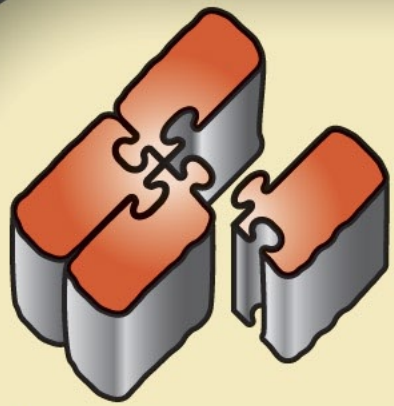


Temap

Helping you solve the Fibre Puzzle

Introduction

- It is hoped that this short presentation will provide some understanding of how the characteristics of different fibres can affect the properties of paper.
- The properties of fibres can be well understood if we consider their physical properties, specifically their length, diameter and wall thickness. We refer to these properties as the *morphological* properties of the fibres.

  The dictionary defines morphology as

  "the science of form"
- These slides only deal with wood based fibres, however the general principles apply to all cellulose fibres and hence to annual fibres too.

FIBRE MORPHOLOGY

What is Fibre Morphology?

- The “science of form”
- Fibre shape (curl, kink)
- Fibre dimensions (length, width, etc.)
- Their impact on pulp properties

Hardwoods or softwoods

- Hardwoods are also often known as deciduous trees
- Softwoods are often known as coniferous trees

- Softwoods are the more primitive plants
  - fibre is used for mechanical support and to conduct food (sap).
  - 90% fibres, 10% parenchyma cells
- Hardwoods are the more evolved plants
  - fibres only provide mechanical support, nutrients are conducted by the vessels.
  - 65% fibres, 25% vessels, 10% parenchyma

HW versus SW

- Hardwoods can be denser, hence the name i.e.
  - HW 0.3 - 0.7 g/cm^2
  - SW 0.3 - 0.5 g/cm^2
- Softwood fibres (tracheids) are long with relatively wide lumens.
  - 2.5 - 4 mm long, 16 - 35 mg/100m coarseness
- Hardwood fibres are short, and thick walled
  - 0.8 -1.5 mm long, 9-15 mg/100m coarseness

What holds a sheet of paper together?

- Cellulose fibers, are the main component of the raw material “pulp”. The individual fibers are present in a network of fibres.

  This can easily be seen by looking at the torn edge of a piece of paper. The more softwood is used, the longer will be the prominent fibres at the torn edge of a sheet.
- Each cellulose fiber is bonded to its neighbouring fibers by thousands of relatively weak hydrogen bonds.

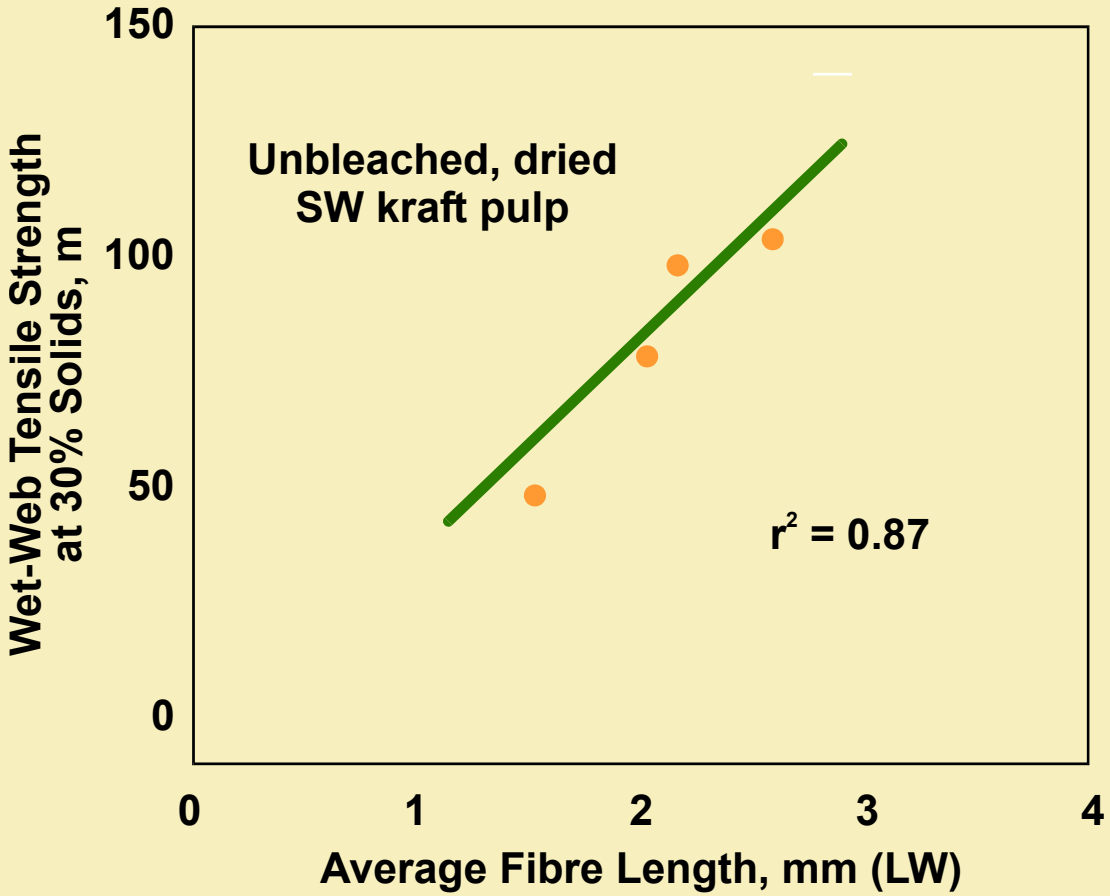
  Mechanical entanglement of the fibers makes only a small contribution to holding fibers together in a sheet.
- Textiles use similar fibres, but rely on entanglement.

Fibre Coarseness

- Fibre length and cross section are two of the key properties of fibres.
- These properties vary between species and even with trees. As a result variation exists.
- Fibre coarseness is a way of rapidly measuring these parameters, and of controlling or explaining them.
- Coarseness is defined as :

  The weight per unit length of fibre
  expressed in milligrams per 100 metres.
  Numerically, coarseness = 11.1 * denier.

Wet-Web Tensile Strength vs Fibre Length



Source: Seth Tappi, 1995

Fibre Coarseness

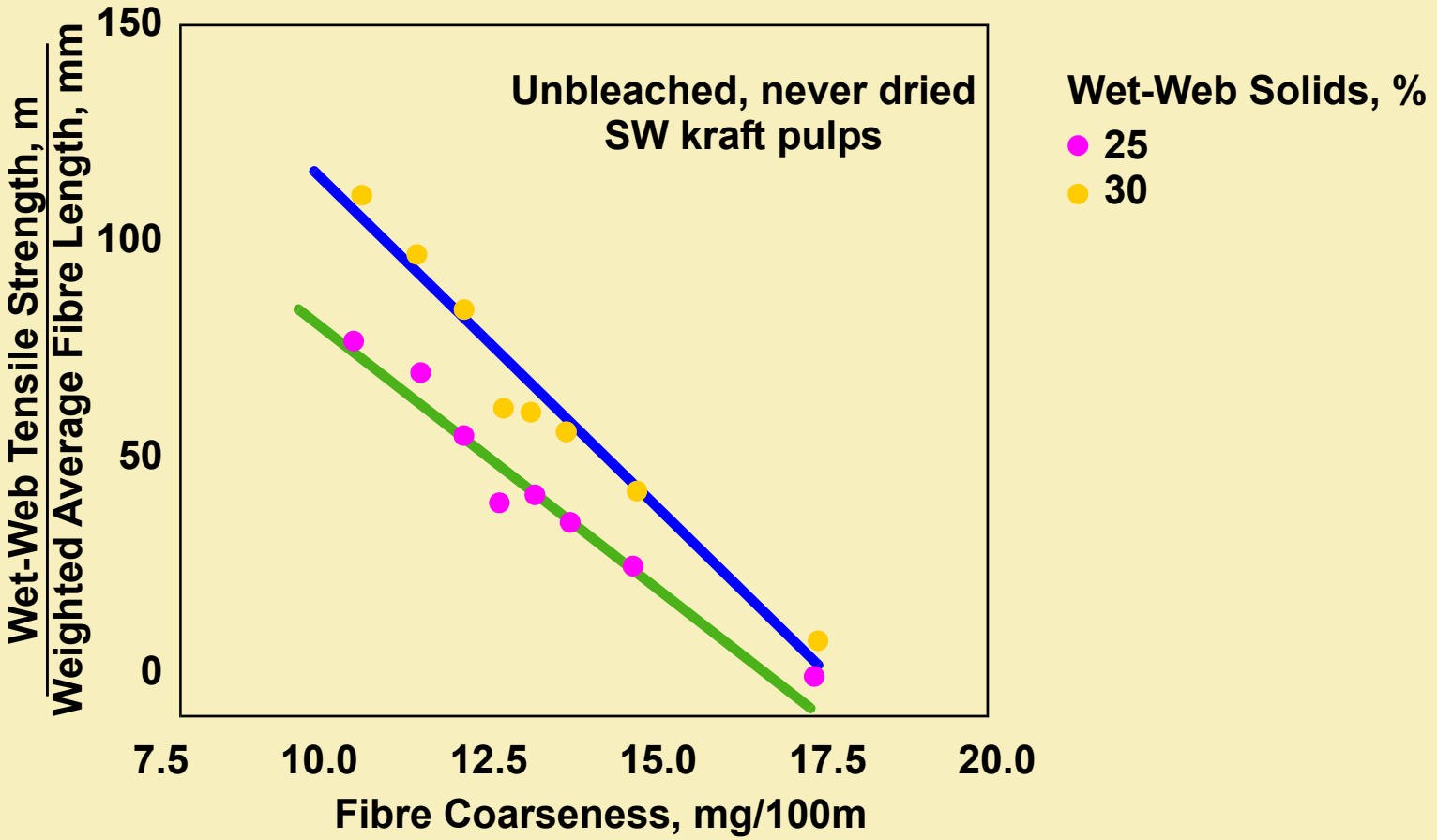
- Simple
- Useful
- Describes the weight of a constant length of fibre

100 metres!

- Low numbers mean fine fibres

  High numbers mean coarse fibres
- Fibre wall thickness and diameter make the difference
- Fibre length has no role

Wet-Web Tensile Strength vs Coarseness



Source: Seth Tappi, 1995

Fibre Coarseness

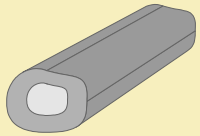
Lower coarseness = More fibres/gram of pulp
= Greater bonding area
= Higher tensile strength

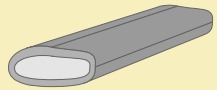
Fibre Coarseness of typical BC species

Species	Coarseness (mg/100m)	Wall Thickness (μm)	Fibres/gram ($x10^6$)
Douglas-fir	24	4.0	1.8
Hemlock	20	2.7	2.8
Spruce/pine	18	2.2	3.6
Cedar	16	1.6	4.2

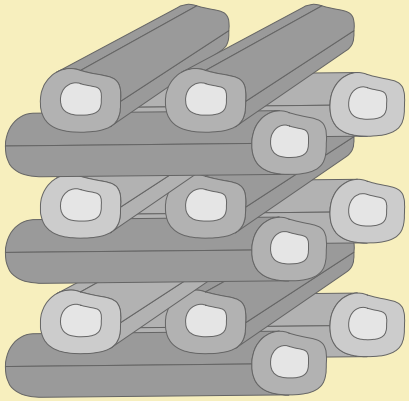
Fibre Coarseness

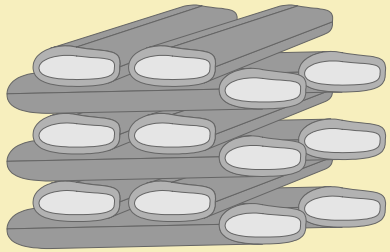
Coarse Fibres | **Fine Fibres**





High Tear
High Bulk
High Porosity
Rough





High Tensile
Low Bulk
Low Porosity
Smooth

Significance of Fibre Coarseness

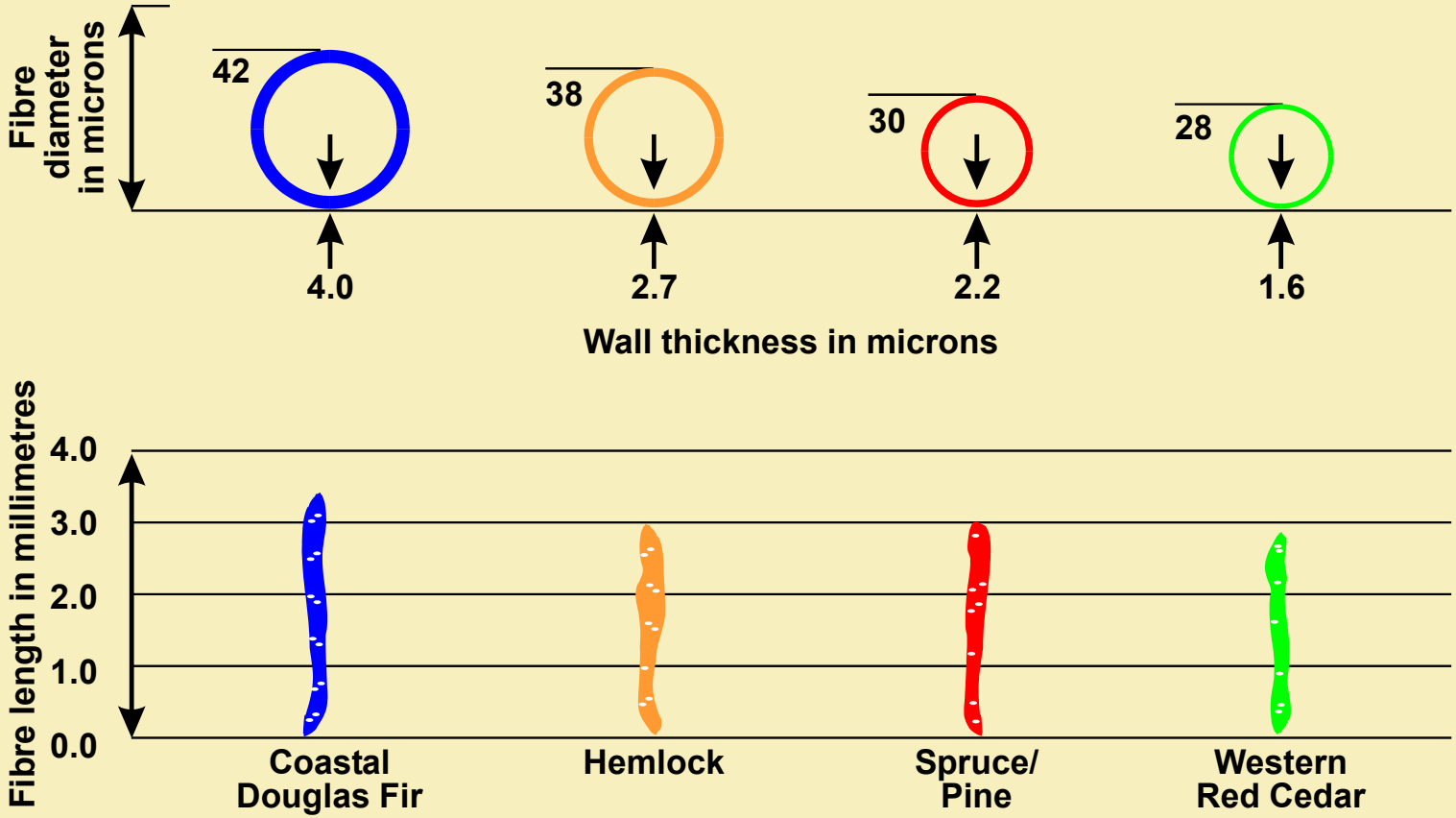
Low Coarseness

- High wet web strength
- High breaking length
- High sheet opacity (at given density)
- Good sheet formation
- Smooth sheet

High Coarseness

- Good drainage
- High tear
- High porosity
- High sheet bulk

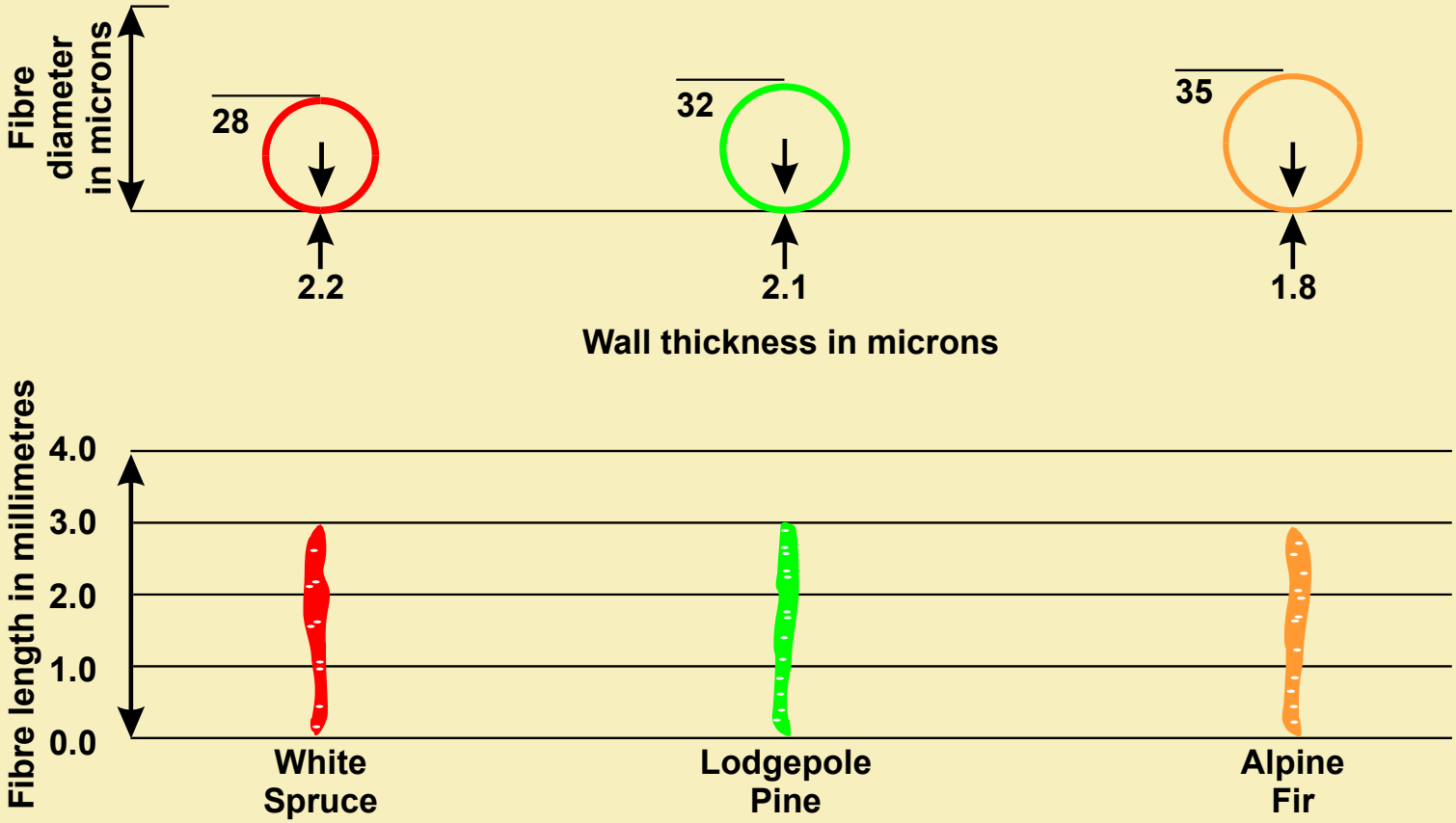
Typical Fibre Dimensions



"Weight weighted lengths measured by Kajaani FS200"

CANFOR

Typical Fibre Dimensions



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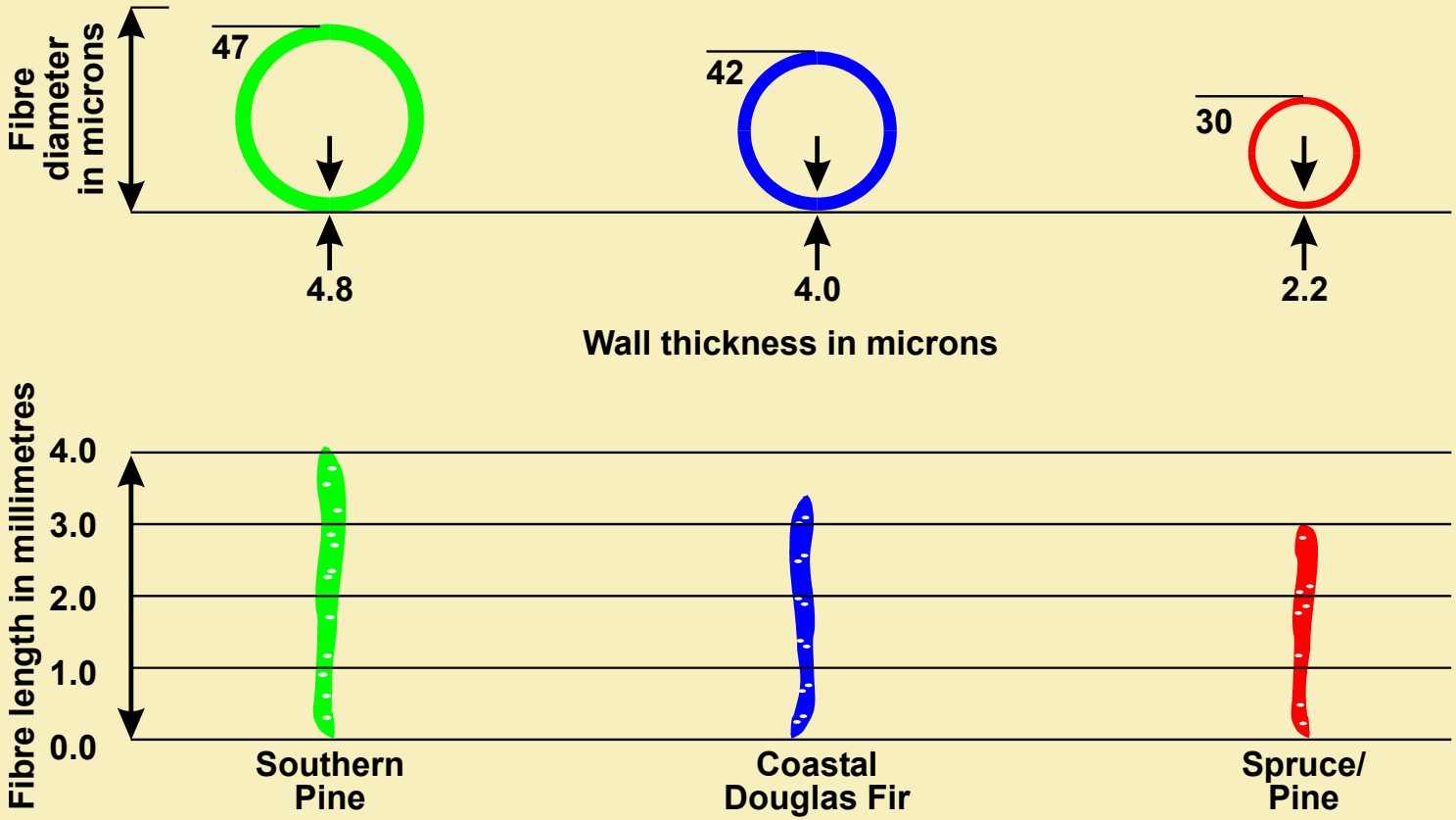
Typical Fibre Dimensions



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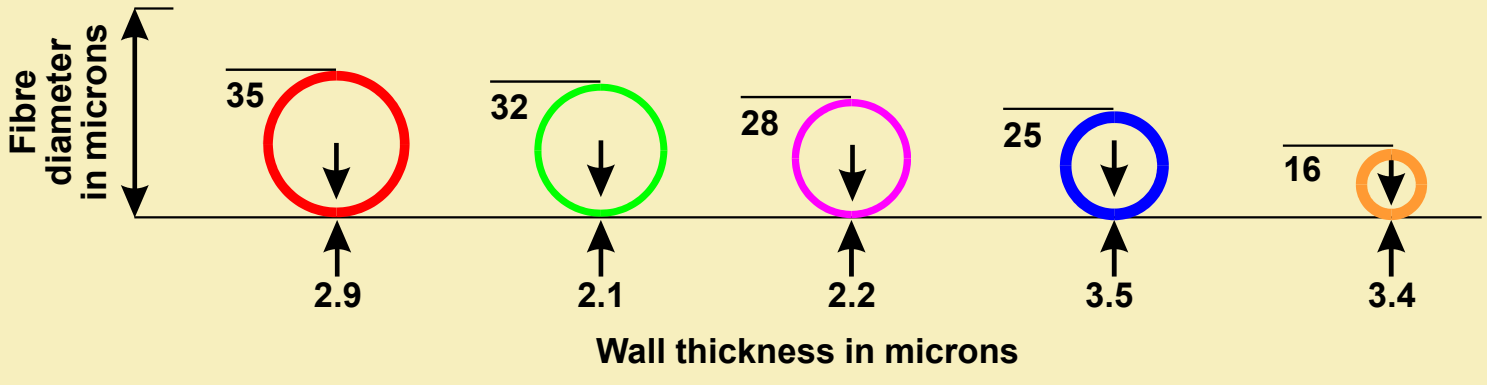
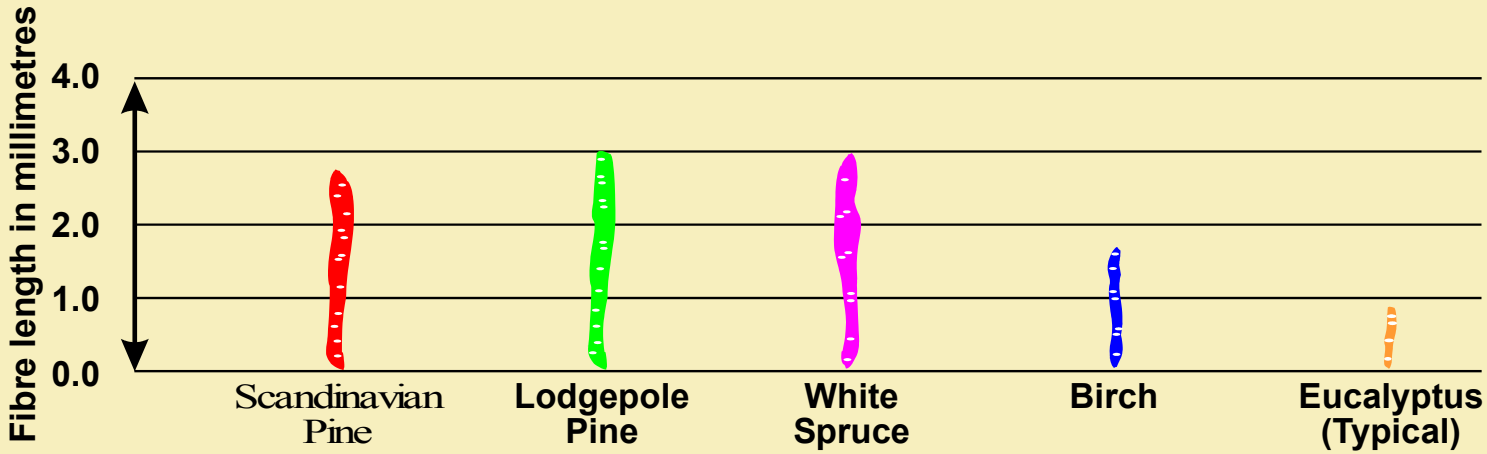
Typical Fibre Dimensions





"Weight weighted lengths measured by Kajaani FS200"

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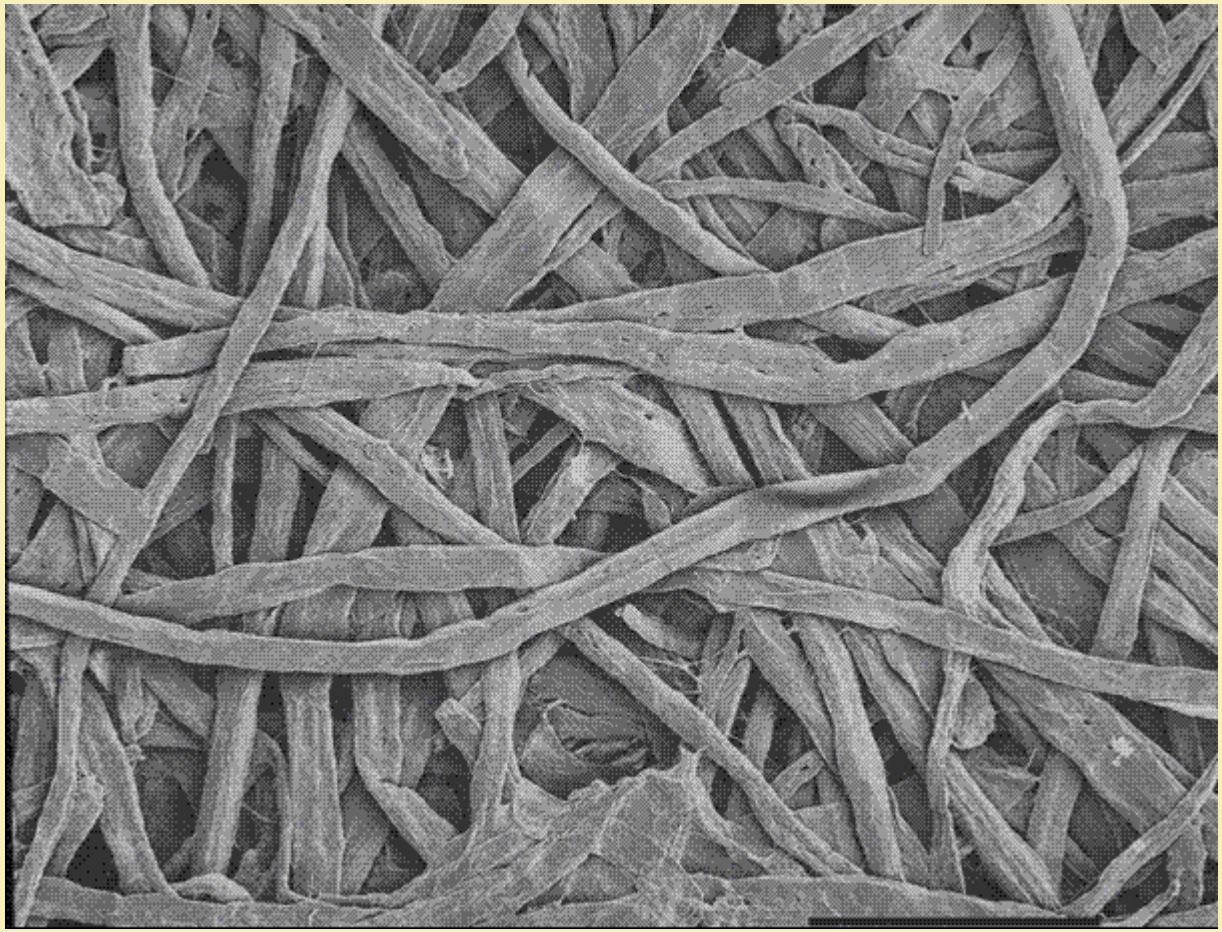
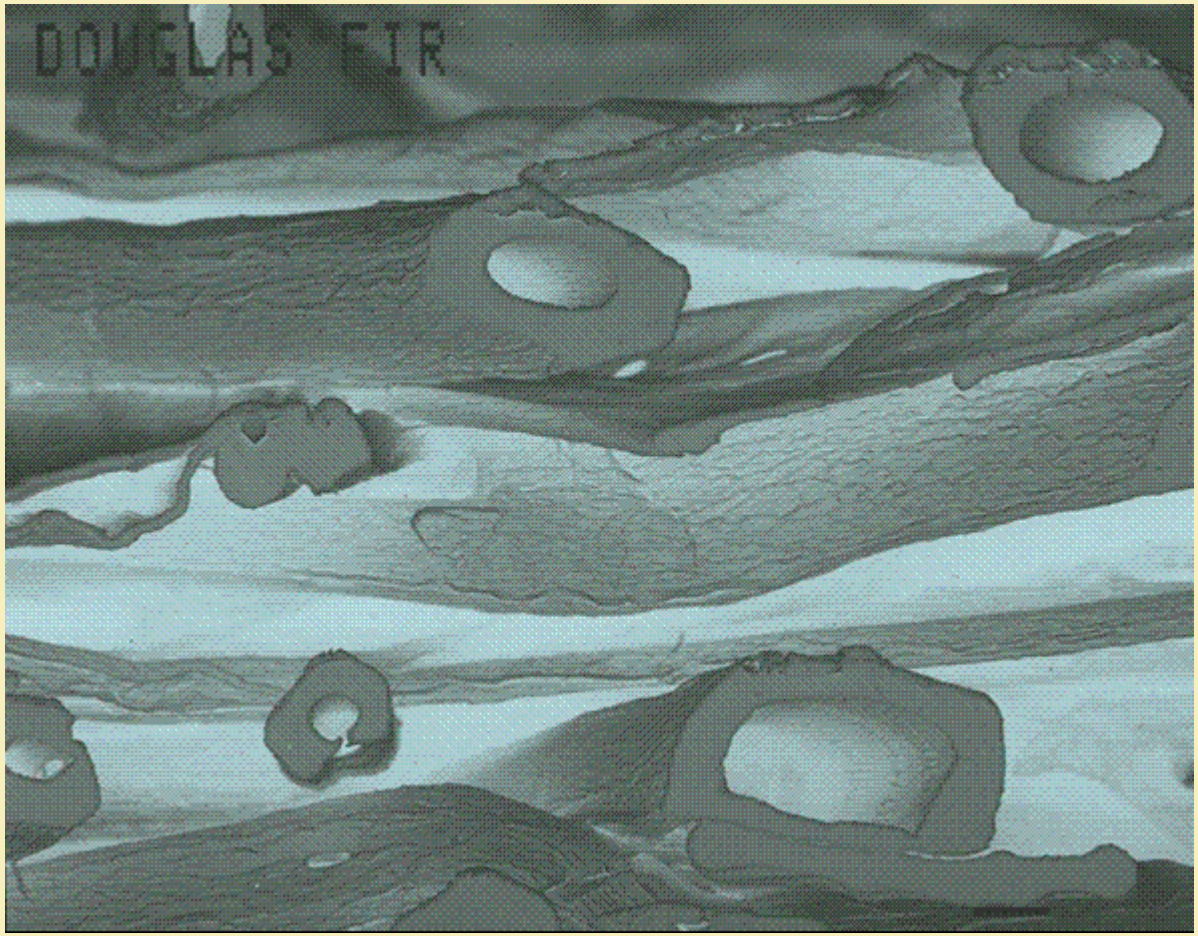
Douglas-fir Handsheet



Microphoto courtesy of Pulp and Paper Research Institute of Canada

Douglas-fir Handsheet

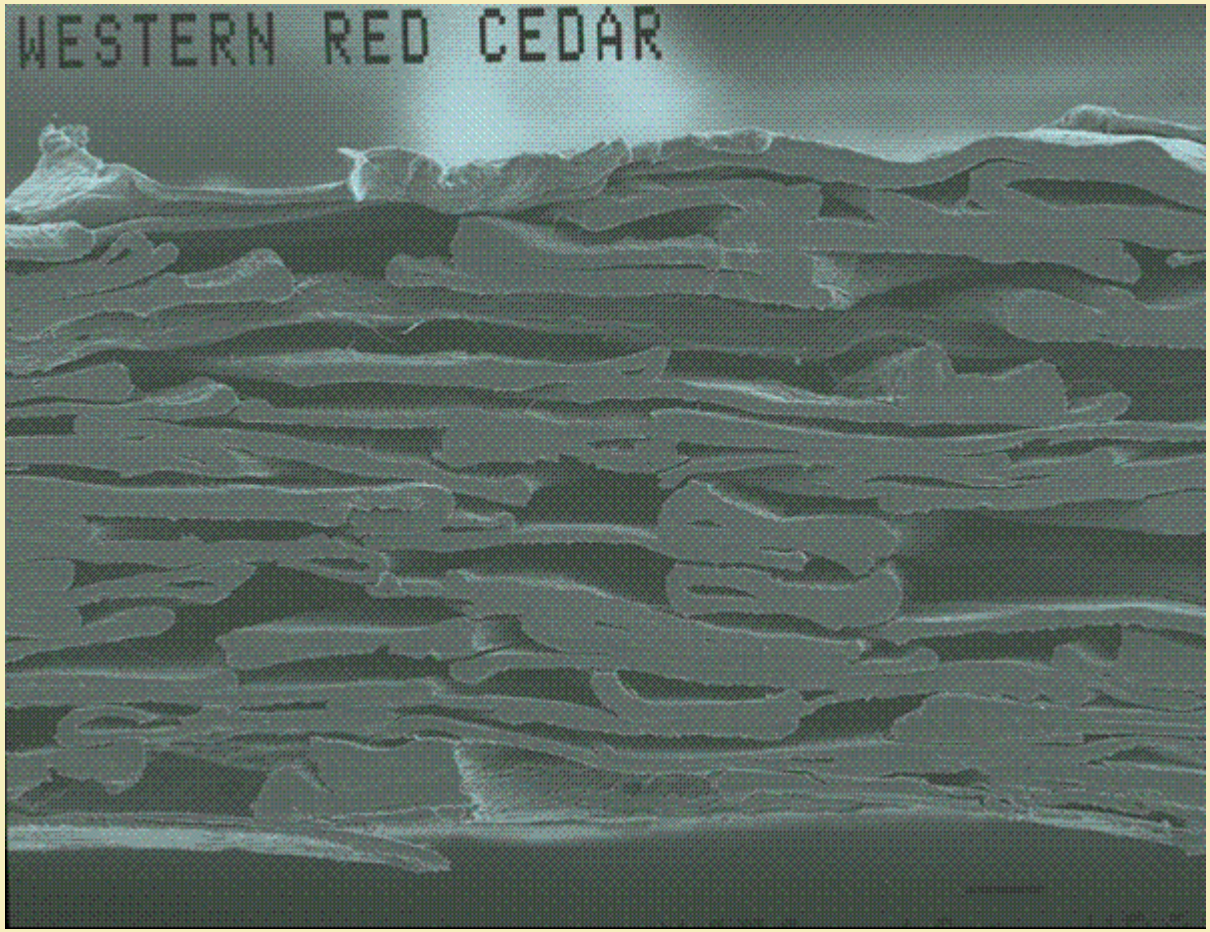


Microphoto courtesy of Pulp and Paper Research Institute of Canada

Cedar Handsheet

Microphoto courtesy of Pulp and Paper Research Institute of Canada

Cedar Handsheet



Microphoto courtesy of Pulp and Paper Research Institute of Canada

But fibres are really not that simple,
they are much more complex in reality!

Sketch of a Typical Tracheid