BREEDING AND POSTNUPTIAL MOLT OF THE RED-VENTED BULBUL IN WESTERN SAMOA

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As the timing of molt in the annual cycle of a bird can be very flexible, it is interesting to study molt in species introduced into a humid tropical environment. The Red-vented Bulbul (*Pycnonotus cafer*) is a common resident in India, Pakistan, Burma and Sri Lanka. Around 1903 it was introduced into Fiji (Mercer 1967) where the subspecies is *bengalensis* (Mayr 1945, Ali and Ripley 1971). The bulbul probably reached Upolu (Western Samoa) in the early fifties (Keith 1957) and has since spread to other islands of the Samoa group [Tutuila (Clapp and Sibley 1966), Savai'i (Dhondt 1976a)] and has also reached Tonga (Dhondt 1976b). The subspecies in Samoa is also *bengalensis* (Ashmole 1963). As in its region of origin, the bulbul is common in gardens, villages and plantations, but rare along forest edges. Two molt studies of bulbuls occurring normally in the tropics have shown that breeding and molt are seasonal although the molting season of the population is long and extends over five months in *Phyllastrephus flavostriatus* and over seven months in *Pycnonotus xanthopygos* (Moreau et al. 1947) and in *Pycnonotus goiavier* (Ward 1969). Unpublished data on *Pycnonotus barbatus* from A. De Roo in Zaire indicate that its molting season might be even longer.

This study describes postnuptial molt in a Samoan population of the Red-vented Bulbul, in which the molting season is shorter than that of non-introduced bulbuls.

METHODS

I was in Western Samoa from January to July 1973 and again from January until September 1974. Molt records are based on 30 captures in April 1973 and one in March 1974. All birds were mist-netted in my garden in Moto'otua, Apia. Visual observations also gave some information on molt condition.

Molt state was scored according to the numerical method used by Newton (1966). Each feather scores as follows: old feather, 0; missing or small pin, 1 point; up to one-third grown, 2 points; up to one-half grown, 3 points; up to three-quarters grown, 4 points; fully grown, 5 points. The molt score for each feather tract is determined by adding the individual scores for all feathers in that tract. As molt was recorded in one wing only, the primary score may range from 0 to 50 points (10 primaries), the secondary score from 0 to 30 points (6 secondaries) and the score for the posthumeral quills ("inner secondaries" or "tertials") from 0 to 15 points (3 feathers). As tail molt often is asymmetrical, the condition for all 12 tail feathers was recorded giving possible scores between 0 and 60 points. Primaries are numbered in descending order, secondaries and tertiaries in ascending order and tail feathers centrifugally. The minimum wing length of the captured birds was determined by laying the left wing on a flat ruler without deforming it.

BREEDING

In its original range the Red-vented Bulbul usually has an extended breeding season and may have up to three successive broods. Geographic variation in the timing of the breeding season is large, however, and breeding mostly coincides with the monsoon. Clutch size varies, and for different subspecies it is two to three, or three to four eggs (Ali and Ripley 1971). In Fiji the breeding season extends from November to January (Mercer 1967). Data on breeding in Samoa are scarce but suggest that the breeding season is much as in Fiji and that the species is often double-brooded. The clutch size is three or four (one case each). Goodman (1969) found a nest in a mango tree from which young fledged in mid-November 1968 and which contained three eggs on 14 January 1969. A second nest contained young on 16 January 1969. My observations are limited to the end of the breeding season, as I was absent between October and January.

On 10 January 1974 four young fledged from a nest in a dead tree in Moto'otua. The nest was about 8 m up on a small platform 15 cm under the top of a broken stem. It was built of small twigs and dry grass. The outer diameter was 12 cm, the cup 6 cm in diameter and 3 cm deep. After fledging, the young were fed by the adults for more than three weeks, sometimes on ripe pawpaw. On 17 January 1974 I found one dependent young and one adult in Apia, and on 9 February 1974 I saw one dependent young and one adult in Moto'otua. I did not see dependent young at other times of the year. Two mist-netted juveniles were molting at about the same time as the adults. As they seem to undergo a complete postjuvenile molt and acquire a plumage identical to that of the adults, it is impossible to distinguish them from adults in the field.

The Condor 79:257–260, 1977

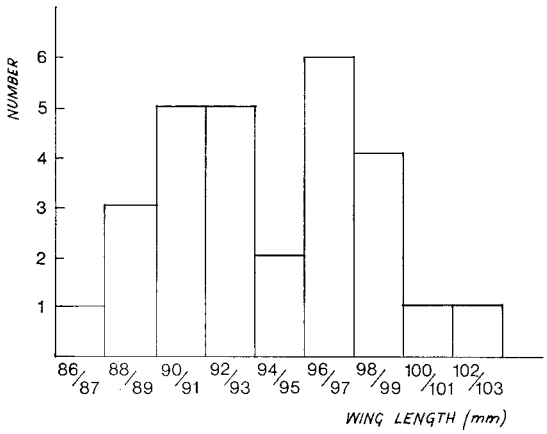

FIGURE 1. Distribution of wing-lengths of the Red-vented Bulbul in Western Samoa.

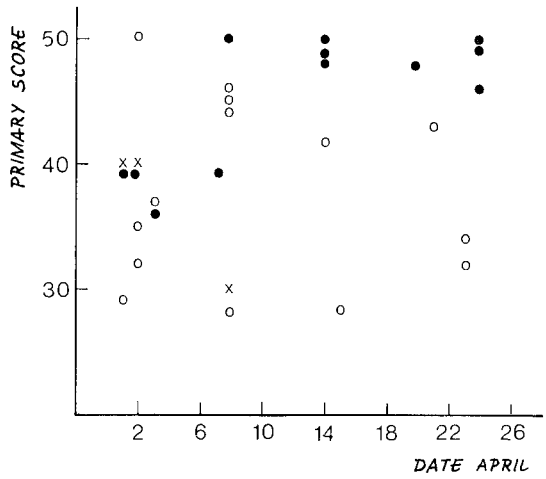

FIGURE 2. Primary score plotted against date. Filled circles: males; open circles: females; crosses: sex unknown.

TIMING OF MOLT

Postnuptial molt seems to be seasonal and to start soon after breeding, i.e., during the second half of January. This estimate is based on the 20 February 1974 observation of a few bulbuls lacking the central tail feathers and, five days later, of many that had started tail molt. Tail molt starts at an average primary score of 19 points (considering one wing only). The rate of primary molt is not known, but Ward (1969) determined that for the Yellow-vented bulbul (*Pycnonotus goiavier*) in Singapore it takes about 16 weeks. In my scoring system this would give an average primary molt rate of 0.45 points per day (50 points in 112 days). However, the overall molting season in Singapore covers a seven-month period whereas in the Samoan population of the Red-vented Bulbul it is only about four months (see below). Hence, the primary molt rate is probably higher and can be estimated to be between 0.6 and 1 point per day. At these rates it would take between 32 and 19 days to reach a primary score of 19 points; counting back from 20 February, I estimate that primary molt started during the second half of January or at the beginning of February. Because postnuptial body molt in the Yellow-vented Bulbul starts about one week before primary molt (Ward 1969), I estimate that postnuptial molt of the Red-vented Bulbul starts during the second half of January. The first bird with fully renewed primaries was caught on 2 April, but on 24 April some captured birds were still molting. Therefore I estimate that the bulbuls terminate molt in May, which is corroborated by field observations. In sum, the molt period of adult Red-vented Bulbuls on Samoa lasts from January until May.

WING LENGTH AND SEX

Of the 31 bulbuls handled, 29 were adults. Plotting the wing length (of 28 birds) reveals a bimodal distribution (fig. 1) with a minimum in the 94–95 mm class. Although some birds may have been missexed, all those with a wing length up to and including 93 mm were considered to be females, and those with a wing length of 96 mm or more were considered to be males. Thus, the sample included 14 females, 12 males and 3 birds of unknown sex. Ali and Ripley (1971) gave ranges of 89–102 and 96–107 for females and males respectively, of *bengalensis* in its original range. Their overall range of 89 to 107 compares well to mine of 86–102, allowing for differences in methods of measurements.

MOLT

PRIMARY REMIGES

As usual in passeriformes, the primaries molt in ascending order. On the average this molt is completed earlier in birds considered to be males than in females (fig. 2). In 15 birds in which the outermost primary (P 10) was still old, the average number of primaries growing simultaneously was 2.3. This means that each primary is dropped when the previous one is almost three-quarters of its final size, or that the next growing primary is about half its size when the previous one terminates growing.

SECONDARY REMIGES, POSTHUMERAL QUILLS AND TAIL

As in most passeriformes, the secondaries molt in descending order and the tail molts centrif-

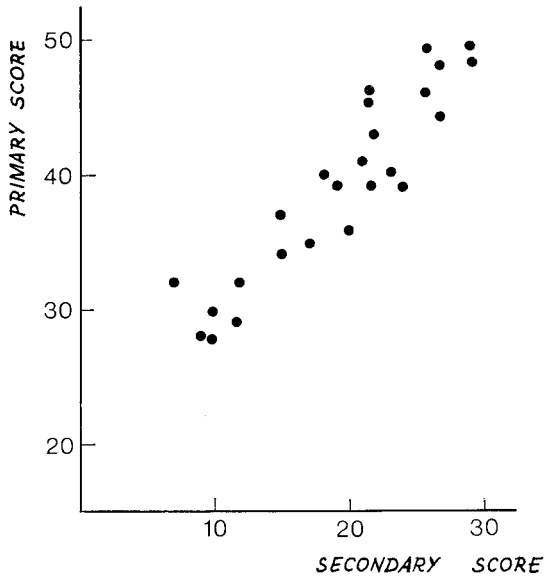

FIGURE 3. Secondary score plotted against primary score (one wing).

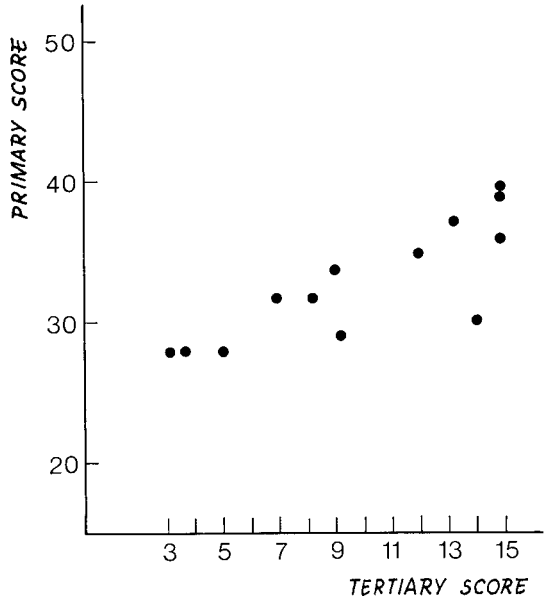

FIGURE 4. Posthumeral (tertiary) scores plotted against primary scores (one wing).

ugally. In figure 3, secondary and primary scores are plotted against each other. From the calculated regression equation ($y = 20.31 + 0.97\ x$) it can be deduced that secondary 1 is dropped when primary molt score averages 20.3 points (when P 4 is growing) and that on the average, molt terminates at the same time in these feather tracts ($x = 30$, $y = 49.4$). As the regression coefficient (0.97) is not significantly different from 1.0, molt proceeds at a similar rate in both tracts.

The sequence of the renewal of the posthumeral quills is middle (2), proximal (3), distal (1). From the regression ($y = 26.60 + 0.56\ x$) calculated when the score for these feathers is plotted (fig. 4) against primary score, it can be deduced that posthumeral 2 is dropped when the primary score averages 26.6 (when P 5 is growing) and posthumeral 1 is fully renewed when the primary score averages 35.0. Thus posthumeral molt starts later than either secondary or tail molt but finishes before molt in any other feather tract. Posthumeral molt proceeds at a lower rate than primary molt ($0.56 \neq 1.0$; $P < 0.01$).

Scores for tail molt are plotted against primany scores in figure 5 ($y = 18.68 + 0.42\ x$); the central pair of rectrices is dropped when the primary score averages 18.7 (P 4 growing), and tail molt is completed when the primary score averages 44. The tail thus starts to molt slightly before the secondaries and is renewed before them. Tail and primary molt rates do not differ significantly.

In summary, I found molt occurring only in the primary tract until P 4 is dropped. Shortly after this, the central rectrix (T 1) and the distal-most secondary (S 1) are shed, and molt proceeds at an equal rate in these three tracts. After P 5 is dropped, the middle posthumeral is shed; molt proceeds at a slower rate in this latter tract. By the time P 7 is dropped, molt of the posthumerals is com-

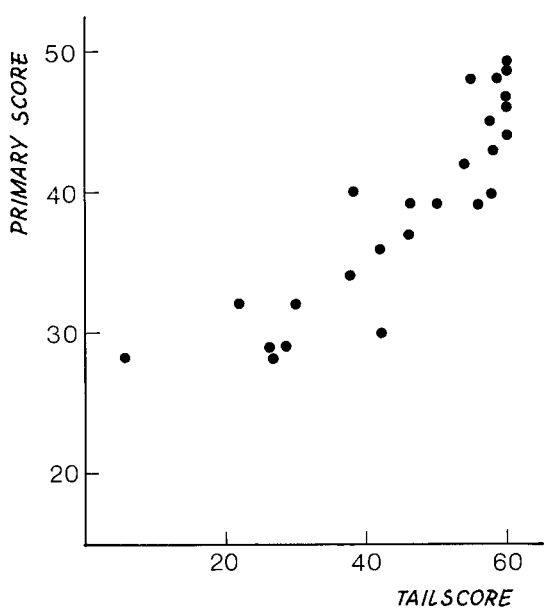

FIGURE 5. Tail score (complete tail) against primary score (one wing).

pleted, and tail molt is terminated just before P 8 is regrown. Secondary 6 and P 10 finish growing almost simultaneously.

MOLT OF THE ALULA

Although molt of the body feathers and of the coverts was not recorded routinely, I gave special attention to the molt of the alula. I noted if these feathers were old, growing, or new. In seven of the birds captured, the alula was growing. Remarkably, in the three males with a growing alula, the primary score was 39 (innermost growing P 7) whereas in the three females the primary score averaged 43.7 (42, 43, 46), and the innermost growing primary was P 8. Although the number of observations is small, the difference in the relative timing of the alula molt in the overall molt sequence is significant (Mann-Whitney U-test; $P < 0.05$). I conclude that within the overall molt pattern, males molt their alula significantly earlier than females. The significance of this is unknown.

ACKNOWLEDGMENTS

I am grateful to E. H. Bryan, Jr., Pacific Science Information Center, Bernice P. Bishop Museum, Honolulu, for sending literature that I would otherwise not have obtained. I also thank M. S. Foster for comments on the manuscript.

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