seen Purple Martins pulling at oyster shell in stucco buildings. Many martin fanciers have provided egg shell for their colonies.

In Eugene, in 1952, I observed a martin try without success to pull a small white particle from a freshly poured cement column. In July, 1952, I went to a reservoir on

a hill top a mile from my home where I had seen martins flying about and tested their interest in egg shell. The concrete reservoir is covered and the top is a flat expanse of about four acres of cement. Waiting until martins were a short distance overhead, I threw a handful of crushed chicken egg shell upon the reservoir top and backed away 30 yards. The flying birds noticed the shell at once and made passes to look at it closely. Within two minutes, a female alighted and picked up several small pieces and flew away. In the next ten minutes another female and two males came down to the spot to eat and apparently carry away some of the material. A week later, I returned and could not find any of the shell. The well leached, acid soil of western Oregon is low in lime (Powers, Jones, and Ruzek, 1939); also calcium carbonate outcroppings are absent so that calcium salts are seldom available in visible form in the dark, volcanic crust.

Mrs. William Schnorenberg, who resides on a hill top about five miles to the west of Eugene, reported that in the summer of 1950 she marked out the dimensions of a proposed driveway by pouring streaks of slaked lime from a sack. Later in the day she saw large, black swallows come down and take beakfuls of the powder and fly away. They made several trips in the next three days. Mrs. Schnorenberg subsequently located a Purple Martin nesting site in a tall snag on her acreage.

AVAILABILITY OF BIRD BOXES

Apparently the Indians of western North America did not put up artificial nesting sites for birds as did the Indians of the eastern and southern regions. According to Twining (1931:90), the Indians of the West called the martin "the bird that never rests"; so perhaps this bird has always nested in scattered, remote places throughout the West.

Few bird houses seen about Oregon are adequate for martins. The most common inadequacy noted is smallness of the opening; skimpy size and poor location are also repeatedly seen if one notices bird boxes. Many well-built, advantageously placed houses are seen with openings of one inch or even less. Most of the older Oregonians never have known the Purple Martin and the newcomers who are familiar with the bird often do not know it is here; this may be the reason why desirable nesting boxes have not been put up in large numbers with Purple Martins in mind.

Questionnaires were sent out to 100 individuals in western Oregon known to be interested in birds, as indicated by their participation in annual bird counts, compilation of avifaunal lists, and/or active membership in the Oregon Audubon Society. The results of the questionnaire (table 1) indicate that this not uncommon species does not receive the attention it deserves.

Table 1

Frequency and Abundance of Purple Martins as Determined by Questionnaires Received from 86* Observers in Western Oregon

Never observed 45	Seen once 12	Seen occasionally 16	Seen frequently or each summer 13
Abundant 0	Very common 0	Common 8	Uncommon 39
		Rare 37	Absent 2

* Thirty-one observers had known martins elsewhere in the United States; 19 of these never saw the species in Oregon. Eleven had erected one or more suitable bird boxes with 2-inch openings. Sixteen had observed nests.

More than forty units of housing for Purple Martins were erected by me within a ten-mile radius of Eugene in the past five years. Ten units have been up for three years and several units for five years. These houses were traditional, white, multiple-unit martin boxes on fifteen- and twenty-foot aluminum poles. Fourteen units were placed

atop an eight-story business building; of these, eight built together in a house, were erected on a tall pole upon the roof, and the others were tucked under the eaves at the top of the building facing an area one mile distant where martins have been repeatedly seen. No one has reported a prospecting martin at any of the boxes on the building or elsewhere. Tree Swallows (*Iridoprocne bicolor*), Violet-green Swallows (*Tachycineta thalassina*), and English Sparrows have taken some of the lower boxes. In suburban areas, two boxes were taken by Western Bluebirds (*Sialia mexicana*) and one by a House Wren (*Troglodytes aëdon*). Each spring there is considerable activity of Tree Swallows around the boxes on the business building at the eighth floor level and above, with half-hearted attempts at nest building. Tree Swallows have nested successfully in boxes on the window sill at third floor level for the past two years, but there has been no successful swallow nesting in the other, fought-over spaces higher up. Only fifty per cent of the 40 units erected in the Eugene area have been utilized.

The Purple Martin in this region apparently has little interest in bird boxes, for even though I have had wild martin visitors about my home frequently in 1951 and 1952, I have seen only one of these visitors ever alight on a bird house and inspect it in spite of the presence of five houses on poles around the back yard. In late July, 1952, a martin came several successive mornings and examined the same double-unit house on a pole. The bird was apparently a year-old male, not banded. The wild birds visited because of the presence of young, hand-raised martins in the back yard. The visitors would usually circle slowly overhead or perch for a few minutes on wires adjacent to the property.

COMPETITION FOR BOXES

The English Sparrow, Western Bluebird, and to a lesser extent the House Wren are important competitors for the swallow boxes. That Tree Swallows may prevent the establishment of a martin colony merits some consideration. Both Tree Swallows and Violet-green Swallows are present in large numbers in western Oregon, and as soon as they arrive in late February and March, they begin to inspect and fight over the available boxes. Thus, when the Purple Martins arrive in mid-April or May the smaller swallows are well situated. Pairs of these less sociable species often choose a multiple-unit house and allow no other swallow to use any of the vacant cells. This is not true of English Sparrows, which may co-occupy such a house with martins. In Tree Swallows, however, even before serious nest building begins, a male will select a house and drive all birds from adjacent houses within 75 feet of his own, especially if the houses are in front of his. In regions where martins are not using houses and where Tree Swallows are abundant, the latter should be considered the principal deterrent to the establishment of Purple Martin colonies. Evidence for this is given in the following paragraphs.

In discussing Purple Martins and their troubles with Tree Swallows in Massachusetts, Bagg and Eliot (1937:392-394) state that "Tree swallows have established large colonies; occupy all available houses before martins come and resent the occasional attempts of their larger cousins to lodge beside them. The mobbing of house-hunting martins by tree swallows is an all too frequent sequel to the hopeful erection of a martin house."

Kuerzi (1941:14) reported that a colony of Tree Swallows he observed would allow four species of swallow to enter into their bounds to feed or gather nesting material; however, the appearance of a Purple Martin caused considerable agitation, and the larger swallow was driven off. Weingartner (see Nichols, 1952:276) noted Tree Swallows take over a martin house and drive the later arriving martins away when they attempted to co-occupy.

Allen (1952:644), who spent many hours studying Purple Martins, thought that the martin's fighting ability was mostly bluff, because it gave up easily if an opponent persisted. He noted that martins too often fought as individuals rather than as a group and that a male English Sparrow or Tree Swallow often bested a male martin in individual combat.

In 1952, I observed several Tree Swallows at my colony as they spotted two approaching Purple Martins at a distance of 200 yards. Giving alarm calls, the Tree Swallows charged out to meet the martins and harassed them as they would hawks until the martins turned away. It is felt that a well established martin colony could return and repossess its nesting spaces in most instances, but if a solitary martin, scouting for a location, received such attention as the birds just mentioned, the martin would no doubt lose interest in a new nesting site.

The Tree Swallow has three biologic advantages over the Purple Martin: first, it often produces two sets of young a season; second, it arrives at the nesting site a month earlier; and third, according to Beal (1918:16), the Tree Swallow may utilize as high as 19 per cent vegetable matter in its diet. This vegetarian faculty may be a decisive factor in survival during occasional prolonged cold or rainy spells which are often disastrous to the completely insectivorous martin.

It has been suggested that the problem of house competition at a given location might be solved for the martin by setting up a large number of houses and thus providing space for all birds, but such a step has failed to lure Purple Martins from their nearby snags on the Lyle Dunsmoor estate, near Portland, Oregon. "We have 60 houses at our place, occupied at times 100% by tree swallows, violet-greens, house wrens and blue birds," writes Mr. Dunsmoor. The houses have been provided for the past six years and Tree and Violet-green swallows constitute 75 per cent of the housed birds.

"DOMESTICATION" OF PURPLE MARTINS

The obvious way to cause a martin to return to a nesting box is to cause it to be born and raised in a nesting box. Accordingly, several steps were taken with a view to producing this result. In the first three years of the project, two clutches of four martin eggs were received from Arkansas by air mail and were substituted in accessible boxes under Tree Swallows just starting incubation. The foster parents waited out the extra days required to hatch the larger eggs and each clutch produced two Purple Martins which were then well tended by the Tree Swallows. The first clutch died at two weeks of age when the box became overrun with black mites and the second pair of martins died from heavy infestation with *Apaulina* larvae.

These efforts involving different genera of swallows did not last long enough to reveal some of the problems which the feeding and fledging differences might have produced. The earlier proficiency of young Tree Swallows, which are self-reliant when they first take the air, might have caused some difficulty, inasmuch as martins normally remain in the nest longer and are then fed in or near the nest for several days after they can fly about.

Another attempt to obtain some martins hatched and raised in bird houses involved the erection of bird boxes adjacent to wild nesting sites of Purple Martins, in the hope that the martins might take over a more suitable nesting space after becoming familiar with it. Other bird students in the state were urged to do the same if a nesting site was found. Of the two houses I erected, one of twelve rooms was lost in the snag-felling program and the other was brought down by a bored huntsman with a rifle. The latter house was in place an entire season in which the birds returned and took their hole in the snag a few feet away. The house had not been there when they left the year before, however,

so it was something new to them. Could the house have been spared another season, the young birds that returned might have taken to it since it would have been a natural part of their world. This experiment should be carried further.

A house with a trap-door was put up on one of the coastal Southern Pacific draw-bridges in 1951 and later a brood of three, ten-day old Purple Martins and an adult female were trapped at night and the box carefully transported and attached to a pole in my yard within two hours. In an effort to get both parent birds, the box had been made 9×9×10 inches, but in spite of the roomy house, the father took the male swallow's traditional prerogative and roosted out at night.

Next morning, the parent bird flew out and away in ever widening circles when the box was opened. After an hour or two of waiting, the house was taken down and hand feeding of the nestlings was begun. The three birds survived. Their interest in and utilization of a bird house was such that a possible method of establishing a martin colony through the hand raising of birds in boxes became apparent; for, as indicated previously, the greatest impasse met in trying to start a Purple Martin colony in the West is the martin's seeming lack of interest in bird houses. Allen and Nice (1952:652) found that the majority of Purple Martins returned to the exact or general location of their birthplace.

HAND RAISING OF PURPLE MARTINS

Twenty-one martins have been hand raised, 3 in 1951, 10 in 1952, and 7 in 1953. This strenuous work was begun initially when the mother bird deserted the three birds in the relocated box mentioned and was continued the following year with birds hatched from eggs and with nestlings taken from nests when a week or more old. Another trap box was used in the daytime to get both parent birds and three nestlings for another trial at relocating a family of martins. The same result was obtained as before, but the young birds were successfully raised.

Eggs taken from nests may be placed under swallows for incubation or they can be hatched in an incubator. In either case, they were first incubated artificially until transillumination revealed a growing embryo in order that infertile eggs would not be placed under swallows. Martins hatched by swallows were removed for hand feeding when about six days old.

In three years, a few lessons have been learned concerning the handling of eggs. All the eggs were lost during shipping from Arkansas in 1951 when they burst at high altitudes during air transportation. This happened repeatedly to small shipments of three or four carefully packed eggs in spite of various labels and explanatory data attached to shipping containers. Air line officials doubted that their handling had been at fault since they successfully transport fertile chicken eggs without this damage; they added, however, that some breakage difficulties occurred at high altitudes when confections such as candied cherries were shipped by air.

After losses in two successive years from this cause we now know that the best way to ship small birds' eggs is by parcel post, special delivery, wherein they must be separately packed in cotton or individual sponge rubber capsules and enclosed in a strong, rigid shipping container. The rail shipment takes only a day or two longer from Arkansas to the west coast and has given better results than by plane, although the eggs would no doubt be safe in the air if carried in pressurized passenger compartments.

The dozen eggs received from the east by Parcel Post in 1952 were placed directly into an incubator upon arrival and eight of them developed. Two of these were later placed under a setting Tree Swallow where one hatched. Of the remaining six, three were hatched in the small incubator containing an electrical heating unit, a thermostat, two small fans, a water pan, and hygrometer.

Unless one has nothing else to do, or has considerable help that is reliable, he should not attempt to hatch and raise insectivorous birds. In the case of Purple Martins, even if one uses a related species such as the Tree Swallow to incubate and feed the tiny nestling until it is a week old, the young bird requires hand feeding for yet another four weeks.

For incubator hatching, the martin eggs were placed on cotton in the incubator tray and kept at a temperature of 101°F. for one day; they were then held at near 100°F. for several days after which the temperature was gradually lowered to around 98°F. The eggs were gently turned with the eraser end of a pencil every twelve hours. The humidity was kept near 70 per cent until within two or three days of hatching when 80 per cent or above was sought in order to soften the shell. The artificially incubated eggs hatch in 17 or 17½ days.

In one clutch of three eggs, each bird made the initial peep hole within two hours of the others, and the birds could be seen struggling within the shell. After two or three hours, one of the three was helped out by means of some delicate picking instruments. It was thought that this interference was unnecessary, so the other two eggs went on into the night without help. The following morning, the shells were essentially the same; each was then carefully opened. One bird was dead and the other definitely depressed. Only the first of the three birds survived. In retrospect, it is recalled that the shells of these three eggs were unusually tough and glass-like which would indicate deficient moisture in the incubator. Humidity is difficult to regulate in a small incubator. Green leaves are usually found in nests with Purple Martin eggs and it is thought that the leaves furnish necessary moisture for hatching; however, Miller (1935) suggested that the choice of aromatic leaves might indicate a different reason. Byrens (1942) substantiated this suggestion.

As soon as the martins are free from the shell they gape unsteadily for food and some of them give a *cheep* of extremely high pitch and surprising volume. It is most difficult to feed them, for the diameter of the mouth is 5 millimeters or less, and the head sways erratically from side to side so that the mouth is difficult to hit during the brief period of gaping. Anything placed in the back of the pharynx is eagerly swallowed. If a common house fly is rolled in the fingers to break up and streamline the contour, the newly hatched martin can swallow it. Smaller insects of a more fragile type such as lacewings and pieces of mayfly are more easily handled. If not fed, the bird assumes the embryonic position with the head tucked down upon the abdomen and sleeps fitfully for a few minutes after which it will again gape for food. Some slight disturbance such as jarring, fanning a current of air, or giving a high, whistled note will initiate gaping after the bird has slept for a few minutes, providing it is hungry. A combination of the above stimuli works best. Small insects and small forceps are necessary and a useful prop is a slightly opened button-hook which is placed around the neck near the chin to fix the swaying head while poking a small morsel into the pharynx.

During the next five days the incubator was kept at 95°F. but was opened at hourly and later at thirty-minute intervals for feeding. The small bird soon resumes gaping after swallowing the first morsel of food given and will accept two or three small insects or fragments consecutively. The intervals of satisfied sleep become shorter as growth progresses. At the age of six days the young martins were transferred to an indoor bird box with hinged roof and feeding through the entrance hole was started. After observing the direction from which the food comes, the nestlings, within a day or two, begin to gape toward the hole instead of straight overhead; when fourteen days old, they extend their heads from the box in anticipation of food. By the nineteenth day, the birds will come out on the porch when hungry, if enticed with food.

DIET OF HAND-RAISED MARTINS

The procurement of an adequate food supply presents an even more difficult problem than the time required to feed and care for young birds. The food must be fresh and clean since passerines are especially subject to virus and bacterial agents causing rhinitis, bronchitis and pneumonia as well as enteritis. Special care was exercised to prevent contamination of the food and of the birds' mouths, for birds, if not gathering their food under natural circumstances, may quickly acquire an unfavorable intestinal flora (Fox, 1923:418). Material from the oral-respiratory tract of humans is potentially dangerous, and a likely source of infection is children, whose hands are usually contaminated and who are naturally attracted by the birds. The hungry martins will try to swallow a finger that is thrust toward them, and children find this quite intriguing. A small amount of antibiotic powder was added to the daily diet of the birds because of its nutritional effect and to maintain an increased resistance to infection.

The procurement of enough insects to feed ten young martins over a five-week period is a problem to be solved only by means of outside help. Through the cooperation of the county agricultural agent of a neighboring county and accompanied by young helpers, Mr. Pruitt and I harvested twenty-five pints of eastern Oregon grasshoppers on one expedition scheduled shortly before the annual grasshopper poisoning program began. These large hoppers, captured while soft and immature, were quick-frozen in water and kept under refrigeration as a frequently used, auxiliary food supply for the martins.

The birds show a preference for live insects at all times, and it is necessary that these be collected incessantly. Traps were devised to catch earwigs while other insects were gathered from their habitat or purchased from neighborhood youngsters. The following insects have been used repeatedly with no bad effect: crickets, moths, small butterflies, mayflies, dragonflies, lacewings, pill- or sow-bugs, earwigs, spiders of many kinds, cutworms, houseflies, horseflies, bees and wasps, smooth caterpillars, and anterior portions of a few earthworms.

If spiders or insects that can bite or sting are used, the stings should be completely removed and the mandibles crushed before they are given to these soft-beaked, moist-throated birds. Grant (1945) observed that martins and other swallows apparently do not eat worker bees but choose the stingless drones. In the present project, I have been repeatedly convinced that swallows would not eat worker bees voluntarily. The worker bee's sting is so constructed that even after it has been removed it can penetrate any suitable surface coming in contact with it. Hungry juvenal martins would often grab a bee before I could remove the sting and in every case the bird at once began repeatedly to shake its head violently and then would often appear sick or depressed for an hour or two. One bird was evidently stung deep in the esophagus near the level of the syrinx, for in addition to discomfort, there was an immediate voice change that lasted an entire day. On several occasions when a bee had been stepped on or hit with a fly swatter, I could not locate the sting readily in the disorganized specimen; yet even these mashed bees often produced a sting in the gullet. Although many worker bees with stings removed were eagerly eaten during the hand feeding phase, it was repeatedly noticed that juvenal birds, having started daily foraging for food, would reject or even appear frightened when subsequently offered worker bees as food; this indicated that they had tried taking bees while out feeding and had learned a lesson. During its glutinous phase, the bird that was stung near the syrinx had two other painful experiences with bees and became so afraid of bees that it would fly away if offered one.

One healthy ten-day-old martin became sick immediately and died two hours after being given half a large, hairy, black and yellow caterpillar (species undetermined).

However, on several occasions the pale green, horned caterpillar of the monarch butterfly was cut up and used as food without the birds' showing evidence of distaste or illness. This instance of mortality was the only one occurring in Purple Martins over three days old in the course of the hand feeding in 1951 and 1952. The unfortunate nestling was one of the incubator-hatched martins from an Arkansas egg. It showed signs of distress at once after swallowing the piece of hairy caterpillar, regurgitated it with difficulty and then appeared depressed. During the next hour there was some edema of the eyes with a watery, mucoïd discharge from the eyes, mouth and nares. Respirations became slow and labored preceding death. The esophagus contained many of the spiny, black hairs that were apparently lightly penetrating the mucosa.

Since live insects are often difficult to obtain, one casts about for suitable substitute or accessory foods with which to pad the diet of insectivorous birds. Because protein is the essential diet requirement for growth, it would appear that lean meat and boiled egg would be acceptable. Both of these have been used regularly; however, careful selection of fresh, lean meat rather than hamburger or other conglomerations is advisable. Small amounts of fresh liver are excellent as occasional additions to the diet.

The Purple Martin's gastrointestinal tract must need a certain amount of roughage as furnished by the exoskeletons of insects, for when such non-residue foods as lean meat and egg are given in even moderate amount, a diarrhea develops which would no doubt soon lead to serious intestinal and metabolic changes. Each juvenal martin can ingest about one cubic inch of meat or egg daily, in divided portions, without such difficulties. The martins greatly enjoyed pulverized, hard-boiled egg containing some antibiotic powder and a small amount of the common vitamins, calcium and iron salts and other nutritional factors in powdered form as they occur in a capsule (Natabec,[®] Parke-Davis & Co., Detroit) often dispensed for pregnant or lactating women:

Dicalcium phosphate (anhydrous)	500 mg.
Ferrous sulfate	75 mg.
Folic acid	1 mg.
Rutin	20 mg.
Vitamin B ₁ (thiamine hydrochloride)	3 mg.
Vitamin B ₂ (riboflavin)	2 mg.
Vitamin B ₆ (pyrodoxine hydrochloride)	1 mg.
Vitamin B ₁₂ (crystalline)	2 mcg.
Vitamin C (ascorbic acid)	35 mg.
Vitamin K (synkamin, the hydrochloride)	0.5 mg.
Nicotinamide (niacinamide)	10 mg.
Vitamin A	4000 units
Vitamin D	400 units

The contents of one capsule, as listed, was divided into two equal portions and one portion thoroughly mixed with one pulverized, hard-boiled chicken egg of large size and antibiotic added:

Aureomycin hydrochloride	125 mg.
Methylparaben	45 mg.
Propylparaben	11 mg.

(The parabens are fungus inhibitors now dispensed with many Aureomycin preparations by the Lederle Laboratories division of American Cyanamid Co., New York.)

The ingredients listed were made into a semi-wet paste to be extruded through a 3/8-inch nozzle into the begging birds' mouths. Even the older martins that had been feeding themselves for weeks would accept some of this mixture before going to roost.

The mixture was consumed by seven to ten birds each evening during the pre-roosting lineup. Twice a week, some finely crushed egg shell was added.

The possibility of using mealworms, the larvae of the beetle *Tenebrio molitor*, as martin food was investigated. The exoskeleton of these larvae is tough and apparently somewhat resistant to the martin's digestive process; however, the mealworms must be an excellent source of protein, and about 3000 of them were used during the summer of 1952. The worms molt as they grow and the freshly molted larvae are pale, tender morsels which must be utilized rather soon, for within a few hours the worm is again covered by a glistening, tough coat of brown. The mealworms make better food if cut transversely into half-centimeter sections. Like all other foods, except live or fresh, flying insects, these worms do not appear to be a suitable all-round food but are a good dietary supplement. When given generous helpings of the mealworms, the juvenal birds regurgitate pellets of the exoskeletons. The birds make motions as if trying to sing, then shake the head from side to side and bring up the pellet without difficulty, casting it a few feet away from their perch. When many grasshoppers had been taken consecutively, the juvenal birds would sometimes bring up pellets of the legs and skeletons squeezed almost devoid of juice and nutrition. The act could be so quickly accomplished that I received the impression that the birds made use of this device more often than I formerly suspected. Pellets found in the roosting box or accidentally noticed on the ground was the evidence most often seen. I never saw a martin younger than ten days old bring up a pellet and assume that the older birds only do it when the diet is rather tough and coarse. One fledgling ejected a pellet made up of mealworm skeleton fragments and crushed egg shell that contained in its center a large carpet tack. The tack may have been given to the bird by one of its nest mates or by an experimenting child. The young birds often pick up peat moss and other small objects within reach but, after mouthing them, always flip them away by shaking the head.

The necessity for calcium in the diet of young birds is paramount and both nestlings and juvenal birds accept small pieces of chicken egg shell as if it had a delicious taste. A small amount of powdered egg shell was included in the daily diet of newly hatched martins. Wild Purple Martins have never tried to feed insects to the hand-raised birds, but in 1951 an adult female alighted near one of the fledglings and offered it a piece of egg shell whereas on another occasion the oldest of the group of hand-raised birds in 1952 was observed to bring a piece of egg shell to the youngest of the group.

Martins get their water from the insects they eat and the giving of water, even in small amounts, to nestlings is soon followed by watery feces. In feeding newly hatched martins, if the small insects have been dead more than a few minutes, they can be momentarily dipped in water to re-hydrate them. In general, the amount of moisture given can be regulated by the appearance of the droppings. The young birds will drink water as if they appreciate it but apparently they do not need it. On a very hot day, fledgling martins enjoyed wading in the inch-deep bird bath provided for them to cavort in. There is apparently a reflex which causes them to open the mouth when they enter the water. While squatting and wading about they keep the mouth open and the chin touching the surface. Water does not always get into the mouth, but they frequently seem to swallow a little. On a day of low humidity, the older, foraging juveniles at times came in late in the afternoon to drink water like thirsty chickens; then their droppings showed that they had been feeding on small, black, flying ants. The younger, hand-fed birds that are getting grasshoppers and other relatively juicy insects need no water.

BEHAVIOR OF HAND-RAISED MARTINS

There is something soul-satisfying in raising any young, helpless thing and being the object of its pleadings for food. To satisfy the hunger of a baby bird and watch its

daily, almost hourly, growth gives one a feeling of accomplishment and perhaps appeals to the maternal instinct in us all. The person who finds a fallen nestling can accomplish more with less effort if he first backs away a considerable distance to watch and see if the parent bird is not in attendance on the young one. But if the foundling is a naked, helpless bird, the finder would save both energy and birds by getting ladders or whatever help is needed to replace the young in the nest. Even a different nest, providing it contained young birds, would be better for all concerned than attempting to hand raise a young bird in most instances. The hand raising of Purple Martins in the present case was undertaken as a means to an end and not to satisfy a thwarted instinct.

At the age of about eight days, the hand-raised Purple Martin nestling begins to develop its personality as it peers at the immediate surroundings through recently opened eyes. It begins to address pleadings for food to the nearest person rather than straight overhead, and when hunger is finally eased, the young one spends considerable time inspecting its host and making satisfied, clucking chirps. The readiness with which the young Purple Martin cooperates in hand feeding is notable even in wild birds taken from the nest at the age of two weeks. These nestlings having first been force-fed several times will begin to beg for and accept food within three or four hours after capture. Brauner (1953) found it necessary to force-feed a 15-day-old Poor-will (*Phalaenoptilus nuttallii*) for eleven days after taking it from the nest before it voluntarily took food from a forceps. In 1952, I took three Purple Martins from the nest at the age of 30 days, and they required forced feedings for only 36 hours when one of them carefully took a grasshopper from the forceps; the remaining two gave in within an hour.

The obvious comfort and sense of security a nestling derives from presence of nest mates makes the raising of a single bird less interesting. Martins have a strong social bond to one another and this tendency is noted as soon as they can see and crawl about. Each evening near dusk, the birds become playfully aggressive and contend with one another but will join together in a defensive attitude with owl-like popping of beaks in the direction of anyone approaching too near the box. This ferocious bluffing is noted only at roosting time and is very amusing in pin-feathered birds. They crowd together in a corner to sleep, resting on their underparts. The younger birds sleep or remain inactive for a while after daylight each morning unless awakened and are not as hungry early in the morning as one would expect. As the day advances, the appetite increases and reaches its amazing plateau from about three until six in the afternoon.

The young martins are peculiarly alert to moving, airborne objects. All but invisible, floating particles of lint in the air would attract the attention of several birds at once, whereas I could locate the object only by scrutinizing the point of their converging attention on the moving bit.

In order that they might exercise, the birds were kept in a large tray, the bottom of which was covered with peat moss. This material is soft and comfortable to the birds' feet while its absorptive qualities facilitate sanitation. While in the bird box, the pin-feathered martin moves to the perimeter of the nest to deposit droppings, generally in a corner of the box. As soon as it is more agile, it backs up to the entrance hole and deposits on the porch. Whereas the younger birds are rather careless, the older fledglings and juveniles, when capable of flight, rarely soil the premises but move to the edge of the porch or fly away from the box as I have often seen adult martins do only to return at once after defecating in flight, a few yards away.

The young birds have a reflex to defecate with any major change of location, as when carried from the peat moss tray back to the bird box. When placed on the porch, they immediately head for the door but pause to defecate just before entering. A bird that has emptied the cloaca prior to the change in location will pause at the threshold

and go through the motion of defecating before entering the house. Another reflex which is strikingly demonstrated is that elicited when well feathered nestling martins are suddenly placed in strong sunlight. The nestlings at once drop over on one wing, turn the head horizontal, close the eyes and erect the feathers of the head and neck so that the sunlight reaches the epidermis. They raise the wing on the side toward the sun so that it points at the sun and the rays reach into the axillary space, side of the breast and abdomen; then they remain motionless, except for respiration. I did not wait to see how long a tray of the young birds would maintain this unusual tableau, but after a minute of exposure I always removed them to the cool shade where they would recover their usual stance and begin moving about again. I assume that this hurried, maximum use of sunlight is an instinct of a heavily parasitized, hole-nesting species.

When the birds were fully feathered, they were eased into a 1-inch deep bird bath during the hot part of the day. They would usually stand still with the mouth open and often would defecate, but when martins have been flying for some time and are self sufficient, they apparently never soil the bird bath. On the first trip to the wading pool some of the juveniles began to squat and flutter in the water at once while others waded swiftly about with the chin barely resting on the surface. An occasional martin does not seem to care much for the wading pool at this age, but most of them do and three of the birds took from two to four spontaneous baths daily. Some of these wading sprees were just to cool off the feet and the belly, but at other times the birds would get wet from head to foot so that flying was difficult upon taking off from the elevated wading pool and repeated, vigorous shaking was done in flight to cast off the water. The hand-raised martin's method of using the bird bath was to squat and run through the water with tail and chin on the surface and with only an occasional flipping of water into the feathers. Thus they seemed to approach as nearly as possible bathing while in flight.

For several days before attempting the first flight, the young birds grip a perch and fan their wings vigorously many times a day. This exercise usually lasts from ten to twenty seconds and reminds one of a plane warming up engines, especially when the dust and peat moss begins to fly. Although the birds can fly a little if tossed into the air at this time, they apparently know by the pull exerted on their feet when they should attempt an excursion, which they soon do by choosing a nearby destination, leaning as far toward it as possible, and then barely making it amid considerable excitement. The behavior is contagious, but one or more birds are usually a day late in making their first flight. Proficiency in the air comes rapidly thereafter, and the 30-day old martin begins to fly like an adult. The trick of smooth landings comes more slowly, however, and usually requires several days of practice.

Before the young birds learn evasive tactics, they are frequently disconcerted during flight when other birds pursue them. Finches, robins and other swallows take special pains to harass them by flying below and behind the juvenal martin and nipping at its tail feathers and feet. Immature robins and adult Tree Swallows were the worst offenders. The latter would approach the martin during flight, while the robin would perch beside the martin for several minutes in a peaceful attitude only to pursue the newly flying bird the instant it took flight. Some tail feathers were lost in these attacks. Ten days later, the martins can outfly the lot and apparently consider the pursuing birds minor nuisances.

As the young martins begin to perch on wires in the immediate neighborhood, they frequently sidestep rapidly along the wire to approach and associate more closely with nearby birds. They are especially curious about birds their own size or smaller. When a mature or juvenal American Goldfinch (*Spinus tristis*) would alight close by, a sidestepping approach was used, only to have the finch take flight when the martin came

too close. Emlen (1952) showed that the Purple Martin has a tendency to perch less than four inches from adjacent martins, which distance in the case of the finches was too near. The juvenal martins never showed signs of aggressiveness as they approached other species nor did they pursue any bird taking flight.

The approach of larger birds of any species would produce alarm calls from the first martin taking notice, and the call would be echoed by the group as it took wing to disperse. This reflex was brought out almost daily by a pair of low-flying Green Herons (*Butorides virescens*) which nested nearby. The Red-shafted Flicker (*Colaptes cafer*) and domestic pigeons caused the alarm reaction frequently when flying low in the direction of the loafing, juvenal martins. On one occasion, I noted that two falcons, swiftly coursing directly overhead, but at about 200 feet altitude, caused no sign of alarm in any of the perching martins. During 1951, while I was handling three fledgling martins that had been on the wing for only a day, a Cooper Hawk (*Accipiter cooperii*) whizzed by my ear in a dive toward the birds, then banked sharply a few yards away and came back toward the birds but desisted when I yelled and gestured. At the time, we were on a second story sundeck, and the young birds, perched on the railing of the deck, did not show fear or give any alarm note prior to or during the incident. The handling and feeding of the noisy young martins frequently caused birds of other species to alight nearby from curiosity. The finches and small sparrows most often came near and showed considerable concern about the proceedings.

As soon as the juvenal martins are adept at flying, they can be seen to make occasional and often unsuccessful attempts to catch flying insects. Then they are out early each morning foraging for themselves but still getting considerable food from headquarters. At midday, they usually perch on high electric wires behind our lot or out in front where they seem interested in watching a busy thoroughfare; however, for about ten more days they keep an eye on the back door for the man with the grasshoppers. At this time, to encourage their maturation, I fed the birds liberally only once during the morning and again just before going to roost when they were given all they would take. In the late afternoon, if they beg for food and get none, they will fly out and hunt as a group. When I hunted bees and grasshoppers for them, they would circle about overhead or perch nearby and come sailing in a direct line when I gave the come-and-get-it signal, which was a loud, high-pitched "Hey" called out as the insect was held aloft in the tip of a forceps. The birds would come from perches 75 to 150 yards away when moderately hungry. They would perch on a proffered finger or wrist and assume a begging posture with wings vibrating and mouth gaping, and they were quick to compete for each insect as it was caught and held out toward them. Occasionally in the melee, a bird would swallow an inch or two of the feeding forceps and more than once a martin flew head-on at the grasped insect and impaled itself on the blunt blades of the forceps while my attention was taken by one of the other birds. No discomfiture resulted as far as behavior or subsequent appetite indicated.

As the martins mature, they become more selective about artificial feeding as well as less tame so that they often fly down in response to a call but take off without landing if they see no food in evidence. Then they were gone for longer intervals each day until I saw them perching only in midday and anxiously awaited the thrill of their return about an hour before dusk each afternoon, when they would suddenly appear in a scattered group high overhead and drop down individually to perch on the wires or come directly to my hand if hunting had been poor. After first getting damp in the bird bath, they would spend the hour perching and preening in the remaining sunshine striking the high wires. Some of the martins habitually landed on the flat surface of the wooden crossarms of the power pole where they continually walked back and forth around and

under the glass insulators as if in play. It was necessary for them to squat as they passed under an insulator; this activity had been a favorite one for the hand-raised martins the previous year. On two occasions I saw a young martin, which was preening on a wire following a bath, suddenly hang head down from the wire with clinched feet and remain motionless for ten or fifteen seconds with wings outstretched, ventral surface toward the sun. I thought this behavior unusual, but Davis (1944) observed inverted, soaring flights of several yards by Purple Martins, and I recalled the agility of these birds previously as they perched on a slick, plastic clothesline; several times one leaned too far forward in trying to reach an insect, turned a complete flip, and regained its normal perching position without having let go of the line.

The success of the day's hunt could be gauged by the hunger shown each evening. During one brief spell of cool, overcast weather some of the birds that had been feeding themselves for two weeks came in and asked for food. The oldest martin was then 75 days old and the three youngest were 34 days of age.

Playful aggressiveness was evident at roosting time when the first bird inside a box would try to keep his mates from entering by guarding the door with snapping beak until those on the porch became impatient and shouldered their way inside. Then all would be quiet except for an occasional, satisfied peep. The birds in each age group crowd together in their box so that they are in maximum contact with heads partially hidden under mates' shoulders and breasts or jammed into the corners of the box. The older birds sleep standing upright with feathers slightly erect while very young birds squat on their lower breast and underparts. The upper eyelid is the last spot to become feathered on the young bird and this tender, relatively naked point gives mosquitoes an opportunity to annoy the sleeping birds considerably. Some palpebral redness and swelling resulted from this cause before the boxes were screened.

As the time for migration approached, the number of birds returning in late afternoon to roost decreased. The oldest bird was the first to leave permanently. This was on August 17. On the 18th the nine remaining birds roosted in the boxes. During the last ten days the group dwindled as indicated in table 2. Two of the last birds to leave

Table 2
Last Records of Purple Martins at Roost Prior to Migration in 1952

Day of August	Number of birds returning in p.m.	General behavior	Food taken	Number of birds spending night
19th	7	calm, friendly	few insects; egg mixture	7
20th	5	calm, aloof	egg mixture	5
21st	3	calm, aloof	egg mixture	2
22nd	4	flighty	egg mixture	4
23rd	4	flighty	egg mixture	4
24th (cloudy)	5	calm, friendly	insects and egg mixture	5
25th (cloudy)	5	calm, friendly	many insects and egg mixture	5
26th	5	flighty	4 ate; 3 departed	2
27th	2	nervous	no food taken	2
28th		(3 birds last seen in mid-morning)		0

were considered to be males as judged by their behavior, and this circumstance gave some encouragement to hope for the return of the martins the following spring, since the male Purple Martin scouts for a nesting site each year. The two suspect males were not the youngest of the group but they seemed more attached to the roosting boxes and remained after the other three birds in their age group had gone.

SEX DETERMINATION

Sex determination is not possible in the living, young Purple Martin until the age of one year when the males begin to show an occasional black feather on the breast or neck. Although the plumage is identical with the female at this age, except for the rare black feather, the year-old male may successfully mate and its sex thus can be determined by its actions. After raising a group of Purple Martins and watching their behavior, I have the impression that certain ones are males as judged by their behavior and song. There does not seem to be any difference in size. By repeatedly checking

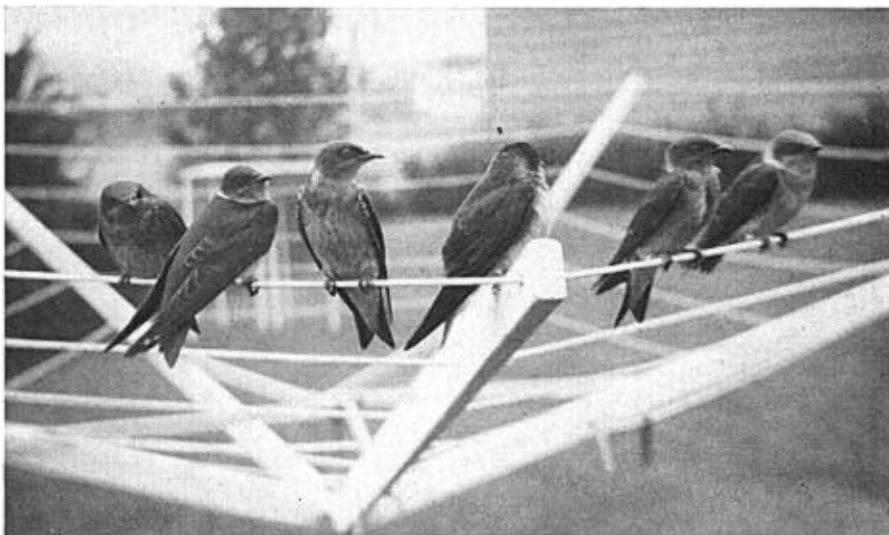


Fig. 1. Pre-roosting lineup of juvenal Purple Martins.

bands, I found that the three most aggressive and self-reliant birds had voices of lower pitch and more melody (in the begging chirp) than others in the group. One of these three flew down and mounted, in simulated copulation, a fledgling martin which had fallen to the ground and fluttered with outstretched wings. Two of the suspect males attempted more complicated songs of successive, variable notes on more than one occasion while sunning. Some martins give a frequent, loud peep while yet inside the egg before getting completely free and then continue to be vociferous, while others make no sound for the first few days of feeding. Some correlation between sex and early use of the voice may possibly exist.

SONG OF JUVENAL MARTINS

Until the birds are about five weeks old, they make use of the begging chirp almost exclusively. This is similar to the chirp of an adult English Sparrow but slightly more prolonged. Besides a few weak, piping half-chirps given when hunger is satisfied and sleep is overpowering, the young martins make three other sounds. A cat-like, screaming noise is made by many birds while struggling to get away when they are being held or hurt, and a trilled, lower pitched, ascending note is uttered as a group warning whenever a cat or dog comes near or when a large, unidentified bird is approaching. This last sound is very similar to the alarm call of the Cliff Swallow (*Petrochelidon pyrrhonota*). The third sound is a mechanical, clicking noise of low frequency produced while the beak is widely opened in a menacing attitude during squabbles between mates.

At about six weeks of age the juveniles begin to produce some guttural, martin-type noises, and occasionally one will sing two or three low, warbled notes consecutively with much movement of the chin and throat feathers. Certain individuals within a given age group sing more than others; whether these are males has not been determined. At this time the typical *pee-you* call is given by one or more birds at times of great excitement. This note was heard most often when the birds were released from their bird houses early in the morning. This circumstance came about because mosquitoes were pestering the birds on the roost, so a piece of screen was put over the entrance hole as soon as the last bird retired. The screen was so placed that the birds could usually dislodge it in the morning; but on some occasions the older birds were still shut in at six in the morning, the other birds having meanwhile departed shortly after daylight. When the barrier was removed, the impatient birds would give this familiar call as they took off on their delayed hunt.

VISITS BY ADULT MARTINS

In 1951, when only three Purple Martins were hand raised, both male and female martins came to visit briefly with the young birds on several occasions. These visits were usually late in the afternoon, and the wild birds often would only circle the place and fly away. An adult female made almost a daily appearance, flew down near the residence when the birds were being handled and flew near them often in a harrying manner as if urging them to fly with her. It is interesting that although she acted in a nervous and apprehensive manner when she first began to visit the fledglings, she never uttered a sound that I could hear even when she flew within a yard of me in pursuing the young. After the three birds were more proficient at flying, they were absent for long intervals and would often return in the company of an adult female thought to be the same visitor.

In 1952, a wire recording of Purple Martin song and chatter during nest building activity was made at the colony on the Umpqua River drawbridge. A permanent, plastic record was made and when martins were seen at a distance of about a mile from my home, the record was amplified through a six-foot trumpet loudspeaker in the direction of the observed birds. Within five minutes, three martins came in at about 150 feet elevation and looked the place over. This experiment was tried again on another day to be certain that it worked and then discontinued to await the time when hand-raised fledglings would be about the place. It was during one of these broadcasts that Tree Swallows were observed flying out to attack approaching martins.

When the first hand-raised martin of the season was flying about fairly well, the recording was again broadcast and within five minutes an adult male martin perched on the wire beside the fledgling for a minute. While subsequently acquired birds were nestlings and fledglings, the record was often played for their benefit and they always halted their activities to listen raptly.

After the local martins discovered the presence of the hand-raised young, they came around daily and the recorded sounds were not broadcast again, except on two occasions at sundown when a young martin on its first or second day of flight went too far or seemed to stay too long; then the sound was turned on as a possible beacon to aid the lost bird. One of the birds returned during the broadcast, whereas the other did not return until early the following morning. Several times at midday when no birds could be seen, the sound was turned on and some or all of the juveniles came in and accepted food.

Another method used to attract martins to the location was the provision of a source of calcium visible to flying birds. A mixture of crushed chicken egg shell and oyster

shell was spread thickly over an area of a square yard in two places out in the gravelled parking area adjacent to the back yard. The visiting martins located it within a few hours and both sexes made daily trips thereafter to eat and carry away some of the material. They definitely preferred the egg shell. Judging from their angle of flight as they ascended, they were nesting at a considerable distance, for they were still climbing as they disappeared in an 8-power binocular field. One of the piles of shell was only twenty feet from the nearest cover but the other was sixty feet out in the clear. The martins sometimes came to the nearby spot but usually preferred the square in the open over which they would often make a dozen passes before cautiously alighting. Such caution was probably displayed by newcomers to the calcium bonanza, for other adult martins came in and landed on the first approach. I thought that from five to ten adult birds made use of the shell but I never saw more than four birds in a group at the shell. The banded juveniles did not visit the shell piles to my knowledge. They were receiving some egg shell almost daily in their egg mixture.

Since a larger group of birds was hand raised in 1952 and the recorded martin song as well as the egg shell were added attractions, there were many more visiting martins in 1952. Most of the visitors were adult females. Often a group of five or six martins would approach the neighborhood and the males would continue to circle about or fly at a distance while the females from the group would come near or perch on the wires for a few minutes. One large black male came in, dived at my head, and rejoined the waiting males sailing about nearby.

One of the most frequent visitors in 1952 was a year-old martin that came on several consecutive mornings, alighting on and inspecting the same duplex house on a pole. It was then July and too late for nesting. This bird was not wearing a leg band as far as I could determine, although the bands are difficult to see against the almost white underparts when the bird is overhead; also, when perching, the martin rests the tarsus against the feathers of the abdomen. Bands are easily seen when martins walk on the ground.

Most of the visiting martins came in July and August by which time the Tree Swallows had completed nesting and most of the families had flown; so the martins did not encounter any opposition in these months.

In 1953, seven juvenal martins that were hand raised helped attract visiting martins, but no nests resulted. The egg shell was a very strong attraction with martins arriving singly and in small groups at all hours of the day. About fifty martins came down to the calcium daily and certain groups and individuals came at the same time each day. Some of these were banded birds from the previous year. Two banded immature males and one banded immature female were observed in one group on the ground. Mature and immature martins spent considerable time loafing on the wires. A one-year-old female mixed with the hand raised birds daily and lit on the various bird houses. This bird tasted a mealworm I held out to it in a forceps; it was not a banded bird.

AMOS AND ANDY

The details about two of the ten birds raised in 1952 are out of the ordinary. The bird called Andy was taken from a nest in old piling on Lake Tahkenitch on the Oregon coast at the age of about $4\frac{1}{2}$ weeks. Three birds of the clutch were taken from the nest, while a fourth bolted and flew 100 yards to the shore without great difficulty. The three captives were taken home for hand feeding, although they were obviously about ready to become self-supporting. They were kept inside the residence at a window but not otherwise confined. It was necessary to force-feed them for the first day and a half after which time they began to take food voluntarily. After only six hours of voluntary feeding, the three were banded and released because they spent most of their time trying

to get through the window glass. The three flew off together giving a loud *chirrup* at regular, long intervals. They flew into the wind and remained in flight for ten minutes before they returned to nearby wires to rest; then they flew away together. There was considerable swallow activity at the time and an abundance of insects flying about. This was the deciding factor in releasing the three, able birds after less than 48 hours of captivity.

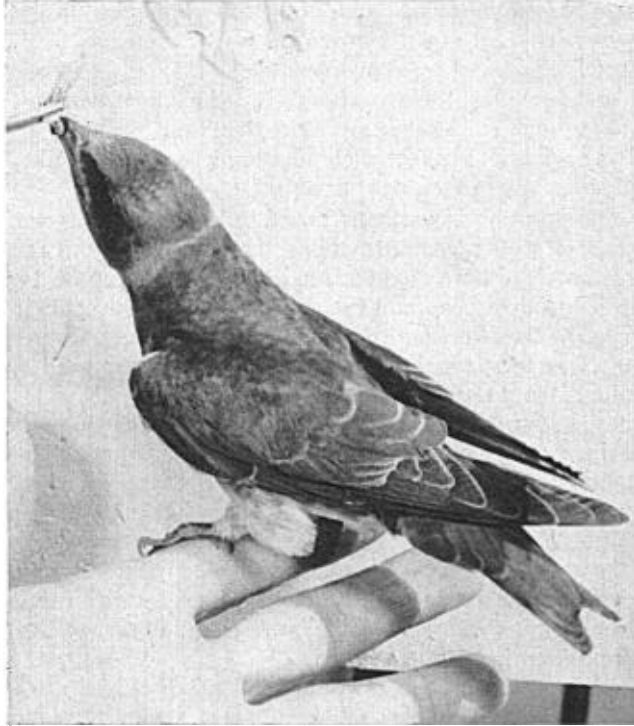


Fig. 2. Andy returned for a grasshopper after only 48 hours of captivity.

There was, at this time, only one hand-raised martin flying about the place. This was Amos, hatched from an Arkansas egg seven weeks previously. On the afternoon of the third day following the release of the three newly acquired birds, Amos came home accompanied by another martin. They perched high on the wires, and Amos was called in and fed. An insect was then held out toward the strange bird and to my surprise, it sailed in and landed at my feet when I called. I picked it up. This was one of the three recently banded martins, and it was obviously quite hungry, accepting food eagerly, although its droppings demonstrated that it had been eating flying ants. This martin, then named Andy, remained as one of the house-roosting martins for the next 41 days during which time he was aloof and self-sufficient but accepted food each evening before going to roost and could be coaxed on occasion to step up and perch on a finger in order to get his egg mixture. I am of the opinion that this bird is a female, in spite of the name. Its two mates were not seen again as far as was known, although one or two immature martins visited during the remainder of the summer; often while feeding the group of hand-raised birds, I would hold up a grasshopper toward the visitors on the electric wires and call to them, and they would lean forward as if tempted to come

down. Occasionally one would make a pass down almost to me but climb steeply as its courage failed.

Amos is also a female, I believe. Having been hatched in an incubator and completely raised by hand, Amos occupied a favorite position in relation to the members of the household. Obviously jealous and ill at ease when other birds were subsequently brought on the scene, she nevertheless made friends with Andy (fig. 3); later, when five nestlings were brought in, Amos, at the age of only 54 days, began to walk over the little ones as if brooding them and soon began to bring insects to them. This help was appreciated, and the good work was encouraged by giving her insects to give the nestlings; but Amos would be gone for five minutes when I could see no flying insects and return with insect wings and legs protruding from both sides of her bill. She fed the

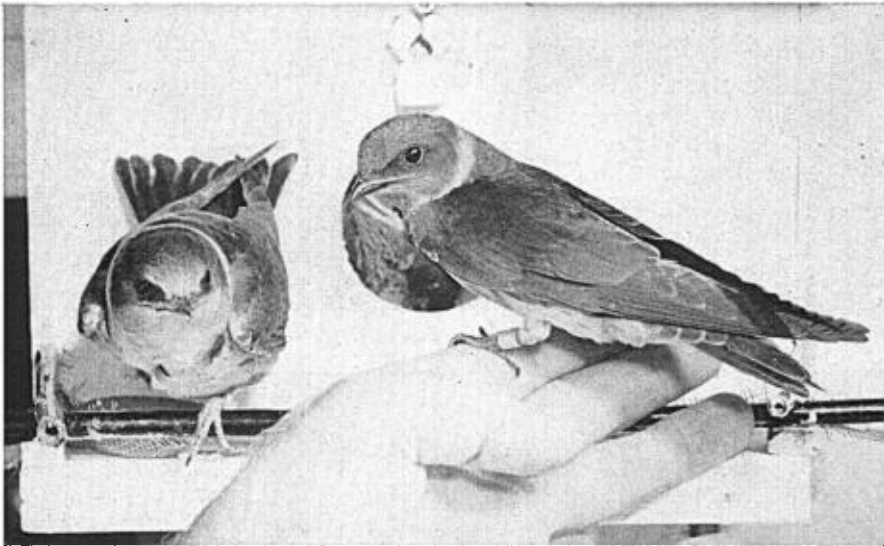


Fig. 3. Amos and Andy in detail; nestling in background.

young birds every morning and frequently in the afternoon (figs. 4, 5). Eight consecutive trips were counted at one feeding period in a thirty minute interval in mid-morning.

Prior to feeding herself, Amos had gone insect hunting daily, perched on my finger or on a short, wooden, T-shaped perch, as I waded in the grass and weeds. She would grasp the perch or finger firmly with her toes and lean far forward to snap an insect off a leaf, or occasionally I would carry her along under a slowly flying insect and she would snap it out of the air. Soon, she was springing into the air after flying insects and circling back to my hand to perch and await her next victim.

Later on, when she began feeding the nestlings, we would go hunting and she would perch on my finger, accepting insects that I caught and meanwhile catching some herself. Carefully saving them until she had a mouthful, she would fly 100 yards to the bird box, feed the young birds and return to my hand to start collecting another five or six insects before returning to the bird house. Amos once made six consecutive trips of this type in 45 minutes.

As the five well tended birds began to fly, Amos was successfully transferred to feeding three younger birds just added to the aviary, but her previous charges were not easily weaned and would gang up on Amos whenever she arrived with food for the

smaller birds. In spite of my praise and assistance, Amos could not see the profit in following her precocious instincts to the extent of trying to feed eight birds; so she gave it up. Several days later she was observed to bring a piece of egg shell to one of the smallest birds.

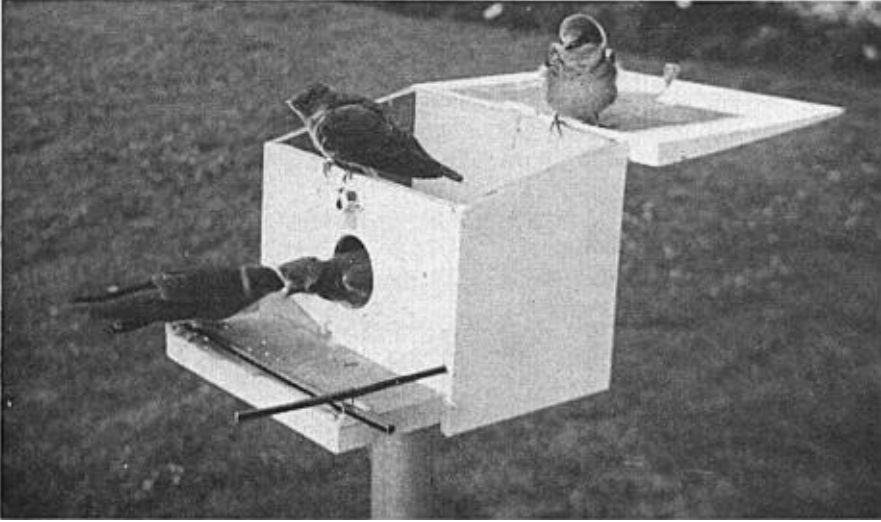


Fig. 4. Amos feeding nestling.

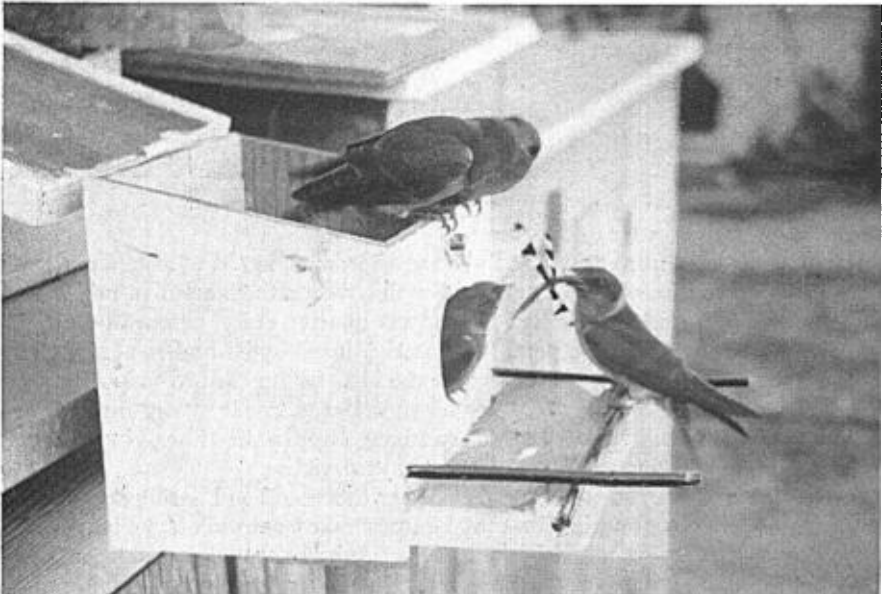


Fig. 5. Amos brings a large dragonfly; the fledglings inspect the food before eating it.

Amos was the only bird of the lot that would fly down and perch on the finger for purely social reasons. Hunger was always the motivating impulse causing the other birds to flutter around and land on head and shoulders when one approached. Amos would

often fly down from her perch and stand nearby waiting for a proffered finger to perch upon. Without touching it, she would refuse all food with the negative shake of the head that birds use when they wish to flip something from the mouth; she only wanted to sit and give a tiny, whistling peep now and then. One evening after dark, while I worked in the shop, she quit her roost and flew into the shop apparently to investigate the noise made by the table saw and to watch me work. In the afternoon, when I was hunting insects in the grass and weeds with all the younger birds flying around contending for what I caught, Amos, often having been gone all day, would suddenly fly in and land on my wrist if it was unoccupied, or if birds were there she would fly around me peeping helplessly until I would "shoo" the others away and receive her. Part of the time she was not hungry and only wanted to be the object of my attention. When other pets would come in and land she would take flight, but I could call her back if I dispersed the other juveniles.

Amos would often not roost in a box with the other birds but tried many different places about the eaves and windows. At dusk, she sometimes came into the residence through the window-opening-hole in the screen and would fly along the ceiling beams looking for a roost. But the madre domo of my establishment thought that birds should roost outside; so Amos would be escorted out to try another roosting spot. She would sometimes use a separate box I had put up for her, but she would not mix with the other birds, or if she entered a box first, she would leave when others crowded in to roost. Occasionally she would not show up to roost and would be brought over on the finger of a neighbor whose company and house she had chosen for the night. Often I would not see her for 24 hours. She took her final departure on August 17 at the age of 80 days.

SUMMARY

In the southern Willamette Valley of Oregon the Purple Martin is a common summer resident. It nests in inaccessible places perhaps because the less social and very abundant Tree Swallows and Violet-green Swallows arrive a month or more earlier than the martins and successfully monopolize the small number of suitable bird houses. The fact that the Purple Martin inhabits remote areas in this region makes it unknown to the general public, and it is seldom seen by those interested in birds.

Purple Martins are colonized in boxes hanging under the eaves of powerhouses atop railroad drawbridges over the Umpqua and Siuslaw rivers on the Oregon coast. One of these colonies dates from 1944 and the other was established in 1952. Martins utilize bird boxes at some points in the neighboring states of Washington and California, and the coastal cities of these states have often had Purple Martins nesting about business buildings. No instance of utilization of a traditional, colonial martin-house on a tall pole has been found in Oregon, nor has any such site been reported recently from the west coast states.

As the Purple Martin is dependent upon a highly specialized nesting site for which competition is keen, some active help for this long-time friend of man will likely be necessary to establish the bird in artificial nesting sites in urban areas. The recent inauguration, by major lumber interests, of a program for widespread felling of dead trees as well as the spraying of forests with DDT makes logical the effort to adapt Purple Martins to bird houses at this time.

Over a five-year period, various means were used to attract Purple Martins in an endeavor to establish a martin colony at a suitable urban location at Eugene, Oregon. Fourteen nesting boxes containing 40 adequate units were erected at the urban location and elsewhere in the vicinity during the five-year effort with only one observation of interest in a box by a Purple Martin. Tree Swallows, Violet-green Swallows, Western

Bluebirds, House Wrens and English Sparrows nested in the boxes with only 50 per cent of the available space utilized. Only the sparrows encountered active human interference. Incomplete nest building and fighting by Tree Swallows occurred around all the houses during March and April, and in this way Tree Swallows tied up considerably more space during the nest building season than they ultimately used.

A more successful means of attracting Purple Martins was the use of recorded and rebroadcast martin song, a ruse which almost invariably produced visits from nearby martins within a few minutes. This method was used with restraint to advertise the presence of fledgling martins that were being hand raised at the site of the intended Purple Martin colony.

The hand raising of Purple Martins has produced house-conscious, juvenal birds friendly to man and roosting in bird boxes until time for migration in late August. At the time of migration, the youngest birds were 45 days old and the oldest bird was 80 days old. The latter was self-reliant during the last seven weeks of its stay and helped feed the younger birds. The presence of young martins brought daily visits by adult martins, most of which were females.

The proposed site for a martin colony was made more attractive to wild Purple Martins by providing a plentiful supply of calcium (chicken egg shell) visible to flying birds. The eager utilization of calcium by Purple Martins suggests that this element is a necessary supplement to the 100 per cent insect diet, especially in regions where the soil is low in calcium.

Those wishing to attempt establishment of a Purple Martin colony should provide multiple-unit boxes with entrance holes of at least $2\frac{1}{2}$ inches diameter and rooms no smaller than $7\times 7\times 7$ inches. In areas where the Tree Swallow is abundant, active help may be necessary, at least to the extent of postponing erection of martin houses until mid-April or later, and then discouraging Tree Swallows from dominating the location.

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