Using a translocation experiment with feral brown trout to investigate anthropogenic impacts on fish

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Introduction

- Waterbodies are impacted by **contaminants in complex mixtures**
- **Ecologically relevant effects** are difficult to assess
- Impact-oriented *in situ* studies using realistic exposure scenarios are scarce

Aims

- Investigating impacts of multiple chemical stressors on feral fish by
  - comparing **biomarker response patterns** of translocated and locally adapted populations
  - identify biomarkers responsive to **long-term** & **short-term** exposure
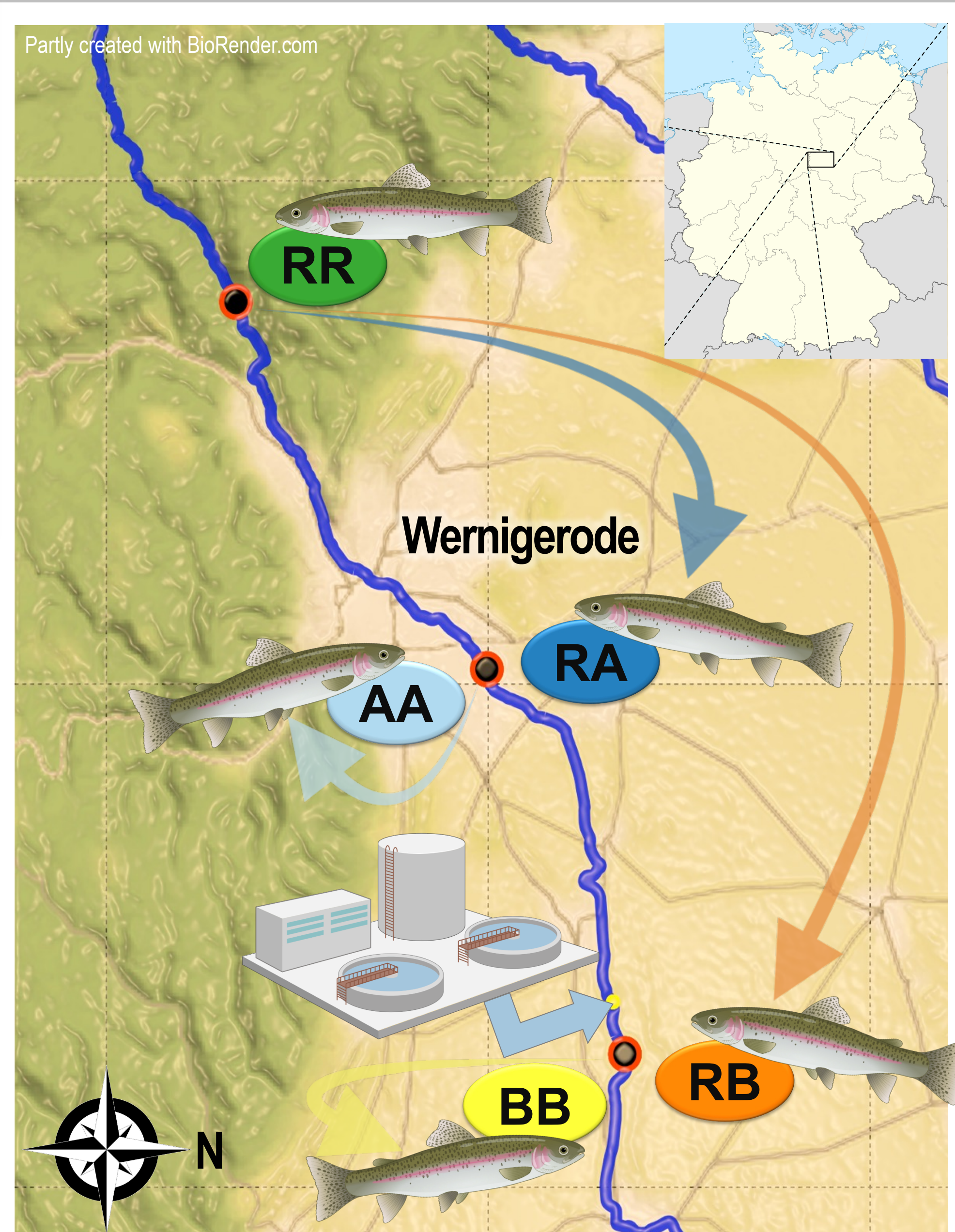 - applying the **translocation design** as diagnostic tool

Fig 1. Schematic figure of the experimental design.

Experimental design & methods

- Brown trout (*Salmo trutta*) were caught at **three sites** and exposed (21 days) in **five groups**:
  - **RR**, **AA** & **BB**: caught and caged at **reference** site, **urban** site & **downstream of WWTP**, respectively
  - **RA** & **RB**: caught at reference site, **relocated** to **urban** site & downstream of **WWTP**, respectively
- Determination of haemoglobin (**Hb**), activity of **complement** system, acetylcholinesterase (**AChE**), liver somatic index (**LSI**), ethoxy-resorufin-O-deethylase (**EROD**), glutathione-S-transferases (**GST**), glutathione reductase (**GR**), catalase (**CAT**), reduced (**GSH**) and oxidised glutathione (**GSSG**)
- Water sampling (large-volume solid phase extraction) & HR LC-MS/MS (457 compounds)

Results

	RR	AA	BB	RA	RB
Hb	-				
Complement	-	***			
AChE	-	*	**	*	**
LSI	-		**		
EROD	-	***		*	**
GST	-				**
GR	-		*		
CAT	-				
GSH	-			*	*
GSSG	-	**			*
GSSG/GSH	-	*	*		

Fig 2. Biomarker response patterns for locally adapted (AA & BB) and translocated (RA & RB) groups compared to the reference group (RR). Blue and red bars indicate increased and decreased response, respectively. The degree of change is shown by the length of the bar. Asterisks denote statistically significant differences (p < 0.05) using ANOVA + Holm-Šídák (Hb, AChE, GST, GR, GSH) or Kruskal-Wallis + Dunn's post hoc test (Complement, LSI, EROD, CAT, GSSG, GSSG/GSH).
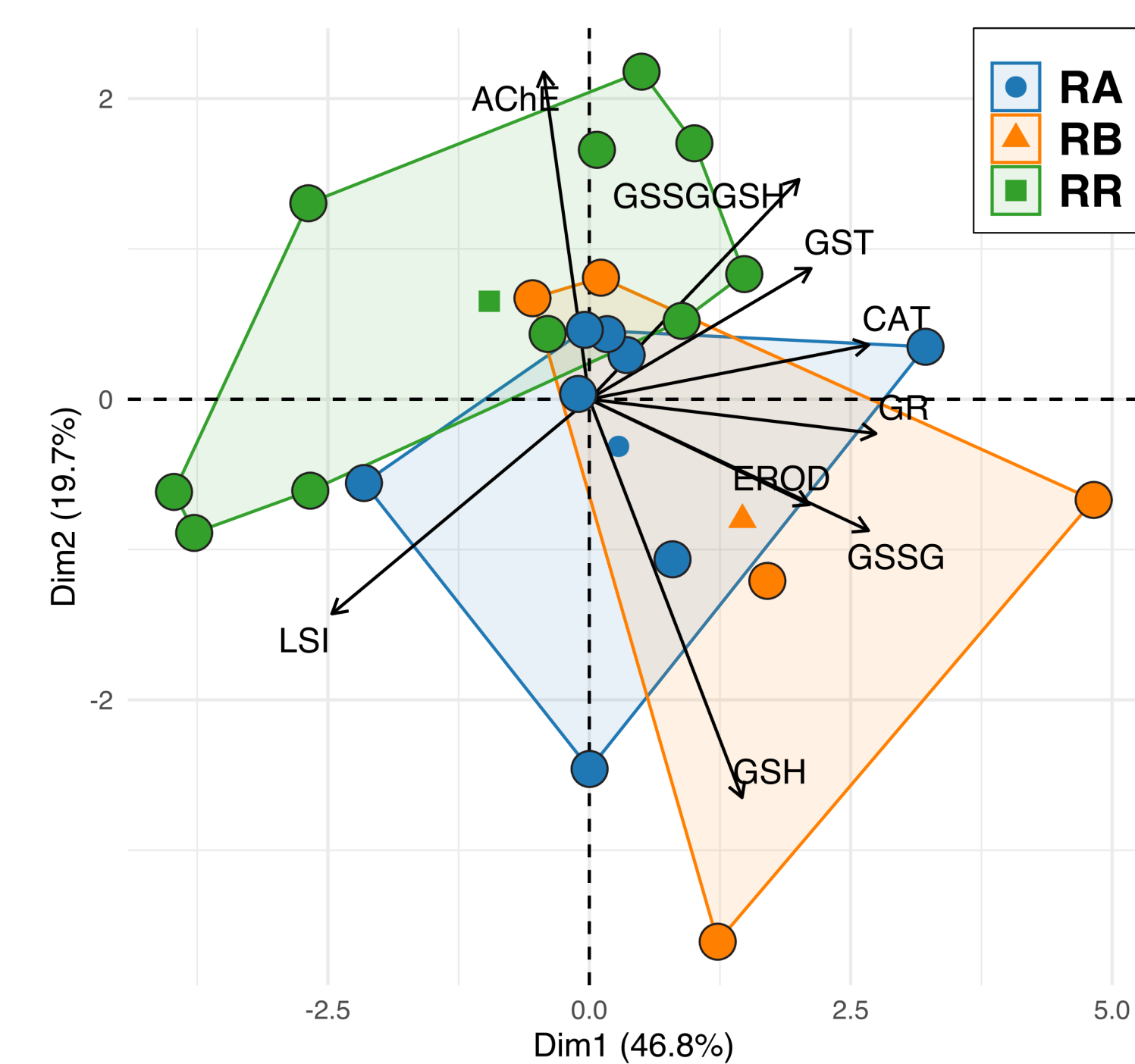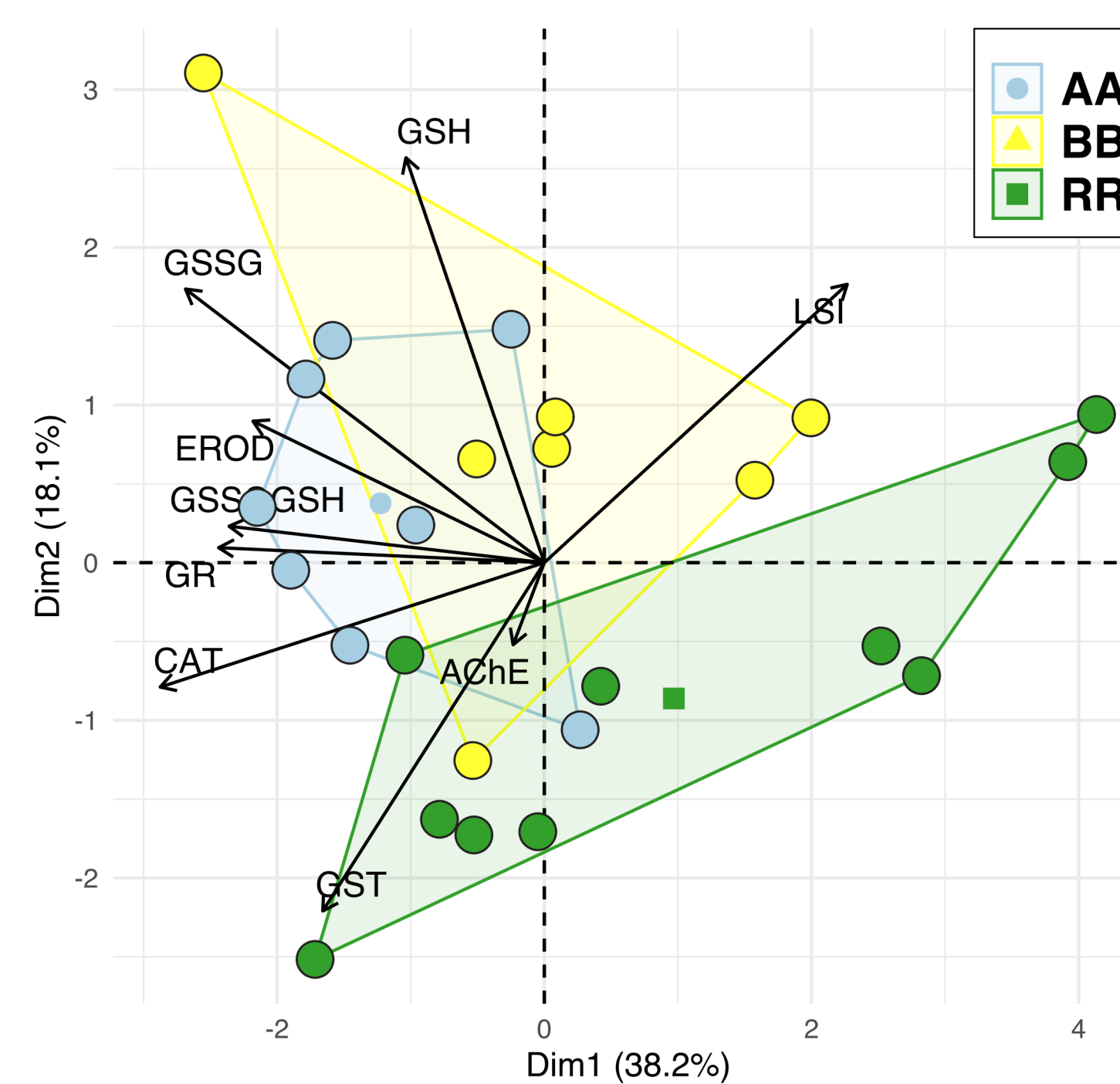

Fig 3. Principal Component Analysis of biomarker data (AChE, LSI, EROD, GST, GR, CAT, GSH, GSSG, GSSG/GSH) measured in female fish from reference & locally adapted groups (left panel) as well as from reference & translocated groups (right panel). The data set was reduced to female fish as GR, GSH and GSSG exhibited significant differences between male and female individuals.
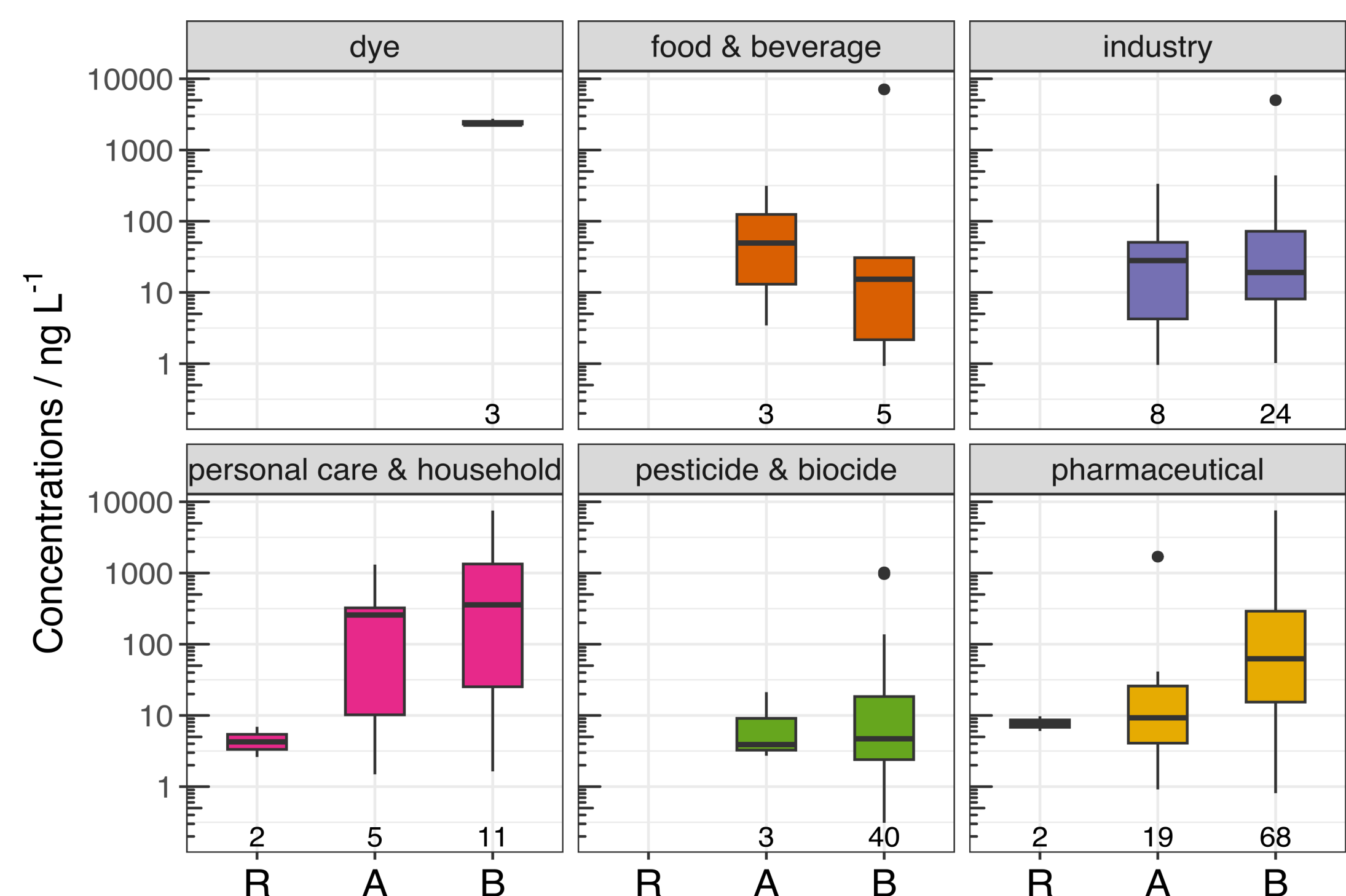

Fig 4. Measured concentrations of organic contaminants in extracts from each sampling site, grouped by compound class. Black horizontal dash shows the mean concentrations. Numbers above sampling sites indicate number of chemicals measured above method detection limit.

Conclusion & Outlook

- Biomarker **responses vary** between locally adapted and translocated populations
- **Short-term** responsive: GST & GSH
- **Long-term** responsive: LSI, GR, GSSG/GSH
- **Overall** responsive: AChE, EROD, GSSG
- Next steps
  - **RNAseq** data will be analysed
  - Molecular **sex determination**
  - Determining **internal concentrations** of contaminants in fish tissue

Take-home message

- Pollution from **urban areas** and **WWTP** impact **biomarker responses**
- Measuring **multiple biomarkers** is crucial for the understanding of exposure impacts
- **Translocation experiments** are a great tool to **study adaptational processes**

in memoriam **Otfried Wüstemann**