THE CHALLENGES IN AQUATIC RISK ASSESSMENT OF CATIONIC POLYMERS

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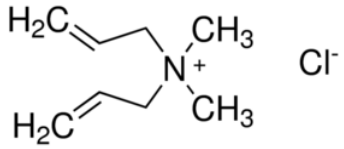
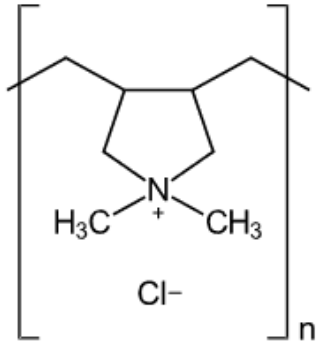
THE CHALLENGES

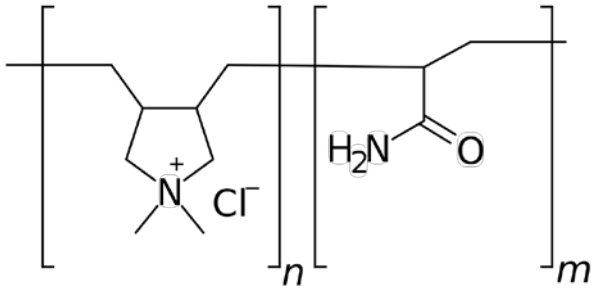
WHAT?



Monomer



Homopolymer



Copolymer

ALL PLASTICS ARE POLYMERS
BUT NOT ALL POLYMERS ARE PLASTIC

WHAT?

WHY? HOW? WHO?

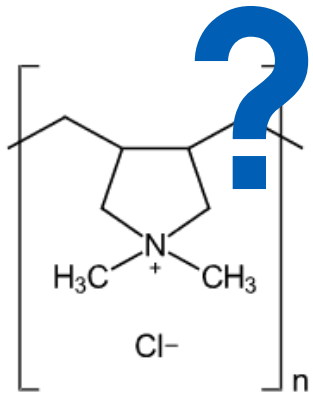
THM

polymer:

*… **sequence of one or more types of monomer units**.*
*… distributed over a range of **molecular weights***
*… containing **at least three monomer units***

- ECHA, 2006

Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH)



microplastic:

*we propose that **any synthetic polymer** (…) that has the potential to exist as a **small solid particle** in the environment, and which is **resistant to (bio)degradation**, should be considered to be consistent with the concerns associated with the term '**microplastic**'*

- ECHA, 2019

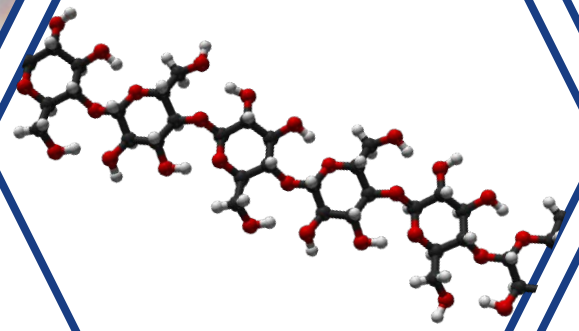
ECHA ANNEX XV RESTRICTION REPORT – MICROPLASTICS

WHAT?

WHY? HOW? THM

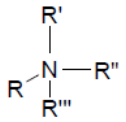
Microplastic

Polymers



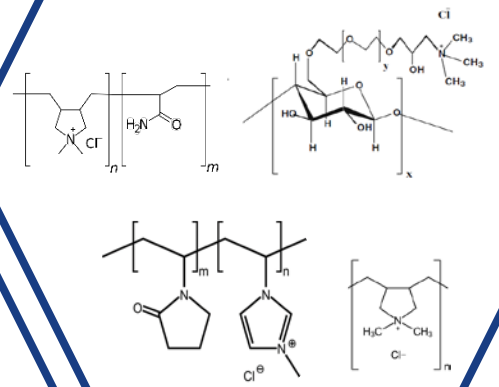
E.g.
cationic polymers

- Same backbone and charge
- Different functional groups



Quaternary

Polyquaterniums



Group of polymers

- Synthetic/natural
- Backbone
- Charge
- Applications

Still not the same!

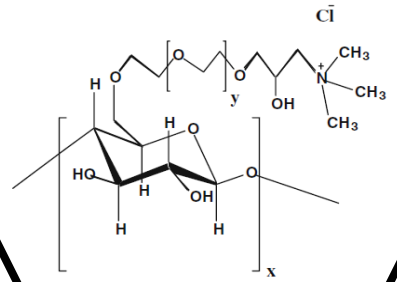
- MW 29,000 – 2,500,000 (g/mol) (PQ6?
- Charge density varies (copolymers)
- U**V**CB

WHAT?

Tradename	MW	Viscosity (mPa/s) (2% aq soln)	%-N	Charge density
UCARE JR125	250 kDa	75-125	1.5-2.2	0.9
UCARE JR30M	600 kDa	30000	1.5-2.2	1
UCARE JR30M	600 kDa	30000	1.5-2.2	1
UCARE LK	Low	300-500	0.4-0.6	Low
UCARE LR30M	High	30000	0.8-1.1	Low
UCARE LR400	Low	300-500	0.8-1.1	Low

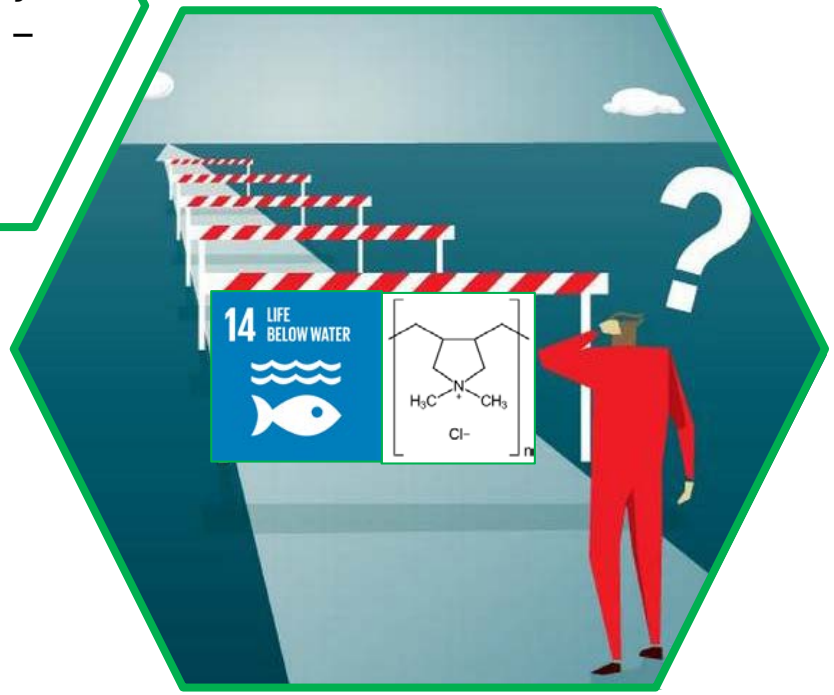
Still not the same!

Example with PQ10



References:
Cumming 2008, Cumming et al 2011, DOW TDS, DOW Product brochure

"The provisions of Titles II and VI shall not apply to polymers" – REACH exemption



"The provisions of Titles II and VI shall not apply to polymers" – REACH exemption

Very little new knowlegde

But we do know something!

They are not our "usual suspects"

- Size
- "Mode of action"
- Average molecular weight
- Charge density
- Polydispersity
- % monomer (and type)

HOW?

They are not our "usual suspects"

Development

FT-ICR?
(MP overlap)

How to analyze these "compounds"?

Older methods

Colorimetric wet chemistry methods (Dubois, 1956 & Kanzaki, 1959)

Early P&G work

Cap-GPC-MS semi-quantitative + quantitative w/high selectivity

Current state

CapGPC-QTOF (characterization)
FI-HRQTOF-MS (quantitation)

Acknowledgements:
P&G analytical team (P&G) 2019

They are not our "usual suspects"

How to analyze these "compounds"?

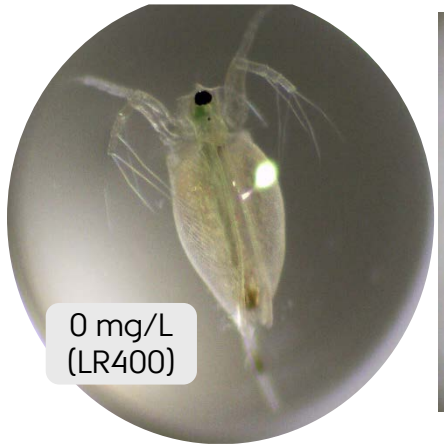
How to apply standard tests to non-standard compounds?

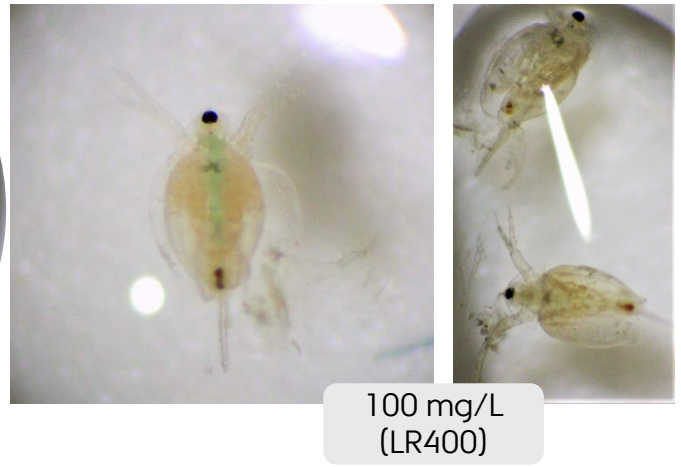
CD/MW	Test Material (PQ10)	Desmodesmus subspicatus 72-h ErC50 (mg/L)	Ceriodaphnia dubia 48-h EC50 (mg/L)	Daphnia magna 48 h EC50 (mg/L) (RCW)	Zf FET 96 h LC50 (mg/L)	Daphnia magna 48 h EC50 (mg/L) (M7W)	Aliivibrio fischeri 30 min IC50 (mg/L)
High/High	JR30M	>100	<1	23	9	100-1000	>1000
Med/Low	JR125	>100	<1	100-1000	89	>1000*	>1000
Med/Low	JR400	>100	<1	100-1000	9		>1000
Low/High	LR30M	>100	10-100	>1000*	>1000	>1000*	>1000
Low/Low	LR400	>100	1-10	93	321	100-1000	>1000

Acknowledgements: Jessica Brill (P&G), Jane Rawlings (P&G) and Anna Brun (AU) 2019

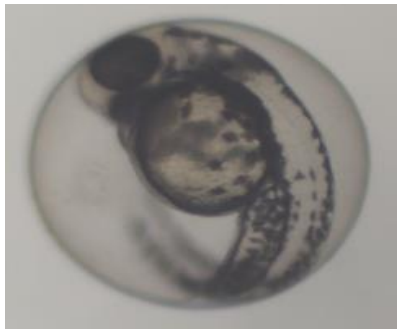
* Labored movement

- Toxicity patterns with MW and CD
- Differences between test species
- Differences between test media
- Physical impairment of organism
  (preliminary range finding experiments)

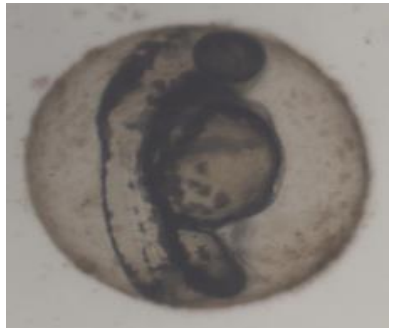




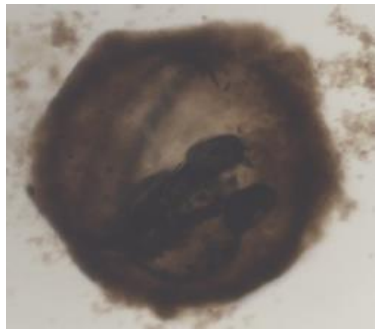
- Effect of humic acid!



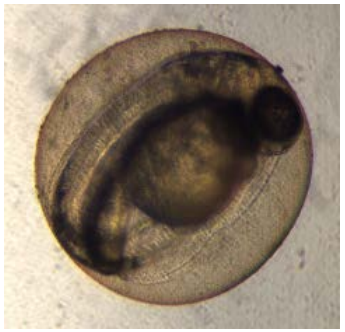
48-h, No HA



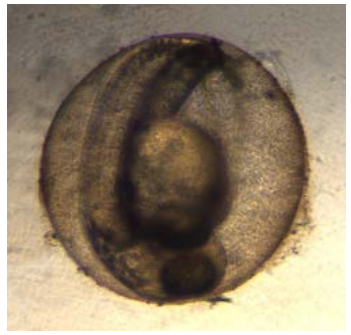
48-h, 2 mg HA/L



48-h, 20 mg HA/L



48-h
10 mg JR30/L 20 mg HA/L



48-h
100 mg JR30/L
20 mg HA/L

Acknowledgements:
Jane Rawlings (P&G)
2019

Regulators

- Science-based ERA

Scientists in polymer-field

- Understading of mechanisms

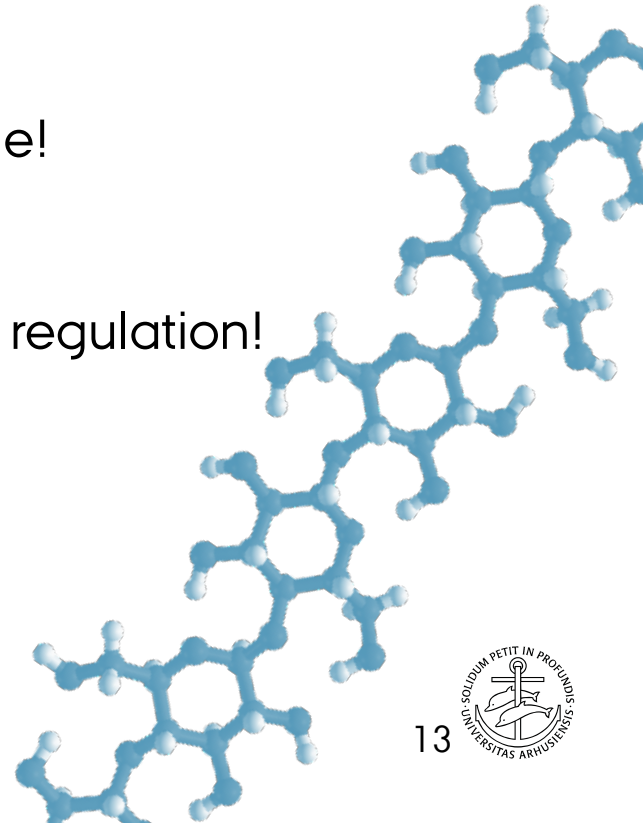
Public

- Safe use of chemicals

TAKE HOME MESSAGES

- All plastics are polymers, but not all polymers are plastics
- A polymer is not just a polymer
- There are challenges but it's not impossible!

  (Effect and analytics)
- Relevant and needed research – eminent regulation!



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