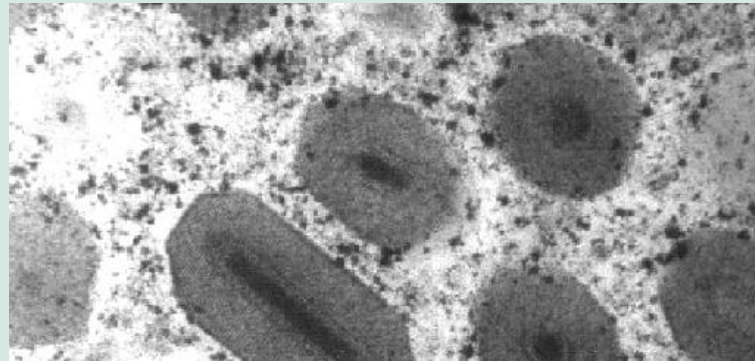




***where Nature
leads Innovation***

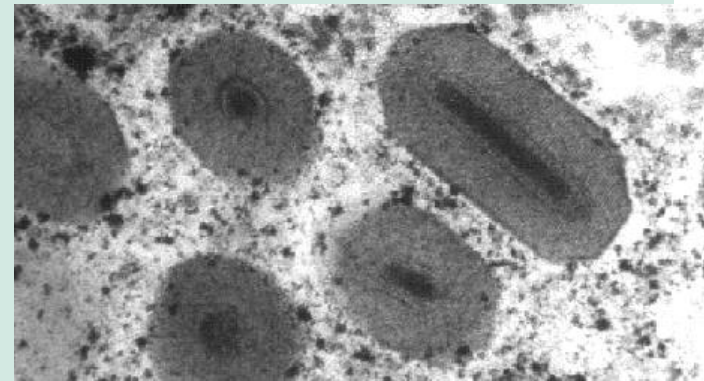
Overcoming baculovirus resistance



Philip Kessler, Andermatt Biocontrol AG
ABIM, Basel, 21 October 2015

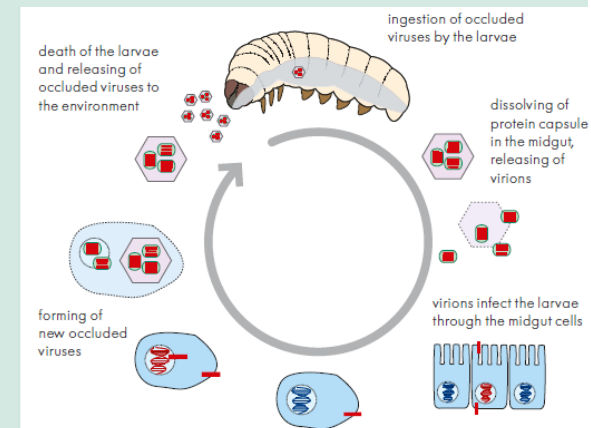
Baculoviruses – characteristics

- Insect pathogenic viruses
- Very host specific
- Safe for humans and non-target organisms, including beneficials
- More than 60 different baculovirus products registered in more than 50 different countries

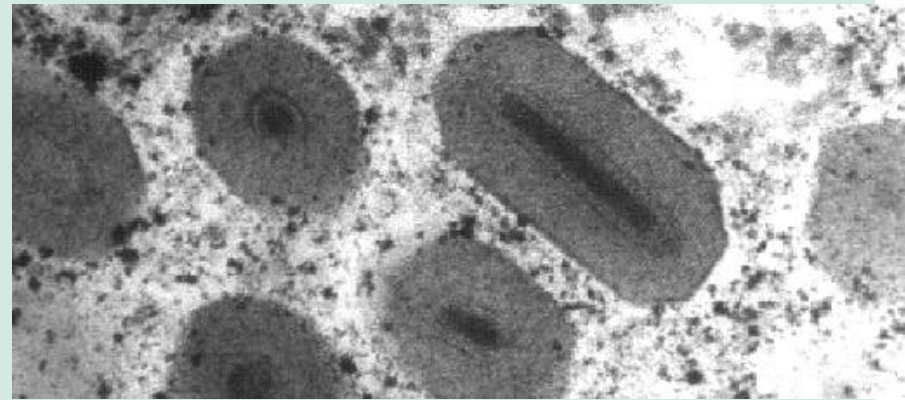


Insect immune system

- “Do insects produce antibodies after contact with baculovirus insecticides?”
 - well developed native immune response against microbial infections
 - lack of an acquired immune system
 - immune response shows no memory
- Resistance on population level by increasing the frequency of a resistance allele (selection)

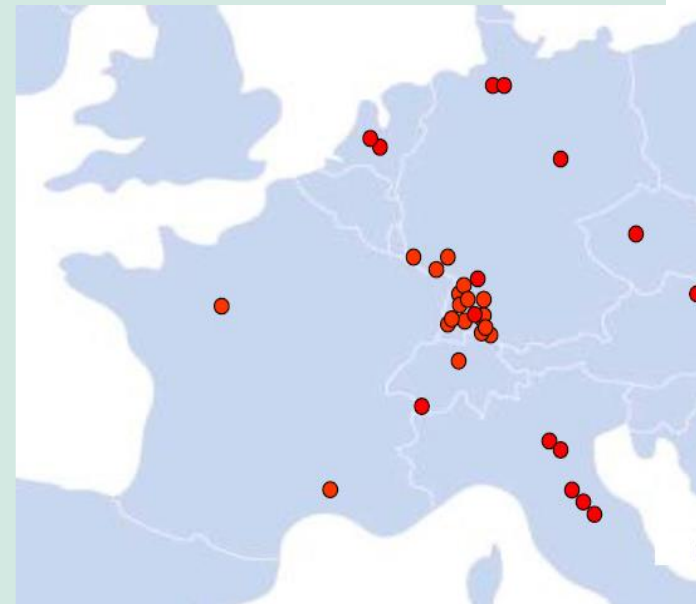


Cydia pomonella granulovirus (CpGV)



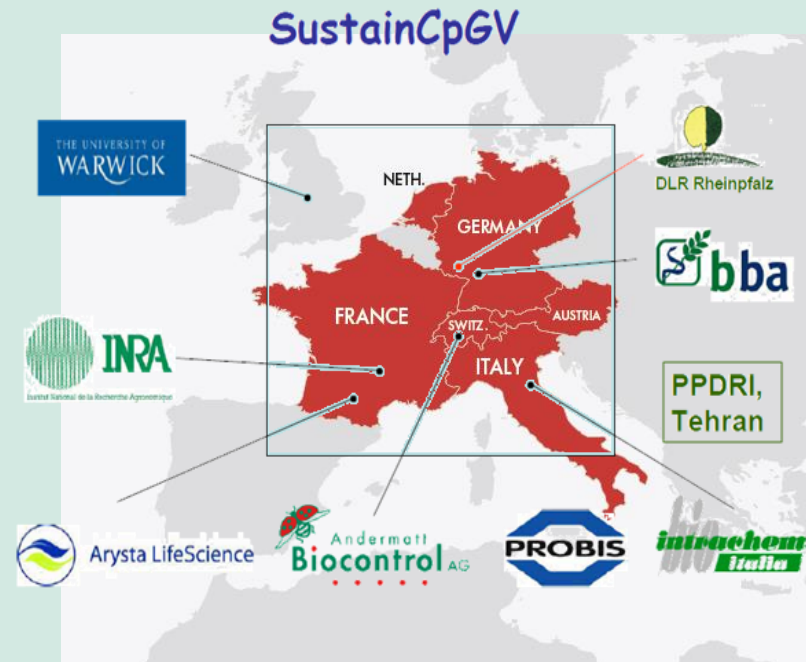
Resistance of codling moth against CpGV-M (mexican strain)

- Resistance of CM discovered in 2004
- Resistance of CM against CpGV-M
- Around 50 orchards (DE, NL, FR, IT, CH, CZ, AT)
- Organic orchards
- Population up to 1'000 times more resistant towards CpGV-M than sensitive populations



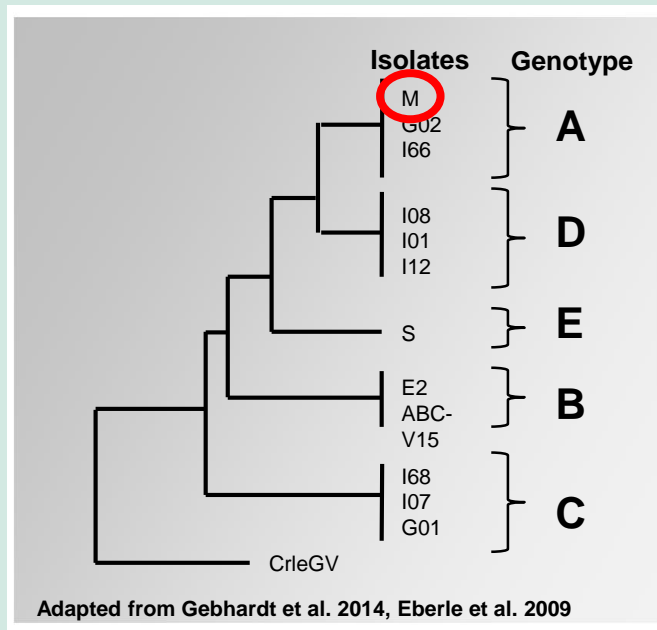
Resistance of CM against CpGV-M (mexican strain)

- Incompletely dominant
- Monogenic
- Linked to Z (sex) chromosome
- Not associated with any fitness cost



Resistance of CM against CpGV-M (mexican strain)

- Different genotypes within CpGV
- CpGV-M belonging to genotype A

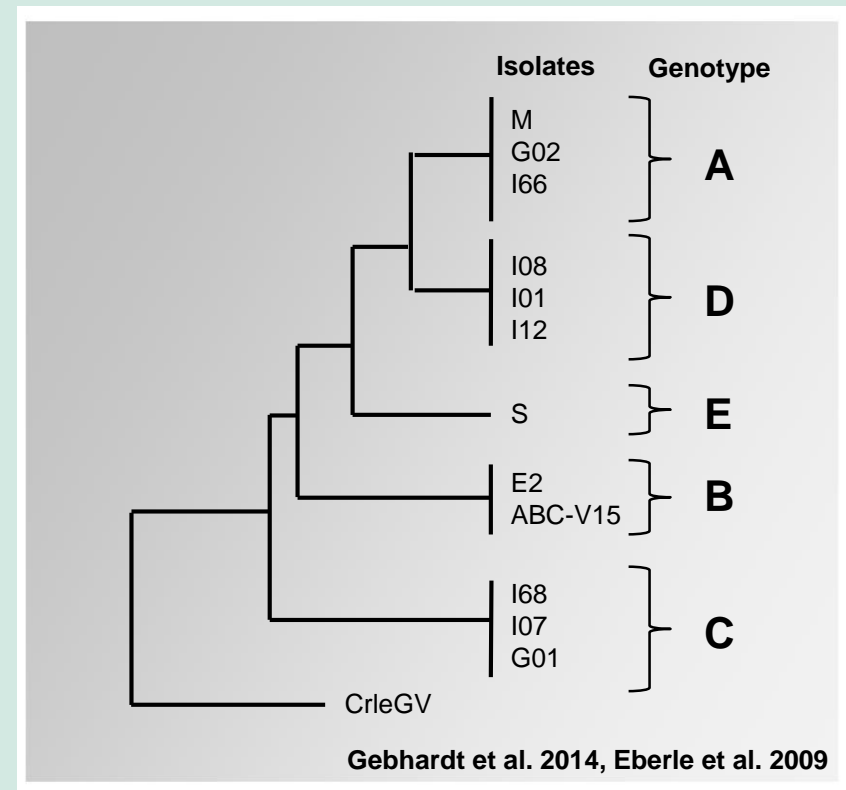


Gebhardt et al 2014:

- Gene *pe38* involved in viral infection in CM
- Insertion of 24nt in viral gene *pe38*
- Insertion specific to CpGV-M
- Insertion of 24nt renders this isolate to be prone to CpGV resistance

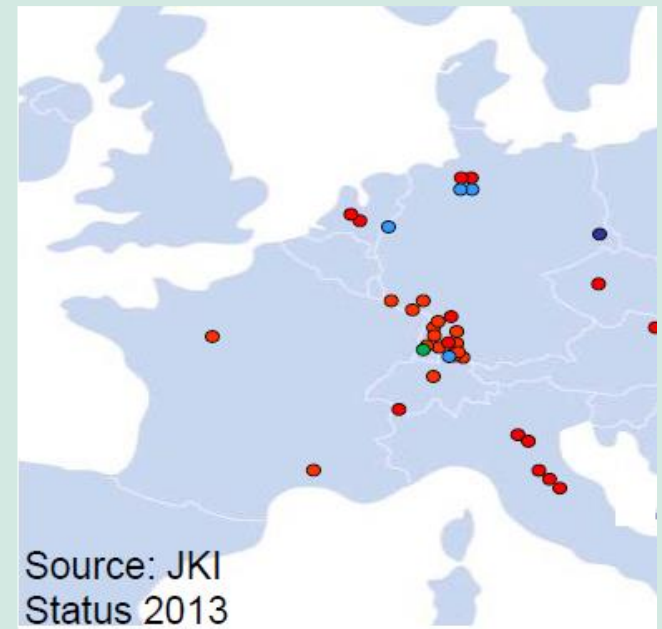
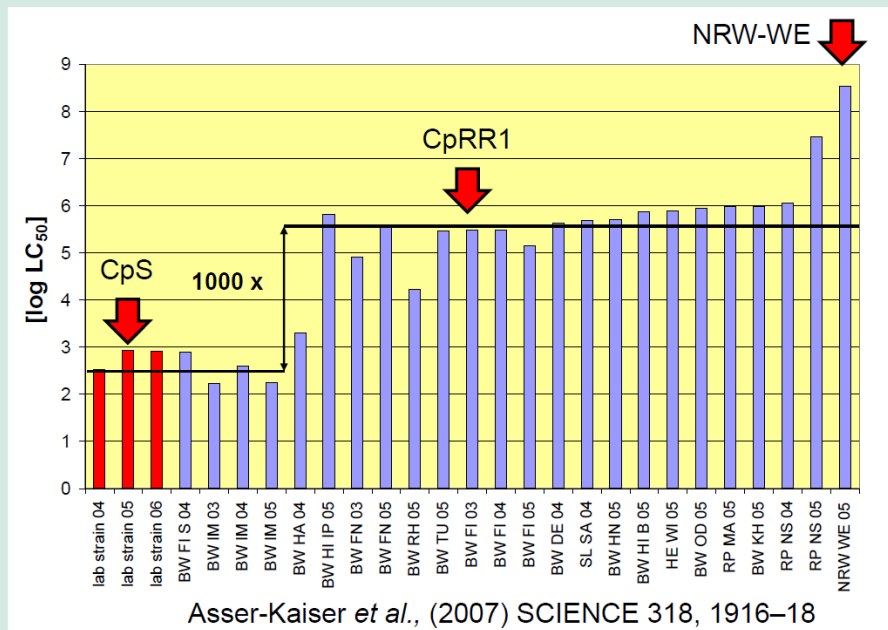
Overcome baculovirus resistance

- Investment in R&D within CpGV industry
- Selection of new CpGV isolates on CpGV-resistant CM populations
- First resistance breaking isolate in 2006 (CpGV ABC-V01, Madex Plus)
- Using of new CpGV genotypes, to develop new effective isolates

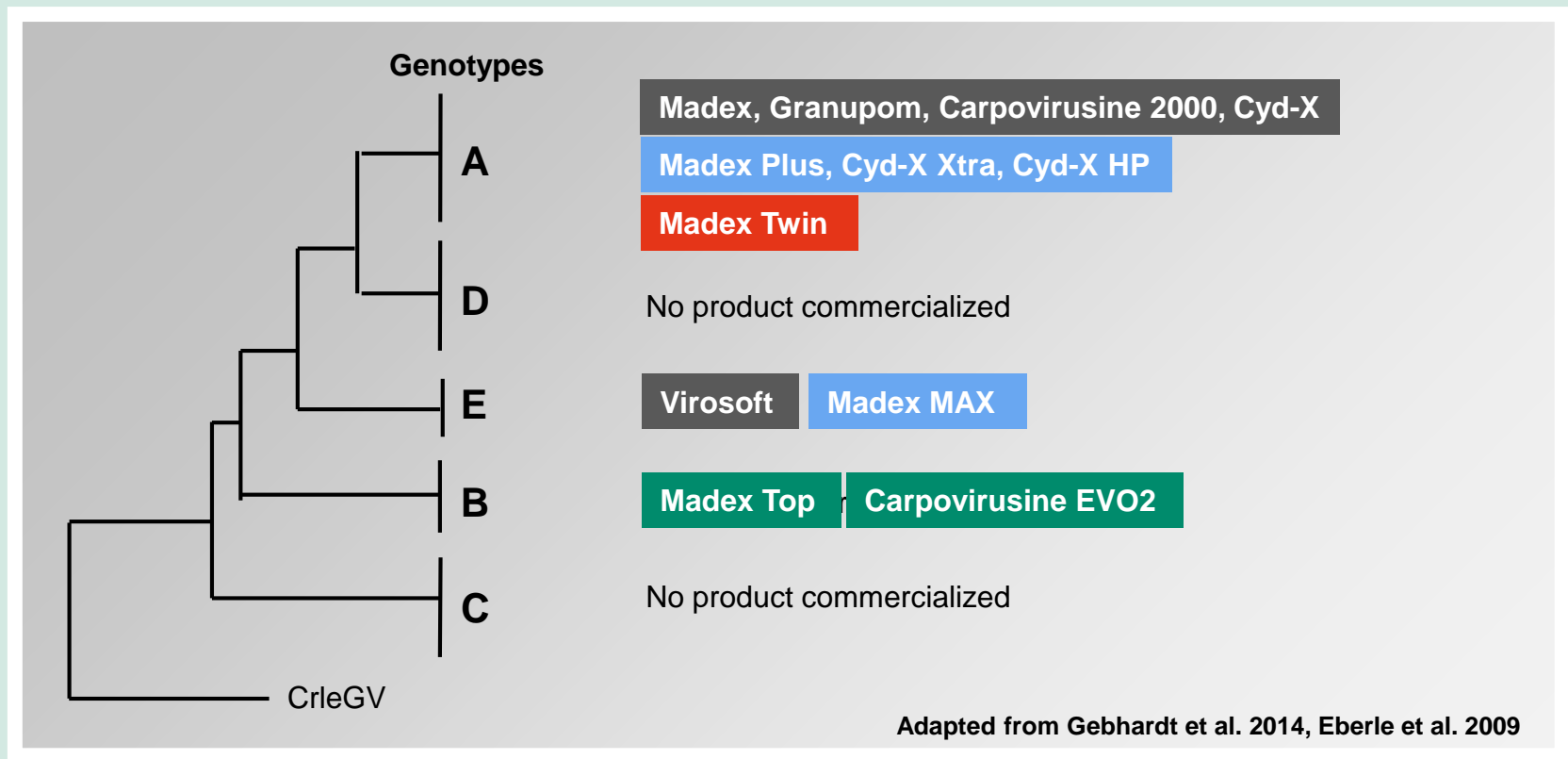


pe38-resistance is not the end of the story

- New resistant populations (e.g. NRW-WE) 1000 times more resistant
- CpGV type B is able to break the new resistance



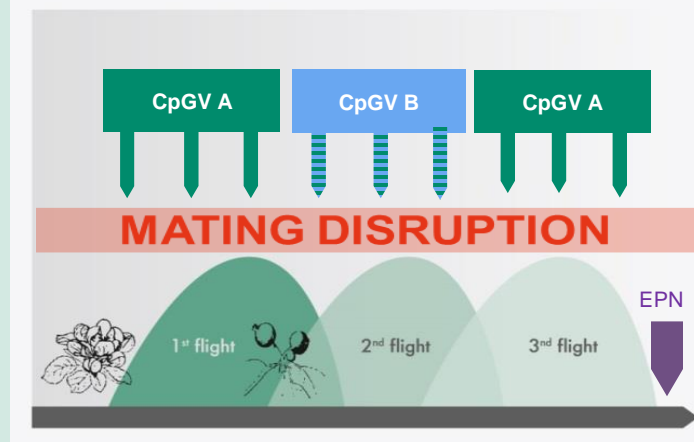
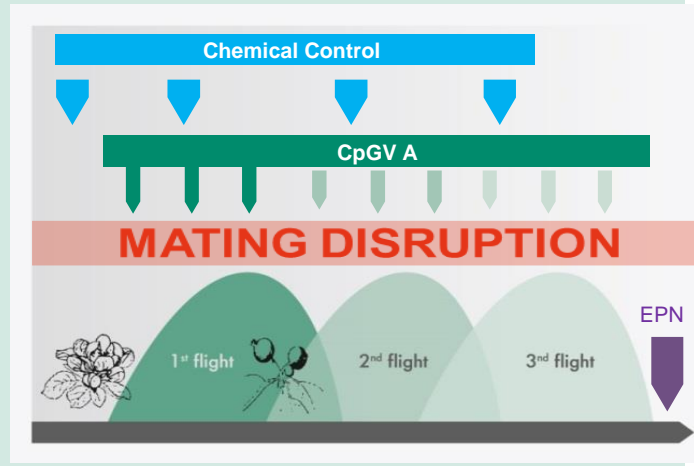
Evolution of new CpGV products



Adapted from Gebhardt et al. 2014, Eberle et al. 2009

CpGV resistance management

- **Combination with other control measurments**
 - Chemical control
 - Mating disruption
 - Entomopathogenic nematodes
- **Alternation of CpGV isolates between pest generations**
 - Where CpGV covers more than 1/3 of a CM control program
 - In biological control with limited CM control alternatives



CpGV resistance management

Opportunities and achievements

Biocontrol Industry as provider of new solutions

- Development of an extended product range (resistance breakers, or Madex Twin)
- Strengthen liability and trust in technology and industry

Registration

- EU SANCO 0253/2008 rev2

Challenges

Rotation and Handling of different isolates

- Production
- Logistics
- Marketing

Registration

- Generation of new product data

Baculovirus resistance – lessons learned

- Rare, but not impossible
- Industry is capable to develop new effective isolates
- Resistance management
- Use and rotation of several isolates

➔ CpGV resistance triggered intensive R&D, improved genotype management and extended product life time





***Thank you for
your attention!***



Andermatt
Biocontrol



***where Nature
leads Innovation***