

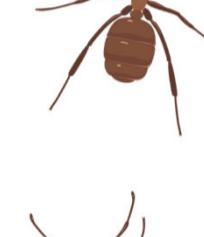
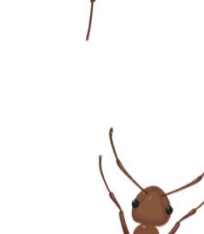
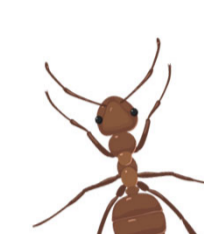
# How Are Ants Exposed to Plant Protection Products and Transgenic Plant Toxins?

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## Introduction

- Ants provide several ecosystem services (Box 1). Sanders & van Veen (2011) stress especially their role in ecosystem engineering and predation.
- There are also disservices by ants, especially by invasive species.
- Species living or foraging in agricultural areas may be exposed to plant protection products (PPP) or toxins produced by Genetically Modified Plants (GMPs) against pests, e.g. other insects.
- However, ants are not yet considered explicitly in risk assessments, neither for PPPs nor GMPs where the focus is traditionally on e.g. bees, predators and parasitoids of pests, earthworms, springtails or butterflies.
- The aim of the project is to identify the most relevant exposure routes for ants in or close to agricultural fields, select representative surrogate test species and to develop tests on lethal and sublethal endpoints (see also the poster 7604 by Pohl et al.).

## Ecology of ants drives exposure

- Like honeybees, ants belong to the order of Hymenoptera and are eusocial insects and share common characteristics, e.g. division of labour, overlapping generations and cooperative brood care.
- Thus, only the foraging workers have a direct risk of exposure, while the larvae and the queen may be indirectly exposed by the diet provided by the workers.
- While the workers may also become exposed via overspray and contact to plant protection products, the most relevant exposure path for systemic PPP and GMP toxins is probably the one via the diet for the workers and via the food pulp for the larvae and the queen.
- The **type of application** drives the exposure
  - Sprayed PPP** can result in direct overspray of workers or contact with surface films or in soil. Contaminated water or diet may be taken up.
  - Systemic PPP** (e.g. neonicotinoids) are distributed within the whole plant. Regarding this, they are similar to toxins produced by GMPs. However, exposure due to GMPs is longer since the toxins are continuously produced.
- Exposure to **GMP toxins** is reduced to the path via the diet and via soil if the toxin is exudated from the plant roots into the soil.
- The relevance of the exposure via the diet depends on the **feeding types** ('jobs') realized by the ant species:
  - '**Grazers**': Leaf cutting ants are not relevant in the EU. However, if they feed on crops, the ants become target organisms
  - '**Hunters**': dead pests may be an easy prey
  - '**Collectors**': dead pests may be easily collected, exposure arises also from collecting GMP material, e.g. pollen, leaves
  - '**Shepherds**': aphids feeding on GMP but not killed may provide contaminated honey dew
  - '**Gardeners**': if fungi colonies are fed by GMP plant material, the GMP toxin may be transferred into the fungi and thus, the food of the ants.

## Box 1: Ecosystem services and disservices provided by ants (Elizalde et al. 2020, Del Toro et al. 2012, Bisseleua et al. 2017). Not all may be relevant in agricultural areas in Europe

- Provisioning services**
  - Antibiotics, anti-inflammatory, and venom therapies
  - Food / feed
  - Others (e.g. silk)
- Regulating services**
  - Pollination
  - Regulation of community structure
  - Biological control (predatory, seed control)
  - Seed dispersal
- Supporting services**
  - Soil movement, soil formation, water holding capacity
  - Nutrient cycling & decomposition
  - Carbon cycling / mineralization
  - Ecosystem engineering
- Cultural services**
  - Biological indicators
  - Literature and arts
  - Cultural traditions & religion

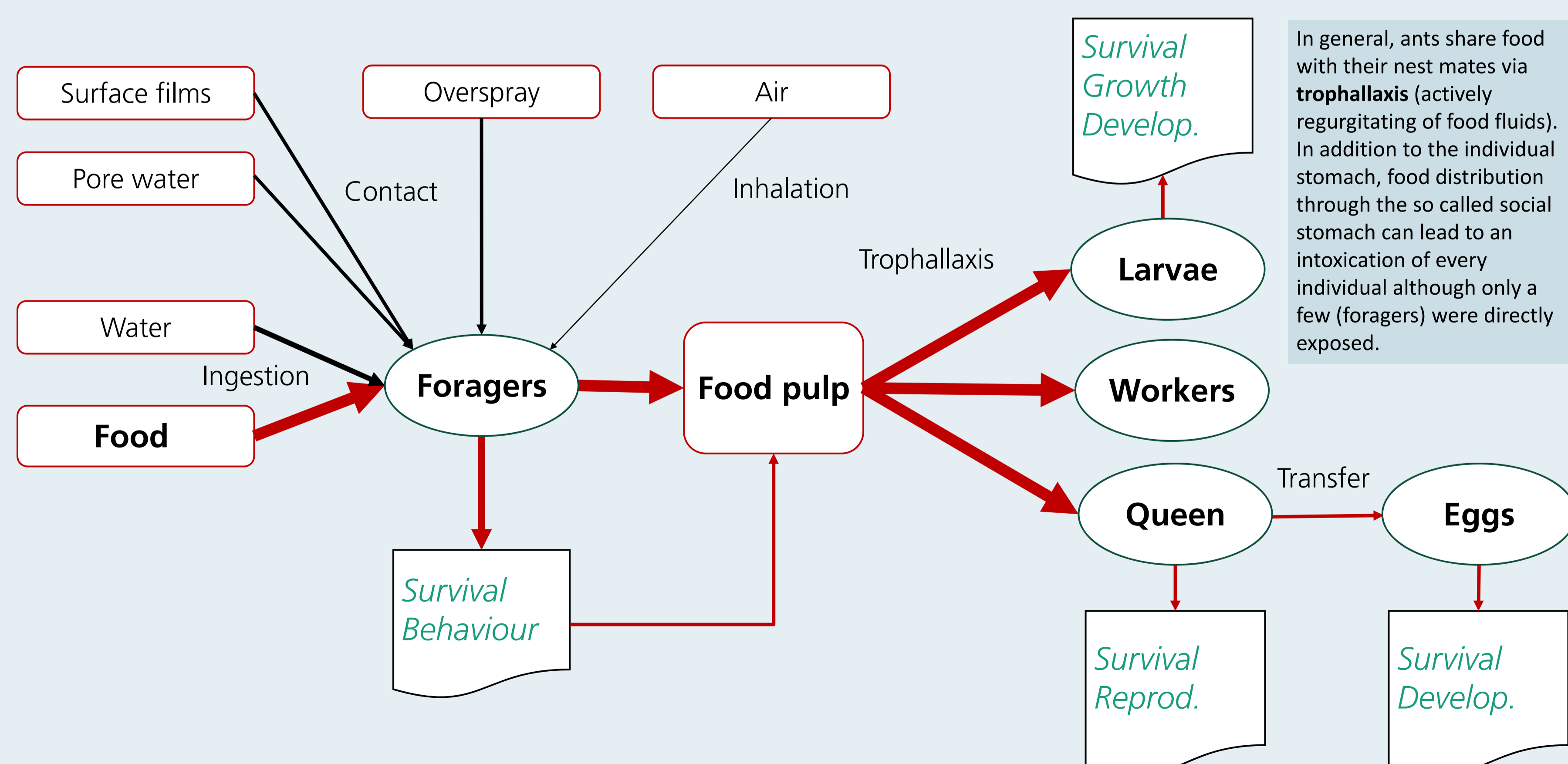
## Disservices

- Pests on their own
- Health risks due to stings
- Pathogen spread
- Protection of pest organisms

## Relevance of the exposure routes for risk assessment

- Ants show a large variety of feeding types which determine the importance of exposure routes.
- Effects on larvae fed with food pulp from exposed workers should be assessed.
- First assumptions on the relevance of routes:
  - Contact / overspray** (sprayed PPP): Probably covered by assessment for bees and non-target arthropods unless indication of high sensitivity of ants. However, in most cases these tests focus on lethal effects only while foraging behaviour of the workers may also have large impact on the ant colony
  - Soil** (sprayed PPP, maybe exudates from plants treated with systemic PPP and GMPs): Covered by springtail and soil mite tests unless indication of high sensitivity of ants
  - Dust** (seed treatment): Covered by bee risk assessment unless indication of high sensitivity of ants, relevance of exposure route unclear
  - Drinking water** (sprayed PPPs): PECs can be used from bee risk assessment. Tests with sugar solutions can provide toxicity data for ants. However, in these tests, the sugar solution is also diet. How much water do ants drink if natural food is available?
  - Honey dew** (PPP, GMPs): Estimations for expected concentration in honey dew available yet? Relevance of the route compared to diet?
  - Diet** (PPP and especially GMPs): A worst case assumption could be that 100 % of the diet are dead pest organisms with residues. For PPPs, Residues per Unit Dose values (RUD) are available:  
 $C_{prey} = AR \times RUD \Rightarrow Dose = feeding\ rate \times C_{prey}$   
 Expected dose can be compared to experimentally derived threshold doses for workers and larvae.

## Routes of exposure of ants to plant protection products and toxins produced by GMPs. The assumed main routes of exposure to GMP toxins are indicated by thick red arrows. Effects are indicated by green font.



## References

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- Sanders & van Veen (2011): Ecosystem engineering and predation: the multi-trophic impact of two ant species. *Journal of Animal Ecology* 80 (3), 569–576. doi.org/10.1111/j.1365-2656.2010.01796.x
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- Ants created with Biorender.com

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