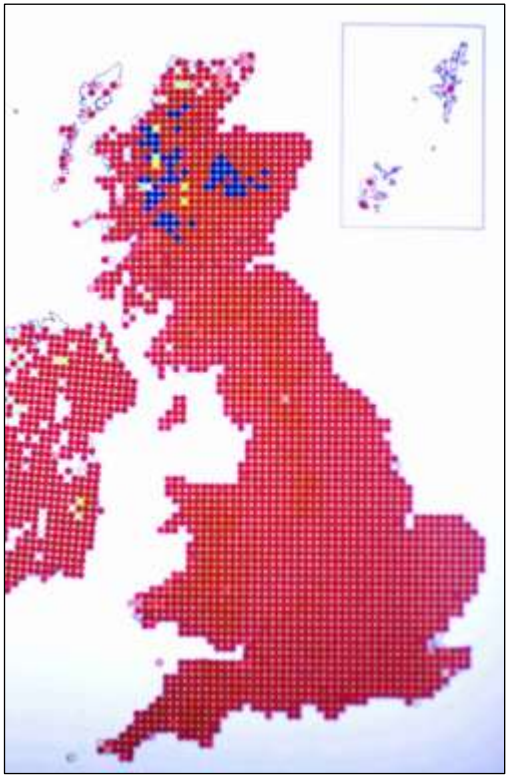
Scots pine: the world's most successful tree.

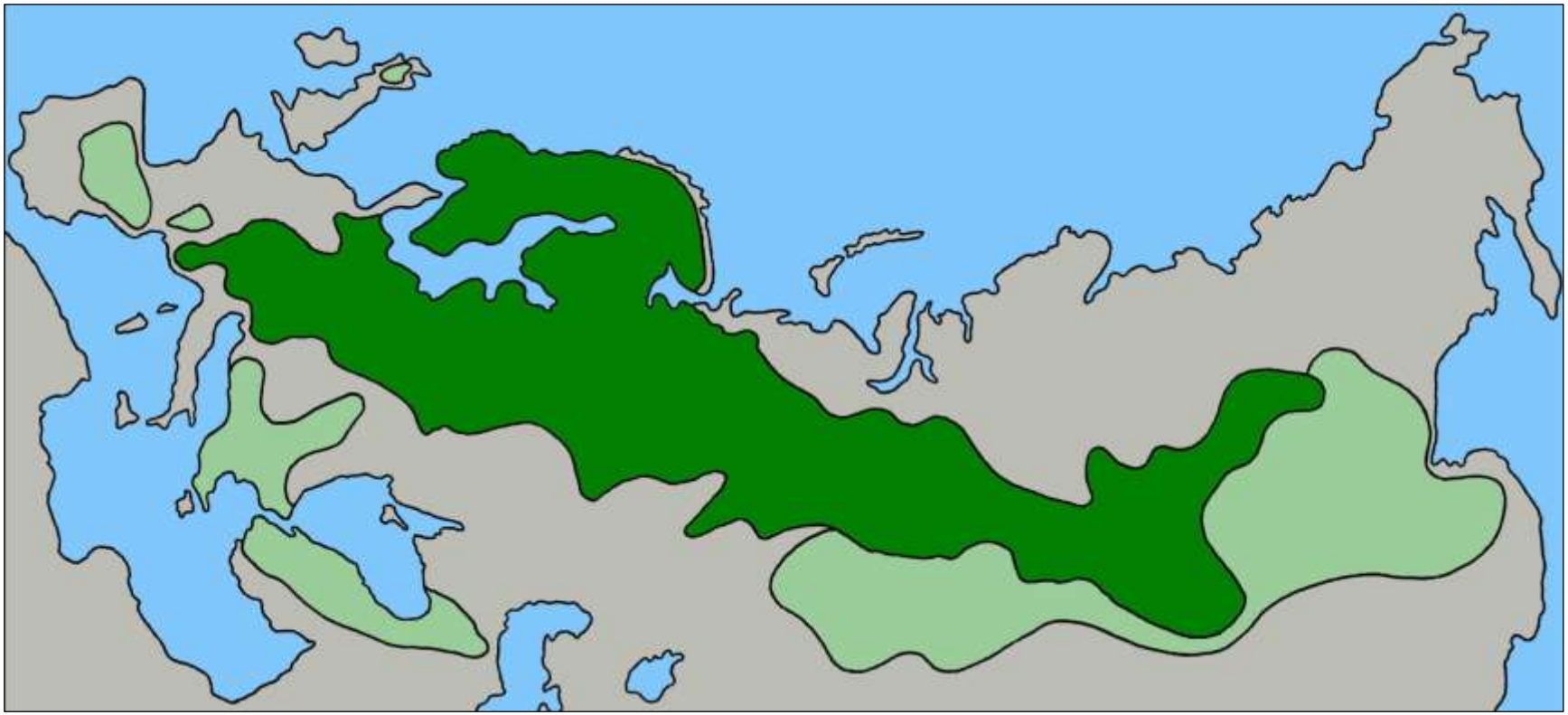
Black Wood of Rannoch: represents the original *Caledonian pine forest,* in Scotland.

Really – on what basis?



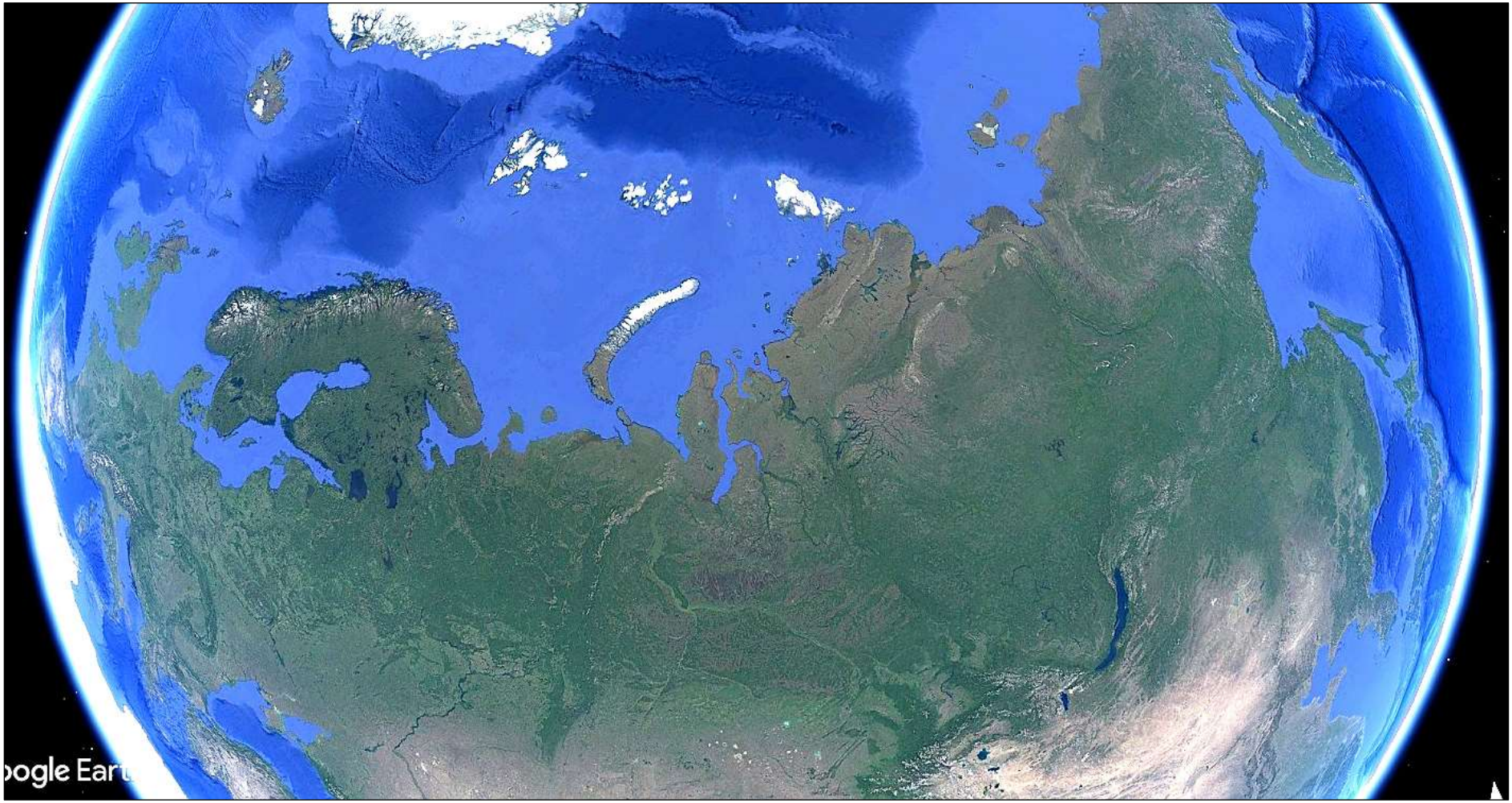
'Botanical Society of Britain and Ireland': distribution map of *Pinus sylvestris* (the blue dots).

World's most extensive natural distribution of a clearly defined species of tree.



Dark green shows contiguous populations of *Pinus sylvestris;* light green shows scattered populations.

Pinus sylvestris distribution on the globe of Earth: this is not just an artifact of a Mercator projection of Earth.



An image from Google Earth

Pinus halapensis, a common tree in southern Europe, possibly representing a species from which *Pinus sylvestris* evolved by genetic divergence.

Pinus sylvestris is also known in Britain also as “Baltic pine”, “Red Deal” and similar, but further eastwards by very many vernacular names.

This species of tree came into existence possibly by some accident of geographical isolation followed by divergent evolution. That prevented its ability interbreed with its original population. Or there might have been some genetic mutation that made it diverge genetically from its parent population.

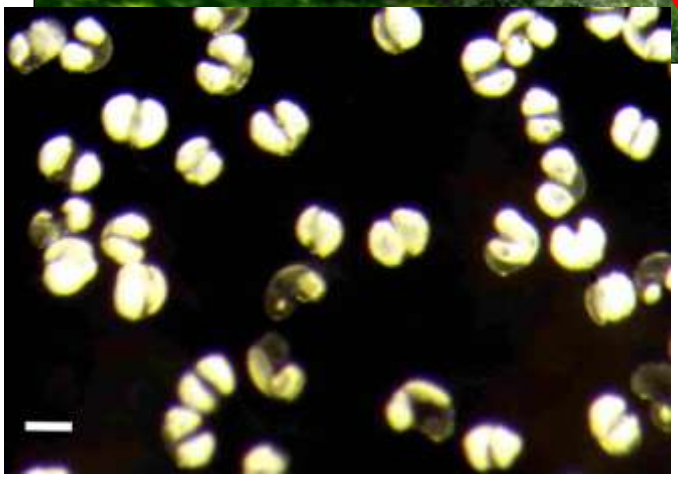
Whatever the mechanism of it origin as a separate species the evidence of where it started as *Pinus sylvestris* points to somewhere in southern continental Europe. From there this population spread in all directions, going as far as west as Scotland, and possibly to Ireland.

What defines a species? Reproductive isolation by pine cones.

Scots pines are bisexual but pollen is incompatible.

What defines a species? Reproductive isolation by seeds.

Female cones and seeds : small, light, WIND-BORNE.



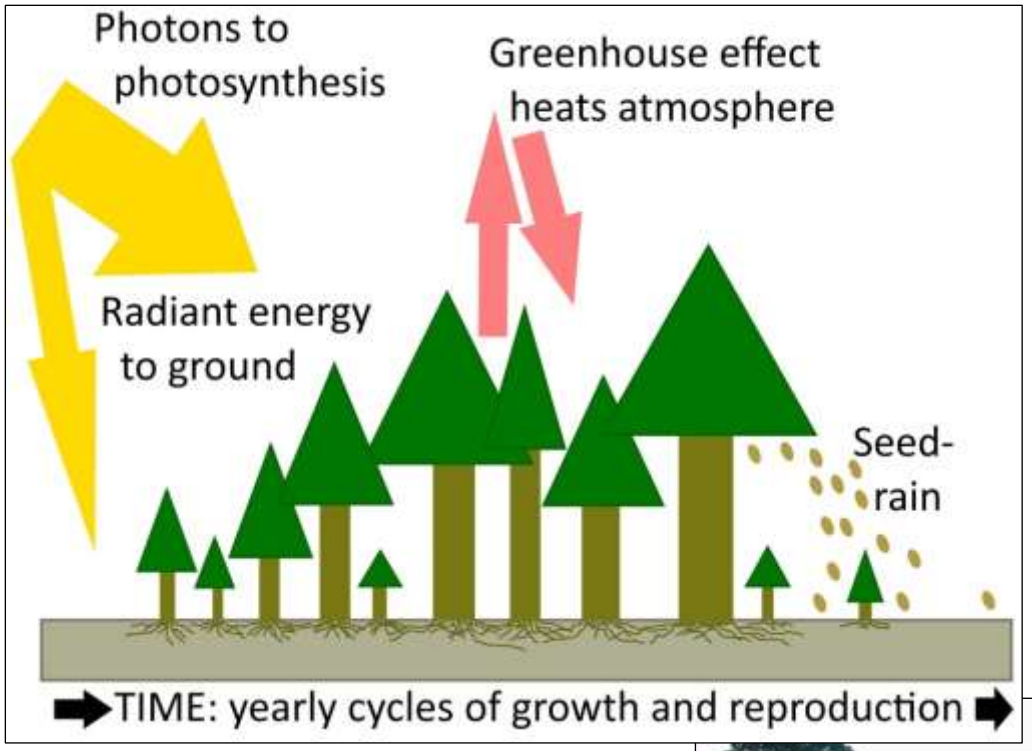
Male cones dispersing wind-borne pollen. Single pollen grains at left.

Survival of the fittest in a world of competitive reproduction. Trees that have reached reproductive maturity, 30 to 35 years for Scots pine, will continue to produce vast numbers of seeds every year for 200 to 300 years more. But very few seeds ever grow into another mature tree. The calculation is stark.

3 pines contributing **pollen** for 200 years
+ **3** pines contributing **seed** for 200 years
= very many new seedlings
of which **at least 7** must survive
to reproductive maturity to
maintain a local population.

The **longevity** of trees, with, Scots pine as a distinct example, seems to be a fundamental evolved adaptation for their reproduction.

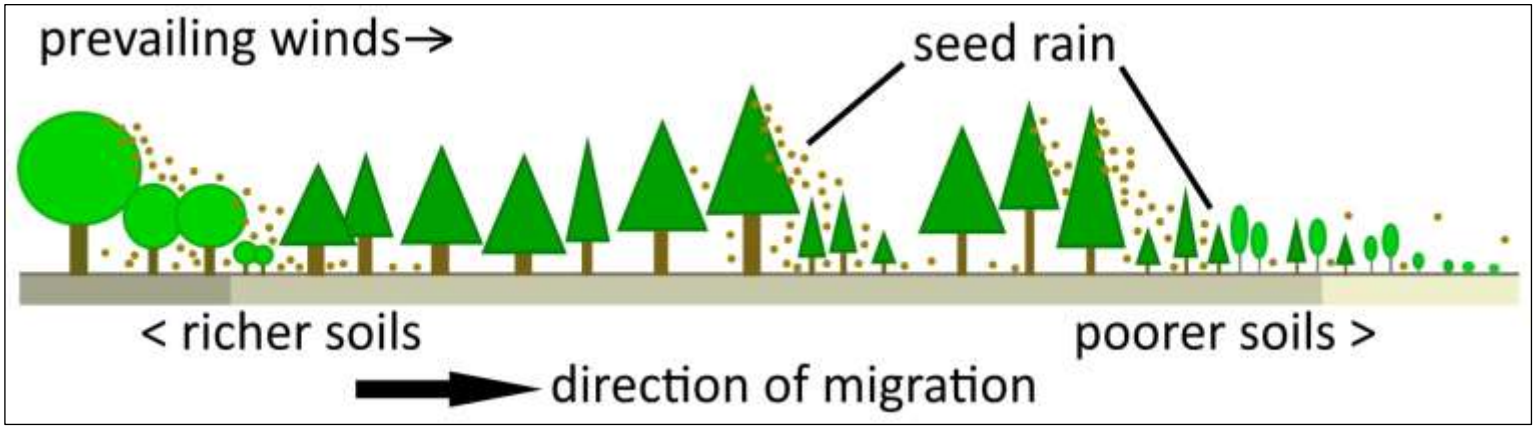
Trees feed on sunlight and minerals in soil.



A Scots pine will stand where its seed fell, then gain energy direct from the sun, warmth from the greenhouse effect, and minerals from the soil, for 300 years.

Scots pines grow best on sandy soil and manage well on soils of poor mineral content. They do not thrive on peat bogs.

Seed dispersal and establishment of seedlings is crucial for spread and maintenance of a forest.



Forests can migrate, very slowly, over long distances. Much depends on how they disperse their seed. So a species such as Scots pine is well adapted for dispersal far away from the parent trees. The part of the seed that will germinate into a seedling is small and has few reserves of material to start growth as a seedling.

However, the seed has a long membranous wing. Typical habitats of Scots pine are on areas of poor soils, also on upland areas. The mature trees are exposed to the prevailing wind. During the long life time of each tree sufficient seed is likely to have be wind-blown away from the forest edge, out onto new ground. The forest moves about, at a very long timescale.

30 years to grow enough for defence and reproduction.

Risks to seedlings: The growing point (apical meristem) is eaten by herbivores, or other plants overgrow the seedling.

Apical meristem growing.

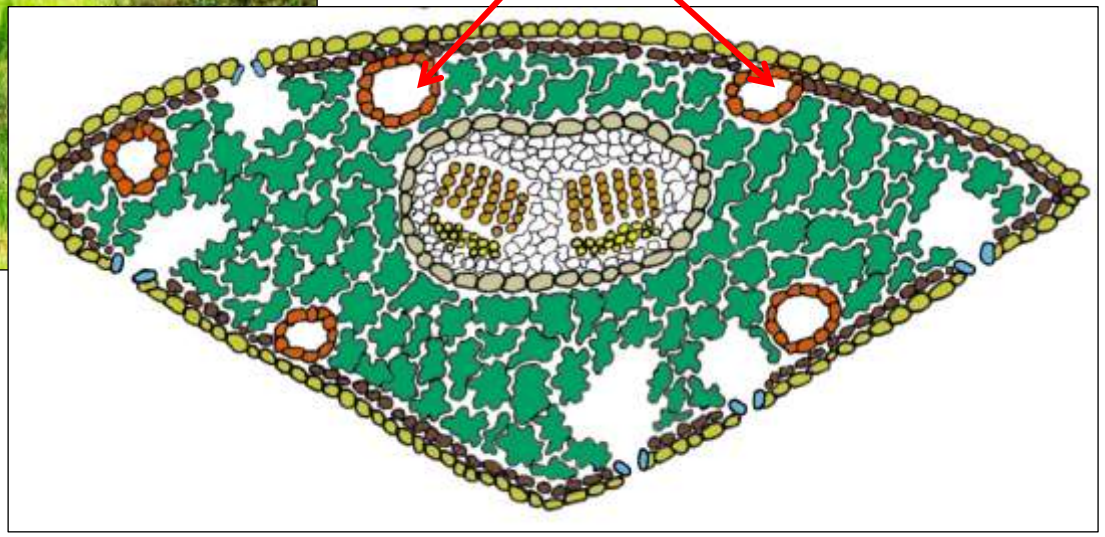
Apical meristem eaten.

Seedling smothered by heather.

30 years to grow enough for defence and reproduction.

Rapid seasonal growth of **saplings**.

Anti-herbivore chemical defences: **terpenes** in tree's **resin-ducts**, shown here as ducts in a needle-leaf cross-section.



Seedlings with mutual help from soil fungi.

Mushroom

Seedling with mycorrhiza

Seedling’s roots with mycorrhizal hyphae.

Young trees compete against adults for light and nutrient.

Wind-blown pine with a pine growing on its root-plate.

Change in ground conditions permits advance of saplings onto open ground.

Scots pines in a contrary world: climate and weather.

Bog-wood of Scots pine. The era of **pine decline** probably due to change of climate to wetter conditions favouring sphagnum moss and formation of **peat**.

Scots pines: reproductive at **tree-line**, expanding their population range.

For the seed of Scots pines to develop into mature trees there are many risks to avoid. Herbivore animals such as voles and deer eat the growing point at the top of the seedling (a single apical meristem). Without that crucial part the seedling will never grow into a tall tree in the sunny canopy of the forest.

Seedlings need light, space, and supportive nutrients in soil to grow faster than herbivores can eat them. Scots pine is a resinous species: ducts carrying resin are a chemical defence against herbivores, from deer to leaf-eating insects.

Seedlings grow better if in partnership with mycorrhizal fungi: a mutualistic symbiosis that swaps minerals from the fungi in exchange for carbohydrate from the tree.

Seedlings must outgrow moss, heather, and other seedlings to gain the forest canopy in order to become reproductively mature.

Scots pines and the timber trade: deforestation or protection?

Scots pine plantation, grown for sale to a sawmill and then the timber trade.

Scots pines made excellent masts for ships.

Trees of commercial value are better protected than others and are grown in large scale plantations. Scots pine has many characteristics of a valuable timber tree when planted and harvested for that purpose.

Trunks grow tall and straight when planted close together. They were valued as masts for sail-ships. The wood is suitable for many domestic and building purposes. Formerly the resinous wood was processed to produce turpentine fluid, of many commercial and domestic uses.

And as the next, final, slide shows the aesthetic value to us of beautiful pine forests encourages their protection.

Natural forest of Scots pines thriving within its original area of distribution in the Highlands of Scotland.

End