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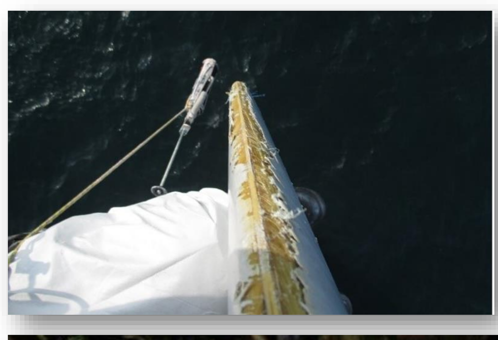
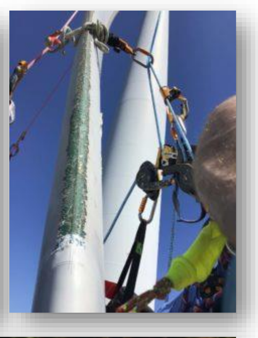
Ecological impacts of wind turbine blade erosion on blue mussels (*Mytilus edulis*)





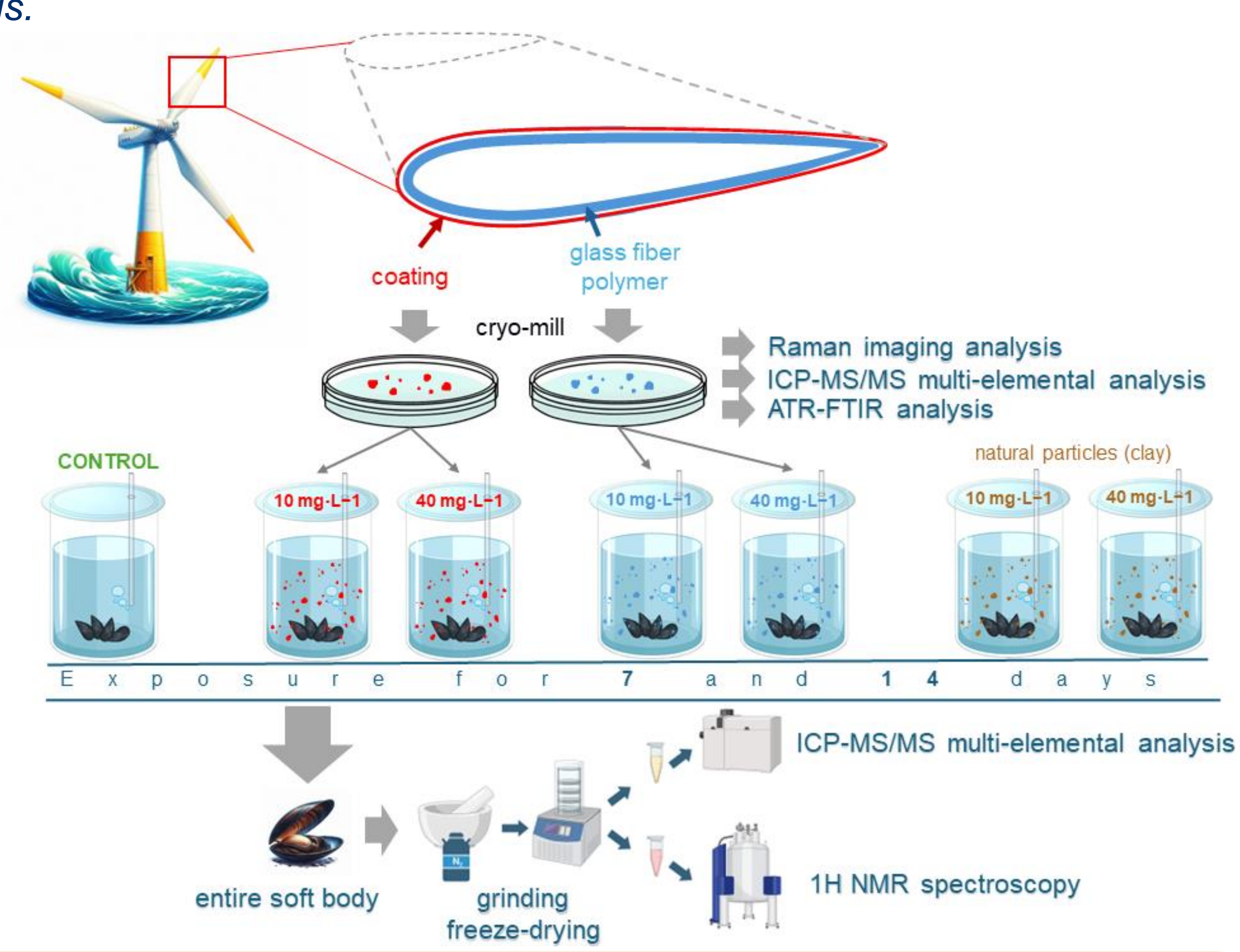
The maximum material release can be estimated as **1,395 t/y** for all German wind turbines.

Background

Offshore wind farms (OWFs) pose new anthropogenic pressures to marine ecosystems as the erosion of turbine blades releases micro plastic (MP) that might affect marine filter-feeders like bivalves (Wang et al. 2023).
Using a worst-case scenario of massive abrasion, we investigated possible effects of MP particles and associated chemical additives from turbine blades on the blue mussel, *Mytilus edulis.*

Methods

M. edulis was exposed for 7 and 14 days to seawater without (controls) or with different concentrations (10 & 40 mg/L) of clay (natural controls, size <20 µm) and cryo-milled MP from turbine blades divided into coating & core material (glass fiber polymer, GFP). Alterations in the metabolic profiles of the mussels` entire soft body were evaluated via 1H NMR spectroscopy. Multielement analysis was performed using an ICP-MS/MS instrument. To assess metal contamination in exposed mussels, the enrichment factor (EF) was calculated with data of control mussels exposed to clean seawater. Using Raman Imaging, MP numbers and size distribution were determined.



Results

MP quantity and size distribution was similar between coating and GFP particles with ~ 1400 N/µg material.
A significant majority (~97%) of both materials had a particle size ≤50 µm with ~35% exhibited MP sizes <5 µm. Thus, particles were in the size range of mussels` natural food (Beecham 2008).

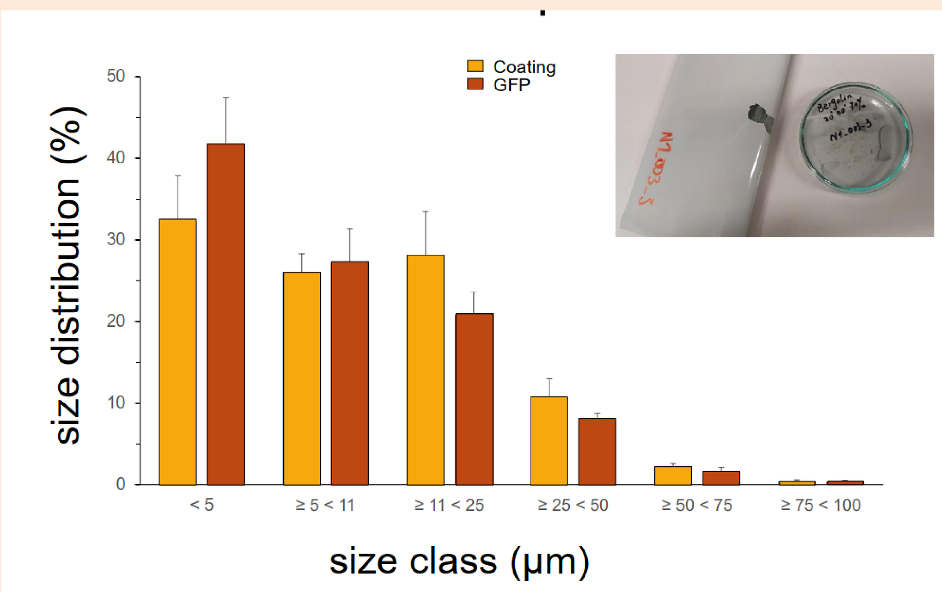
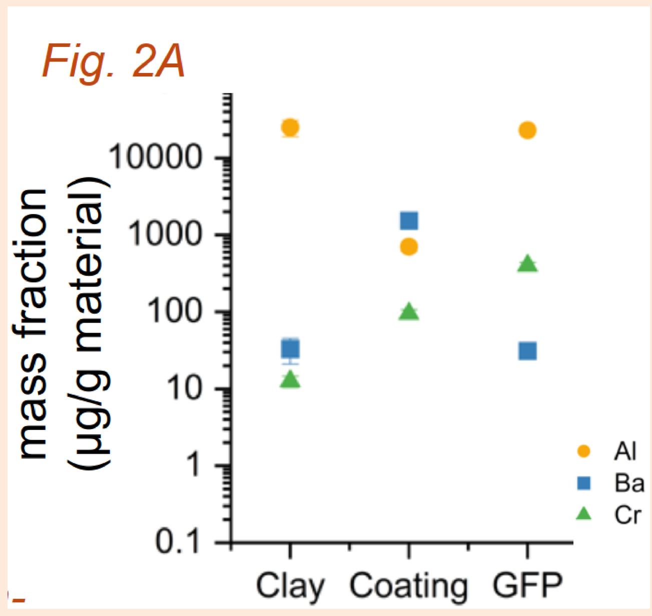


Fig. 1 Size distribution of MP obtained from windmill coating and glass fiber polymer (GFP) material. (Data are means ± SD of 3-4 technical replicates.)

Multi-elemental analyses revealed high mass fractions of Aluminum, Barium and Chromium in raw material of both natural & synthetic particles (Fig. 2A). In line, exposed mussels showed elevated EFs with increasing material concentration, most prominent for Ba in coating- and Cr in GFP-exposed mussels, whereas prolonged exposure time seems to decrease EFs (2B).



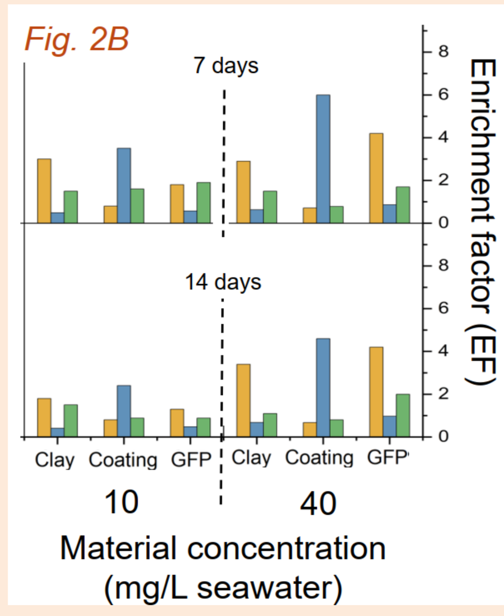
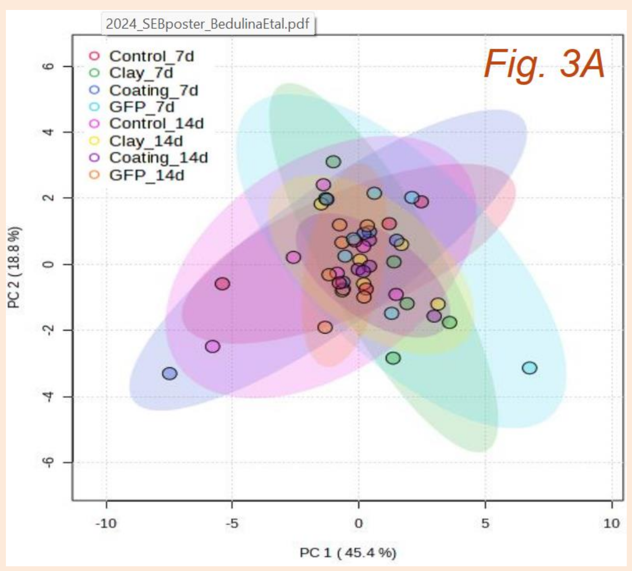


Fig 2
A) Material dependent mass fractions of specific metals
B) corresponding enrichment factors in mussels to different concentrations for 7 and 14 days (Data are means ± SD of technical triplicates. EFs are the average of 3 mussels).

Metabolic profiles of *M. edulis* revealed no significant changes irrespective of exposure time, material or concentration. The scores plot of the PC Analysis showed no clear separation between profiles obtained from differently treated mussels (Fig. 3A).

However, variation and average intensity of many metabolites increased. Specifically, in mussels exposed to clay & GFP for 7 days, levels of sn-glycero-3-phosphocholine, 4Fig -aminobutyrate and alanine increased (Fig. 3B)



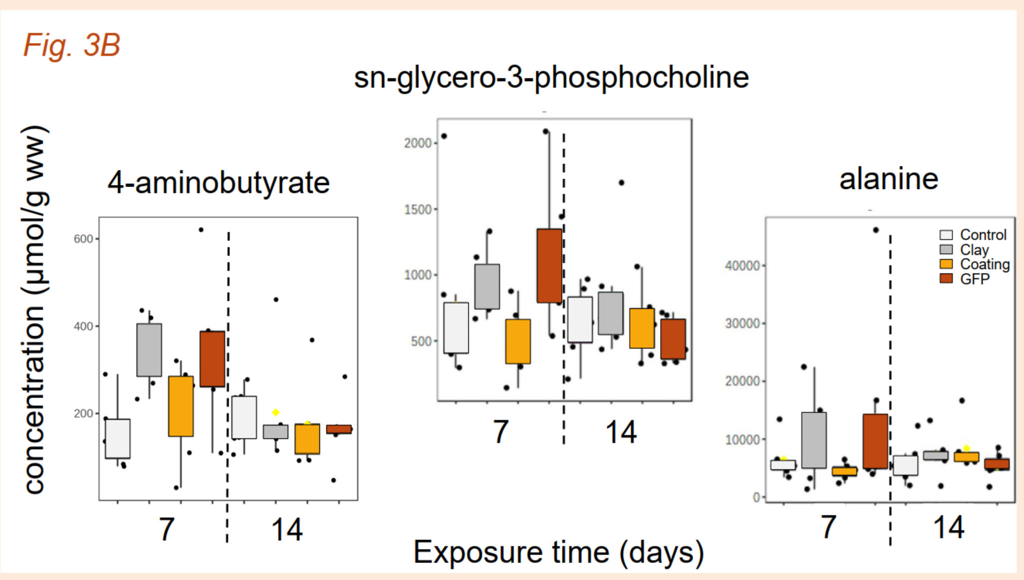


Fig. 3 Metabolic profiles of the entire soft body tissue of M. edulis exposed for 7 and 14 days to the high load (40 mg/L) of different materials. A) Principal Components Analysis and B) specific metabolite levels (N=6).

Discussion

Despite worst-case scenario of wind blade erosion & obvious metal uptake by the mussels, metabolic profiles showed only little to no effect. Observed metabolic changes suggest possible short-term effect on neuroendocrine system and amino acid metabolism.
Mussels‘ ability of particle sorting & egestion may have limited possible long-term effects. However, potential tissue-specific effects may have been masked by analyzing the entire soft body. Follow-up studies will evaluate this aspect in more detail.

While present results are promising, our study is far from providing a comprehensive understanding of the MP risks to the marine environment associated with OWF erosion.

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References

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