TABLE 1. Nest development, nesting success, and nest placement for Cassin's Finch nesting in big sagebrush at Hart Mountain, Oregon, in 1984.

Date found	Number of eggs	Hatching date	Number of nestlings	Fledging date	Nest shrub height	Nest height
29 June	4	8 July	2	24 July	119 cm	86 cm
4 July	5	8 July	3	24 July	119 cm	67 cm
5 July	4	11 July	3	27 July	100 cm	60 cm
9 July	—	6 July	4	22 July	120 cm	90 cm

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EGG PRODUCTION IN HAND-RAISED WHITE-CROWNED SPARROWS[1]

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The principal stimulus to gonadal growth in birds in temperate latitudes is usually attributed to photoperiod (Farner and Follett 1979). Male White-crowned Sparrows (*Zonotrichia leucophrys*) may be stimulated to full testicular maturity in the laboratory by increasing photoperiod (Farner and Wilson 1957). However, some investigators have found that under similar conditions, ovarian development in females of this species appears arrested at the early stages of vitellogenesis, and these birds do not lay eggs (Farner et al. 1966, Lofts and Murton 1973). These conclusions are based on work with migratory *Z. l. gambelii,* but apply also to nonmigratory *Z. l. nuttalli* (M. L. Morton and L. F. Baptista, unpubl.). More recently, however, J. R. King (in litt.) found that a few *Z. l. gambelii* captured in the wild may lay eggs in captivity.

The pituitaries of captive wild-caught females had only 25% of the gonadotropic potency of wild females (King et al. 1966). Females held on long day and stimulated with taped male song exhibited higher rates of ovarian growth than controls held on long day alone (Morton et al. 1985). Neither treatment group laid eggs, however, and ovaries collapsed after attainment of peak weights. It has been suggested that the final stages of ovarian development may require additional proximate factors, such as stimulation of the nest cup or other characteristics of the habitat (Wingfield and Farner 1978). In this paper we report that hand-raised female White-crowned Sparrows regularly laid eggs in the laboratory, and we suggest reasons why these data differ from those of previous investigators. In addition, two instances of White-crowned Sparrows breeding in captivity are described.

In 1983 we hand-raised 22 White-crowned Sparrows of the sedentary subspecies *Z. l. nuttalli* and two females of the montane subspecies *Z. l. oriantha,* all taken as nestlings. Two female *Z. l. nuttalli* collected as fledglings were also included in the laboratory colony. In 1984, 10 more females were hand-raised. Birds were housed singly in cages 62 × 59 × 39 cm or 80 × 38.5 × 70 cm. Birds were maintained in a room with windows, and thus experienced natural photoperiods. Females could hear and see singing males in neighboring cages.

These 36 females laid a total of 134 eggs between 29 February and 21 August. Each female laid from one to eleven eggs during that period. Nine females laid only one egg each. Whereas eggs in a clutch are usually laid on consecutive days in the wild, intervals between eggs tended to be irregular in our captive colony. For example, one individual laid single eggs on 18 April, 8 May, 6 June, and 21 June. The intervals between laying dates suggested that many females laid single egg "clutches." The one female that laid eleven eggs laid three single-egg clutches, two three-egg clutches, and one two-egg clutch.

Two instances of White-crowned Sparrows breeding in captivity were observed. In the 1979 breeding season, LFB placed a hand-raised female *Z. l. nuttalli* in an outdoor aviary (4.8 × 1.8 × 4 m) with a wild-caught male. The female built a nest in a small potted juniper, laid two eggs, and hatched one young. The nestling died after four days, possibly due to lack of insect food in the diet.

In 1982 a wild-caught male *Z. l. gambelii* was injected

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with testosterone to induce singing and was then released into an aviary. This individual developed a cloacal protuberance and sang profusely. A hand-raised female *Z. l. nuttalli* in an adjoining aviary repeatedly made precopulatory displays with the tail up and trilled loudly each time this male sang. We placed them together in an aviary which consisted of an outdoor portion (1.6 × 1.2 × 1.8 m) and a sheltered portion (1.7 × 1.2 × 2.2 m). The female built a nest among some pine branches that were lashed together to simulate a bush in their shelter and had a clutch of three eggs by 23 January. The nest was not observed between 24 January and 8 February, but on 9 February a nestling, estimated to be about three days old, and three unhatched eggs were found in the nest. Live insects were supplied and the parents fed the nestling until it was eight days old, at which time it was separated from its parents and hand-raised to independence.

The above observations indicate that hand-raised female White-crowned Sparrows can breed in captivity. Although intervals between dates of laying of consecutive eggs are irregular, our data show that hand-raised females will lay in the laboratory. The results for the two aviary-housed females suggest that if females are provided with proper nesting materials, their laying intervals and clutch sizes may approach normality.

The February hatching date of our captive is unusually early for the species. At the latitude of San Francisco, California, nesting activity in wild birds begins in early March, although gonadal recrudescence may begin in late February (Blanchard 1941, Mewaldt and King 1977). Female White-crowned Sparrows treated with estradiol will perform copulation-solicitation displays. These displays stimulate production of testosterone and dihydrotestosterone in males (Moore 1982). The singing activity of our testosterone-treated male apparently stimulated the female to perform solicitation displays. Her displays probably in turn stimulated the male into breeding condition, precipitating their early breeding effort.

Why is there a difference between our data and those of earlier investigators? Song alone acts synergistically with photoperiod in stimulating ovarian growth but not ovulation in White-crowned Sparrows (Morton et al. 1985). One possible explanation for our data is that the sight of posturing and singing males in nearby cages stimulated our hand-raised females to lay. If this were so, others who have studied this bird would have observed egg laying in captives. Instead, investigators have consistently reported the virtual absence of ovulation in captive wild-caught adults. Farner (in litt.) noted that first year females rarely if ever produce eggs when photoperiodically stimulated after the refractory phase.

Wingfield and Farner (1978) have suggested that completion of yolking and ovulation may be triggered by adequate proximate factors, such as stimulation from the proper habitat. This may explain why females that were wild-caught as adults seldom lay in captivity. Birds learn the qualities of their habitat during an early sensitive phase (Löhrl 1959; Klopfer 1963, 1969; Immelmann 1975). It is possible that White-crowned Sparrows imprint on habitat characteristics during their first breeding season. Because our hand-raised White-crowned Sparrows were collected as nestlings or fledglings, they had no opportunity to learn the characteristics of their natural breeding environs. They may have imprinted on the characteristics of their holding cages and accepted these as substitutes for the stimuli from natural habitats that wild birds may require in order to complete egg formation. These ideas could be tested in the laboratory by banding nestlings in the wild and bringing them into the laboratory at various ages before and after their first breeding experience.

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