The University of Manchester

MANCHESTER 1824

A Fork in the Road…

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Myerscough College

A Fork in the Road

Image courtesy of Ian Braddock (ADAS)

Structure of Presentation

This PhD study at the University of Manchester commenced in 2009, and completes 30th Sept 2015.

I will take you through the main findings of my PhD

I will concentrate on findings applicable to arborists and arboriculturists

Year One

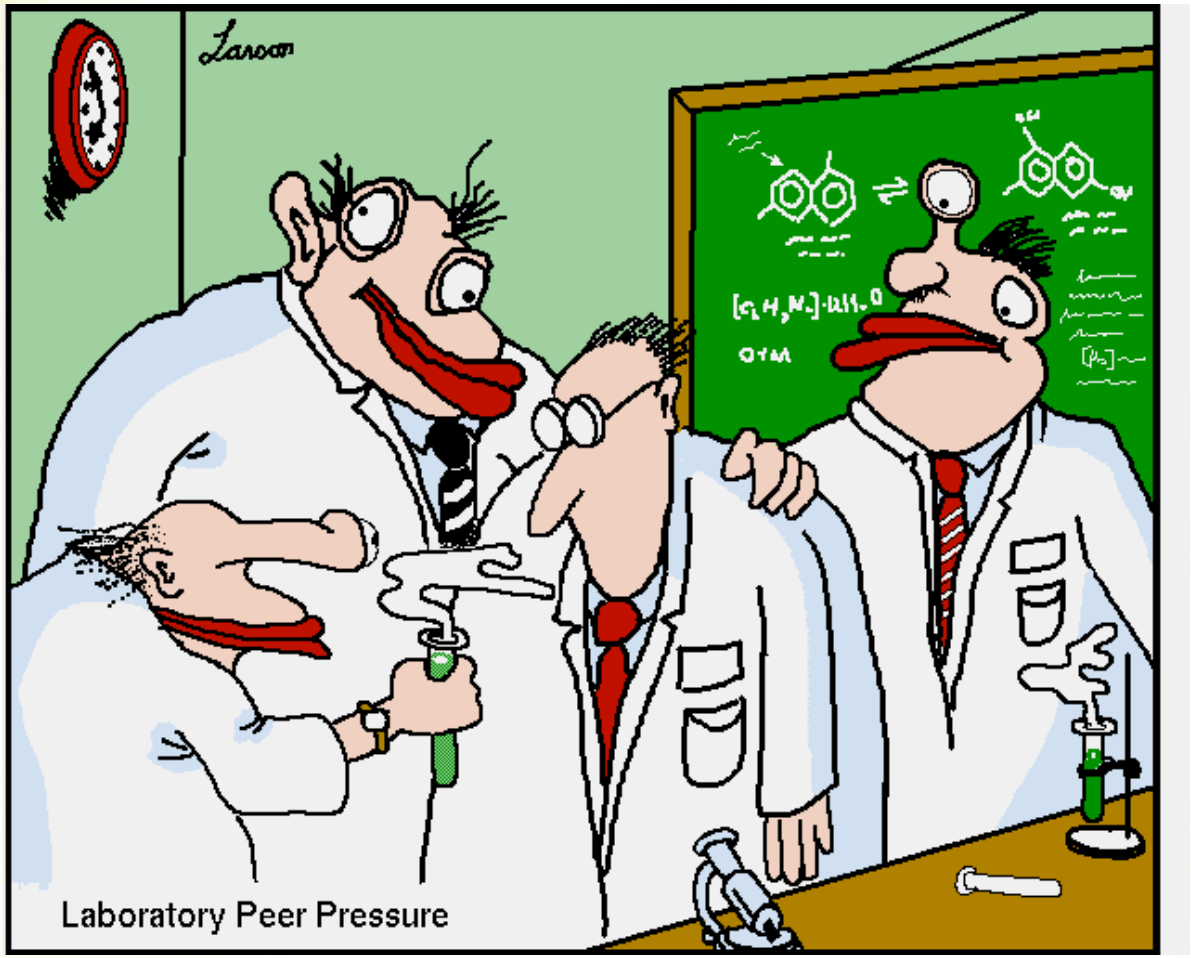
Year Two

Year Three

Year Four

Year Five

Year Six



Output of the PhD

- A new anatomical model for branch attachment
- Proof to support this model
- Assessment of bark-inclusions
- The effect of induced defects
- Wind-induced movement
- Ten papers!

Related Publications

- Slater D and Harbinson C J (2010) Towards a new model for branch attachment; *Arboricultural Journal* **33** (2), 95-105

- Slater D and Ennos A R (2013) Determining the mechanical properties of hazel forks by testing their component parts; *Trees: Structure and Function* **27** (6), 1515-1524

- Slater D, Bradley R S, Withers P J and Ennos A R (2014) The anatomy and grain pattern in forks of hazel (*Corylus avellana* L.) and other tree species; *Trees: Structure and Function* **28** (5), 1437-1448

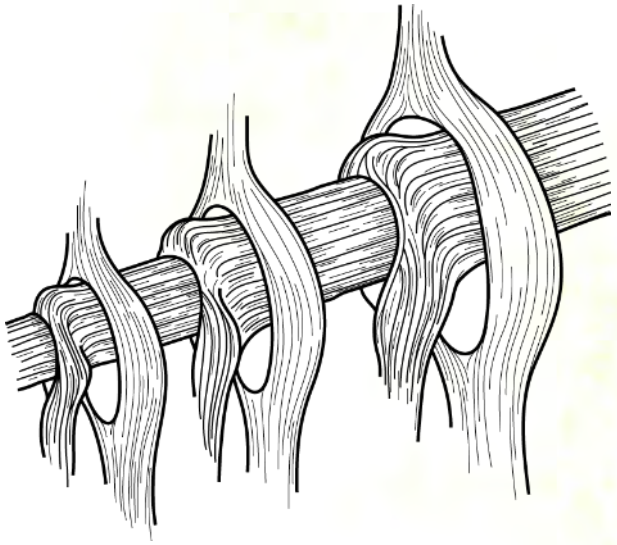
- Slater D and Ennos A R (2015) Interlocking wood grain patterns provide improved wood strength properties in forks of hazel (*Corylus avellana* L.); *Arboricultural Journal* **37**, 21-32

- Slater D and Ennos A R (2015) The level of occlusion of included bark affects the strength of bifurcations in hazel (*Corylus avellana* L.); *Journal of Arboriculture and Urban Forestry* **41** (4), 194-207

A new model for branch attachment

Slater and Harbinson (2010)

Arguments for a new model

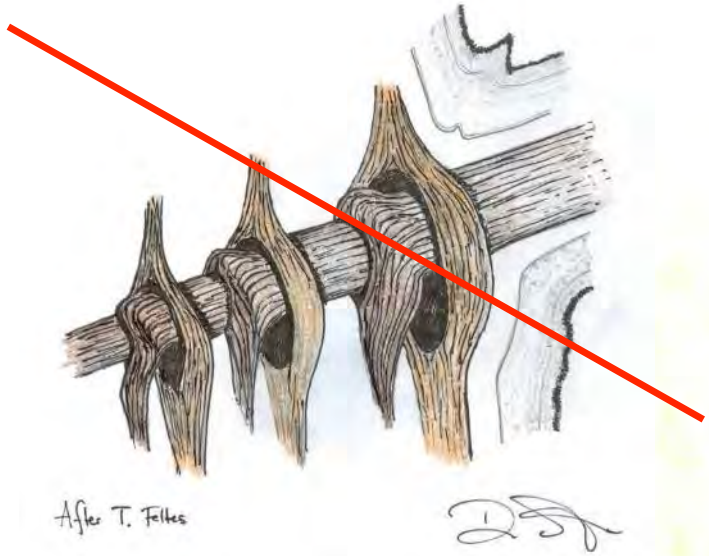


Illogical: does not apply to co-dominant stems or tropical trees

Infeasible: the vascular cambium cannot produce this type of 3D structure

Not evidenced: lacks scientific support

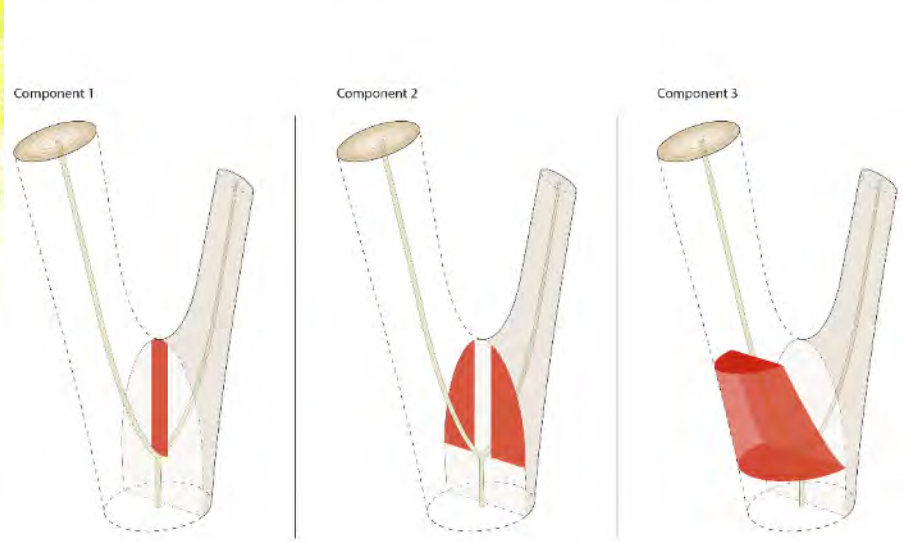
Truths…



All truth passes through three stages:

- **First, it is ridiculed**
- **Second, it is violently opposed**
- **Third, it is accepted as self-evident**

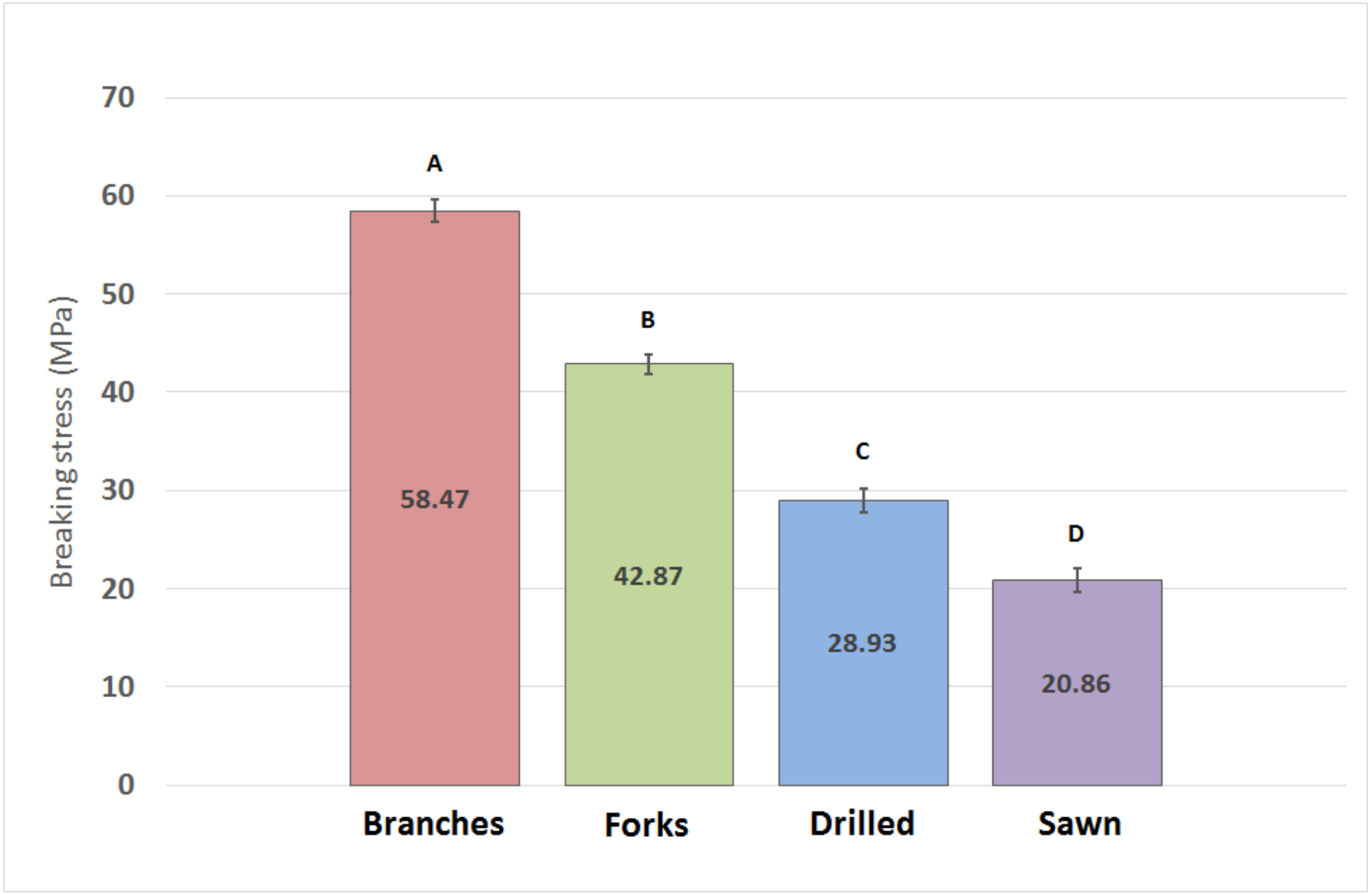
Arthur Schopenhauer



Testing the component parts

Slater and Ennos (2013)

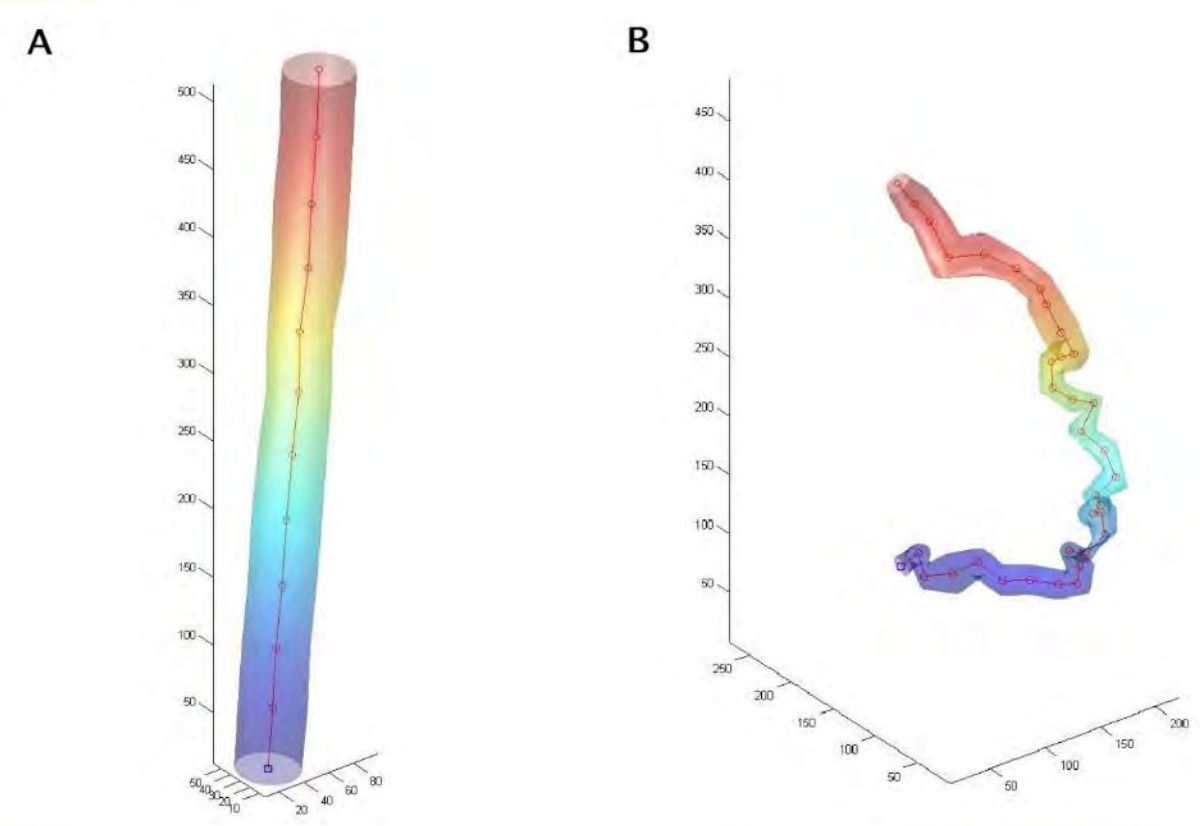
Contributions of Component Parts



Finding that Grain of Truth

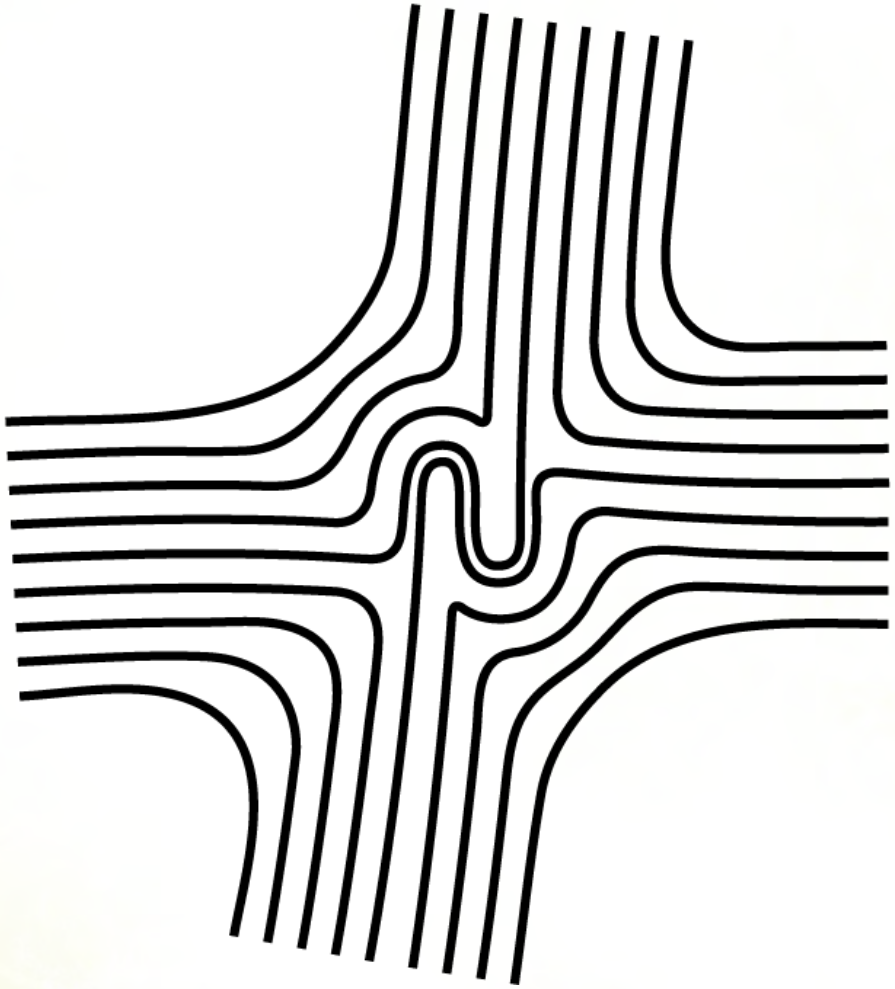
Slater *et al.* (2014)

Following a vessel's route digitally

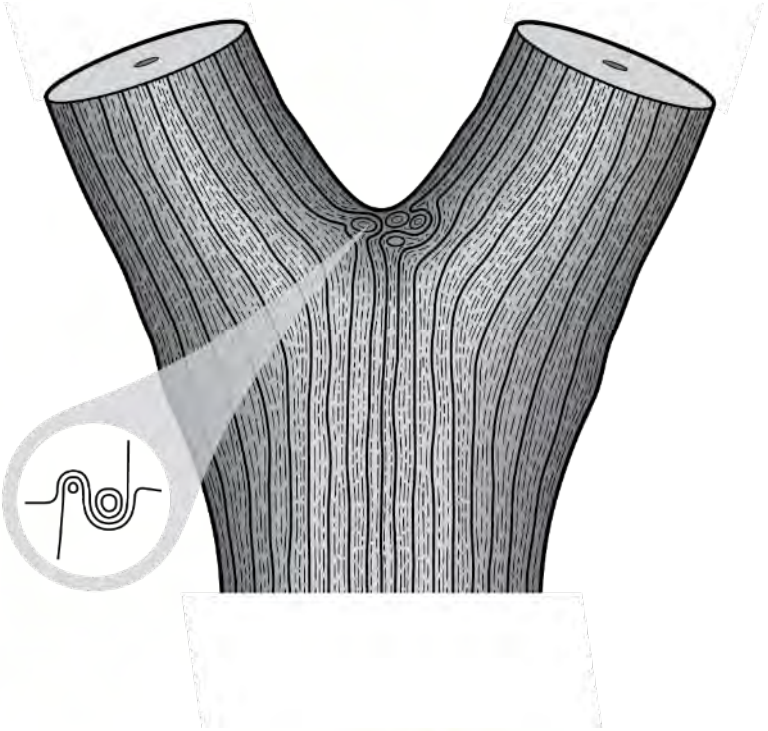


Stemwood **Forkwood**

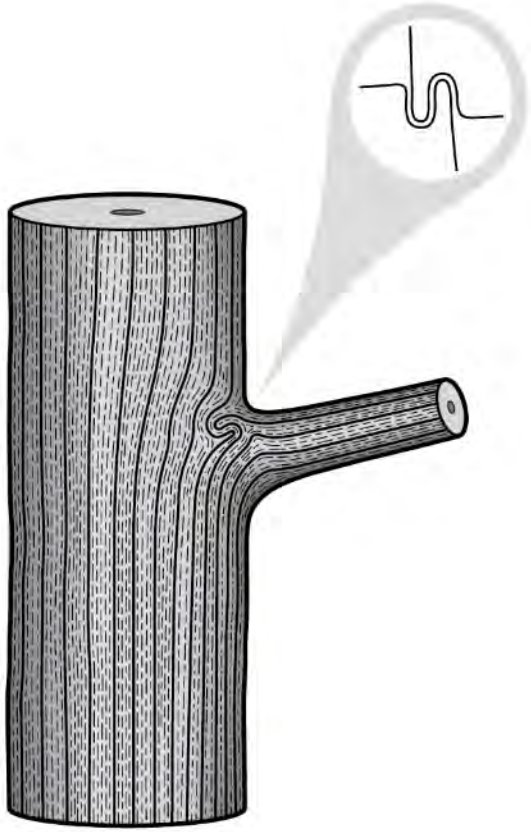
A simple pattern of ‘Interlocking Grain’



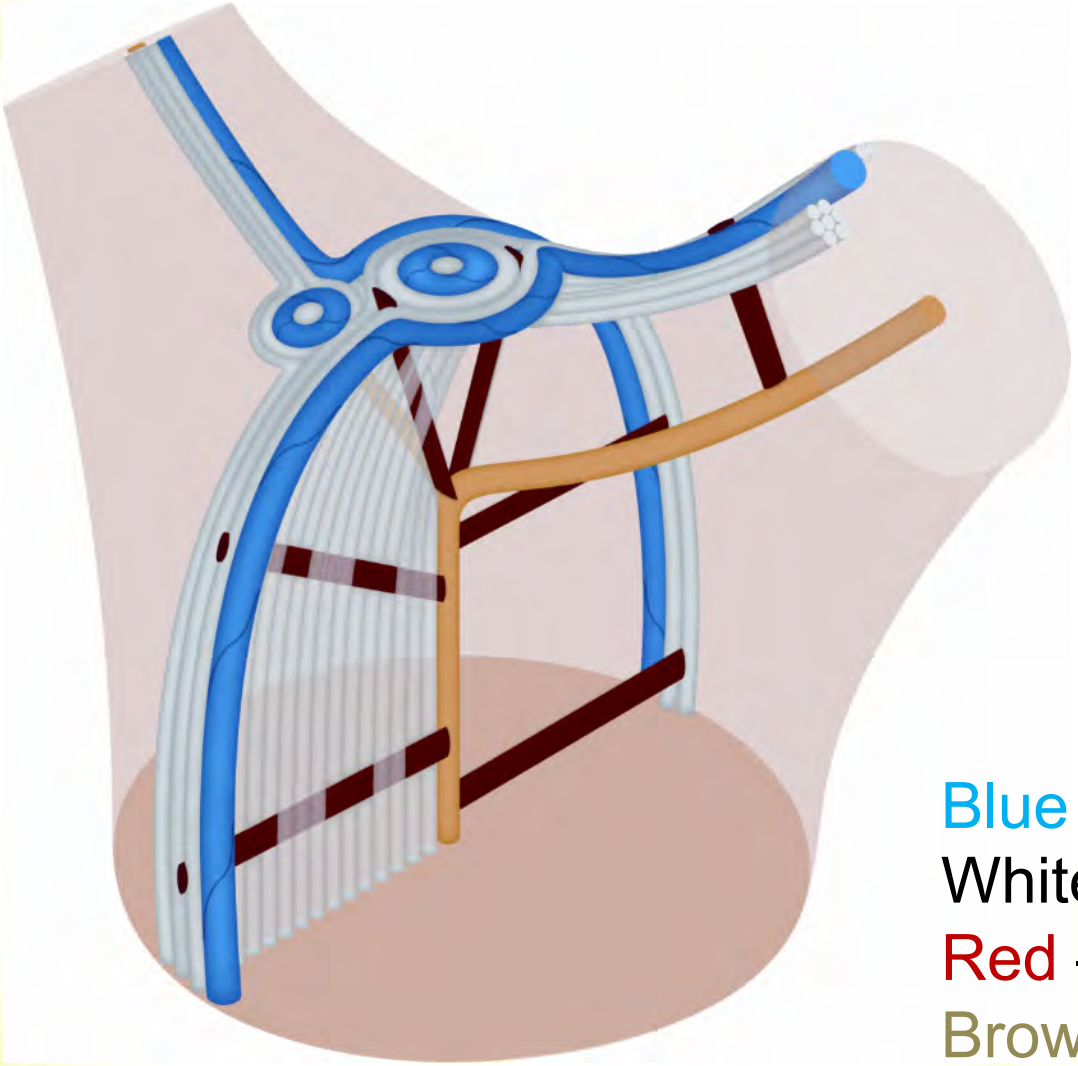
‘Interlocking Grain’ - tree forks



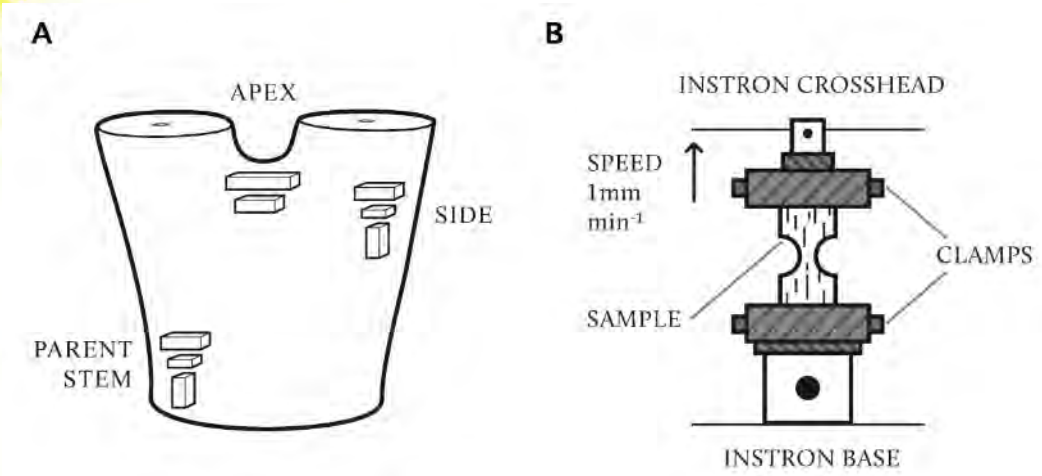
‘Interlocking Grain’ - branch attachments



Anatomy of a junction



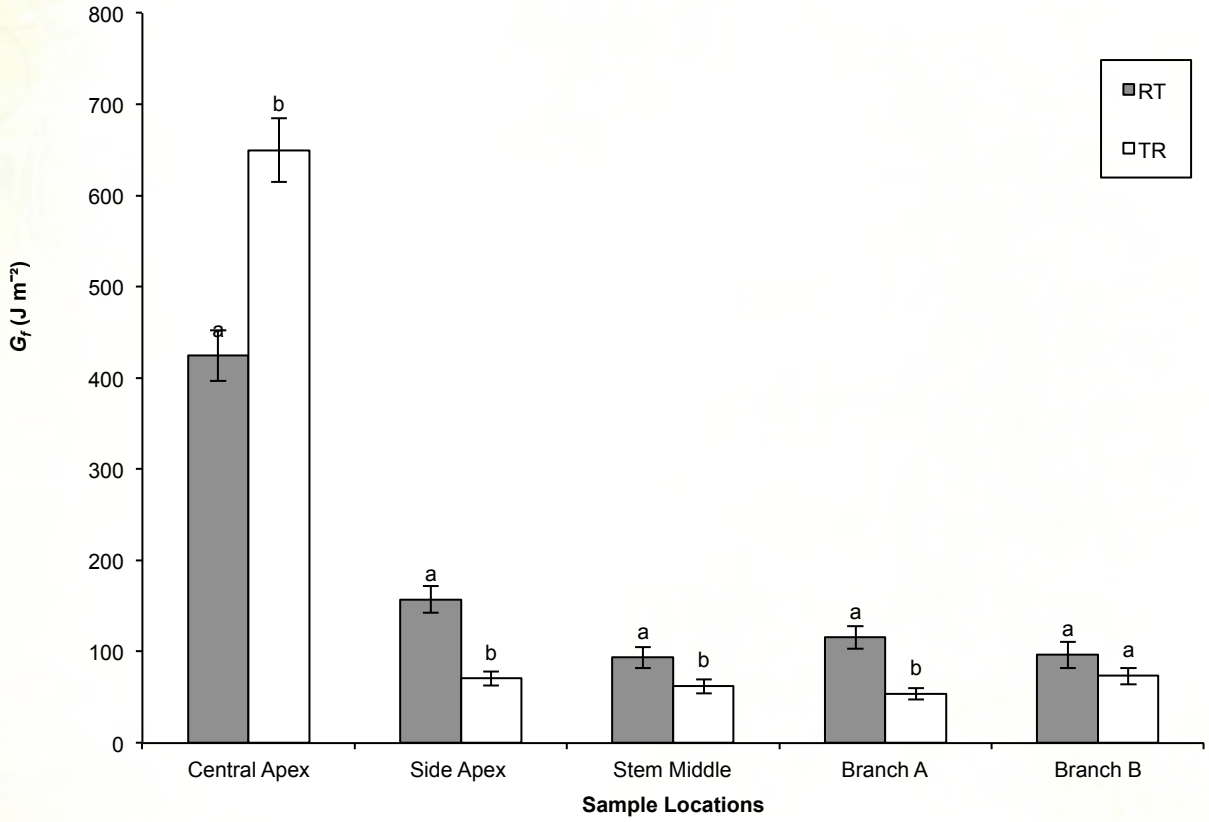
Blue – vessel
White – fibre
Red – ray
Brown - pith



...and the evidence...

Slater and Ennos (2015)

Tougher, denser wood

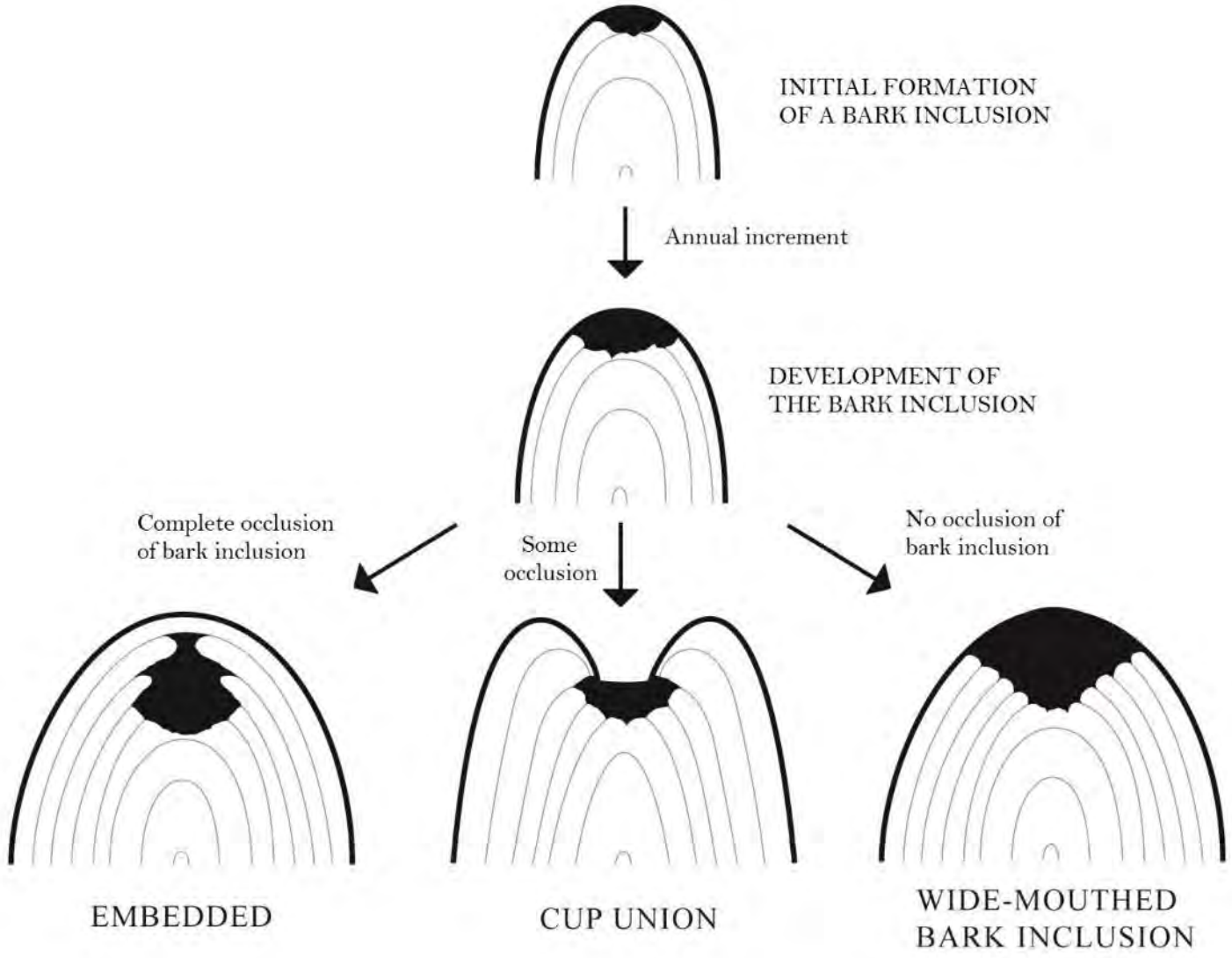


Graph courtesy of Ozden and Ennos, 2015

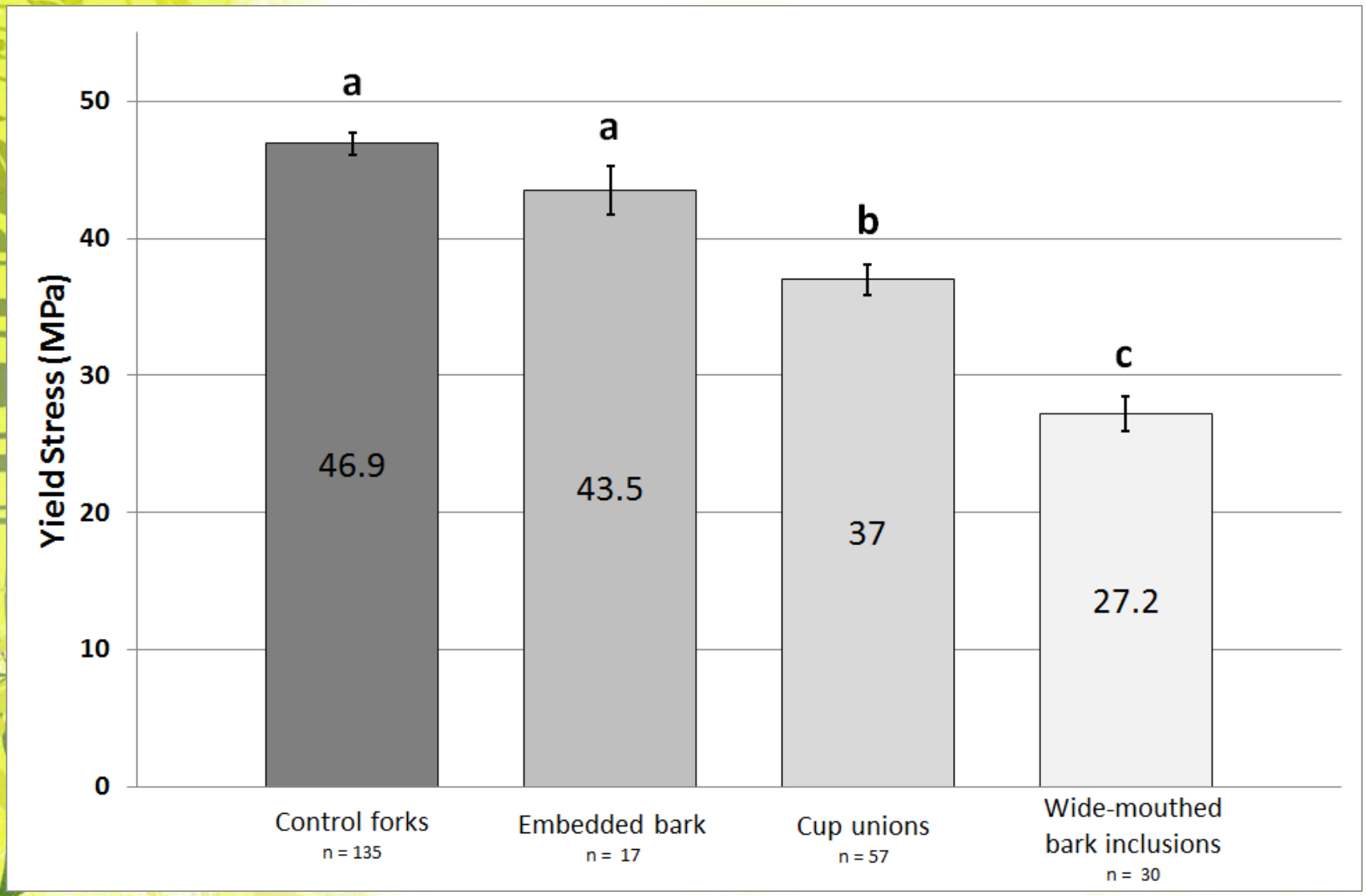
So you've bought your tree and the bark's included

Slater and Ennos (2015)

Types of Bark Inclusion



Differences in Strength



This problem is caused by us!

We can cause bark inclusions to become a problem!

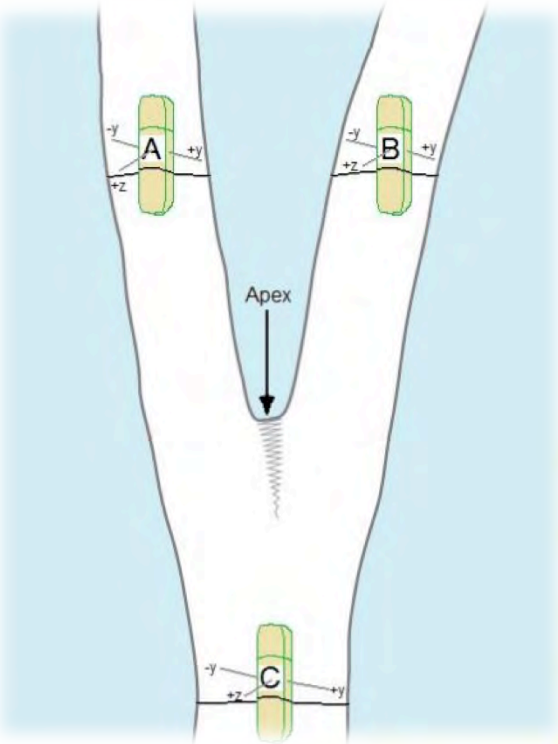
Grow trees close together, grow them as upright cultivars, shelter them when young, don't thin your woodland early, and you will get more inclusions

Then we complain when the junction snaps a few years later, after we thin or move it

Poor old trees! ☹

Surveying a bark-inclusion

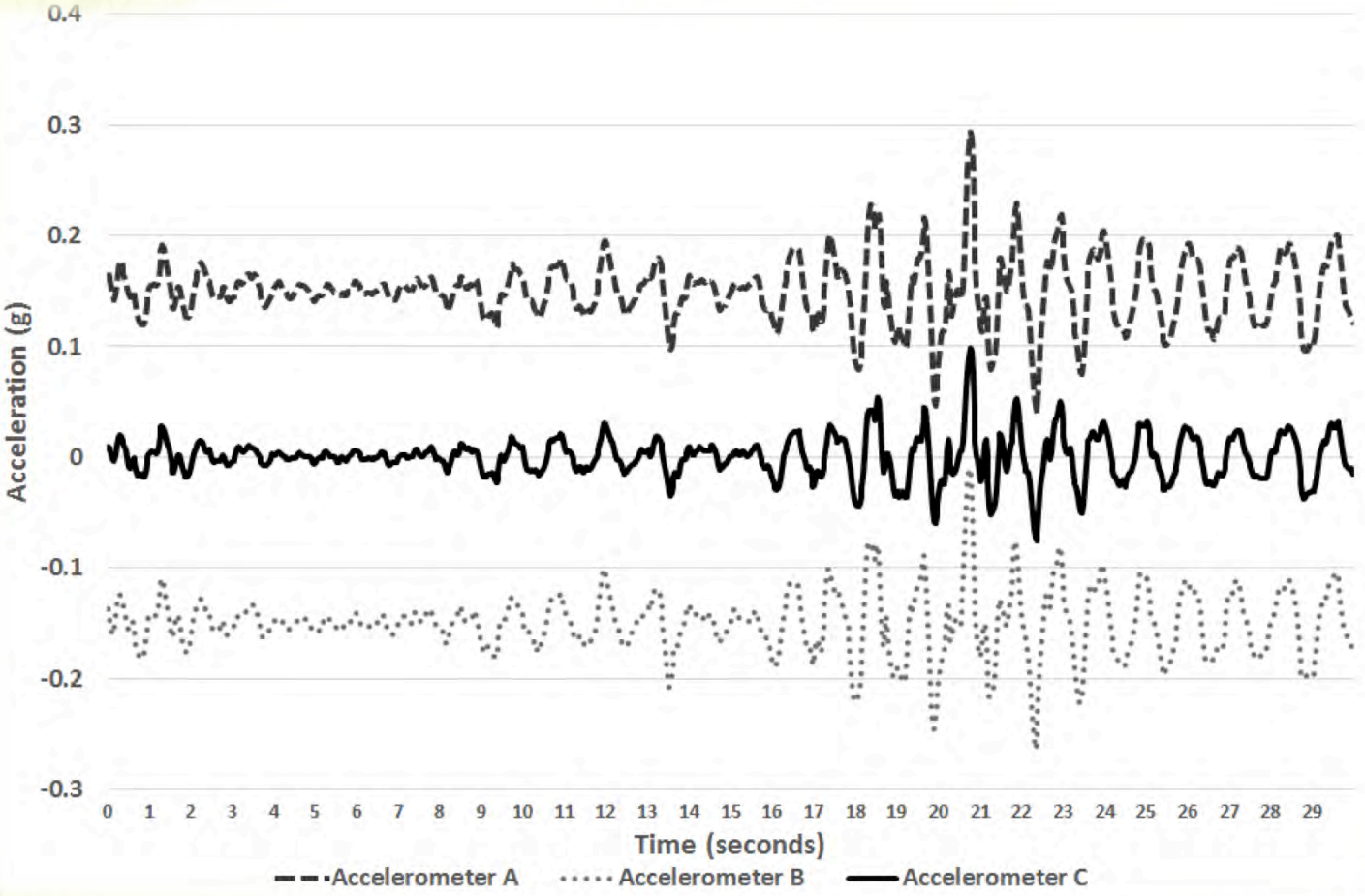
Survey differently…



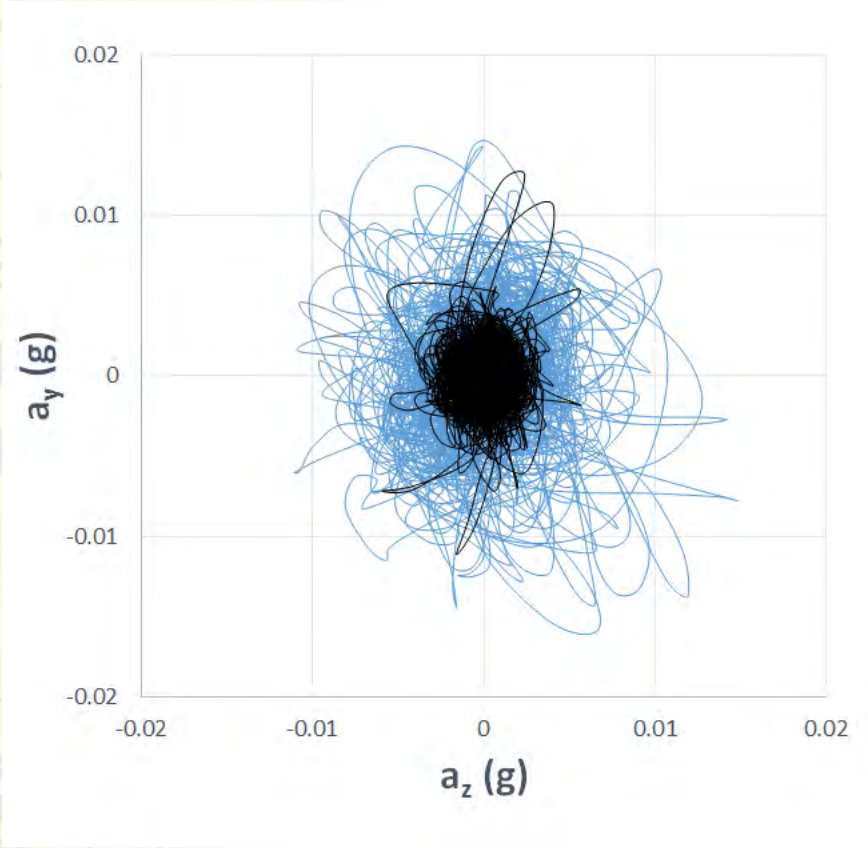
The answer, my friend, is blowing in the wind

Slater and Ennos (Submitted)

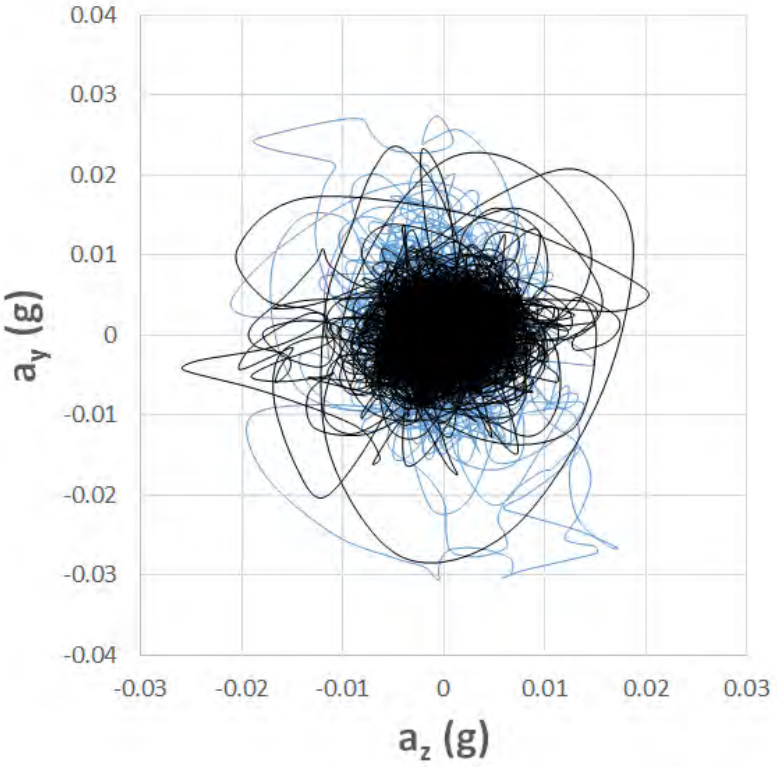
Analysing Wind-induced Movement Behaviour



Differences in Movement Behaviour

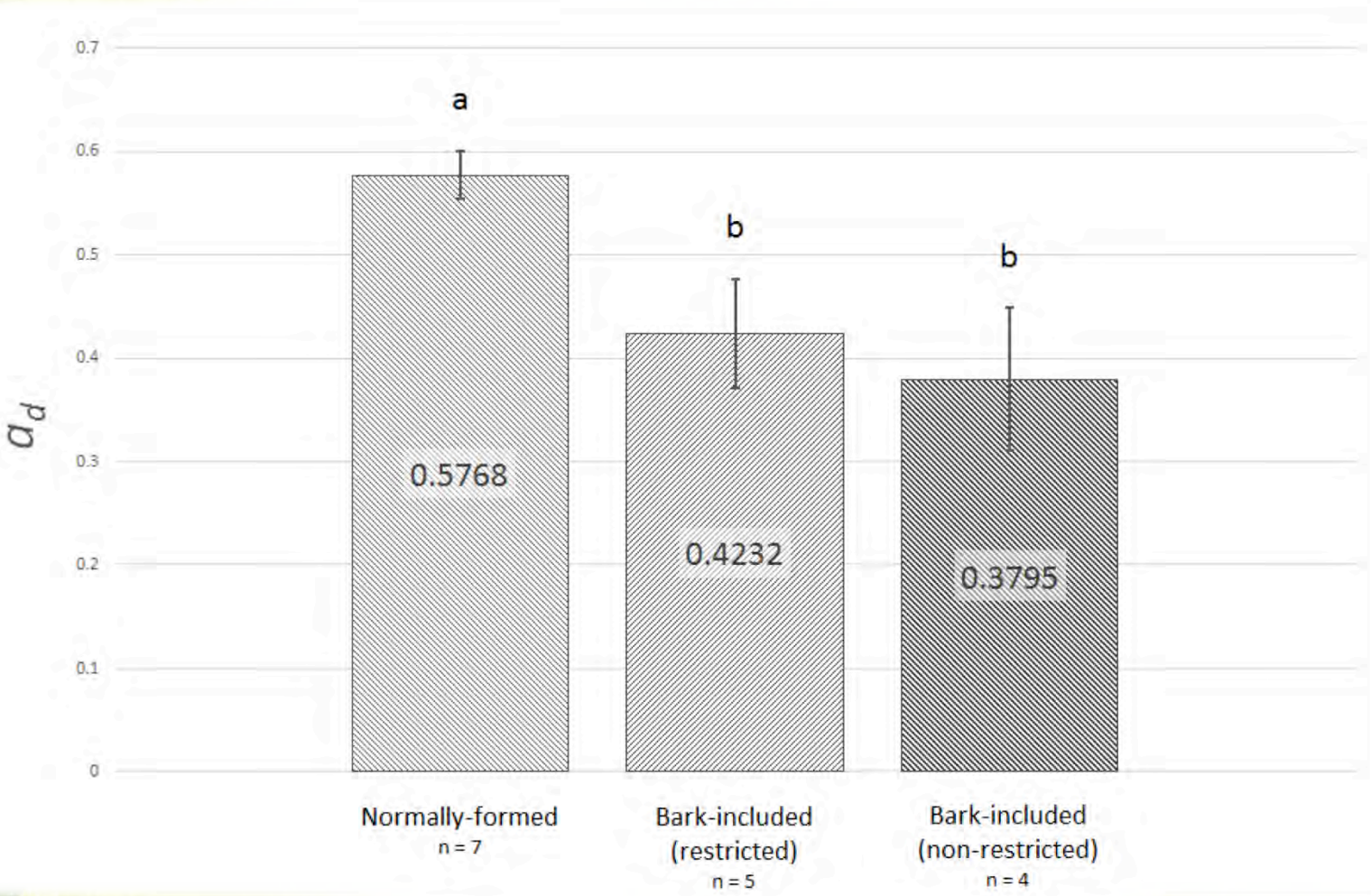


Normally-Formed



Bark-Included

A Shocking Difference!



A Summary of Key Points

I know how tree branches are joined together…

Perhaps, now, you do too! ☺

Tree forks aren't necessarily flaws

All previous studies were not 'deep' enough.

Bark inclusions can be defects

We need to look at our practices, to minimise this problem

Be careful if you do a part-time PhD

It may kill you!!! ;-)

Future Research Work

- Man-made components based on these interlocking wood grain patterns
- Showing that the “axiom of uniform stress” is not applicable to trees
- Novel tree production and establishment techniques
- Investigations into tree autotoxicity
- Plenty of other interests…
- You’ll be hearing from me soon! ;-)

With Thanks…

- *My supervisor, Prof. Roland Ennos*
- *Staff of the University of Manchester*
- *Myerscough College for their sponsorship of this research*
- *BSc. (Hons) students Joe Barnes, Gareth Buckley, Matthew Dumelow, Owen Haines-Myers, Claire Harbinson, Peter Lowes, Laurence Smith, Sam Turner & Ian Williams*

Thank You!