Nanosafety: ecotoxicology

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MGV is granted by European ERC-C EcoWizard (101002123).



Nanomaterials make significant inroads into the market 2000 – Nanomaterials in consumer products

Nanotechnology growth is 22% each year

DISCOVEL THE MOLIA AT TELACH OTHACISITY

Aim: identification of ecotoxicological mechanisms

- What is the added risk of size (and shape) on uptake an toxicity?
 - Accounting for **fate**

Current risk assessment inadequate for nanoparticles

- Nanotechnology growth is 22% each year
- Policy: safe by design

Nanosafety in Europe 2015-2025: Towards Safe and Sustainable Nanomaterials and Nanotechnology Innovations

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Nanoparticles behave different from molecules



Nanoparticles behave different from molecules





100 80 Mortality (%) 60· 40 LC50 25 nm 1.03 50 nm 1.99 20 100 nm 2.33 Cu2+ 0.70 0 0.5 -1.0 1.0 -0.5 0.0 Log concentration (mg/L) Cu²⁺ 25 nm 🔺 100 nm 🔸 50 nm

Hua, Vijver,Peijnenburg 2014

Distribution in zebrafish larvae



Van Pomeren, Vijver et al 2017

Van Pomeren, Vijver et al 2018

Distribution and immuno-responses





Cortisol levels in zebrafish larvae



Glucocorticoid

Brun, ...Vijver.. et al 2019 Nature Communications Biology 2:382

Glucose levels in zebrafish larvae



Brun, ...Vijver.. et al 2019 Nature Communications Biology 2:382



DanioVision

Swimming distance tracking analyzed by EthoVision XT

Dark-light challenge test



Brun, ...Vijver.. et al 2019 Nature Communications Biology 2:382

Adverse outcome pathway Subsequent key events



Brun, ...Vijver.. et al 2019 Nature Communications Biology 2:382



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Full length article

Nanoplastics causes extensive congenital malformations during embryonic development by passively targeting neural crest cells

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- Binding of nanoplastics to neural crest cells.
- Disrupt the migration and survival of an embryonic population of stem cells.
- Malformations in the chick embryo/ defects in heart, great vessels, eye development



EFFECTS on a communities



– Treatment application: June (n=7)

Fig. 3: Aerial picture of Living Lab test setup (photo by Sam Boerlijst, Leiden University, 2020)





- JRC NM105
- ~85% anatase : 15% rutile crystalline forms
- Reported primary particle size of 15-24nm

Data collection: Taxonomic & Feeding guilds

Macroinvertebrates

Timepoints: May (baseline), July & September

Zooplankton Timepoints: Week 0 (baseline), Week 1 & Week 4





1. Schmidt-Kloiber, A. & Hering D. (2015): www.freshwaterecology.info - an online tool that unifies, standardises and codifies more than 20,000 European freshwater organisms and their ecological preferences. Ecological Indicators 53: 271-282. doi: 10.1016/j.ecolind.2015.02.007

 Schmidt-Kloiber A. & Hering D. (eds.): www.freshwaterecology.info - the taxa and autecology database for freshwater organisms, version 7.0 (accessed on 28.03.2021). 3. Sabo, J. L., Bastow, J. L., & Power, M. E. (2002). Length-mass relationships for adult aquatic and terrestrial invertebrates in a California watershed. Journal of the North American Benthological Society, 21(2), 336-343. doi: 10.2307/1468420



Nederstigt et al <u>Science of The Total</u> <u>Environment 838:4</u>, 2022, 156554

Macroinvertebrate-dominated pioneer ecosystem



Pronounced changes in **zooplankton community composition** after application of an **environmentally realistic concentration** of **nTiO**₂



Can lead to indirect effects





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