THE RED-WHISKERED BULBUL IN FLORIDA: 1960–71

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THE suburbs about Kendall, Dade County, Florida support an expanding population of the first bulbuls (Pycnonotidae) in the New World. Red-whiskered Bulbuls (*Pycnonotus jocosus*) escaped from captivity here in the summer of 1960 (Fisk 1966). Their successful invasion of southeastern Florida provided opportunity for the study of the biology of introduction and insight into the ecology of a rapidly changing region that comprises a large part of the only tropical portion of the continental United States.

The Kendall bulbuls came from the eastern portion of the Indian peninsula and are assignable to the subspecies *P. j. emeria* (Linnaeus) (Banks and Laybourne 1968). This part of India and southeastern Florida are climatically somewhat similar. In the several decades preceding the release of the bulbuls, changes in the ecology of southeastern Florida made the region, in some ways, increasingly similar to the Indian habitat of *P. jocosus* (Owre 1973).

Colonization by exotics is often facilitated in man-modified regions (Elton 1958). Changes in the ecology of southeastern Florida have probably been as rapid and as profound as any generated by man in the United States. The increase in human population, in 1970 ten times that of 1930 in the four southeastern counties (Bur. Census 1932, 1971), and the accompanying urban-suburban sprawl are spectacular. Natural ecological communities of the Atlantic coastal ridge are largely gone, while the flora of remaining open spaces is largely exotic. Sturrock and Menninger (1946) estimated the number of species of exotic trees and shrubs established in southeastern Florida at more than 1000. Aspects of this flora merit elaboration.

The adaptations of zoochorous plants that make them attractive to birds (Snow 1971) delight landscapers. Urban and suburban southeastern Florida is now extensively planted with exotic fruiting plants. Showy flowering (often nectar-containing) exotic shrubs and trees are as widely planted. For shade the landscaper sought the exotic trees that line boulevards and shelter parks and yards. Fruit trees have been planted by both home gardeners and commercial growers. The "Gold Coast" has become a botanical garden representative of the world's tropics. Flowering and fruiting plants, almost without end, provide variety and abundance of food for birds and have masked any seasonality of flowering or fruiting characteristic of the native flora. At every season throughout the year some species are in fruit or flower.

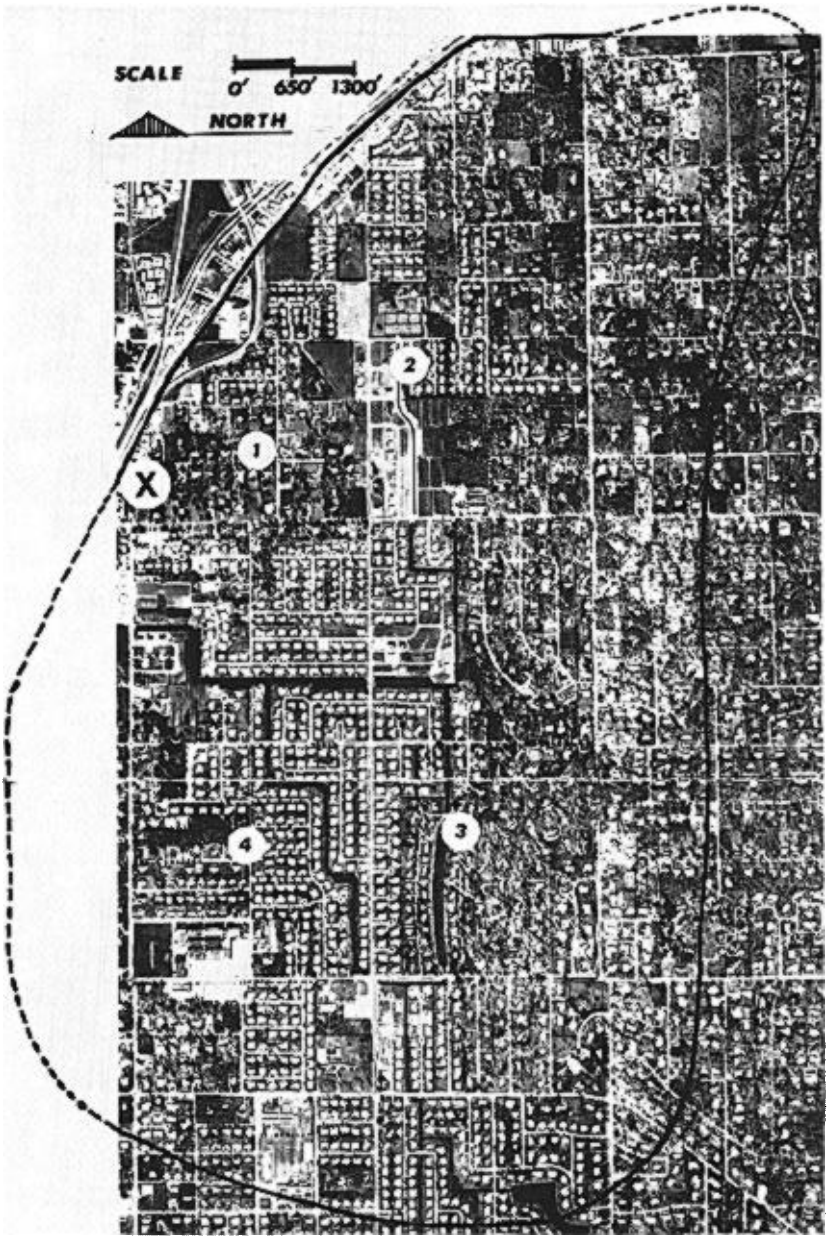

Fig. 1. An aerial view of the territory (outlined) occupied by the Kendall *Pycnonotus jocosus* population in 1969–70. Locations of the late winter roost sites are designated numerically. X = site of release of the bulbuls in 1960. U.S. Highway No. 1 runs along the northwest corner.

Introduction of this bulbul into Florida might have been anticipated. Popular as a cagebird (Ali 1943), it had already been introduced, escaped, and become established elsewhere. Miami became an important center for commerce in tropical birds. While records of early importation are lacking, the second author recalls seeing these bulbuls in importers' establishments, in particular at the Rare Bird Farm, which was in the block where the birds were discovered free-flying.

The species obviously had potential to establish itself in Florida. In India it is a familiar bird in villages, gardens, and farm lands (Baker 1935), well-adapted to the suburban habitat. Plants associated with the birds in India are now part of the Florida environment.

The suburb the bulbuls invaded contains large yards, and the trees and shrubs are old enough to produce crops of ornamental fruits and flowers. Within a mile of the escape point were four nurseries with concentrations of exotic zoochorous plants. Close by were feeding stations that the birds frequented. Bulbuls attracted wide attention and people were zealous in protecting them.

ROOSTING

Red-whiskered Bulbuls flock during the nonbreeding season and start gathering in roosting assemblages in July and August. Roosting sites shift during summer and early fall. Initially the birds may roost in trees affording far less shelter (e.g. *Pinus* and *Casuarina*) than those such as figs they seek in colder months (December and January).

We located roosts by driving along the suburban streets in late afternoon. Assemblages are conspicuous from the birds' calls, flights to the roost, and flycatching activities. During the winter of 1969–70 the population occupied four roosts (Fig. 1) as follows: roost No. 1, a pair of fig trees (*Ficus benjamina*) native to southern Asia (Fig. 2); roost No. 2, an extensive patch of tall Napier grass (*Pennisetum purpurem*) native to Africa; roost No. 3, a very large *F. benjamina* (Fig. 3); and roost No. 4, a tall hedge of an exotic species of *Acalypha*. The next winter birds roosted in the first two of the above, in a mango (*Mangifera indica*) native to tropical Asia, in additional figs (*F. benjamina*), and a few roosted in exotic palms.

During the winter of 1969–70 we determined the population size by counting the birds flying to or from the roosts. Extensive search convinced us that no additional roosts existed. Maximum numbers of birds at the roosts were: roost No. 1, 72; No. 2, 91; No. 3, 46; and No. 4, 10. The maximum count at roost No. 2 was presumed low, its extent making counting difficult. Single birds or pairs sometimes roosted near the

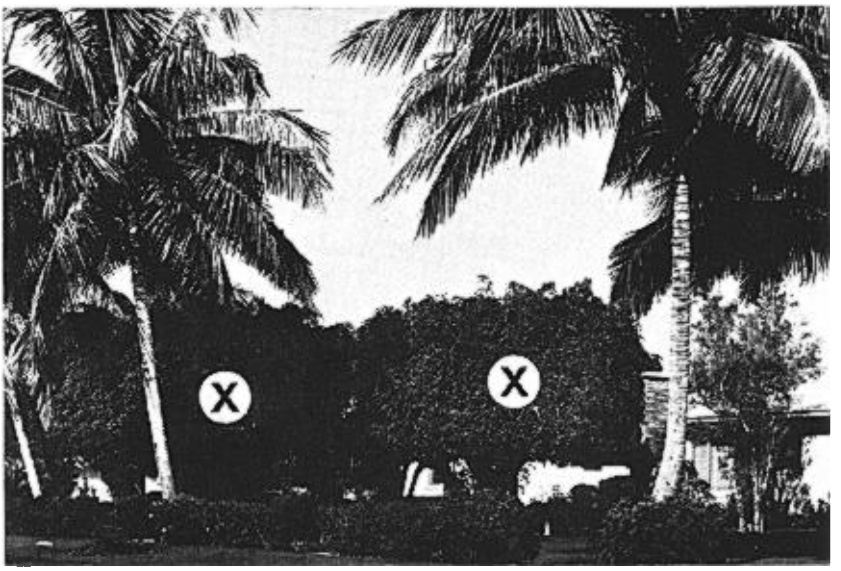

Fig. 2. The two trees, *Ficus benjamina*, of roost No. 1 are marked. These trees (in this picture much trimmed) functioned as a roost for the birds from at least 1964 through 1969. The trees are approximately 1200 feet from the site of release of the birds in 1960. Note the two coconut palms and the cajeput trees (against the house), flowers of which the bulbuls search for nectar.

main roosts. We estimated the total population that winter at about 250.

Increase of the Population

Although no previous yearly population counts had been made, some available data make estimates possible. We do not know how many birds founded the population. Talks with residents who watched the bulbuls in 1960 suggest the number then was not large. Because the birds apparently escaped in midsummer, none bred that year. Paulson et al. (*in* Stevenson 1964) estimated the population at 40–50 in 1964. Vavra (pers. comm. 1970) in whose yard the birds roosted since at least 1964, estimated the 1964 population at about one-half of the 71 in this roost in 1970. As these are fairly close estimates, we have a halfway mark in estimating population growth. We assume that the entire population was gathered into this roost in 1964 because the birds were seen principally in that immediate neighborhood.

To produce the present population, a founding population of fewer than five feeding pairs would have had an annual rate of increase of

Fig. 3. The large *Fiscus benjamina* of roost No. 3. This tree was first used as a roost in 1967 and was so used through the winter of 1969–70.

more than 50%—which seems excessive. An initial population of more than 10 pairs seems too large from accounts of residents. With an annual increment of slightly more than 40%, five pairs would have increased to a fall population of about 38 birds in 1964 and close to 220 in 1969. Ten pairs, with an annual increment of 33%, would yield a theoretical fall population of 59 in 1964 and about 260 in 1969. Thus, from tentative data, we hypothesize that between 5 and 10 breeding pairs founded the population and that this population increased during the years 1961–69 at an average annual rate of about 33 to 40%. Such a rate falls within the category of successful introduction that Phillips (1928: 3) described as a response to the environment "little short of marvelous."

FOOD AND FEEDING HABITS

Although bulbuls eat some insects and other animal food, the mainstays of their diet are berries and fruit (Austin 1961: 244). *Pycnonotus jocosus* also consumes such plant materials as seedlings, growing shoots, flower parts, and nectar. The birds damage fruit in India (Baker 1922) and in Australia (Chaffer 1933, Barrett 1947). As apprehensions arose (Fisk 1966) that the birds were a threat to Florida's fruit crops, citrus in particular, this study paid particular attention to feeding habits.

The mouth of *P. jocosus* has a small median ridge on the internal surface of the rhinotheca. Surfaces of origin of the jaws' adductor muscles are well-developed. These structures seem significantly connected with

breaking up or scraping objects held between the mandibles. For *P. jocosus* to so manipulate them, objects obviously cannot be large.

In this study four bulbuls (two trapped as adults, two in juvenal plumage) were kept in the laboratory. Adults were housed separately, juveniles together. We offered the birds a wide variety of foods and watched their feeding activities closely. We also watched feeding throughout the suburban habitat, solicited information from many persons, and examined the stomach contents of 22 wild birds. *P. jocosus* takes drupes, berries, small syconia, and other fruits of sizes easily mouthed, and these appear to be major food items. Certain of these merit discussion for they have, no doubt, been important to successful invasion.

The Brazilian peppertree (*Schinus terebinthifolius*), a shrub or small tree introduced from South America, is widespread in southern Florida. Its seeds are widely disseminated by birds. It forms dense stands on vacant lots, along canal banks, and in old field situations. Morton (1969) described the plant as "overwhelming" native vegetation. As it bears its main crop from October through February, it is in heavy fruit during winter when insects may become scarce in southern Florida, and the bulbuls feed upon it extensively.

Captive birds manipulated *Schinus* drupes between partly closed mandibles. Examination of their droppings (and stomach contents of other bulbuls) indicated that chunks of the fleshly mesocarp, the red exocarp still attached, had been shaved from the stony endocarp, presumably by the rhinotheca's median ridge. Significance of manipulation of the drupes within the mouth seems evident.

Of comparable importance in the diet of Kendall bulbuls are syconia of fig trees (*Ficus* spp.). While two species of fig are native, at least 19 exotic species, several of Asian origin (Barrett 1951), are planted ornamentally (Avery pers. comm.). Two figs, *F. benghalensis* and *F. indica,* fruits of which the birds apparently eat in India (Hume 1889), are exotic in Florida. *F. aurea,* the common native species, is still present about Kendall; its fruits ripen in April and for several months thereafter. Miles of streets are lined with exotic figs bearing fruits that ripen the year-round. Captive birds mouthed these too, although with some difficulty for the syconia are larger than most drupes they eat. The birds partly crushed the fleshly, soft syconia, which have no central endocarp, and then swallowed them, apparently with some difficulty.

Robinson (1927: 212) noted that in southern Asia *P. jocosus* spread the drupaceous seeds of *Lantana* and Ali (1943: 37) considered *Lantana* a favorite food in India. Seven species of *Lantana* occur in Dade County.

As with *Ficus*, the bulbuls encountered a food generically, in some cases specifically, the same as in India.

Ten exotic species of jasmines (Oleaceae) grow in southern Florida. One of these jasmines (*Jasminum fluminense*), a scandent shrub, is abundant in Kendall, blanketing walls and vegetation. Bulbuls feed extensively on the drupes of this and other jasmines. They also eat berries of jessamine (Solanaceae), particularly those of the day jessamine (*Cestrum diurnum*), a widely planted shrub.

We saw bulbuls devour drupes, berries, and other small fruits of more than 24 exotic species. We were interested in fruits of native species they might eat, for though these are largely lacking from suburbia they will be encountered if the population spreads to exurban habitats. The captives were offered fruits of: wild coffee (*Psychotria undata*), Florida holly or Dahoon (*Ilex cassine*), French mulberry (*Callicarpa americana*), marlberry (*Ardisia escallonoides*), and Virginia creeper (*Parthenocissus quinquefolia*). All were consumed readily.

Citrus, mangos, and avocados were of special interest. The largest fruits we saw wild birds eat were fleshy pomes (3 or 4 cm in diameter) of the exotic loquat (*Eriobotrya japonica*), which man consumes in Asia but seldom harvests in Florida. The birds ate this fruit when it became overripe, probing into it and gobbling from mushy areas.

Slices of orange, apples, bananas, and other seasonal fruits as well as sugar water were the main food of the birds in captivity, with orange slices a mainstay in the diet. They ignored intact oranges left in the cage for 24 h with no other food available.

After we fed the birds peanut butter, the butter surface was filled with indentations of the slightly opened mandibles. While the birds readily sink their bills into fleshy fruits and other soft substances, they do not (and we infer they probably cannot) sink their mandibles, bite, or tear into structures that offer more resistance. Captive birds ate sliced mangos avidly, but left whole ripe mangos untouched, even when deprived of food for 24 h. We then punctured the thin skin of each mango with the bill of a study skin of a Red-bellied Woodpecker (*Centurus carolinus*). In eight such feeding trials for each adult the birds probed into the mangos, enlarged the original puncture, and fed on the fruit in a total of 10 of the 16 trials. The immature birds did not feed from punctured mangos.

Damage to fruit by Red-bellied Woodpeckers is a problem to growers in Dade County (Goldweber pers. comm.). Of many we questioned who claimed damage to citrus by bulbuls, no one was certain the bulbul made the initial puncture into the fruit. As we have no evidence to the contrary, we assume that bulbuls damage citrus and other large fruit only

secondarily after other animals do the initial damage. It would be interesting to know what animals effect initial damage to such fruit in India.

The captive birds did not damage intact avocados and they ate slices of the fruit only sparingly. An avocado grove within the bulbuls' population center marketed avocados in 1969 (Wood pers. comm.) and the fruit buyer commented on lack of damage to it.

Certain small fleshy fruits eaten by humans suffer depredations from bulbuls. Captive birds ate mulberries (*Morus rubra*) and, if crushed for them, Barbados cherries (*Malphigia punicifolia*). Baker (1922: 395) commented that bulbuls destroy raspberries. We saw them eat a tropical Indian raspberry (*Rubus albescens*) that was introduced into Florida in 1948 (Ledin 1953).

Nectar feeding is known for some bulbuls (Thomson 1964: 111). The Kendall birds visit showy flowers of many shrubs and trees. One of the most widely planted of these is the bottlebrush (*Callistemon lanceolatus*), flowers of which are a great attraction to bulbuls; they cling to the slender branches and work their way from one mass of flowers to another. The length of time they spend probing and the methodical way they investigate the blossoms suggests they are obtaining something in addition to insects. Other blossoms regularly visited are the cajeput (*Melaleuca quinquenervia*), the coconut palm (*Cocos nucifera*), the woman's tongue (*Albizzia lebbeck*), cecropias (*Cecropia palmata*), and Queensland umbrella trees (*Brassaia actinophylla*). Flowers of these exotic plants contain much nectar. The captive birds exhausted containers of sugar water solutions long before they emptied those of plain water.

Insect gathering is particularly noticeable at the roosts. As the birds gather they spend much time hawking from trees, shrubs, and wires. After moving to the roost they remain active for some time within the canopy fringes. Here they often make short, vertically oriented flights, which Bannerman (1936: 139) described (for *Pycnonotus barbatus*) as "almost vertical upward jumps." Meriwani (1973) commented on *P. leucogenys* "jumping into the air for insects." When light is much reduced the birds retreat into the deep canopy. At dawn they move back into the periphery of the foliage and again hawk for insects until shortly after sunrise when they leave the roost. Presumably they hunt for diurnal insects that gather for protection in the foliage of the roost as well as for those that become active at twilight (Frost 1963). Selection of roosting sites may be based in part upon insect-harboring characteristics of the foliage. The highly concentrated food provided may be significant in maintaining metabolism during the night as well as in

renewing energy supplies swiftly at dawn. Ward (1969a, 1969b) showed that overnight fat can be critical for a bulbul (*P. goiavier*). His observations were at 1° N in warmer and more equable conditions than in Kendall.

In places still supporting native pines, bulbuls display another search and capture technique. Here they perch close to tree trunks, gaze about, particularly downward, and make frequent short horizontal flights. They often spiral down around the tree trunks after insects, especially small Lepidoptera, which they pursue right to earth and sometimes chase along the ground. They will also occasionally cling to a trunk and gaze about intently or search interstices of the bark.

A third type of insect searching is incidental to berry gathering or almost any activity. They will carefully search cobwebs and foliage and explore curled over leaves. Captive birds became excited when foliage was placed in their cages and searched it busily, often obtaining leaf insects, caterpillars, scale insects, and larvae of spittle insects (Cercopidae). We saw bulbuls feed upon masses of foliage caterpillars, particularly the mahogany web caterpillar (*Macolla thrysisalis*).

Of 22 stomachs examined, four contained insects. Identified were: *Cycloneda sanguinea* (Coccinellidae), fragments of tropical web-spinning insects (Embryoptera), and portions of dipterans and hemipterans. That the stomachs came from nonroosting birds collected largely in winter may explain the paucity of insects.

REPRODUCTION

Data indicate that gonadal enlargement begins in some birds in January: male, testes slightly enlarged, 17 January; male, testes moderately enlarged, 20 January; male, testes greatly enlarged, 20 January; female, follicles slightly enlarged, 20 January; follicles of three females taken 20 January, no enlargement. Comparison of these data with counts of birds at a roost (Table 1) is of interest.

Dissociation of roosts began at the end of January, some departing birds beginning to breed in early February. Nearly half the assemblages remained until the end of February and the roosts did not break up entirely until mid-March. Thus approximately 2 months passed from the first discerned enlargement of gonads in some birds to total roost abandonment.

The earliest nest, recorded 9 February 1971, was in the same tree and crotch as one of the previous season and, according to owners of the premises (Pate pers. comm.), was the same nest to which the birds added new materials. This seemed verified by a photograph of the old nest. We suggest that if these were the same birds that built

TABLE 1

TOTALS OF BULBULS AT ROOST NO. 3 IN 1970

Date	Number	Date	Number
19 January	45	1 March	18
22 January	46	2 March	15
26 January	46	9 March	3
2 February	36	12 March	3
9 February	21	16 March	3
16 February	23	22 March	0
24 February	20		

the original nest, experienced birds may nest earlier than others. Ali and Ripley (1971: 79) gave March, chiefly April, as the onset of nesting in India. Many adult plumaged birds of the roosting assemblages associate in pairs. Ali and Ripley (1971: 77) commented that each pair remains in the neighborhood of its breeding haunts throughout the year. Van Someren (1956: 248) stated that *Pycnonotus tricolor* mates for life and that *Phyllastrephus fischeri* remains paired in successive seasons.

Throughout the year pairs of adult plumaged birds were frequently accompanied by a third bird in adult plumage that perched and foraged close to the pair and followed it about. Agonistic behavior on the part of one of the pair towards this bird took place only when it came very close. Driven off, a third bird usually returned shortly. Third birds seemed more numerous or evident at the start of the breeding season, but we did not see them participate in nesting activities.

Sexes of Red-whiskered Bulbuls cannot be distinguished in the field. We frequently noted that birds of a pair were of different size. In some species of bulbuls males are larger than females (Delacour 1943). Weights of 17 adult plumaged birds we collected were: 8 males, range 23.5–30.7 g, average 27.0; 9 females, range 26.1–28.2 g, average 27.1.

We did not determine whether new pair relationships are established before birds leave roosting assemblages. Paired birds remain very close together for extended periods and they perch but a few inches apart, sometimes in actual contact. Their tails may even cross, one over the other. Flight of one is closely followed by the other, sometimes only a few inches behind. They forage close together and occasionally one bird feeds the other.

Throughout breeding, birds often intensify activities toward each other. One usually advances by jumping or hopping sideways. Both lower and raise their crests nervously and utter low chirring calls. The bird approached often flies at this point, the other following. In absence of flight, the advancing bird wingflutters and postures with its head low and inclined downwards. The bird displayed to usually forages

Fig. 4. A Red-whiskered Bulbul nest built in a fish-tail palm (*Caryotis mitis*), a plant exotic to Florida. Note the many oddments woven into it. The X marks a strip of cajeput bark. A long strip of plastic covers much of this view of the nest.

and/or preens or billwipes vigorously. One bird being displayed to fed the other. We noted that a bird that had watched a vigorous display always flew eventually, the other following closely. We never witnessed copulation. These described activities were commonplace in the population from March through June, the principal breeding season.

Nests in Florida are made of rootlets and grasses and appear no different from these described for Indian birds (Baker 1935: 372; Ali and Ripley 1971). Ali (1943: 37) described nests built of casuarina "needles." Florida bulbuls build their nests of these too (casuarina is a common Florida exotic). Dewar (1913) wrote of "oddments" woven into the outer fabric. All nests examined were so embellished (Fig. 4) with bits of paper, strips of plastic, papery bark of the cajeput tree, dried leaves, even snakeskin.

Baker (1922: 395) called *Pycnonotus jocosus* a "species of civilization" that selected gardens and cultivated lands for its abode, adding (Baker

1935: 371) that "breeding excursions into jungle and forest are rare." At present in Florida the birds nest entirely within suburbs, using virtually any shrubs, hedges, or small trees available. Heights of a dozen nests inspected ranged from 2 to 8 feet. During this investigation we made prolonged observations at two nests. At neither did events proceed to fledging; at one the eggs disappeared at night after 13 days of incubation, at the other the two 7-day-old young were eaten by a black snake (*Coluber constrictor*).

Ali and Ripley (1971: 78) stated that the sexes "presumably" share incubation. From our observations of a marked pair, this *is* the case. The young are psilopaedic—a fact apparently not established for the family (Van Tyne and Berger 1959: 518) and not mentioned by Ali and Ripley (1971). Much of the skin of the freshly hatched bird is pink, the wings and head appear steel gray. Weight of one at hatching was exactly 2.0 g. Eyes open on about the third post-hatching day. Both parents feed the young and remove shells and fecal sacs.

A bird returning to its incubating mate usually flew to a nearby perch where it paused and preened or foraged. When it uttered low-pitched, somewhat muted calls, the incubating bird left the nest. Both then usually flew off together, foraging and preening at some distance. The two often returned to the nest vicinity together. Here they usually continued feeding and preening for a time, sometimes performing mutual preening about the head and neck. Not infrequently one presented the other with a drupe or syconium. Both sometimes flew to the nest tree together. After pauses here, characterized by low calling of both, one moved quickly into the foliage concealing the nest. The other frequently remained briefly, moved off to neighboring trees, then eventually left.

Fig. 5 outlines the 8.6-acre territory in which a pair (one color-banded) was active during 12 days of incubation. The nesting territory hardly fits the category of a "defended" area. Other bulbuls were frequent about the nest and they constantly visited the fruiting fig directly across the street (see Fig. 5) where they fed, often along with the nesting pair. Visiting bulbuls perched near the nest elicited low warbling calls, not alarm notes, from the resident birds and were often joined by them. Although Baker (1922: 395) stated that males fight fiercely if their "special ground" is invaded, we saw no agonistic behavior. Fisk (1966) also failed to note any such behavior, commenting that as many as eight bulbuls gathered about a nest.

Molt of Juveniles

Juvenal plumaged birds differ markedly from adults. They first appear in late March or April and soon become numerous. In post-

Fig. 5. An aerial view of the territory (outlined) in which a nesting pair of bulbuls was active. Location of the nest is indicated by a circle. The Xs shows the Napier grass of roost No. 2. Directly across the street (east) of the nest is a large strangler fig from which the nesting bulbuls and many other birds fed. A mango grove lies east of the strangler fig. West of the nest are tennis courts.

breeding assemblages they are conspicuous in August and September, and become constantly less noticeable thereafter.

We followed plumage changes in two juvenal plumaged captives (sexes undetermined). These were somewhat different in size when mist-netted in May and were probably of slightly different ages. In

the larger, quills of the red subocular feathers ("whiskers") appeared 17 August, in the other 10 September. By 15 October crests, other head feathers, and breast bands were black. Both molted rectrices during late August. Tawny undertail coverts were replaced by orange ones (not so orange as those of wild adults) in late August.

Specimens collected in late fall and early winter show varying stages of molt, particularly of rectrices, tail coverts, and chin and throat regions. A female of 7 November was in extensive molt of subocular feathers, the gular area, sides of head, and rectrices. Lack of an extensive dark breast band indicated it was an immature bird acquiring adult plumage.

First-year birds, judging from the captives, go through a partial second molt. The captives replaced the red subocular feathers acquired in August and September during February and March and grew a second set of rectrices between mid-January and mid-February.

Predators

Snakes, rats, cats, and certain birds are common potential predators of the bulbuls. Cotton rats (*Sigmodon hispidus*) and cats are plentiful in the suburban habitat. Blue Jays (*Cyanocitta cristata*) took the young from two nests.

American Kestrels (*Falco sparverius*) return to southeastern Florida in September (*F. s. paulus*, the resident race of this falcon, has disappeared as a nesting bird from southeastern Florida). In the second author's experience, these derive considerable prey from the large roosting assemblages of the House Sparrow (*Passer domesticus*). As with the sparrows, the falcons seemed to know the bulbul roost locations. They were often seen flying toward a roost from a distance. We believe the falcons made the rounds of roosts at evening. They frequently hovered above a roost and their obvious presence inhibited the bulbuls' preroosting activities. They also visited at dawn, arriving before the bulbuls began leaving. Although the falcons often stooped at bulbuls and closely pursued groups of birds, we never saw them capture any. Pursued bulbuls and others nearby responded with high-pitched, discordant notes that we interpreted as alarm calls, although not necessarily hawk-specific ones.

Distribution and Spread of the Population

Ali and Ripley (1971: 77) described *Pycnonotus jocosus* as sedentary, "each pair usually remaining in the neighborhood of its breeding haunts throughout the year." Although they found "loose feeding flocks" during the nonbreeding season, they did not mention roosting assemblages.

The two fig trees close to where the original birds escaped served as a late winter roost since at least 1964. We assume this roost once accommodated the entire population. Additional roosts formed as the population grew. Roost No. 3 was established about 1967. Roost No. 4 by its small population (10 birds) is probably the most recently established. We have no information about maximum size, although it appears to be about 100. Roost sites of 1969–70 (Fig. 1) are not far apart. We have no information on factors determining roost distribution, but the fact that the birds are sedentary, the history (origin) of each roost, and the minimum foraging space required for a roost's population all seem to be important. The fact that birds return yearly to the same roosts, or to their general area, appears to have minimized diffusion of the population.

In searching for roosts and in determining the distribution of the breeding population, we kept records of all sightings and solicited information of local residents. We then plotted the region within which the birds were conspicuous, approximately 3.2 square miles in extent (Fig. 1). Bulbuls have been reported at distances up to several miles from the center of concentration shown in Fig. 1. The irregular sightings are probably of birds exploring beyond the territory ordinarily frequented. Exploring of this sort, even by relatively sedentary species, must be basic to range extensions of an invading population.

Density of occurrence correlated with age of neighborhood. Birds were less frequent around recently built homes with newer plantings. They spent considerable time at nurseries as well as in isolated tracts of native pine.

ESTABLISHMENT OF THE POPULATION

Numerous factors seem significant to the species' establishment. This bulbul was already adapted to habitats modified by man and the birds invaded an environment not dissimilar from their native one. In Florida they found profusion of fruiting and flowering shrubs and trees borrowed from the world's tropics, India included. The spectrum of the birds' diet assures a year-around food supply. In appearance and habits the species is attractive to man and is accorded protection and assistance (e.g. feeding stations catering to its tastes). Highly significant to a pioneering population in a vast new landscape is the roosting aggregation. Young of the year follow adults to these assemblages, which can both serve as "information centers" for food finding (Ward and Zahavi 1973) and also synchronize breeding cycles. Social roosting affords the birds a degree of immunity from predation.

Phillips (1928) recognized two categories of successful invaders: those

successful briefly, then dwindling in numbers and disappearing, and those succeeding permanently. It is perhaps early to predict which category will apply to *P. jocosus*. The species gives indication of being permanently successful. No obvious ecological factors exist that will prevent colonization of the entire tropical zone of southeastern Florida. How far north can the birds extend their range? Many of the plants important for food range at least to Martin County on the east coast (ca. 80 miles north of Dade County). This is the approximate northward limit of the tropical plants. Many of the ornamental plants with which the birds are associated grow wild, or are cultivated, to the north of the tropical zone in Florida. Should the birds extend their range northward of the tropical zone they will encounter increasingly temperate conditions. Study of the ecology during such a period would be interesting indeed.

ACKNOWLEDGMENTS

Invaluable assistance was given by faculty of the University of Miami: T. R. Alexander, F. G. Butcher, the late M. J. Dijkman, C. H. Dodson, J. F. Morton, M. J. Mustard, and F. H. Strohecker. S. Kiem and G. Avery of Fairchild Garden gave needed information as did R. Hunt and S. Goldweber of the Dade County Agricultural Agent's Office and D. O. Wolfenbarger of the University of Florida Research Station. E. J. Fisk of Homestead and many residents of the Kendall area cooperated and gave information: M. Gallagher, H. Vavra, M. Wood, Mr. and Mrs. G. Kelly, Mr. and Mrs. N. Ward, Mr. and Mrs. D. Rupp, and A. Pate. H. Alexander, D. Cary, R. Fergen, J. Klinovsky, M. and J. Kushlan, R. Paterson, C. Senna, W. Fernandez, J. Paul and others assisted in many ways. Frederick Folger took some of the photographs. The Royal Palm Tennis Club cooperated. We thank John Seubert, U.S. Fish and Wildlife Service. Portions of the above were submitted by the senior author in partial fulfillment of requirements for the M.S. degree at the University of Miami.

The first year of study was supported by the U.S. Department of the Interior, Fish and Wildlife Service, Contract No. 14-16-0008-534, awarded 15 September 1969; the second year by the Maytag Chair of Ornithology.

SUMMARY

The Red-whiskered Bulbul population in Dade County, Florida was studied from September 1969 through May 1971. Introduction of the species into southern Florida was a predictable consequence of a large import trade in exotic birds. Man-produced modifications of the landscape facilitated establishment.

The birds are associated with a flora in part exotic to Florida. This is noteworthy with respect to feeding, roosting, and nesting.

This bulbul seems predominately adapted to eating small fruits that it can easily mandibulate and crush. It supplements fruit with insects and nectar. Feeding trials with captive birds, field observations, and other

information have produced no indication of initial damage to citrus or other large fruits of commercial importance, but the bulbuls will enlarge openings made in fruit by woodpeckers or other animals.

Gonadal enlargement begins in January and is followed by dissociation of roosting assemblages in February and March. Some birds breed in early February. Postbreeding flocking begins as breeding terminates, generally in July.

Nest structures and placement are similar to those in India. Both sexes incubate and feed young. Young are psilopaedic. Although the breeding population is widely spaced, there is no evidence of territorial defense. A pair of incubating birds ranged within 8.6 acres.

Juveniles molt into adult plumage during late summer and early fall (July–October). Judging from captive birds, a second (prenuptial) molt occurs in first-year birds.

The population in the winter of 1969–1970 was about 250. Since introduction in 1960, average annual increment to the population has been between 33 and 40%. The 1969–70 population was conspicuous within approximately 3.2 square miles of suburbs. Sedentary habits and attachment to roosting sites and/or areas have mitigated against rapid population spread.

The species gives indication of being successfully established, although it is perhaps too early to be sure of this. Success is attributed to several factors. The birds were already adapted to an environment much modified by man. Their natural food is plentiful in tropical Florida and man protects them. Social roosting habits allow for transmission of environmental information and probably greatly facilitated establishment.

No ecological factors are apparent to hinder spread of the species along coastal (tropical) southeastern Florida.

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