Climate change and human waste in freshwater environments: How *Daphnia magna* responds to high environmental ammonia, high temperature and the combination

Introduction

- Human waste enters waterways from many sources (agricultural fields, factories, etc.) contributing to eutrophication events[1] (Figure 1, 2)
- Current wastewater treatment methods (chlorination, etc.) are affiliated with drawbacks including the production of toxic biproducts (chloroform, etc.)[5]
- Filter feeders are found on the bottom of the food chain and can clarify a water column by filtering particulates making them potential candidates for use in water remediation systems[3, 7]
- *Daphnia magna* (Straus 1820), a freshwater crustacean found throughout the world, is highly sensitive to chemical compounds introduced into the environment[2] (Figure 3)
- If these realistic extreme conditions negatively affect *Daphnia* survival, a consequence could be the decoupling of the entire food web[7]

Figure 1. Human contributing factors to the pollution of water.

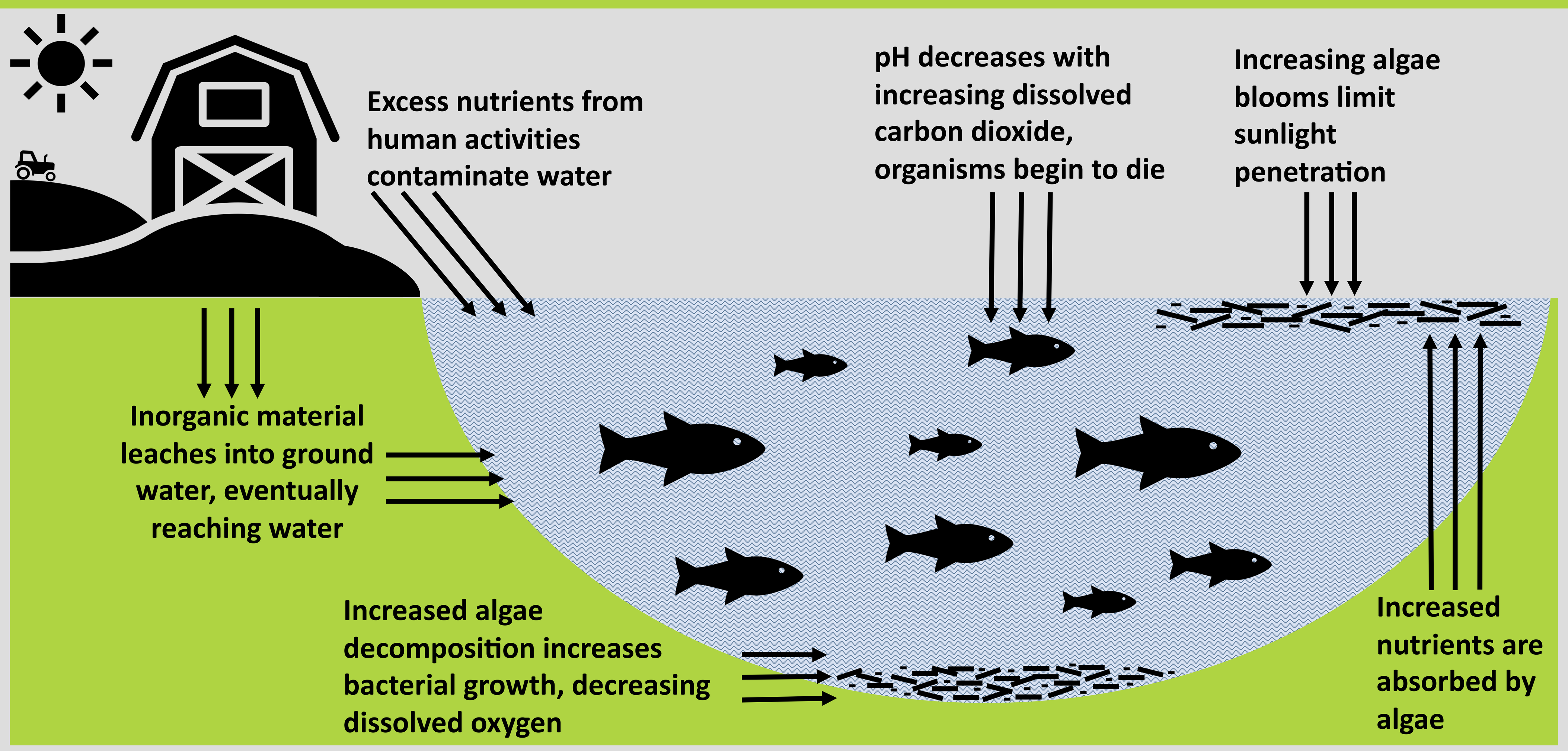


Figure 2. Process of eutrophication in a body of water.

Objectives

- Determine whether *Daphnia* will modify their ammonia excretion rates and/or branchial messenger RNA expression levels following the exposure to high environmental ammonia, high temperature or the combination
- Use this data to later compare laboratory to wild *Daphnia* to see whether their results differ due to sustained differences in the pressures of natural selection

Experimental design

- High environmental ammonia (300 µmol L^{-1}) simulates the environmental impacts resulting from human wastewater runoff
- The increase in temperature (28°C) replicates environmental conditions seen due to climate change
- The combination of both high ammonia and temperature reflects nature's multi-stressor state

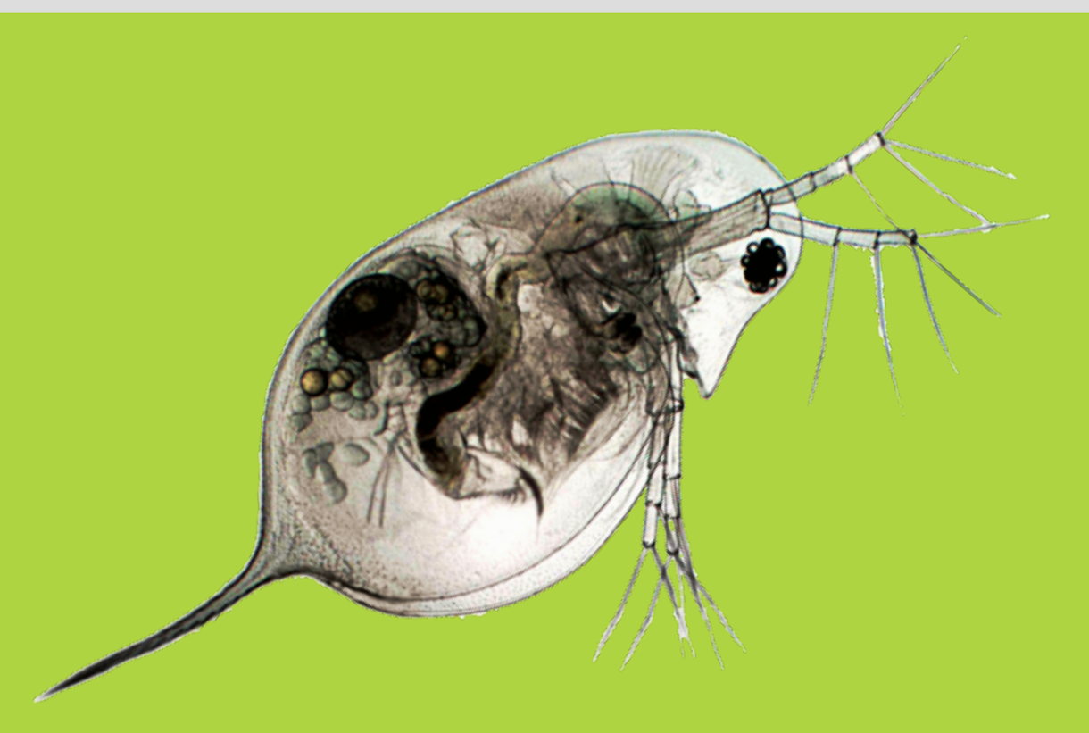


Figure 3. *Daphnia* sp., a planktonic arthropod commonly known as the water flea.

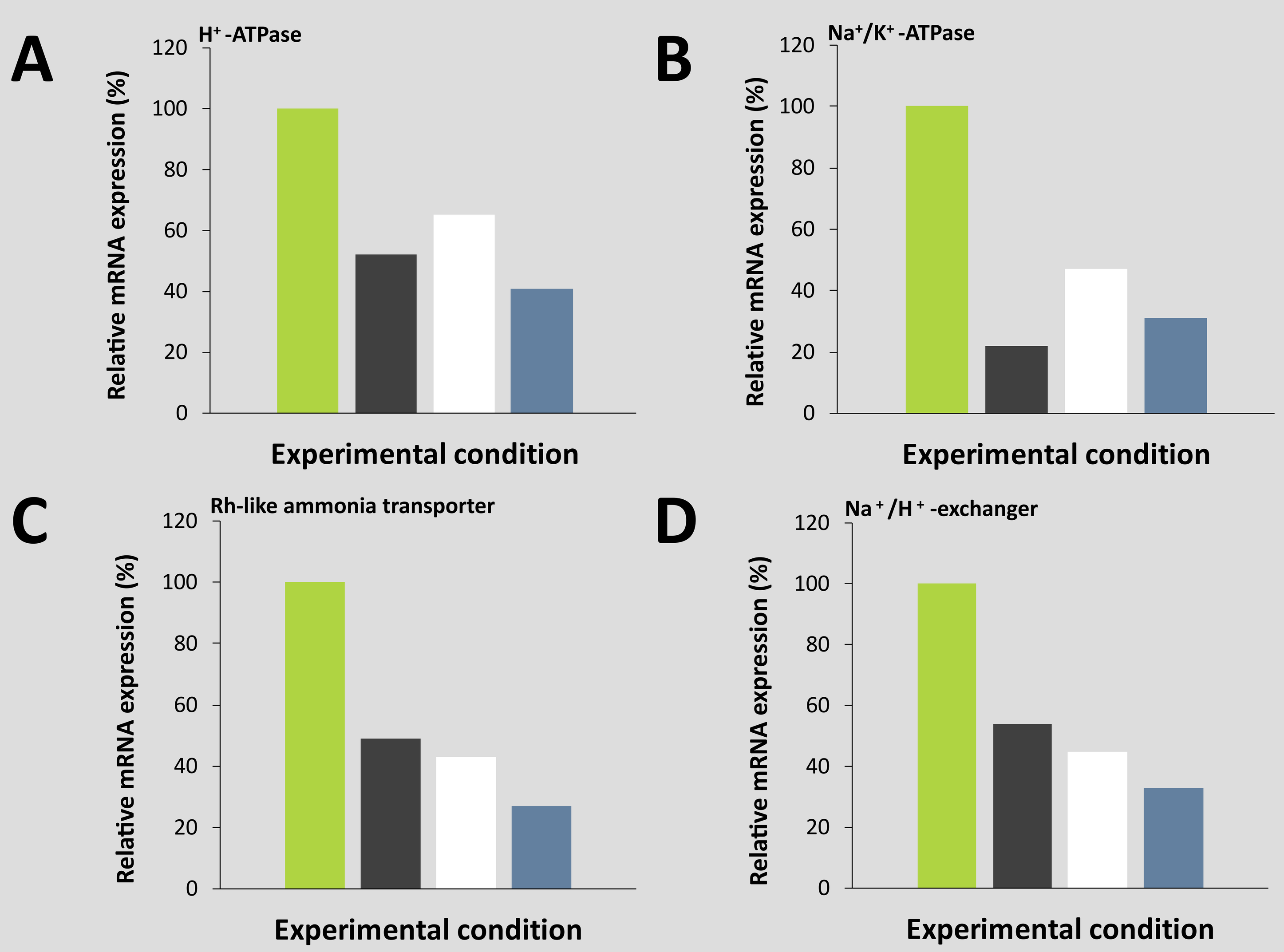
Methods

- Ammonia excretion rates determined using the salicylate-hypochlorite assay
- RNA isolation using the Qiagen RNeasy Mini Kit
- Branchial messenger RNA (mRNA) expression levels determined by a quantitative gene expression analysis (qPCR)

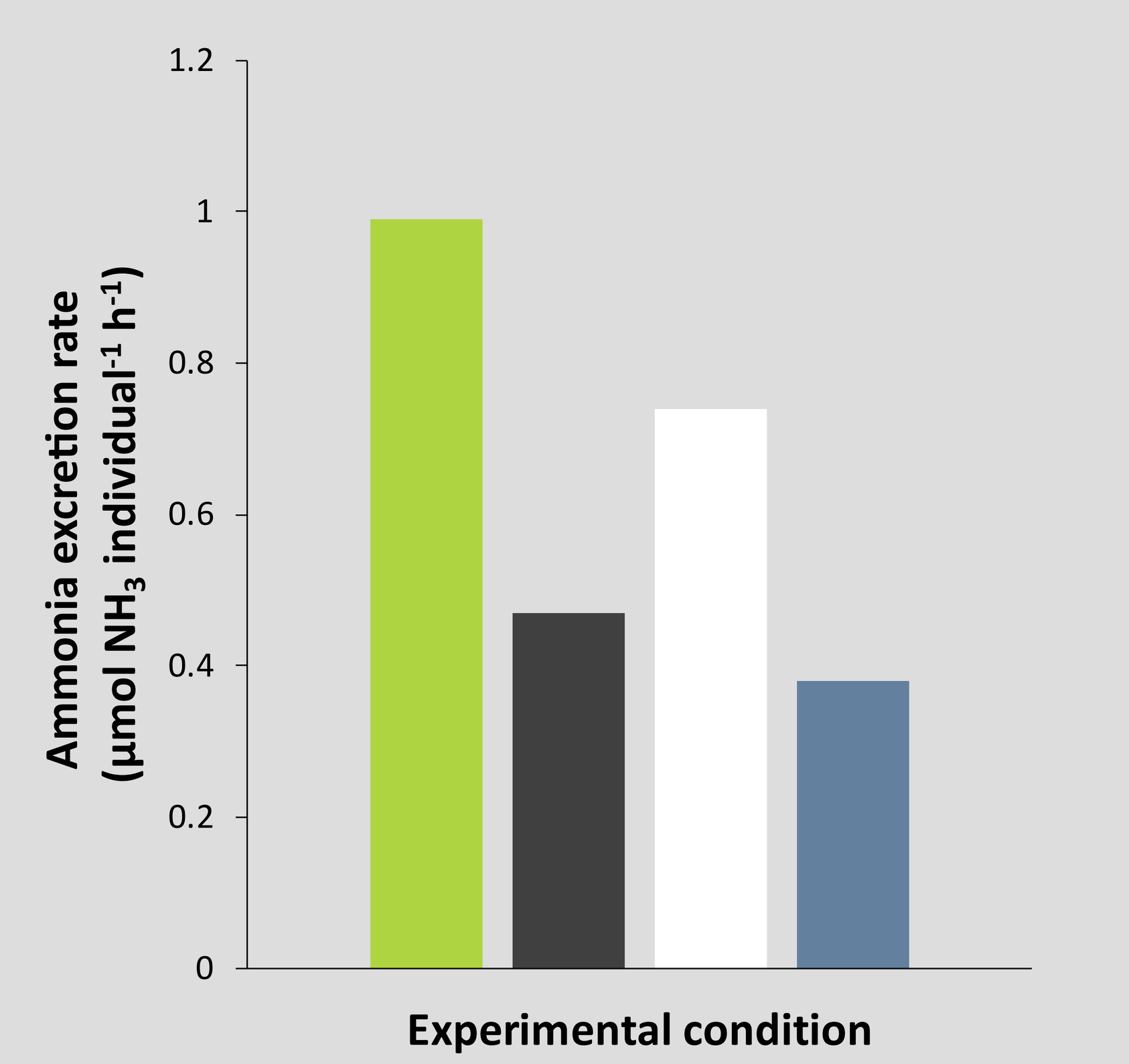
Summary

- *Daphnia* are very sensitive to the exposure of these three realistic environmental conditions and could have a potential role in bioindication
- Research efforts are needed to understand the effects of human activity on the bottom of the food web to ensure it does not collapse

Predicted results

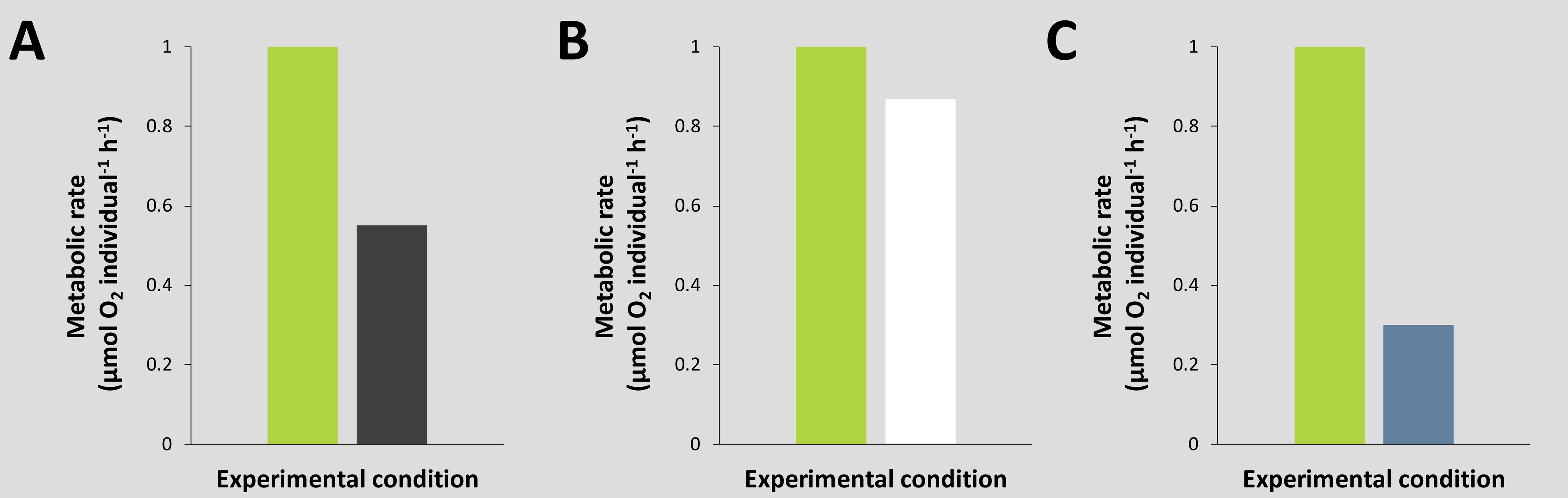


◀ **Figure 4**. Relative mRNA expression levels of H^+-ATPase (A), Na^+/K^+-ATPase (B), Rh-like ammonia transporter (C) and Na^+/H^+-exchanger (D) in the whole body (n=7) of *Daphnia magna* following the exposure to high environmental ammonia, high temperature and the combination for 7 days.[4,6]



▲ **Figure 5**. Whole body (n=7) ammonia excretion of *Daphnia magna* exposed to high environmental ammonia, high temperature and the combination for 7 days.[4,6]

Control | High environmental ammonia (150 µmol L^{-1}) | High temperature (28ºC) | Combination



▲ **Figure 6**. Metabolic rate (n=7) of *Daphnia magna* exposed to high environmental ammonia (A), high temperature (B) and the combination (C) for 7 days.[6]

Acknowledgment

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References

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