





Fate studies of selected BFRs

Patrik Andersson and Jenny Rattfelt Nyholm
Umeå University, Sweden



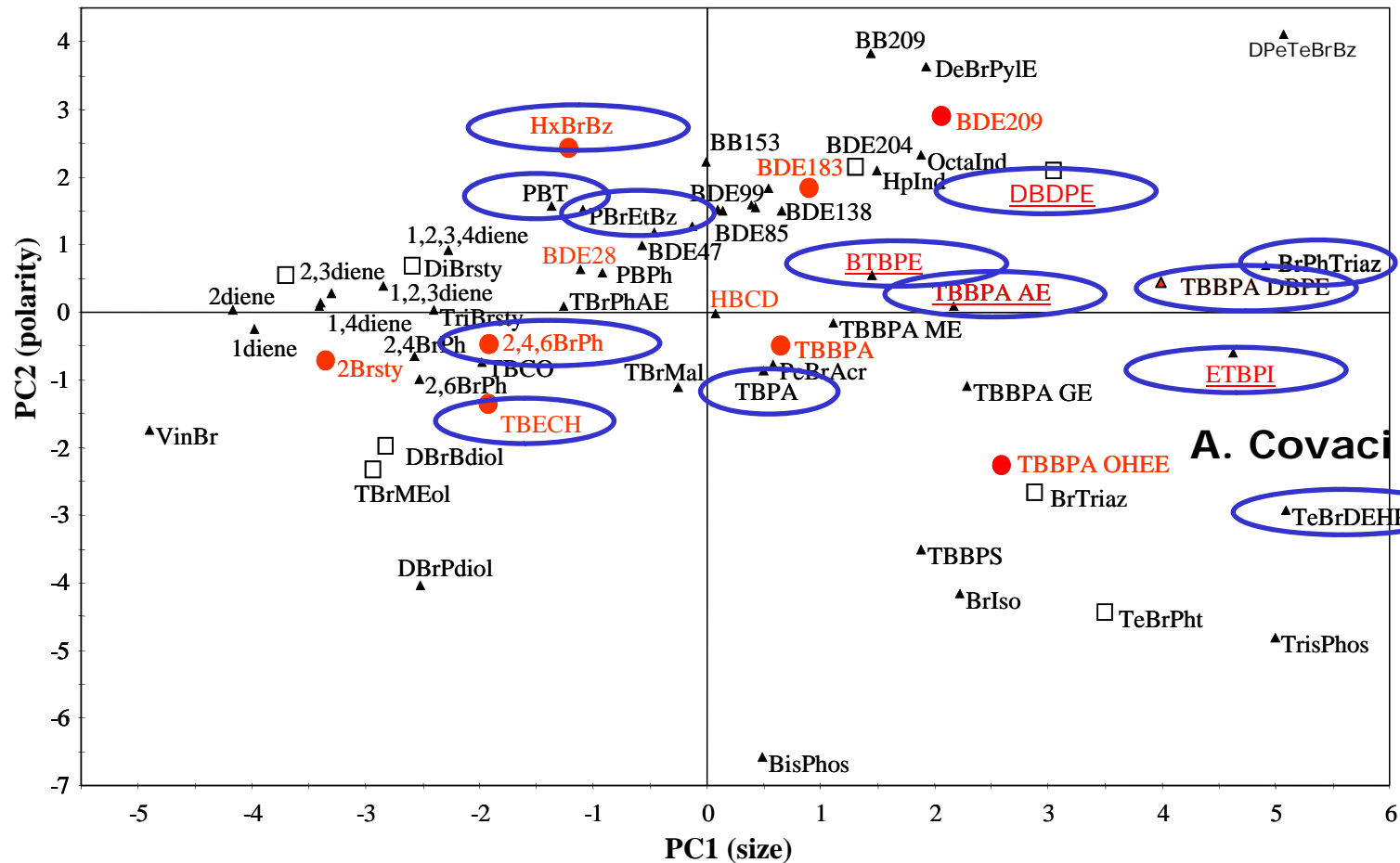
Outline

- Chemical variation of brominated flame retardants
- Biodegradation in sludge amended soil
- Uptake of BFRs in earthworms
- Uptake and maternal transfer in zebrafish
- New BFRs in the environment



Chemical variation of BFRs

Andersson et al ETC 2006



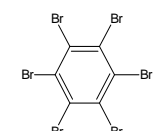
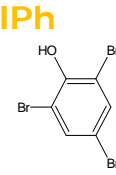
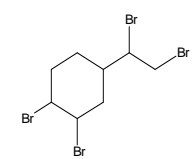
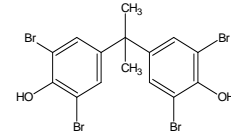
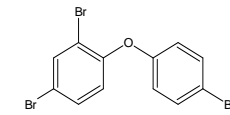
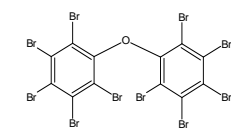
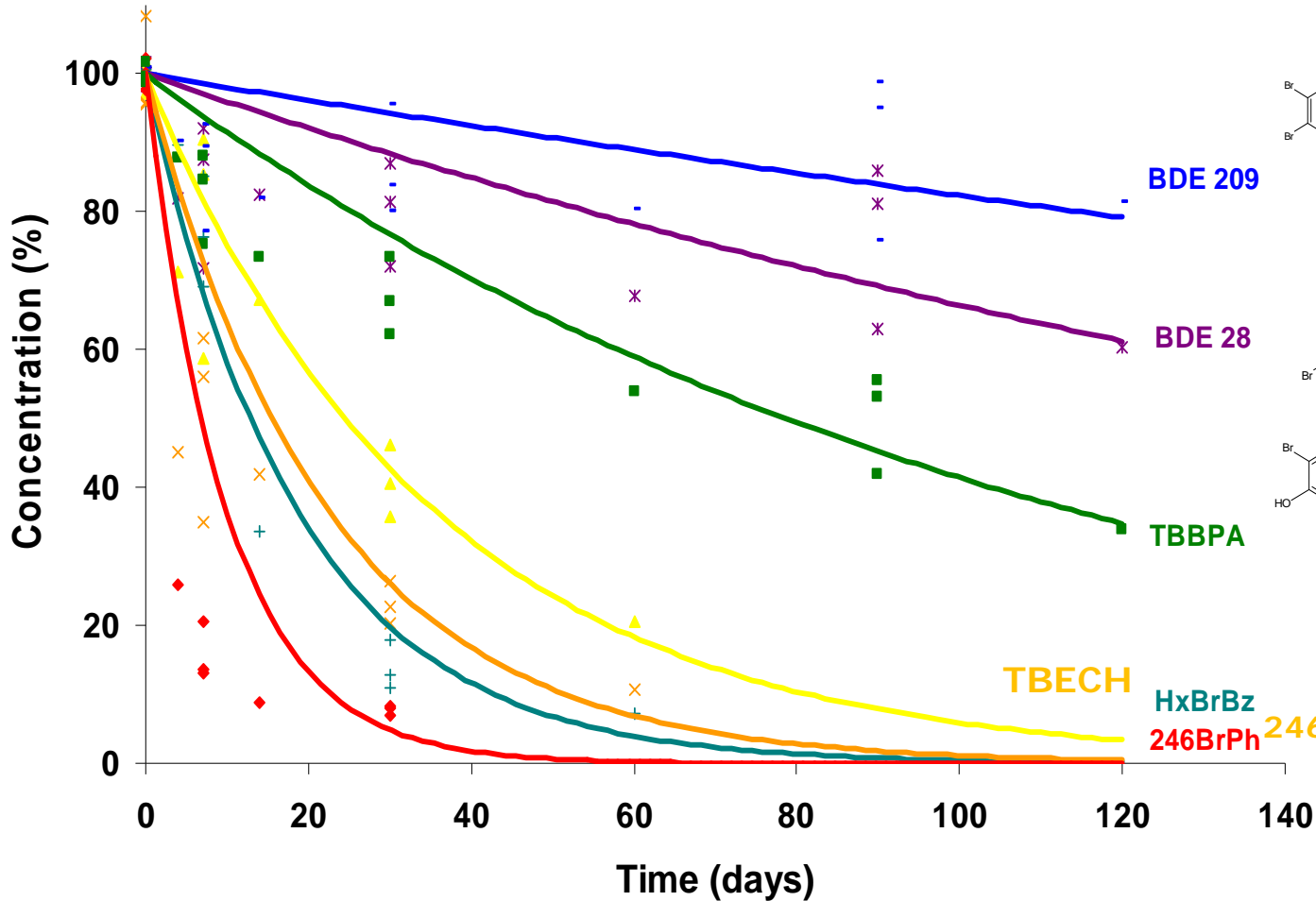
A. Covaci et al 2011

1,2-Dibromo-4-(1,2-dibromoethyl)cyclohexane (TBECH)



Biodegradation in aerobic soil

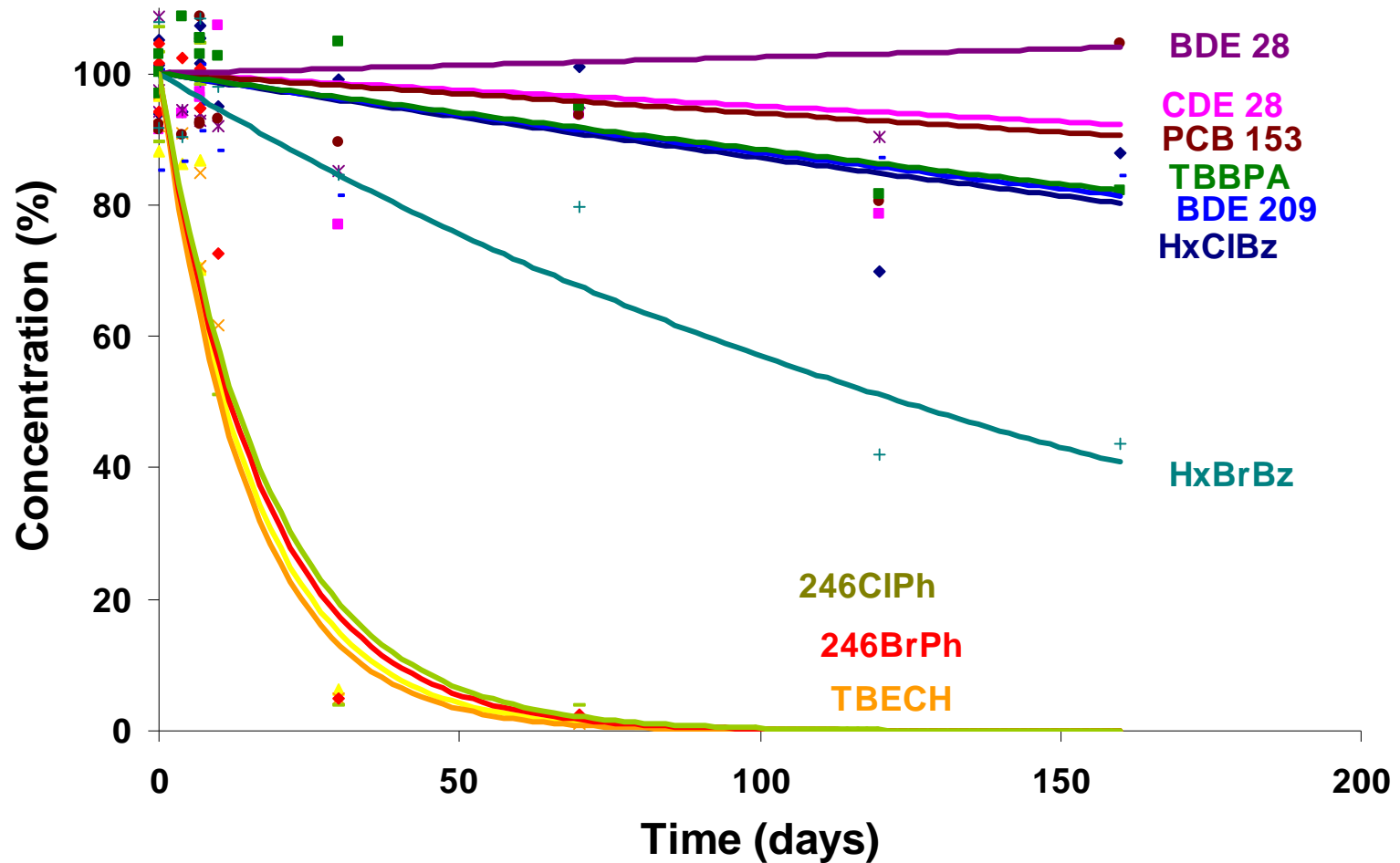
(Nyholm et al EP 2010)





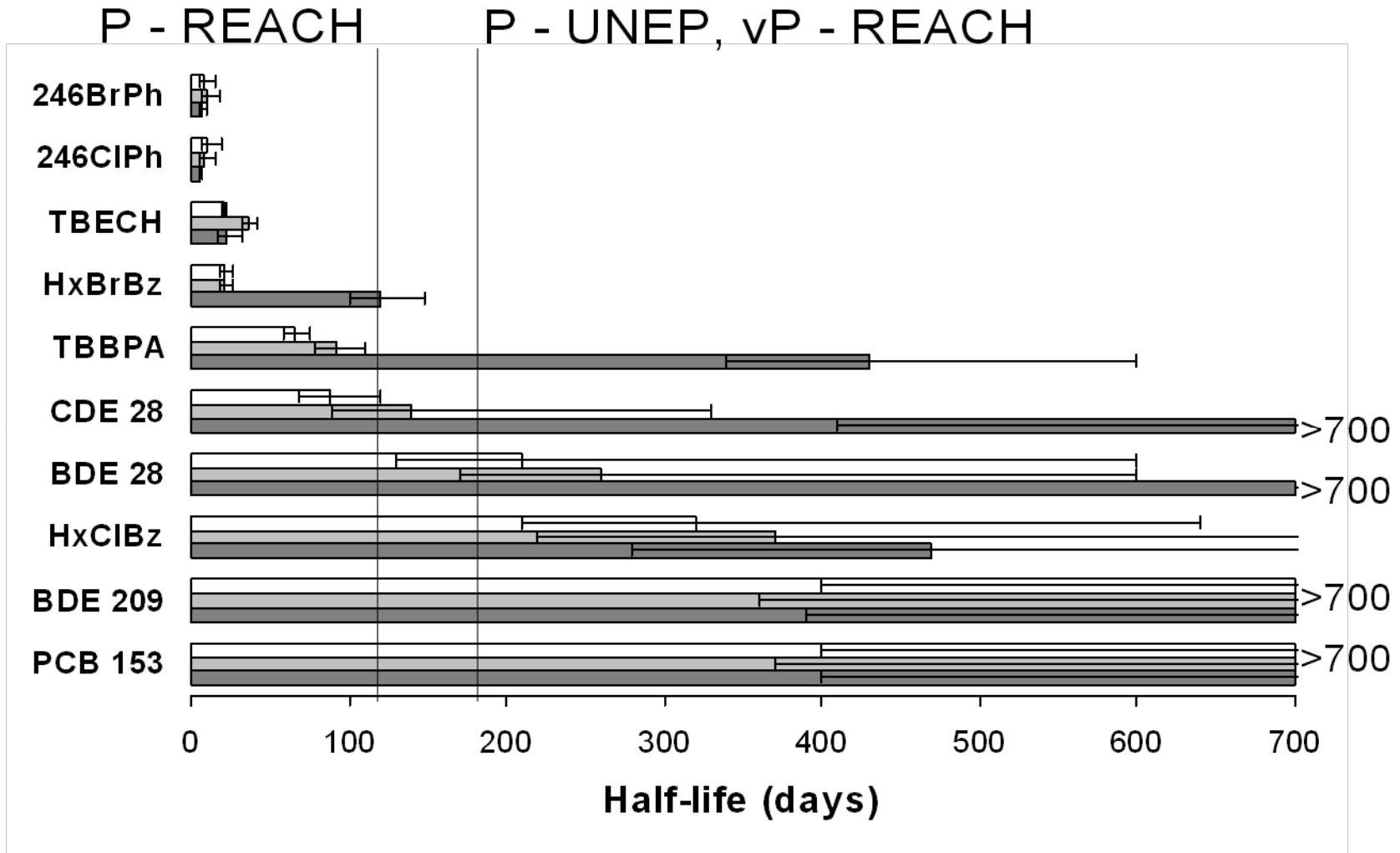
Biodegradation in anaerobic soil

(Nyholm et al EP 2010)





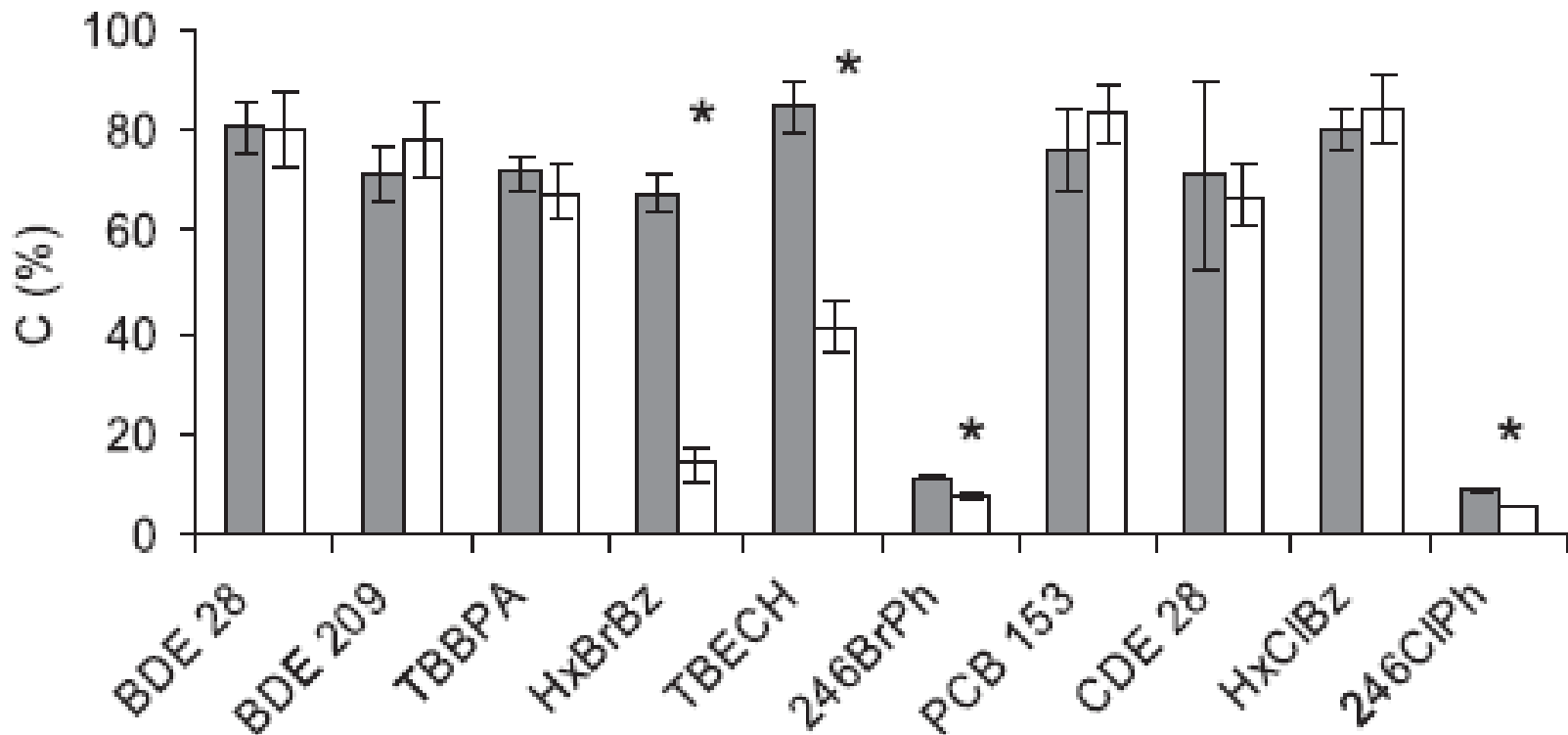
Half-lives of brominated flame retardants in soil





Temperature affects biodegradation: 8 vs 20°C

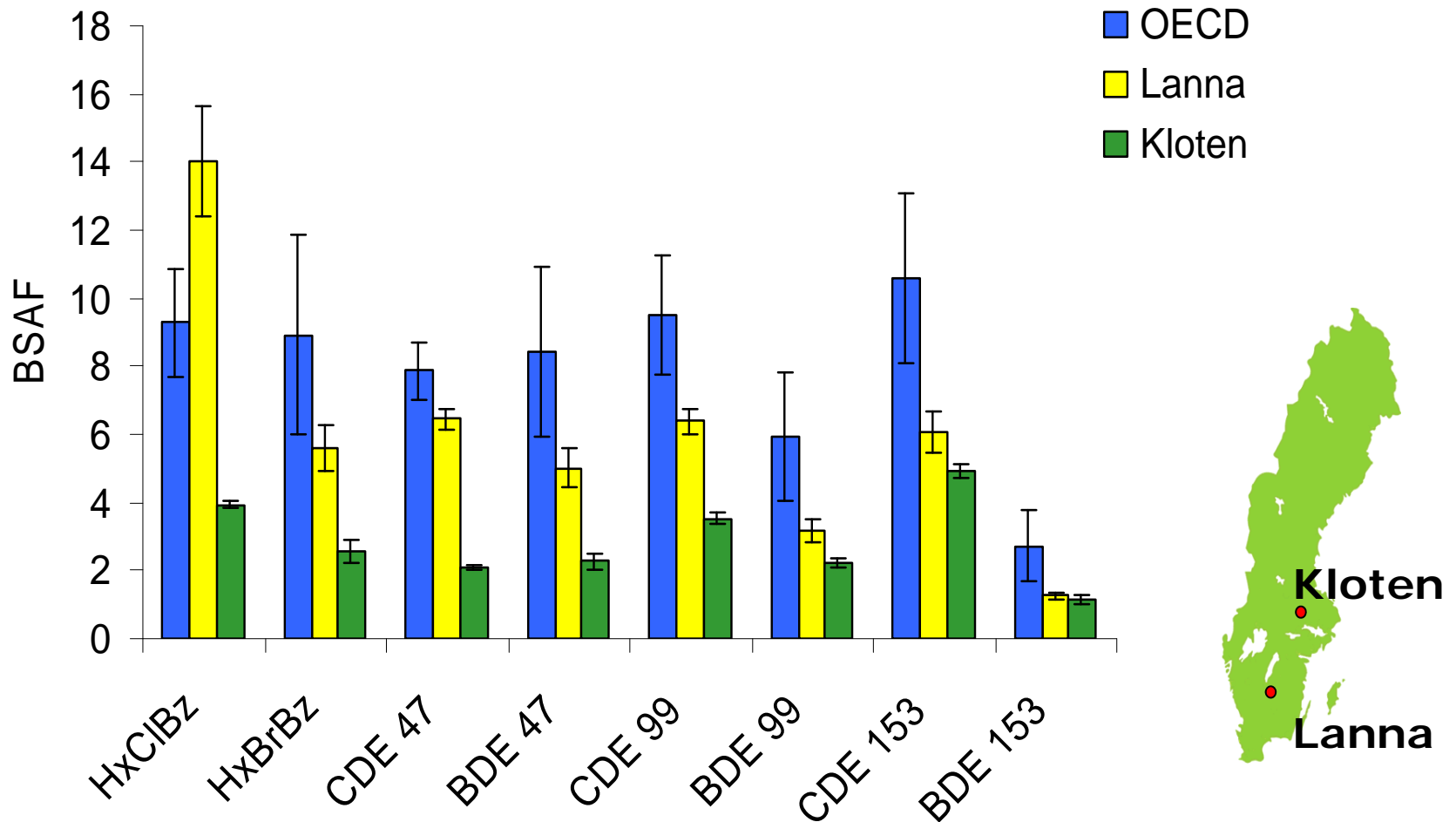
(Nyholm et al EP 2010)





Accumulation in earthworms from three different soils

(Nyholm et al EST 2010)

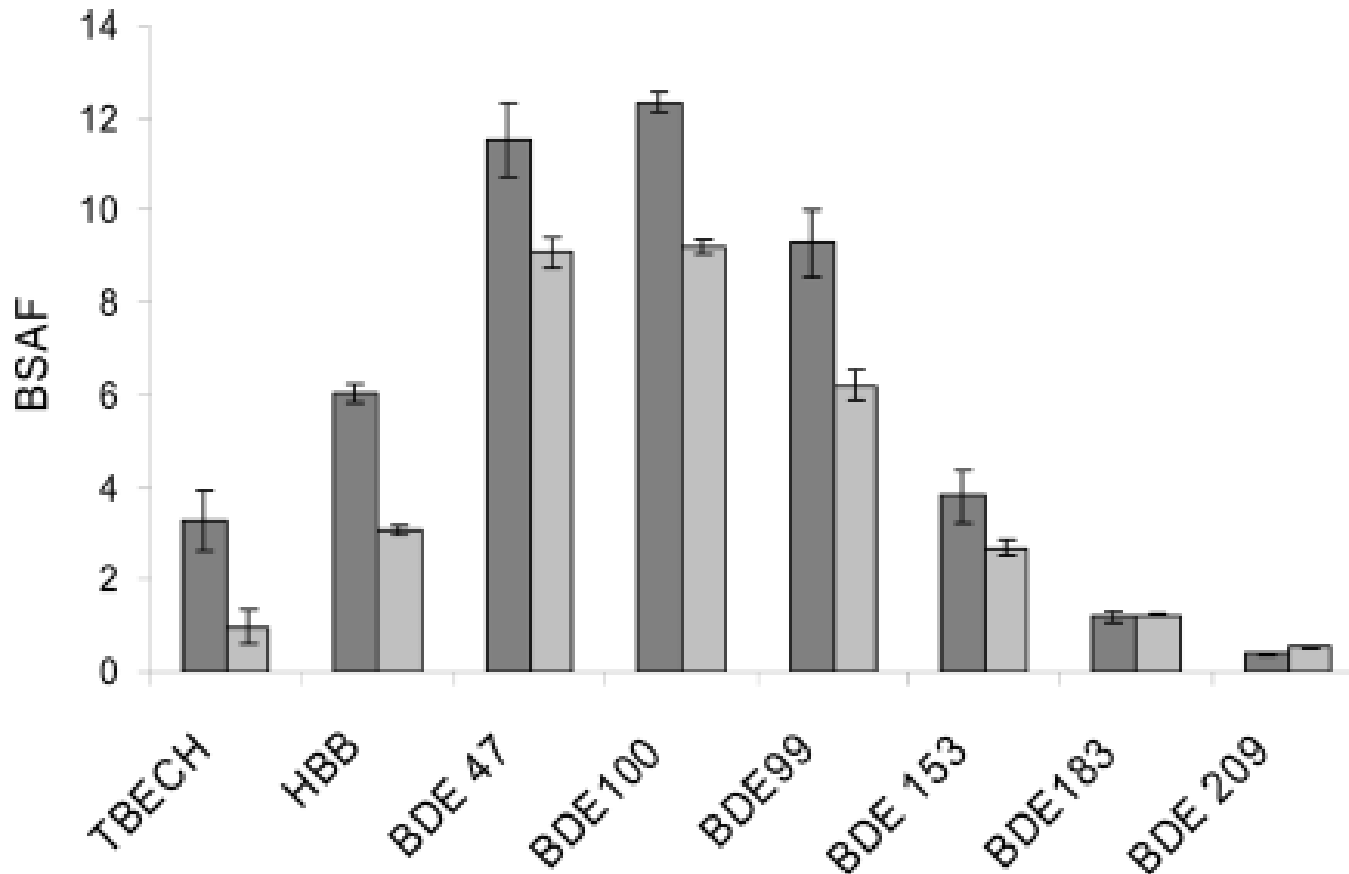




Accumulation in earthworms (OECD)

Aging 7 days vs 2 years

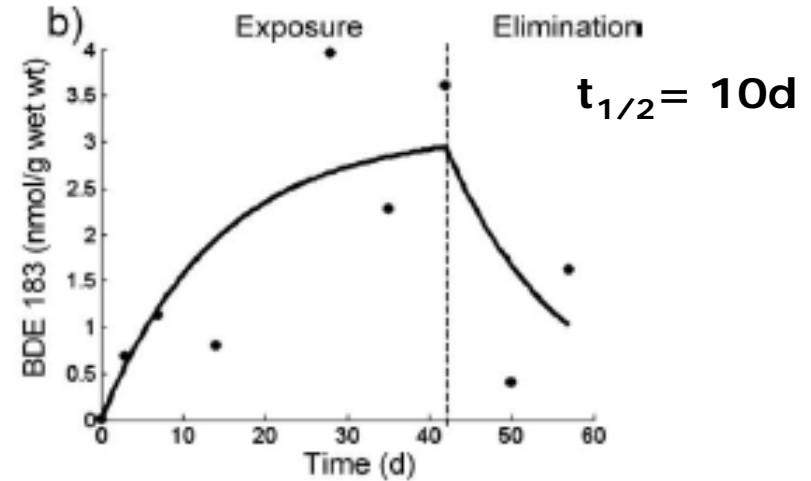
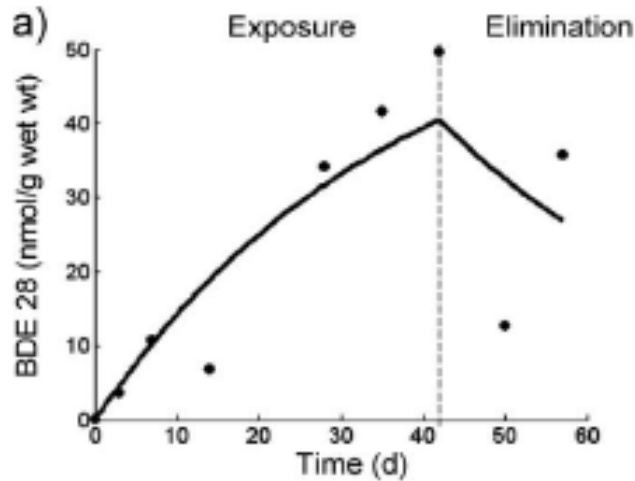
(Nyholm et al EST 2010)



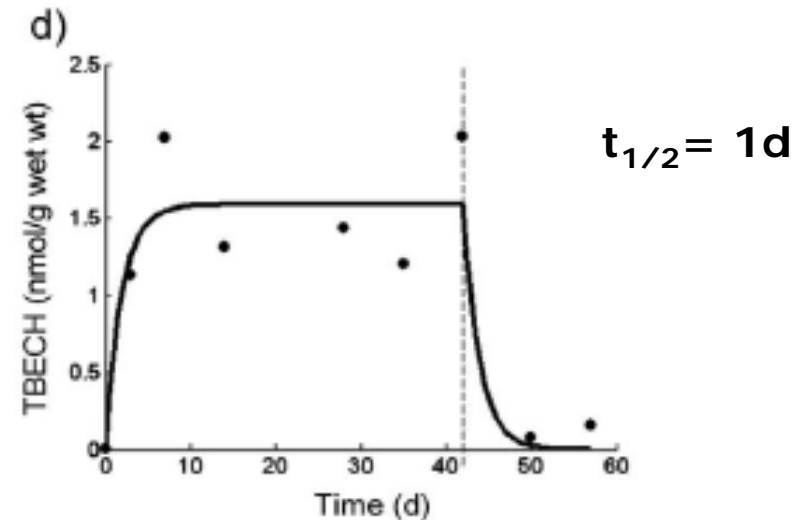
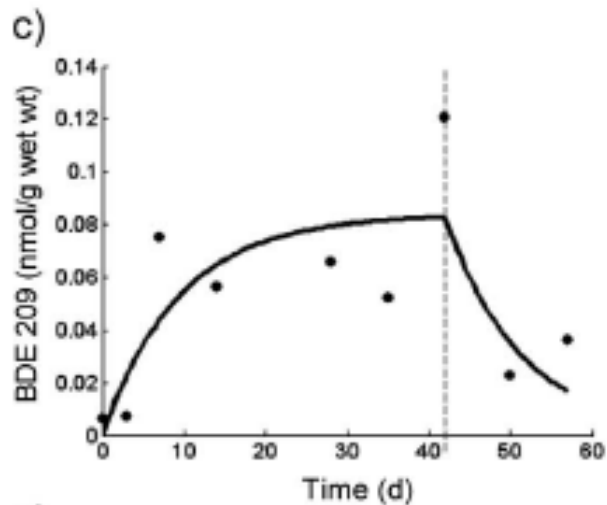


Uptake of BFRs in zebrafish through feed (Nyholm et al ETC 2009)

$t_{1/2} = 25d$

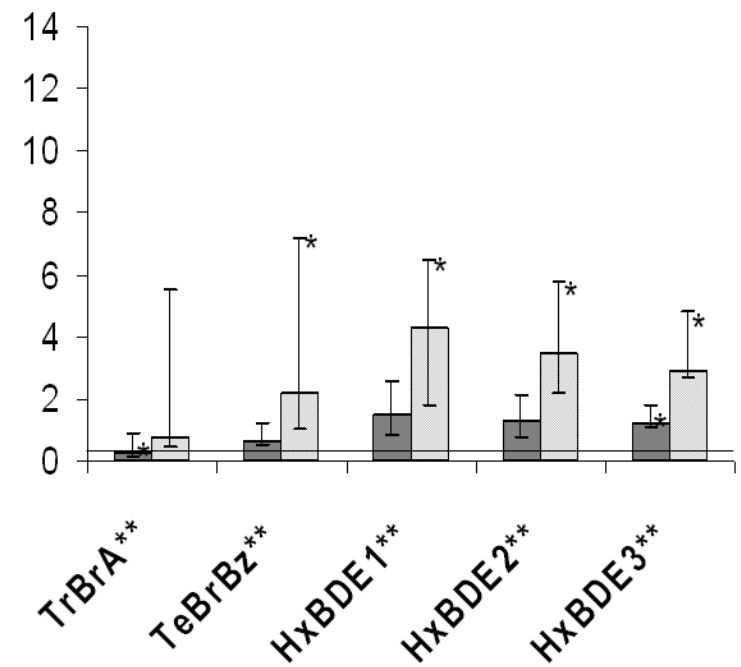
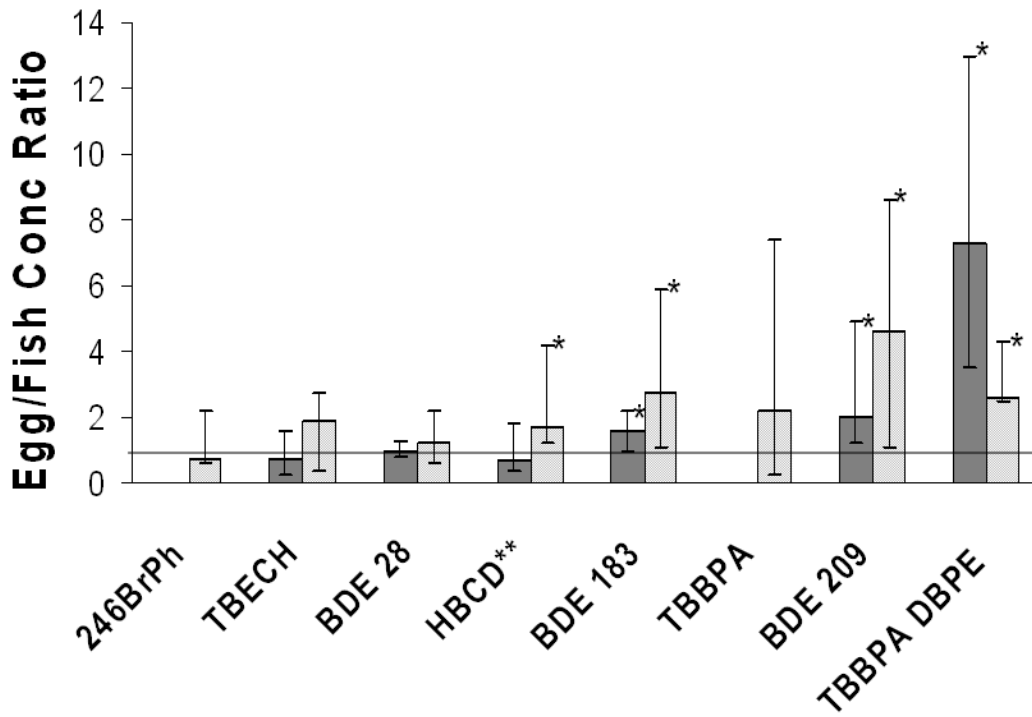


$t_{1/2} = 6d$

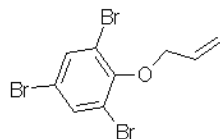




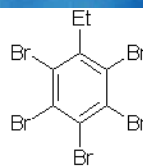
Maternal transfer in zebrafish (Nyholm et al ETC 2009)



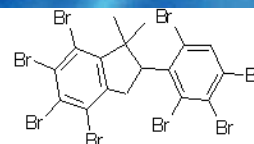
Emerging BFRs ???



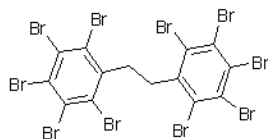
2,4,6-Tribromophenyl allyl ether



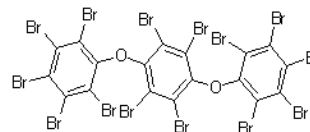
Pentabromoethylbenzene



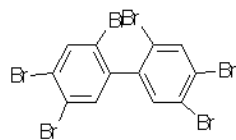
Octabromo-2,3-dihydro-1,1,3-trimethyl-3-phenylindane



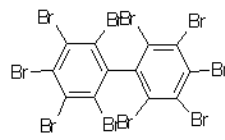
Decabromodiphenylethane



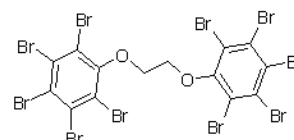
1,4-Bis(pentabromophenoxy) tetrabromobenzene



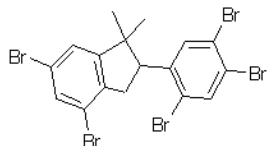
2,2',4,4',5,5'-hexabromobiphenyl (BB 153)



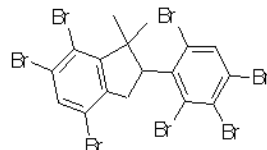
Decabromobiphenyl (BB 209)



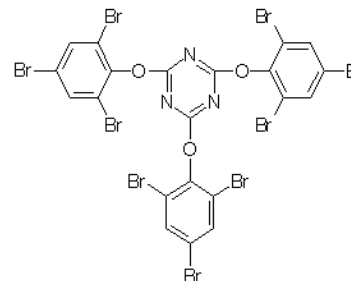
1,2-Bis(pentabromophenoxy)ethane



Pentabromo-2,3-dihydro-1,1,3-trimethyl-3-phenylindane



Heptabromo-2,3-dihydro-1,1,3-trimethyl-3-phenylindane



2,4,6-Tris(2,4,6-tribromophenoxy)-1,3,5-triazine



Some conclusions

- Legacy BFRs are most abundant!
- New BFRs are emerging!
- Analytical challenges!
- Large variation in fate!
- Toxicity?
- Which are the most critical and which are the next generation BFRs?



Thanks!

- Formas, Mistra – NewS, EU – FIRE, Norwegian Climate Pollution Authority (KLIF)
- Hans-Peter Arp, Tomas Möskeland, Roman Grabic
- Ulrika Örn, Åke Bergman
- Leif Norrgren, Anna Norman,
- Peter Haglund, Mats Tysklind
- Leon van der Waal, Robert Asamoah, Charlotte Lundberg, Conny Danielsson