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A female Gambel's Quail with partial male plumage.—Gambel's Quail (*Callipepla gambelii*) are sexually dimorphic, with males exhibiting head plumes that are long, wide, and black, a rusty head patch, a black facial bib outlined in white, and a black belly patch. Females have dark brown plumes which are shorter and narrower than males, and do not exhibit the other listed traits (Johnsgard 1973). In the late summer of 1996, we observed a captive female Gambel's Quail molting into partial male plumage. The female was at least two years old and had exhibited only female plumage in previous years.

We compared this female with typical male and female Gambel's quail (Table 1). The head plumes of the aberrant female were long, wide, and black, consistent with male plumes. In addition, the female had developed a striking rusty head patch. The posterior portion of the patch contained a mixture of rust and gray feathers, unlike a typical male. The female had an obvious facial bib composed primarily of beige, rather than black feathers. The white outline of the bib was present on the sides, but did not extend far down the throat. There was no black belly patch, but some black-tipped feathers were scattered throughout the belly region. A typical female has beige belly feathers with some brown streaking.

Many sexually dimorphic galliform birds, best studied in the pheasants (Phasianinae), exhibit estrogen-dependent plumage development (Domm 1939, Witschi 1961, Owens and Short 1995). Dull female plumage is dependent upon the presence of estrogen, while ornamental plumage of males develops in the absence of estrogen. This has been demonstrated experimentally, where ovariectomized females developed full male plumage. Similarly older females, or females with diseased ovaries, molt into partial or full male plumage because they do not produce sufficient estrogen. Therefore, ornamental male plumage is the "default" state in both sexes, and female plumage may be more derived (Owens and Short 1995).

The actual mechanism that disrupted normal estrogen levels in the female Gambel's Quail we observed is unknown. She had experienced no known injuries or disease while in captivity, and acted as healthy and vigorous as other females in her pen. When the female first exhibited partial male plumage, she was at least two years old, which is older than most wild females. Sowls (1960) reported an annual survival rate of only 28–40% for Gambel's Quail. Mean longevity for quail after their first fall is approximately 8–10 months (Johnsgard 1973: Table 21).

Given abnormal estrogen production in the female we observed, partial male plumage development may have occurred in one of two ways. First, feather tracts differ in their sensitivity to estrogen (Juhn et al. 1931). If this female produced low concentrations of estrogen throughout molt, male plumage may have developed in some areas that were highly estrogen sensitive, but not in others. Alternatively, estrogen may have been produced only during a portion of molt. Thus, female feathers developed when estrogen was present, while male feathers developed in the absence of estrogen.

While estrogen-dependent plumage dimorphism has been observed most in Phasianinae (Domm 1939, Witschi 1961, Owens and Short 1995), it has not been well documented in

TABLE 1
PLUMAGE CHARACTERISTICS OF GAMBEL'S QUAIL

	Typical male (N = 45)	Typical female (N = 38)	Female with male plumage
Plume length, mm[a] ($\bar{\chi} \pm$ SD)	42.1 ± 2.5	31.4 ± 1.9	42.0
Plume color	Black	Dark brown	Black
Rusty head patch	Present	Absent	Present
Black belly patch	Present	Absent	Some black-tipped feathers
Facial bib	Present	Absent	Present
Facial bib color	Black	———	Beige, some black feathers

[a] Typical male and female plumes are significantly different ($t = -24.5$, $df = 81$, $P = 0.001$).

New World quail (Odontophorinae). Domm (1939) cited unpublished data indicating ovariectomized female Northern Bobwhites (*Colinus virginianus*) developed male plumage. In addition, Crawford et al. (1987) observed a female California Quail (*Callipepla californica*) with partial male plumage in the wild.

We suggest that Gambel's Quail also exhibit estrogen-dependent plumage control. Our hypothesis is supported by experiments on male Gambel's Quail. Castrated juveniles exhibited completely normal male plumage as adults, suggesting that testosterone was unimportant in the development of male ornamental plumage (J. C. Hagelin, unpub. data). Furthermore, some females in wild Gambel's Quail populations have dark, male-like plumes that are longer than average for a female, and exhibit some male-like rusty flecking on their heads (J. C. Hagelin, unpub. data).

Our observations of Gambel's Quail, combined with data on Phasianinae (Domm 1939, Witschi 1961), one species of Old World partridge (Kannankeril and Domm 1968), and other Odontophorines (Domm 1939, Crawford et al. 1987), lends support to the idea that estrogen control of sexually dimorphic plumage is universal among galliforms. This has implications in studies of honest signaling and good genes models of sexual selection (Andersson 1994). Folstad and Karter (1992) suggested that males with testosterone dependent, secondary sexual traits may be signaling immunocompetence, because high testosterone levels negatively affect immune function. Highly ornamented plumage, however, does not reflect testosterone levels in male galliforms. Rather, it reflects a lack of estrogen. Thus, the validity of the immunocompetence handicap to explain the evolution and maintenance of the highly ornamented male plumage in the Galliformes must be questioned (Owens and Short 1995). Consistent with this hypothesis, several studies of mate choice in galliforms indicate that male plumage does not influence female choice (e.g. Buchholtz 1995; Ligon and Zwartjes 1995; J. C. Hagelin, unpub. data).

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Ice fishing by wintering Bald Eagles in Arizona.—Northern Arizona winters vary within and between years with occasional heavy snows (up to 0.6 m) and extreme cold (overnight lows −18 to −29°C) interspersed with dry periods, mild temperatures (daytime highs reaching 10°C), and general loss of snow cover at all but highest elevations. Lakes in the area may freeze and thaw partially or totally several times during a winter. The freezing and thawing of 1000-ha, 2-m deep Mormon Lake, 34 km south of Flagstaff, Arizona, during the winter of 1994–95 set the stage for the unusual Bald Eagle (*Haliaeetus leucocephalus*) ice fishing behaviors we describe.

Traditional ice fishing.—We here use "traditional" in the anthropomorphic sense, i.e., breaking a hole in the ice and waiting for fish to come within striking distance. On 22 Dec. 1994, when Mormon Lake was 100% frozen over from an early cold spell, we observed an adult Bald Eagle land near shore and begin intermittently jumping up and down on the ice for about 1 min. It broke the ice creating a 0.6-m diameter opening without falling into the water. Then it flapped onto an unbroken edge. It removed a chunk of ice from the opening with its foot, before moving 2 m away to stand among emergent reeds (*Carex* sp. and *Juncus* sp.). After about 2 min, the eagle hopped to the open water hole, grabbed a 10-cm (estimated) fish, and flew back to the reeds to feed. After four head-to-foot feeding movements, the adult was flushed by a second adult and an immature eagle landing nearby.

Subsequently, between 2–8 February 1995 when Mormon Lake was again 70–95% fro-