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Behavioral Response of Mallards to Contaminated Drinking Water

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Reports of waterbird mortality due to chemical contamination of waterways illustrate the inability to avoid and/or detect environmental pollutants. In 1976 a spill of 250,000 gallons of fuel oil in the Chespeake Bay resulted in the deaths of 30,000-50,000 waterbirds representing over 31 species (REIGER 1977). Although some birds appear to avoid oil slicks (CASEMENT 1966), the large mortalities suggest that avoidance is not common to all avian species. Many permanent water systems also exist, such as industrial settling ponds, sewage treatment ponds and heated water systems, that may contain hazardous substances. BOAD and LEWIN (1980) describe collecting 87 dead or moribund waterbirds at a tailings pond associated with an oil sands extraction plant in Alberta. Avoidance or detection of waterborne contaminants by waterbirds in permanent water systems is not easily observed or confirmed.

Avoidance response by birds to contaminated foodstuffs is varied. Although bioaccumulation of persistent pesticides such as DDT and dieldrin that have been incorporated into foodstuffs is well documented (EDWARDS 1970), there is no evidence that birds are able to detect the contaminants. Some chemicals added or coated onto feed can be detected and avoided by birds. HILL (1972) found that house sparrows (Passer domesticus) detected pesticides in their diet and selected alternative nontreated food if available. If there was no alternative, food consumption decreased even though they still consumed lethal doses of pesticides. BENNETT and PRINCE (1981) observed similar results with ring-necked pheasants (Phasianus colchicus). They found that pheasants would shift from eating treated, preferred foods and revert to original food preferences if treatment ceased.

Does this observed detection and often avoidance response of contaminated feed by terrestrial birds imply similar behavior in waterbirds? FLICKINGER et al. (1980) observed mortality of shorebirds due to Furadan 3G, which is an insecticide formulation of carbofuran sprayed onto flooded rice fields. They noted that Furadan did not repell birds. CUSTER and ALBERS (1980) showed that caged mallards (Anas platyrhynchos) subjected to heavily oiled water avoided the oil after initial contact. These investigators suggest that ducks may avoid oiled water if unoiled water is available. LIPICUS et al. (1980) found that mallards avoided water dyed orange and were possibly attracted to black-colored water. Visual stimuli appeared to be responsible for avoidance or hesitancy towards usage of orange-colored water. Thus, if given adequate stimuli, waterbirds seem able to detect certain compounds in aquatic systems. It appears that both visual and taste stimuli may be involved. The present study was designed to determine if some of the potentially hazardous chemicals that occur in aquatic systems can be detected and avoided by mallards.

MATERIALS AND METHODS

Hydroquinone (purified grade), copper sulfate granules (cupric sulfate pentahydrate) and simazine (2-chloro-4, 6-bis (ethylamino)-s-triazine) as the product Aquazine Algicide were utilized for this study. Hydroquinone is an ingredient of developing solutions and is discharged by the printing and press industry (WINDHOLZ 1976). Copper sulfate is used as an algicide and molluscicide at concentrations from 0.25-100 ppm in aquatic systems (MCINTOSH 1974, MALEK 1974). Simazine, marketed as Aquazine 80W, is used to control a variety of algae and submerged aquatic macrophytes (ELLIS et al. 1976).

Male game farm mallards, donated by the McGraw Wildlife Foundation, Dundee, Ill. were housed in individual compartments each measuring 68 by 70 by 28 cm in a Petersime finishing battery. Room temperature varied from 18° to 26° C during each trial. Water consumption was measured for 12 birds given a choice between distilled water and distilled water containing one of three concentrations of hydroquinone, copper sulfate or simazine based on % active ingredient. Daily water consumption was recorded and corrected for water loss via evaporation. Each chemical was offered for a 15 day treatment period which followed a 10 day acclimation period. Treatment solutions consisting of 100, 500 and 1000 ppm hydroquinone; 30, 60 and 100 ppm copper sulfate; and 5, 20 and 50 ppm simazine were prepared daily. Watering cups constructed of plexiglass and specially designed to minimize spillage and food contamination (PUROL 1975) were utilized. During the treatment period, watering cups were randomly switched to decrease position bias. Birds were kept under continuous light and food was available ad libitum.

Statistical comparisons of water consumption for individual mallards were made with a Scheffe interval test and a Mann-Whitney test was used for individual birds with heterogeneous variance. A 2-way analysis of variance with individuals and concentrations as main effects was used to analyze water consumption for each treatment. All levels of significance are reported at ≤ 0.05. Standard errors are used to denote variation about the mean.

RESULTS

Mallards developed drinking preferences based on 38 individual records (Figure 1). Sixteen birds showed a preference for left or right watering cups. A treatment preference (preference of the untreated or treated water supply) was recorded for 11 ducks. A dual position and treatment preference occurred for 7 ducks because random switching of the watering cups occassionally caused uneven

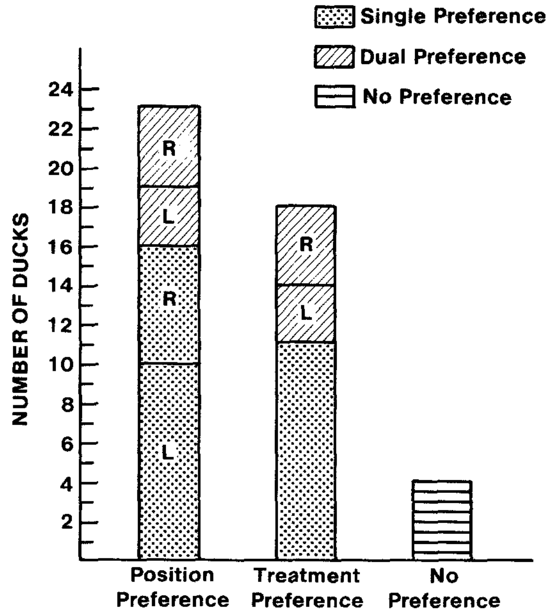

Figure 1. Number of mallards demonstrating a preference for a position (L=left, R=right), treatment (nontreated or treated water) or dual (both position and treatment) during a 10 day period.

distribution of treatments, so that it was possible to demonstrate both preferences. Four ducks showed no left or right water or treatment preference.

Mallards drank an average of 353±5 g of water per day during the treatment period (TABLE 1). Mean daily consumption remained relatively constant even when a shift away from the treated water at 1000 ppm hydroquinone, or towards the treated water at 100 ppm copper sulfate occurred. Water consumption by ducks given simazine varied significantly from a mean daily consumption of 289±64 g at 5 ppm to 454±80 g at 50 ppm. Mean daily water consumption by ducks given simazine was not significantly different from those given hydroquinone or copper sulfate at all concentrations. Although it was not statistically significant, ducks offered hydroquinone solutions appeared to consume more distilled water per day (210±19 g) than treated water (154±27 g). The opposite was observed in the copper sulfate treatment where ducks consumed more treated water per day (190±12 g) than distilled water (151±4 g). Consistent water consumption between treated (168±20 g) and distilled water (188±14 g) appeared to occur in the simazine treatment.

TABLE 1. Mean daily water consumption (g) of mallards at three concentrations of hydroquinone, copper sulfate and simazine when offered treated and nontreated water simultaneously.

Treatment	Concentration (ppm)	Distilled water (g)	Treated water (g)
Hydroquinone	100	186±18 (3)[a]	160± 9 (3)
	500	170±25 (3)	232±37 (3)
	1000	273±16 (3)	71±19 (3)[c]
Copper Sulfate	30	157±28 (3)	150±13 (3)[c]
	60	159±20 (2)	207±44 (2)
	100	137±13 (4)	214±14 (4)[b]
Simazine	5	142±26 (3)	147±20 (3)
	20	202±67 (2)	122±13 (2)[c]
	50	219±19 (4)	236±22 (4)

[a] $\bar{x} \pm$ S.E. (n)

[b] The two means in this row have a significant water main effect ($P \leq 0.05$).

[c] The two means in this row have a significant interaction ($P \leq 0.05$).

Preference at individual treatment concentrations varied (TABLE 1). No water preference occurred for ducks at 100 or 500 ppm hydroquinone. A significant interaction between individuals and concentrations was apparent at 1000 ppm hydroquinone. Due to a significant interaction, no conclusion within the main effects can be drawn. At 30 ppm copper sulfate a significant interaction occurred and at 60 ppm the ducks showed no preferences. Mallards preferred the treated water at 100 ppm copper sulfate. No preference was apparent at 5 and 50 ppm simazine; however, a significant interaction of main effects occurred at 20 ppm.

DISCUSSION

Many food preference studies have shown that birds can detect and avoid contaminated foodstuffs (HILL 1972, BENNETT and PRINCE 1981). Although death due to toxic concentrations of contaminants in water systems has been observed in birds (FLICKINGER et al. 1980), only a few water preference studies have been conducted (CUSTER and ALBERS 1980, LIPICUS et al. 1980). It has been noted that some waterbirds may avoid oil spills (CASEMENT 1966, BOURNE 1968); however, avoidance behavior of waterborne pollutants in natural systems is difficult to observe. In the present laboratory study, drinking preferences (i.e.: avoidance of treated water) of mallards was observed as interruptions of prior drinking patterns.

Mallards developed a ritual in daily drinking when confined to a small cage. The ritualization of a drinking location was disrupted by some of the treatments. This disruption in position patterning was variable and included a shift towards and away from the treated water supply. When offered copper sulfate treated water at 100 ppm the mallards shifted their consumption to prefer the treated water supply. Hydroquinone treated water was avoided. Although treatment concentrations were additive and most shifts in position patterning occurred at the higher concentrations, total daily water intake ramained constant.

Ducks given copper sulfate treated water were undergoing pre-basic molt which may have influenced their response. Energy needs increase during molt and trace mineral requirements may rise. In the case of copper sulfate, an increased need of trace minerals may have resulted in a preference of a "metallic tasting" solution.

Although location seemed to be an important proximate cue used to establish a drinking pattern, cues to identify a waterborne contaminant may include vision, taste or smell. Taste, functioning as a discriminatory tool against toxins, is believed to be the method of detection in the present sutdy. Visual stimuli may have been used in detection of hydroquinone, although the watering cups minimize sight contact of the drinking water.

Birds established use of a watering cup based on location and altered the patterning based on waterborne stimuli. Use of natural water areas could follow a similar pattern. Water use may be based on location and then modified by possible variations in water quality. A disruption of habitat utilization is a major deleterious effect of pollution.

Both field observation and laboratory preference studies must be conducted to determine the implications of waterway contamination on waterbirds. Results of the present study imply that waterbirds may be able to avoid polluted water systems even at non-toxic levels of contamination. Loss of wetlands due to drainage is already a serious problem, however a contributing loss due to pollution and the resulting avoidance by waterbirds should be considered. The opposite reaction of nonavoidance by birds may result in the loss of a portion of the waterbird community.

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