WING AND TAIL MOLT OF THE SPARROW HAWK

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IN the order Falconiformes, the family Falconidae is unique in that the molt of the primaries begins with the fourth primary and proceeds simultaneously in both directions (Stresemann, 1958; Stresemann and Stresemann, 1960). Mebs (1960) studied the wing and tail molt sequences in several species of large falcons and concluded that these molt sequences served as additional proof that the Lanner Falcon (*Falco biarmicus*), Sakar Falcon (*F. cherrug*), Prairie Falcon (*F. mexicanus*), and Gyrfalcon (*F. rusticolus*) are more closely related to each other than to the Peregrine Falcon (*F. peregrinus*). Wing and tail molt sequences have not been described in detail for the Sparrow Hawk, or American Kestrel (*F. sparverius*), although Parkes (1955) and Roest (1957: 10) discussed its molts and plumages. Since the molt sequence of remiges and rectrices may be useful as a taxonomic tool, this paper describes wing and tail molt sequences of 13 captive Sparrow Hawks.

METHODS

Six male and seven female Sparrow Hawks were housed in internally illuminated flight rooms (12 × 6 × 8 feet). The birds were kept in pairs on artificial photoperiods for breeding experiments, as reported by Willoughby and Cade (1964). The lighting schedule was 16 hours of light per day from 12 February to 31 July 1962; 8 hours per day from 31 July to 27 October 1962; and 18 hours from 27 October 1962 to 6 May 1963.

During molting periods the floor of each room was inspected every morning and all remiges and rectrices were picked up and labelled with the date and animal's designation. The molt sequence could then be determined. I use the term "set" to refer to the feathers of a given class from one side (e.g., all the primaries from the left wing make a set). In the sequences given herein, a comma separating two feathers indicates that their order of dropping out was frequently reversed, and a slash indicates that the feathers fell out less than one day apart.

RESULTS

Figure 1 shows the average time sequence of molt in wings and tail. The molt of the wing and tail feathers was accompanied by molt of the contour feathers of the body. The first sign of molt in a bird usually was the dropping of one or two remiges, accompanied by a few body feathers. The molt of the remiges extended through the whole period of general body molt. Molting is associated with the breeding cycle, beginning shortly after egg laying (Willoughby and Cade, 1964: 87, 89). Females began to molt an average of 16 days ahead of males. Table 1 shows the time from beginning of the long photoperiods to beginning of molt. There were no substantial differences of molt sequences between the sexes. There apparently was no difference between old and young birds, since a captive-

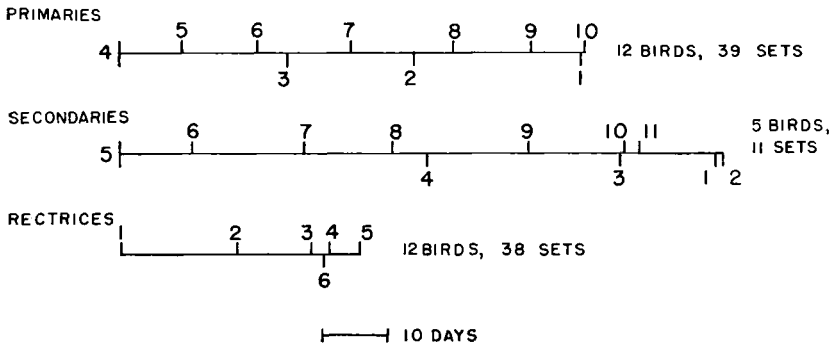
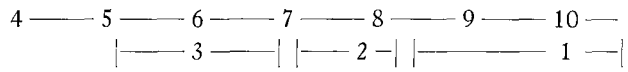


Figure 1. Molt sequence in captive Sparrow Hawks. The left end of each line starts with the first feather molted. The length of the horizontal line connecting the feathers denotes the mean time interval between dropping of the feathers.

bred female which began molting when eight and one-half months old had the same molt sequences as most of the older birds.

Primaries.—Individual molt sequences varied considerably. In primaries, the order of dropping of the feathers proximal and distal to the fourth primary was quite constant. However, the timing of events between these two groups of feathers was not constant. This variability can be schematically represented by the method of Stresemann (1958) as follows:



(For example, this diagram shows that the third primary fell out any time from shortly after the fifth to shortly before the seventh.) The molting of the first primary with respect to the ninth and tenth was most variable. In 34 sets of primaries from 13 birds the sequences and their frequencies were: 1—9—10 (2 sets), 9—1—10 (17), 9—10/1 (2), 9—10—1 (13).

Secondaries.—Because of the difficulty of determining the order of

TABLE 1

NUMBER OF DAYS FROM BEGINNING OF LONG PHOTOPERIOD TO BEGINNING OF MOLT

Date of beginning of photoperiod	*Days until beginning of molt*		
	♂♂ (N = 6)	♀♀ (N = 6)	♂♂ − ♀♀
12 February 1962	Mean 98 Range 77–125	Mean 82.2 Range 77–101	15.8
27 October 1962	Mean 95.3 Range 70–124	Mean 78.7 Range 74–92	16.7

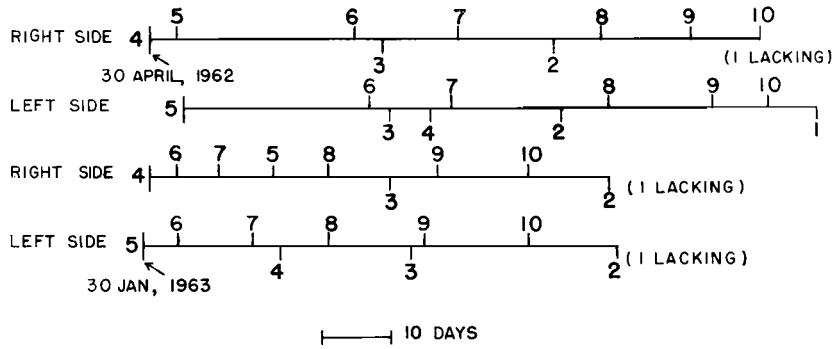
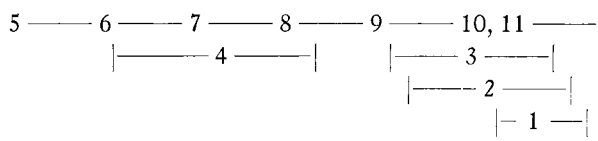


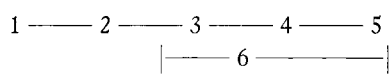
Figure 2. Aberrant molt sequences in the primaries of one female in two consecutive molts. The dates are those when the first feather dropped out in each molt. The length of the horizontal line connecting the feathers denotes the mean time interval between dropping of the feathers.

secondaries in a set of molted feathers, only 11 complete sets from five individuals could be used; they show considerable variability. The variations mostly involved the order of molting of the tenth and eleventh secondaries and the relative timing of the molting of feathers distal and proximal to the fifth. In four sets (three individuals), secondary 10 was lost before 11; in four sets (three individuals) the order was reversed, and in two sets (two individuals) secondaries 10 and 11 dropped out less than a day apart. The variation between the feathers proximal and distal to the fifth is as follows:



The molting of the first secondary preceded that of the second in 3 of 14 sets.

Rectrices.—The Sparrow Hawk follows the general rule that the sixth rectrix drops sometime between the dropping of the first and fifth (Mebs, 1960: 176). The variation can be diagrammed thus:



In all 38 sets, rectrix 6 fell some time after rectrix 2. In one set 6 dropped not more than a day after 5.

Variability.—In addition to the variations between individuals, there was also appreciable variability in some individuals between right and left sides and between consecutive molts. For example, in a pair of primary

sets from one male, the right side molted 4—5—3—6—7—2—8—9/10—1, and the left side molted 4—5—6—7—2—8—9—10—1—3 (3 falling nine days after 10 and six days after 1). In the same male, the fifth rectrix preceded the fourth on the left side only, in two consecutive molts. In the right wing of another male, primary 9 fell six days before primary 10 in one molt, and nine days after 10 in the subsequent molt; in the same bird the fourth rectrix preceded the third on the right side only, in two consecutive molts.

One female was rather aberrant in the molt sequence of the primaries (see Figure 2). The first primary is lacking from three of the four sets because in these instances it was dropped after the bird had been removed from the flight room.

One male had only 10 rectrices. The tail molt sequence of this bird was 1—2—3, 4, 5, the last three pairs falling out within five days of each other, in various orders. The duration of the tail molt for this bird in two consecutive molts was 22 and 26 days.

Correlations in wing and tail molt.—There was no definite relationship in the timing of dropping of primaries, secondaries, and rectrices, except that all the rectrices dropped during the molt of the remiges. The molting of primaries and secondaries generally began within a week of each other, although in one male, molt of the secondaries began 11 to 16 days before molt of the primaries. In general, corresponding feathers of right and left sides fell out together or within three days of each other.

DISCUSSION

Wing and tail molt sequences in the European Kestrel, *Falco tinnunculus*, have been reported by Piechocki (1956) and Sutter (1956). The data for that kestrel correspond closely to those for *F. sparverius*. Piechocki studied a single captive male. Sutter examined five specimens from the field and six captives, each of which represented a different stage in the molt. His sample indicated considerable variability of the sort shown by the Sparrow Hawk. Most of Sutter's specimens conformed to Piechocki's data which gave an order of the molting of primaries of 4—5—6—3—7—8—2—9—10—1 (Piechocki, 1956: 304, 306); but in one bird the second primary fell out before the eighth, and in another the first fell before the ninth and tenth (Sutter, 1956: 174). Sutter (1956: 176) concluded from his material that it was not feasible to arrange primaries 9, 10, and 1 in a precise order because they tended to fall out within a very few days of each other.

The tail molt sequence of the Sparrow Hawk differs from that of the Kestrel. The latter loses the sixth rectrix just before the second (Piechocki, 1956: 302) or somewhat after the second (Sutter, 1956: 179). The Sparrow Hawks which I studied always lost the sixth after the second, usually within a short time of the dropping of the third.

Dementiev (1940) determined wing and tail molt sequences of some falcons in the Zoological Park of Moscow. He found that in a Gyrfalcon the sequence of molt of the primaries was 4—5—6—3—7—8—2—9—1—10 (p. 481). A single Saker Falcon molted the primaries in the same order (p. 485). The rectrices of the Gyrfalcon fell in the order 1—2—3—4—6—5 (pp. 481–482).

Stabler (1942) found a primary molt sequence of 4—5—6—3—7—2—8—9—1—10 and a tail sequence of 1—2—6—3—4—5 in a captive Gyrfalcon. Mebs (1960) determined molt sequences of 11 *F. peregrinus*, 5 *F. biarmicus feldeggii*, 1 *F. cherrug*, 2 *F. mexicanus*, and 4 *F. rusticolus*. Mebs' data indicated (p. 178) that *F. peregrinus* differed from the others in that primary 1 normally falls out between 8 and 9 instead of between 9 and 10. In the Sparrow Hawk primary 1 usually falls between 9 and 10 (Figure 1), and thus it also differs from the Peregrine Falcon. Indeed, *F. peregrinus* appears to have the first primary preceding the ninth quite regularly (Mebs, 1960: 180), but not invariably (see Stabler, 1942: 8; and Bond, 1936). The European Kestrel and Sparrow Hawk might be distinguished from the Peregrine Falcon by their greater variability in the molt order of primaries 1, 9, and 10; but the use of such a characteristic as a key to intrageneric relationships among falcons will require large samples of precisely determined molt sequences to establish the limits of the variability in each species.

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SUMMARY

The molt sequences of remiges and rectrices were determined in 13 captive Sparrow Hawks. On the average primaries dropped in the sequence 4—5—6—3—7—2—8—9—10/1, secondaries in the sequence 5—6—7—8—4—9—3/10—11—1—2, and rectrices in the sequence 1—2—3—6—4—5. There was substantial variability in the order of molt between individuals and between successive molts in a given individual. The most common variation involved the order of dropping of the first primary with relation to the ninth and tenth.

One female began molting the primaries of the left wing with the fifth instead of the fourth feather in two consecutive molts. One male had only five pairs of rectrices instead of the normal six pairs.

There was no definite relationship between dropping of the primaries, secondaries, and rectrices. Molt of the primaries and secondaries generally began less than a week apart, and rectrices all molted during the molt of

the remiges. Corresponding feathers of right and left sides fell out normally within three days of each other. The molt of remiges extended through the period of general body molt.

The molt sequence of the primaries of the Sparrow Hawk resembles closely that of the Kestrel. Both species show considerable variability in the molting sequence of primaries 1, 9, and 10. The Peregrine Falcon differs from the kestrels in that primary 1 regularly molts before primary 9. Use of molt sequences in determining interspecific relationships among falcons must be based on large samples to define the limits of variability in each species.

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