出國報告（出國類別：開會）

參加 2025 年環境毒理與化學學會（SETAC）歐洲第 35 屆年會

服務機關：國家環境研究院

姓名職稱：莊淑如專員

派赴國家：奧地利

出國期間：114 年 5 月 8 日至 114 年 5 月 20 日

報告日期：114 年 7 月 30 日

摘要

SETAC Europe 年會是環境毒理與化學界的重磅年度科學盛會，本次會議更致力於推動安全與永續設計（SSbD）理念，為科學家、監管者及業界提供跨界合作的平台，促進科學結果轉向政策應用，並以實際綠色措施體現環保責任。

會議具豐富之研究議題與發表篇幅，其中重點議題「替代動物試驗毒性測試方法與新方法開發（NAMs, New Approach Methodologies）」、「PFAS（全氟/多氟烷基物質）污染與風險評估」、「塑膠微粒與奈米塑膠（Microplastics & Nanoplastics）」等，均為本院現正執行之研究重點，本次參與會議五日議程，其中兩日分別進行海報發表研究計畫成果共兩則，並與相近研究議題之發表人進行研究成果交流，有利本院環境檢測技術開發，及環境治理相關研究規劃與應用策略之精進參考。

目次

壹、目的

為瞭解有關環境毒理學、化學物質危害、風險評估與環境管理等領域資訊，收集國際研究趨勢及先導技術開發等相關議題，環境毒理與化學學會（Society of Environmental Toxicology and Chemistry，簡稱 SETAC）研討會為適切之資訊來源。SETAC 成立於 1979 年，為國際性的非營利組織，致力於環境毒理學與化學的跨學科合作，推動科學研究、教育、政策溝通與領導力發展，擁有超過 10,000 位會員，來自 90 多個國家；鑒於近期環境檢測技術開發與環境治理相關研究，多數參考經濟合作暨發展組織(OECD)發布之檢測方法指引及環境治理相關管理辦法，評估歐洲年會應可收穫較多有利業務規劃或技術建立之參考資訊。

本次出國目的亦配合行政院成立 3R 政策跨部會平台之施政要點，落實動物試驗 3Rs 替代方案技術開發，並瞭解國際間新興污染物物種資訊及生物毒性危害評估，為擬定環境管理策略之參考依據；收集國際環境污染危害風險評估方式、環境毒理學與環境管理相關資訊及技術開發應用，應用毒理學新知執行環境管理相關議題，並擴展研究開發量能。於環境毒理學領域，應用動物試驗 3Rs 替代技術進行化學品及環境污染物毒理評估；化學物質暴露分析，針對新興污染物研究與環境危害評估；瞭解風險政策管理與溝通案例。

貳、過程

一、會議基本資訊

2025 年環境毒理與化學學會（Society of Environmental Toxicology and Chemistry ，簡稱 SETAC）歐洲第 35 屆年會，於 114 年 5 月 11 至 15 日於維也納的奧地利中心（The Austria Center Vienna，如圖 1）舉行。與會資訊網站為 https://www.setac.org/discover-events/global-meetings/setac-europe-35th-annual-meeting.html，網站中公布會議地點、議程、會議主題、論文投稿相關格式及截止日期、註冊資訊、旅館飯店的預定等，投稿時間為 2024 年 10 月 11 日至 11 月 20 日，並於 2025 年 1 月 31 日寄出摘要錄取通知；本屆研討會吸引了超過 2,600 名環境領域專業人士與學生參與，參與者涵蓋歐洲各國、北美、亞洲等地，可有效促進國際合作與經驗交流。

圖 1 大會會場維也納奧地利中心
The Austria Center Vienna

本次研討會場地配置圖如圖 2，共規劃 10 個演講廳、2 個海報展示區及 1 個儀器展示場地；科學會議總共 450 場次的平台報告與 1,860 篇論文海報展示，自會議開始第二天起，每日於 10 個演講廳均分配有不同主題之論文口頭報告，且 2 個海報展示區亦每日更換不同子議題之論文海報張貼，為利與會人員規劃聆聽論文報告與海報論文討論，大會亦設有線上會議平台，方便與會人員預先規劃參與之議程與閱覽各論文之摘要說明，會後亦於期限內保留口頭論文報告錄影檔與電子海報供與會人員參閱（線上會議平台網址 https://setac.confex.com/setac/europe2025/meetingapp.cgi/Home/0）。

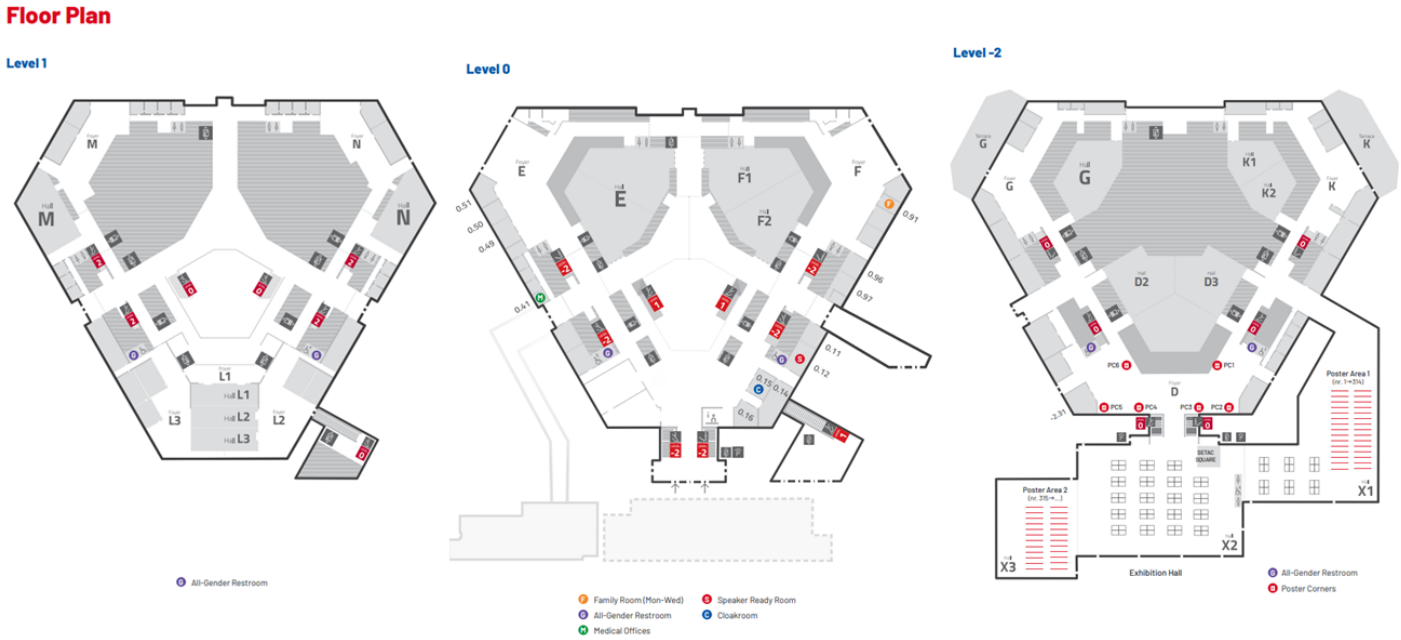

圖 2 研討會場地配置圖

二、 參與會議議程說明

第 35 屆 SETAC Europe 年會會議活動包含全體會議、科學會議及訓練課程（需額外付費），本次參與議程以科學會議為主，科學會議由 7 個平行會議組成如圖 3，包含「環境與人類毒理學：從分子到生物體，從組學到體內」、「生態毒理學成為壓力生態學：從族群到生態系與棲地格局」、「環境化學與暴露評估：分析、監測、宿命與模型建立」、「化學品、混合物與壓力源對生態與人類健康之風險評估與緩解策略」等七大主題，各主題分別包含數相關子議題，總共 450 場次的平台報告、與 1,860 篇海報展示，內容充分契合本次出國計畫之目標，透過參與此次會議汲取歐盟國家之經驗，充實本院環境毒理評估技術並與國際趨勢接軌。年會每日議程如附件 1。

圖 3 科學會議主題

三、 開幕式與大會演講

第 35 屆 SETAC Europe 年會每日議程如附件 1，本屆大會主題是「明日創新：安全與永續概念的進展」，強調將尖端創新與安全和永續性考量相結合，並推廣「安全與永續設計 (Safe and Sustainable by Design, SSbD)」的思維。第一日為大會開幕式，由英國的永續發展先驅 John Elkington 演講「Chemistries of the Future: Why Tomorrow's "Green Swans" Mean Refocusing From Negative To Positive Externalities」（如圖 4），針對未來化學，提出「綠天鵝」（Green Swans）的概念，作為對傳統「黑天鵝」事件的積極回應，黑天鵝事件為極其罕見、難以預測，一旦發生卻會產生巨大影響的事件；綠天鵝事件則與氣候變遷和環境惡化相關、極具破壞性、且可能引發系統性金融危機的事件，為已知事件但無法預測時間點，並可能帶來長期的經濟和社會衝擊。「綠天鵝」在 SETAC 會議中的意義，包含強調科學在應對環境風險中的關鍵作用、推動「安全與永續設計 (SSbD)」、預警潛在的化學污染危機、鼓勵跨領域合作；其中「預警潛在的化學污染危機」提醒我們即使是看似無害或有益的技術，如果缺乏周全的環境考量，也可能累積成巨大且難以逆轉的環境問題，像是藥物濫用、綠色轉型、奈米微粒、藥物排放至水體影響生態系等，皆為科技進步帶來的化學污染，長遠之下可能引發社會和經濟危機，需提前預防潛在的「綠天鵝」風險。

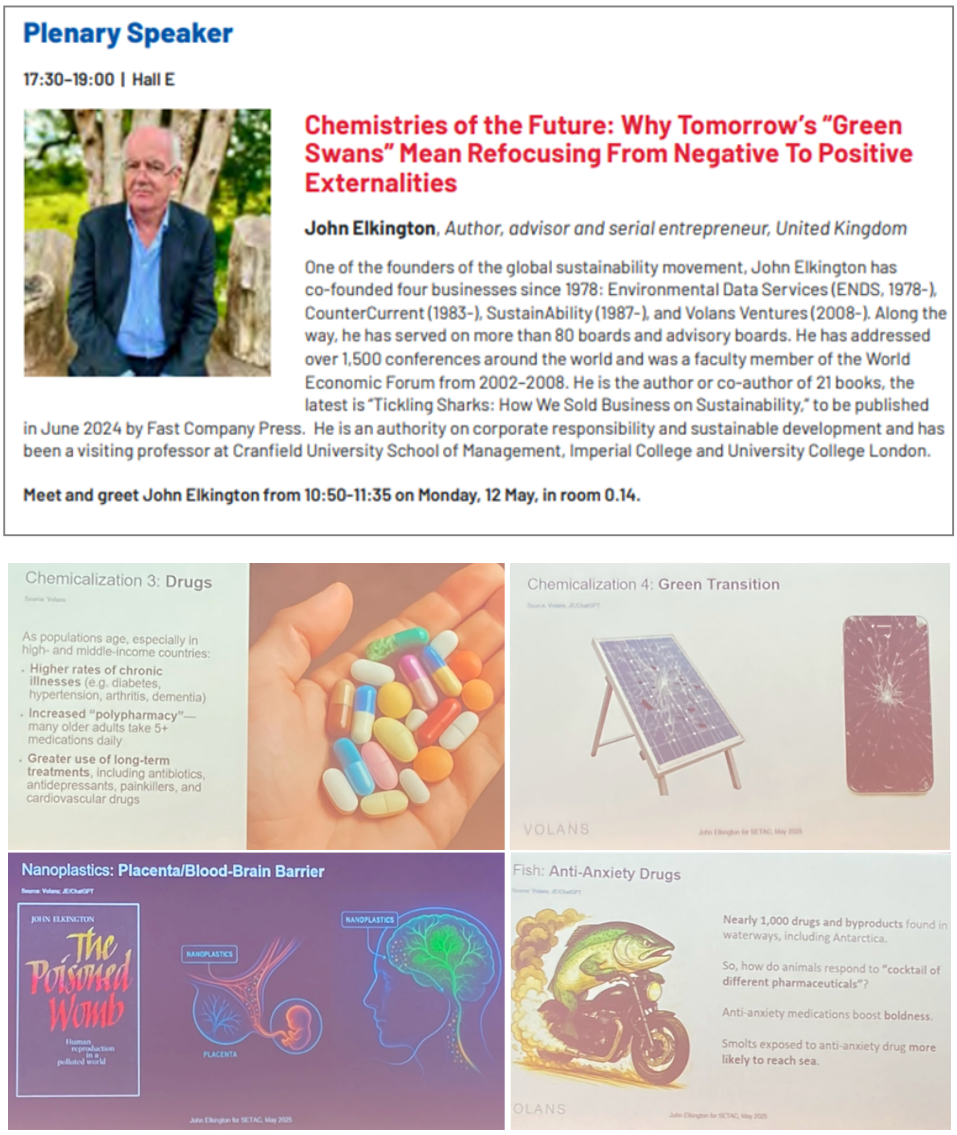

圖 4 大會演講

四、大會重點議題：「替代動物試驗毒性測試方法與新方法開發（NAMs, New Approach Methodologies）」。

受到歐盟 REACH 法規與 OECD 替代測試指南的推動，強調「無動物實驗」的毒性預測技術。本院於會議第二天進行第一則海報展示「Application of Electric Cell-Substrate Impedance Sensing (ECIS) Technology in the Ecotoxicological Evaluation of Industrial and Wastewater Effluents」（細胞基底

電阻抗感測 (ECIS) 技術應用於廢(污)水之生態毒理評估）如附件 2-1，係參考「OECD TG249 魚細胞株急毒性試驗」[1] 使用之魚鰓細胞株（RTgill-W1），搭配基於電阻抗式細胞監測（ECIS）技術的即時細胞分析系統（xCELLigence, Real-Time Cell Analysis），應用於評估工業及廢水排放物之生態毒性，海報展示期間亦與瑞士聯邦水生科學與技術研究所發表人 Jenny Maner 進行交流（如圖 5），該單位係隸屬於蘇黎世聯邦理工學院之研究機構，其展示「Real-Time Chemical Toxicity Monitoring with a Microfluidic Multi-Cell Line Fish-on-Chip Model」如附件 2-2，利用微流體晶片接種魚類三種不同器官之細胞株，包含魚鰓細胞、肝細胞及腦細胞，以模擬化學物質進入魚體之毒理試驗，初步針對部分化學品進行測試，該團隊利用細胞貼附特性經由電阻抗式細胞監測（ECIS）進行之技術開發 [2,3]，符合本院該技術研究之願景，將持續追蹤其研究成果發表並進行交流，加速本院技術開發。

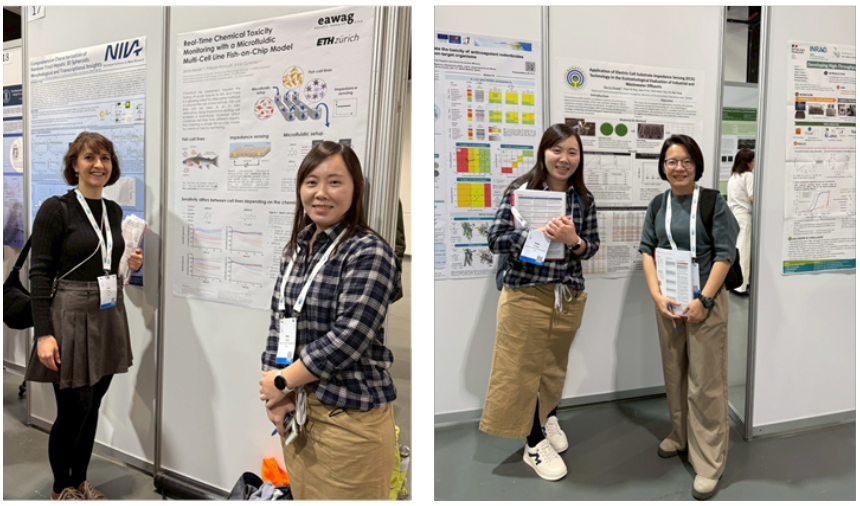

圖 5 本院於會議第二天論文海報發表及技術交流

針對「OECD TG249 魚細胞株急毒性試驗」之指引，本次會議有來自美國環保署計算毒理學與暴露中心的 Jo Nyffeler 發表演說「A High-Throughput Alternative Approach for Acute Fish Toxicity」（如圖 6），以 TG429 為起點，開發 384 孔格的高通量化替代方案，並增加兩項測試，包含基於圖像的細胞活力測定（使用 Hoechst 和碘化丙啶）與高通量表型分析（採用 Cell painting assay/細胞繪畫技術 [4]）來檢測細胞亞毒性作用。測試了 225 種化學物質，有 151 種（67%）在高通量表型分析中表現出活性。相較於 TG429，384 孔格的高通量化，在細胞存活率分析上較不靈敏，而結合 Cell painting assay 與電腦預測的方式可以取得相當於 TG429 的結果，且該方法能夠對化學品進行高通量測試對化學品進行優先排序。

圖 6 Jo Nyffeler 研究成果演說

本院於會議第五天進行第二則海報展示「Applying in vitro high-throughput and high-content screening assays for toxicity analysis of environmental water samples: emphasis on liver and endocrine disrupting effects」（利用體外高通量及高涵量測試方法進行環境水樣毒性分析：重點關注肝臟毒性與內分泌干擾影響）如圖 7，詳附件 2-3。該則海報展示係為本院與國立成功大學合作之研究成果，因應 OECD 2023 年發布《內分泌干擾物質在淡水中的監測與水質品質管理》[5] 提及生物測定法能透過體外試驗方式來評估內分泌干擾物質對於環境毒理學終點的影響，遂針對環境部河川測站以參考過往監測數據選點方式，搭配四個季節變化因素，取得多樣化的河川水質樣品，執行細胞效應試驗，包含內分泌干擾反應之試驗，評估基於效應的體外試驗方法用於河川水質監測之可行性，結果發現雄激素受體(androgen receptor, AR)活性呈現季節性變化，且類固醇生合成途徑中的雌二醇(estradiol, E2)生成也有受到影響，顯示出潛在的內分泌干擾活性並具有季節性波動。上述研究規劃與會議第二天厄爾布魯大學發表的「Effect-based screening of chemical pollutants present in suspended particulate matter of German rivers」（附件 2-4）研究標的相近，該研究係厄爾布魯大學與德國聯邦環境署合作，利用細胞進行基於效應的體外試驗方法來評估 17 年間萊茵河兩個地點的懸浮顆粒物（SPM）樣本（取自德國聯邦環境署的 Environmental Specimen Bank/環境樣本庫，收集於 2005 年至 2022 年之間）

的潛在毒性。其使用非極性溶劑（己烷：二氯甲烷，1:1）和極性溶劑（甲醇）以連續超音波萃取樣品，再經由基於效應的體外試驗方法（Effect-based screening）評估非極性和極性萃取物之雌激素受體、雄性激素受體拮抗劑、芳香烴受體和氧化壓力等生物反應，結果發現在氧化壓力試驗，於 36 件極性萃取物中，有 35 件表現出較高的生物活性，其中來自科布倫茨 (2021) 的樣本呈現最高的生物等效濃度，而非極性萃取物在測試濃度下沒有表現出氧化壓力反應，顯示極性化合物驅動氧化壓力反應；激素受體的初步篩選，根據 2015 年科布倫茨樣本的結果，雌激素受體促效作用與雄性激素受體拮抗作用似乎僅受極性化合物的影響，相較之下，非極性萃取物在芳香烴受體測定中表現出比極性萃取物更高的活性。該研究強調了使用基於效應的方法作為早期預警系統監測水環境中化學危害的優勢，提供水質評估的全面視角，發表內容可供本院後續研究規劃及技術應用策略之參考與精進。

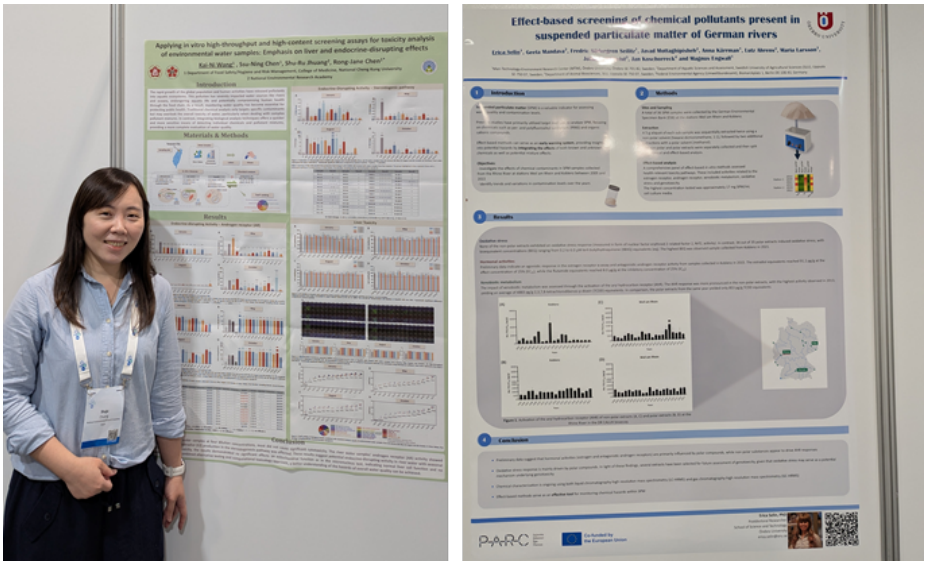

圖 7 本院於會議第五天論文海報發表及技術交流

五、大會重點議題：「PFAS（全氟/多氟烷基物質）污染與風險評估」。

針對 PFAS 相關研究包含 PFAS 在環境與飲用水中的分布與濃度、體內累積、毒性機制與混合物效應、預測模型與風險管理策略等，有多場專門主題場次及跨領域發表；於會議第三天聆聽「揭開 PFAS 從環境毒理學到人類健康的複雜性」、「揭示長期生態影響：從表觀遺傳生物標記到環境污染物及其混合物的多代和慢性影響」及「新興和新型全氟烷基物質 (PFAS)：安全永續替代品的最新發現與創新」等議題平台報告，議題重點在於關注眾所周知和鮮為人知的 PFAS 同源物，包括短鏈 PFAS 和下一代同源物，及後續研究 PFAS 混合物及其長期影響，強調與單一化合物不同的累積效應和潛在的協同效應，乃至生物體發育和長期接觸微塑膠、奈米塑膠、PFOS/PFAS、藥物、毒素和內分泌干擾物等環境污染物，會引起具持續性、可遺傳的生理、生殖和行為影響。

其中來自盧森堡科學技術研究所的 Opeoluwa Ogunsuyi，發表了「A tale of banned and novel PFAS: approach to developmental toxicity in zebrafish embryo」成果演說（如圖 8），因應新型 PFAS（全氟烷基物質）替代品的出現，該研究團隊針對全氟醚羧酸 (PFECA) 和全氟醚磺酸 (PFESA)，以斑馬魚（Danio rerio）為毒理模型，試驗了 PFECA 類化合物（例如 HFPO-TA 和 PFO3DA）、PFESA 類化合物（例如 NBP1 和 NBP2）以及研究最廣泛且已被禁用的 PFAS、PFOA 和 PFOS 鉀鹽（PFOS-K）的發育毒性。透過計算

斑馬魚胚胎暴露於上述六種 PFAS 化合物時的半數致死濃度（LC_{50}，濃度範圍為 0 至 100 mg/L）來評估其急性毒性；並在受精後 6 至 96 小時期間，評估暴露於環境相關濃度（7、70、350 和 700 μg/L）的 PFAS 條件下，對發育異常、孵化率、心律和體長的影響。結果顯示，計算出的 LC_{50} 值顯示毒性效力的等級如下：NBP1 > PFOS-K > PFO3DA > NBP2 > HFPO-TA > PFOA；在環境濃度下暴露於 PFASs 會導致多種發育畸形，包括心包膜水腫、魚鰾充氣不足、脊索畸形、充血、卵黃囊水腫/變形、鰭發育受損以及體長縮短等；除 PFOA 和 NBP1 導致心律顯著增加外，其他 PFASs 均顯著抑制了心律；在所測試的 PFASs 中，幼魚的體長顯著縮短。綜上所述，新 PFAS 替代品可能會對斑馬魚胚胎產生發育毒性，顯示該類新型 PFAS 替代品並非比 PFOS 和 PFOA 更安全。

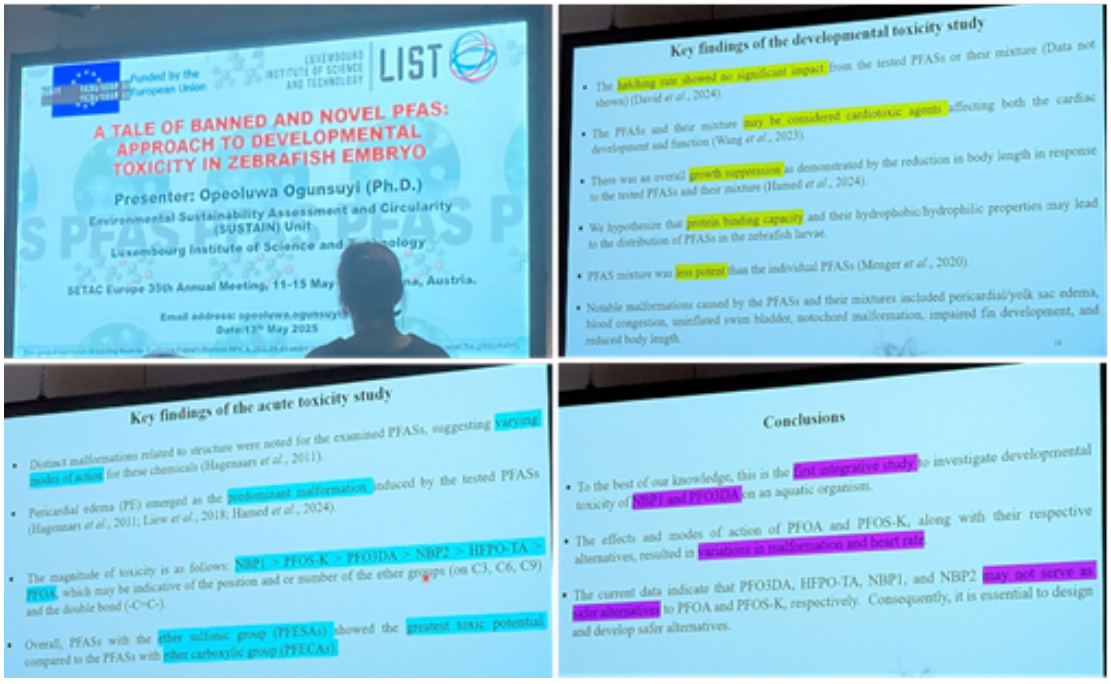

圖 8 Opeoluwa Ogunsuyi 研究成果演說

六、大會重點議題：「塑膠微粒與奈米塑膠（Microplastics & Nanoplastics）」

塑膠污染具備高媒體關注度、跨環境介質影響（海洋、淡水、土壤、大氣）與多物種風險，是近年 SETAC 會議固定熱門主題，相關研究包含微粒來源、環境傳輸與生物攝入機制、毒性評估與作用模式、污水處理與政策減量策略等，相關發表篇數眾多，含多篇政策模擬研究與模型建構。

於會議第四天聆聽「可生物降解聚合物能否作為解決聚合物環境累積的安全、永續的解決方案？」議題平台報告，重點討論可生物降解聚合物的開發和應用，以彌合與環境中聚合物累積（例如大型塑膠、微型塑膠和奈米塑膠）相關問題，評估可生物降解聚合物提供安全和永續解決方案的潛力。

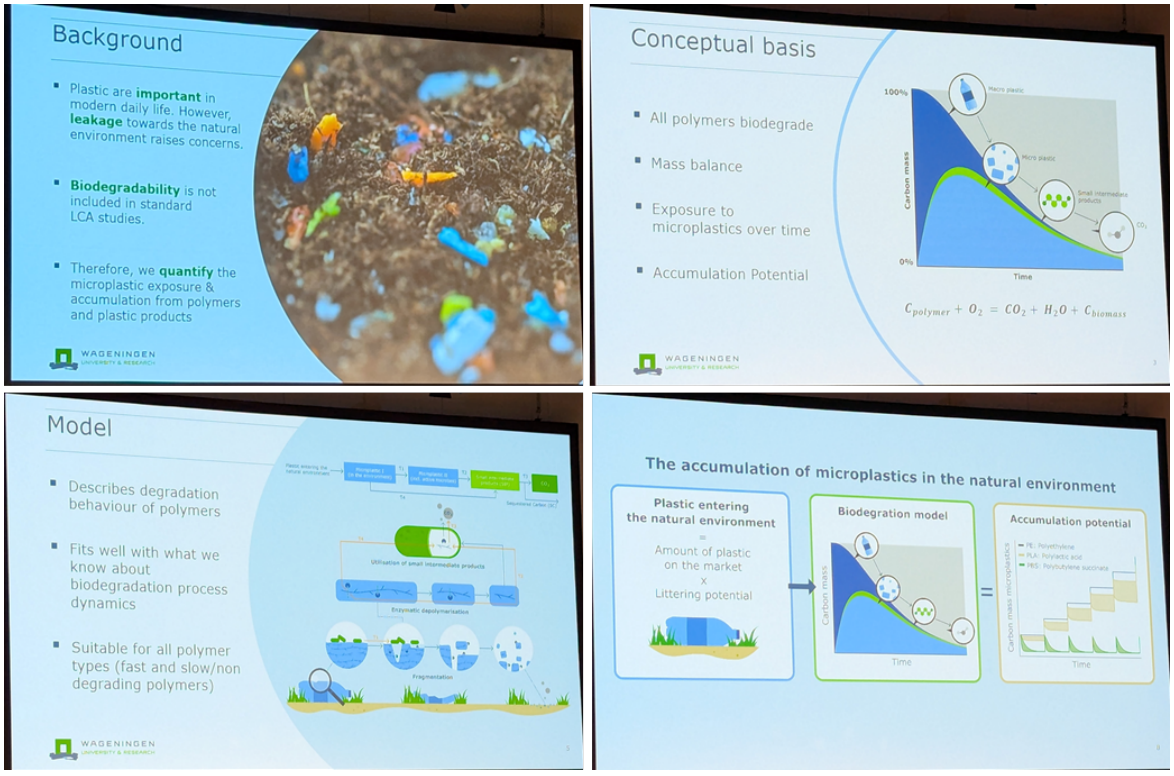

圖 9 可生物降解聚合物相關研究介紹

會議期間參觀塑膠微粒相關議題之海報發表。「The evolving Full Multi: Flexibly simulating microplastic exposure in aquatic environments」（附件 2-5），發展 Full Multi 模型用於動態模擬河川系統中微型塑膠的遷移與宿命，並可用於真實環境估算從河川到海洋的微型塑膠運輸速率。

「Biodegradation Rates of Polylactic Acid Microplastics in Aquatic Environment: Role of Particle Size and Environmental Aging」（附件 2-6）、「Relating Biotic Degradation to Polymer Characteristics to Better Predict the Fate of Biodegradable Plastics in the Environment」（附件 2-7）均以聚乳酸(PLA)材質之生物可降解塑膠為研究標的，前者探討使用活性污泥針對不同尺寸（5、20 和 150 μm）和老化狀態（未老化、熱老化和 UV/H2O2 加速老化）在生物降解中作用，後者探討光老化 PLA 中酵素水解作用和生物膜形成之間的相互作用，強調了非生物風化和生物降解性之間相互作用的重要性。

「Effects of Polyethylene (PE) and Polyvinyl Chloride (PVC) Plastic Particles on Isolated Human Erythrocytes」（附件 2-8）、「The impact of fossil and biobased microplastics on human cells」（附件 2-9），分別利用細胞模式針對不同材質之塑膠微粒進行毒性試驗。前者藉由製備聚乙烯 (PE) 和聚氯乙烯 (PVC) 顆粒，於紅血球濃度與人體血液相近的條件下進行體外試驗，觀察塑膠微粒對紅血球的影響，發現紅血球數量在生理濃度下，塑膠

微粒的暴露即可能損害紅血球有效穿過血管的能力，在未來的研究中，將加入血漿蛋白並使用更廣泛的粒徑，助於更全面了解貼近真實的體內條件下，微型塑膠、奈米塑膠和紅血球之間的動態相互作用；後者將五種塑膠（三種來自化石來源（LDPE、PS 和 PP）和兩種來自生物來源（PLA 和 PHB）進行機械降解，使用不銹鋼網過濾按尺寸分離，選擇小於 1.6 μm 範圍的顆粒，以人類細胞系的肝臟細胞株（HepG2）和腸道細胞株（HCT116）之生物模式，暴露於每種塑膠類型和尺寸範圍的八種不同濃度（從 1.28 μg/L 到 100 mg/L），使用 MTT assay 於三個時間點（24、48 和 72 小時）評估細胞活力，研究結果強調了進一步研究新型生物來源和可生物降解聚合物對人類健康的影響的重要性。

整體而言，塑膠污染之研究議題涉及範圍廣泛，包含塑膠材質、尺寸大小、流布、降解與生物毒性等，無明顯聚焦重點，有海報展示「Micro- and nanoplastics - a wish list for reliable determination of the risks for humans」（附件 2-10）針對巨觀的現況，提及微型塑膠和奈米塑膠 (MNP) 在尺寸大小、材質、型態等特性差異，及其相關化學物質對人體健康的風險評估，因在人體暴露、生物歸宿和潛在健康影響方面存在巨大的不確定性和數據缺口而受到阻礙，也缺乏經過驗證測試可作為參考對照的 MNP 天然顆粒，以及缺乏專門針對 MNP 獨特性質而設計的統一毒理學評估方法。而歐洲研究團隊 CUSP (https://cusp-research.eu/) 提供一平台，透過收集可靠的數據以填補目

前相關數據缺口，並提出評估 MNP 及其相關化學物質（包括污染物）的人體暴露和健康風險的方法；CUSP 係由歐盟資助的多學科團隊，由科學家、工業界和政策制定者組成，共同研究微型塑膠和奈米塑膠 (MNP) 與人類健康（從早期生命到成年期）之間的複雜關係，包含五個項目從不同角度探討 MNP 的健康風險，重點關注不同的暴露途徑和健康影響。其中，PlasticsFatE 計畫（https://www.plasticsfate.eu/）建構了資料要求，並制定克服 MNP 在危害和風險評估中普遍存在和特定材料障礙的策略；基於工程奈米材料安全性研究，因研究表明不可能透過實驗測試所有 MNP 變體及其化學混合物，故 CUSP 亦強調務實方法的必要性。這些方法旨在有效利用奈米材料研究的知識，強調重複使用產生的關於 MNP 宿命和效應的數據，並在考慮 MNP 的特性和測試方法的同時，識別和解決數據與知識方面的差距以及不確定性。

七、與會國內專家學者

會議期間幸遇與會之國內專家學者（如圖 10），臺灣大學公共衛生學院環境與職業健康科學研究所的陳家揚教授及其學生海報展示「Analysis of Per- and Poly-fluoroalkyl Compounds in Textile and Leather Goods Using Energized Dispersive Guided Extraction Combined with UPLC-MS/MS and APGC-MS/MS」（附件 2-11）開發一種分析紡織品和皮革消費品中 PFAS 的方法，重點在於七類 32 種 PFAS，藉由自動化能量分散引導萃取 (EDGE)

系統在 70°C 和 30-35 psi 下依序使用甲醇和丙酮萃取樣品，採用超高效液相層析法 (UPLC) 和大氣壓力氣相層析法 (APGC) 以及串聯質譜法 (MS/MS)，測定以防水、防污為賣點的消費品中的 PFAS。

屏東科技大學環境工程與科學系的謝季吟教授海報展示「Exploring the Hidden Threat of Short-chain Chlorinated Paraffins: Trophic Level Transfer and Cross-Generational Toxicity」（附件 2-12）在模式水生物種（大型蚤和搖蚊）中的急性和慢性毒理學效應，依據攝食效應，以近頭狀偽足藻（Pseudokirchneriella subcapitata）作為食物，評估短鏈氯化石蠟在目標物種中的營養層級生物累積及其對生長和畸形的跨世代影響。

臺灣大學公共衛生學院環境與職業健康科學研究所的陳玟伶副教授海報展示「Interactions between reclaimed water irrigation and planting season revealed by non-target HRMS rice fingerprinting」（附件 2-13），成功將高解析質譜 HRMS 非目標分析應用於水稻中小分子指紋圖譜鑑定，針對再生水灌溉與種植季節之間的相互作用作探討。

台南大學生態暨環境資源學系陳韋妤副教授海報展示「Ecotoxicological assessment of anti-tuberculosis medications in aquatic environments: occurrence, reproductive effects and ecological risks」（附件 2-14），研究不同抗結核藥物在水環境中的生態毒理學影響，並強調異菸酸醯肼（isonicotinic acid hydrazide，INH）為最高的殘留量和暴露風險的潛在問題。

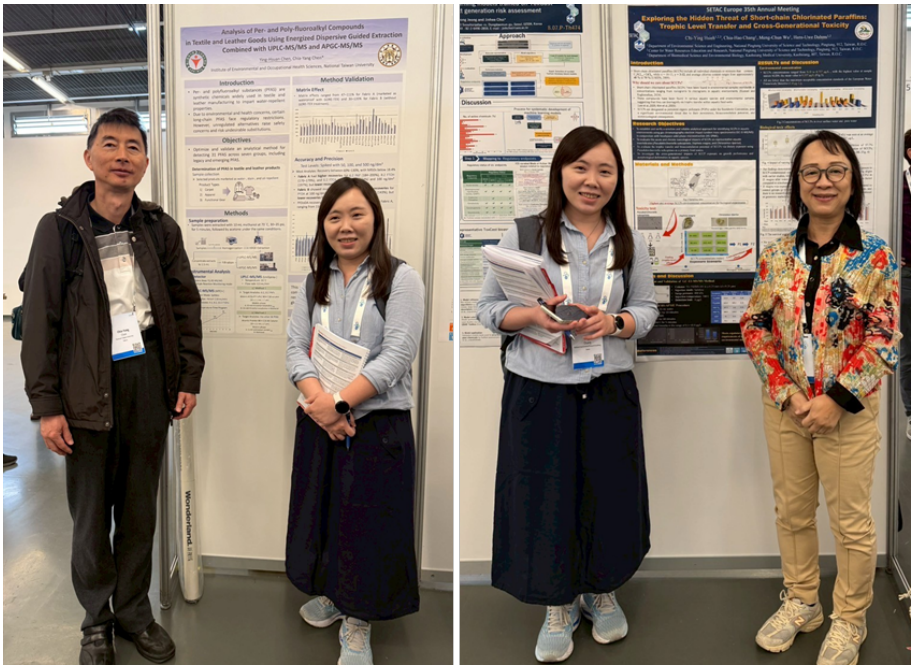

圖 10 與會國內專家學者

八、參觀「氣候。知識。行動！」展覽（如圖 11）

該展覽為維也納科技博物館（Technisches Museum Wien）於 2024 年剛設立的常態展，為參觀者提供有關氣候危機的關鍵數據，以大量數據與視覺化圖像，呈現人類活動對氣候的影響，包含氣候與地球系統相關網絡圖說、森林資源、溫室氣體效應、水資源、氮循環、持久性污染物，最終至生物多樣性的流失等各種角度的統計數據，顯示氣候變遷的重大影響，說明國家因應措施及搭配科技工藝的進化歷程；針對物種多樣性流失問題，展示了一套西蘇門答臘省 Sumpur Kunduz 地區的監測警報系統，在當地安裝了五個太陽能供電的警報系統，具備全天候監控能力，可即時傳送環境資料（包括聲音、溫度、濕度、生物活動等），以便進行快速回應與短期干預，例如防範盜伐、非法捕獵或自然災害預警，並利用 AI 模型分析資料，辨識生物多樣

性的變化趨勢，例如物種出現頻率改變、異常聲音事件等，以監控森林物種多樣性的變化；於該館中的其他工藝特展亦均有展示納入因應氣候變遷的技術發展，例如減碳概念納入建築工藝、科技產業所需大量銅金屬的循環利用等，藉由展覽將氣候變遷議題與科技應變之作為導入民眾（如圖 12）。

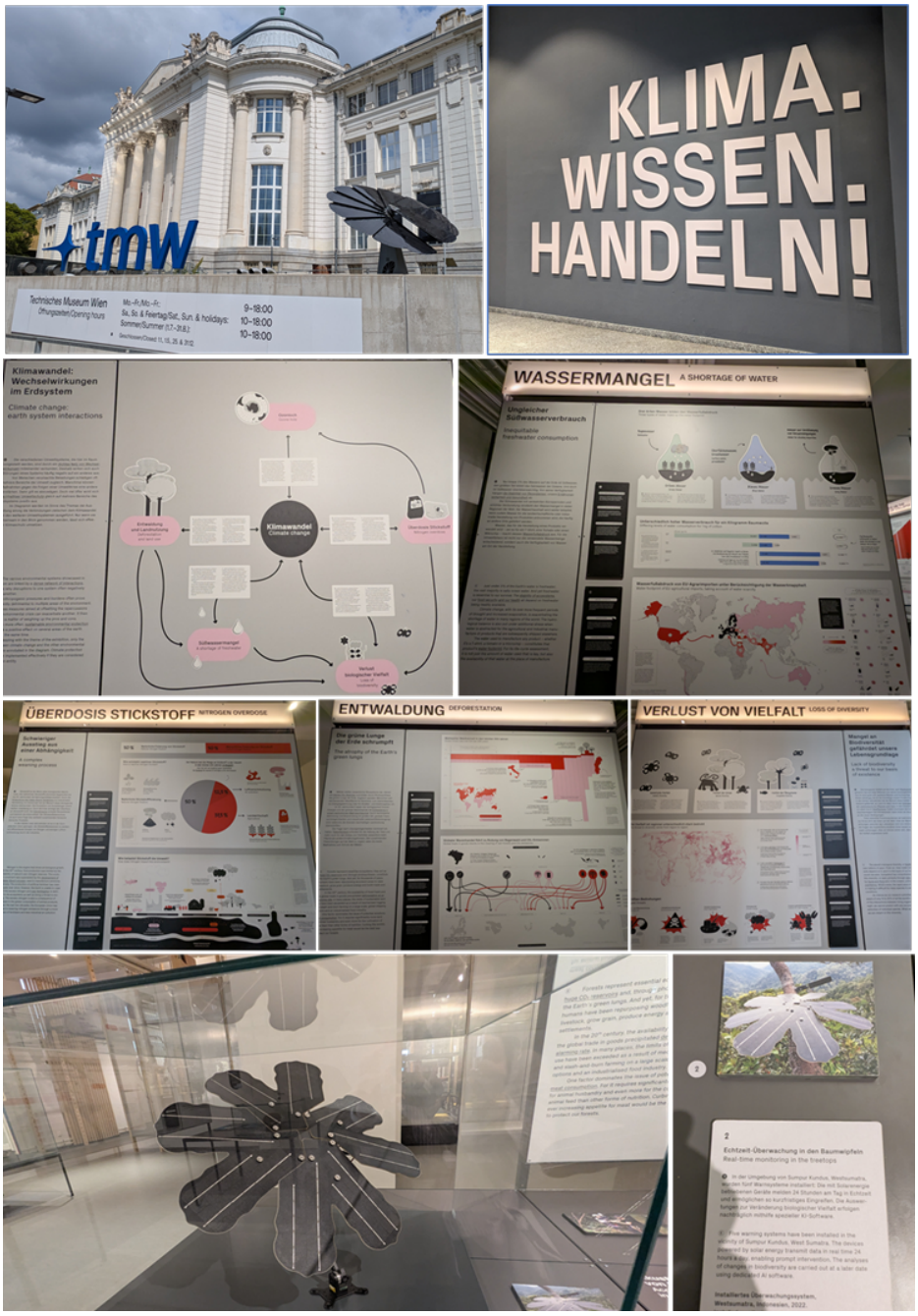

圖 11「氣候。知識。行動！」展覽

圖 12 維也納科技博物館其他展區

參、心得

本次出國目的為收集國際環境毒理與環境管理相關資訊及技術開發應用，包含生態毒理試驗技術開發與各式生物技術方法評估出環境危害物質之毒理資料，做為推動維護生態及人類生活環境化學安全之政策管制重要依據。主要心得如下：

一、SETAC（環境毒理與化學學會）組織每年於世界各洲（包含美洲、歐洲、亞洲…等）均有舉辦不同場次之年會，雖本次為歐洲地區會議，然與會人員包含亞洲本國與韓國均具有能見度的研究發表篇幅，美國環保署亦有研究單位常年參與歐洲會議，顯現歐盟對於環境議題的重視及其漸為環保意識領頭之趨勢；會議期間膳食均為全素供應並使用環保材質耗材，亦可見大會落實環境保護之精神，大會開幕式主席演講強調研究交流的彼此尊重並勉勵初次參與的成員，是個兼容多國際與鼓勵新進共同持續為環境努力的氛圍。

二、大會議程包含多主題及大量的平台報告與海報展示，提供與會人員非常豐富的交流機會，從大會主題及與會人員發表的熱門議題，均與本國關注議題相同，亦顯示本院研究議題適切與國際接軌，憑藉本院目前現有的專業背景人才，若未來可有更多人員同行參與此類型國際研討會，應能斬獲更多有利資訊，助於本院研究量能持續擴展。

三、會議中部份研究已將環境分析及毒理研究納入氣候變遷因素（如圖 13），該議題亦受國際高度重視，如同維也納科技博物館於 2024 新設「氣候。知

識。行動！」常態展覽，將氣候變遷議題納入科技工藝精進範疇，多處細節顯示歐洲國家對於環境及氣候議題的重視，並已逐步融入人民生活。環境污染及氣候變遷應對措施，政府監管及政策決策扮演決定性的角色，需要各領域之研究與政策決策單位共同合作努力解決當前環境與氣候議題。

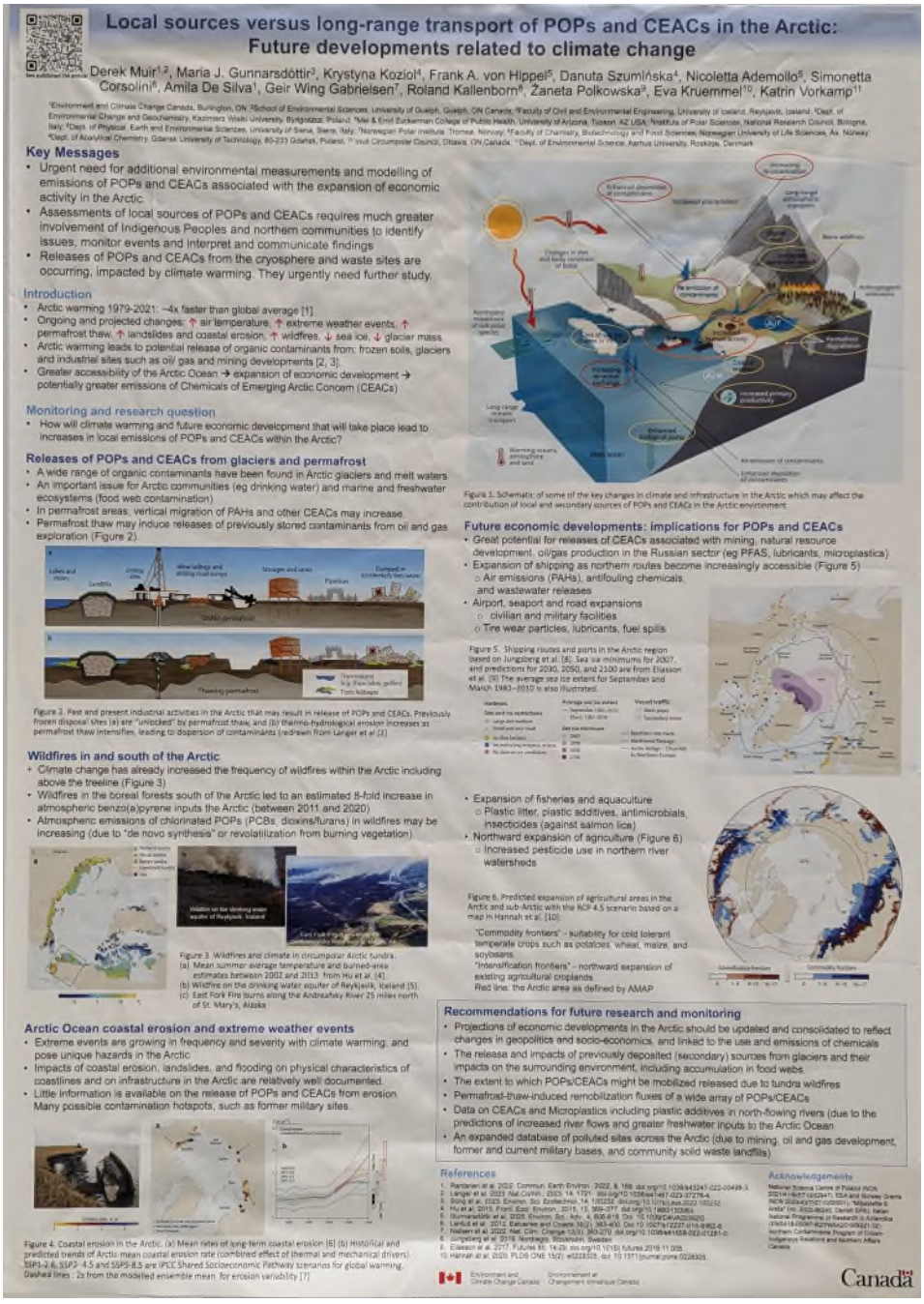

圖 13 持久性有機污染物與新化學物質之調查研究納入氣候變遷因素

肆、建議

一、針對 PFAS 與微型塑膠等重點關注污染物，本院均具備相當程度之檢測量能，本次會議多數研究亦著重探討污染物質毒理研究與環境流布至最終宿命等完整評估，是提供歐盟擬定政策管理之重要依據與參考，我國目前多參考歐盟或美國管制標準，若有完備之毒理試驗與風險評估平台，或可針對本土實際污染物種、分布、遷移路徑至最終宿命，量身打造適合國內的標準或管制措施，本次會議有國內多位專家學者與會，並各自發表不同子領域之毒理研究，亦顯示國內學界相關研究之量能。

二、微型塑膠與奈米塑膠(MNP)之研究議題涉及範圍廣泛，包含塑膠材質、尺寸大小、流布、降解與生物毒性等，目前似無顯著聚焦管制重點及檢測技術，歐盟資助之團體 CUSP (https://cusp-research.eu/) 提供一平台，收集可靠的數據以填補人體危害與風險評估等相關數據缺口，並提出評估 MNP 及其相關化學物質（包括污染物）的人體暴露和健康風險的方法，可供執行相關研究前之先期預備作業，逐步聚焦適用於國內需求之技術開發或環境毒理調查。

三、大會主題演講藉由「綠天鵝」概念，提醒我們「預警潛在的化學污染危機」；厄爾布魯大學與德國聯邦環境署合作，利用細胞進行基於效應的體外試驗方法作為早期預警系統以偵測水環境中的化學危害。現今新興化學品之開發應用進展迅速，一旦眾多新興化學物質進入環境中造成污染，逐一化合物之檢測、鑑識方式，恐無法立即因應監測大量新興污染物之需求，且無法

得知污染物對生物體之累加、協同或複合作用所導致之毒性反應，本次會議中亦見為數眾多的化學檢測非目標分析及生物毒性試驗之技術開發與應用，均可供於尚未鑑定危害物質前之預警作為。

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3. Jenny Maner, Carolin Drieschner, René Schönenberger, Christian Ebi, Philippe Renaud and Kristin Schirmer. Time-Resolved Acute Toxicity Testing With Fish Cells Under Flow Conditions in the RainbowFlow CHIP Biosensor. (SETAC 2023). Society of Environmental Toxicology and Chemistry (SETAC) Europe 33nd Annual Meeting, Dublin, Ireland, 30 April – 4 May 2023.
4. Jo Nyffeler, Clinton Willis, Felix R. Harris, MJ Foster, Bryant Chambers, Megan Culbreth, Richard E. Brockway, Sarah Davidson-Fritz, Daniel Dawson, Imran Shah, Katie Paul Friedman, Dan Chang, Logan J. Everett, John F. Wambaugh, Grace Patlewicz, Joshua A. Harrill. (2023). Application of Cell Painting for chemical hazard evaluation in support of screening-level chemical assessments. *Toxicol Appl Pharmacol*. 468: 116513.
5. OECD. (2023). Endocrine Disrupting Chemicals in Freshwater MONITORING AND REGULATING WATER QUALITY.

附件 1 第 35 屆 SETAC Europe 年會每日議程

Sunday, 11 May

SUNDAY SCHEDULE		
08:00-20:30	Badge Pick-Up and Registration	Entrance Hall
08:00-21:00	Cloakroom	0.15
08:30-17:30	Training Courses	
09:00-15:00	SETAC Europe Council Meeting	-2.31
14:00-20:00	Speaker Ready Room	0.12
17:30-19:00	**Opening and Awards Ceremony Featuring Sunday Plenary John Elkington**	**Hall E**
19:00-20:30	**Welcome Reception**	**Exhibition Hall**

Training Courses

MORNING HALF-DAY COURSES | 8:30-12:30		
TC01	Safety and Sustainability Assessment in the Context of EU SSbD Framework	0.49-0.50

FULL-DAY COURSES | 8:30-17:30		
TC02	Contaminant Biotransformation Pathways and Kinetics – The enviPath database, Open Research Data, and Prediction Tools	0.14
TC03	Environmental Omics as a Novel Approach Methodology	0.96-0.97
TC04	Introduction to in Silico Modelling Approaches for Regulatory Ecotoxicological Hazard Assessment	0.16
TC05	Introduction to Mechanistic Effect Modelling for Environmental Risk Assessment	0.51
TC06	Statistical Methods in Ecotoxicology Using R	0.11

AFTERNOON HALF-DAY COURSES | 13:30-17:30		
TC07	Activity-Based Environmental Risk Assessment for PFAS and POPs	0.49-0.50

Monday, 12 May

MONDAY SCHEDULE		
08:30-18:15	Badge Pick-Up & Registration	Entrance Hall
08:30-21:00	Cloakroom	0.15
08:30-18:15	Speaker Ready Room	0.12
08:30-09:30	Poster Setup	Exhibition Hall
08:30-18:00	ibacon Business Meetings	0.11
09:30-10:50	**Presentation Sessions**	
10:50-11:35	Coffee & Poster Break	Exhibition Hall
10:50-11:35	**John Elkington Meet and Greet**	**0.14**
10:50-11:35	SETAC Journals: Meet the Editors	SETAC Square
11:35-12:55	**Presentation Sessions**	
12:55-14:25	Lunch & Poster Break	Exhibition Hall
12:55-14:25	**Student Lunch: Career Perspectives** (sponsored by Colgate)	**Hall L1**
13:25-14:25	LGBTIAQ+ Meetup	0.49-0.50
13:30-14:30	Advancement and Application of Alternatives Assessment (A4) Interest Group Meeting	0.96-0.97
14:25-15:45	**Presentation Sessions**	
15:45-16:45	Coffee Break & Poster Corners	Exhibition Hall
15:45-16:45	EDTRA Interest Group Meeting	0.49-0.50
16:00-16:45	**Poster Corners**	**Foyer D**
16:00-17:00	Effect Modelling Interest Group Meeting	0.14
16:00-18:00	Advancement in Technologies and Reference Materials for Nanoplastics Detection: Innovation and Future Perspectives	0.96-0.97
16:30-18:00	SETAC Europe LCA IG Steering Committee Meeting	0.51
16:45-17:45	**Plenary: Katrin Vorkamp**	**Hall E**
17:00-18:00	Bioaccumulation Science Interest Group Meeting	0.14
17:00-18:15	Students Evening Event: Toxic Tales	Hall L1
17:45-18:15	**Poster Social**	**Exhibition Hall**

Tuesday, 13 May

TUESDAY SCHEDULE		
08:30-18:15	Badge Pick-Up, Registration & Cloakroom	Entrance Hall
08:30-18:15	Speaker Ready Room	0.12
08:30-09:30	Poster Setup	Exhibition Hall
08:30-12:55	Corteva Business Meetings	0.11
08:30-18:00	ibacon Business Meetings	0.45
08:30-18:15	FERA Science Business Meetings	0.16
09:00-10:00	IBERA Breakfast Information Session	Hall L1
08:30-12:30	Job Event	0.49-0.50
09:30-10:50	**Presentation Sessions**	
10:50-11:35	Coffee & Poster Break	Exhibition Hall
11:00-12:00	Omics Interest Group Meeting	0.96-0.97
11:35-12:55	**Presentation Sessions**	
12:15-13:45	Eurometaux	0.96-0.97
12:55-14:25	Lunch & Poster Break	Exhibition Hall
12:55-14:25	ET&C and IEAM Joint Editorial Meeting	0.14
12:55-14:25	Sciex Sponsored Lunch Seminar	Hall L1
12:55-14:25	Labcorp Sponsored Lunch Seminar	Hall L2
12:55-14:25	Agilent Sponsored Lunch Seminar	Hall L3
14:25-15:45	**Presentation Sessions**	
14:30-16:00	Regional Branches Committee Meeting	0.14
15:00-17:00	Taiwan's Ministry of Environment: Carbon Footprint Database and Exchange Opportunities	0.96-0.97
15:30-16:30	SETAC Europe Science Committee Meeting	0.51
15:45-16:45	Coffee & Poster Break	Exhibition Hall
16:00-16:45	**Poster Corners**	**Foyer D**
16:00-17:30	Pharmaceuticals Interest Group Meeting	Hall D2
16:00-18:00	Animal Alternatives Interest Group Meeting	0.49-0.50
16:00-18:00	Metals Interest Group Meeting	Hall L1
16:00-18:00	Persistence Science Interest Group Meeting	0.14
16:30-17:30	SETAC Europe Awards Committee Meeting	0.51
16:45-17:45	**Tuesday Plenary: Marco Baity-Jesi**	**Hall E**
17:45-18:15	**Poster Social**	**Exhibition Hall**
19:30-22:00	Strauss Dinner Show	Straus Dinner Show (Prater 75)
21:00 - ...	SETAC Party (entrance closes at 23:30)	Ottakringer Brewery

Wednesday, 14 May

WEDNESDAY SCHEDULE		
08:30-18:15	Badge Pick-up, Registration & Cloakroom	Entrance Hall
08:30-18:15	Speaker Ready Room	0.12
08:30-09:30	Poster Setup	Exhibition Hall
08:30-18:00	Corteva Business Meetings	0.11
08:30-18:15	FERA Science Business Meetings	0.16
09:30-10:50	**Presentation Sessions**	
10:00-12:00	Application of SSbD Framework to Polymeric Materials Workshop	0.96-0.97
10:50-11:35	Coffee & Poster Break	Exhibition Hall
11:00-12:00	SETAC Europe Italian Language Branch Meeting	0.49-0.50
11:35-12:55	**Presentation Sessions**	
12:55-14:25	Lunch & Poster Break	Exhibition Hall
12:55-14:25	SETAC Europe Annual General Assembly	Hall L1
12:55-14:25	Bayer Sponsored Lunch Seminar	Hall L2
12:55-14:25	Bionomous Lunch Seminar	Hall L3
12:55-14:25	Waters Sponsored Lunch Seminar	0.14
13:30-14:25	Wildlife Toxicology Interest Group Meeting	0.49-0.50
14:25-15:45	**Presentation Sessions**	
15:00-16:00	SETAC Europe Council Meeting	0.49-0.50
15:45-16:45	Coffee & Poster Break	Exhibition Hall
16:00-16:45	**Poster Corners**	**Foyer D**
15:45-16:45	SETAC Journals: Meet the Editors	SETAC Square
16:00-18:00	Plants Interest Group Meeting	0.51
16:00-18:00	Plastics Interest Group Meeting	0.49-0.50
16:15-16:45	Student Advisory Council General Assembly	Hall L1
16:15-18:00	SETAC UK Branch Speed Networking	0.96-0.97
16:30-18:00	Global Soils Interest Group Meeting	0.14
16:45-17:45	**Wednesday Plenary: Yaz Ellis**	**Hall E**
16:45-18:00	Biodiversity Interest Group Meeting	Hall L1
17:45-18:15	**Poster Social**	**Exhibition Hall**

Thursday, 15 May

THURSDAY SCHEDULE		
08:30-14:30	Badge Pick-Up and Registration	Entrance Hall
08:30-15:00	Cloakroom	0.15
08:30-12:00	Speaker Ready Room	0.12
08:30-09:30	Poster Setup	Exhibition Hall
09:30-10:50	**Presentation Sessions**	
10:50-11:35	Coffee & Poster Break	Exhibition Hall
11:35-12:55	**Presentation Sessions**	
12:55-14:20	Lunch & Poster Break	Exhibition Hall
14:25-15:00	**Closing Ceremony**	**Hall G**

Join Us for the Closing Ceremony!

14:25–15:00 | Hall G

Join us for the closing ceremony as we announce and celebrate the **SETAC Europe Best Student Presentation Awards** and have a look back on a successful science-packed week.

Hear delightful closing remarks from the SETAC Vienna Programme Committee Chairs and newly elected SETAC Europe President, and get a taste of next year's meeting in Maastricht, Netherlands.

附件 2 摘錄本次與會之參展海報

附件 2-1

Application of Electric Cell-Substrate Impedance Sensing (ECIS) Technology in the Ecotoxicological Evaluation of Industrial and Wastewater Effluents

Shu-Ju Chuang*, Chun-Yu Kuo, Siao-Yi Jin, Chih-Hsien Tsai, His-Nan Yang

National Environmental Research Academy, Ministry of Environment, Executive yuan, Taiwan

Introduction

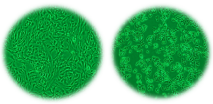
Conventional water quality surveillance systems rely primarily on physicochemical analyses, which may overlook biological effects caused by complex mixtures of pollutants. To address this limitation, cell-based sensing technologies offer a promising complementary strategy, combining real-time biological responsiveness with enhanced analytical resolution.

Objective

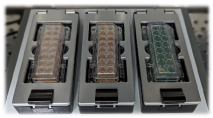
This study aims to evaluate the applicability of electric cell-substrate impedance sensing (ECIS) technology for the ecotoxicological assessment of complex water matrices, including industrial influents and treated effluents . By comparing cell-based and organism-level bioassays, we explore the effectiveness of *in vitro* methods in detecting key toxicants.

Material & Method

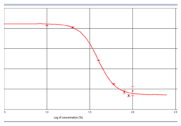
Water samples：
Including industrial raw influents, treated effluents, influents and effluents from wastewater treatment plants (WWTPs).



Cell Lines Used：
RTgill-W1: Derived from rainbow trout gill cells, representing fish-specific toxicity pathways.
HepG2: A human hepatoblastoma cell line, representing potential human health relevance.



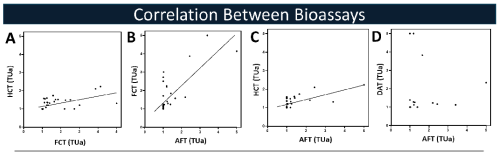
Technology：
xCELLigence Real-Time Cell Analysis system based on ECIS for dynamic monitoring of cell viability.



Toxic Unit-Acute (TUa)：
Defined as 100/EC_{50}, where EC_{50} represents the effluent concentration causing 50 % effect (e.g., cell index reduction or mortality). TUa provides a normalized metric of acute toxicity.

Results

Correlation Between Bioassays



E

	r	95% C.I.	P value	P value summary	N
FCT vs. HCT	0.5796	0.3272 to 0.7548	<0.0001	****	40
AFT vs. FCT	0.7639	0.5812 to 0.8733	<0.0001	****	36
AFT vs. HCT	0.6550	0.4159 to 0.8093	<0.0001	****	36
AFT vs. DAT	0.1283	-0.2571 to 0.4785	0.5152	ns	28

FCT：Fish Cell-Line Toxicity Test (RTgill-W1) HCT：Human Cell-Line Toxicity Test (HepG2)
AFT：Acute Fish Toxicity Test (whole-organism) DAT：Daphnia Acute Immobilisation Test

Figure 1. Correlation analysis of toxic unit (TUa) values derived from cell-based and organism-level bioassays. (A) Deming regression between RTgill-W1 and HepG2 cell-based assays. (B-D) Deming regression of cell-based and organism-level bioassays. (E) Summary table of regression analyses, including sample size (N) and correlation coefficient (r) for each comparison.

Toxicity Assessment Criteria: If cell index reduction is < 50 % across all concentrations: EC_{50} > 100 %, TUa < 1.0 (reported as 1)；If cell index reduction > 50 % across all concentrations: EC_{50} < 20 %, TUa > 5.0 (reported as 5)

Toxicity Sensitivity and Predictive Accuracy Relative to Regulatory Thresholds

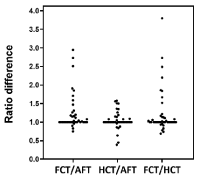


Figure 2. Toxicity Sensitivity
Comparison of different bioassay results shows the TUa conversion ratio distribution. The toxicity sensitivity of some FCT results is significantly higher than that of AFT and HCT.

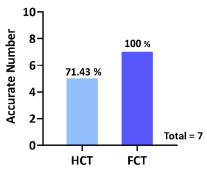


Figure 3. Predictive Accuracy
Applying a regulatory toxicity threshold of TUa = 1.43, FCT outcomes demonstrated complete predictive concordance with AFT results, whereas HCT demonstrated an accuracy of approximately 71.43 %.

Comparative Analysis of Bioassay Results and Water Quality Parameters to Identify Primary Toxicity Contributors

A

	r	95% C.I.	P value	P value summary	N
FCT vs. COD	0.07266	-0.2529 to 0.3834	0.6646	ns	38
FCT vs. BOD	0.07582	-0.2544 to 0.3903	0.6558	ns	37
FCT vs. NH_3-N	0.43190	0.1391 to 0.6552	0.0054	**	40
FCT vs. As	-0.10690	-0.4250 to 0.2347	0.5409	ns	35
FCT vs. Cu	0.19970	-0.1282 to 0.4882	0.2294	ns	38
FCT vs. Zn	-0.09413	-0.4017 to 0.2326	0.5740	ns	38
FCT vs. Ni	-0.00482	-0.3240 to 0.3153	0.9771	ns	38
FCT vs. ABS	-0.03657	-0.3702 to 0.3054	0.8373	ns	34
FCT vs. SO_4^{2-}	0.55460	0.1187 to 0.8115	0.0169	*	18
FCT vs. PO_4^{3-}	0.40020	-0.0820 to 0.7305	0.0999	ns	18
FCT vs. NO_3-N	-0.02690	-0.3835 to 0.3366	0.8878	ns	30
FCT vs. Cl^-	0.51760	0.0670 to 0.7929	0.0278	*	18
FCT vs. F^-	0.36200	0.0020 to 0.6389	0.0493	*	30
FCT vs. NO_2-N	0.28420	-0.2106 to 0.6631	0.2530	ns	18
FCT vs. TKN	0.64010	0.2757 to 0.8437	0.0024	**	20
FCT vs. T-P	0.20080	-0.2936 to 0.6105	0.4242	ns	18
FCT vs. T-N	0.64140	0.2135 to 0.8628	0.0074	**	16

B

	r	95% C.I.	P value	P value summary	N
HCT vs. COD	-0.1832	-0.4750 to 0.1450	0.2710	ns	38
HCT vs. BOD	-0.1473	-0.4498 to 0.1856	0.3843	ns	37
HCT vs. NH_3-N	0.6818	0.4701 to 0.8193	<0.0001	****	40
HCT vs. As	-0.1381	-0.4506 to 0.2045	0.4287	ns	35
HCT vs. Cu	0.1504	-0.1778 to 0.4486	0.3673	ns	38
HCT vs. Zn	-0.1709	-0.4651 to 0.1574	0.3051	ns	38
HCT vs. Ni	-0.1160	-0.4201 to 0.2115	0.4879	ns	38
HCT vs. ABS	-0.1648	-0.4764 to 0.1836	0.3517	ns	34
HCT vs. SO_4^{2-}	0.7696	0.4724 to 0.9096	0.0002	***	18
HCT vs. PO_4^{3-}	0.5452	0.1050 to 0.8067	0.0193	*	18
HCT vs. NO_3-N	0.0243	-0.3389 to 0.3813	0.8984	ns	30
HCT vs. Cl^-	0.6535	0.2685 to 0.8584	0.0033	**	18
HCT vs. F^-	0.6558	0.3870 to 0.8219	<0.0001	****	30
HCT vs. NO_2-N	0.1975	-0.2968 to 0.6083	0.4322	ns	18
HCT vs. TKN	0.4703	0.0351 to 0.7556	0.0364	*	20
HCT vs. T-P	0.1509	-0.3399 to 0.5771	0.5500	ns	18
HCT vs. T-N	0.6566	0.2386 to 0.8694	0.0057	**	16

C

	r	95% C.I.	P value	P value summary	N
AFT vs. COD	0.0253	-0.3156 to 0.3604	0.8871	ns	34
AFT vs. BOD	0.0772	-0.2734 to 0.4096	0.6695	ns	33
AFT vs. NH_3-N	0.4983	0.2031 to 0.7105	0.0020	**	36
AFT vs. As	-0.0836	-0.4201 to 0.2730	0.6490	ns	32
AFT vs. Cu	0.1898	-0.1585 to 0.4962	0.2822	ns	34
AFT vs. Zn	-0.0919	-0.4171 to 0.2541	0.6050	ns	34
AFT vs. Ni	-0.1073	-0.4299 to 0.2395	0.5457	ns	34
AFT vs. ABS	-0.0255	-0.3709 to 0.3261	0.8898	ns	32
AFT vs. SO_4^{2-}	0.4954	0.0371 to 0.7815	0.0368	*	18
AFT vs. PO_4^{3-}	0.4140	-0.0656 to 0.7382	0.0877	ns	18
AFT vs. NO_3-N	0.0530	-0.3133 to 0.4055	0.7811	ns	30
AFT vs. Cl^-	0.4877	0.0270 to 0.7776	0.0400	*	18
AFT vs. F^-	0.2415	-0.1301 to 0.5536	0.1985	ns	30
AFT vs. NO_2-N	0.3661	-0.1216 to 0.7114	0.1351	ns	18
AFT vs. TKN	0.4997	0.0429 to 0.7838	0.0347	*	18
AFT vs. T-P	0.2295	-0.2659 to 0.6289	0.3597	ns	18
AFT vs. T-N	0.6640	0.2508 to 0.8725	0.0050	**	16

D

	r	95% C.I.	P value	P value summary	N
DAT vs. COD	0.7218	0.4773 to 0.8626	<0.0001	****	28
DAT vs. BOD	0.8546	0.7028 to 0.9319	<0.0001	****	27
DAT vs. NH_3-N	0.0663	-0.3146 to 0.4288	0.7375	ns	28
DAT vs. As	0.1357	-0.2656 to 0.4970	0.5085	ns	26
DAT vs. Cu	0.0103	-0.3641 to 0.3819	0.9583	ns	28
DAT vs. Zn	-0.0781	-0.4384 to 0.3039	0.6930	ns	28
DAT vs. Ni	0.5691	0.2489 to 0.7772	0.0016	**	28
DAT vs. ABS	0.0559	-0.3388 to 0.4339	0.7862	ns	26
DAT vs. SO_4^{2-}	0.7072	0.2244 to 0.9113	0.0101	*	12
DAT vs. PO_4^{3-}	0.4178	-0.2053 to 0.7999	0.1765	ns	12
DAT vs. NO_3-N	-0.1591	-0.5286 to 0.2611	0.4578	ns	24
DAT vs. Cl^-	0.5496	-0.0355 to 0.8541	0.0642	ns	12
DAT vs. F^-	0.2720	-0.1476 to 0.6086	0.1985	ns	24
DAT vs. NO_2-N	0.0028	-0.5720 to 0.5758	0.9932	ns	12
DAT vs. TKN	0.8120	0.4458 to 0.9453	0.0013	**	12
DAT vs. T-P	0.1315	-0.4786 to 0.6559	0.6838	ns	12
DAT vs. T-N	0.9487	0.7923 to 0.9881	<0.0001	****	10

Figure 4. Correlation Between Bioassays and Pollutant Analyses (A-C) Integrated analysis revealed significant associations between bioassay outcomes (FCT, HCT, AFT) and nitrogenous compounds and anionic salts. (D) DAT results correlated with COD, BOD, and nickel levels, highlighting species-specific sensitivities.

Pollutant analysis followed standard methods issued by the Taiwan Ministry of Environment.

Conclusion

- Our findings underscore the value of integrating ECIS technology into routine water quality monitoring workflows. The use of sensitive cell lines in impedance-based assays not only enhances early detection capabilities but also offers a practical step forward in minimizing animal use in regulatory frameworks.
- Toxicity contributor analysis revealed that different bioassay systems respond to distinct pollutant classes. This variability underscores the necessity of employing a multi-species assessment strategy to ensure comprehensive and mechanism-inclusive ecotoxicity evaluations.

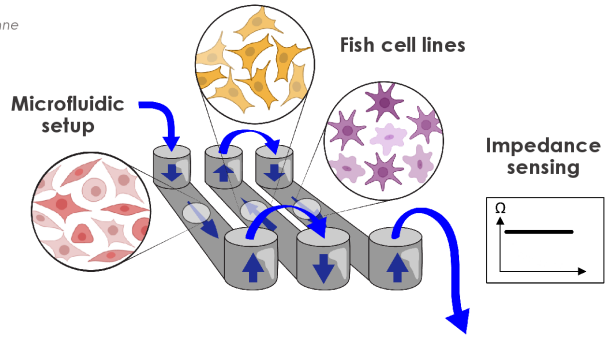
附件 2-2

Real-Time Chemical Toxicity Monitoring with a Microfluidic Multi-Cell Line Fish-on-Chip Model

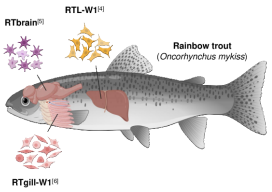
Jenny Maner[1,2], Philippe Renaud[3], Kristin Schirmer[1,2]

[1]Swiss Federal Institute of Aquatic Science and Technology (Eawag), CH-8600 Dübendorf
[2]Swiss Federal Institute of Technology Zurich (ETHZ), CH-8092 Zürich
[3]Swiss Federal Institute of Technology Lausanne (EPFL), CH-1015 Lausanne

Chemical risk assessment requires the testing of acute toxicity to fish, and there is a growing need for alternative methods to reduce the use of live animals. Fish cell lines can be used as an *in vitro* alternative. Using impedance sensing, we establish a microfluidic biosensor which combines cell lines from different organs, thus creating a simple fish-on-chip model for chemical toxicity monitoring.

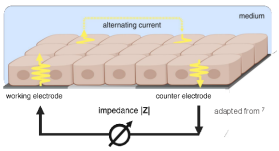


Fish cell lines



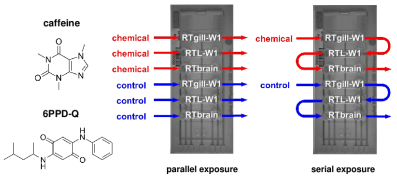
Fish cell lines can predict toxicity to fish[1-3]. We use cell lines from the **gill, liver, and brain** of the rainbow trout.

Impedance sensing



Electric cell-substrate impedance sensing (ECIS): cells' **resistance [Ω] to** a non-invasive **electric current** reflects their health status - decrease is an indicator for loss of cell viability, e.g. due to chemical exposure[6]. Continuous automated measurement allows monitoring in real-time.

Microfluidic setup



Cell lines are **exposed under flow conditions**. Parallel exposure: one channel per cell line is used as control, and one channel each exposed to the same chemical concentrations. Serial exposure: channels are connected through a unidirectional fluidic flow.

Sensitivity differs between cell lines depending on the chemical

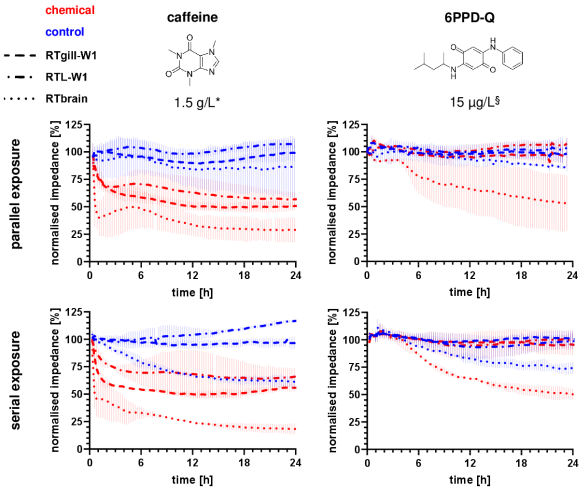


Figure 1. Multi-cell line exposure with two test chemicals.

Normalised impedance (% of t_0, frequency = 5 kHz) of three cell lines exposed over 24 h under flow conditions (Q = 100 µL/h, τ = 0.001 dyne/cm², medium = L-15/FBS(1%)), n=2. *EC_{50} for RTgill-W1, §EC_{50} for RTbrain, concentrations are nominal.

- Caffeine:
  - RTgill-W1 and RTL-W1 cells show similar sensitivities, RTbrain cells slightly more sensitive
  - no significant difference in sensitivity between parallel and serial exposure
- 6PPD-Q:
  - no effect on RTgill-W1 and RTL-W1 at the tested concentration, but impedance of RTbrain cells decreases
  - no significant difference in sensitivity between parallel and serial exposure, but impedance of RTbrain control cells significantly lower in serial vs parallel flow setup

➢ The fish-on-chip model integrates cell line-specific sensitivities

➢ next step: increase number of independent replicates

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附件 2-3

Effect-based screening of chemical pollutants present in suspended particulate matter of German rivers

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1 Introduction

Suspended particulate matter (SPM) is a valuable indicator for assessing water quality and contamination levels.

Previous studies have primarily utilized target methods to analyze SPM, focusing on chemicals such as per- and polyfluoroalkyl substances (PFAS) and organic cationic compounds.

Effect-based methods can serve as an **early warning system**, providing insights into potential hazards by **integrating the effects** of both known and unknown chemicals as well as potential mixture effects.

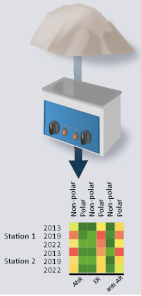
Objectives:
- Investigate the effects of chemical contaminants in SPM samples collected from the Rhine River at stations Weil am Rhein and Koblenz between 2005 and 2022
- Identify trends and variations in contamination levels over the years

2 Methods

Sites and Sampling
A total of 36 SPM samples were collected by the German Environmental Specimen Bank (ESB) at the stations Weil am Rhein and Koblenz.

Extraction
A 5 g aliquot of each sub-sample was sequentially extracted twice using a non-polar solvent (hexane:dichloromethane, 1:1), followed by two additional extractions with a polar solvent (methanol).
The non-polar and polar extracts were separately collected and then split for chemical and effect-based analysis.

Effect-based analysis
A comprehensive panel of effect-based *in vitro* methods assessed health-relevant toxicity pathways. These included activities related to the estrogen receptor, androgen receptor, xenobiotic metabolism, oxidative stress and genotoxicity.
The highest concentration tested was approximately 17 mg SPM/mL cell culture media.



3 Results

Oxidative stress
None of the non-polar extracts exhibited an oxidative stress response (measured in form of nuclear factor erythroid 2-related factor 2, Nrf2, activity). In contrast, 34 out of 35 polar extracts induced oxidative stress, with bioequivalent concentrations (BEQ) ranging from 0.2 to 6.0 µM tert-butylhydroquinone (tBHQ) equivalents (eq). The highest BEQ was observed sample collected from Koblenz in 2021.

Hormonal activities
Preliminary data indicate an agonistic response in the estrogen receptor α assay and antagonistic androgen receptor activity from samples collected in Koblenz in 2015. The estradiol equivalents (eq.) reached 91.2 pg/g at the effect concentration of 25% (EC_{25}), while the flutamide equivalents (eq.) reached 8.0 µg/g at the inhibitory concentration of 25% (IC_{25}).

Xenobiotic metabolism
The impact of xenobiotic metabolism was assessed through the activation of the aryl hydrocarbon receptor (AhR). The AhR response was more pronounced in the non-polar extracts, with the highest activity observed in 2013, yielding an average of 4883 pg/g 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) equivalents. In comparison, the polar extracts from the same year yielded only 853 pg/g TCDD equivalents.

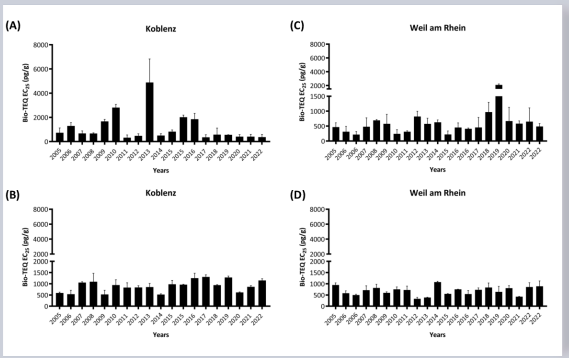


Figure 1. Activation of the aryl hydrocarbon receptor (AhR) of non-polar extracts (A, C) and polar extracts (B, D) at the Rhine River in the DR CALUX bioassay.

4 Conclusion

- Preliminary data suggest that hormonal activities (estrogen and antagonistic androgen receptors) are primarily influenced by polar compounds, while non-polar substances appear to drive AhR responses
- Oxidative stress response is mainly driven by polar compounds. In light of these findings, several extracts have been selected for future assessment of genotoxicity, given that oxidative stress may serve as a potential mechanism underlying genotoxicity
- Chemical characterization is ongoing using both liquid chromatography-high resolution mass spectrometry (LC-HRMS) and gas chromatography-high resolution mass spectrometry (GC-HRMS)
- Effect-based methods serve as an **effective tool** for monitoring chemical hazards within SPM

Co-funded by the European Union

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附件2-4

Applying in vitro high-throughput and high-content screening assays for toxicity analysis of environmental water samples: Emphasis on liver and endocrine-disrupting effects

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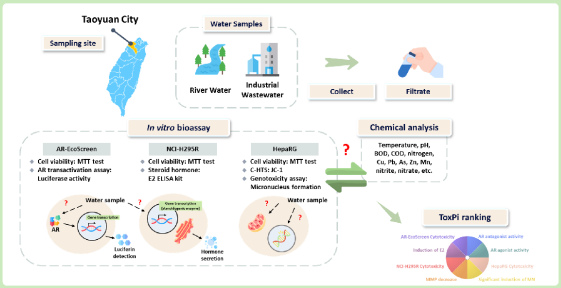
2 National Environmental Research Academy

Introduction

The rapid growth of the global population and human activities have released pollutants into aquatic ecosystems. This pollution has severely impacted water sources like rivers and oceans, endangering aquatic life and potentially compromising human health through the food chain. As a result, monitoring water quality has become essential for protecting public health. Traditional chemical analysis only targets specific contaminants but may overlook the overall toxicity of water, particularly when dealing with complex pollutant mixtures. In contrast, integrating biological analysis techniques offers a quicker and more sensitive means of detecting individual chemicals and pollutant mixtures, providing a more complete evaluation of water quality.

Materials & Methods



Results

Endocrine-disrupting Activity – Androgen receptor (AR)

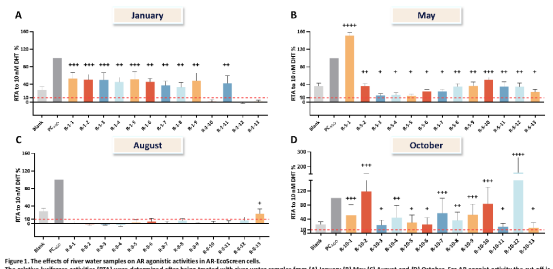


Figure 1. The effects of river water samples on AR agonistic activities in AR-EcoScreen cells.
The relative luciferase activities (RTA) were determined after being treated with river water samples from (A) January (B) May (C) August and (D) October. For AR agonist activity the cut-off is defined as 10% of DHT maximum response. Each value represents the mean ± SEM (N≥3). P_{DHT}: AR agonist control (10 nM of DHT) R: River Water, First Number: Sampling Month, Second Number: Sample ID '+' indicates the relatively androgenic activities: 10-30%(+), 30-50%(+ +), 50-100%(+ + +), >100%(+ + + +)

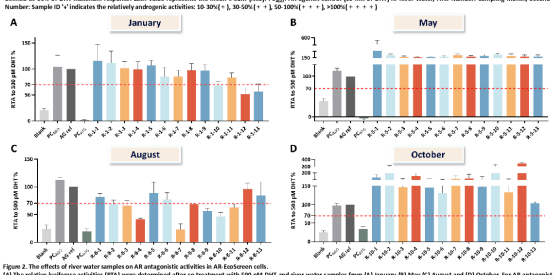


Figure 2. The effects of river water samples on AR antagonistic activities in AR-EcoScreen cells.
(A) The relative luciferase activities (RTA) were determined after co-treatment with 500 pM DHT and river water samples from (A) January (B) May (C) August and (D) October. For AR antagonist activity the cut-off is defined as 30% reduction of the 500 pM DHT control. Each value represents the mean ± SEM (N≥3). PCAGO: AR agonist control (10 nM of DHT); AG ref: AR agonist reference (500 pM of DHT). PCATG: AR antagonist control (1 μM of HF and 500 pM of DHT) R: River Water, First Number: Sampling Month, Second Number: Sample ID

Table 1. Summary of AR agonistic and antagonistic activities of water samples collected in January, May, August, and October. R: River Water, First Number: Sampling Month, Second Number: Sample ID

Sample	Agonistic	Antagonistic	Result	Sample	Agonistic	Antagonistic	Result	Sample	Agonistic	Antagonistic	Result	Sample	Agonistic	Antagonistic	Result
R-1-1	+ + +	–	Agonistic	R-5-1	+ + + +	–	Agonistic	R-8-1	–	–	No impact	R-10-1	+ + +	–	Agonistic
R-1-2	+ + +	–	Agonistic	R-5-2	+ +	–	Agonistic	R-8-2	–	+	Antagonistic	R-10-2	+ + + +	–	Agonistic
R-1-3	+ + +	–	Agonistic	R-5-3	+	–	Agonistic	R-8-3	–	+	Antagonistic	R-10-3	+	–	Agonistic
R-1-4	+ +	–	Agonistic	R-5-4	+	–	Agonistic	R-8-4	–	+	Antagonistic	R-10-4	+ +	–	Agonistic
R-1-5	+ + +	–	Agonistic	R-5-5	+	–	Agonistic	R-8-5	–	–	No impact	R-10-5	+	–	Agonistic
R-1-6	+ +	–	Agonistic	R-5-6	+	–	Agonistic	R-8-6	–	–	No impact	R-10-6	+	–	Agonistic
R-1-7	+ +	–	Agonistic	R-5-7	+	–	Agonistic	R-8-7	–	+	Antagonistic	R-10-7	+ + +	–	Agonistic
R-1-8	+ +	–	Agonistic	R-5-8	+ +	–	Agonistic	R-8-8	–	+	Antagonistic	R-10-8	+ +	–	Agonistic
R-1-9	+ +	–	Agonistic	R-5-9	+ +	–	Agonistic	R-8-9	–	+	Antagonistic	R-10-9	+ + +	–	Agonistic
R-1-10	–	+	Antagonistic	R-5-10	+ + +	–	Agonistic	R-8-10	–	+	Antagonistic	R-10-10	+ + +	–	Agonistic
R-1-11	+ +	–	Agonistic	R-5-11	+ +	–	Agonistic	R-8-11	–	+	Antagonistic	R-10-11	+	–	Agonistic
R-1-12	–	+	Antagonistic	R-5-12	+ +	–	Agonistic	R-8-12	–	–	No impact	R-10-12	+ + + +	–	Agonistic
R-1-13	–	+	Antagonistic	R-5-13	+	–	Agonistic	R-8-13	+	–	Agonistic	R-10-13	+	–	Agonistic

AR Agonistic Activities: 10-30%(+); 30-50%(+ +); 50-100%(+ + +); >100%(+ + + +); no effect(–)
AR Antagonistic Activities: Reduction in RTA >30% (+); no effect(–)

Endocrine-Disrupting Activity – Steroidogenic pathway

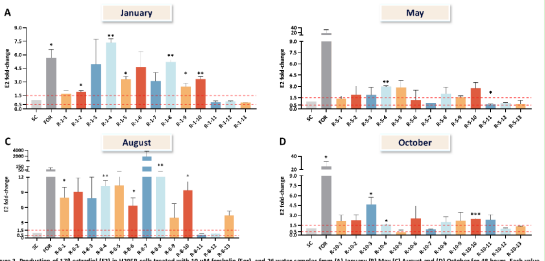


Figure 3. Production of 17β-estradiol (E2) in H295R cells treated with 10 μM forskolin (For), and 26 water samples from (A) January (B) May (C) August and (D) October for 48 hours. Each value represents the mean ± SEM (N≥3). *statistically significant difference compared to control (*p≤0.05, **p≤0.01, ***p≤0.001)

Table 2. Summary of the 17β-estradiol (E2) production fold-change in NCI-H295R cells treated with water samples from four seasons. The groups highlighted in blue represent those with a statistically significant >1.5-fold increase. R: River Water, First Number: Sampling Month, Second Number: Sample ID

Sample	Result	Sample	Result	Sample	Result	Sample	Result
R-1-1	I	R-5-1	–	R-8-1	I I I I I	R-10-1	I
R-1-2	+	R-5-2	+	R-8-2	+ + + + +	R-10-2	+
R-1-3	+ + +	R-5-3	+	R-8-3	+ + + + +	R-10-3	+ + +
R-1-4	+ + + +	R-5-4	+	R-8-4	+ + + + +	R-10-4	+
R-1-5	++	R-5-5	+	R-8-5	+ + + + +	R-10-5	–
R-1-6	+ + +	R-5-6	–	R-8-6	+ + + + I	R-10-6	+
R-1-7	++	R-5-7	–	R-8-7	+ + + + +	R-10-7	–
R-1-8	+ + +	R-5-8	–	R-8-8	+ + + + +	R-10-8	+
R-1-9	I	R-5-9	I	R-8-9	I I	R-10-9	I
R-1-10	I I I	R-5-10	I	R-8-10	I I I I I	R-10-10	I
R-1-11	–	R-5-11	–	R-8-11	–	R-10-11	I
R-1-12	–	R-5-12	–	R-8-12	–	R-10-12	–
R-1-13	–	R-5-13	–	R-8-13	++	R-10-13	–

E2 fold-change: <1.5(–), 1.5-3.0(+), 3.0-4.5(++), 4.5-6.0(+++), 6.0-7.5(++++), >7.5(+++++)

Liver Toxicity

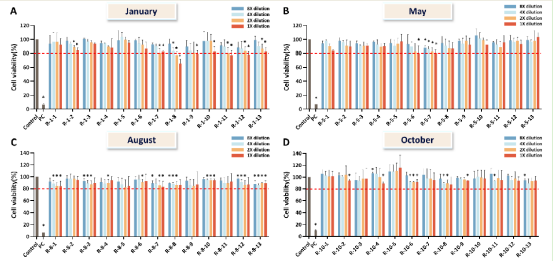


Figure 4. Cell viability in HepaRG cells exposed to water samples collected in (A) January, (B) May, (C) August, and (D) October.
Treatment groups (n=3) were normalized to plate vehicle control (n=6) set to 100%. The cut-off for compromised cell viability in HepaRG cells was 50%. *statistically significant difference compared to control (*p≤0.05)

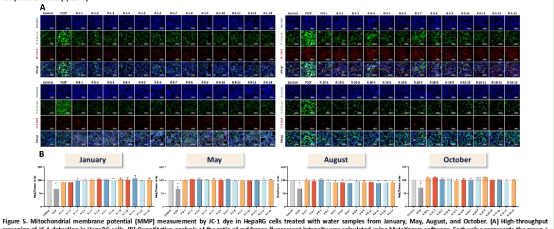


Figure 5. Mitochondrial membrane potential (MMP) measurement by JC-1 dye in HepaRG cells treated with water samples from January, May, August, and October. (A) High-throughput screening of JC-1 detection in HepaRG cells. (B) Quantitative analysis of the ratio of red/green fluorescent intensity was calculated using MetaXpress software. Each value represents the mean ± SEM (N≥3). *statistically significant difference compared to control (*p≤0.05)

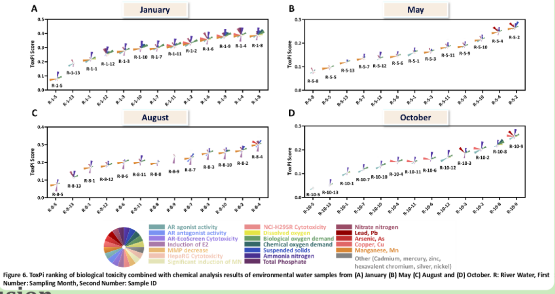


Figure 6. ToxPi ranking of biological toxicity combined with chemical analysis results of environmental water samples from (A) January (B) May (C) August and (D) October. R: River Water, First Number: Sampling Month, Second Number: Sample ID

Conclusion

After exposure to river water samples at four dilution concentrations, most did not cause significant cytotoxicity. The river water samples' androgen receptor (AR) activity showed seasonal variation, and estradiol (E2) production in the steroidogenesis pathway was affected. These results suggest potential endocrine-disrupting activity in river water with seasonal fluctuations. For liver toxicity, the results demonstrated no significant effects on mitochondrial function or in the micronucleus test, indicating normal liver cell function and no genotoxicity. With this combined alternative testing and computational toxicology approach, a better understanding of the hazards of overall water quality can be achieved.

附件2-5

The evolving Full Multi: Flexibly simulating microplastic exposure in aquatic environments

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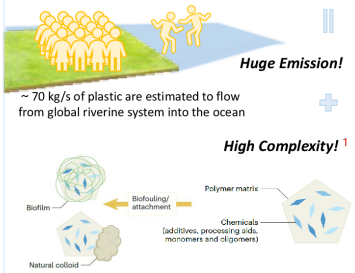
[2] School of Geography, Geology and the Environment, University of Leicester, United Kingdom
[3] Institute for Biodiversity and Ecosystem Dynamics, University of Amsterdam, Netherlands

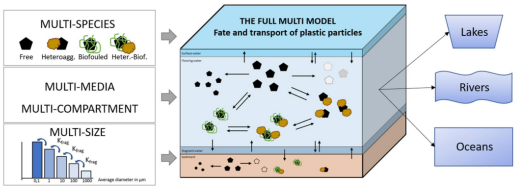
Introduction

Plastic threats



Computational models

assist in understanding novel entities

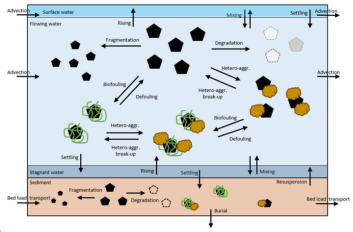


e.g., The Full Multi [2]

- A modular, easy-to-run and open-access model for nano- & microplastics transport and fate in aquatic systems
- Limited in dynamic vertical transport description (i.e., resuspension, turbulent mixing, burial)

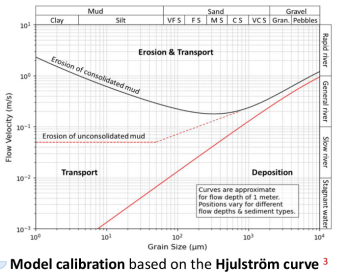
Research Q.: *How can we incorporate variable hydrodynamics into mass-balance models (e.g., the Full Multi) so they are able to describe dynamic aquatic systems?*

Methodology



Model parameterization optimization:

Process	Old	New
Vertical mixing in waters	constant	$k_{mixing} \propto v_{flow}^2$
Resuspension from sediment	constant	$k_{resuspension} \propto v_{flow}^2$
Burial in sediment	constant	$k_{burial} = k_{settling} - k_{resuspension}$



Model calibration based on the **Hjulström curve** [3]

Model validation by natural particles:

- Estimating suspended solid (SS) concentration in the non-tidal section of River Thames during 2009-2017

Results

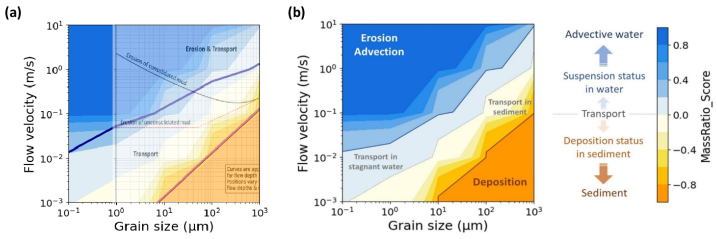


Figure 1. Contour plots for the steady-state mass distribution of natural sediment particles (ρ=2700 kg/m³) in the 1-meter-deep generic river:
(a) the graphical validation with the shear stress baseline (in dark blue) and the deposition line (in dark red), covered with the Hjulström curve;
(b) the illustration for the contour plot aligning with the concept of the Hjulström curve.

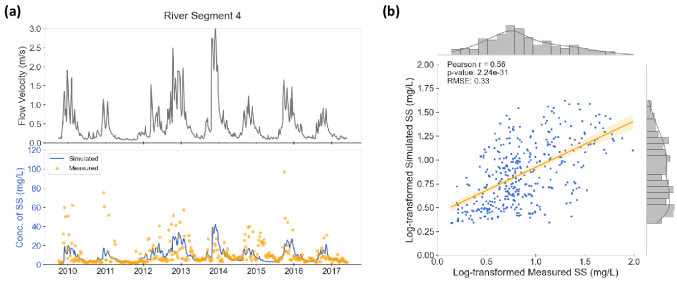


Figure 2. **(a)** Comparison between simulated (blue line) and measured (yellow dot) data [4] of suspended solid (SS) concentrations in a downstream segment (river segment 4) of River Thames.
(b) Pearson correlation analysis of measured and simulated SS concentrations. Notably, the RMSE value is calculated for log-transformed concentrations.

Conclusion

- Model results are consistent with expectations derived from the well-known Hjulström curve.
- The evolving Full Multi model will be able to dynamically simulate the fate and transport of microplastics in aquatic systems with better fidelity to the real environment.

Acknowledgments This research is funded by the Swedish Science Foundation (Vetenskaprådet) 2023-05085 (MμPPET) and the European Chemical Industry Council (CEFIC) Long Range Initiative (CEFIC-LRI ECO48 & ECO57).

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Play with the Full Multi

附件2-6

Biodegradation Rates of Polylactic Acid Microplastics in Aquatic Environment: Role of Particle Size and Environmental Aging

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Key to Infinite Tomorrow

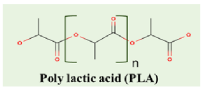
1 Abstract

The increasing adoption of biodegradable plastics as alternatives to conventional plastics aims to reduce environmental pollution. While these materials degrade more rapidly than traditional plastics, their accelerated breakdown may lead to a higher production of microplastics (MPs). Once released into aquatic environments, these MPs undergo aging processes such as physical abrasion, chemical oxidation, weathering, and UV irradiation, which modify their physicochemical properties. These changes, particularly in surface area and functional groups, influence the rate of microbial degradation, as degradation predominantly occurs on particle surfaces. This study investigated the biodegradation of polylactic acid (PLA) microplastics (MPs) of different sizes (5, 20, and 150 μm) and aging states (unaged, thermal aged, and UV/H_2O_2 accelerated aged) over a 90-day period using activated sludge. The results demonstrated that smaller particle sizes exhibited faster biodegradation rates, with the rate constant (k, day^{-1}) increasing 0.0006 to 0.0027, highlighting the critical role of surface area in the biodegradation of MPs. Additionally, aging processes, particularly UV/H_2O_2 accelerated aging, significantly enhanced biodegradation by altering surface properties such as fragmentation and surface oxidation. For example, 10 days of UV/H_2O_2 aging increased the biodegradation rate constant (k, day^{-1}) from 0.0022 to 0.0096 for 20 μm MPs. These findings suggest that PLA MPs subjected to natural weathering conditions may degrade more rapidly than under controlled laboratory conditions, emphasizing the importance of understanding environmental factors in predicting the fate of biodegradable MPs.

2 Materials & Methods

1. Materials

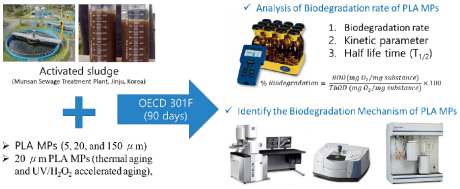
- PLA MPs
  - PLA MPs were manufactured by the Korea Institute of Industrial Technology in Ansan, Korea, with labeled particle sizes of 5 μm, 20 μm, and 150 μm in diameter.



- PLA MPs aging
  - To simulate environmental aging, pristine PLA MPs with a diameter of 20 μm underwent artificial weathering through two distinct protocols (Hydrothermal aging at temperatures of 20, 40, or 60 ° C for 5 days, UV/H_2O_2 accelerated aging for 5 or 10 days)

2. Methods

- Biodegradation experiments
  - Assessed through repirometric test, the OECD test guideline 301F (OECD 1992)
  - Activated sludge used as the inoculum was collected from the sewage treatment plant (STP) of Munsan in Jinju, Korea.
  - The reference substances (sodium benzoate and micro-crystalline cellulose (MCC, 20 μm average particle size).



3 Results & Discussion

1. Effects of particle size

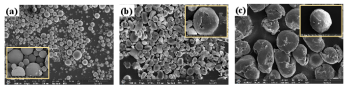


Fig. 1. SEM images; (a) 5 μm PLA MPs, (b) 20 μm PLA MPs, (c) 150 μm PLA MPs

	5 μm PLA	20 μm PLA	150 μm PLA
Zeta Potential (mV) [1]	-7.58 ± 0.27	-46.77 ± 3.01	-38.2 ± 3.14
Surface area ($m^2 g^{-1}$)	3.667	1.702	0.272

[1] Particles in 10mM NaCl solution

Table 1. Zeta potentials and surface area of different sized of PLA MPs

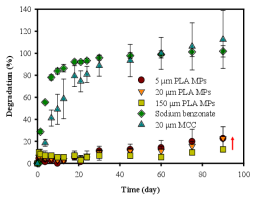


Fig. 2. Biodegradation curves of different sizes of PLA MPs and reference substances

	k(day^{-1})	$T_{1/2}$ (day)	$T_{1/2}$ (year)	r^2
5 μm PLA	0.0027	252	0.7	0.9265
20 μm PLA	0.0022	318	0.9	0.8895
150 μm PLA	0.0006	1247	3.4	0.2471
Sodium Benzoate	0.1285	5	0	0.9247
20 μm MCC	0.0658	11	0	0.9700

Table 2. Biodegration kinetic parameters of different sizes of PLA MPs and reference substances

→Smaller particles exhibited increased biodegradation rates, indicating higher susceptibility to microbial degradation.

2. Effects of particle aging

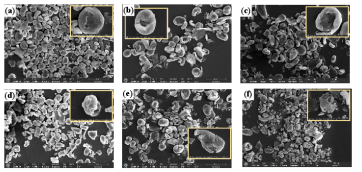


Fig. 3. SEM images of pristine and aged PLA MPs: (a) pristine PLA MPs; (b–d) hydrothermally aged PLA MPs at (a) 20 ° C, (b) 40 ° C, and (c) 60 ° C for 5 days; (e–f) UV/H_2O_2–exposed PLA MPs for (e) 5 days, and (f) 10 days.

		Surface Area ($m^2 g^{-1}$)	Carbonyl index (CI) [1]
Pristine PLA MPs		1.702	4.930
Hydrothermally aged PLA MPs	20 °C	1.942	4.988
	40 °C	2.160	5.284
	60 °C	2.737	5.306
UV/H_2O_2-exposed PLA MPs	5 days	1.900	5.341
	10 days	5.220	5.706

[1] Carbonyl index (CI) was calculated as the ratio of the carbonyl group area (1690-1810 cm^{-1}) to the methylene group area (1420-1490 cm^{-1})

Table 3. Surface area and carbonyl index of pristine and aged PLA MPs

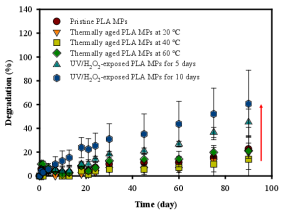


Fig. 6. Biodegradation curves of pristine and aged MPs

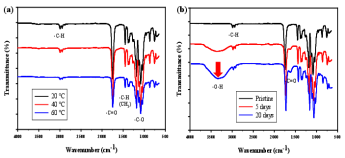


Fig. 4. FTIR spectra of pristine and aged MPs: (a) hydrothermally aged PLA MPs, and (b) pristine and UV/H_2O_2–exposed PLA MPs.

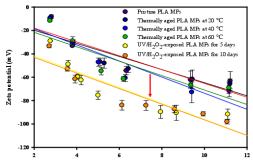


Fig. 5. Plots of zeta potentials as a function of pH for pristine and aged PLA MPs

		k (day^{-1})	$T_{1/2}$ (day)	$T_{1/2}$ (year)	R^2
Pristine PLA MPs		0.0022	318	0.9	0.8895
Hydrothermally aged PLA MPs	20 °C	0.0018	384	1.1	0.8806
	40 °C	0.0016	435	1.2	0.9286
	60 °C	0.0022	321	0.9	0.7470
UV/H_2O_2-exposed PLA MPs	5 days	0.0060	115	0.3	0.9695
	10days	0.0096	72	0.2	0.9879

Table 4. Biodegradation kinetics parameters of pristine and aged PLA MPs

→While hydrothermal aging induced hydrolysis without significantly affecting biodegradation rates, UV-accelerated aging resulted in the oxidation of PLA MPs, markedly enhancing biodegradation.

→This highlights the role of oxidative processes in facilitating microbial activity on aged PLA MPs.

Acknowledgments : This research was supported by the National Research Council of Science & Technology (NST) grant from Korea government (MSIT) (No. CAP20025-000) and the Korea Institute of Toxicology (grant No. KK-2406).

附件2-7

UMD
UNIVERSITY OF MINNESOTA DULUTH
Driven to Discover

Relating Biotic Degradation to Polymer Characteristics to Better Predict the Fate of Biodegradable Plastics in the Environment

Melissa A. Maurer-Jones, Margaret Brown, Thomas Badzinski, Emma Sorensen, Clare List, Ariana Campanaro, R. Lee Penn

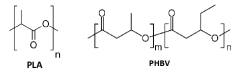
Introduction and Project Aims

- Bio-derived and biodegradable plastics are one part of the solution to minimize environmental impact of plastics
- Current standards for compost and anaerobic digestion specify degradation conditions, though there are some limitations of these methods including the time required to run the assays
- Optimization of waste streams for these materials requires fundamental understanding that relates the synergistic biotic degradation pathways to polymer structures and properties, which are known to influence the biodegradability

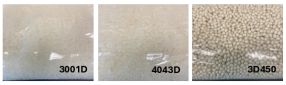
AIMS:

- Characterize enzymatic hydrolysis of aliphatic polyesters with varying materials properties
- Explore a multi-step, synergistic biodegradation assay, studying the sequential degradation resulting from enzyme hydrolysis and biofilm formation

Polymers and Materials Characterization



Plastics -- thin films of of PLA and PHBV and resin pellets from Ingeo® PLA



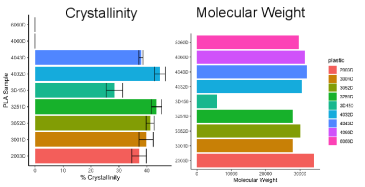
Photodegradation of PLA and PHBV thin films were used to alter materials properties while starting with the same base polymers

Ingeo® PLA polymer resins were used to have varied properties without weathering

Photodegraded PLA characteristics (minimal changes in FTIR measured surface chemistry observed – data not shown)

UV light Amount	% Crystallinity (DSC)	M_w (^{1}H NMR)
0 h	30	18,900
2 h	36	16,600
4 h	45	15,050

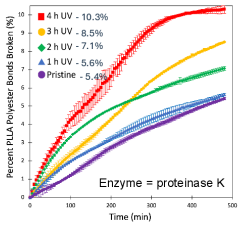
Ingeo® PLA polymer characteristics



Enzymatic Hydrolysis Quantification

Generation of fluorescent signal from probe molecule solvent cast with polymer matrix used to assess enzyme hydrolysis (Zumstein 2019).

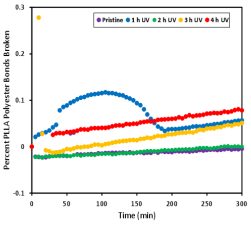
PLA



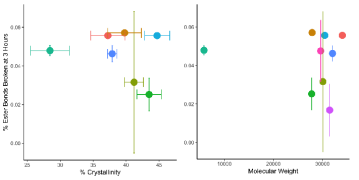
Photodegraded PLA: UV-light degradation "kickstarts" enzymatic hydrolysis likely the result of decreased M_W

Photodegraded PHBV: polymer recalcitrant to enzymatic hydrolysis, despite similar characteristics as pristine PLA

PHBV



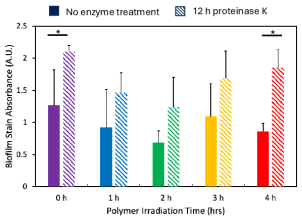
Crystallinity Molecular Weight



No observed correlation of hydrolysis yields and Ingeo® PLA polymer characteristics – suggests a more complex model required to predict a polymer's biodegradability potential

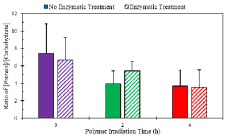
Sequential Biofilm Growth Assay

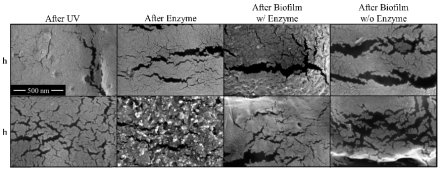
Growth of facultative anaerobe *Shewanella oneidensis* measured with crystal violet staining on photodegraded PLA after samples allowed to enzymatically hydrolyze



Biofilm growth is dependent on UV-degradation and/or "pre-treated" with enzyme hydrolysis, with enzyme pretreatment promoting bacterial attachment

Analysis of the cell exudate (EPS) reveals the bacteria excrete different ratio of proteins and carbohydrates based on the UV-treatment





SEM analysis reveals UV-light, enzymes and biofilms cause variable changes to the PLA surface, including increased pitting and enlargement of cracks.

Conclusions

- UV light degradation of PLA promotes enzymatic hydrolysis, likely because of decreased molecular weights, although likely multiple properties impact biodegradability
- Enzyme hydrolysis promotes biofilm formation, though trends of increased hydrolysis does not correlate to increased biofilm
- Need to consider the breadth of materials characteristics and the unintentional changes that occur in the environment for "sustainable" design of polymers

Acknowledgements: NSF Center for Sustainable Polymers, Warren F. Davis Endowment Fund, UM Duluth Department of Chemistry and Biochemistry
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附件2-8

DANUBE PRIVATE UNIVERSITY
Austria

Effects of polyethylene (PE) and polyvinyl chloride (PVC) plastic particles on isolated human erythrocytes

Liesa Geppner[1], Veit Erhart[1], Moritz Rados[1], Sandro Wariwoda[1], Maja Henjakovic[1]

[1] Department of Medicine, Faculty of Medicine and Dentistry, Danube Private University, Krems, Austria

Introduction

The prevalence of micro- and nanoplastic particles as widespread environmental contaminants raises significant concerns regarding their potential health implications. Following ingestion or inhalation, small microplastics and nanoplastics can enter the bloodstream, thereby affecting human erythrocytes and potentially having an effect on their morphology, aggregation behavior, and membrane integrity.

The aim of this study was to investigate the effects of environmentally realistic polyethylene (PE) and polyvinyl chloride (PVC) microplastic particles, compared to polystyrene (PS) model particles, on human erythrocytes in vitro.

Methods

❖ Manifacturing of microplastic particles

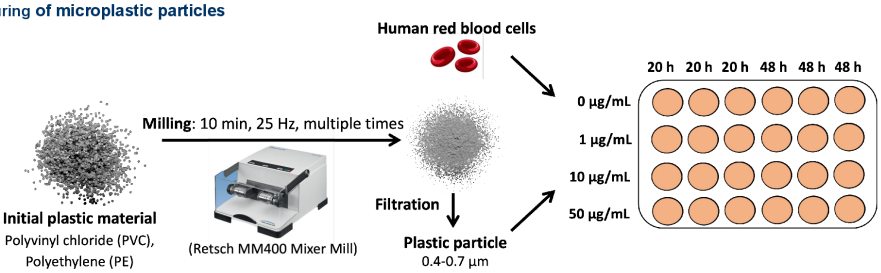

Fig. 1 Process for the production of microplastics with a size between 0.7 and 0.4 µm followed by the investigation of their effects on human blood cells in vitro using 24-well cell culture plates.

Results

❖ Effect of PS model particles compared to milled PE and PVC particles in the presence or absence of plasma proteins on the red blood cell count

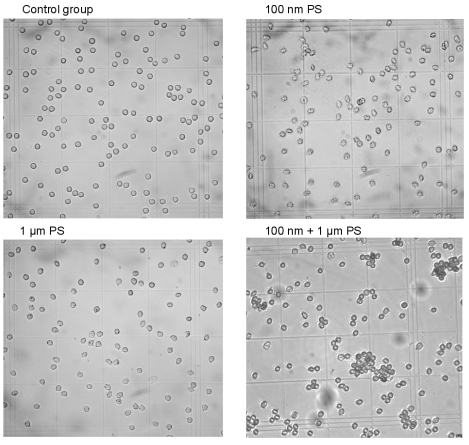

Fig. 2 Microscopic images of red blood cells after 20 h incubation without and with PS particles at a concentration of 100 µg/ml in a protein-free medium with different particle sizes.

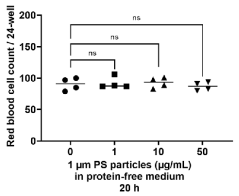

Fig. 3 PS particle exposition of isolated human red blood cells for 20 h in protein-free medium.

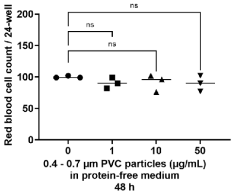

Fig. 5 PVC particle exposition of isolated human red blood cells for 48 h in protein-free medium.

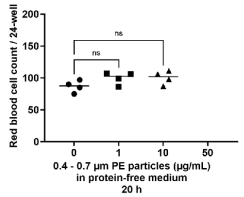

Fig. 4 PE particle exposition of isolated human red blood cells for 20 h in protein-free medium.

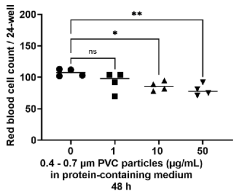

Fig. 6 PVC particle exposition of isolated human red blood cells for 48 h in protein-containing medium.

Conclusion

These findings suggest that exposure to nanoplastics may impair the ability of red blood cells to pass through blood vessels efficiently, due to altered cell morphology. Moreover, PVC plastic particles seem to reduce the red blood cell count in the presence of plasma protein. Future studies incorporating plasma proteins and a broader range of particle sizes will enhance understanding of micro- and nanoplastics interactions with red blood cells under realistic in vivo conditions.

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DANUBE PRIVATE UNIVERSITY

附件2-9

The impact of fossil and biobased microplastics on human cells

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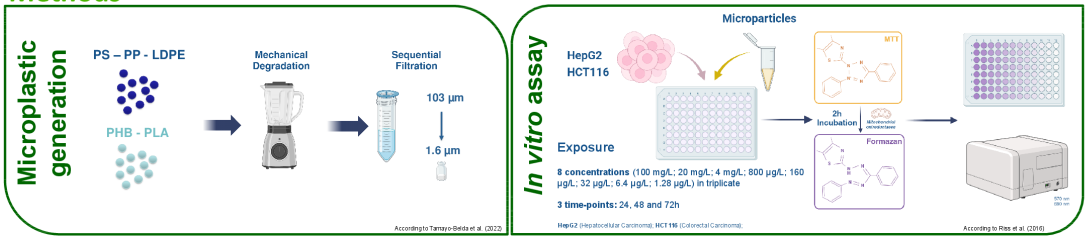
Introduction

Micro and nanoplastics have become pervasive environmental contaminants, raising concerns about human exposure through ingestion, inhalation, and dermal contact (Oliveira & Almeida, 2019). Toxicological responses depend on particle size, shape, and chemical composition (Oliveira, 2019). While polystyrene (PS) is the most studied polymer, polypropylene (PP) and low-density polyethylene (LDPE) dominate global plastic production (Plastics Europe, 2024). Biobased alternatives such as polyhydroxybutyrate (PHB) and polylactic acid (PLA) degrade more readily, but their cellular toxicity remains poorly understood. This study examines the effects of these particles on human cell models to assess potential health risks.

Methods



Results

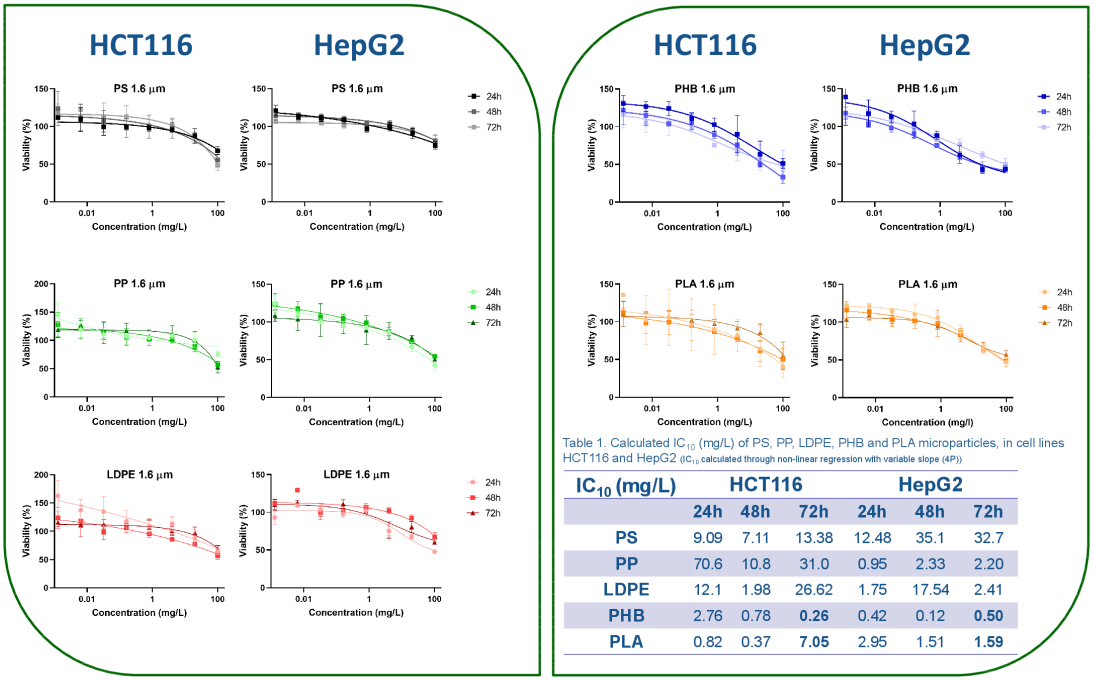


Table 1. Calculated IC_{10} (mg/L) of PS, PP, LDPE, PHB and PLA microparticles, in cell lines HCT116 and HepG2 (IC_{10} calculated through non-linear regression with variable slope (4P))

IC_{10} (mg/L)	HCT116			HepG2		
	24h	48h	72h	24h	48h	72h
PS	9.09	7.11	13.38	12.48	35.1	32.7
PP	70.6	10.8	31.0	0.95	2.33	2.20
LDPE	12.1	1.98	26.62	1.75	17.54	2.41
PHB	2.76	0.78	**0.26**	0.42	0.12	**0.50**
PLA	0.82	0.37	**7.05**	2.95	1.51	**1.59**

Conclusions

- PLA and PHB microplastics are more toxic than fossil based PS, PP and LDPE microplastics.
- PS and PP have the lower toxic profile of all plastic types tested.
- HepG2 cell line is more sensitive to PP, LDPE and PLA, while HCT116 cell line was more sensitive to PS and PHB, at 72h time-point.
- The present data support the need for more studies regarding biobased and biodegradable polymers and their impact in human health.

References

Thanks are due for the financial support within the strategic funding program to CESAM (UIDP/50017/2020. UIDB/50017/2020. LA/P/0094/2020) and FCT/MEC through project NanoPlanet (2022.02340.PTDC). Thanks are also due to the Spanish Government, Ministerio de Ciencia Tecnología e Innovación Grants TED2021-131609B-C32/33, PID2020-113769RB-C21/C22, PLEC2021-007693 and RyC2021-034953-I from the European Union "NextGenerationEU/PRTR.

附件2-10

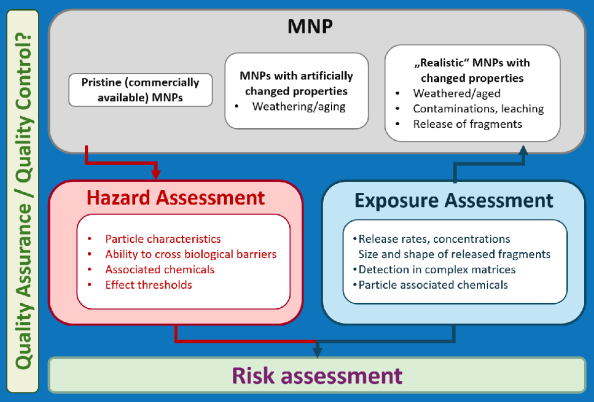
Micro- and nanoplastics (MNP) — a wish list for reliable determination of the risks for humans

Dana Kühnel[1], Anita Jemec Kokalj[2], Anja F.R.M. Ramsperger[3], Damjana Drobne[2], Anna Undas[4], Annegret Potthoff[5], Korinna Altmann[6], Willie Peijnenburg[7,8], Nina Jeliazkova[9], Anani Komlavi Afanou[10], Martin G.J. Löder[3], Christian Laforsch[3], Rudolf Reuther[11], Bernd Giese[12]

[1]Helmholtz Centre for Environmental Research GmbH – UFZ, Leipzig, Germany; [2]University of Ljubljana, Biotechnical Faculty, Ljubljana, Slovenia; [3]University of Bayreuth, Animal Ecology I & BayCEER, Bayreuth, Germany; [4]Wageningen Food Safety Research (WFSR), Wageningen, The Netherlands; [5]Fraunhofer Institute for Ceramic Technologies and Systems IKTS, Dresden, Germany; [6] Bundesanstalt für Materialforschung und -prüfung, Berlin, Germany; [7]Institute of Environmental Sciences (CML), Leiden University, Leiden, The Netherlands; [8]National Institute of Public Health and the Environment, Centre for the Safety of Substances and Products, Bilthoven, The Netherlands; [9]Ideaconsult Ltd., Sofia, Bulgaria; [10]National Institute of Occupational Health, Oslo, Norway; [11]ENAS Environmental Assessments, Lauf, Germany; [12]Institute of Safety and Risk Sciences (ISR), BOKU University, Vienna, Austria

The risk assessment of nano and microplastic particles is challenging, due to data and knowledge gaps on release, exposure as well as hazard. The research field is quite diverse, as MNP encompass a huge variety in different polymer materials, size and shapes, as well as properties that are tailored by the addition of various substances.

MNP risk assessment



European research cluster to understand the health impacts of MNP - CUSP

SCAN ME

Further reading in our Zenodo community:

CUSP

PlasticsFatE

www.plasticsfate.eu

Plastics Fate and Effects in the Human Body

Priority areas (Pas) for future MNP data generation

Knowledge and Data gaps	General and test material-related challenges	Strategy to overcome challenges & QA/QC aspects
PA 1: Exposure and hazard assessment for plastic associated chemicals (incl. plastic additives)		
PA2: Quality assurance and quality control		
PA3: MNP material provision with various compositions and properties		
PA4: Appropriate control particles for toxicity testing		
PA5: Assessing the joint effects of MNP and associated chemicals		
PA6: : Characterise functional biomarkers as basis for AOPs and IATAs		

Manuscript in preparation!

Knowledge and Data gaps	General and test material-related challenges	Strategy to overcome challenges & QA/QC aspect
PA6: Characterise functional biomarkers as basis for AOPs and IATAs	• Identify and characterize MNP-specific functional biomarkers • Cell-based assays selected based on the various human exposure routes	• For detection of potential long-term effects of MNP • Basis to build MNP specific AOPs and IATAs

Conclusion & Outlook

- RA for MNP is a multidisciplinary effort, where combining data and knowledge from several fields is necessary
- Data collaboration should ensure bringing together different data sources to create value and improve decision-making
- Data comparability must generally be ensured
- Greater harmonization is needed for research, while for routine analyses, such as monitoring and regulatory assessments, standardization of methods and materials is necessary
- The agreed methods and materials should be based on quality standards that must be defined in advance

PlasticsFatE has received funding from the European Union's Horizon 2020 Research and Innovation programme, under the Grant Agreement number 965367

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附件2-11

Analysis of Per- and Poly-fluoroalkyl Compounds in Textile and Leather Goods Using Energized Dispersive Guided Extraction Combined with UPLC-MS/MS and APGC-MS/MS

Ying-Hsuan Chen, Chia-Yang Chen*

Introduction

- Per- and polyfluoroalkyl substances (PFAS) are synthetic chemicals widely used in textile and leather manufacturing to impart water-repellent properties.
- Due to environmental and health concerns, certain long-chain PFAS face regulatory restrictions. However, unregulated alternatives raise safety concerns and risk undesirable substitutions.

Objectives

- Optimize and validate an analytical method for detecting 31 PFAS across seven groups, including legacy and emerging PFAS.

Determination of PFAS in textile and leather products

Sample collection

➢ Selected products marketed as water-, stain-, and oil-repellent

➢ Product Types 1) Carpet 2) Apparel 3)Functional Gear

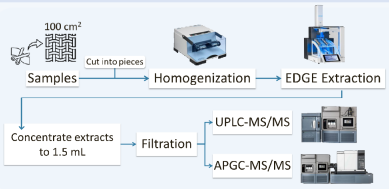
Methods

Sample preparation

Extraction Solvents:

➢ 10 mL methanol → 10 mL acetone

➢ 70 ˚C, 30–35 psi, 5 min each



Instrumental Analysis

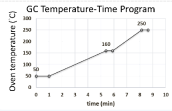
Detector

- Waters Xevo TQ-XS MS/MS
- Multiple Reaction Monitoring mode

APGC-MS/MS (APCI+)

- Injection Mode: Splitless
- Carrier Gas: Helium (1.8 mL/min)

➢ Target Analytes: 4:2, 8:2, 10:2 FTOHs



UPLC-MS/MS (UniSpray-)

- Temperature: 55 ˚C
- Flow rate: 0.5 mL/min

LC Method 1

➢ Target Analytes: 6:2, 8:2 PAPs

Waters ACQUITY UPLC BEH C18 column (50 x 2.1 mm, 1.7 µm)

Mobile phase

A: 10-mM *N*-methyl morpholine

B: 10-mM *N*-methyl morpholine in Methanol

Gradient		
Time	A%	B%
Initial	80	20
0.5	80	20
4.5	40	60
5.5	0	100
6.0	0	100
6.2	80	20
8.2	80	20

LC Method 2

➢ Target Analytes: the other 26 PFAS

Atlantis Premier BEH C18 AX Column (50 x 2.1 mm, 1.7 µm)

Mobile phase

A: 5-mM ammonium acetate

B: Methanol

Gradient		
Time	A (%)	B (%)
Initial	70	30
0.5	70	30
7.5	0	100
8	0	100
8.2	70	30
10.2	70	30

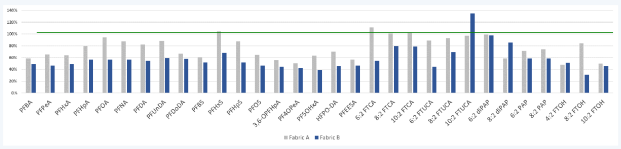
MS conditions

Parameters	Value
Impacter voltage (kV)	2.5
Desolvation temperature (˚C)	450
Desolvation gas flow (L/hr)	900
Cone gas flow (L/hr)	150
Nebulizer (Bar)	7.0
Collision gas flow (mL/min)	0.14
Source temperature (˚C)	150

Method Validation

Matrix Effect

- Matrix effects ranged from 47–111% for Fabric A (marketed as waterproof with GORE-TEX) and 30–135% for Fabric B (without GORE-TEX treatment).

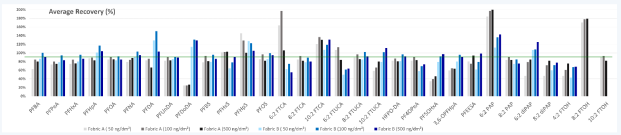


Accuracy and Precision

Test Levels: Spiked with 50, 100, and 500 ng/dm²

➢ Most Analytes: Recovery between 60%–130%, with %RSDs below 18.4%

- **Fabric A** had **higher recoveries** for 6:2 PAP (184–200%), 8:2 FTOH (170–179%), and 6:2 FTCA at 50 ng/dm² (164%) and 100 ng/dm² (197%), but **lower recoveries** for PFDoDA (24–27%).
- **Fabric B** showed more consistent results, with **high recoveries** for PFDA at 100 ng/dm² (151%) and 6:2 PAP at 500 ng/dm² (143%), but **lower recoveries** for 4:2 FTOH at 50 ng/dm² (43%).
- PFDoDA recovery in Fabric B was significantly higher than in Fabric A, ranging from 114% to 131%.



Conclusion

This method is appropriate for the analysis of PFAS in consumer products, particularly those designed to resist water or stains, such as carpets, jackets, shoes, gloves, and umbrellas.

Acknowledgements This work was supported by the National Science and Technology Council, Taiwan (Grant No. : NSTC 113-2314-B-002-171-MY3)

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附件2-12

SETAC Europe 35th Annual Meeting

Exploring the Hidden Threat of Short-chain Chlorinated Paraffins: Trophic Level Transfer and Cross-Generational Toxicity

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[2] Center for Water Resources Education and Research, National Pingtung University of Science and Technology, Pingtung, 912, Taiwan, R.O.C.
[3] Department of Biomedical Science and Environmental Biology, Kaohsiung Medical University, Kaohsiung, 807, Taiwan, R.O.C.

Introduction

- Short-chain chlorinated paraffins (SCCPs) include all individual chemicals or mixtures that contain: $C_xH_{(2x-y+2)}Cl_y$, while x = 10-13, **y = 3-12**, and average chlorine content ranges from approximately **40 %** to **70 %** (USEPA, 2009).

Why should we care about SCCPs?

Fig 1. Structure of SCCPs

- Short-chain chlorinated paraffins (SCCPs) have been found in environmental samples worldwide at concentrations ranging from nanograms to micrograms in aquatic environments (Kumari and Raghunathan, 2024).
- These compounds have been found in various aquatic species and environmental samples, suggesting that they can biomagnify via trophic transfer within aquatic food webs (Lee et al.,2025; Kim et al.,2025).
- SCCPs are designated as persistent organic pollutants (POPs) under the Stockholm Convention, pose a significant environmental threat due to their persistence, bioaccumulation potential, and ecotoxicological consequences.

Research Objectives

- To establish and verify a sensitive and reliable analytical approach for identifying SCCPs in aquatic environments using gas chromatography-electron impact tandem mass spectrometry (GC-EI-MS/MS) in conjunction with headspace solid-phase microextraction (HS-SPME).
- To evaluate the acute and chronic toxicological impacts of SCCPs on representative aquatic invertebrates (*Pseudokirchneriella subcapitata*, *Daphnia magna*, and *Chironomus riparius*).
- To evaluate the trophic transfer and bioaccumulation potential of SCCPs via dietary exposure using *Pseudokirchneriella subcapitata* as a primary food source.
- To investigate the cross-generational impacts of SCCP exposure on growth performance and morphological deformities in aquatic species.

Materials and Methods

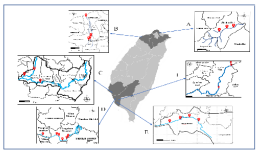
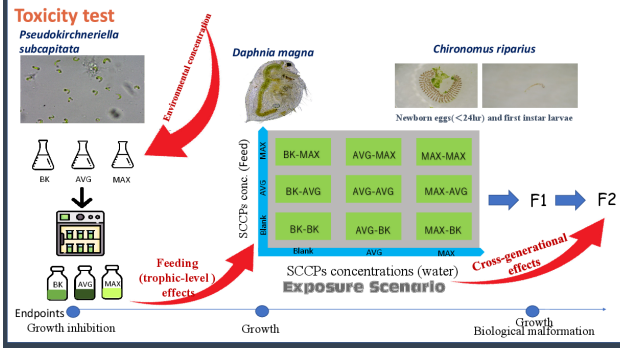


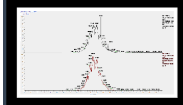
Fig 2 Sampling sites

Highest and **average** SCCPs environmental concentration for biological experiments



Results and Discussion

Establishment and Validation of GC-EI-MS/MS Method

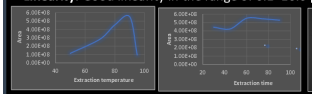


- **Column**: TG-5SilMS (60 m x 0.25 mm i.d x 0.25 μm)
- **Injection mode**: Splitless
- **Surge pressure**: 400 kPa
- **Injection temperature**: 300℃
- **Detection limit** : 0 μg/L

Compound	Precursor Mass	Product Mass	RT (min)	Collision Energy
$^{13}C_6$-α-BHC	222.9	187	8.28	10
$^{13}C_6$-α-BHC	224.9	189.2	8.28	10
HCB-$^{13}C_6$	287.8	218	8.36	20
HCB-$^{13}C_6$	289.9	219.9	8.36	20
SCCP	91	53.0	14.00	15
SCCP	75.1	49.1	14.00	10

Optimization of HS-SPME Procedure

- **Sample volume**: 25 mL water
- **Equilibration**: 90℃ for 10 minutes
- **Fiber**: 100-μm PDMS
- **Extraction**: 90℃ for 60 minutes
- **Desorption**: 260℃ for 5 minutes
- **Linearity**: Good linearity in the range of 0.1–10.0 μg/L



Meets regulatory requirements of most environmental standards

RESULTs and Discussion

Environmental concentration

- SCCPs concentrations ranged from N.D to 0.757 μg/L , with the highest value at sample station AGD6; the mean value is 0.337 μg/L (Fig.3).
- All are lower than the maximum acceptable concentration standards of the European Water Framework Directive (1.4 μg /L).

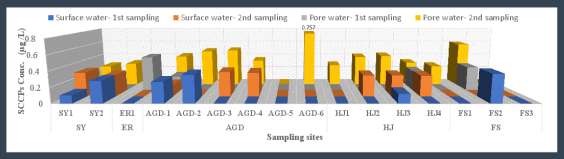
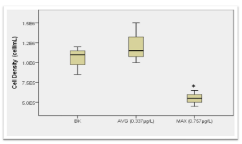


Fig.3 Concentrations of SCCPs in river surface water and pore water

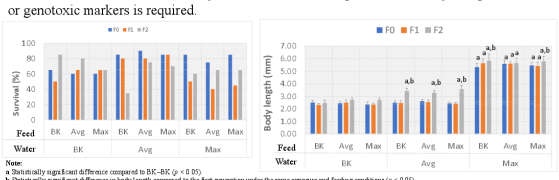
Biological toxic effects



- No notable inhibition (6.4%) was seen at an average SCCPs concentration of 0.337 μg/L.
- There is a notable growth inhibition of 57.7% observed at the highest concentration of SCCPs, which is 0.757μg/L, in comparison to BK (Fig. 4)

Fig. 4 Impact of varying water concentrations on the development of *P. subcapitata*

- Our findings demonstrate that the survival of D. magna is much more influenced by exposure to SCCP-contaminated water than by changes in feeding behavior (Fig. 5). This finding aligns with earlier studies, which have shown that the concentration of chlorinated paraffins (CPs) in *D. magna* after water-only exposure is increased, indicating a higher bioaccumulation factor compared to simultaneous water and food exposure (Castro et al., 2019).
- *D. magna* was exposed to 0.757 μg/L. SCCPs had considerably longer body length compared to control groups ($p < 0.05$) (Fig. 5). SCCPs supported rather than inhibited development, and there is no research on their toxicity mechanisms in D. magna. Further study using biochemical or genotoxic markers is required.



Note:
a Statistically significant difference compared to BK–BK ($p < 0.05$).
b Statistically significant difference in body length compared to the first generation under the same exposure and feeding conditions ($p < 0.05$).

Fig. 5 The survival and body length of *D. magna* at the endpoint under various conditions of SCCPs

- No major variations were identified, although feeding inhibited *C. riparius* growth more than water concentration, indicating the possibility of SCCP trophic accumulation and biomagnification.
- In the third generation of *C. riparius*, there was no clear link between the surrounding concentration and mentum malformations, which could be due to some recovery from the damage caused by pollutants in the offspring of invertebrates (Li et al., 2022).

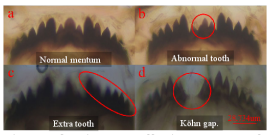


Fig 6. Deformity types affecting mentums of *C. riparius* larvae

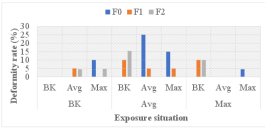


Fig. 7 The deformity rate of *C. riparius* at the endpoint under various conditions of SCCPs

Bioaccumulation in *C. riparius*:

- SCCP levels were undetectable in the control group (BK-BK).
- The F0–F2 generations exhibited the highest concentrations of 14.83 ng/g dw (Avg–Max), 3.34 ng/g dw (Max–BK), and 17.42 ng/g dw (BK–Max), respectively.
- SCCP bioaccumulation transpires via both aqueous and dietary pathways.
- Concentrations did not show a correlation with exposure or algal feeding levels, probably attributable to variations in metabolic or excretion rates.

Conclusion

- All of the SCCP concentrations in the river waters that were analyzed are below the utmost permissible values set forth in the European Water Framework Directive (1.4 μg/L).
- SCCPs in water and food impede the development of P. subcapitata and D. magna, whereas C. riparius suffers toxic effects, resulting in mentum deformation.
- The findings suggest that SCCPs have the potential to biomagnify through trophic interactions, with their ecological risks influenced by chemical exposure and food web dynamics.

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附件2-13

Interactions between reclaimed water irrigation and planting season revealed by non-target HRMS rice fingerprinting

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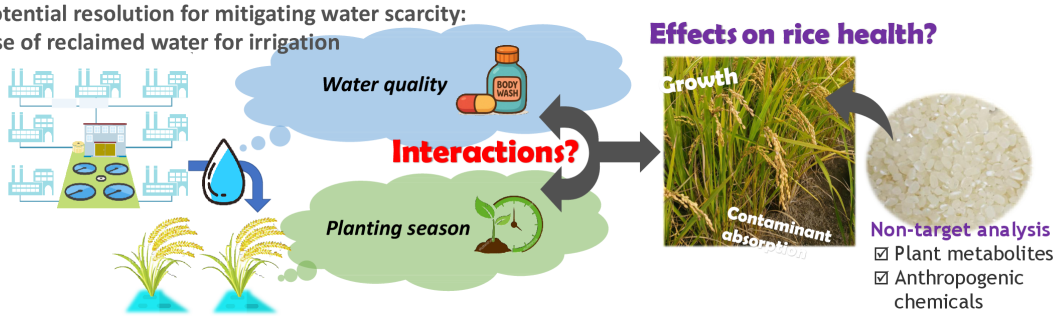
[3]Agricultural Engineering Research Center, Taoyuan, Taiwan

Potential resolution for mitigating water scarcity:
Use of reclaimed water for irrigation



Methods

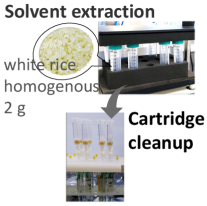
Field experiments and Sampling

Rice (*Oryza sativa* L. ssp. japonica) paddy irrigation

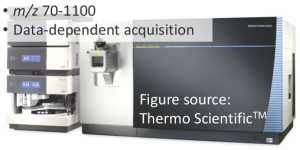
Two crop cycles
- Aug–Dec 2023
  - Reclaimed water irrigated (n = 22)
  - River water irrigated (n = 25) samples
- Mar–Jul 2024
  - Reclaimed water irrigated (n = 33)
  - River water irrigated: (n = 36)

Sample preparation & instrumental analysis

Solvent extraction

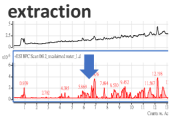


LC–Orbitrap MS
- Ionization: ESI
- Mass analysis
  - *m/z* 70-1100
  - Data-dependent acquisition

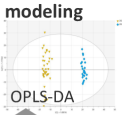


Non-target analysis

Molecular feature extraction



Discriminant modeling



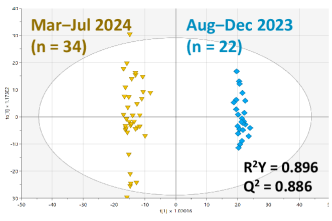
RSD screening using pooled samples (n = 5)

VIP, Univariate analyses

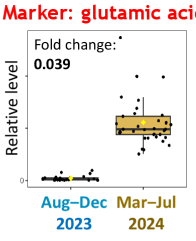
Marker selection & identification

Results

Small-molecule fingerprints in rice irrigated with reclaimed water



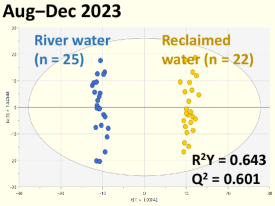
Marker: glutamic acid



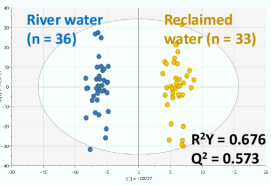
Results

Small-molecule fingerprints differed by irrigation water

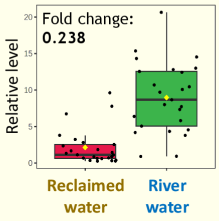
Aug–Dec 2023



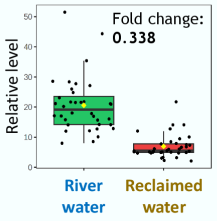
Mar–Jul 2024



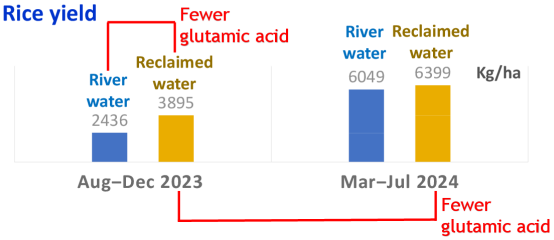
Marker: glutamic acid
- A metabolite related to defense functions (Uawisetwathana, 2015; Du et al., 2024)



Marker: triethyl phosphate
- Flame retardant
- Found in river water; absent in reclaimed water
- Absorption by rice plants



Rice yield



Conclusions

- **Irrigation water interacted with the planting season to modulate small-molecule fingerprints in rice**
  - **Glutamic acid**: a marker of reclaimed water and season
- **Reference for the promotion of reclaimed water irrigation policies:** ☑ Irrigation season ☑ Target monitoring substances

Funding: National Land Management Agency, Ministry of the Interior, Taiwan (21111219-Y2) and National Taiwan University (NTU-113L8402)

附件2-14

SETAC Europe 35th Annua Meeting

Ecotoxicological assessment of anti-tuberculosis medications in aquatic environments: occurrence, reproductive effects and ecological risks

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Aims To assess the reproductive toxicity of anti-TB medication in *Daphnia magna*, determine their threshold levels, and evaluate the ecotoxicological risks to aquatic ecosystems.

Research Motivation

Adverse Effects of First-Line Anti-TB Medicines

Most evidence shows that first-line antituberculosis (TB) medicines, rifampicin (RMP), isoniazid (INH), and ethambutol (EMB), caused adverse events in mice, rats, and humans:

- **INH** poses neurotoxicity
- **RMP** poses nephritis
- **EMB** poses ocular toxicity
- Threee of them exert reproductive toxicity

Limited Information on Aqutic Toxicity

To date, few studies have focused on toxic effects of antiTB medications on aquatic organisms, information is still limited regarding their effects on behavior and reproduction.

Methodology

Daphnia magna Reproduction Tests

OECD 211

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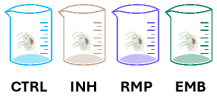


- **Test treatments**: control & five conc. for each substance
- **Endpoints**: time to first brood, broods per female, neonates per brood, total neonates per female, and survival of parents and neonates.
- **Threshold** estimates: **NOEC, LOEC,**and **BMDL**

WWTP & River Sampling

Kaohsiung has the highest TB incidence in Taiwan

Sampling Sites:

- Central District Sewage Treatment Plant
- Fengshan Reclaimed Water Plant
- Fengshan River (receiving water)

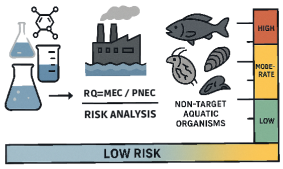
Sample info.:

- 1 L samples in triplicates per site,
- PE bottles + ascorbic acid, 4 °C, dark storage

Chemical analysis:

- **Instruments:** HPLC (Agilent 1260 Infinity II), Triple quadrupole MS/MS (Agilent 6470A)
- **Analytes:** INH, RMP, andEMB

Ecotoxicological Risk Assessment



RQ: Risk quotient
MEC: Measured environmental concentration
PNEC: Predicted no effect concentration

Results

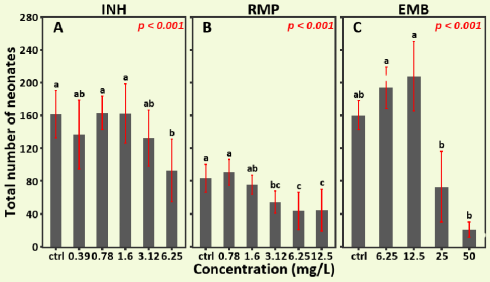


Figure 1 Effect of anti-TB medication (A) INH, (B) RMP, and (C) EMB on total number of neonates of *D. magna*. Values represent mean ± standard deviation. Different letters denote a significant difference between treatments (ANOVA or Kruskal-Wallis, $p < 0.05$).

	Concentration (mg/L)		
	INH	RMP	EMB
NOEC	3.12	1.60	**12.50**
LOEC	6.25	3.12	25.00
BMDL	**2.80**	**1.38**	22.14

Table 1 Threshold estimates of anti-TB medication based on total neonate production in *D. magna*.

- Thresholds were set using BMDL for INH and RMP, and NOEC for EMB to ensure conservative risk assessment.

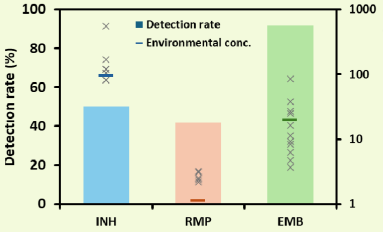
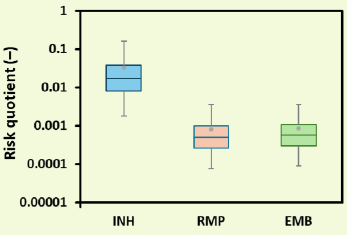


Figure 2 Year-round concentrations and detection rates of anti-TB medications detected in river water samples collected monthly in 2022.

- EMB exhibited the highest detection rate (92%) in river water, indicating its widespread presence. In contrast, INH showed the highest concentration levels, ranging from 81.01 to 547.88 ng/L, suggesting potential accumulation or persistence.
- RMP had both the lowest detection rate and the lowest residue concentrations, indicating limited environmental occurrence among the three medication.

Figure 3 Ecotoxicological risk assessment of anti-TB medications in river water based on probability-based risk characterization.



- Although there are no ecotoxicological risk concerns, INH has the highest exposure risk with a risk quotient of 0.03 (95%CI: 0.0018 – 0.1630).

Take-Home Message

This study combined reproduction tests, environmental monitoring, and risk assessment to evaluate the impacts of anti-TB medication in aquatic environments. No significant ecological risks were identified. However, isoniazid (INH) showed the highest environmental exposure, and its BMDL-based threshold indicates a higher sensitivity in Daphnia magna. These findings highlight the importance of threshold-based evaluation in aquatic risks assessments