LETHAL DIETARY TOXICITIES OF ENVIRONMENTAL POLLUTANTS TO BIRDS

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LETHAL DIETARY TOXICITIES OF ENVIRONMENTAL POLLUTANTS TO BIRDS

By

Elwood F. Hill, Robert G. Heath
James W. Spann, and Joseph D. Williams

Patuxent Wildlife Research Center
Laurel, Maryland 20811

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ABSTRACT

This report is a compilation and analysis of the results of nearly 10 years of testing the lethal dietary toxicities of pesticidal and industrial chemicals to young bobwhites (*Colinus virginianus*), Japanese quail (*Coturnix c. japonica*), ring-necked pheasants (*Phasianus colchicus*), and mallards (*Anas platyrhynchos*).

A total of 131 compounds were tested. Toxicities are expressed as median lethal dietary concentrations (LC50) and are based on 5 days of dietary exposure to the test compound followed by 3 days of untreated feed. From these data statistical comparisons between toxicities are possible for a given species.

Certain classes of pesticides -- organochlorine compounds, organophosphates and organometallic compounds -- contained most of the compounds judged "highly toxic". The most frequent order of species response was bobwhite > Japanese quail > ring-necked pheasant > mallard. This order correlates with their body sizes at the ages tested.

INTRODUCTION

This report is a compilation of the results of nearly 10 years of testing the subacute toxicities of pesticides and industrial chemicals to young bobwhites (*Colinus virginianus*), Japanese quail (*Coturnix c. japonica*), ring-necked pheasants (*Phasianus colchicus*) and mallards (*Anas platyrhynchos*). It supersedes our earlier publication (Heath et al. 1972). A total of 131 compounds were tested, including 30 organochlorine compounds, 39 organophosphates, 17 carboxylates, 15 carbamates, 12 metallic compounds, 5 organonitrogen compounds, 4 organosulfates, 4 ureas, 3 ketones, and 2 nitrophenols.

Our objectives were two-fold: to provide a readily referable source of subacute toxicity data for the species and chemicals we tested, and to compare the responses of different species to different classes of chemicals.

A detailed exposition of mathematical procedures and a list of chemical and common names (with often-used synonyms) are included in appendices.

PROCEDURES

Subacute toxicity tests were designed to measure a median lethal dietary concentration (LC50) of chemical to young birds during an 8-day test, including 5 days of treated diet followed by 3 days of untreated diet. Five or six geometrically arranged concentrations of toxicant were used per test at levels expected to kill from 10 to 90% of the test population. An equal number of positive and negative controls accompanied each test. Using shared controls, several compounds could be tested simultaneously. A completely randomized experimental design was used.

Feed treated with dieldrin dissolved in corn oil served as the positive control (standard) and feed treated with corn oil, the diluent used for most compounds tested, was the negative control.

Each test group (one test group per toxic concentration) consisted of 10 birds. Ages of test birds were 14 days for quail and 10 days for pheasants and mallards. In the 1973 tests, mallards were 5 days old.

Testing commenced at midday. Mortality and feed consumption were recorded at 24-hour intervals thereafter. Fresh feed was added to all pens daily. After the 5th day, all feed, including that of controls, was replaced by untreated feed.

Occasional deviations from the basic procedure were necessary because of shortages of facilities or birds. As few as five birds per test group and four toxic concentrations per test were sometimes used. Before standardization in 1970, age of birds sometimes varied as much as 1 week between tests.

All test birds were incubator-hatched progeny of randomly outbred Patuxent colonies. Bobwhite and pheasant colonies originated from the Pennsylvania Game Commission's game farm stock; Japanese quail from Auburn University; and mallards from wild stock. Parent colonies were outbred to maximize individual variation and to more closely approximate characteristics of wild populations.

Gallinaceous birds were tested in six-tiered brood units with tiers divided into four pens measuring 35 x 100 x 24 cm. Floors and external walls were of wire mesh; ceilings and common walls were galvanized sheeting. Tiers were equipped with thermostatically controlled heat and fluorescent lighting. Mallards were tested in wooden, walk-in pens on concrete slabs. The pens measured 1.5 x 3.0 x 2.1 m. The upper half of the lee wall of the pen was screened. Heat (infra-red), straw litter, and running water were provided.

Test diets were prepared by blending a toxicant-carrier solution into commercial starter mash in the ratio of 2:98, by weight. Corn oil was the usual carrier, although propylene glycol was substituted when compounds were insoluble in oil. Chemicals were dissolved in the carrier, over heat when necessary. Some chemicals were first dissolved in minimal quantities of acetone. If extremely large quantities of a compound were required, or if the compound had a talc base, it was mixed directly into the feed and appropriate amounts of the carrier were added to the mixture as a supplement. Unstable compounds were mixed immediately before the test. Control diets contained corn oil in the ratio of 2:98, by weight.

The LC50's and associated statistics were derived by methods of probit analysis described by Finney (1952) and were programmed for computer by the system of Daum and Killcreas (1966). The 50% response level was chosen because it can be estimated more precisely than extreme percentage levels (Finney 1952; see Appendix 1 for statistical details). Positive and negative control data were included in the probit analysis with every set of compounds tested simultaneously. Compounds with LC50's exceeding 5000 ppm in preliminary range finding experiments were not tested further. Estimates for preliminary data were made graphically by the method of Litchfield and Wilcoxon (1949) and are presented as approximate values that are considered to be provisional.

In Table 1, the toxicity of each compound to each species is compared with the toxicity of the dieldrin standard to the same species as determined by concurrent tests. The resultant value (relative toxicity of dieldrin or RTD) is a direct ratio of the LC50's of the two compounds and represents the difference in toxicity between those two compounds under a single condition. Therefore, toxicities of different chemicals in relation to each other can be estimated statistically by using the RTD's as described in Appendix 2. Lethal concentrations in addition to the LC50's can also be estimated from data in Table 1 as described in Appendix 2.

RESULTS AND DISCUSSION

Five-day subacute dietary toxicities of 131 compounds were determined for young bobwhites, Japanese quail, ring-necked pheasants and mallards. In Table 1, results are arranged alphabetically by common name of the test compound. Chemical names, purity, chemical classes, and principal uses are shown in Appendix 3.

Comparative Toxicity in Relation to Chemical Class

Although interest in toxicity data tends to center on specific comparisons between chemicals, broader generalization is also useful in understanding the toxicity process, especially if judgments of relative toxicity are desired. Several rating systems have been developed for this purpose (Hodge and Sterner 1949, Radeleff 1964, and Melnikov 1971). These systems classify LD50's (median lethal dose) into categories of relative toxicity from "highly toxic" (<50 mg/kg) to "practically nontoxic" (>5000 mg/kg) with class divisions arranged geometrically. We developed a similar system for rating subacute data in which five toxicity classes were recognized. The classes are: I, <41 ppm; II, 41-200 ppm; III, 201-1000 ppm; IV, 1001-5000 ppm; and V, >5000 ppm.

Table 2 illustrates differences in general order of toxicity among chemical classes for Japanese quail, mallards, and rats. The rat data were derived from previously published acute toxicity tests (Gaines 1960, 1969; Melnikov 1971).

Japanese quail and mallards showed similar responses, except that mallard results fell slightly more often into the least toxic class, V. Both species responded similarly to organochlorine and organophosphorus compounds. These chemical classes tended to be most toxic to birds, as they contained the greatest proportion of compounds rated class I and II. All carboxylates and most "miscellaneous" compounds fell in the least toxic class. The toxicity ratings for rats were different because a much higher percentage of compounds were judged to be highly toxic (classes I and II).

With the possible exception of carboxylates, it is clear that lethal hazard cannot be predicted solely on the basis of chemical class. Nor can it be assumed that relative hazard of chemicals based on acute study with rats will follow the same order when tested subacutely on birds.

In Table 3 relative toxicities of different classes of chemicals to birds are given in more detail by subdividing the major classes according to their structural properties. Here, toxicities of similar compounds follow more definable patterns.

Organochlorines tested are halogen derivatives of either alicyclic or aromatic hydrocarbons. Nearly all compounds in class I and II are alicyclic. In contrast, most aromatic hydrocarbons are in class IV or V.

There are exceptions, however. For example, Starlicide, an aromatic hydrocarbon bird control agent, is surpassed in subacute toxicity to Japanese quail only by endrin, an alicyclic hydrocarbon, and azodrin, an organophosphorus compound (Table 1).

Tests with rats followed a similar toxicity pattern (Gaines 1960, 1969). Alicyclic hydrocarbons generally produced LD50's of less than 100 mg/kg (class I and II) whereas aromatic hydrocarbons were above 800 mg/kg (class III-V). Starlicide was generally in line with other aromatics in rat tests as the reported LD50 is 1170 mg/kg (Christensen 1973).

Organophosphorus compounds are derivatives of four phosphorus acids: phosphoric, thiophosphoric, dithiophosphoric, and phosphonic. All organophosphates that fell into class I were derivatives of either phosphoric or thiophosphoric acids, except Mocap (bobwhite LC50, 33 ppm), a dithiophosphoric acid. Phosphoric and thiophosphoric acids produced few LC50's above 1000 ppm (class IV and V), although nearly all LC50's of dithiophosphoric and phosphonic acids were over 1000 ppm. Among the phosphoric acids, azodrin (the most toxic compound tested), its close relative Bidrin, and phosphamidon were consistently among the most toxic of all compounds tested. Several thiophosphoric acids -- Dasanit, famphur, fenthion, methyl parathion and thionazin -- also were highly toxic. In general, the order of toxicity of these phosphorus acids to birds was: phosphoric $\geq$ thiophosphoric > dithiophosphoric $\geq$ phosphonic. Phosphoric and thiophosphoric acids also were highly toxic to rats (Gaines 1960, 1969). Abate, a thiophosphoric acid, provides an interesting contrast because it was quite toxic to birds (Table 1 and Hill 1971), but not to rats (Gaines 1969).

The metallic compounds tested varied widely in chemical composition and permitted only general comparisons. Organic forms tended to be more toxic than inorganic forms. The organomercurials Ceresan M and Morsodren consistently gave LC50's less than 100 ppm (class II). LC50's for other metallics usually exceeded 1000 ppm (class IV and V).

Comparative Toxicity in Relation to Species

Comparisons of the susceptibility of Japanese quail, ring-necked pheasants and mallards to different chemicals are shown in Table 4. Quail appeared to be most sensitive to the comparatively toxic alicyclic hydrocarbons and mallards the least sensitive. Pheasants were most sensitive to aromatic hydrocarbons and mallards appeared least sensitive (based on response rating and median LC50). Species sensitivity to organophosphorus compounds followed the order: quail > pheasant > mallard. For carbamates, the order was quail > mallard > pheasant. This indicates a change in the pheasant-mallard relationship, even though organophosphates and carbamates both are chlorinesterase inhibitors. Meaningful comparisons were not possible for other classes of chemicals, but some observations are pertinent. Only pheasants produced LC50's less than 5000 ppm for carboxylates. Pheasants appeared most sensitive and mallards least sensitive to inorganic metallics, but the reverse was true for organic metallics.

Overall comparisons showed the probable order of sensitivity to be Japanese quail > ring-necked pheasant > mallard; this relationship occurred 31% of the time. The opposite order occurred least frequently (6%). The second most frequent order of sensitivity (27%) was pheasant > quail > mallard.

Because all possible variations in order of species sensitivity occurred in all chemical classes, it is clear that an LC50 for any of these species probably would not permit prediction of that chemical's toxicity to either untested species. A similar conclusion was reached by Tucker and Haegele (1971) from the results of tests of acute pesticidal toxicity to six species of birds.

Although accurate prediction of the sensitivity of one species to a given compound from data for a different species appears unlikely, there are positive correlations between LC50's for different species within a given chemical class. Table 5 shows correlation coefficients for paired LC50's for the species we tested within the major chemical classes. All correlations of LC50's for Japanese quail and mallards were statistically significant ($P<0.05$ or $P<0.01$). Correlations between LC50's for ring-necked pheasants and either mallards or Japanese quail were significant in three of four comparisons with each species. Only three of eight comparisons between bobwhite and other species proved significant. Because all correlations are positive, 17 of 20 are either significant or very nearly significant at $P=0.05$, and one-half are highly significant ($P<0.01$), it is clear that the test species responded similarly, in a relative sense.

CONCLUSIONS

We have measured the dietary susceptibility of two to four species of birds to 131 toxic compounds. From the data provided in Table 1 the toxicities of different compounds to the same species can be tested statistically; thus, toxicity rankings are possible.

Most of the more toxic compounds were halogen derivatives of alicyclic hydrocarbons, derivatives of phosphoric and thiophosphoric acids, and organomercurials. Carbamates, often of extreme acute toxicity to rats, were only moderately toxic when fed to birds. Most carboxylates, ketones, organonitrogen compounds, organosulfates and ureas were of a relatively low order of toxicity.

Interspecies comparisons showed the overall order of susceptibility to be quail > pheasant > mallard which is size related. All combinations of species order occurred. Although the order of susceptibility of species varied, a characteristic order usually prevailed within a given class of chemicals and the LC50's for any two test species were strongly correlated.

This suggests that, regardless of test species, the relative toxicities of different chemicals in the same class would be similar if test conditions were constant. However, unpredictable differences in species' susceptibility occur often enough that tests of at least two species are desirable.

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Table 1. Dietary toxicities of 131 compounds tested in 5-day diets of young bobwhites, Japanese quail, ring-necked pheasants, or mallards (1964-73).

Compound / Species	Age (days)[a]	No. of conc.[b]	No. birds/ conc.	Toxicity statistics: LC_{50}[c]	(95% C.L.)	Slope[d]	(S.D.)	RTD[e]	(95% C.L.)
Abate									
Bobwhite	15	4	6	92	(70- 117)	9.842	(2.816)	2.67	(1.94- 3.67)
Japanese quail	19	6	16	260	(206- 334)	5.247	(1.047)	5.27	(3.87- 7.34)
Ring-necked pheasant	10	4	8	162	(120- 207)	8.135	(3.332)	3.05	(2.22- 4.05)
Mallard	17	4	8	894	(575- 1910)	2.739	(1.586)	2.79	(1.42- 4.76)
Acetone									
Japanese quail	14	3	10	>40,000	(No mortality to 40,000 ppm)				
Ring-necked pheasant	10	3	10	>40,000	(No mortality to 40,000 ppm)				
Aldicarb									
Japanese quail	14	6	10	381	(317 - 453)	9.716	(1.931)	6.9	(5.5 - 8.7)
Ring-necked pheasant	10	5	10	>300	(No mortality to 300 ppm)				
Mallard	10	1	10	<1000	(70% mortality at 1000 ppm)				
Mallard	5	6	10	594	(507- 695)	5.291	(1.245)	4.8	(3.9 - 6.0)
Aldrin									
Bobwhite	17	6	10	37	(33- 41)	9.867	(2.082)	0.94	(0.82- 1.09)
Japanese quail	6	5	18	34	(28- 41)	5.133	(1.243)	0.81	(0.66- 0.99)
Ring-necked pheasant	8	6	10	57	(50- 64)	10.433	(1.835)	1.05	(0.88- 1.25)
Mallard	8	6	10	155	(129- 186)	4.417	(1.507)	0.76	(0.60- 0.98)
Aminocarb									
Ring-necked pheasant	10	5	10	>2000	(No mortality to 2000 ppm)				
Mallard	10	3	10	2552	(1698-3855)	1.864	(1.139)	20.1	(12.5 -33.2)

Table 1. Dietary toxicities of 131 compounds tested in 5-day diets of young bobwhites, Japanese quail, ring-necked pheasants, or mallards (1964-73)--continued

Compound / Species	Age (days)[a]	No. of conc.[b]	No. birds/ conc.	Toxicity statistics: LC50[c]	(95% C.L.)	Slope[d]	(S.D.)	RTD[e]	(95% C.L.)
Amitrole									
Japanese quail	12	3	14	>5000	(No mortality to 5000 ppm)				
Ring-necked pheasant	10	3	9	>5000	(No mortality to 5000 ppm)				
Mallard	10	3	10	>5000	(No mortality to 5000 ppm)				
Aramite									
Bobwhite	10	3	10	>5000	(10% mortality at 2500 ppm, 20% at 5000 ppm)				
Japanese quail	14	3	10	>5000	(No mortality to 5000 ppm)				
Ring-necked pheasant	14	6	10	>5000	(No mortality to 5000 ppm)				
Aroclor 1221									
Bobwhite	10	6	10	>6000	(No mortality to 4800 ppm, 30% at 6000 ppm)				
Japanese quail	14	3	10	>12000	(No mortality to 12000 ppm)				
Ring-necked pheasant	10	1	10	>5000	(No mortality at 5000 ppm)				
Mallard	10	1	10	>5000	(No mortality at 5000 ppm)				
Aroclor 1232									
Bobwhite	10	4	10	3002	(2577-3501)	11.631	(2.695)	75.1	(62.0 -92.4)
Japanese quail	14	3	10	>5000	(No mortality to 5000 ppm)				
Ring-necked pheasant	10	6	10	3146	(2626-3948)	5.786	(1.522)	61.6[f]	--
Mallard	10	5	8	>6000	(12% mortality at 4558 ppm, 25% at 6000 ppm)				

Table 1. Dietary toxicities of 131 compounds tested in 5-day diets of young bobwhites, Japanese quail, ring-necked pheasants, or mallards (1964-73)--continued

Compound / Species	Age (days)[a]	No. of conc.[b]	No. birds/ conc.	Toxicity statistics: LC_{50}[c]	(95% C.L.)	Slope[d]	(S.D.)	RTD[e]	(95% C.L.)
Aroclor 1242									
Bobwhite	10	5	10	2098	(1706-2610)	3.724	(1.739)	70.8	(53.3-101)
Japanese quail	14	8	10	>6000	(20% mortality at 5432 ppm, 20% at 6000 ppm)				
Ring-necked pheasant	10	5	10	2078	(1843-2347)	7.808	(2.616)	40.6	(34.7- 47.7)
Mallard	10	5	10	3182	(2613-3879)	2.577	(1.513)	19.7	(15.0- 26.3)
Aroclor 1248									
Bobwhite	10	6	10	1175	(966-1440)	2.950	(1.355)	39.7	(30.0- 55.8)
Japanese quail	14	7	10	4844	(4355-5410)	7.845	(1.996)	77.4	(66.2- 90.7)
Ring-necked pheasant	10	6	10	1312	(1166-1477)	7.534	(2.366)	25.7	(21.9- 30.0)
Mallard	10	5	10	2798	(2264-3422)	4.725	(1.516)	17.3	(13.1- 23.0)
Aroclor 1254									
Bobwhite	10	5	10	604	(410- 840)	6.379	(1.848)	20.4	(15.0- 27.7)
Japanese quail	14	8	10	2898	(2598-3241)	5.772	(1.364)	46.3	(39.4- 54.5)
Ring-necked pheasant	10	5	10	1091	(968-1228)	12.174	(2.431)	21.3	(18.2- 25.0)
Mallard	10	6	10	2699	(2159-3309)	6.674	(1.263)	16.7	(12.7- 22.0)
Aroclor 1260									
Bobwhite	10	5	10	747	(577- 937)	6.211	(1.631)	25.2	(18.9- 34.4)
Japanese quail	14	7	10	2186	(1917-2478)	7.444	(1.439)	34.9	(29.3- 41.3)
Ring-necked pheasant	10	6	10	1260	(1106-1433)	5.421	(2.715)	24.6	(20.8- 29.1)
Mallard	10	5	10	1975	(1363-2749)	4.054	(1.759)	12.2	(8.9- 16.3)

Table 1. Dietary toxicities of 131 compounds tested in 5-day diets of young bobwhites, Japanese quail, ring-necked pheasants, or mallards (1964-73)--continued

Compound / Species	Age (days)[a]	No. of conc.[b]	No. birds/ conc.	Toxicity statistics: LC_{50}[c]	(95% C.L.)	Slope[d]	(S.D.)	RTD[e]	(95% C.L.)
Aroclor 1262									
Bobwhite	10	5	10	871	(702-1069)	4.037	(1.584)	29.4	(22.1 -40.8)
Japanese quail	14	7	10	2291	(2038-2575)	7.552	(1.501)	36.6	(31.0 -43.2)
Ring-necked pheasant	10	5	10	1234	(1086-1402)	13.518	(2.574)	24.1	(20.5 -28.5)
Mallard	10	6	10	3008	(2461-3634)	2.351	(1.226)	18.6	(14.2 -24.5)
Aroclor 5442									
Japanese quail	14	3	10	≈ 4800	--			≈ 89	--
Aspon									
Japanese quail	14	3	10	>5000	(No mortality to 5000 ppm)				
Ring-necked pheasant	10	3	10	>5000	(No mortality to 5000 ppm)				
Mallard	10	3	12	>5000	(No mortality to 5000 ppm)				
Atrazine									
Bobwhite	9	3	10	>5000	(No mortality to 5000 ppm)				
Japanese quail	7	3	14	>5000	(No mortality to 2500 ppm, 7% at 5000 ppm)				
Ring-necked pheasant	10	3	8	>5000	(No mortality to 5000 ppm)				
Mallard	10	3	10	>5000	(No mortality to 2500 ppm, 30% at 5000 ppm)				
Azodrin									
Japanese quail	14	6	10	2.4	(2.0- 2.9)	5.757	(1.439)	0.044	(0.035- 0.056)
Ring-necked pheasant	10	6	10	3.1	(2.6- 3.7)	7.390	(1.450)	0.045[f]	(0.035- 0.057)
Mallard	10	5	10	32	(19 -57)	1.782	(0.485)	0.151	--
Mallard	5	6	10	9.6	(7.7-12.0)	5.453	(1.227)	0.068	(0.052- 0.090)

Table 1. Dietary toxicities of 131 compounds tested in 5-day diets of young bobwhites, Japanese quail, ring-necked pheasants, or mallards (1964-73)--continued

Compound / Species	Age (days)[a]	No. of conc.[b]	No. birds/ conc.	Toxicity statistics: LC_{50}[c]	(95% C.L.)	Slope[d]	(S.D.)	RTD[e]	(95% C.L.)
Baygon									
Bobwhite	14	4	10	206	(168- 251)	4.215	(1.988)	7.68	(5.8-10.6)
Japanese quail	14	3	10	>5000	(No mortality to 1581 ppm, 10% at 5000 ppm)				
Ring-necked pheasant	10	6	10	≃ 1750	--			≃ 26.5	--
Mallard	10	3	8	<1000	(75% mortality at 1000 ppm)				
Bidrin									
Japanese quail	14	6	10	32	(26- 39)	7.917	(2.052)	0.58	(0.45-0.75)
Ring-necked pheasant	10	6	10	44	(38- 51)	6.443	(1.400)	0.78	(0.65-0.95)
Mallard	10	5	10	144	(110- 185)	3.308	(1.198)	1.13	(0.79-1.62)
Mallard	5	8	10	94	(80- 111)	3.926	(1.008)	0.68	(0.53-0.85)
Bux									
Japanese quail	14	3	12	>5000	(8% mortality at 2236 ppm, 42% at 5000 ppm)				
Ring-necked pheasant	10	3	10	>5000	(No mortality to 5000 ppm)				
Mallard	10	3	8	>5000	(12% mortality at 1000 ppm, 38% at 5000 ppm)				
Cadmium chloride									
Japanese quail	14	6	10	2584	(2165-3083)	4.144	(1.734)	34.2	(26.9-43.2)
Ring-necked pheasant	10	6	10	767	(651- 898)	3.068	(1.400)	12.1	(9.7-15.0)
Mallard	10	3	12	>5000	(No mortality to 1580 ppm, 8% at 5000 ppm)				
Cadmium succinate									
Bobwhite	14	5	10	1728	(1381-2132)	4.574	(1.162)	41.6[f]	--
Japanese quail	12	6	10	2693	(2269-3202)	3.671	(1.136)	50.5	(39.7-64.4)
Ring-necked pheasant	14	5	10	1411	(1202-1657)	4.437	(1.523)	26.9	(21.9-33.0)
Mallard	10	3	8	>5000	(No mortality to 2235 ppm, 12% at 5000 ppm)				

Table 1. Dietary toxicities of 131 compounds tested in 5-day diets of young bobwhites, Japanese quail, ring-necked pheasants, or mallards (1964-73)--continued

Compound / Species	Age (days)[a]	No. of conc.[b]	No. birds/ conc.	Toxicity statistics: LC50[c]	(95% C.L.)	Slope[d]	(S.D.)	RTD[e]	(95% C.L.)
Captan									
Bobwhite	14	6	8	>2400	(No mortality to 2400 ppm)				
Japanese quail	7	3	14	>5000	(No mortality to 5000 ppm)				
Ring-necked pheasant	10	3	12	>5000	(No mortality to 5000 ppm)				
Mallard	16	3	10	>5000	(No mortality to 5000 ppm)				
Carbaryl									
Bobwhite	23	2	7	>5000	(No mortality to 5000 ppm)				
Japanese quail	7	3	14	>5000	(No mortality to 2500 ppm, 7% at 5000 ppm)				
Ring-necked pheasant	23	1	4	>5000	(No mortality at 5000 ppm)				
Mallard	24	4	6	>5000	(No mortality to 5000 ppm)				
Carbofuran									
Japanese quail	14	5	10	438	(356- 529)	8.714	(2.072)	8.1	(6.5 - 9.9)
Ring-necked pheasant	10	6	10	573	(492- 666)	12.049	(3.156)	10.3	(8.6 -12.3)
Mallard	10	5	10	190	(156- 230)	7.824	(1.594)	1.0	(0.8 - 1.3)
Ceresan M									
Bobwhite	14	6	10	≃ 70				≃ 1.68	--
Japanese quail	12	6	10	100	(84- 118)	7.450	(1.119)	1.87	(1.47 - 2.39)
Ring-necked pheasant	10	6	10	146	(127- 167)	5.960	(1.192)	2.15	(1.75 - 2.60)
Mallard	10	6	8	≃ 50	--			≃ 0.28	--
Mallard	5	3	10	≃ 54	--			≃ 0.30	--

Table 1. Dietary toxicities of 131 compounds tested in 5-day diets of young bobwhites, Japanese quail, ring-necked pheasants, or mallards (1964-73)--continued

Compound / Species	Age (days)[a]	No. of conc.[b]	No. birds/ conc.	Toxicity statistics: LC_{50}[c]	(95% C.L.)	Slope[d]	(S.D.)	RTD[e]	(95% C.L.)
CHE-1843									
Japanese quail	14	3	10	>5000	(No mortality to 5000 ppm)				
Chlordane									
Bobwhite	17	6	6	331	(197- 497)	4.866	(1.760)	7.27	(4.71-10.80)
Japanese quail	7	5	14	350	(305- 403)	6.651	(1.220)	5.86	(4.86- 7.08)
Ring-necked pheasant	15	5	9	430	(366- 505)	7.120	(1.775)	8.06	(6.51- 9.94)
Mallard	10	5	10	858	(629-1241)	3.796	(1.236)	4.23	(2.99- 6.28)
Chlordimeform									
Japanese quail	14	3	10	1749	(1289-2344)	7.779	(2.322)	23.2	(16.5 -31.9)
Ring-necked pheasant	10	6	10	2608	(2156-3171)	5.299	(1.052)	40.2	(31.0 -51.7)
Mallard	5	3	10	>5000	(No mortality to 2236 ppm, 20% at 5000 ppm)				
Chlormethylfos									
Japanese quail	14	3	10	>5000	(No mortality to 2236 ppm, 20% at 5000 ppm)				
Ring-necked pheasant	10	6	10	4168	(3685-4712)	6.096	(1.847)	79.8	(67.6 -94.4)
Mallard	10	3	8	>5000	(No mortality to 1000 ppm, 38% at 5000 ppm)				
Chlorpyrifos									
Japanese quail	14	6	13	299	(146-1682)	1.591	(0.766)	5.2[f]	--
Ring-necked pheasant	10	6	10	553	(421- 687)	4.717	(1.221)	10.6[f]	--
Mallard	10	8	8	≃ 940	--			≃ 6.0	--

Table 1. Dietary toxicities of 131 compounds tested in 5-day diets of young bobwhites, Japanese quail, ring-necked pheasants, or mallards (1964-73)--continued

Compound / Species	Age (days)[a]	No. of conc.[b]	No. birds/ conc.	Toxicity statistics: LC_{50}[c]	(95% C.L.)	Slope[d]	(S.D.)	RTD[e]	(95% C.L.)
Chromium acetylacetonate									
Japanese quail	14	3	10	>5000	(No mortality to 5000 ppm)				
Mallard	10	1	10	>5000	(No mortality at 5000 ppm)				
Co-Ral									
Bobwhite	14	6	10	120	(104- 139)	7.348	(1.923)	2.89	(2.36- 3.54)
Japanese quail	14	5	10	225	(172- 306)	4.642	(1.049)	≃ 4.00	--
Ring-necked pheasant	14	6	10	318	(277- 364)	7.228	(1.452)	6.06	(5.03- 7.30)
Mallard	10	6	10	709	(521-1032)	1.981	(0.993)	3.54	(2.34- 5.53)
2,4-D,acetamide									
Japanese quail	14	3	16	>5000	(No mortality to 5000 ppm)				
2,4-D,butoxyethanol ester									
Bobwhite	23	4	4	>5000	(No mortality to 5000 ppm)				
Japanese quail	12	4	14	>5000	(No mortality to 5000 ppm)				
Ring-necked pheasant	10	3	12	>5000	(No mortality to 2500 ppm, 17% at 5000 ppm)				
Mallard	23	8	11	>5000	(No mortality to 5000 ppm)				
2,4-D,dimethylamine salt									
Bobwhite	23	2	7	>5000	(No mortality to 5000 ppm)				
Japanese quail	20	4	20	>5000	(No mortality to 5000 ppm)				
Ring-necked pheasant	10	3	8	>5000	(No mortality to 5000 ppm)				
Mallard	17	3	8	>5000	(No mortality to 5000 ppm)				

Table 1. Dietary toxicities of 131 compounds tested in 5-day diets of young bobwhites, Japanese quail, ring-necked pheasants, or mallards (1964-73)--continued

Compound Species	Age (days)[a]	No. of conc.[b]	No. birds/ conc.	Toxicity statistics LC_{50}[c]	(95% C.L.)	Slope[d]	(S.D.)	RTD[e]	(95% C.L.)
Dalapon, sodium salt[g]									
Japanese quail	12	3	14	>5000	(No mortality to 5000 ppm)				
Ring-necked pheasant	10	3	8	>5000	(No mortality to 5000 ppm)				
Mallard	10	3	10	>5000	(No mortality to 5000 ppm)				
Dasanit									
Bobwhite	10	5	10	35	(29- 43)	5.076	(3.408)	0.89	(0.70- 1.15)
Japanese quail	14	6	10	83	(71- 98)	3.655	(1.544)	1.44	(1.16- 1.79)
Ring-necked pheasant	10	6	10	148	(119- 179)	5.010	(1.369)	≃ 3.50	--
Mallard	10	6	10	43	(36- 51)	5.139	(1.192)	0.21	(0.15- 0.26)
Mallard	5	6	10	41	(32- 55)	4.399	(0.825)	0.23	(0.16- 0.33)
2,4-DB									
Bobwhite	14	3	10	>5000	(10% mortality at 2236 ppm, 40% at 5000 ppm)				
Japanese quail	14	3	12	>5000	(No mortality to 5000 ppm)				
Ring-necked pheasant	14	3	10	>5000	(No mortality to 5000 ppm)				
Mallard	10	1	10	>5000	(No mortality at 5000 ppm)				
DDE									
Bobwhite	23	5	7	825	(697- 976)	8.132	(2.436)	22.5	(18.1 -28.0)
Japanese quail	7	6	12	1355	(1111-1648)	6.469	(1.205)	24.1	(18.6 -31.0)
Ring-necked pheasant	10	6	10	829	(746- 922)	8.578	(2.220)	16.5	(14.3 -19.0)
Mallard	17	6	10	3572	(2811-4669)	3.709	(1.069)	18.4	(13.6 -25.7)

Table 1. Dietary toxicities of 131 compounds tested in 5-day diets of young bobwhites, Japanese quail, ring-necked pheasants, or mallards (1964-73)--continued

Compound / Species	Age (days)[a]	No. of conc.[b]	No. birds/ conc.	Toxicity Statistics: LC_{50}[c]	(95% C.L.)	Slope[d]	(S.D.)	RTD[e]	(95% C.L.)
DDT									
Bobwhite	23	5	7	611	(514- 724)	7.357	(2.489)	16.6	(13.4 -20.8)
Japanese quail	7	6	12	568	(470- 687)	4.770	(1.367)	10.1	(7.9 -13.0)
Ring-necked pheasant	21	4	7	311	(256- 374)	10.982	(4.644)	7.3	(5.9 - 8.9)
Mallard	17	6	10	1869	(1500-2372)	3.896	(0.996)	9.6	(7.1 -13.3)
DDVP									
Japanese quail	14	6	10	298	(257- 345)	6.535	(1.369)	5.1	(4.2 - 6.2)
Ring-necked pheasant	10	6	10	568	(473- 675)	5.521	(1.315)	10.1	(8.1 -12.7)
Mallard	16	3	10	>5000	(10% mortality at 1250 ppm, 30% at 5000 ppm)				
Mallard	5	6	10	1317	(1043-1674)	2.349	(0.941)	8.3	(6.0 -11.5)
Demeton									
Bobwhite	14	6	8	596	(472- 768)	4.510	(1.289)	13.5[f]	--
Japanese quail	12	6	10	275	(228- 327)	5.168	(1.314)	5.2	(4.0 - 6.5)
Ring-necked pheasant	10	6	8	665	(572- 773)	7.238	(1.915)	10.2	(8.3 -12.5)
Mallard	10	6	11	598	(488- 733)	2.689	(0.873)	4.3	(3.2 - 5.8)
Diazinon[g]									
Bobwhite	10	4	8	245	(178- 324)	10.771	(3.271)	6.41	(4.29 - 9.44)
Japanese quail	6	5	18	47	(40- 54)	6.962	(1.017)	1.11	(0.91 - 1.35)
Ring-necked pheasant	22	4	8	244	(177- 322)	6.796	(1.794)	6.01	(4.19 - 9.18)
Mallard	10	5	10	191	(138- 253)	3.687	(1.186)	0.94	(0.63 - 1.33)

Table 1. Dietary toxicities of 131 compounds tested in 5-day diets of young bobwhites, Japanese quail, ring-necked pheasants, or mallards (1964-73)--continued

Compound Species	Age (days)[a]	No. of conc.[b]	No. birds/ conc.	Toxicity statistics LC50[c]	(95% C.L.)	Slope[d]	(S.D.)	RTD[e]	(95% C.L.)
Dibutyl phthalate									
Mallard	10	2	10	>5000	(No mortality to 5000 ppm)				
Dichlobenil									
Japanese quail	14	3	16	>5000	(No mortality at 1250 ppm, 12% at 2500 ppm, 19% at 5000 ppm)				
Ring-necked pheasant	10	3	8	≃ 1500	--			≃ 27	--
Dichlone									
Bobwhite	14	2	10	>5000	(No mortality to 5000 ppm)				
Japanese quail	17	3	15	>5000	(No mortality to 5000 ppm)				
Ring-necked pheasant	10	3	8	>5000	(No mortality to 5000 ppm)				
Mallard	10	3	9	>5000	(No mortality to 5000 ppm)				
Dichlorobenzophenone									
Mallard	10	3	5	>5000	(No mortality to 5000 ppm)				
Dicofol									
Bobwhite	15	6	8	3010	(2635-3424)	4.306	(2.871)	67.9	(56.8 -81.0)
Japanese quail	12	6	14	1418	(1232-1628)	4.133	(1.002)	26.5	(21.7 -32.2)
Ring-necked pheasant	16	6	12	2126	(1892-2387)	7.378	(1.861)	37.1	(31.6 -43.6)
Mallard	10	5	9	1651	(1356-2029)	5.638	(1.354)	13.7	(10.5 -18.8)

Table 1. Dietary toxicities of 131 compounds tested in 5-day diets of young bobwhites, Japanese quail, ring-necked pheasants, or mallards (1964-73)--continued

Compound / Species	Age (days)[a]	No. of conc.[b]	No. birds/ conc.	Toxicity statistics: LC_{50}[c]	(95% C.L.)	Slope[d]	(S.D.)	RTD[e]	(95% C.L.)
Dieldrin[h]									
Bobwhite	14	6	10	37	(30- 46)	9.257	(2.214)	1	--
Japanese quail	14	6	10	62	(53- 71)	7.767	(1.552)	1	--
Ring-necked pheasant	10	6	10	58	(51- 67)	9.973	(2.021)	1	--
Mallard	10	5	10	169	(131- 217)	4.881	(1.378)	1	--
Mallard	5	6	10	153	(123- 196)	5.435	(1.137)	1	--
Dimethoate[g]									
Japanese quail	14	6	16	346	(303- 394)	6.782	(1.273)	5.8	(4.9 - 7.0)
Ring-necked pheasant	10	6	8	332	(293- 376)	10.075	(3.872)	7.0	(6.0 - 8.3)
Mallard	10	6	9	1011	(707-1372)	2.017	(0.931)	10.0	(6.5 -17.2)
Dinoseb									
Japanese quail	14	6	10	409	(356- 470)	7.018	(1.400)	7.1	(5.8 - 8.5)
Ring-necked pheasant	10	6	10	515	(473- 562)	13.446	(3.021)	9.2[f]	--
Mallard	10	3	8	≃ 540	--			≃ 3.0	--
Dioctyl phthalate									
Ring-necked pheasant	10	3	10	>5000	(No mortality to 5000 ppm)				
Mallard	10	3	12	>5000	(No mortality to 5000 ppm)				
Dioxathion									
Japanese quail	12	6	14	6640	(5105-9000)	7.195	(1.885)	124	(102 -158)
Ring-necked pheasant	10	5	9	4067	(3593-4610)	7.769	(2.502)	82.7	(69.1-99.3)
Mallard	17	4	8	≃ 3600	--			≃ 18	--

Table 1. Dietary toxicities of 131 compounds tested in 5-day diets of young bobwhites, Japanese quail, ring-necked pheasants, or mallards (1964-73)--continued

Compound Species	Age (days)[a]	No. of conc.[b]	No. birds/ conc.	Toxicity statistics LC_{50}[c]	(95% C.L.)	Slope[d]	(S.D.)	RTD[e]	(95% C.L.)
Diquat, dibromide[g]									
Bobwhite	14	4	8	2932	(1811-5256)	7.5888	(2.727)	83.9	(53.6-145)
Japanese quail	14	5	16	1346	(1178-1540)	4.755	(1.414)	22.7	(19.0- 27.1)
Ring-necked pheasant	10	6	9	3742	(3329-4220)	7.507	(2.011)	76.1	(63.9- 91.1)
Mallard	16	3	9	>5000	(No mortality to 2500 ppm, 33% at 5000 ppm)				
Disulfoton									
Bobwhite	14	4	8	715	(617- 827)	10.241	(3.310)	16.1	(13.3- 19.5)
Japanese quail	12	6	10	333	(282- 392)	5.812	(1.244)	6.2	(4.9- 7.9)
Ring-necked pheasant	10	5	9	634	(547- 737)	7.110	(1.821)	12.9	(10.6- 15.8)
Mallard	10	6	11	510	(415- 625)	4.713	(0.887)	3.6	(2.8- 4.9)
Diuron									
Bobwhite	9	5	10	1730	(1482-2035)	7.218	(1.796)	41.4	(33.8- 51.7)
Japanese quail	12	3	14	>5000	(No mortality to 1250 ppm, 14 % at 5000 ppm)				
Ring-necked pheasant	15	6	9	>5000	(No mortality to 1500 ppm, 11% at 2000 ppm, 33% at 4200 ppm)				
Mallard	10	6	10	≈ 5000	--			≈ 28.6	--
Dyfonate									
Bobwhite	14	5	6	133	(105- 195)	4.166	(2.764)	3.46	(2.60- 5.23)
Japanese quail	14	6	10	295	(259- 336)	6.841	(1.476)	6.00	(4.98- 7.25)
Ring-necked pheasant	10	6	10	270	(239- 306)	8.942	(3.105)	4.69	(4.03- 5.46)
Mallard	10	5	10	1225	(889-1773)	3.399	(1.082)	6.11	(3.96- 9.59)

Table 1. Dietary toxicities of 131 compounds tested in 5-day diets of young bobwhites, Japanese quail, ring-necked pheasants, or mallards (1964-73)--continued

Compound / Species	Age (days)[a]	No. of conc.[b]	No. birds/ conc.	Toxicity statistics: LC_{50}[c]	(95% C.L.)	Slope[d]	(S.D.)	RTD[e]	(95% C.L.)
Endosulfan									
Bobwhite	9	5	8	805	(690- 939)	4.796	(3.997)	19.9	(16.5 -24.5)
Japanese quail	14	6	13	≃ 1250	--			≃ 22	--
Ring-necked pheasant	10	6	8	1275	(1098-1482)	5.326	(1.904)	19.6	(15.9 -24.0)
Mallard	16	4	10	1053	(781-1540)	5.316	(1.507)	4.2	(3.0 - 6.3)
Endrin									
Bobwhite	17	6	10	14	(11- 24)	2.993	(1.243)	0.37[f]	--
Japanese quail	14	6	13	18	(15- 20)	9.020	(1.844)	0.30	(0.26- 0.36)
Ring-necked pheasant	22	4	8	14	(11- 17)	3.485	(1.536)	0.34	(0.24- 0.53)
Mallard	8	6	10	22	(17- 31)	3.425	(0.991)	0.10[f]	--
Mallard	5	6	10	18	(15- 21)	5.728	(1.302)	0.55	(0.44- 0.69)
EPN									
Bobwhite	10	5	10	349	(289- 411)	7.547	(2.080)	8.9	(7.1 -11.0)
Japanese quail	14	5	10	443	(349- 550)	3.246	(1.405)	≃ 7.9	--
Ring-necked pheasant	14	6	10	1075	(943-1230)	6.776	(1.510)	20.5	(17.1 -24.7)
Mallard	10	3	5	≃ 330	--			≃ 1.7	--
Mallard	5	6	10	168	(125- 237)	2.730	(0.856)	0.9	(0.6 - 1.4)
Ethion									
Japanese quail	14	3	14	>5000	(No mortality to 1000 ppm, 10% at 2236 ppm, 10% at 5000 ppm)				
Ring-necked pheasant	10	3	10	>5000	(No mortality to 1000 ppm, 30% at 5000 ppm)				
Mallard	10	3	8	>5000	(25% mortality at 2000 ppm, 44% at 5000 ppm)				

Table 1. Dietary toxicities of 131 compounds tested in 5-day diets of young bobwhites, Japanese quail, ring-necked pheasants, or mallards (1964-73)--continued

Compound / Species	Age (days)[a]	No. of conc.[b]	No. birds/ conc.	Toxicity statistics: LC_{50}[c]	(95% C.L.)	Slope[d]	(S.D.)	RTD[e]	(95% C.L.)
Famphur									
Japanese quail	14	6	10	68	(59- 78)	7.678	(1.359)	1.26	(1.03- 1.53)
Ring-necked pheasant	10	4	10	49	(40- 61)	6.994	(2.809)	0.94	(0.75- 1.19)
Mallard	10	3	8	≃ 35	--			≃ 0.22	--
Fenac									
Bobwhite	14	2	9	>5000	(No mortality to 5000 ppm)				
Japanese quail	14	3	16	>5000	(No mortality to 5000 ppm)				
Ring-necked pheasant	10	3	8	>5000	(No mortality to 5000 ppm)				
Mallard	10	3	9	>5000	(No mortality to 5000 ppm)				
Fenitrothion									
Bobwhite	14	5	10	157	(135- 183)	6.986	(1.936)	3.8	(3.1 - 4.7)
Japanese quail	14	5	10	≃ 440	--			≃ 11.6	--
Ring-necked pheasant	14	6	10	453	(388- 525)	8.131	(2.051)	8.4	(6.9 -10.1)
Mallard	10	5	10	2482	(1693-3985)	2.083	(1.166)	12.4	(8.0 -20.2)
Fenthion									
Bobwhite	10	5	8	30	(21- 41)	6.640	(3.675)	0.78	(0.51- 1.16)
Japanese quail	19	6	16	86	(68- 109)	6.361	(0.946)	1.73	(1.28- 2.37)
Ring-necked pheasant	10	4	8	202	(154- 254)	7.371	(3.071)	3.80	(2.79- 5.06)
Mallard	10	6	9	231	(108- 395)	2.080	(1.115)	2.29	(1.35- 3.66)
Fenuron									
Bobwhite	14	3	9	>5000	(No mortality to 5000 ppm)				
Japanese quail	12	3	14	>5000	(No mortality to 5000 ppm)				
Ring-necked pheasant	16	3	5	>5000	(No mortality to 5000 ppm)				
Mallard	10	3	10	>5000	(No mortality to 5000 ppm)				

Table 1. Dietary toxicities of 131 compounds tested in 5-day diets of young bobwhites, Japanese quail, ring-necked pheasants, or mallards (1964-73)--continued

Compound / Species	Age (days)[a]	No. of conc.[b]	No. birds/ conc.	Toxicity statistics: LC_{50}	(95% C.L.)	Slope[d]	(S.D.)	RTD[e]	(95% C.L.)
Gardona									
Japanese quail	14	3	10	>5000	(No mortality to 5000 ppm)				
Ring-necked pheasant	10	3	10	>5000	(No mortality to 5000 ppm)				
Mallard	10	1	10	>5000	(No mortality at 5000 ppm)				
Guthion									
Bobwhite	14	6	6	488	(394- 601)	6.441	(2.395)	14.2	(10.6 -19.4)
Japanese quail	9	6	16	639	(512- 796)	4.189	(0.932)	12.9	(9.5 -17.7)
Ring-necked pheasant	22	4	8	1821	(1355-2468)	4.466	(1.504)	44.8	(30.5 -74.0)
Mallard	10	6	9	1940	(978-4506)	1.791	(0.587)	11.4[f]	--
HCS-3260									
Japanese quail	14	6	10	642	(556- 745)	7.744	(1.409)	11.1	(9.1 -13.7)
Ring-necked pheasant	10	6	10	1086	(962-1226)	10.168	(1.889)	20.8	(17.7 -24.6)
Mallard	10	5	8	1657	(1337-2056)	3.563	(1.402)	10.5	(7.9 -14.1)
Heptachlor									
Bobwhite	23	5	7	92	(76- 113)	7.350	(2.233)	2.51	(1.99- 3.22)
Japanese quail	19	6	16	93	(74- 116)	3.722	(0.939)	1.88	(1.39- 2.58)
Ring-necked pheasant	8	4	10	224	(191- 265)	7.277	(2.876)	4.13	(3.42- 5.04)
Mallard	10	6	9	480	(389- 570)	5.264	(1.646)	2.82	(2.12- 3.71)
Hexachlorobenzene									
Ring-necked pheasant	10	6	10	617	(520- 730)	5.411	(1.236)	8.4	(6.6 -10.5)
Mallard	5	3	10	>5000	(No mortality to 707 ppm, 30% at 5000 ppm)				

Table 1. Dietary toxicities of 131 compounds tested in 5-day diets of young bobwhites, Japanese quail, ring-necked pheasants, or mallards (1964-73)--continued

Compound / Species	Age (days)[a]	No. of conc.[b]	No. birds/ conc.	Toxicity statistics: LC_{50}[c]	(95% C.L.)	Slope[d]	(S.D.)	RTD[e]	(95% C.L.)
Hinosan									
Japanese quail	14	6	10	2534	(2089-3059)	4.068	(1.135)	34.9	(26.3 -44.8)
Imidan									
Bobwhite	14	6	8	501	(340- 781)	2.422	(0.844)	14.3[f]	--
Japanese quail	14	6	10	1217	(1065-1392)	4.481	(1.439)	24.7	(20.5 -30.0)
Ring-necked pheasant	10	6	10	3146	(2624-3804)	4.688	(1.268)	62.5[f]	--
Mallard	10	3	8	>5000	(No mortality to 2235 ppm, 38% at 5000 ppm)				
Landrin									
Japanese quail	14	6	10	2003	(1760-2283)	4.201	(1.536)	34.5	(28.7 - 41.5)
Ring-necked pheasant	10	6	10	4500	(3677-5615)	4.794	(1.660)	80.7	(65.2 -102)
Mallard	10	5	8	≃ 2300	--			≃ 10.1	--
Lead arsenate									
Japanese quail	14	6	10	4185	(3215-5351)	(1.915)	(1.323)	76.1[f]	--
Ring-necked pheasant	10	5	10	4989	(4235-5927)	(5.557)	(1.616)	88.7	(72.1 -110.1)
Mallard	10	3	12	>5000	(No mortality to 5000 ppm)				
Leptophos									
Japanese quail	14	3	10	≃ 1500	--			≃ 20.0	--
Ring-necked pheasant	10	6	10	1075	(700-1746)	1.974	(0.499)	16.5[f]	--
Mallard	5	6	10	1635	(1279-2109)	4.285	(0.953)	10.3	(7.4 - 14.4)

Table 1. Dietary toxicities of 131 compounds tested in 5-day diets of young bobwhites, Japanese quail, ring-necked pheasants, or mallards (1964-73)--continued

Compound / Species	Age (days)[a]	No. of conc.[b]	No. birds/ conc.	Toxicity statistics: LC_{50}[c]	(95% C.L.)	Slope[d]	(S.D.)	RTD[e]	(95% C.L.)
Lindane									
Bobwhite	9	6	10	882	(755-1041)	2.456	(1.673)	21.1	(17.2 - 26.4)
Japanese quail	7	6	15	425	(347- 520)	3.487	(0.692)	7.1[f]	--
Ring-necked pheasant	10	5	8	561	(445- 690)	8.251	(2.752)	10.6	(7.9 - 14.1)
Mallard	15	6	12	>5000	(12% mortality to 1500 ppm, 17% at 5000 ppm)				
Linuron									
Japanese quail	14	3	10	>5000	(10% mortality to 1000 ppm, 30% at 5000 ppm)				
Ring-necked pheasant	10	6	10	3438	(2874-4139)	3.643	(1.089)	53.0	(41.2 - 67.7)
Mallard	5	6	10	3083	(2419-3990)	3.450	(1.001)	19.5	(14.1 - 27.0)
Malathion									
Bobwhite	14	6	6	3497	(2959-4117)	5.931	(2.533)	102	(78.2 -135)
Japanese quail	14	6	10	2962	(2453-3656)	5.272	(1.330)	45.3	(35.7 - 58.2)
Ring-necked pheasant	10	6	10	2639	(2220-3098)	5.122	(1.475)	52.5[f]	--
Mallard	16	3	10	>5000	(No mortality to 5000 ppm)				
MCPB									
Bobwhite	14	3	10	>5000	(No mortality at 2236 ppm, 10% at 5000 ppm)				
Japanese quail	14	3	12	>5000	(No mortality to 5000 ppm)				
Ring-necked pheasant	14	3	10	>5000	(No mortality to 5000 ppm)				
Mallard	10	1	10	>5000	(No mortality at 5000 ppm)				
Mercuric chloride[g]									
Japanese quail	14	7	10	5926	(4950-7896)	6.202	(1.884)	104.9[f]	--
Ring-necked pheasant	10	6	10	3790	(2768-5541)	2.640	(0.778)	60.0[f]	--
Mallard	10	3	8	>5000	(No mortality to 5000 ppm)				

Table 1. Dietary toxicities of 131 compounds tested in 5-day diets of young bobwhites, Japanese quail, ring-necked pheasants, or mallards (1964-73)--continued

Compound / Species	Age (days)[a]	No. of conc.[b]	No. birds/ conc.	Toxicity statistics: LC_{50}[c]	(95% C.L.)	Slope[d]	(S.D.)	RTD[e]	(95% C.L.)
Mesurol 97%									
Japanese quail	14	6	10	1427	(1176-1727)	6.103	(1.834)	25.9	(20.2 -33.4)
Ring-necked pheasant	10	6	10	>5000	(No mortality to 5000 ppm)				
Mallard	10	4	8	4113	(2817-7504)	5.117	(1.426)	≃ 18.0	--
Mallard	5	6	10	1071	(808-1405)	2.558	(0.823)	6.0	(4.0 - 8.6)
Mesurol 50%									
Japanese quail	14	6	10	1199	(988-1452)	6.141	(1.843)	21.8	(17.0 -28.1)
Ring-necked pheasant	10	6	10	3849	(3318-4488)	5.379	(1.344)	52.4	(42.0 -64.5)
Mallard	10	4	8	2082	(1482-3139)	2.206	(1.321)	≃ 9.2	--
Mallard	5	6	10	929	(680-1245)	1.530	(1.344)	5.16	(3.43- 7.46)
Methomyl									
Bobwhite	14	4	10	≃ 1100	--			≃ 28	--
Japanese quail	14	6	10	3124	(2513-3940)	2.682	(2.147)	59.5	(46.7 -77.0)
Ring-necked pheasant	10	5	10	1975	(1641-2374)	3.700	(1.483)	28.8	(22.4 -36.1)
Mallard	10	6	10	2883	(2000-4572)	1.283	(1.086)	16.7	(9.7 -31.7)
Methoxychlor									
Bobwhite	23	2	7	>5000	(No mortality to 5000 ppm)				
Japanese quail	14	3	12	>5000	(No mortality to 5000 ppm)				
Ring-necked pheasant	16	3	5	>5000	(No mortality to 5000 ppm)				
Mallard	16	3	10	>5000	(No mortality to 5000 ppm)				
Methoxyethylmercuric chloride[h]									
Japanese quail	14	6	10	≃ 1750	--			≃ 30.2	--
Ring-necked pheasant	10	4	10	1102	(957-1263)	8.480	(3.031)	19.7	(16.6 -23.4)
Mallard	10	5	8	≃ 280	--			≃ 1.8	--

Table 1. Dietary toxicities of 131 compounds tested in 5-day diets of young bobwhites, Japanese quail, ring-necked pheasants, or mallards (1964-73)--continued

Compound / Species	Age (days)[a]	No. of conc.[b]	No. birds/ conc.	Toxicity statistics: LC_{50}[c]	(95% C.L.)	Slope[d]	(S.D.)	RTD[e]	(95% C.L.)
Methyl Parathion									
Bobwhite	14	6	6	90	(73- 111)	5.240	(2.164)	2.63	(1.96 -3.57)
Japanese quail	14	6	10	79	(65- 100)	5.327	(1.410)	1.22	(0.96 -1.57)
Ring-necked pheasant	10	6	10	91	(77- 107)	6.855	(1.401)	1.43	(1.14 -1.78)
Mallard	10	5	10	682	(541- 892)	3.216	(1.227)	4.98	(3.61 -7.83)
Mallard	5	5	10	336	(269- 413)	5.330	(1.267)	2.39	(1.82 -3.10)
Methyl trithion									
Japanese quail	14	6	10	3165	(2738-3688)	5.491	(1.645)	54.6	(45.3 -66.2)
Ring-necked pheasant	10	5	10	1586	(1333-1881)	7.755	(1.390)	28.5	(22.6 -35.5)
Mallard	10	3	8	≃ 3000	--			≃ 19.0	--
Mexacarbate									
Japanese quail	7	3	14	≃ 500	--			≃ 8.9	--
Ring-necked pheasant	10	5	9	846	(724- 985)	6.558	(1.936)	17.2	(14.0 -21.0)
Mallard	10	6	11	334	(268- 412)	3.041	(0.921)	2.4	(1.8 - 3.2)
Mirex									
Bobwhite	14	6	10	2511	(2160-2908)	6.032	(1.731)	60.6	(49.3 -74.2)
Japanese quail	14	1	10	>5000	(20% mortality at 5000 ppm)				
Ring-necked pheasant	14	6	10	1540	(1320-1789)	5.801	(1.508)	29.3	(24.1 -35.7)
Mallard	10	3	8	>5000	(No mortality to 5000 ppm)				
Mocap									
Bobwhite	14	6	10	33	(27- 40)	4.956	(1.437)	1.24	(0.947-1.66)
Japanese quail	14	6	10	100	(85- 117)	5.285	(1.498)	2.03	(1.65 -2.50)
Ring-necked pheasant	10	6	10	118	(103- 134)	9.500	(1.956)	1.79	(1.50 -2.12)
Mallard	10	3	8	≃ 550	--			≃ 3.50	--
Mallard	5	6	10	287	(215- 382)	2.685	(0.676)	1.59	(1.07 -2.33)

Table 1. Dietary toxicities of 131 compounds tested in 5-day diets of young bobwhites, Japanese quail, ring-necked pheasants, or mallards (1964-73)--continued

Compound / Species	Age (days)[a]	No. of conc.[b]	No. birds/ conc.	LC_{50}[c]	(95% C.L.)	Slope[d]	(S.D.)	RTD[e]	(95% C.L.)
Monuron									
Bobwhite	17	3	6	>5000	(No mortality to 5000 ppm)				
Japanese quail	12	3	14	>5000	(No mortality at 1250 ppm, 7% at 2500 ppm, 21% at 5000 ppm)				
Ring-necked pheasant	15	5	9	4682	(3902- 5746)	8.213	(2.470)	87.7	(72.1 -109)
Mallard	10	3	10	>5000	(No mortality at 1250 ppm, 10% at 2500 ppm, 10% at 5000 ppm)				
Morsodren[g]									
Japanese quail	14	6	10	47	(40- 56)	7.745	(1.466)	0.96	(0.78- 1.19)
Ring-necked pheasant	10	5	10	64	(55- 73)	4.678	(3.080)	1.14	(0.96- 1.35)
Mallard	10	5	8	60	(47- 76)	7.547	(1.407)	0.38	(0.28- 0.52)
Mallard	5	6	10	51	(43- 60)	8.226	(1.259)	0.41	(0.33- 0.52)
Nabam									
Bobwhite	14	2	9	>5000	(No mortality at 2500 ppm, 11% at 5000 ppm)				
Japanese quail	17	3	15	>5000	(No mortality to 5000 ppm)				
Ring-necked pheasant	10	3	8	>5000	(No mortality to 5000 ppm)				
Mallard	10	3	10	>5000	(No mortality to 5000 ppm)				
Naled									
Bobwhite	10	6	8	2117	(1502- 2890)	5.169	(3.257)	55.5	(36.4 - 83.8)
Japanese quail	20	5	20	1327	(1178- 1490)	6.542	(1.059)	23.3	(19.9 - 27.3)
Ring-necked pheasant	8	5	10	2538	(2221- 2896)	4.905	(1.974)	46.8	(39.0 - 56.2)
Mallard	10	5	10	2724	(1068-15089)	0.912	(0.792)	16.0[f]	--

Table 1. Dietary toxicities of 131 compounds tested in 5-day diets of young bobwhites, Japanese quail ring-necked pheasants, or mallards (1964-73)--continued

Compound / Species	Age (days)[a]	No. of conc.[b]	No. birds/ conc.	Toxicity statistics: LC_{50}[c]	(95% C.L.)	Slope[d]	(S.D.)	RTD[e]	(95% C.L.)
Nemacur									
Japanese quail	14	6	10	59	(49- 71)	4.423	(1.223)	0.81	(0.62- 1.04)
Ortho 11775									
Bobwhite	14	5	8	1474	(1075-2108)	8.368	(1.814)	42.2	(27.2- 68.0)
Japanese quail	14	6	10	1345	(1139-1588)	7.810	(1.366)	25.6	(20.5- 32.1)
Ring-necked pheasant	10	6	10	2874	(2567-3209)	9.888	(2.273)	51.7	(44.4- 60.2)
Mallard	10	3	8	≃ 2300	--			≃ 11	--
Oxydemetonmethyl									
Bobwhite	14	5	8	434	(304- 600)	5.209	(1.714)	12.4	(7.7- 19.4)
Japanese quail	14	6	10	1309	(1097-1552)	4.163	(1.352)	25.0	(19.8- 31.3)
Ring-necked pheasant	10	6	10	1497	(1326-1690)	9.292	(2.412)	25.7	(22.0- 29.9)
Mallard	10	3	8	>5000	(No mortality at 1000 ppm, 25% at 2235 ppm, 38% at 5000 ppm)				
Paraquat, dichloride									
Bobwhite	14	6	10	981	(784-1213)	5.022	(1.283)	25.0[f]	--
Japanese quail	14	6	10	970	(823-1140)	6.059	(1.307)	18.5	(14.8- 23.1)
Ring-necked pheasant	10	6	10	1468	(1287-1673)	5.846	(1.973)	22.3	(18.7- 26.5)
Mallard	10	6	10	4048	(3432-4886)	6.765	(1.281)	23.5	(18.5- 30.7)

Table 1. Dietary toxicities of 131 compounds tested in 5-day diets of young bobwhites, Japanese quail, ring-necked pheasants, or mallards (1964-73)--continued

Compound / Species	Age (days)[a]	No. of conc.[b]	No. birds/ conc.	Toxicity statistics: LC_{50}[c]	(95% C.L.)	Slope[d]	(S.D.)	RTD[e]	(95% C.L.)
Parathion									
Bobwhite	14	5	6	194	(150- 245)	4.690	(2.636)	5.65	(4.15- 7.68)
Japanese quail	14	8	10	197	(177- 220)	6.517	(1.506)	≃ 3.02	--
Ring-necked pheasant	10	6	10	336	(296- 380)	6.595	(2.472)	6.67	(5.70- 7.81)
Mallard	10	5	10	275	(183- 373)	4.383	(1.375)	2.01	(1.40- 2.86)
Mallard	5	6	10	76	(61- 93)	3.725	(1.270)	0.54	(0.41- 0.70)
Paris Green[g]									
Bobwhite	14	6	8	480	(206-2042)	3.474	(1.920)	10.9[f]	--
Japanese quail	20	5	20	1204	(1069-1351)	4.925	(1.105)	21.1	(18.0 - 24.7)
Ring-necked pheasant	10	6	8	1043	(896-1217)	6.644	(2.043)	16.0	(13.0 - 19.7)
Mallard	10	6	10	>5000	(No mortality to 1900 ppm, 10% at 2625 ppm, 20% at 5000 ppm)				
Pentachlorophenol									
Bobwhite	10	3	10	≃ 3400	--			≃ 85.0	--
Japanese quail	14	5	16	5204	(4536-6034)	6.877	(1.790)	87.6	(73.9 -105)
Ring-necked pheasant	16	6	12	4331	(3926-4787)	8.990	(1.945)	75.5	(65.2 - 88.0)
Mallard	10	2	8	≃ 4500	--			≃ 24	--
Perthane									
Bobwhite	10	3	10	>5000	(No mortality to 2240 ppm, 10% at 5000 ppm)				
Japanese quail	20	4	20	>5000	(No mortality to 5000 ppm)				
Ring-necked pheasant	10	3	8	>5000	(No mortality to 5000 ppm)				
Mallard	16	3	10	>5000	(No mortality to 5000 ppm)				

Table 1. Dietary toxicities of 131 compounds tested in 5-day diets of young bobwhites, Japanese quail, ring-necked pheasants, or mallards (1964-73)--continued

Compound / Species	Age (days)[a]	No. of conc.[b]	No. birds/ conc.	Toxicity statistics: LC_{50}[c]	(95% C.L.)	Slope[d]	(S.D.)	RTD[e]	(95% C.L.)
Phenthoate									
Japanese quail	14	6	10	3536	(3053-4117)	7.354	(1.525)	61.0	(50.3 -74.3)
Ring-necked pheasant	10	6	10	2775	(2455-3120)	5.554	(1.843)	53.1	(45.1 -62.4)
Mallard	10	3	10	≃ 4500	--			≃ 24.7	--
Phenylmercuric acetate[g]									
Japanese quail	14	6	10	1028	(874-1208)	5.786	(1.361)	17.8	(14.4 -22.0)
Ring-necked pheasant	10	5	10	≃ 2350	--			≃ 45.2	--
Mallard	10	3	10	≃ 1175	--			≃ 7.4	--
Phorate									
Bobwhite	14	4	8	373	(326- 431)	16.173	(3.640)	8.4	(7.0 -10.2)
Japanese quail	17	3	15	≃ 200	--			≃ 3.6	--
Ring-necked pheasant	10	6	9	441	(381- 510)	7.648	(1.693)	9.0	(7.4 -10.9)
Mallard	10	6	11	248	(198- 306)	4.853	(0.924)	1.8	(1.3 - 2.4)
Phosdrin									
Japanese quail	14	5	10	286	(232- 348)	3.644	(1.906)	5.28	(4.17- 6.57)
Ring-necked pheasant	10	6	10	246	(210- 292)	5.052	(1.365)	4.42	(3.58- 5.49)
Mallard	10	5	12	1991	(1219-3240)	1.896	(0.799)	8.74[f]	--
Phosphamidon[g]									
Bobwhite	10	6	8	24	(10- 37)	3.691	(1.451)	0.63[f]	--
Japanese quail	17	6	14	89	(77- 102)	5.818	(1.057)	1.16	(0.94- 1.41)
Ring-necked pheasant	8	6	10	77	(68- 87)	6.564	(1.809)	1.42	(1.19- 1.70)
Mallard	10	6	10	712	(558- 887)	3.860	(1.154)	3.51	(2.47- 4.82)

Table 1. Dietary toxicities of 131 compounds tested in 5-day diets of young bobwhites, Japanese quail, ring-necked pheasants, or mallards (1964-73)--continued

Compound / Species	Age (days)[a]	No. of conc.[b]	No. birds/ conc.	Toxicity statistics: LC_{50}[c]	(95% C.L.)	Slope[d]	(S.D.)	RTD[e]	(95% C.L.)
Picloram									
Bobwhite	10	3	10	>5000	(No mortality to 5000 ppm)				
Japanese quail	7	3	14	>5000	(No mortality to 5000 ppm)				
Ring-necked pheasant	10	3	8	>5000	(No mortality to 5000 ppm)				
Mallard	10	3	10	>5000	(No mortality to 5000 ppm)				
Potassium dichromate[g]									
Japanese quail	14	6	10	≃ 4400	--			≃ 67.7	--
Mallard	10	3	10	>5000	(No mortality to 5000 ppm)				
Pyrethrins									
Japanese quail	14	3	10	>5000	(No mortality to 5000 ppm)				
Ring-necked pheasant	10	1	10	>5000	(No mortality at 5000 ppm)				
Mallard	10	2	10	>5000	(No mortality to 5000 ppm)				
Rotenone									
Japanese quail	14	3	10	1882	(1418-2497)	5.091	(1.589)	28.8	(20.7- 39.7)
Ring-necked pheasant	10	6	10	1608	(1365-1875)	5.421	(1.498)	25.4	(20.3- 31.2)
Mallard	10	5	10	≃ 2600	--			≃ 11.5	--
SBP-1382 90.0%									
Japanese quail	14	3	10	>5000	(No mortality to 5000 ppm)				
Mallard	10	2	8	>5000	(No mortality to 5000 ppm)				

Table 1. Dietary toxicities of 131 compounds tested in 5-day diets of young bobwhites, Japanese quail, ring-necked pheasants, or mallards (1964-73)--continued

Compound / Species	Age (days)[a]	No. of conc.[b]	No. birds/ conc.	Toxicity statistics: LC_{50}[c]	(95% C.L.)	Slope[d]	(S.D.)	RTD[e]	(95% C.L.)
SBP-1382 40%									
Japanese quail	14	3	10	>5000	(No mortality to 5000 ppm)				
Mallard	10	2	8	>5000	(No mortality to 5000 ppm)				
Silvex									
Japanese quail	12	3	14	>5000	(No mortality to 5000 ppm)				
Ring-necked pheasant	10	3	8	≃ 4500	--			≃ 96	--
Silvex, butoxyethanol ester									
Bobwhite	14	3	10	3031	(2441-3774)	10.808	(3.945)	113	(84.2 -160)
Japanese quail	14	3	16	>5000	(No mortality at 1250 ppm, 6% at 2500 ppm, 12% at 5000 ppm)				
Ring-necked pheasant	10	3	8	≃ 2100	--			≃ 44.7	--
Mallard	10	2	8	>5000	(No mortality to 5000 ppm)				
Simazine									
Bobwhite	10	3	10	>5000	(No mortality to 5000 ppm)				
Japanese quail	12	3	14	>3720	(No mortality to 3720 ppm)				
Ring-necked pheasant	10	3	8	>5000	(No mortality to 5000 ppm)				
Mallard	10	3	9	>5000	(No mortality to 5000 ppm)				
Starlicide[g]									
Japanese quail	14	6	13	23	(20- 26)	7.841	(1.792)	0.39	(0.33- 0.47)

Table 1. Dietary toxicities of 131 compounds tested in 5-day diets of young bobwhites, Japanese quail, ring-necked pheasants, or mallards (1964-73)--continued

Compound / Species	Age (days)[a]	No. of conc.[b]	No. birds/ conc.	Toxicity statistics: LC_{50}[c]	(95% C.L.)	Slope[d]	(S.D.)	RTD[e]	(95% C.L.)
2,4,5-T, butoxyethanol ester									
Bobwhite	14	6	10	≃ 3400	--			≃ 126	--
Japanese quail	12	3	15	>5000	(No mortality to 5000 ppm)				
Ring-necked pheasant	10	5	10	3950	(3106-6118)	4.939	(1.901)	67.8[f]	--
Mallard	10	3	10	>5000	(No mortality to 2500 ppm, 10% at 5000 ppm)				
TDE									
Bobwhite	23	5	7	2178	(1835-2584)	9.379	(2.497)	59.2	(47.7 -74.2)
Japanese quail	7	4	12	3165	(2534-3978)	4.613	(1.780)	56.2	(43.0 -74.0)
Ring-necked pheasant	10	6	10	445	(402- 494)	12.180	(2.117)	8.9	(7.7 -10.2)
Mallard	17	6	10	4814	(3451-7054)	3.455	(1.343)	24.7	(17.9 -36.1)
Tetradifon									
Bobwhite	10	3	10	>5000	(No mortality to 2240 ppm, 10% at 5000 ppm)				
Japanese quail	12	3	14	>5000	(No mortality to 5000 ppm)				
Ring-necked pheasant	10	3	8	>5000	(No mortality to 5000 ppm)				
Mallard	10	3	9	>5000	(No mortality to 5000 ppm)				
TFM									
Mallard	8	3	10	>5000	(No mortality to 5000 ppm)				
Thionazin									
Bobwhite	14	5	10	65	(53- 78)	3.520	(1.465)	2.42	(1.83- 3.35)
Japanese quail	14	6	10	58	(49- 68)	8.316	(1.431)	1.18	(0.96- 1.45)
Ring-necked pheasant	10	6	10	72	(63- 82)	5.148	(2.593)	1.30	(1.10- 1.54)
Mallard	10	6	10	≃ 420	--			≃ 2.44	--

Table 1. Dietary toxicities of 131 compounds tested in 5-day diets of young bobwhites, Japanese quail, ring-necked pheasants, or mallards (1964-73)--continued

Compound / Species	Age (days)[a]	No. of conc.[b]	No. birds/ conc.	Toxicity statistics: LC_{50}[c]	(95% C.L.)	Slope[d]	(S.D.)	RTD[e]	(95% C.L.)
Thiram									
Bobwhite	14	5	6	≃ 3950	--			≃ 102.9	--
Japanese quail	14	3	10	>5000	(No mortality to 5000 ppm)				
Ring-necked pheasant	10	4	10	>5000	(No mortality to 5000 ppm)				
Mallard	10	2	9	>5000	(No mortality at 1000 ppm, 22% at 5000 ppm)				
Toxaphene									
Bobwhite	17	6	6	828	(619-1102)	2.509	(1.406)	18.2[f]	(12.6 -29.1)
Japanese quail	17	6	14	686	(523-1002)	2.796	(0.782)	8.7	--
Ring-necked pheasant	15	5	9	542	(462- 638)	5.917	(1.734)	10.2[f]	(8.2 -12.5)
Mallard	5	4	8	538	(474- 614)	14.113	(3.128)	2.6	--
Trichlorfon									
Bobwhite	10	5	10	720	(591- 871)	5.604	(2.677)	18.3	(14.5 -23.3)
Japanese quail	12	6	10	1901	(1601-2255)	4.898	(1.108)	35.6	(28.0 -45.4)
Ring-necked pheasant	10	6	10	3401	(2927-3957)	3.826	(1.344)	61.0	(49.4 -75.2)
Mallard	10	3	10	>5000	(No mortality to 1581 ppm, 30% at 5000 ppm)				
Vapam									
Bobwhite	14	2	10	>5000	(No mortality to 5000 ppm)				
Japanese quail	7	3	14	>5000	(No mortality at 1250 ppm, 7% at 2500 ppm, 14% at 5000 ppm)				
Ring-necked pheasant	10	3	8	>5000	(No mortality to 5000 ppm)				
Mallard	10	2	8	>5000	(No mortality to 5000 ppm)				
Zinc phosphide									
Mallard	10	6	10	1285	(1026-1620)	3.980	(0.944)	10.1	(7.2 -14.6)

Table 1. Footnotes.

[a]Age of birds at start of test.

[b]Number of dietary concentrations used in probit analysis.

[c]LC50: ppm compound (based on active ingredient) in ad libitum diet calculated to produce 50% mortality in 8 days (5 days of toxic diet followed by 3 of untreated diet).

[d]Slope: probit on log concentration.

[e]Relative toxicity of dieldrin (RTD) read as: "Dieldrin is x times as toxic as the given compound as tested." See test for use of RTD's to compare toxicities of any two compounds.

[f]RTD applies only at LC50 since probit slope is significantly different (P=0.05) from that of dieldrin.

[g]Propylene glycol was used as vehicle.

[h]Dieldrin toxicity statistics are mean values for all comparable dieldrin tests (sample size: bobwhite, 7; Japanese quail, 15; ring-necked pheasant, 19; 10-day-old mallard, 11; and, 5-day-old mallard, 6).

[i]Posttreatment observation was extended 3 to 6 days, depending on mortality patterns, for all organic metallics. Mallard LC50's for Ceresan M include 9 days of posttreatment observation, all other LC50's are from the standard protocol.

Table 2. Percentage frequency distribution by toxicity class for pesticidal compounds tested subacutely against Japanese quail and mallards as compared to acute rat toxicities[a].

Chemical class	Species	Toxicity class[b] I	II	III	IV	V
Organochlorine (n = 18)	Quail	11	11	33	33	11
	Mallard	6	11	28	28	28
	Rat	11	33	33	6	17
Organophosphorus (n = 35)	Quail	9	26	31	23	11
	Mallard	6	6	40	26	23
	Rat	43	31	17	6	3
Carbamate (n = 12)	Quail			25	33	42
	Mallard		8	25	33	33
	Rat	33	25	42		
Carboxylate (n = 7)	Quail					100
	Mallard					100
	Rat	14		43	29	14
Metallic (n = 9)	Quail		22	11	56	11
	Mallard		22	11	11	56
	Rat	22	56	22		
Miscellaneous[c] (n = 14)	Quail			14	7	79
	Mallard			7	21	71
	Rat		21		50	29

[a]Only compounds providing complete data for each species are included. Avian data are from Table 1; rat data are from Gaines (1960, 1969) or Melnikov (1971).

[b]Bounds of toxicity ratings: I = <41, II = 41-200, III = 201-1000, IV = 1001-5000, V = >5000. Toxicologic parameters are LC50's as ppm compound in diet of birds and LD50's as mg compound per kg body weight for rats.

[c]Miscellaneous includes nitrophenol, ketone, organonitrogen, organosulfer and urea compounds.

Table 3. Frequency distribution by toxicity class for organochlorine, organophosphorus, carbamate and metallic compounds tested subacutely against birds[a].

Chemical class	Species[b]	Toxicity class[c] I	II	III	IV	V
ORGANOCHLORINE COMPOUNDS						
Derivatives of alicyclic hydrocarbons	BW	3	1	5	1	
	JQ	2	2	5	1	1
	PH	1	2	5	3	
	ML	1	2	4	2	2
Derivatives of aromatic hydrocarbons	BW			5	6	3
	IQ	1		1	9	6
	PH			4	9	3
	ML				10	7
ORGANOPHOSPHORUS COMPOUNDS						
Derivatives of phosphoric acid	BW	1			1	
	JQ	2	2	2	1	1
	PH	1	2	2	1	1
	ML	1	1	1	3	1
Derivatives of thiophosphoric acid	BW	2	6	3		
	JQ		7	5	1	1
	PH		5	7	2	
	ML	1	2	8	1	2
Derivatives of dithiophosphoric acid	BW	1		4	1	
	JQ		1	4	5	3
	PH		1	4	5	3
	ML			3	5	4
Derivatives of phosphonic acid	BW		1	2		
	JQ			2	2	
	PH			1	3	
	ML			1	2	1

Table 3. Frequency distribution by toxicity class for organochlorine, organophosphorus, carbamate and metallic compounds tested subacutely against birds[a]--continued

Chemical class	Species[b]	Toxicity class[c] I	II	III	IV	V
CARBAMATE COMPOUNDS						
Derivatives of carbamic acid	BW			1	2	1
	JQ			3	5	3
	PH			3	6	3
	ML		1	3	6	2
Derivatives of dithiocarbamic acid	BW				1	2
	JQ				1	3
	PH					3
	ML					3
METALLIC COMPOUNDS						
Inorganic	JQ				3	1
	PH			1	2	
	ML				1	4
Organic	BW		1	1	1	
	JQ		2		4	1
	PH		2		4	
	ML		2	1	1	3

[a]Basis for frequency distribution is Table 1.

[b]Species: BW, bobwhite; JQ, Japanese quail; PH, ring-necked pheasant; and, ML, mallard.

[c]Bounds of toxicity ratings, I = <41 ppm, II = 41-200 ppm, III = 201-1000 ppm, IV = 1001-5000 ppm, and V = >5000 ppm.

Table 4. Comparative responsiveness among young Japanese quail, ring-necked pheasants and mallards to pesticidal compounds when tested subacutely[a].

Chemical class	Species	Response rating[b] Most	Least	Median LC_{50}[c]	(Extremes)
ORGANOCHLORINE					
Derivatives of alicyclic hydrocarbons					
(10)[d]	Quail	50%	0	388	(18->5000)
	Pheasant	30%	20%	495	(14- 1540)
	Mallard	20%	80%	669	(22->5000)
Derivatives of aromatic hydrocarbons					
(15/12)	Quail	17%	50%	3165	(568->5000)
	Pheasant	84%	8%	2078	(311->5000)
	Mallard	0	42%	3572	(1651->5000)
ORGANOPHOSPHOROUS					
Derivatives of phosphoric acid					
(7/6)	Quail	67%	0	286	(2->5000)
	Pheasant	33%	0	246	(3->5000)
	Mallard	0	100%	1991	(32->5000)
Derivatives of thiophosphoric acid					
(13)	Quail	69%	8%	211	(47->5000)
	Pheasant	15%	23%	240	(49->5000)
	Mallard	15%	69%	640	(43->5000)
Derivatives of dithiophosphoric acid					
(12/10)	Quail	50%	15%	2067	(100->5000)
	Pheasant	40%	20%	2230	(118->5000)
	Mallard	10%	65%	3300	(248->5000)
Derivatives of phosphonic acid					
(4)	Quail	25%	0	972	(295- 1901)
	Pheasant	50%	25%	708	(270- 3401)
	Mallard	25%	75%	1430	(≈330->5000)

Table 4. Comparative responsiveness among young Japanese quail, ring-necked pheasants and mallards to pesticidal compounds when tested subacutely[a]--continued

Chemical class	Species	Response rating[b] Most	Least	Median LC_{50}[c]	(Extremes)
CARBAMATE					
Derivatives of carbamic acid					
(11/9)	Quail	56%	22%	1427	(381->5000)
	Pheasant	11%	67%	2874	(573->5000)
	Mallard	33%	11%	2300	(190->5000)

[a] Comparisons are restricted to compounds providing comparable data among the species as shown in Table 1. Mallard values used are mainly for 10-day-old birds.

[b] Percentage of times each species produced the lowest (most responsive) or highest (least responsive) LC50 for compounds within each chemical class.

[c] Derivation of median toxicities were restricted to LC50's of compounds used in construction of this table.

[d] Where two numbers are shown, the first represents total compounds used for determination of median toxicities and the second is the total compounds upon which response rating percentages are based.

Table 5. Relation between four avian species in subacute responsiveness to pesticidal compounds[a].

Species compared	Statistic[b]	Chemical class[c] OC	OP	CB	IM+OM
Bobwhite - Japanese quail	n	5	13	6	I.D.
	r	0.704	0.900**	0.491	--
Bobwhite - ring-necked pheasant	n	I.D.	11	6	I.D.
	r	--	0.561	0.675**	--
Bobwhite - mallard	n	6	13	6	I.D.
	r	0.759	0.543	0.958**	--
Japanese quail - ring-necked pheasant	n	12	30	11	7
	r	0.679*	0.941**	0.486	0.836*
Japanese quail - mallard	n	14	28	11	11
	r	0.918**	0.853**	0.633*	0.774**
Ring-necked pheasant - mallard	n	12	28	13	9
	r	0.897**	0.902**	0.902**	0.622

[a]Correlation coefficients are for paired LC50's from standardized data in Table 1. Standardized data includes only results for tests of 12-18-day-old quail and 8-12-day-old pheasants and mallards.

[b]n, number of paired LC50's; r, correlation coefficient; I.D., insufficient data.

[c]OC, organochlorine; OP, organophosphorus; CB, carbamate; IM, inorganic metallic; OM, organometallic.

*Correlation coefficient statistically significant (P<0.05).

**Correlation coefficient highly significant (P<0.01).

APPENDIX

Appendix 1

Toxicity Statistics

The principal statistical reference point is the LC50, as determined by computorized probit analysis. The LC50, as used under our procedure, is ppm toxicant (based on active ingredient) in an ad libitum diet producing 50% mortality in 8 days (5 days of toxic diet followed by 3 days of untreated diet).

The probit analysis program calculates the following maximum likelihood statistics: LC50 and its 95% confidence limits; slope of the weighted linear regression of probits on log-concentration and its standard deviation; and relative toxicity, with 95% confidence limits, of any two compounds after testing regression lines for parallelism and heterogeneity. The program permits simultaneous analysis of all compounds tested in any single experiment.

Comparison of toxicities between compounds is by determination of their relative toxicity or "toxicity ratio." The toxicity ratio may be expressed unconditionally as the ratio between LC50's of two compounds provided the level of tolerance of test populations is the same and probit regression lines are parallel. The level of tolerance can be assumed comparable only if both test populations are drawn from the same population and are tested concurrently in a completely randomized experiment. Because this condition is obviously restrictive, adjustment for tolerance differences between experiments is possible with the positive control, according to the procedure presented in Appendix 2. Parallelism is assumed if slopes of regression lines are not shown to be different at a specified level of significance.

Lethal concentrations other than the LC50 may be useful. These values can be estimated from data in Table 1 by the procedure described in Appendix 2. Estimates of this type should be derived from especially designed experiments, however, because extrapolation from a standard probit regression line can be misleading if the true regression equation has some curvature (Finney 1952).

Appendix 2

Calculation of Some Significant Toxicity Values

Toxicity ratios: The RTD values listed in Table 2 are used to calculate the toxicity ratio of two compounds for a particular species as follows:

1. Compute the toxicity ratio of "Compound 1" to "Compound 2" by dividing the RTD of Compound 2 by the RTD of Compound 1. For example, if dieldrin is 4 times as toxic as Compound 1 (RTD_1 = 4) and 6 times as toxic as Compound 2 (RTD_2 = 6), then Compound 1 is 1.5 times as toxic as Compound 2 (i.e., $RTD_2/RTD_1 = 6/4 = 1.5$). An algebraic argument for the procedure was previously presented (Heath et al. 1972). The calculation of confidence limits for potency ratios require more data than could reasonably be included in this paper.

2. Test the slopes of the probit regression lines of the two chemicals for parallelism using a 2-tailed t-test. Let b_1 and b_2 be the estimated slopes and s_1 and s_2 their standard deviations. (The s values are actually in standard error form.) Also let n_1 and n_2 equal the number of concentrations used in the respective determinations.

   Then

   $$t = (b_1 - b_2) \ / \ \sqrt{s_1^2 + s_2^2}.$$

   Since s_1^2 and s_2^2 have $n_1 - 2$ and $n_2 - 2$ degrees of freedom, t is given $n_1 + n_2 - 4$ degrees of freedom, provided s_1^2 and s_2^2 can be considered estimates of a common σ^2. We expect homogeniety of variances in most instances; however, procedures for testing the equality of two variances and the significance of the difference of two means (i.e., b_1 and b_2) when variances are unequal are presented in Snedecor and Cochran (1967).

LC's for the percentage of response:

Lethal concentrations for percentages of mortality other than the median can be estimated from the data in Table 2 as follows:

1. Transform the LC50 to its common logarithm and the desired percentage of mortality to its probit, the probit of 50% being 5. If we let k equal the new percentage of mortality for which we wish to estimate the lethal dietary concentration (i.e., the LC_k), and b equal the particular slope value from Table 2, then

   $$\log LC_k = \log LC50 + (\text{probit } k - 5) / b.$$

The antilog of LC_k is the desired estimate. Tables for transforming percentages to probits can be found in various statistical texts, including Finney (1952, 1964).

Appendix 3. Compounds tested in 5-day diets of young bobwhites, Japanese quail, ring-necked pheasants, and mallards (1964-73)[a].

Common or trade name	Chemical name	Purity[b] (%)	Class[c]	Principal uses[d]
Abate	0,0,0',0'-tetramethyl 0,0'-thiodi-p-phenylene phosphorothioate	86.8	OP-TR	I
Accothion	(see fenitrothion)			
Acetone	acetone	Tech	KT	IN
Agallol	(see methoxyethylmercury chloride)			
Aldicarb	2-methyl-2-(methylthio)propionaldehyde, 0-(methylcarbamoyl)oxime	99.0	CB-CA	A,I,N
Aldrin	hexachlorohexahydro-endo, exo-dimethano-naphthalene 95% and related compounds 5%	Tech	OC-AL	I
Aminocarb	4-(dimethylamino)-m-tolyl methylcarbamate	Tech	CB-CA	I,M
Amitrole	3-amino-s-triazole	90.0	ON	H
Aramite	2-(p-tert-butylphenoxy)-1-methylethyl 2-chloroethyl sulfite	92.0	OS	A
Aroclor 1221	polychlorinated biphenyls (21% chlorine)	Tech	OC-AR	IN
Aroclor 1232	polychlorinated biphenyls (32% chlorine)	Tech	OC-AR	IN
Aroclor 1242	polychlorinated biphenyls (42% chlorine)	Tech	OC-AR	IN
Aroclor 1248	polychlorinated biphenyls (48% chlorine)	Tech	OC-AR	IN

Appendix 3. Compounds tested in 5-day diets of young bobwhites, Japanese quail, ring-necked pheasants, and mallards (1964-73)[a]--continued

Common or trade name	Chemical name	Purity[b] (%)	Class[c]	Principal uses[d]
Aroclor 1254	polychlorinated biphenyls (54% chlorine)	Tech	OC-AR	IN
Aroclor 1260	polychlorinated biphenyls (60% chlorine)	Tech	OC-AR	IN
Aroclor 1262	polychlorinated biphenyls (62% chlorine)	Tech	OC-AR	IN
Aroclor 5442	polychlorinated triphenyls (42% chlorine)	Tech	OC-AR	IN
Aspon	0,0,0,0-tetrapropyl dithiopyrophosphate	95.0	OP-DR	A,I
Atrazine	2-chloro-4-(ethylamino)-6-(isopropylamino)-s-triazine	99.0	ON	H
Azodrin	dimethyl phosphate of 3-hydroxy-N-methyl-cis-crotonamide	8.2	OP-PR	A,I
Baygon	o-isopropoxyphenyl methylcarbamate	95.0	CB-CA	I
Baytex	(see fenthion)			
Bidrin	dimethyl phosphate ester with 3-hydroxy-N,N-dimethyl-cis-crotonamide	85.0	OP-PR	I
Biothion	(see abate)			
Bux	mixture of m-(1-ethylpropyl)phenyl methylcarbamate and m-(1-methylbutyl)phenyl methylcarbamate	Tech	CB-CA	I

Appendix 3. Compounds tested in 5-day diets of young bobwhites, Japanese quail, ring-necked pheasants, and mallards (1964-73)[a]--continued

Common or trade name	Chemical name	Purity[b] (%)	Class[c]	Principal uses[d]
Cadmium chloride	cadmium chloride	Tech	IM	F
Cadmium succinate	cadmium succinate	60.0(29.0% Cd)	OM	F
Captan	N-[(trichloromethyl)thio]-4-cyclohexene-1, 2-dicarboximide	95.0	OS	F
Carbaryl	1-naphthyl methylcarbamate	99.8	CB-CA	I
Carbofuran	2,3-dihydro-2,2-dimethyl-7-benzofuranyl methylcarbamate	99.0	CB-CA	I,N
Ceresan M	N-(ethylmercury)-p-toluenesulfonanilide	7.7(3.2% Hg)	OM	F
CHE 1843 (experimental)	trans-1,2-bis(propylsulfonyl)ethene	95.0	OS	F
Chlordane (see HCS 3260)	60% octachloro-4,7-methanotetrahydroindane and 40% related compounds	72.0	OC-AL	I
Chlordimeform	N'-(4-chloro-o-tolyl)-N,N-dimethylformamidine	96.9	FO	A,I
Chlormethylfos	O,O-dimethyl O-(3,5,6-trichloro-2-pyridyl) phosphorothioate	95.6	OP-TR	I
Chlorphenamidine	(see chlordimeform)			

Appendix 3. Compounds tested in 5-day diets of young bobwhites, Japanese quail, ring-necked pheasants, and mallards (1964-73)[a]-- continued

Common or trade name	Chemical name	Purity[b] (%)	Class[c]	Principal uses[d]
Chlorpyrifos	0,0-diethyl 0-(3,5,6-trichloro-2-pyridyl) phosphorothioate	97.0	OP-TR	I
Chromium acetylacetonate	chromium acetylacetonate	Tech(14.9% Cr)	OM	F
Cidial	(see phenthoate)			
Co-Ral	0,0-diethyl 0-(3-chloro-4-methyl-2-oxo-2H-1 benzopyran-7-yl) phosphorothioate	95.0	OP-TR	I,P,R
Corrosive sublimate	(see mercuric chloride)			
Cygon	(see dimethoate)			
2,4-D, acetamide	(2-4-dichlorophenoxyacetic acid, acetamide	75.0	CX-AX	H
2,4-D, butoxy-ethanol ester	2,4-dichlorophenoxyacetic acid, butoxyethanol ester	69.3	CX-AX	H
2,4-D, dimethyl amine salt	2,4-dichlorophenoxyacetic acid, dimethylamine salt	49.4	CX-AX	H
Dalapon, sodium salt	2,2-dichloropropionic acid, sodium salt	74.0	CX-MC	H
Dasanit	0,0-diethyl 0-[p-(methylsulfinyl)phenyl phosphorothioate	94.0	OP-TR	I,N

Appendix 3. Compounds tested in 5-day diets of young bobwhites, Japanese quail, ring-necked pheasants, and mallards (1964-73)[a]--continued

Common or trade name	Chemical name	Purity[b] (%)	Class[c]	Principal uses[d]
2,4-DB	4-(2,4-dichlorophenoxy)butyric acid	Tech	CX-AX	H
DDD	(see TDE)			
DDE	1,1-dichloro-2,2-bis-(p-chlorophenyl)ethylene	99.9	OC-AR	DP(DDT)
DDT	dichloro diphenyl trichloroethane	100.0	OC-AR	I
DDVP	2,2-dichlorovinyl dimethyl phosphate and related compounds	94.8	OP-PR	I
Delnav	(see dioxathion)			
Demeton	0,0-diethyl 0-[2-(ethylthio)ethyl] phosphorothioate and 0,0-diethyl S-[2-(ethylthio)ethyl] phosphorothioate	96.0	OP-TR	A,I
Diazinon	0,0-diethyl 0-(2-isopropyl-6-methyl-4-pyrimidinyl) phosphorothioate	92.1	OP-TR	I
Dibrom	(see naled)			
Dibutyl phthalate	dibutyl phthalate	Tech	CX-AR	IR
Dichlobenil	2,6-dichlorobenzonitrile	96.4	CX-MC	H
Dichlone	2,3-dichloro-1,4-naphthoquinone	95.0	KT	F,H
Dichlorobenzophenone	4,4'-dichlorobenzophenone	Tech	OC-AR	DP(DDT)

Appendix 3. Compounds tested in 5-day diets of young bobwhites, Japanese quail, ring-necked pheasants, and mallards (1964-73)[a]--continued

Common or trade name	Chemical name	Purity[b] (%)	Class[c]	Principal uses[d]
Dichlorovos	(see DDVP)			
Dicofol	1,1-bis(chlorophenyl)-2,2,2-trichloroethanol	Tech	OC-AR	A
Dicrotophos	(see bidrin)			
Dieldrin	hexachloroepoxyoctahydro-endo-exo-dimethanonaphthalene 89% and related compounds 15%	100.0	OC-AL	I
Dimecron	(see phosphamidon)			
Dimethoate	0,0-dimethyl S-[(methylcarbamoyl)methyl] phosphorodithioate	99.0	OP-DR	A,I
Dinoseb	2-sec-butyl-4,6-dinitrophenol	Tech	PH	H,I
Dioctyl phthalate	bis(2-ethylhexyl)phthalate	Tech	CX-AR	A
Dioxathion	2,3-p-dioxanedithiol S,S-bis,(0,0-diethyl-phosphorodithioate) and related compounds 30%	Tech	OP-DR	A,I
Dipterex	(see trichlorfon)			
Diquat, dibromide	6,7-dihydrodipyrido[1,2-a:2',1'-c] pyrazinediium dibromide	37.0	ON	H
Disulfoton	0,0-diethyl S-[2-(ethylthio)ethyl] phosphorodithioate	Tech	OP-DR	A,I
Diuron	3-(3,4-dichlorophenyl)-1,1-dimethylurea	Tech	SU	H

Appendix 3. Compounds tested in 5-day diets of young bobwhites, Japanese quail, ring-necked pheasants, and mallards (1964-73)[a]--continued

Common or trade name	Chemical name	Purity[b] (%)	Class[c]	Principal uses[d]
DNBP	(see dinoseb)			
DOP	(see dioctyl phthalate)			
DRC 1339	(see starlicide)			
Dursban	(see chlorpyrifos)			
Dyfonate	0-ethyl S-phenyl ethylphosphonodithioate	93.0	OP-PN	I
Endosulfan	hexachlorohexahydromethano-2,4,3-benzodioxathiepin-3-oxide	96.0	OC-AL	I
Endrin	hexachloroepoxyoctahydro-endo, exo-dimethanonaphthalene	Tech	OC-AL	A,I
EPN	0-ethyl 0-(p-nitrophenyl) phenylphosphonothioate	Tech	OP-PN	A,I
Ethion	0,0,0',0'-tetraethyl S,S'-methylene biphosphorodithioate	95.0	OP-DR	A,I
Famphur	0,0-dimethyl 0-[p-(dimethylsulfamoyl)phenyl] phosphorothioate	Tech	OP-TR	I
Fenac	2,3,6-trichlorophenylacetic acid	100.0	CX-AR	H
Fenitrothion	0,0-dimethyl 0-(4-nitro-m-tolyl) phosphorothioate	Tech	OP-TR	A,I
Fensulfothion	(see dasanit)			

Appendix 3. Compounds tested in 5-day diets of young bobwhites, Japanese quail, ring-necked pheasants, and mallards (1964-73)[a]--continued

Common or trade name	Chemical name	Purity[b] (%)	Class[c]	Principal uses[d]
Fenthion	0,0-dimethyl 0-[4-(methylthio)-m-tolyl] phosphorothioate	Tech	OP-TR	A,BC,I
Fenuron	3-phenyl-1,1-dimethylurea	Tech	SU	H
Furadan	(see carbofuran)			
Gardona	2-chloro-1-(2,4,5-trichlorophenyl)vinyl dimethyl phosphate	96.0	OP-PR	A,I
Guthion	0,0-dimethyl S-[(4-oxo-1,2,3-benzotriazin-3(4H)-yl)methyl] phosphorodithioate	92.0	OP-DR	I
HCB	(see hexachlorobenzene)			
HCS 3260 (experimental chlordane)	alpha and gamma isomers of octachloro-4,7 methanotetrahydroindane	95.0	OC-AL	I
Heptachlor	heptachlorotetrahydro-4,7-methanoindene 71.9% and related compounds	Tech	OC-AL	I
Hexachloro-benzene	hexachlorobenzene	95.0	OC-AR	F
Hinosan	0-ethyl S,S-diphenyl phosphorodithioate	83.0	OP-DR	F,I
Imidan	N-(metcaptomethyl)phthalimide S-(0,0-dimethyl phosphorodithioate)	98.5	OP-DR	A,I
Kelthane	(see dicofol)			

Appendix 3. Compounds tested in 5-day diets of young bobwhites, Japanese quail, ring-necked pheasants, and mallards (1964-73)[a]--continued

Common or trade name	Chemical name	Purity[b] (%)	Class[c]	Principal uses[d]
Landrin	3,4,5-trimethylphenyl methylcarbamate and 2,3,5-trimethylphenyl methylcarbamate	94.4	CB-CA	I
Lannate	(see methomyl)			
Lead arsenate, standard	lead arsenate	70.5	AS	F,I
Leptophos	0-(4-bromo-2,5-dichlorophenyl) 0-methyl phenylphosphonothioate	87.0	OP-PN	F,I
Lindane	gamma isomer of benzene hexachloride	Tech	OC-AL	I
Linuron	3-(3,4-dichlorophenyl)-1-methoxy-1-methylurea	50.0	SU	H
Lorox	(see linuron)			
Malathion	0,0-dimethyl dithiophosphate of diethyl mercaptosuccinate	95.0	OP-DR	I
Marlate	(see methoxychlor)			
Matacil	(see aminocarb)			
MCPB	4-(2-methyl-4-chlorophenoxy)butyric acid	Tech	CX-AX	H
Mercaptothion	(see malathion)			
Mercuric chloride	mercuric chloride	Tech(73.9% Hg)	IM	F
Mesurol	4-(methylthio)-3,5-xylyl methylcarbamate	97.0 and 50.0	CB-CA	A,I,M

Appendix 3. Compounds tested in 5-day diets of young bobwhites, Japanese quail, ring-necked pheasants, and mallards (1964-73)[a]--continued

Common or trade name	Chemical name	Purity[b] (%)	Class[c]	Principal uses[d]
Metasystox R	(see oxydemetonmethyl)			
Metham	(see vapam)			
Methiocarb	(see mesurol)			
Methomyl	S-methyl N-[(methylcarbamoyl)oxy] thioacetimidate	Tech	CB-CA	I,N
Methoxyclor	2,2-bis(p-methoxyphenyl)-1,1,1-trichloroethane 89% and related compounds 12%	Tech	OC-AR	I
Methoxyethyl mercury chloride	methoxyethyl mercury chloride	Tech(68.0% Hg)	OM	F
Methyl parathion	0,0-dimethyl 0-p-nitrophenyl phosphorothioate	80.0	OP-TR	I
Methyl trithion	S-[[(p-chlorophenyl)thio]methyl] 0,0-dimethyl phosphorodiethioate	85.0	OP-DR	A,I
Mexacarbate	4-(dimethylamino)-3,5-xylyl methylcarbamate	93.3	CB-CA	A,I
Mevinphos	(see phosdrin)			
Mirex	dodecachlorooctahydro-1,3,4-metheno-1H-cyclobuta[cd]pentalene	98.0	OC-AL	I
Mocap	0-ethyl S,S-dipropyl phosphorodithioate	95.8	OP-DR	I,N
Monocrotophos	(see azodrin)			

Appendix 3. Compounds tested in 5-day diets of young bobwhites, Japanese quail, ring-necked pheasants, and mallards (1964-73)[a]--continued

Common or trade name	Chemical name	Purity[b] (%)	Class[c]	Principal uses[d]
Monuron	3-(p-chlorophenyl)-1,1-dimethylurea	Tech	SU	H
Morsodren	cyano(methylmercuri)guanidine	2.2(1.51% Hg)	OM	F
Nabam	Disodium ethylene bisdithiocarbamate	93.0	CB-DA	F,H,N
Naled	1,2-dibromo-2,2-dichloroethyl dimethyl phosphate	Tech	OP-PR	A,I
Neguvon	(see trichlorfon)			
Nemacur	ethyl 4-(methylthio)-m-tolyl isopropylphosphoramidate	81.0	OP-PR	N
Ortho 11775	3-(2-butyl)phenyl-N-methyl-N-(phenylsulfenyl)carbamate	Tech	CB-CA	I
Oxydemetonmethyl	S-[2-ethylsulfinyl)ethyl]0,0-dimethyl phosphorothioate	50.0	OP-TR	A,I
Panogen	(see morsodren)			
Paraquat CL	(see paraquat dichloride)			
Paraquat dichloride	1,1'-dimethyl-4,4'-bipyridinium dichloride	29.1	ON	H
Parathion	0,0-diethyl 0-p-nitrophenyl phosphorothioate	99.5	OP-TR	A,I
Paris green	copper acetoarsenite	97.4	AS	I
PCB	(see aroclor, number)			
Pentachlorophenol	pentachlorophenol, related compounds	40.0	OC-AR	F,H,I,M,WP

Appendix 3. Compounds tested in 5-day diets of young bobwhites, Japanese quail, ring-necked pheasants, and mallards (1964-73)[a]--continued

Common or trade name	Chemical name	Purity[b] (%)	Class[c]	Principal uses[d]
Perthane	diethyl diphenyl dichloroethane 95.0% and related compounds	Tech	OC-AR	I
Phenthoate	S-[alpha-(ethoxycarbonyl)benzyl] 0,0-dimethyl phosphorodithioate	91.0	OP-DR	A,I
Phenylmercuric acetate	phenylmercuric acetate	Tech(59.5% Hg)	OM	F,H
Phorate	0,0-diethyl S-[(ethylthio)methyl] phosphorodithioate	90.0	OP-DR	A,I
Phosdrin	2-carbomethoxy-1-methylvinyl dimethyl phosphate, alpha isomer and related compounds	Tech	OP-PR	A,I
Phosphamidon	2-chloro-N,N-diethyl-3-hydroxycrotonamide, ester with dimethyl phosphate	78.0	OP-PR	A,I
Phosvel	(see leptophos)			
Phygon	(see dichlone)			
Picloram	4-amino-3,5,6-trichloropicolinic acid	90.5	CX-MC	H
PMA	(see phenylmercuric acetate)			
Potassium dichromate	potassium dichromate	>99.9(35.4% Cr)	IM	F
Prolate	(see imidan)			
Prophos	(see mocap)			
Pyrethrins	pyrethrins	20.0	CX-MC	I

Appendix 3. Compounds tested in 5-day diets of young bobwhites, Japanese quail, ring-necked pheasants, and mallards (1964-73)[a]--continued

Common or trade name	Chemical name	Purity[b] (%)	Class[c]	Principal uses[d]
Resmethrin	(see SBP-1382)			
Rothane	(see TDE)			
Rotenone	1,2,12,12a-tetrahydro-2-isopropenyl-8,9-dimethoxy[1]benzopyrano[3,4-b]-furo [2,3-h][1]benzopyran-6(6aH)-one, and other cube resins	34.5	KT	I
SBP-1382	(5-benzyl-3-furyl)methyl 2,2-dimethyl-3-(2-methylpropenyl) cyclopropanecarboxylate	96.0 and 45.4	CX-MC	I
SD 8447	(see gardona)			
Sevin	(see carbaryl)			
Silvex	2-(2,4,5-trichlorophenoxy)propionic acid	100.0	CX-AX	H
Silvex, butoxy-ethanol ester	2-(2,4,5-trichlorophenoxy) propionic acid, butoxyethanol ester	Tech	CX-AX	H
Simazine	2-chloro-4,6-bix(ethylamino)-s-triazine	99.1	ON	H
Starlicide	3-chloro-p-toluidine hydrochloride	89.0	OC-AR	BC
Strobane	terpene polychlorinates, 65 or 66% chlorine	Tech	OC-AL	A,F,I
Sumithion	(see fenitrothion)			
Systox	(see demeton)			
2,4,5-T, butoxy-ethanol ester	3,4,5-trichlorophenoxyacetic acid, butoxyethanol ester	Tech	CX-AX	H
TDE	dichloro diphenyl dichloroethane	Tech	OC-AR	I

Appendix 3. Compounds tested in 5-day diets of young bobwhites, Japanese quail, ring-necked pheasants, and mallards (1964-73)[a]--continued

Common or trade name	Chemical name	Purity[b] (%)	Class[c]	Principal uses[d]
Tedion	(see tetradifon)			
Temik	(see aldicarb)			
Terpene polychlorinates	(see strobane)			
Tetradifon	p-chlorophenyl 2,4,5-trichlorophenyl sulfone	97.9	OS	A,I
TFM	alpha, alpha, alpha-trifluoro-4-nitro-meta-cresol	Tech	PH	L
Thimet	(see phorate)			
Thiodan	(see endosulfan)			
Thionazin	0,0-diethyl 0-2-pyrazinyl phosphorothioate	Tech	OP-TR	A,F,I,N
Thiram	tetramethylthiuram disulfide	95.0	CB-DA	AR,F
Tordon	(see picloram)			
Toxaphene	chlorinated camphene, 67-69% chlorine	100.0	OC-AL	I,R
2,4,5-TP	(see silvex)			
Trichlorfon	dimethyl (2,2,2-trichloro-1 hydroxyethyl) phosphonate	98.0	OP-PN	I
Vapam	sodium methyldithiocarbamate	Tech	CB-DA	F,H,N
Vapona	(see DDVP)			

Appendix 3. Compounds tested in 5-day diets of young bobwhites, Japanese quail, ring-necked pheasants, and mallards (1964-73)[a]--continued

Common or trade name	Chemical name	Purity[b] (%)	Class[c]	Principal uses[d]
Zectrar	(see mexacarbate)			
Zinc phosphide	zinc phosphide	Tech	IM	R
Zinophos	(see thionazin)			

[a]Nomenclature is after Caswell et al. (1972).

[b]Based upon supplier's statement. "Technical" assumes purity to be $\geq$95% (actual value unknown).

[c]AS, arsenic; CB, carbamate (-CA=carbamic acid, -DA=dithiocarbamic acid); CS, carboxylate (-AR=aromatic, -AX=aryloxyl-carboxylic, -MC=miscellaneous); FO, formamidine; IM, inorganic metallic; KT, ketone; OC, organochlorine (-AL=alicyclic, -AR=aromatic); OM, organometallic; ON, organonitrogen; OP, organophosphorus (-PR, phosphoric acid, -TR=thiophosphoric acid, -DR=dithiophosphoric acid, -PN-phosphonic acid); OS, organosulfer; PH, phenolic; SU, synthetic urea.

[d]A, acaricide; AR, animal repellent; BC, bird control; DP, degradation product (parent compound parenthesized); F, fungicide; H, herbicide; I, insecticide; IN, industrial; IR, insect repellent; L, lampricide; M, molluscide; N, nematocide; P, parasiticide; R, rodenticide; WP, wood preservative.

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