Analysis of Transparent Exopolymer Particles (TEPs) in marine and freshwater

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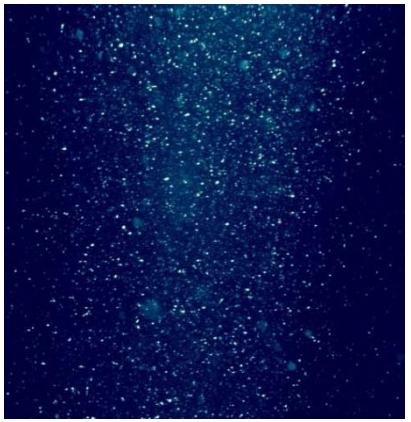
What are TEPs?

=> Transparent Exopolymer Particles (TEPs)

Natural properties:

- transparent
- variable size (0.4–200 µm)
- gel-like structure, sticky
- high negative charge



Marine snow

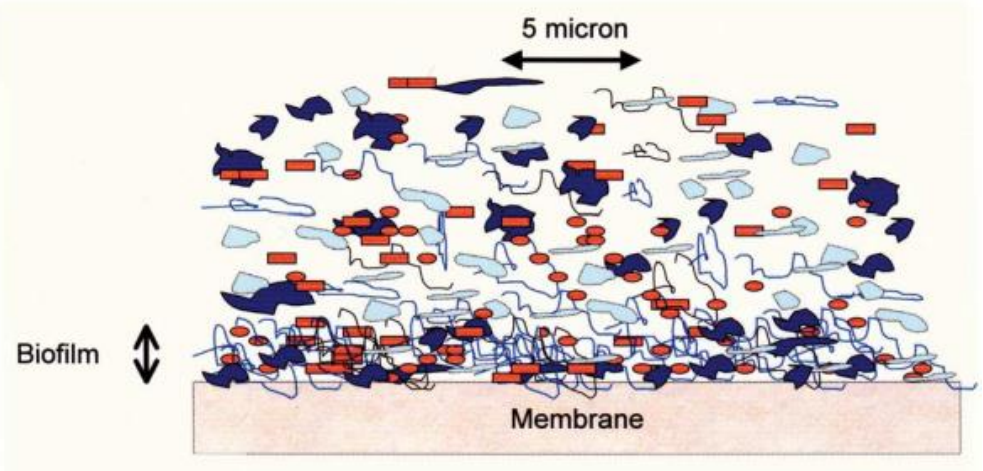
Originate from:

- human debris
- bacteria or multicellular organisms like macroalgae, oysters or sea snails
- microalgae (majority!) (Passow, 2001; Engel and Passow, 2001; Bar-Zeev et al., 2009).

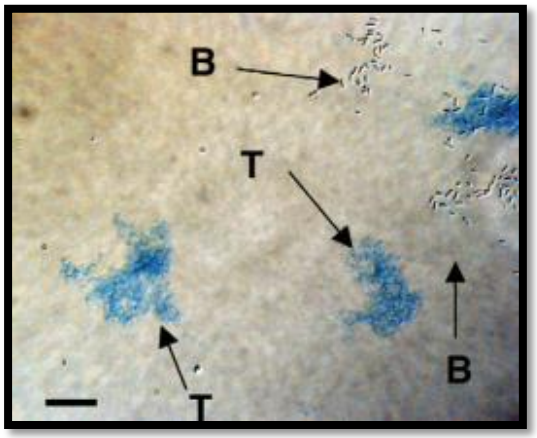
Exist in:

- seas, lakes, rivers, reservoirs and recycled wastewater

TEP and the formation of biofilm



Schematic diagram of TEP involvement in biofilm development on a membrane surface. (Berman; Holenberg, 2005)



TEP are made visible by staining with alcian blue. (Berman, 2010)

- **Aquatic microbiologist Tom Berman and filtration specialist Marina Holenberg argue that TEP in source waters can lead to biofilm growth on membrane surfaces.**

TEP analysis protocol

Sample (5mL)

Filter (0.4 µm or 0.05 µm polycarbonate filters)

1 ml of 0.02% Alcian Blue in 0.06% acetic acid (pH 2.5)

Filter to dry (within 2 s)

Rinse (1 mL of DI water)

Transfer to 50 ml beaker

Soak for 2 h, gently agitated 3-5 times

Measure absorption of H_2SO_4 (787 nm)

Forms of TEP

- **cTEP (colloidal) : 0.05 to 0.4 µm**
- **pTEP (particulate) : > 0.4 µm**

(Passow and Alldredge, 1995; Villacorte, et al., 2009)

Sampling:

- **Seawater**

(Nanliao, HsinTsu)

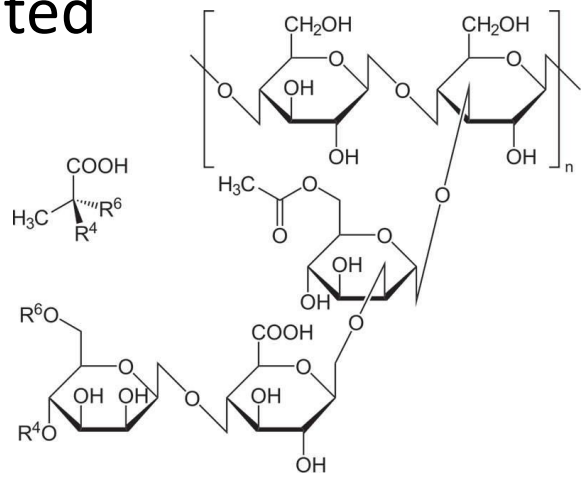
- **Freshwater**

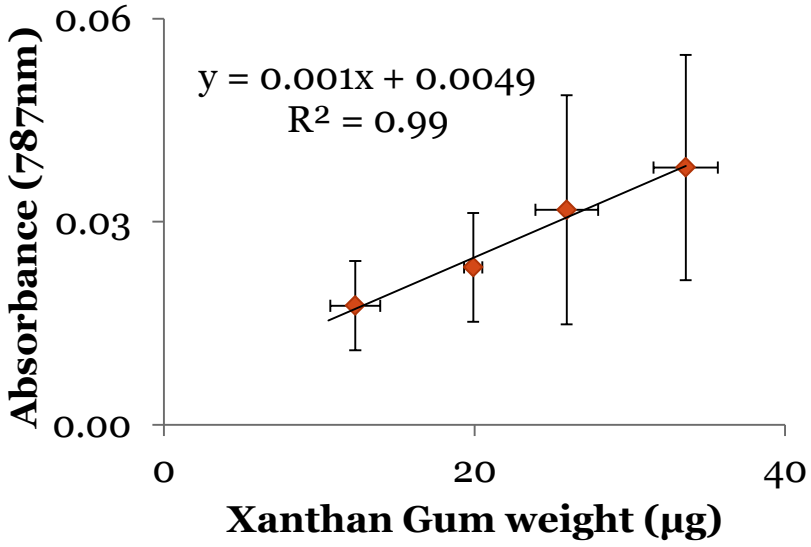
(Baoshan reservoir, HsinTsu)

Results and Discussion

--Calibration curve

- The TEP concentrations were calibrated with xanthan gum (Sigma G- 1253)





- Calculate calibration factor :

$$f_x = W \times [(est_{787} - C_{787}) / V_{st}]^{-1}$$

W: dry weight of the standard (µg/L)

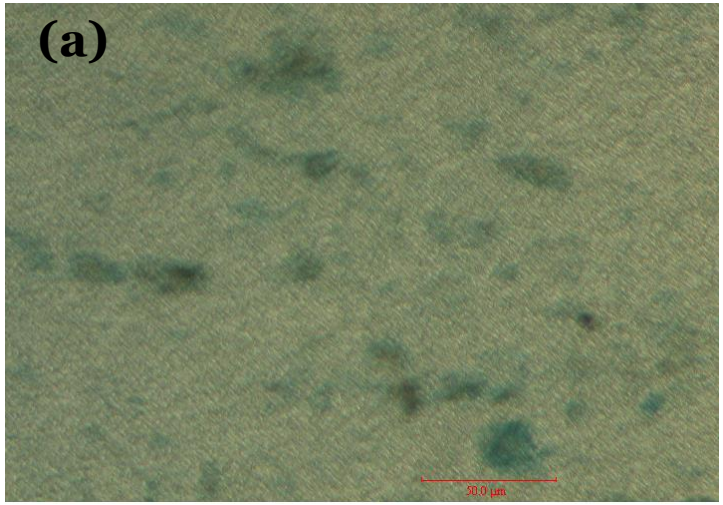
est_{787}: its average absorption

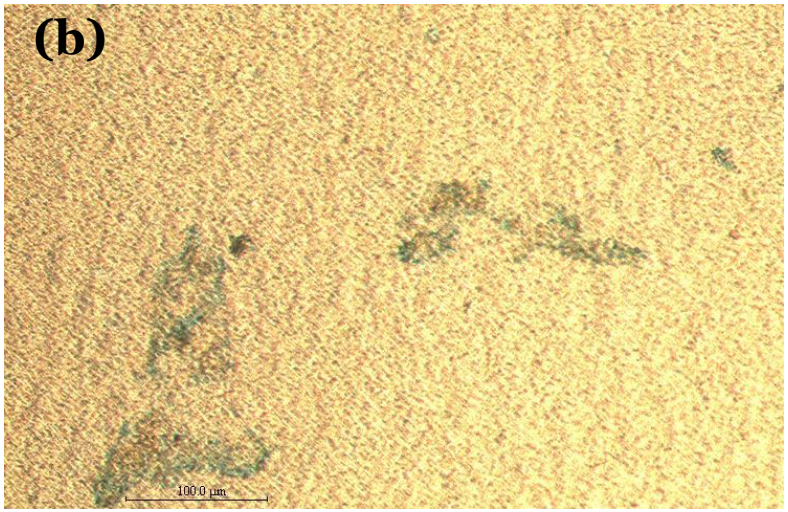
C_{787}: absorption of the blank

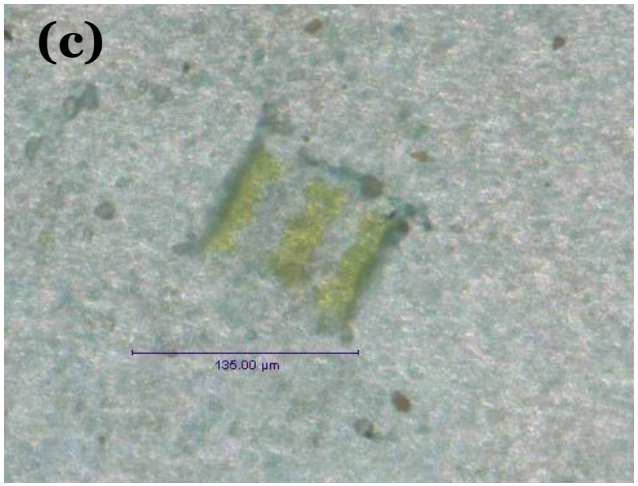
V_{st}: Volume filtered for staining (L)

Results and Discussion

---Visualization of TEP in seawater







Various TEP forms:
(a) blue spots, (b) irregular shape,
(c) microorganisms cirrounding with TEP.

Photos taken by
Epi-fluorescence microscope: Nikon E-400 ; Camera: PAXcam ; Software: Spot Basic.

Summary

Significance of this research

- Extend knowledge about TEP and its seasonal fluctuations, correlations between TEP and other water parameters in Taiwan, compared to previous studies
- Forecasting the effect of TEP on membrane fouling based on TEP size distribution

Future works

- Monitoring pTEP in freshwater, cTEP in both seawater and freshwater
- Investigating the effects of TEP on membrane fouling