Tissue Lead Concentrations and Blood Characteristics of Mourning Doves from Southwestern Virginia

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Abstract. Studies were conducted on the feasibility of sampling the blood from live mourning doves (Zenaida macroura) as a technique for evaluating lead exposure in this species. Measurements of the blood enzyme, delta-aminolevulinic acid dehydratase (ALAD), were essentially the same in blood from the brachial vein or trunk blood. The ALAD activity decreased as liver lead concentration increased in mourning doves. Mourning doves that ingested lead shot had elevated lead concentrations in their femur bones and livers as compared to other doves which had not recently ingested lead shot.

Lead poisoning has been well documented as a significant mortality factor in waterfowl populations (Bellrose 1959; Bagley, et al. 1967). However, little is known of the extent of lead poisoning in mourning doves or upland game birds in general. Hunting over managed dove fields will likely increase the availability of spent lead shot to doves as well as increase the risk of ingestion (Locke and Bagley 1967; Lewis and Legler 1968; Kendall and Scanlon 1979). A confirmed case of lead poisoning in a mourning dove was reported by Locke and Bagley (1967). The bird contained two lead pellets in the gizzard, was moribund and emaciated, and acid-fast intranuclear inclusions were found in kidney cells. After ingesting lead shot, pheasants (Phasianus colchicus) have also been reported to die (Hunter and Rosen 1965) with similar signs of lead poisoning as seen in mourning doves. Westemeier (1966) reported a bobwhite quail (Colinus virginianus) had apparently died of lead poisoning as no gunshot wounds were present and the bird was emaciated and four eroded lead shot were present in the gizzard. Interpretation of risks of ingestion of lead shot by mourning doves using samples from free flying doves is compounded by their use of grit particles from roadsides which are contaminated by lead from automobile exhausts. Kendall and Scanlon (1979) reported high bone lead (up to 700 µg/g) concentrations in a collection of mourning doves from middle Atlantic states. They attributed these elevated bone lead concentrations to various sources of lead in the environment, particularly lead contaminated roadside grit. Since mourning doves have a potential for lead accumulation, information on the relationship between their tissue lead concentrations and blood characteristics could allow monitoring for lead exposure in this species by blood sampling of live doves. The present study explored the relationship of the blood characteristics, delta-aminolevulinic acid dehydratase (ALAD) activity, packed cell volume (PCV) and hemoglobin with tissue lead concentrations in mourning doves.

Material and Methods

Mourning doves (35) were trapped in 1979, August through September, on the V.P.I. & S.U. Farms, using modified Kniffin funnel traps baited with cracked corn. Mourning doves trapped for this project were used ancillary to another mourning dove study that was conducted in the Department of Fisheries and Wildlife Sciences, V.P.I. & S.U. (Mirarchi 1978). The doves were brought into the laboratory and held overnight in suspended 6.35 mm mesh stainless steel cages (24 x 18 x 18 cm) before sacrifice the next morning between 0900-1000 hr. Each of the doves had a blood sample removed from the brachial vein before sacrifice. The liver and femur bone of all birds were analyzed for lead by atomic absorption spectrophotometry (Scanlon, et al. 1980). Delta-aminolevulinic acid dehydratase activity (Burch and Siegel 1971) and PCV were measured from the brachial vein blood. The doves were decapitated and a trunk blood sample was collected into a heparinized test tube. The crop and gizzard of each dove were examined for ingested lead shot. Five doves (aged 28 to 45 days) were randomly selected from the 1979 sample and were dosed with one number 8 lead pellet per bird and sacrificed at 24 hr after lead shot ingestion. Blood samples were obtained as previously described. The liver and femur bone of all birds were analyzed for lead by atomic absorption spectrophotometry (Scanlon, et al. 1980). Delta-aminolevulinic acid dehydratase activity (Burch and Siegel 1971) and PCV were measured from the brachial vein blood and from the trunk blood. Hemoglobin was determined colorimetrically in the trunk blood by the formation of cyanomethemoglobin with Hycel, Inc., Houston, TX reagents (No. 116) and standard (No. 117). A paired t-test was used to test differences between ALAD in brachial blood versus ALAD in trunk blood, and PCV in brachial blood versus PCV in trunk blood. Regression analyses by the
least squares procedure (Steel and Torrie 1960) were performed with PCV on hemoglobin and log liver lead concentrations of ALAD activity in brachial vein blood and log liver lead on ALAD activity in trunk blood.

Data were analyzed using the Statistical Analysis System (SAS76, Barr, et al. 1976). Tests attaining a probability level of P < 0.05 were statistically significant.

Results

The blood ALAD of mourning doves was essentially similar whether blood was collected from the brachial vein or trunk blood at sacrifice (Table 1). A linear regression of log ALAD activity in blood collected from the brachial vein on log liver lead concentrations is presented in Figure 1 (all logarithmic transformations in the present report were calculated as the natural logarithm, base e).

A linear regression of log ALAD activity in trunk blood on log liver lead concentration is presented in Figure 2. Doves that ingested lead shot had reduced ALAD values which were associated with increased liver lead concentrations. Juvenile birds in the sample had ALAD readings as high as 360 units of activity. However, ALAD activity decreased as liver lead increased. Birds experimentally dosed (5) or found to have ingested lead shot (1) had reduced ALAD activity. Mean (± S.E.) ALAD activity was 21.90 ± 3.87, and 30.67 ± 8.81 units in trunk and brachial vein blood samples, respectively, in doves that had ingested lead shot. Packed cell volumes obtained from the brachial vein blood were lower (P < 0.05) than those obtained from the trunk blood samples (Table 1).

A plot of liver lead versus bone lead concentrations (μg/g, d.w.) in doves is presented in Figure 3. Most of the bone lead observations were located between zero and 25.00 μg/g. The doves generally had less than 4.00 μg/g liver lead. Four individuals had between zero and 25.00 μg/g bone lead. One bird (2.9%) out of the 35 trapped was found to have lead shot in the gizzard. The five birds that were dosed with one number 8 lead pellet, as well as the captured bird which had ingested a lead shot, had elevated liver lead. Liver lead was greater than 16.00 μg/g and bone lead was greater than 50 μg/g in these six individuals. Thus, there was a distinct separation of birds with evidence of ingested lead shot and those without. A linear regression of hemoglobin on PCV in trunk blood is shown in Figure 4. As PCV increased the hemoglobin concentrations increased.

Discussion

In a mourning dove collection, the assay for the blood enzyme, ALAD, proved to be quite useful in respect to monitoring for any elevated lead ingestion in this species. Birds that ingested lead shot were found to exhibit a reduced ALAD activity (30.67 ± 8.8 units, X ± S.E.) as compared to the mean of all doves of 230.88 ± 20.59 (X ± S.E.) units in brachial vein blood. Studies by Dieter et al. (1976) showed that canvasback ducks (Aythya valisneria) that exhibited abnormally low ALAD readings (28.80 ± 3.9, X ± S.E.) had elevated blood lead concentrations. The ability to sample a live bird for ALAD examination would be useful in detecting potential lead toxicosis problems in the environment, even after a relatively long interval since the ingestion of lead pellets. Dieter and Finley (1978) found ALAD activity to remain depressed (ALAD activity was 70% of controls) three months after dosing mallard ducks (Anas platyrhynchos) with one number 4 lead pellet. Furthermore, Dieter and Finley (1979) have determined that one number 4 pellet was enough to inhibit blood ALAD activity by 75% and brain and liver ALAD by 30 to 50%. Inhibitions of ALAD of such magnitude in the brain were noted to immediately precede symptoms of the latter stages of lead poisoning.

Mourning doves that were collected in fall 1979, in general, had high ALAD activities which corresponded to low tissue lead concentrations. Liver lead was below 4.00 μg/g, d.w. in individuals that had not ingested lead shot. Those birds that had ingested a lead shot had liver lead concentrations greater than 15 μg/g, d.w. which was associated with greatly reduced ALAD activity. Dieter and Finley (1979) have also noted decreased ALAD activities in mallard ducks that contained elevated liver lead concentrations.

Packed cell volume and hemoglobin concentrations in the doves indicated normal blood characteristics. The birds had, in general, received relatively little lead exposure as compared to other dove collections (Kendall and Scanlon 1979) which was indicated by ALAD assays. Lead shot ingestion in five experimentally dosed doves probably