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The Condor 89:911-913
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SEXUALLY MOSAIC PLUMAGE IN A FEMALE AMERICAN KESTREL¹

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Key words: American Kestrel; *Falco sparverius*; bilateral gynandromorphism; plumage mosaic; endocrine abnormality.

The plumage of the American Kestrel (*Falco sparverius*) is well recognized to be dichromic between the sexes (Mearns 1892, Bent 1938, Bond 1943, Friedman 1950, Parkes 1955, Cade 1982). On 24 July 1986, a female American Kestrel was found along a roadside in Salt Lake City, Utah, apparently having collided with an automobile. The right wing was missing, and the bird was emaciated and generally in poor condition. The bird was euthanized and upon examination showed both male and female plumage characteristics (Fig. 1). The breast plumage color pattern was characteristically female except for the lower left abdominal region (Fig. 1a), where dark brown/black spotting similar to male breast plumage pattern was present.

The rectrices were most aberrant (Figs. 1a, b, c), and hereafter are numbered 1 (outermost) through 6 (central). Rectrix 1 right (1R) is characteristic of a typical female, except the subterminal, black band is considerably wider (Fig. 1c). Rectrix 2R is incompletely barred with black on the outer vane decreasing proximally to form tiny black spots on the margin. The inner vane contains only two partial black bars immediately proximal to a broad, subterminal black band. Rectrix 3R is incompletely barred with black on the outer vane decreasing proximally to form tiny spots as in rectrix 2R. The inner vane contains only a small black spot immediately proximal to a broad, subterminal black band, typical of males. Rectrix 4R contains no barring on either side of the vane. One small, black spot occurs

on the inner vane, near the margin, and immediately proximal to a broad, subterminal black band. Rectrix 5R is virtually identical in color pattern to rectrix 4R. Rectrix 6R is incompletely barred in black on either side of the vane with the inner vane more heavily barred, but the proximal black bars do not meet at the rachis. Rectrix 6R terminates in a broad, black band, proximal to a rust colored tip. Rectrices 1R to 5R are tipped in an ivory/whitish color, typical of males. Rectrices 6R, 6L, and 2L to 5L are tipped in a pale rust color, typical of females. Rectrix 1L is tipped in an ivory/whitish color similar to rectrix 1R.

In general, rectrices 3R, 4R, and 5R are virtually without female characteristics, with the exception of the incomplete barring on the outer vane margin of rectrix 3R. The length of the rectrices does not vary abnormally, but the vane of rectrices 2R to 5R is approximately 2 mm wider than rectrices 2L to 5L. None of the tips of the rectrices show signs of wear (Fig. 1c). Based on crown plumage characteristics (Parkes 1955) the kestrel was considered to be a hatch-year bird.

The gonads were paired, not an uncommon condition that has been found in 30 to 50% of females of the genus *Falco* (see White 1969). The left gonad measured 1.50 × 1.00 mm and the right measured 0.66 × 0.66 mm. The right gonad was somewhat lighter in color and smoother in texture than the left, and neither was enlarged nor contained enlarged follicles. Results of a histological examination of the gonads proved inconclusive in determining whether testicular tissue was present. Visually, both gonads appeared to be ovaries.

The occurrence of sexually mosaic plumage is somewhat difficult to explain, since a variety of systems control secondary sex characteristics in birds. One case of gynandromorphism has been reported for the American Kestrel (Brodkorb 1935), and generally refers to individuals visually one-half male and one-half female

¹ Received 5 November 1986. Final acceptance 8 April 1987.

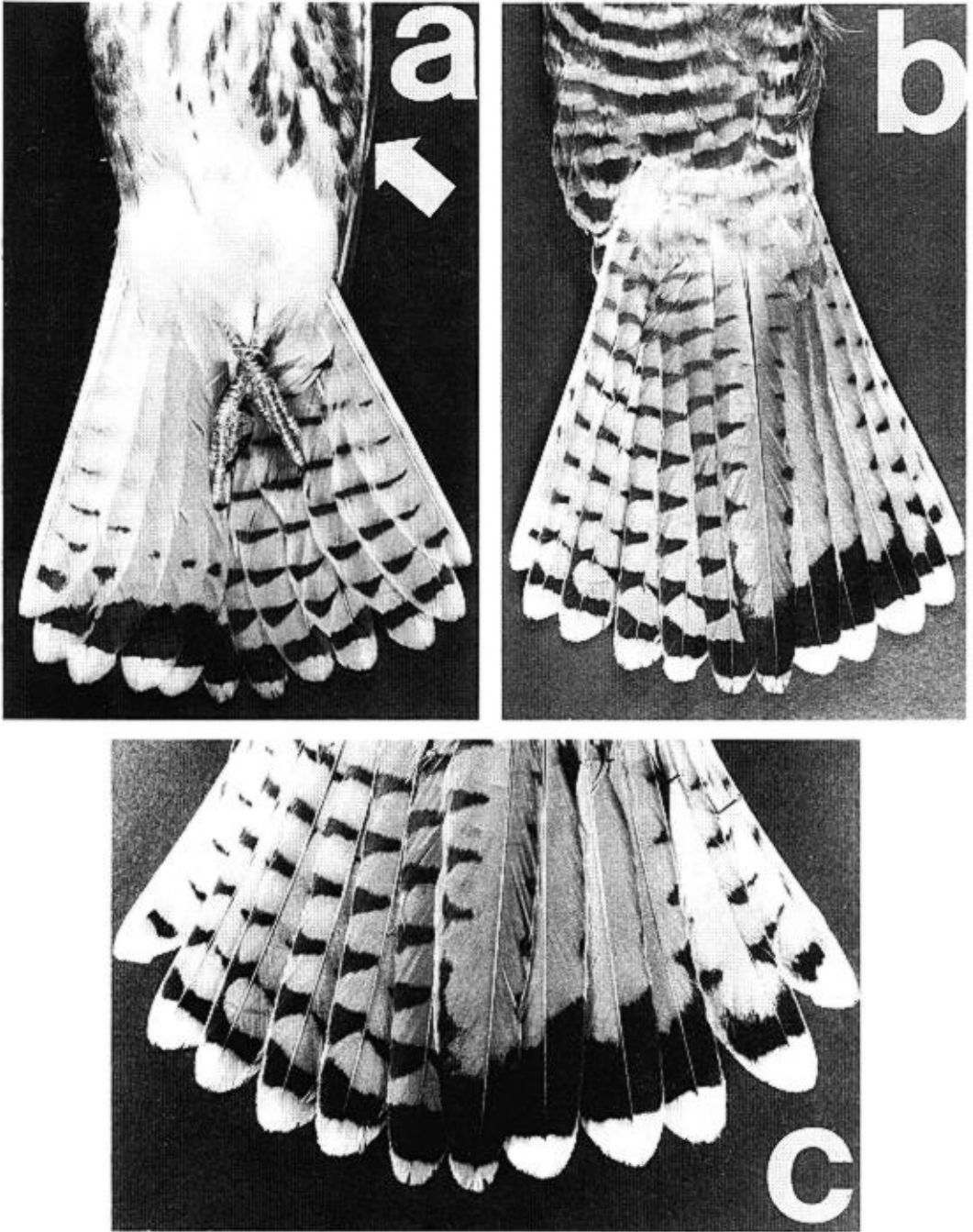


FIGURE 1. (a) Ventral view of female American Kestrel showing dark, masculinized flank feathers on the left side and masculinized rectrices on the right side; (b) dorsal view; (c) close-up dorsal view of rectrices shown in Figures 1a and 1b.

and possessing ovary and testis (Campbell and Lack 1985). When sex-linked differences in plumage exist, they will externally reflect the place of gonads, with one side displaying male plumage characteristics and the other female (Witschi 1961). Most described gynanders appear male on the right side and female on the left (Kumerloeve 1954). Bilateral gynandromorphism usually occurs when both an ovary and a testis are present but may result when an ovary and an ovotestis, or a mixed, undifferentiated gonad, are present (P. A. Buckley, pers. comm.). Since incomplete masculinization occurred on both sides of the female reported on herein, however, the bird cannot be considered a gynandromorph in the strictest sense.

Buckley (1982) reported on a wide range of plumage variation resulting from both genetic and epigenetic factors. Sexual difference in phenotype is often the result of a precise balance between medullary (male) and cortical (female) hormonal components of the gonads of fowl and lower orders of birds. However, this balance can be too easily disturbed or shifted during development. Thus, a plausible explanation for sexually mosaic plumage is that the condition resulted from some abnormality in the endocrine system of the bird, as any imbalance of this system can produce profound plumage changes. Huxley and Bond (1934) demonstrated that cock-feathering in the hen Ring-necked Pheasant (*Phasianus colchicus*) resulted from phasic imbalance of endocrine function. Masculinization of females suggests an evolutionary trend in some dimorphisms which were short-lived and mediated by hormonal secretions during the breeding cycle, suggesting endocrine control of plumage characteristics is advanced during ontogeny (Murton and Westwood 1977). Androgens have a function in adult female birds and generally influence secondary sexual characteristics (Murton and Westwood 1977). Increased androgen levels associated with paired or undifferentiated gonads could account for both male and female plumage being expressed in a mosaic fashion rather than bilaterally.

In related congeners the male Mauritius Kestrel (*F. punctatus*) plumage pattern has become feminized while the female Seychelles Kestrel (*F. araea*) plumage pattern has become masculinized (Cade 1982). The genetic factors controlling plumage pattern differences may simply be labile in most kestrel stocks and could account for our finding, as well as for the extreme variability in tail and head plumage patterns of the American Kestrel.

It is unfortunate that the described bird met with such a fatal set of circumstances. If it had not been so critically injured, perhaps monitoring of subsequent feather growth and hormonal manipulation in vivo could have helped identify what caused the expression of sexually mosaic plumage, and if the condition was

permanent. Cade (1982) questioned why sexual dichromatism appears in the juvenile plumage of American Kestrels and not in congeners. Hormonal manipulation experiments may help to identify the effects of epigenetic factors on sexual dichromatism, as well as on the unique evolutionary phenomena of masculinization and feminization of plumage pattern currently taking place in some congeners.

R. A. Heckman conducted the histological examination of the gonads. D. M. Bird, P. A. Buckley, R. Bowman, Jan Dyck, and an unidentified reviewer provided helpful comments on the manuscript. The specimen (No. 8251) is currently in the bird collection of the Monte L. Bean Life Sciences Museum, Brigham Young University, Provo, Utah 84602.

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