Accessory publication

Antimony in the environment: knowns and unknowns

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Table A1. Reviews on antimony, or that contain a significant part on this element, published in the last 20 years

Reference	Title	Main topics	No. of pages	No. of references	References' year of publication[A]	Number of citations[B]
[1]	Analytical techniques and methods used for antimony speciation analysis in biological matrices	- Sb-species stability and extraction from solid biological matrices - Selective hydride generation (sel-HG) for Sb speciation in extracts from biological matrices - Sb speciation in biological matrices based on HG-GC separation - Sb speciation in biological matrices based on HPLC separation - The potential use of ES-MS in future Sb speciation	13	72	1981-2008 2001	0
[2]	Antimony in the environment as a global pollutant: A review on analytical methodologies for its determination in atmospheric aerosols	- Antimony in environmental matrices: general considerations - Analytical methods for antimony determination - Determination of antimony in airborne atmospheric aerosols	13	92	1968-2008 2000	0
[3]	Antimony in the environment: a review focused on natural waters III. Microbiota relevant interactions	- Occurrence in microbiota - Uptake transport mechanisms - Pathways of Sb(III) removal from cells = involved in antimony tolerance - Reactivity	23	184	1935-2006 1997	1
[4]	Anthropogenic impacts on the biogeochemistry and cycling of antimony	- Chemistry and behavior in the environment - Abundance and occurrence in the environment - Biological chemistry and toxicity - Total antimony determination - Ancient and modern uses of antimony - Atmospheric emissions to the environment - Archives of atmospheric deposition - Antimony and human health	33	156	1935-2004 1999	3

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Reference	Title	Main topics	No. of pages	No. of references	References' year of publication[A]	Number of citations[B]
[5]	Environmental distribution, analysis, and toxicity of organometal(oid) compounds	- Environmental chemistry of alkylated metal(oids) - Occurrence: environmental distribution - Occurrence: biological samples - Toxicity of metalloids and alkylated species	33	275[C]	1918-2003 1997	25
[6]	Antimony	- Physical and chemical properties, and analytical methods - Sources, production, important compounds, uses, waste products, recycling - Distribution in the environment, in foods and in living organisms - Uptake, absorption, transport and distribution, metabolism and elimination in plants, animals and humans - Effects on animals and humans - Hazard evaluation and limiting concentrations	12	75	1945-2002 1994	-
[7]	Organoantimony compounds in the environment	- Chemistry - Uses and environmental distribution - Toxicology - Analytical methods - Inorganic antimony compounds - Organoantimony compounds - Biological production in the laboratory - Antimony and algae - Antimony metabolism in mammals	27	100	1850-2002 1997	-
[8]	Antimony in the environment: a review focused on natural waters I. Occurrence	- Uses - Toxicity - Occurrence in natural waters - Occurrence in sediments and soils - Reference materials	52	250	1940-2001 1987	100

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Reference	Title	Main topics	No. of pages	No. of references	References' year of publication[A]	Number of citations[B]
		- Occurrence in biota - Speciation in natural waters - Importance of atmospheric input				
[9]	Antimony in the environment: a review focused on natural waters II. Relevant solution chemistry	- Interactions with low molecular weight (l.m.w.) ligands - Interactions with natural organic matter - Interactions with solid phases - Solution chemistry of methylated species - Eh-pH diagrams - Kinetic aspects	21	199	1883-2002 1981	53
[10]	Microbial methylation of metalloids: arsenic, antimony, and bismuth	- Antimony and SIDS[D] - Microbial methylation of Sb	2[D]	39[D]	1935-2001[D] 1997[D]	70
[11]	Biological methylation of less-studied elements		<1[D]	21[D]	1953-2001[D] 1998[D]	17
[12]	Speciation of antimony for the 21st century: promises and pitfalls	- Biological relevance of Sb species - Occupational and environmental exposure to Sb - Analytical problems encountered with Sb speciation - Simultaneous speciation of Sb compounds with hyphenated techniques	12	48	1989-2001 1998	59
[13]	Methodologies for determination of antimony in terrestrial environmental samples	- The determination of antimony in aqueous samples - Determination of antimony in soils, sediments and biological materials	13	117	1974-1999 1993	41

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Reference	Title	Main topics	No. of pages	No. of references	References' year of publication[A]	Number of citations[B]
[14]	Environmental and medicinal chemistry of arsenic, antimony, and bismuth	- Group 15 in the environment - Toxicology - The medicinal chemistry of group 15 - Group 15 in the human circulatory system - Stress and inducible proteins - Immunochemistry and radiochemistry	38	216[E]	1945-1997 1992	-
[15]	Analytical methods for antimony speciation in waters at trace and ultratrace levels	- Chemical methods - Methods based on chromatographic techniques - Methods based on electrochemical techniques - Kinetic methods	7	88	1947-1996 1986.5	52
[16]	Antimony, its sources, applications and flow paths into urban and industrial waste	- Occurrence and production - Applications - Flame retardants - Antimony in waste and waste incineration - The Bamberg study - Antimony balances	9	26	1974-1996 1991	5
[17]	Occurrence, formation and fate of organoantimony compounds in marine and terrestrial environments	- Occurrence of organoantimony compounds in marine and terrestrial environments - Analysis of organoantimony compounds - Microbial biotransformation of antimony compounds	16	52	1926-1999 1994	-
[18]	Arsenic and antimony: comparative approach on mechanistic toxicology	- Toxicokinetics with special regard to the influence of DNA reactivity - Ion charge, cellular intake and biological effect - Organ distribution - Metabolism	14	110[F] (37[G])	1943-1997 1989.5	83

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Reference	Title	Main topics	No. of pages	No. of references	References' year of publication[A]	Number of citations[B]
		- Excretion - Cellular excretion				
[19]	Antimony speciation in water	- Stability of antimony species - Analytical methods for the determination of inorganic Sb	21	58	1960-1992 1985	-
[20]	Antimony	- Chemistry - Distribution and technical uses - Physiology - Analytical determination	10	65	1890-1991 1978	-
[21]	The biochemistry of arsenic, bismuth and antimony	- Chemistry[D] - Biological aspects	2[D]	11[D]	1922-1990[D] 1987[D]	-
[22]	Effects of antimony on cellular systems in animals	- Physical and chemical properties - Sources of exposure and distribution - Exposure of the human system - Biological indicators of Sb pollution - Levels in tissues and biological fluids - Toxic effects of antimony - Toxic effects on human systems - Factors affecting Sb toxicity - Anticarcinogenic and carcinogenic effects - Effects on reproduction - Effect on cells and cellular components	26	213	1926-1994 1980	-
[23]	Safety and environmental effects	- Production and use - Concentration and speciation in the natural environment - Antimony pollution - Toxicity - Biological methylation, transformation, fate - Health effect assessment and safety	11[D]	39[D]	1986[D] 1956-1992[D]	-

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Reference	Title	Main topics	No. of pages	No. of references	References' year of publication[A]	Number of citations[B]
[24]	Antimony	- Physical and chemical properties, and analytical methods - Sources, production, important compounds, uses, waste products, recycling - Distribution in the environment, in foods and living organisms - Uptake, absorption, transport and distribution, metabolism and elimination in plants, animals and humans - Effects on animals and humans - Hazard evaluation and limiting concentrations	8	70	1931-1990 1984	-
[25]	Arsenic and antimony	- Environmental chemistry - Sample collection, storage and stabilization - Preparation procedures - Preconcentration procedures - Hydride generation - Detection systems - Hydride-generation cold-trap systems - Coupled gas chromatography methods - HPLC combination methods - Standardization and accuracy	41	189[F]	1926-1987 1980	-
[26]	Toxicity considerations: antimony metal and its oxides	- Acute effects - Chronic effects	3	34	1913-1986 1961.5	-
[27]	Toxicity of antimony and its compounds	- Chemistry - Current uses of antimony and its compounds - Pharmacokinetics - Toxicology - Epidemiology	23	133	1787-1986 1966.5	12

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Reference	Title	Main topics	No. of pages	No. of references	References' year of publication[A]	Number of citations[B]
[28][H]	Antimony	- Physical and chemical properties - Methods and problems of analysis - Production and uses - Environmental levels and exposures - Metabolism - Levels in tissues and biological fluids - Effects and dose-response relationships - Carcinogenic effects	17	101	1927-1984 1968	-

[A]Range and median value.

[B]According to ISI Web of Knowledge[SM], last checked on the 3rd January 2009.

[C]References on all elements that form organometalic compounds.

[D]Antimony only.

[E]References on arsenic, antimony and bismuth.

[F]References on arsenic and antimony.

[G]Antimony references only.

[H]In the first edition of the book published in 1979, the number of references was 76, the median 1966 and the range 1927-77.

Table A2. Speciation data on antimony in natural waters published after 2001

System[A]	System details	Total Sb / µg L^{-1}	[Sb^{III}] / µg L^{-1}	[Sb^{V}] / µg L^{-1}	Filtration	Experimental technique	Analytical method development	Reference
Gniezno city, PL					Not mentioned	HG-AAS	No	[29]
Pond near Jelonek			0.40	0.30				
Lake Jelonek			0.35	0.65				
Lake Swietokrayskie			0.30	0.10				
Lake Winiary			0.20	0.10				
Coastal water North Brittany, FR					No filtration	DP-ASV	Yes	[30]
Sample 1		0.186 (RSD 3%)	ND					
Sample 2		196 (RSD 5%)	0.012 (RSD 14%)					
Yamagata, JP					0.8 µm	Preconcentration on anion exchange resin and GF-AAS	Yes	[31]
River water A	pH 4.6		0.1	1.05				
River water B	pH 5.0		0.05	0.52				
River water C	pH 6.6		<0.040	0.21				
Marine and freshwater, AU					Not mentioned	HG-ICP-MS	Yes	[32]
Coastal seawater		0.124[B]	0.134[B]					
Open ocean		0.120[B]	ND					
Lake Burley Griffin		0.132[B]	0.026[B]					
Lake Ginninderra		0.134[B]	0.039[B]					
Tap Water, Canberra		0.011[B]	0.002[B]					
Lab water, SG		0.028	<0.001	0.028	0.45 µm Nylon membrane	Solid phase extraction (APDC) and ICP-MS	Yes	[33]
Drinking water, SG		0.357-0.422	0.040-0.066	0.291-0.392				

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System[A]	System details	Total Sb / µg L^{-1}	$[Sb^{III}]$ / µg L^{-1}	$[Sb^{V}]$ / µg L^{-1}	Filtration	Experimental technique	Analytical method development	Reference
Lake water and porewater, CA	Two lakes, one with anoxic sediment-water interface	0.068-0.122[B]	0-0.146[B] (present in anoxic waters)	0.007-0.068[B]	0.2 µm	HG-AFS	No	[34]
Pszczewski Landscape Park, PL		<0.01-0.44	0.09 ± 0.08 (<0.04-0.33)	0.12 ± 0.11 (<0.04- 0.38)	Not mentioned	HG-AAS	No	[35]
Tap water, PL		0.44 (RSD 4.5%)	0.05 (RSD 15%)	0.39	Not mentioned	HG-GF-AAS	Yes	[36]
Mineral water, PL	n = 6	0.52 ± 0.19	0.14 ± 0.16	0.39 ± 0.15 (by difference)				
North Atlantic Ocean deep seawater	13 depths between 1000 and 2000m	0.166 ± 0.009 (0.153-0.180)	0.008 ± 0.004	0.157 ± 0.007	0.45 µm PP filter	Adsorption on thiol cotton fibre and HG-MC-ICP-MS	No	[37]
Jaroslawieckie Lake, PL	March 2003 (n = 11)		0.34 ± 0.04 (0.28-0.38)	0.30 ± 0.24 (0.11-0.98)	Not mentioned	HG-AAS	No	[38]
	July 2002 (n = 11)		0.06 ± 0.01 (0.05-0.08)	0.05 ±0.01 (0.03-0.07)				
Valparaiso, CL					0.45 µm	HPLC-HG-AFS	Yes	[39]
Harbour		0.55 ± 0.04	0.23 ± 0.04	0.20 ± 0.03				
Coastal area				Predominant				
Groundwater Poznan City, PL			C	C	No filtration	HG-AAS	No	[40]
Piatkowo	n = 11	0.39 ± 0.14 (0.24-0.71)	0.14 ± 0.05 (0.09-0.24)	0.25 ± 0.14 (0.13-0.29)				
Winogrady	n = 9	0.42 ± 0.05 (0.34-0.52)	0.17 ± 0.03 (0.14-0.23)	0.24 ± 0.05 (0.13-0.29)				

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System[A]	System details	Total Sb / µg L^{-1}	[Sb^{III}] / µg L^{-1}	[Sb^{V}] / µg L^{-1}	Filtration	Experimental technique	Analytical method development	Reference
North Pacific Ocean	Vertical profiles at 9 stations and surface samples along a 15,000 km transect	~0.07-0.24[B] with surface max. at 2 stns.; slight increase with depth; avg 0.14[B] in surface transect	ND except in 6 samples, up to 0.15[B]		0.45 µm polycarbonate	HG-GC-PID	No	[42]
Tap water, Wuhan, CN			1.00 ± 0.04	2.50 ± 0.08	Not filtered	Solid phase extraction (APDC) and ETV-ICP-AES	Yes	[43]
Yantse River, CN			ND	1.20 ± 0.05	0.45 µm			
Pond water, CN			1.30 ± 0.03	2.83 ± 0.07	0.45 µm			
Lakes and ponds in Gniezno City and neighbourhood, PL	n = 46	0.38 ± 0.24 (0.13-1.61)	0.20 ± 0.17 (0.05-1.04)	0.18 ±0.11 (0.04-0.57)	Not mentioned	HG-AAS	No	[44]
Seawater, Zhangpu, CN		0.97	0.29	0.68		Preconcentration (TiO_2) and HG-AAS	Yes	[45]
Jiulong River, CN		2.55	0.53	2.02				
Hot Spring, CN		5.29	0.74	4.55				
Fen River, CN	pH 5.6	0.236 ± 0.008	<LOD		0.45 µm	Preconcentration (BPHA) and ET-AAS	Yes	[46]
Seawater, Tianjin, CN	pH 6.3	0.189 ± 0.033	<LOD					
Wuhan, CN					0.45 µm	Preconcentration of PDC chelates (TiO_2) and ICP-OES	Yes	[47]
Well water,			ND-0.74	1.57-2.55				
Lake water,			ND-1.02	2.45-3.23				
Pond water,			ND-1.24	2.32-3.83				

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System[A]	System details	Total Sb / µg L^{-1}	$[Sb^{III}]$ / µg L^{-1}	$[Sb^{V}]$ / µg L^{-1}	Filtration	Experimental technique	Analytical method development	Reference
Pacific water, Inage coast, JP	.	0.97	0.60	0.37	0.45 µm cellulose acetate membrane	Solid phase extraction (APDC) and GF-AAS	Yes	[48]
Edogawa River, JP		0.86	0.42	0.44				
Tap water, Wuhan, CN			0.9 ± 0.06	1.4 ± 0.1	0.45 µm	Preconcentration and ETV-ICP-MS	Yes	[49]
East Lake, CN			0.8 ± 0.05	1.4 ± 0.08				
Yangtze River, CN			0.77 ± 0.05	1.1 ± 0.08				
River, BR	close to petrol refinery	0.7-2.5	0.5-2.0	<DL-0.9	Microfiber filter	Preconcentration (L-proline) and HG-ICP-OES	Yes	[50]

[A]International country codes follow the ISO 3166 convention.

[B]In molar scale units in the original.

[C]Values calculated from the published total antimony concentrations and Sb^{III}/Sb^{V} ratios. Similar type of information can be found in [41] for surface waters from Poznan City, PL.

Table A3. Observations related to the preservation of antimony speciation during sampling and storage of natural waters

System	Preservation method	Comments	Reference
Coastal seawater	Filtration (0.45 μm) Storage in PE bottles	Analysis after 5 and 25 days show a decrease in Sb contents, probably caused by wall adsorption with vessel wall, but no change in Sb^{III}/Sb^{V} ratio	[51]
Coastal seawater	Filtration (0.45 μm) and immediate separation of Sb^{III} and Sb^{V} by extraction with diethyldithiocarbamates with chloroform	Detailed study for As but Sb study precluded by hydrolysis	[52]
Fresh, estuarine, marine waters	Storage in LPE bottles in the dark at room temperature for up to 4 days If longer, freezing storage at -20^{o}C	No change in speciation (including MMA and DMA) for up to 4 days	[53]
Estuarine waters	For long storage: quick freezing, storage at -30^{o}C	Samples unchanged up to 2 days Avoid freezing in a freezer: fast oxidation in the brine formed during partial freezing Acidification with HCl (4 mL conc HCl in 1 L sample) leads to the rapid oxidation of Sb^{III} but total and organoSb remain stable over a few months	[54]
Seawater	Two methods: - Rapid freezing by immersion into dry ice/isopropyl alcohol bath - Acidification with 4 mL conc HCl per L of sample	No discussion	[55]
Freshwater	Filtration glass fibre filter (Whatman GF/F) Deep-freezing	No discussion	[56]
Fresh and estuarine waters	Filtration glass fibre filter (0.45 μm) Deep-freezing, only if analysis not possible within 2 h	Priority must be given to performing Sb^{III} determination as soon as possible (tentatively within 2 h)	[57]
Pond water, reservoir water, seawater, polluted water	Filtration (0.45 μm) Addition of tartaric acid (1% w/v in the sample)	Sample stable several days (> 5) In the absence of tartaric acid, Sb^{III} was lost: total removal in 2-5 h, depending on sample	[58]

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System	Preservation method	Comments	Reference
River water	Filtration membrane filters (0.45 µm) and stored in a refrigerator at 4°C for 'several days'	No changes in the Sb concentrations and species in natural water stored at 4°C for 1 week observed	[59]
Oxic and anoxic seawater	Filtration Nucleopore polycarbonate filters (0.4 µm) in a clean room, with pressurized N_2, immediately after sampling: - One aliquot stored in Teflon bottles kept in the refrigerator until analysis (< 12 h) - Second aliquot of filtered water kept in PE bottles acidified to pH < 2 with HCl (analysis methylated Sb)	No discussion	[42, 60, 61]
Oxic and anoxic seawater	Storage in high-density PE bottles and rapid freezing by immersion in liquid nitrogen. Storage at -40°C Samples thawed by using a microwave oven (do not allow T to rise above 30°C)	Method based on previous publications	[62]
Interstitial water of sediments from a river in polluted area	Prior to extraction from sediments, submersion in dry ice and storage in a cooler After extraction, filtration (0.45 µm) and storage at 4°C	No discussion	[63]
Atlantic Ocean waters	Quick freezing by immersion in liquid nitrogen and storage at -40°C until analysis	Laboratory experiments show that quick frozen samples cannot be stored longer than one month before the inorganic speciation is compromised	[64]
Meromictic lake	In site filtration membrane filters (0.4 µm) Kept in the dark at 4°C for three days and stored frozen in the lab. Frozen samples were thawed in hot water	During storage of frozen samples, diffusion of oxygen suspected with precipitation of Fe in samples from the anoxic monolimnion water	[65]
Lake water	Freezing immediately after sampling, method not mentioned Filtered (0.45 µm) after thawing	No discussion	[66]
Ocean waters	Pumping through a 0.2 µm capsule filter (surface water) and laboratory 0.4 µm filtration (deep waters) Storage in high-density PE bottles and acidification to pH < 2 with HCl	The collection and storage of samples did not allow the preservation of the original Sb^{III}/Sb^{V} ratios. However, under these conditions, methylated species are stable	[67]

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System	Preservation method	Comments	Reference
River water	Sampling in PE bottles and freezing at -20°C back to laboratory Filtration (0.45 µm) after thawing	No discussion	[68]
Coastal seawater		Sb^{III} is oxidised in seawater acidified with HCl. "Preservation through freezing and a rapid analysis after sampling appear recommendable" but no proof is given. "For long storage periods, the use of a hydrazinium/HCl mixture or ascorbic acid may also be suggested" but, again, no proof given	[69]
Harbour water	Filtration (0.45 µm) Addition of 20 mM EDTA	Only Sb^{V} detection without EDTA addition. With EDTA addition, Sb^{III} detection in one sample. Test of EDTA effect with spiked samples	[39]
Surface waters	Freezing -30°C for not more than 5 days. Freezing method and other details not mentioned	No discussion	[41, 44]

Table A4. Procedures described for soil sampling, pretreatment and conservation in studies where redox speciation measurements, determination of methylated species or solid speciation have been performed

Species determined	Speciation method used	Procedure as described	Reference
Methylated species	HG/LT-GC/ICP-MS	No information given	[70]
III/V	Citric acid extraction + HPLC-ID-ICP-MS	Collected samples, after drying at ambient T, were filled in plastic bottles and closed using two tight covers and stored in dry places at room T. Samples were sieved to obtain the < 2 mm soil fraction. The sieved sample was grinded used a mixer mill[A]	[71]
Methylated species	HG-PT-GC/ICP-MS	Samples were transported immediately to the laboratory, sieved (2 mm) and stored at -80^{o}C prior to GC analysis	[72]
Solid phase speciation	XAFS	No information given. Soils oven-dried at 60^{o}C for 48 h for NAA total Sb determination	[73]
Solid phase speciation	XAFS	Soil was sealed in polystyrene bottles after sampling and kept at 4 ^{o}C during transportation. Soil was passed through a 0.5 mm stainless steel sieve at 0-5^{o}C. Homogenised soil was stored at -20^{o}C	[74]
Solid phase speciation	XAFS	Soils were air dried and sieved (< 2 mm and 0.5 mm)	[75]
III/V	Water extraction + HPLC-ICP-MS	The collected soil samples were allowed to dry in large open Petri dishes and sieved using a 2 mm sieve	[76]

[A]Many samples taken in 2002 and analysed in 2005.

Table A5. Chemical parameters in published antimony acute toxicity tests for aquatic organisms

Substance	Organism	Medium composition[A]	T / °C	Concentrations: nominal (N), measured (M)	Comments in the article related to solubility issues	Concentrations / mg Sb L^{-1} [B]	Reference
$SbCl_3$	*Daphnia magna*	Lake Erie water: pH = 8.2-8.4	25	N	In concentrations 1.25 mM and greater a precipitate formed when added to lake water. The 1.25 mM solution had a pH of 2.9. The pH of a 0.372 mM solution was 8.1 and no precipitate formed	Threshold for immobilisation: 0.16 mM	[77]
$SbCl_3$ $SbCl_5$	*Petromyzum marinus* (larval lampreys)	Lake Huron water	55 F	N		All salts tested at 5 mg L^{-1}. No effect observed.	[78]
PAT	*Escherichia* *Scenedesmus* *Daphnia*	Complex test culture media composition detailed in the article				*E*: 33 *S*: 3.5 *D*: 9 Not clear whether they are salt or Sb concentration	[79]
$Sb_2O_32SbOCl$	*Chlorella vulgaris*	0.05% K_2HPO_4, 0.05% KH_2PO_4, 0.05% $(NH_4)_2SO_4$, 0.05% KNO_3 pH just below 7		N	"Antimony is easily hydrolysed"	Highest conc. tolerated = 0.032, lowest inhibitory conc. = 0.064	[80]
$SbCl_3$	*Carcinus maenas* *Palaemon serratus* *Blennius pholis*	Sea water	15	N	To overcome solubility problems, two types of solution preparation used: (A) $SbCl_3$ suspension in seawater, (B) $SbCl_3$ dissolution at pH 1 followed by neutralisation	Salt concentration added: 0.1-1000 (element: 0.05-534) Adult *Cm* LC_{50} (salt): 1000 (A), 500 (B)	[81]

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Substance	Organism	Medium composition[A]	T / °C	Concentrations: nominal (N), measured (M)	Comments in the article related to solubility issues	Concentrations / mg Sb L^{-1} [B]	Reference
						Other LC_{50} values obtained only with A or B solutions, not with both (A values always 500-1000)	
Sb_2O_3	*Fundulus heteroclitus* (mummichog)	Salty waters: S: 6, 21.6	20	N		All LC_{50} (24, 48, 72, 96 h) >1000	[82]
$SbCl_3$	*Carassius auratus* (goldfish) *Salmo gairdneri* (rainbow trout) *Gastrophryne carolinensis* (toad)	Test water: pH 7.4, H = 195 (*Ca*, *Gc*), 104 (*Sg*) DO = near saturation	13 (trout eggs), 22 (other species)	N	-	*Sg*: LC_{50} = 0.58, LC_1 = $28.6x10^{-3}$ *Ca*: LC_{50} = 11.3, LC_1 = $111x10^{-3}$ *Gc*: LC_{50} = 0.30, LC_1 = $3.8x10^{-3}$	[83]
$K[Sb(OH)_6]$	*Entosiphon sulcatum* (protozoa)	Complex test culture media composition detailed in the article		N		Toxicity threshold: 185 Not clear whether it is salt or Sb concentration	[84]
$K[Sb(OH)_6]$	*Mycrocystis aeruginosa* (blue algae) *Scenedesmus quadricauda* (green alga)	Complex test culture media composition detailed in the article		N		Toxicity threshold: 50 (*Ma*), >2120 (*Sq*) Not clear whether it is salt or Sb concentration	[85]

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Substance	Organism	Medium composition[A]	T / °C	Concentrations: nominal (N), measured (M)	Comments in the article related to solubility issues	Concentrations / mg Sb L^{-1} [B]	Reference
$SbCl_3$	*D. magna* *Pimephales promelas* (fathead minnow)			N		LC_{50} (48 h) = 18.8 LC_{50} (48 h) = 21.9	[86]
Salt not given	*D. magna*	Reconstituted water: pH = 8.0 ± 0.2, H = 173 ± 13, DO > 60%	22	N		LC_{50} (24, 48 h) > 530 Not clear whether it is salt or Sb concentration	[87]
Sb_2O_3	*Lepomis macrochirus* (bluegill)	Well water: pH = 6.7-7.8, H = 32-48, Alk = 28-34, DO = 7.0-8.8	22	N	Sb_2O_3 qualified as "undissolved chemical" by the authors	LC_{50} (96 h)> 530 Not clear whether it is salt or Sb concentration	[88]
Sb_2O_3	*P. promelas* (fathead minnow)	Reconstructed soft water: pH 7.2-7.9, H = 40-48, Alk = 30-35	22	N		LC_{50} (96 h) = 833.0 Not clear whether it is salt or Sb concentration	[89]
Salt not given	*Cyprinodon variegatus* (sheepshead minnow)	Filtered (10 µm) seawater: S: 1-31	25-31	N	"Many of the chemicals were insoluble in seawater and either floated upon the water surface or formed globules on the bottoms of the test containers"	LC_{50} (24, 48, 72, 96 h) >6.2 <8.3	[90]
$SbCl_3$	*Gammarus pseudolimnaeus* *Lumbricus variegatus* *Pycnopsche* sp. *P. promelas*					EC_{50} (72 h) >25.7 (*Gp*, *Lv*, *P*sp) LC_{50} (96 h) >14.4 (*Pp*)	[91]

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Substance	Organism	Medium composition[A]	T / °C	Concentrations: nominal (N), measured (M)	Comments in the article related to solubility issues	Concentrations / mg Sb L^{-1} [B]	Reference
PAT	*D. magna*					LC_{50} (48 h) = 5	[92]
PAT	*Oncorhynchus mykiss*					LC_{50} (96 h) > 37	
$SbCl_3$						LC_{50} (96 h) > 25.7	
Sb_2O_3	*D. magna* Straus	Tubewell water: pH 7.6, H = 240, Alk = 400, DO = 5.6	13			EC_{50} (24 h) = 555, EC_{50} (48 h) = 423	[93]
$SbCl_3$	*Caenorhabditis elegans* (free-living nematode)	Distilled water with 1.23 g of NaCl and 0.986 g of KCl	20	N	"The Sb value is the highest concentration obtainable due to solubility limitations"	No values of LC_{50} for days 1, 2, 3 and >20 for day 4	[94]
Sb_2O_3	*Tubifes tubifex* (worm)	Tubewell water: pH 7.6, H = 245, Alk = 400, DO = 5.8	30	N	"Antimony trioxide was boiled in a small amount of dilute HCl to dissolve it"	EC_{50} (24 h) = 108, EC_{50} (48 h) = 920, EC_{50} (96 h) = 678	[95]
PAT	*Chlorococcum infusionum*					EC_{50} =59	[96]
	Scenedesmus subsoicatus					EC_{50} =43	
	D. magna					EC_{50} =8	
	Vibrio fisheri					EC_{50} =7	
$SbCl_3$	*Oreochromis mossambicus* (tilapia) larvae	Freshwaters: composition not given	Not given	N		LC_{50} (48, 96 h) = 156 µM (= 35.5 µg $SbCl_3$ L^{-1})	[97]

Continued on next page

Substance	Organism	Medium composition[A]	T / ^{o}C	Concentrations: nominal (N), measured (M)	Comments in the article related to solubility issues	Concentrations / mg Sb L^{-1} [B]	Reference
$SbCl_3$, $SbCl_5$, $K[Sb(OH)_6]$	*Pargus major* (red seabream)	Seawater: S = 33.7	20	M		Range of concs. tested: $SbCl_3$: 7.8-25.7 $SbCl_5$: 0.40-1.06 $K[Sb(OH)_6]$: 2.8-10.3 LC_{50}: $SbCl_3$: 12.4, $SbCl_5$: 0.93, $K[Sb(OH)_6]$: 6.9	[98]
$SbCl_3$	*Cyprinus carpio* (common carp)	Dechlorinated tap water: pH 7.4-7.8, H = 38-45, DO = 7.3-8.1	25	N		LC_{50} (48 h) =19.36, LC_{50} (96 h) =14.05	[99]

[A]Alk: alkalinity in mg $CaCO_3$ L^{-1}, H: hardness in mg $CaCO_3$ L^{-1}, DO: dissolved oxygen in mg O_2 L^{-1} (except when in % saturation), S: salinity in $^{o}/_{oo}$.

[B]Units are in mg Sb L^{-1} unless stated otherwise.

Abbreviations

AAS	atomic absorption spectroscopy
AES	atomic emissions spectrometry
AFS	atomic fluorescence spectroscopy
APDC	ammonium pyrrolidine dithiocarbamate
DP ASV	differential pulse anodic stripping voltammetry
BPHA	*N*-benzoyl-*N*-phenylhydroxylamine
DMA	dimethylantimony species
EC_{50}	effective concentration, 50%
EDTA	ethylenediaminetetraacetic acid
ES-MS	electrospray mass spectrometry
ET	electrothermal
ETV	electrothermal vaporisation
GC	gas chromatography
GF-AAS	graphite furnace atomic absorption spectroscopy
HG	hydride generation
HPLC	high-performance liquid chromatography
ICP	inductively coupled plasma
ICP-MS	inductively coupled plasma mass spectrometry
ICP-SMS	inductively coupled plasma sector field mass spectrometry
ID	isotope dilution
LC_{50}	lethal concentration, 50%
LOD	limit of detection
LOEC	lowest observed effect concentration
LPE	linear polyethylene
LT-GC	low temperature gas chromatography
MC	multiple-collector
MS	mass spectrometry
MMA	monomethylantimony species
NAA	neutron activation analysis
ND	not detected
OES	optical emissions spectrometry

PAT	potassium antimonyl tartrate
PDC	pyrrolidine dithiocarbamate
PE	polyethylene
PID	photoionization detection
PP	polypropylene
PT-GC	purge and trap gas chromatography
RSD	relative standard deviation
SIDS	sudden infant death syndrome
T	temperature
XAFS	X-ray absorption fine structure

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