Marine snow enhances the adverse effects of oil on benthic invertebrates

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Background

- Deepwater Horizon explosion
- Marine snow; MOSSFA (Marine Oil Snow Sedimentation and Flocculent Accumulation)
- Estimates vary, but as much as 14% of total oil on sediment *(Daly et al., 2016)*
- What about the consequences for the benthic community?

MOSSFA
MARINE OIL SNOW SEDIMENTATION & FLOCCULENT ACCUMULATION

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Daly et al. 2016 *Anthropocene* 13 "Assessing the impacts of oil-associated marine snow formation and sedimentation during and after the Deepwater Horizon oil spill"

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Objective

- Question: what does MOSSFA mean for the benthic ecosystem?
- Hypotheses:
  - Oil-contaminated marine snow negatively impacts benthic invertebrates
  - Marine snow by itself also affects benthic invertebrates, but to a lesser extent
  - Presence of marine snow inhibits oil biodegradation

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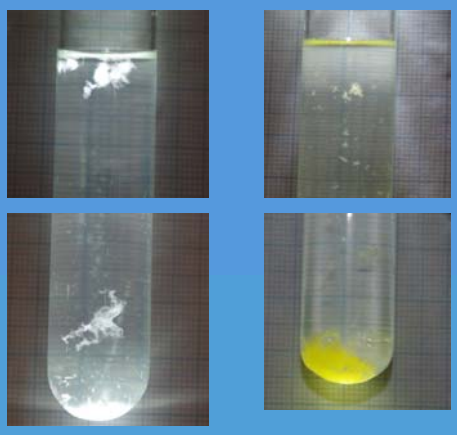
Marine snow production

- Marine snow in the lab: alginate-like polysaccharides *(van Eenennaam et al. 2016)*



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(van Eenennaam et al. 2016 *Marine Pollution Bulletin* 104(1-2), "Oil spill dispersants induce formation of marine snow by phytoplankton-associated bacteria")

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Marine snow production

- Marine snow in the lab: alginate-like polysaccharides *(van Eenennaam et al. 2016)*
- Artificial marine snow to mimic marine snow event during DWH
- Created with alginate, algae biomass, kaolin clay with and without oil (slightly weathered BP surrogate oil)

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(van Eenennaam et al. 2016 *Marine Pollution Bulletin* 104(1-2), "Oil spill dispersants induce formation of marine snow by phytoplankton-associated bacteria")

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Setup of Aquarium Experiment

Aquaria:

- Natural sediment and organisms from intertidal area in Waddensea, The Netherlands
- Temperature and light controlled room
- 5 treatments in triplicate:
  - "Control"
  - "Clay"
  - "Snow"
  - "Clay+Oil"
  - "Snow+Oil"
- Slightly weathered oil, same amounts in each aquarium (10 g/m^2)

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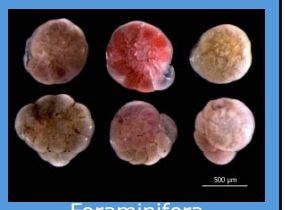
Setup of Aquarium Experiment

- Organisms

Corophium volutator (amphipod)

Hydrobia ulvae (gastropod)

Macoma balthica (bivalve)



Foraminifera

- Samples
  - t=16 benthic invertebrates; t=42 oil biodegradation samples (separate aquaria)

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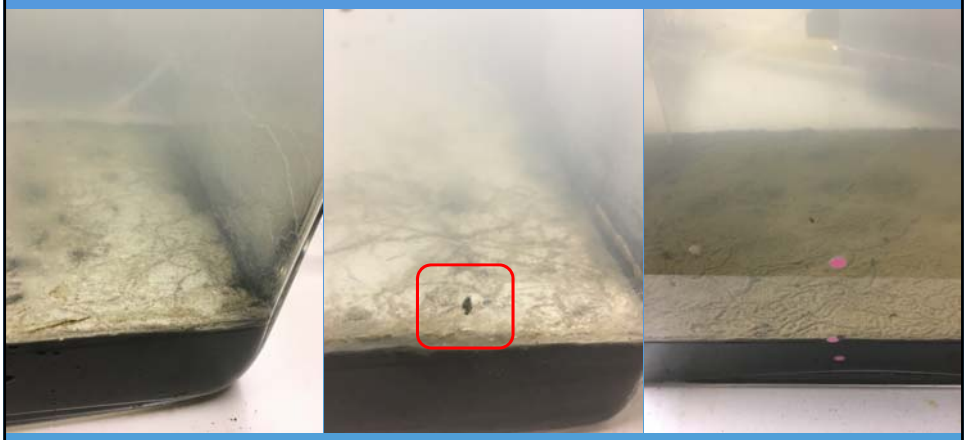
Some examples: tracks on top sediment



Clay | Clay | Control

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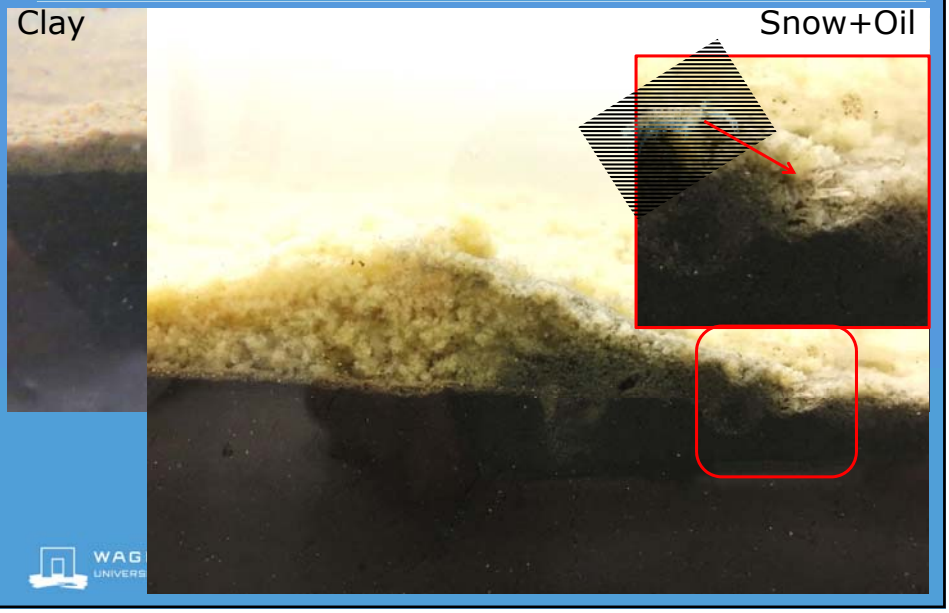
Some examples: burrows

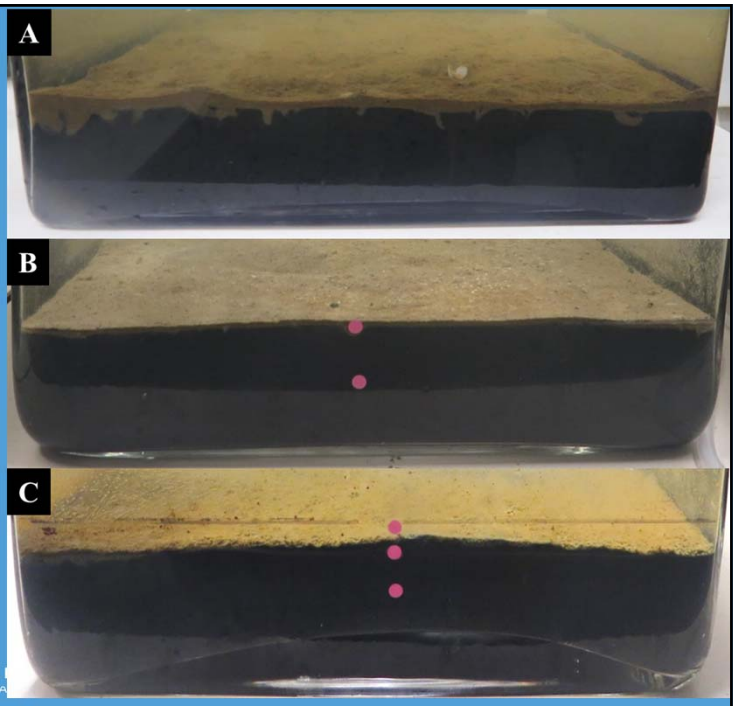


Burrowing *Corophium* in Snow+Oil: bioturbation in progress!

Control: normal oxidized layer with burrowing activity

Clay+Oil: thin layer, no burrows

Snow+Oil: no layer



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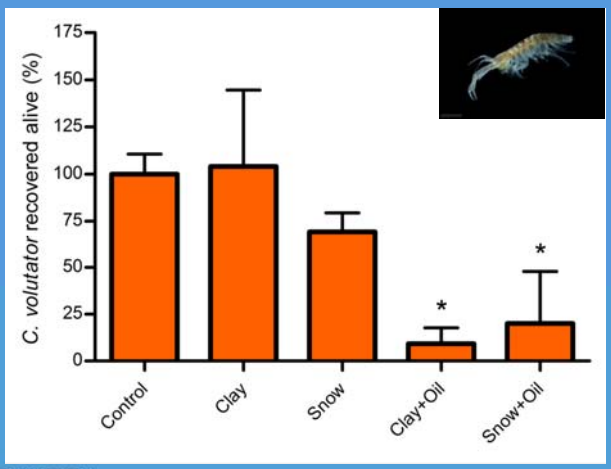
In vivo toxicity: *Corophium volutator*

- *C. volutator* mortality highest in aquaria with oil



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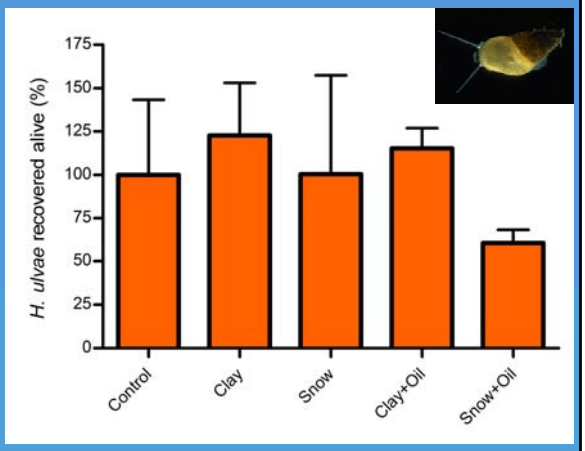
In vivo toxicity: *Hydrobia ulvae*

- Indication of reduced survival in Snow+Oil
- Avoidance of oil?
- (Oiled) snow as food?
- Confirmed in longer experiment, ongoing.
- See poster presentation van Eenennaam *et al.* tonight 6pm-8pm



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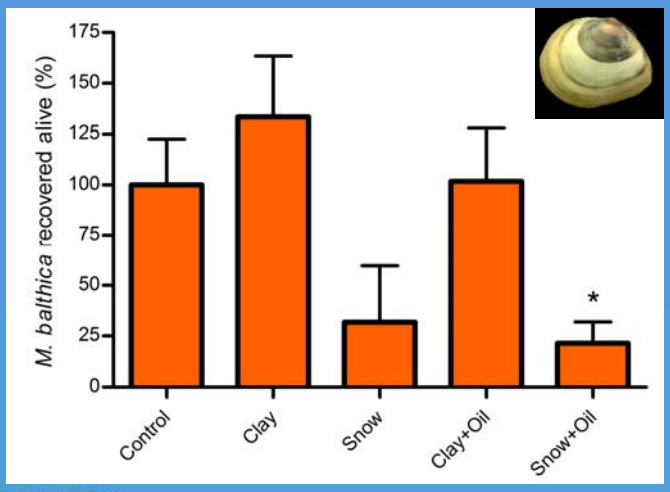
In vivo toxicity: *Macoma balthica*

- Less living *Macoma* in Snow and Snow+Oil



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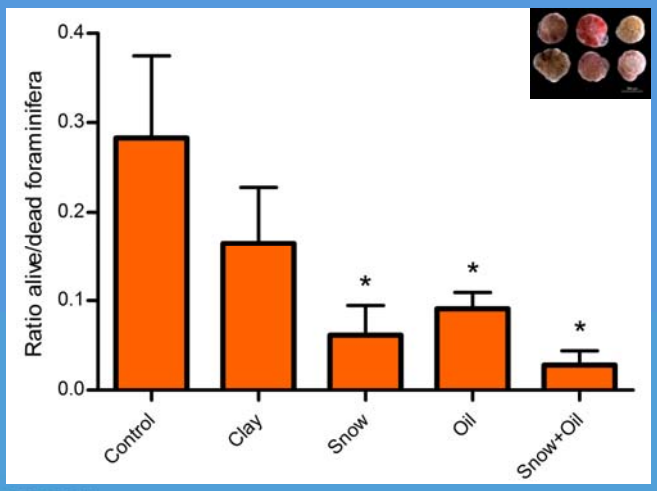
Foraminifera

- Ratio alive/dead decreases -> less living foraminifera



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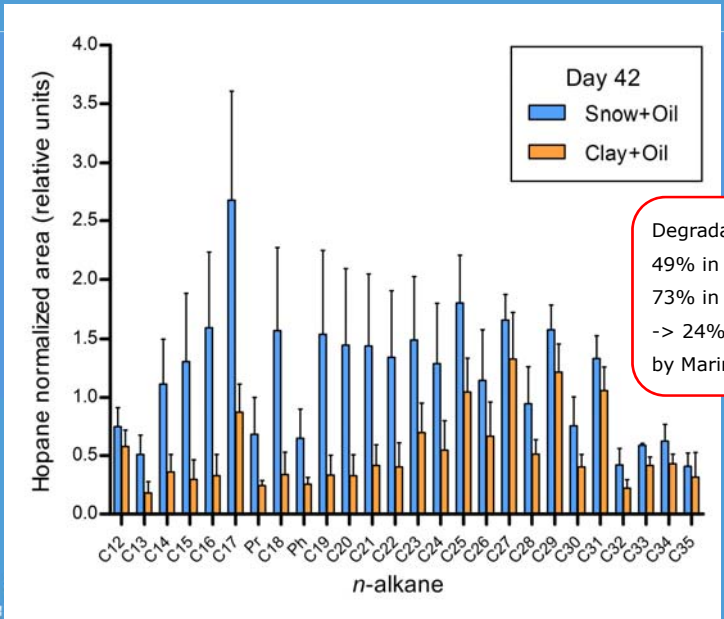
Fingerprint of *n*-alkanes at t=42



Degradation:
49% in Snow+Oil
73% in Clay+Oil
-> 24% inhibition
by Marine Snow

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Conclusions

Indeed:

- *Oil-contaminated marine snow negatively impacts benthic invertebrates*
- *Marine snow by itself also affects benthic invertebrates, but to a lesser extent*
- *Presence of marine snow inhibits oil biodegradation*

Benthic community can be affected by oil spill response

- ➢ Healthy benthic ecosystem is crucial for other organisms in the food chain, like fish

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Thank you!

GULF OF MEXICO RESEARCH INITIATIVE

C-IMAGE - II
Center for the Integrated Modeling and Analysis of Gulf Ecosystems
GoMRI C-IMAGE project (#SA 12-10/GoMRI-007)

TripleP@Sea

Wageningen UR – IPOP TripleP@Sea (KB-14-007)

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Edwin Foekema
(Feb 6, MOSSFA Workshop)
Tinka Murk
(Feb 8, 12.15 pm, session 010)
C-IMAGE NL
Sophie Vonk
(Feb 8, 3.15 pm, session 015)
Justine van Eenennaam
(Feb 8, 12.00 pm, session 010)
Alette Langenhoff
Marieke Zeinstra
(Feb 9, 10.00 am, session 018)
Shokouh Rahsepar
(Feb 8, 12.00 pm, session 012)
Wierd Koops
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effects
scenario
spill
populations
oil-contaminated
invertebrates
marine
model
MOSSFA
dispersants
snow
benthic
sediment
response
survival
oxygen
surface
biodegradation
oil
slick
species
resilience
reduced