



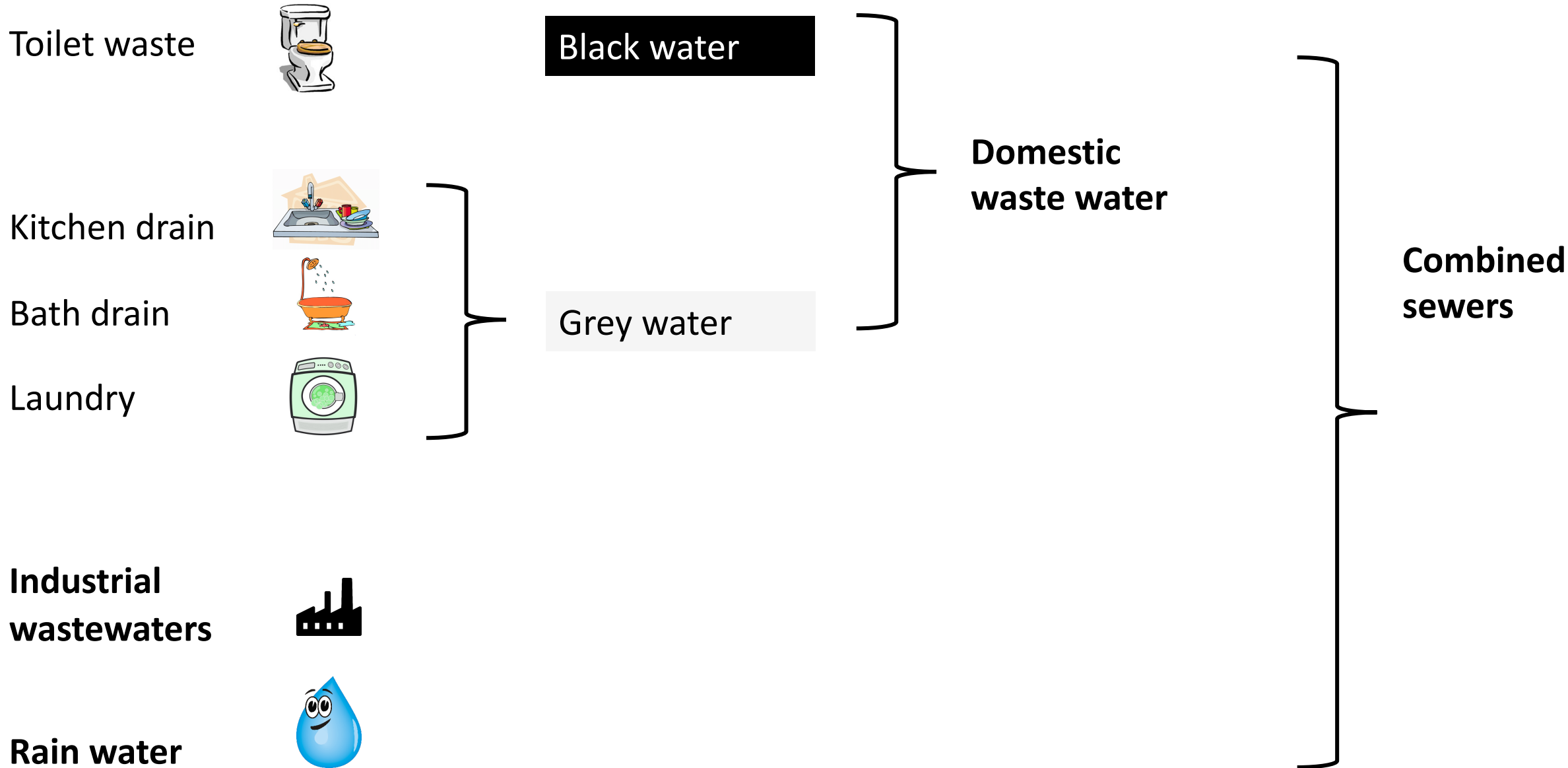
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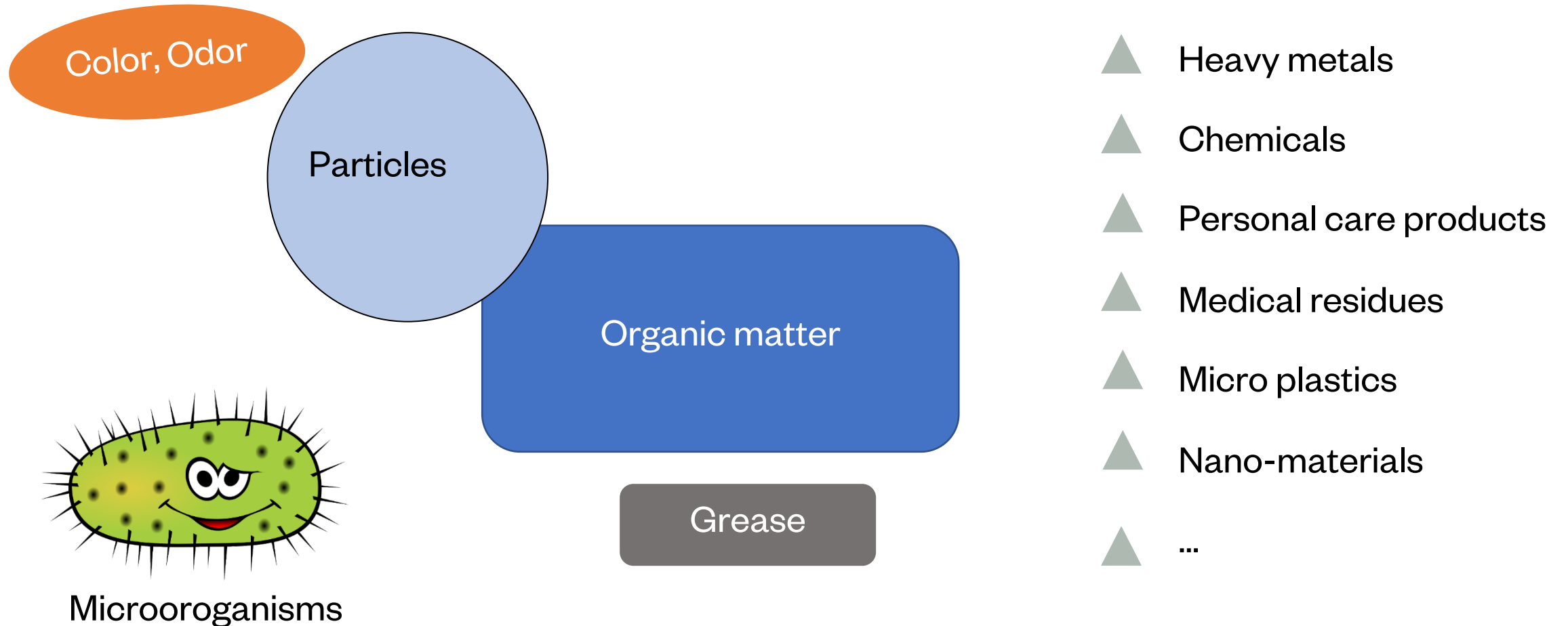
Waste water management and environmental concerns in cold climate

Pernille Erland Jensen,
Department of Civil Engineering
Technical University of Denmark (DTU)
pej@byg.dtu.dk

What is waste water?



What does wastewater contain?



Conventional treatment recap

Treatment level	Method	Effect
Preliminary	Screening	Large particles removal
Primary	Screening and/ or sedimentation	Smaller particles removal, sand, fraction of OM inkl. some P, fraction of HM's and other compounds bound to OM.
Secondary	Chemical and/or biological treatment (e.g. flocculation/ biological conversion and sedimentation)	Smaller biodegradable organics and suspended solids. Disinfection effect.
Tertiary	Biological treatment and or chemical (e.g. precipitation of nutrients with Fe and Al salts, fluctuating oxygen /anaerobic)	High level nutrient removal. Disinfection effect.
Advanced	Various additions	Depending on need

Present management of waste water the North



Wastewater lagoons
Primary/secondary
(photo: Lisbeth Truelstrup Hansen)

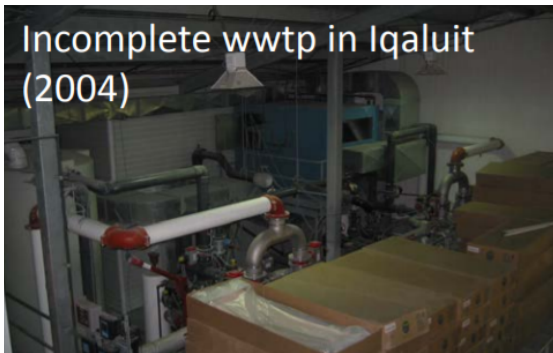


No treatment

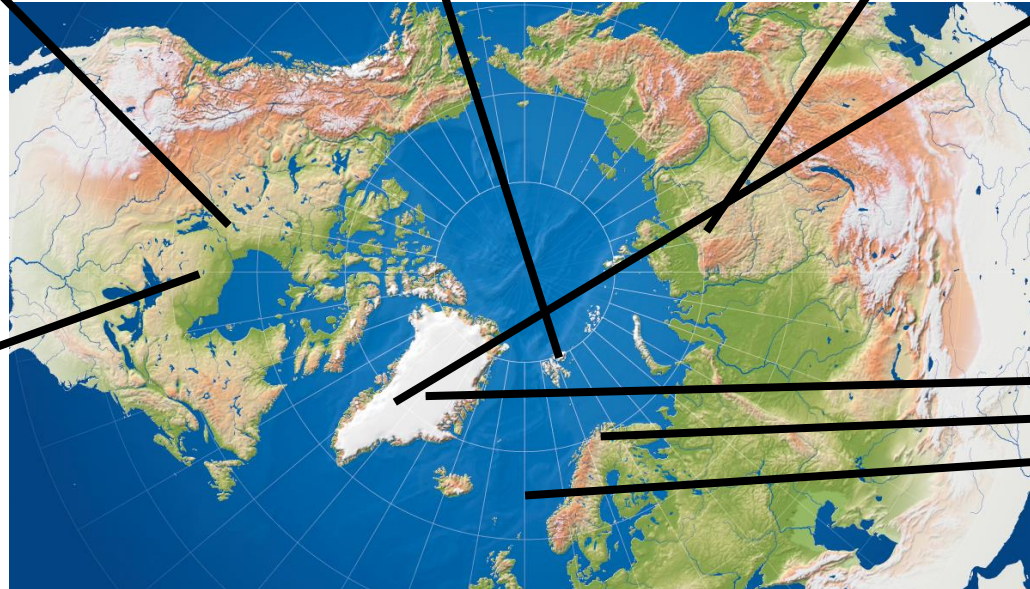
Secondary treatment for towns
> 20.000 persons
Smaller places no treatment



No treatment



Mechanical plants – primary/secondary
(photo: Kenneth Johnson)



Primary treatment

Wastewater in Greenland



- ▲ In 2005 a report concluded that no harm to the environment was to be expected from current practise. *
- ▲ BUT the report also clearly states:
Only nutrients are considered, not e.g. pathogens, heavy metals or anthropogenic compounds.
The evaluation anticipates that the outlet is in open water and not closed Fjords.

*COWI Consultants 2005. Udrednings- og pilotprojekt vedrørende håndtering af miljøproblemer som følge af spildevand i de grønlandske byer. Miljøstyrelsen (Danish EPA).

Wastewater in Greenland

▲ New legislation requires municipalities to make environmental impact assessment of recipients and implement treatment of wastewater if impacts are observed. **

▲ Water quality criteria set for wastewater from mineral extraction projects.***



**Selvstyrets bekendtgørelse nr. 10 af 12. juni 2015 om bortskaffelse af latrin og spildevand:

http://naalackersuisut.gl/~media/Nanoq/Files/Kundgoerelser/DK/2015/Bekendtgoerelser/bkg_10%20dk.pdf

***http://naalackersuisut.gl/~media/Nanoq/Files/Hearings/2015/Nye%20retningslinjer%20for%20udarbejdelse%20af%20VVM%20for%20mineprojekter%20i%20Groenland/Documents/EIA%20Guidelines_UK_.pdf

Observed environmental effects (no treatment)

- ▲ Floating items on surface
- ▲ Eutrophication and dead bottom of bay
- ▲ Ecosystem disturbance
- ▲ Heavy metal accumulation in sediments
- ▲ Antibiotic resistance

Observed environmental effects: Visibility



Ecosystem disturbance

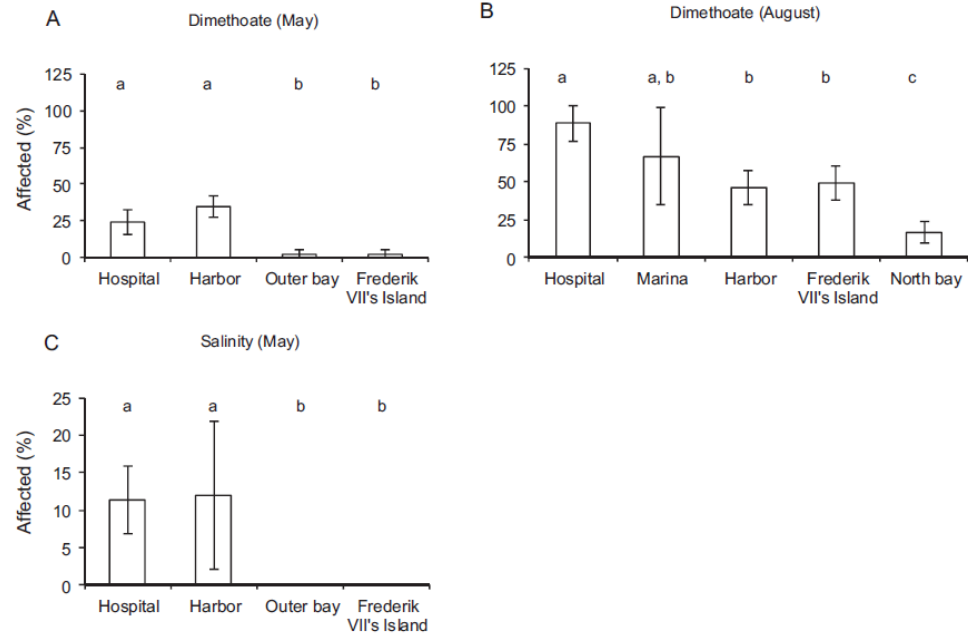
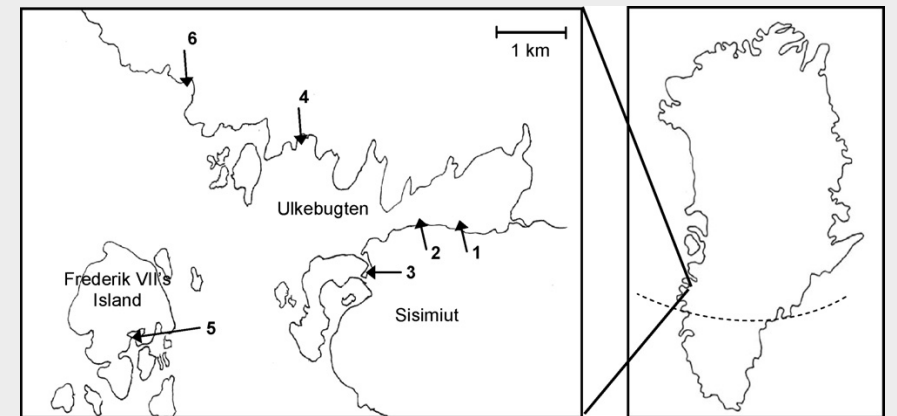


Fig. 6. Population cost as % affected individuals measured as mortality \pm standard deviation after 7 days of exposure to unknown contaminant, dimethoate ($150 \mu\text{M}$) (A) tested in May and (B) tested in August and to salinity (C) tested in August (26‰). Letters above each bar refers to the statistics where different letters indicate significant differences ($p < 0.05$, Kruskal–Wallis test) between sites.



Elevated concentrations of heavy metals and anthropogenic compounds



Elevated concentrations of heavy metals and anthropogenic compounds

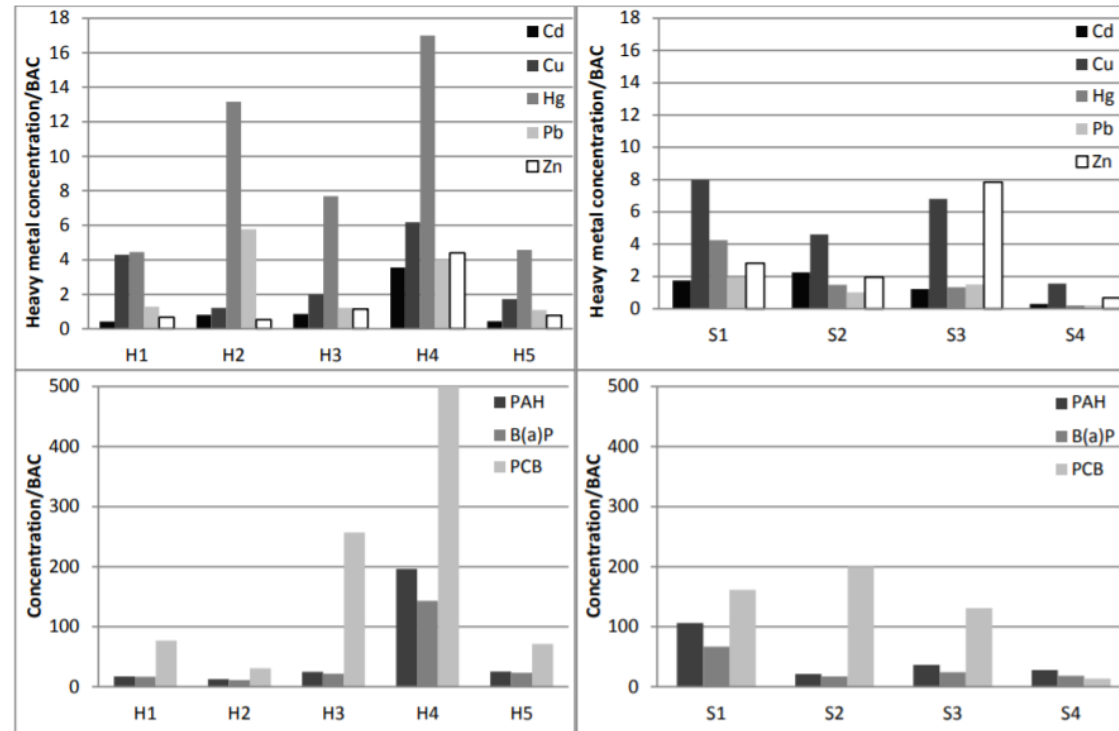


Fig 1 Pollutant concentrations compared to BAC in sediments from Hammerfest (H) and Sisimiut (S)

H: Hammerfest, S: Sisimiut. H4: Sewage outlet, all others harbor activity,

Ecosystem disturbance

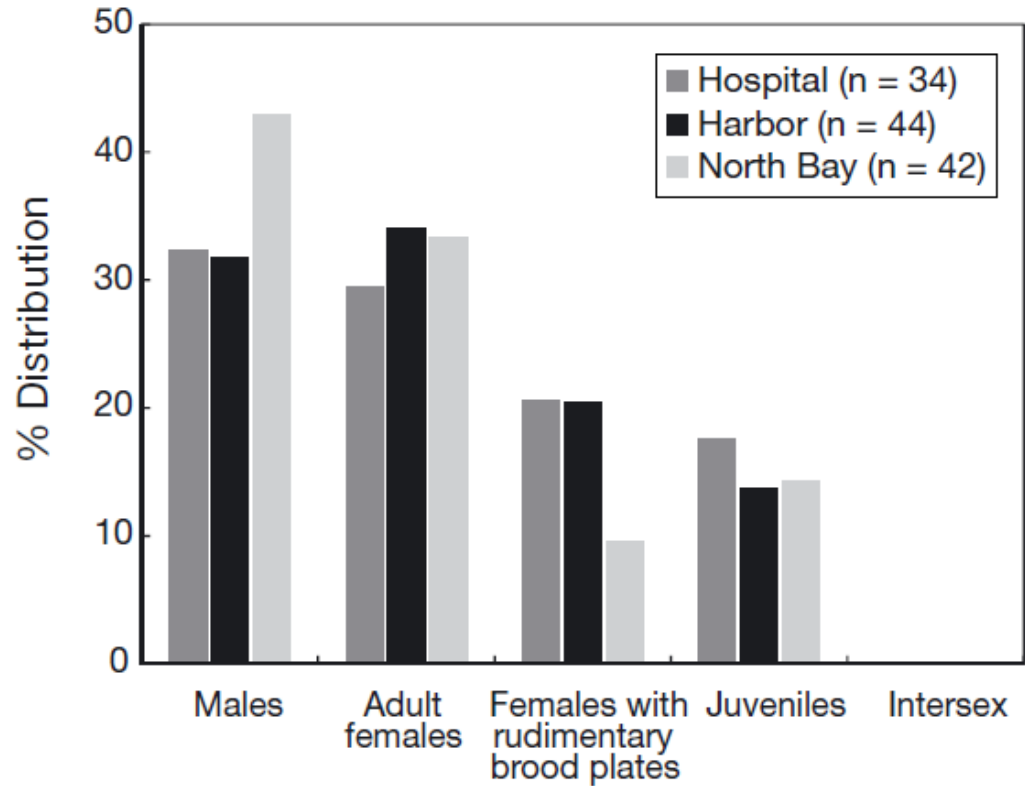


Fig. 6. *Orchomenella pinguis*. Gender and intersex distribution for the Harbor, Hospital and North Bay samples

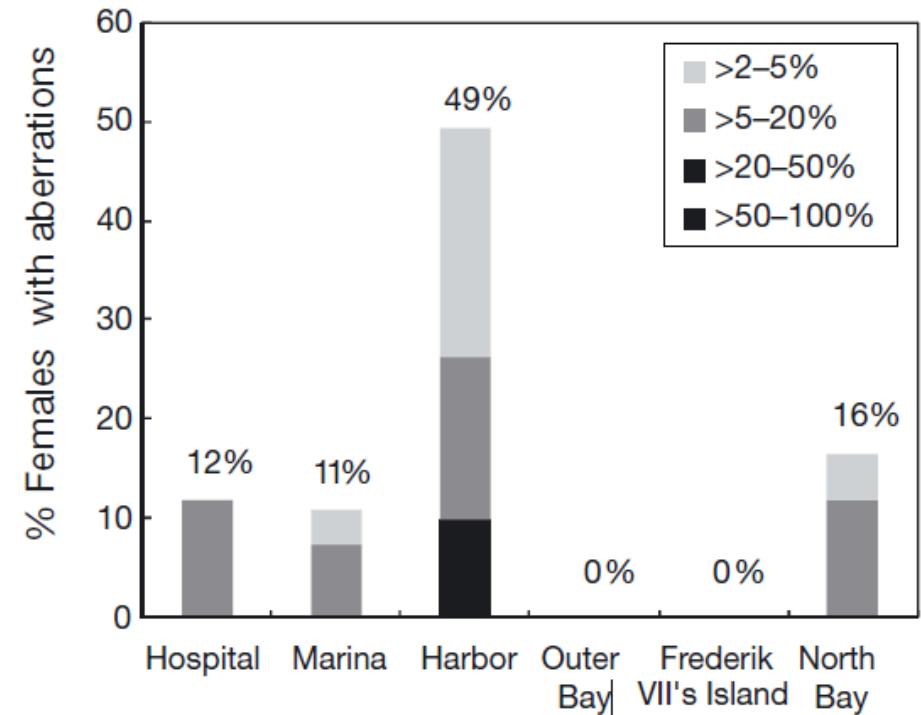
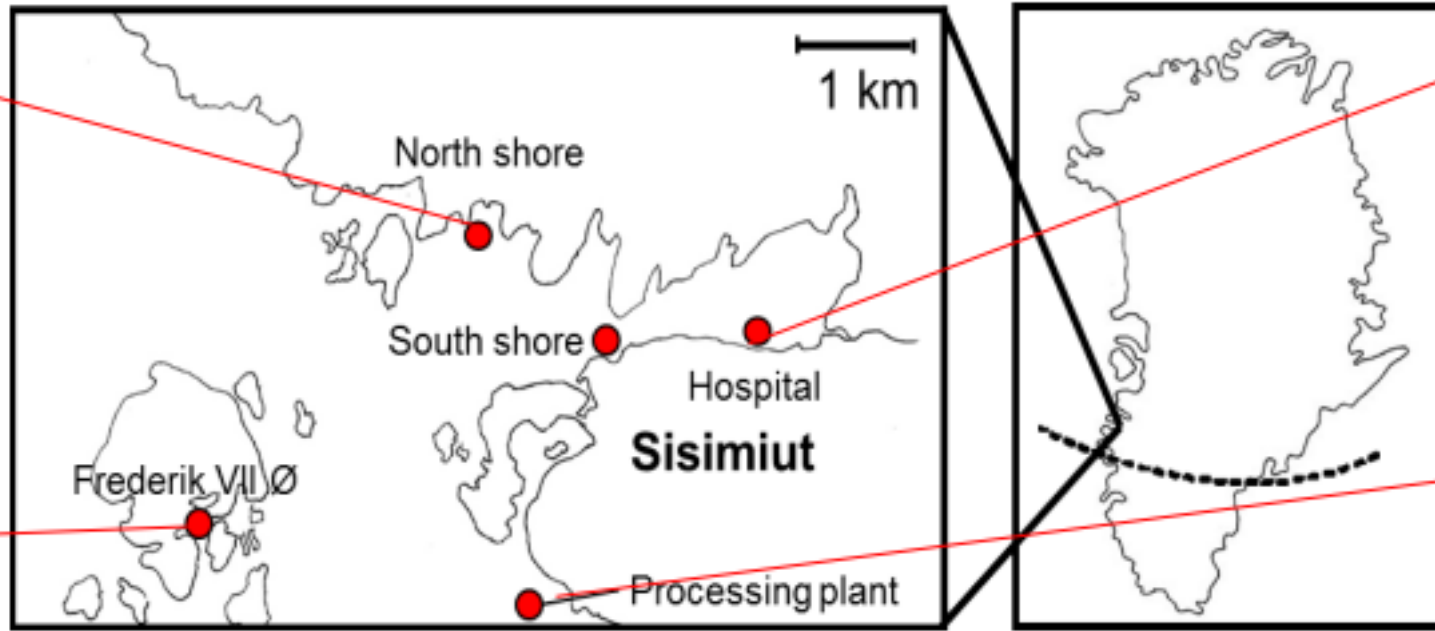


Fig. 4. *Orchomenella pinguis*. Percentage of females within each site carrying broods with aberrations (see Fig. 3). The degree of aberrations is indexed within each brood into >2-5%, >5-20%, >20-50% and >50-100% embryo aberrations per female

Sediment bacterial community impact



Sediment bacterial community impact

- ▲ There is a difference in resistance patterns between unexposed and exposed areas.
- ▲ Ciprofloxacin, Tetracyclin and Macrolide resistance is only found near the sewage outlet.
- ▲ β -lactam resistance is found everywhere as is one type of aminoglycoside resistance.
- ▲ Sediment bacterial community function at the sewage outlet shows signs of eutrophication impact.
- ▲ Bacterial abundance is severely reduced in guts of marine organisms living in the vicinity of the sewage outlet.
- ▲ Resistance patterns are replicated at different trophic levels along the exposure gradient.

DTU

