Transgenic Trees

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Overview

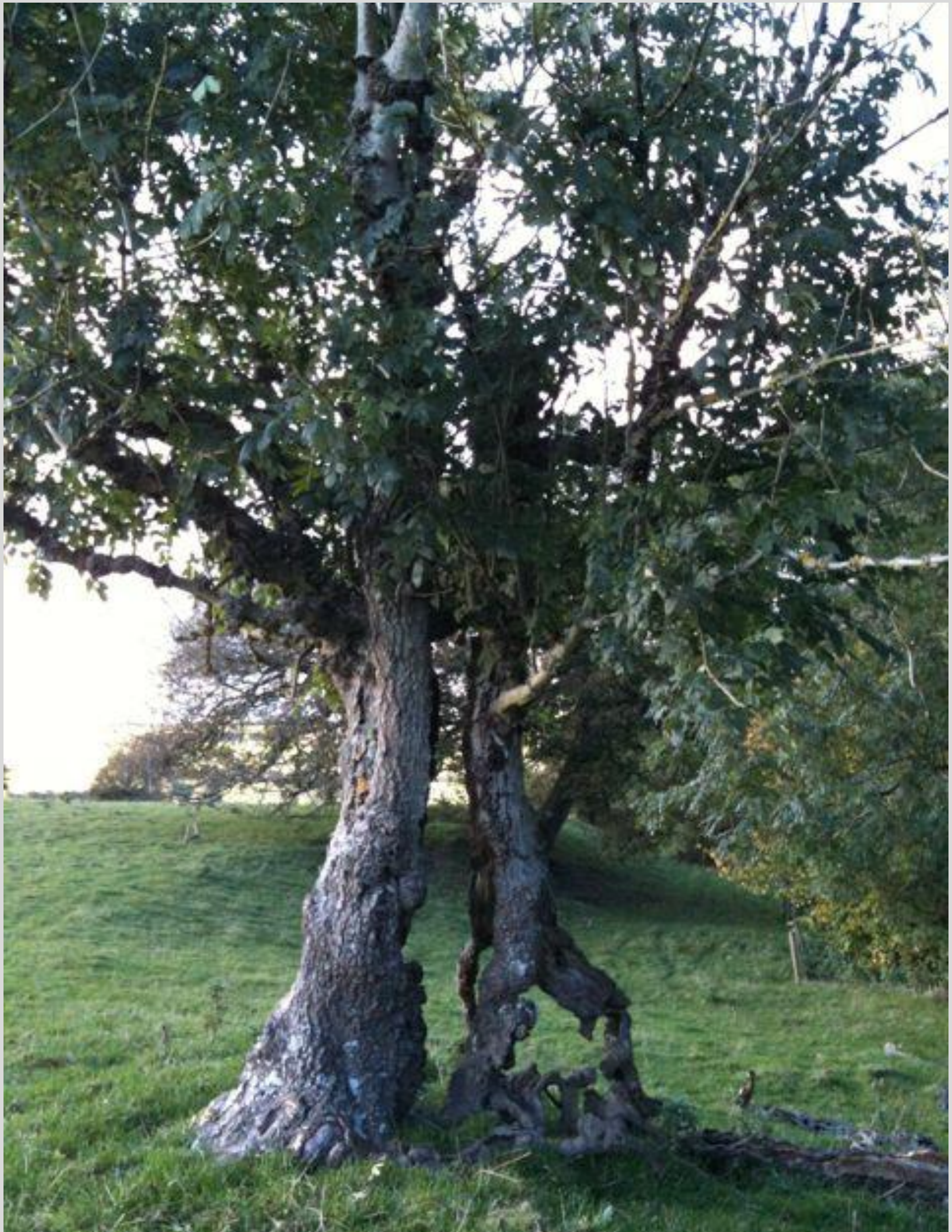
- GE trees & traits
- Special risk factors: trees vs annual crops, incl. spread
- Status quo

GE Trees and their traits (1)

* **A**merica chestnut
* Apples
  Apple
  Paradise apple
* Avocado
* Birch
* Citrus
  Citrange
  Grapefruit
  Lemon
  Mexican lime
  Orange
* Coffee
* **E**lm
  American elm
  Elm
* **E**ucalyptus
* **N**ordmann fir
* Olive
* Palm
* Papaya
* Pear
* Persimmon
* **P**ine
  Loblolly pne
  Monterey pine
  Pine hybrid
  Pitch pine
  Scots pine
  Swiss pine
* **P**oplar
  Aspen
  Black Cottonwood
  Cottonwood
  Eastern Cottonwood
  Grey poplar
  Poplar hybrid
* Prunes
  Plum
  Sweet cherry
* Rubber tree
* **S**ilver birch
* **S**pruce
  Black spruce
  Norway spruce
  White spruce
* Sweet gum
* **W**alnut

GE Trees and their traits (2)

- insect tolerance/resistance (e.g. Bt pine and poplar)
- herbicide tolerance (e.g. eucalyptus, poplar)
- virus resistance e.g. fruit trees (apple, papaya) and elm
- altered/lower lignin content (e.g. eucalyptus, poplar)
- altered branching (e.g. poplar)
- higher cellulose content (e.g. poplar)
- salt tolerance (eucalyptus)
- “fast growth” (e.g. poplar with altered nitrogen metabolism)
- male or/and female sterility
- tolerance to acidic soils (e.g. eucalyptus)
- altered cold and/or light adaptation (e.g. eucalyptus, birch)
- delayed fruit ripening (e.g. coffee)
- bioremediation (e.g. mercury - poplar)



Special risk factors: trees vs crops

- Trees are not domesticated
- Pollen and seed: abundant production and wide distribution (pine pollen up to 2000 miles by wind)
- Propagation also via roots, shoots, grafts
- Slow to mature
- Long lifespan
- Strong exposure to stress (temp., seasons, drought, fire, insect attack, storm etc)
- Integral part of crucial ecosystems
- Co-evolution / Forest Ecosystems are global

Dispersal (1)

Contamination & invasiveness

- Dispersal by wind, water, pollinators (e.g. insects), animals and humans.
- Propagation (vegetative) via roots, shoots, grafts
- Pollen and seed: abundant production and wide distribution
  - Pine pollen up to 2000 miles by wind
  - Spruce (*Picea*) 1000km (Gregory 1973)
  - White spruce (*Picea glauca*): mostly within range of 250-3000m (O'Connell et al. 2007)
  - Birch (*Betula*) 100s km

Dispersal (2)

- “As an **evidence of long distance pollen transport**, Betula pollen concentrations in Fennoscandia can be relatively high before the local flowering period [here pollen production]. The pollen is transported by south-eastern air-masses from central Europe and the Baltic countries with travelling times for pollen grains in the range of 9-20 hours.” (Hjelmroos 1991)

Dispersal (3)

North Carolina coastline, including 45 000 ha of mature *Pinus taeda* plantations and barrier islands. CG Williams tested three hypotheses:

(1)pine pollen germinates after dispersal on meso-scale distances,

(2)sodium chloride exposure reduces germination of pollen captured over open saltwater, and

(3)viable pine pollen is present at high altitudes before local peak pollen shed.

The experimental findings are as follows: pine pollen had germination rates of 2 to 57% after dispersal at distances from 3 to 41 km, sodium chloride solutions mildly reduced *P. taeda* pollen germination, and viable pine pollen grains were captured at an altitude of 610 meter.

GM pine plantings thus have a potential to disperse viable pollen at least 41 km from the source.

Williams CG (2010). Long-distance pine pollen still germinates after meso-scale dispersal. American Journal of Botany 97(5): 846-855

Sterility

Scenarios:

- Male sterility often not 100% (e.g. eucalyptus).
- Pollen is produced but sterile – prevents rejuvination
- Pollen not produced – not available as food source
- Seed (long distance travel)
- Pollen, flowers, seeds sustenance for forest dwelling animals.
- GURTs (genetic use restriction technologies) – not 100% reliable / effective

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Lack of scientific knowledge

At the:

- Level of interaction of these genetically engineered trees with the ecosystems into which they are intentionally or unintentionally introduced.
- Level of the introduction (or transfer) of novel genes into the tree genome.
- Level of the transformation process itself. It is known that this process is prone to cause thousands of mutations in addition to substantial genome scrambling.

Pulp and biomass-

the interests.

Combinatorial Uncertainties

GM Eucalyptus (USA – field trials)

(cold tolerance, male sterility, reduced lignin)

Because clone EH1 is a hybrid, the EA concludes a number of times that since neither of the parental lines is known to be a problem, the combined hybrid is not expected to cause any problems.

YET: "…the soil samples from *E. grandis* X *urophylla* plantations had an inhibitory effect on germination of maize, bean and watermelon **but had a stimulatory effect on squash**. The soil from *E. grandis* plantations had an **inhibitory effect** on squash." (Epinosa-Garcia et al. 2008)

Current GM tree development

Eucalyptus (cold tolerant) – Arborgen (US)

Eucalyptus (fast growth) – Futuragen/Suzano (Brazil)

Loblolly Pine – US

American Chestnut (blight resistance) – US

Industry asserts: “more trees on less land”

- No scientific consensus on GMO safety.
- It is currently not possible to conduct a meaningful and sufficiently comprehensive risk assessment for GE trees.
- We also need uncertainty assessment within the risk assessment and suggested risk management strategies, esp. for GE trees.

Genetically Engineered Trees and Risk Assessment – an overview of risk assessment and risk management issues.

R. Steinbrecher & A. Lorch, 2008

http://www.econexus.info/publication/genetically-engineered-trees-risk-assessment

thank you