Appendix 7. Trace-Element Data in Caddisfly Larvae

Table A7-1. Dry tissue weight and metal concentration data for caddisfly larvae.

Table A7-2. Dry tissue weight and metal concentration data for standard reference materials processed concurrently with caddisfly samples.

Table A7-3. Metal mass balance of body fractions prepared from caddisfly samples collected from the Sacramento River and Cottonwood Creek.

Table A7-1. Dry tissue weight and metal concentration data for caddisfly larvae

[Br., bridge; c, cytosol sample; Cr., creek; p, pellet sample; wb, whole body sample; s, spiked sample; R., River. Sac., Sacramento. Results given are the dry weight of tissue and raw concentrations of the tissue digest. Conversion to metal concentrations in the original tissue requires application of conversion factors (not given) that account for dilutions during sample preparation. Cytosolic and pellet concentrations were obtained from the same 7 millliliter subsample of the whole tissue homogenate, whereas the subsample for the whole body samples was usally 4–5 millliliters. µg, microgram; g, gram]

Station	Sample	Dry weight (g)	Aluminum (µg/sample)	Cadmium (µg/sample)	Copper (µg/sample)	Iron (µg/sample)	Lead (µg/sample)	Zinc (µg/sample)
Sac R.–Rodeo	SRRH1wb	0.1365	163 ± 7	0.28 ± 0.01	4.7 ± 0.1	177 ± 0	0.17 ± 0.00	22 ± 0
	SRRH2wb	0.1371	169 ± 9	0.30 ± 0.01	5.6 ± 0.1	219 ± 0	0.17 ± 0.00	23 ± 0
	SRRH3wb	0.1285	166 ± 8	0.29 ± 0.00	4.8 ± 0.0	193 ± 0	0.17 ± 0.00	23 ± 0
	SRRH4wb	0.1431	145 ± 1	0.30 ± 0.00	4.8 ± 0.0	186 ± 0	0.17 ± 0.01	27 ± 4
	SRRH1c	0.0500	1.2 ± 0.2	0.18 ± 0.01	2.8 ± 0.0	6 ± 1	0.033 ± 0.002	11 ± 0
	SRRH2c	0.0502	1.5 ± 0.2	0.16 ± 0.00	2.7 ± 0.0	6 ± 1	0.038 ± 0.002	11 ± 0
	SRRH3c	0.0484	1.2 ± 0.2	0.17 ± 0.00	2.8 ± 0.0	6 ± 0	0.030 ± 0.002	11 ± 0
	SRRH4c	0.0470	1.5 ± 0.2	0.16 ± 0.00	2.6 ± 0.0	3 ± 0	0.025 ± 0.000	11 ± 1
	SRRH1p	0.1030	151 ± 13	0.13 ± 0.00	1.6 ± 0.0	175 ± 10	0.11 ± 0.00	13 ± 2
	SRRH2p	0.1168	206 ± 25	0.20 ± 0.00	3.7 ± 0.1	304 ± 0	0.21 ± 0.01	18 ± 1
	SRRH3p	0.1145	182 ± 16	0.20 ± 0.00	3.3 ± 0.3	286 ± 11	0.27 ± 0.00	18 ± 1
	SRRH4p	0.1283	172 ± 7	0.19 ± 0.00	3.5 ± 0.3	244 ± 0	0.19 ± 0.01	18 ± 1
Sac R.–Churn Cr.	SRAH1wb	0.1081	149 ± 14	0.10 ± 0.00	4.2 ± 0.0	227 ± 0	0.13 ± 0.01	17 ± 0
	SRAH2wb	0.1108	141 ± 15	0.11 ± 0.00	4.0 ± 0.0	222 ± 0	0.14 ± 0.00	18 ± 0
	SRAH3wb	0.1086	147 ± 5	0.11 ± 0.00	4.0 ± 0.1	228 ± 0	0.14 ± 0.00	18 ± 1
	SRAH4wb	0.1090	154 ± 0	0.10 ± 0.00	4.3 ± 0.1	229 ± 0	0.14 ± 0.00	17 ± 1
	SRAH1wb/s	0.1070	166 ± 5	0.50 ± 0.00	14 ± 0	225 ± 0	1.0 ± 0.0	27 ± 2
	SRAH1c	0.0383	0.88 ± 0.46	0.064 ± 0.005	2.3 ± 0.0	7 ± 1	0.018 ± 0.002	11 ± 0
	SRAH2c	0.0380	0.96 ± 0.49	0.062 ± 0.001	2.4 ± 0.0	5 ± 3	0.019 ± 0.001	11 ± 0
	SRAH3c	0.0372	0.97 ± 0.08	0.059 ± 0.001	2.1 ± 0.0	7 ± 1	0.015 ± 0.002	9.9 ± 0.5
	SRAH4c	0.0378	0.87 ± 0.11	0.055 ± 0.003	2.3 ± 0.0	6 ± 2	0.015 ± 0.001	10 ± 0
	SRAH1p	0.1024	235 ± 2	0.059 ± 0.001	2.7 ± 0.0	287 ± 20	0.16 ± 0.00	15 ± 0
	SRAH2p	0.1076	219 ± 1	0.067 ± 0.003	3.1 ± 0.0	312 ± 0	0.16 ± 0.00	16 ± 0
	SRAH3p	0.1033	207 ± 6	0.063 ± 0.001	2.9 ± 0.0	310 ± 0	0.18 ± 0.00	16 ± 0
	SRAH4p	0.1041	210 ± 2	0.060 ± 0.002	2.6 ± 0.1	312 ± 0	0.16 ± 0.00	15 ± 0

Table A7-1. Dry tissue weight and metal concentration data for caddisfly larvae—*Continued*

Station	Sample	Dry weight (g)	Aluminum (µg/sample)	Cadmium (µg/sample)	Copper (µg/sample)	Iron (µg/sample)	Lead (µg/sample)	Zinc (µg/sample)
Sac R.– Balls Ferry	SRBFH1wb	0.1741	223 ± 6	0.16 ± 0.00	3.9 ± 0.0	209 ± 17	0.18 ± 0.00	30 ± 1
	SRBFH2wb	0.1694	218 ± 7	0.13 ± 0.00	4.3 ± 0.1	237 ± 0	0.16 ± 0.00	28 ± 1
	SRBFH3wb	0.1762	218 ± 16	0.13 ± 0.00	4.5 ± 0.0	136 ± 4	0.15 ± 0.00	31 ± 0
	SRBFH4wb	0.1926	243 ± 7	0.14 ± 0.00	4.7 ± 0.0	270 ± 0	0.15 ± 0.00	32 ± 0
	SRBFH5wb	0.1614	216 ± 2	0.11 ± 0.00	4.0 ± 0.0	274 ± 16	0.14 ± 0.00	27 ± 1
	SRBFH6wb	0.1466	192 ± 3	0.11 ± 0.00	3.8 ± 0.0	220 ± 15	0.15 ± 0.01	25 ± 0
	SRBFH1c	0.0335	0.99 ± 0.10	0.069 ± 0.004	1.2 ± 0.0	6 ± 0	0.024 ± 0.002	7.8 ± 0.4
	SRBFH2c	0.0414	1.1 ± 0.1	0.051 ± 0.002	1.5 ± 0.0	7 ± 3	0.019 ± 0.001	10 ± 0
	SRBFH3c	0.0330	1.2 ± 0.3	0.039 ± 0.000	1.2 ± 0.0	6 ± 0	0.015 ± 0.002	8.1 ± 0.0
	SRBFH4c	0.0322	0.99 ± 0.24	0.040 ± 0.002	1.2 ± 0.0	5 ± 0	0.013 ± 0.003	8.1 ± 0.3
	SRBFH5c	0.0379	0.91 ± 0.13	0.042 ± 0.004	1.4 ± 0.0	7 ± 0	0.016 ± 0.001	9.9 ± 0.8
	SRBFH6c	0.0380	0.98 ± 0.24	0.051 ± 0.004	1.5 ± 0.0	6 ± 0	0.015 ± 0.001	10 ± 0
	SRBFH1p	0.0992	192 ± 3	0.061 ± 0.003	1.8 ± 0.0	248 ± 10	0.19 ± 0.00	16 ± 0
	SRBFH2p	0.0948	188 ± 2	0.045 ± 0.002	1.7 ± 0.0	237 ± 0	0.12 ± 0.00	13 ± 1
	SRBFH3p	0.1009	171 ± 4	0.049 ± 0.002	1.7 ± 0.1	232 ± 0	0.12 ± 0.00	13 ± 0
	SRBFH4p	0.1004	191 ± 1	0.047 ± 0.001	1.8 ± 0.0	211 ± 10	0.11 ± 0.00	13 ± 1
	SRBFH5p	0.0970	188 ± 8	0.043 ± 0.001	1.8 ± 0.1	194 ± 58	0.12 ± 0.00	12 ± 0
	SRBFH6p	0.1043	187 ± 3	0.049 ± 0.005	1.9 ± 0.0	177 ± 94	0.12 ± 0.00	13 ± 0
Sac R.– Bend Br.	SRBH1wb	0.1047	206 ± 3	0.12 ± 0.00	3.3 ± 0.0	251 ± 10	0.12 ± 0.01	22 ± 0
	SRBH2wb	0.1042	202 ± 2	0.13 ± 0.00	3.4 ± 0.1	240 ± 0	0.11 ± 0.00	21 ± 1
	SRBH3wb	0.1069	203 ± 2	0.11 ± 0.00	2.9 ± 0.0	118 ± 21	0.11 ± 0.00	22 ± 0
	SRBH4wb	0.1118	221 ± 7	0.13 ± 0.00	3.6 ± 0.1	235 ± 22	0.12 ± 0.00	24 ± 0
	SRBH1wb/s	0.1064	212 ± 0	0.51 ± 0.02	12 ± 0	245 ± 11	1.1 ± 0.0	30 ± 1
	SRBH2wb/s	0.1026	197 ± 5	0.51 ± 0.00	11 ± 0	226 ± 10	1.0 ± 0.0	30 ± 2
	SRBH1c	0.0330	0.47 ± 0.15	0.066 ± 0.002	1.5 ± 0.0	7 ± 0	0.015 ± 0.001	9.2 ± 0.2
	SRBH2c	0.0310	0.42 ± 0.06	0.062 ± 0.003	1.5 ± 0.0	7 ± 0	0.012 ± 0.001	8.8 ± 0.2
	SRBH3c	0.0248	0.42 ± 0.16	0.044 ± 0.002	1.0 ± 0.0	5 ± 0	0.007 ± 0.000	6.7 ± 0.1
	SRBH4c	0.0323	0.49 ± 0.15	0.062 ± 0.004	1.4 ± 0.0	6 ± 0	0.025 ± 0.003	9.0 ± 0.1
	SRBH1c/s	0.0331	1.1 ± 0.2	0.26 ± 0.00	3.4 ± 0.1	4 ± 1	0.21 ± 0.00	11 ± 0
	SRBH2c/s	0.0320	1.5 ± 0.0	0.27 ± 0.00	3.3 ± 0.1	7 ± 0	0.20 ± 0.00	11 ± 0
	SRBH1p	0.1077	235 ± 11	0.069 ± 0.002	2.1 ± 0.0	215 ± 43	0.14 ± 0.00	15 ± 0
	SRBH2p	0.0975	269 ± 1	0.078 ± 0.004	2.4 ± 0.0	341 ± 0	0.15 ± 0.00	16 ± 0
	SRBH3p	0.1010	273 ± 9	0.076 ± 0.001	2.5 ± 0.0	273 ± 91	0.16 ± 0.00	16 ± 0
	SRBH4p	0.1102	253 ± 14	0.087 ± 0.002	2.7 ± 0.0	298 ± 33	0.16 ± 0.01	18 ± 0
	SRBH1p/s	0.1012	275 ± 2	0.46 ± 0.00	12 ± 0	283 ± 111	1.1 ± 0.1	26 ± 0
	SRBH2p/s	0.0983	255 ± 16	0.46 ± 0.01	12 ± 0	334 ± 0	1.1 ± 0.0	25 ± 0

Table A7-1. Dry tissue weight and metal concentration data for caddisfly larvae—*Continued*

Station	Sample	Dry weight (g)	Aluminum (µg/sample)	Cadmium (µg/sample)	Copper (µg/sample)	Iron (µg/sample)	Lead (µg/sample)	Zinc (µg/sample)
Sac R.–Tehama	SRTH1wb	0.1124	250 ± 3	0.073 ± 0.001	2.9 ± 0.0	315 ± 11	0.15 ± 0.00	18 ± 0
	SRTH2wb	0.1095	235 ± 3	0.072 ± 0.000	3.0 ± 0.0	329 ± 22	0.14 ± 0.00	17 ± 0
	SRTH3wb	0.1021	222 ± 2	0.070 ± 0.002	2.6 ± 0.0	306 ± 20	0.12 ± 0.00	17 ± 0
	SRTH4wb	0.1099	216 ± 4	0.074 ± 0.000	2.7 ± 0.0	286 ± 11	0.13 ± 0.00	18 ± 0
	SRTH1wb/s	0.1130	264 ± 7	0.46 ± 0.01	12 ± 0	305 ± 23	1.0 ± 0.0	27 ± 0
	SRTH2wb/s	0.1119	230 ± 2	0.47 ± 0.00	12 ± 0	325 ± 11	1.0 ± 0.0	27 ± 0
	SRTH3wb/s	0.1091	215 ± 2	0.47 ± 0.01	12 ± 0	284 ± 11	1.1 ± 0.0	27 ± 1
	SRTH4wb/s	0.1115	225 ± 0	0.47 ± 0.01	12 ± 0	256 ± 11	1.0 ± 0.0	27 ± 0
	SRTH1c	0.0386	0.73 ± 0.07	0.043 ± 0.001	1.4 ± 0.0	7 ± 2	0.021 ± 0.003	8.7 ± 0.0
	SRTH2c	0.0381	0.52 ± 0.13	0.039 ± 0.001	1.4 ± 0.0	6 ± 0	0.016 ± 0.002	8.7 ± 0.4
	SRTH3c	0.0376	0.63 ± 0.09	0.038 ± 0.002	1.3 ± 0.0	6 ± 1	0.018 ± 0.001	8.9 ± 0.5
	SRTH4c	0.0338	0.67 ± 0.07	0.037 ± 0.002	1.2 ± 0.0	5 ± 1	0.012 ± 0.003	8.5 ± 0.4
	SRTH1p	0.1297	338 ± 6	0.059 ± 0.002	2.7 ± 0.0	571 ± 26	0.21 ± 0.01	18 ± 0
	SRTH2p	0.1349	329 ± 7	0.064 ± 0.001	2.8 ± 0.0	540 ± 0	0.21 ± 0.01	19 ± 0
	SRTH3p	0.1207	325 ± 1	0.051 ± 0.002	2.6 ± 0.1	519 ± 0	0.19 ± 0.00	17 ± 0
	SRTH4p	0.1280	311 ± 1	0.056 ± 0.002	2.6 ± 0.0	461 ± 13	0.19 ± 0.00	18 ± 1
Cottonwood Cr.	SRCCH1wb	0.1149	162 ± 8	0.006 ± 0.001	1.6 ± 0.0	184 ± 34	0.064 ± 0.001	12 ± 1
	SRCCH2wb	0.1141	145 ± 1	0.009 ± 0.001	1.7 ± 0.0	217 ± 34	0.068 ± 0.002	13 ± 1
	SRCCH3wb	0.1102	152 ± 2	0.009 ± 0.001	1.6 ± 0.0	231 ± 11	0.068 ± 0.002	13 ± 0
	SRCCH4wb	0.1089	174 ± 3	0.004 ± 0.002	1.6 ± 0.0	218 ± 11	0.072 ± 0.002	12 ± 0
	SRCCH5wb	0.1163	137 ± 0	0.007 ± 0.003	1.7 ± 0.0	198 ± 12	0.061 ± 0.002	14 ± 0
	SRCCH1wb/s	0.1073	155 ± 0	0.41 ± 0.00	11 ± 0	193 ± 11	0.93 ± 0.03	21 ± 1
	SRCCH2wb/s	0.1136	139 ± 0	0.39 ± 0.00	10 ± 0	227 ± 23	0.99 ± 0.01	22 ± 0
	SRCCH1c	0.0395	0.39 ± 0.10	0.008 ± 0.001	0.83 ± 0.02	8 ± 1	0.007 ± 0.001	7.5 ± 0.2
	SRCCH2c	0.0406	0.30 ± 0.06	0.009 ± 0.001	0.82 ± 0.02	9 ± 0	0.004 ± 0.002	6.8 ± 0.3
	SRCCH3c	0.0403	0.38 ± 0.09	0.007 ± 0.001	0.78 ± 0.02	8 ± 0	0.007 ± 0.001	6.7 ± 0.3
	SRCCH4c	0.0380	0.33 ± 0.10	0.007 ± 0.002	0.71 ± 0.01	8 ± 1	0.005 ± 0.002	6.1 ± 0.2
	SRCCH5c	0.0391	0.42 ± 0.08	0.007 ± 0.001	0.74 ± 0.02	6 ± 0	< 0.003 ± 0.001	6.2 ± 0.1
	SRCCH1p	0.1058	165 ± 0	< 0.003 ± 0.002	1.1 ± 0.0	296 ± 0	0.083 ± 0.001	8.2 ± 0.2
	SRCCH2p	0.1073	180 ± 1	0.002 ± 0.002	1.3 ± 0.0	311 ± 0	0.081 ± 0.001	9.7 ± 0.5
	SRCCH3p	0.1058	181 ± 4	< 0.003 ± 0.001	1.2 ± 0.0	307 ± 0	0.083 ± 0.003	8.5 ± 0.0
	SRCCH4p	0.1059	197 ± 1	< 0.003 ± 0.001	1.3 ± 0.1	275 ± 42	0.082 ± 0.001	9.4 ± 0.0
	SRCCH5p	0.1105	168 ± 7	< 0.003 ± 0.001	1.3 ± 0.1	298 ± 0	0.078 ± 0.001	10 ± 1

Table A7-2. Dry tissue weight and metal concentration data for standard reference materials processed concurrently with caddisfly samples

[NIST, National Institute of Standards and Technology; SRM, Standard Reference Material. Results given are the dry weight of tissue and raw concentrations of the tissue digest. Conversion to metal concentrations in the original tissue requires application of conversion factors (not given) that account for dilutions during sample preparation. Certified concentration values reported by the NIST for SRM 1566a–Oyster tissue and SRM 50–Albacore tuna are presented in Table 22. g, gram; µg, microgram]

Standard	Dry weight (g)	Aluminum (µg/sample)	Cadmium (µg/sample)	Copper (µg/sample)	Iron (µg/sample)	Lead (µg/sample)	Zinc (µg/sample)
NIST SRM 1566A-1	0.3941	53 ± 1	1.7 ± 0.0	25 ± 0	205 ± 4	0.18 ± 0.01	335 ± 0
NIST SRM 1566A-2	0.4010	50 ± 2	1.7 ± 0.0	24 ± 0	205 ± 20	0.13 ± 0.01	321 ± 20
NIST SRM 1566A-3	0.4133	59 ± 0	1.8 ± 0.0	27 ± 0	227 ± 4	0.14 ± 0.00	335 ± 4
NIST SRM 1566A-4	0.4342	61 ± 1	1.9 ± 0.0	25 ± 0	221 ± 13	0.16 ± 0.00	365 ± 17
NIST SRM 1566A-5	0.4125	57 ± 1	1.9 ± 0.0	26 ± 0	206 ± 8	0.14 ± 0.01	338 ± 4
NIST SRM 50-1	0.3540	2.7 ± 0.1	0.026 ± 0.003	1.1 ± 0.0	19 ± 1	0.21 ± 0.00	4.9 ± 0.4
NIST SRM 50-2	0.4242	3.0 ± 0.0	0.018 ± 0.001	1.3 ± 0.0	22 ± 1	0.29 ± 0.00	6.1 ± 0.1
NIST SRM 50-3	0.3798	2.7 ± 0.1	0.017 ± 0.001	1.2 ± 0.0	20 ± 0	0.21 ± 0.00	5.5 ± 0.1
NIST SRM 50-4	0.4340	2.2 ± 0.2	0.021 ± 0.001	1.2 ± 0.0	22 ± 0	0.17 ± 0.00	5.7 ± 0.3
NIST SRM 50-5	0.4430	2.0 ± 0.1	0.043 ± 0.001	1.4 ± 0.0	24 ± 1	0.17 ± 0.00	5.8 ± 0.5

Table A7-3. Metal mass balance of body fractions prepared from caddisfly samples collected from the Sacramento River and Cottonwood Creek

[Results reported as percentage recovery from cytosol and pellet relative to concentration in whole body, for example, $100 \times (M_c + M_p)/ M_{wb}$, where (M) is the metal concentration, subscript c is the cytosol fraction, subscript p is the pellet fraction, and subscript wb is the whole body; na, not analyzed; Br., Bridge; Cr., creek, R., River; Sac., Sacramento]

Station	Sample	Aluminum	Cadmium	Copper	Iron	Lead	Zinc
Sac R.–Rodeo	SRRH1	67	97	84	74	66	92
	SRRH2	88	101	95	102	111	104
	SRRH3	79	108	107	109	131	104
	SRRH4	86	99	106	95	95	88
Sac R.–Churn Cr.	SRAH1	113	106	101	93	102	128
	SRAH2	112	100	115	103	95	125
	SRHA3	101	95	104	100	103	118
	SRHA4	98	98	97	100	92	122
Sac R.–Balls Ferry	SRBFH1	99	130	114	141	147	113
	SRBFH2	99	102	101	119	105	110
	SRBFH3	91	103	97	204	111	100
	SRBFH4	102	107	107	105	114	109
	SRBFH5	100	106	107	85	116	109
	SRBFH6	98	109	105	84	94	108
Sac R.–Bend Br.	SRBH1	82	110	102	65	99	101
	SRBH2	95	102	106	105	111	107
	SRBH3	96	116	119	172	115	103
	SRBH4	82	107	102	94	121	100
Sac R.–Tehama	SRTH1	78	105	101	106	94	105
	SRTH2	80	105	100	96	97	115
	SRTH3	84	96	107	99	105	109
	SRTH4	83	93	99	94	93	104
Cottonwood Cr.	SRCCH1	73	na	101	119	104	111
	SRCCH2	89	116	103	107	91	106
	SRCCH3	85	na	102	98	97	98
	SRCCH4	81	na	102	94	88	107
	SRCCH5	88	na	98	111	na	95
Statistical results:							
Median		88	105	102	100	102	107
Average		90	105	103	106	104	107
Standard Deviation		11	8	7	28	16	9