4.11.T-04 Interactive Effects of Emerging Contaminants and Climate Change Stressors: Chronic Impacts of Amitriptyline and Tributyl Phosphate on the Phisiology and Behaviour of Marine Medaka (Oryzias melastigma

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The increasing presence of Contaminants of Emerging Concern (CECs) in coastal ecosystems, combined with ocean warming and acidification, poses growing risks for marine organisms, yet long-term effects data remain limited. We investigated the chronic effects of two widely detected CECs on the marine medaka Oryzias melastigma, a robust ecotoxicological model. The individual and combined effects of chemical exposure, increased temperature (29 °C), and reduced pH (7.6) were evaluated over a 4-month exposure. Fish were exposed to amitriptyline (AMI) or tributyl phosphate (TBP) through spiked food (100 ng/g), mimicking environmentally realistic trophic transfer. The evaluation of interactive impacts of climate stress and CECs was made possible through the establishment of twelve experimental conditions combining two chemical treatments, two temperatures, two pH levels, and their interactions. Growth, metabolism, reproduction, behaviour, transcriptomics, and microbiome responses were assessed across different tissues.

Preliminary findings highlight temperature as a key driver of biological responses. Males exhibited significant growth increases at warmer temperatures, whereas females showed no clear effect. Reproductive outputs revealed an increase in egg production in females under acidic conditions, particularly with AMI exposure, suggesting a synergistic interaction between the chemical and lowered pH. However, warming consistently reduced fecundity across treatments, even when pH was lowered, indicating its role as a dominant stressor. Full interpretation will rely on ongoing analyses of F1 hatching success, parental and offspring behaviour, and transcriptomics to evaluate potential multigenerational effects and the pathways disrupted by both contaminants in combination with climate-change stressors.

Overall, the experimental framework provides a powerful approach to disentangle chemical-climate interactions and their chronic impacts on fish. By integrating behavioural, physiological, transcriptomic, and microbiome endpoints, this work will advance understanding of how marine organisms respond and adapt to co-occurring environmental stressors. The results will support improved assessment of ecological risks in future ocean scenarios shaped by pollution and climate change.

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4.11.T-05 Uncoating the Problem: Leachates From Coatings Affect Estuarine Copepods Under Climate Change Scenarios

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Antifouling coatings have been used to prevent the growth of fouling organisms on submerged vessels and structures. However, coatings undergo physical and chemical degradation, leaching the toxic biocides from their coating matrix. These leachates have been found to have hazardous effects on aquatic organisms, such as copepods, cockles, and ragworms. In parallel, climate change, particularly rising seawater temperature, exacerbates existing environmental stressors and introduces further ecological challenges. Yet, the combined effects of leachates from coatings and climate change-related stressors remain largely unexplored. The goal of this study was to investigate the combined effects of leachates from coatings and increased temperatures in the harpacticoid copepod Nitokra spinipes, a species with a relevant role in estuarine food webs. Paint items were produced by applying thin layers of a commercial coating onto silicone molds. Leachates were generated by immersing the paint items in a filtered 7 PSU aquatic medium for seven days, at room temperature (21 °C), in the dark. The toxicity was then assessed by exposing N. spinipes adults and nauplii to the leachates at 22 °C and 25 °C (+3 °C; RCP 8.5 scenario, IPCC 2021). To ensure that the organisms were responsive to the toxicants, a positive control was included using copper sulphate in acute toxicity tests on both the adults and nauplii at 22 °C. Our results showed a synergistic effect in adults resulting from combined exposure to coating leachates and higher temperature, expressed by a lower median lethal dose (LC50) at 25 °C (after 72-h, $LC50_{22°C} = 48.8 \pm 2.92\%$ and $LC50_{25°C} = 14.2 \pm 10.00\%$). In contrast, the nauplii showed no significant temperature-related differences in mortality ($LC50_{22°C} = 22.3 \pm 13.08\%$, and $LC50_{25°C} = 16.9 \pm 1.57\%$), or larval development.

Therefore, the tested leachates induced significant toxicity in both life stages. Interestingly, a significant hormesis effect was observed for the larval development ratio at both temperatures, showing a positive effect from the leachates at a low dose. Our findings suggest that the predicted increase in temperature may have additional effects on the leachate's toxicity in adult copepods, and could lead to cascading effects (e.g., at the population level). These results advance our understanding of the combined effects of coating leachates and climate change on aquatic organisms.

4.11.P Navigating Marine Pollution in a Changing Climate: Emerging Contaminants, Ecosystem Impacts, and Integrated Solutions

4.11.P-We343 Warming Increases the Toxicity of Plastic Additives in the Marine Copepod Centropages typicus: Towards Climate-Aware Marine Pollution Risk Assessment

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Plastic additives are emerging contaminants in marine ecosystems, yet their combined effects with climate-related stressors remain poorly understood. Copepods, as key zooplankton components of marine food webs, are highly sensitive to environmental changes, and their vulnerability to pollution under warming conditions may have far-reaching ecological consequences.
This study investigated the individual and combined effects of five plastic additives: bisphenol A; dibutyl phthalate; 3,3?,5,5?-tetrabromobisphenol A; triphenyl phosphate; and 2-ethylhexyl diphenyl phosphate, on the marine copepod Centropages typicus under two temperature regimes representing ambient (16°C) and heatwave (22°C) conditions. The goals were: 1) to determine acute toxicity thresholds (LC50 values), 2) evaluate how elevated temperature modifies toxicity, and 3) assess effects of chemical mixtures and biomarker responses to investigate sublethal stress responses.
Adult copepods were exposed in multi-well plates to the five plastic additives. Additionally, different mixtures were tested: two mixtures containing an equitoxic concentration corresponding to the total LC50 (LC10 of each additive), 2) a sublethal LC15 mixture (LC3 of each compound), and 3) a mixture at an environmentally relevant concentration. Biomarker response was analysed in the LC15 mixture to investigate sublethal physiological effects.
Results showed that increased temperature consistently enhanced the toxicity of organophosphorus compounds and dibutyl phthalate, lowering their LC50 value and revealing that thermal stress can worsen the effects of plastic-associated chemicals. The exposure to the chemical mix caused higher mortality than predicted from single-compound exposures. This may indicate synergistic interactions, with its effects amplified under heatwave conditions. Moreover, the environmental concentrations under heatwave condition caused significantly higher mortality. Exposure to the LC15 mixture induced significant biomarker responses.
These findings show that rising ocean temperatures may exacerbate the risks posed by environmental chemical mixtures associated with plastics. By considering multiple stressors and biological endpoints, this work contributes to a better understanding of contaminant effects in a changing ocean. It also contributes to realistic, temperature-inclusive approaches for environmental risk assessment and management which are essential to safeguard marine ecosystems.

4.11.P-We344 Microplastic Contamination In Deep-Sea Invertebrates From The Central Mediterranean Sea

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Microplastics are recognised as an emerging contaminant in marine ecosystems, but information on their presence in deep-sea habitats remains limited. This study addresses this knowledge gap by examining microplastic occurrence in 35 specimens representing nine species of deep-sea invertebrate collected from the Gulf of Orosei on the east coast of Sardinia, Italy. The aim was to assess the extent of contamination and to explore whether ecological traits influence microplastic accumulation patterns.
Organisms belonging to three major invertebrate groups (i.e., Arthropoda, Echinodermata and Mollusca) were sampled at depths between 250 and 450 metres. After laboratory processing to isolate and characterise microplastic particles, the polymer types and particle shapes were identified using Fourier Transform Infrared