Tracking the bioaccumulation, the metabolization and synergy between Nanoplastics and Per- and polyfluoroalkyl substances (PFAS) in the food web

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Investigations on the effects of nanoplastics (NP) on aquatic organisms used concentrations between 2 to 7 order-of-magnitudes higher than those predicted in the open ocean. This divided the community between those sounding the alarm due to the observed toxicological effects, and those predicting that NP concentrations in the environment are far below any threshold-effect. Fit-to-purpose experimental designs have been hindered by a lack of appropriate NP models, tracking methods, and monitoring strategies for environmentally realistic concentrations.

Using ^{14}C-labelled-NP and conventional nuclear techniques, we recently modelled potential accumulation of NPs in scallops, chronically exposed (Fig 1) to 15 µg/L NP. Astonishingly, this suggests that NP might already be beyond threshold-effects in organisms and harming the marine biota.

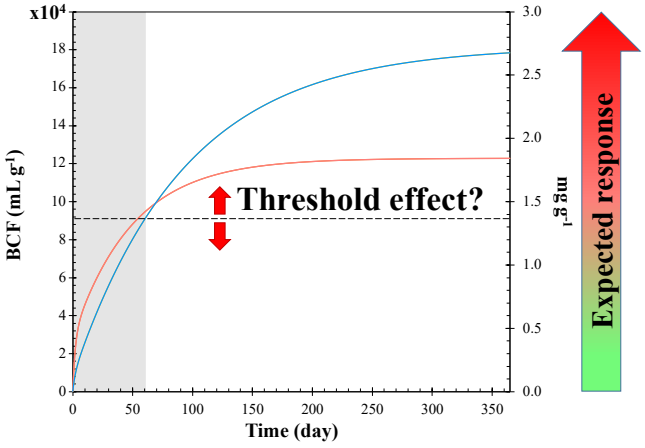

Fig 1. Long-term toxicokinetic model for accumulation over a one year of exposure to a constant seawater concentration of 15 µg/L nPS. The pink curve represents accumulation of 20 nm and the blue curve is 250 nm nPS (Al-Sid-Cheikh et al.). The grey area represents the current length of study in the literature. The dotted line is a hypothetic threshold concentration.

Perfluoroalkyl and polyfluoroalkyl substances (PFASs), a large class of persistent chemicals and known to be an additive of plastics products, are widespread through consumer products and present in various environmental bodies. A small number of PFASs have been shown to bioaccumulate and/or toxic to different taxa, with PFOS and PFOA listed under the Stockholm Convention on persistent organic pollutants. However, the transport and and toxicological mechanism still unclear and the potential vectorisation by NPs misunderstood.

The combination of NPs and PFASs could potentially lead to higher health risks in humans and animals. Therefore, the three relevant questions i-iii are relevant for the mixture of NPs/PFASs.

Despite the significance of the topic, relevant questions remain unanswered; specifically:

i) Are NPs accumulating through a chronic exposure at sub-ppb levels and reach high tissue concentrations?

ii) Can we track and quantify sub-ppb concentration of NP in tissues?

iii) Do NP accumulate in the food web over time at sub-ppb levels?

iv) Does NP and PFASs have a synergy effect on the biota?

Training opportunities:

The student will receive technical training in animal handling, environmental chemistry, organic synthesis and radiochemistry. They will access the newly Applied radioisotope and Environmental Laboratory funded by NERC. They will also be able to travel to Weymouth at Cefas for animal testing and to Zurich to measure their samples and gain experience on 14C analyses using accelerator mass spectrometry already work with other members of the Al-Sid-Cheikh research group. The student will be encouraged to take a number of professional development courses: at the University of Surrey.

Student profile:
This project would suit a candidate with a chemical or ecotoxicological sciences background, with a keen interest in applying experimental science to real-world scenarios. Strong interest in promoting and improving sustainability. Ability to drive would be an advantage.

Funding particulars:
This project is co-sponsored by Cefas and ETH.

https://research.reading.ac.uk/scenario/