

Lumsden (1970) reported that male Blue Grouse display shoulder spots before and while attacking their images in a mirror. He concluded that the display may express fear in conflict with other behavioral states. McNicholl (1978) saw Blue Grouse displaying shoulder spots in various alert postures, at the approach of an observer while the male was courting a female, and during aggressive interactions. He suggested that the display represents fear, and perhaps subordination, in conflict situations. Hjorth (1970) observed shoulder spots on territorial Blue Grouse that were moving in the vicinity of an intruder. However, in summarizing the function of this display for grouse in general, he suggested that it is associated with subordination and avoidance behaviors.

It is sometimes difficult to interpret the signal content of a behavioral display. By using sequential analysis it may be possible to infer tendencies associated with given postures (Slater, pp. 131–153 in *Perspectives in Ethology*, Vol. 1, P. P. G. Bateson and P. H. Klopfer, eds., Plenum Press, New York, New York, 1973). For example, if the shoulder-spot display signalled fear or subordination, as some researchers have suggested, one would expect the signalling bird to retreat or act submissively after showing the display. Likewise, the receiver would not be expected to retreat or be attacked. Yet, Table 1 rather strongly implies that the shoulder-spot display signals aggression. This display was often followed by an attack by the signalling bird and invariably by the retreat of the receiver. Furthermore, the display was primarily given by territorial adult males when confronting non-territorial yearling males that had intruded on or near their territory. These observations suggest that under natural conditions the shoulder-spot display of male Blue Grouse is associated with aggressive behaviors and may function as a threat display. However, for other species of grouse this display may serve different functions. More observations of birds in natural situations are needed before further speculation on the evolutionary development of the shoulder-spot display and its role in the behaviors of various grouse species.

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**Nestling growth relationships of Brown-headed Cowbirds and Dickcissels.**—Data on nestling growth of brood parasites and their hosts are surprisingly few in the literature. Even the Brown-headed Cowbird (*Molothrus ater*), whose host relations have been studied in some other respects, has not been studied in any detail from this standpoint. This is particularly regrettable because the lack of host specialization and high incidence of multiple parasitism in this species recommend it for intensive studies of parasite-host growth relationships. Isolated or fragmentary records of growth in cowbirds are available in Friedman (The Cowbirds, C. C. Thomas, Springfield, Illinois, 1929), Pickwell (Trans. Acad. Sci. St. Louis 27:1–160, 1931), Herrick (Wild Birds at Home, Appleton-Century, New York, New York, 1935), Nice (Trans. Linn. Soc. N.Y. 4, 1937; Wilson Bull. 51:233–239, 1939), Mayfield (The Kirtland's Warbler, Cranbrook Inst. Sci., Illinois, 1960), and Nolan (Ornithol. Monogr. No. 26, 1978). Hann (Wilson Bull. 49:145–237, 1937) illustrated the growth of five cowbirds raised in three nests of the Ovenbird (*Seiurus aurocapillus*), Norris (Wilson Bull. 59:83–103, 1947) provided data for five individuals raised by different host species, and Scott (Wilson

Bull. 91:464–466, 1979) presented pooled growth data for nine individuals raised by three different host species. King (Auk 90:19–34, 1973) measured the growth of Shiny Cowbirds (*Molothrus bonariensis*) in nests of Rufous-collared Sparrows (*Zonotrichia capensis*) and found that broods of two cowbirds grew at a substantially slower rate than broods of one. He suggested that *Z. capensis* could rear a maximum of two cowbirds or four sparrows, or an equivalent combination.

In 1974 I collected data on the growth relationships of Brown-headed Cowbirds and Dickcissels (*Spiza americana*) in prairie habitat in eastern Kansas (Konza Prairie Research Natural Area). The intensity of cowbird parasitism in this study was extremely high—I found nests containing as many as nine cowbird eggs and three host eggs. More than one cowbird was evidently laying in many of the nests, behavior that may present some intricate evolutionary problems with respect to clutch-size manipulation by cowbirds. Fifty-nine of 65 nests were parasitized (91%), and the mean number of cowbird eggs per parasitized nest was 3.1 (SD = ±1.74). Dickcissels raised up to five young in mixed broods of various composition. Brood composition at fledging in 27 successful nests (42% of the total) averaged 1.6 Dickcissels and 1.3 cowbirds.

I visited nests every other day and weighed young to the nearest 0.1 g with a Pesola spring balance. I estimated the ages of nestlings hatched between visits to the nearest day by tarsal measurements. Because the frequency of visits seemed to induce premature nest leaving in many instances, my data on weight gain are adequate for analysis through only about the first week of the nestling period. The measure of growth I use is the weight of a nestling on day 7 (cowbirds, N = 22) or day 6 (Dickcissels, N = 33; differences in initial weight at hatching were negligible within species). I regressed these values on the number of cowbirds ( $X_1$ ) and the number of Dickcissels ( $X_2$ ) in the broods from which the measurements were obtained. I also included date of hatching ( $X_3$ ) as an independent variable since there was a seasonal decline in growth rates. The analysis for cowbirds yielded the following multiple regression equation ( $P < 0.05$ ):

$$\text{Weight day 7 (g)} = 35.3 - 2.67X_1 - 1.64X_2 - 0.18X_3.$$

Each of the independent variables contributed significantly to the regression ( $P < 0.05$ ), which has an  $R$  value of 0.658. Thus, the body weight of cowbirds a week after hatching was inversely related to the number of competitors in the nest, and another cowbird had a considerably larger effect than a competing host nestling. In contrast, there was no significant relationship between the weights of host nestlings and either the number of conspecifics or the number of parasites in the brood. This could arise if Dickcissels showed greater overall variability in age-specific weights, thus requiring a larger sample to detect the effects of brood-size and composition. However, coefficients of variation for the weights of cowbirds and Dickcissels were 0.144 and 0.103, respectively ( $P < 0.11$ , cf. Sokal and Braumann, Syst. Zool. 29:50–66, 1980).

These results raise the interesting possibility that Dickcissels and other species may preferentially feed their own young as an adaptive response to brood parasitism. Vocal mimicry of begging calls is common in some groups of brood parasites (Payne, Ann. Rev. Ecol. Syst. 8:1–28, 1977), and Rothstein (Auk 95:152–160, 1978) found geographical variation in the mouth coloration of nestling cowbirds which he suggested is an incipient adaptation to prevent detection by various hosts. It would not be surprising to find that some of the cowbird's hosts are adapting to brood parasitism through discrimination at feeding time.

There is, however, an alternative explanation for the insensitivity of Dickcissel growth to cowbird parasitism, with rather different implications for the parasite. S. D. Fretwell (pers. comm.) has observed that some passerine species feed the smaller members of a brood preferentially during the latter part of the nestling period and has developed a mathematical

model to show when this should occur. (Such behavior is, of course, the opposite of brood reduction by selective starvation.) To the extent that this occurs, the difference in size between cowbirds and most of their host species would be less advantageous for the parasite than is usually supposed. Notably, Elliott (Auk 95:161–167, 1978) reported that one of the cowbird's largest hosts, the Eastern Meadowlark (*Sturnella magna*), appeared better able to feed more than one cowbird per nest than two smaller host species. The mean number of cowbird eggs per nest was higher for meadowlarks than for the smaller hosts in the same study. With data presently available, however, I can only suggest that growth of brood parasites and their hosts may be influenced to a considerable degree by behavioral interactions.

Considering the results of the present work and theoretical interest in growth of brood parasites and their hosts, recommended further studies would include: (1) thorough study of growth in a nonspecialized brood parasite such as the Brown-headed Cowbird and a full range of its hosts with respect to body size, growth rates, and behavior; (2) experimental manipulation of brood-size and composition; and (3) direct observations of feeding activity to determine if adults feed their own young or the smaller of the brood preferentially.

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**A Common Loon nest from Minnesota containing four eggs.**—On 12 June 1982 we found a Common Loon (*Gavia immer*) nest containing four eggs. The nest was located on a lake approx. 50 ha in size, 25 km NE of Bemidji, Beltrami Co., Minnesota, and was situated about 30 m from shore on a mat of floating vegetation. Two adult loons, the only loons observed on the lake, were nearby and were diving repeatedly within 40–60 m of the nest. When we visited the nest 6 days later it was destroyed. The large end had been broken away from one egg and the contents removed except for a small amount of albumen that still appeared fresh. The other three eggs were found intact in shallow water adjacent to the nest. Two loons were observed on the opposite side of the lake. The eggs were collected and placed in a refrigerator. Later, they were measured, weighed, and examined for fertility.

The four eggs were similar in size to those measured by other authors (Table 1). Weights of the three whole eggs were 140, 144, and 146 g, respectively. Nearly equal volume:weight ratios indicated the eggs were at similar stages of incubation. When examined for fertility on 26 July, one of the three whole eggs contained a 30 mm long embryo. The contents of the other two eggs had putrified and no signs of embryonic development could be detected.

Nests with more than two eggs have been rarely documented for the Common Loon. Audubon (*Ornithol. Biogr.* 4:43–57, 1838) believed three-egg clutches were fairly common, while Bent (*U.S. Natl. Mus. Bull.* 107:47–62, 1919) thought them to be very rare. Henderson (*Condor* 26:143–145, 1924) reported two, three-egg clutches in 19 nests from Alberta, and Vermeer (*Can. Field-Nat.* 87:403–408, 1973) observed one, three-egg clutch in Alberta nests. In contrast, Olson and Marshall (*Minn. Mus. Nat. Hist., Occ. Paps.* 5:76, 1952) recorded