OP-230 [Beekeeping Technology and Quality]
Beeswax quality: the entry root of pesticides trough pollen

Christina Kast, Marion Fracheboud
Swiss Bee Research Centre, Agroscope, Schwarzenburgstrasse 161, 3003 Berne, Switzerland

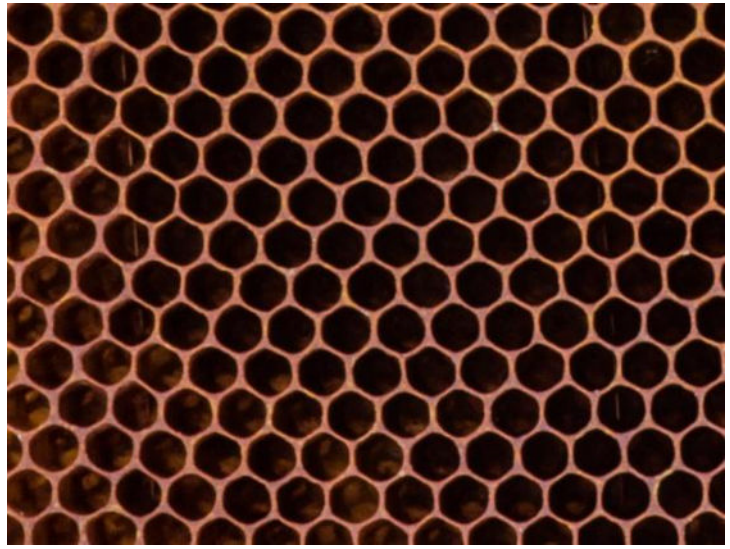
Pesticide residues originating from beekeeping and/or agriculture can affect beeswax quality. Here, we investigated the entry root of pesticides trough pollen, their subsequent accumulation in beeswax as well as their possible fate during wax purification for the production of new foundation sheets. For our study, we chose an apiary in a typical agricultural environment for Switzerland. Pollen was collected from traps on ten sampling days from April to October 2022 from five colonies. At the same time, two comb pieces of beeswax containing freshly stored pollen were collected from each colony. Out of the 50 pesticides analyzed, 23 pesticides were quantified in pollen, including 13 fungicides, 5 insecticides/acaricides, 4 herbicides and a synergist. Eighteen of these pesticides were also quantifiable in beeswax. Among these were 17 lipophilic pesticides with logarithmic octanol water coefficients (log Kow) above 2.5. These pesticides appeared at the same time in beeswax as in pollen. For example, peak levels of the fungicide cyprodinil were observed in April in pollen and simultaneously in beeswax. As determined by pollen analysis, the presence of cyprodinil was related to pollen from fruit orchards. However, the temporal profiles differed for hydrophilic pesticides, such as the neonicotinoid insecticide acetamiprid (log Kow of 0.8). Acetamiprid was present in pollen from April to August up a maximal level of 48 µg/kg, but was absent in beeswax.

We also investigated whether lipophilic pesticides have the potential to remain in beeswax during recycling. We placed wax samples containing the above-mentioned pesticides for 1h in a baker containing water at 80°C and subsequently determined pesticide levels in wax and water. Lipophilic pesticides with log Kow above 2.5 remained in the beeswax (>85%), while the hydrophilic insecticides acetamiprid and thiacloprid were mainly found in the water (>64%).
In conclusion, pesticides from agricultural use may be brought into the hive through pollen and subsequently accumulate in beeswax. When beekeepers recuperate the beeswax from old brood combs, a large variety of these lipophilic pesticides stay in the wax during recycling and are also present in the new foundation sheets.

Beeswax quality: the entry of pesticides through pollen

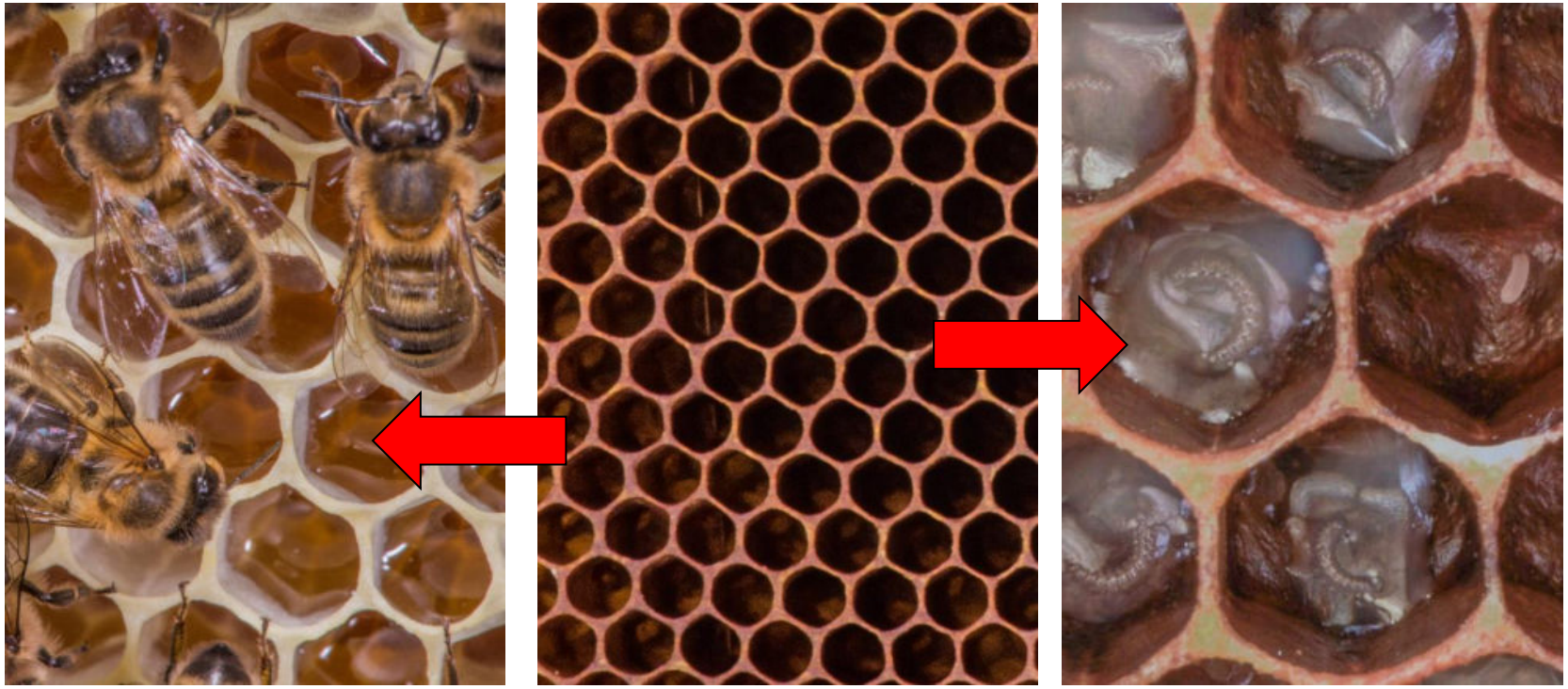
Christina Kast
Swiss Bee Research Centre

Apimondia, September 25th, 2025



Agroscope

Bees wax – the vessel for honey and brood rearing

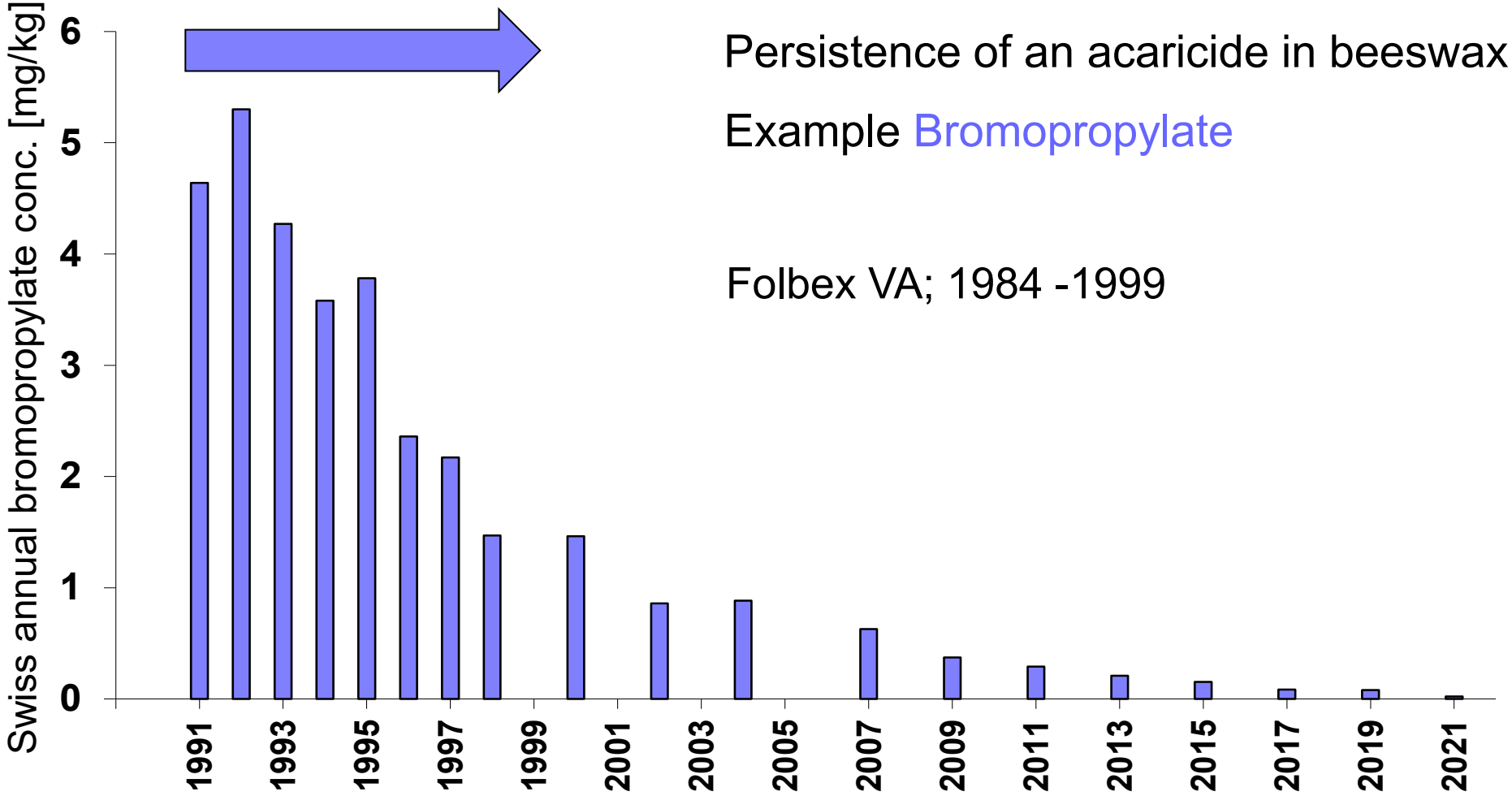


Kochansky, Wilzer & Feldlaufer (2001)

Kast & Kilchenmann (2022)

Agroscope

Residues can remain in beeswax for a long time



Persistence of an acaricide in beeswax

Example Bromopropylate

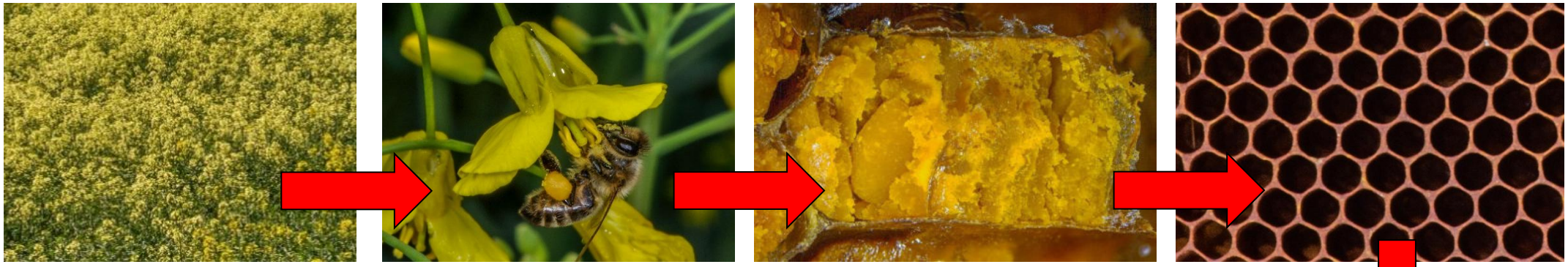
Folbex VA; 1984 -1999

Kast *et al.*, 2021

Agroscope

Our research questions

pesticide types?



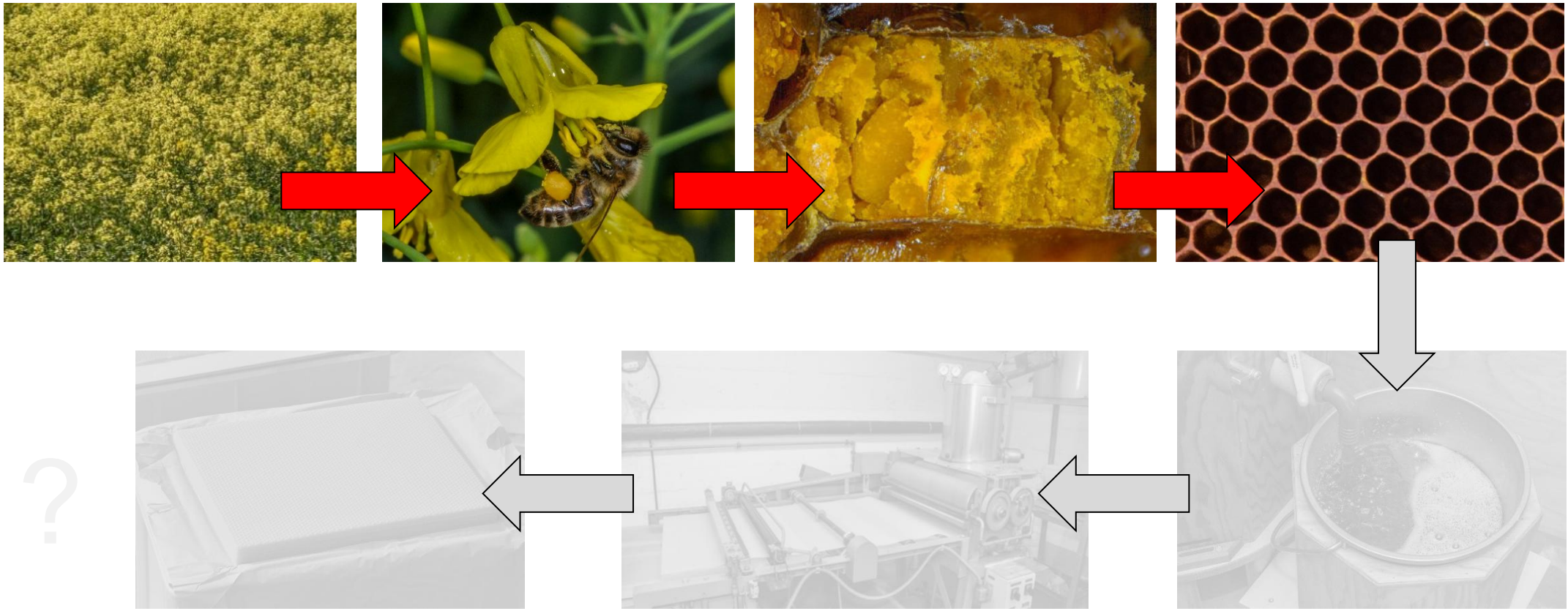
?

pesticide levels in Swiss wax

pesticide fate?

Agroscope

What types of pesticides in beeswax originate from contaminated pollen?



Agroscope

Experiment at our apiary in Bellechasse

Agroscope

Sampling

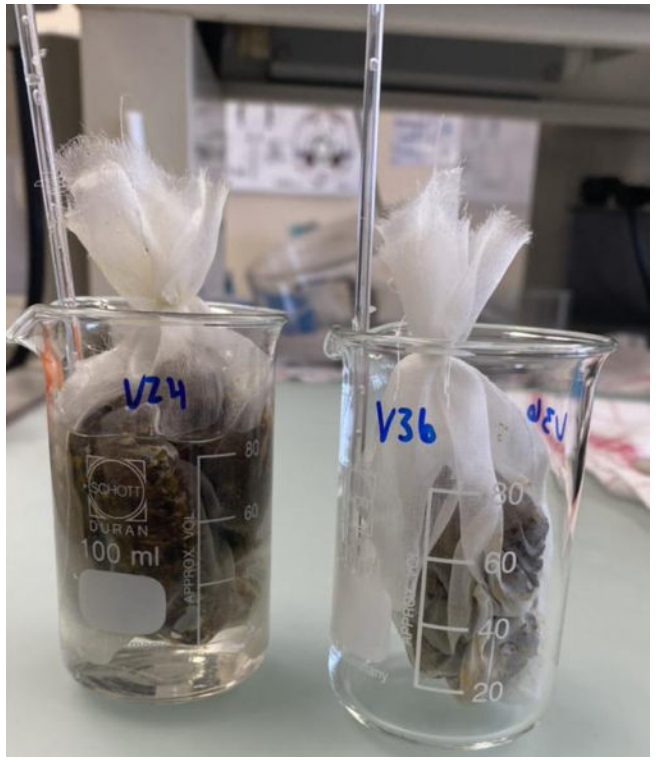
- Sampling every second week from April to August 2022; 1 last sample in October
- 5 colonies

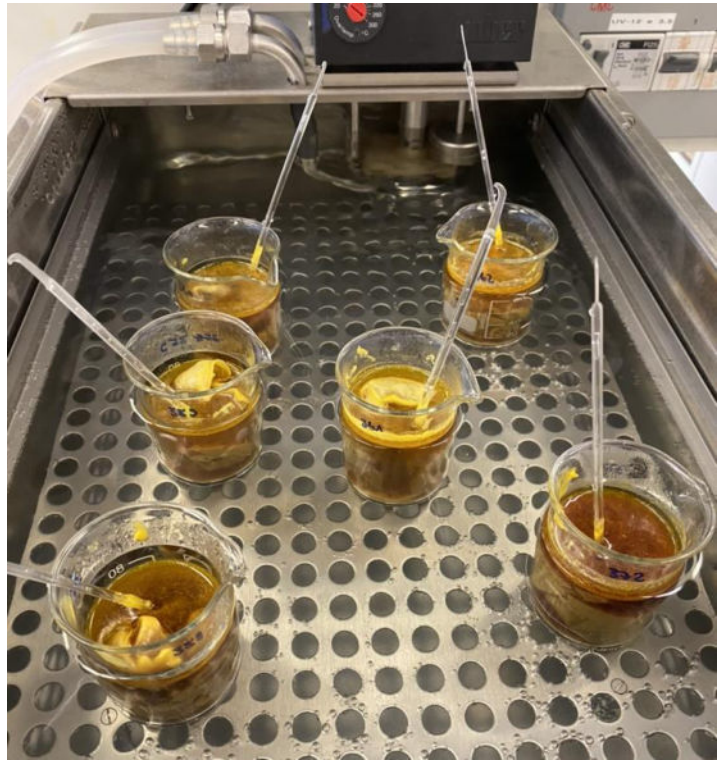
- Pollen

- Comb pieces with bee bread (stored pollen)
  - Bee bread samples
  - Wax samples

Agroscope

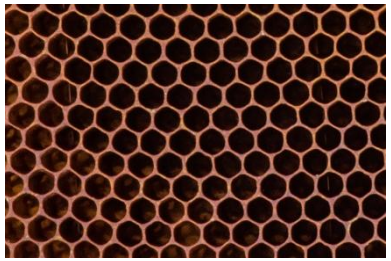
Separation of bee bread from wax

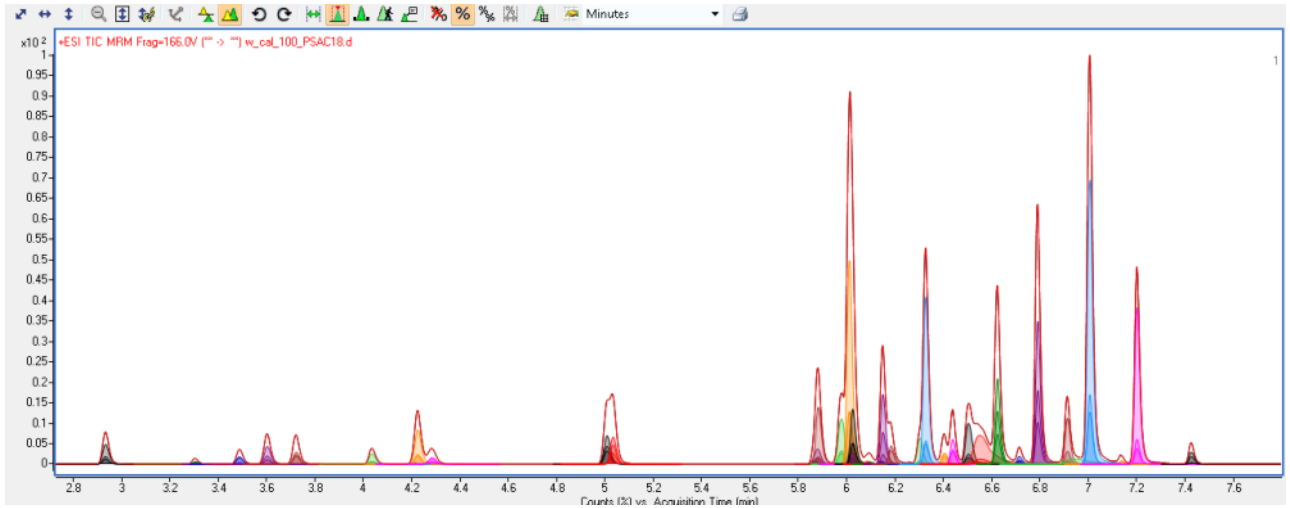




Agroscope

Identification of pesticides

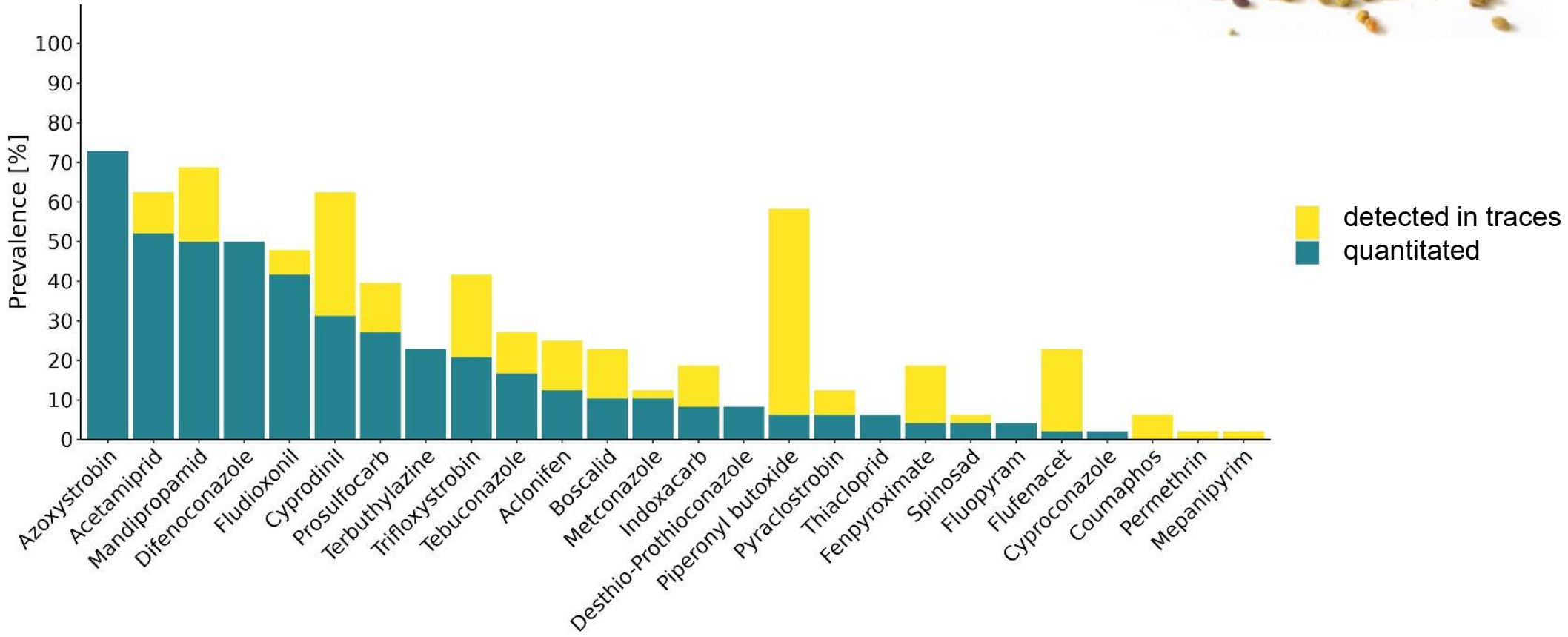




Extraction of pesticides (QuEChERS)
Separation, detection, quantitation (LC-MS/MS)

Agroscope

Prevalence of pesticides in pollen

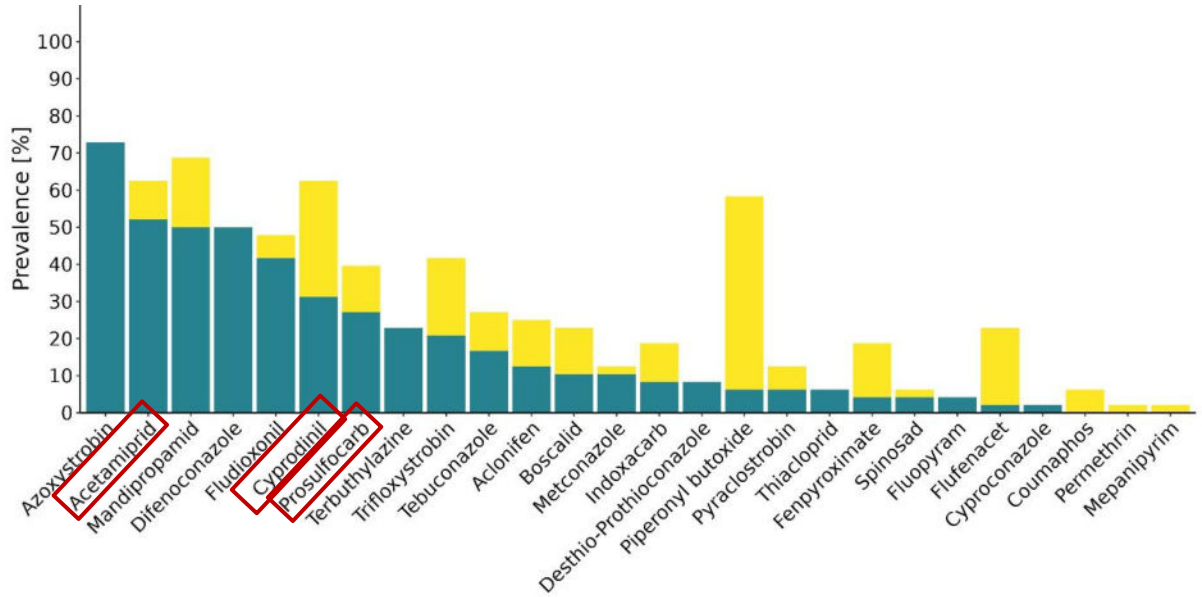


26 pesticides detected in pollen (out of 50)

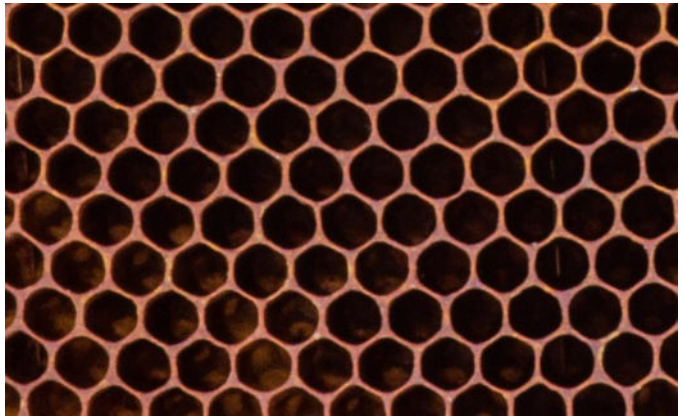
Kast *et al.*, 2024

Agroscope

Prevalence of pesticides in wax



26 pesticides in pollen

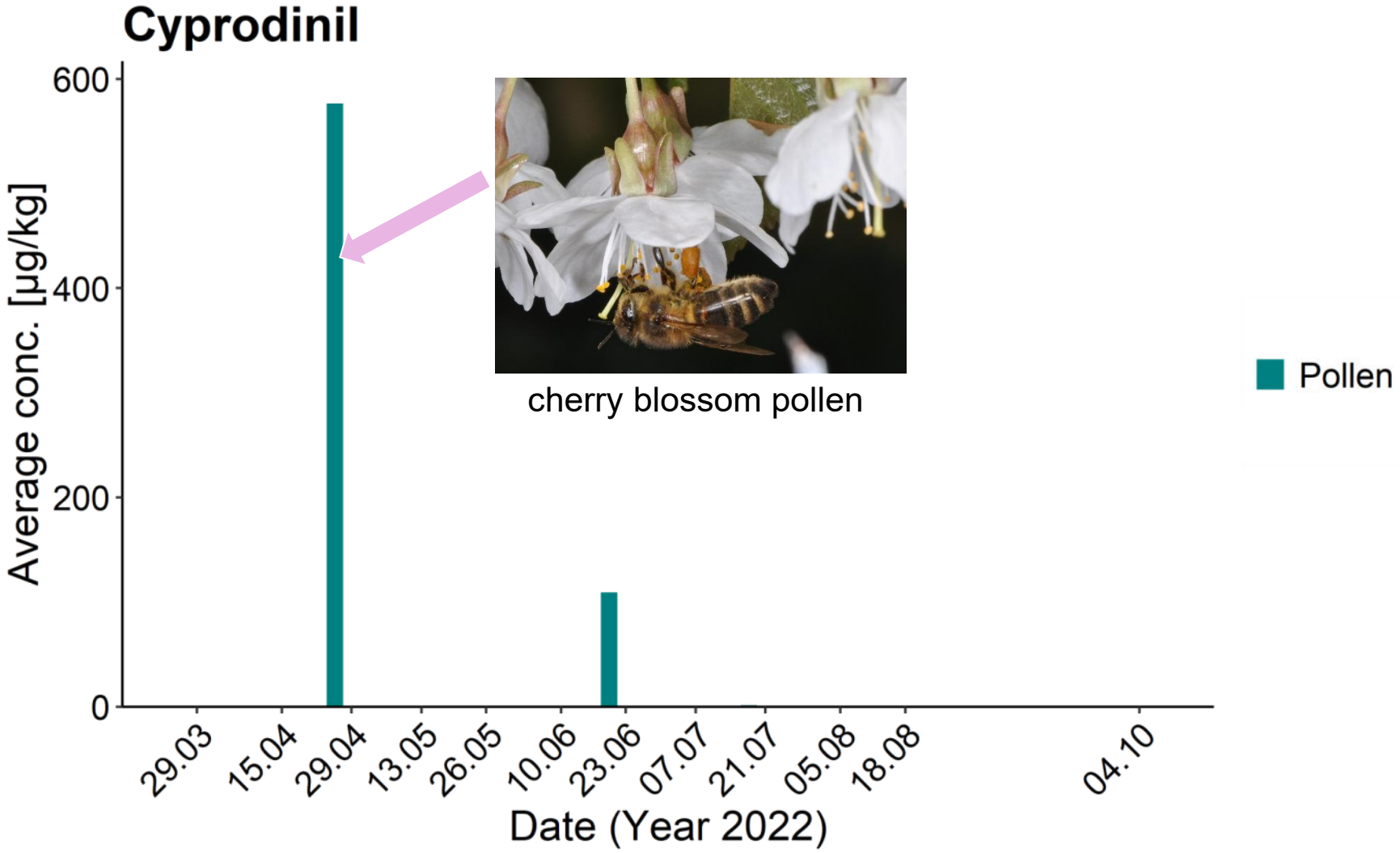


18 of the pollen pesticides also detected in wax

Kast *et al.*, 2024

Agroscope

Temporal entry of a fungicide into the hive

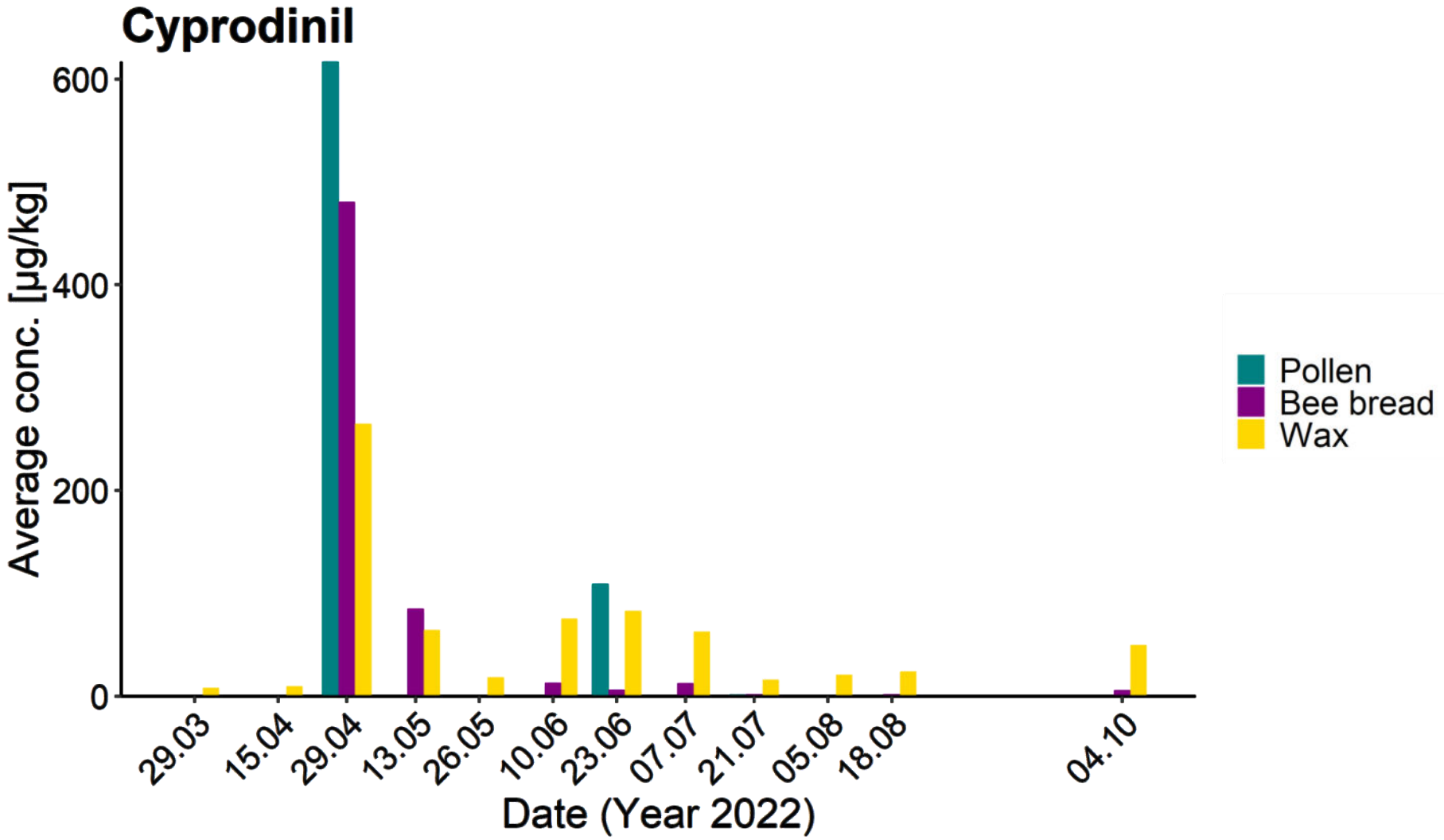


cherry blossom pollen

Kast *et al.*, 2024

Agroscope

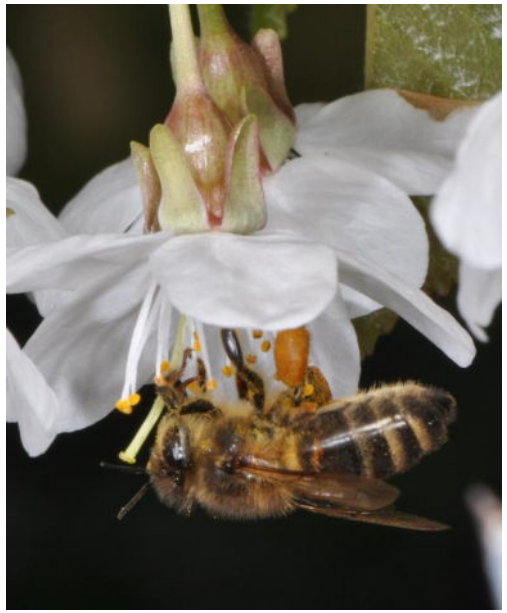
Temporal entry of a fungicide into the hive

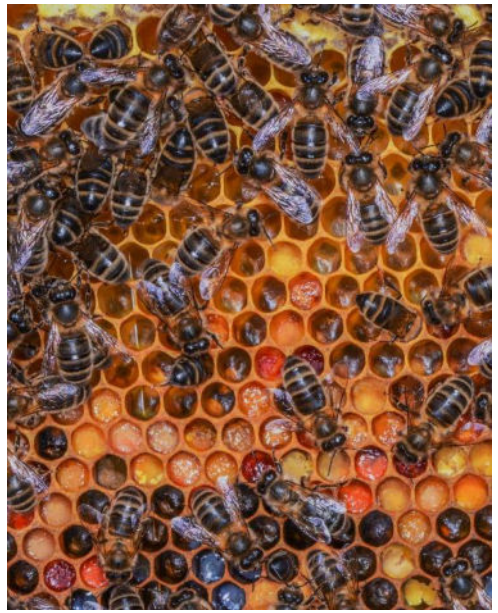


Kast *et al.*, 2024

Cyprodinil in beeswax can originate from pollen

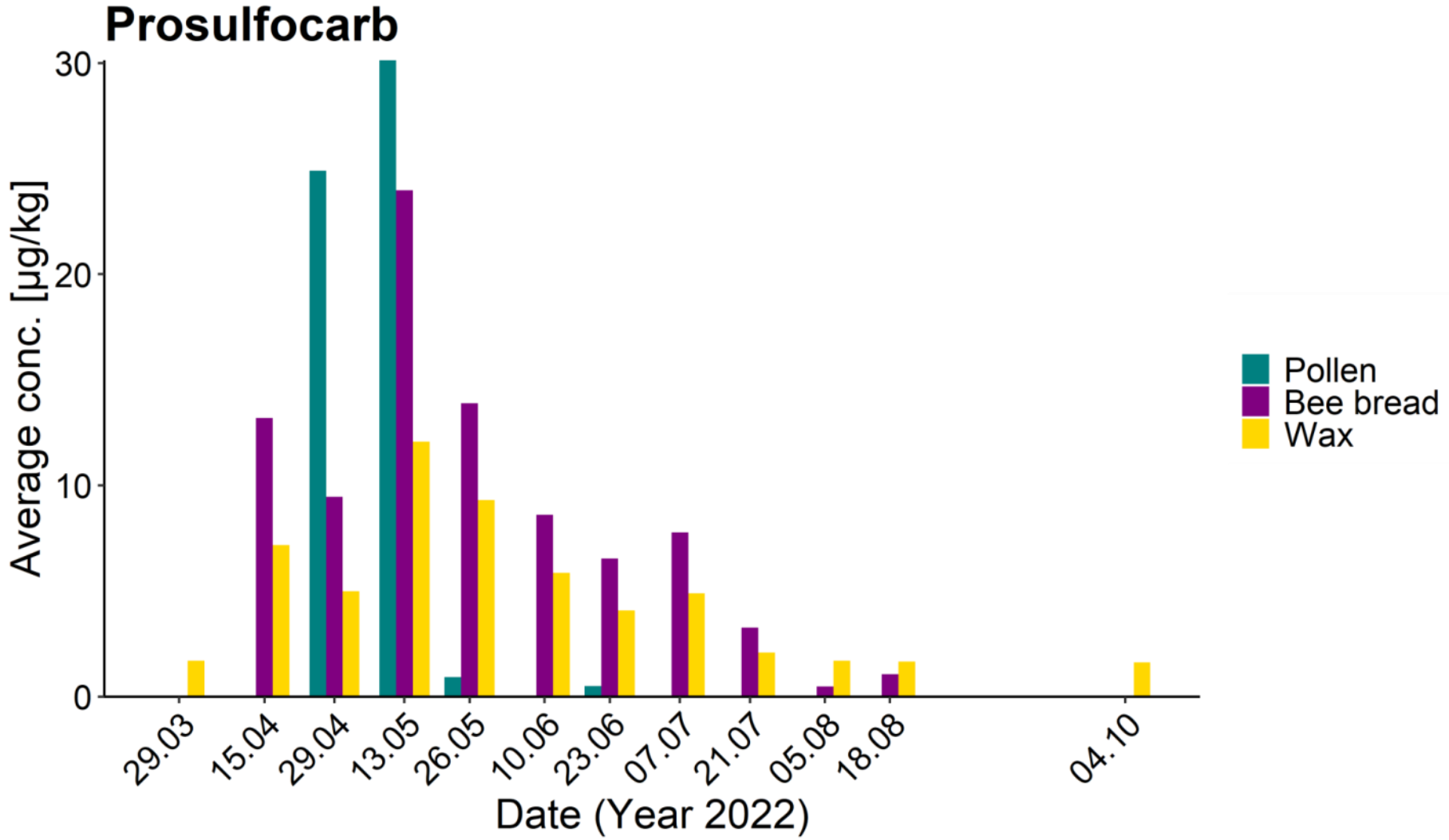
Cyprodinil → Pollen → Cyprodinil → Bee bread → Cyprodinil → Wax





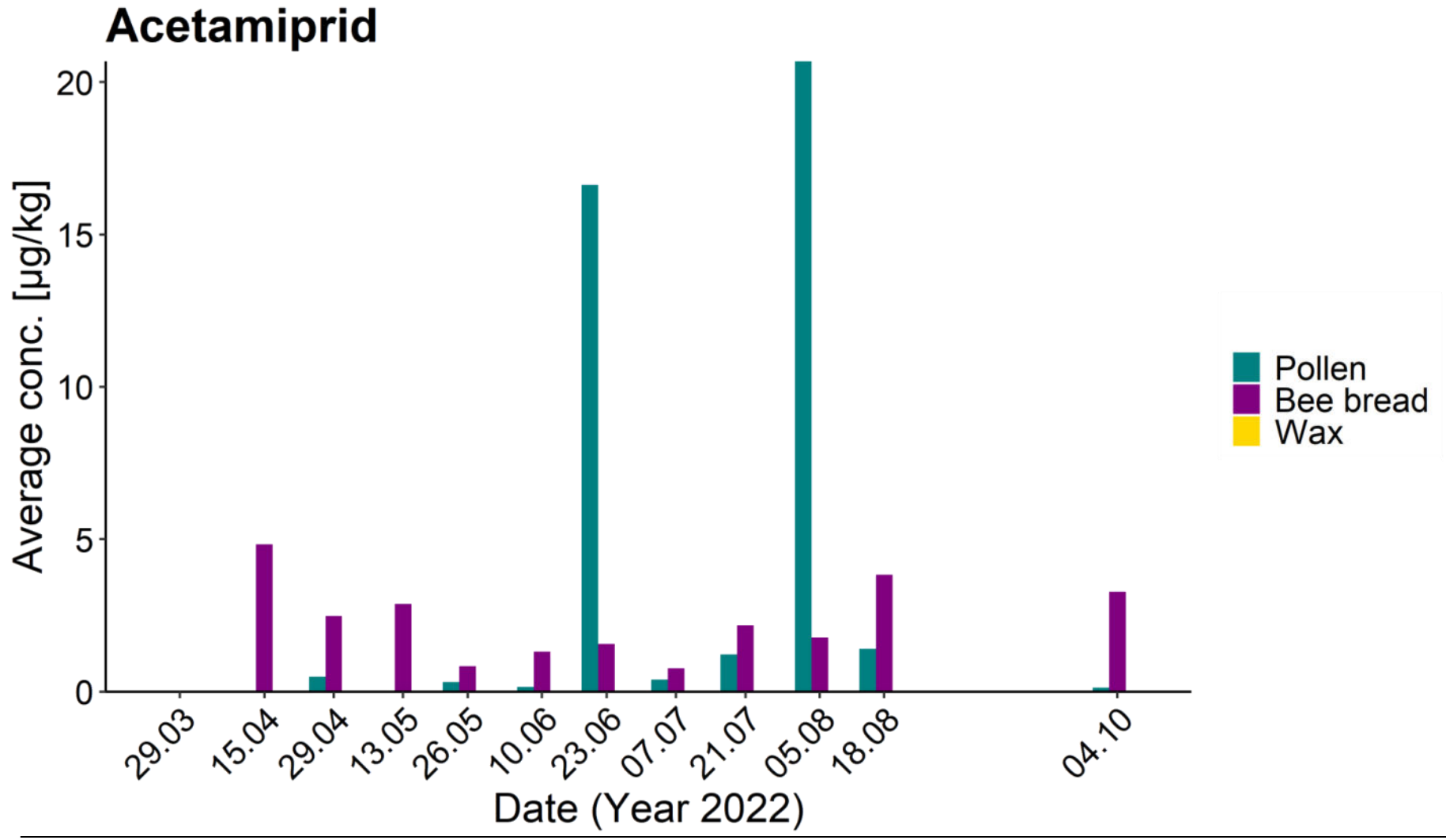
Agroscope

Temporal entry of an herbicide into the hive



Kast *et al.*, 2024

Temporal entry of an insecticide into the hive



Kast *et al.*, 2024

Agroscope

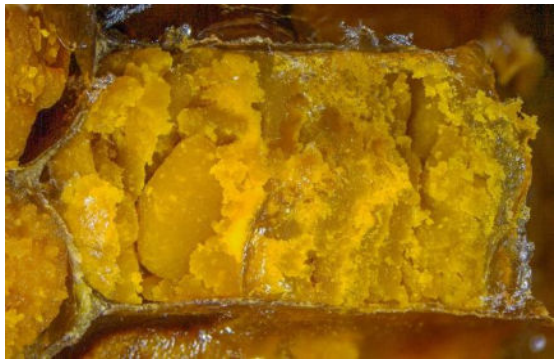
Classification into water- and fat-soluble pesticides

fat soluble

Pesticides

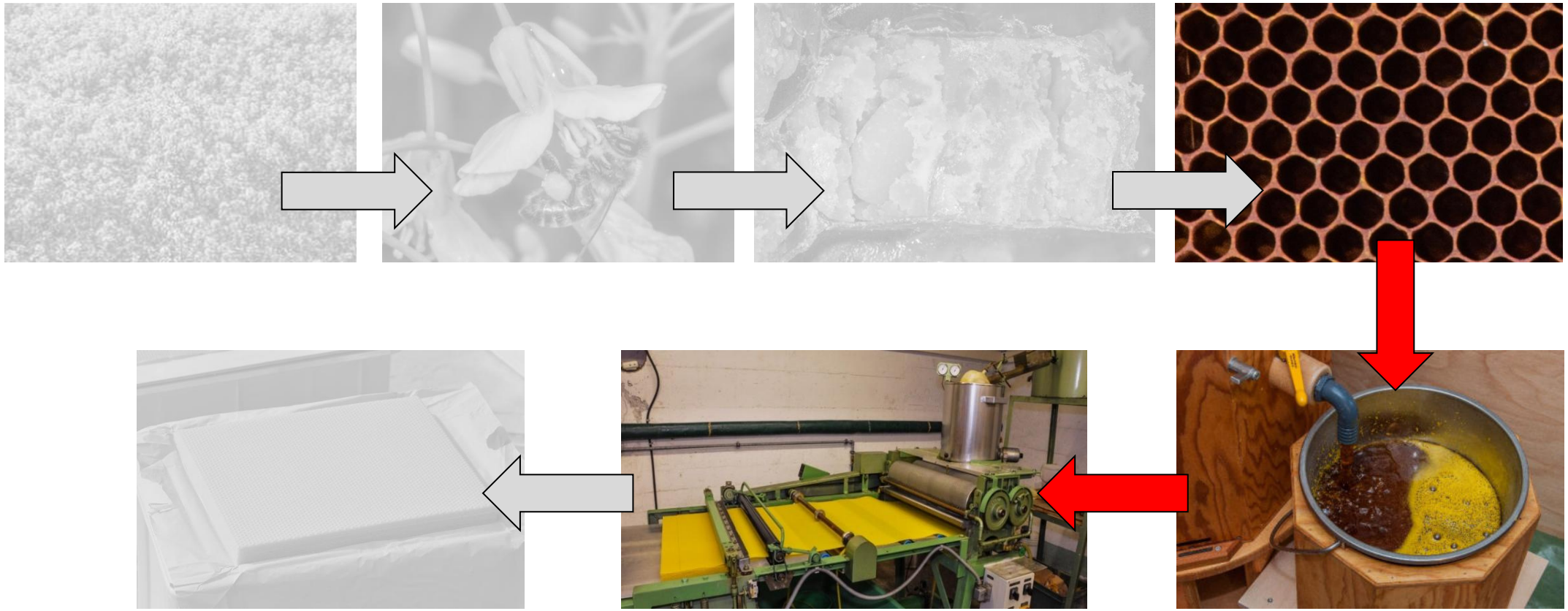
- Acetamiprid
- Thiacloprid
- Azoxystrobin
- Boscalid
- Mandipropamid
- Fluopyram
- Terbuthylazine
- Tebuconazole
- Metconazol
- Pyraclostrobin
- Cyprodinil
- Fluodixonil
- Difenoconazole
- Aclonifen
- Prosulfocarb
- Trifloxystrobin
- Indoxacarb

water soluble



Agroscope

Fate of pesticides when old wax is purified in water

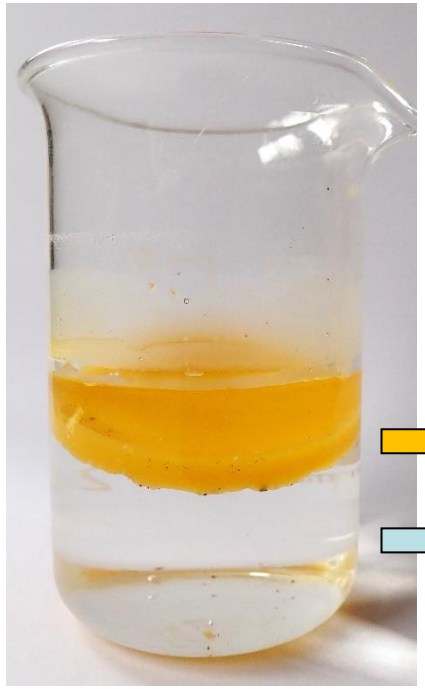


Agroscope

Spiking experiment

Spiking of wax
with pesticides
(500 µg/kg)

Melting for 1h in
50 mL water
at 80°C



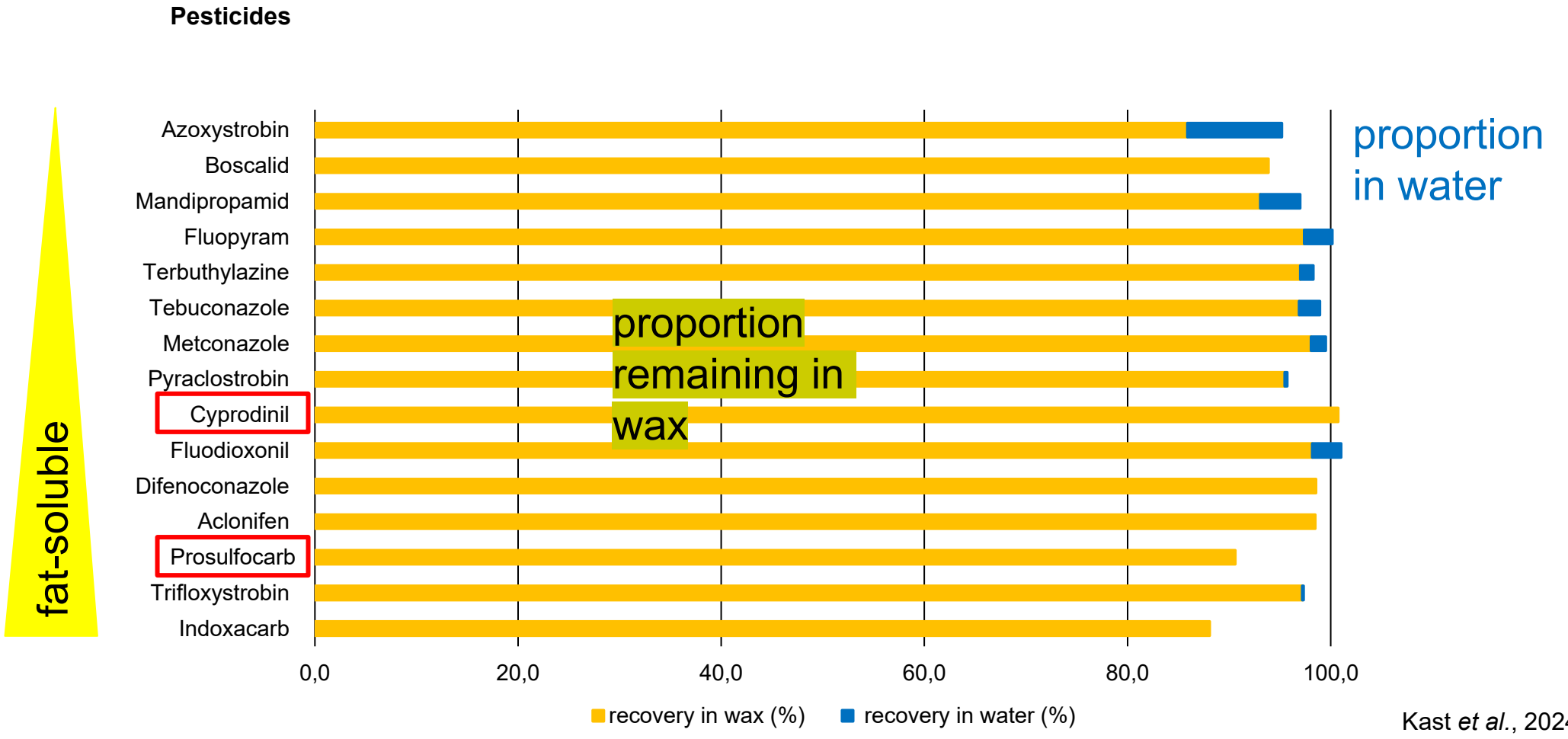
Proportion of pesticides

in wax?

in water?

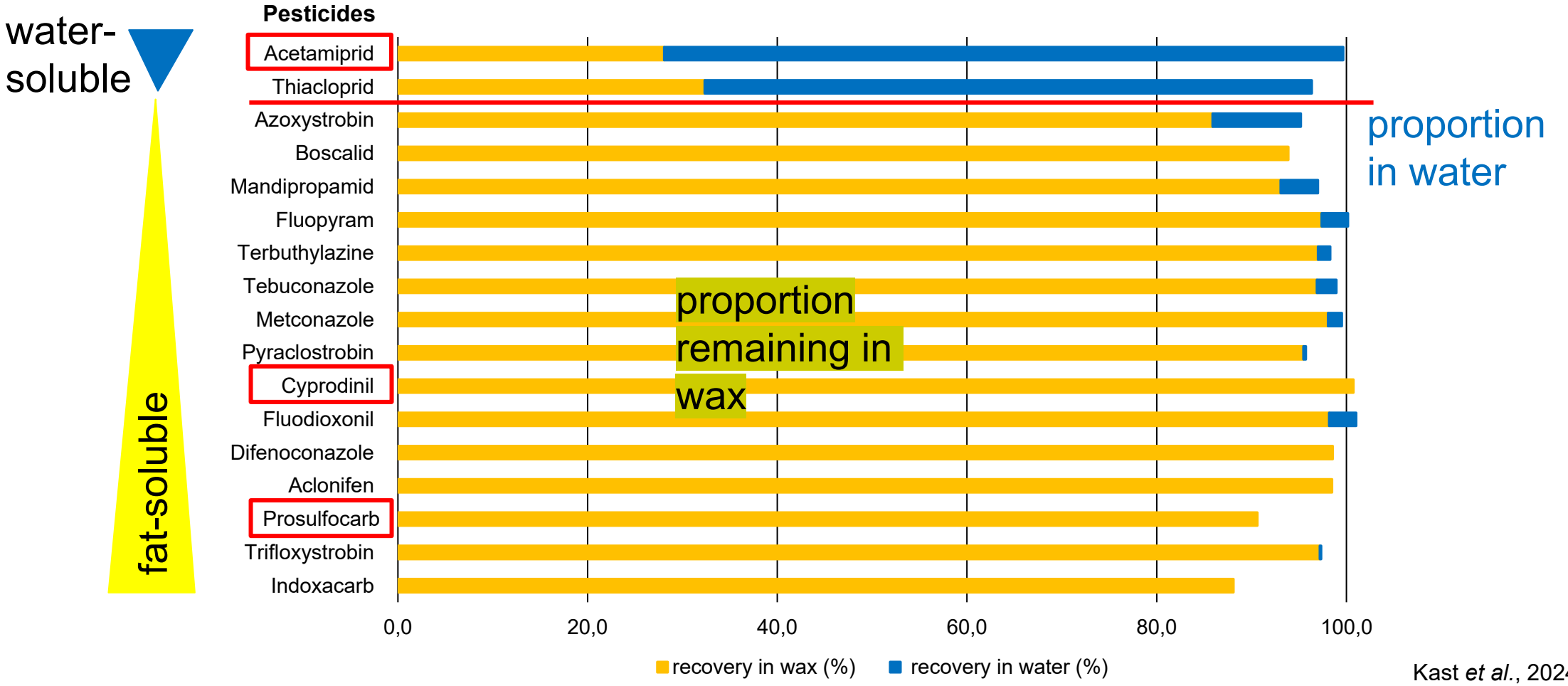
Agroscope

Fat-soluble pesticides mainly remain in wax



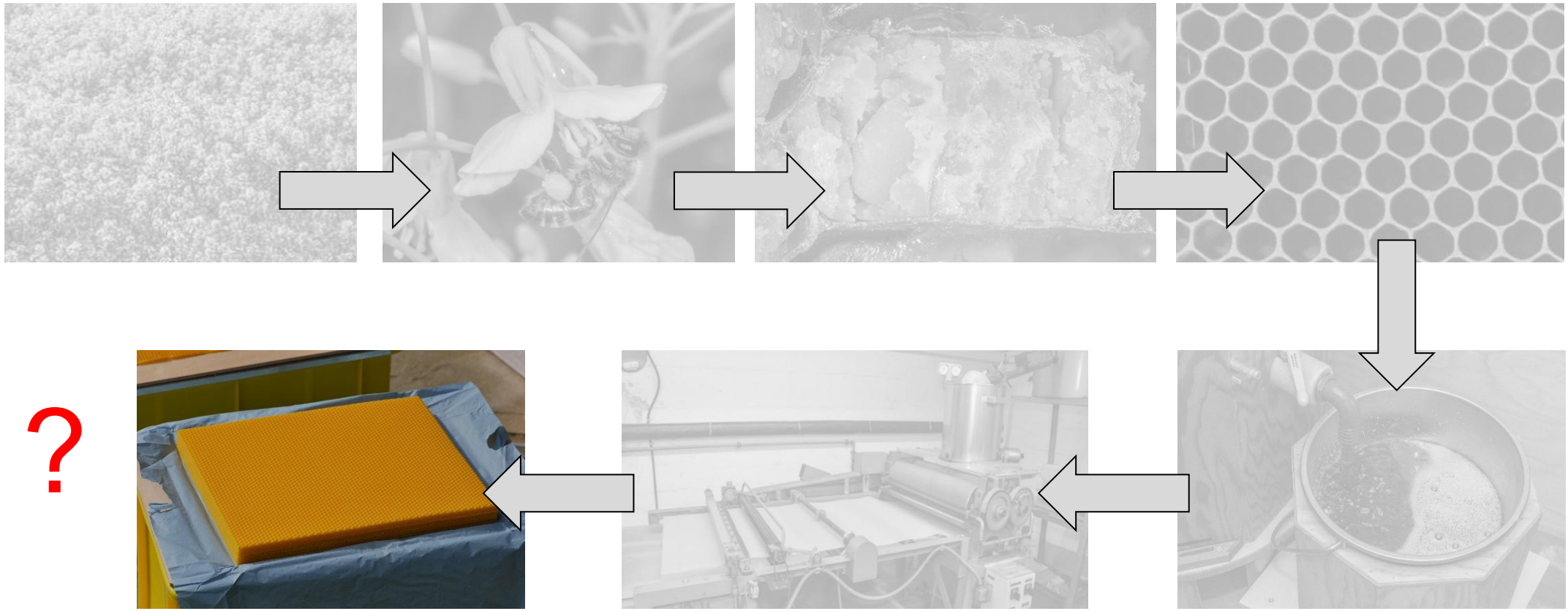
Kast *et al.*, 2024

Water-soluble pesticides: greater proportions in the water



Kast *et al.*, 2024

Residue levels in Swiss beeswax?

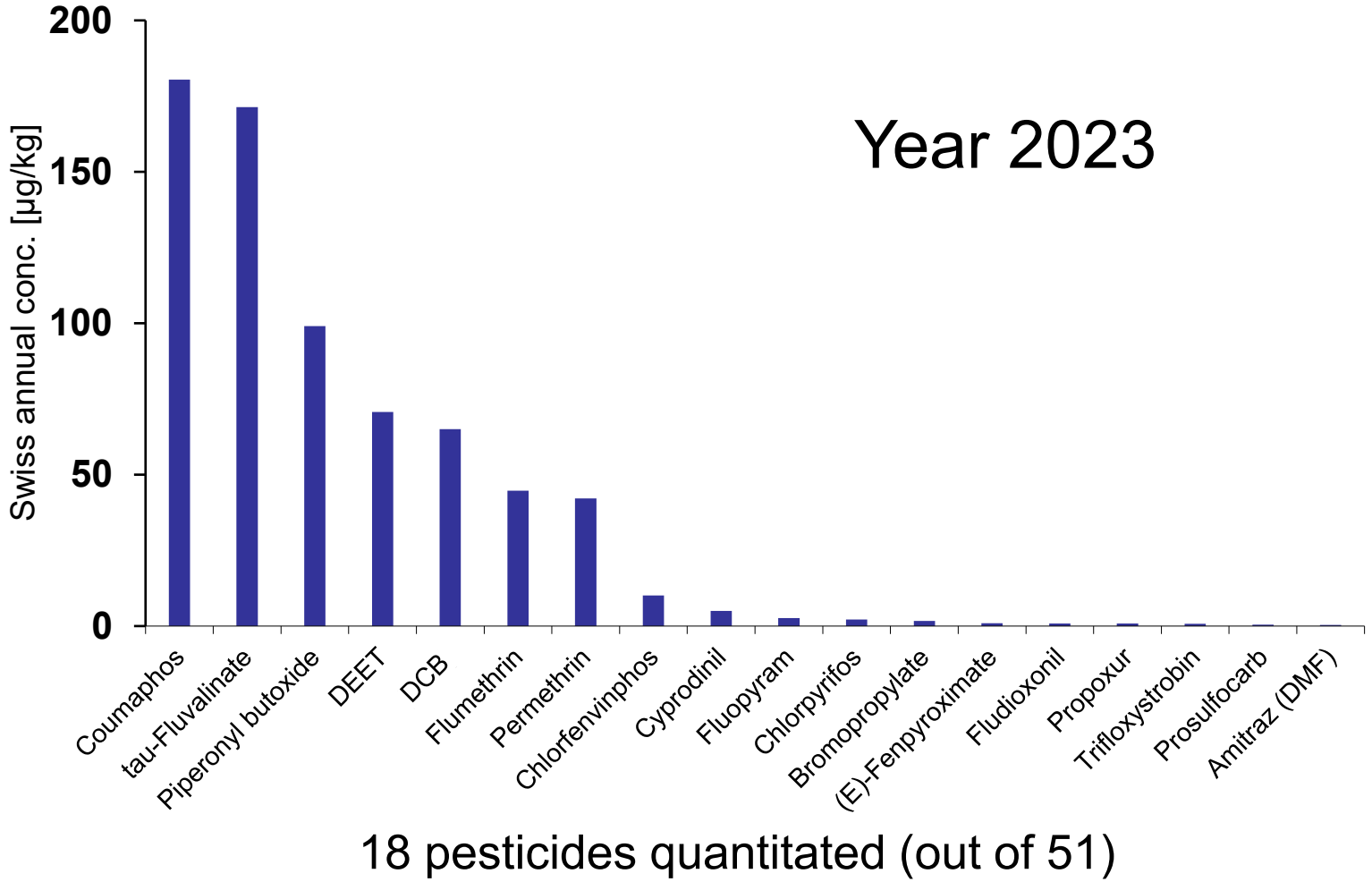


Agroscope

Collaboration with all major manufacturers of foundation sheets in Switzerland

- Total production: ~ 60’000 kg/year
- In 2023, samples collected from each production lot during the entire year
- Analysis of pooled samples per manufacturer: average value per manufacturer
- Average annual value was calculated for entire Switzerland

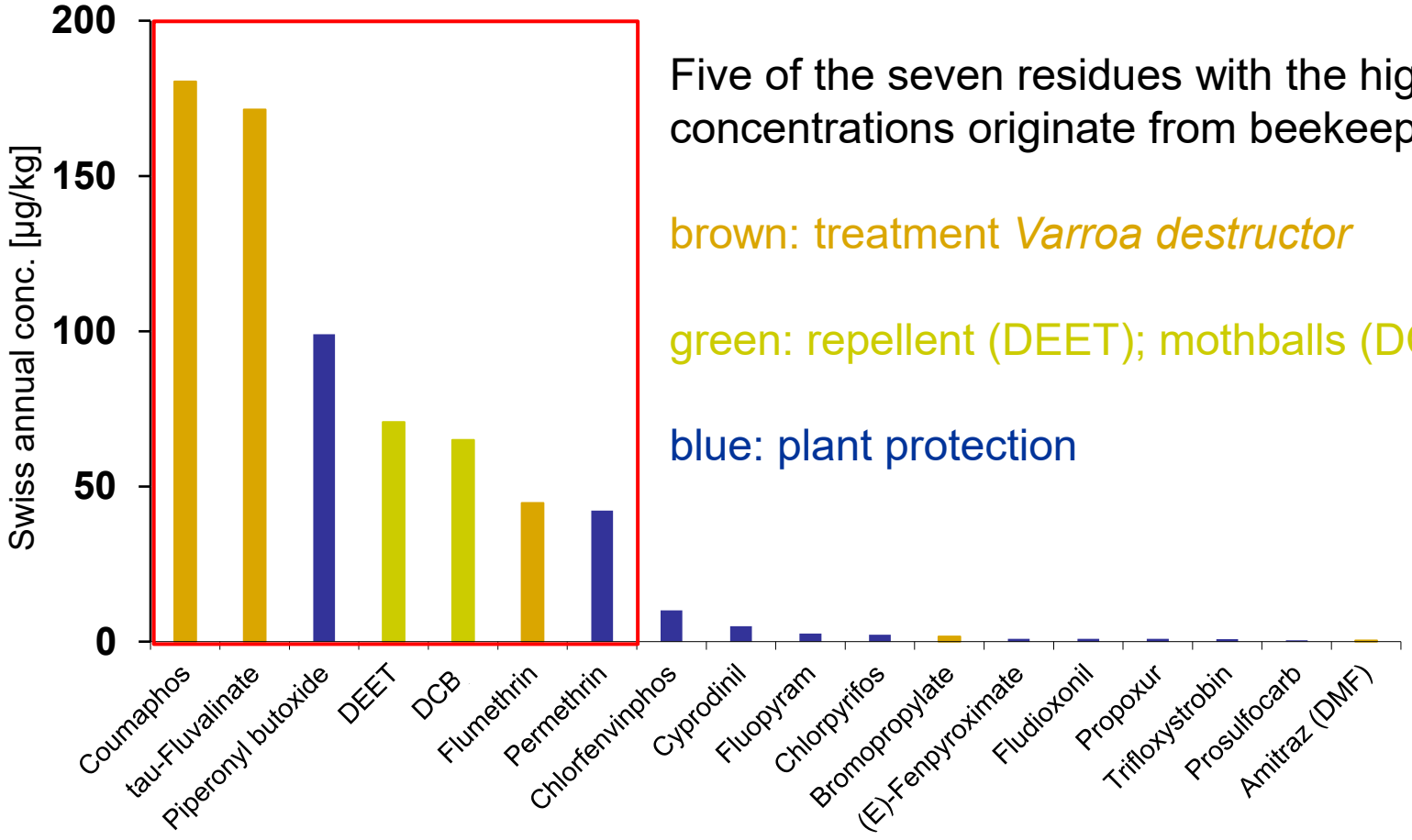
Residues levels in Swiss beeswax



18 pesticides quantitated (out of 51)

Agroscope

Residues in beeswax from beekeeping



Five of the seven residues with the highest concentrations originate from beekeeping.

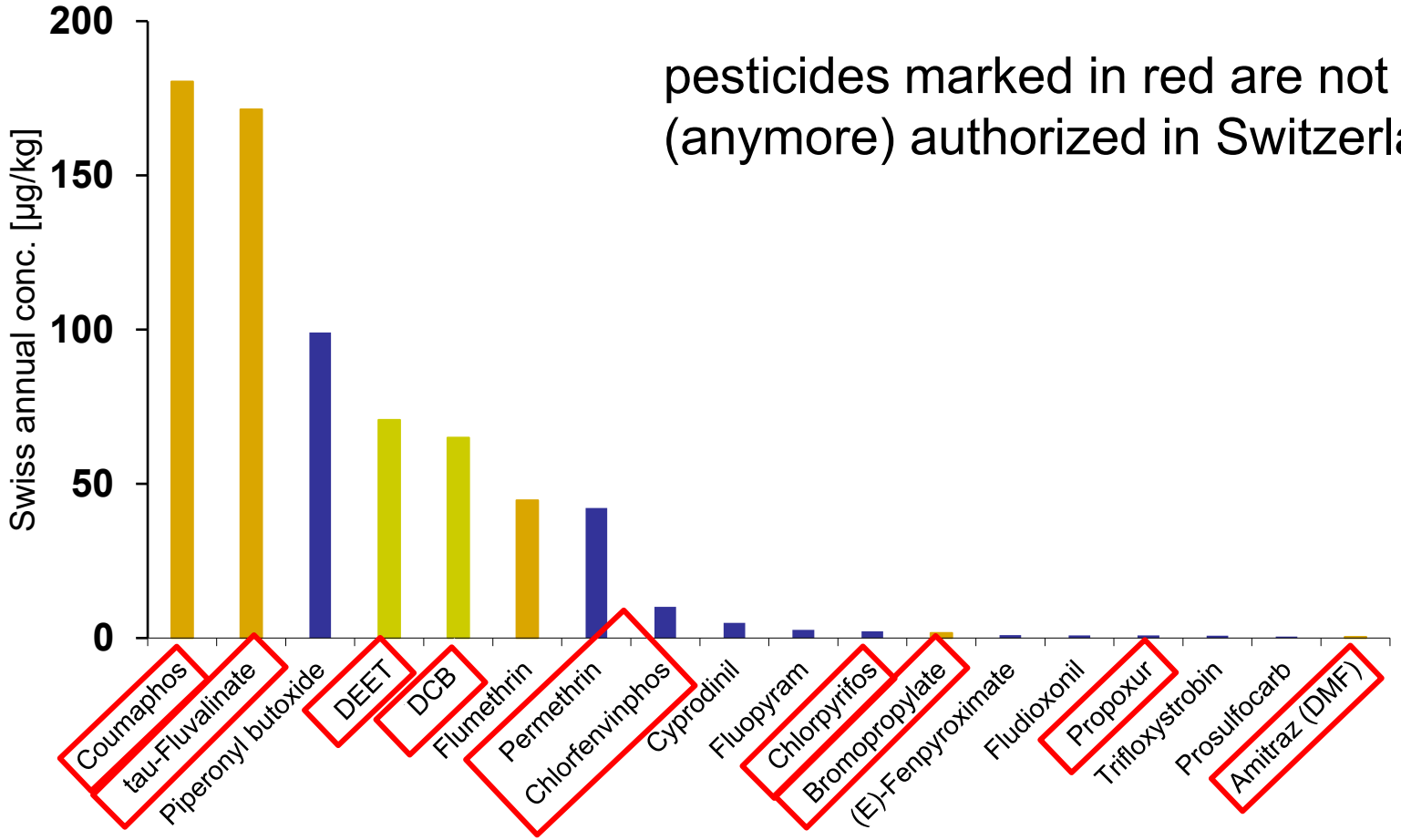
brown: treatment *Varroa destructor*

green: repellent (DEET); mothballs (DCB)

blue: plant protection

Agroscope

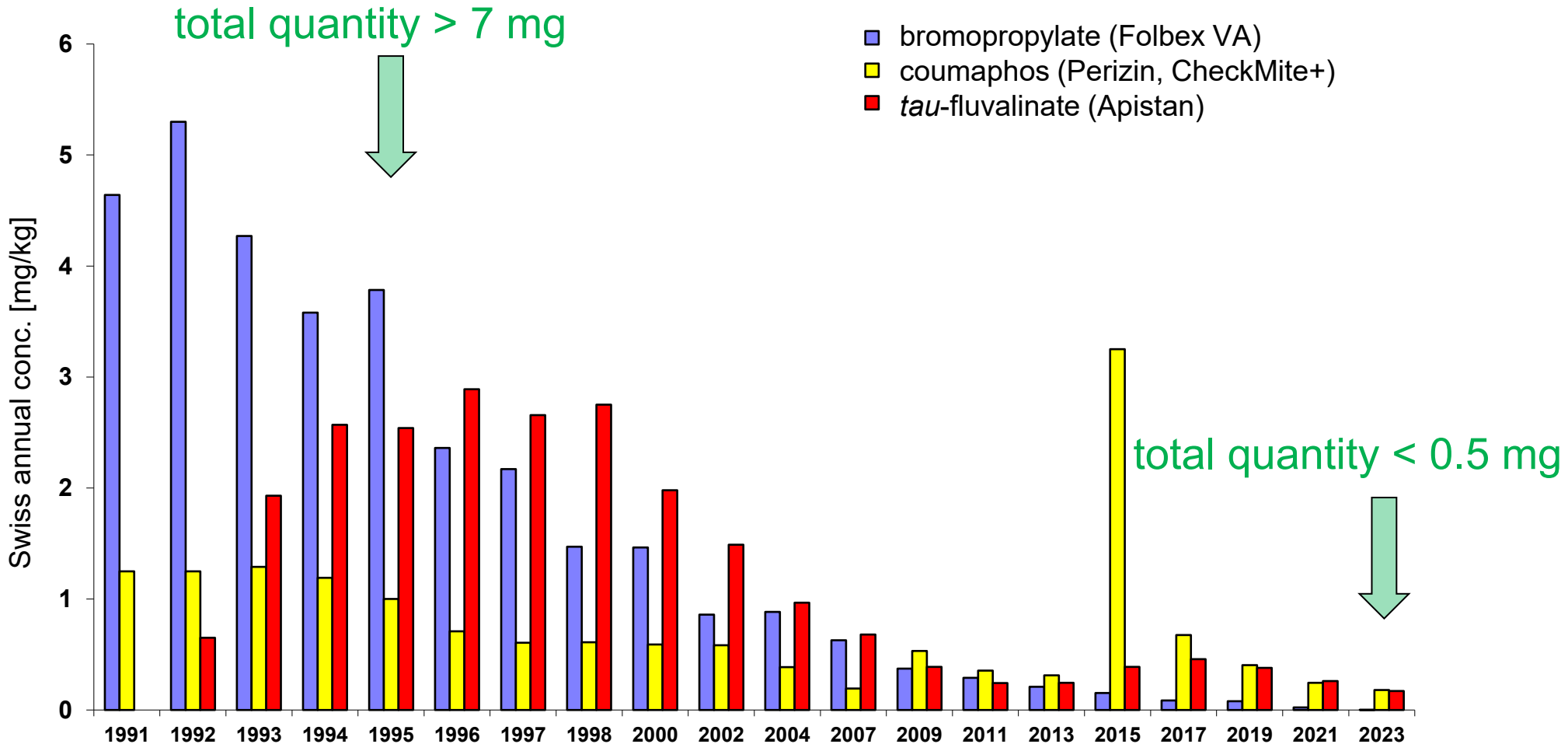
Residues levels in Swiss beeswax



pesticides marked in red are not (anymore) authorized in Switzerland

Agroscope

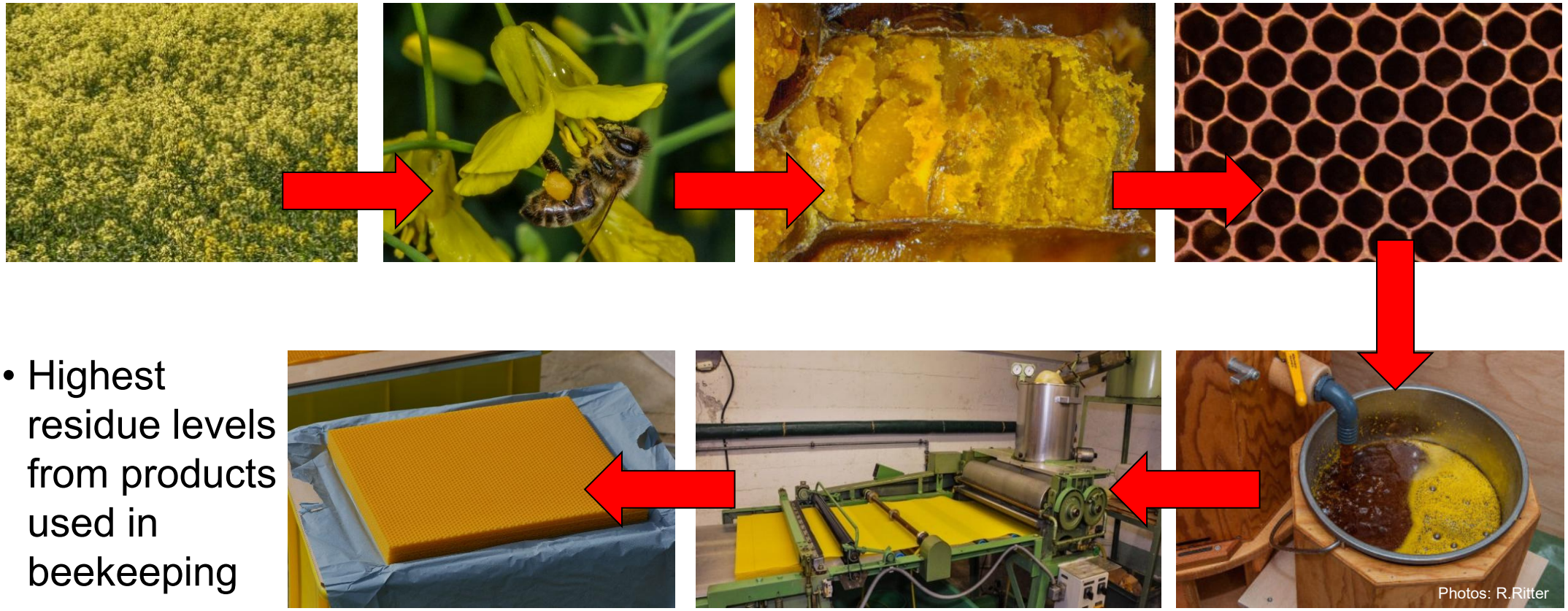
Good beeswax quality today in Switzerland



Agroscope

Summary

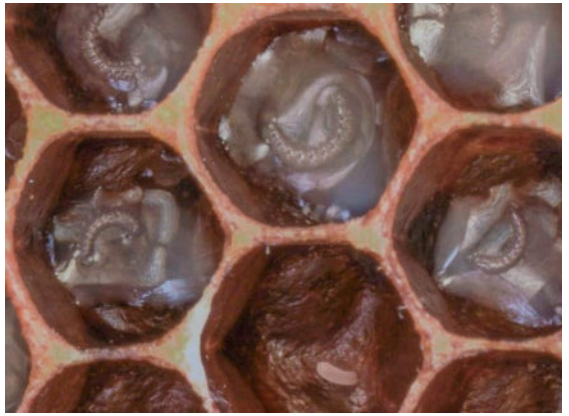
- Bees bring pesticides used in agriculture into the hive through pollen
- Fat soluble pesticides accumulate in wax and remain during recycling



- Highest residue levels from products used in beekeeping

Conclusion

- Residues in beeswax reflect beekeeping practices and plant protection products approved in a particular country
- Most Swiss beekeepers use organic acids for mite control
- Nowadays, we have good quality wax in Switzerland
- Good quality wax is important for honey production and the development of bees



Agroscope

Thank you for your attention
Team bee products:
M. Fracheboud (chemical analysis)
B. Droz (beekeeping)
S. Stalder and J. Müller (graphics)
R. Ritter (photos)