Gene Drive Organisms
Unpredictabilities and novel risks

Dr. Ricarda A. Steinbrecher

European Network of Scientists
for Social and Environmental Responsibility - ENSSER

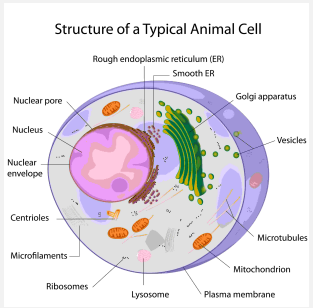
European Parliament – Online Roundtable – 08 December 2020

r.steinbrecher@econexus.info

Complexity & Unpredictability

All levels important to consider:

1. **Genome:** Nucleotides and DNA (molecules)
2. **Epigenome:** gene regulation
3. **Cells:** function and communication
4. **Organism:** incl. action and interaction
5. **Populations:** behaviour, genetic diversity
6. **Ecosystems:** interdependence; function (and services)
7. **Landscapes**
8. **Biosphere:** climate change, water cycles, nutrient cycles
9. **Socio-economic circumstances** (differ across the globe)



Across time and space

Engineered gene drives are **very new**

- **'Natural' or 'nature based' does not mean safe or predictable**
- Concepts and components taken from nature, redesigned, recombined and moved into new context and new species:
  - **Overriding rules of inheritance and selection**
  - **no co-evolved safeguards**
  - **high unpredictability at all levels** (incl. mating behaviour)
- CRISPR-based GDOs create **new GMOs each generation** in the wild *(no risk assessment of final product(s) possible*)
- Resistance build-up stops gene drives from working - *Risk*
- Concerning theoretical designs or proof of concept: **assumptions are insufficient for predictions** (incl. theoretical 'local' gene drives)

Risks & Inability of reliable risk assessment

Risk of uncontrolled global spread, esp. of global (i.e. standard) gene drives: intentional or unintentional

- **Robust risk assessment is impossible** (esp. taking into account all levels)

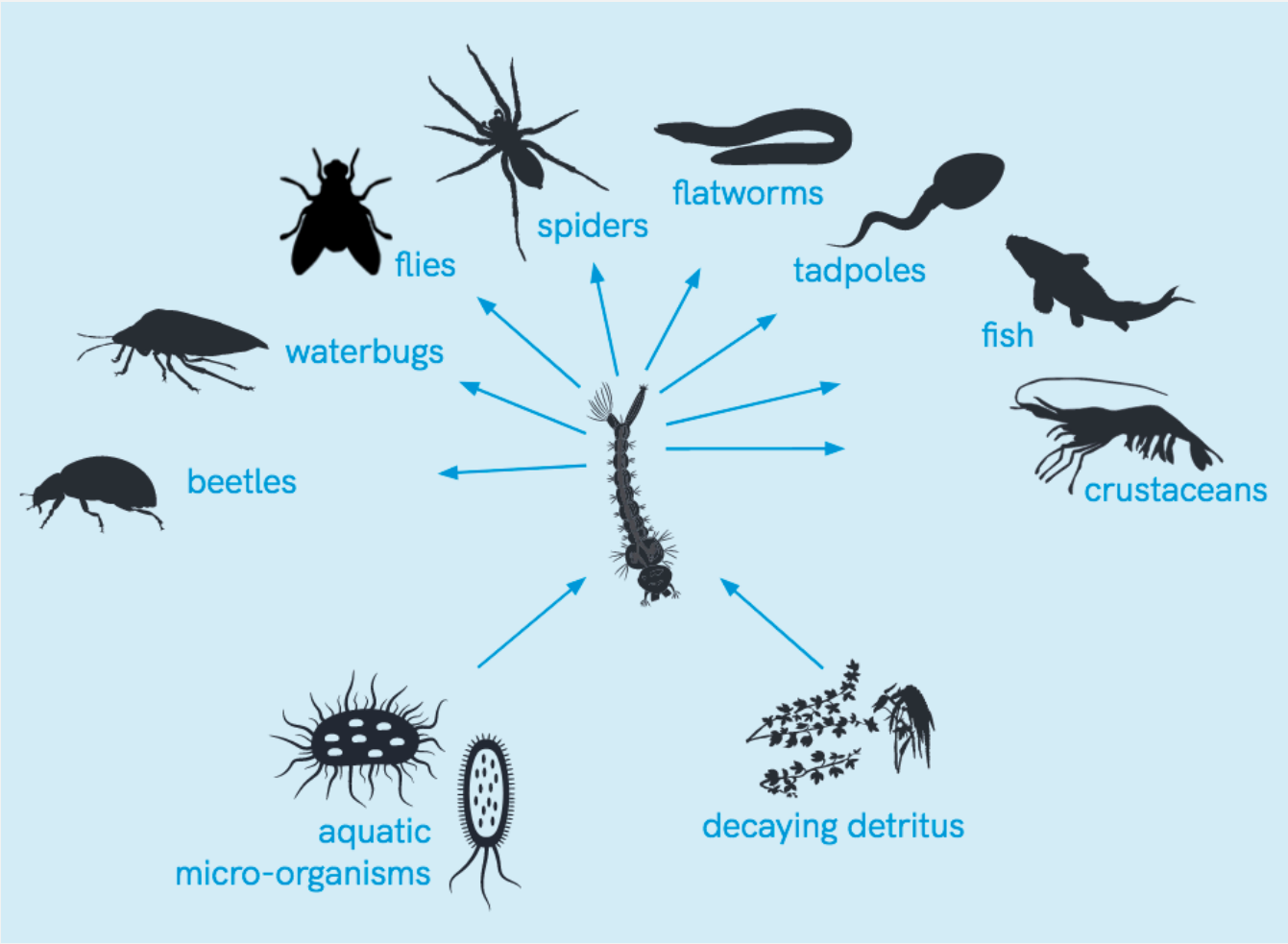
What if:

- a GD Organism becomes: more invasive, virulent, spreads other diseases, changes behaviour or interactions, impacts soil composition, alters behaviour of predators? Halt it? Reverse it?

Irreversibility: at phenotypic and genotypic level

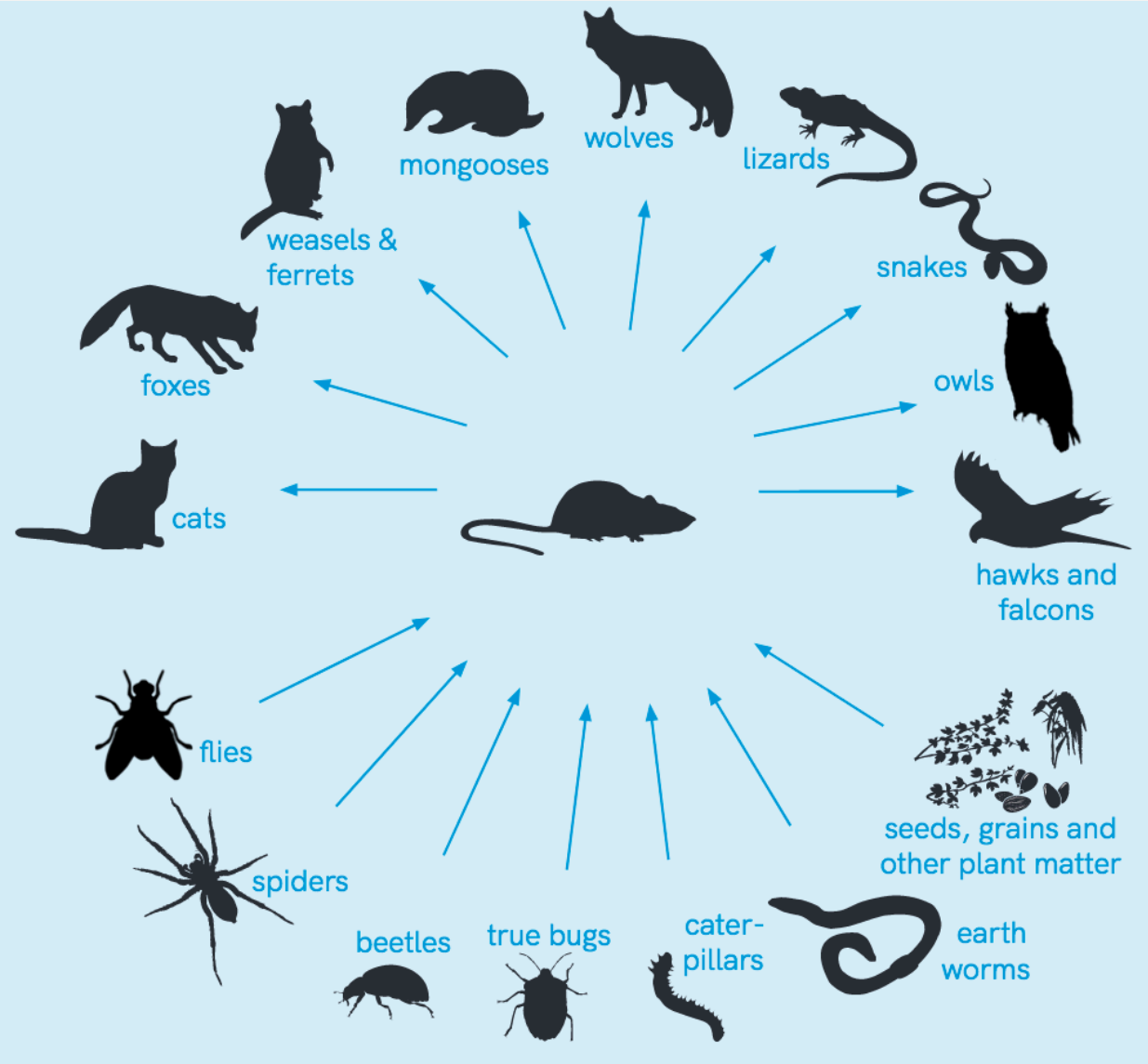
- Secondary gene drives (gene drive catchers; 'immunisers') are largely theoretical and are incapable to restore the genome.

Trophic interactions of larval mosquitoes



Source: Gene Drives: A report on their science, applications, social aspects, ethics and regulation (2019). Chapter 2, page 94

Trophic interactions of house mice



Source: Gene Drives: A report on their science, applications, social aspects, ethics and regulation (2019). Chapter 2, page 106

Hazard identification, unpredictability & lack of knowledge

Spectrum of scenarios

What if:

- The gene drive **works** as intended
  - with **unexpected outcomes** (see above)
  - with **expected outcomes** but **unexpected consequences** (e.g. niche replacement)
- The gene drive works for a while but then **stops:**
  - Repopulation, **rebound effect**, unexpected changes in ecological interaction (e.g. after prolonged absence)
  - Presence of GMOs of various genotype with unpredicted behaviour, phenotype or genotype
  - **……**

Ecosystem-based approach

- valuable as guidance for selecting the right approach to solve problems
- Ecosystem approach used and defined under the UN Convention on Biological Diversity (CBD)

  COP Decision V/6 https://www.cbd.int/decision/cop/?id=7148

  COP Decision IX/7 https://www.cbd.int/decision/cop/?id=11650

What is '*nature based*'? Nuclear power? Carbon and biodiversity offsets? Nano technology? GeoEngineering? – anything based on nature?

- Regarding "Nature-based Solutions" (NbS): the term, concept and approach is problematic and too broad; not defined under CBD (international treaty).

Gene drives for agricultural pests holds clear risks for biodiversity

Gene Drives. A report on their science, applications, social aspects, ethics and regulation. (2019) CSS/ ENSSER/ VDW
https://genedrives.ch/report/

Gene Drive Organisms: Implications for the Environment and Nature Conservation. (2019)
https://www.umweltbundesamt.at/fileadmin/site/publikationen/rep0705.pdf

Also:

Late Lessons from Early Warnings: The Precautionary Principle 1896–2000. (2001; 2002 online). European Environment Agency (EEA).
https://www.eea.europa.eu/publications/environmental_issue_report_2001_22

Late Lessons from Early Warnings: Science, Precaution, Innovation. EEA 2013.
https://www.eea.europa.eu/publications/late-lessons-2