

國立臺灣海洋大學
海洋環境與生態研究所 專題討論

題目：以天然生物膜作為評估 PFAS 對水生生態系統的污染和影響的潛在綜合樣本

英文題目：Natural biofilm as a potential integrative sample for evaluating the contamination and impacts of PFAS on aquatic ecosystems

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Abstract

Natural biofilm can be a suitable medium for the monitoring of pollutants. Limited information is currently available regarding the occurrence of per- and polyfluoroalkyl substances (PFAS) in periphytic biofilm and low-trophic level organisms of freshwater ecosystems. In this study, surface water, biofilm, phytoplankton, and freshwater snails were collected from Taihu Lake, China, and characterized for 16 PFAS, including legacy compounds (PFSAs/PFCAs) and PFAS of emerging concern (fluorotelomer sulfonates and F-53B). The colonized biofilms effectively bioaccumulated PFAS from water, with the total concentration (\sum PFAS) in the range of 1.96- 20.1 ng/g wet weight, and the bioaccumulation factor increased with the PFAS log K_{ow} values. As compared with phytoplankton, the \sum PFAS in biofilms displayed a stronger correlation with those in water. PFAS distinctly biomagnified from the biofilm to freshwater snail, with the biomagnification factor in the range of 3.09 ± 2.03 - 17.8 ± 10.2 , implying the important role of biofilm in PFAS transfer in aquatic environment. Extracellular proteins production in biofilm increased with the water PFAS concentrations. The total extracellular polymeric substances (EPS) content increased with the water PFAS concentration firstly and then declined to a steady level, while the algal chlorophyll level exhibited a similar relationship with the PFAS in biofilm. High PFAS levels were also associated with depressed alpha diversity of fungal community in biofilms. Biofilm appears as a relevant indicator to characterize the occurrence of PFAS in aquatic ecosystems.

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中文摘要

環境中生物膜可以作為監測污染物的適用介質。目前關於全氟烷基物質和多氟烷基物質 (PFAS) 在淡水生態系統中附著生物膜和低營養級生物中的調查研究有限。在這項研究中，從中國太湖採集了地表水、生物膜、浮游植物和蝸牛，並檢測了 16 種目標化合物，包括傳統化合物 (PFASs/PFCAs) 和新出現的 PFAS (fluorotelomer sulfonates 和 F-53B)。結果顯示定殖的生物膜能有效地從水中生物富集 PFAS，總濃度 (Σ PFAS) 在 1.96-20.1 ng/g 濕重範圍內，生物富集因子隨著 PFAS $\log K_{ow}$ 值的增加而增加。與浮游植物相比，生物膜中的 Σ PFAS 與水中的 Σ PFAS 具有更強的相關性。PFAS 從生物膜到淡水蝸牛有明顯的生物放大，生物放大係數在 $3.09 \pm 2.03 - 17.8 \pm 10.2$ 範圍內，表明生物膜對於 PFAS 在水生環境中的轉移有著重要的作用。而生物膜中細胞外蛋白的產生隨著水中 PFAS 濃度的增加而增加。細胞外聚合物 (EPS) 含量隨水體 PFAS 濃度的增加先增加後下降至穩定水平，而藻類葉綠素濃度與生物膜中的 PFAS 表現出相似的關係。高 PFAS 水平還與生物膜中真菌群落的 α 多樣性降低有關。該研究指出，生物膜似乎能夠作為 PFAS 在水生生態系統中出現的相關指標。