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No. 109

LITERATURE REVIEW ON THE 21-DAY FISH ASSAY AND THE FISH SHORT-TERM REPRODUCTION ASSAY

IOMC

INTER-ORGANIZATION PROGRAMME FOR THE SOUND MANAGEMENT OF CHEMICALS

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No.107, Preservative treated wood to the environment for wood held in storage after treatment and for wooden commodities that are not cover and are not in contact with ground.

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No.109, Literature Review on the 21-Day Fish Assay and the Fish Short-Term Reproduction Assay

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The Inter-Organisation Programme for the Sound Management of Chemicals (IOMC) was established in 1995 following recommendations made by the 1992 UN Conference on Environment and Development to strengthen co-operation and increase international co-ordination in the field of chemical safety. The participating organisations are FAO, ILO, OECD, UNEP, UNIDO, UNITAR and WHO. The World Bank and UNDP are observers. The purpose of the IOMC is to promote co-ordination of the policies and activities pursued by the Participating Organisations, jointly or separately, to achieve the sound management of chemicals in relation to human health and the environment.

FOREWORD

This document is a review of the literature on tests conducted using the 21-day Fish Assay for the Screening of Oestrogenic and Androgenic Activity and Aromatase Inhibition (OECD TG 230) and the Fish Short-Term Reproduction Assay (OECD TG 229), or similar protocols, up to December 2008. The review consists in a compilation of highly compressed summaries on about 170 studies on approximately 50 different chemicals. The review was undertaken to address comments from peer-reviewers that literature should be retrieved to further support the validation and regulatory acceptance of the 21-day Fish Assay for the Screening of Oestrogenic and Androgenic Activity and Aromatase Inhibition (TG 230) and the Fish Short-Term Reproduction Assay (TG229).

The review is presented in the form of a table listing the fish species used, the chemical identity and test concentrations used, the exposure duration (normally 21 days), the effect level and the most sensitive endpoint measured (shaded cell), and the source/reference.

This document is published on the responsibility of the Joint Meeting of the Chemicals Group and Management Committee of the Special Programme on the Control of Chemicals of the OECD.

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List of abbreviations

2Gen	parental generation of 2 generation test
beh	behaviour
chg	change
conc	concentration
dec	decrease
dep	dependent
F	female
fec	fecundity
fert	fertility
histo	histology
histo o-t	histology ovo-testis
inc	increase
ind	individuals
M	male
Meas/Nom	measured / nominal
No	number
pheno	phenotype
qual	only qualitative changes considered
red	reduction
sign	significant
SSC	secondary sex characteristics
stat	statistically
stats	statistics
VTG	vitellogenin

FHM	fathead minnow
MED	medaka
ZEB	zebrafish

Separation lines

separation between publications or tests

separation between species

separation between modes of action

LITERATURE REVIEW ON THE 21-DAY FISH ASSAY AND THE FISH SHORT-TERM REPRODUCTION ASSAY

Species	Chemical	Suspected MOA	Conc nominal	Conc measured	Exposure (d)	Endpoint	Effect	Dose	Unit	Meas/ Nom M/N	Tendency	Comments	Year	Author(s) Title and Source
FHM	17β-estradiol	natural estrogen	12,120,1200 ng/L	9.0,61,850 ng/L	21	LOEC	histo m	61	ng/L	M	dec*	* dec functional gametogenesis, dec sperm precursor cells in male	2002	Caunter JE 17β-oestradiol: 21 day exposure to mature fatehad minnows (Pimephales promelas) CEFIC-Project
						LOEC	histo f	850	ng/L	M	dec*	* dec vitellogenic follicles		
FHM	17β-estradiol	natural estrogen	500 ng/L	316 ng/L	21	LOEC	fec	316	ng/L	M	dec		2004	Bringolf RB, Belden JB, Summerfelt RC Effects of Atrazine on Fathead Minnow in a Short-Term Reproduction Assay Environ Toxicol Chem 23(4):1019-1025
						LOEC	fert	> 316	ng/L	M	no effect			
						LOEC	hatch	> 316	ng/L	M	no effect			
						LOEC	VTG f&m	316	ng/L	M	inc			
						LOEC	SSC m	316	ng/L	M	dec*	* dec nuptial tubercles		
						LOEC	histo m	316	ng/L	M	dec*	* dec maturation		
						LOEC	histo f	316	ng/L	M	dec*	* dec maturation		
FHM	17β-estradiol	natural estrogen	10,32,100,320,1000 ng/L		21 males	LOEC	VTG m	100	ng/L	N	inc		1998	Panter GH, Thompson RS, Sumtper JP Adverse reproductive effects in male fathead minnows (Pimephales promelas) exposed to environmentally relevant concentrations of the natural oestrogens, oestradiol and oestrone Aquatic Toxicol 42: 243-253
FHM	17β-estradiol	natural estrogen	10,32,100 ng/L	13,29,60 ng/L	14 males	LOEC	VTG m	29	ng/L	M	inc		2007	Thorpe KL, Benstead R, Hutchinson TH, Tyler CR Associations between altered vitellogenin concentrations and adverse health effects in fathead minnow (Pimephales promelas), Aquatic Toxicol 85:176-183
FHM	17β-estradiol	natural estrogen	10,32,100 ng/L	8.8,29,86 ng/L	21	LOEC	VTG f&m	29	ng/L	M	inc		2006	Seki M, Fujishima S, Nozaka T, Maeda M, Kobayashi K COMPARISON OF RESPONSE TO 17β-ESTRADIOL AND 17β-TRENBOLONE AMONG THREE SMALL FISH SPECIES Environ Toxicol Chem 25(10):2742-2752
						LOEC	SSC m	86	ng/L	M	dec			

Species	Chemical	Suspected MOA	Conc nominal	Conc measured	Exposure (d)	Endpoint	Effect	Dose	Unit	Meas/ Nom M/N	Tendency	Comments	Year	Author(s) Title and Source
FHM	17β-estradiol	natural estrogen	27,272,2724 ng/L	79% of nominal:	19	EC50	fec	120	ng/L	M	dec		1998	Kramer VJ, Miles-Richardson S, Pierens SL, Giesy JP Reproductive impairment and induction of alkaline-labile phosphate, a biomarker of estrogen exposure, in fathead minnows (*Pimephales promelas*) exposed to waterborne 17β-estradiol. AquaticToxicol 40:335-360
						EC10	fec	6.6	ng/L	M	dec			
						EC50	VTG m	251	ng/L	M	inc			
FHM	17β-estradiol	natural estrogen	0.023,0.037,0.046, 0.091,0.18,0.37,0.73, 5.4, 27,272,2724 ng/L	79% of nominal	14	LOEC	SSC m	5.4	ng/L	N	dec*	*dec in tubercle diameter (fatpad not sign)	1999	Miles-Richardson SR, Kramer VJ, Fitzgerald SD, Render JA, Yamini B, Barbee SJ, Giesy JP Effects of waterborne exposure to 17β-estradiol on secondary sex characteristics and gonads of fathead minnows (Pimephales promelas) AquaticToxicol 47(2):129-145
						LOEC	histo m	5.4	ng/L	N	chg*	*inc in proportion of sec. follicles, but no clear dose-effect relationship		
						LOEC	histo f	0.05	ng/L	N	chg*	*sign differences in proportion of Graafian follicles and between primary follicles & other stages; but no clear dose-effect relationship		
MED	17β-estradiol	natural estrogen	1,3,10,30,100 nM		14 males	LOEC	fec	3	nM	N	dec		2000	Shioda T, Wakabayashi M Effect of certain chemicals on the reproduction of medaka (Oryzias latipes) Chemosphere 40:239-243
						LOEC	hatch	3	nM	N	dec			
MED	17β-estradiol	natural estrogen	0.01,0.1,1,10,100 nM		14 females	LOEC	fec	1	nM	N	dec		1999	Wakabayashi M Evaluation of reproductivity of medaka (Oryzias latipes) exposed to chemicals using 2-week reproduction test Presentation at OECD VMGeco meeting
						LOEC	hatch	0.1	nM	N	dec			
MED	17β-estradiol	natural estrogen		5.8,11,22, 41,84 ng/L	21 males	LOEC	VTG m	22	ng/L	M	inc		2006	Results of Assay and Tests in Evaluation of the Endocrine Disrupting Acitivities in Fish (Medaka) Japanese Ministry of Environment
MED	17β-estradiol	natural estrogen	10,32,100 ng/L	8.9,28, 85 ng/L	21	LOEC	SSC m	> 85	ng/L	M	no effect		2006	Seki M, Fujishima S, Nozaka T, Maeda M, Kobayashi K COMPARISON OF RESPONSE TO 17β-ESTRADIOL AND 17β-TRENBOLONE AMONG THREE SMALL FISH SPECIES Environ Toxicol Chem 25(10):2742-2752
						LOEC	VTG f	85	ng/L	M	inc			
						LOEC	VTG m	8.9	ng/L	M	inc			

Species	Chemical	Suspected MOA	Conc nominal	Conc measured	Exposure (d)	Endpoint	Effect	Dose	Unit	Meas/ Nom M/N	Tendency	Comments	Year	Author(s) Title and Source
MED	17β-estradiol	natural estrogen		29,56,116, 227,463 ng/L	21	LOEC	fec	463	ng/L	M	dec		2002	Kang IJ, Yokota H, Oshima Y, Tsuruda Y, Yamaguchi T, Maeda M, Imada N, Tadokoro H, Honjo T Effects of 17β-estradiol on the reproduction of Japanese medaka (*Oryzias latipes*). Chemosphere 47(1): 71-80
						LOEC	fert	463	ng/L	M	dec			
						LOEC	histo o-t	29	ng/L	M	inc			
						LOEC	VTG m	56	ng/L	M	inc			
ZEB	17β-estradiol	natural estrogen	1 ug/L		70	LOEC	VTG m	1	ug/L	N	inc		2001	Andersen L, Petersen GI, Gessbo A, Oern S, Holbech H, Bjerregaard P, Norrgren L Zebrafish Danio rerio and roach Rutilus rutilus: two species suitable for evaluating effects of endocrine disrupting chemicals? AquaticEcosystem Health Managem 4:275-282
ZEB	17β-estradiol	natural estrogen	0.01,0.1, 1,10 ug/L		30	LOEC	fec	> 10	ug/L	N	no effect		2000	Oern S, Gessbo A, Steinholz A, Norrgren L Zebrafish (Danio rerio) - A candidate to evaluate endocrine disrupting chemicals In: Zebra fish for testing endocrine disrupting chemicals. TemaNord 2000:555, Nordic Council of Ministers, Copenhagen, ISBN 92-893-0480-4, pp 47-62
						LOEC	sex ratio	1	ug/L	N	inc*	* inc in females		
ZEB	17β-estradiol	natural estrogen	0.01,0.1, 1,10 nM males	40-80% of nominal	21	LOEC	VTG m	0.1	nM	N	inc		2003	Wester PW, van den Brandhof EJ, Vos JH, van der Ven LTM Identification of Endocrine Disruptive Effects in the Aquatic Environment; a partial life cycle assay in Zebrafish RIVM report 640920001/2003 (DG SANCO, project B6-7920/98/00025) pp 112
			0,10 nM females			LOEC	VTG f	10	nM	N	inc			
ZEB	17β-estradiol	natural estrogen	0.1,0.32, 1 nM	gradual decline to 4% of nominal within 4d	21	LOEC	fec	> 1	nM	N	no effect		2003	Wester PW, van den Brandhof EJ, Vos JH, van der Ven LTM Identification of Endocrine Disruptive Effects in the Aquatic Environment; a partial life cycle assay in Zebrafish RIVM report 640920001/2003 (DG SANCO, project B6-7920/98/00025) pp 112
						LOEC	hatch	> 1	nM	N	no effect			
						LOEC	histo	1	nM	N	inc*	* basophilia in male hepatocytes		
						LOEC	sex ratio	0.1	nM	N	chg*	* dec of males, inc of undifferentiated		
						LOEC	VTG f&m	> 1	nM	N	no effect*	* inc in males not stat sign		
ZEB	17β-estradiol	natural estrogen	0.1,0.32, 1 nM	1 nM: decline to	21	LOEC	VTG m	1	nM	N	inc		2007	van der Ven LT, van den Brandhof EJ, Vos JH, Wester PW

Species	Chemical	Suspected MOA	Conc nominal	Conc measured	Exposure (d)	Endpoint	Effect	Dose	Unit	Meas/ Nom M/N	Tendency	Comments	Year	Author(s) Title and Source
				3.8% in 4d		LOEC	fec	> 1	nM	N	no effect			Effects of the estrogen agonist 17beta-estradiol and antagonist tamoxifen in a partial life-cycle assay with zebrafish (Danio rerio) Environ Toxicol Chem 26(1):92-9
						LOEC	sex ratio	0.32	nM	N	inc*	*inc in females		
ZEB	17β-estradiol	natural estrogen	10,32,100 ng/L	10,25,86 ng/L	21	LOEC	VTG f&m	86	ng/L	M	inc		2006	Seki M, Fujishima S, Nozaka T, Maeda M, Kobayashi K COMPARISON OF RESPONSE TO 17β-ESTRADIOL AND 17β-TRENBOLONE AMONG THREE SMALL FISH SPECIES Environ Toxicol Chem 25(10):2742-2752
ZEB	17β-estradiol	natural estrogen	1,10,100 nM	decline to 26% in 3d	21	LOEC	histo m	100	nM	N	chg*	* inc cyst surface in spermatogonium & dec in cyst size in spermatocytes and spermatids; 1-100nM: sign conc-dep chg	2003	van der Ven L, Wester PW, Vos JG HISTOPATHOLOGY AS A TOOL FOR THE EVALUATION OF ENDOCRINE DISRUPTION IN ZEBRAFISH (*DANIO RERIO*) Environ Toxicol Chem 22(4):908-913
FHM	oestrone	natural estrogen	9.9,32,99,318,993 ng/L		21 males	LOEC	VTG m	32	ng/L	N	inc		1998	Panter GH, Thompson RS, Sumtper JP Adverse reproductive effects in male fathead minnows (Pimephales promelas) exposed to environmentally relevant concentrations of the natural oestrogens, oestradiol and oestrone Aquatic Toxicol 42: 243-253
FHM	oestrone	natural estrogen	32,100,320,1000 ng/L	34,98,307,781ng/L	21	LOEC	fec	307	ng/L	M	dec		2007	Thorpe KL, Benstead R, Hutchinson TH, Tyler CR Associations between altered vitellogenin concentrations and adverse health effects in fathead minnow (Pimephales promelas), Aquatic Toxicol 85:176-183
						LOEC	VTG m	34	ng/L	M	inc			
						LOEC	VTG f	307	ng/L	M	inc			
FHM	17α-ethinyl-estradiol	synthetic estrogen	5,10,20,40 ng/L		14	LOEC	VTG m	5	ng/L	N	inc*	* 5-20 ng/L: conc dep inc; no stats	2000	Zerulla M, Länge R, Steger-Hartmann T, Dietrich DR Effects of Ethyinylestratiol, Methyltestosterone and Fadrozole on fathead minnows (Pimephales promelas) SETAC-Europe Poster 2000, Brighton
FHM	17α-ethinyl-	synthetic estrogen	10 ng/L		21	LOEC	VTG m	10	ng/L	N	inc		2006	Panter GH Development of chronic tests for endocrine

Species	Chemical	Suspected MOA	Conc nominal	Conc measured	Exposure (d)	Endpoint	Effect	Dose	Unit	Meas/ Nom M/N	Tendency	Comments	Year	Author(s) Title and Source
	estradiol					LOEC	VTG f	> 10	ng/L	N	no effect			active chemicals. Part 3: A pair-breeding study for oestrogenic active chemicals in the fathead minnow (Pimephales promelas) CEFIC Project B2
						LOEC	fec	> 10	ng/L	N	no effect			
FHM	17α-ethinyl-estradiol	synthetic estrogen	10 ng/L		21	LOEC	SSC m	> 10	ng/L	N	no effect*	* dec, but not sign	2004	Panter GH, Hutchinson TH, Hurd KS, Sherren A, Stanley RD, Tyler CR Successful detection of (anti-)androgens and aromatase inhibitors using a sub-adult fathead minnow non-spawning assay AquaticToxicol 70, 11-21
						LOEC	VTG f	> 10	ng/L	N	no effect			
						LOEC	VTG m	10	ng/L	N	inc			
FHM	17α-ethinyl-estradiol	synthetic estrogen	50 ng/L	48 ng/L	35	LOEC	VTG	48	ng/L	M	inc*	* VTG mRNA in liver sign from day 3; VTG protein in plasma sign from day 21	2002	Schmid T, Gonzalez-Valero J, Rufli H, Dietrich DR Determination of vitellogenic kinetics in male fathead minnows (Pimephales promelas) Tox Lett 131(1-2):65-74
FHM	17α-ethinyl-estradiol	estrogen	10 ng/L	14 ng/L	28	LOEC	fec	> 14	ng/L	M	no effect		2008	Bogers R, Buitenweg S, Baltussen E, Legler J, Murk A A pair-breeding study with fathead minnow (Pimephales promelas) exposed to an androgenic chemical. In: Markers of endocrine disruption in fish CEFIC Project B2, as part of Thesis Wageningen University, Netherlands
						LOEC	VTG f&m	14	ng/L	M	inc			
						LOEC	SSC m	14	ng/L	M	dec			
FHM	17α-ethinyl-estradiol	synthetic estrogen	0.1,1,3,10,100 ng/L	20-32% of nominal	21	LOEC	VTG f&m	1.0	ng/L	N	inc		2004	Pawlowski, S, Van Aerle R, Tyler CR, Braunbeck T Effects of 17α-ethinylestradiol in a fathead minnow (Pimephales promelas) Gonadal Recrudescence Assay Ecotoxicol Environ Safety 57(3):302-317
						LOEC	SSC f	> 100	ng/L	N	no effect			
						LOEC	SSC m	1.0	ng/L	N	dec*	*dec no of tubercles		
						LOEC	fec	0.1	ng/L	N	chg*	*0.1-1ng/L: inc; 10-100ng/L: dose-dependent dec		
						LOEC	fert	10	ng/L	N	dec			
						LOEC	histo f	> 100	ng/L	N	no effect			
						LOEC	histo m	10	ng/L	N	dec*	* no fertile sperm detectable by light microscopy		
MED	17α-ethinyl-	synthetic estrogen	0.2,5,500 ,2000	not measured	14	LOEC	VTG f&m	500	ng/L	N	inc		2005	Tilton SC, Foran CM, Benson WH Relationship Between Ethinylestradiol-

Species	Chemical	Suspected MOA	Conc nominal	Conc measured	Exposure (d)	Endpoint	Effect	Dose	Unit	Meas/ Nom M/N	Tendency	Comments	Year	Author(s) Title and Source
	estradiol		ng/L			LOEC	pheno	> 500	ng/L	N	no effect			Mediated Changes in Endocrine Function and Reproductive Impairment in Japanese Medaka (Oryzias latipes) Environ Toxicol Chem 24(2):352-359
						LOEC	sex ratio	> 500	ng/L	N	no effect			
						LOEC	fec	500	ng/L	N	dec			
						LOEC	hatch	500	ng/L	N	dec			
						LOEC	fert	500	ng/L	N	dec			
MED	17α-ethinyl-estradiol	synthetic estrogen		15,32,61,127,254 ng/L	21	LOEC	VTG m	≤ 15	ng/L	M	inc		2006	Results of Assay and Tests in Evaluation of the Endocrine Disrupting Acitivities in Fish (Medaka) Japanese Ministry of Environment
						LOEC	VTG f	61	ng/L	M				
MED	17α-ethinyl-estradiol	synthetic estrogen		33,64,116,261,488 ng/L	21	LOEC	fec	488	ng/L	M	dec		2002	Seki M, Yokota H, Matsubara H, Tsuruda Y, Maeda M, Tadokoro H, Kobayashi K EFFECT OF ETHINYLESTRADIOL ON THE REPRODUCTION AND INDUCTION OF VITELLOGENIN AND TESTIS-OVA IN MEDAKA (*ORYZIAS LATIPES*) Environ Toxicol Chem 21(8):1692-1698
						LOEC	VTG m	64	ng/L	M	inc			
						LOEC	histo o-t	64	ng/L	M	inc			
ZEB	17α-ethinyl-estradiol	synthetic estrogen	10,20,50,100 ng/L		30	LOEC	VTG m	20	ng/L	N	inc	*inc in males	2000	Petersen GI, Andersen L, Holbech H, Pedersen KL Baseline Test Studies and Development of ELISA In: Zebra fish for testing endocrine disrupting chemicals. TemaNord 2000:555, Nordic Council of Ministers, Copenhagen, ISBN 92-893-0480-4, pp 35-46
ZEB	17α-ethinyl-estradiol	synthetic estrogen	0.01,0.1,1,10,25 ng/L		30	LOEC	fec	0.01	ng/L	N	inc*	*inc at 0.01 and dec starting at 10 ug/L	2000	Oern S, Gessbo A, Steinholz A, Norrgren L Zebrafish (Danio rerio) - A candidate to evaluate endocrine disrupting chemicals In: Zebra fish for testing endocrine disrupting chemicals. TemaNord 2000:555, Nordic Council of Ministers, Copenhagen, ISBN 92-893-0480-4, pp 47-62
						LOEC	sex ratio	0.01	ng/L	N	inc*	* inc in females		
ZEB	17α-ethinyl-estradiol	synthetic estrogen	25 ng/L	26 ng/L	7 males	LOEC	VTG m	26	ng/L	M	inc		2006	Andersen, L., R. Goto-Kazeto, J.M. Trant JM, Nash JP, Korsgaard B, Bjerregaard P Short-Term Exposure to Low Concentrations of the Synthetic Androgen Methyltestosterone Affects Vitellogenin and Steroid Levels in Adult male Zebrafish (Danio rerio) AquaticToxicol 76(3/4):343-352
ZEB	17α-ethinyl-estradiol	estrogen	1,10 ng/L		70 males	LOEC	histo m	1	ng/L	N	dec*	* disorganised tubule	>1998	Norrgren L, Bjerregaard P, Gessbo A, Holbech H, Pedersen K, Steinholtz A, Orn S The zebrafish (Danio rerio) - a candidate for

Species	Chemical	Suspected MOA	Conc nominal	Conc measured	Exposure (d)	Endpoint	Effect	Dose	Unit	Meas/ Nom M/N	Tendency	Comments	Year	Author(s) Title and Source
						LOEC	histo o-t	10	ng/L	N	inc	system, reduced density of mature sperms		evaluation of endocrine disrupting chemicals
ZEB	17α-ethinyl-estradiol	synthetic estrogen	10 ng/L		12 males	LOEC	VTG m	10	ng/L	N	inc		2001	Oern S, Norman A, Holbech H, Gessbo A, Petersen GI, Norrgren L Short-term exposure of zebrafish to pulp mill effluent and 17alpha-ethinylestradiol: A comparison between juvenile and adult fish In: Petersen GI, Norrgren L, Holbech H, Lundgren A, Koivisto S, eds, Suitability of Zebrafish as Test Organism for Detection of Endocrine Disrupting Chemicals, TemaNord 2001:597, Nordic Council of Ministers, Copenhagen, Denmark
ZEB	17α-ethinyl-estradiol	synthetic estrogen	10 ng/L		12	LOEC	VTG	10	ng/L	N	inc		2001	Norman A, Oern S, Holbech H, Gessbo A, Parkkonen J, Foerlin L, Norrgren L. Exposure of zebrafish (Danio rerio) and rainbow trout (Oncorhynchus mykiss) to 17α-ethinylestradiol and effluent from a sewage treatment plant In: Petersen GI, Norrgren L, Holbech H, Lundgren A, Koivisto S, eds, Suitability of Zebrafish as Test Organism for Detection of Endocrine Disrupting Chemicals, TemaNord 2001:597, Nordic Council of Ministers, Copenhagen, Denmark
ZEB	17α-ethinyl-estradiol	synthetic estrogen	10,25 ng/L	9.4,18 ng/L	24	LOEC	VTG f&m	9.4	ng/L	M	inc		2002	van den Belt K, Wester PW, van der Ven LTM, Verheyen R, Witters H EFFECTS OF ETHYNYLESTRADIOL ON THE REPRODUCTIVE PHYSIOLOGY IN ZEBRAFISH (*DANIO RERIO*): TIME DEPENDENCY AND REVERSIBILITY Environ Toxicol Chem 21(4):767-775
						LOEC	histo f&m	9.4	ng/L	M	chg*	*f: inc atretic vitellogenic stages, only previtellogenic stages remained. M: inc clusters of spermatogonia, dec of cysts of further stages		
ZEB	17α-ethinyl-estradiol	synthetic estrogen	5,10,25,50 ng/L		21	LOEC	fec	10	ng/L	N	dec*	* dose related dec in %-spawing females, at	2001	van den Belt K, Verheyen R, Witters H Reproductive effects of ethynylestradiol and 4t-octylphenol on the zebrafish (Danio rerio) Arch Environ Contam Toxicol 41:458-467
						LOEC	fert m	5	ng/L	N	dec			

Species	Chemical	Suspected MOA	Conc nominal	Conc measured	Exposure (d)	Endpoint	Effect	Dose	Unit	Meas/ Nom M/N	Tendency	Comments	Year	Author(s) Title and Source
						LOEC	VTG f&m	10	ng/L	N	inc	25 ng/L complete inhibition		
						LOEC	histo m	10	ng/L	N	dec*	* dec testis somatical index		
FHM	4-nonylphenol	weak estrogen (+anti-androgen)	0.1,0.3,1.0,3.0,10 ug/L	0.05,0.16,0.4,1.6,3.4 ug/L	42	LOEC	VTG m	> 3.4	ug/L	M	no effect		2000	Giesy JP, Pierens SL, Snyder EM, Miles-Richardson S, Kramer VJ, Snyder SA, Nichols KM, Villeneuve DA Effects of 4-nonylphenol on fecundity and biomarkers of estrogenicity in fathead minnows (Pimephales promelas) Environ Toxicol Chem 19(5):1368-1377
						LOEC	VTG f	1.6	ug/L	M	dec*	*inverted U-shape curve		
						LOEC	fec	> 3.4	ug/L	M	no effect*	*dec, but not stat sign due to variability / inverted U-shape curve		
FHM	4-nonylphenol	weak estrogen (+anti-androgen)	0.1,0.3,1.0,3.0,10 ug/L	0.09,0.1,0.33,0.93,2.4 ug/L	42	LOEC	SSC m	> 2.4	ug/L	M	no effect		1999	Miles-Richardson SR, Pierens SL, Nichols KM, Kramer VJ, Snyder EM, Snyder SA, Render JA, Fitzgerald SD, Giesy JP Effects of waterborne exposure to 4-nonylphenol and nonylphenol ethoxylate on secondary sex characteristics and gonads of fathead minnows (Pimephales promelas) Environ Res 80:122-137
						LOEC	histo m	0.33	ug/L	M	inc*	* severity scores of testes & inc in Sertoli cell, necrotic spermatozoa and germ cell syncytia: stat sign trend in 0.33-2.4 ug/L		
						LOEC	histo f	> 2.4	ug/L	M	no effect			
FHM	4-nonylphenol	weak estrogen (+ anti-androgen)	100 ug/L	71 ug/L	21	LOEC	fec	71	ug/L	M	dec		2000	Harries JE, Runnalls T, Hill E, Harries CA, Maddix S, Sumpter JP, Tyler CR Development of a reproductive performance test for endocrine disrupting chemicals using pair-breeding fathead minnows (*Pimephales promelas*) Environ Sci Technol 34(14):3003-3011
FHM	4-nonylphenol	weak estrogen (+ anti-androgen)	1,10,100 ug/L	0.65,7.3,53 ug/L	21	LOEC	VTG f	53	ug/L	M	inc		2000	Harries JE, Runnalls T, Hill E, Harries CA, Maddix S, Sumpter JP, Tyler CR Development of a reproductive performance test for endocrine disrupting chemicals using pair-breeding fathead minnows (*Pimephales*

Species	Chemical	Suspected MOA	Conc nominal	Conc measured	Exposure (d)	Endpoint	Effect	Dose	Unit	Meas/ Nom M/N	Tendency	Comments	Year	Author(s) Title and Source
						LOEC	VTG m	7.3	ug/L	M	inc	*promelas*)		
						LOEC	SSC m	0.65	ug/L	M	dec*	*dec in tubercles		Environ Sci Technol 34(14):3003-3011
						LOEC	fec	7.3	ug/L	M	dec*	*no of spawnings, but not egg no		
MED	p-nonylphenol	weak estrogen (+anti-androgen)	0.03,0.1, 0.3 uM		14 males	LOEC	fec	> 0.3	uM	N	no effect		2000	Shioda T, Wakabayashi M Effect of certain chemicals on the reproduction of medaka (Oryzias latipes) Chemosphere 40:239-243
						LOEC	hatch	> 0.3	uM	N	no effect*	* dec no of hatchlings at 0.3 uM, but not stat sign		
MED	p-nonylphenol	weak estrogen (+anti-androgen)	0.03,0.1, 0.3 uM		14 females	LOEC	fec	> 0.3	uM	N	no effect		1999	Wakabayashi M Evaluation of reproductivity of medaka (Oryzias latipes) exposed to chemicals using 2-week reproduction test Presentation at OECD VMGeco meeting
						LOEC	hatch	> 0.3	uM	N	no effect			
MED	4-nonylphenol	weak estrogen (+anti-androgen)	25,50,100,200 ug/L	25,51,101, 184 ug/L	21	LOEC	fec	101	ug/L	M	dec		2003	Kang IJ, Yokota H, Oshima Y, Tsuruda Y, Hano T, Maeda M, Imada N, Tadokoro H, Honjo T EFFECTS OF 4-NONYLPHENOL ON REPRODUCTION OF JAPANESE MEDAKA, *ORYZIAS LATIPES* Environ Toxicol Chem 22(10):2438-2445
						LOEC	fert	184	ug/L	M	dec			
						LOEC	histo o-t	184	ug/L	M	inc*	*184 ug/L: 1 out of 3 ind; 101 ug/L: 1 out of 7 ind		
						LOEC	VTG f&m	51	ug/L	M	inc			
MED	4-nonylphenol (branched)	weak estrogen (+anti-androgen)		7.4,13,23, 56,118 ug/L	21	LOEC	VTG f	118	ug/L	M	inc		2006	Results of Assay and Tests in Evaluation of the Endocrine Disrupting Acitivities in Fish (Medaka) Japanese Ministry of Environment
						LOEC	VTG m	23	ug/L	M	inc			
FHM	nonylphenol ethoxylate	weak estrogen (+anti-androgen)	0.3,1.0,3.0,10 ug/L	0.15,0.43, 1.5,5.5 ug/L	42	LOEC	SSC f&m	> 5.5	ug/L	M	no effect		1999	Miles-Richardson SR, Pierens SL, Nichols KM, Kramer VJ, Snyder EM, Snyder SA, Render JA, Fitzgerald SD, Giesy JP Effects of waterborne exposure to 4-nonylphenol and nonylphenol ethoxylate on secondary sex characteristics and gonads of fathead minnows (Pimephales promelas) Environ Res 80:122-137
						LOEC	histo	> 5.5	ug/L	M	no effect			

Species	Chemical	Suspected MOA	Conc nominal	Conc measured	Exposure (d)	Endpoint	Effect	Dose	Unit	Meas/ Nom M/N	Tendency	Comments	Year	Author(s) Title and Source
FHM	4t-octylphenol	estrogen	1.0,50,150 ug/L	LabA: 0.57,37,120 ug/L	21	LOEC	histo m	0.57, 0.58	ug/L	M	inc*	*LabA&B: inc proportion of spermatogonia	2007	Biever RC, Kruger H, Kern M, Blackshear PE, Sloan CS Inter-laboratory validation of the fish short-term reproduction assay, run simultaneously across three independent contract laboratories EPA Contract No. EP-W-06-026
				LabB: 0.58,31,98 ug/L		LOEC	histo m	120	ug/L	M	inc*	*LabC: inc proportion of spermatogonia		
				LabC: 0.84,42,120 ug/L		LOEC	histo f	0.57	ug/L	M	inc*	*LabA: inc oocyte atresia		
						LOEC	histo f	98	ug/L	M	inc*	*LabB: inc oocyte atresia		
						LOEC	histo f	> 120	ug/L	M	no effect*	*LabC		
						LOEC	VTG m	0.84	ug/L	M	inc*	*LabC		
						LOEC	VTGm	37,31	ug/L	M	inc*	*LabA&B		
						LOEC	VTG f	37	ug/L	M	inc*	*LabA		
						LOEC	VTG f	> 98,120	ug/L	M	no effect*	*LabB&C		
						LOEC	SSC m	0.57	ug/L	M	dec*	*LabA: dec fatpad score		
						LOEC	SSC m	42	ug/L	M	dec*	*LabC: dec tubercle score		
						LOEC	SSC m	98	ug/L	M	dec*	*LabB: dec tubercle score & count		
						LOEC	fec	120, 98,120	ug/L	M	dec*	*LabA,B,C		
						LOEC	fert	120, 98	ug/L	M	dec*	*LabA&B		
						LOEC	fert	> 120	ug/L	M	no effect*	*LabC		
MED	4t-octylphenol	estrogen		13,28,64,129,296 ug/L	21	LOEC	VTG f	296	ug/L	M	inc		2006	Results of Assay and Tests in Evaluation of the Endocrine Disrupting Acitivities in Fish (Medaka) Japanese Ministry of Environment
						LOEC	VTG m	64	ug/L	M	inc			
ZEB	4t-octylphenol	estrogen	13,25,50, 100 ug/L		21	LOEC	fert m	> 100	ug/L	N	no effect		2001	van den Belt K, Verheyen R, Witters H Reproductive effects of ethynylestradiol and 4t-octylpheno on the zebrafish (Danio rerio) Arch Environ Contam Toxicol 41:458-467
						LOEC	fec	> 100	ug/L	N	no effect			

Species	Chemical	Suspected MOA	Conc nominal	Conc measured	Exposure (d)	Endpoint	Effect	Dose	Unit	Meas/ Nom M/N	Tendency	Comments	Year	Author(s) Title and Source
FHM	bisphenol A	weak estrogen	64, 640 ug/L	57,344 ug/L	21	LOEC	fec	344	ug/L	M	dec		2006	Multi-chemical evaluation of the short-term reproduction assay with the fathead minnow Batelle, EPA contract No. 68-W-01-023
						LOEC	hatch	> 344	ug/L	M	no effect*	* dec hatch at 57, but not at 344 ug/L		
						LOEC	histo f	344	ug/L	M	inc*	* inc proportion of follicles in stage 1A		
						LOEC	histo m	> 344	ug/L	M	no effect			
						LOEC	VTG m	57	ug/L	M	inc			
						LOEC	VTG f	344	ug/L	M	inc			
FHM	bisphenol A	weak estrogen	1,16,160, 640,1280 ug/L	70-96% of nominal	164	LOEC	VTG m	160	ug/L	N	inc		2001	Sohoni P, Tyler CR, Hurd K, Caunter J, Hetheridge M, Williams T, Woods C, Evans M, Toy R, Gargas M, Sumpter JP Reproductive Effects of Long-Term Exposure to Bisphenol A in the Fathead Minnow (Pimephales promelas) Environ Sci Technol 35:2917-2925
						LOEC	VTG f	> 1280	ug/L	N	no effect*	*sign inc at 640, but not at 1280 ug/L		
						LOEC	fec	1280	ug/L	N	dec			
						LOEC	hatch	640	ug/L	N	dec			
						LOEC	histo m	16	ug/L	N	dec*	* dec of proportion of testis occupied by spermatozoa		
						LOEC	histo f	> 1280	ug/L	N	no effect			
MED	bisphenol A	weak estrogen	0.3,1,3,10 uM		14 males	LOEC	fec	10	uM	N	dec		2000	Shioda T, Wakabayashi M Effect of certain chemicals on the reproduction of medaka (Oryzias latipes) Chemosphere 40:239-243
						LOEC	hatch	10	uM	N	dec			
MED	bisphenol A	weak estrogen		59,141,334,772,1740 ug/L	21 males	LOEC	VTG m	334	ug/L	M	inc		2006	Results of Assay and Tests in Evaluation of the Endocrine Disrupting Acitivities in Fish (Medaka) Japanese Ministry of Environment
MED	bisphenol A	weak estrogen	1000,2000,4000 ug/L	837,1720, 3120 ug/L	21	LOEC	fec	> 3120	ug/L	M	no effect		2002	Kang IJ, Yokota H, Oshima Y, Tsuruda Y, Oe T, Imada N, Tadokoro H, Honjo T EFFECTS OF BISPHENOL A ON THE REPRODUCTION OF JAPANESE MEDAKA (*ORYZIAS LATIPES*) Environ Toxicol Chem 21(11):2394-2400
						LOEC	fert	> 3120	ug/L	M	no effect			
						LOEC	sex ratio	> 3120	ug/L	M	no effect			
						LOEC	VTG m	3120	ug/L	M	inc			
						LOEC	histo o-t	1720	ug/L	M	inc			
FHM	methoxychl	weak	0.5,	0.55,3.6	21	LOEC	fec	3.6	ug/L	M	dec		2001	Ankley GT, Jensen KM, Kahl MD, Korte JJ,

Species	Chemical	Suspected MOA	Conc nominal	Conc measured	Exposure (d)	Endpoint	Effect	Dose	Unit	Meas/ Nom M/N	Tendency	Comments	Year	Author(s) Title and Source
	or	estrogen	5ug/L	ug/L		LOEC	fert	> 3.6	ug/L	M	no effect			Makynen E
						LOEC	hatch	> 3.6	ug/L	M	no effect			Description and evaluation of a short-term reproduction test with the fathead minnow (Pimephales promelas)
						LOEC	VTG f	> 3.6	ug/L	M	no effect			Environ Toxicol Chem 20(6):1276-1290
						LOEC	VTG m	3.6	ug/L	M	inc			
						LOEC	SSC f&m	> 3.6	ug/L	M	no effect			
						LOEC	histo f	0.55	ug/L	M	inc*	* inc of severity of atretic follicles		
						LOEC	histo m	> 3.6	ug/L	M	no effect			
FHM	methoxychlor	weak estrogen	1.0,5.0 ug/L	0.83, 4.1 ug/L	21	LOEC	VTG f&m	> 4.1	ug/L	M	no effect		2003	Comparative evaluation of fathead minnow assays for detecting endocrine-disrupting chemicals
						LOEC	histo f&m	> 4.1	ug/L	M	no effect			Batelle, EPA contract No. 68-W-01-023
						LOEC	SSC	> 4.1	ug/L	M	no effect			
						LOEC	fec	4.1	ug/L	M	dec			
						LOEC	hatch	> 4.1	ug/L	M	no effect			
FHM	butyl benzyl phthalate	estrogen (+ anti-androgen)	100 ug/L	76 ug/L	21	LOEC	fec	76	ug/L	M	dec*	*number of spawnings, but not of eggs	2000	Harries JE, Runnalls T, Hill E, Harries CA, Maddix S, Sumpter JP, Tyler CR
						LOEC	VTG f&m	> 76	ug/L	M	no effect			Development of a reproductive performance test for endocrine disrupting chemicals using pair-breeding fathead minnows (*Pimephales promelas*)
						LOEC	SSC m	> 76	ug/L	M	no effect			Environ Sci Technol 34(14):3003-3011
MED	butyl benzyl phthalate	estrogen (+anti-androgen)		14,27,70,337,1045 ug/L	21 males	LOEC	VTG m	> 1045	ug/L	M	no effect		2006	Results of Assay and Tests in Evaluation of the Endocrine Disrupting Acitivities in Fish (Medaka)
														Japanese Ministry of Environment
FHM	4t-pentylphenol	weak estrogen	56,180,560 ug/L	48,173,570 ug/L	21	LOEC	fec	48	ug/L	M	dec		2006	Panter GH
						LOEC	VTG m	570	ug/L	M	inc			Development of chronic tests for endocrine active chemicals. Part 3: A pair-breeding study for oestrogenic active chemicals in the fathead minnow (Pimephales promelas)
						LOEC	VTG f	> 570	ug/L	M	no effect			CEFIC Project B2
						LOEC	SSC m	570	ug/L	M	dec*	*dec in tubercle prominence, but not counts		
						LOEC	hatch	> 570	ug/L	M	no effect			
						LOEC	F1 survival	48	ug/L	M	dec			
MED	di-(2-ethylhexyl) phthalate	estrogen	0.1,0.3,1 uM		14 males	LOEC	fec	> 1	uM	N	no effect		2000	Shioda T, Wakabayashi M
						LOEC	hatch	> 1	uM	N	no effect			Effect of certain chemicals on the reproduction of medaka (Oryzias latipes)

Species	Chemical	Suspected MOA	Conc nominal	Conc measured	Exposure (d)	Endpoint	Effect	Dose	Unit	Meas/ Nom M/N	Tendency	Comments	Year	Author(s) Title and Source
														Chemosphere 40:239-243
FHM	trilostane	estrogen (3β-hydroxysteroid dehydrogenase inhibitor (HSD))	60,300,1500 ug/L	50,348,1555 ug/L	21	LOEC	fec	1555	ug/L	M	dec		2008	Villeneuve DL, Blake LS, Brodin JD, Cavallin JE, Durhan EJ, Jensen KM, Kahl MD, Makynen EA, Martinovic D, Mueller ND, Ankley GT Effects of a 3β-hydroxysteroid dehydrogenase inhibitor, trilostane, on the fathead minnow reproductive axis Toxicol Sci 104(1):113-123
						LOEC	VTG f	1555	ug/L	M	dec			
						LOEC	VTG m	> 1555	ug/L	M	no effect			
						LOEC	SSC	> 1555	ug/L	M	no effect			
						LOEC	histo f&m	> 1555	ug/L	M	no effect			
FHM	tamoxifen citrate	anti-estrogen	0.18,0.56,1.8,5.6,18 ug/L	0.11,0.41,1.7,6.0,18 ug/L	42	LOEC	fec	18	ug/L	M	dec		2007	Williams TD, Caunter JE, Lillicrap AD, Hutchinson TH, Gillings EG, Duffell S Evaluation of the reproductive effects of tamoxifen citrate in partial and full life-cycle studies using fathead minnows (Pimephales promelas) Environ Toxicol Chem 26(4): 695-707
						LOEC	hatch	> 18	ug/L	M	no effect			
						LOEC	VTG f&m	> 18	ugL	M	no effect			
						LOEC	VTG F1	0.41	ug/L	M	dec			
ZEB	tamoxifen	anti-estrogen	32,100,320 ug/L	11% of nominal	21	LOEC	fec	320	ug/L	N	dec		2003	Wester PW, van den Brandhof EJ, Vos JH, van der Ven LTM Identification of Endocrine Disruptive Effects in the Aquatic Environment; a partial life cycle assay in Zebrafish RIVM report 640920001/2003 (DG SANCO, project B6-7920/98/00025) pp 112
						LOEC	fert	> 320	ug/L	N	no effect			
						LOEC	histo m	100	ug/L	N	inc*	* inc no of Leydig cells in testis		
						LOEC	histo f	320	ug/L	N	dec*	* dec vitality of mature oocytes		
						LOEC	sex ratio	32	ug/L	N	inc*	* inc no of males, almost complete sex reversal		
ZEB	tamoxifen	anti-estrogen	0.16,0.5,1.6,5.0,16 ug/L		2Gen	LOEC	fert	5.0	ug/L	N	dec		2007	Teigeler M, Knacker T, Schäfers C Characterisation of endocrine mediated impacts on fish. Relevant parameters for the development of a new OECD test method and the application in regulatory environmental risk assessment Research project FKZ 206 67 470 UBA, Berlin-FB 20667470, pp 96
						LOEC	sex ratio	5.0	ug/L	N				
						LOEC	VTG	5.0	ug/L	N	dec			
ZEB	tamoxifen	anti-estrogen	8.6,27,86,270,860 nM	86 nM: decline to 2.5% in 3d	21	LOEC	hatch	86	nM	N	dec		2007	van der Ven LT, van den Brandhof EJ, Vos JH, Wester PW Effects of the estrogen agonist 17beta-estradiol and antagonist tamoxifen in a partial life-cycle assay with zebrafish (Danio rerio) Environ Toxicol Chem 26(1):92-9
						LOEC	sex ratio	86	nM	N	inc*	*inc in males		
						LOEC	fec	860	nM	N	dec			
						LOEC	VTG f	860	nM	N	dec			

Species	Chemical	Suspected MOA	Conc nominal	Conc measured	Exposure (d)	Endpoint	Effect	Dose	Unit	Meas/ Nom M/N	Tendency	Comments	Year	Author(s) Title and Source
						LOEC	VTG m	> 860	nM	N	no effect			
FHM	17α-methyl-testosterone	androgen (+estrogenic)	1,10,100 ug/L		14	LOEC	VTG m	1	ug/L	N	inc*	* plateau level reached, no stats	2000	Zerulla M, Länge R, Steger-Hartmann T, Dietrich DR Effects of Ethyinylestratiol, Methyltestosterone and Fadrozole on fathead minnows (Pimephales promelas) SETAC-Europe Poster 2000, Brighton
FHM	17α-methyl-testosterone	androgen (+estrogenic)	20,200 ug/L		7	LOEC	SSC f	20	ug/L	N	inc*	*inc in tubercle score	2004	Hornung MW, Jensen KM, Korte JJ, Kahl MD, Durhan EJ, Denny JS, Henry TR, Ankley GT Mechanistic basis for estrogenic effects in fathead minnow (Pimephales promelas) following exposure to the androgen 17α-methyltestosterone: conversion of 17α-methyltestosterone to 17α-methylestradiol AquaticToxicol 66(1):15-23
						LOEC	SSC m	> 200	ug/L	N	no effect			
						LOEC	VTG f&m	20	ug/L	N	inc			
FHM	17α-methyl-testosterone	androgen (+estrogenic)	0.13,0.25,0.5 mg/L added weekly		10	LOEC	SSC f&m	0.13	mg/L	N	inc*	*inc in tubercles	1974	Smith RJF Effects of 17α-methyltestosterone on the dorsal pad and tubercles of fathead minnows (Pimephales promelas) Can J Zool 52: 1031-1038
			0.5 mg/L at start (init)		18 males	LOEC	SSC m	0.5 (init)	mg/L	N	inc*	* inc in tubercles		
FHM	17α-methyl-testosterone	androgen (+estrogenic)	0.2,2 mg/L	near 100% day 0-10, then drop to 10%	12	LOEC	VTG f&m	0.2	mg/L	N	inc		2001	Ankley GT, Jensen KM, Kahl MD, Korte JJ, Makynen EA Description and evaluation of a short-term reproduction test with the fathead minnow (*Pimephales promelas*) Environ Toxicol Chem 20:1276–1290
						LOEC	fec	0.2	mg/L	N	dec			
						LOEC	SSC f	0.2	mg/L	N	inc*	*inc in tubercles		
						LOEC	SSC m	> 2	mg/L	N	no effect			
FHM	17α-methyl-testosterone	androgen (+estrogenic)	0.1,1,5,50 ug/L	85-110% of nominal / 0.1: 0.09-0.11; 50: 43-48 ug/L	21	LOEC	fec	5	ug/L	N	dec		2004	Pawlowski S, Sauer A, Shears JA, Tyler CR, Braunbeck T Androgenic and estrogenic effects of the synthetic androgen 17α-methyltestosterone on sexual development and reproductive performance in the fathead minnow (*Pimephales promelas*) determined using the gonadal recrudescence assay AquaticToxicol 68(3):277-291
						LOEC	fert	5	ug/L	N	dec			
						LOEC	beh f	5	ug/L	N	chg*	*change in mating bhaviour		
						LOEC	SSC f	1	ug/L	N	inc*	*inc in male-specific sex characteristics		
						LOEC	histo f	0.1	ug/L	N	inc*	*atretic follicles		

Species	Chemical	Suspected MOA	Conc nominal	Conc measured	Exposure (d)	Endpoint	Effect	Dose	Unit	Meas/ Nom M/N	Tendency	Comments	Year	Author(s) Title and Source
						LOEC	VTG f	50	ug/L	N	inc			
						LOEC	VTG m	1	ug/L	N	inc			
ZEB	17α-methyl-testosterone	androgen (+estrogenic)	0.1,1,10,50,100 ug/L		30	LOEC	sex ratio	0.1	ug/L	N	inc*	* inc in males, but 100% females at 100 ug/L	2000	Oern S, Gessbo A, Steinholz A, Norrgren L Zebrafish (Danio rerio) - A candidate to evaluate endocrine disrupting chemicals In: Zebra fish for testing endocrine disrupting chemicals. TemaNord 2000:555, Nordic Council of Ministers, Copenhagen, ISBN 92-893-0480-4, pp 47-62
						LOEC	histo f&m	100	ug/L	N	dec*	*no gonad-like structure developed		
ZEB	17α-methyl-testosterone	androgen (+estrogenic)	2.5,5,10, 25,50,100 ng/L	4.5,6.4,8.5 ,20,36,62 ng/L	7 males	LOEC	VTG m	4.5	ng/L	M	inc*		2006	Andersen, L., R. Goto-Kazeto, J.M. Trant JM, Nash JP, Korsgaard B, Bjerregaard P Short-Term Exposure to Low Concentrations of the Synthetic Androgen Methyltestosterone Affects Vitellogenin and Steroid Levels in Adult male Zebrafish (Danio rerio) AquaticToxicol 76(3/4):343-352
ZEB	17α-methyl-testosterone	androgen (+estrogenic)	1,10 ug/L		70 females	LOEC	pheno f	10	ug/L	N	inc*	* inc of male like fish	>1998	Norrgren L, Bjerregaard P, Gessbo A, Holbech H, Pedersen K, Steinholtz A, Orn S The zebrafish (Danio rerio) - a candidate for evaluation of endocrine disrupting chemicals
						LOEC	histo f	10	ug/L	N	chg*	* ovaries dominated by non-mature or degenerating oocytes		
FHM	17α-trenbolone	androgen	0.003,0.01,0.03,0.1 ug/L	0.0035,0.0097,0.032, 0.094 ug/L	21	EC50	fec	0.01	ug/L	M	dec		2006	Jensen KM, Makynen EA, Kahl MD, Ankley GT Effects of the Feedlot Contaminant 17α--Trenbolone on Reproductive Endocrinology of the Fathead Minnow Environ Sci Technol 40:3112-3117
						LOEC	fert	> 0.09	ug/L	M	no effect			
						LOEC	hatch	> 0.09	ug/L	M	no effect			
						LOEC	VTG f	0.03	ug/L	M	dec			
						LOEC	VTG m	> 0.09	ug/L	M	no effect			
						LOEC	SSC f	0.09	ug/L	M	inc*	*inc in tubercle score		
						LOEC	SSC m	> 0.09	ug/L	M	no effect			
FHM	17β-	androgen	0.1,1	0.041,0.60	21	LOEC	fec	0.60	ug/L	M	dec		2003	Comparative evaluation of fathead minnow

Species	Chemical	Suspected MOA	Conc nominal	Conc measured	Exposure (d)	Endpoint	Effect	Dose	Unit	Meas/ Nom M/N	Tendency	Comments	Year	Author(s) Title and Source
	trenbolone		ug/L	ug/L		LOEC	hatch	> 0.60	ug/L	M	no effect			assays for detecting endocrine-disrupting chemicals Batelle, EPA contract No. 68-W-01-023
						LOEC	SSC f	0.60	ug/L	M	inc*	* inc in tubercles * fatpad		
						LOEC	histo f	0.60	ug/L	M	chg*	* inc atretic follicles & dec in corpus lutea		
						LOEC	histo m	> 0.60	ug/L	M	no effect			
						LOEC	VTG f	0.60	ug/L	M	dec			
						LOEC	VTG m	> 0.60	ug/L	M	no effect			
FHM	17β-trenbolone	androgen	0.005,0.05,0.5,5.0, 50 ug/L	0.0015,0.026,0.27,4.4,41 ug/L	21	LOEC	fec	0.03	ug/L	M	dec		2003	Ankley GT, Jensen KM, Makynen EA, Kahl MD, Korte JJ, Hornung MW, Henry TR, Denny JS, Leino RL, Wilson VS, Cardon MC, Hartig PC, Gray LE Effects of the androgenic growth promoter 17β-trenbolone on fecundity and reproductive endocrinology of the fathead minnow Environ Toxicol Chem 22(6):1350-1360
FHM	17β-trenbolone	androgen	50,500,5000 ng/L	41,401,4060 ng/L	21	LOEC	SSC f	0.03	ug/L	M	inc*	*inc in tubercle score		Seki M, Fujishima S, Nozaka T, Maeda M, Kobayashi K COMPARISON OF RESPONSE TO 17β-ESTRADIOL AND 17β-TRENBOLONE AMONG THREE SMALL FISH SPECIES Environ Toxicol Chem 25(10):2742-2752
						LOEC	VTG m	> 41	ug/L	M	no effect			
						LOEC	VTG f	0.03	ug/L	M	dec			
						LOEC	SSC m	> 4060	ng/L	M	no effect		2006	
						LOEC	SSC f	> 4060	ng/L	M	no effect			
						LOEC	VTG f	4060	ng/L	M	dec			
						LOEC	VTG m	> 4060	ng/L	M	no effect			
MED	17β-trenbolone	androgen	2.0 ug/L		7	LOEC	fec	2	ug/L	N	dec		2008	Zhang X, Hecker M, Park J, Tompsett AR, Jones PD, Newsted J, Au DWT, Kong R,Wu RSS, Giesy JP TIME-DEPENDENT TRANSCRIPTIONAL PROFILES OF GENES OF THE HYPOTHALAMIC-PITUITARY-GONADAL AXIS IN MEDAKA (*ORYZIAS LATIPES*) EXPOSED TO FADROZOLE AND 17β-TRENBOLONE Environ Toxicol Chem 27(12):2504-2511
MED	17β-trenbolone	androgen	50,500,5000 ng/L	40,365,4010 ng/L	21	LOEC	SSC m	> 4010	ng/L	M	no effect		2006	Seki M, Fujishima S, Nozaka T, Maeda M, Kobayashi K COMPARISON OF RESPONSE TO 17β-
						LOEC	SSC f	365	ng/L	M	inc			

Species	Chemical	Suspected MOA	Conc nominal	Conc measured	Exposure (d)	Endpoint	Effect	Dose	Unit	Meas/ Nom M/N	Tendency	Comments	Year	Author(s) Title and Source
						LOEC	VTG f	40	ng/L	M	dec			ESTRADIOL AND 17β-TRENBOLONE AMONG THREE SMALL FISH SPECIES Environ Toxicol Chem 25(10):2742-2752
						LOEC	VTG m	> 4010	ng/L	M	no effect			
ZEB	17β-trenbolone	androgen	50,500,5000 ng/L	35,351,3440 ng/L	21	LOEC	VTG f	351	ng/L	M	dec		2006	Seki M, Fujishima S, Nozaka T, Maeda M, Kobayashi K COMPARISON OF RESPONSE TO 17β-ESTRADIOL AND 17β-TRENBOLONE AMONG THREE SMALL FISH SPECIES Environ Toxicol Chem 25(10):2742-2752
						LOEC	VTG m	> 3440	ng/L	M	no effect			
FHM	flutamide	anti-androgen	400 ug/L	88-112% of nominal	14	LOEC	VTG f	> 400	ug/L	N	no effect*	* sign dec during post-exposure	2004	Ankley GT, Defoe DL, Kahl MD, Jensen KM, Makynen EA Evaluation of the model anti-androgen flutamide for assessing the mechanistic basis of responses to an androgen in the fathead minnow (Pimephales promelas) Environ Sci Technol 38:6322-6327
FHM	trenbolone	androgen	0.5 ug/L		14	LOEC	SSC f	> 400	ug/L	N	no effect			Ankley GT, Defoe DL, Kahl MD, Jensen KM, Makynen EA Evaluation of the model anti-androgen flutamide for assessing the mechanistic basis of responses to an androgen in the fathead minnow (Pimephales promelas) Environ Sci Technol 38:6322-6327
						LOEC	VTG f	> 0.5	ug/L	N	no effect*	* sign dec after 1d & during post-exposure, but not after 14d	2004	
						LOEC	SSC f	0.5	ug/L	N	inc*	*inc in tubercles		
FHM	flutamide+trenbolone	anti-androgen + androgen	400 + 0.5 ug/L		14	LOEC	VTG f	> 400 + 0.5	ug/L	N	no effect*	* sign dec after 1d & during post-exposure, but not after 14d	2004	Ankley GT, Defoe DL, Kahl MD, Jensen KM, Makynen EA Evaluation of the model anti-androgen flutamide for assessing the mechanistic basis of responses to an androgen in the fathead minnow (Pimephales promelas) Environ Sci Technol 38:6322-6327
						LOEC	SSC f	> 400 + 0.5	ug/L	N	no effect			
FHM	dihydro-testosterone	androgen	10,32,100 ug/L	6,0,6.1,8.6 ug/L	21	LOEC	SSC f&m	6.0	ug/L	M	inc tubercl		2004	Panter GH, Hutchinson TH, Hurd KS, Sherren A, Stanley RD, Tyler CR Successful detection of (anti-)androgens and aromatase inhibitors using a sub-adult fathead minnow non-spawning assay AquaticToxicol 70, 11-21
						LOEC	VTG f	> 8.6	ug/L	M	no effect			
						LOEC	VTG m	6.1	ug/L	M	inc			

Species	Chemical	Suspected MOA	Conc nominal	Conc measured	Exposure (d)	Endpoint	Effect	Dose	Unit	Meas/ Nom M/N	Tendency	Comments	Year	Author(s) Title and Source
FHM	17α-methyldihydro testosterone	non-aromatizable androgen	0.1,1,10 ug/L	0.040,0.61,7.8 ug/L	21	LOEC	fec	0.61	ug/L	M	dec		2008	Bogers R, Buitenweg S, Baltussen E, Legler J, Murk A A pair-breeding study with fathead minnow (Pimephales promelas) exposed to an androgenic chemical. In: Markers of endocrine disruption in fish CEFIC Project B2, as part of Thesis Wageningen University, Netherlands
FHM	17α-methyldihydro testosterone	non-aromatizable androgen	0.1,0.32, 1 ug/L	0.060,0.19,0.42 ug/L	28	LOEC	fec	> 0.42	ug/L	M	no effect*	* dec, but not stat sign due to high variability; 0.19 & 0.42 ug/L produced eggs during first week only	2008	Bogers R, Buitenweg S, Baltussen E, Legler J, Murk A A pair-breeding study with fathead minnow (Pimephales promelas) exposed to an androgenic chemical. In: Markers of endocrine disruption in fish CEFIC Project B2, as part of Thesis Wageningen University, Netherlands
						LOEC	histo f&m	0.06	ug/L	M	inc*	*f: oocyte atresia. M: enlarged seminiferous tubuli		
						LOEC	SSC f	0.06	ug/L	M	inc*	* inc in tubercles		
						LOEC	SSC m	0.42	ug/L	M	inc*	*stat sign inc also at 0.060, but not at 0.19 ug/L		
						LOEC	VTG f&m	> 0.42	ug/L	M	no effect			
ZEB	17α-methyldihydro testosterone	non-aromatizable androgen	0.1,1,10 ug/L	30-50% of nominal within 1d	21	LOEC	fec	1	ug/L	N	dec		2003	Wester PW, van den Brandhof EJ, Vos JH, van der Ven LTM Identification of Endocrine Disruptive Effects in the Aquatic Environment; a partial life cycle assay in Zebrafish RIVM report 640920001/2003 (DG SANCO, project B6-7920/98/00025) pp 112
						LOEC	hatch	> 10	ug/L	N	no effect			
						LOEC	histo f&m	10	ug/L	N	inc*	* f: inc in abdominal span (inhibited ovulation) m: accelerated spermatogenesis		
						LOEC	sex ratio	0.1	ug/L	N	chg*	* complete masculinization		

Species	Chemical	Suspected MOA	Conc nominal	Conc measured	Exposure (d)	Endpoint	Effect	Dose	Unit	Meas/ Nom M/N	Tendency	Comments	Year	Author(s) Title and Source
ZEB	17α-methyldihydro testosterone	non-aromatizable androgen	1,10,100 ug/L	decline to 6% in 2d	21	LOEC	histo f	100	ug/L	N	dec*	*dec oocyte size & ration vitellogenic /previtellogenic oocytes	2003	van der Ven L, Wester PW, Vos JG HISTOPATHOLOGY AS A TOOL FOR THE EVALUATION OF ENDOCRINE DISRUPTION IN ZEBRAFISH (*DANIO RERIO*) Environ Toxicol Chem 22(4):908-913
FHM	flutamide	anti-androgen	100,320, 1000 ug/L	95,320,939 ug/L	21	LOEC	VTG f	95	ug/L	M	inc		2004	Panter GH, Hutchinson TH, Hurd KS, Sherren A, Stanley RD, Tyler CR Successful detection of (anti-)androgens and aromatase inhibitors using a sub-adult fathead minnow non-spawning assay AquaticToxicol 70, 11-21
						LOEC	VTG m	> 939	ug/L	M	no effect			
						LOEC	SSC m	939	ug/L	M	dec*	*dec in tubercles		
						LOEC	SSC f	> 939	ug/l	M	no effect			
FHM	flutamide	anti-androgen	50,500 ug/L	63,651 ug/L	21	LOEC	fec	651	ug/L	M	dec		2004	Jensen KM, Kahl MD, Makynen EA, Korte JJ, Leino RL, Butterworth BC, Ankley GT Characterization of responses to the anti-androgen flutamide in a short-term reproduction assay with fathead minnow Aquatic Toxicol 70:99-110
						LOEC	hatch	651	ug/L	M	dec			
						LOEC	VTG f&m	651	ug/L	M	inc			
						LOEC	histo f&m	651	ug/L	M	chg*	*females: dec mature oocytes, inc atretic follicles. Males: spermatocyte degeneration & necrosis		
FHM	flutamide	anti-androgen	100,500, 1000 ug/L		21	LOEC	VTG f	500	ug/L	N	inc		2006	Jensen KM, Ankley GT Evaluation of a Commercial Kit for Measuring Vitellogenin in the Fathead Minnow (Pimephales promelas) Ecotoxicol.Environ.Saf. 64:101-105
FHM	flutamide	anti-androgen	60,650 ug/L	47,510 ug/L	21	LOEC	VTG f&m	> 510	ug/L	M	no effect		2003	Comparative evaluation of fathead minnow assays for detecting endocrine-disrupting chemicals Batelle, EPA contract No. 68-W-01-023
						LOEC	histo f	510	ug/L	M	inc*	* inc atretic follicles		
						LOEC	histo m	> 510	ug/L	M	no effect			
						LOEC	SSC	> 510	ug/L	M	no effect			
						LOEC	fec	510	ug/L	M	dec			
						LOEC	hatch	> 510	ug/L	M	no effect			
MED	flutamide	anti-androgen		0.10,0.20, 0.40,0.79, 1.6 mg/L	21	LOEC	fec	1.6	mg/L	M	dec		2006	Kang IJ, Hano T, Oshima Y, Yokota H, Tsuruda, Y, Shimasaki Y, Honjo T Anti-androgen flutamide affects gonadal
						LOEC	fert	1.6	mg/L	M	dec			

Species	Chemical	Suspected MOA	Conc nominal	Conc measured	Exposure (d)	Endpoint	Effect	Dose	Unit	Meas/ Nom M/N	Tendency	Comments	Year	Author(s) Title and Source
						LOEC	VTG f&m	> 1.6	mg/L	M	no effect			development and reproduction in medaka (Orizias latipes) Marine Environ Res 62(1):253-257
ZEB	flutamide	anti-androgen	10,100,1000 ug/L	53% of nominal within 5d	21	LOEC	fec	1000	ug/L	N	dec		2003	Wester PW, van den Brandhof EJ, Vos JH, van der Ven LTM Identification of Endocrine Disruptive Effects in the Aquatic Environment; a partial life cycle assay in Zebrafish RIVM report 640920001/2003 (DG SANCO, project B6-7920/98/00025) pp 112
						LOEC	hatch	> 1000	ug/L	N	no effect			
						LOEC	histo m	10	ug/L	N	dec*	* inhibition of spermatogenesis		
						LOEC	sex ratio	100	ug/L	N	chg*	* masculinization		
ZEB	flutamide	anti-androgen	80,250,800 ug/L		21	LOEC	fec	> 800	ug/L	N	no effect		2006	Teigeler M, Boshof U, Wenzel A, Schäfers C, Schäffer A Predictivity of biomarkers in short time exposure tests with main focus on androgen-receptor antagonists in zebrafish (Danio rerio) SETAC-Europe Poster 2006
						LOEC	VTG f&m	> 800	ug/L	N	no effect			
ZEB	flutamide	anti-androgen	36,82,189,435,1000 ug/L		2Gen	LOEC	fec	435	ug/L	N	dec		2006	Teigeler M, Boshof U, Wenzel A, Schäfers C, Schäffer A Predictivity of biomarkers in short time exposure tests with main focus on androgen-receptor antagonists in zebrafish (Danio rerio) SETAC-Europe Poster 2006
						LOEC	fert	1000	ug/L	N	dec			
						LOEC	VTG f&m	> 1000	ug/L	N	no effect			
ZEB	flutamide	anti-androgen	38,82,189,465,1000 ug/L		2Gen	LOEC	fec	465	ug/L	N	dec		2007	Teigeler M, Knacker T, Schäfers C Characterisation of endocrine mediated impacts on fish. Relevant parameters for the development of a new OECD test method and the application in regulatory environmental risk assessment Research project FKZ 206 67 470 UBA, Berlin-FB 20667470, pp 96
						LOEC	VTG f	1000	ug/L	N	dec			
FHM	linuron	suspected anti-androgen, similarity to flutamide	220,460,1000,2200ug/L		42	LOEC	VTG	> 2200	ug/L	N	no effect		2004	Thorpe K, Benstead R, Hutchinson T, Tyler C Reproductive Effects of Linuron in a Fathead Minnow Pair-Breeding Test SETAC Poster; Prague
						LOEC	SSC m	220	ug/L	N	dec*	* dec fatpad index after 21d		
						LOEC	fec	1000	ug/L	N	dec			

Species	Chemical	Suspected MOA	Conc nominal	Conc measured	Exposure (d)	Endpoint	Effect	Dose	Unit	Meas/ Nom M/N	Tendency	Comments	Year	Author(s) Title and Source
FHM	vinclozolin	anti-androgen	200,700 ug/L	176,706 ug/L	21	LOEC	histo f	706	ug/L	M	*dec	* dec in oocyte size and in gonadal condition (qual)	2000	Makynen EA, Kahl MD, Jensen KM, Tietge JE, Wells KL, Van der Kraak G, Ankley GT Effects of the mammalian antiandrogen vinclozolin on development and reproduction of the fathead minnow (Pimephales promelas) AquaticToxicol 48:461-475
						LOEC	histo m	> 706	ug/L	M	no effect			
FHM	vinclozolin	anti-androgen	100,300, 900 ug/L	LabA: 75,280,830 ug/L	21	LOEC	histo m	75,150	ug/L	M	inc*	*LabA&B: inc proportion of spermatogonia of interstitial cells & testicular degeneration	2007	Biever RC, Kruger H, Kern M, Blackshear PE, Sloan CS Inter-laboratory validation of the fish short-term reproduction assay, run simultaneously across three independent contract laboratories EPA Contract No. EP-W-06-026
				LabB: 150,370,1200 ug/L		LOEC	histo m	> 760	ug/L	M	no effect*	*LabC		
				LabC: 84,270,760 ug/L		LOEC	histo f	1200	ug/L	M	inc*	*LabB: inc oocyte atresia, interstitial fibrosis, perifollicular cell hyperplasia/hypertrophy		
						LOEC	histo f	> 760, 830	ug/L	M	no effect*	*LabA&C		
						LOEC	VTG m	270	ug/L	M	inc*	*LabC		
						LOEC	VTG m	> 830, 1200	ug/L	M	no effect*	*LabA&B		
						LOEC	VTG f	270	ug/L	M	inc*	*LabC		
						LOEC	VTG f	> 830, 1200	ug/L	M	no effect*	*LabA&B		
						LOEC	SSC m	150	ug/L	M	dec*	*LabB: dec tubercle score, fatpad weight & index		
						LOEC	SSC m	830, 760	ug/L	M	dec*	*LabA&C: dec in tubercle score		
						LOEC	fec	370	ug/L	M	dec*	*LabB		
						LOEC	fec	830, 760	ug/L	M	dec*	*Lab A&B		
						LOEC	fert	830, 370, 760	ug/L	M	dec*	*LabA,B,C		

Species	Chemical	Suspected MOA	Conc nominal	Conc measured	Exposure (d)	Endpoint	Effect	Dose	Unit	Meas/ Nom M/N	Tendency	Comments	Year	Author(s) Title and Source
FHM	vinclozolin	anti-androgen	100,400, 700 ug/L	60,255,450 ug/L	21	LOEC	fec	60	ug/L	M	dec		2008	Martinovic D, Blake LS, Durhan EJ, Greene KJ, Kahl MD, Jensen KM, Makynen EA, Villeneuve DL, Ankley GT Reproductive Toxicity of Vinclozolin in the Fathead Minnow: Confirming an Anti-Androgenic Mode of Action Environ Toxicol Chem 27(2): 478-488
						LOEC	SSC f	> 450	ug/L	M	no effect			
						LOEC	SSC m	255	ug/L	M	dec*	*dec in tubercle score		
						LOEC	VTG f	255	ug/L	M	inc			
						LOEC	VTG m	> 450	ug/L	M	no effect			
						LOEC	histo f	450	ug/L	M	inc*	* inc severity of atresia		
FHM	vinclozolin	anti-androgen	200,700 ug/L	158,590 ug/L	13	LOEC	VTG f&m	> 590	ug/L	M	no effect		2008	Martinovic D, Blake LS, Durhan EJ, Greene KJ, Kahl MD, Jensen KM, Makynen EA, Villeneuve DL, Ankley GT Reproductive Toxicity of Vinclozolin in the Fathead Minnow: Confirming an Anti-Androgenic Mode of Action Environ Toxicol Chem 27(2): 478-488
						LOEC	SSC f	158	ug/L	M	inc*	* inc in fatpad index		
FHM	17β-trenbolone	androgen	500 ng/L	457 ng/L	13	LOEC	SSC f	457	ng/L	M	inc*	*inc in tubercle score & fatpad index	2008	Martinovic D, Blake LS, Durhan EJ, Greene KJ, Kahl MD, Jensen KM, Makynen EA, Villeneuve DL, Ankley GT Reproductive Toxicity of Vinclozolin in the Fathead Minnow: Confirming an Anti-Androgenic Mode of Action Environ Toxicol Chem 27(2): 478-488
						LOEC	VTG f	> 457	ng/L	M	no effect*	* dec but not sign		
						LOEC	VTG m	> 457	ng/L	M	no effect			
FHM	17β-trenbolone+ vinclozolin		500+200, 500+700 ng+ug/L	457+177,457+591VZ ng+ug/L	13	LOEC	SSC f	457+177	ng + ug/L	M	inc*	*inc in fatpad index	2008	Martinovic D, Blake LS, Durhan EJ, Greene KJ, Kahl MD, Jensen KM, Makynen EA, Villeneuve DL, Ankley GT Reproductive Toxicity of Vinclozolin in the Fathead Minnow: Confirming an Anti-Androgenic Mode of Action Environ Toxicol Chem 27(2): 478-488
						LOEC	VTG f&m	> 457+591	ng + ug/L	M	no effect			
FHM	p,p'-dichloro-diphenyl-dichlorethylene	weak anti-androgen	0.02,0.2 ug/L	0.022, 0.17 ug/L	21	LOEC	fec	> 0.17	ug/L	M	no effect		2006	Multi-chemical evaluation of the short-term reproduction assay with the fathead minnow Batelle, EPA contract No. 68-W-01-023
						LOEC	hatch	> 0.17	ug/L	M	no effect			
						LOEC	histo f	0.02	ug/L	M	inc*	* inc proportion of atretic follicles		
						LOEC	histo m	> 0.17	ug/L	M	no effect			
						LOEC	VTG f&m	> 0.17	ug/L	M	no effect			
MED	p,p'-dichloro-diphenyl-dichlorethy	weak anti-androgen		7.4,17,28, 54,115 ug/L	21 males	LOEC	VTG m	54	ug/L	M	inc		2006	Results of Assay and Tests in Evaluation of the Endocrine Disrupting Acitivities in Fish (Medaka) Japanese Ministry of Environment

Species	Chemical	Suspected MOA	Conc nominal	Conc measured	Exposure (d)	Endpoint	Effect	Dose	Unit	Meas/ Nom M/N	Tendency	Comments	Year	Author(s) Title and Source
	lene													
FHM	fadrozole	aromatase-inhibitor, anti estrogen	10,100 ug/L		14	LOEC	VTG m	> 100	ug/L	N	no effect*	* no conc dependent inc	2000	Zerulla M, Länge R, Steger-Hartmann T, Dietrich DR Effects of Ethyinylestratiol, Methyltestosterone and Fadrozole on fathead minnows (Pimephales promelas) SETAC-Europe Poster 2000, Brighton
FHM	fadrozole	aromatase-inhibitor, anti estrogen	2,10,50 ug/L	1.4,7.3,57 ug/L	21	LOEC	fec	1.4	ug/L	M	dec*	* 50% dec in egg no per spawn	2002	Ankley GT, Kahl MD, Jensen KM, Hornung MW, Korte JJ, Makynen EA, Leino RL Evaluation of the aromatase inhibitor fadrozole in a short-term reproduction assay with the fathead minnow (Pimephales promelas) Toxicol Sci 67(1):121-130
						LOEC	VTG f	1.4	ug/L	M	dec*	*conc dependent dec		
						LOEC	hatch	> 57	ug/L	M	no effect			
						LOEC	VTG m	> 57	ug/L	M	no effect			
						LOEC	SSC	> 57	ug/L	M	no effect			
						LOEC	histo f	1.4	ug/L	M	chg*	* inc in preovulatory atretic follicles and dec in mature oocytes; no stats		
						LOEC	histo m	7.3	ug/L	M	inc*	* inc in the lumina of the seminiferous tubules and of sperm in testes; no stats		
FHM	fadrozole	aromatase-inhibitor, anti estrogen	25,20,100 ug/L	25,52,96 ug/L	21	LOEC	VTG f&m	25	ug/L	M	inc		2004	Panter GH, Hutchinson TH, Hurd KS, Sherren A, Stanley RD, Tyler CR Successful detection of (anti-)androgens and aromatase inhibitors using a sub-adult fathead minnow non-spawning assay AquaticToxicol 70, 11-21
						LOEC	SSCf&m	> 96	ug/L	M	no effect			
FHM	fadrozole	aromatase-inhibitor, anti estrogen	100 ug/L		21	LOEC	VTG f	100	ug/L	N	dec		2006	Jensen KM, Ankley GT Evaluation of a Commercial Kit for Measuring Vitellogenin in the Fathead Minnow (Pimephales promelas) Ecotoxicol.Environ.Saf. 64:101-107
FHM	fadrozole	aromatase-inhibitor, anti-estrogen	5,50 ug/L	5.2,56 ug/L	21	LOEC	VTG f	5.2	ug/L	M	dec		2003	Comparative evaluation of fathead minnow assays for detecting endocrine-disrupting chemicals Batelle, EPA contract No. 68-W-01-023
						LOEC	VTG m	> 56	ug/L	M	no effect			
						LOEC	histo f	5.2	ug/L	M	chg*	* dec proportion of ova in stage 1b & corpora lutea, inc atretic follicles		
						LOEC	histo m	56	ug/L	M	inc*	* inc in tubule diameter		
						LOEC	SSC m&f	> 56	ug/L	M	no effect			

Species	Chemical	Suspected MOA	Conc nominal	Conc measured	Exposure (d)	Endpoint	Effect	Dose	Unit	Meas/ Nom M/N	Tendency	Comments	Year	Author(s) Title and Source
						LOEC	fec	56			dec			
						LOEC	hatch	> 5.2	ug/L	M	no effect*	* no eggs laid at high dose of 56 ug/L		
MED	fadrozole	aromatase-inhibitor, anti estrogen	50 ug/L		7	LOEC	fec	50	ug/L	N	dec		2008	Zhang X, Hecker M, Park J, Tompsett AR, Jones PD, Newsted J, Au DWT, Kong R,Wu RSS, Giesy JP TIME-DEPENDENT TRANSCRIPTIONAL PROFILES OF GENES OF THE HYPOTHALAMIC-PITUITARY-GONADAL AXIS IN MEDAKA (*ORYZIAS LATIPES*) EXPOSED TO FADROZOLE AND 17β-TRENBOLONE Environ Toxicol Chem 27(12):2504-2511
FHM	6-chloro-N-ethyl-N'-(1-methylethyl)-1,3,5-triazine-2,4-diamine	inhibitor of steroid synthesis, neuro-endocrine activity	5,50 ug/L	4.3,44ug/L	21	LOEC	fec	> 44	ug/L	M	no effect		2004	Bringolf RB, Belden JB, Summerfelt RC Effects of Atrazine on Fathead Minnow in a Short-Term Reproduction Assay Environ Toxicol Chem 23(4):1019-1025
						LOEC	fert	> 44	ug/L	M	no effect*	*dec, but not stat sign		
						LOEC	hatch	> 44	ug/L	M	no effect			
						LOEC	VTG f	> 44	ug/L	M	no effect			
						LOEC	VTG m	4.3	ug/L	M	inc			
						LOEC	SSC m	> 44	ug/L	M	no effect			
						LOEC	histo f&m	> 44	ug/L	M	no effect			
FHM	atrazine	inhibitor of steroid synthesis, neuro-endocrine activity	25,250 ug/L	25,224 ug/L	21	LOEC	fec	> 224	ug/L	M	no effect		2006	Multi-chemical evaluation of the short-term reproduction assay with the fathead minnow Batelle, EPA contract No. 68-W-01-023
						LOEC	hatch	> 224	ug/L	M	no effect			
						LOEC	histo f	> 224	ug/L	M	no effect			
						LOEC	histo m	224	ug/L	M	dec*	*dec seminiferous tubule diameter		
						LOEC	VTG m&f	> 224	ug/L	M	no effect			
FHM	fenarimol	CYP enzymes inhibition (steroid synthesis)	0.1,1 mg/L	0.096,0.57 mg/L	21	LOEC	fec	0.57	mg/L	M	dec		2005	Ankley GT, Jensen KM, Durhan EJ, Makynen EA, Butterworth BC, Kahl MD, Villeneuve DL, Linnum AL, Gray LE, Cardon M, Wilson VS. Effects of two fungicides with multiple modes of action on reproductive endocrine function in the fathead minnow (Pimephales promelas) Toxicol Sci 86:300-308
						LOEC	VTG m	> 0.57	mg/L	M	no effect			
						LOEC	VTG f	0.57	mg/L	M	dec			

Species	Chemical	Suspected MOA	Conc nominal	Conc measured	Exposure (d)	Endpoint	Effect	Dose	Unit	Meas/ Nom M/N	Tendency	Comments	Year	Author(s) Title and Source
						LOEC	histo m	0.57	mg/L	M	inc*	*inc in testicular stage		
						LOEC	histo f	0.57	mg/L	M	inc*	* inc oocyte atresia		
FHM	fenarimol	inhibitor of steroid synthesis	100,220, 460,1000 ug/L	51,94,177, 497 ug/L	21	LOEC	fec	497	ug/L	M	dec		2007	Thorpe KL, Benstead R, Hutchinson TH, Tyler CR Associations between altered vitellogenin concentrations and adverse health effects in fathead minnow (Pimephales promelas), Aquatic Toxicol 85:176-183
FHM	cadmium chloride	altered steroidgenesis	1,10 ug/L	1.2, 11 ug/L	21	LOEC	VTG m	> 497	ug/L	M	no effect		2006	Multi-chemical evaluation of the short-term reproduction assay with the fathead minnow Batelle, EPA contract No. 68-W-01-023
						LOEC	VTG f	497	ug/L	M	dec			
						LOEC	fec	> 11	ug/L	M	no effect			
						LOEC	hatch	> 11	ug/L	M	no effect			
						LOEC	histo f&m	> 11	ug/L	M	no effect			
						LOEC	VTG m&f	> 11	ug/L	M	no effect			
ZEB	cadmium		1,10 ug/L	65-80% of nominal	36	LOEC	fec	10	ug/L	N	dec*	* no stats	1982	Bresch H Investigation of the long-term action of xenobiotics on fish with special regard to reproduction Ecotoxicol Environ Safety 6:102-112
FHM	prometon	inhibitor of steroid synthesis	15,50,250,1250 ug/L	20,45,200, 1000 ug/L	21	LOEC	SSC m	200	ug/L	M	dec*	*dec in fatpad index	2006	Villeneuve DL, Murphy MB, Kahl MD, Jensen KM, Butterworth BC, Makynen EA, Durhan EJ, Linnum A, Leino RL, Curtis LR, Giesy JP, Ankley GT. EVALUATION OF THE METHOXYTRIAZINE HERBICIDE PROMETON USING A SHORT-TERM FATHEAD MINNOW REPRODUCTION TEST AND A SUITE OF IN VITRO BIOASSAYS Environ Toxicol Chem 25(8):2143-2153
						LOEC	fec	> 1000	ug/L	M	no effect			
						LOEC	VTG f&m	> 1000	ug/L	M	no effect			
FHM	ketoconazole	inhibitor of steroid synthesis	25,100,400 ug/L	LabA: 20,74,290 ug/L	21	LOEC	histo m	20,18,16	ug/L	M	inc*	* LabA,B,C: inc proportion of interstitial cells	2007	Biever RC, Kruger H, Kern M, Blackshear PE, Sloan CS Inter-laboratory validation of the fish short-term reproduction assay, run simultaneously across three independent contract laboratories EPA Contract No. EP-W-06-026
				LabB: 18,81,320 ug/L		LOEC	histo f	20,18	ug/L	M	inc*	*LabA&B: inc oocyte atresia		

Species	Chemical	Suspected MOA	Conc nominal	Conc measured	Exposure (d)	Endpoint	Effect	Dose	Unit	Meas/ Nom M/N	Tendency	Comments	Year	Author(s) Title and Source
				LabC: 16,75,240 ug/L		LOEC	histo f	> 240	ug/L	M	no effect*	*LabC		
						LOEC	VTG m	> 290, 320, 240	ug/L	M	no effect*	*LabA,B,C		
						LOEC	VTG f	20	ug/L	M	dec*	*LabA		
						LOEC	VTG f	> 320, 240	ug/L	M	no effect*	*LabB&C		
						LOEC	SSC m	320	ug/L	M	dec*	*LabB: dec in tubercle score		
						LOEC	SSC m	> 290, 240	ug/L	M	no effect*	*LabA&C		
						LOEC	fec	> 290, 240	ug/L	M	no effect*	*LabA&C		
						LOEC	fec	320	ug/L	M	dec*	*LabB		
						LOEC	fert	> 290, 320, 240	ug/L	M	no effect*	*LabA,B,C		
FHM	ketoconazole	inhibitor of steroid synthesis	6,25,100, 400 ug/L	7.0,25,88, 357 ug/L	21	LOEC	fec	25	ug/L	M	dec		2007	Ankley GT, Jensen KM, Kahl MD, Makynen EA, Blake LS, Greene KJ, Johnson RD, Villeneuve DL KETOCONAZOLE IN THE FATHEAD MINNOW (*PIMEPHALES PROMELAS*): REPRODUCTIVE TOXICITY AND BIOLOGICAL COMPENSATION Environ Toxicol Chem 26(6):1214-1223
						LOEC	VTG f&m	> 357	ug/L	M	no effect			
			100,300, 900 ug/L	69,159,468 ug/L	7	LOEC	VTG f	468	ug/L	M	dec			
FHM	prochloraz	CYP enzymes inhibition (steroid synthesis) & anti-androgen	20,100,300 ug/L		21	LOEC	VTG f	20	ug/L	N	dec		2006	Jensen KM, Ankley GT Evaluation of a Commercial Kit for Measuring Vitellogenin in the Fathead Minnow (Pimephales promelas) Ecotoxicol.Environ.Saf. 64:101-106
FHM	prochloraz	CYP enzymes inhibition (steroid synthesis) & anti-androgen	20,100,300 ug/L	LabA: 16,77,220 ug/L	21	LOEC	histo m	23	ug/L	M	inc*	*LabC: inc testicular degeneration	2007	Biever RC, Kruger H, Kern M, Blackshear PE, Sloan CS Inter-laboratory validation of the fish short-term reproduction assay, run simultaneously across three independent contract laboratories EPA Contract No. EP-W-06-026
				LabB: 15,83,230 ug/L		LOEC	histo m	83	ug/L	M	inc*	*LabB: inc testicular degeneration		

Species	Chemical	Suspected MOA	Conc nominal	Conc measured	Exposure (d)	Endpoint	Effect	Dose	Unit	Meas/ Nom M/N	Tendency	Comments	Year	Author(s) Title and Source
				LabC: 23,90,270 ug/L		LOEC	histo m	220	ug/L	M	inc*	*LabA: inc testicular degeneration		
						LOEC	histo f	15	ug/L	M	inc*	*LabB: inc oocyte atresia		
						LOEC	histo f	77	ug/L	M	inc*	*LabA: inc oocyte atresia		
						LOEC	histo f	> 270	ug/L	M	no effect*	*LabC: inc oocyte atresia		
						LOEC	VTG m	> 220, 230, 270	ug/L	M	no effect*	*LabA,B,C		
						LOEC	VTG f	83	ug/L	M	dec*	*LabB		
						LOEC	VTG f	> 220	ug/L	M	no effect*	*LabA		
						LOEC	VTG f	23	ug/L	M	dec*	*LabC		
						LOEC	SSC m	15	ug/L	M	dec*	* LabB: dec fatpad index		
						LOEC	SSC m	77,90	ug/L	N	dec*	*LabA&C: dec in tubercle score		
						LOEC	fec	220, 230, 270	ug/L	M	dec*	*LabA,B,C		
						LOEC	fert	220, 230, 270	ug/L	M	dec*	*LabA,B,C		
FHM	prochloraz	CYP enzymes inhibition (steroid synthesis) & anti-androgen	0.03,0.1, 0.3 mg/L	0.032,0.12 ,0.31 mg/L	21	LOEC	VTG m	> 0.31	mg/L	M	no effect		2005	Ankley GT, Jensen KM, Durhan EJ, Makynen EA, Butterworth BC, Kahl MD, Villeneuve DL, Linnum AL, Gray LE, Cardon M, Wilson VS Effects of two fungicides with multiple modes of action on reproductive endocrine function in the fathead minnow (Pimephales promelas) Toxicol Sci 86:300-308
						LOEC	VTG f	0.12	mg/L	M	dec			
						LOEC	fec	0.12	mg/L	M	dec			
						LOEC	histo m	0.03	mg/L	M	inc*	*inc spermatogonia		
						LOEC	histo f	0.31	mg/L	M	inc*	*inc oocyte atresia		
FHM	perfluoro-octane-sulfonate		0.03,0.1, 0.3,1.0 mg/L	0.028,0.10 ,0.28,0.82 mg/L	21	EC50	fec	0.23	mg/L	N	dec		2005	Ankley GT, Kuehl DW, Kahl MD, Jensen KM, Linnum A, Leino RL, Villeneuve DA REPRODUCTIVE AND DEVELOPMENTAL TOXICITY AND BIOCONCENTRATION OF PERFLUOROOCTANESULFONATE IN A PARTIAL LIFE-CYCLE TEST WITH THE FATHEAD MINNOW (*PIMEPHALES PROMELAS*) Environ Toxicol Chem 24(9):2316-2324
						LOEC	VTG f&m	> 0.3	mg/L	N	no effect			
						LOEC	fert	> 1.0	mg/L	N	no effect			
						LOEC	hatch	> 0.3	mg/L	N	no effect			

Species	Chemical	Suspected MOA	Conc nominal	Conc measured	Exposure (d)	Endpoint	Effect	Dose	Unit	Meas/ Nom M/N	Tendency	Comments	Year	Author(s) Title and Source
ZEB	propyl-thiouracil	inhibitor of thyroid hormone synthesis	1,10,100 mg/L	106-125% of nominal within 4d	21	LOEC	fec	> 100	mg/L	N	no effect		2003	Wester PW, van den Brandhof EJ, Vos JH, van der Ven LTM Identification of Endocrine Disruptive Effects in the Aquatic Environment; a partial life cycle assay in Zebrafish RIVM report 640920001/2003 (DG SANCO, project B6-7920/98/00025) pp 112
						LOEC	hatch	> 100	mg/L	N	no effect			
ZEB	propyl-thiouracil	inhibitor of thyroid hormone synthesis	1,10,100 mg/L		21	LOEC	fec	100	mg/L	N	inc*	* sign conc-dep inc at 1-100 mg/L	2006	van der Ven LT, van den Brandhof EJ, Vos JH, Power DM, Wester PW Effects of the antithyroid agent propylthiouracil in a partial life cycle assay with zebrafish Environ Sci Technol 40(1):74-81
						LOEC	histo f	100	mg/L	N	dec*	* sign conc-dep dec of mature oocyte size at 1-100 mg/L		
						LOEC	fert	> 100	mg/L	N	no effect			
						LOEC	hatch	> 100	mg/L	N	no effect			
FHM	perchlorate	iodine uptake inhibition, anti-thyroid	5,50 mg/L	5.6,44 mg/L	21	LOEC	fec	> 44	mg/L	M	no effect		2006	Multi-chemical evaluation of the short-term reproduction assay with the fathead minnow Batelle, EPA contract No. 68-W-01-023
						LOEC	hatch	> 44	mg/L	M	no effect			
						LOEC	histo f	5.6	mg/L	M	chg*	*inc of atretic follicles, dec of stage 1A oocytes		
						LOEC	histo m	> 44	mg/L	M	no effect			
						LOEC	VTG f&m	> 44	mg/L	M	no effect			
FHM	sodium dodecyl sulfate	negative substance	LabA: 2 mg/L	LabA: 0.27 mg/L	21	LOEC	hist m	0.27, <0.4 4-13	mg/L	M	inc*	*LabA&B: inc in testicular degeneration	2007	Biever RC, Kruger H, Kern M, Blackshear PE, Sloan CS Inter-laboratory validation of the fish short-term reproduction assay, run simultaneously across three independent contract laboratories EPA Contract No. EP-W-06-026
			LabB: 14 mg/L	LabB: <0.44-13 mg/L		LOEC	histo m	> 0.62	mg/L	M	no effect*	*LabC		
			LabC: 2 mg/L	LabC: 0.62 mg/L		LOEC	histo f	0.27, <0.4 4-13	mg/L	M	inc*	*LabA&B: inc oocyte atresia		
						LOEC	histo f	> 0.62	mg/L	M	no effect*	*LabC		
						LOEC	VTG m	0.62	mg/L	M	inc*	*LabC		

Species	Chemical	Suspected MOA	Conc nominal	Conc measured	Exposure (d)	Endpoint	Effect	Dose	Unit	Meas/ Nom M/N	Tendency	Comments	Year	Author(s) Title and Source
						LOEC	VTG m	> 0.27, <0.44-13	mg/L	M	no effect*	*LabA&B		
						LOEC	VTG f	0.62	mg/L	M	inc*	*LabC		
						LOEC	VTG f	> 0.27, <0.44-13	mg/L	M	no effect*	*LabA&B		
						LOEC	SSC m	0.62	mg/L	M	dec*	*LabC: dec fatpad weight, score, index		
						LOEC	SSC m	> 0.27, <0.44-13	mg/L	M	no effect*	*LabA&B		
						LOEC	fec	14	mg/L	N	dec*	*LabB		
						LOEC	fec	> 0.27, <0.44-13	mg/L	M	no effect*	*LabA&C		
						LOEC	fert	14	mg/L	N	dec*	*LabB		
						LOEC	fert	> 0.27, 0.62	mg/L	N	no effect*	*LabA&C		
MED	cis:trans-permethrin 40:60			0.28,0.63, 1.3,2.2,5.5 ug/L	21 males	LOEC	VTG m	> 5.5	ug/L	M	no effect		2006	Results of Assay and Tests in Evaluation of the Endocrine Disrupting Acitivities in Fish (Medaka) Japanese Ministry of Environment
MED	tributyltin chloride		3,10,30 nM		14 females	LOEC	fec	> 30	nM	N	no effect		1999	Wakabayashi M Evaluation of reproductivity of medaka (Oryzias latipes) exposed to chemicals using 2-week reproduction test Presentation at OECD VMGeco meeting
MED	tributyltin chloride			0.12,0.27, 0.61,1.6,4.0 ug/L	21	LOEC	hatch	> 30	nM	N	no effect		2006	Results of Assay and Tests in Evaluation of the Endocrine Disrupting Acitivities in Fish (Medaka) Japanese Ministry of Environment
						LOEC	VTG f&m	> 4.0	ug/L	M	no effect			
MED	triphenyltin chloride			0.12,0.28, 0.93,2.9 ug/L	21 males	LOEC	VTG m	> 2.9	ug/L	M	no effect		2006	Results of Assay and Tests in Evaluation of the Endocrine Disrupting Acitivities in Fish (Medaka) Japanese Ministry of Environment
MED	trans-nonachlor			0.79,1.9,4.3,9.7,22 ug/L	21 males	LOEC	VTG m	> 22	ug/L	M	no effect		2006	Results of Assay and Tests in Evaluation of the Endocrine Disrupting Acitivities in Fish (Medaka) Japanese Ministry of Environment

Species	Chemical	Suspected MOA	Conc nominal	Conc measured	Exposure (d)	Endpoint	Effect	Dose	Unit	Meas/ Nom M/N	Tendency	Comments	Year	Author(s) Title and Source
MED	octachloro-styrene			0.24,0.49, 1.1,2.8,6.6 ug/L	21 males	LOEC	VTG m	> 6.6	ug/L	M	no effect		2006	Results of Assay and Tests in Evaluation of the Endocrine Disrupting Acitivities in Fish (Medaka) Japanese Ministry of Environment
FHM	17α-ethinyl-estradiol	synthetic estrogen	4 ng/L	3.5 ng/L	14	LOEC	VTG m	3.5	ng/L	M	inc		2005	Brodeur JC, Woodburn KB, Klecka GM POTENTIATION OF THE VITELLOGENIC RESPONSE TO 17α-ETHINYLESTRADIOL BY CORTISOL IN THE FATHEAD MINNOW *PIMEPHALES PROMELAS* Environ Toxicol Chem 24(5): 1125-1132
						LOEC	VTG f	> 3.5	ng/L	M	no effect			
FHM	cortisol		144,360, 800 ug/L	99,311,730 ug/L	14	LOEC	VTG f&m	> 730	ug/L	M	no effect		2005	Brodeur JC, Woodburn KB, Klecka GM POTENTIATION OF THE VITELLOGENIC RESPONSE TO 17α-ETHINYLESTRADIOL BY CORTISOL IN THE FATHEAD MINNOW *PIMEPHALES PROMELAS* Environ Toxicol Chem 24(5): 1125-1132
FHM	cortisol+17α-ethinyl-estradiol		144+4,360+4,800+4 ug/L+ng/L	102+3.5,298+3.5,723+3.5 ug/L+ng/L	14	LOEC	VTG f&m	723+3.5	ug+ng/L	M	inc		2005	Brodeur JC, Woodburn KB, Klecka GM POTENTIATION OF THE VITELLOGENIC RESPONSE TO 17α-ETHINYLESTRADIOL BY CORTISOL IN THE FATHEAD MINNOW *PIMEPHALES PROMELAS* Environ Toxicol Chem 24(5): 1125-1132
FHM	anthracene		6,12 ug/L	6.7,12 ug/L	42	LOEC	fec	> 12	ug/L	M	no effect*	* 52% dec in no of eggs (not stat sign) observed weeks 3-6	1991	Hall AT, Oris JT Anthracene reduces reproductive potential and is maternally transferred during long-term exposure in fathead minnows Aquatic Toxicol 19:249-264
						LOEC	hatch	12	ug/L	M	dec			
ZEB	3,4-dichloroaniline+ lindane		0+40,100+40,200+40,200+0 ug/L	0+42,93+34,205+42, 197+0 ug/L	70	LOEC	fec	93/34	ug/L	M	dec		1997	Ensenbach U, Nagel R Toxicity of binary chemical mixtures: Effects on reproduction of zebrafish (Brachydanio rerio) Arch Envrion Contam Toxicol 32:204-210
						LOEC	fert	205/42	ug/L	M	dec*	*dec only in 1 out of 2 groups		
ZEB	zinc		5 mg/L		9	LOEC	fec	5	mg/L	N	dec		1977	Speranza AW, Seeley RJ, Seeley VA, Perlmutter A The effect of sublethal concentrations of zinc on reproduction in the zebrafish, Brachydanio rerio Hamilton-Buchanan Environ Pollut 12:217-222
						LOEC	hatch	5	mg/L	N	dec			

Species	Chemical	Suspected MOA	Conc nominal	Conc measured	Exposure (d)	Endpoint	Effect	Dose	Unit	Meas/ Nom M/N	Tendency	Comments	Year	Author(s) Title and Source
MED	pentachloro-phenol			1.2,2.5,10, 29,95 ug/L	21 males	LOEC	VTG m	> 95	ug/L	M	no effect		2006	Results of Assay and Tests in Evaluation of the Endocrine Disrupting Acitivities in Fish (Medaka) Japanese Ministry of Environment
MED	malathion			1.5,4.6,15, 46,148 ug/L	21 males	LOEC	VTG m	> 148	ug/L	M	no effect		2006	Results of Assay and Tests in Evaluation of the Endocrine Disrupting Acitivities in Fish (Medaka) Japanese Ministry of Environment
MED	mirex			1.1,3.0,8.4 ,24,66 ug/L	21 males	LOEC	VTG m	> 66	ug/L	M	no effect		2006	Results of Assay and Tests in Evaluation of the Endocrine Disrupting Acitivities in Fish (Medaka) Japanese Ministry of Environment
MED	4-nitrotoluene			20,58,182, 600,1920 ug/L	21 males	LOEC	VTG m	> 1920	ug/L	M	no effect		2006	Results of Assay and Tests in Evaluation of the Endocrine Disrupting Acitivities in Fish (Medaka) Japanese Ministry of Environment
ZEB	4-chloraniline		0.04,0.2, 1.0 mg/L	±20% of nominal	119	LOEC LOEC	fec fert	> 1 > 1	mg/L mg/L	N N	no effect no effect		1990	Bresch H, Beck H, Ehlermann D, Schlaszus H, Urbanek M A long-term toxicity test comprising reproduction and growth of zebrafish with 4-chloroaniline Arch Environ Contam Toxicol 19: 419-427
ZEB	3,4-dichloroaniline		50,100,2 00 ug/L		28	LOEC LOEC LOEC	fec fert mating beh	> 200 > 200 > 200	ug/L ug/L ug/L	N N N	no effect no effect no effect		1991	Schäfers C Toxizität und Populationsökologie – Wirkungen von 3,4-Dichloranilin auf Fische mit unterschiedlichen Reproduktionsstrategien Frauenhofer IRB Verlag, pp 174
MED	aldrin			2.0,3.3,7.3 ,15,29 ug/L	21 males	LOEC	VTG m	15	ug/L	M	inc		2006	Results of Assay and Tests in Evaluation of the Endocrine Disrupting Acitivities in Fish (Medaka) Japanese Ministry of Environment
MED	amitrole			.084,.32,.9 5,3.1,9.5 mg/L	21 males	LOEC	VTG m	> 9.5	mg/L	M	no effect		2006	Results of Assay and Tests in Evaluation of the Endocrine Disrupting Acitivities in Fish (Medaka) Japanese Ministry of Environment
MED	benzophenone		1,3,10 uM		14 males	LOEC LOEC	fec hatch	> 10 > 10	uM uM	N N	no effect no effect		1999	Wakabayashi M Evaluation of reproductivity of medaka (Oryzias latipes) exposed to chemicals using 2-week reproduction test Presentation at OECD VMGeco meeting

Species	Chemical	Suspected MOA	Conc nominal	Conc measured	Exposure (d)	Endpoint	Effect	Dose	Unit	Meas/ Nom M/N	Tendency	Comments	Year	Author(s) Title and Source
MED	benzophenone			48,161,501,1390,4650 ug/L	21 males	LOEC	VTG m	501	ug/L	M	inc		2006	Results of Assay and Tests in Evaluation of the Endocrine Disrupting Acitivities in Fish (Medaka) Japanese Ministry of Environment
MED	cis-chlordane			0.81,1.7,4.0,7.6,20 ug/L	21 males	LOEC	VTG m	> 7.6	ug/L	M	no effect*	* 100% mortality at 20 ug/L	2006	Results of Assay and Tests in Evaluation of the Endocrine Disrupting Acitivities in Fish (Medaka) Japanese Ministry of Environment
MED	p,p'-DDD			1.3,2.6,5.4,10,21 ug/L	21 males	LOEC	VTG m	> 21	ug/L	M	no effect		2006	Results of Assay and Tests in Evaluation of the Endocrine Disrupting Acitivities in Fish (Medaka) Japanese Ministry of Environment
MED	o,p'-DDT			0.37,0.80,1.5,3.2,6.6 ug/L	21 males	LOEC	VTG m	1.5	ug/L	M	inc		2006	Results of Assay and Tests in Evaluation of the Endocrine Disrupting Acitivities in Fish (Medaka) Japanese Ministry of Environment
MED	p,p'-DDT			0.37,0.62,1.3,2.7,5.3 ug/L	21 males	LOEC	VTG m	> 5.3	ug/L	M	no effect		2006	Results of Assay and Tests in Evaluation of the Endocrine Disrupting Acitivities in Fish (Medaka) Japanese Ministry of Environment
MED	di-n-butyl phthalate			24,55,133,328,822 ug/L	21	LOEC LOEC	VTG m VTG f	> 822 > 822	ug/L ug/L	M M	no effect no effect		2006	Results of Assay and Tests in Evaluation of the Endocrine Disrupting Acitivities in Fish (Medaka) Japanese Ministry of Environment
MED	2,4-dichlorophenol			34,105,324,946,3280 ug/L	21 males	LOEC	VTG m	324	ug/L	M	inc		2006	Results of Assay and Tests in Evaluation of the Endocrine Disrupting Acitivities in Fish (Medaka) Japanese Ministry of Environment
MED	dicyclohexyl phthalate			18,38,87,188,388 ug/L	21 males	LOEC	VTG m	> 388	ug/L	M	no effect		2006	Results of Assay and Tests in Evaluation of the Endocrine Disrupting Acitivities in Fish (Medaka) Japanese Ministry of Environment
MED	dieldrin			0.27,0.70,2.3,7.2,24 ug/L	21 males	LOEC	VTG m	0.27	ug/L	M	inc		2006	Results of Assay and Tests in Evaluation of the Endocrine Disrupting Acitivities in Fish (Medaka) Japanese Ministry of Environment
MED	di-(2-ethylhexyl) adipate			2.4,7.9,22,182,454 ug/L	21 males	LOEC	VTG m	> 454	ug/L	M	no effect		2006	Results of Assay and Tests in Evaluation of the Endocrine Disrupting Acitivities in Fish (Medaka) Japanese Ministry of Environment

Species	Chemical	Suspected MOA	Conc nominal	Conc measured	Exposure (d)	Endpoint	Effect	Dose	Unit	Meas/ Nom M/N	Tendency	Comments	Year	Author(s) Title and Source
MED	di-(2-ethylhexyl) phthalate			19,42,96,210,405 ug/L	21 males	LOEC	VTG m	> 405	ug/L	M	no effect		2006	Results of Assay and Tests in Evaluation of the Endocrine Disrupting Acitivities in Fish (Medaka) Japanese Ministry of Environment
MED	diethyl phthalate			8.1,27,120,356,1053 ug/L	21 males	LOEC	VTG m	> 1053	ug/L	M	no effect		2006	Results of Assay and Tests in Evaluation of the Endocrine Disrupting Acitivities in Fish (Medaka) Japanese Ministry of Environment
MED	dihexyl phthalate			1.5,4.1,16,58,143 ug/L	21 males	LOEC	VTG m	> 143	ug/L	M	no effect		2006	Results of Assay and Tests in Evaluation of the Endocrine Disrupting Acitivities in Fish (Medaka) Japanese Ministry of Environment
MED	dipentyl phthalate			4.8,14,51,161,583 ug/L	21 males	LOEC	VTG m	> 583	ug/L	M	no effect		2006	Results of Assay and Tests in Evaluation of the Endocrine Disrupting Acitivities in Fish (Medaka) Japanese Ministry of Environment
MED	dipropyl phthalate			13,43,158,572,1690 ug/L	21 males	LOEC	VTG m	> 1690	ug/L	M	no effect		2006	Results of Assay and Tests in Evaluation of the Endocrine Disrupting Acitivities in Fish (Medaka) Japanese Ministry of Environment
MED	endrin			0.037,0.075,0.14,0.31 ug/L	21	LOEC	VTG m	> 0.31	ug/L	M	no effect		2006	Results of Assay and Tests in Evaluation of the Endocrine Disrupting Acitivities in Fish (Medaka) Japanese Ministry of Environment
MED	heptachlor			0.67,1.3,2.5,5.7,11 ug/L	21 males	LOEC	VTG m	> 11	ug/L	M	no effect		2006	Results of Assay and Tests in Evaluation of the Endocrine Disrupting Acitivities in Fish (Medaka) Japanese Ministry of Environment
MED	hexachloro-benzene			1.8,4.1,8.0,16,35 ug/L	21 males	LOEC	VTG m	> 35	ug/L	M	no effect		2006	Results of Assay and Tests in Evaluation of the Endocrine Disrupting Acitivities in Fish (Medaka) Japanese Ministry of Environment
MED	β-hexachloro-cyclohexane			0.97,3.0,9.2,31,95 ug/L	21 males	LOEC	VTG m	> 95	ug/L	M	no effect		2006	Results of Assay and Tests in Evaluation of the Endocrine Disrupting Acitivities in Fish (Medaka) Japanese Ministry of Environment
MED	p,p'-kelthane			3.0,4.5,6.7,10,15 ug/L	21 males	LOEC	VTG m	15	ug/L	M	inc		2006	Results of Assay and Tests in Evaluation of the Endocrine Disrupting Acitivities in Fish (Medaka) Japanese Ministry of Environment

Note: shaded cells indicate the most sensitive endpoint identified in a study.