NATIONAL INSTITUTE OF PUBLIC HEALTH AND ENVIRONMENTAL PROTECTION
BILTHOVEN, THE NETHERLANDS

Annex to Report no. 679101 012

TOWARDS INTEGRATED ENVIRONMENTAL QUALITY OBJECTIVES FOR SEVERAL COMPOUNDS WITH A POTENTIAL FOR SECONDARY POISONING: UNDERLYING DATA

E.J. van de Plassche[1], J.H. Canton[1], Y.A. Eijs[2], J.W. Everts[3], P.J.C.M. Janssen[1], J.E.M. v. Koten-Vermeulen[1], M.D. Polder[1], R. Posthumus[1], J.M. de Stoppelaar[1]

June 1994

1 National Institute of Public Health and Environmental Protection
2 AIDEnvironment
3 Ministry of Transport, Public Works and Water Management, Tidal Waters Division

This research was carried out on behalf of the Directorate-General for Environmental Protection, Directorate for Chemicals, External Safety, and Radiation Protection, in the frame of the project 'Integrated environmental quality objectives for water, soil and air' (Quality objectives and risks, project no. 679101).

CONTENTS

Appendix 1. Toxicity data for freshwater organisms

In this appendix toxicity data for freshwater organisms are presented in three different tables:
- table 1.1: acute data: L(E)C50 values,
- table 1.2: chronic data: NOEC values,
- table 1.3: data from deviating tests.

Legenda:

A	+ test substance analysed in test solution - test substance not analysed in solution or : no data
test type	S: static; R: renewal; F: continuous flow;
test water	am = artificial medium; DSW = dutch standard water; dtw = dechlorinated tap water; nw = natural water; rw = reconstituted water; rdw = reconstituted deionized sterile-filtered water; sw = standard water; tap = tap water
exposure time	h: hour(s); d: day(s); w: week(s); m: months; min: minute(s)
> and ≥	value indicated is highest concentration used in the test.
< and ≤	value indicated is lowest concentration used in the test.
α	given value based on measured concentrations

Content:

Table 1.1.1 Acute toxicity of aldrin to freshwater organisms: L(E)C50-values

Organism	A	Test type	Purity compound	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Crite-rion	Result µg/l	Reference
crustaceans										
Asellus brevicaudus, mature	-	S	tech	rdw	7.1	31	96 h	LC50[a]	8.0	Sanders, 1972
Cypridopsis vidua, mature	-	S	90%	-	7.4	40	48 h	EC50[b]	18	Mayer & Ellersieck, 1986
Daphnia magna	-	-	-	-	-	-	48 h	LC50	28	Verschueren, 1983
Daphnia magna, 2-26 h	-	S	-	-	-	-	26 h	LC50	30	Murphy, 1978
Daphnia pulex, 1st instar	-	S	90%	rdw	7.4-7.8	44	48 h	EC50[c]	28	Sanders & Cope, 1966
Gammarus lacustris, 2 m	-	S	tech	rdw	7.1	31	96 h	LC50[d]	9.8	Sanders, 1969
Simocephalus cerrulatus, 1st instar	-	S	90%	rdw	7.4-7.8	44	48 h	EC50[c]	23	Sanders & Cope, 1966
insects										
Acroneuria pacifica, larva 2-2.5 cm	-	S	93%	nw	7.8-8.2	-	96 h	LC50	143[1]	Jensen & Gaufin, 1966
Aedes aegypti, 3-4th instar	-	S	≥99%	-	-	-	48 h	LC50[e]	3	Sutherland & Rosen, 1968
Culex pipiens, 4th instar	-	S	≥99%	-	-	-	48 h	LC50[e]	1	Sutherland & Rosen, 1968
Ephemerella grandis, larval	-	S	-	-	-	-	96 h	LC50	9.0	Murphy, 1978
Hexagenia bilineata	-	-	-	-	-	-	96 h	LC50	42	Murphy, 1978
Ischnura verticalis	-	-	-	-	-	-	96 h	LC50	18	Murphy, 1978
Pteronarcys spec.	-	-	-	-	-	-	48 h	LC50	43	Verschueren, 1983
Pteronarcys californica larva 2-5 cm	-	S	93%	nw	7.8-8.2	-	96 h	LC50	180[1]	Jensen & Gaufin, 1966
Pteronarcys californica, last instar	-	S	-	rdw	7.1	44	96 h	LC50[c]	1.3	Sanders & Cope, 1968
fish										
Carassius auratus	-	S	-	-	-	-	96 h	LC50	32	IPCS, 1989a
Cyprinus carpio	+	S	-	nw	7.2	50	96 h	LC50[f]	4 α	Rehwoldt et al., 1977
Ictalurus melas, 1.5 g	-	S	90%	-	7.1	40	96 h	LC50	19	Mayer & Ellersieck, 1986
Ictalurus punctatus, 5.2 g	-	S	90%	-	7.4	40	96 h	LC50	53[1]	Mayer & Ellersieck, 1986
Lebistes reticulatus	-	S	-	-	-	-	96 h	LC50	37	IPCS, 1989a
Lebistes reticulatus	+	S	-	nw	7.2	50	96 h	LC50[g]	20 α	Rehwoldt et al., 1977
Lepomis gibbosus	+	S	-	nw	7.2	50	96 h	LC50[f]	20 α	Rehwoldt et al., 1977
Lepomis macrochirus, 0.7 g	-	S	90%	-	7.4	40	96 h	LC50	5.6	Mayer & Ellersieck, 1986
0.8 g	-	S	90%	-	7.7	135	96 h	LC50	10.0	Mayer & Ellersieck, 1986
Lepomis macrochirus	-	-	-	-	-	-	96 h	LC50	13	EPA, 1972
Lepomis macrochirus	-	S	-	-	-	-	96 h	LC50	6.2	IPCS, 1989a
Lepomis macrochirus, 0.8 g	-	S	90%	-	7.1	40	96 h	LC50	12.0	Mayer & Ellersieck, 1986
0.7 g	-	S	90%	-	7.4	40	96 h	LC50	9.7	Mayer & Ellersieck, 1986
0.7 g	-	S	90%	-	7.4	40	96 h	LC50	7.7	Mayer & Ellersieck, 1986
0.7 g	-	S	90%	-	7.4	40	96 h	LC50	6.2	Mayer & Ellersieck, 1986
Lepomis macrochirus	-	S	-	-	-	-	96 h	LC50	15	IPCS, 1989a
Lepomis macrochirus, 0.6-1.5 g	-	S	tech	am	7.1	45	96 h	LC50[h]	4.6	Macek et al., 1969

(to be continued)

Table 1.1.1 Acute toxicity of aldrin to freshwater organisms: L(E)C50-values (continued)

Organism	A	Test type	Purity compound	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Crite-rion	Result µg/l	Reference
fish (continued)										
Micropterus salmoides, 2.5 g	-	S	90%	-	8	135	96 h	LC50	5.0	Mayer & Ellersieck, 1986
Mugil cephalus	-	S	-	-	-	-	96 h	LC50	100[1]	Verschueren, 1983
Pimephales promelas	-	-	-	-	-	-	96 h	LC50	28	EPA, 1972
Pimephales promelas, 0.6 g	-	S	90%	-	7.1	40	96 h	LC50	8.2	Mayer & Ellersieck, 1986
Pimephales promelas	-	S	-	-	-	-	96 h	LC50	32	IPCS, 1989a
Roccus americanus	+	S	-	nw	7.2	50	96 h	LC50[f]	42 α	Rehwoldt et al., 1977
Oncorhynchus mykiss	-	-	-	-	-	-	96 h	LC50	18	EPA, 1972
Oncorhynchus mykiss, 0.6 g	-	S	90%	-	7.1	40	96 h	LC50	2.6	Mayer & Ellersieck, 1986
1 g	-	S	90%	-	7.1	40	96 h	LC50	8.2	Mayer & Ellersieck, 1986
1 g	-	S	90%	-	7.7	135	96 h	LC50	9.3	Mayer & Ellersieck, 1986
0.6 g	-	S	90%	-	7.1	40	96 h	LC50	3.2	Mayer & Ellersieck, 1986
0.6 g	-	S	90%	-	7.1	40	96 h	LC50	3.4	Mayer & Ellersieck, 1986
Oncorhynchus mykiss, 0.6-1.5 g	-	S	tech	am	7.1	45	96 h	LC50[h]	2.2	Macek et al., 1969
Oncorhynchus mykiss	-	S	-	-	-	-	96 h	LC50	10	Verschueren, 1983
Oncorhynchus mykiss	-	S	-	-	-	-	96 h	LC50	36	Verschueren, 1983
Salmo kisutch	-	-	-	-	-	-	96 h	LC50	46	EPA, 1972
Salmo tshawytscha	-	-	-	-	-	-	96 h	LC50	7.5	EPA, 1972
Salmo tshawytscha, 0.8 g	-	F	90%	-	7.2	81	96 h	LC50	14	Mayer & Ellersieck, 1986
amphibia										
Bufo woodhousii fowleri, tadpole	-	S	90%	-	7.1	40	96 h	LC50	68[1]	Mayer & Ellersieck, 1986

1 above water solubility (presumed 50 µg/l)
a solvent: ethanol (≤ 1 ml/l); addition of solvent to the control is not reported
b immobility
c immobility; solvent: ethanol (unknown concentration); solvent control not reported; animals from natural population acclimatized for at least 48 h
d solvent: ethanol (≤ 1ml/l); addition of solvent to the control is not reported
e solvent: ethanol (unknown concentration); solvent control not reported
f fish from natural population, duration of acclimation not reported; testcompound obtained as a 1000 ppm solution; solvent used and solvent control not reported
g as f, but fish from local pet store
h solvent: acetone (unknown concentration); solvent control with maximum amount solvent used; mortality in control not reported

Table 1.1.2 Acute toxicity of carbofuran to freshwater organisms: L(E)C50-values

Organism	A	Test type	Purity compound	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Crite-rion	Result ug/l	Reference
insects										
Chironomus tentans, 3rd-4th instar	-	S	≥90%	tap	-	-	24 h	LC50[a]	1.6	Karnak & Collins, 1974
fish										
Ictalurus punctatus, 1 g	-	S	99%	-	7.4	44	96 h	LC50	250	Mayer & Ellersieck, 1986
Lepomis macrochirus	-	-	-	-	-	-	96 h	LC50	240	LeBlanc, 1984.
1.1 g	-	S	100%	-	7.1	40	96 h	LC50	88	Mayer & Ellersieck, 1986
Oncorhynchus kisutsch, 0.6 g	-	S	99%	-	7.5	44	96 h	LC50	530	Mayer & Ellersieck, 1986
Oncorhynchus mykiss, 1.5 g	-	S	99%	-	7.4	44	96 h	LC50	380	Mayer & Ellersieck, 1986
0.3 g	-	S	99%	-	7.5	44	96 h	LC50	600	Mayer & Ellersieck, 1986
Perca flavescens, 0.6 g	-	S	99%	-	7.5	44	96 h	LC50	240	Mayer & Ellersieck, 1986
0.6 g	-	S	99%	-	9.5	44	96 h	LC50	120	Mayer & Ellersieck, 1986
1.3 g	-	S	99%	-	7.5	42	96 h	LC50	400	Mayer & Ellersieck, 1986
Pimephales promelas, 0.5 g	-	S	99%	-	7.5	44	96 h	LC50	2000	Mayer & Ellersieck, 1986
1.3 g	-	S	99%	-	7.1	44	96 h	LC50	870	Mayer & Ellersieck, 1986
0.5 g	-	F	99%	-	7.5	314	96 h	LC50	1200	Mayer & Ellersieck, 1986
Salmo trutta, 0.5 g	-	S	99%	-	7.5	44	96 h	LC50	560	Mayer & Ellersieck, 1986
0.6 g	-	F	99%	-	7.5	314	96 h	LC50	280	Mayer & Ellersieck, 1986
Salvelinus namaycush, 0.5 g	-	F	99%	-	7.5	314	96 h	LC50	160	Mayer & Ellersieck, 1986
amphibia										
Rana hexadactyla, 2 cm	-	R	80%	-	6.0-6.4	15-35	96 h	LC50[a]	110	Khangarot et al., 1985

a solvent: acetone (unknown concentration)

Table 1.1.3 Acute toxicity of chlordane to freshwater organisms: L(E)C50-values

Organism	A	Test type	Purity compound	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Crite-rion	Result ug/l	Reference
insects										
Pteronarcys californica, naiad	-	S	tech	nw	7.1	44	96 h	LC50[a]	15	Sanders & Cope, 1968
crustaceans										
Daphnia magna	-	S	tech	nw	7.7	156	96 h	EC50[b]	28	Cardwell et al, 1977
Daphnia pulex, 1st instar	-	S	100%	rw	7.4-7.8	44	48 h	EC50[c]	29	Sanders & Cope, 1966
Gammarus lacustris, 2 m old	-	S	tech	nw	7.1	31	96 h	LC50[a]	26	Sanders, 1969
Gammarus fasciatus, mature	-	S	tech	nw	7.1	31	96 h	LC50[a]	40	Sanders, 1972
Simocephalus serrulatus, 1st instar	-	S	100%	rw	7.4-7.8	44	48 h	EC50[c]	20	Sanders & Cope, 1966
fish										
Catostomus commersoni, 0.4 g	-	F	100%	-	7.5	314	96 h	LC50	17	Mayer & Ellersieck, 1986
Ictalurus punctatus, 1.9 g	-	S	100%	-	7.1	44	96 h	LC50	6.7	LeBlanc, 1984
0.9 g	-	S	100%	-	7.4	44	96 h	LC50	0.8	Mayer & Ellersieck, 1986
Lepomis macrochirus	-	-	-	-	-	-	96 h	LC50	57	LeBlanc, 1984
0.6-1.5 g	-	S	tech	am	7.1	45	96 h	LC50[d]	77	Macek et al., 1969
	-	S	tech	nw	7.6	156	96 h	LC50	59	Cardwell et al., 1977
Micropteres salmoides	-	-	-	-	-	-	96 h	LC50	3	LeBlanc, 1984
Oncorhynchus clarki, 1 g	-	S	100%	-	7.4	272	96 h	LC50	23	Mayer & Ellersieck, 1986
Oncorhynchus kisutch, 0.6 g	-	S	100%	-	7.1	44	9h h	LC50	15	Mayer & Ellersieck, 1986
Oncorhynchus mykiss, 1-1.2 g	-	S	tech	am	7.4	40	96 h	LC50[e]	20	Mehrle et al., 1974
0.8-46 g	-	S	100%	-	7.1	44	96 h	LC50	10-135[1]	Mayer & Ellersieck, 1986
0.25 g	-	S	100%	-	7.5	42	96 h	LC50	29	Mayer & Ellersieck, 1986
Perca flavescens, 0.6 g	-	F	100%	-	7.1	44	96 h	LC50	9.6	Mayer & Ellersieck, 1986
Pimephales promelas, 0.4 g	-	S	100%	-	7.5	314	96 h	LC50	560[1]	Mayer & Ellersieck, 1986
	-	S	tech	nw	7.7	156	96 h	LC50	37	Cardwell et al., 1977
Salmo trutta, 0.6 g	-	F	100%	-	7.5	314	96 h	LC50	11	Mayer & Ellersieck, 1986
Salvelinus fontinalis	-	S	tech	nw	7.3	150	96 h	LC50	47	Cardwell et al., 1977
Tilapia nilotica, 0.6-3 g	+	F	99%	tap	7.5-8.5	230-270	96 h	LC50	480 α	Stephenson et al., 1984

1 value above the water solubility (9-100 µg/l).
a solvent: ethanol (≤ 1ml/l); solvent control not reported
b immobilization
c immobilization; solvent: acetone
d solvent: ethanol (unknown concentration)
e solvent: acetone (1 ml/l); LC50-values varied with the commercial diets fed to fish prior to testing; reported value is geometric mean of a range of 6 values

Table 1.1.4 Acute toxicity of chlorpyrifos to freshwater organisms: L(E)C50-values

Organism	A	Test type	Purity compound	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Crite-rion	Result ug/l	Reference
insecta										
Chironomus tentans, 3-4th instar	-	S	>90%	tap	7.1-7.4	-	24 h	LC50	3.7	Karnak & Collins, 1974
Pteronarcys californica, naiad	-	S	tech	nw	7.1	44	96 h	LC50[a]	10	Sanders & Cope, 1968
Pteronarcella badia, naiad	-	S	tech	nw	7.1	44	96 h	LC50[a]	0.38	Sanders & Cope, 1968
Claassenia subulosa, naiad	-	S	tech	nw	7.1	44	96 h	LC50[a]	0.57	Sanders & Cope, 1968
crustaceans										
Anostraca sp.	-	-	-	-	-	-	11 h	LC50	0.39	RIZA, 1992
Gammarus fasciatus, mature	-	S	tech	rw	7.1	31	11 h	LC50	0.32	Sanders, 1972
Gammarus lacustris, 2 m	-	S	tech	nw	7.1	31	96 h	LC50[a]	0.11	Sanders, 1969
Gammarus pseudolimnaeus	-	-	-	-	-	-	96 h	LC50	0.18	RIZA, 1992
Orconectes immunis, 1.8 g	+	F		nw	7.1-7.8	44.4	96 h	LC50[b]	6	Phipps & Holcombe, 1985
fish										
Anguilla anguilla, 20-30 g	-	F	97%	tap	7.9	250	96 h	LC50[c]	540	Ferrando et al., 1991
Carassius auratus	-	-	-	-	-	-	24 h	LC50	180	RIVM archives, 1988
Cyprinus carpio, 1.1-1.4 g	-	S	-	-	-	-	72 h	LC50	1.3	Dutt & Guha, 1988
Ictalurus punctatus	-	-	-	-	-	-	96 h	LC50	13	RIVM archives, 1988
7.9 g	+	F	-	nw	7.1-7.8	44.4	96 h	LC50[b]	810	Phipps & Holcombe, 1985
Lepomis macrochirus	-	-	-	-	-	-	96 h	LC50	3	RIVM archives, 1988
0.5 g	-	S	97%	-	7.4	272	96 h	LC50	2.5	Mayer & Ellersieck, 1986
0.8 g	+	F	-	nw	7.1-7.8	44.4	96 h	LC50[b]	10	Phipps & Holcombe, 1985
Oncorhynchus clarki, 1.4 g	-	S	97%	-	7.5	44	96 h	LC50	18	Mayer & Ellersieck, 1986
0.9 g	-	S	97%	-	9.0	44	96 h	LC50	5.4	Mayer & Ellersieck, 1986
0.9 g	-	S	97%	-	7.4	162	96 h	LC50	26	Mayer & Ellersieck, 1986
2.3 g	-	S	97%	-	7.4	162	96 h	LC50	13	Mayer & Ellersieck, 1986
Oncorhynchus mykiss	-	-	-	-	-	-	96 h	LC50[d]	3-10	RIVM archives, 1988
0.6-1.5 g	-	S	tech	am	7.1	45	96 h	LC50[c]	7.1	Macek et al., 1969
3.0 g	+	F		nw	7.1-7.8	44.4	96 h	LC50[b]	9	Phipps & Holcombe, 1985
Pimephales promelas, larvae	-	S	98.7%	nw	7.4-7.8	45.8	96 h	LC50	170	Jarvinen & Tanner, 1982
	-	S	10CR[e]	nw	7.4-7.8	45.8	96 h	LC50	130	Jarvinen & Tanner, 1982
	-	F	98.7%	nw	7.4-7.8	45.8	96 h	LC50	140	Jarvinen & Tanner, 1982
	-	F	10CR[e]	nw	7.4-7.8	45.8	96 h	LC50	120	Jarvinen & Tanner, 1982
Pimephales promelas, 0.1 g	+	F	99.9%	nw	7.0-7.4	45.3	96 h	LC50	200	Holcombe et at al., 1982
	+	S	10CR[e]	nw	7.1-8.3	46.0	96 h	EC50[f]	55	Jarvinen et al., 1988
0.5 g	+	F	-	nw	7.1-7.8	44.4	96 h	LC50[b]	540	Phipps & Holcombe, 1985
Salvelinus namaycush, 2.3 g	-	S	97%	-	7.5	44	96 h	LC50	98	Mayer & Ellersieck, 1986
2.9 g	-	S	97%	-	7.4	162	96 h	LC50	73	Mayer & Ellersieck, 1986
2.3 g	-	F	97%	-	7.4	162	96 h	LC50	240	Mayer & Ellersieck, 1986
Tilapia mossambica, 1.3-1.5 g	-	S	-	-	-	-	72 h	LC50	26	Dutt & Guha, 1988

(to be continued)

a solvent: ethanol (≤ 1 ml/l)
b solvent: DMF (unknown concentration); solvent control included
c solvent: acetone (unknown concentration); solvent control included
d LC50 for temperatures of 7.2, 12.8 and 15.6 °C.
e encapsulated slow-release formulation with similar toxicity compared to technical grade
f deformities

Table 1.1.5 Acute toxicity of DDD to freshwater organisms: L(E)C50-values

Organism	A	Test type	Purity compound	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Crite-rion	Result µg/l	Reference
crustaceans										
Daphnia magna, 2-26 h	-	S	-	-	-	-	26 h	EC50[a]	4.6	Murphy, 1978
Daphnia magna, 1st instar	-	S	99%	-	7.1	44	48 h	EC50[a]	8.9	Mayer & Ellersieck, 1986
Daphnia pulex, 1st instar	-	S	99%	-	7.1	44	48 h	EC50[a]	3.2	Mayer & Ellersieck, 1986
Simocephalus serrulatus, 1st instar	-	S	99%	-	7.1	44	48 h	LC50	4.5	Mayer & Ellersieck, 1986
insects										
Pteronarcys californica, 2nd year	-	S	99%	-	7.1	44	96 h	LC50	380	Mayer & Ellersieck, 1986
fish										
Ictalurus punctatus, 0.8 g	-	S	99%	-	7.1	44	96 h	LC50	1500	Mayer & Ellersieck, 1986
Lepomis macrochirus, 0.9 g	-	S	99%	-	7.4	44	96 h	LC50	42	Mayer & Ellersieck, 1986
Micropterus salmoides, 0.7 g	-	S	99%	-	7.1	44	96 h	LC50	42	Mayer & Ellersieck, 1986
Salmo gairdneri, 1 g	-	S	99%	-	7.1, 7.4	44, 272	96 h	LC50	70	Mayer & Ellersieck, 1986
Stizostedion vitreum, 1 g	-	S	99%	-	7.1	44	96 h	LC50	14	Mayer & Ellersieck, 1986
amphibia										
Bufo woodhousii fowleri, tadpole	-	S	99%	-	7.1	44	96 h	LC50	140	Mayer & Ellersieck, 1986
Pseudacris triseriata	-	-	-	-	-	-	96 h	LC50	400	IPCS, 1989b

a immobility

Table 1.1.6 Acute toxicity of DDE to freshwater organisms: L(E)C50-values

Organism	A	Test type	Purity compound	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Crite-rion	Result µg/l	Reference
flatworms										
Polycelis feleina	-	S	-	-	-	-	96 h	LC50	1100	Kouyoumjian & Uglow, 1974
fish										
Lepomis macrochirus, 0.9 g	-	S	99%	-	7.1	44	96 h	LC50	240	Mayer & Ellersieck, 1986
Salmo gairdneri, 0.8 g	-	S	99%	-	7.1	44	96 h	LC50	32	Mayer & Ellersieck, 1986
Salmo salar, 0.5 g	-	S	99%	-	7.5	44	96 h	LC50	96	Johnson & Finley, 1980

Table 1.1.7 Acute toxicity of DDT to freshwater organisms: L(E)C50-values

Organism	A	Test type	Purity compound	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Crite-rion	Result µg/l	Reference
crustaceans										
Asellus brevicaudus, mature	-	S	99%	-	7.1	44	96 h	LC50	4.0	Mayer & Ellersieck, 1986
Cypridopsis vidua, mature	-	S	99%	-	7.1	44	48 h	LC50	15	Mayer & Ellersieck, 1986
Daphnia magna, 1st instar	-	S	99%	-	7.1	44	48 h	EC50[a]	4.7	Mayer & Ellersieck, 1986
Daphnia magna	-	S	-	-	-	-	48 h	LC50	1.1	IPCS, 1989b
Daphnia magna	-	S	-	-	-	-	48 h	LC50	1.1	IPCS, 1989b
Daphnia magna	-	S	-	-	-	-	48 h	LC50	1.3	IPCS, 1989b
Daphnia magna, 6-24 h	-	S	99%	tap	8.4-8.5	250	48 h	LC50[b]	0.5	Berglind & Dave, 1984
Daphnia magna, 6-24 h	-	S	99%	rw	7.8-8.2	250	48 h	LC50[b]	0.68	Berglind & Dave, 1984
Daphnia magna, < 24 h	-	S	99 %	nw	-	-	48 h	EC50[a]	1.2	Stratton & Giles, 1990
Daphnia pulex	-	S	≥96%	am	-	160-180	48 h	EC50[a]	1.1	Smith et al., 1988
Daphnia pulex, 1st instar	-	S	99%	-	7.1	44	48 h	EC50[a]	0.36	Mayer & Ellersieck, 1986
Gammarus fasciatus, mature	-	F	99%	-	7.4	272	96 h	LC50	0.8	Mayer & Ellersieck, 1986
Gammarus fasciatus, mature	-	S	99%	-	7.4	272	96 h	LC50	1.8	Mayer & Ellersieck, 1986
Gammarus fasciatus, mature	-	S	99%	-	7.1	44	96 h	LC50	3.2	Mayer & Ellersieck, 1986
Gammarus lacustris, mature	-	S	99%	-	7.1	44	96 h	LC50	1.0	Mayer & Ellersieck, 1986
Gammarus lacustris	-	S	-	-	-	-	96 h	LC50	9.0	Murphy, 1978
Procamburus spec., 0.7 g	-	S	-	tap	7	soft	96 h	LC50	28	Carter & Graves, 1972
Simocephalus serrulatus, 1st instar	-	S	99%	-	7.1	44	48 h	EC50[a]	2.5	Mayer & Ellersieck, 1986
Simocephalus serrulatus, 1st instar	-	S	99%	-	7.1	44	48 h	EC50[a]	2.8	Mayer & Ellersieck, 1986
insects										
Atherix variegata, late instar	-	S	99%	-	7.1	44	96 h	LC50	17.0	Mayer & Ellersieck, 1986
Chaoborus spec., late instar	-	S	99%	-	7.1	44	96 h	LC50	7.4	Mayer & Ellersieck, 1986
Chironomus riparius	-	-	-	-	-	-	24 h	LC50	4.7	Verschueren, 1983
Claassenia sabulosa, 2nd year	-	S	99%	-	7.1	44	96 h	LC50	3.5	Mayer & Ellersieck, 1986
Ephemerella spec., late instar	-	S	99%	-	7.1	44	96 h	LC50	1.2	Mayer & Ellersieck, 1986
Isoperla spec., naiad	-	S	99%	-	7.1	44	96 h	LC50	1.2	Mayer & Ellersieck, 1986
Notonecta undulata	-	S	-	-	-	-	96 h	LC50	20	Murphy, 1978
Ophiogomphus spec., late instar	-	S	99%	-	7.1	44	96 h	LC50	32	Mayer & Ellersieck, 1986
Pentaneura spec., late instar	-	S	99%	-	7.1	44	96 h	LC50	1.5	Mayer & Ellersieck, 1986
Pteronarcella badia, 2nd year	-	S	99%	-	7.1	44	96 h	LC50	1.9	Mayer & Ellersieck, 1986
Pteronarcys californica, 2nd year	-	S	99%	-	7.1	44	96 h	LC50	7.0	Mayer & Ellersieck, 1986
Tipula spec., late instar	-	S	99%	-	7.1	44	96 h	LC50	1.6	Mayer & Ellersieck, 1986
fish										
Carassius auratus, 0.9 g	-	S	99%	-	7.1	44	96 h	LC50	15.5	Mayer & Ellersieck, 1986
Carassius auratus, 0.9 g	-	S	99%	-	7.4	272	96 h	LC50	14.7	Mayer & Ellersieck, 1986
Carassius auratus	-	-	-	-	-	-	96 h	LC50	21	Verschueren, 1983
Cyprinus carpio, 0.6 g	-	S	99%	-	7.1	44	96 h	LC50	9.7	Mayer & Ellersieck, 1986

(to be continued)

Table 1.1.7 Acute toxicity of DDT to freshwater organisms: L(E)C50-values (continued)

Organism	A	Test type	Purity compound	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Crite-rion	Result µg/l	Reference
fish (continued)										
Esox lucius, 0.7 g	-	S	99%	-	7.4	272	96 h	LC50	2.7	Mayer & Ellersieck, 1986
Gambusia affinis, 0.5 g	-	S	-	tap	7	soft	96 h	LC50	27	Carter & Graves, 1972
Ictalurus melas, 1.2 g	-	S	99%	-	7.4	272	96 h	LC50	5.1	Mayer & Ellersieck, 1986
Ictalurus melas, 1.2 g	-	S	99%	-	7.1	44	96 h	LC50	4.8	Mayer & Ellersieck, 1986
Ictaluras punctatus, 1.5 g	-	S	99%	-	7.1	44	96 h	LC50	21.5	Mayer & Ellersieck, 1986
Ictaluras punctatus, 1.5 g	-	S	99%	-	7.4	272	96 h	LC50	17.3	Mayer & Ellersieck, 1986
Ictaluras punctatus, 0.7 g	-	S	99%	-	7.1	44	96 h	LC50	6.9	Mayer & Ellersieck, 1986
Ictaluras punctatus, 1.6 g	-	S	99%	-	7.1	44	96 h	LC50	22	Mayer & Ellersieck, 1986
Ictaluras punctatus, 1.4 g	-	S	99%	-	7.1	44	96 h	LC50	16	Mayer & Ellersieck, 1986
Ictaluras punctatus, 1.4 g	-	S	99%	-	7.7	272	96 h	LC50	7.0	Mayer & Ellersieck, 1986
Ictaluras punctatus	-	-	-	-	-	-	96 h	LC50	16.0	EPA, 1972
Lepomis cyanellus, 0.8 g	-	S	99%	-	7.1	44	96 h	LC50	6.5	Mayer & Ellersieck, 1986
Lepomis cyanellus, 1.1 g	-	S	99%	-	7.1	44	96 h	LC50	10.9	Mayer & Ellersieck, 1986
Lepomis cyanellus, 1.1 g	-	S	99%	-	7.7	272	96 h	LC50	9.9	Mayer & Ellersieck, 1986
Lepomis macrochirus, 0.5 g	-	S	-	tap	7	soft	96 h	LC50	7	Carter & Graves, 1972
Lepomis machrochirus, 1.5 g	-	S	99%	-	7.1	44	96 h	LC50	8.6	Mayer & Ellersieck, 1986
Lepomis machrochirus, 1.5 g	-	S	99%	-	7.4	272	96 h	LC50	6.3	Mayer & Ellersieck, 1986
Lepomis machrochirus, 1.3 g	-	S	99%	-	7.1	44	96 h	LC50	4.3	Mayer & Ellersieck, 1986
Lepomis machrochirus, 1.3 g	-	S	99%	-	7.1	44	96 h	LC50	5.8	Mayer & Ellersieck, 1986
Lepomis machrochirus	-	-	-	-	-	-	96 h	LC50	8.0	EPA, 1972
Lepomis machrochirus	-	-	-	-	-	-	96 h	LC50	16	Verschueren, 1983
Lepomis microlophus	-	-	-	-	-	-	96 h	LC50	5.0	EPA, 1972
Lepomis microlophus, 3.2 g	-	S	99%	-	7.1	44	96 h	LC50	15.0	Mayer & Ellersieck, 1986
Micropterus salmoides, 0.8 g	-	S	99%	-	7.1, 7.4	44, 272	96 h	LC50	1.5	Mayer & Ellersieck, 1986
Micropterus salmoides	-	-	-	-	-	-	96 h	LC50	2.0	EPA, 1972
Notropsis blennius, 0.3 g	-	S	99%	-	7.1	44	96 h	LC50	5.8	Mayer & Ellersieck, 1986
Perca flavencens, 1.4 g	-	S	99%	-	7.1	44	96 h	LC50	9.0	Mayer & Ellersieck, 1986
Pimephales promelas, 1.2 g	-	S	99%	-	7.1	44	96 h	LC50	12.4	Mayer & Ellersieck, 1986
Pimephales promelas, 1.2 g	-	S	99%	-	7.4	272	96 h	LC50	13.2	Mayer & Ellersieck, 1986
Pimephales promelas	-	-	-	-	-	-	96 h	LC50	19.0	EPA, 1972
Pimephales promelas	-	S	-	-	-	-	96 h	LC50	21.0	IPCS, 1989b
Pimephales promelas	-	S	-	-	-	-	96 h	LC50	8.6	IPCS, 1989b
Pimephales promelas	-	S	-	-	-	-	96 h	LC50	6.3	IPCS, 1989b
Pomoxis nigromaculatus, 1 g	-	S	99%	-	7.1	44	96 h	LC50	5.6	Mayer & Ellersieck, 1986
Oncorhynchus clarki, 1 g	-	S	99%	-	7.1	44	96 h	LC50	5.5	Mayer & Ellersieck, 1986
Oncorhynchus clarki, 1.8 g	-	S	99%	-	7.4	162	96 h	LC50	7.9	Mayer & Ellersieck, 1986
Oncorhynchus mykiss	-	-	-	-	-	-	96 h	LC50	7.0	EPA, 1972
Oncorhynchus mykiss	-	-	-	-	-	-	96 h	LC50	9.6	Verschueren, 1983
Oncorhynchus mykiss, fry	-	-	-	-	-	-	96 h	LC50	2.4	Verschueren, 1983
Oncorhynchus mykiss	-	-	-	-	-	-	96 h	LC50	18	Verschueren, 1983

(to be continued)

Table 1.1.7 Acute toxicity of DDT to freshwater organisms: L(E)C50-values (continued)

Organism	A	Test type	Purity compound	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Crite-rion	Result µg/l	Reference
fish (continued										
Salmo clarki, 1.30 g	-	S	95%	nw	7.2-7.6	318-348	96 h	LC50[b]	1.4	Post & Schroeder, 1971
Salmo gairdneri, 0.4 g	-	S	95%	nw	7.2-7.6	318-348	96 h	LC50[b]	1.7	Post & Schroeder, 1971
Salmo gairdneri, 1 g	-	S	99%	-	7.1	44	96 h	LC50	8.7	Mayer & Ellersieck, 1986
Salmo gairdneri, 1 g	-	S	99%	-	7.4	272	96 h	LC50	7.6	Mayer & Ellersieck, 1986
Salmo gairdneri, 0.9 g	-	S	99%	-	7.1	44	96 h	LC50	4.7	Mayer & Ellersieck, 1986
Salmo gairdneri, 1.4 g	-	S	99%	-	7.1	40	96 h	LC50	11.4	Mayer & Ellersieck, 1986
Salmo kisutch, 1 g	-	S	99%	-	7.1	44	96 h	LC50	4.0	Mayer & Ellersieck, 1986
Salmo kisutch, 6 g	-	S	99%	-	7.1	40	96 h	LC50	19.3	Mayer & Ellersieck, 1986
Salmo salar, 0.45 g	-	S	99%	-	7.5	40	96 h	LC50	1.8	Mayer & Ellersieck, 1986
Salmo trutta, 1.7 g	-	S	99%	-	7.1	44	96 h	LC50	1.8	Mayer & Ellersieck, 1986
Salmo tshawytscha	-	S	-	-	-	-	96 h	LC50	11.5	IPCS, 1989b
Stizostedion vitreum, 1.4 g	-	S	99%	-	7.1	44	96 h	LC50	2.9	Mayer & Ellersieck, 1986
Stizostedion vitreum, 1.3 g	-	S	99%	-	7.4	272	96 h	LC50	4.6	Mayer & Ellersieck, 1986
Tilapia mossambica, 0.8 g	-	F	99%	-	7.4	272	96 h	LC50	5.1	Mayer & Ellersieck, 1986
Tilapia mossambica, 0.8 g	-	S	99%	-	7.4	272	96 h	LC50	14	Mayer & Ellersieck, 1986
Tilapia mossambica, 0.8 g	-	S	99%	-	7.1	44	96 h	LC50	17	Mayer & Ellersieck, 1986
Tilapia zilli	-	S	-	-	-	-	96 h	LC50	15.5	IPCS, 1989b
amphibia										
Bufo woodhousii fowleri, tadpole 7 w	-	S	99%	-	7.1	44	96 h	LC50	30	Mayer & Ellersieck, 1986

a immobility
b solvent: acetone (unknown concentration); solvent control not reported

Table 1.1.8 Acute toxicity of endrin to freshwater organisms: L(E)C50-values

Organism	A	Purity type	Purity compound	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Crite-rion	Result µg/l	Reference
crustaceans										
Asellus brevicaudus, mature	-	S	tech	rdw	7.1	31	96 h	LC50[a]	1.5	Sanders, 1972
Daphnia magna, <24 h	+	S	99.6%	nw	8-8.5	196	48 h	EC50[b]	230 α	Thurston et al., 1985
Daphnia magna, 1st instar	-	S	99%	-	7.1	44	48 h	EC50[c]	4.2	Mayer & Ellersieck, 1986
Daphnia magna, 1st instar	-	S	99%	-	7.4	48	48 h	EC50[c]	74	Mayer & Ellersieck, 1986
Daphnia magna, 1st instar	-	S	99%	-	7.4	48	48 h	EC50[c]	41	Mayer & Ellersieck, 1986
Daphnia pulex, 1st instar	-	S	90%	rdw	7.4-7.8	44	48 h	EC50[d]	20	Sanders & Cope, 1966
Cypridopsis vidua, mature	-	S	99%	-	7.1	44	48 h	EC50[c]	1.8	Mayer & Ellersieck, 1986
Gammarus fasciatus	-	S	tech	nw	7.4	272	96 h	LC50[a]	1.3	Sanders, 1972
	-	S	tech	rdw	7.1	31	96 h	LC50[a]	4.3	Sanders, 1972
	-	F	tech	nw	7.4	272	96 h	LC50[a]	5.5	Sanders, 1972
Gammarus lacustris, 2 m	-	S	tech	rdw	7.1	31	96 h	LC50[a]	3.0	Sanders, 1969
Orconectes nais, 3-5 w	-	S	tech	nw	7.4	272	96 h	LC50[a]	3.2	Sanders, 1972
Orconectes nais, 7-11 g, mature	-	S	tech	nw	7.4	272	96 h	LC50[a]	320	Sanders, 1972
Simocephalus cerrulatus, 1st instar	-	S	90%	rdw	7.4-7.8	44	48 h	EC50[d]	20	Sanders & Cope, 1966
insects										
Acroneuria pacifica, larva 2-2.5 cm	-	S	98%	nw	7.8-8.2	-	96 h	LC50	0.32	Jensen & Gaufin, 1966
Acroneuria pacifica, larva 2-2.5 cm	-	S	98%	nw	7.9-8.3	-	96 h	LC50	0.39	Jensen & Gaufin, 1964
Baetis spec., late instar	-	S	99%	-	7.1	44	96 h	LC50	0.90	Mayer & Ellersieck, 1986
Claassenia sabulosa, last instar	-	S	tech	rdw	7.1	44	96 h	LC50[d]	0.76	Sanders & Cope, 1968
Hexagenia bilineata, late instar	-	S	99%	-	7.1	44	96 h	LC50	62	Mayer & Ellersieck, 1986
Ischnura verticalis, early instar	-	S	99%	-	7.1	44	96 h	LC50	2.4	Mayer & Ellersieck, 1986
Ischnura verticalis, late instar	-	S	99%	-	7.4	272	96 h	LC50	2.1	Mayer & Ellersieck, 1986
Pteronarcella badia, last instar	-	S	tech	rdw	7.1	44	96 h	LC50[d]	0.54	Sanders & Cope, 1968
Pteronarcys californica, last instar	-	S	tech	rdw	7.1	44	96 h	LC50[d]	0.25	Sanders & Cope, 1968
Pteronarcys californica larva 2-5 cm	-	S	98%	nw	7.8-8.2	-	96 h	LC50	2.4	Jensen & Gaufin, 1966
Tanytarsus dissimilis, 3-4th instar	+	S	99.6%	nw	8.5	196	48 h	EC50[b]	0.83 α	Thurston et al., 1985
fish										
Carassius auratus, fingerling	-	F	99%	-	7.6	314	96 h	LC50	0.44	Mayer & Ellersieck, 1986
Carassius auratus, 1-4 g	+	F	99.6%	nw	8	196	96 h	LC50[e]	0.95 α	Thurston et al., 1985
Cyprinus carpio, fingerling	-	F	99%	-	7.6	314	96 h	LC50	0.32	Mayer & Ellersieck, 1986
Gambusia affinis, 0.6 g	-	S	99%	-	7.1	44	96 h	LC50	1.1	Mayer & Ellersieck, 1986
Gambusia affinis, 0.1-1 g	+	F	99.6%	nw	8.1	196	96 h	LC50[e]	0.69 α	Thurston et al., 1985
Ictalurus punctatus, 0.3-4 g	+	F	99.6%	nw	7.9-8.1	196	96 h	LC50[e]	0.42 α	Thurston et al., 1985
Ictalurus punctatus, 5.2 g	-	S	99%	-	7.1	44	96 h	LC50	1.9	Mayer & Ellersieck, 1986
Jordanella floridae, 33 d fish	+	F	96.1%	nw	7.3-7.6	41-46	96 h	LC50	0.85 α	Hermanutz, 1978
Lepomis macrochirus, 0.3-2 g	+	F	99.6%	nw	7.9-8	196	96 h	LC50[e]	0.21 α	Thurston et al., 1985
Lepomis macrochirus, 0.6-1.5 g	-	S	tech	am	7.1	45	96 h	LC50[f]	0.37	Macek et al., 1969

(to be continued)

Table 1.1.8 Acute toxicity of endrin to freshwater organisms: L(E)C50-values (continued)

Organism	A	Test type	Purity compound	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Crite-rion	Result µg/l	Reference
fish (continued)										
Lepomis macrochirus	-	-	-	-	-	-	96 h	LC50	0.6	Verschueren, 1983
Lepomis macrochirus, 1.3 g	-	S	99%	-	7.1	44	96 h	LC50	0.37	Mayer & Ellersieck, 1986
Lepomis macrochirus	-	-	-	-	-	-	96 h	LC50	6	Verschueren, 1983
Micropteris salmoides, 2.5 g	-	S	99%	-	7.4	272	96 h	LC50	0.31	Mayer & Ellersieck, 1986
Oncorhynchus kisutch, 1.5 g	-	S	95%	nw	7.2-7.6	318-348	96 h	LC50[g]	0.76	Post & Schroeder, 1971
Oncorhynchus mykiss, 0.6-8 g	+	F	99.6%	nw	7.9-8	196	96 h	LC50[e]	0.33 α	Thurston et al., 1985
Oncorhynchus mykiss, 1.24 g	-	S	95%	nw	7.2-7.6	318-348	96 h	LC50[g]	0.41	Post & Schroeder, 1971
Oncorhynchus mykiss, 0.6-1.5 g	-	S	tech	am	7.1	45	96 h	LC50[f]	1.1	Macek et al., 1969
Oncorhynchus mykiss, 1 g	-	S	99%	-	7.1	44	96 h	LC50	0.75	Mayer & Ellersieck, 1986
1 g	-	S	99%	-	7.4	272	96 h	LC50	0.74	Mayer & Ellersieck, 1986
Oncorhynchus mykiss	-	-	-	-	-	-	96 h	LC50	0.6	Verschueren, 1983
	-	-	-	-	-	-	96 h	LC50	7	Verschueren, 1983
Perca flavescens, fingerling	-	F	99%	-	7.6	314	96 h	LC50	0.15	Mayer & Ellersieck, 1986
Pimephales promelas, 0.2-1 g	+	F	99.6%	nw	8.1-8.2	196	96 h	LC50[e]	0.64 α	Thurston et al., 1985
Pimephales promelas, 1.2 g	-	S	99%	-	7.1	44	96 h	LC50	1.8	Mayer & Ellersieck, 1986
0.9	-	F	99%	-	7.6	314	96 h	LC50	0.24	Mayer & Ellersieck, 1986
Pimephales promelas	-	-	-	-	-	-	96 h	LC50	1.0	Verschueren, 1983
Pimephales promelas, < 24 h larvae	+	F	98%	nw	7.1-8.3	46	96 h	LC50	0.7 α	Jarvinen et al., 1988
Pimephales promelas, 3cm	-	F	>99%	dtw	7.9	116	96 h	LC50	0.39	Lincer, 1970
Salmo clarki, 0.37 g	-	S	95%	nw	7.2-7.6	318-348	96 h	LC50[g]	0.11	Post & Schroeder, 1971
Salmo clarki, 1.30 g	-	S	95%	nw	7.2-7.6	318-348	96 h	LC50[g]	0.19	Post & Schroeder, 1971
Salmo kisutch, fingerling	-	S	99%	-	7.1	44	96 h	LC50	0.089	Mayer & Ellersieck, 1986
Salmo kisutch	-	-	-	-	-	-	96 h	LC50	0.5	Verschueren, 1983
Salmo tschaw.	-	-	-	-	-	-	96 h	LC50	1.2	Verschueren, 1983
Salmoides micropterus, 0.48 g	-	S	tech	dtw	-	-	48 h	LC50[h]	0.27	Fabacher, 1976
Salvelinus fontinalis, 1.2 g	-	S	95%	nw	7.2-7.6	318-348	96 h	LC50[g]	0.36	Post & Schroeder, 1971
Salvelinus fontinalis, 2 g	-	S	95%	nw	7.2-7.6	318-348	96 h	LC50[g]	0.59	Post & Schroeder, 1971
Tilapia mossambica, 1.1 g	-	S	99%	-	7.1	44	96 h	LC50	<5.6	Mayer & Ellersieck, 1986
amphibia										
Bufo woodhousei fowleris, tadpole	-	S	99%	-	7.1	44	96 h	LC50	120	Mayer & Ellersieck, 1986
Pseudacris triseriata, tadpole	-	S	99%	-	7.1	44	96 h	LC50	180	Mayer & Ellersieck, 1986
Rana catesbiana, tadpole 2-5 g	+	F	99.6%	nw	8	196	96 h	LC50[e]	2.5 α	Thurston et al., 1985

a solvent: ethanol (≤ 1ml/l); addition of solvent to the control is not reported
b immobility and no respiratory or appendage movement; solvent: acetone ≤ 0.5 ml/l; solvent control not reported
c immobility
d solvent: erthanol (unknown concentration); solvent control not reported; animals from natural population acclimatized for at least 48 h
e solvent: acetone (≤ 0.5 ml/l); solvent control not reported
f solvent: acetone (unknown concentration); solvent control with maximum solvent used; mortality in control not reported
g solvent: acetone (unknown concentration); solvent control not reported
h solvent: acetone (1 ml/l); solvent control performed; results not reported

Table 1.1.9 Acute toxicity of fenthion to freshwater organisms: L(E)C50-values

Organism	A	Test type	Purity compound	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Crite-rion	Result ug/l	Reference
insecta										
Acroneuria pacifia, 2-2.5 cm	-	S	93%	nw	7.9-8.3	122-210	96 h	LC50[a]	5.1	Jensen & Gaufin, 1964
Pteronarcella badia, 1st year	-	S	97%	-	7.2	170	96 h	LC50	11	Mayer & Ellersieck, 1986
Pteronarcys californica, 4-6 cm	-	S	93%	nw	7.9-8.3	122-210	96 h	LC50[a]	27	Jensen & Gaufin, 1964
naiad	-	S	tech	nw	7.1	44	96 h	LC50[b]	4.5	Sanders & Cope, 1968
molluscs										
Indonaia caeruleus, 4.5-5.0 cm	-	-	-	-	-	-	96 h	LC50	14	Mane et al., 1986
crustaceans										
Asellus brevicaudus, mature	-	S	97%	-	7.1	44	96 h	LC50	1800	Mayer & Ellersieck, 1986
Daphnia pulex, 1st instar	-	S	97%	-	7.1	44	48 h	EC50[c]	0.8	Mayer & Ellersieck, 1986
Gammarus lacustris, 2 m	-	S	tech	nw	7.1	31	96 h	LC50[b]	8.5	Sanders, 1969
Moina macrocopa	-	S	99%	am	-	-	48 h	LC50	35	Hatakeyama & Sugaya, 1989
Orconectus nais, mature	-	S	tech	rw	7.4	272	96 h	LC50[b]	210	Sanders, 1972
3-5 w	-	S	tech	rw	7.4	272	96 h	LC50[b]	50	Sanders, 1972
Paratya compressa improvisa, 2 w	-	S	99%	am	-	-	48 h	LC50	1	Hatakeyama & Sugaya, 1989
Simocephalus serrulatus, 1st instar	-	S	97%	-	7.1	44	48 h	EC50[c]	0.62	Mayer & Ellersieck, 1986
fish										
Lepomis macrochirus, 1.40 g	-	S	97%	-	7.4	272	96 h	LC50	3400	Mayer & Ellersieck, 1986
Oncorhynchus clarki, 1.40 g	-	S	97%	-	7.1	44	96 h	LC50	1000	Mayer & Ellersieck, 1986
Salvelinus namaycush, 0.30 g	-	S	97%	-	6.0	44	96 h	LC50	1400	Mayer & Ellersieck, 1986
amphibia										
Rana hexadactyla, 20 mm	-	S	80%	-	6.0-6.4	15-35	96 h	LC50[a]	0.84	Khangarot et al., 1985

a solvent: acetone (unknown concentration)
b solvent: ethanol (≤ 1 ml/l)
c immobilization

Table 1.1.10 Acute toxicity of heptachlor to freshwater organisms: L(E)C50-values

Organism	A	Test type	Purity compound	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Crite-rion	Result µg/l	Reference
crustaceans										
Daphnia pulex, 1st instar	-	S	90%	rdw	7.4-7.8	44	48 h	EC50[a]	42	Sanders & Cope, 1966
Gammarus fasciatus	-	S	tech	rdw	7.4	≥272	96 h	LC50[b]	40	Sanders, 1972
	-	S	tech	rdw	7.1	31	96 h	LC50[b]	56	Sanders, 1972
Gammarus lacustris, 2 m	-	S	tech	rdw	7.1	31	96 h	LC50[b]	29	Sanders, 1969
Orconectes nais, 3-5 w	-	S	tech	nw	7.4	≥272	96 h	LC50[b]	7.8	Sanders, 1972
Simocephalus cerrulatus, 1st instar	-	S	90%	rdw	7.4-7.8	44	48 h	EC50[a]	47	Sanders & Cope, 1966
Simocephalus serrulatus, 1st instar	-	S	99%	-	7.1	44	48 h	EC50[c]	80[1]	Mayer & Ellersieck, 1986
insects										
Claassenia sabulosa, last instar	-	S	tech	rdw	7.1	44	96 h	LC50[a]	2.8	Sanders & Cope, 1968
Pteronarcella badia, last instar	-	S	tech	rdw	7.1	44	96 h	LC50[a]	0.9	Sanders & Cope, 1968
Pteronarcys californica, last instar	-	S	tech	rdw	7.1	44	96 h	LC50[a]	1.1	Sanders & Cope, 1968
fish										
Brachidanio rero, 0.4 g	-	-	99.3%	-	7.9	-	96 h	LC50	170[1]	Vitozzi & De Angelis, 1991
Esox lucius, 0.7 g	-	S	99%	-	7.4	272	96 h	LC50	6.2	Mayer & Ellersieck, 1986
Ictalurus melas, 0.9 g	-	S	99%	-	7.4	44	96 h	LC50	63[1]	Mayer & Ellersieck, 1986
Ictalurus punctatus, 1 g	-	S	99%	-	7.1	44	96 h	LC50	25	Mayer & Ellersieck, 1986
Lebistes reticulates, 0.6 g	-	-	99.3%	-	7.9	-	96 h	LC50	85[1]	Vitozzi & De Angelis, 1991
Lepomis macrochirus, 1.0 g	-	S	99%	-	7.1	44	96 h	LC50	13	Mayer & Ellersieck, 1986
Lepomis macrochirus, 0.8 g	-	S	99%	-	7.4	40	96 h	LC50	17	Mayer & Ellersieck, 1986
Lepomis macrochirus	-	-	-	-	-	-	96 h	LC50	19	EPA, 1972
Lepomis macrochirus	-	-	-	-	-	-	96 h	LC50	190[1]	Verschueren, 1983
Lepomis microlophus, 1.1 g	-	S	99%	-	7.1	44	96 h	LC50	17	Mayer & Ellersieck, 1986
Micropterus salmoides, 1.1 g	-	S	99%	-	7.4	272	96 h	LC50	10	Mayer & Ellersieck, 1986
Oncorhynchus mykiss, 1.4 g	-	-	-	-	-	-	96 h	LC50	19	EPA, 1972
Oncorhynchus mykiss, 1.4 g	-	S	99%	-	7.1	44	96 h	LC50	32	Mayer & Ellersieck, 1986
0.8 g	-	S	99%	-	7.4	272	96 h	LC50	43	Mayer & Ellersieck, 1986
0.8 g	-	S	99%	-	7.1	44	96 h	LC50	7.1	Mayer & Ellersieck, 1986
Oncorhynchus mykiss	-	-	-	-	-	-	96 h	LC50	150[1]	Verschueren, 1983
Oncorhynchus mykiss, 0.6-1.5 g	-	S	tech	am	7.1	45	96 h	LC50[d]	7.0	Macek et al., 1969
Pimephales promelas	-	-	-	-	-	-	96 h	LC50	59[1]	EPA, 1972
Pimephales promelas, 1.3 g	-	S	99%	-	7.1	44	96 h	LC50	23	Mayer & Ellersieck, 1986
Pimephales promelas	-	S	-	-	-	-	96 h	LC50	56	Verschueren, 1983
Salmo kisutch	-	-	-	-	-	-	96 h	LC50	59[1]	EPA, 1972
Salmo tshawytscha	-	-	-	-	-	-	96 h	LC50	17	EPA, 1972
amphibia										
Bufo woodhousii fowleri, tadpole	-	S	99%	-	7.1	44	96 h	LC50	440[1]	Mayer & Ellersieck, 1986

1 above water solubility (56 µg/l)
a immobility; solvent: ethanol (unknown concentration); solvent control not reported; animals from natural population acclimatized for at least 48 h
b solvent: ethanol (≤ 1ml/l); addition of solvent to the control is not reported
c immobility
d solvent: acetone (unknown concentration); solvent control with maximum solvent used; mortality in control not reported

Table 1.1.11 Acute toxicity of heptachlorepoxide to freshwater organisms: L(E)C50-values

Organism	A	Test type	Purity compound	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Crite-rion	Result µg/l	Reference
crustaceans										
Daphnia magna	-	S	-	-	-	-	48 h	LC50	240[1]	Polster, 1973
fish										
Lepomis macrochirus, 0.5 g	-	S	99%	-	7.1	44	96 h	LC50	5.3	Mayer & Ellersieck, 1986
Oncorhynchus mykiss, 1.2 g	-	S	99%	-	7.1	44	96 h	LC50	20	Mayer & Ellersieck, 1986

1 above the estimated water solubility (150 µg/l)

Table 1.1.12 Acute toxicity of quintozene to freshwater organisms: L(E)C50-values

Organism	A	Test type	Test compound purity	Test water	pH	Hardness mg CaCO3/l	Exp. time	Crite-rion	Result µg/l	Reference
fish										
Lepomis macrochirus, larvae	-	-	98%	-	-	-	96 h	LC50	290	RIVM/ACT-archives, 1980
Oncorhynchus mykiss, larvae	-	-	98%		-	-	96 h	LC50	310	RIVM/ACT-archives, 1980

Table 1.1.13 Acute toxicity of thiram to freshwater organisms: L(E)C50-values

Organism	A	Test type	Purity compound	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Crite-rion	Result ug/l	Reference
bacteria										
Nitrosomonas/nitrobacter	-	R	98%	-	-	-	3 h	LOEC[a]	18000	Van Leeuwen et al., 1985a
algae										
Chlorella pyrenoidosa	-	R	98%	-	-	-	96 h	EC50[b]	30	Van Leeuwen et al., 1985a
	-	R	98%	-	-	-	96 h	EC50[c]	1000	Van Leeuwen et al., 1985a
	-	R	98%	-	-	-	96 h	EC50[d]	4000	Van Leeuwen et al., 1985a
crustaceans										
Daphnia magna	-	R	98%	-	-	-	48 h	LC50	210	Van Leeuwen et al., 1985a
< 24 h	-	S	-	am	-	192	26 h	LC50[j]	1300	Frear & Boyd, 1967
fish										
Carassius auratus, 4 cm	-	S	≥99%	-	-	-	48 h	LC50	3700	RIVM archives, 1990
Cyprinus carpio, 5 cm	-	S	≥99%	-	-	-	48 h	LC50	4000	RIVM archives, 1990
Misgurnus anguillicaudatus, 10 cm	-	S	≥99%	-	-	-	48 h	LC50	7500	RIVM archives, 1990
Oncorhynchus mykiss, 34 g	-	S	>98%	sw	7.8	50	24 h	LC50	260	Van Leeuwen et al., 1986a
Oryzias latipes, 2.5 cm	-	S	≥99%	-	-	-	48 h	LC50	7500	RIVM archives, 1990
Poecilia reticulata	-	R	98%	-	-	-	96 h	LC50	270	Van Leeuwen et al., 1985a
amphibia										
Bufo bufo, 30 days old	-	S	≥99%	-	-	-	48 h	LC50	10000-40000[1]	RIVM archives, 1990

1 value above the solubility of the test compound (30000 µg/l).
a minimal inhibiting concentration was determined and considered as lowest effect dose; percentage effect not given
b effect on inoculum (increase in time-lag until maximum population growth)
c inhibition of the maximum specific growth rate
d inhibition of assimilation
e immobilization

Table 1.2.1 Chronic toxicity of carbofuran to freshwater organisms: NOEC-values

Organism	A	Test type	Purity compound	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Crite-rion	Result ug/l	Reference
crustaceans										
Daphnia magna	+	-	tech	-	-	-	21 d	NOEC[a]	9.8 α	Rand, 1989
fish										
Oncorhynchus mykiss, ELS	+	F	tech.	-	-	-	90 d	NOEC[b]	24.8 α	Rand, 1989

a NOEC based on mortality, reproduction and growth
b NOEC based on fry growth (length and wet weight)

Table 1.2.2 Chronic toxicity of chlordane to freshwater organisms: NOEC-values

Organism	A	Test type	Purity compound	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Crite-rion	Result ug/l	Reference
crustaceans										
Daphnia magna, 1st instar	+	F	tech	nw	7.7	156	28 d	NOEC[a]	12.1 α	Cardwell et al., 1977
Hyallela azteca, newly hatched	+	F	tech	nw	7.8	148	65 d	NOEC[b]	5.3 α	Cardwell et al., 1977
insects										
Chironomus sp.	+	F	tech	nw	7.9	150	emerg.[c]	NOEC[c]	0.7 α	Cardwell et al., 1977
fish										
Lepomis macrochirus, juvenile	+	F	tech	nw	7.6	156	9.5 m	NOEC[d]	0.54 α	Cardwell et al., 1977
Pimephales promelas, 5 d	+	F	tech	nw	7.7	156	60 d	NOEC[e]	0.75 α	Cardwell et al., 1977
Salvelinus fontinalis, yearling	+	F	tech	nw	7.3	150	13 m	NOEC[f]	0.11	Cardwell et al., 1977

a NOEC based on mortality
b NOEC based on mortality and growth
c exposure until emergence; NOEC based on percentage emergence
d NOEC based on reproduction
e NOEC based on mortality of adults during spawning
f NOEC calculated as LOEC/3 (at 0.32 µg/l 35% decrease in hatchability; number of embryos initially found dead increased with 13.8% in comparison with control group)

Table 1.2.3 Chronic toxicity of chlorpyrifos to freshwater organisms: NOEC-values

Organism	A	Test type	Purity compound	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Crite-rion	Result ug/l	Reference
protozoans										
Tetrahymena pyriformis	-	S	>96%	am	-	-	3 d	NOEC[a]	330	Lal, Saxena & Lal, 1987
insects										
Wyeomyia smithii, 2nd instar	-	S	≥93%	tap	-	-	7 d	NOEC[b]	0.5	Strickman, 1985
crustaceans										
Daphnia magna, newborn	+	R	-	am	7.0-8.1	-	21 d	NOEC[c]	0.06 α	Kersting & van Wijngaarden, 1992
fish										
Pimephales promelas, ELS-test	+	F	98.7%	nw	7.4-7.8	45.8	32 d	NOEC[b]	3.2 α	Jarvinen & Tanner, 1982
	+	F	98.7%	nw	7.4-7.8	45.8	32 d	NOEC[d]	1.6 α	Jarvinen & Tanner, 1982
	+	F	10CR	nw	7.4-7.8	45.8	32 d	NOEC[e]	2.2 α	Jarvinen & Tanner, 1982
larvae < 24 h	+	F	10CR	nw	7.2-7.7	43.1	30 d	NOEC[f]	1.2 α	Jarvinen et al., 1983
	+	F	10CR	nw	7.2-7.7	43.1	60 d	NOEC[f]	0.63 α	Jarvinen et al., 1983
	+	F	10CR	nw	7.2-7.7	43.1	136 d	NOEC[f]	1.2 α	Jarvinen et al., 1983
	+	F	10CR	nw	7.2-7.7	43.1	200 d	NOEC[g]	0.63 α	Jarvinen et al., 1983
	+	F	10CR	nw	7.2-7.7	43.1	200 d	NOEC[h]	1.2 α	Jarvinen et al., 1983
	+	F	10CR	nw	7.2-7.7	43.1	200 d	NOEC[i]	0.27 α	Jarvinen et al., 1983
second generation larvae	+	F	10CR	nw	7.2-7.7	43.1	30 d	NOEC[j]	1.2 α	Jarvinen et al., 1983
second generation larvae	+	F	10CR	nw	7.2-7.7	43.1	30 d	NOEC[f]	0.12 α	Jarvinen et al., 1983
second generation larvae	+	F	10CR	nw	7.2-7.7	43.1	30 d	NOEC[k]	0.012 α	Jarvinen et al., 1983
larvae, <24 h	+	F	10CR	nw	7.1-8.3	46	30 d	NOEC[f]	3.9 α	Jarvinen et al., 1988
larvae, <24 h	+	F	10CR	nw	7.1-8.3	46	30 d	NOEC[l]	1.3 α	Jarvinen et al., 1988

a population growth; NOEC calculated as LOEC/3 (1 mg/l, 30% effect on population growth)
b mortality
c mortality and reproduction; corrected NOEC: nominal concentrations decreased with 40% caused by feeding of the daphnids with algal suspensions
d growth (length and weight)
e mortality and growth (length and weight)
f growth (length and weight); encapsulated slow-release formulation was used because of easy handling and comparable toxicity with the technical grade substance
g mortality; encapsulated slow-release formulation, see f
h reproduction as mean spawns per spawning pair, mean eggs per spawn per spawning pair and embryo hatchability; encapsulated slow-release formulation, see f
i reproduction as total egg production; encapsulated slow-release formulation, see f
j mortality and deformities (lateral bend in the spine); encapsulated slow-release formulation, see f
k estimated NOEC biomass (total egg production x hatchability x survival x mean weight in g); encapsulated slow-release formulation, see f
l NOEC based on deformities (lateral bend in the spine); encapsulated slow-release formulation, see f

Table 1.2.4 Chronic toxicity of DDT to freshwater organisms: NOEC-values

Organism	A	Test type	Purity compound	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Crite-rion	Result µg/l	Reference
green algae										
Selenastrum capricornutum	-	S	-	am	7.5	-	3 d	NOEC[a]	≥3.6 and <36	Lee et al., 1976
crustaceans										
Daphnia magna, < 24 h	-	R	≥99%	nw	7.6	320-340	14 d	NOEC[b]	0.067	Maki & Johnson, 1975
Daphnia magna, < 24 h	-	R	≥99%	nw	7.6	320-340	14 d	NOEC[c]	0.05	Maki & Johnson, 1975
fish										
Pimephales promelas, 42-48 d	+	F	77%	nw	7.2-7.8	44	266 d	NOEC[d]	0.35	Jarvinen et al., 1977

a inhibition of ^{14}C fixation; incomplete described study, but usefull as an indication of the relative insensibility of green algae to DDT
b mortality; NOEC calculated as LC50/10; test-concentrations and concentration-effect relation not given by the author
c reproduction; NOEC calculated as EC50/10; see c
d survival of parents and larvae (both exposed); spawning between day 112 and 224 (real measured p,p'-DDT conc is given)

Table 1.2.5 Chronic toxicity of endosulfan to freshwater organisms: NOEC-values

Organism	A	Test type	Purity compound	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Crite-rion	Result µg/l	Reference
green algae										
Chlorella vulgaris	-	S/R	35%	-	-	-	14 d	NOEC[a]	700	Knauf & Schulze, 1973
protozoans										
Paramecium aurelia	-	S	94%	am	-	-	5 d	NOEC[b]	100	Tandon et al., 1987
crustaceans										
Daphnia magna, < 24 h	+	F	99%	nw	6.8-7.1	30-39	64 d	NOEC[c]	2.7 α	Macek et al., 1976a
fish										
Sarotherodon mossambicus, 3-4 m	+	F	35%	tap	8.1-8.3	286-296	9 w	NOEC[d]	0.2 α	Matthiessen & Logan, 1984

a growth; 50% renewal every 24 h; 35% endosulfan, 5% emulgator, 2% epichlorhydrine, 10% aromatic mineral oil, 48% aromatic mixture with high boiling point; concentration expressed as 100% endosulfan (see Rao et al., 1980)
b growth
c mortality; given actual conc is the sum of α = 60% and ß = 40%
d reproduction as fry mortality

Table 1.2.6 Chronic toxicity of endrin to freshwater organisms: NOEC-values

Organism	A	Test type	Purity compound	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Crite-rion	Result µg/l	Reference
blue-green algae										
Anacystis nidulans	-	S	>99%	am	8.2	108	26-36 h	NOEC[a]	95	Batterton et al., 1971
fish										
Jordanella floridae, 1-2 d larvae	+	F	96.1%	nw	7.3-7.6	41-46	110 d	NOEC[b]	0.22 α	Hermanutz, 1978
Jordanella floridae, 2-3 d fish	+	F	96.1%	nw	6.9-7.8	43-48	140 d	NOEC[c]	0.21 α	Hermanutz et al., 1985
2-3 d fish	+	F	96.1%	nw	6.9-7.8	43-48	140 d	NOEC[d]	0.29 α	Hermanutz et al., 1985
Pimephales promelas, 38-44 d fish	+	F	99%	nw	7.1-7.9	49	300 d	NOEC[e]	0.14 α	Jarvinen & Tyo, 1978
Pimephales promelas, < 24 h larvae	+	F	98%	nw	7.1-8.3	46	30 d	NOEC[f]	0.2 α	Jarvinen et al., 1988

a growth; solvent: ethanol 0.01-0.1 ml/20 ml; solvent controls similar to water control; only results of 0.05 ml ethanol given by the author (equal to water control); test-concentrations 0.2-19-95-475-950 µg/l
b reproduction and growth
c reproduction
d mortality and growth; effect occurred only during the first 30 days of the test
e mortality; only 2 test-concentrations: 0.14 and 0.25 µg/l
f growth

Table 1.2.7 Chronic toxicity of fenthion to freshwater organisms: NOEC-values

Organism	A	Test type	Purity compound	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Crite-rion	Result ug/l	Reference
protozoans										
Tetrahymena pyriformis	-	S	80.9%	am	-	-	6 d	NOEC[a]	100	Saini & Saxena, 1986
molluscs										
Lymnaea stagnalis, young	-	R	96.8%	tap	7.5	230	17 w	NOEC[b]	<2000	Seugé & Bluzat, 1980
young	-	R	96.8%	tap	7.5	230	17 w	NOEC[c]	1000	Seugé & Bluzat, 1980
adult	-	R	96.8%	tap	7.5	230	8 m	NOEC[d]	2000	Seugé & Bluzat, 1980
young	-	R	96.8%	tap	7.5	230	11 m	NOEC[e]	<2000	Seugé & Bluzat, 1980

a NOEC based on population growth; solvent: acetone (≤ 0.5%); DT50 of fenthion in river water is 7 days
b NOEC based on mortality; % effect unknown; exposure from hatching
c NOEC based on shell growth; exposure from hatching
d NOEC based on fecundity (number of eggs/snail, number of clutch/snail, number of eggs/clutch, begin of laying period); exposure from month 4 until month 11 of age
e NOEC based on fecundity (number of eggs/snail, number of clutch/snail, number of eggs/clutch, begin of laying period); exposure from hatching; % effect unknown

Table 1.2.8 Chronic toxicity of α-HCH to freshwater organisms: NOEC-values

Organism	A	Test type	Purity compound	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Crite-rion	Result µg/l	Reference
green algae										
Chlorella pyrenoidosa	-	S	>95%	am	-	-	96 h	NOEC[a]	3300	Canton et al., 1975
Scenedesmus acutus	-	S	-	am	7-8	-	5 d	NOEC[b]	80	Krishnakumari, 1977
protozoans										
Tetrahymena pyriformis	-	S	-	am	-	-	5 d	NOEC[c]	9	Mathur et al., 1984
molluscs										
Lymnaea stagnalis, eggs	+	R	-	am	-	-	40 d	NOEC[d]	20	RIVM, 1977 (unpublished)
crustaceans										
Daphnia magna, < 24 h	+	R	-	DSW	8-8.4	200	21 d	NOEC[e]	90	Canton et al., 1986
Daphnia magna, < 24 h	+	R	-	DSW	8-8.4	200	21 d	NOEC[f]	270	Canton et al., 1986
fish										
Oryzias latipes, just fert. eggs	+	R	-	DSW	8-8.4	200	35 d	NOEC[g]	800	Canton et al., 1986

a 20% inhibition at 10000 µg/l, maximum solubility in medium; NOEC calculated as LOEC/3
b growth; NOEC extrapolated; 25% growth inhibition at lowest test-concentration of 500 µg/l
c growth; NOEC extrapolated; 54% growth inhibition at lowest test-concentration of 83 µg/l; clear concentration-effect relation
d reproduction (as amounts of eggs/clutch, clutches/female and % hatch)
e growth
f mortality and reproduction
g mortality and growth

Table 1.2.9 Chronic toxicity of β-HCH to freshwater organisms: NOEC-values

Organism	A	Test type	Purity compound	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Crite-rion	Result µg/l	Reference
green algae										
Scenedesmus acutus	-	S	-	am	7-8	-	5 d	NOEC[a]	500	Krishnakumari, 1977
Scenedesmus quadricauda	-	S	-	am	7.2-8.2	51	96 h	NOEC[b]	≥1000	Canton et al., 1982
Chlorella pyrenoidosa	-	S	-	am	7.2-8.2	51	96 h	NOEC[b]	≥1000	Canton et al., 1982
protozoans										
Tetrahymena pyriformis	-	S	-	am	-	-	5 d	NOEC[c]	83	Mathur et al., 1984
crustaceans										
Daphnia magna, < 24 h	+	R	-	DSW	8-8.4	200	22 d	NOEC[d]	320	Canton et al., 1982
fish										
Oryzias latipes, just fert. eggs	+	R	-	DSW	8-8.4	200	35 d	NOEC[e]	27 α	Canton et al., 1982
Oryzias latipes, just fert. eggs	+	R	98.9%	DSW	7.8-8.4	200	3 m	NOEC[f]	56	Wester & Canton, 1986
Oryzias latipes, 1 m juvenile	+	R	98.9%	DSW	7.8-8.4	200	3 m	NOEC[f]	32	Wester & Canton, 1986
Poecilia reticulata, 1 m	+	R	98.9%	DSW	7.8-8.4	200	3 m	NOEC[g]	180	Wester et al., 1985

a growth
b growth; highest concentration tested (maximum solubility in water)
c growth
d reproduction
e mortality, growth, embryonic development and behavior
f strong abnormal behavior
g growth and strong abnormal behavior

Table 1.2.10 Chronic toxicity of heptachlor to freshwater organisms: NOEC-values

Organism	A	Test type	Purity compound	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Crite-rion	Result µg/l	Reference
crustaceans										
Daphnia magna, ≤24 h	-	F	98%	nw	6.8-7.2	35-42	64 d	NOEC[a]	12.5	Macek et al., 1976
fish										
Pimephales promelas, 1 d	+	F	98%	nw	6.6-7.0	21-40	40 w	NOEC[b]	0.86 α	Macek et al., 1976

a mortality; nominal concentrations; water contaminated with trace organics (not reported which); (in the study with P. promelas actual concentrations were ± 0.4 of nominal ones
b mortality and reproduction; unexplained high mortality occurred in one of the two replica's at 0.86 µg/l

Table 1.2.11 Chronic toxicity of thiram to freshwater organisms: NOEC-values

Organism	A	Test type	Purity compound	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Crite-rion	Result ug/l	Reference
green algae										
Scenedesmus acutus	-	S	-	-	-	-	5 d	NOEC[a]	250	Krishnakumari, 1977
crustaceans										
Daphnia magna	-	R	98%	nw	8.1	225	21 d	NOEC[b]	5.6	Van Leeuwen et al., 1985b
	-	R	98%	nw	8.1	225	21 d	NOEC[c]	1	Van Leeuwen et al., 1985b
fish										
Oncorhynchus mykiss, ELS	-	R	98%	rw	7.7	50	60 d	NOEC[d]	0.56	Van Leeuwen et al., 1986b
	-	R	98%	rw	7.7	50	60 d	NOEC[e]	0.32	Van Leeuwen et al., 1986b

a NOEC based on growth; calculated as LOEC/2 (18% growth reduction at 500 µg/l); solvent: ethanol (unknown concentration)
b LOEC or NOEC based on intrinsic rate of natural increase calculated from an equation based on surviving rate and fecundity
c NOEC based on length
d NOEC based on mortality
f NOEC based on weight

Table 1.3. Values from deviating tests.

Organism	A	Test type	Purity compound	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Crite-rion	Result µg/l	Reference
aldrin										
insects										
Acroneuria pacifica, larva 2-2.5 cm	-	F	93%	nw	7.8-8.2	-	30 d	LC50	22	Jensen & Gaufin, 1966
Pteronarcys californica, larva 2-5 cm	-	F	93%	nw	7.8-8.2	-	30 d	LC50	2.5	Jensen & Gaufin, 1966
carbofuran										
crustaceans										
Caridina rajdhari	-	S	75%	tap	7.4	50	96 h	LC50[a]	0.24	Pawar & Katdare, 1983
Macrobrachium kistnensis	-	S	75%	tap	7.4	50	96 h	LC50[a]	120	Pawar & Katdare, 1983
fish										
Mystus vittatus, 8-10 cm	-	S	75%	-	6.9-7.4	59	96 h	LC50[b]	310	Verma et al., 1980
Ophiocephalus punctatus, 9-11 cm	-	S	75%	-	6.9-7.4	59	96 h	LC50[b]	180	Verma et al., 1981
Saccobranchus fossilis, 5-7.5 cm	-	S	75%	-	7.2	-	96 h	LC50[c]	550	Verma et al., 1982
chlorpyrifos										
crustaceans										
Procambarus clarkii	-	S	-	tap	7.0	2-5	-	LC50[d]	2	Carter & Graves, 1972
fish										
Gambusia affinis, 0.6 g	-	S	EC	nw	-	-	72 h	LC50[e]	260	Davey et al., 1976
	-	S	-	tap	7.0	2-5	-	LC50[d]	280	Carter & Graves, 1972
Ictalurus punctatus	-	S	-	tap	7.0	2-5	-	LC50[d]	160	Carter & Graves, 1972
Lepomis cyanellus, 1.8 g	-	S	EC	nw	-	-	72 h	LC50[e]	40	Davey et al., 1976
Lepomis macrochirus	-	S	-	tap	7.0	2-5	-	LC50	30	Carter & Graves, 1972
DDE										
flatworms										
Phagocata gracilis	-	S	-	-	-	-	10 d	LC50	2400	Bonner & Wells, 1987

(to be continued)

Table 1.3. Values from deviating tests (continued)

Organism	A	Test type	Purity compound	Test water	pH	Hardness mg $CaCO_3$/l	Exp. time	Crite-rion	Result µg/l	Reference
DDT										
crustaceans										
Gammarus fasciatus	-	S	-	-	-	-	5 d	LC50	0.32	IPCS, 1989b
Gammarus fasciatus	-	F	-	-	-	-	5 d	LC50	0.6	IPCS, 1989b
fish										
Oncorhynchus mykiss	-	-	-	-	-	-	15 d	LC50	0.26	EPA, 1972
endrin										
insects										
Acroneuria pacifica, larva 2-2.5 cm	-	F	98%	nw	7.8-8.2	-	30 d	LC50	0.035	Jensen & Gaufin, 1966
Pteronarcys californica larva 2-5 cm	-	F	98%	nw	7.8-8.2	-	30 d	LC50	1.2	Jensen & Gaufin, 1966
fish										
Micropterus salmoides, 0.48 g	-	S	tech	dtw	-	-	48 h	LC50[f]	0.27	Fabacher, 1976
fenthion										
insects										
Acroneuria pacifica, 2-2.5 cm	-	F	93%	nw	7.8-8.2	-	30 d	LC50[g]	0.64	Jensen & Gaufin, 1966
Laccotrephes griseus, adult f.	-	-	tech	-	-	-	28 d	NOEC[h]	20	Mathavan & Jayakumar, 1987
	-	-	tech	-	-	-	20 d	NOEC[i]	<20	Mathavan & Jayakumar, 1987
Pteronarcys californica, 2-5 cm	-	F	93%	nw	7.8-8.2	-	30 d	LC50[g]	3.6	Jensen & Gaufin, 1966
heptachlor										
crustaceans										
Daphnia magna, < 24 h	-	S	-	am	-	192	26 h	LC50[j]	52	Frear & Boyd, 1967
thiram										
crustaceans										
Daphnia magna	-	R	98%	nw	8.1	225	21 d	LC50	8	Van Leeuwen et al., 1985b
fish										
Oncorhynchus mykiss, eggs	-	R	98%	rw	7.7	50	60 d	LC50	1.1	Van Leeuwen et al., 1986b
	-	R	98%	rw	7.7	50	60 d	EC50[k]	6.4	Van Leeuwen et al., 1986b
Rasbora heteromorpha	-	F	80%	-	8.1	20	96 h	LC50[l]	7	Tooby & Hursey, 1975

a solvent: acetone (unknown concentration); value corrected for 100% active ingredient
b solvent: DMF; value corrected for 100% active ingredient
c solvent: acetone : ethanole mixture (1:1 v/v); value corrected for 100% active ingredient
d hardness as 2-5 mg/l as CaCO3
e solvent: acetone (1 ml/l); solvent control included.
f solvent: acetone (1 ml/l); solvent control included
g solvent: acetone (≤ 0.5%)
h growth; females were maintained in fenthion concentrations of 20, 50 and 80 µg/l and fed Culex quinquefasciatus pretreated with the same fenthion concentrations
i reproduction as number of eggs/female, 42% reduction in number of eggs/female; females were maintained in fenthion concentrations of 20, 50 and 80 µg/l and fed Culex quinquefasciatus pretreated with the same fenthion concentrations
j solvent: acetone (1 ml/l); solvent controls included
k EC50 based on mortality and teratogenicity
l solvent: acetone (unknown concentration)

References

Batterton, J.C., G.M. Boush and F. Matsumura (1971) Growth response of blue-green algae to aldrin, dieldrin, endrin and their metabolites. Bull. Environ. Contam. Toxicol. **6**, (6), 589-594.

Berglind, R. and G. Dave (1984) Acute toxicity of chromate, DDT, PCP, TPBS, and zinc to Daphnia magna cultured in hard and soft water. Bull. Environ. Contam. Toxicol. **33**, 63-68.

Bonner, J.C. and M.R. Wells (1987) Comparitive acute toxicity of DDT metabolites among American and European species of planarians. Comp. Biochem. Physiol. **87C**, (2), 437-438.

Canton, J.H. et al. (1975) Toxicity, accumulation and elimination studies of α-hexachlorocyclohexane (α-HCH) with freshwater organisms of different trophic levels. Water Res. **9**, 1163-1169.

Canton, J.H. et al. (1982) Onderzoek naar de toxiciteit van beta-HCH voor zoetwaterorganismen. RIV-rapport nr. 627917 001.

Canton et al. (1986) Personal communication.

Cardwell, R.D., D.G. Foreman, and T.R. Payne (1977) Acute aand chronic toxicity of chlordane to fish and invertebrates. Report No. PB-267 544/5 ST, US. National Technical Information Service, Springfield. Va.

Carter, F.L. and J.B. Graves (1972) Measuring effects of insecticides on aquatic animals. La. Agric. **16**, (2), 14-15.

Davey, R.B., M.V. Meisch, and F.L. Carter (1976) Toxicity of five ricefield pesticides to the mosquitofish Gambusia affinis, and green sunfish, Lepomis cyanellus, under laboratory and field conditions in Arkansas. Environ. Entomol. **5**, (6), 1053-1056.

Dutt, N, and R.S. Guha (1988) Toxicity of few organophosphorus insecticides to fingerlings of bound water fishes, Cyprinus carpio (Linn.) and Tilapia mossambica Peters. Indian J. Ent. **50**, (4), 403-421.

EPA (1972) Water quality criteria. Ecological research series. EPA-R3-73-033-March 1973.

Fabacher, D.L. (1976) Toxicity of endrin and an endrin-methyl parathion formulation to largemouth bass fingerlings. Bull. Environ. Contam. Toxicol. **16**, (3), 376-378.

Ferrando, M.D., E. Sancho, amd E. Andreu-Moliner (1991) Comparative acute toxicities of selected pesticides to Anguilla anguilla. J. Environ. Sci. Health **B26**, (5&6), 491-498.

Frear, D.E.H. and J.E Boyd (1967) Use of Daphnia magna for the microbioassay of pesticides. I. Development of standardized techniques for rearing Daphnia and preparation of dosage-mortality curves for pesticides. J. Econ. Entomol. **60**, (5), 1228-1236.

Hatakeyama, S and Y. Sugaya (1989) A freshwater shrimp (Paratya compressa improvisa) as a sensitive test organism to pesticides. Environ. Pollut. **59**, 325-336.

Hermanutz, R.O. (1978) Endrin and malathion toxicity to flagfish (Jordanella floridae). Arch. Environm. Contam. Toxicol. **7**, 159-168.

Hermanutz, R.O., J.G. Eaton and L.H. Mueller (1985) Toxicity of endrin and malathion mixtures to flagfish (Jordanella floridae). Arch. Environm. Contam. Toxicol. **14**, 307-314.

Holcombe, G.W., G.L. Phipps, and D.K. Tanner (1982) The acute toxicity of kelthane, dursban, disulfoton, pydrin, and permethrin to fathead minnows Pimephales promelas and to rainbow trout Salmo gairdneri. Environ. Pollut. (series A) **29**, 167-178.

IPCS (1989a) Environmental health criteria 91, aldrin and dieldrin. WHO, Geneve.

IPCS (1989b) Environmental health criteria 83, DDT and its derivatives - Environmental aspects. WHO, Geneve.

Jarvinen, A.W., M.J. Hofman and T.W. Thorslund (1977) Long-term toxic effects of DDT food and water exposure on fathead minnows (Pimephales promelas). J. Fish. Res. Board Can. **34**, 2089-2103.

Jarvinen, A. W., B.R. Nordling, and M.E. Henry (1983) Chronic toxicity of dursban (chlorpyrifos) to the fathead minnow (Pimephales promelas) and the resultant acetylcholinesterase inhibition. Ecotoxicol. Environ. Saf. **7**, 423-434.

Jarvinen, A.W., and D.K. Tanner (1982) Toxicity of selected controlled release and corresponding unformulated technical grade pesticides to the fathead minnow Pimapheles promelas. Environ. Pollut. Ser. A. **27**, 179-195.

Jarvinen, A.W., D.K. Tanner and E.R. Kline (1988) Toxicity of chlorpyrifos, endrin, or fenvalerate to fathead minnows following episodic or continuous exposure. Ecotox. Environ. Saf. **15**, 78-95.

Jarvinen, A.W. and R.M. Tyo (1978) Toxicity to fathead minnows of endrin in food and water. Arch. Environm. Contam. Toxicol. **7**, 409-421.

Jensen, L.D. and A.R. Gaufin (1964) Effects of ten organic insecticides on two species of stonefly naiads. Trans. Am. Fish Soc. **93**, 27-34.

Jensen, L.D. and A.R. Gaufin (1966) Acute and long-term effects of organic insecticides on two species of stonefly naiads. J. Wat. Pollut. Control Fed. **38**, 1273-1286.

Johnson, W.W. and M.T. Finley (1980) Handbook of acute toxicity of chemicals to fish and aquatic invertebrates. Resource publ. 137.

Khangarot, B.S., A. Sehgal and M.K. Bhasin (1985) "Man and biosphere"- Studies on the Sikkim Himalayas. Part 6: Toxicity of selected pesticides to frog tadpole Rana hexadactyla (Lesson). Acta hydrochim. Hydrobiol. **13**, (3), 391-394.

Karnak, R.E., and W.J Collins (1974) The susceptibility to selected insecticides and acetylcholinesterase activity in a laboratory colony of midge larvae, Chironomus tentans (Diptera: chironomidae). Bull. Environ. Contam. Toxicol. **12**, (1), 62-69.

Kersting, K., and R. Van Wijngaarden (1992) Effects of chlorpyrifos on a microsystem. Environ. Toxicol. Chem. **11**, 365-372.

Knauf, W. and E.F. Schulze (1973) New findings on the toxicity of endosulfan and its metabolites to aquatic organisms. Farbwerke Hoechst AG, 717-732.

Kouyoumjian, H.H. and R.F. Uglow (1974) Some aspects of the toxicity ofp,p'-DDT, p,p'-DDE and p,p'-DDD to the freshwater planarian Polycelis felina (Tricladida). Environ. Pollut. **7**, 103-109.

Krishnakumari, M.K. (1977) Sensitivity of the alga Scenedesmus acutus to some pesticides. Life Sci. **20**, 1525-1532.

Lal, S., D.M. Saxena, and R. Lal (1987) Uptake, metabolism and effects of DDT, fenitrothion and chlorpyrifos en Tetrahymena pyriformis. Pestic. Sci. **21**, 181-191.

LeBlanc, G.A. (1984) Interspecies relationships in acute toxicity of chemicals to aquatic organisms. Environ. Toxicol. Chem. **3**, 47-60.

Lee, S.S., S.C. Fang and V.H. Freed (1976) Effect of DDT on photosynthesis of Selenastrum capricornutum. Pest. Biochem. and Physiol. **6**, 46-51.

Macek, K.J., C. Hutchinson and O.B. Cope (1969) The effects of temperature on the susceptibility of bluegills and rainbow trout to selected pesticides. Bull. Environ. Contam. Toxicol. **4**, (3), 174-183.

Macek, K.J., M.A. Lindberg, S. Sauter, K.S. Buxton and P.A. Costa (1976) Toxicity to four pesticides to waterfleas and fathead minnows, acute and chronic toxicity of acrolein, heptachlor, endosulfan and trifluralin to the water flea (Daphnia magna) and the fathead minnow (Pimephales promelas). EPA 600/3-76-099, PB-262.912.

Maki, A.W. and H.E. Johnson (1975) Effects of PCB (Aroclor 1254) and p,p'DDT on production and survival of Daphnia magna Strauss. Bull. Environ. Contam. Toxicol. **13**, (4), 412-416.

Mane, U.H., S.R. Akarte, and D.A. Kulkarni (1986) Acute toxicity of fenthion to freshwater Lamellibranch mollusc, Indonaia caeruleus (Pradhad 1918), from Godavari river at Paithan - A biochemical approach. Bull. Environ. Contam. Toxicol. **37**, 622-628.

Mathavan, S., and E. Jayakumar (1987) Long-term effects of pesticides (fenthion and temephos) on growth and fecundity of an aquatic bug Laccotrephes griseus (Guerin). Indian J. Experim. Biol. **25**, 48-51.

Mathur, R., D.M. Saxena and H.C. Agarwal (1984) Growth of a ciliate protozoan, Tetrahymena pyriformis in the presence of different isomers of hexachloro-cyclohexane (HCH). Acta Prootozool. **23**, (3), 165-174.

Matthiessen, P. and J.W.M. Logan (1984) Low concentration effects of endosulfan insecticide on reproductive behaviour in the tropical cichlid fish Sarotherodon mossambicus. Bull. Environ. Contam. Toxicol. **33**, 575-583.

Mayer, F.L. and M.R. Ellersieck (1986) Manual of acute toxicity: interpretation and data base for 410 chemicals and 66 species of freshwater animals. United states department of the interior, fish and wildlife service, Resource publication 160, Washington D.C.

Mehrle, P.M., W. Waynon Johnson, and F.L. Mayer, Jr. (1974) Nutritional effects on chlordane toxicity in rainbow trout. Bull. Environ. Contam. Toxicol. **12**, (5), 513-517.

Murphy, P.M. (1978) Freshwater macroinvertebrate toxicity testing: a feasibility study. University of Wales, Institute of science and technology.

Pawar, K.R., and M. Katdare (1983) Acute toxicity of sumithion, BHC and furadan to the freshwater prawn (Macrobrachium kistnensis) and shrimp (Caridina rajdhari). Geobios **10**, 136-137.

Phipps, G.L., and G.W. Holcombe (1985) a method for aquatic multiple species toxicant testing: Acute toxicity of 10 chemicals to 5 vertebrates and 2 invertebrates. Environ. Pollut. (series A) **38**, 141-157.

Polster, M. (1973) On problems of toxicity of heptachlor residues. Scr. Med. Fac. Med. Univ. Brun. Purkynianae **46**, (2) 71-77.

Post, G. and T.R. Schroeder (1971) The toxicity of four insecticides to four salmonid speciesirn. Contam. Toxicol. **6**, (2), 144-155.

Rand, G.M. (1989) An environmental risk assessment of a pesticide. Dennis J. Paustenbach (editor): The risk assessment of environmental aand human health hazards: a textbook of case studies, J. wiley & Sons, New York.

Rehwoldt, R.E., E. Kelley, and M. Mahoney (1977) Investigations into the acute toxicity and some chronic effects of selected herbicides and pesticides on several freshwater fish species. Bull. Environ. Contam. Toxicol. **18**, (3), 361-365.

RIVM archives (1977).

RIVM archives (1980).

RIVM archives (1988).

RIVM archives (1990).

RIZA (1992) Inventarisatie bestrijdingsmiddelen I carbamaten, dithiocarbamaten, fenolherbiciden en organofosforinsecticiden (Aquatox) Adviesbureau Bongaerts, Kuyper en Huiswaard, Delft.

Saini, A., D.M. Saxena (1986) Effect of organophosphorus insecticides on the growth of Tetrahymena pyriformis. Arch. Protestenk. **131**, 143-152.

Sanders (1969) Toxicity of pesticides to the crustacean Gammarus lacustris. Techn. Paper 25, Bur. Sports Fish. Wildl., Fish Wildl. Serv.

Sanders, H.O. (1972) Toxicity of some insecticides to four species of malacostracan crustaceans. Techn. Paper 66, Bur. Sports Fish. Wildl., Fish Wildl. Serv.

Sanders, H.O. and O.B. Cope (1966) Toxicities of several pesticides to two species of cladocerans. Trans. Am. Fish. Soc. **95**, (2), 165-169.

Sanders, H.O. and O.B. Cope (1968) The relative toxicities of several pesticides to naiads of three species of stoneflies. Limnol. Oceanogr. **13**, (1), 112-117.

Seugé, J., and R. Bluzat (1980) Toxicité a long terme d'un insecticide organophosphore (fenthion) chez le mollusque Lymnea stagnalis L. Hydrobiol. **76**, 241-248.

Smith, S.B., J.F. Savino and M.A. Blouin (1988) Acute toxicity to Daphnia pulex of six classes of chemical compounds potentially hazardous to Great Lakes aquatic biota. J. Great Lakes Res. **14**, (4), 394-404.

Stephenson, R.R, S.Y. Choi and A. Olmos-Jerez (1984) Determining the toxicity and hazard to fish of a rice insecticide. Crop Protection **3**, 151-165.

Stratton G.W. and J. Giles (1990) Importance of bioassay volume in toxicity tests using algae and aquatic invertebrates. Bull. Environ. Contam. Toxicol. **44**, 420-427.

Strickman, D. (1985) Aquatic bioassay of 11 pesticides using larvae of the mosquito, Wyeomyia smithii (Diptera: Culicidae). Bull. Environ. Contam. Toxicol. **35**, 133-142.

Sutherland, D.J. and J.D. Rosen (1968) Photoaldrin and its toxicity to mosquito larvae. Mosq. News **28**, (2), 155-159.

Tandon, R.S., R. Lal and V.V.S. Narayana Rao (1987) Effects of malathion and endosulfan on the growth of Paramecium aurelia. Acta Protozool. **26**, (4), 325-328.

Tooby, T.E., and P.A. Hursey (1975) The acute toxicity of 102 pesticides and miscellaneous substances to fish. Chem. Industr. **21**, (6), 523-526.

Thurston, R.V., T.A. Gilfoil, E.L. Meyn, R.K. Zajdel, T.I. Aoki, and G.D. Veith (1985) Comparative toxicity of ten organic chemicals to ten common aquatic species. Water Res. **9**, (9), 1145-1155.

Van Leeuwen, C.L., J.L. Maas-Diepeveen, G. Niebeek, W.H.A. Vergouw, P.S. Griffioen, and M.W. Luijken (1985a) Aquatic toxicological aspects of dithiocarbamates and related compounds. I. Short-term toxicity tests. Aquat. Toxicol. **7**, 145-164.

Van Leeuwen, C.L., F. Moberts, and G. Niebeek (1985b) Aquatic toxicological aspects of dithiocar bamates and related compounds. II. Effects on survival, reproduction and growth of Daphnia magna. Aquat. toxicol. **7**, 165-175.

Van Leeuwen, C.J., J.L. Maas-Diepeveen, and H.C.M. Overbeek (1986a) Sublethal effects of tetramethylthiuram disulfide (thiram) in rainbow trout (Salmo gairdneri). Aquat. Toxicol. **9**, 13-19.

Van Leeuwen, C.J., A. Espeldoorn, and F. Mol (1986b) Aquatic toxicological aspects of dithiocar bamates and related compounds. III. Embryolarval studies with rainbow trout (Salmo gairdneri). Aquat. Toxicol. **9**, 129-145.

Verma, S.R., S. Rani, S.K. Bansal, and R.C. Dalela (1980) Effects of the pesticies thiotox, dichlorvos and carbofuran on the test fish Mystus vittatus. Water, Air, Soil Pollut. **13**, 229-234.

Verma, S.R., S. Rani, S.K. Bansal, and R.C. Dalela (1981) Evaluation of the comparative toxicity of thiotox, dichlorvos and carbofuran to two fresh water teleosts Ophiocephalus punctatus and Mystus vittatus. Acta Hydrochim. Hydrobiol. **9**, 119-129.

Verma, S.R., S.K. Bansal, A.K. Gupta, N. Pal, A.K. Tyagi, M.C. Bhatnagar, V. Kumar, and R.C. Dalela (1982) Bioassay trials with twenty three pesticides to a fresh water teleost,

Saccobranchus fossilis. Water Res. **16**, 525-529.

Verschueren, K. (1983) Handbook of environmental data on organic chemicals. ISBN 0-442-28802-6 van Nostrand Reinhold Company Inc.

Vitozzi, L. and G. De Angelis (1991) A critical review of comparative acute toxicity data on freshwater fish. Aquat. Toxicol. **19**, 167-204.

Wester, P.W., J.H. Canton and A. Bisschop (1985) Histopathological study of Poecilia reticulata (guppy) after long-tem ß-hexachlorocyclohexane exposure. Aquat. Toxicol. **6**, 271-296.

Wester, P.W. and J.H. Canton (1986) Histopathological study of Oryzias latipes (medaka) after long-tem ß-hexachlorocyclohexane exposure. Aquat. Toxicol. **9**, 21-45.

References: evaluated but rejected.

Bansal, S.K., S.R. Verma, A.K. Gupta, and R.C. Dalela (1980) Predicting long-term toxicity by subacute screening of pesticides with larvae and early juveniles of four species of freshwater major carp. Ecotoxicol. Environ. Safety **4**, 224-231.

Bednarz, T. (1981) The effect of pesticides on the growth of green and blue-green algae cultures. Acta Hydrobiol. **23**, (2), 155-172.

Bluzat, R., O. Jonot, and J. Seugé (1982) Acute toxicity of thiram in Gammarus pulex: Effect of one-hour contamination and degradation of an aqueous suspension. Bull. Environm. Contam. Toxicol. **29**, 248-252.

Brock, T.C.M., S.J.H. Crum, R. van Wijngaarden, B.J. Budde, J. Tijink, A. Zuppeli, and P. Leeuwangh (1992) Fate and effects of the insecticide Dursban 4E in indoor Elodea-dominated and macrophyte-free freshwater model ecosystems: I. Fate and primary effects of the active ingredient chlorpyrifos. Arch. Environ. Contam. Toxicol. **23**, 69-84.

Brown, J. R., L.Y. Chow, and Ching Bee Deng (1976) The effect of dursban upon fresh water phytoplankton. Bull. Environ. Contam. Toxicol. **15**, 437-441.

Butler, G.L. (1977) Algae and pesticides. Residue Rev. **66**, 19-62.

Clark, J.R., P.W. Borthwick, L.R. Goodman, J.M. Patrick, Jr.,E.M. Lores and J.C. Moore (1987) Comparison of laboratory toxicity test results with responses of estuarine animals exposed to fenthion in the field. Environ. Toxicol. Chem. **6**, 151-160.

Cole, D.R. and F.W. Plapp Jr. (1974) Inhibition and photosynthesis in Chlorella pyrenoidosa by a polychlorinated biphenyl and several insecticides. Environ. Entomol. **3**, (2), 217-220.

Cooke, A.S. (1970) The effect of pp'-DDT on tadpoles of the common frog (Rana temporaria). Environ. Pollut. **1**, 57-71.

Cooke, A.S. (1973) Response of Rana temporaria tadpoles to chronic doses of pp'-DDT. Copeia **4**, 647-652.

Cope, O.B. (1963) Sport fishery investigations. U.S. Fish Wildl. Serv. Circ. **199**, 29-43.

Cope, O.B. (1965) Sport fishery investigations. U.S. Fish Wildl. Serv. Circ. **226**, 51-63.

Dad, N.K. (1982) Acute toxicity of two insecticides to tubificid worms, Tubifex tubifex and Limnodrilus hoffmeisteri. Environ. Internat. **7**, 361-363.

Derby, S.B. (Sleeper), and E. Ruber (1971) Primary production: Depression of oxygen evolution in algal cultures by organophosphorus insecticides. Bull. Environ. Contam. Toxicol. **5**, (6), 553-558.

Dive, D., H. Leclerc and G. Persoone (1980) Pesticide toxicity on the ciliate protozoan Colpidium campylum: possible consequences of the effct of pesticedes in the aquatic environment. Ecotox. Environ. Saf. **4**, 129-133.

El-Refai, A., F.A. Fahmy, M.F.A. Abdel-Lateef, and A-K.E. Imam (1976) Toxicity of three insec ticides to two species of fish. Int. Pest. Control, nov/dec, 4-8.

Feroz, M. and M.A.Q. Khan (1979) Fate of ^{14}C-cis-chlordane in goldfish, Carassius auratus (L.). Bull. Environ. Contam. Toxicol. **23**, 64-69.

Gardner, D.R. (1973) The effect of some DDT and methoxychlor analos on temperature selection and lethality in brook trout fingerlings. Pest. Biochem. Physiol. **2**, 437-446.

Goulding, K.H. and S.W. Ellis (1981) The interaction of DDT with two species of freshwater algae. Environ. Pollut. (Series A) **25**, 271-290.

Grant, I.F., E.A. Egan and M. Alexander (1983) Pesticides to control ostracods grazing on blue-green algae. Soil Biol. Biochem. **15**, 193-197.

Greeff, C.G., and L.G. Van Dijk (1978) Preliminary investigation of fenthion pollution on aquatic invertebrates. Chemosphere **5**, 393-402.

Hartman, W.A., and D.B. Martin (1984) Effect of suspended bentonite clay on the acute toxicity of glyphosate to Daphnia pulex and Lemna minor. Bull. Environ. Contam. Toxicol. **33**, 355-361.

Hartman, W.A., and D.B. Martin (1985) Effects of four agricultural pesticides on Daphnia pulex, Lemna minor, and Potamogeton pectinatus. Bull. Environ. Contam. Toxicol. **35**, 646-651.

Holcombe, G.W., G.L. Phipps, and J.T. Fiandt (1983) Toxicity of selected priority pollutants to various aquatic organisms. Ecotoxicol. Environ. Saf. **7**, 400-409.

Huang, J. and E.F, Gloyna (1968) Effect of organic compounds on photosynthetic oxygenation - I. chlorophyll destruction and suppression of photosynthetic oxygen production. Wat. Res. **2**, 347-366.

Hurlbert, S.H., M.S. Mulla, J.O. Keith, W.E. Westlake, and M.E. Düsch (1970) Biological effects and persistence of Dursban in freshwater ponds. J. Econ. Entomol. **63**, 43-45.

Jash, N.B., and S. Bhattacharya (1983) Delayed toxicity of carbofuran in freshwater teleosts, Channa punctatus (Bloch) and Ananbas testudineus (Bloch). Water, Air, Soil Pollut. **19**, 209-

213.

Johnson, B.T. (1986) Potential impact of selected agricultural chemical contaminants on a northern prairie wetland: a microcosm evaluation. Environ. Toxicol. Chem. **5**, 473-485.

Joshi, P.C. and R.B. Misra (1986) Evaluation of chemically-induced phototoxicity to aquatic organism using Paramecium as a model. Biochem. Biophys. Res. Comm. **139**, (1), 79-84.

Kar, S. and P.K. Singh (1978) Toxicity of carbofuran to blue-green alga Nostoc muscorum. Bull. Environ. Contam. Toxicol. **20**, 707-714.

Konar, S.K. (1968) Experimental use of chlordane in fishery management. Progres. Fish-Cult. 96-99.

Koning, H.W. de and D.C. Mortimer (1971) DDT uptake and growth of Euglena gracilis. Bull. Environ. Contam. Toxicol. **6**, (3), 244-248.

Kuhr, R.J., A. Hassan and F.P.W. Winteringham (1980) Carbamate insecticides (Issue No. I) Comparative summary. Chemosphere **9**, 251-253.

Kulshrestha, S.K., N. Arora, and S. Sharma (1986) Toxicity of four pesticides on the fingerlings of indian major carps Labeo rohita, Catla catla, and Cirrhinus mrigala. Ecotoxicol, Environ. Saf. **12**, 114-119.

Lal, R. and D.M. Saxena (1979) Effect of DDT on growth of Tetrahymena pyriformis. Arch. Protistenk. **122**, 382-386.

Lal, R. and D.M. Saxena (1980) Effect of DDT on cell population growth, cell division, and DNA synthesis in Stylonychia notophora (Stokes). Arch. Environm. Contam. Toxicol. **9**, 163-170.

Lal, R. and D.M. Saxena (1982) Accumulaton, metabolism and effects of organochlorine insecticides on microorganisms. Microbiol. Rev. **46**, 95-127.

Lim, R.P., and M.C. Wong (1986) The effect of pesticides on the population dynamics and production of Stenocypris major Baird (Ostracoda) in ricefields. Arch. Hydrobiol. **106**, (3), 421-427.

Livingston, R.J. (1977) Review of current literature concerning the acute and chronic effects of pesticides on aquatic organisms. CRC Crit Rev. Environ. Control, nov 1977, 325-351.

Macek, K.J., and W.A. McAllister (1970) Insecticde susceptibility of soome common fish family representatives. Trans. Amer. Fish. Soc. **1**, 20-27.

Macek, K.J., D.F. Walsh, J.W. Hogan, and D.D. Holz (1972) Toxicity of the insecticide Dursban to fish and aquatic invertebrates in ponds. Tran. Amer. Fish. Soc. **3**, 420-427.

Mani, K. and P.K. Saxena (1985) Effect of some pesticides on ovarian recrudescence in the freshwater murrel, Channa punctatus (Bl): A quantitative study. Ecotoxicol. Environ. Saf. **9**, 241-249.

Mayer, Jr. F.L (1986) Acute toxicity handbook of chemicals to estuarine organisms. Environmental Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Gulf Breeze, Florida, EPA/600/X-86/321.

McKenney, Jr.,C.L. (1986) Influence of the organophosphate insecticide fenthion on Mysidopsis bahia exposed during a complete life cycle I. Survival, reproduction, and age-specific growth. Dis. Aquat. Org. **1**, 131-139.

McLeese, D.W., and C.D. Metcalfe (1980) Toxicities of eight organochlorine compounds in sediment and seawater to Crangon septemspinosa. Bull. Environ. Contam. Toxicol. **25**, 921-928.

McLeese, D.W., L.E. Burridge, and J. Van Dinter (1982) Toxicities of five organochlorine compounds in water amd sediment to Nereis virens. Bull. Environ. Contam. Toxicol. **28**, 216-220.

Morgan, J.R. (1972) Effects of Aroclor 1242 (apolychlorinated biphenyl) and DDT on cultures of an alga, protozoan, daphnid, ostracod, and guppy. Bull. Environ. Contam. Toxicol. **8**, (3), 129-137.

Muirhead-Thomson, R.C. (1978) Relative susceptibility of stream macroinvertebrates to temephos and chlorpyrifos, determined in laboratory continuous-flow systems. Arch. Environ. Contam. Toxicol. **7**, 129-137.

Mullié, W.C., P.J. Verwey, A.G. Berends, F. Sène, J.H. Koeman, and J.W. Everts (1991) The impact of furadan 3G (carbofuran applications on aquatic macroinvertebrates in irrigated rice in Senegal. Arch. Environ. Contam. Toxicol. **20**, 177-182.

Murphy P.M. (1978) A manual for toxicity tests with freshwater macroinvertebrates and a review of the effects of specific toxicants. The university of Wales, Institute of science and technology.

Naqvi, S.M.Z. (1973) Toxicity of twenty-three insecticides to a tubificid worm Branchiura sowerbyi from the Mississippi Delta. J. Econ. Entomol. **66**, (1), 70-74.

Neely, W.B. (1984) An analysis of aquatic toxicity data: water solubility and acute LC50 fish data. Chemoshere **13**, (7), 813-819.

Newell, S.Y., K.E. Cooksey, J.W. Fell, I.M. Master, C. Miller, amd M.A. Walter (1981) Acute impact of an orgnophosphorus insecticide on microbes and small invertebrates of a mangrove estuary. Arch. Environ. Contam. Toxicol. **10**, 427-435.

Norberg, T.J., and D.J. Mount (1985) A new fathead minnow (Pimephales promelas) subchronic

toxicity test. Environ. Toxicol. Chem. **4**, 711-718.

Norberg-King, T.J. (1989) An evaluation of the fathead minnow seven-day subchronic test for estimating chronic toxicity. Environ. Toxicol. Chem. **8**, 1075-1089.

Parsons, J.T., and G.A. Surgeoner (1991) Effect of exposure time on ethe acute toxicities of permethrin, fenitrothion, carbaryl and carbofuran to mosquito larvae. Environ. Toxicol. Chem. **10**, 1219-1227.

Pawar, K.R., and M. Katdare (1984) Effect of sublethal and lethal concentrations of fenitrothion , BHC and carbofuran on behaviour and oxygenconsumption of the freshwater prawn Macrobrachium kistnensis (Tiwari). Arch. Hydrobiol. **99**, (3), 398-403.

Rastogi, A., snd S. K. Kulshrestha (1990) Effect of sublethal doses of three pesticides on the ovary of a carp minnow Rasbora daniconius. Bull. Environ. Contam. Toxicol. **45**, 742-747.

Sanders, H.O. and O.B. Cope (1966) Toxicities of several pesticides to two species of cladocerans. Trans. Am. Fish. Soc. **95**, (2), 165-169.

Sanders, H.O. and O.B. Cope (1968) The relative toxicities of several pesticides to naiads of three species of stoneflies. Limnol. Oceanogr. **13**, (1), 112-117.

Seugé, J., and R. Bluzat (1983) Chronic toxicity of three insecticides (carbaryl, fenthion and lindane) in the freshwater snail Lymnaea stagnalis. Hydrobiol. **106**, 65-72.

Sharma, M.P. and A.K. Dattagupta (1983) Response of some freshwater micrometazoans to DDT. Proc. Indian Acad. Sci. **92**, (1), 19-29.

Södergren, A. (1968) Uptake and acuumulation of C^{14} by Chlorella sp. (Chlorophyceae). Oikos, **19**, 126-138.

Stevens, M.N. (1991) Insecticide treatments used against a rice bloodworm, Chironimus tepperi (Diptera: Chironomidae): Toxicity and residual effects in water. J. Econ. Entomol. **84**, 795-

Thompson, C.Q., and J.W. Tucker, Jr (1989) Toxicity of the organophosphate insecticide fenthion, alone and with thermal fog carriers to and estuarine copepod and young fish. Bull. Environ. Contam. Toxicol. **43**, 789-796.

Trotter, D.M. (1991) Aquatic fate and effect of carbofuran. Crit. Rev. Environ. Control **21**, 137-176.

Vance, B.D. and W. Drummond (1969) Biological concentration of pesticides by algae. J. Am. Water Works Assoc. **61**, 360-362.

Van Dijk, L.P., C.G. Greeff, and J.J. Brink (1975) Total population density of crustacea and aquatic insecta as an indicator of fenthion pollution of river water. Bull. Environ. Contam. Toxicol. **14**, (4), 426-431.

Van Leeuwen, C.J., T. Helder, and W. Seinen (1986c) Aquatic toxicological aspects of dithiocarbamates and related compounds. IV. Teratogenicity and histopathology in rainbow trout (Salmo gairdneri). Aquat. Toxicol. **9**, 147-159.

Verma, S.R., S.K. Bansal, and R.C. Dalela (1978) Toxicity of selected organic pesticides to a fresh water teleost fish, Saccobranchus fossilis and its application in controlling water pollution. Arch. Environ. Contam. Toxicol. **7**, 317-323.

Ware, G.W. and C.C. Roan (1970) Interaction of pesticides with aquatic microorganisms and plankton. Residue Rev. **33**, 15-45.

Wayland, M. (1991) Effect of carbofuran on selected macroinvertebrates in a prairy parkland pond: An enclosure approach. Arch. Environ. Contam. Toxicol. **21**, 270-280.

Westin, D.T., C.E. Olney, and B.A. Rogers (1985) Effects of parental and dietary organochlorines on survival and body burdens of striped bass larvae. Trans. Am. Fish. Soc. **114**, 125-136.

Woltering, D.M (1984) The growth response in fish chronic and early life stage toxicity tests: A critical review. Aquat. Toxicol. **5**, 1-21.

Yoshioka, Y., T. Mizuno, Y. Ose, and T. Sato (1986) The estimation for toxicity of chemicals on fish by physico-chemical properties. Chemosphere **15**, 195-203.

Appendix 2. Toxicity data for saltwater organisms

In this appendix toxicity data for saltwater organisms are presented in three different tables:
- table 2.1: acute data: L(E)C50 values,
- table 2.2: chronic data: NOEC values,
- table 2.3: data from deviating tests.

Legenda:

A	+ test substance analysed in test solution - test substance not analysed in solution or : no data
test type	S: static; R: renewal; IF: intermittent flow; CF: continuous flow;
test water	sw: seawater; fs: filtered seawater; es: enriched seawater; sa: salt water; as: artificical seawater; am: artificial medium
exposure time	h: hour(s); d: day(s); w: week(s);
> and ≥	value indicated is highest concentration used in the test.
< and ≤	value indicated is lowest concentration used in the test.
α	given value based on measured concentrations

Content:

Table 2.1.1 Acute toxicity of aldrin to saltwater organisms: L(E)C50 values

Organism	A	Test type	Purity compound	Test water	pH	Salinity in ‰	Exp. time	Criterion	Result µg/l	Reference
crustaceans										
Callinectes sapidus (juvenile)	-	F	95%	-	-	21	48 h	EC50[3]	23	Mayer, 1987
Callinectes sapidus	-[1]	F	-	sw	-	-	48 h	EC50[2]	42[6]	Butler, 1963
Crangon septemspinosa (0.25 g, 2.6 cm)	-	S	-	-	-	-	96 h	LC50	8.0	WHO, EHC 91[5]
Pagurus longicarpus (0.28 g, 0.35 cm)	-	S	-	-	-	-	96 h	LC50	33[6]	WHO, EHC 91[5]
Palaemonetes vulgaris (0.47 g, 3.1 cm)	-	S	-	-	-	-	96 h	LC50	9.0	WHO, EHC 91[5]
Penaeus duorarum	-[1]	F	-	sw	-	-	24 h	EC50[2]	0.6	Butler, 1963
Penaeus duorarum (juvenile)	-	F	95%	-	-	30	48 h	EC50[3]	0.32	Mayer, 1987
molluscs										
Crassostrea virginica (juvenile)	-	F	95%	-	-	27	96 h	EC50[4]	15	Mayer, 1987
fish										
Fundulus heteroclitus (42 mm)	-	S	-	sw	8	24	96 h	LC50	4.0	Eisler, 1970a
Gasterosteus aculeatus (0.4-0.8 g)	-	S	88.4%	-	-	5	96 h	LC50	40[6]	Katz, 1961a
Gasterosteus aculeatus (0.4-0.8 g)	-	S	88.4%	-	-	25	96 h	LC50	27	Katz, 1961a
Leiostomus xanthurus (juvenile)	-	F	95%	-	-	28	48 h	LC50	3.2	Mayer, 1987
Morone saxatilis (70 mm, 4.3 g)	-	IF	90%	fs	-	28	96 h	LC50	7.2	Korn, 1974
Mugil cephalus	-	F	95%	-	-	23	48 h	LC50	2.0	Mayer, 1987
Mugil curema	-[1]	F	-	sw	-	-	48 h	LC50	2.8	Butler, 1963

1. stock solution introduced at continuous rate
2. mortality or loss of equilibrium
3. immobility or loss of equilibrium
4. shell growth
5. original reference, Eisler 1969, not checked
6. > solubility (in freshwater)

Table 2.1.2 Acute toxicity of carbofuran to saltwater organisms: L(E)C50 values

Organism	A	Test type	Purity compound	Test water	pH	Salinity in ‰	Exp. time	Criterion	Result µg/l	Reference
crustaceans										
Cancer magister (zoea)	-	R[1]	techn. grade	sw	7.8	25	96 h	EC50[2]	1.5	Caldwell, 1977
Cancer magister (zoea)	-	R[1]	techn. grade	sw	7.8	25	96 h	LC50	2.5	Caldwell, 1977
Cancer magister (adult)	-	R[1]	techn. grade	sw	7.5	25	96 h	LC50	190	Caldwell, 1977
Penaeus duorarum (juvenile)	-	F	99.2%	-	-	30	48 h	EC50[3]	4.6	Mayer, 1987
fish										
Cyprinodon variegatus (juvenile)	+	IF	-	as	-	21	96 h	LC50	390 α	Hansen, 1977a
Lagodon rhomboides (46-102 mm)	-	F	techn. grade	sw	-	17-29	48 h	LC50	100	Coppage, 1977

1. daily renewal
2. inhibition of swimming
3. immobility or loss of equilibrium

Table 2.1.3 Acute toxicity of chlordane to saltwater organisms: L(E)C50 values

Organism	A	Test type	Purity compound	Test water	pH	Salinity in ‰	Exp. time	Criterion	Result µg/l	Reference
crustaceans										
Callinectes sapidus	-[4]	F	-	sw	-	-	48 h	EC50[5]	480[9]	Butler, 1963
Cancer magister (zoea)	-	R[1]	techn. grade	sw	7.8	25	96 h	EC50[2]	1.3	Caldwell, 1977
Crangon septemspinosa	+	R[3]	-	sw	-	-	96 h	LC50	2.0 α	McLeese, 1980
Palaemonetes pugio (20-29 mm)	+[8]	F	99.9%	sw	-	22.7	96 h	LC50	4.8 α	Parrish, 1976
Penaeus aztecus (juvenile)	-	F	techn. grade	-	-	23	48 h	EC50[7]	2.4	Mayer, 1987
Penaeus aztecus	-[4]	F	-	sw	-	-	48 h	EC50[5]	4.4	Butler, 1963
Penaeus duorarum (50-65 mm)	+[8]	F	99.9%	sw	-	21.8	96 h	LC50	0.4 α	Parrish, 1976
molluscs										
Crassostrea virginica (29-53 mm)	+[8]	F	99.9%	sw	-	24.3	96 h	EC50[6]	6.2 α	Parrish, 1976
Crassostrea virginica (juvenile)	-	F	techn. grade	-	-	27	96 h	EC50[6]	10	Mayer, 1987
fish										
Cyprinodon variegatus (19-27 mm)	+[8]	F	99.9%	sw	-	25	96 h	LC50	4.8 α	Parrish, 1976
Cyprinodon variegatus (adult)	+	IF	techn. grade	fs	-	-	96 h	LC50	13[9] α	Parrish, 1978
Gasterosteus aculeatus (0.4-0.8 g)	-	S	100%	-	-	5	96 h	LC50	90	Katz, 1961a
Gasterosteus aculeatus (0.4-0.8 g)	-	S	100%	-	-	25	96 h	LC50	160[9]	Katz, 1961a
Lagodon rhomboides (34-62 mm)	+[8]	F	99.9%	sw	-	24.6	96 h	LC50	6.4 α	Parrish, 1976
Mugil cephalus	-	F	techn. grade	-	-	23	48 h	LC50	3.2	Mayer, 1987
Mugil curema	-[4]	F	-	sw	-	-	48 h	LC50	5.5	Butler, 1963

1. daily renewal
2. inhibition of swimming
3. renewed after 48 h
4. stock solution introduced at continuous rate
5. mortality or loss of equilibrium
6. shell growth
7. immobility or loss of equilibrium
8. analysed once
9. > solubility (in freshwater)

Table 2.1.4 Acute toxicity of chlorpyrifos to saltwater organisms

Organism	A	Test type	Purity compound	Test water	pH	Salinity in ‰	Exp. time	Criterion	Result µg/l	Reference
protozoa										
Photobacterium phosphoreum	-	S	-	saline	-	-	5 min	EC50[9]	3900	Benson & Long, 1991
	-	S	-	saline	-	-	15 min	EC50[9]	4600	Benson & Long, 1991
	-	S	-	saline	-	-	30 min	EC50[9]	5800	Benson & Long, 1991
algae										
Isochrysis galbana	-	S	92%	-	-	30	96 h	EC50[1]	140	Mayer, 1987
Skeletonema costatum	-	S	92%	-	-	30	96 h	EC50[1]	300	Mayer, 1987
Skeletonema costatum	-	S	-	as	8.1	30	48 h	EC50[1]	1200	Walsh, 1983
Thalassiosira pseudonana	-	S	92%	-	-	30	96 h	EC50[1]	150	Mayer, 1987
crustaceans										
Callinectes sapidus (juvenile)	-	F	92%	-	-	26	48 h	EC50[5]	5.2	Mayer, 1987
Mysidopsis bahia (juvenile 1d)	-	S	92%	-	-	20	96 h	LC50	0.056	Mayer, 1987
Mysidopsis bahia (juvenile 1d)	+	F	92%	-	-	27	96 h	LC50	0.035 α	Mayer, 1987
Mysidopsis bahia (adult)	-	F	92%	-	-	27	96 h	LC50	0.040	Mayer, 1987
Mysidopsis bahia	-	F	92%	fs	-	26.7	96 h	LC50	0.035	Schimmel, 1983
Penaeus aztecus (juvenile)	-	F	92%	-	-	26	48 h	EC50[5]	0.2	Mayer, 1987
Penaeus duorarum (juvenile)	-	F	92%	-	-	26	48 h	EC50[5]	2.4	Mayer, 1987
Palaemonetes pugio (juvenile)	-	F	92%	-	-	26	48 h	EC50[5]	1.5	Mayer, 1987
molluscs										
Crassostrea virginica (embryo)	-	S	92%	-	-	20	48 h	EC50[6]	2000	Mayer, 1987
Crassostrea virginica (juvenile)	-	F	92%	-	-	28	96 h	EC50[7]	34	Mayer, 1987
Crassostrea virginica (juvenile)	-	F	92%	-	-	24	96 h	EC50[7]	270	Mayer, 1987
fish										
Cyprinodon variegatus (juvenile)	-	S	92%	-	-	20	96 h	LC50	270	Mayer, 1987
Cyprinodon variegatus (juvenile)	+	F	92%	-	-	10	96 h	LC50	140 α	Mayer, 1987
Cyprinodon variegatus	-	F	92%	fs	-	10.3	96 h	LC50	140	Schimmel, 1983
Fundulus grandis (juvenile)	+	F	92%	-	-	28	96 h	LC50	1.8 α	Mayer, 1987
Fundulus heteroclitus (5.54 cm, 1.67 g)	-	S	99.5%	as	-	-	96 h	LC50	4.7	Thirugnanam, 1977
Fundulus similis (juvenile)	-	F	92%	-	-	24	48 h	LC50	3.2	Mayer, 1987
Fundulus similis (adult)	+	F	92%	-	-	26	96 h	LC50	4.1 α	Mayer, 1987
Fundulus similis	-	F	92%	fs	-	25.9	96 h	LC50	4.1	Schimmel, 1983
Fundulus sp.	-	-	-	-	-	-	48 h	LC50	470	WHO, EHC 63[8]
Leiostomus xanthurus (juvenile)	-	F	92%	-	-	26	48 h	LC50	7.0	Mayer, 1987
Leuresthes tenuis (day-of-hatch)	+[2]	S	92%	sw	-	25	96 h	LC50	5.5 α	Borthwick, 1985a
Leuresthes tenuis (28 days old)	+[2]	S	92%	sw	-	25	96 h	LC50	2.6 α	Borthwick, 1985a
Leuresthes tenuis (28 days old)	+[3]	F	92%	sw	-	25	96 h	LC50	1.3 α	Borthwick, 1985a
Leuresthes tenuis (prolarva)	-	S	92%	-	-	25	96 h	LC50	5.5	Mayer, 1987

(to be continued)

Table 2.1.4 Acute toxicity of chlorpyrifos to saltwater organisms (continued)

Organism	A	Test type	Purity compound	Test water	pH	Salinity in ‰	Exp. time	Criterion	Result µg/l	Reference
Leuresthes tenuis (day-of-hatch)	+[3]	F	92%	sw	-	25	96 h	LC50	1.0 α	Borthwick, 1985a
Leuresthes tenuis (7 days old)	+[2]	S	92%	sw	-	25	96 h	LC50	2.7 α	Borthwick, 1985a
Leuresthes tenuis (7 days old)	+[3]	F	92%	sw	-	25	96 h	LC50	1.0 α	Borthwick, 1985a
Leuresthes tenuis (14 days old)	+[2]	S	92%	sw	-	25	96 h	LC50	1.8 α	Borthwick, 1985a
Leuresthes tenuis (14 days old)	+[3]	F	92%	sw	-	25	96 h	LC50	1.0 α	Borthwick, 1985a
Leuresthes tenuis (prolarva)	+	F	92%	-	-	31	96 h	LC50	1.0 α	Mayer, 1987
Leuresthes tenuis (larva 7d)	-	S	92%	-	-	25	96 h	LC50	2.7	Mayer, 1987
Leuresthes tenuis (larva 7d)	+	F	92%	-	-	25	96 h	LC50	2.7 α	Mayer, 1987
Leuresthes tenuis (larva 14d)	-	S	92%	-	-	25	96 h	LC50	1.8	Mayer, 1987
Leuresthes tenuis (larva 14d)	+	F	92%	-	-	20	96 h	LC50	1.0 α	Mayer, 1987
Leuresthes tenuis (larva 28d)	-	S	92%	-	-	25	96 h	LC50	2.6	Mayer, 1987
Leuresthes tenuis (larva 28d)	+	F	92%	-	-	21	96 h	LC50	1.3 α	Mayer, 1987
Menidia beryllina (juvenile 72d)	+	F	92%	-	-	5	96 h	LC50	4.2 α	Mayer, 1987
Menidia beryllina (juvenile)	+	F	techn. grade	fs	-	5	96 h	LC50	4.2 α	Clark, 1985
Menidia menidia (larva <1d)	-	S	92%	-	-	20	96 h	LC50	4.5	Mayer, 1987
Menidia menidia (larva <1d)	+	F	92%	-	-	27	96 h	LC50	0.51 α	Mayer, 1987
Menidia menidia (larva 7d)	N	S	92%	-	-	20	96 h	LC50	2.8	Mayer, 1987
Menidia menidia (larva 7d)	+	F	92%	-	-	20	96 h	LC50	1.0 α	Mayer, 1987
Menidia menidia (larva 14d)	-	S	92%	-	-	20	96 h	LC50	2.4	Mayer, 1987
Menidia menidia (larva 14d)	+	F	92%	-	-	20	96 h	LC50	1.1 α	Mayer, 1987
Menidia menidia (larva 28d)	-	S	92%	-	-	20	96 h	LC50	4.1	Mayer, 1987
Menidia menidia (larva 28d)	+	F	92%	-	-	27	96 h	LC50	3.0 α	Mayer, 1987
Menidia menidia (larva 53d)	+	F	92%	-	-	24	96 h	LC50	1.7 α	Mayer, 1987
Menidia menidia (adult)	+	F	92%	-	-	24	96 h	LC50	1.7 α	Mayer, 1987
Menidia menidia (day-of-hatch)	+[2]	S	92%	sw	-	20	96 h	LC50	4.5 α	Borthwick, 1985a
Menidia menidia (7 days old)	+[2]	S	92%	sw	-	20	96 h	LC50	2.8 α	Borthwick, 1985a
Menidia menidia (14 days old)	+[2]	S	92%	sw	-	20	96 h	LC50	2.4 α	Borthwick, 1985a
Menidia menidia (28 days old)	+[2]	S	92%	sw	-	20	96 h	LC50	4.1 α	Borthwick, 1985a
Menidia menidia (day of hatch)	+[3]	F	92%	sw	-	20	96 h	LC50	0.5 α	Borthwick, 1985a
Menidia menidia (7 days old)	+[3]	F	92%	sw	-	20	96 h	LC50	1.0 α	Borthwick, 1985a
Menidia menidia (14 days old)	+[3]	F	92%	sw	-	20	96 h	LC50	1.1 α	Borthwick, 1985a
Menidia menidia (28 days old)	+[3]	F	92%	sw	-	20	96 h	LC50	3.0 α	Borthwick, 1985a
Menidia menidia	-	F	92%	fs	-	24.3	96 h	LC50	1.7	Schimmel, 1983
Menidia peninsula (day-of-hatch)	+[2]	S	92%	sw	-	20	96 h	LC50	4.2 α	Borthwick, 1985a
Menidia peninsula (7 days old)	+[2]	S	92%	sw	-	20	96 h	LC50	2.0 α	Borthwick, 1985a
Menidia peninsula (14 days old)	+[2]	S	92%	sw	-	20	96 h	LC50	1.8 α	Borthwick, 1985a
Menidia peninsula (28 days old)	+[2]	S	92%	sw	-	20	96 h	LC50	3.9 α	Borthwick, 1985a
Menidia peninsula (day of hatch)	+[3]	F	92%	sw	-	20	96 h	LC50	1.0 α	Borthwick, 1985a
Menidia peninsula (larva 14d)	-	S	92%	-	-	20	96 h	LC50	1.8	Mayer, 1987
Menidia peninsula (larva 14d)	+	F	92%	-	-	20	96 h	LC50	0.42 α	Mayer, 1987
Menidia peninsula (larva 28d)	-	S	92%	-	-	20	96 h	LC50	3.9	Mayer, 1987

Table 2.1.4 Acute toxicity of chlorpyrifos to saltwater organisms (continued)

Organism	A	Test type	Purity compound	Test water	pH	Salinity in ‰	Exp. time	Criterion	Result µg/l	Reference
Menidia peninsula (7 days old)	+[3]	F	92%	sw	-	20	96 h	LC50	0.5 α	Borthwick, 1985a
Menidia peninsula (14 days old)	+[3]	F	92%	sw	-	20	96 h	LC50	0.4 α	Borthwick, 1985a
Menidia peninsula (28 days old)	+[3]	F	92%	sw	-	20	96 h	LC50	0.9 α	Borthwick, 1985a
Menidia peninsula (juvenile)	+	F	techn. grade	fs	-	19.3	96 h	LC50	1.3 α	Clark, 1985
Menidia peninsula (larva 7d)	+	F	92%	-	-	20	96 h	LC50	0.52 α	Mayer, 1987
Menidia peninsula (larva 28d)	+	F	92%	-	-	30	96 h	LC50	0.89 α	Mayer, 1987
Menidia peninsula (larva 60d)	+	F	92%	-	-	19	96 h	LC50	1.3 α	Mayer, 1987
Menidia peninsula (larva <1d)	-	S	92%	-	-	20	96 h	LC50	4.2	Mayer, 1987
Menidia peninsula (larva <1d)	+	F	92%	-	-	27	96 h	LC50	0.96 α	Mayer, 1987
Menidia peninsula (larva 7d)	-	S	92%	-	-	20	96 h	LC50	2.0	Mayer, 1987
Mugil cephalus (juvenile)	+	F	92%	-	-	25	96 h	LC50	5.4 α	Mayer, 1987
Opsanus beta (juvenile)	+	S	92%	-	-	30	96 h	LC50	520 α	Mayer, 1987
Opsanus beta (juvenile)	+	F	92%	-	-	25	96 h	LC50	68 α	Mayer, 1987
Opsanus beta	-	R[4]	techn.	fs grade	-	29-30	96 h	LC50	520	Hansen, 1986

1. growth
2. initial concentration measured
3. measured at 48 and 96 h
4. renewal at 24 h intervals
5. immobility or loss of equilibrium
6. development
7. shell growth
8. original reference, Yoshida 1972, not checked
9. fluorescens

Table 2.1.5 Acute toxicity of DDD to saltwater organisms: L(E)C50 values

Organism	A	Test type	Purity compound	Test water	pH	Salinity in ‰	Exp. time	Criterion	Result µg/l	Reference
algae										
Agmenellum quadruplicatum	-	-	-	-	-	-	24 h	EC50[1]	790[5]	Boush, 1975
crustaceans										
Artemia salina	-	-	-	-	-	-	24 h	LC50	60[2]	Boush, 1975
Penaeus duorarum (juvenile)	-	F	100%	sw	-	31	48 h	EC50[3]	2.4	Mayer, 1987
molluscs										
Crassostrea virginica (juvenile)	-	F	100%	-	-	30	96 h	EC50[4]	25	Mayer, 1987
fish										
Fundulus similis (juvenile)	-	F	100%	sw	-	28	48 h	LC50	42	Mayer, 1987
Leiostomus xanthurus (juvenile)	-	F	100%	sw	-	30	48 h	LC50	20	Mayer, 1987
Morone saxatilis (40 mm, 0.6 g)	-	IF	99%	fs	-	30	96 h	LC50	2.5	Korn, 1974

1. growth
2. extrapolated
3. immobility or loss of equilibrium
4. shell growth
5. > solubility (in freshwater)

Table 2.1.6 Acute toxicity of DDE to saltwater organisms: L(E)C50 values

Organism	A	Test type	Purity compound	Test water	pH	Salinity in ‰	Exp. time	Criterion	Result µg/l	Reference
crustaceans										
Nitocra spinipes	-	-	99.9%	sa	8	7	96 h	LC50	2.5	Bengtsson, 1978
Penaeus aztecus (juvenile)	-	F	-	-	-	17-27	48 h	EC50[4]	28	Butler, 1965
Penaeus aztecus (juvenile)	-	F	99%	-	-	30	48 h	EC50[2]	28	Mayer, 1987
molluscs										
Crassostrea virginica (juvenile)	-	F	99%	sw	-	17-27	96 h	EC50[3]	14	Butler, 1965/Mayer, 1987

1. > solubility (in freshwater)
2. immobility or loss of equilibrium
3. shell growth
4. mortality or loss of equilibrium

Table 2.1.7 Acute toxicity of DDT to saltwater organisms: L(E)C50 values

Organism	A	Test type	Purity compound	Test water	pH	Salinity in ‰	Exp. time	Criterion	Result µg/l	Reference
algae										
Coccolithus huxleyi	-	S	-	es	-	-	24 h	EC50[10]	10[1,12]	Wurster, 1968
Peridinium trochoideum	-	S	-	es	-	-	24 h	EC50[10]	10[1,12]	Wurster, 1968
Pyramimonas sp.	-	S	-	es	-	-	24 h	EC50[10]	30[1,12]	Wurster, 1968
Skeletonema costatum	-	S	-	es	-	-	24 h	EC50[10]	20[1,12]	Wurster, 1968
crustaceans										
Artemia salina	-	-	-	-	-	-	24 h	LC50	14[1,12]	Boush, 1975
Callinectes sapidus	-[4]	F	-	sw	-	-	48 h	EC50[5]	10[12]	Butler, 1963
Cancer magister (zoea)	+[2]	S	techn. grade	fs	8.1	30	96 h	LC50	1.1 α	Dinnel, 1989
Crangon septemspinosa	+	R[3]	-	sw	-	-	96 h	LC50	0.4 α	McLeese, 1980
Gammarus duebeni	-	S	-	sw	-	-	96 h	LC50	3.8	Lockwood, 1975
Mysidopsis bahia (adult)	-	S	99.3%	-	-	23	96 h	LC50	0.45	Mayer, 1987
Nitocra spinipes (3-6 weeks)	-	S	>99%	fs	7.8	7	96 h	LC50	30[12]	Lindén, 1979
Palaemonetes pugio (juvenile)	-	F	99.3%	-	-	28	24 h	EC50[7]	0.8	Mayer, 1987
Penaeus aztecus	-[4]	F	-	sw	-	-	48 h	EC50[5]	10[12]	Butler, 1963
Penaeus duorarum (juvenile)	-	F	99.3%	-	-	28	48 h	EC50[7]	0.6	Mayer, 1987
Penaeus setiferus (juvenile)	-	F	99.3%	-	-	28	24 h	EC50[7]	0.7	Mayer, 1987
molluscs										
Crassostrea virginica (juvenile)	-	F	99.3%	-	-	23	96 h	EC50[8]	9.0	Mayer, 1987
fish										
Cymatogaster aggregata (1.2-11 g)	-	S	99%	-	-	26	96 h	LC50	7.6	WHO, EHC 83[11]
Cymatogaster aggregata (1.2-11 g)	-	IF	99%	-	-	13-23	96 h	LC50	0.45	WHO, EHC 83[11]
Cyprinodon variegatus (juvenile)	-[4]	F	-	sw	-	25	48 h	LC50	5.0	Butler, 1964
Cyprinodon variegatus (juvenile)	-	F	-	sw	-	17-27	48 h	LC50	5.0	Butler, 1965
Cyprinodon variegatus (juvenile)	-	F	99.3%	sw	-	30	48 h	LC50	2.0	Mayer, 1987
Fundulus heteroclitis (42 mm)	-	S	-	sw	8	24	96 h	LC50	3.0	Eisler, 1970a
Fundulus similis (juvenile)	-	F	99.3%	-	-	30	48 h	LC50	2.8	Mayer, 1987
Fundulus similis	-[4]	F	-	sw	-	-	48 h	LC50	5.5[12]	Butler, 1963
Gasterosteus aculeatus (0.4-0.8 g)	-	S	-	-	-	5	96 h	LC50	18[12]	Katz, 1961a
Gasterosteus aculeatus (0.4-0.8 g)	-	S	-	-	-	25	96 h	LC50	12[12]	Katz, 1961a
Lagodon rhomboides (juvenile)	-	F	99.3%	-	-	29	48 h	LC50	0.3	Mayer, 1987
Leiostomus xanthurus (juvenile)	-[4]	F	-	sw	-	20	48 h	LC50	2.0	Butler, 1964
Morone saxatilis (70 mm, 2.7 g)	-	IF	77.2%	fs	-	28	96 h	LC50	0.41[9]	Korn, 1974
Mugil cephalus (juvenile)	-	F	99.3%	sw	-	30	48 h	LC50	0.4	Mayer, 1987
Mugil curema	-[4]	F	-	sw	-	-	48 h	LC50	0.4	Butler, 1963

1. extrapolated
2. initial and final concentrations measured
3. renewal after 48 h
4. stock solution introduced at continuous rate
5. mortality or loss of equilibrium
6. daily renewal
7. immobility or loss of equilibrium
8. shell growth
9. recalculated to a purity of 100%
10. photosynthesis
11. original reference, Earnest 1972, not checked
12. > solubility (in freshwater)

Table 2.1.8 Acute toxicity of endosulfan to saltwater organisms: L(E)C50 values

Organism	A	Test type	Purity compound	Test water	pH	Salinity in ‰	Exp. time	Criterion	Result µg/l	Reference
archiannelids										
Dinophilus gyrociliatus	-	R[1]	-	fs	-	31	96 h	LC50	1000[2,4]	Carr, 1986
crustaceans										
Callinectes sapidus (juvenile)	-	F	96%	-	-	24	48 h	EC50[10]	19	Mayer, 1987
Callinectes sapidus (juvenile)	-[13]	F	-	sw	-	-	48 h	EC50[5]	35	Butler, 1963
Cancer magister (zoea)	+[7]	S	techn. grade	fs	8.1	30	96 h	LC50	15 α	Dinnel, 1989
Crangon septemspinosa (adult)	+	R[6]	-	sw	-	-	96 h	LC50	0.2 α	McLeese, 1980
Crangon septemspinosa (adult)	+[8]	F	techn. grade	fs	7.9	30	96 h	LC50	3.2 α	Dinnel, 1989
Palaemonetes pugio (adult)	+	F	96%	fs	-	21	96 h	LC50	1.3 α	Schimmel, 1977/Mayer, 1987
Penaeus aztecus (juvenile)	-	F	96%	-	-	24	48 h	EC50[10]	0.24	Mayer, 1987
Peneaus aztecus (adult)	-[13]	F	96%	sw	-	-	48 h	EC50[5]	0.4	Butler, 1963
Peneaus duorarum (adult)	+	F	96%	fs	-	16	96 h	LC50	0.04 α	Schimmel, 1977/Mayer, 1987
echinoderms										
Dendraster excentricus (embryo)	+[7]	S	techn. grade	fs	8.0-8.1	30	72 h	LC50	820[4] α	Dinnel, 1989
Strongylocentrotus purpuratus (embryo)	+[7]	S	techn. grade	fs	7.8-8.1	30	5 d	LC50	230 α	Dinnel, 1989
molluscs										
Crassostrea sp.	-[13]	F	-	sw	-	21	96 h	EC50[12]	380[14,4]	Butler, 1964
Crassostrea sp.	-[13]	F	-	sw	-	22	96 h	EC50[12]	65[3]	Butler, 1964
Crassostrea virginica	-[13]	F	-	sw	-	22	96 h	EC50[12]	65[3]	Butler, 1963
Crassostrea virginica (larva)	-	S	96%	-	-	20	48 h	EC50[11]	460[4]	Mayer, 1987
Crassostrea virginica (juvenile)	-	F	96%	-	-	22	96 h	EC50[12]	42	Mayer, 1987
fish										
Cymatogaster aggregata (adult)	+[8]	F	techn. grade	fs	8	29.2	96 h	LC50	1.1 α	Dinnel, 1989
Lagodon rhomboides (adult)	+	F	96%	fs	-	16	96 h	LC50	0.3 α	Schimmel, 1977/Mayer, 1987
Leiostomus xanthurus (adult)	+	F	96%	fs	-	18	96 h	LC50	0.09 α	Schimmel, 1977/ Mayer, 1987
Leiostomus xanthurus (juvenile)	-	F	96%	-	-	26	48 h	LC50	0.32	Mayer, 1987
Leiostomus xanthurus (juvenile)	-[13]	F	-	sw	-	26	48 h	LC50	0.6	Butler, 1964
Morone saxatilis (33 mm, 0.3 g)	-	IF	-	fs	-	30	96 h	LC50	0.1	Korn, 1974
Mugil cephalus (juvenile)	+	F	96%	fs	-	15	96 h	LC50	0.38 α	Schimmel, 1977/Mayer, 1987
Mugil cephalus (juvenile)	-	F	96%	-	-	25	48 h	LC50	0.32	Mayer, 1987
Mugil curema (juvenile)	-[13]	F	-	sw	-	-	48 h	LC50	0.6	Butler, 1963
Oncorhynchus kisutch (adult)	+[8]	F	techn. grade	fs	8.1	28.4	96 h	LC50	2.1 α	Dinnel, 1989

1. daily 50% renewal
2. average of two results
3. at 28°C
4. > solubility (in freshwater)
5. mortality or loss of equilibrium
6. renewal after 48 h
7. initial and final concentrations measured
8. measured daily
9. daily renewal
10. immobility or loss of equilibrium
11. development
12. shell growth
13. stock solution introduced at continuous rate
14. at 19°C

Table 2.1.9 Acute toxicity of endrin to saltwater organisms: L(E)C50 values

Organism	A	Test type	Purity compound	Test water	pH	Salinity in ‰	Exp. time	Criterion	Result µg/l	Reference
algae										
Agmenellum quadruplicatum	-	-	-	-	-	-	24 h	EC50[1]	950[10]	Boush, 1975
crustaceans										
Callinectes sapidus	-[5]	F	-	sw	-	-	48 h	EC50[6]	25	Butler, 1963
Callinectes sapidus (juvenile)	-	F	98%	-	-	16	48 h	EC50[7]	15	Mayer, 1987
Cancer magister (larva)	+[2]	S	techn. grade	fs	8.1	30	96 h	LC50	2.0 α	Dinnel, 1989
Crangon septemspinosa	-	-	-	-	-	-	96 h	LC50	1.7	WHO, EHC 2nd draft Endrin[9]
Crangon septemspinosa	+	R[3]	-	sw	-	-	96 h	LC50	0.6 α	McLeese, 1980
Crangon sp. (adult)	+	F	techn. grade	fs	8.1	28.8	96 h	LC50	0.4 α	Dinnel, 1989
Pagurus longicarpus	-	-	-	-	-	-	96 h	LC50	1.2	WHO, EHC 2nd draft Endrin[9]
Palaemonetes pugio (adult)	+	F	98%	fs	-	20.8	96 h	LC50	0.69 α	Tyler-Schroeder, 1979
Palaemonetes pugio (adult)	+	F	98%	-	-	28	96 h	EC50	0.63 α	Mayer, 1987
Palaemonetes pugio (juvenile)	+	F	98%	fs	-	23	96 h	LC50	0.35 α	Tyler-Schroeder, 1979
Palaemonetes pugio (juvenile)	-	F	98%	-	-	30	48 h	EC50[7]	0.8	Mayer, 1987
Palaemonetes pugio (larva)	+	F	98%	fs	-	12.4	96 h	LC50	1.2 α	Tyler-Schroeder, 1979
Penaeus aztecus	-[5]	F	-	sw	-	-	48 h	EC50[6]	0.3	Butler, 1963
Penaeus aztecus (juvenile)	-	F	98%	-	-	26	48 h	EC50[7]	0.2	Mayer, 1987
Penaeus duorarum (adult)	+	F	98%	-	-	28	96 h	LC50	0.037 α	Mayer, 1987
Penaeus duorarum (juvenile)	-	F	98%	-	-	30	48 h	EC50[7]	0.2	Mayer, 1987
echinoderms										
Dendraster excentricus (embryo)	+[2]	S	techn. grade	fs	8.0-8.1	30	72 h	LC50	360 α	Dinnel, 1989
molluscs										
Crassostrea virginica (adult)	+	F	98%	-	-	29	96 h	EC50[8]	14 α	Mayer, 1987
Crassostrea virginica (juvenile)	-	F	98%	-	-	22	96 h	EC50[8]	33[13]	Mayer, 1987
Crassostrea virginica (juvenile)	-	F	98%	-	-	21	96 h	EC50[8]	400[14]	Mayer, 1987
fish										
Anguilla rostrata (57 mm)	-	-	-	-	-	-	96 h	LC50	0.6	WHO, EHC 2nd draft Endrin[12]
Brevoortia partronus	-	F	98%	-	-	29	24 h	LC50	0.8	Mayer, 1987
Cymatogaster aggregata (adult)	+[4]	F	techn.	fs	8.0	29.5	96 h	LC50	0.5 α	Dinnel, 1989 grade
Cyprinodon variegatus (adult)	+	IF	-	fs	-	25.5	96 h	LC50	0.36 α	Hansen, 1977b
Cyprinodon variegatus (adult)	+	F	98%	-	-	18	96 h	LC50	0.38 α	Mayer, 1987
Cyprinodon variegatus (adult)	+	F	98%	-	-	16	96 h	LC50	0.36 α	Mayer, 1987
Cyprinodon variegatus (fry)	+	IF	-	fs	-	25.5	96 h	LC50	0.37 α	Hansen, 1977b

(to be continued)

Table 2.1.9 Acute toxicity of endrin to saltwater organisms: L(E)C50 values (continued)

Organism	A	Test type	Purity compound	Test water	pH	Salinity in ‰	Exp. time	Criterion	Result µg/l	Reference
Cyprinodon variegatus (juvenile)	+	IF	-	fs	-	25.5	96 h	LC50	0.34 α	Hansen, 1977b
Cyprinodon variegatus (juvenile)	+	IF	-	fs	-	26	96 h	LC50	0.34 α	Hansen, 1977a
Cyprinodon variegatus (juvenile)	-	F	98%	-	-	30	48 h	LC50	1.0	Mayer, 1987
Cyprinodon variegatus (juvenile)	+	F	98%	-	-	24	96 h	LC50	0.34 α	Mayer, 1987
Fundulus heteroclitus (42 mm)	-	S	-	sw	8	24	96 h	LC50	0.6	Eisler, 1970a
Fundulus heteroclitus (51 mm)	-	S	-	-	8	24	96 h	LC50	0.6	WHO, EHC 2nd draft Endrin[12]
Fundulus majalis (40 mm)	-	S	-	-	8	24	96 h	LC50	0.3	WHO, EHC 2nd draft Endrin[12]
Fundulus similis	-[5]	F	-	sw	-	-	48 h	LC50	0.3	Butler, 1963
Fundulus similis (juvenile)	-	F	98%	-	-	19	24 h	LC50	0.23	Mayer, 1987
Gasterosteus aculeatus (0.3 g)	-	S	75%	sa	-	5	96 h	LC50	1.2[11]	Katz, 1961b
Gasterosteus aculeatus (0.3 g)	-	S	75%	sa	-	15	96 h	LC50	1.2[11]	Katz, 1961b
Gasterosteus aculeatus (0.3 g)	-	S	75%	sa	-	22	96 h	LC50	0.9[11]	Katz, 1961b
Gasterosteus aculeatus (0.3 g)	-	S	75%	sa	-	25	96 h	LC50	1.1[11]	Katz, 1961b
Gasterosteus aculeatus (0.3 g)	-	S	75%	sa	-	27	96 h	LC50	1.2[11]	Katz, 1961b
Gasterosteus aculeatus (egg)	-	S	75%	sa	-	10	96 h	LC50	2.4[11]	Katz, 1961b
Leiostomus xanthurus (juvenile)	-[5]	F	-	sw	-	24	24 h	LC50	4.4	Butler, 1964
Leiostomus xanthurus (juvenile)	-	F	98%	-	-	24	48 h	LC50	0.30	Mayer, 1987
Leiostomus xanthurus (juvenile)	-[5]	F	-	sw	-	24	48 h	LC50	0.6	Butler, 1964
Menidia menidia (54 mm)	-	S	-	-	8	24	96 h	LC50	0.05	WHO, EHC 2nd draft Endrin[12]
Morone saxatilis (70 mm, 2.9 g)	-	IF	99%	fs	-	28	96 h	LC50	0.094	Korn, 1974
Mugil cephalus (juvenile)	-	F	99%	-	-	30	48 h	LC50	0.40	Mayer, 1987
Mugil cephalus (83 mm)	-	S	-	-	8	24	96 h	LC50	0.3	WHO, EHC 2nd draft Endrin[12]
Mugil curema	-[5]	F	-	sw	-	-	48 h	LC50	2.6	Butler, 1963
Oncorhynchus kisutch (adult)	+[4]	F	techn. grade	fs	8.0	28.2	96 h	LC50	1.2 α	Dinnel, 1989
Poecilia latipinna (adult)	+	F	98%	-	-	27	96 h	LC50	0.63 α	Mayer, 1987
Sphaeroidus maculatus (131 mm)	-	S	-	-	8.0	24	96 h	LC50	3.1	WHO, EHC 2nd draft Endrin[12]
Thalassoma bifasciatum (90 mm)	-	S	-	-	8.0	24	96 h	LC50	0.1	WHO, EHC 2nd draft Endrin[12]

1. growth
2. initial and final concentrations measured
3. renewal after 48 h
4. measured daily
5. stock solution introduced at continuous rate
6. mortality or loss of equilibrium
7. immobility or loss of equilibrium
8. shell growth
9. original reference, Eisler 1970c, not checked
10. > solubility (in freshwater)
11. recalculated to a purity of 100%
12. original reference, Eisler 1970b, not checked
13. at 24°C
14. at 12°C

Table 2.1.10 Acute toxicity of fenthion to saltwater organisms: L(E)C50 values

Organism	A	Test type	Purity compound	Test water	pH	Salinity in ‰	Exp. time	Criterion	Result µg/l	Reference
algae										
Cyclotella nana	-	S	-	am	-	-	24 h	EC50[6]	1000	Derby, 1971
Platymonas sp.	-	-	-	-	-	-	4 h	EC50[1]	1000	Butler, 1963
Skeletonema costatum	-	S	-	am	-	-	24 h	EC50[6]	100	Derby, 1971
crustaceans										
Acartia tonsa (adult)	+	S	98%	sa	7.7-8.2	29	48 h	LC50	550 α	Thompson, 1989
Callinectes sapidus (juvenile)	-	F	93%	-	-	25	48 h	EC50[4]	2.3	Mayer, 1987
Callinectes sapidus (juvenile)	-	F	-	-	-	-	48 h	EC50[3]	2.3	Persoone 1985[7]
Mysidopsis bahia	+	S	techn. grade	sw	-	-	48 h	LC50	0.35 α	Clark, 1987b
Mysidopsis bahia (juvenile 1d)	-	S	93%	-	-	20	48 h	LC50	0.77	Mayer, 1987
Mysidopsis bahia (juvenile 1d)	+	F	93%	-	-	21	96 h	LC50	0.15 α	Mayer, 1987
Penaeus aztecus (juvenile)	-	F	-	-	7.8	26-30	24 h	LC50	0.03	Persoone 1985[9]
Penaeus aztecus (juvenile)	-	F	-	-	-	26-30	48 h	EC50[3]	0.024	Persoone 1985[7]
Penaeus aztecus (juvenile)	-	F	93%	-	-	26	48 h	EC50[4]	0.024	Mayer, 1987
Penaeus aztecus (juvenile)	-	F	-	-	7.8	26-30	48 h	LC50	0.02	Persoone 1985[9]
Penaeus aztecus (juvenile)	-	F	-	-	-	-	24 h	EC50[3]	0.032	Persoone 1985[7]
Penaeus duorarum (juvenile)	-	F	-	-	-	-	24 h	EC50[3]	0.2	Persoone 1985[7]
Penaeus duorarum (juvenile)	-	F	-	-	-	-	48 h	EC50[3]	0.032	Persoone 1985[7]
Penaeus duorarum (juvenile)	-	F	-	-	7.8	21-25	24 h	LC50	0.2	Persoone 1985[9]
Penaeus duorarum (juvenile)	-	F	-	-	7.8	21-25	48 h	LC50	0.03	Persoone 1985[9]
Penaeus duorarum	+	S	techn. grade	sw	-	-	48 h	LC50	0.21 α	Clark, 1987b
Penaeus duorarum	-[2]	F	-	sw	-	-	48 h	EC50[3]	0.06	Butler, 1963
Penaeus duorarum (juvenile)	-	S	93%	-	-	20	48 h	LC50	0.25	Mayer, 1987
Penaeus duorarum (juvenile)	-	F	93%	-	-	25	48 h	EC50[4]	0.032	Mayer, 1987
Penaeus duorarum (juvenile)	+	F	93%	-	-	20	96 h	LC50	0.11 α	Mayer, 1987
Palaemon macrodactylus	-	IF	-	-	-	29	96 h	LC50	3.0	Persoone 1985[8]
Palaemon macrodactylus (adult)	-	S	-	-	8.2	26-30	24 h	LC50	28	Persoone 1985[9]
Palaemon macrodactylus (adult)	-	S	-	-	8.2	26-30	96 h	LC50	5.3	Persoone 1985[9]
Palaemonetes pugio (juvenile)	-	S	93%	-	-	20	48 h	LC50	4.7	Mayer, 1987
insects										
Chironomus (larva)	-	S	-	-	-	33	72 h	LC50	8.5	Persoone 1985[10]
molluscs										
Crassostrea virginica (juvenile)	-	F	93%	-	-	16	96 h	EC50[5]	360	Mayer, 1987
Crassostrea virginica (juvenile)	-	F	93%	-	-	23	96 h	EC50[5]	340	Mayer, 1987

(to be continued)

Table 2.1.10 Acute toxicity of fenthion to saltwater organisms: L(E)C50 values (continued)

Organism	A	Test type	Purity compound	Test water	pH	Salinity in ‰	Exp. time	Criterion	Result µg/l	Reference
fish										
Brevoortia patronus (egg)	+	S	98%	sa	7.7-8.2	30	48 h	LC50	540 α	Thompson, 1989
Centropomus undecimalis (egg)	+	S	98%	sa	7.7-8.2	33	48 h	LC50	1400 α	Thompson, 1989
Centropomus undecimalis (juvenile)	+	S	98%	sa	7.7-8.2	22	48 h	LC50	1000 α	Thompson, 1989
Cynoscion nebulosus (egg)	+	S	98%	sa	7.7-8.2	30	48 h	LC50	1300 α	Thompson, 1989
Cyprinodon variegatus (juvenile 14d)	-	S	93%	-	-	20	48 h	LC50	1900	Mayer, 1987
Cynoscion nebulosus (juvenile)	+	S	98%	sa	7.7-8.2	36	48 h	LC50	1100 α	Thompson, 1989
Fundulus sp.	-	-	-	-	-	-	48 h	LC50	2500	WNO, EHC 63[11]
Leiostomus xanthurus (egg)	+	S	98%	sa	7.7-8.2	30	48 h	LC50	1500 α	Thompson, 1989
Leiostomus xanthurus (juvenile)	-[2]	F	93%	sa	-	23	48 h	LC50	1200	Butler, 1963/Mayer, 1987
Menidia berillina (juvenile 14d)	-	S	93%	-	-	18	48 h	LC50	2200	Mayer, 1987
Morone saxatilis (35 mm, 0.33 g)	-	IF	-	fs	-	29	96 h	LC50	450	Korn, 1974
Mugil cephalus (juvenile)	-	F	93%	-	-	24	48 h	LC50	1600	Mayer, 1987
Mugil cephalus (juvenile)	-	F	-	-	7.8	21-25	48 h	LC50	1600	Persoone 1985[9]
Mugil curema	-[2]	F	-	sw	-	-	48 h	LC50	1600	Butler, 1963

1. decrease in productivity 50.9%
2. stock solution introduced at continuous rate
3. mortality or loss of equilibrium
4. immobility or loss of equilibrium
5. shell growth
6. oxygen production
7. original reference, USEPA unpublished data, not checked
8. original reference, Doll 1962, not checked
9. original reference, Menzie ?, not checked
10. original reference, Tsai ?, not checked
11. original reference, Yoshida 1972, not checked

Table 2.1.11 Acute toxicity of heptachlor to saltwater organisms: L(E)C50 values

Organism	A	Test type	Purity compound	Test water	pH	Salinity in ‰	Exp. time	Criterion	Result µg/l	Reference
algae										
Skeletonema costatum	-	S	-	as	-	-	72 h	EC50[5]	120[7]	Walsh, 1987
Dunaliella tertiolecta	-	S	-	as	-	-	72 h	EC50[5]	340[7]	Walsh, 1987
Porphyridium cruentum	-	S	-	as	-	-	72 h	EC50[5]	420[7]	Walsh, 1987
crustaceans										
Callinectes sapidus (juvenile)	-	F	74%	-	-	27	48 h	EC50[3]	50[7,8]	Mayer, 1987
Callinectes sapidus	-[1]	F	-	sw	-	-	48 h	EC50[2]	63[7]	Butler, 1963
Mysidopsis bahia (adult)	+	F	99%	-	-	23	96 h	LC50	3.4 α	Mayer, 1987
Pagurus longicarpus	-	S	standard grade	-	8	24	24 h	LC50	470[7]	WHO, EHC 38[6]
Pagurus longicarpus	-	S	-	-	8	24	96 h	LC50	55	WHO, EHC 38[6]
Palaemonetes vulgaris (juvenile)	+	F	89%	-	-	26	96 h	LC50	1.1 α	Mayer, 1987
Penaeus duorarum (juvenile)	-	F	74%	-	-	16	48 h	EC50[3]	0.15[8]	Mayer, 1987
Penaeus duorarum (adult)	+	F	89%	-	-	27	96 h	LC50	0.11 α	Mayer, 1987
Penaeus duorarum (adult)	+	F	99%	-	-	21	96 h	LC50	0.03 α	Mayer, 1987
Penaeus duorarum	-[1]	F	-	sw	-	-	48 h	EC50[2]	0.3	Butler, 1963
Penaeus duorarum (71-97 mm)	+	F	99.8%	fs	-	20.0-22.0	96 h	LC50	0.03 α	Schimmel, 1976a
molluscs										
Crassostrea virginica (juvenile)	-	F	74%	-	-	21	96 h	EC50[4]	16[8]	Mayer, 1987
Crassostrea virginica (juvenile)	-	F	74%	-	-	23	96 h	EC50[4]	13[8]	Mayer, 1987
Crassostrea virginica (adult)	+	F	89%	-	-	26	96 h	EC50[4]	1.5 α	Mayer, 1987
fish										
Anguilla rostrata	-	S	-	-	8	24	96 h	LC50	10	WHO, EHC 38[9]
Cyprinodon variegatus (adult)	+	F	89%	-	-	22	96 h	LC50	3.7 α	Mayer, 1987
Cyprinodon variegatus (juvenile)	+	IF	-	FW	-	19	96 h	LC50	11 α	Hansen, 1977a
Fundulus heteroclitus (42 mm)	-	S	-	sw	8	24	96 h	LC50	50	Eisler, 1970a
Lagodon rhomboides (adult)	+	F	89%	-	-	28	96 h	LC50	3.8 α	Mayer, 1987
Leiostomus xanthurus (juvenile)	-	F	74%	-	-	20	48 h	LC50	11[8]	Mayer, 1987
Leiostomus xanthurus (adult)	+	F	89%	-	-	20	96 h	LC50	0.85 α	Mayer, 1987
Leiostomus xanthurus (juvenile)	-[1]	F	-	-	-	20	48 h	LC50	25	Butler, 1964
Leiostomus xanthurus (20-30 mm)	+	F	99.8%	fs	-	20-22	96 h	LC50	0.86 α	Schimmel, 1976a
Mugil cephalus (juvenile)	-	F	74%	-	-	24	48 h	LC50	2.4[8]	Mayer, 1987
Mugil curema	-[1]	F	-	sw	-	-	48 h	LC50	3.0	Butler, 1963

1. stock solution introduced at continuous rate
2. mortality or loss of equilibrium
3. immobility or loss of equilibrium
4. shell growth
5. growth
6. original reference, Eisler 1969, not checked
7. > solubility (in freshwater)
8. recalculated to a purity of 100%
9. original reference, Eisler 1970, not checked

Table 2.1.12 Acute toxicity of heptachlorepoxide to saltwater organisms: L(E)C50 values

Organism	Analysed	Test type	Purity compound	Test water	pH	Salinity in ‰	Exp. time	Criterion	Result µg/l	Reference
crustaceans										
Penaeus duorarum (62-81 mm)	+	F	99%	fs	-	20	96 h	LC50	0.04 α	Schimmel, 1976a

Table 2.1.13 Acute toxicity of α-HCH to saltwater organisms: L(E)C50 values

Organism	Analysed	Test type	Purity compound	Test water	pH	Salinity in ‰	Exp. time	Criterion	Result µg/l	Reference
crustaceans										
Artemia salina (3 d)	+	R	> 95%	as	-	32	48 h	LC50	> 1400[4] α	Canton, 1978
Artemia salina (3 w)	+	R	> 95%	as	-	32	48 h	LC50	> 1400[4] α	Canton, 1978
Artemia salina (3 w)	+	R	> 95%	as	-	32	96 h	LC50	500 α	Canton, 1978
fish										
Lebistes reticulatus (3 w)	+	R	> 95%	as	-	32	96 h	EC50[1]	1300 α	Canton, 1978
Lebistes reticulatus (3 w)	+	R	> 95%	as	-	32	96 h	LC50	> 1400[4] α	Canton, 1978
Lebistes reticulatus (3 w)	-	-	-	sa	-	-	48 h	LC50	3500[2]	WHO, EHC 123[3]

1. mortality or immobilization
2. > solubility
3. original reference, Boulekbache 1980, not checked
4. maximum solubility of α-HCH in the test medium

Table 2.2.1 Chronic toxicity of aldrin to saltwater organisms: NOEC-values

Organism	A	Test type	Purity compound	Test water	pH	Salinity in ‰	Exp. time	Criterion	Result µg/l	Reference
molluscs										
Mercenaria mercenaria (larva)	-	R[1]	-	sw	-	-	12 d	NOEC[2]	83[3,7]	Davis, 1961
fish										
Fundulus heteroclitus (embryo)	-	R[4]	-	50% sw	-	-	30 d	NOEC[5]	3.3[6]	Crawford, 1985

1. renewal every second day
2. development
3. 20% effect; NOEC calculated as LOEC/3
4. changed daily for the first 10 days and every 3 days thereafter
5. development
6. NOEC calculated as LOEC/3
7. > solubility (in freshwater)

Table 2.2.2 Chronic toxicity of carborfuran to saltwater organisms: NOEC-values

Organism	Analysed	Test type	Purity compound	Test water	pH	Salinity in ‰	Exp. time	Criterion	Result µg/l	Reference
crustaceans										
Cancer magister (zoea)	-	F	techn. grade	fs	8.1	28.8	50 d	NOEC[1]	0.5[2]	Caldwell, 1977
Cancer magister (adult)	-	F	techn. grade	fs	7.9	25.4	90 d	NOEC[1]	25	Caldwell, 1977
fish										
Cyprinodon variegatus (fry)[3]	+	IF	-	as	-	25	19 w	NOEC[4]	15 α	Hansen, 1977a

1. mortality
2. extrapolated from graph
3. partial life-cycle test
4. mortality, growth, and reproduction

Table 2.2.3 Chronic toxicity of chlordane to saltwater organisms: NOEC-values

Organism	A	Test type	Purity compound	Test water	pH	Salinity in ‰	Exp. time	Criterion	Result µg/l	Reference
crustaceans										
Cancer magister (zoea)	-	F	techn. grade	fs	8.1	28.8	20 d	NOEC[1]	0.15	Caldwell, 1977
Cancer magister (zoea)	-	F	techn. grade	fs	8.1	28.8	30 d	NOEC[1]	0.015	Caldwell, 1977
Cancer magister (adult)	-	F	techn. grade	fs	7.9	25.4	90 d	NOEC[1]	1.0	Caldwell, 1977
fish										
Cyprinodon variegatus (fry)	+[5]	F	99.9%	sw	-	17.4	28 d	NOEC[6]	3.3 α	Parrish, 1976
Cyprinodon variegatus (egg → juvenile)	+	F	techn. grade	fs	-	-	189 d[2]	NOEC[3]	0.5 α	Parrish, 1978
Cyprinodon variegatus (juvenile)	+	F	techn. grade	fs	-	-	91 d[2]	NOEC[4]	1.7 α	Parrish, 1978
Cyprinodon variegatus (juvenile)	+	F	techn. grade	fs	-	-	148 d[2]	NOEC[4]	0.8 α	Parrish, 1978
Cyprinodon variegatus (adult)	+	F	techn. grade	fs	-	-	120 d	NOEC[1]	1.7 α	Parrish, 1978

1. mortality
2. only parents were exposed
3. hatching succes juveniles
4. mortality juveniles
5. analysed weekly
6. mortality or loss of equilibrium

Table 2.2.4 Chronic toxicity of chlorpyrifos to saltwater organisms: NOEC-values

Organism	A	Test type	Purity compound	Test water	pH	Salinity in ‰	Exp. time	Criterion	Result µg/l	Reference
fish										
Leuresthes tenuis (embryo)	+	IF	92%	fs	7.6-7.9	28.6	35 d	NOEC[1]	0.3 α	Goodman, 1985a
Leuresthes tenuis (fry)	+	IF	92%	fs	7.6-7.9	29.3	26 d	NOEC[1]	0.62 α	Goodman, 1985a
Menidia beryllina (fry)	+	IF	-	fs	-	4-6	28 d	NOEC[1]	0.75 α	Goodman, 1985b
Menidia menidia (fry)	+	IF	-	fs	-	18-27	28 d	NOEC[1]	0.28 α	Goodman, 1985b
Menidia peninsulae (fry)	+	IF	-	fs	-	18-25	28 d	NOEC[1]	0.38 α	Goodman, 1985b
Opsanus beta (fry)	+	F	techn. grade	fs	-	24-33	49 d	NOEC[1]	93 α	Hansen, 1986

1. mortality

Table 2.2.5 Chronic toxicity of DDE to saltwater organisms: NOEC-values

Organism	A	Test type	Purity compound	Test water	pH	Salinity in ‰	Exp. time	Criterion	Result µg/l	Reference
crustaceans										
Nitocra spinipes	-	R[1]	99.9%	sa	8	7	14 d	NOEC[2]	0.1[3]	Bengtsson, 1978

1. renewal to 90% after 7 d
2. reproduction
3. extrapolated from graph
4. growth
5. > solubility (in freshwater)

Table 2.2.6 Chronic toxicity of DDT to saltwater organisms: NOEC-values

Organism	A	Test type	Purity compound	Test water	pH	Salinity in ‰	Exp. time	Criterion	Result µg/l	Reference
algae										
Coccolithus huxleyi	-	S	-	am	-	-	24 h	NOEC[3]	10[1,9]	Menzel, 1970
Coccolithus huxleyi	-	S	-	es	-	-	24 h	NOEC[4]	2.0[1]	Wurster, 1968
Cyclotella nana	N	S	-	am	-	-	24 h	NOEC[2]	10[9]	Derby, 1971
Cyclotella nana	N	S	-	am	-	-	24 h	NOEC[3]	1.0[1]	Menzel, 1970
Peridinium trochoideum	-	S	-	es	-	-	24 h	NOEC[4]	0.5[5]	Wurster, 1968
Pyramimonas sp.	-	S	-	es	-	-	24 h	NOEC[4]	8.0[1,9]	Wurster, 1968
Skeletonema costatum	-	S	-	am	-	-	24 h	NOEC[3]	1.0[1]	Menzel, 1970
Skeletonema costatum	-	S	-	es	-	-	24 h	NOEC[4]	2.0[1]	Wurster, 1968
Thalassiosira pseudonana	-	S	-	-	-	-	96 h	NOEC[3]	25[9]	Mosser, 1972
fish										
Fundulus heteroclitus (embryo)	-	R[6]	-	sw	-	-	30 d	NOEC[7]	33[8]	Crawford, 1985

1. extrapolation from figure
2. oxygen production
3. growth
4. photosynthesis
5. NOEC calculated as LOEC/2
6. changed daily for the first 10 d and every 3 d thereafter
7. effect: development
8. NOEC calculated as LOEC/3
9. > solubility (in freshwater)

Table 2.2.7 Chronic toxicity of endosulfan to saltwater organisms: NOEC-values

Organism	A	Test type	Purity compound	Test water	pH	Salinity in ‰	Exp. time	Criterion	Result µg/l	Reference
algae										
Champia parvula	-	R[1]	-	es	-	30	14 d	NOEC[2]	80[3]	Thursby, 1985
molluscs										
Mytilus edulis	-	F	-	sw	-	-	112 d	NOEC[4]	100	Roberts, 1972

1. medium changed once a week
2. sexual reproduction
3. extrapolation from graph
4. protraction of the spawning period

Table 2.2.8 Chronic toxicity of endrin to saltwater organisms: NOEC-values

Organism	A	Test type	Purity compound	Test water	pH	Salinity in ‰	Exp. time	Criterion	Result µg/l	Reference
algae										
Agmenellum quadruplicatum	-	S	-	am	-	-	36 h	NOEC[1]	0.067[2]	Batterton, 1971
Coccolithus huxleyi	-	S	-	am	-	-	24 h	NOEC[1]	10[3]	Menzel, 1970
Cyclotella nana	-	S	-	am	-	-	24 h	NOEC[1]	0.1[3]	Menzel, 1970
Skeletonema costatum	-	S	-	am	-	-	24 h	NOEC[1]	100[3]	Menzel, 1970
crustaceans										
Palaemonetes pugio (juvenile)[4]	+	F	-	fs	-	20	145 d	NOEC[5]	0.11 α	Tyler-Schroeder, 1979
Palaemonetes pugio (F_1 larva)[4]	+	F	-	fs	-	20	145 d	NOEC[5]	0.05 α	Tyler-Schroeder, 1979
Palaemonetes pugio (F_1 larva)[4]	+	F	-	fs	-	20	145 d	NOEC[1]	0.05 α	Tyler-Schroeder, 1979
Palaemonetes pugio (F_1 larva)[4]	+	F	-	fs	-	20	145 d	NOEC[6]	0.03 α	Tyler-Schroeder, 1979
molluscs										
Crassostrea virginica (larva)	-	R[7]	-	sw	-	-	12 d	NOEC[1]	25	Davis, 1969
fish										
Cyprinodon variegatus (embryo)[4]	+	IF	-	fs	-	20.8	4 w	NOEC[5]	0.12 α	Hansen, 1977b
Cyprinodon variegatus (embryo)[4]	+	IF	-	fs	-	21	25 w	NOEC[8]	0.12 α	Hansen, 1977a
Gasterosteus aculeatus (egg)	-	S	75%	sa	-	10	9 d	NOEC[9]	0.19[10,11]	Katz, 1961b

1. growth
2. NOEC calculated as LOEC/3
3. extrapolation in figure
4. entire life-cycle test
5. mortality
6. weight
7. renewal every second day
8. ortality, growth and reproduction
9. hatching
10. 48% effect; NOEC calculated as LOEC/3
11. recalculated to a purity of 100%

Table 2.2.9 Chronic toxicity of fenthion to saltwater organisms: NOEC-values

Organism	A	Test type	Purity compound	Test water	pH	Salinity in ‰	Exp. time	Criterion	Result µg/l	Reference
algae										
Cyclotella nana	-	S	-	am	-	-	24 h	NOEC[1]	10	Derby, 1971
crustaceans										
Mysidopsis bahia (juvenile)	+	IF[2]	-	fs	-	20	16 d	NOEC[3]	0.079 α	McKenney, 1986
Mysidopsis bahia (juvenile)	+	IF[2]	-	fs	-	20	16 d	NOEC[4]	0.037 α	McKenney, 1986
Mysidopsis bahia (juvenile)	+	F	-	sw	-	20	16 d	NOEC[5]	0.037[6] α	McKenney, 1990
Mysidopsis bahia (juvenile)	+	F	-	sw	-	20	9 d	NOEC[7]	0.079[6] α	McKenney, 1990
Mysidopsis bahia (juvenile)	+	F	-	sw	-	20	8 d	NOEC[4]	0.037[6] α	McKenney, 1990
Mysidopsis bahia (adult)	+	IF[2]	-	fs	-	20	20 d	NOEC[8]	0.079 α	McKenney, 1986
Mysidopsis bahia (adult)	+	IF[2]	-	fs	-	20	19 d	NOEC[9]	0.037 α	McKenney, 1986

1. oxygen production
2. every 3 min 1 liter solution renewed
3. mortality
4. growth
5. respiration
6. extrapolated in figure
7. ammonia excretion
8. delay of first brood release
9. number of young in first brood

Table 2.2.10 Chronic toxicity of α-HCH to saltwater organisms: NOEC-values

Organism	A	Test type	Purity compound	Test water	pH	Salinity in ‰	Exp. time	Criterion	Result µg/l	Reference
algae										
Chlamydomonas sp.	+	S	-	am	-	-	48 h	NOEC[2]	> 1400[1] α	Canton, 1977
Dunaliella sp.	+	S	> 95%	am	-	-	48 h	NOEC[2]	> 1400[1] α	Canton, 1978
Dunaliella sp.	+	S	> 95%	am	-	-	96 h	NOEC[2]	> 1400[1] α	Canton, 1978
fish										
Lebistes reticulatus (3 w)	+	R	> 95%	as	-	32	35 d	NOEC[3]	250[4] α	Canton, 1978

1. maximum solubility of α-HCH in the test medium
2. growth
3. mortality or immobilization
4. NOEC calcultaed as LOEC/2

Table 2.2.11 Chronic toxicity of β-HCH to saltwater organisms

Organism	A	Test type	Purity compound	Test water	pH	Salinity in ‰	Exp. time	Criterion	Result µg/l	Reference
crustaceans										
Artemia salina (egg)	-	S	-	2% NaCl	7-8	-	48 h	NOEC[1]	10	Kuwabara, 1980

1. hatchability

Table 2.3.1 Values from deviating tests: aldrin

Organism	A	Test type	Purity compound	Test water	pH	Salinity in ‰	Exp. time	Criterion	Result µg/l	Reference
molluscs										
Mercenaria mercenaria (egg)	-	S	-	sw	-	-	48 h	NOEC[1]	250[2]	Davis, 1961

1. development
2. > solubility (in freshwater)

Table 2.3.2 Values from deviating tests: carbofuran

Organism	A	Test type	Purity compound	Test water	pH	Salinity in ‰	Exp. time	Criterion	Result µg/l	Reference
molluscs										
Crassostrea virginica (juvenile)	-	F	99.2%	sw	-	29	96 h	EC50[1]	> 1000[2]	Mayer, 1987
fish										
Cyprinodon variegatus (juvenile)	-	F	99.2%	sw	-	31	48 h	LC50	> 100	Mayer, 1987

1. immobility or loss of equilibrium
2. > solubility (in freshwater)

Table 2.3.3 Values from deviating tests: chlordane

Organism	A	Test type	Purity compound	Test water	pH	Salinity in ‰	Exp. time	Criterion	Result µg/l	Reference
annelids										
Nereis virens	+[1]	R[2]	-	sw	-	-	12 d	LC50	220[3] α	McLeese, 1982

1. all renewed solutions analysed at 0, 2, 6, 24 and 48 h
2. 48 h renewal
3. > solubility (in freshwater)

Table 2.3.4 Values from deviating tests: chlorpyrifos

Organism	A	Test type	Purity compound	Test water	pH	Salinity in ‰	Exp. time	Criterion	Result µg/l	Reference
coral										
Pocillopora damicornis	-	S	-	sw	-	-	24 h	NOEC[1]	100	Acevedo, 1991
fish										
Cyprinodon variegatus (juvenile)	-	F	92%	sw	-	24	48 h	LC50	> 1000	Mayer, 1987

1. mortality

Table 2.3.5 Values from deviating tests: DDE

Organism	A	Test type	Purity compound	Test water	pH	Salinity in ‰	Exp. time	Criterion	Result µg/l	Reference
algae										
Exuviella baltica	-	S	-	am	-	-	96 h	LOEC[1]	≤ 25[2]	Powers, 1979
crustaceans										
Nitocra spinipes	-	R[3]	99.9%	sa	8	7	14 d	LC50	0.6	Bengtsson, 1978
Nitocra spinipes	-	R[3]	99.9%	sa	8	7	14 d	EC50[4]	0.3	Bengtsson, 1978
fish										
Leiostomus xanthurus (juvenile)	-	F	99%	sw	-	26	48 h	LC50	> 100[6]	Mayer, 1987

1. growth
2. only concentration tested
3. renewal to 90% after 7 d
4. reproduction
5. shell growth
6. > solubility (in freshwater)

Table 2.3.6 Values from deviating tests: DDT

Organism	A	Test type	Purity compound	Test water	pH	Salinity in ‰	Exp. time	Criterion	Result µg/l	Reference
annelids										
Nereis virens	+[1]	R[2]	-	sw	-	-	12 d	NOEC[3]	≥ 30[4,5] α	McLeese, 1982
crustaceans										
Uca pugilator (16-19 mm)	-	R[9]	98%	sw	-	28-30	20 d	LOEC[8]	≤ 10[6,5]	Weis, 1976
Uca pugnax	-	R[9]	98%	sw	-	28-30	14 d	LOEC[8]	≤ 10[6,5]	Weis, 1976
Uca sp.	-	R[9]	98%	sw	-	28-30	21 d	LOEC[10]	≤ 10[6,5]	Weis, 1976
echinoderms										
Dendraster excentricus (embryo)	+[11]	S	techn. grade	fs	8.0-8.1	30	72 h	LC50	> 17[5] α	Dinnel, 1989
Strongylocentrotus droebachiensis (sperm)	+[11]	S	techn. grade	fs	-	30	1 h	EC50[12]	3.0 α	Dinnel, 1989
Strongylocentrotus droebachiensis (embryo)	+[11]	S	techn. grade	fs	7.8-8.1	30	5 d	LC50	> 8.2[5] α	Dinnel, 1989
Strongylocentrotus purpuratus (sperm)	+[11]	S	techn. grade	fs	-	30	1 h	EC50[12]	0.75 α	Dinnel, 1989
Strongylocentrotus purpuratus (embryo)	+[11]	S	techn. grade	fs	7.8-8.1	30	5 d	LC50	> 8.2[5] α	Dinnel, 1989
fish										
Ambassis gymnocephalus (5.0 cm, 2.0 g)	-	R[2]	100%	sw	7.5	15.9	15 d	LOEC[13]	≤ 2.0[7]	Lingaraja, 1979
Gambusia affinis (1.8-4.8 cm)	-	F	-	sa	-	()[18]	24 h	NOEC[14]	1.0	Hansen, 1972
Therapon jarbua (3.5 cm, 5.5 g)	-	S	100%	sw	7.5	15.9	5 d	LOEC[15]	≤ 2.0[6]	Lingaraja, 1979
Therapon jarbua (3.5 cm, 5.5 g)	-	R[2]	100%	sw	7.5	15.9	15 d	LOEC[13]	≤ 2.0[7]	Lingaraja, 1979

1. measured at 0, 2, 6, 24 and 48 h
2. test water changed once every two days
3. mortality
4. highest concentration tested
5. > solubility (in freshwater)
6. lowest concentration tested
7. only concentration tested
8. regeneration of limbs
9. renewal twice weekly
10. molting
11. initial and final concentration measured
12. fertility
13. mophological changes
14. salinity selection
15. effect: behavior (feeding, aggression, coughing)

Table 2.3.7 Values from deviating tests: endosulfan

Organism	A	Test type	Purity compound	Test water	pH	Salinity in ‰	Exp. time	Criterion	Result µg/l	Reference
algae										
Chaetomorpha linum	-	S	90%	fs	-	31	6 h	LOEC[1]	≤ 50[6]	Ramachandran, 1981
Champia parvula	-	R[2]	-	es	-	30	14 d	NOEC[3]	> 24[4]	Thursby, 1985
Chlorella sp.	-	S	-	es	-	22-28	10 d	NOEC[3]	≥ 1000[5,16]	Ukeles, 1962
Dunaliella euchlora	-	S	-	es	-	22-28	10 d	NOEC[3]	≥ 1000[5,16]	Ukeles, 1962
Enteromorpha intestinalis	-	S	90%	fs	-	31	6 h	LOEC[1]	≤ 50[6]	Ramachandran, 1981
Gracilaria verrucosa	-	S	90%	fs	-	31	6 h	LOEC[1]	≤ 50[6]	Ramachandran, 1981
Grateloupia sp.	-	S	90%	fs	-	31	6 h	LOEC[1]	≤ 50[6]	Ramachandran, 1981
Monochrysis lutheri	-	S	-	es	-	22-28	10 d	NOEC[3]	≥ 1000[5,16]	Ukeles, 1962
Phaeodactylum tricornutum	-	S	-	es	-	22-28	10 d	NOEC[3]	≥ 1000[5,16]	Ukeles, 1962
Protococcus sp.	-	S	-	es	-	22-28	10 d	NOEC[3]	≥ 1000[5,16]	Ukeles, 1962
annelids										
Nereis virens	+[14]	SS[15]	-	sw	-	-	12 d	LC50	100 α	McLeese, 1982
echinoderms										
Dendraster excentricus (sperm)	+[7]	S	techn. grade	fs	-	30	1 h	EC50[8]	350[16] α	Dinnel, 1989
Strongylocentrotus droebachiensis (sperm)	+[7]	S	techn. grade	fs	-	30	1 h	EC50[8]	500[16] α	Dinnel, 1989
Strongylocentrotus droebachiensis (embryo)	+[7]	S	techn. grade	fs	7.8-8.1	30	5 d	LC50	> 550[16] α	Dinnel, 1989
Strongylocentrotus purpuratus (sperm)	+[7]	S	techn. grade	fs	-	30	1 h	EC50[8]	82 α	Dinnel, 1989
molluscs										
Mytilus edulis	-	S	-	sw	-	-	24 h	EC50[11]	500[16]	Roberts, 1975a
Mytilus edulis	-	S	-	sw	-	-	48 h	EC50[11]	400[16]	Roberts, 1975a

1. photosynthesis and respiration
2. medium renewed once a week
3. growth and reproduction
4. presented as MATC; NOEC = MATC/2
5. highest concentration tested
6. only concentration tested
7. initial and final concentration measured
8. fertility
9. respiration
11. byssus formation
12. renewal daily
13. oxygen consumption, ammonia excretion
14. analyses at 0, 2, 6, 24 and 48 h
15. 48 h renewal
16. > solubility (in freshwater)

Table 2.3.8 Values from deviating tests: endrin

Organism	A	Test type	Purity compound	Test water	pH	Salinity in ‰	Exp. time	Criterion	Result µg/l	Reference
algae										
Dunaliella tertiolecta	-	S	-	am	-	-	24 h	NOEC[1]	≥ 1000[3,2]	Menzel, 1970
annelids										
Nereis virens	+[6]	R[7]	-	sw	-	-	12 d	NOEC[8]	> 110[9] α	McLeese, 1982
echinoderms										
Dendraster excentricus (sperm)	+[4]	S	techn. grade	fs	-	30	1 h	EC50[5]	440[2] α	Dinnel, 1989
Strongylocentrotus droebachiensis (sperm)	+[4]	S	techn. grade	fs	-	30	1 h	EC50[5]	340 α	Dinnel, 1989
Strongylocentrotus droebachiensis (embryo)	+[4]	S	techn. grade	fs	7.8-8.1	30	5 d	LC50	> 360 α	Dinnel, 1989
Strongylocentrotus purpuratus (sperm)	+[4]	S	techn. grade	fs	-	30	1 h	EC50[5]	100 α	Dinnel, 1989
fish										
Gasterosteus aculeatus (egg → embryo)	-	S	75%	sa	-	10	72 h	NOEC[8]	1.0[12]	Katz, 1961b
Gasterosteus aculeatus (egg → embryo)	-	S	75%	sa	-	10	96 h	NOEC[8]	≤ 0.19[11,12]	Katz, 1961b

1. growth
2. > solubility in freshwater
3. extrapolation from figure
4. initial and final concentrations measured
5. fertility
6. analysed at 0, 2, 6, 24 and 48 h
7. 48 h renewal
8. mortality
9. highest concentration tested
10. hatching
11. 31% effect; NOEC calculated as LOEC/3
12. recalculated to a purity of 100%

Table 2.3.9 Values from deviating tests: heptachlor

Organism	A	Test type	Purity compound	Test water	pH	Salinity in ‰	Exp. time	Criterion	Result µg/l	Reference
fish										
Cyprinodon variegatus (fry)[1]	+	IF	-	fs	-	16	18 w	NOEC[3]	≤ 0.71 α	Hansen, 1977a

1. partial life-cycle test
2. mortality, growth, and reproduction

Table 2.3.10 Values from deviating tests: α-HCH

Organism	A	Test type	Purity compound	Test water	pH	Salinity in ‰	Exp. time	Criterion	Result µg/l	Reference
fish										
Lebistes reticulatus (3 w old)	+	R	> 95%	as	-	32	96 h	LC50	> 1400[1] α	Canton, 1978

1. maximum solubility of α-HCH in the test medium

References

Acevedo, R. (1991) Preliminary observations on effects of pesticides carbaryl, naphtol, and clorpyrifos on planulae of the hermatypic coral Pocillopora damicornis. Pacific Science **45**, (3), 287-289.

Batterton, J.C. et al. (1971) Growth response of blue-green algae to aldrin, dieldrin, endrin and their metabolites. Bull. Environ. Contam. Toxicol. **6**, (6), 589-594.

Bengtsson, B. (1978) Use of a harpacticoid copepod in toxicity tests. Marine Pollution Bulletin **9**, 238-241.

Benson, W.H., and S.F. Long (1991) Evaluation of humic-pesticide interactions on the acute toxicity of selected organophosphate and carbamate insecticides. Ecotoxicol. Environ. Saf. **21**, 301-307.

Borthwick, P.W. et al. (1985a) Comparative acute sensitivities of early life stages of atherinid fishes to chlorpyrifos and thiobencarb. Arch. Environ. Contam. Toxicol **14**, 465-473.

Boulekbache H. (1980) Study of the toxicity of the alpha-, beta-, and gamma-isomers of hexachlorocyclohexane to fish, using the guppy as the test species. Paris, Université Paris VII, Laboratoire d' Anatomie comparée. (unpublished report).

Boush, G.M. et al. (1975) Pesticide degradation by marine algae. US National Technical Information Service, Doc A 008 275.

Butler, P.A. (1963) Pesticide-wildlife studies, a review of fish and wildlife service investigations during 1961 and 1962. In: George (ed.) US Department of the Interior, Fish and Wildlife Service, circular 167, 1-25.

Butler, P.A. (1964) Pesticide-wildlife studies, 1963, a review of fish and wildlife service investigations during the calendar year. US Department of the Interior, Fish and Wildlife Service, circular 199, 5-28.

Butler, P.A. (1965) Commercial fishery investigations. In: The effects of pesticides on fish and wildlife, Wash. DC, US Dept. of the Interior, Fish and Wildlife Service, 65-77 (Circular No. 226).

Caldwell, R.S. (1977) Biological effects of pesticides on the Dungeness crab (EPA-600/3-77-131). Ecological research series, Environmental Research Laboratory, Office of Research and Development, US EPA, Gulf Breeze, Florida 32501.

Canton J.H. et al. (1977) Accumulation and elimination studies of α-HCH with the marine algae Chlamydomonas and Dunaliella. Water Res. **11**, 111-115.

Canton J.H. et al. (1978) Toxicity, accumulation and elimination studies of α-hexachlorocyclohexane (α-HCH) with saltwater organisms of different trophic levels. Water Res. **12**, 687-690.

Carr, R.S. et al. (1986) Evaluation of the archiannelid Dinophilus gyrociliatus for use in short-term life-cycle toxicity tests. Environ. Toxicol. Chem. **5**, 703-712.

Clark, J.R. et al. (1985) Relative sensitivity of six estuarine fishes to carbophenothion, chlorpyrifos, and fenvalerate. Ecotoxicol. Environ. Saf. **10**, 382-390.

Clark, J.R. et al. (1987b) Comparison of laboratory toxicity test results with responses of estuarine animals exposed to fenthion in the field. Environ. Toxicol. Chem. **6**, 151-160.

Coppage, D.L. (1977) Anticholinesterase action of pesticidal carbamates in the central nervous system of poisoned fishes. In: Vernberg F.J. (ed.), Symp.: Physiological response of marine biota to pollutants, Acad. Press New York, 93-102.

Crawford, R.B. and A.M. Guarino (1976) Effects of DDT in Fundulus: Studies on toxicity, fate and reproduction. Arch. Environ. Contam. Toxicol. **4**, 334-348.

Crawford, R.B. and A.M. Guarino (1985) Effects of environmental toxicants on development of a teleost embryo. J. Environ. Pathol. Toxicol. Oncol. **6**, 185-194.

Davis, H.C. (1961) Effects of some pesticides on eggs and larvae of oysters (Crassostrea virginica) and clams (Venus mercenaria). Commercial Fisheries Review **23**, (12), 8-23.

Davis, H.C. and H. Hidu (1969) Effects of pesticides on embryonic development of clams and oyster and on survival and growth of the larvae. Fish. Bull. **67**, (2), 393-404.

Derby, S.B. and E. Ruber (1971) Primary production: Depression of oxygen evolution in algae cultures by organophosphorus insectides. Bull. Environ. Contam. Toxicol. **5**, (6), 553-558.

Dinnel, P.A. et al. (1989) Comparative sensitivity of sea urchin sperm bioassays to metals and pesticides. Arch. Environ. Contam. Toxicol. **18**, 748-755.

Doll, J.M. et al. (1962) Evaluation of Baytex as a mosquito larvicide in Delaware and its comparison with Dibrom, DDT and BHC. Proc. New Yersey Mosquito Exterm. Assoc. 49th Ann. Meeting, 156-163.

Earnest, R.D. and P.E. Benville (1972). Acute toxicity of four organochlorine insecticides to two species of surf perch. California Fish Game **58**, 127-132.

Eisler, R. (1969) Acute toxicities of insecticides to marine decapod crustaceans. Crustaceana **16**, 302-310.

Eisler, R. (1970a) Factors affecting pesticide-induced toxicity in an estuarine fish. US Dept. of the Interior, Bureau of Sport Fisheries and Wildlife, Technical Paper 45.

Eisler, R. (1970b) Acute toxicities of organochlorine and organophospherous insecticides to estuarine fishes. Wash. DC, US Dept. of the Interior, Bureau of Sport Fishing and Wildlife, 3-12 (Technical Paper No. 46).

Eisler, R. (1970c) Latent effects of insecticide intoxication to marine molluscs. Hydrobiologia **36**, (3-4), 345-352.

Goodman, L.R. et al. (1985a) A new early life-stage toxicity test using the California grunion (Leuresthes tenuis) and results with chlorpyrifos. Ecotoxicol. Environ. Saf. **10**, 12-21.

Goodman, L.R. et al. (1985b) Method for early life-stage toxicity tests using three atherinid fishes and results with chlorpyrifos. In: R.D. Cardwell et al. (eds.). Aquatic toxicology and hazard anessment: seventh symposium, ASTM STP 854, American society for Testing and Materials, Philadelphia, 145-154.

Hansen, D.J. (1972) DDT and malathion: Effect on salinity selection by mosquitofish. Trans. Am. Fish. Soc. **2**, 346-350.

Hansen, D.J. and P.R. Parrish (1977a) Suitability of sheepshead minnows (Cyprinodon variegatus) for life-cycle toxicity tests. In: F.L. Mayer and J.L. Hamelink (eds.), Aquatic toxicology and hazard evaluation, ASTM STP 634, American Society for Testing and Materials, 117-126.

Hansen, D.J. et al. (1977b) Endrin: Effects on the entire life cycle of a saltwater fish, Cyprinodon variegatus. J. Toxicol. Environ. Health **3**, 721-733.

Hansen, D.J. et al. (1986) Early life-stage toxicity test methods for gulf toadfish (Opsanus beta) and result using chlorpyrifos. Ecotoxicol. Environ. Saf. **11**, 15-22.

Katz, M. (1961a) Acute toxicity of some organic insecticides to three species of salmonids and to the threespine stickleback. Trans. Am. Fish. Soc. **90**, (2), 264-268.

Katz, M. and G.G. Chadwick (1961b) Toxicity of endrin to some Pacific Northwest fishes. Trans. Am. Fish. Soc. **90**, 394-397.

Korn, S. and R. Earnest (1974) Acute toxicity of twenty insecticides to striped bass, Morone saxatilis. Calif. Fish Game **60**, (3), 128-131.

Kuwabara K. et al. (1980) Effect of petroleum oil, pesticides, PCBS and other environmental contaminants on the hatchability of Artemia salina dry eggs. Bull. Environ. Contam. Toxicol. **25**, 69-74.

Lindén, E. et al. (1979) The acute toxicity of 78 chemicals and pesticide formulations against two brackish water organisms, the bleak (Alburnus alburnus) and the harpacticoid Nitocra spinipes. Chemosphere **11/12**, 843-851.

Lingaraja, T. et al. (1979) DDT induced ethological changes in estuarine fish. Env. Biol. Fish **4**, (1), 83-88.

Lockwood, A.P.M. and C.B.E. Inman (1975) Diuresis in the amphipod Gammarus duebeni induced by methylmercury, DDT, Lindane and fenithrothion. Comp. Biochem. Physiol **52c**, 75-80.

Mayer, F.L. (1987) Acute toxicity handbook of chemicals to estuarine organisms. US Dept. of Commerce, National Technical Information Service, Springfield VA, 283 pp. (EPA/600/8-87/017).

McKenney, C.L. (1986) Influence of the organophosphate insecticide fenthion on Mysidopsis bahia exposed during a complete life cycle, I. Survival, reproduction, and age-specific growth. Dis. Aquat. Org. **1**, 131-139.

McKenney, C.L. and E. Matthews (1990) Alterations in the energy metabolism of an estuarine mysid (Mysidopsis bahia) as indicators of stress from chronic pesticide exposure. Mar. Environ. Res. **30**, 1-19.

McLeese, D.W. and C.D. Metcalfe (1980) Toxicities of eight organochlorine compounds in sediment and seawater to Crangon septemspinosa. Bull. Environ. Contam. Toxicol. **25**, 921-928.

McLeese, D.W. et al. (1982) Toxicities of five organochlorine compounds in water and sediment to Nereis virens. Bull. Environ. Contam. Toxicol. **28**, 216-220.

Menzel, D.W. (1970) Marine phytoplankton vary in their response to chlorinated hydrocarbons. Science N.Y. **167**, 1724-1726.

Menzie, M.C. US Dept of the Interior, Fish and Wildlife Service, Parks and Marine Resources Bureau of Sport Fisheries and Wildlife Washington D.C.

Mosser, J.L. et al. (1972) Polychlorinated biphenyls and DDT alter species composition in mixed cultures of algae. Science N.Y. **76**, 533-535.

Parrish, P.R. et al. (1976) Chlordane: effects on several estuarine organisms. J. Toxicol. Environ. Health **1**, 485-494.

Parrish, P.R. et al. (1978) Chronic toxicity of chlordane, trifluralin, and pentachlorophenol to sheepshead minnows (Cyprinodon variegatus). EPA-600/3-78-010, Ecological Research series. Environmental Research Laboratory, Office of Research and Development, US EPA, Gulf Breeze, Florida, 32561.

Persoone G. et al. (1985) Evaluation of the impact of parathion, methyl-parathion, fenitrothion and fenthion on the aquatic environment, Part B: fenitrothion, fenthion. Report no. XI/785/83 (U/84/120). Commission of the European Econonie Community.

Powers, C.D. et al. (1979) DDE inhibition of marine algal cell division and photosynthesis per cell. Pest. Biochem. Physiol. **10**, 306-312.

Ramachandran, S. et al. (1981) Inhibition of photosynthesis and respiration by chlorinated hydrocarbons in some marine algae. Mahasagar Bull. Nat. Inst. Ocean. **14**, (4), 317-319.

Roberts, D. (1972) The assimilation and chronic effects of sub-lethal concentrations of endosulfan on condition and spawning in the common mussel Mytilus edulis. Mar. Biol. **16**, 119-125.

Roberts, D. (1975a) The effect of pesticides on byssus formation in the common mussel, Mytilus edulis. Environ. Pollut. **8**, 241-254.

Schimmel, S.C. et al. (1976a) Heptachlor: Toxicity to and uptake by several estuarine organisms. J. Toxicol. Environ. Health **1**, 955-965.

Schimmel, S.C. et al. (1977) Acute toxicity to and bioconcentration of endosulfan by estuarine animals. In: F.L. Mayer and J.L. Hamelink (eds), Aquatic toxicology and hazard evaluation, ASTM STP 634, Am. Soc. Test. Mat. 241-252.

Schimmel, S.C. et al. (1983) Acute toxicity, bioconcentration, and persistence of AC 222, 705, Benthiocarb, Chlorpyrifos, Fenvalerate, Methyl Parathion, and Permethrin in the estuarine environment. J. Agric. Food Chem. **31**, 104-113.

Thirugnanam, M. and A.J. Forgash (1977) Environmental impact of mosquito pesticides: toxicity and anticholinesterase activity of chlorpyrifos to fish in a salt marsh habitat. Arch. Environ. Contam. Toxicol. **5**, 415-425.

Thompson, C.Q. and J.W. Tucker (1989) Toxicity of the organophosphate insecticide fenthion, alone and with thermal fog carriers, to an estuarine copepod and young fish. Bull. Environ. Contam. Toxicol. **43**, 789-796.

Thursby, G.B. et al. (1985) Effect of organic chemicals on growth and reproduction in the marine red alga Champia parvula. Environ. Toxicol. Chem. **4**, 797-805.

Tsai, S.C. (1978) Control of chironomids in milkfish (Chanos chanos) ponds with Abate (temephos) insectide. Trans. Am. Fish. Soc. **107**, (3), 493-499.

Tyler-Schroeder, D.B. (1979) Use of the grass shrimp (Palaemonetes pugio) in a life-cycle toxicity test. In: L.L. Marking and R.A. Kimerle (eds.). Aquatic toxicology, ASTM STP 667, Am. Soc. Test. Mat., 159-170.

Ukeles, R. (1962) Growth of pure cultures of marine phytoplankton in the presence of toxicants. Appl. Microbiol. **10**, 532-537.

Walsh, G.E. (1983) Cell death and inhibition of population growth of marine unicellular algae by pesticides. Aquat. Toxicol. **3**, 209-214.

Walsh, G.E. et al. (1987) Comparison of the EC50s of algal toxicity tests calculated by four methods. Environ. Tox. Chem. **6**, 767-770.

Weis, J.S. and L.H. Mantel (1976) DDT as an accelerator of limb regeneration and molting in fiddler crabs. Estuarine and Coastal Marine Science **4**, 461-466.

Wurster, C.F. (1968) DDT reduces photosynthesis by marine phytoplankton. Science N.Y. **159**, 1474-1475.

Yoshida, K. and Y. Nishiuchi (1972) Toxicity of pesticides to some water organisms. Bull. Agric. Chem. Inspect. Stn. (Japan) **12**, 122-128.

References: evaluated but rejected

Amico, V. et al. (1979) Levels of chlorinated hydrocarbons in marine animals from the central mediterranean. Marine Pollution Bulletin **10**, 282-284.

Bednarz, T. (1981) The effect of pesticides on the growth of green and blue-green algae cultures. Acta Hydrobiol. **23**, (2), 155-172.

Borthwick, P.W. et al. (1985b) Field confirmation of a laboratory-derived hazard assessment of the acute toxicity of fenthion to pink shrimp, Penaeus duorarum. Environmental Research Lab., Gulf Breeze, Fl. NTIS/PB85-169613.

Butler, P.A. et al (1960) Effect of pesticides on oysters. Proceedings of the National Shellfisheries Association 51, 23-32.

Clark, J.R. et al. (1986) Field and laboratory toxicity test with shrimp, mysids, and sheepshead minnows exposed to fenthion. Environmental Research Lab., Gulf Breeze, FL., NTIS/PB 86-158649.

Clark, J.R. et al. (1987a) Effects of aerial thermal fog applications of fenthion on caged pink shrimp, mysids and sheepshead minnows. J. Am. Mosq. Contr. Fed. **3**, (3), 466-472.

Fisher, N.S. (1975) Chlorinated hydrocarbon pollutants and photosynthesis of marine phytoplankton: a reassessment. Science N.Y. **189**, 463-464.

Gill, T.S. et al. (1991) Individual and combined toxicity of common pesticides to teleost Puntius conchonius Hamilton. Indian Journal of Experimental Biology **29**, (2), 145-148.

Hansen, D.J. (1969) Avoidance of pesticides by untrained sheepshead minnows. Trans. Am. Fish. Soc. **3**, 426-429.

Holden, A.V. (1973) In: Environmental pollution by pesticides, Edwards C.A. (ed.), London.

Jackson, M.D. and R.G. Lewis (1979) Volatilization of methyl parathion from fields treated with micro encapsulated and emulsifiable concentrate formulations. Bull. Environ. Contam. Toxicol. **21**, 202-205.

Janicki, R.H. and W.B. Kinter (1971) DDT: Disrupted osmoregulatory events in the intestine of the eel Anguilla rostrata adapted to seawater. Science **173**, 1146-1148.

Jowett, P.E. et al. (1978) In vitro changes in the activity of ATPase in the gills of Carcinus maenas exposed to various concentrations of pp'-DDT. Environ. Pollut. **17**, 1-6.

Kinter, W.B. et al. (1972) Studies on the mechanism of toxicity of DDT and polyclorinated biphenyls (PCBs): Disruption of osmoregulation in marine fish. Environ. Health Perspect. **1**, 169-173.

Leffler, C.W. (1975) Effects of ingested mirex and DDT on juvenile Callinectes sapidus Rathbun. Environ. Pollut. **8**, 283-300.

Lores, E.M. et al. (1985) Determination of fenthion residues in samples of marine biota and seawater from laboratory exposures and field applications. J. Chrom. Sci. **23**, 124-127.

Macek, K.J. (1975) Acute toxity of pesticide mixtures to bluegills. Bull. Environ. Contam. Toxicol. **14**, (6), 648-652.

MacFarlane, R.B. et al. (1972) The interaction of light intensity and DDT concentration upon the marine diatom Nitzschia delicatissima Cleve. Hydrobiologia **39**, (3), 373-382.

Magnani, B. et al. (1978) Effects of chlordane and heptachlor on the marine dinoflagellate, Exuviella baltica Lohmann. Bull. Environ. Contam. Toxicol. **20**, 1-8.

Maly, M. and E. Ruber (1983) Effects of pesticides on pure and mixed species cultures of salt marsh pool algae. Bull. Environ. Contam. Toxicol. **30**, 464-472.

Mandoul, R. et al. (1967) Effets in vitro d'organophosphorés sur l'huître portugaise, quelques mollusques dulçaquicoles et le micro-plancton d'eau douce. Bulletin de la Société de Pathologie Exotique 60(6), 568-580.

McCain, B.B. et al. (1988) Marine pollution problems, North American west coast. Aquat. Toxicol. **11**, 143-162.

Naqvi, S.M.Z. (1973) Toxicity of twenty-three insecticides to a tubificid worm Branchiura sowerbyi from the Mississippi Delta. J. Econ. Entomol. **66**, (1), 70-74.

Neufeld, G.J. and J.B. Pritchard (1979) An assessment of DDT toxicity on osmoregulation and gill Na, K-ATPase activity in the blue crab. In: Aquatic toxicology, ASTM STP 667, L.L. Marking and R.A. Kimerle (eds.), Am. Soc. Test. Mat., 23-34.

Newell, S.Y. et al. (1981) Acute impact of an organophosphorus insecticide on microbes and small invertebrates of a mangrove estuary. Arch. Environ. Contam. Toxicol. **10**, 427-435.

Pesch, C.E. and G.L. Hoffman (1983) Interlaboratory comparison of a 28-day toxicity test with the polychaete Neanthes arenaceodentata. In: Bishop W.E. et al. (eds.). Aquatic toxicology and hazard assessment. Sixth symposium, ASTM STP 802, Philadelphia, 482-493.

Rajendran, N. and V.K. Venugopalan (1991) Bioconcentration of endosulfan in different body tissues of estuarine organisms under sublethal exposure. Bull. Environ. Contam. Toxicol. **46**, 151-158.

Rao, B.V. et al. (1988) Toxicity of organochlorine pesticide endosulfan (EC35) to a brackish water oligochaete Pontodrilus bermudensis. J. Environ. Biol. **9**, (3), 327-332.

Schimmel, S.C. and R.L. Garnas (1985) Interlaboratory comparison of the ASTM bioconcentration test method using the eastern oyster. In: Bahner R.C. and Hansen D.J. (eds.), Aquatic toxicology and hazard assessment: eight symposium, ASTM STP 891, Philadelphia, 277-287.

Schimmel, S.C. et al. (1976b) Heptachlor: uptake, depuration, retention and metabolism by spot, Leiostomus xanthurus. J. Toxicol. Environ. Health **2**, 169-178.

Scott, G.I. et al. (1987) Lethal and sublethal effects of insecticides commonly found in nonpoint source agricultural runoff to estuarine fish and shellfish. In: W.B. Vernberg et al. (eds.). Pollution physiology of estuarine organisms. Symp. Georgetown, South Carolina, USA oct. 21-24, 1985. Univ. S. Carolina Press. USA, 251-274.

Tachikawa, M. et al. (1987) Difference between freshwater and seawater fishes in the accumulation and effects of environmental chemical pollutants. J. Pharm. Sciences **76**, (11).

Tagatz, M.E. et al. (1982) Effects of chlorpyrifos on field- and laboratory-developed estuarine benthic communities. J. Toxicol. Environ. Health **10**, 411-421.

Trim, A.H. (1987) Acute toxicity of emulsifiable concentrations of three insecticides commonly found in nonpoint source runoff into estuarine waters to the mummichog Fundulus heteroclitus. Bull. Environ. Contam. Toxicol. **38**, 681-686.

Turgeon, D.D. and T.P. O'Connor (1991) Long Island Sound: Distributions, trends, and effect of chemical contamination. Estuaries **14**, 279-289.

Walsh, G.E. (1972) Insecticides, herbicides and polychlorinated biphenyls in estuaries. J. Wash. Acad. Sci. **62**, (2), 122-139.

Ward, G.S. and P.R. Parrish (1980) Evaluation of early life-stage toxicity tests with embryos and juveniles of sheepshead minnows (Cyprinodon variegatus). In: Aquatic toxicology, ASTM STP 707, J.G. Eaton et al. (eds.), Am. Soc. Test. Mat., 243-247.

Zitko, V. (1978) Nonachlor and chlordane in aquatic fauna. Chemosphere **1**, 3-7.

Appendix 3. Toxicity data for soil organisms

In this appendix toxicity data for soil organisms are presented in four different tables:
- table 3.1: acute data: L(E)C50 values,
- table 3.2: chronic data: NOEC values,
- table 3.3: toxicity to soil microbial processes and enzymeactivity,
- table 3.4: data from deviating tests.

Legenda:

art. soil	artificial soil
% om	% organic matter (if presented in % organic carbon a factor of 1.7 was used to calculate % om)
exp. time	exposure time
criterion	LC: lethal concentration; EC: effect concentration; NOEC: no observed effect concentration
test time	h: hours; d: days
st. soil	standard soil (10 % om and 25% clay)

Content:

Table 3.1.1 Acute toxicity of aldrin to soil organisms

Organism	Soil type	pH	% O.m.	% Clay	Temp °C	Exp. time	Criterion	Result test soil (mg/kg d.w.)	Result stand. soil (mg/kg d.w.)	Reference
oligochaetes										
Pheretima posthuma, adults	artificial	6	10	5	25	14 d	LC50	11	11	Hans et al., 1990
collembola										
Folsomia candida	sand	-	0.7	1.7	13	24 h	LC50	0.75	3.8	Thompson & Gore, 1972
	sand	-	0.7	1.7	24	24 h	LC50	0.42	2.1	Thompson & Gore, 1972
insects										
Pterostichus melanarius, first instar	sand	-	0.7	1.7	20	24 h	LC50	0.11	0.55	Tomlin, 1975a

Table 3.1.2 Acute toxicity of carbofuran to soil organisms

Organism	Soil type	pH	% O.m.	% Clay	Temp °C	Exp. time	Criterion	Result test soil (mg/kg d.w.)	Result stand. soil (mg/kg d.w.)	Reference
nematodes										
Aphelenchus avenae	sand	-	2*	5*	22	3 d	LC21	15[a]	75	Pree et al., 1987
	sand	-	2*	5*	22	3 d	LC41	30	150	Pree et al., 1987
	sand	-	2*	5*	22	3 d	LC64	150	750	Pree et al., 1987
oligochaetes										
Eisenia andrei	art. soil	7	10*	5*	22	14 d	LC50	5	5	Heimbach, 1985
Lumbricus terrestris	loam	6.1	36*	-	-	5 d	LC50	12	4	Stenersen et al., 1973
collembola										
Folsomia candida	sand	-	0.7	1.7	13	24 h	LC50	0.15	0.75	Thompson & Gore, 1972
	sand	-	0.7	1.7	24	24 h	LC50	0.06	0.3	Thompson & Gore, 1972
	sand	-	0.7	1.7	21	24 h	LC50	0.06	0.3	Tomlin, 1975b
Hypogastrura armata	sand	-	0.7	1.7	21	24 h	LC50	0.22[b]	1.1	Tomlin, 1975b
Onychiurus justi porteri	sand	-	0.7	1.7	21	24 h	LC50	1.5	7.5	Tomlin, 1975b
insects										
Pterostichus melanarius, first instar	sand	-	0.7	1.7	20	24 h	LC50	0.19	0.95	Tomlin, 1975a

a not significantly different from the control
b 95% confidence limit not reliable due to steep concentration-effect curve

Table 3.1.3 Acute toxicity of chlordane to soil organisms

Organism	Soil type	pH	% O.m.	% Clay	Temp °C	Exp. time	Criterion	Result test soil (mg/kg d.w.)	Result stand. soil (mg/kg d.w.)	Reference
oligochaetes										
Eisenia andrei	artificial	7	10*	5*	22	14 d	LC50	42	42	Heimbach, 1984
insects										
Gryllus pennsylvanicus, first instar	sandy loam	7.2	1.4	2.3	27	24 h	LC50	0.85	4.3	Harris, 1967
collembola										
Folsomia candida	sand	-	0.7	1.7	13	24 h	LC50	1.7	8.5	Thompson & Gore, 1972

Table 3.1.4 Acute toxicity of chlorpyrifos to soil organisms

Organism	Soil type	pH	% O.m.	% Clay	Temp °C	Exp. time	Criterion	Result test soil (mg/kg d.w.)	Result stand. soil (mg/kg d.w.)	Reference
oligochaetes										
Eisenia foetida	artificial	6.0	10	5	15	14 d	LC50	1077	1077	Ma and Bodt, 1993
Eisenia veneta	artificial	6.0	10	5	15	14 d	LC50	1174	1174	Ma and Bodt, 1993
Aporrectodea caliginosa	artificial	6.0	10	5	15	14 d	LC50	755	755	Ma and Bodt, 1993
Aporrectodea longa	artificial	6.0	10	5	15	14 d	LC50	778	778	Ma and Bodt, 1993
Lumbricus rubellus	artificial	6.0	10	5	15	14 d	LC50	129	129	Ma and Bodt, 1993
Lumbricus rubellus	artificial	6.0	10	5	15	14 d	LC50	104	104	Ma and Bodt, 1993
Lumbricus rubellus	sandy soil	4.8	3.7	1.4	15	14 d	LC50	262	708	Ma and Bodt, 1993
Lumbricus terrestris	artificial	6.0	10	5	15	14 d	LC50	458	458	Ma and Bodt, 1993
collembola										
Folsomia candida	sand	-	0.7	1.7	13	24 h	LC50	0.17	0.85	Thompson & Gore, 1972
	sand	-	0.7	1.7	24	24 h	LC50	0.03	0.15	Thompson & Gore, 1972

Table 3.1.5 Acute toxicity of DDT to soil organisms

Organism	Soil type	pH	% O.m.	% Clay	Temp °C	Exp. time	Criterion	Result test soil (mg/kg d.w.)	Result stand. soil (mg/kg d.w.)	Reference
insects										
Gryllus pennsylvanicus, first instar	fine s.l.	-	1.4	2.3	27	24 h	LC50	3.07[a]	22	Denneman & v. Gestel, 1990
	clay loam	-	15.9	23.2	27	24 h	LC50	11.75[b]	7.4	Denneman & v. Gestel, 1990
	muck	-	64.6	16.5	27	24 h	LC50	77.23[c]	12	Denneman & v. Gestel, 1990
	quartz sand	-	0	0	27	18 h	LC50	0.08[d]	0.8	Denneman & v. Gestel, 1990
	sand	-	0.5	1.7	27	18 h	LC50	1.75[d]	35	Denneman & v. Gestel, 1990
	silt loam	-	2.0	10.8	27	18 h	LC50	4.12[d]	29.4	Denneman & v. Gestel, 1990
	loam	-	6.6	14.9	27	18 h	LC50	11.41[d]	17.3	Denneman & v. Gestel, 1990
	clay	-	9.1	47.4	27	18 h	LC50	4.23[d]	4.7	Denneman & v. Gestel, 1990
	clay	-	15.9	23.8	27	18 h	LC50	11.75[d]	7.4	Denneman & v. Gestel, 1990
	clay	-	18.7	26.1	27	18 h	LC50	20.35[d]	10.9	Denneman & v. Gestel, 1990
	muck	-	39.8	22.8	27	18 h	LC50	45.20[d]	11.4	Denneman & v. Gestel, 1990
	muck	-	64.6	16.5	27	18 h	LC50	77.23[d]	12	Denneman & v. Gestel, 1990

a moisture content 12%
b moisture content 41%
c moisture content 162%
d soil on fieldcapacity; RH 65%

Table 3.1.6 Acute toxicity of endosulfan to soil organisms

Organism	Soil type	pH	% O.m.	% Clay	Temp °C	Exp. time	Criterion	Result test soil (mg/kg d.w.)	Result stand. soil (mg/kg d.w.)	Reference
plants										
Lactuca sativa	OECD	7.8	1.4	12		14 d	EC50	> 1000[a]	>1000	Denneman & v.Gestel, 1990
oligochaetes										
Pheretima posthuma	OECD	-	-	-	-	24 h	LC50	5.01	5.01	Hans et al., 1990
Eisenia andrei	art.soil	7	10	5	22	28 d	LC50	6.7[b]	6.7	Denneman & v. Gestel, 1990
Lumbricus terrestris	sandy loam	6.1	11.5	2.9	10	14 d	LC50	9.0[b]	7.8	Denneman & v. Gestel, 1990

a growth

Table 3.1.7 Acute toxicity of endrin to soil organisms

Organism	Soil type	pH	% O.m.	% Clay	Temp °C	Exp. time	Criterion	Result test soil (mg/kg d.w.)	Result stand. soil (mg/kg d.w.)	Reference
collembola										
Folsomia candida	sand	-	0.7	1.7	13	24 h	LC50	0.19	0.95	Thompson & Gore, 1972

Table 3.1.8 Acute toxicity of B-HCH to soil organisms

Organism	Soil type	pH	% O.m.	% Clay	Temp °C	Exp. time	Criterion	Result test soil (mg/kg d.w.)	Result stand. soil (mg/kg d.w.)	Reference
plants										
Lactuca sativa	OECD	7.8	1.4	12	22	7 d	EC50	>1000	>1000	Hulzebos et al., 1989
	OECD	7.8	1.4	12	22	14 d	EC50	>1000	>1000	Hulzebos et al., 1989

a growth

Table 3.1.9 Acute toxicity of heptachlor to soil organisms

Organism	Soil type	pH	% O.m.	% Clay	Temp °C	Exp. time	Criterion	Result test soil (mg/kg d.w.)	Result stand. soil (mg/kg d.w.)	Reference
oligochaetes										
Pheretima posthuma, adults	artificial	6	10	5	25	14 d	LC50	32	32	Hans et al., 1990
collembola										
Folsomia candida	sand	-	0.7	1.7	13	24 h	LC50	0.18	0.9	Thompson & Gore, 1972
	sand	-	0.7	1.7	24	24 h	LC50	1.9	9.5	Thompson & Gore, 1972
Folsomia candida	sand	-	0.7	1.7	21	24 h	LC50	0.79	4	Tomlin, 1975b
Hypogastrura armata	sand	-	0.7	1.7	21	24 h	LC50	2.2[a]	11	Tomlin, 1975b
Onychiurus justi porteri	sand	-	0.7	1.7	21	24 h	LC50	3.6	18	Tomlin, 1975b
insects										
Gryllus pennsylvanicus, 1st instar	sandy loam	-	1.4	2.3	27	24 h	LC50	0.09	0.45	Harris, 1967
	clay loam	-	16	23	27	24 h	LC50	0.73	0.46	Harris, 1967
	muck	-	65	17	27	24 h	LC50	4.2	1.4	Harris, 1967
Pterostichus melanarius, 1st instar	sand	-	0.7	1.7	20	24 h	LC50	0.03	0.15	Tomlin, 1975a

a 95% confidence limit not reliable due to steep concentration-effect curve

Table 3.1.10 Acute toxicity of heptachlor epoxide to soil organisms

Organism	Soil type	pH	% O.m.	% Clay	Temp °C	Exp. time	Criterion	Result test soil (mg/kg d.w.)	Result stand. soil (mg/kg d.w.)	Reference
collembola										
Folsomia candida	sand	-	0.7	1.7	21	24 h	LC50	0.02	0.1	Tomlin, 1975b
Hypogastrura armata	sand	-	0.7	1.7	21	24 h	LC50	2.1	11	Tomlin, 1975b
Onychiurus justi porteri	sand	-	0.7	1.7	21	24 h	LC50	4.4	22	Tomlin, 1975b

Table 3.2.1 Chronic toxicity of aldrin to soil organisms

Organism	Soil type	pH	% O.m.	% Clay	Temp °C	Exp. time	Criterion	Result test soil (mg/kg d.w.)	Result stand. soil (mg/kg d.w.)	Reference
bacteria										
actinomycetes	sandy loam	-	1.7	-	30	3 w	EC20[1]	25[a]	125	Kahlon et al., 1990
	sandy loam	-	1.7	-	30	4 w	EC20[1]	50	250	Kahlon et al., 1990
bacteria spec.	sandy loam	-	1.7	-	30	4 w	EC7[1]	25[b]	125	Kahlon et al., 1990
	sandy loam	-	1.7	-	30	4 w	EC13[1]	50[b]	250	Kahlon et al., 1990
fungi										
fungi spec.	sandy loam	-	1.7	-	30	3 w	EC33[1]	25	125	Kahlon et al., 1990
	sandy loam	-	1.7	-	30	3 w	EC65[1]	50	250	Kahlon et al., 1990
nematodes										
Melanotus communis, late instar larvae	org. loam	-	7.4	-	-	21 d	LC42	2.4	3.2	Campbell et al., 1971
	org. loam	-	7.4	-	-	21 d	LC93	3.6	4.9	Campbell et al., 1971
	silt loam	-	9	-	-	28 d	LC23	2.4	2.7	Campbell et al., 1971
	silt loam	-	9	-	-	28 d	LC63	3.6	4	Campbell et al., 1971
	silt loam	-	9	-	-	28 d	LC77	4.8	5.3	Campbell et al., 1971
	loamy sand	-	3.5	-	-	28 d	LC82	2.4	6.9	Campbell et al., 1971
	loamy sand	-	3.5	-	-	28 d	LC100	3.6	10	Campbell et al., 1971
	loamy sand	-	1.3	-	-	14 d	LC100	2.4	12	Campbell et al., 1971

1 inhibition
a standard plate count method on agar plates, 7-10 days
b as a, 2 days

Table 3.2.2 Chronic toxicity of carbofuran to soil organisms

Organism	Soil type	pH	% O.m.	% Clay	Temp °C	Exp. time	Criterion	Result test soil (mg/kg d.w.)	Result stand. soil (mg/kg d.w.)	Reference
bacteria										
bacteria spec.	black clay	7.2	2.1	-	28	7 d	EC20[1]	0.5[a]	2.4	Kale & Raghu, 1989
	black clay	7.2	2.1	-	28	7 d	EC22[1]	5[a]	24	Kale & Raghu, 1989
	black clay	7.2	2.1	-	28	21 d	EC22[1]	5[a]	24	Kale & Raghu, 1989
fungi										
fungi spec.	black clay	7.2	2.1	-	28	21 d	NOEC[1]	0.5[b]	2.4	Kale & Raghu, 1989
	black clay	7.2	2.1	-	28	21 d	EC30[1]	5[b]	24	Kale & Raghu, 1989
	sandy loam	6.8	0.78	-	28	21 d	NOEC[1]	0.5[b]	2.5	Kale & Raghu, 1989
	sandy loam	6.8	0.78	-	28	21 d	EC20[1]	5[b]	25	Kale & Raghu, 1989
oligochaetes										
Allolobophora caliginosa, adults	sand	-	2	5	20	14 d	NOEC[1]	0.1	0.5	Martin, 1986

1 inhibition
a 4-6 d on nutrient agar plates
b 4-6 d on Martin's medium plates

Table 3.2.3 Chronic toxicity of chlordane to soil organisms

Organism	Soil type	pH	% O.m.	% Clay	Temp °C	Exp. time	Criterion	Result test soil (mg/kg d.w.)	Result stand. soil (mg/kg d.w.)	Reference
fungi										
fungi	sandy loam	7.8	2.9	-	28	2 d	EC50[1]	5[a]	17	Tu, 1978
	sandy loam	7.8	2.9	-	28	2 d	EC55[1]	10[a]	34	Tu, 1978

1 inhibition
a agar plate counting

Table 3.2.4 Chronic toxicity of chlorpyrifos to soil organisms

Organism	Soil type	pH	% O.m.	% Clay	Temp °C	Exp. time	Criterion	Result test soil (mg/kg d.w.)	Result stand. soil (mg/kg d.w.)	Reference
fungi										
fungi	sandy loam	8.1	2	17	28	1 w	EC40[1]	10[a]	50	Tu, 1970
oligochaetes										
Eisenia foetida	artificial	7	10	5	20	3 w	NOEC[2]	100	100	RIVM, 1992 (unpubl. data)
Eisenia veneta	sandy soil	4.8	3.7	1.4	15	14 d	NOEC[2]	49	132	Ma and Bodt, 1993
Lumbricus rubellus	sandy soil	4.8	3.7	1.4	15	14 d	NOEC[2]	4.6	12	Ma and Bodt, 1993
Lumbricus rubellus	sandy soil	4.8	3.7	1.4	15	14 d	NOEC[2]	2.6	7.0	Ma and Bodt, 1993

1 inhibition
2 reproduction
a agar plate counting; at 100 mg/kg also 40% inhibition occurred

Table 3.2.5 Chronic toxicity of endosulfan to soil organisms

Organism	Soil type	pH	% O.m.	% Clay	Temp °C	Exp. time	Criterion	Result test soil (mg/kg d.w.)	Result stand. soil (mg/kg d.w.)	Reference
algae										
Algae (Chlorella,	red lat.	8.1	2	-	27	20 d	NOEC	25[a]	125	Denneman & v. Gestel, 1990
Scenedesmus,	red lat.	8.1	2	-	27	20 d	EC12	50[b]	250	Denneman & v. Gestel, 1990
Oscillatoria)	red lat.	8.1	2	-	27	20 d	EC52	100[b]	500	Denneman & v. Gestel, 1990
	red lat.	8.1	2	-	-	20 d	EC39	10[d]	50	Denneman & v. Gestel, 1990
	red lat.	8.1	2	-	-	20 d	EC68	50[d]	250	Denneman & v. Gestel, 1990
crustaceans										
Pseudobradya pulchella	sediment	-	3.86	-	-	7 d	NOEC	≥0.2[e]	≥0.5	Chandler, 1991
	sediment		3.86	-	-	7 d	NOEC	≥0.2[f]	≥0.5	Chandler, 1991
Nannopus palustris	sediment	-	3.86	-	-	7 d	NOEC	≥0.1[e]	≥0.26	Chandler, 1991
polychaetes										
Streblospio benedicti	sediment	-	3.86	-	-	7 d	NOEC	<0.05[g]	<0.13	Chandler, 1991
	sediment	-	3.86	-	-	7 d	NOEC	<0.05[h]	<0.13	Chandler, 1991
	sediment	-	3.86	-	-	7 d	EC100	0.2[i]	0.5	Chandler, 1991
plants										
Lactuca sativa	OECD	7.8	1.4	12		14 d	NOEC	320[j]	2290	Denneman & v. Gestel, 1990

a growth; NOEC estimated; non-flooded soil, WHC 50%
b growth; non-flooded soil, WHC 50%
c growth; NOEC estimated; flooded soil
d growth; flooded soil
e mortality; endosulfan contaminated sediment from a tidal creek (260 µg/kg), serially diluted to levels of 0, 0.05, 0.1 and 0.2 mg/kg
f reproduction; sediment see e
g significant reduction in postsettlement (larval) growth at 0.05 and 0.1 mg/l; sediment see e
h colonization: 48% and 60% reduction in colonization rate at 0.05 and 0.1 mg/kg, respectively; sediment see e
i colonization; sediment: see e
j growth

Table 3.2.6 Chronic toxicity of thiram to soil organisms.

Organism	Soil type	pH	% O.m.	% Clay	Temp °C	Exp. time	Criterion	Result test soil (mg/kg d.w.)	Result stand. soil (mg/kg d.w.)	Reference
bacteria										
bacteria spec.	sandy loam	7.8	2.9	-	28	2 d	EC52[1]	5[a]	17	Tu, 1978
	sandy loam	7.8	2.9	-	28	2 d	EC61[1]	10[a]	34	Tu, 1978
bacteria spec.	clay loam	7.2	1.8	-	-	2 d	EC40[1]	5[a]	25	Tu, 1981 a
fungi										
fungi spec.	sandy loam	7.8	2.9	-	28	2 d	EC55[1]	5[a]	17	Tu, 1978
	sandy loam	7.8	2.9	-	28	2 d	EC60[1]	10[a]	34	Tu, 1978
fungi spec.	clay loam	7.2	1.8	-	-	2 d	EC50[1]	5[a]	25	Tu, 1981 a

1 inhibition
a soil-dilution plate technique on agar plates

Table 3.3.1 Toxicity of carbofuran to soil microbial processes and enzymeactivity

Organism	Soil type	pH	% O.m.	% Clay	Temp °C	Exp. time	Criterion	Result test soil (mg/kg d.w.)	Result stand. soil (mg/kg d.w.)	Reference
enzymeactivity										
nitrogenase	sandy loam	7.8	2.9	-	28	2 d	EC31[1]	5	17	Tu, 1978
	sandy loam	7.8	2.9	-	28	2 d	EC34[1]	10	34	Tu, 1978
nitrogenase	sandy loam	6.2	1.6	18*	28	25 d	EC7	5[a]	25	Nayak et al., 1982
urease	organic	7.2	46	-	28	1 w	EC14[1]	10	3.3	Tu, 1981
	organic	7.2	46	-	28	2 w	NOEC[1]	5	1.7	Tu, 1981

1 inhibition
a only one concentration tested

Table 3.3.2 Toxicity of chlordane to soil microbial processes and enzymeactivity

Organism	Soil type	pH	% O.m.	% Clay	Temp °C	Exp. time	Criterion	Result test soil (mg/kg d.w.)	Result stand. soil (mg/kg d.w.)	Reference
microbial processes										
nitrification	sandy loam	7.6	2.9	-	28	1 w	EC92[1]	10[a]	34	Tu, 1991
sulfur oxidation	sandy loam	7.6	2.9	-	28	1 w	EC40[1]	10[a]	34	Tu, 1991
enzymeactivity										
dehydrogenase	organic	7.2	46	-	28	2 w	NOEC[1]	5	1.7	Tu, 1981
nitrogenase	sandy loam	7.8	2.9	-	28	6 d	NOEC[1]	5	17	Tu, 1978
urease	organic	7.2	46	-	28	1 w	EC2[1]	5[b]	1.7	Tu, 1981
	organic	7.2	46	-	28	1 w	EC15[1]	10[b]	3.3	Tu, 1981

1 inhibition
a 100% chlordane, only one concentration tested
b ≥ 94% a.i.; significantly different from the control

Table 3.3.3 Toxicity of chlorpyrifos to soil microbial processes and enzymeactivity

Organism	Soil type	pH	% O.m.	% Clay	Temp °C	Exp. time	Criterion	Result test soil (mg/kg d.w.)	Result stand. soil (mg/kg d.w.)	Reference
microbial processes										
nitrification	sandy soil	5.2	0.6	11	27	10 d	NOEC[1]	10	50	Saltzman & Brates, 1990
nitrification	sandy loam	8.1	2	17	28	2 w	EC58[1]	10[a]	50	Tu, 1970
	sandy loam	8.1	2	17	28	2 w	EC86[1]	100[a]	500	Tu, 1970
sulphur oxidation	sandy loam	8.1	2	17	28	4 w	NOEC[1]	10[b]	50	Tu, 1970
	sandy loam	8.1	2	17	28	4 w	EC15[1]	100[b]	500	Tu, 1970
enzymeactivity										
nitrogenase	sandy loam	7.8	2.9	-	28	2 d	EC28[1]	5	17	Tu, 1978
	sandy loam	7.8	2.9	-	28	2 d	EC37[1]	10	34	Tu, 1978
phosphatase	organic	7.2	46	-	28	2 h	EC39[1]	5	1.7	Tu, 1981
	organic	7.2	46	-	28	2 h	EC61[1]	10	3.3	Tu, 1981
urease	organic	7.2	46	-	28	2 w	NOEC[1]	5	1.7	Tu, 1981
	organic	7.2	46	-	28	1 w	EC14[1]	10	3.3	Tu, 1981

1 inhibition
a 200 mg/kg nitrogen added as ammonium sulfate
b 1,000 mg/kg powdered elemental sulfur added; 2 concentrations tested; no effect occurred at both concentrations when no sulfur was added

Table 3.3.4 Toxicity of endosulfan to soil microbial processes and enzymeactivity

Organism	Soil type	pH	% O.m.	% Clay	Temp °C	Exp. time	Criterion	Result test soil (mg/kg d.w.)	Result stand. soil (mg/kg d.w.)	Reference
microbial processes										
nitrification	sandy loam	5.7	3.2	8	25	30 d	EC50[1]	960[a]	3000	Stratton, 1990
	sandy loam	5.7	3.2	8	25	30 d	EC50[1]	>4500[b]	>14062	Stratton, 1990
	sandy loam	5.7	3.2	8	25	40 d	EC50[1]	550[c]	1719	Stratton, 1990
	sandy loam	5.7	3.2	8	25	40 d	EC50[1]	>2400[d]	>7500	Stratton, 1990
	silt loam	5.0	5.4	14	25	50 d	EC50[1]	525[a]	972	Stratton, 1990
	silt loam	5.0	5.4	14	25	50 d	EC50[1]	1130[b]	2093	Stratton, 1990
	silt loam	5.0	5.4	14	25	65 d	EC50[1]	390[c]	722	Stratton, 1990
	silt loam	5.0	5.4	14	25	65 d	EC50[1]	870[d]	1611	Stratton, 1990

1 inhibition
a formulation Thiodan (400 g/l), EC50 expressed in mg a.i./kg; determined in a soil perfusion experiment
b determined in a soil perfusion experiment
c formulation Thiodan (400 g/l), EC50 expressed in mg a.i./kg; determined in a batch incubation experiment
d determined in a batch incubation experiment

Table 3.3.5 Toxicity of thiram to soil microbial processes and enzymeactivity

Organism	Soil type	pH	% O.m.	% Clay	Temp °C	Exp. time	Criterion	Result test soil (mg/kg d.w.)	Result stand. soil (mg/kg d.w.)	Reference
microbial processes										
ATP amount	brown earth	6.9	1.9	-	-	42-56 d	EC3[1]	5	25	Hund et al., 1988
	brown earth	6.9	1.9	-	-	42-56 d	EC17[1]	50	250	Hund et al., 1988
arginine ammonification	brown earth	6.9	1.9	-	-	42-56 d	EC9[1]	5	25	Hund et al., 1988
	brown earth	6.9	1.9	-	-	42-56 d	EC16[1]	50	250	Hund et al., 1988
	peat	6.6	20	-	-	42-56 d	NOEC[1]	30[a]	15	Hund et al., 1988
	peat	6.6	20	-	-	42-56 d	EC8[1]	100[a]	50	Hund et al., 1988
nitrification	loamy soil	7.3	2.3	-	-	4 w	NOEC[1]	10[b]	43	Govindaraju et al., 1975
	sandy loam	7.1	1.9	-	-	4 w	NOEC[1]	1[b]	5	Govindaraju et al., 1975
enzymeactivity										
FDH hydrolysis	brown earth	6.9	1.9	-	-	42-56 d	EC14[1]	5	25	Hund et al., 1988
	brown earth	6.9	1.9	-	-	42-56 d	EC36[1]	50	250	Hund et al., 1988
	peat	6.6	20	-	-	42-56 d	EC3[1]	3	1.5	Hund et al., 1988
	peat	6.6	20	-	-	42-56 d	EC4[1]	10	5	Hund et al., 1988
	peat	6.6	20	-	-	42-56 d	EC10[1]	30	15	Hund et al., 1988
	peat	6.6	20	-	-	42-56 d	EC30[1]	100	50	Hund et al., 1988
nitrogenase	loamy soil	7.3	2.3	-	-	1 w	NOEC[1]	5[b]	22	Govindaraju et al., 1975
phosphatase	organic	7.2	46	-	28	2 h	EC35[1]	5	1.7	Tu, 1981
	organic	7.2	46	-	28	2 h	EC52[1]	10	3.3	Tu, 1981
urease	organic	7.2	46	-	28	1 w	EC38[1]	5	1.7	Tu, 1981
	organic	7.2	46	-	28	1 w	EC43[1]	10	3.3	Tu, 1981

1 inhibition
a testconc's 3, 10, 30 and 100 ppm; at 30 ppm 10% stimulation occurred
b NOEC estimated from a graph

References

Campbell, W.V., D.A. Mount, and B.S. Heming (1971) Influence of organic matter content of soils on insecticidal control of the wireworm Melanotus communis. J. Econ. Entomol. **64**, 41-44.

Chandler, G.T. (1991) Effects of sediment-bound endosulfan on survival, reproduction and larval settlement of meiobenthic polychaetes and copepods. Environ. Toxicol. Chem. **10**, 375-382.

Denneman, C.A.J., C.A.M. van Gestel (1990) Bodemverontreiniging en bodemecosystemen: voorstel voor C-(toetsings)waarden op basis van ecotoxicologisch risico's. RIVM Report, No. 725201 001 (in Dutch).

Govindaraju, K. K. Vlassak, and K.A.H. Heremans (1975) Effect of the thiocarbamates cycloate and diallate and the dithiocarbamates maneb and thiram on the biological nitrogen mineralization in soils. Meded. Fac. Landbouw., Rijksuniv. Gent **2**, (40), 1209-1219.

Hans, R.K., R.C. Gupta, and M.U. Beg (1990) Toxicity assessment of four insecticides to earthworm, Pheretima posthuma. Bull. Environ. Contam. Toxicol. **45**, 358-364.

Harris, C.R. (1967) Further studies on the influence of soil moisture on the toxicity of insecticides in soil. J. Econ. Entomol. **60**, 41-44.

Heimbach, F. (1984) Correlations between three methods for determining the toxicity of chemicals to earthworms. Pestic. Sci. **15**, 605-611.

Heimbach, F. (1985) Comparison of laboratory methods, using E. Foetida and L. terrestris, for the assessment of the hazard of chemicals. Z. Pflanzenkr. Pflanzenschutz **92**, (2), 186-193.

Hulzebos, E.M., E.M. Dirven-van Breemen, W.A. van Dis, C.A.M. van Gestel, H.A. Herbold, R. Baerselman, M. Stolk (1989) Toxiciteit van 45 prioritaire stoffen voor sla (Lactuca sativa). Eindrapport van het RIVM-aandeel in het project Fytotoxiciteit 2. RIVM Report No. 718710 002 (in Dutch).

Hund, K., L. Zelles, I. Scheunert, and F. Korte (1988) A critical estimation for methods for measuring side-effects of chemicals on microorganisms in soils. Chemosphere **17**, (6), 1183-1188.

Kahlon, R.S., G. Kaur, B. Dhesi, and M.S. Kalra (1990) Effect of organochlorinated pesticides on non-target soil microflora. J. Res. Punjab agric. Univ. **27**, (3), 463-468.

Kale, S.P. and K. Raghu (1989) Effect of carbofuran and its degradation products on microbial numbers and respiration in soils. Chemosphere **18**, (11/12), 2345-2351.

Ma, W., and J. Bodt (1993). Differences in toxicity of the insecticide chlorpyrifos to six species of earthworms (Oligochaeta, Lumbricidea) in standardized soil tests. Bull. Environ. Contam. Toxicol. **50**, 864-870.

Martin, N.A. (1986) Toxicity of pesticides to Allolobophora caliginosa (Oligochaeta: Lumbricidae). N. Zealand J. Agric. Res. **29**, 699-706.

Nayak, D.N. and V. Rajaramamohan Rao (1982) Pesticides and nitrogen fixation in a paddy soil. Soil Biol. Biochem. **14**, 207-210.

Pree, D.J., J.L. Townshend, and D.E. Archibald (1987) Sensitivity of acetylcholinesterases from Aphelenchus avenae to organophosphorous and carbamate pesticides. J. Nematol. **19**, 188-193.

RIVM (1992) Unpublished data from a laboratory study of the toxicity of chlorpyrifos on Eisenia foetida.

Saltzman, S. and N. Brates (1990) Effects of pesticides and CO_2 stress on ammonium oxidation in soil. Environ. Sci. Health B **25**, (6), 689-711.

Stenersen, J., A.P. Gilman, and A. Vardanis (1973) Carbofuran: its toxicity to and metabolism by earthworm (Lumbricus terrestris). J. Agric. Food Chem. **21**, 166-171.

Stratton, G.W (1990) Effects of the insecticide endosulfan on nitrification in low pH agricultural soils. Toxicity Assessment: An International Journal **5**, 319-336.

Thompson, A.R. and F.L. Gore (1972) Toxicity of 29 insecticides to Folsomia candida: Laboratory studies. J. Econ. Entomol. **65**, 1255-1260.

Tomlin, A.D. (1975a) The toxicity of insecticides by contact and soil treatment to two species of ground beetles. Can. Entomol. **107**, 529-532.

Tomlin, A.D. (1975b) Toxicity of soil applications of insecticides to three species of springtails (Collembola) under laboratory conditions. Can. Entomol. **107**, 769-774.

Tu, C.M. (1970) Effect of four organophosphorus insecticides on microbial activities in soil. Appl. Microbiol. **19**, (3), 479-484.

Tu (1978) Effect of pesticides on acetylene reduction and microorganisms in a sandy loam. Soil Biol. Biochem. **10**, 451-456.

Tu, C.M. (1981) Effects of some pesticides on enzyme activities in an organic soil. Bull. Environ. Contam. Toxicol. **27**, 109-114.

Tu, C.M. (1981a) Effects of pesticides on activities of enzymes and microorganisms in a clay soil. J. Environ. Sci. Health B **16**, (2), 179-191.

Tu, C.M.(1991) Effect of some technical and formulated insecticides on microbial activities in soil. J. Environ. Sci. Health B **26**, 557-573.

References: evaluated but rejected

Baldwin, N.A. and J.R. Bennett (1990) Evaluation of chemical treatments for inhibition of earthworm casting in amenity turf. Tests of Agrochemicals and Cultivars, 11. Ann. Appl. Biol. **116** (supplement).

Beatty, K.L. and M.L. Sohn (1986) Effect of three insecticides on growth rates of soil fungi. Bull. Environ. Contam. Toxicol. **36**, 533-539.

Beyer, W.N., A.J. Krynitsky (1989) Long-term persistence of dieldrin, DDT, and heptachlorepoxide in earthworms. Ambio **18**, (5), 271-273.

Brown, D.M., C.L. Groom, M. Cvitanik, M. Brown, J.L. Cooper, and J. Arditti (1982) Effects of fungicides and bactericides on orchid seed germination and shoot tip cultures in vitro. Plant Cell Tissue Organ Culture **1**, 165-180.

Clements, R.O. Effects of pesticides on white clover (Trifolium repens) establishment, nematodes and weeds. Ann. Appl. Biol. **116** (supplement), 6-7.

Csinos, A.S. (1985) Nontarget activity of chlorpyrifos and hydrolysis products on Sclerotium rolfsii. Plant Disease **69**, (3), 254-256.

Funderbunk, J.E., L.B. Braxton, and R.E. Lynch (1990) Nontarget effects of soil-applied chlorpyrifos on defoliating pests and arthropod predators in peanut. Peanut Science **17**, 113-117.

Georgis, R., H.K. Kaya, and R. Gaugler (1991) Effect of Steinernematid and Heterorhabditid Nematodes (Rhabditida: Steinernematidae and Heterorhabditidae) on nontarget Arthropods. Environ. Entomol. **20**, (3), 815-822.

Gilman, A.P. and A. Vardanis (1974) Carbofuran. Comparative toxicity and metabolism in the worms Lumbricus terrestris L. and Eisenia foetida S. J. Agric. Food Chem. **22**, (4), 625-628.

Gupta, G.P. (1989) Efficacy of soil insecticides against jassids and their effect on non-target soil organisms. Pesticides **23**, (8), 37-41.

Haque, A. and W. Ebing (1983) Toxicity determination of pesticides to earthworms in the soil substrate. Z. Pflanzenkr. Pflanzenschutz **90**, 395-408.

Holoubek, I., L. Houskova, Z. Seda (1990) Project TOCOEN. The fate of selected organic pollutants in the environment - IV. Soil, earthworms and vegatation 1988. Toxicol. Environm. Chem. **29**, 73-83.

Hopkins, A.R. and V.M. Kirk (1957) Effect of several insecticides on the english red worm. J. Econ. Entomol. **50**, (5), 699-700.

Huber, S.J. G. Poschenrieder, and P.R. Wallnöfer (1980) Einfluß von Pflanzen behandlungsmitteln und deren Metaboliten auf Wachstum und Atmung einiger Bodenmikroorganismen. Z. PflKrankh. PflSchutz. **87**, (9), 533-545.

Ingham, E.R. and D.C. Coleman (1984) Effects of streptomycin, cycloheximide, fungizone, captan, carbofuran, cygon, and PCNB on soil microorganisms. Microb. Ecol. **10**, 345-358.

Jones, A.L. and D.B. Johnson (1991) Effects of soil treatments with aldicarb, carbofuran, and chlorfenvinphos on the size and composition of microbial biomass. BCPC Mono no. 47, Pesticides in soils and water.

Joy, V.C. and P.P. Chakravorty (1991) Impact of insecticides on nontarget microarthropod fauna in agricultural soil. Ecotoxicol. Environ. Saf. **22**, 8-16.

Kale, S.P., N.B.K. Murthy, and K. Raghu (1989) Effect of carbofuran, carbaryl, and their metabolites on the growth of Rhizobium sp. and Azotobacter chroococcum. Bull. Environ. Contam. Toxicol. **42**, 769-772.

Kale, S.P. and K. Raghu (1990) Effect of carbofuran on soil phosphatases and aryl sulfatase activities. J. Environ. Biol. **11**, (1), 1-5.

Kandaswamy, D., K. Chadrayan, and G. Oblisami (1977) The growth in vitro of Azotobacter in the presence of certain organophosphorus insecticides. Pesticides **11**, (7), 36.

Knowles, C.O., D.D. Errampalli, and G.N. El-Sayed (1988) Comparative toxicities of selected pesticides to bulb mite (Acari: Acaridae) and twospotted spider mite (Acari: Tetranychidae). J. Econ. Entomol. **81**, (6), 1586-1590.

Levi, R. and T.W. Miller Jr. (1977) Susceptibility of the mosquito nematode Romanomermis culicivorax (Mermithidae) to pesticides and growth regulators. Environ. Entomol. **6**, (3), 447-448.

Megharaj, M., K. Venkateswarlu, and A.S. Rao (1989) Effects of carbofuran and carbaryl on the growth of a green alga and two cyanobacteria isolated from a rice soil. Agric. Ecosyst. Environ. **25**, (4), 329-336.

Megharaj, M., K. Venkateswarlu, and A.S. Rao (1989) The use of unicellular soil green algae for insecticide bioassay. J. Microbiol. Methods **10**, 119-122.

Mishra, A.K., A.B. Pandey, and H.D. Kumar (1989) Effects of three pesticides on MSX-induced ammonia photoproduction by the cyanobacterium Nostoc linckia. Ecotoxicol. Environ. Saf. **18**, 145-148.

Nordmeyer, D. and D.W. Dickson (1989) Effect of carbamate, organophosphate, and avermec-tin nematicides on oxygen consumption by three Meloidogyne spp. Journal of Nematology **21**, (4), 472-476.

Odeyemi, O., A. Salami, and E.O. Ugoji (1988) Effect of common pesticides used in Nigeria on soil microbiol population. Indian J. Agric. Sci. **58**, (8), 624-628.

Pati, B.R., K. Chandra, and S. Gupta (1984) The in vitro effect of some pesticides on the nitrogen fixing bacteria isolated from the phyllosphere of some crop plants. Plant and Soil **80**, 215-225.

Potter, D.A., M.C. Buxton, C.T. Redmond, C.G. Patterson, and A.J. Powell (1990) Toxicity of pesticides to earthworms (Olichochaeta: Lumbricidae) and effect on thatch degradation in Kentucky bluegrass turf. J. Econ. Entomol. **83**, (6), 2362-2369.

Rennie, R.J. (1978) Immunofluorescence detection of Nitrobacter in soil during NO_2^- oxidation in the presence of exotic chemicals. Microbios. Lett. **6**, 19-26.

Roark, J.H. and J.L. Dale (1979) The effect of turf fungicides on earthworms. Arkansas Academy of Science Proceedings **33**, 71-74.

Schnelle, M.A. and D.L. Hensley (1990) Effects of pesticides upon nitrogen fixationand nodulation by dry bean. Pestic. Sci. **28**, 83-88.

Shamiyeh, N.B. and L.F. Johnson (1973) Effect of heptachlor on numbers of bacteria, actinomycetes and fungi in soil. Soil Biol. Biochem. **5**, 309-314.

Tu, C.M. (1982) Influence of pesticides on activities of invertase, amylase and level of adenosine triphosphate in organic soil. Chemosphere **11**, (9), 909-914.

Tu, C.M. (1988) Effects of selected pesticides on activities of invertase, amylase, and microbiol respiration in a sandy soil. Chemosphere **17**, (1), 159-163.

Turco, R.F. and A.E. Konopka (1990) Response of microbial populations to carbofuran in soils enhanced for its degradation. ACS Symp. Ser., vol. 426, ISS Enhanced Biodegrad. , Pestic. Environ., 153-166.

Villani, M.G., R.J. Wright, and P.B. Baker (1988) Differential susceptibility of japanes beetle, oriental beetle, and european chafer (Coleoptera: Scarabaeidae) larvae to five soil insecticides. J. Econ. Entomol. **81**, (3), 785-788.

Wall, W.J. Jr. and V.M. Marganian (1971) Control of Culicoides melleus (Coq.) (Diptera: Ceratopogonidae) with granular organophosphorus pesticides, and the direct effect on other fauna. Mosquito News **31**, (2), 209-214.

Yeomans, J.C. and J.M. Bremner (1985) Denitrification in soil: effects of insecticides and fungicides. Soil Biol. Biochem. **17**, (4), 453-456.

Appendix 4. Bioconcentration factors for fish and bivalves

Legenda:

test water:	nw = natural freshwater; ns = natural seawater; sw = salt water; tap = tap water
age/live stage	cm: centimeters; g: grammes; juv: juveniles, larv: larvae, fert. = fertilized, egg: eggs; mm: millimeters
Test type	F: continuous flow; - : not reported
Exp. time	d: days; w: weeks; m: months
Conc.	x-y: 3 or more exposure concentrations with x the lowest and y the highest concentration
Equil. after	-: not reported; d: days

Table 4.1. Whole body bioconcentration factors for fish, based on wet weight

Organism	Test type	Test sub. purity	Test water	pH	Hardness mg $CaCO_3$/l * salinity in g/l	Exp. time	Conc. µg/l	Equil. after	BCF	Reference
chlordane										
Cyprinodon variegatus,	F	99.9%	ns	-	*17.4	28 d	1.3, 3.3	-	9,400[a]	Parrish et al., 1976
just fert. eggs	F	100%	ns	-	*-	189 d	0.5 0.8 1.7	-	14,000[a]	Parrish et al., 1978
	F	100%	ns	-	*-	28 d	0.5, 0.8	-	20,000[b]	
	F	100%	ns	-	*-	28 d	0.5, 0.8	-	9,000[c]	
Pimephales promelas, 6 m	F	-	nw	7.5	45.5	32 d	5.9	-	38,000	Veith et al., 1979
chlorpyrifos										
Leuresthes tenuis, 2.5 d eggs	F	92%	ns	7.6-7.9	*24.5-34	35 d	0.14-0.63	-	690[d]	Goodman et al., 1985a
13 d larvae	F	92%	ns	7.6-7.9	*24.5-31.5	26 d	0.28 0.62	-	62[d]	
Menidia beryllina, 32-36 h egg	F	-	ns	-	*4-6	28 d	0.18-0.75	-	140[e]	Goodman et al., 1985b
Menidia peninsulae 32-36 h egg	F	-	ns	-	*18-25	28 d	0.093-0.38	-	460[e]	
Opsanus beta, eggs	F	-	ns	-	*23.5-34.5	49 d	1.4-46	-	420[f]	Hansen et al., 1986
Pimephales promelas, posthatch	F	-	nw	7.2-7.7	43	60 d	0.12-2.68	-	1,700[g]	Jarvinen et al., 1983
endosulfan										
Mugil cephalus, 24-27 mm juv.	F	>99%	ns	-	*8.5-21	28 d	0.035	-	2,800[h]	Schimmel et al., 1977

a eggs produced in the laboratory by adults collected from a natural population; BCF's determined at end of exposure
b F1 juveniles, from first spawn of parents (from eggs: see a); exposed to the same concentrations
c as b, from second spawn
d eggs collected from natural population, containing no detectable chlorpyrifos, organophosphate and chlorinated pesticides, nor PCB's; BCF's determined at end of exposure
e as a; embryos contained 0.012 µg/g DDE
f as d, except that the embryos in 3 of the 9 testconcentrations contained 0.017 µg/g DDE; BCF increased from 100 to 900 with increasing test-concentrations from 1.4 to 50 µg/l; NOEC (growth) = 1.4 µg/l, NOEC (mortality) = 93 µg/l (water solubvility = 73 µg/l)
g BCF's determined at end of exposure; Dursban was used, an encapsulated slow-release formulation with a similar toxicity as technical grade (98.7%)
h BCF is the value at 28 d; equilibrium maybe not attained (BCF's at day 1, 2, 9, 16, 22 and 28 were 1000, 1600, 830, 1700, 1700 and 2800, respectively)

Organism	Test type	Test sub. purity	Test water	pH	Hardness mg $CaCO_3$/l * salinity in g/l	Exp. time	Conc. µg/l	Equil. after	BCF	Reference
endrin										
Cyprinodon variegatus,	F	-	ns	-	*8-30.5	28 d	0.027-0.12	-	2,300[a]	Hansen et al., 1977
just fert. eggs	F	-	ns	-	*8-30.5	23 w	0.027-0.12	-	6,000[a]	
Jordanella floridae ≤2 d larv.	F	96.1%	nw	7.3-7.6	41-46	110 d	0.051-0.3	-	9,900	Hermanutz, 1978
F1 eggs	F	96.1%	nw	7.3-7.6	41-46	30 d	0.051-0.3	-	12,000[b]	
Jordanella floridae, 1 d fish	F	96.1%	nw	6.9-7.8	43-48	15 d	0.21 0.29	-	12,000[b]	Hermanutz et al., 1985
Leiostomus xanthurus	F	98%	ns	-	*11-33	8 m	0.05	-	1,300[b]	Lowe, 1966
Leiostomus xanthurus	F	98%	ns	-	*11-33	5 m	0.05	-	1,600[b]	
Pimephales promelas, 41 d fish	F	99%	nw	7.1-7.9	49	300 d	0.14	28-56	5,600	Jarvinen & Tyo, 1978
fenthion										
Poecilia reticulata, 6-7 m	F	>97%	-	7.5-8	-	11 d	19	3 d	170[c]	De Bruijn, 1991
heptachlor										
Cyprinodon variegatus, juv.	F	65%	-	-	*-	28 d	-	-	3,600[d]	(IPCS, EHC nr. 38, 1984)
Leiostomus xanthurus, 20-30 mm	F	99.8%	ns	-	*20-22	4 d	0.47	-	4,900[e]	Schimmel et al., 1976
Pimephales promelas, 6 m	F	-	nw	7.5	45.5	32 d	3.1	-	9,500	Veith et al., 1979
heptachlor epoxide										
Pimephales promelas, 6 m	F	-	nw	7.5	45.5	32 d	1.3	-	14,000	Veith et al., 1979

a eggs from induced spawn, parents collected from a natural population, acclimated for 2 weeks; BCF determined at end of exposure
b BCF's determined at end of exposure
c exposure to a mixture of SV5, methylisocyanothion, fenthion-S2145, fenthion, chlorothion, bromophos, and 1,2,3,5-tetrachlorobenzene, with concentrations of the compounds between 1/50 en 3/50 of their LC50 values (toxic units); total sum not exceeding 0.2 toxic units
d original literature not available; test-substance of 65% purity contained 65% heptachlor, 22% γ-chlordane, 2% nonaclor, and 9% others
e BCF's determined at end of exposure; in fish heptachlor metabolises to heptachlor epoxide, BCF is based on whole body residues of both heptachlor and heptachlor epoxide (correction was made for different M.W.); fish collected from natural water, 10 days acclimation

Organism	Test type	Test sub. purity	Test water	pH	Hardness mg $CaCO_3$/l * salinity in g/l	Exp. time	Conc. µg/l	Equil. after	BCF	Reference
α-HCH										
Brachydanio rerio, 213 mg	F	-	tap	8	-	9 d	9.4	3 d	1100	Butte et al., 1991
Cyprinus carpio, 22 g	F	-	-	-	-	20 d	60	6 d	330[b]	Sugiura et al., 1979
Leuciscus idus melanotus 1.9 g	F	-	-	-	-	20 d	60	4 d	1200[b]	Sugiura et al., 1979
Oncorhynchus trutta, 1.6 g	F	-	-	-	-	20 d	60	4 d	600[b]	Sugiura et al., 1979
Poecilia reticulata	F	-	tap	-	-	10 d	1	4 d	700[a]	Yamato et al., 1983
0.48 g	F	-	-	-	-	20 d	60	4 d	590[c]	Sugiura et al., 1979
3 w	R	-	as	-	*32	5 d	10 50 140	1-2 d	500	Canton et al., 1978
3-4 w	R	>95%	am	-	20	4 d	10	3 h	180[d]	Canton et al, 1975
β-HCH										
Brachydanio rerio, 213 mg	F	-	tap	8	-	9 d	10.4	4 d	1500	Butte et al., 1991
Cyprinus carpio, 22 g	F	-	-	-	-	20 d	60	10 d	270[b]	Sugiura et al., 1979
Leuciscus idus melanotus 1.9 g	F	-	-	-	-	20 d	60	8 d	970[b]	Sugiura et al., 1979
Oncorhynchus trutta, 1.6 g	F	-	-	-	-	20 d	60	4 d	660[b]	Sugiura et al., 1979
Poecilia reticulata	F	-	tap	-	-	10 d	2	4 d	1000[a]	Yamato et al., 1983
0.48 g	F	-	-	-	-	20 d	60	15 d	1500[c]	Sugiura et al., 1979
pentachlorobenzene										
Lepomis macrochirus 0.2-1.3 g	F	-	nw	6.3-7.9	35	28 d	3-7.5	7-10 d	3,400[e]	Barrows et al., 1980
Pimephales promelas, eggs	F	-	nw	7.3-7.6	45	32 d	28 55	-	8,100	Carlson & Kosian, 1987

a amount of ethanol not reported
b 1 ppm Tween 20 was used; aerated
c 1 ppm Tween 20 was used
d amount of aceton not reported
e ^{14}C labeled pentachlorobenzene; number of test-concentrations not reported

Organism	Test type	Test sub. purity	Test water	pH	Hardness mg $CaCO_3$/l * salinity in g/l	Exp. time	Conc. µg/l	Equil. after	BCF	Reference
pentachlorophenol										
Cyprinodon variegatus,	F	100%	ns	-	*-	151 d	18, 47	-	17[a]	Parrish et al., 1978
just fert. eggs	F	100%	ns	-	*-	28 d	18, 47, 88	-	30[b]	
Fundulus similis	F	-	sw	7.5	*-	7 d	57-120	6 d	64[c]	Trujillo et al., 1982
Jordanella floridae, 4-6 m juv	F	-	nw	-	-	28 d	5	2-3 d	220[d]	Smith et al., 1990
Pimephales promelas, 6 m	F	-	nw	7.5	45.5	32 d	11.1	-	770	Veith et al., 1979
Oncorhynchus mykiss, 400 g	F	>99%	nw	7.6-8.2	135	115 d	0.035 0.66	-	230[e]	Niimi et al., 1982
quintozene										
Pseudorasbora parva, adult	F	>97%	tap	6.8	32	14 d	5-20	-	240[f]	Kanazawa, 1981

a BCF's determined at end of exposure
b as a; F1 juveniles, from first spawn of parents, exposed to the same concentrations
c fish from natural population, two weeks acclimated; 96 h LC50 > 306 µg/l according to Schimmel et al (1978); medium was Instant Ocean; BCF's determined at end of exposure
d nominal concentration
e reagent grade PCP in 0.04 M NaOH gave NaPCP as test compound; residues in test fish were corrected for mean residue in control fish (was 1.6 µg/kg, control water contained < 10 ng/l)
f fish from natural population, 2-5 g and 4-8 cm when caught; acclimated for 2.5 months

Table 4.2. Whole body bioconcentration factors for bivalves, based on wet weight

Organism	Test type	Test sub. purity	Test water	pH	Hardness mg $CaCO_3$/l * salinity in g/l	Exp. time	Conc. µg/l	Equil. after	BCF	Reference
chlordane										
Gonidea spec.	field	-	nf	-	-	-	0.039	-	140	Godsil & Johnson, 1988
Crassostrea virginica	F	-	ns	-	*27.3	28 d	2.2-4.7	-	5360	Parrish et al., 1976
copper										
Mytilus edulis	field	-	-	-	-	-	-	-	800	Scholten et al., 1991
Mytilus edulis	-	-	-	-	-	35 d	10-40	-	79	Phillips, 1976
Mytilus edulis	field	-	-	-	-	-	1.5-1.85	-	754	Schobben
Mytilus edulis	-	-	-	-	-	25 d	-	-	0.48	Kock, 1981
Mytilus edulis	-	-	-	-	-	16 d	-	-	14	Amiard, 1986
D. Polymorfa	field	-	-	-	-	-	-	-	480	Scholten et al., 1991
endosulfan										
Mytilus edulis	F	-	ns	-	-	112 d	100-1000	56 d	10	Roberts, 1972
Mytilus edulis	F	-	ns	-	-	35 d	100	20 d	26	Roberts, 1975
Mytilus edulis	F	-	ns	-	*32-33	7 d	0.14	2 d	600	Ernst, 1977
endrin										
Mytilus edulis	F	-	ns	-	*32-33	7 d	0.17	2 d	1920	Ernst, 1977
Gonidea spec.	field	-	nf	-	-	-	0.07	-	93	Godsil & Johnson, 1968
Crassostrea virginica	F	-	ns	-	*16	7 d	0.1	2 d	1670	Mason & Rowe, 1976
α-HCH										
Venerupis japonica	F	-	ns	-	*-	10 d	1	3 d	160[a]	Yamato et al., 1983

Organism	Test type	Test sub. purity	Test water	pH	Hardness mg $CaCO_3$/l * salinity in g/l	Exp. time	Conc. µg/l	Equil. after	BCF	Reference
ß-HCH										
Venerupis japonica	F	-	ns	-	*-	10 d	2	3 d	130[a]	Yamato et al., 1983
heptachlor										
Crassostrea virginica	F	-	ns	-	*24-27	4 d	430-3100	-	6300	Schimmel et al., 1976
heptachlorepoxide										
Mytilus edulis	F	-	ns	-	*32-33	7 d	0.22	2 d	1700	Ernst, 1977
pentachlorphenol										
Anodonta anatina	F	-	nf	7.1	-	8 d	0.8	-	128	Mäkelä et al., 1991
Crassostrea virginica	F	-	ns	-	*13	-	3.7-11.3	4 d	60	Schimmel & Garnas, 1985

a amount of ethanol not reported

References

Amiard-Triquet, C., B. Berther, C. Metayer and J.C. Amiard (1986) Contribution to the ecotoxicological study of cadmium, copper and zinc in the mussel Mytilus edulis. II. Experimental study. Mar. Biol. **92**, 7-13.

Barrows, M.E., S.R. Petrocelli, K.J. Macek, and J.J. Carroll (1980) Bioconcentration and elimination of selected waterpollutants by the bluegill sunfish (Lepomis macrochirus). Dyn. Exposure Hazard Assess. Toxic Chem., Ann Arbor, MI.

Butte, W., K. Fox, and G. Zauke (1991) Kinetics of bioaccumulation and clearance of isomeric hexachlorocyclohexanes. Sci. Total Environ. **109/110**, 377-382.

Canton, J.H., P.A. Greve, W. Slooff, and G.J. van Esch (1975) Toxicity, accumulation and elimination studies of α-hexachlorocyclohexane (α-HCH) with freshwater organisms of different trophic levels. Water Res. **9**, 1163-1169.

Canton, J.H., R.C.C. Wegman, T.J.A. Vulto, C.H. Verhoef, and G.J. van Esch (1978) Toxicity, accumulation and elimination studies with α-hexachlorocyclohexane (α-HCH) with saltwater organisms of different trophic levels. Water Res. **12**, 687-690.

Carlson, A.R. and P.A. Kosian (1987) Toxicity of chlorinated benzenes to fathead minnows (Pimephales promelas). Arch. Environ. Contam. Toxicol. **16**, 129-135.

De Bruijn, J. and J.L.M. Hermens (1991) Uptake and elimination kinetics of organophosphorous pesticides in the guppy (Poecilia reticulata): Correlations with the octanol/water partition coefficient. Environ. Toxicol. Chem. **10**, (6), 791-804.

Gosil, P.J. and Johnson, W.C. (1968) Residues in fish, wildlife, and estuaries. Pesticides Monitoring Journal **1**, (4), 21-26.

Goodman, L.R., D.J. Hansen, G.M. Cripe, D.P. Middaugh, and J.C. Moore (1985a) A new early life-stage toxicity test using the California grunion (Leuresthes tenuis) and results with chlorpyrifos. Ecotoxicol. Environ. Saf. **10**, 12-21.

Goodman, L.R., D.J. Hansen,D.P. Middaugh, G.M. Cripe, and J.C. Moore (1985b) Method for the early life-stage toxicity tests using three Atherinid fishes and results with chlorpyrifos. In: Aquatic Toxicology and Hazard Assessment: Seventh Symposium, ASTM STP 854. R.D. Cardwell, R. Purdy and R.C. Bahner (eds), Amer. Soc. for Testing & Materials, Philadelphia, 145-154.

Hansen, D.J., L.R. Goodman, G.M. Cripe, and S.F. Macauley (1986) Early life-stage toxicity test methods for gulf toadfish (Opsanus beta) and results using chlorpyrifos. Ecotoxicol. Environ. Saf. **11**, 15-22.

Hansen, D.J., S.C. Schimmel, and J. Forester (1977) Endrin: effects of the entire life cycle of a saltwater fish, Cyprinodon variegatus. J. Toxicol. Environ. Health **3**, 721-733.

Hermanutz, R.O. (1978) Endrin and malathion toxicity to flagfish (Jordanella floridae). Arch. Environ. Contam. Toxicol. **7**, 159-168.

Hermanutz, R.O., J.G. Eaton, and L.H. Mueller (1985) Toxicity of endrin and malathion mixtures to flagfish (Jordanella floridae). Arch. Environ. Contam. Toxicol. **14**, 307-314.

IPCS (1984) Environmental health criteria 38, heptachlor. WHO, Geneve.

IPCS (1989) Environmental health criteria for endrin, second draft. WHO, Geneve.

Janus, J.A., R.D.F.M. Taalman, and R.M.C. Theelen (1991) Integrated criteria document chlorophenols - effects. Appendix to RIVM report No. 710401 013.

Jarvinen, A.W., B.R. Nordling, and M.E. Henry (1983) Chronic toxicity of Dursban (chlorpyrifos) to the fathead minnow (Pimephales promelas) and the resultant acetylcholinesterase inhibition. Ecotoxicol. Environ. Saf. **7**, 423-434.

Jarvinen, A.W. and R.M. Tyo (1978) Toxicity to fathead minnows of endrin in food and water. Arch. Environ. Contam. Toxicol. **7**, 409-421.

Kanazawa, J. (1981) Measurement of the bioconcentration factors of pesticides by freshwater fish and their correlation with physicochemical properties or acute toxicities. Pestic. Sci. **12**, 417-424.

Kock, W.Chr. de and J.H. Marquenie (1981) De experimentele toepassing van de mossel Mytilus edulis bij het meten van zware metalen en organische microverontreinigingen in nederlandse kustwateren. TNO Report No. MD-N&E 81/2 (in Dutch).

Lowe, J.L (1966) Some effects of endrin on estuarine fishes. Proc. 19th Ann. Conf. S.E. Assn. Game & Fish Commissioners, 271-276.

Mäkelä, T.P., T. Petänen, J. Kukkonen and A.O.J. Oikari (1991) Accumulation an depuration of chlorinated phenolics in the freshwater mussel (Anodonta anatina). Ecotox. Environ. Saf. **22**, 153-163.

Mason, J.W. and D.R. Roberts (1976) The accumulation and loss of dieldrin and endrin in the eastern oyster. Arch. Environ. Contam. Toxicol. **4**, 349-360.

Niimi, A.J. and C.A. McFadden (1982) Uptake of sodium pentachlorophenate (NaPCP) from water by rainbow trout (Salmo gairdneri) exposed to concentrations in the ng/l range. Bull. Environ. Contam. Toxicol. **28**, 11-19.

Parrish, P.R., E.E. Dyar, J.M. Enos, and W.G. Wilson (1978) Chronic toxicity of chlordane, trifluralin, and pentachlorophenol to sheepshead minnow (Cyprinodon variegatus). EPA-600/3-78-010.

Parrish, P.R., S.C. Schimmel, D.J. Hansen, J.M. Patrick Jr., and J. Forester (1976) Chlordane: effects on several estuarine organisms. J. Toxicol. Environ. Health, **1**, 485-494.

Phillips, D.J.H. (1976) The common mussel Mytilus edulis as an indicator of pollution by zinc, cadmium, lead and copper. I. Effects of environmental variables on uptake of metals. Mar. Biol. **38**, 59-69.

RIVM (1990) Summary of carbofuran. Advisory Center Toxicology.

Roberts, D. (1972) The assimilation and chronic effects of sub-lethal concentrations of endosulfan on condition and spawning in the common mussel Mytilus edulis. Mar. Biol. **16**, 119-125.

Roberts, D. (1976) Differential uptake of endosulfan by the tissues of Mytilus edulis. Bull. Environ. Contam. Toxicol. **13**, (2), 170-176.

Schimmel, S.C. and R.L. Harnas (1985) Interlaboratory comparison of the ASTM bioconcentration test method using eastern oyster. Aquatic toxicology and hazard assessment: eight symposium ASTM. STP Bahner R.C. & Hansen, D.J. 277-287.

Schimmel, S.C., J.M. Patrick Jr., and J. Forester (1976) Heptachlor: toxicity to and uptake by several estuarine organisms. J. Toxicol. Environ. Health **1**, 955-965.

Schimmel, S.C., J.M. Patrick Jr., and A.J. Wilson Jr. (1977) Acute toxicity to and bioconcentration of endosulfan by estuarine animals. In: Aquatic Toxicology and Hazard Evaluation, ASTM STP 634. Mayer, F.L. and J.L. Hamelink (eds), American Society for Testing & Materials, Philadelphia, 241-252.

Schimmel, S.C., J.M. Patrick Jr., and J. Forrester (1977) Toxicity and bioconcentration of BHC and lindane in selected estuarine animals. Arch. Environ. Contam. Toxicol. **6**, 355-363.

Schobben, H.P.M. (1992) Unpublished field data.

Scholten, M.C.Th., R.G. Jak, K.J.M. Kramer, W.Chr. de Kock and H.P.M. Schobben (1991) Verschillen in bioaccumulatie van metalen in zoet- en zoutwater mosselen. TNO Report No. R91/332 (in Dutch).

Smith, A.D., A. Bharath, C. Mallard, D. Orr, L.S. McCarty, and G.W. Ozburn (1990) Bioconcentration kinetics of some chlorinated benzenes and chlorinated phenols in American flagfish, Jordanella floridae (Goode and Bean). Chemosphere **20**, (3/4), 379-386.

Sugiura, K., T. Washino, M. Hattori, E. Sato, and M. Goto (1979) Accumulation of organochlorine compounds in fishes. Difference of accumulation factors by fishes. Chemosphere **8**, 359-364.

Trujillo, D.A., L.E. Ray, H.E. Murray, and C.S. Giam (1982) Bioaccumulation of pentachlorophenol by kilifish (Fundulus similis). Chemosphere **11**, (1), 25-31.

Veith, G.D., D.L. DeFoe, and B.V. Bergstedt (1979) Measuring and estimating the bioconcentration factor of chemicals in fish. J. Fish. Res. Board Can. **36**, 1040-1048.

Verschueren, K. (1983) Handbook of environmental data on organic chemicals. ISBN 0-442-28802-6 van Nostrand Reinhold Company Inc.

References: evaluated but rejected

Amiard, J.C., C. Amiard-Triquet, B. Berthet and C. Metayer (1987) Comparative study of the patterns of bioaccumulation of essential (Cu, Zn) and non-essential (Cd,Pb) trace metals in various estuarine and coastal organisms. J. Exp. Mar. Biol. Ecol. **106**, 73-89.

Banerjee, S., R.H. Sugatt, and D.P. O'Grady (1984) A simple method for determining bioconcentration parameters of hydrophobic compounds. Environ. Sci. Technol. **18**, (2), 79-81.

Calamari, D. and R. Marchetti (1973) The toxicity of metals and surfactants to rainbow trout (Salmo gairdneri Rich.). Water Res. **7**, 1453-1464.

Daramola, J.A. and A.A. Oladimeji (1989) Accumulation of copper in Clarias anguillaris L. and Oreochromis niloticus L. Water, Air and Soil Pollut. **48**, 457-461.

Davies, R.P. and A.J. Dobbs (1984) The prediction of bioconcentration in fish. Water Res. **18**, (10), 1253-1262.

Ernst, W. (1977) Determination of the bioconcentration potential of marine organisms. A steady state approach. I. Bioconcentration data for seven chlorinated pesticides in mussels (Mytilus edulis) and their relation to solubility data. Chemosphere **6**, 731-740.

Ernst, W. (1979) Factors affecting the evaluation of chemicals in laboratory experiments using marine organisms. Ecotox. Environ. Saf. **3**, 90-98.

Grant, B.F. and P.M. Mehrle (1973) Endrin toxicosis in rainbow trout (Salmo gairdneri). J.Fish. Res. Board Can. **30**, (1), 31-40.

Hansen, D.J. and P.R. Parrish (1977) Suitability of sheepshead minnows (Cyprinodon variegatus) for life-cycle toxicity tests. In: Aquatic Toxicology and Hazard Evaluation, ASTM STP 634, Mayer, F.L. and J.L. Hamelink (eds), American Society for Testing & Materials, Philadelphia, 117-126.

Khan, M.A.Q., M. Feroz and P. Sudershan (1979) Metabolism of cyclodiene insecticides by fish. In: Pesticide and xenobiotic metabolism in aquatic organisms, Am. Chem. Soc. Symp. Series 99.

Kobayashi, K., H. Akitake and K. Manabe (1979) Relation between toxicity and accumulation of various chlorophenols in goldfish. Bull. Japan. Soc. Sci. Fish. **45**, (2), 173-175.

Kobayashi, K. and T. Kishino (1980) Effect of pH on the toxicity and accumulation of pentachlorophenol in goldfish. Bull. Japan. Soc. Sci. Fish. **46**, (2), 167-170.

Könemann, H. and K. van Leeuwen (1980) Toxicokinetics in fish: accumulation and elimination of six chlorobenzenes by guppies. Chemosphere **9**, 3-19.

Mount, D.I. and G.J. Putnicki (1966) Summary report of the 1963 Mississippi fish kill. Proc. 31st. North Am. Wildl. Conf., 177-184.

Muramoto, S. (1982) Effects of complexans (DTPA, EDTA) on the toxicity of low concentrations of copper to fish. J. Environ. Sci. Health A **17**, (3), 313-319.

Neely, W.B., D.R. Branson and G.E. Blau (1974) Partition coefficient to measure bioconcentration potential of organic chemicals in fish. Environ. Sci. Technol. **8**, 1113-1115.

Oliver, B.W. and A.J. Niimi (1983) Bioconcentration of chlorobenzenes from water by rainbow trout: correlations with partition coefficients and environmental residues. Environ. Sci. Technol. **17**, 287-291.

Oliver, B.W. and A.J. Niimi (1985) Bioconcentration factors of some halogenated organics for rainbow trout: limitations in their use for predicition of environmental residues. Environ. Sci. Technol. **19**, 842-849.

Opperhuizen, A., P. Serné, and J.M.D. van der Steen (1988) Thermodynamics of fish/water and octan-1-ol/water partitioning of some chlorinated benzenes. Environ. Sci. Technol. **22**, 286-292.

Pruitt, G.W., B.J. Grantham and R.H. Pierce Jr. (1977) Accumulation and elimination of pentachlorophenol by the bluegill, Lepomis macrochirus. Trans. Am. Fish. Soc. **106**, (5), 462-465.

Rajendran, N. and V.K. Venugopalan (1991) Bioconcentration of endosulfan in different body tissues of estuarine organisms under sublethal exposure. Bull. Environ. Contam. Toxicol. **46**, 151-158.

Renberg, L., M. Tarkpea, and E. Linden (1985) The use of the bivalve Mytilus edulis as a test organism for bioconcentration studies. Ecotox. Environ. Saf. **9**, 171-178.

Sanborn, J.R., R.L. Metcalf, W.N. Bruce and P. Lu (1976) The fate of chlordane and toxaphene in a terrestrial-aquatic model ecosystem. Environ. Entomol., 533-538.

Schimmel, S.C., J.M. Patrick Jr. and L.F. Faas (19) Effects of sodium pentachlorophenate on several estuarine animals: toxicity, uptake, and depuration. In: Pentachlorophenol: chemistry, pharmacology, and environmental toxicology. International symposium on pentachlorophenol Pensacola, Florida, 1977. K.R. Rao (ed), Plenum Press, New York, London.

Schimmel, S.C., J.M. Patrick Jr. and J. Forester (1976) Heptachlor: uptake, depuration, retention, and metabolism by spot, Leiostomus xanthurus. J. Toxicol. Environ. Health **2**,

Stehly, G.R. and W.L. Hayton (1989) Disposition of pentachlorophenol in rainbow trout (Salmo gardneri): effect of inhibition of metabolism. Aquat. Toxicol. **14**, 131-148.

Stehly, G.R. and W.L. Hayton (1990) Effect of pH on the accumulation kinetics of pentachlorophenol in goldfish. Arch. Environ. Contam. Toxicol. **19**, 464-470.

Tachikawa, M., R. Sawamura, S. Okada and A. Hamada (1991) Differences between freshwater and seawater killifish (Oryzias latipes) in the accumulation and elimination of pentachlorophenol. Arch. Environ. Contam. **21**, 146-151.

Van Hoogen, G. and A. Opperhuizen (1988) Toxicokinetics of chlorobenzenes in fish. Environ. Toxicol. Chem. **7**, 213-219.

Vigano,L., S. Galassi, and M. Gatto (1991) Factors affecting the bioconcentration of hexachlorocyclohexanes in early life stages of Oncorhynchus mykiss. Environ. Toxicol. Chem. **11**, 535-540.

Welling, W. and J.W. de Vries (1992) Bioconcentration kinetics of the organophosphorus insectide chlorpyrifos in guppies (Poecilia reticulata). Ecotoxicol. Environ. Saf. **23**, 64-75.

Yamato, Y., M. Kiyonaga, and T. Watanabe (1983) Comparative bioaccumulation of HCH isomers in short-necked clam (Venerupis japonica) and guppy (Poecilia reticulata). Bull. Environ. Contam. Toxicol. **31**, 352-359.

Appendix 5. Toxicity data for mammals

Legenda:

exposure time	d: day(s); w: week(s); m: month(s); y: year(s); gen: generation; gest: gestation; lact: lactation
criterion	NOEC: No Observed Effect Concetration based on mortality (m), growth (g), reproduction (r); LOEC: Lowest Observed Effect Concentration

Content:

Table 5.1 Toxicity of aldrin to mammals

Species	Age	Purity	Application route and exposure time	Criterion	Result	Reference
Mus musculus	-	-	diet, 56 d	$NOEC_m$	10 mg/kg diet	1
Mus musculus	-	-	diet, 120 d	$NOEC_m$	10 mg/kg diet	1
Mus musculus	-	-	diet, 6-gen.	$NOEC_r$	3 mg/kg diet	2
Rattus norvegicus	-	-	diet, 56 d	$NOEC_m$	160 mg/kg diet	1
Rattus norvegicus	-	-	diet, 180 d	$NOEC_g$	75 mg/kg diet	1
Rattus norvegicus	-	-	diet, 2 y	$NOEC_g$	20 mg/kg diet	2
Rattus norvegicus	-	-	diet, 74-80 w	$LOEC_g$	30 mg/kg diet	2,3
Rattus norvegicus	-	-	diet, 31 m	$LOEC_g$	20 mg/kg diet	2
Rattus norvegicus	-	-	diet, 3-gen.	$LOEC_r$	2.5 mg/kg diet	2
Oryctolagus cuniculis	-	-	diet, 90 d	$NOEC_m$	40 mg/kg diet	1
Canis domesticus	-	-	diet, 313 d	$NOEC_m$	25 mg/kg diet	1
Canis domesticus	-	-	diet, 1 y	$NOEC_m$	3 mg/kg diet	1
Canis domesticus	-	-	25 m	$NOEC_m$	0.5 mg/kg bw	2

References:

1. ATSDR (1989) Agency for Toxic Substances and Disease Registry. Toxicological Profile for Aldrin/Dieldrin. U.S. Public Health Service in collaboration with U.S. Environmental Protection Agency (EPA). May 1989.

2. IPCS (1989) Environmental Health Criteria 91, aldrin and dieldrin. WHO, Geneve.

3. NCI (1978) National Cancer Institute. Bioassay of Aldrin and Dieldrin for possible carcinogenicity. Carcinogenesis Technical Report Series No.21 (NCI-CG-TR-21). U.S. Department of Health, Education and Welfare, Public Health Service, NIH, 1978.

Table 5.2 Toxicity of carbofuran to mammals

Species	Age	Purity	Application route and exposure time	Criterion	Result	Reference
Rattus norvegicus	-	-	diet, 3-gen.	$NOEC_{g,r}$	10 mg/kg diet	1
Rattus norvegicus	-	-	diet, 3-gen.	$NOEC_{g,r}$	20 mg/kg diet	2
Rattus norvegicus	-	-	diet, 2 y	$NOEC_{g,r}$	25 mg/kg diet	1
Rattus norvegicus	-	-	diet, 2 y	$NOEC_{g}$	20 mg/kg diet	2
Rattus norvegicus	-	-	gavage, gest. d 6-19	$NOEC_{g}$	1 mg/kg bw	3
Rattus norvegicus	-	-	gavage, gest. d 6-19	$NOEC_{g}$	1 mg/kg bw	3
Mus musculus	-	-	diet, 2 y	$NOEC_{g}$	125 mg/kg diet	2,3
Oryctolagus cuniculus	-	-	capsules, gest. d 6-18	$NOEC_{r}$	0.1 mg/kg bw	1
Oryctolagus cuniculus	-	-	gavage, gest. d 6-18	$NOEC_{m}$	0.6 mg/kg bw	2
Oryctolagus cuniculus	-	-	gavage, gest. d 6-18	$NOEC_{g}$	0.5 mg/kg bw	3
Canis domesticus	-	-	1 y	$NOEC_{r}$	0.5 mg/kg bw	3

References:

1. FAO/WHO (1976) Evaluations of some pesticide residues in food. Joint Meeting of the FAO Panel of Experts on Pesticide Residues and the Environment and the WHO Expert Group on Pesticide Residues, Rome, 22-30 November 1976. WHO Technical Report, Series No. 612, 1977; FAO Plant Production and Protection Series No. 8, 1977.

2. FAO/WHO (1980) Pesticide residues in food - 1980: Evaluations. Joint Meeting of the FAO Panel of Experts on Pesticide Residues in Food and the Environment and the WHO Expert Group on Pesticide Residues, Rome, 1-15 October 1980. FAO Plant Production and Protection Paper 26 Sup., 1981.

3. US-EPA (1988) Health Advisories for 16 Pesticides - Carbofuran. Rev. Environ. Contam. and Toxicology, 104, 35-46.

Table 5.3 Toxicity of chlordane to mammals

Species	Age	Purity	Application route and exposure time	Criterion	Reference	
Rattus norvegicus	-	-	diet, 2 y	$NOEC_{m,g}$	150 mg/kg diet	1
Rattus norvegicus	-	techn.	diet, 2 y	$NOEC_{g}$	30 mg/kg diet	1
Rattus norvegicus	-	94.8%	diet, 80 w	$NOEC_{g}$	6 mg/kg bw	2
Rattus norvegicus	-	techn.	diet, 3-gen.	$NOEC_{r}$	30 mg/kg diet	1
Mus musculus	-	94.8%	diet, 6 w	$NOEC_{m}$	10.4 mg/kg bw	2
Mus musculus	-	-	gavage, 30 d	$NOEC_{m}$	3.2 mg/kg bw	2
Oryctolagus cuniculus	-	-	gavage, 16-24 d	$LOEC_{m}$	10 mg/kg bw	2

References:

1. FAO/WHO (1967) Evaluations of some pesticide residues in food. Joint Meeting of the FAO Working Party of Experts and the WHO Expert Group on Pesticide Residues, Rome, 4-11 December 1967. FAO PL:1967/M/11/1. WHO Food Add./68.30. Rome 1968.

2. ATSDR (1989) Toxicological Profile for Chlordane. Agency for Toxic Substances and Disease Registry, U.S. Public Health Service.

Table 5.4 Toxicity of chlorpyrifos to mammals

Species	age	purity	application route and exposure time	criterion	result	reference
Rattus norvegicus	-	-	diet; 2-gen.	$NOEC_r$	0.3 mg/kg bw	1
Rattus norvegicus	-	-	diet; 90 d	$NOEC_g$	100 mg/kg diet	1
Rattus norvegicus	-	-	diet; 90 d	$NOEC_g$	0.3 mg/kg bw	1
Rattus norvegicus	-	-	gavage, gest.d 6-15	$NOEC_{g,m}$	10 mg/kg b.w	2

References:

1.FAO/WHO (1972) Evaluation of some pesticide residues in food. Joint Meeting of the FAO Working Party of Experts on Pesticide Residues and the WHO Expert Committee on Pesticide Residues, Rome, 20-28 November 1972. WHO Pesticide Residues Series No. 2.

2. FAO/WHO (1982) Pesticide residues in food - Evaluations 1982. Joint Meeting of the FAO Panel of Experts on Pesticide Residues in Food and the Environment and the WHO Expert Group on Pesticide Residues, Rome, 23 November-2 December 1982. FAO Plant Production and Protection Paper No. 49.

Table 5.5 Toxicity of copper to mammals

Species	Age	Purity	Application route and exposure time	Criterion	Result	Reference
Rattus norvegicus	90 d	-	gavage, 20 d	$LOEC_g$	25.4 mg/kg bw	1,4
Rattus norvegicus	28 d	-	diet, 4 w	$NOEC_m$	2000 mg/kg diet	1,4
				$LOEC_g$	500 mg/kg diet	1,4
Rattus norvegicus	-	-	diet, 44 w	$NOEC_{g,m}$	530 mg/kg diet	1,4
				$LOEC_r$	530 mg/kg diet	1,4
Mus musculus	-	-	diet, 4 w	$NOEC_r$	398 mg/kg diet	1,4
Mus musculus	-	-	drink.-wat., 15 d	$NOEC_m$	100 mg/kg bw	3
				$NOEC_g$	25 mg/kg bw	3
Susscrofa domesticus	-	-	diet, 61-88 d	$NOEC_g$	250 mg/kg diet	1,2,4
Ovis amon aries	-	-	diet, 88 d	$LOEC_m$	15 mg/kg diet	2
Ovis amon aries	6-12 m	-	diet, 37 w	$NOEC_m$	7 mg/kg diet	3

References:

1. USEPA (1985) Drinking Water Criteria Document for Copper. Final Draft, dated March 1985. Report no. EPA-600/X-84-190-1. Prepared for Office of Drinking Water; prepared by Environmental Criteria and Assessment Office, Cincinatti, Ohio, USA.

2. Janus, J.A., J.H. Canton, C.A.M. van Gestel, E. Heijna-Merkus (1989) Integrated Criteria Document copper - effects. Appendix to RIVM report No. 7584474 009.

3. FAO/WHO (1982) Toxicological evaluation of certain food additives. IPCS - Joint FAO/WHO Exper Committee on Food Additives, Rome, 19-28 April 1982. WHO Food Additives Series No. 17.

4. USEPA (1987) Summary review of the health effects associated with copper - Health issue assessment. UPA Office Health and Environmental Assessment. EPA Report No. EPA/600/8-87/001. EPA Center for Environmental Research Information, Cincinatti, Ohio, USA.

Table 5.6 Toxicity of endosulfan to mammals

Species	Age	Purity	Application route and exposure time	Criterion	Result	Reference
Rattus norvegicus	-	-	gavage, 15 d	$NOEC_{m,g}$	5 mg/kg bw	2
Rattus norvegicus	-	97.1%	diet, 2 y	$NOEC_{g}$	75 mg/kg diet	1
Rattus norvegicus	-	97.3%	gavage, gest. d 6-19	$NOEC_{g,mat.}$	0.66 mg/kg bw	1
Mus musculus	-	techn.	diet, 42 d	$LOEC_{m}$	18 mg/kg diet	1
Mus musculus	-	tech.	diet, 13 w	$NOEC_{m,g}$	18 mg/kg diet	1
Mus musculus	-	97.9%	diet, 2 y	$NOEC_{g}$	6 mg/kg diet	1
Oryctolagus cuniculus	-	97.3%	gavage, gest. d 6-28	$NOEC_{m,mat.}$	0.7 mg/kg bw	1
Oryctolagus cuniculus	-	-	gavage, gest. d 6-28	$NOEC_{r}$	1 mg/kg bw	1
				$NOEC_{m,mat.}$	1 mg/kg bw	1
Canis domesticus	-	techn.	diet, 1 y	$NOEC_{m}$	30 mg/kg diet	1
				$NOEC_{g}$	6 mg/kg diet	1

References:

1. FAO/WHO (1989) Pesticide residues in food - 1989: Evaluations 1989. Part II - Toxicology. Joint Meeting of the FAO Panel of Experts on Pesticide Residues and the WHO Expert Group on Pesticide Residues, Geneva, 18-27 September 1989. FAO Plant Production and Protection Paper 100/2.

2. IPCS (1984) Environmental Health Criteria 40, endosulfan. WHO, Geneve.

Table 5.7 Toxicity of endrin to mammals

Species	Age	Purity	Application route and exposure time	Criterion	Result	Reference
Mus musculus	-	-	diet, 7 m, intervals	$NOEC_r$	c. 47 mg/kg diet	1
Mus musculus	-	-	gavage, gest. d 7-17	$NOEC_{g,r}$	0.5 mg/kg bw	1
Rattus norvegicus	-	techn.	67-72 d	$NOEC_m$	1 mg/kg bw	1
Rattus norvegicus	-	-	gavage, gest. d 7-21	$NOEC_{g,mat}$	0.150 mg/kg bw	1
Rattus norvegicus	-	-	diet, 2 y	$NOEC_g$	1 mg/kg diet	2
Rattus norvegicus	-	-	diet, 3-gen.	$NOEC_r$	1 mg/kg diet	1
Cricetus cricetus	-	-	gavage, gest. d 8	$NOEC_r$	1.5 mg/kg bw	3
Cricetus cricetus	-	-	gavage, gest. d 5-14	$NOEC_r$	0.75 mg/kg bw	3
Canis domesticus	-	-	diet, 16-19 m	$NOEC_g$	3 mg/kg diet	2

References:

1. IPCS (1989) Environmental Health Criteria, endrin (second draft). WHO, Geneve.

2. Treon J.F., F.P. Cleveland & J. Cappel (1955). Toxicity of endrin for laboratory animals. J. Agric. Food. Chem. **3**, (10), 842-8.

3. Chernoff N., R.J. Kavlock, R.C. Hanisch, D.A. Whitehouse, J.A. Gray, L.E. Gray & G.W. Sovocool (1979). Perinatal toxicity of endrin in rodents. I. Fetotoxic effects of prenatal exposure in hamsters. Toxicology **13**, 155-65.

Table 5.8 Toxicity of fenthion to mammals

Species	Age	Purity	Application route and exposure time	Criterion	Result	Reference
Rattus norvegicus	-	-	diet, 3-gen.	$NOEC_g$	15 mg/kg diet	1
Rattus norvegicus	-	-	diet, 3 m	$LOEC_g$	0.25 mg/kg diet	1
Rattus norvegicus	-	-	diet, 3 m	$NOEC_r$	0.5 mg/kg diet	1
Rattus norvegicus	-	-	diet, 2 y	$NOEC_{m,g}$	15 mg/kg diet	2

References:

1. FAO/WHO (1971) Evaluation of some pesticide residues in food. Joint Meeting of the FAO Working Party and the WHO Expert Group on Pesticide Residues, Rome, 22-29 November 1971. AGP: 1971/M/9/1. WHO Techn. Rep Series No. 502.

2. FAO/WHO (1978) Pesticide residues in food - 1978: Evaluations. Joint Meeting of the FAO Panel of Experts on Pesticide Residues in Food and the Environment and the WHO Expert Group on Pesticide Residues, Rome, 27 November - 6 December, 1978. FAO Plant Production and Protection Paper 15 Sup.

Table 5.9 Toxicity of α-HCH to mammals

Species	Age	Purity	Application route and exposure time	Criterion	Result	Reference
Rattus norvegicus	-	-	diet, 90 d	$NOEC_g$	50 mg/kg diet	1
Rattus norvegicus	weanl	-	diet, 107 w	$NOEC_{m,g}$	100 mg/kg diet	2

References:

1. Slooff, W., and A.J.C.M. Matthijsen (eds.) (1988) Integrated criteria document hexachlorocyclohexanes. RIVM report No. 758473 011.

2. IPCS (1992) Environmental Health Criteria 123, alpha- and beta-hexachlorocyclohexanes. WHO, Geneve.

Table 5.10 Toxicity of ß-HCH to mammals

Species	age	purity	application route and exposure time	criterion	result	reference
Rattus norvegicus	weanl	>98%	diet, 13 w	$LOEC_{m,g}$	250 mg/kg diet	1
Rattus norvegicus	weanl	>98%	diet, 13 w	$NOEC_{m,g}$	50 mg/kg diet	1
Rattus norvegicus	weanl	-	diet, 107 w	$NOEC_g$	10 mg/kg diet	2
Rattus norvegicus	weanl	-	diet, 107 w	$NOEC_m$	100 mg/kg diet	2
Rattus norvegicus	weanl	>98%	diet, 2-gen.	$NOEC_r$	2 mg/kg diet	2
Rattus norvegicus	weanl	>98%	diet, 2-gen.	$LOEC_r$	10 mg/kg diet	2

References:

1. Van Velsen, F.L., L.H.J.C. Danse, F.X.R. Van Leeuwen, J.A.M.A. Dormans, and M.J. Van Logten (1986) The subchronic oral toxicity of the ß-isomer of hexachlorocyclohexane in rats. Fundam. Appl. Toxicol. **6**, 697-712.

2. IPCS (1992) Environmental Health Criteria 123, alpha- and beta-hexachlorocyclohexanes. WHO, Geneve.

Table 5.11 Toxicity of heptachlor to mammals

Species	Age	Purity	Application route and exposure time	Criterion	Result	Reference
Rattus norvegicus	4 m	pure	oral, 200 d	$NOEC_{m,g}$	5 mg/kg bw	1,2
Rattus norvegicus	-	-	diet, 3-gen.	$NOEC_{r}$	7 mg/kg diet	3
Rattus norvegicus	-	-	diet, 3-gen	$NOEC_{r}$	6 mg/kg diet	2

Table 5.12 Toxicity of heptachlor epoxide to mammals

Species	age	purity	application route and exposure time	criterion	result	reference
Rattus norvegicus 1	-	-	diet, 2 y	$NOEC_{m,g}$	20 mg/kg diet	1,3
Rattus norvegicus 2	-	-	diet, 2 y	$NOEC_{m,g}$	20 mg/kg diet	1,3
Rattus norvegicus	-	-	diet, 3-gen.	$NOEC_{r}$	7 mg/kg diet	3
Canis domesticus	-	-	oral, 52 w	$NOEC_{m,g}$	0.5 mg/kg bw	1,3
Canis domesticus	-	-	diet, 2-gen.	$NOEC_{r}$	7 mg/kg diet	1

References

1. IPCS (1984) Environmental Health Criteria 38, heptachlor. WHO, Geneve.

2. FAO/WHO (1970) Evaluation of some pesticide residues in food. Joint Meeting of the FAO Working Party and the WHO Expert Group on Pesticide Residues, Rome, 9-16 November 1970. AGP: 1970/M/12/1. WHO/Food Add./71.42.

3. FAO/WHO (1966) Evaluation of some pesticide residues in food. Joint Meeting of the FAO Working Party and the WHO Expert Group on Pesticide Residues, Geneva, 14-21 November 1966. FAO PL:CP/15. WHO/Food Add./67.32.

4. IARC (1979) IARC Monographs on the evaluation of the carcingenic risk of chemicals to humans - Volume 32: Some halogenated hydrocarbons. World Health Organisation, IARC, Lyon, France.

Table 5.13 Toxicity of hexachlorobenzene to mammals

Species	Age	Purity	Application route and exposure time	Criterion	Result	Reference
Rattus norvegicus	-	-	diet, 15 w	$NOEC_m$	2 mg/kg bw	1
Rattus norvegicus	-	-	diet, 13 w	$NOEC_g$	125 mg/kg diet	3
Rattus norvegicus	-	-	diet, 2-gen.	$NOEC_r$	8 mg/kg diet	1
Rattus norvegicus	-	-	diet, 4-gen.	$NOEC_r$	40 mg/kg diet	1,2
				$NOEC_{m,mat.}$	80 mg/kg diet	1,2
Cavia aperea	-	-	gavage, gest. d 14-19	$NOEC_{g,mat.}$	1.0 mg/kg bw	1
Mustela vision	-	-	diet, 1-gen.	$NOEC_m$	25 mg/kg diet	2
				$LOEC_r$	1 mg/kg diet	2
Mustela vision	-	-	diet	$LOEC_r$	1 mg/kg diet	4
Mustela putorius	-	-	diet, 1-gen.	$NOEC_m$	23 mg/kg diet	2
				$LOEC_r$	1 mg/kg diet	2
Canis domesticus	-	-	capsule, 1 y	$NOEC_{m,g}$	1.3 mg/kg bw	1
Felis domesticis	-	-	diet, 1-gen.	$NOEC_r$	88 mg/kg diet	4,5
Macaca mulatta	-	-	gavage, 60 d	$LOEC_r$	64 mg/kg bw	1

References:

1. Hesse, J. M., G.J.A. Speijers and R.D.F.M. Taalman (1991) Integrated Criteria Document Chlorobenzenes - effects. Appendix to RIVM report No. 710401 005.

2. DECOS (1988) Health-based recommended occupational exposure limits for Hexachlorobenzene. Dutch Expert Committee for Occupational Standards (DECOS). Directorate-General of Labour of the Ministry of Social Affairs and Employment, Voorburg, the Netherlands Report no. AI RA 2/88.

3. FAO/WHO (1969) Evaluations of some pesticide residues in food. Joint Meeting of the FAO Working Party of Experts and the WHO Expert Group on Pesticide Residues, Rome, 4-15 December 1969. FAO PL:1969/M/17/1. WHO Food Add./70.38. Rome 1970.

4. USEPA (1988) Health Advisories: Hexachlorobenzene. USEPA - Criteria and Standards Division, Office of Drinking Water, Washington, USA. Rev. Environ. Contam. Toxicol. **106**, 143-154.

5. Kociba R.J. (1986) Evaluation of global literature for definition of dose-response relationship for hexachlorobenzene toxicity. In: C.R. Morris & J.R.P. Cabral (eds.), Hexachlorobenzene: Proceedings of an international symposium, held at IARC, Lyon, France 24-28 June 1985. IARC Scientific Publications No. 77.

Table 5.14 Toxicity of quintozene to mammals

Species	Age	Purity	Application route and exposure time	Criterion	Result	Reference
Rattus norvegicus(m)	weanl	-	diet, 3 m	$NOEC_{m,g}$	1250 mg/kg diet	1
Rattus norvegicus(f)	-	techn.	diet, 2 y	$NOEC_{g}$	25 mg/kg diet	1,2
Rattus norvegicus	-	-	diet, 90 d	$NOEC_{g}$	1000 mg/kg diet	2

References:

1. IPCS (1984) Environmental Health Criteria 41, quintozene. WHO, Geneve.

2. FAO/WHO (1969) Evaluation of some pesticide residues in food. Joint Meeting of the FAO Working Party of Experts and the WHO Expert Group on Pesticide Residues, Rome, 8-15 December 1969. FAO/PL: 1969/M/17/1. WHO/Food Add./70.38.

Table 5.15 Toxicity of thiram to mammals

Species	Age	Purity	Application route and exposure time	Criterion	Result	Reference
Mus musculus(f)	-	-	gest. d 6-17	$LOEC_r$	179 mg/kg bw	4
Mus musculus(f)	-	-	13 w(m)/14 d(f)	$LOEC_r$	40 mg/kg bw	5
Rattus norvegicus(f)	-	-	diet, 14 d	$LOEC_r$	400 mg/kg diet	4
				$NOEC_m$	400 mg/kg diet	4
Rattus norvegicus(m)	-	-	diet, 29 d	$NOEC_g$	225 mg/kg diet	4
				$NOEC_r$	300 mg/kg diet	4
Rattus norvegicus(f)	-	-	gest. d 6-15/7-12	$NOEC_r$	90 mg/kg bw	4
Rattus norvegicus(f)	-	-	diet, 75 d	$LOEC_r$	10 mg/kg diet	3
Rattus norvegicus(m)	-	-	diet, 13 w	$LOEC_g$	500 mg/kg diet	2,3
				$NOEC_r$	1000 mg/kg diet	2,3
Rattus norvegicus(m)	-	weanl.	diet, 13 w	$NOEC_r$	1000 mg/kg diet	4
Rattus norvegicus	-	-	water, 26 w	$LOEC_g$	0.04 mg/kg bw	3
Rattus norvegicus	-	-	diet, 80 w	$LOEC_g$	100 mg/kg diet	2,3
Rattus norvegicus	-	weanl.	diet, 2 y	$LOEC_g$	100 mg/kg diet	1
				$NOEC_m$	100 mg/kg diet	1

References:

1. FAO/WHO (1965) Evaluation of the toxicity of pesticide residues in food. Joint Meeting of the FAO Committee on Pesticides in Agricultuer and the WHO Expert Committee on Pesticide Residues, Rome, 15-22 March, 1965. FAO Meeting Report No. PL/1965/10/1. WHO Food Add./27.65.

2. Dreef-van der Meulen, H.C., F. de Vrijer, J.H. de Kreuk, J.M.A. van de Velde & G.J.G. de Kok (1985) Review of literature data on bis(dimethylthiocarbamyl)disulfide (thiram). Report by TNO/CIVO, TNO/MT & Haskoning

3. Shell B.V. (1982) Toxicology data sheet - Tetramethyl thiuram disulphide. Date of issue: August 1982.

4. IPCS (1988) Environmental Health Criteria 78, dithiocarbamate pesticides, ethylenethiourea: A general introduction. WHO, Geneve.

5. Hayes, W.J. & Laws, E.R. (1991) Handbook of Pesticide Toxicology - Volume 3: Classes of Pesticides. San Diego etc., Academic Press Inc., pp. 1441-1445.

Appendix 6. Toxicity data for birds

Legenda:

exposure time	d: day(s); w: week(s); m: month(s); y: year(s); gen: generation; gest: gestation; lact: lactation
criterion	NOEC: No Observed Effect Concetration based on mortality (m), growth (g), reproduction (r); LOEC: Lowest Observed Effect Concentration

Content:

Table 6.1 Toxicity of aldrin to birds

Species	age size (sex)	grade	route	no.birds/ conc.	no. of conc.	parameter	conc. (mg/kg diet)	% effect	reference
Anas platyrhynchos	8 d	tech	diet	10	6	5 d LC50	160	-	Hill & Heath, 1975
Colinus virginianus	17 d	tech	diet	10	6	5 d LC50	37	-	Hill & Heath, 1975
Coturnix c. japonica	6	tech	diet	18	5	5 d LC50	34	-	Hill & Heath, 1975
	1 d	-	diet	40-80	5	47 d $NOEC_m$	<1	100% mortality	DeWitt, 1956
	16-20 w	-	diet	40-48	2	127 d $NOEC_m$	<0.5	97.5% mortality	DeWitt, 1956
	adult	-	diet	8-16	1	$NOEC_r$	<1	19% mortality	DeWitt, 1956
	adult	-	diet	8-16	1	$NOEC_r$	<1	23% reduction	DeWitt, 1956
Phasianus colchicus	8 d	tech	diet	10	6	5 d LC50	57	-	Hill & Heath, 1975
	1 d	-	diet	30-40	2	46 d $NOEC_m$	<5	100% mortality	DeWitt, 1956
	adult	-	diet	8-10	3	$NOEC_r$	1	20% mortality	DeWitt, 1956

Table 6.2 Toxicity of carbofuran to birds

Species	age size (sex)	grade	route	no.birds/ conc(total)	no. of conc.	parameter	conc. (mg/kg diet)	% effect	reference
Agelaius phoenicus	(m)	10%[1]	oral	5	2	$NOEC_m$	<30	20% mortality	Balcomb, Stevens & Bowen, 1984
Anas platyrhynchos	10 d	99%	diet	10	5	5 d LC50	190	-	Hill & Heath, 1975
	10 d	96.5%	diet	12	6	5 d LC50	240	-	Kokonen, Hochstein & Ringer, 1987
	10 d	97.5%	water	10	6	5 d LC50	23	-	Kokonen, Hochstein & Ringer, 1987
	-	tech	diet		1	24 w $NOEC_r$	≥10	-	Rand, 1989
Colinus virginianus	adult (m)	tech	diet	8	2	14 d $NOEC_g$	26	-	Robel et al., 1982
	-	tech	diet	-	1	26 w $NOEC_r$	≥180	-	Rand, 1989
	10 d	96.5%	diet	12	6	5 d LC50	920	-	Kokonen, Hochstein & Ringer, 1987
Coturnix c. japonica	14 d	99%	diet	10	5	5 d LC50	440	-	Hill & Heath, 1975
	1 d	tech	diet	-	-	5 d LC50	140-470	-	Rand, 1989
	7 d	-	diet	-	-	5 d LC50	440-1100	-	Rand, 1989
	14 d	-	diet	-	-	5 d LC50	590-1000	-	Rand, 1989
	21 d	-	diet	-	-	5 d LC50	780-1500	-	Rand, 1989
	14 d (m,f)	tech	diet	5-15	5	6 w LC50	300[2]	-	Sherman & Ross, 1969
	14 d (f)	tech	diet	5-13	5	6 w $NOEC_r$	100	-	Sherman & Ross, 1969
	14 d (f)	tech	diet	7-15	5	6 w $NOEC_g$	200	-	Sherman & Ross, 1969
	14 d (m,f)	tech	diet	5-15	5	6 w $NOEC_m$	<50	-	Sherman & Ross, 1969
Dendrocygna bicolor	-	98.8%	dr.wat.	(15)	-	7 d $NOEC_m$	1[3]	-	Hudson, Tucker & Haegele, 1984
Phasianus colchicus	-	10%[1]	diet	-	-	10 d LC50	960	-	Agrochemicals handbook, 1990
	10 d	99%	diet	10	6	5 d LC50	570	-	Hill & Heath, 1975

[1]: granular formulation
[2]: calculated with data given by the author
[3]: concentration in mg/l for drinking water dosing; 100% mortality at 2 mg/l

Table 6.3 Toxicity of chlordane to birds

Species	age/ size (sex)	grade	route	no.birds/ conc.	no. of conc.	parameter	conc. (mg/kg diet)	% effect	reference
Anas platyrhynchos	10 d	72%	diet	10	5	5 d LC50	860	-	Hill & Heath, 1975
	-	-	diet	-	-	5 d LC50	800	-	Agrochemicals Handbook, 1990
Colinus virginianus	-	-	diet	-	-	5 d LC50	420	-	Agrochemical Handbook, 1987
	17 d	72%	diet	6	6	5 d LC50	330	-	Hill & Heath, 1975
	14 w		diet	-	-	10 w LC0	10	-	Ludke, 1976
	young	-	diet	-	-	<10 d LC50	250	-	DeWitt et al., 1963
	young	-	diet	-	-	<100 d LC50	100	-	DeWitt et al., 1963
	adult	-	diet	-	-	<100 d LC50	250	-	DeWitt et al., 1963
Coturnix c. japonica	7 d	72%	diet	14	5	5 d LC50	350	-	Hill & Heath, 1975
Molothrus ater	adult	-	diet	-	-	30 w LC50	500	-	DeWitt et al., 1963
Phasianus colchicus	15 d	72%	diet	9	5	5 d LC50	430	-	Hill & Heath, 1975
	young	-	diet	-	-	<10 d LC50	500	-	DeWitt et al., 1963
	young	-	diet	-	-	<100 d LC50	50	-	DeWitt et al., 1963
	adult	-	diet	-	-	<100 d LC50	200	-	DeWitt et al., 1963

Table 6.4 Toxicity of chlorpyrifos to birds

Species	age size (sex)	grade	route	no.birds/ conc.	no. of conc.	parameter	conc. (mg/kg diet)	% effect	reference
Anas platyrhynchos	10 d	97%	diet	8	8	5 d LC50	≈940	-	Hill & Heath, 1975
	5 d	-	diet	6-8	7	5 d LC50	190[1]	-	WHO, 1973
	7m+11m	96%	diet	24m+24f	1	6 w $NOEC_g$	<80	8% red. weight	Gile & Meyers, 1986
	7m+11m	96%	diet	24m+24f	1	6 w $NOEC_r$	<80	35% red.egg prod.	Gile & Meyers, 1986
	7m+11m	96%	diet	24m+24f	1	6 w $NOEC_r$	<80	7.5% red. weight of eggs	Gile & Meyers, 1986
	adult	95.7%	diet	5m+5f	5	56 d LC50	170	-	RIVM archives, 1988
Coturnix c. japonica	14 d	97%	diet	13	6	5 d LC50	300	-	Hill & Heath, 1975
	-	-	diet	-	7	28 d $NOEC_{g,r}$	10	-	RIVM archives, 1988
Gallus domesticus	10-12d (m)	98%	diet	20	5	14 d $NOEC_m$	200	-	Sherman et al., 1967
	10-12d (m)	98%	diet	20	5	7 d $NOEC_m$	200	-	Sherman et al., 1967
	-	-	diet	-	3	4 w $NOEC_g$	<25	-	WHO, 1973
	3-5 d	-	water	10	7	3 w $NOEC_m$	<80[2]	20% mortality	Brust, Miazaki & Hodgson, 1971
	-	480 g/l	water	-	-	28 d LC50	120[2]	-	RIVM archives, 1988
	-	480 g/l	water	-	-	28 d NOEC	20[2]	-	RIVM archives, 1988
Passer domesticus	(m,f)	15%[3]	oral	5	2	$NOEC_m$	<27	20% mortality	Balcomb, Stevens & Bowen, 1984
Phasianus colchicus	10 d	97%	diet	10	6	5 d LC50	550	-	Hill & Heath, 1975

[1]: calculated with data given by the author
[2]: concentration in mg/l water
[3]: 15% granular formulation

Table 6.5 Toxicity of endosulfan to birds

Species	age/ size (sex)	grade	route	no.birds/ conc.	no. of conc.	parameter	conc. (mg/kg diet)	% effect	reference
Anas platyrhynchos	16 d	96%	diet	10	4	5 d LC50	1100	-	Hill & Heath, 1975
	young	35%	diet	-	-	<10 d LC50	1000	-	IPCS 40, 1984 b
	adult	35%	diet	-	-	<10 d LC50	>5000	-	IPCS 40, 1984 b
	adult	35%	diet	-	-	<100 d LC50	1000	-	IPCS 40, 1984 b
Colinus virginianus	9 d	96%	diet	8	5	5 d LC50	810	-	Hill & Heath, 1975
	young	35%	diet	-	-	<10 d LC50	300	-	IPCS 40, 1984 b
	young	35%	diet	-	-	<100 d LC50	100	-	IPCS 40, 1984 b
Coturnix c. japonica	14 d	96%	diet	13	6	5 d LC50	≈1250	-	Hill & Heath, 1975
Molothrus ater	-	35%	diet	-	-	10 d LC50	1000	-	DeWitt et al., 1963
Phasianus colchicus	10 d	96%	diet	8	6	5 d LC50	1300	-	Hill & Heath, 1975
	young	35%	diet	-	-	<10 d LC50	500	-	DeWitt et al., 1963
	adult	35%	diet	-	-	<100 d LC50	1000	-	DeWitt et al., 1963

Table 6.6 Toxicity of endrin to birds

Species	age/ size (sex)	grade	route	no.birds/ conc.	no. of conc.	parameter	conc. (mg/kg diet)	% effect	reference
Anas platyrhynchos	8 d	tech	diet	10	6	5 d LC50	22	-	Hill & Heath, 1975
	5 d	tech	diet	10	6	5 d LC50	18	-	Hill & Heath, 1975
	-	-	diet	2m+5f	2	12 w $NOEC_r$	3	9.6% red. embryo survival	Roylance et al., 1985
Colinus virginianus	17 d	tech	diet	10	6	5 d LC50	14	-	Hill & Heath, 1975
Coturnix c. japonica	14 d	tech	diet	13	6	5 d LC50	18	-	Hill & Heath, 1975
	1 d	-	diet	40-60	6	41 d $NOEC_m$	<0.5	16% mortality	DeWitt, 1956
	16-20w	-	diet	47-60	2	162 d $NOEC^m$	<0.5	1.3% mortality	DeWitt, 1956
	adult	-	diet	16	1	$NOEC_m$	<1	19% mortality	DeWitt, 1956
Otis asio	-	-	diet	15m+15f	1	$NOEC_r$	<0.8	43% fewer owlets 23% red. hatch. 22% red. eggprod.	Fleming, McLane & Cromartie, 1982
Phasianus colchicus	14 d	tech	diet	8	4	5 d LC50	14	-	Hill & Heath, 1975
	1 d	-	diet	40	2	8 d $NOEC_m$	<5	72% mortality	DeWitt, 1956
	adult	-	diet	10	4	$NOEC_{m,r}$	2	10% red. hatch.	Dewitt, 1956

Table 6.7 Toxicity of fenthion to birds

Species	age size (sex)	grade	route	no.birds/ conc.	no. of conc.	parameter	conc. (mg/kg diet)	% effect	reference
Anas platyrhynchos	10 d	tech	diet	9	6	5 d LC50	230	-	Hill & Heath, 1975
Colinus virginianus	10 d	tech	diet	8	5	5 d LC50	30	-	Hill & Heath, 1975
	-	-	diet			10 d LC50	25	-	Agrochemicals Handbook, 1990
Coturnix c. japonica	19 d	tech	diet	16	6	5 d LC50	86	-	Hill & Heath, 1975
Gallus domesticus	(f)	tech	diet	10	4	7 d $NOEC_m$	220	-	Sherman & Ross, 1961
	(f)	tech	diet	10	4	7 d $NOEC_g$	2.2	-	Sherman & Ross, 1961
Phasianus colchicus	10 d	tech	diet	8	4	5 d LC50	200	-	Hill & Heath, 1975
Quiscalus quiscula	adult	97.1%	diet	3m+3f	4	5 d LC50	57	-	Grue, 1982
	adult	97.1%	diet	3m+3f	4	5 d $NOEC_m$	25	-	Grue, 1982
	adult	97.1%	diet	3m+3f	4	5 d LC50	<30	100% mortality	Grue, 1982

Table 6.8 Toxicity of β-HCH to birds

Species	age size (sex)	grade	route	no.birds/ conc.	no. of conc.	parameter	conc. (mg/kg diet)	% effect	reference
Gallus domesticus	-	-	diet	-	-	12 w $NOEC_{m,g,r}$	>=630	-	IPCS, 1992

Table 6.9 Toxicity of heptachlor to birds

Species	age/ size (sex)	grade	route	no.birds/ conc.	no. of conc.	parameter	conc. (mg/kg diet)	% effect	reference
Anas Platyrhynchos	10	tech	diet	9	6	5 d LC50	480	-	Hill & Heath, 1975
Colinus virginianus	23 d	tech	diet	7	5	5 d LC50	92	-	Hill & Heath, 1975
	-	-	diet	-	-	5 d LC50	450-700	-	IPCS 38, 1984 a
Coturnix c. japonica	19 d	tech	diet	16	6	5 d LC50	93	-	Hill & Heath, 1975
	-	-	diet	-	-	5 d LC50	80-95	-	IPCS 38, 1984 a
	0 d	-	diet	-	2	16 w $NOEC_g$	50	-	IPCS 38, 1984 a
	0 d	-	diet	-	2	10 w $NOEC_r$	50	-	IPCS 38, 1984 a
Phasianus colchicus	8 d	tech	diet	10	4	5 d LC50	220	-	Hill & Heath, 1975
	-	-	diet			5 d LC50	250-280	-	IPCS 38, 1984 a

Table 6.10 Toxicity of heptachlor epoxide to birds

Species	age/ size (sex)	grade	route	no.birds/ conc.	no. of conc.	parameter	conc. (mg/kg diet)	% effect	reference
Gallus domesticus	chick		diet	4m+20f	3	25 w $NOEC_{m,g}$	0.2	-	IPCS 38, 1984 a
	chick		diet	4m+20f	3	25 w $NOEC_r$	0.02	-	IPCS 38, 1984 a

Table 6.11 Toxicity of quintozene to birds

Species	age size (sex)	grade	route	no.birds/ conc.	no. of conc.	parameter	conc. (mg/kg diet)	% effect	reference
Gallus domesticus	1 d (f)	75%	diet	29-43	4	35 w $NOEC_r$	100	-	Dunn et al., 1979

Table 6.13 Toxicity of thiram to birds

Species	age size (sex)	grade	route	no.birds/ conc.	no. of conc.	parameter	conc. (mg/kg diet)	% effect	reference
Anas platyrhyngos	10 d	95%	diet	9	2	5 d LC50	>5000	-	Hill & Heath, 1975
Colinus virginianus	-	99.9%	diet			$NOEC_r$	<8.8	50% red. egg prod.	Dalvi, 1988
	14 d	95%	diet	6	5	5 d LC50	≈3950	-	Hill & Heath, 1975
Coturnix c. japonica	14 d	95%	diet	10	3	5 d LC50	>5000	-	Hill & Heath, 1975
Gallus domesticus	6 m	10%	oral	5	1	4 w $NOEC_m$	<180	100% mortality	Rasul & Howell, 1974
Phasianus colchicus	10 d	95%	diet	10	4	5 d LC50	5000	-	Hill & Heath, 1975

References:

Agrochemicals Handbook (1990) The Royal Society of Chemistry, Thomas Graham House, Science Park, Cambridge.

Balcomb, R., R. Stevens, and C. Bowen (1984) Toxicity of 16 granular insecticides to wildcaught songbirds. Bull. Environ. Contam. Toxicol. **33**, 302-307.

Brust, R.A., S. Miyazaki, and G.C. Hodgson (1971) Effect of dursban in the drinking water of chicks. J. Econ. Entomol. **64**, (5), 1179-1183.

Dalvi, R.R. (1988) Toxicology of thiram (tetramethylthiuram disulfide): A review. Vet. Hum. Toxicol. **30**, (5) 480-482.

DeWitt, J.B. (1956) Chronic toxicity to quail and pheasants of some chlorinates insecticides. Fish and wildlife service. U.S. Department of the Interior, Laurel, Md. Agric. Food Chem. **4**, (10), 863-866.

DeWitt, J.B., W.H. Stickel, and P.F. Springer (1963) Wildlife studies, Patuxent Wildlife Research Center. In: Pesticide-wildlife studies. A review of fish and wildlife service investigations during 1961 and 1962, Gulf Breeze, Florida. U.S. Department of the Interior, Fish and Wildlife Service 167, 74-96.

Dunn, J.S., P.B. Bush, N.H. Booth, R.L. Farrell, D.M. Thomason, and D.D. Goetsch (1979) Effect of pentachloronitrobenzene upon egg production, hatchability, and residue accumulation in the tissues of white leghorn hens. Toxicol. Appl. Pharmacol. **48**, 425-433.

Fleming, W.J., M.A.R. McLane, and E. Cromartie (1982) Endrin decreases screech owl productivity. J. Wildl. Manage **46**, (2), 462-468.

Gile, J.D., and S.M. Meyers (1986) Effect of adult mallard age on avian reproductive tests. Arch. Environ. Contam. Toxicol. **15**, 751-756.

Grue, C.E (1982) Response of common grackles to dietary concentrations of four organophosphate pesticides. Arch. Environ. Contam. Toxicol. **11**, 617-626.

Hill, E.F., R.G. Heath, J.W. Spann, and J.D. Williams (1975) Lethal dietary toxicities of environmental pollutants to birds. United states department of the interior fish and wildlife service. Special Scientific Report - Wildlife No. 191, Washington DC.

Hudson, R.H., R.K. Tucker, and M.A. Haegele (1984) Handbook of toxicity of pesticides to wildlife. U.S. Department of the Interior, Fish and Wildlife Service/Resource publication 153. Washington DC.

IPCS (1984a) Environmental Health Criteria 38, heptachlor. WHO, Geneve.

IPCS (1984b) Environmental Health Criteria 40, endosulfan. WHO, Geneve.

IPCS (1992) Environmental Health Criteria 123, alpha-and beta-hexachlorocyclohaxane. WHO, Geneva.

Kononen, D.W., J.R. Hochstein, and R.K. Ringer (1987) Avoidance behavior of mallards and northern bobwhite exposed to carbofuran-contaminated food and water. Environ. Toxicol. Chem. **6**, 41-50.

Ludke, J.L. (1976) Organochlorine pesticide residues associated of chlordane and endrin. Bull. Environ. Contam. Toxicol. **16**, 253-260.

Rand G.M. (1989) An environmental risk assessment of a pesticide. Dennis J. Paustenbach (editor): The risk assessment of environmental and human health hazards: A textbook of case studies. J. Wiley & Sons, New York.

Rasul, A.R., and J.Mc.C. Howell (1974) The toxicity of some dithiocarbamate compounds in young and adult domestic fowl. Toxicol. Appl. Pharmacol. **30**, 63-78.

RIVM archives (1988).

Robel, R.J., Felthousen, R.W., Dayton, A.D. (1982). Effects of carbamates on bowhite food intake, body weight, and locomotor acivity. Arch. Environ. Contam. Toxicol. **11**, 611-615.

Roylance, K.J., C.D. Jorgensen, G.M. Booth, and M.V. Carter (1985) Effects of dietary endrin on reproduction of mallard ducks (Anas platyrhyngos). Arch. Environ. Contam. Toxicol. **14**, 705-711.

Sherman, M., and E. Ross (1961) Acute and subacute toxicity of insecticides to chicks. Toxicol. Appl. Pharmacol. **3**, 521-533.

Sherman, M., and E. Ross (1969) Acute and subchronic toxicity to japanese quail of the carbamate insecticides carbofuran and sd 8530. Poultry Sci. **48**, (6), 2013-2018.

Sherman, M., R.B. Herrick, E. Ross, and M.T.Y. Chang (1967) Further studies on the acute and subacute toxicity of insecticides to chicks. Toxicol. Appl. Pharmacol. **11**, 49-67.

WHO (1973) Pesticide Residue Series, No 2. Evaluation of some pesticide residues in food. WHO, Geneve.