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Response of Japanese Quail (*Coturnix coturnix*) to Organophosphorus Ester-Induced Delayed Neurotoxicity Relative to Domestic Hens (*Gallus gallus* Domesticus)

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The phenomenon of organophosphorus ester induced neurotoxicity is striking for the variability in sensitivity among species. Of mammalian species which have been tested, rats, mice, hamsters, guinea pigs and rabbits have proven resistant to permanent paralysis (JOHNSON 1975) while man, sheep, water buffalo, domestic cats and dogs are sensitive. A single report on paralysis in mice (EL-SEBAE et al. 1977) suggests that resistance in some rodent species is relative rather than absolute. Histological evidence of peripheral nerve damage has not been presented for any rodents. Among birds, ducks are sensitive (HERIN et al. 1978) and an unspecified species of quail is said to be resistant (JOHNSON 1975). Domestic hens are reliably sensitive and have become the routinely used test species (ANONYMOUS 1978).

Over the past several years we have screened 35 organophosphorus esters (FRANCIS et al. 1980a, 1980b) for their neurotoxic potential. Because of the rather large quantities of test compound required to dose mature hens, the space required to house them, and the general inconvenience of working with chickens, we investigated the response of the Japanese quail, *Coturnix coturnix*, to organophosphorus ester-induced neurotoxicity. To be used in evaluating neurotoxic potential of organophosphorus esters, a species should be as sensitive as the hen to the delayed paralysis, and preferably no more sensitive to the acute (acetylcholinesterase inhibiting) toxicity, of these compounds. Our methods were designed, therefore, to ascertain the suitability of Japanese quail as a test species, given that a reliably sensitive species is already available.

METHODS

The Japanese quail were obtained from L&L Pheasantry, Hegins, Pennsylvania; housed in chick brooder cages at 12 to 13 quail per cage and fed Purina Game Bird Conditioner and water *ad lib*. Quail were sexually mature on arrival, and were not segregated by sex. Fertile eggs were obtained. Because this was a pilot study, no effort was made to identify differences in response between the sexes.

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To treat the quail we chose three potent neurotoxins with a reliable acute neurotoxic dose well below the minimum lethal dose in hens (*Gallus gallus* domesticus). Treatments in *Coturnix* were initially chosen to correspond to such nonlethal neurotoxic doses in hens. Where these levels of treatment were lethal to the quail, lower doses were used.

The chemicals used to treat Japanese quail were OMS 156 (*O*-2,5-4,6-trichlorophenyl) *O*-ethyl methylphosphonothioate); OMS 1297 (*O*-(2,5-dichloro-4-bromophenyl) *O*-propyl methylphosphonothioate) and leptophos (*O*-(2,5-dichloro-4-bromophenyl) *O*-methyl phenylphosphonothioate). Three Japanese quail were also treated with OMS 989 (*O*-(2,5-dichloro-4-bromophenyl) *O*-*iso*propyl methylphosphonothioate). These compounds were chosen because their minimum lethal dose and their effective acute neurotoxic dose in hens had been established for our laboratory. The hens were either sexually mature white hybrids less than 9 months of age (Hy-Line pullets from Cornbelt Hatcheries and Roth Hatcheries) or hens older than 18 months. The older hens were of two varieties: a red meat production variety and old Hy-Line hybrids.

RESULTS AND DISCUSSION

The levels of treatment, the number of quail treated, and their response, are shown in Table 1. Comparable data from the ongoing studies in hens are shown in Table 1 also.

None of the quail treated with any of the compounds showed any symptoms of paralysis. In the case of OMS 156, OMS 1297 and leptophos, the highest doses used were lethal. In the case of OMS 989, none of the three quail died of acute cholinergic effects, but the 20 mg/kg bird died 17 days after treatment. Symptoms included weakness and an everted anus: inasmuch as neither the quail treated with 30 mg/kg nor the one treated with 40 mg/kg showed either of these symptoms, they were probably not caused by treatment.

The absence of paralysis, ataxia, or other obvious locomotor disturbances obviated any reason for histological examination of peripheral nerves, since the essence of screening lies in the clarity of the response rather than in subtle analyses. A total of 28 quail were treated with neurotoxins at levels above the minimum neurotoxic dose, and below the minimum lethal dose seen in our hens. Of 19 quail surviving at 30 days, none showed any overt symptoms of ataxia. These data argue strongly against the use of Japanese quail in the testing of organophosphorus esters for delayed neurotoxicity. This does not mean Japanese quail are absolutely resistant to organophosphate-induced neurotoxicity. It is possible that neurotoxicity would be produced by higher dosages of the compounds tested if atropine were administered to protect against the acute cholinergic effects of the compounds. Nevertheless, for those studies in which chemicals are being evaluated for neurotoxic activity, Japanese quail are an inappropriate test organism.

TABLE 1

		QUAIL				HENS			
Compound	Dose (mg/kg)	#	#dead: 24 hrs	#alive: day 30	#ataxic/ paralyzed	#	#dead: 24 hrs	#alive: day 30	#ataxic/ paralyzed
OMS 156	10	-	-	-	-	1[a]	0	1	0
	20	5	0	5	0	1[a]	0	1	1
	25	2	1	1	0	-	-	-	-
	30	8	4	4	0	2	0	2	2
	40	3	3	0	0	-	-	-	-
OMS 989	10	-	-	-	-	1	0	1	0
	20	1	0	0	0	-	-	-	-
	30	1	0	1	-	2	0	2	1
	40	1	0	1	0	-	-	-	-
	50	-	-	-	-	4	0	2[b]	4
OMS 1297	20	1	0	1	0	-	-	-	-
	30	1	0	1	0	3	0	3	1
	35	-	-	-	-	2[c]	0	2	2
	40	1	1	0	0	1	0	1	1
	50	1	1	0	0	4	0	2[b]	4
Leptophos	200	4	1	3	0	5[a,c]	0	5	0
	250	3	1	2	0	1[c]	0	1	1
	300	5	1	4	0	1	0	1	1
	400	1	1	0	0	-	-	-	-
	500	1	1	0	0	-	-	-	-

Numbers of hens and quail treated with each neurotoxin, and symptoms observed.

a. One hen was 18 months old Hy-Line hybrid, b. Two hens killed after onset of ataxia for histological studies, c. One or two hens were 18 months old and of a red breed.

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