

Toxicity of Spill Dispersants and Dispersed Crude Oil

Mace Barron, Michael Hemmer, Rick Greene
USEPA/ORD/NHEERL/GED



EPA Toxicity Studies

<http://www.epa.gov/bpspill/dispersants-testing.html>

Phase I: Dispersant toxicity

- acute toxicity: fish and invertebrate
- human cell line cytotoxicity
- *in vitro* estrogenicity, androgenicity

Phase II: Oil toxicity

- acute toxicity: fish and invertebrate
- oil-only
- dispersant+oil



Dispersant Acute Ecotoxicity

- 8 dispersants, including Corexit 9500A
- methods according to NCP Appendix C (5 sec, 10,000 rpm)
- 48 hr static mysid (GOM invertebrate)
- 96 hr static silverside (GOM fish)
- 6 to 8 test concentrations; calculate LC50
- compare to NCP product schedule data

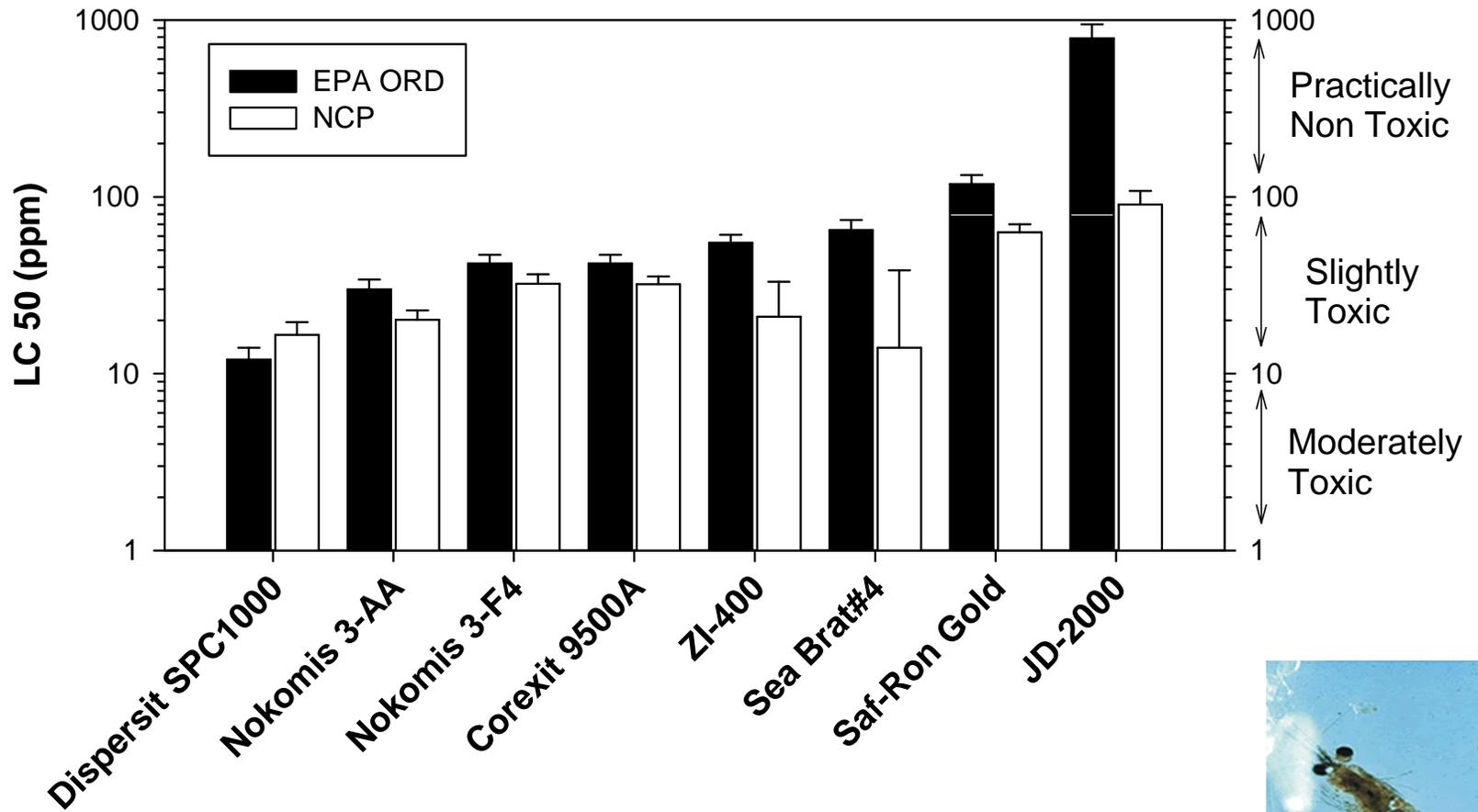


Mysid
(*Americamysis bahia*)



Inland silverside
(*Menidia beryllina*)

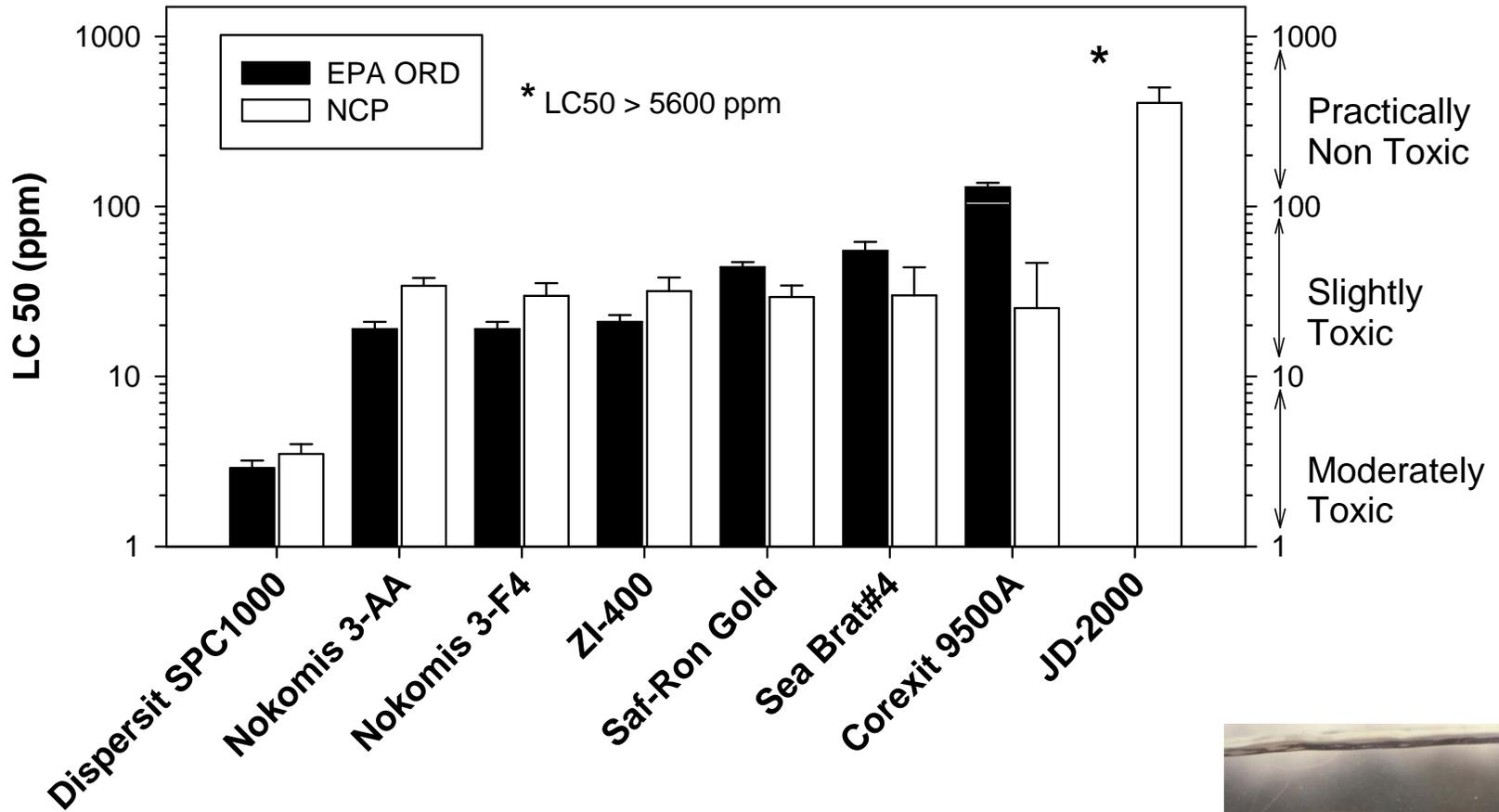
LC50 Values for Mysid 48-hr Static Acute Toxicity Tests with Eight Dispersants



ppm = $\mu\text{L/L}$



LC50 Values for *Menidia* 96-hr Static Acute Toxicity Tests with Eight Dispersants



ppm = $\mu\text{L/L}$



in vitro Cytotoxicity and Endocrine Assays

Over 80 mammalian cell line assays used:

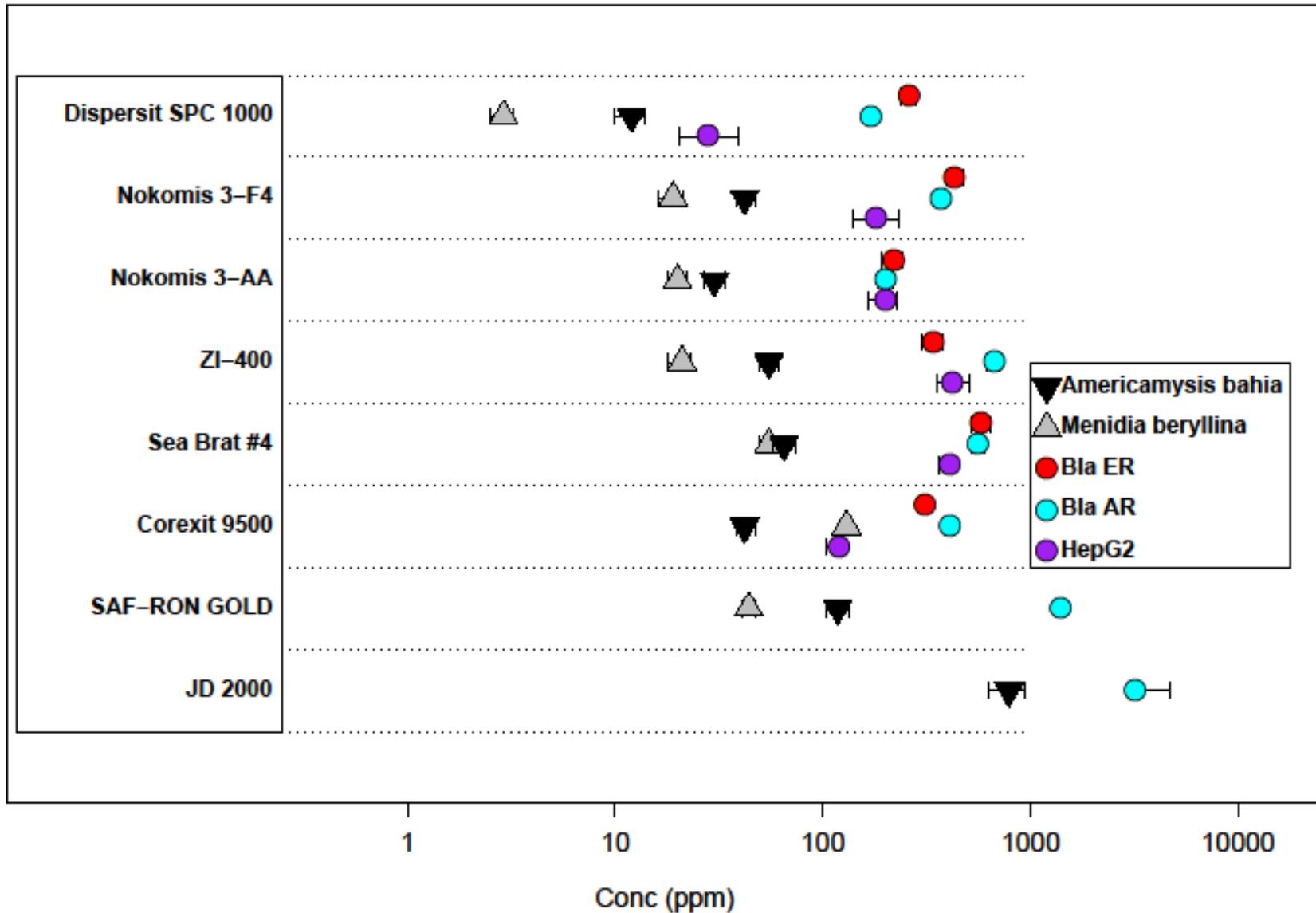
- Cytotoxicity, estrogen receptor agonism, androgen receptor agonism and antagonism
- Dispersant concentrations from 0.001 to 10,000 ppm

Results:

- No significant estrogenic or androgenic activity detected
- Cytotoxicity observed at concentrations above 10 parts per million for all dispersants
- Dispersants tested had similar results - JD 2000 and Saf-Ron Gold less toxic than others
- Ecotoxicology tests results similar

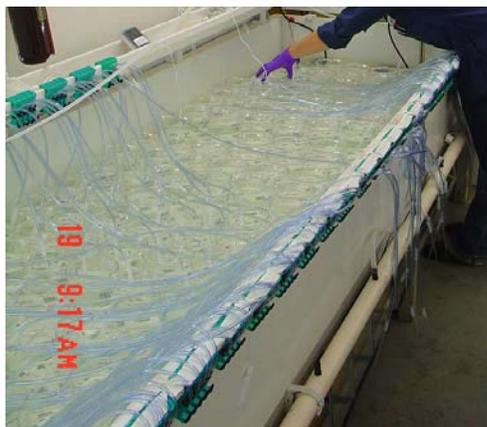
Comparison of cell assays to acute ecotoxicity

Judson et al. (2010) *Environ Sci and Technol* 44:2277-2285

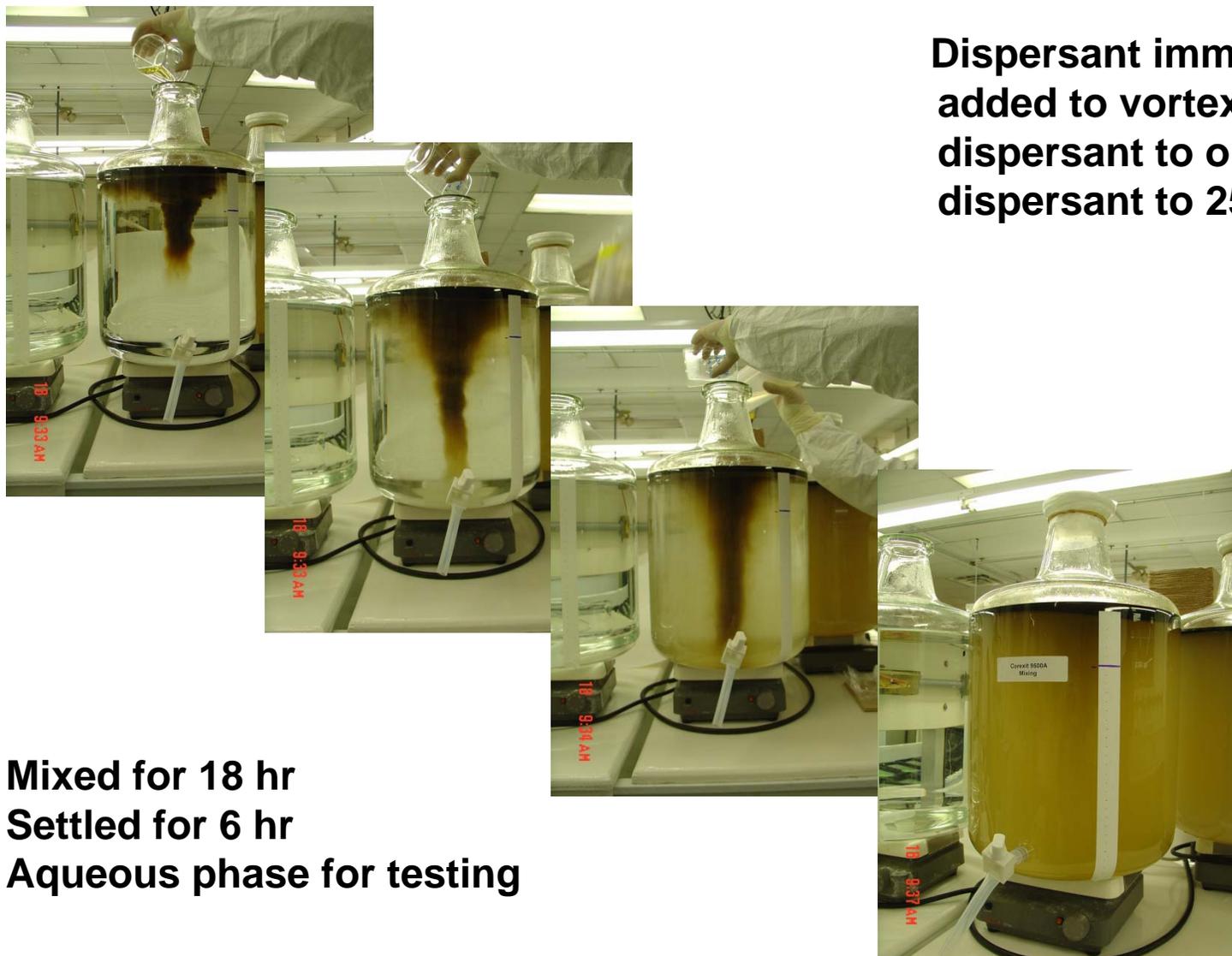


Oil and Oil+Dispersant Acute Toxicity

- South Louisiana crude oil (LCO) only
- LCO plus each of 8 dispersants
- CROSERF WAF preparation
- 48 hr static mysid
- 96 hr static silverside
- 6 to 8 test concentrations; calculate LC50
- compare to dispersant-only toxicity

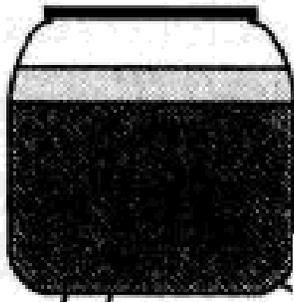


Addition of Dispersant

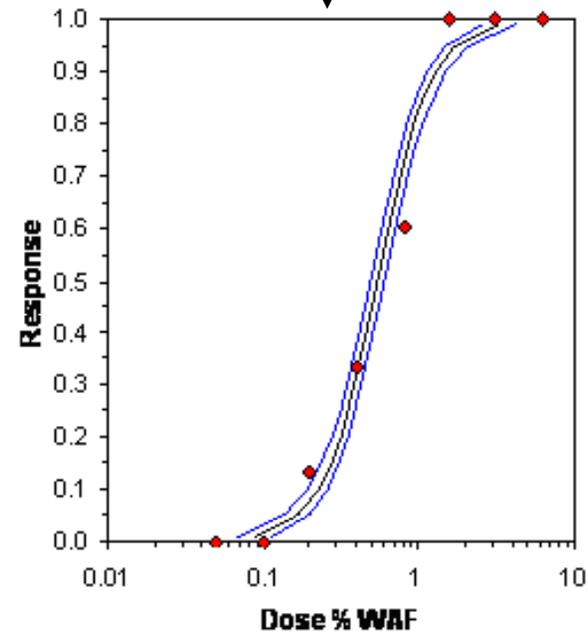
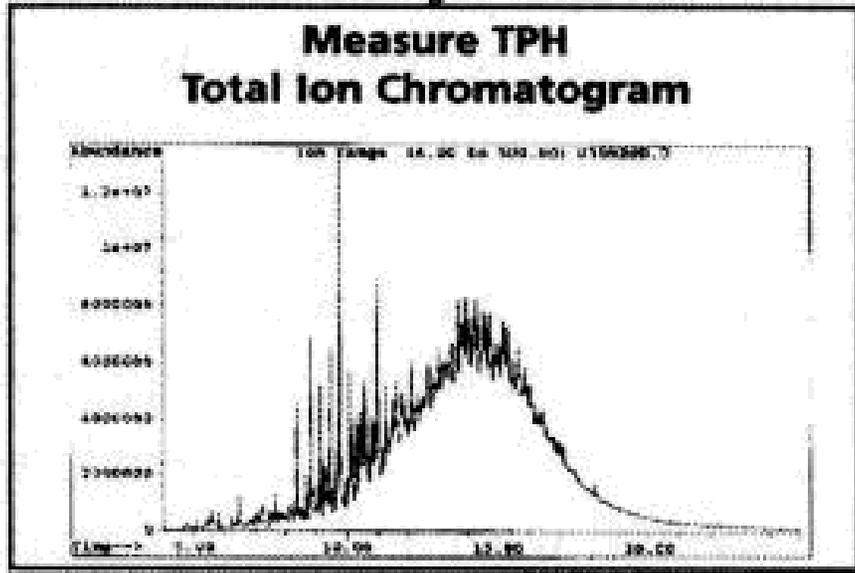
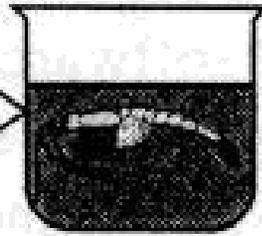


Water Accommodated Fraction (WAF)

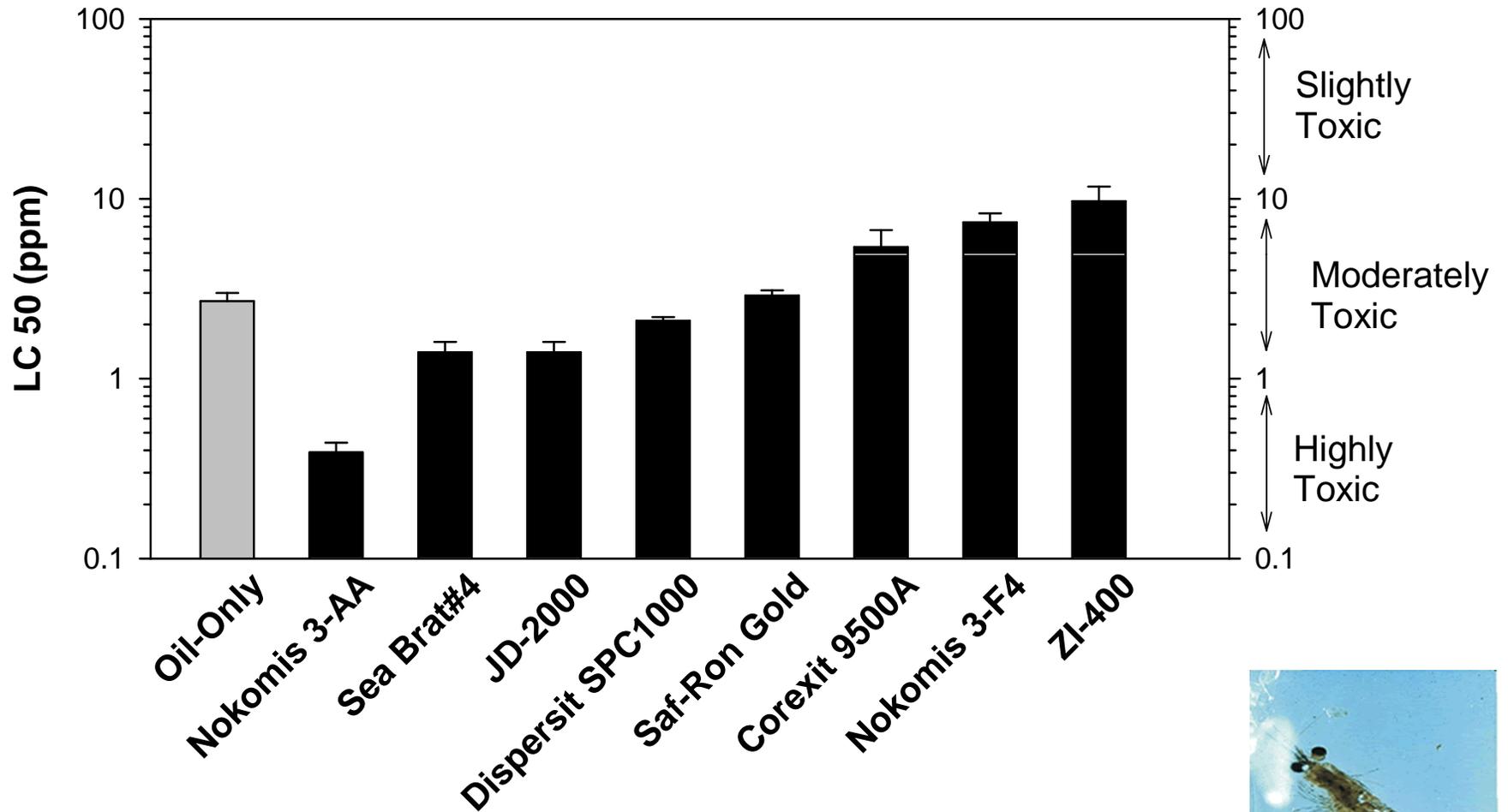
- Slow-Stir**
- Oil:water 1:10
 - Sealed system
 - 24 h, 20°C



Test serial dilutions of dissolved phase



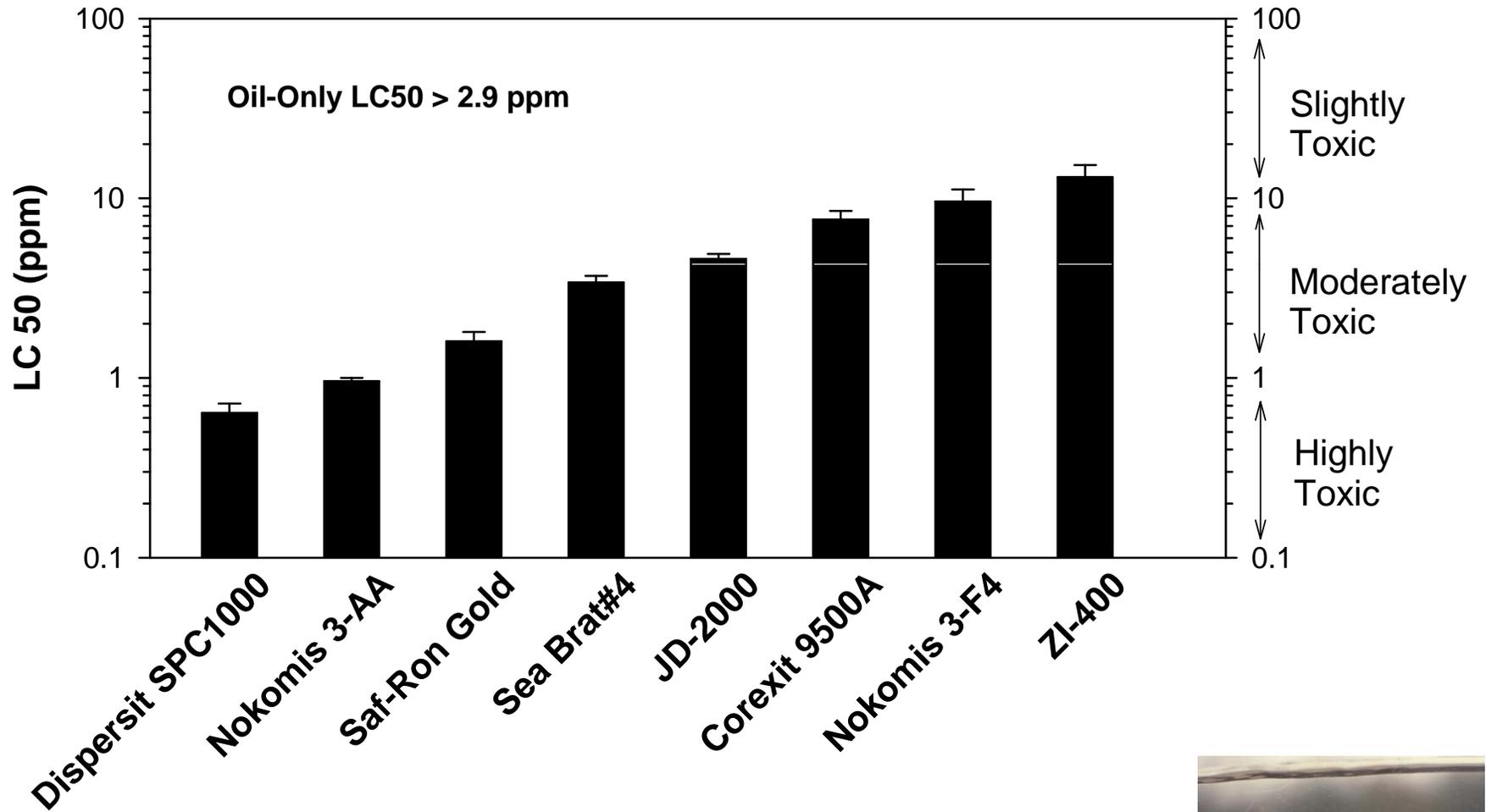
LC50 Values for Mysid 48-hr Static Acute Toxicity Tests with Oil-only and Eight Dispersant-Oil Mixtures



ppm = mg/L



LC50 Values for *Menidia* 96-hr Static Acute Toxicity Tests with Oil-only and Eight Dispersant-Oil Mixtures



ppm = mg/L





Conclusions

Dispersant-only testing:

- No significant estrogenic or androgenic activity in human cell line assays
- Cytotoxicity only observed at concentrations above 10 ppm
- Similar results to ecotoxicity tests showing low toxicity of all 8 dispersants (3 to >5000 ppm)
- Similar toxicity in EPA tests as NCP

Crude oil-only ecotoxicity:

- Louisiana crude: 4.4 mg/L mysid; >2.9 mg/L Menidia

Dispersant+crude oil ecotoxicity:

- LC50s: 0.4 to 13.1 mg/L
- mixtures classified as slightly to highly toxic
- Corexit 9500A: moderately toxic
- Mysid: Similar toxicity of oil alone and dispersant-oil mixtures
- All 8 dispersants less toxic than dispersant-oil mixtures