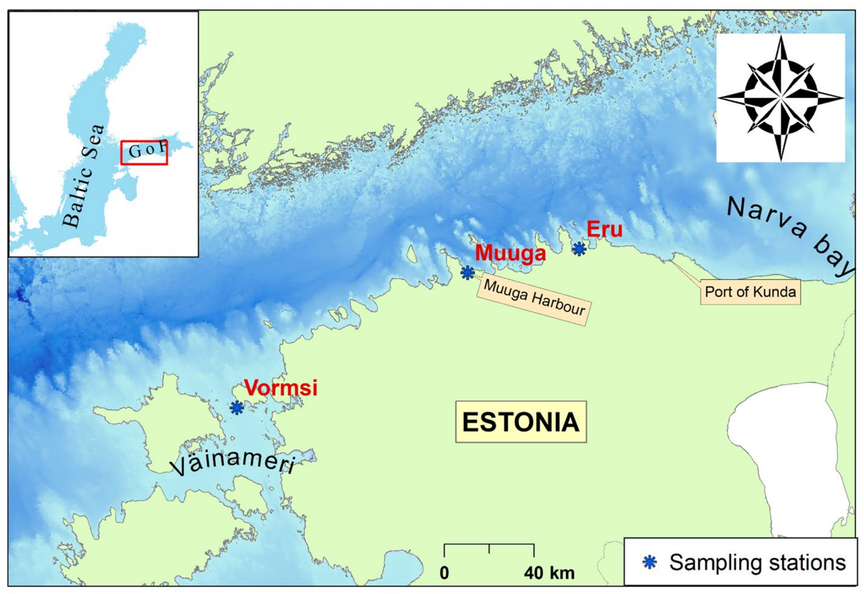
Implementation of microplastic, chemical and biochemical analyses and caging approach to monitor the level of pollution across the southern coast of the Gulf of Finland

Ivan Kuprijanov,[1] *Natalja Buhhalko*[1], *Natalja Kolesova*[1], *Kai Künnis-Beres*[1], *Maarja Lipp*[1], *Fred Buschmann*[1]
[1]*Tallinn University of Technology, Department of Marine Systems, ivan.kuprijanov@taltech.ee*



Study area and sampling stations.

BACKGROUND

Anthropogenic pressure in the Gulf of Finland is manifested through the consequences of severe eutrophication and pollution from both point and diffuse sources. The monitoring activities within different matrices should consider specific heterogeneous conditions of this basin like distribution of the certain substrate and sufficient quantity of biota for the sampling which bring the share of uncertainty into environmental surveys. The biological effect of hazardous substances on biota is tested to distinguish relationships between the bad/good status of the environment and the health of its living organisms. Mussels, being sessile suspension feeders, effectively accumulate substances from the water column and indicate the presence of xenobiotics.

a) Assembling of the cage on research vessel Salme
b) Cage underwater at Eru bay

METHODS

We sampled mussels (*Mytilus trossulus*) from locations with different environmental conditions (Väinameri Archipelago Sea as a reference and Muuga harbour as polluted areas) and implemented caging approach in location where mussels are absent (Eru bay). To detect chemical pollution we have used an array of analytical methods: chemical analyses in tissues (including heavy metals, organotins, PAHs, PCBs, PBDEs), analyses of biomarkers (acetylcholinesterase inhibition - AChE, antioxidant enzymes - CAT, GST, GR) and microplastic extraction/characterization (including µ-FTIR).

Concentrations of metals (I-MET), PAHs (O-PAH), non-dl PCBs and organotins (O-MET) in sediments

		Muuga Bay	Vormsi bay	Eru Bay	
GROUP	Parameter	Value			Unit
I-MET	AS	9,3	2,3	2,8	mg/kg
I-MET	PB	10	6,5	6,3	mg/kg
I-MET	CD	0,17	0,11	0,16	mg/kg
I-MET	CU	37	17	14	mg/kg
I-MET	NI	15	10	12	mg/kg
I-MET	HG	<0,1	0,012	<0,1	mg/kg
I-MET	ZN	128	36	38	mg/kg
O-PAH	SPAH (EPA)	0,526	0,0162	0,0612	mg/kg
O-PAH	NAP	0,017		0,012	mg/kg
O-PAH	ACNLE	<0,01		<0,01	mg/kg
O-PAH	ACNE	<0,01		<0,01	mg/kg
O-PAH	FLE	<0,01		<0,01	mg/kg
O-PAH	PA	0,07	<0,01	<0,01	mg/kg
O-PAH	ANT	0,022	<0,01	0,0032	mg/kg
O-PAH	FLU	0,094	<0,01	0,015	mg/kg
O-PAH	PYR	0,07	0,01	0,01	mg/kg
O-PAH	BAA	0,036	<0,01	<0,01	mg/kg
O-PAH	CHR	0,034	<0,01	<0,01	mg/kg
O-PAH	BBF	0,037		0,011	mg/kg
O-PAH	BKF	0,022		<0,01	mg/kg
O-PAH	BAP	0,035	<0,01	<0,01	mg/kg
O-PAH	ICDP	0,035	<0,01	0,01	mg/kg
O-PAH	DBAHA	0,011		<0,01	mg/kg
O-PAH	BGHIP	0,033		<0,01	mg/kg
OC-CB	SCB	0,00289	0,00012	n.n.	mg/kg
OC-CB	CB28	<0,0001	<0,0001	<0,0001	mg/kg
OC-CB	CB52	0,00015	0,00012	<0,0001	mg/kg
OC-CB	CB101	0,00047	<0,0001	<0,0001	mg/kg
OC-CB	CB118	0,00076	<0,0001	<0,0001	mg/kg
OC-CB	CB153	0,00059	<0,0001	<0,0001	mg/kg
OC-CB	CB138	0,00077	<0,0001	<0,0001	mg/kg
OC-CB	CB180	0,00015	<0,0001	<0,0001	mg/kg
O-MET	MBSN+	3,1	<1	<1	µg/kg
O-MET	DBSN+	2,3	<1	<1	µg/kg
O-MET	MPSN+	<1		<1	µg/kg
O-MET	TBT	5,0	<1	<1	µg/kg
O-MET	MOSN+	<1	<1	<1	µg/kg
O-MET	Tetrabutyltin+	<1	<1	<1	µg/kg
O-MET	DPSN+	<1		<1	µg/kg
O-MET	DOSN+	<1	<1	<1	µg/kg
O-MET	TPSN+	<1	<1	<1	µg/kg
O-MET	TCTIN+	<1	<1,7	<1	µg/kg
	TOC	0,9	0,9	1,8	% DW

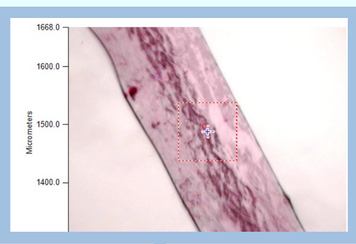
PRELIMINARY RESULTS ON CHEMICALS AND BIOMARKER RESPONSES

The sediments in the port area (Muuga harbour) are characterized by pollution with organotins, mainly toxic compound of antifouling paints TBT (banned from 2008 by IMO, GES threshold - 1,6 µg /kg dw sediment (5% TOC)) and selected non-dl PCBs.

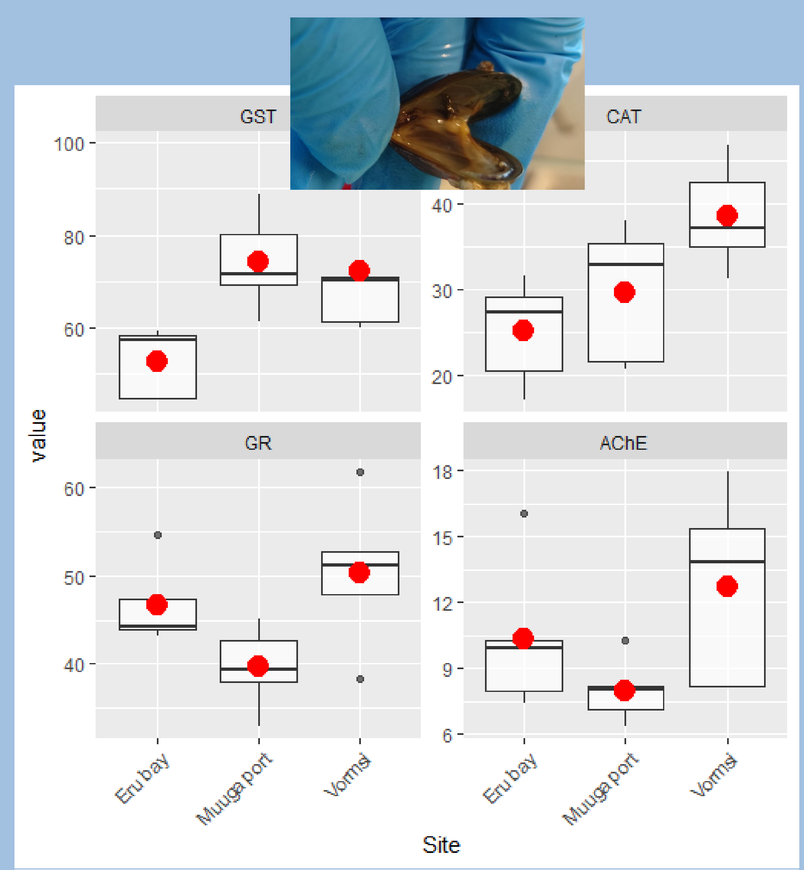
Either TBT level in the tissue of mussels collected from the Muuga harbour, exceeded the HELCOM GES threshold (12 µg/kg dw) more than 5 times.

Statistically significant difference of mean oxidative stress biomarker responses were registered for GST between Muuga/Eru bay and Vormsi/Eru bay; for CAT between Vormsi/Eru bay; for GR between Vormsi/Muuga.

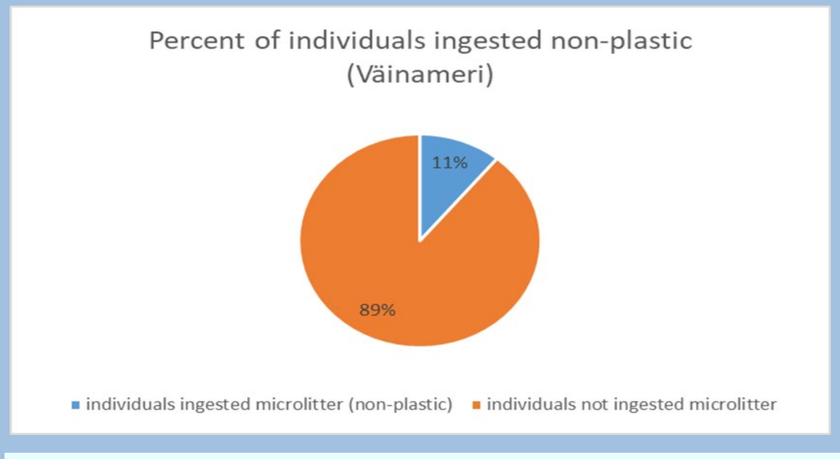
The lowest mean Acetylcholinesterase activity (AChE) was detected at Muuga port which might reflect the effect of neurotoxic agents in the water environment.

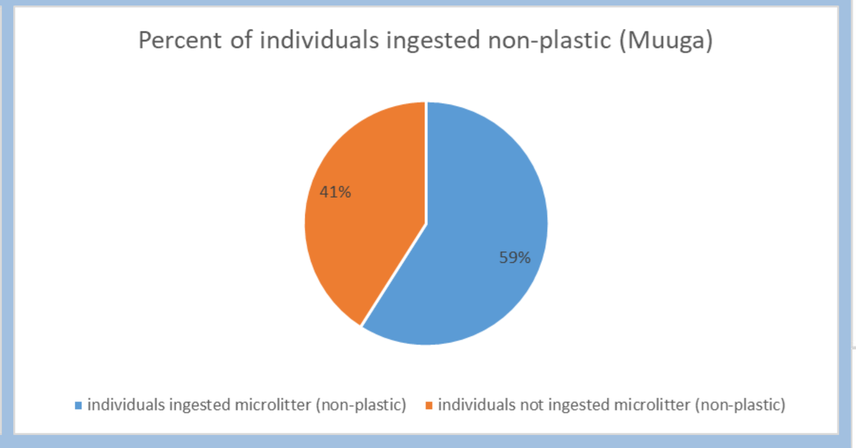


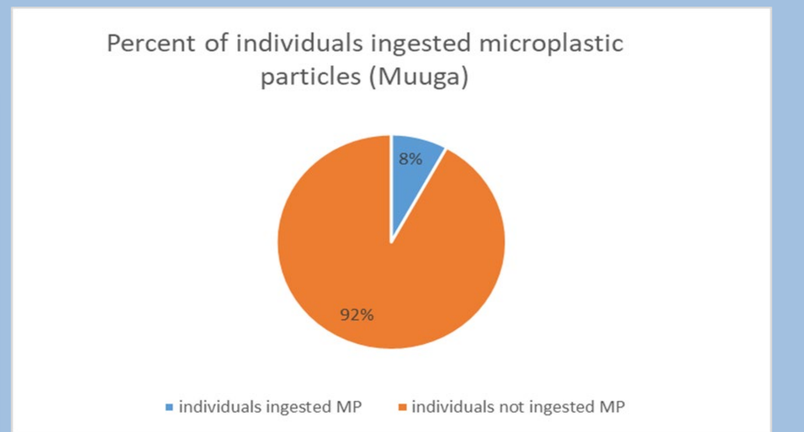
PP (polypropylene) under µ-FTIR

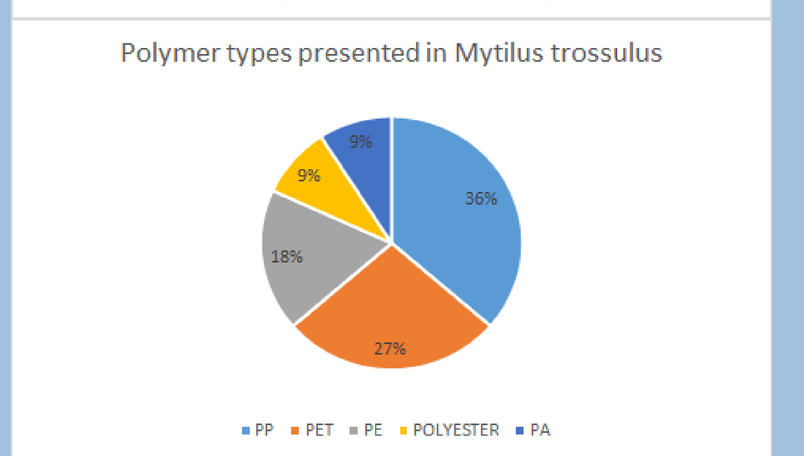


Biomarker responses in sampled mussels (AchE, GR, GST-nmol/min/mg protein, CAT-µmol/min/mg protein). Red dots show mean values, box-whisker plots indicate minimum, first quartile, median, third quartile and maximum.









PRELIMINARY RESULTS ON MICROPLASTIC ANALYSES

No microplastic particles were found in Vormsi (Väinameri) individuals. Non plastic (cotton fibers) were found in 11% of mussels. In Muuga harbour 8% of individuals contained microplastic particles. Types of microplastic found are PP (polypropylene), PET (polyethylene terephthalate), PE (polyethylene), PA (polyamide), polyester. The most abundant polymer was PP. It contributed 36% of all polymer types found in studied mussels.

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