Aggregation and Degradation of Dispersants and Oil by Microbial Exopolymers

GULF OF MEXICO RESEARCH INITIATIVE

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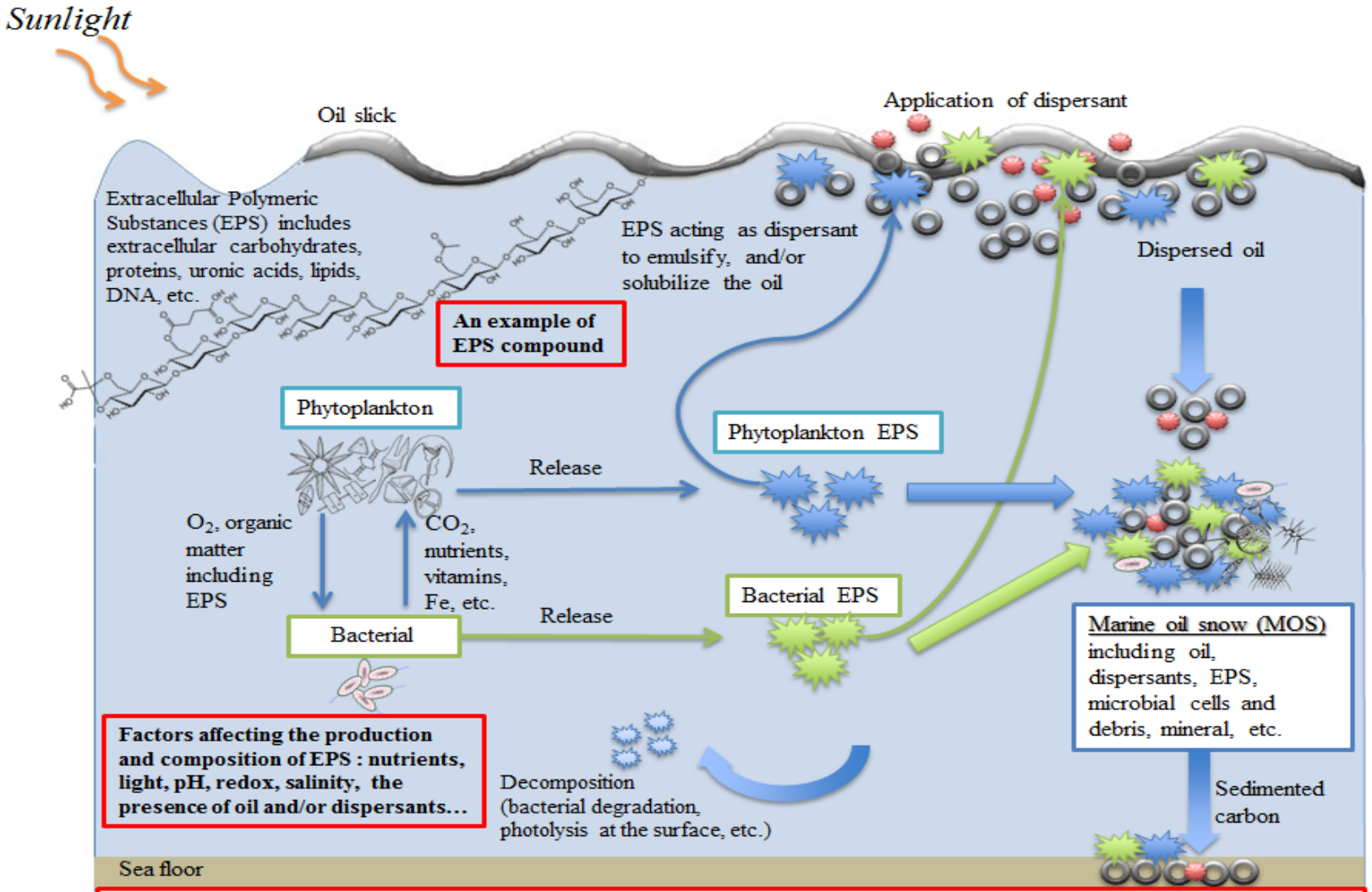
Marine snow appearing at the surface after the oil spill was formed through:

(1) production of mucous webs through the activities of bacterial oil-degraders associated with the floating oil layer;
(2) production of oily particulate matter through interactions of oil components with suspended matter and their coagulation; and
(3) coagulation of phytoplankton with oil droplets incorporated into aggregates.

ADDOMEx - Gulf of Mexico Research Initiative (GoMRI), "Role of microbial exopolymers in aggregation and degradation of oil and dispersants"



EPS Functions:

- **To emulsify and disperse petroleum components and thus enhance their solubility and bioavailability**
- **To provide physical structure allowing the microbial communities to degrade oil**
- **To provide colloidal or particulate traps for petroleum components and subsequent sedimentation (the formation of sedimented 'marine oil snow') through chemical coagulation, aggregation and cross-linking processes.**

ADDOMEX
WAF, CEWAF, AND DCEWAF IN BIOLOGICALLY ENRICHED MESOCOSMS

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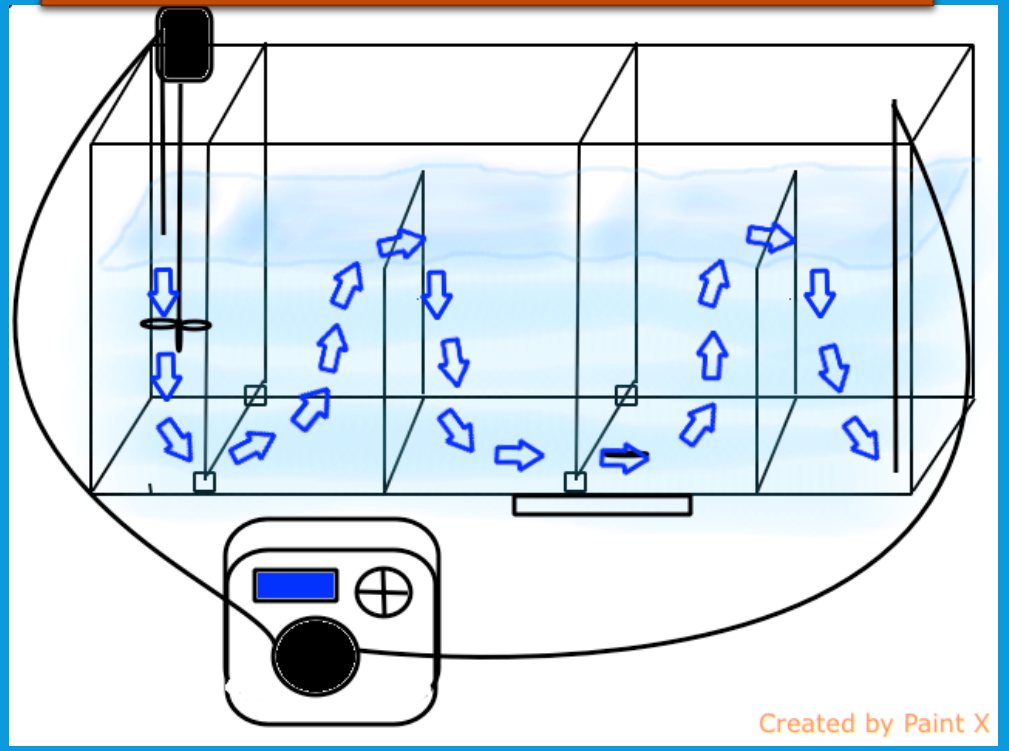
WHAT DID WE DO?

WAF, CEWAF, & DCEWAF generation

In 130 L baffled recirculation tanks:

- Water accommodated oil fraction (WAF)
- Chemically enhanced water accommodated fraction (CEWAF)
- Diluted CEWAF (DCEWAF)

Macondo Surrogate oil (25 ml), and Corexit 9500 (25 ml 20:1).



Morales-McDevitt, drawing

MESOCOSMS EXPERIMENT

- Treatments done in triplicate
- Tanks 81 L of filtered sea water control, WAF, CEWAF, and DCEWAF plus 2 L of concentrated plankton collected from the Galveston Bay.

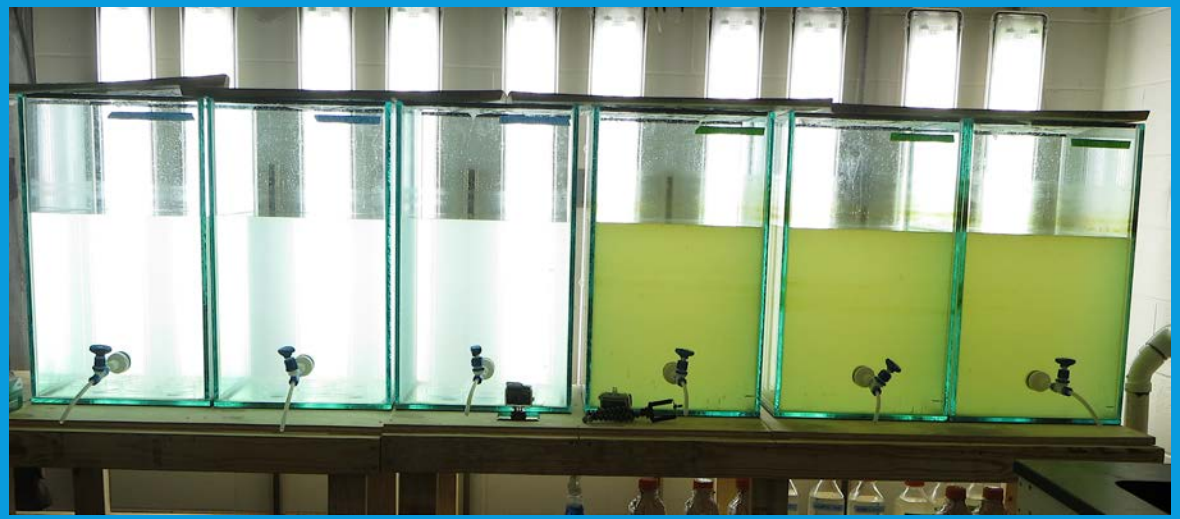
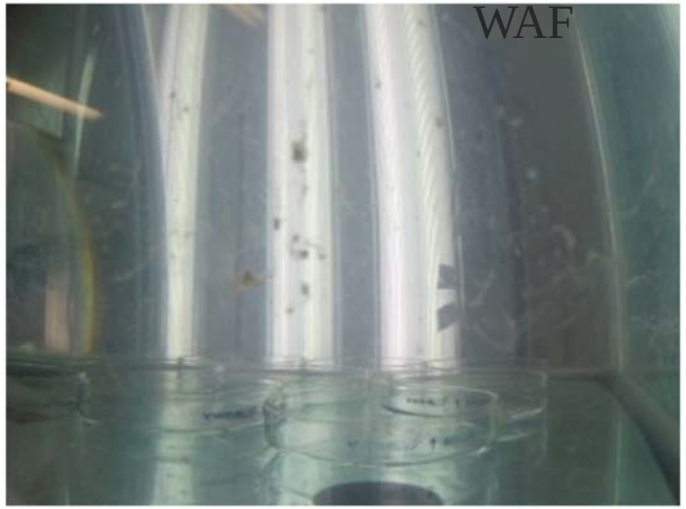
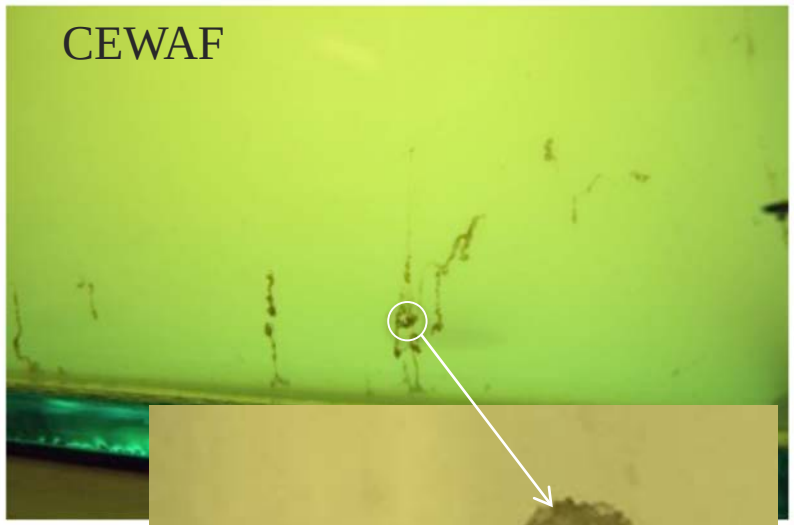
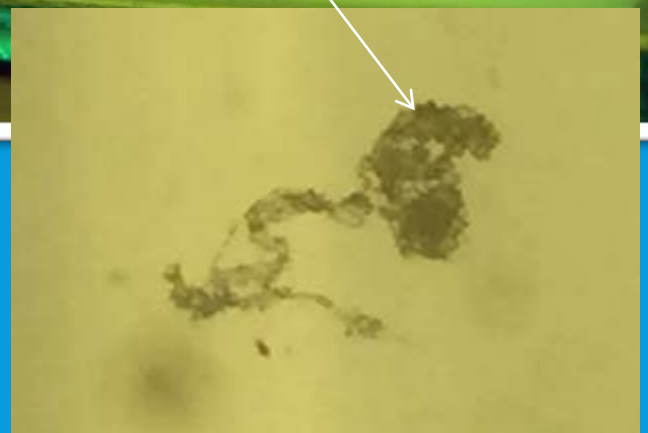


Photo Terry Wade





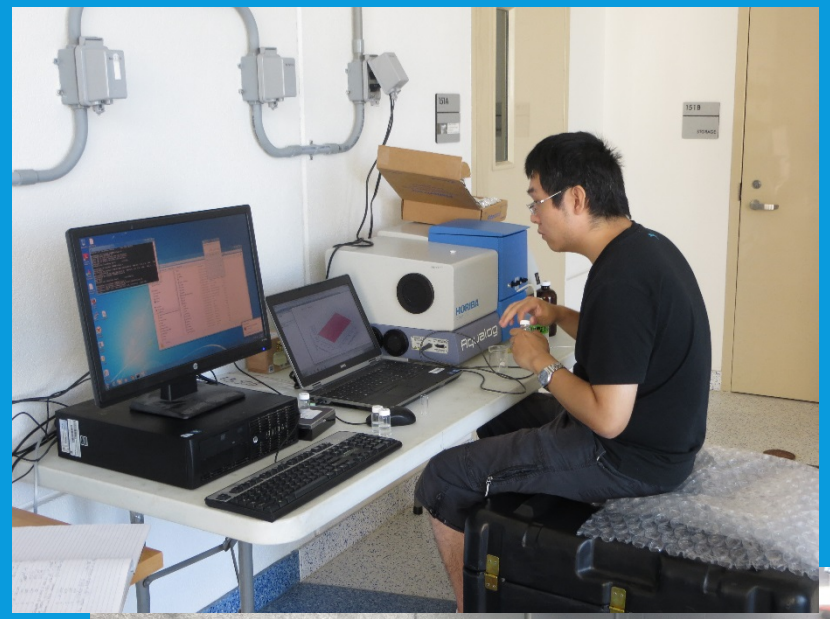


Aggregates formed within hours

- ? **Will the presence of water accommodated fraction (WAF) or WAF+corexit enhance or depress the EPS production, aggregation, and dispersion?**
- ? **What are the physical-chemical characteristics of EPS produced under different conditions (control, WAF, CEWAF, DCEWAF)?**
- ? **Can protein/carbohydrate ratio (as a surrogate hydrophobicity index) be used to predict removal efficiency?**
- ? **How will carbon removal be affected?**
- ? **How could μm fibrillar gels grow into cm-size aggregates?**

TOTAL SCANNING FLUORESCENCE

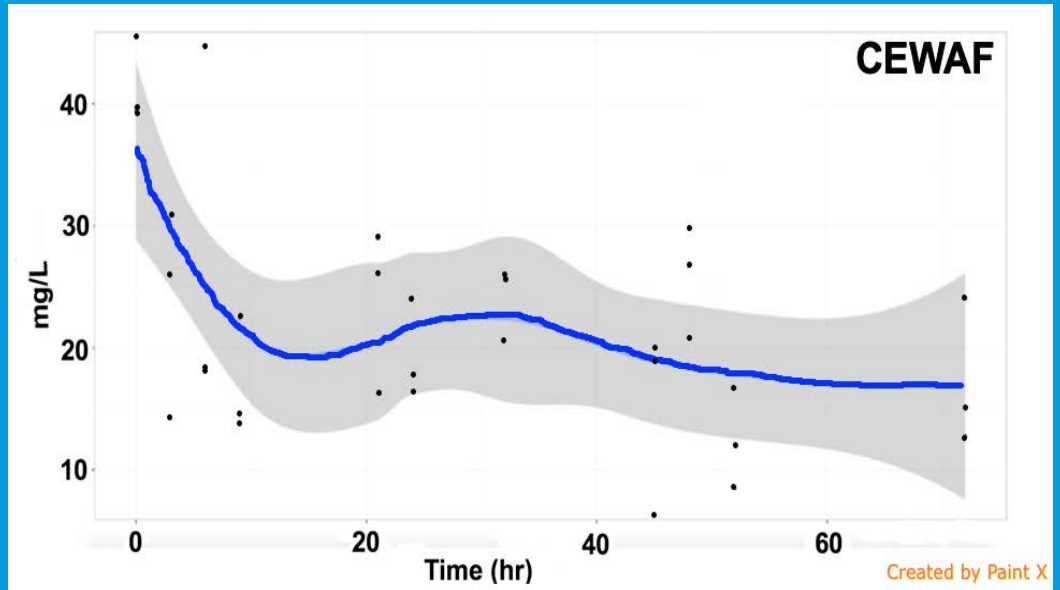
- Estimated oil equivalence (EOE) determined by Total Scanning Fluorescence (TSF)
- EOE concentrations determined at start, during, and end of experiments



WHAT DID WE FIND?

EOE (estimated oil equivalence)

- Variability in data that exceeds 95% confidence interval band, due to stable oil-water mixture
- Variability in EOE: CEWAF > DCEWAF > WAF



WHAT DID WE FIND?

- Decrease of EOE in all experiments within first 10 hrs.
- Concentrations stabilized within experimental variability

time (hours)	control (mg/L)	WAF (mg/L)	DCEWAF (mg/L)	CEWAF (mg/L)
0	0	0.26 (3%)	2.74 (7%)	41.52 (14%)
9	0	0.10 (19%)	0.84 (16%)	17.00 (23%)
45	0	0.06 (30%)	1.27 (3%)	15.08 (41%)
72	0	0.06 (10%)	1.03 (7%)	17.31 (20%)

Why is EOE & PAH variable and decreasing?

- Oil & water don’t mix causing heterogeneity
- Biodegradation, photo oxidation, evaporation
- Oil in surface slicks and adhering to mesocosm walls
- Oil present as droplet of differences sizes

  (WAF vs. CEWAF)
- Association of oil with EPS (sedimentation)
- Selective degradation of PAH

CONCLUSIONS

- Large volumes of WAF and CEWAF can be produced
- Rapid formation (within 4 hrs.) of EPS in the Control, WAF, DCEWAF, and CEWAF. Natural process.
- All treatments show same pattern of rapid decrease in the oil concentrations within the first 10 h.
- Heterogeneity is expected.
- Marine oil snow (MOS) was formed.
- Ongoing studies are looking at the processes of EPS and MOS formation.

We made EPS!!

- EPS within 4 h of addition of plankton concentrate in all experiments

Photo credit by Terry Wade

WHAT DID WE FIND?