

Ács, A., Vehovszky, Á., Győri, J., Farkas, A*. Seasonal and size related variation of subcellular biomarkers in quagga mussels (*Dreissena bugensis*) inhabiting sites affected by moderate contamination with complex mixtures of pollutants.

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Environmental Monitoring and Assessment

Table 1 Physico-chemical characteristics of sediments at the study sites.

Properties	R1	H1	H2	H3		
% < 63 μm	29	31	30	16		
TOC (%)	5	10	10	5		
PAHs ($\mu\text{g kg}^{-1}$)					LOQ	TEC
Naphthalene	1.20	3.38	5.33	1.14	1.252	
Acenaphthene	1.59	1.52	1.91	1.28	2.500	
Fluorene	0.47	3.80	2.98	1.28	0.100	
Phenanthrene	4.26	40.05	25.67	12.32	0.401	
Anthracene	0.28	2.74	2.27	1.83	0.050	
Fluoranthene	4.58	37.78	23.02	23.94	0.497	
Pyrene	4.51	40.63	35.79	25.34	0.996	
Benz[a]anthracene	0.49	9.79	8.80	8.01	0.124	
Chrysene	1.03	11.87	11.28	8.92	0.050	
Benzo[b]fluoranthene	n.d.	30.61	25.17	13.34	0.050	
Benzo[k]fluoranthene	0.93	10.66	10.02	6.56	0.020	
Benzo[a]pyrene	1.24	16.08	16.58	12.23	0.050	
Dibenz(a,h)anthracene	0.39	2.27	2.03	1.12	0.200	
Benzo(ghi)perylene	1.78	12.39	21.00	10.88	0.199	
Indenopyrene	1.30	17.34	17.57	10.67	0.125	
ΣPAH ($\mu\text{g kg}^{-1}$)	24.06	240.90	209.41	138.86		1600
Elements (mg kg^{-1})						TEC
Pb	6.75	24.89	20.68	15.95	36	
Cd	0.08	0.21	0.31	0.16	0.99	
Cr	2.50	4.75	7.00	5.25	43	
Cu	6.25	18.50	17.50	10.25	32	
Ni	6.25	3.11	6.34	6.68	23	
Zn	3.00	61.25	27.87	11.07	121	
ΣMe (mg kg^{-1})	24.83	112.71	79.71	49.36		

Note: data were imported from Acs et. al. (2015).

Table 2 Correlation coefficients (r) and levels of significance (p) for the relationships between the tissue biomarker levels of mussels and their shell length

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		Sampling site				
		R	H1	H2	H3	
MT	June	r	0,03115	-0,37601	-0,77681	-0,3029
		p	0,825	0,049	0,014	0,1037
	October	r	0,9519	0,9014	0,9785	0,9328
		p	<0,001	<0,001	<0,001	<0,001
EROD	June	r	0,2454	-0,5076	0,0347	-0,2209
		p	0,271	0,008	0,843	0,299
	October	r	0,8883	0,9565	0,9829	0,8972
		p	<0,001	<0,001	<0,001	<0,001
LPO	June	r	-0,5632	0,5471	-0,8211	-0,9229
		p	<0,021	<0,031	<0,011	<0,013
	October	r	0,6713	0,9009	0,9362	0,8825
		p	<0,001	<0,001	<0,001	<0,001
DNA	June	r	0,0559	0,7325	-0,6793	-0,6288
		p	0,6970	<0,012	<0,013	0,020
	October	r	0,8660	-0,8844	0,9036	0,8777
		p	<0,001	<0,001	<0,001	<0,001
VTG	June	r	-0,0556	-0,1087	-0,5423	-0,3829
		p	0,787	0,658	0,009	0,079
	October	r	-0,9364	-0,8823	-0,9304	-0,8771
		p	<0,001	<0,001	<0,001	<0,001

Table 3 Biomarker scores and Integrated Biomarker Response (IBR) computed for *Dreissena bugensis* inhabiting the four study sites (R = pristine area, H1-3 = harbours). Zero values in italics indicate the site of lowest response observed in each biomarker while highest values are bolded. For biomarker abbreviations, see text.

Sampling site	Shell length (mm)	June					October					IBR	
		MT	EROD	LPO	DNA	VTG	MT	EROD	LPO	DNA	VTG	June	October
R	15	0.44	1.13	0.73	0.40	0.04	0.44	0.68	0.60	0.22	1.07	0.16	0.11
	18	0.21	0.48	0.42	0.26	0.07	<i>0.00</i>	0.37	<i>0.00</i>	0.29	<i>0.00</i>	0.04	0.03
	21	<i>0.00</i>	<i>0.00</i>	0.35	0.33	0.24	0.14	<i>0.00</i>	0.45	<i>0.00</i>	0.42	0.04	0.04
H1	12	-	-	-	-	-	2.25	0.93	0.80	4.60	3.91	-	2.45
	15	0.18	0.72	<i>0.00</i>	0.22	0.05	2.49	1.67	1.20	3.15	4.02	0.05	2.26
	18	0.12	0.44	0.34	0.56	0.03	0.65	0.59	0.58	1.49	4.23	0.04	0.79
	21	-	-	-	-	-	1.25	1.11	1.35	1.49	1.26	-	0.68
H2	12	0.23	1.45	0.38	0.26	<i>0.00</i>	0.37	1.68	0.53	0.19	0.70	0.10	0.17
	15	0.47	0.50	0.64	0.29	0.04	2.11	2.29	2.15	1.68	0.29	0.08	1.38
	18	-	-	-	-	-	1.91	2.11	1.77	1.17	0.22	-	1.01
H3	12	0.24	1.86	2.26	<i>0.00</i>	0.04	0.85	2.11	0.45	0.28	0.36	0.51	0.30
	15	0.36	1.03	0.93	0.43	0.07	1.61	1.05	0.75	1.04	1.57	0.18	0.49
	18	-	-	-	-	-	0.94	0.64	1.18	1.35	0.25	-	0.33