ing this period. Repeated sampling of nests would serve to determine the relative importance of these factors.

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LACK OF EFFECTS FROM SAMPLING BLOOD FROM SMALL BIRDS[1]

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Key words: Blood sampling; Gallus gallus; *Northern Bobwhite;* Colinus virginianus; *House Sparrow;* Passer domesticus.

Blood samples are desirable for many types of ornithological studies. For example, electrophoresis of proteins found in blood can provide valuable information on population and breeding structure. Because such research often requires nondestructive sampling, it is necessary to know what effect blood sampling has on birds. I conducted a series of experiments to evaluate the effects of taking blood from small birds. Previous studies have used mortality of free-ranging birds as an indicator of stress (Kerlin and Sussman 1963, Raveling 1970, Utter et al. 1971, Bigler et al. 1977, Gowaty and Karlin 1984). I used change in body weight of captive birds as a more sensitive indicator of stress. Three species were tested: domestic broiler chicks (*Gallus gallus*), Northern Bobwhite chicks (*Colinus virginianus*), and adult House Sparrows (*Passer domesticus*).

I used five treatments to test for effects. In Treatment 1, birds were weighed only. In Treatment 2, the brachial vein of the left wing was punctured but blood was not drawn, thus testing for possible complications due to infection but not due to withdrawal of blood. In Treatment 3, a complete blood sample was drawn from the brachial vein in the left wing. One half of the complete blood sample was drawn from each wing in Treatment 4. Clotting could occasionally prevent blood from being drawn from one wing, and sampling from two wings could increase the chance for infection or other complications. In Treatment 5, the complete blood sample was taken from the left wing, and the fifth primary was plucked from each wing to obtain additional tissue from pulp present in the feather shaft. Twenty-five chickens and quail and 15 to 17 sparrows were randomly assigned to each treatment group. Broiler and quail chicks were obtained from breeders immediately after hatching. Adult House Sparrows were captured in June and July using mist nets and traps. Each bird was banded for individual identification.

Broiler chicks were weighed 24 hr after hatching, and on each of the next six days. Blood samples were drawn when chicks were five days old (av. wt. 113.9 g). Bobwhite chicks were weighed 11 days after hatching and then every other day for the next 14 days. Blood was drawn at age 15 days (av. wt. 50.3 g). House Sparrows were weighed on the day of capture and every other day for the next 12 days. Blood was taken on the sixth day of confinement (av. wt. 25.6 g).

Bobwhites and chickens were held separately as groups in two large pens and subjected to similar environmental conditions. House Sparrows were held in five 1 m × 1 m × 0.5 m cages with flexible plastic mesh siding. Broiler and bobwhite chicks were easily captured, but the spar-

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TABLE 1. Summary of F-values from nested two-way ANOVAs of weight change among five different treatments designed to test for effects of various methods of blood withdrawal.

Source	House Sparrow	Bobwhite	Domestic broiler
Treatment	0.47 NS	1.10 NS	0.90 NS
Time	45.26*	12,746.23*	5,956.89*
Interaction	0.89 NS	0.94 NS	0.23 NS

NS indicates tests were not significant.
* $P \leq 0.0001$.
Treatment df = 4,4; time df = 1,4.

rows became extremely agitated when approached and were weighed at night when darkness concealed capture attempts. To randomize cage effects, sparrows were returned after each weighing to a cage chosen randomly. Feeding and weighing times were standardized to reduce daily variation in body weight.

Several techniques for blood collection were reviewed: heart puncture through sternum (Utter et al. 1971), jugular vein (Kerlin 1964), wing vein (Bigler et al. 1977, Dorrestein et al. 1978), and venous occipital sinus (Vuillaume 1983). Wing venipuncture was chosen as the preferred method, and blood was drawn from the brachial vein on the ventral side of the humerus. The overlying skin was sterilized with alcohol before being pierced with a 25-gauge hypodermic needle. Blood was drained into a hematocrit tube, and pressure was applied to the vein until blood flow ceased.

Volumes of 0.7 cc in broiler chicks, 0.25 cc in bobwhite chicks, and 0.2 cc in House Sparrows were withdrawn, approximating 7% or less of each individual's total blood volume based on body weight (Medway and Kare 1959, Sturke 1965:110).

Data were analyzed using a two-way analysis of variance. Analyses were performed using the general linear model procedure of the Statistical Analysis System (SAS Institute Inc.). There were no significant effects of withdrawal methods, but weight changed significantly over time for all species (Table 1). The significant time effect in broiler and bobwhite chicks was likely due to rapid growth in these birds, which gained an average weight of 15% per day (Table 2). There were slight weight losses in sparrows.

Because of the weight changes in all species, the appropriate test of the effects of withdrawal methods is the interaction term between withdrawal methods and time. A significant interaction term would indicate greater rates of weight change through time for different treatment groups. The possible deleterious effects of blood withdrawal would be indicated by slower growth rates in broiler and bobwhite chicks and greater weight loss rates in sparrows.

There were, however, no significant treatment × time interactions for any species, which indicates that the different blood withdrawal procedures had no measurable impact on weight for any species.

All broiler and bobwhite chicks survived, but 15 House Sparrows died during the study period (seven before sampling, eight after). Mortality was not dependent on treatment (contingency $\chi^2 = 0.53$, df = 4, $P > 0.95$). In most cases, birds lost weight for several days before dying. Dead birds weighed significantly less than surviving birds (22.2 g vs. 25.6 g, $t = 6.46$, $P < 0.0001$).

Withdrawal of blood from even small birds does not seem to cause significant stress as indicated by changes in body weight or mortality rate. Prolonged confinement and handling of wild birds may be more stressful than removal of blood. In the present study, overcrowding of House Sparrows may have created additional stress. Although aggression between birds was not observed, House Sparrows flew about their cages excitedly when approached. Repeated disturbances of this type contributed to weight loss in House Sparrows. In the field, birds could be handled once briefly and released, thus reducing stress.

TABLE 2. Mean body weights (g ± 1 SE) for House Sparrows (HS), bobwhite chicks (BO), and domestic broiler chicks (DB) before and after treatment applications designed to test for effects of various methods of blood withdrawal.

Treatment	Species	Weight: Before	Weight: After
1. Control	HS	25.7 ± 0.2	25.0 ± 0.2
	BO	43.4 ± 0.8	66.1 ± 1.0
	DB	100.9 ± 1.7	161.8 ± 3.5
2. Puncture vessel	HS	25.8 ± 0.3	25.8 ± 0.4
	BO	45.3 ± 0.7	69.1 ± 0.9
	DB	100.4 ± 1.3	161.5 ± 2.6
3. Blood one wing	HS	25.6 ± 0.4	25.6 ± 0.4
	BO	44.7 ± 0.7	68.3 ± 0.9
	DB	102.8 ± 1.5	164.4 ± 2.9
4. Blood two wings	HS	26.0 ± 0.3	25.3 ± 0.3
	BO	45.5 ± 0.8	68.6 ± 1.0
	DB	100.6 ± 1.6	160.1 ± 3.1
5. Blood and feathers	HS	25.2 ± 0.3	24.5 ± 0.3
	BO	43.5 ± 0.7	66.8 ± 0.9
	DB	106.1 ± 1.7	169.0 ± 2.8

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