Effects of Lead Nitrate Ingestion on Open-Field Behavior of Mallard Ducklings

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Lead has been shown to affect certain behaviors in the young of mammals (CARSON et al. 1974, SILBERGELD and GOLDBERG 1974, ZOOK 1973), but little is known of the effects on young birds. This study was designed to determine the effects of lead nitrate ingestion on open-field behavior of mallard ducklings.

METHODS

Care of Ducklings: Eggs collected from 14 pairs of adult mallard ducks *(Anas platyrhynchos)* fed a control diet were collected daily and incubated in batches at two-week intervals over 6 weeks. At 9 days of age ducklings were weighed and randomized to groups fed a control diet or a diet containing 5, 50, or 500 ppm lead as lead nitrate. The lead nitrate was dissolved in propylene glycol and mixed into the feed in the ratio of two parts propylene glycol mixture to 98 parts commercial duck starter mash. Analysis showed untreated mash to contain approximately 1 ppm lead. Controls received an equal amount of pure propylene glycol. Ducklings were housed in heated Petersime brood-units with feed and water available *ad libitum*. Half of the ducklings from each of the four treatment groups were tested in an open-field apparatus after 3 days on their respective diets, and the other half after 8 days. A total of 212 ducklings were tested, sacrificed immediately after testing and the carcasses weighed.

Testing Open-field Behavior: The apparatus used to test open-field behavior consisted of a 60 cm x 60 cm x 30 cm high box made of wood and acoustical tile, with 4 pairs of photoelectric light sources and sensors directed, 3.5 cm high, across the floor, dividing it into 9 equal sections. The light sources were covered with filters that passed only infrared light. The number of times the beams were broken by duckling movement was registered on counters outside the box. The walls and ceiling of the box were colored black and the floor was covered by a disposable green paper mat. A 15-watt lightbulb centered on the ceiling provided light. Ducklings were removed from brooder pens and randomized to individual holding pens corresponding to a test number. The first duckling was then removed from its holding pen, placed in the center of the open-field, and 30 seconds later the test started. Movement was

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monitored for 3 minutes and counter scores recorded. The duckling was then removed and the next duckling tested, etc. Each of the 6 testing sessions lasted 3 to 4 hours.

RESULTS

Growth and Health: Data on percentage weight gain is presented in Table 1. Ducklings sacrificed after 3 days showed no significant differences among treatments in percentage weight gained ($F = 1.510$; d.f. = 3·104; $0.25>P>0.10$). There were however significant differences among treatments in percentage weight gained for ducklings kept for 8 days ($F = 3.842$; d.f. = 3·100; $0.025>P>0.01$), the low percentage gain in the 5 ppm group accounting for most of the difference. There was no mortality and all ducklings appeared healthy.

TABLE 1

Mean percentage weight gain of ducklings.

Treatment	Number of days on treatment	
	3 days	8 days
Control	69.7 n=27	182.5 n=26
5 ppm	60.5 n=27	158.5 n=26
50 ppm	59.6 n=27	190.2 n=26
500 ppm	66.8 n=27	191.5 n=26

Open-field Behavior: Mean scores on open-field behavior tests are presented in Table 2. Ducklings on the 500 ppm lead diet scored lower in open-field testing but the difference was not significant for ducklings tested after 3 days on treatments ($F = 1.356$; d.f. = 3·104; $0.50>P>0.25$) or for ducklings tested after 8 days ($F = 0.872$; d.f. = 3·100; $0.50>P>0.25$). Combining these data in a two-way analysis of variance and pooling sums of squares as outlined by DIXON and MASSEY (1969), the difference among treatments was still not significant ($F = 2.091$; d.f. = 3·207; $0.25>P>0.10$).

DISCUSSION

Ingested lead is known to cause mortality in waterfowl (BELLROSE 1951, DEL BONO and BRACA 1973) and is known to lower

fecundity as well (ELDER 1954), but little is known of the effects of lead on behavior of birds. HIRANO and KOCHEN (1973) have shown that lead exposure in developing chick embryos causes hemorrhaging in the central nervous system resulting in permanent brain damage. Lead has been shown to induce hyperactivity in children (DAVID 1974), rats (SILBERGELD and GOLDBERG 1974) and other mammals (ZOOK 1973). Lower scores for ducklings on the highest lead treatments in open-field testing may suggest reduced activity due to lead ingestion, but the difference was not significant.

TABLE 2

Mean scores on open-field behavior test.

Treatment	Number of days on treatment	
	3 days	8 days
Control	143.3 n=27	132.4 n=26
5 ppm	156.0 n=27	131.0 n=26
50 ppm	146.6 n=27	127.5 n=26
500 ppm	127.0 n=27	110.6 n=26

Although ducklings from all treatment groups appeared equally healthy, there was a significant difference in percentage weight gain among the groups kept for 8 days on treatments. The group fed 5 ppm lead had comparatively low growth, while the groups fed 50 and 500 ppm lead had greater growth than controls. Young rats consuming about 25 ppm lead in mothers milk showed retarded growth (MICHAELSON and SAUERHOFF 1974).

SUMMARY

Mallard ducklings were fed a control diet or a diet containing 5, 50, or 500 ppm lead as lead nitrate, *ad libitum*, and their open-field behavior was tested after either 3 or 8 days on treatments. Differences in open-field performances among treatments were not significant. Percentage weight gain differed significantly among treatment groups over an 8 day period, with the least growth occurring in the 5 ppm treatment group.

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