Intertek

Amersham Paper Technology Group

Fibre Testing for Paper & Board Products

Rob Langley
19th March 2014
Pulp and Paper Workshop

Comparison of Fibre Costs

Fibre Type	Relative Price Price	Actual £/t
Abaca	4.80	1680
Flax / Hemp	4.00	1400
Sisal	3.45	1208
Flax	3.30	1155
Cotton	2.50	875
Esparto	1.4	490
Straw	1.35	475
Wood pulp	1.00	350
Bamboo	0.96	340

Geographical Sources of Wood

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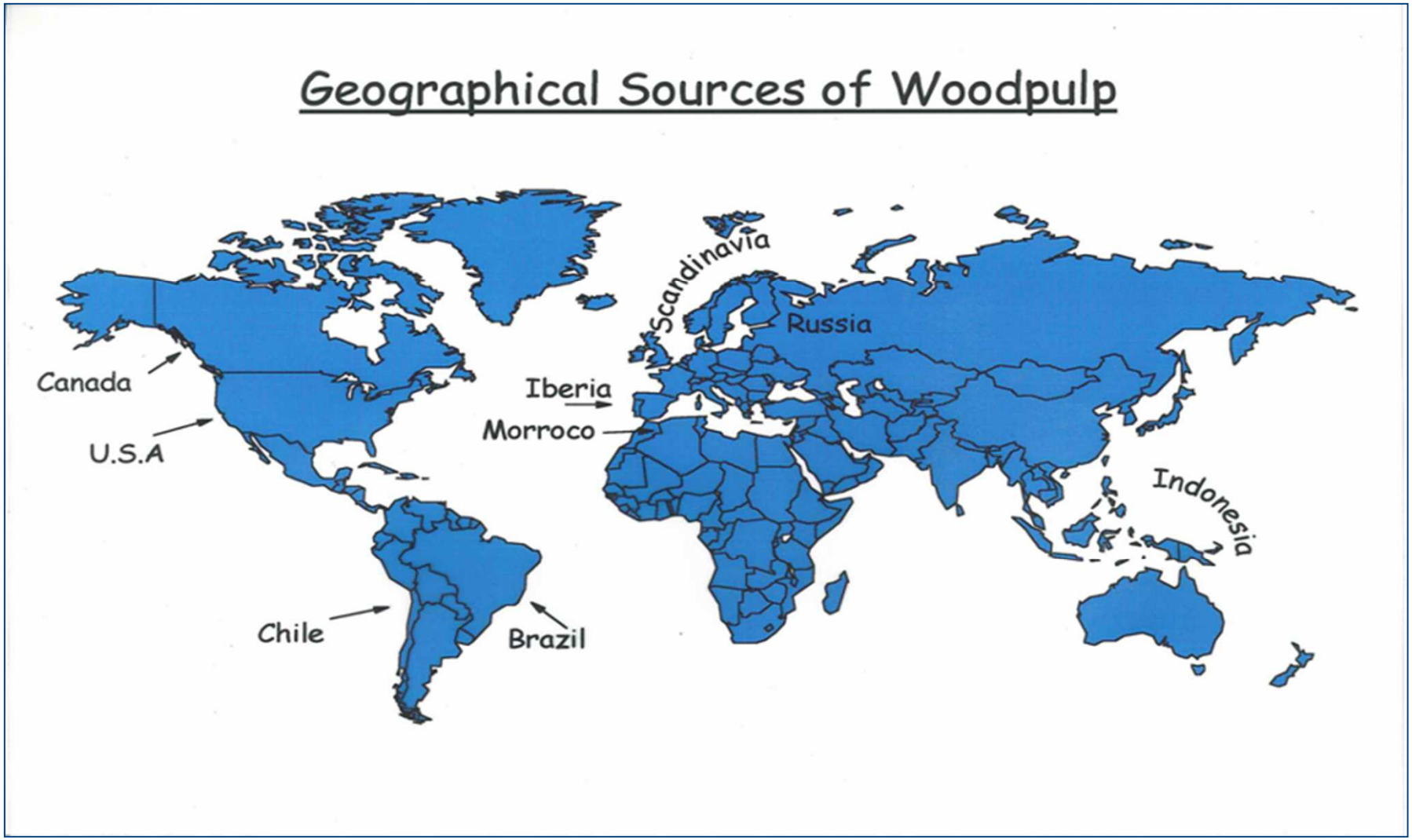

Pulp Industry Cost Curves

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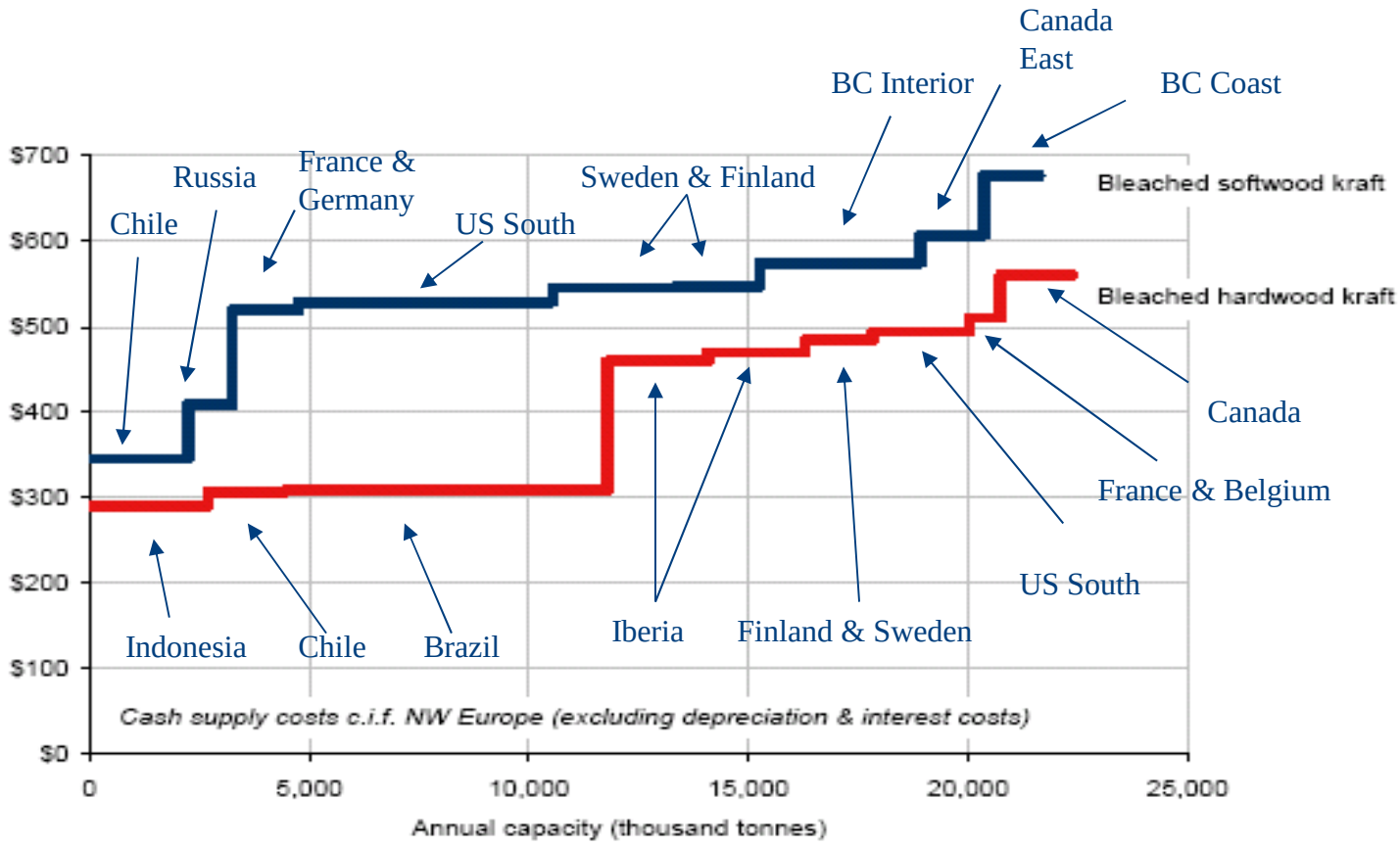

Source: Hawkins Wright

Pulping processes

Mechanical pulp – Low quality papers – Contains Lignin

Type	Applications
Groundwood	Newsprint
Thermo-Mechanical Pulp (TMP)	Boxboard, Mail shots
Chemi-Thermo-Mechanical pulp (CTMP)	Nappies, magazines

Chemical Pulping – High Quality Papers – Lignin removed

Type	Applications
Sulphate (Kraft) Alkaline:	
Chlorine, Elemental Chlorine Free (ECF)	Business Papers
Total Chlorine Free (TCF)	Coating base
Total Effluent Free (TEF)	

Identification of fibres

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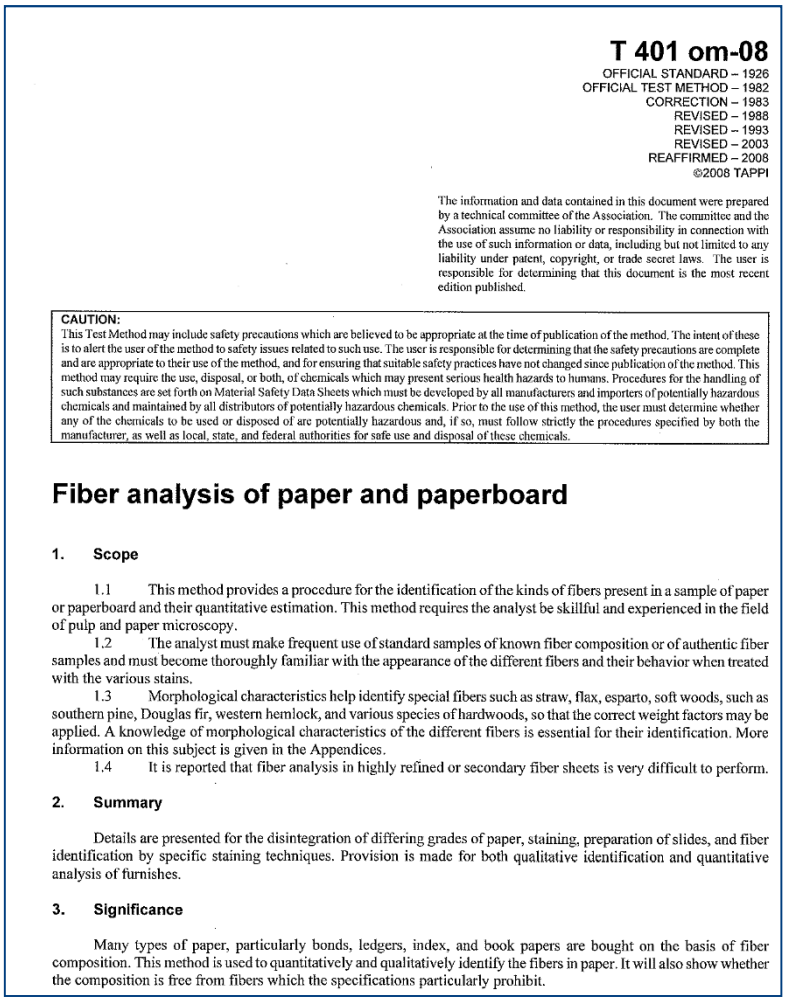
Tappi Method T401 om-8

- Requires frequent use of standard samples of known composition
- Familiarity with reaction of fibres to different stains
- Special Fibres identified by morphological characteristics e.g. Straw, Flax, Esparto
- Fibre analysis in highly refined or secondary fibre sheets is very difficult to perform.
- It takes time and experience to build up fibre identification expertise



T 401 om-08

OFFICIAL STANDARD – 1926
OFFICIAL TEST METHOD – 1982
CORRECTION – 1983
REVISED – 1988
REVISED – 1993
REVISED – 2003
REAFFIRMED – 2008

CAUTION:
This Test Method may include safety precautions which are believed to be appropriate at the time of publication of the method. The intent of these is to alert the user of the method to safety issues related to such use. The user is responsible for determining that the safety precautions are complete and are appropriate to their use of the method, and for ensuring that suitable safety practices have not changed since publication of the method. This method may require the use, disposal, or both, of chemicals which may present serious health hazards to humans. Procedures for the handling of such substances are set forth on Material Safety Data Sheets which must be developed by all manufacturers and importers of potentially hazardous chemicals and maintained by all distributors of potentially hazardous chemicals. Prior to the use of this method, the user must determine whether any of the chemicals to be used or disposed of are potentially hazardous and, if so, must follow strictly the procedures specified by both the manufacturer, as well as local, state, and federal authorities for safe use and disposal of these chemicals.

Fiber analysis of paper and paperboard

1. Scope

1.1 This method provides a procedure for the identification of the kinds of fibers present in a sample of paper or paperboard and their quantitative estimation. This method requires the analyst be skillful and experienced in the field of pulp and paper microscopy.
1.2 The analyst must make frequent use of standard samples of known fiber composition or of authentic fiber samples and must become thoroughly familiar with the appearance of the different fibers and their behavior when treated with the various stains.
1.3 Morphological characteristics help identify special fibers such as straw, flax, esparto, soft woods, such as southern pine, Douglas fir, western hemlock, and various species of hardwoods, so that the correct weight factors may be applied. A knowledge of morphological characteristics of the different fibers is essential for their identification. More information on this subject is given in the Appendices.
1.4 It is reported that fiber analysis in highly refined or secondary fiber sheets is very difficult to perform.

2. Summary

Details are presented for the disintegration of differing grades of paper, staining, preparation of slides, and fiber identification by specific staining techniques. Provision is made for both qualitative identification and quantitative analysis of furnishes.

3. Significance

Many types of paper, particularly bonds, ledgers, index, and book papers are bought on the basis of fiber composition. This method is used to quantitatively and qualitatively identify the fibers in paper. It will also show whether the composition is free from fibers which the specifications particularly prohibit.

Analysis procedure

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- **Objective is to separate the fibres without damage and chemical sensitisation to stain**

  - Coatings to be removed before dispersion
  - Ease of method is paper grade dependant
  - Disintegrate paper to provide separate fibres
  - Separating papers can be time consuming
  - Some wet strength grades of paper will require chemically aided dispersion

Fibre identification by staining

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Stain	Fibre	Digestion	Bleaching	Stain Colour
Graff C	Softwood	Sulfite	Unbleached	Vivid yellow
			Bleached	Light purplish grey
Aluminium chloride		Sulphate	Unbleached	Weak greenish yellow
Calcium chloride			Bleached	Dark bluish grey
zinc chloride				
Iodine chloride	Hardwood	Sulphite	Unbleached	Pale yellow green
			Bleached	Weak purplish blue
	Cotton			Reddish orange
	Abaca		Unbleached	Light greenish yellow
			Bleached	Purplish grey
Hertzberg	Softwood		Unbleached	Light olive grey
			Bleached	Dark purplish grey
Zinc chloride				
Iodine	Hardwood		Unbleached	Weak olive - blue green
Potassium iodide			Bleached	Deep reddish purple
Selleger's Stain				
Wilson's stain				

> 15 stains

Does not differentiate between fibre species

Microscopic analysis method

- Identify fibres by chemically staining
  (Requires Analytical Laboratory for stain manufacture)
- Identify fibres by sight – Manual method – Not Automatic
- Using reference samples, books, literature, make comparisons against ‘’Known’’ fibre sources – Fibrary
- Furnish count
- Quantify fibres using ‘’Weight Factors’’ (wall thickness)
- Process identifies individual fibres thus cleanliness priority need to recognise ‘’rogue’’ fibres reporting <2% as ‘’Traces’’
- Accuracy +/- 3%
- Experience

Stage 1
Furnish Ratio Analysis

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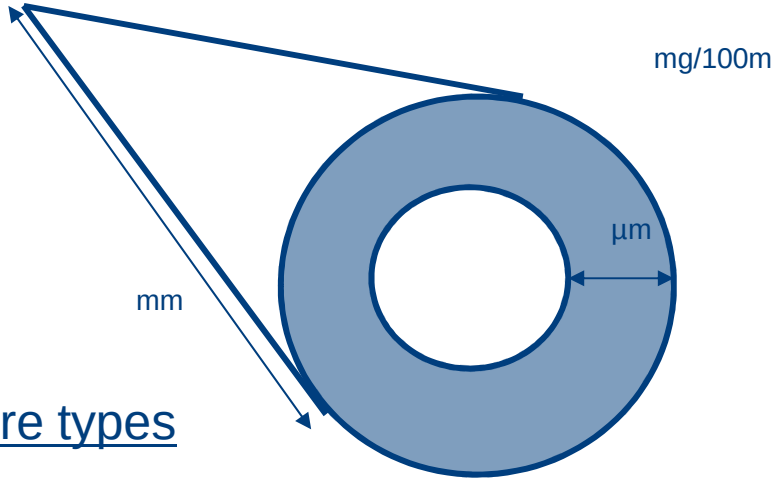
FURNISH ANALYSIS

Fibres manually counted on each slide

Aim 200 / 300 fibres / slide
Stain fibres (Graff C / Hertzberg)

Softwood / Hardwood
Mechanical / Chemical
Bleached / Unbleached



Furnish content for **known Softwood** fibre types

No. fibres (Raw Count) X Fibre Weight factors

Weight factor related to fibre coarseness
Measure of fibre wall thickness / fibre length

Weight Factor	
Western Hemlock	1.0
Douglas Fir	1.4
Loblolly Pine	1.45
Eastern Hemlock	0.9
……etc	

Cannot apply weight factors for Hardwood
Due to inability to identify species from fibres

Furnish species analysis

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Sample	Fibre type	Tappi				Bleaching	Pulping process	Genus of species - (Number of hardwood vessels in brackets)			
		Raw count	Weight factor	Final count	% by weight						
S000/14	HWD	254	0.5	127	**79**	Bleached	Sulphate	Acacia (14)	Eucalyptus (11)	Populus (3)	Acer (2)
Sample	SWD	14	0.9	13	**8**	Bleached	Sulphate	Pinus	Pseudotsuga		
	HWD CTMP	12	0.9	11	**7**			Populus			
	SWD CTMP	8	1.3	10	**6**			Picea			
	Annual fibres							Trace cotton			

Stage 2
Wood Species Analysis

Hardwood

Vessel Architecture

Scaliform vessel ends

Ray Pits

Spiral / Thickening

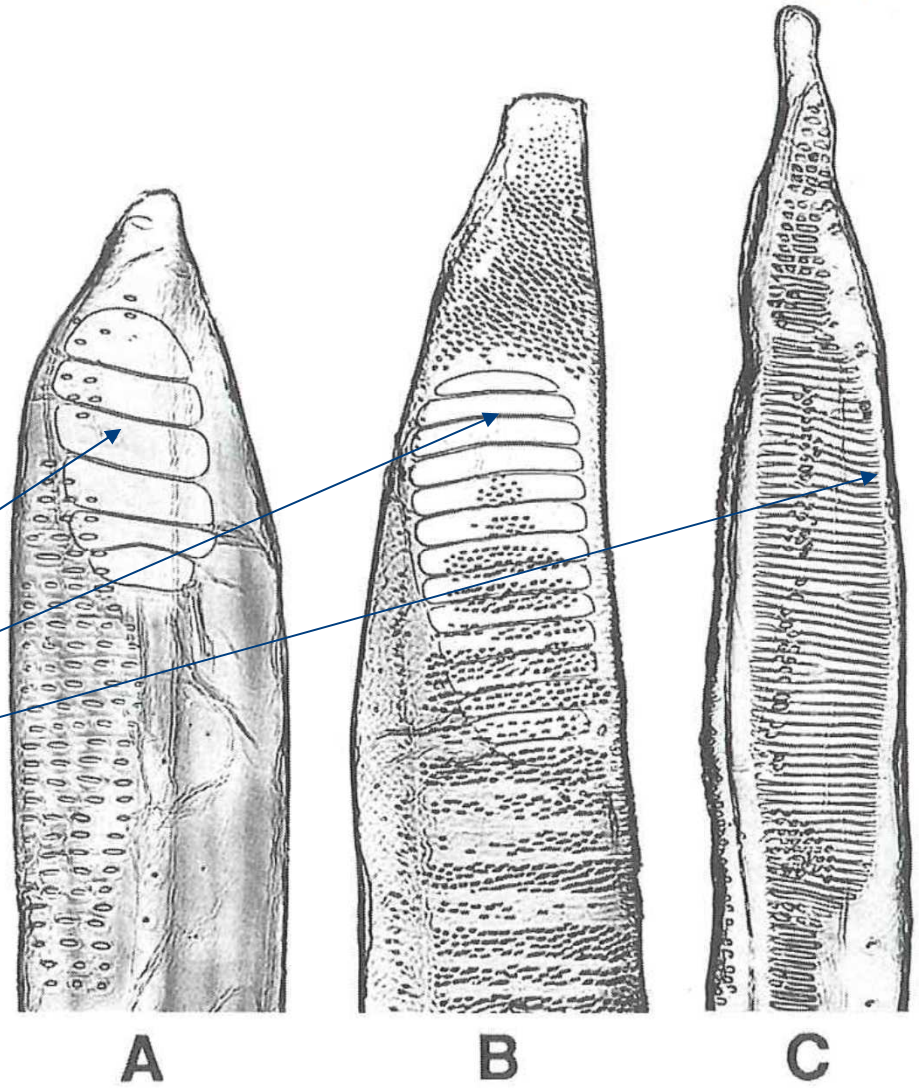
HARDWOOD
Vessel architecture Size / Shape

A – Nyssa sylvatica.
Blackgum – E. USA
B – Betula maximowicziana
Japanese Birch - Japan
C – Populus tremula –
Trembling aspen – Canada
D – Acer pseudoplatanus
Great maple – N. Hemisphere
E – Eucalyptus Globulus
Europe
F – Acacia auriculiformis
Widespread Equitorial
G – Fraxinus excelsior
Common ash – Europe
H – Carya ovata
Shagbark hickory – E. USA

Hardwood
Vessel Perforations

Vessel elements are ‘’Open” or scaliform

A – Liriodendron tulipifera
Yellow poplar – E. USA
B – Betula verrucosa
European white birch
C – Nyssa sylvatica
Blackgum – E. USA



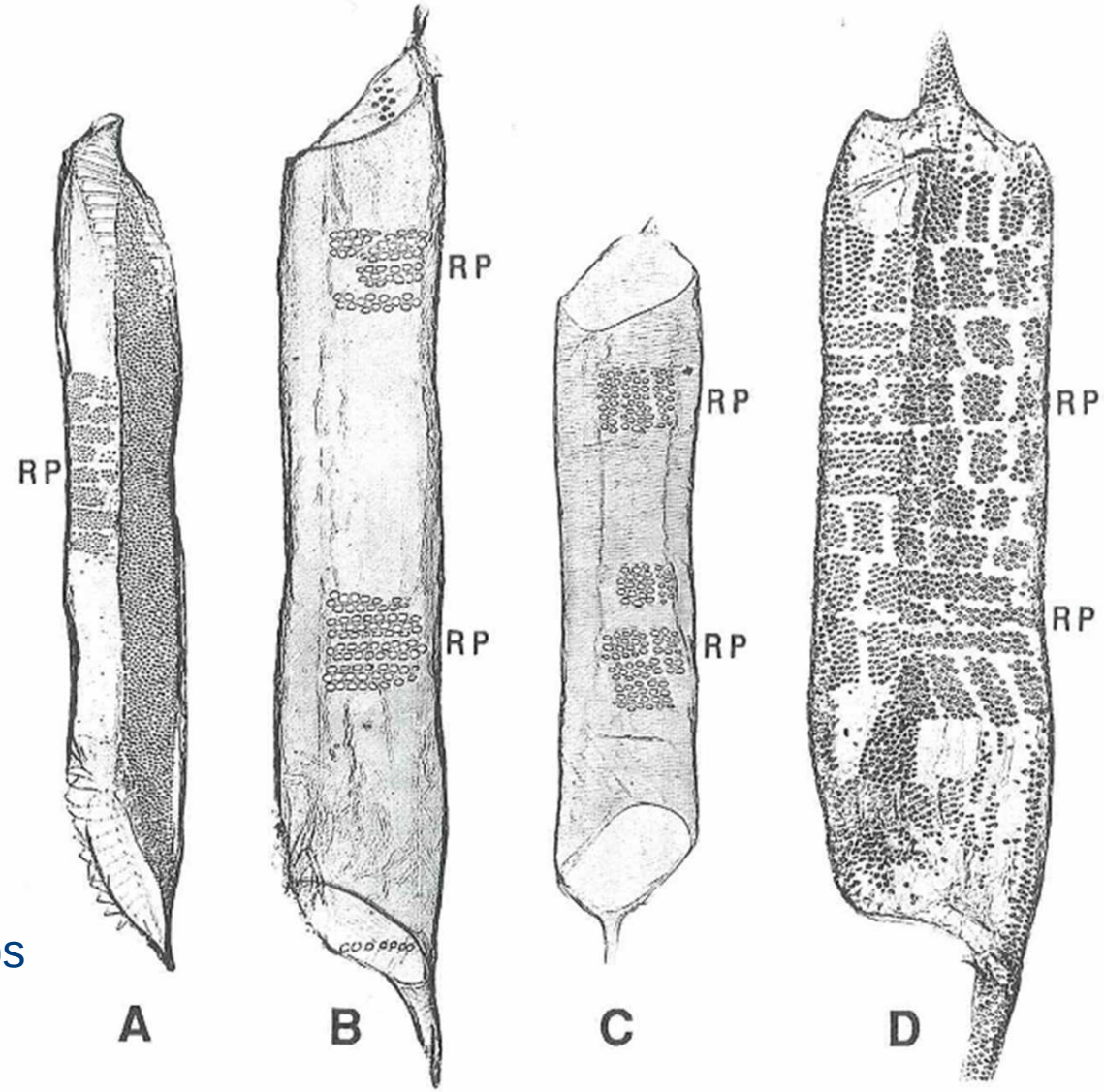
Number of bars varies 1 – 50

Poplar	<10
Birch	5 – 25
Blackgum	20 - 55

Hardwood Vessel Perforations

Vessel elements are Ray Pitted

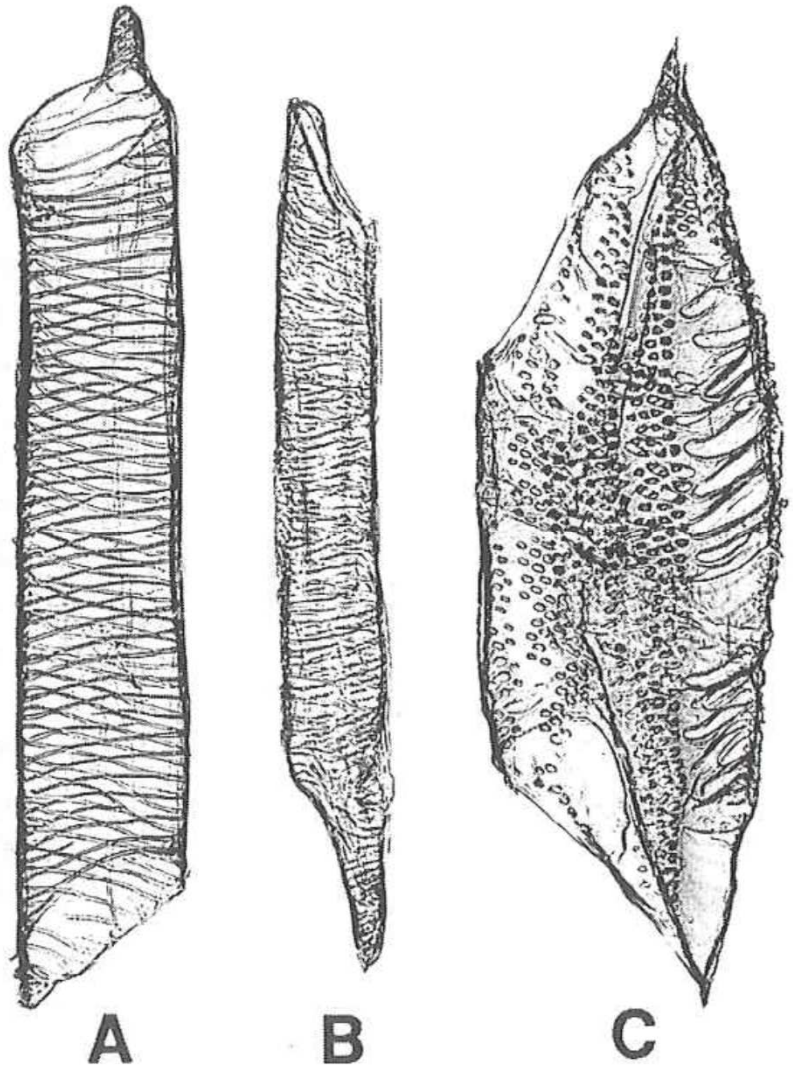
A – Uniformly distributed
Betula verrucosa
B – Widley spaced
Populus deltoides
C – Vertical / horizontal square groups
Salix alba
D – Vertical / horizontal groups uniformly distributed



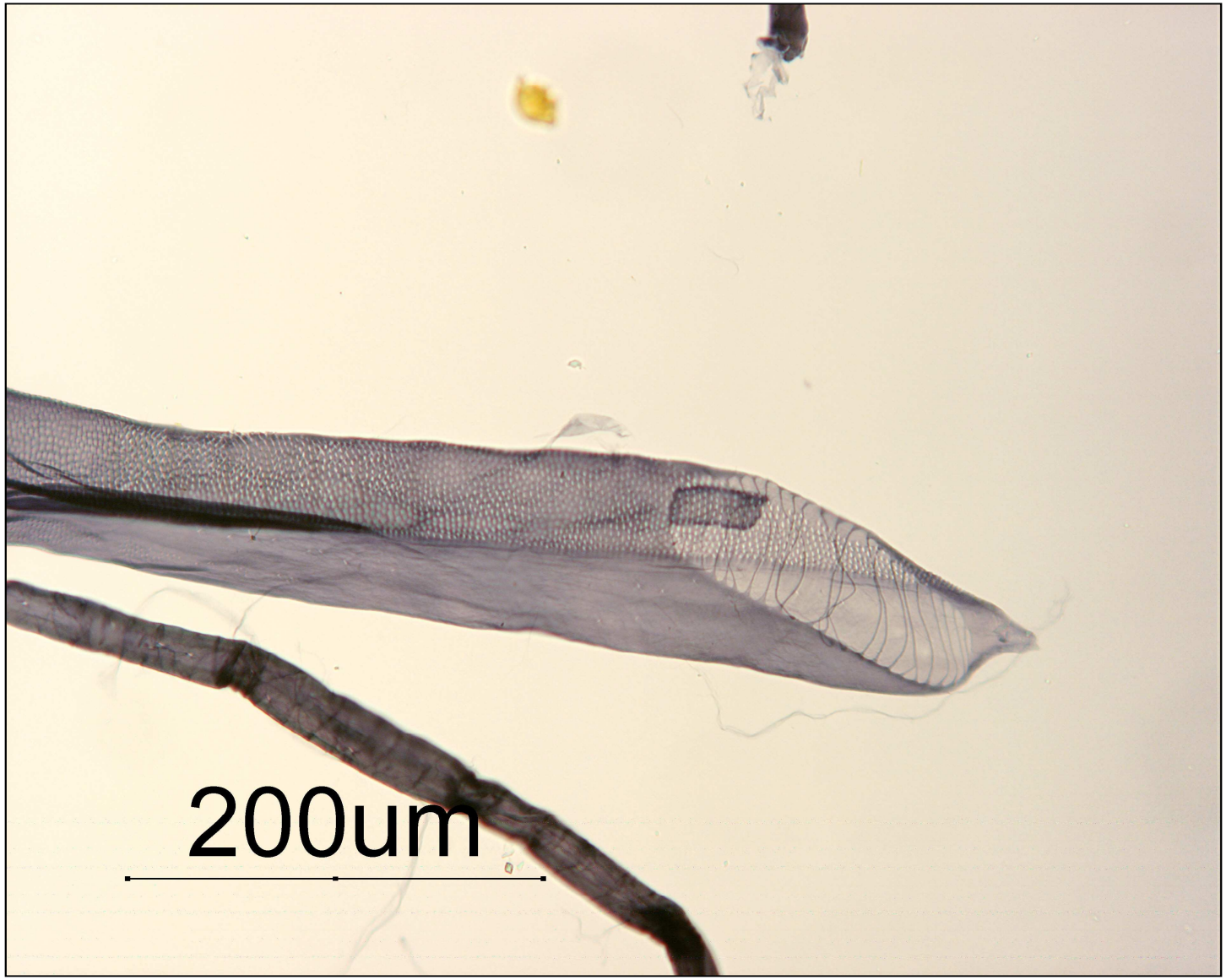
Hardwood
Vessel architecture
Size / Shape

Vessel elements
spiral / thickening

A – Wide spaced spiral + thickening
Tilia Cordata – Common lime
B – Close spiral
Acer saccharum – Sugar maple
C – Thickening
Juglas nigra – Black walnut



Betula - Birch



Stage 2
Wood Species Analysis

Softwood
Cross Field Pitting

SOFTWOOD
Fibre
cross field pitting
Window Like pits

Pinus resinosa
Red pine

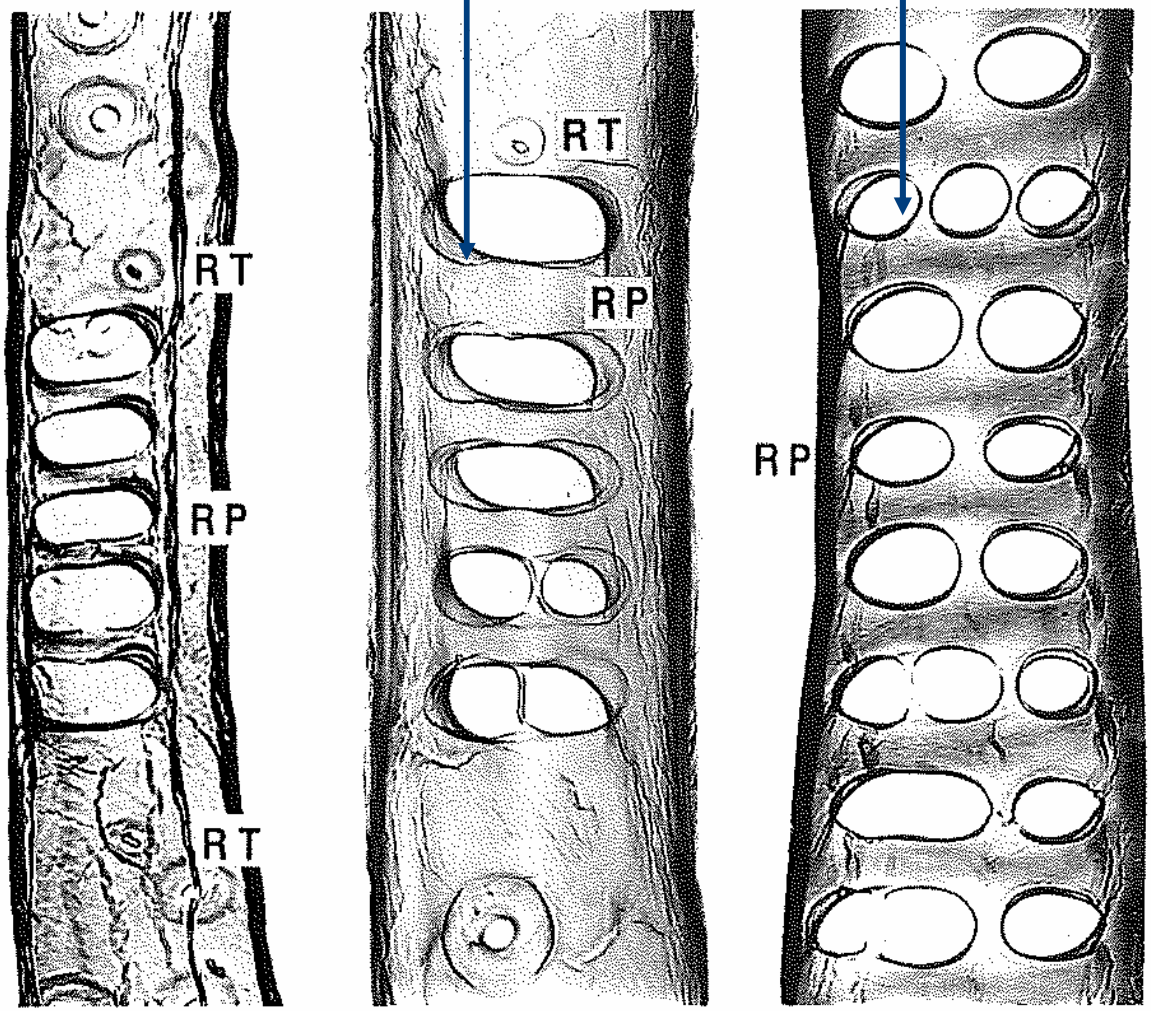
Pinus kesiya
Philippine pine

Pinus lambertiana
Sugar pine

Ray **P**arenchyma
Ray **T**racheids

Large rectangular pits
1 – 2 / cross field

Large oval pits
2 - 3 / cross field



Pinus resinosa | P. kesiya | P. lambertiana

SOFTWOOD
Fibre
cross field pitting

Pinoid pits

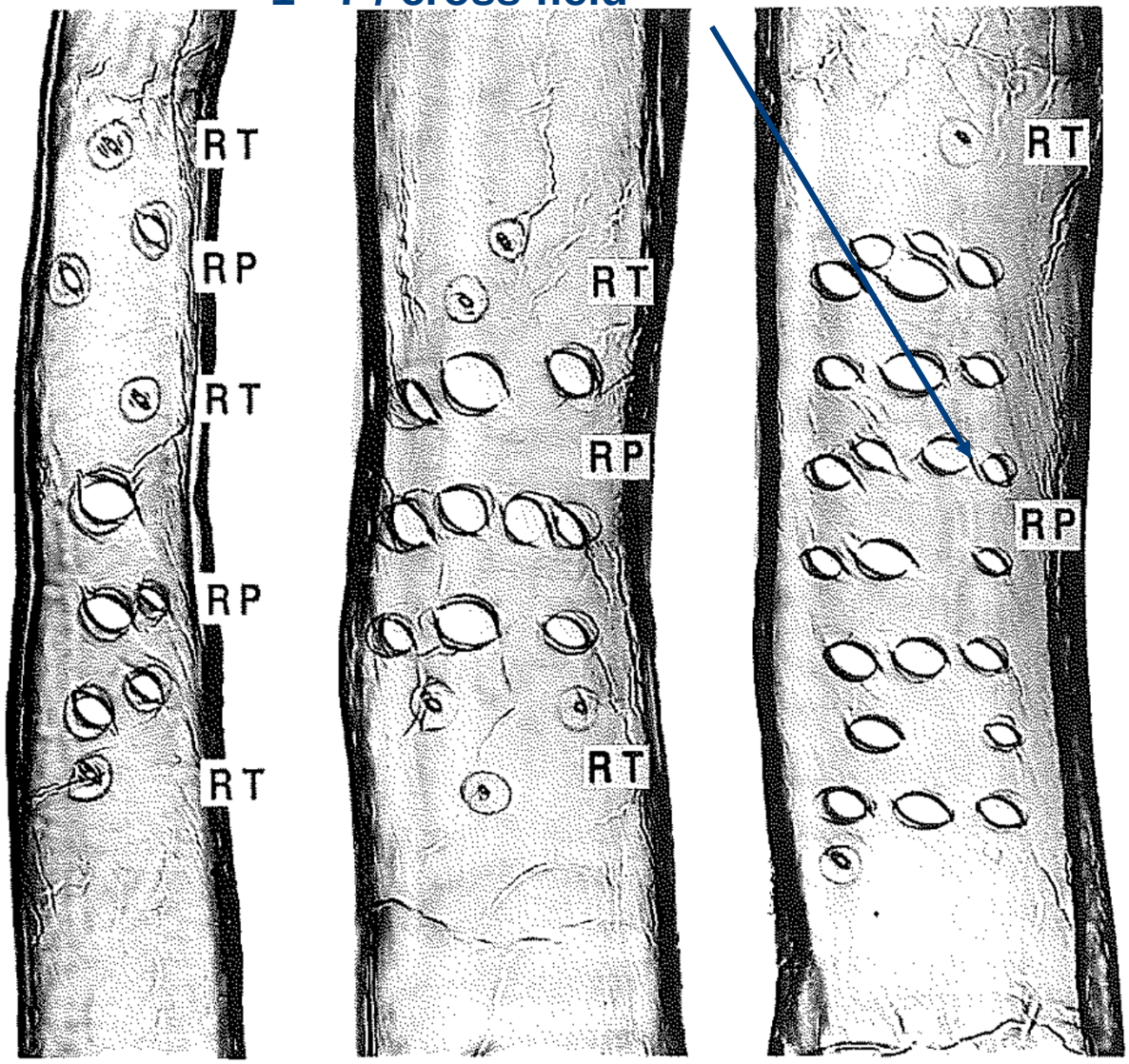
Pinus radiata
Monterey pine

Pinus pinaster
Maritime pine

Pinus taeda
Loblolly pine

Ray **P**arenchyma
Ray **T**racheids

Small size and shape. Groups / clusters
1 - 7 / cross field



Pinus radiata P. pinaster P. taeda

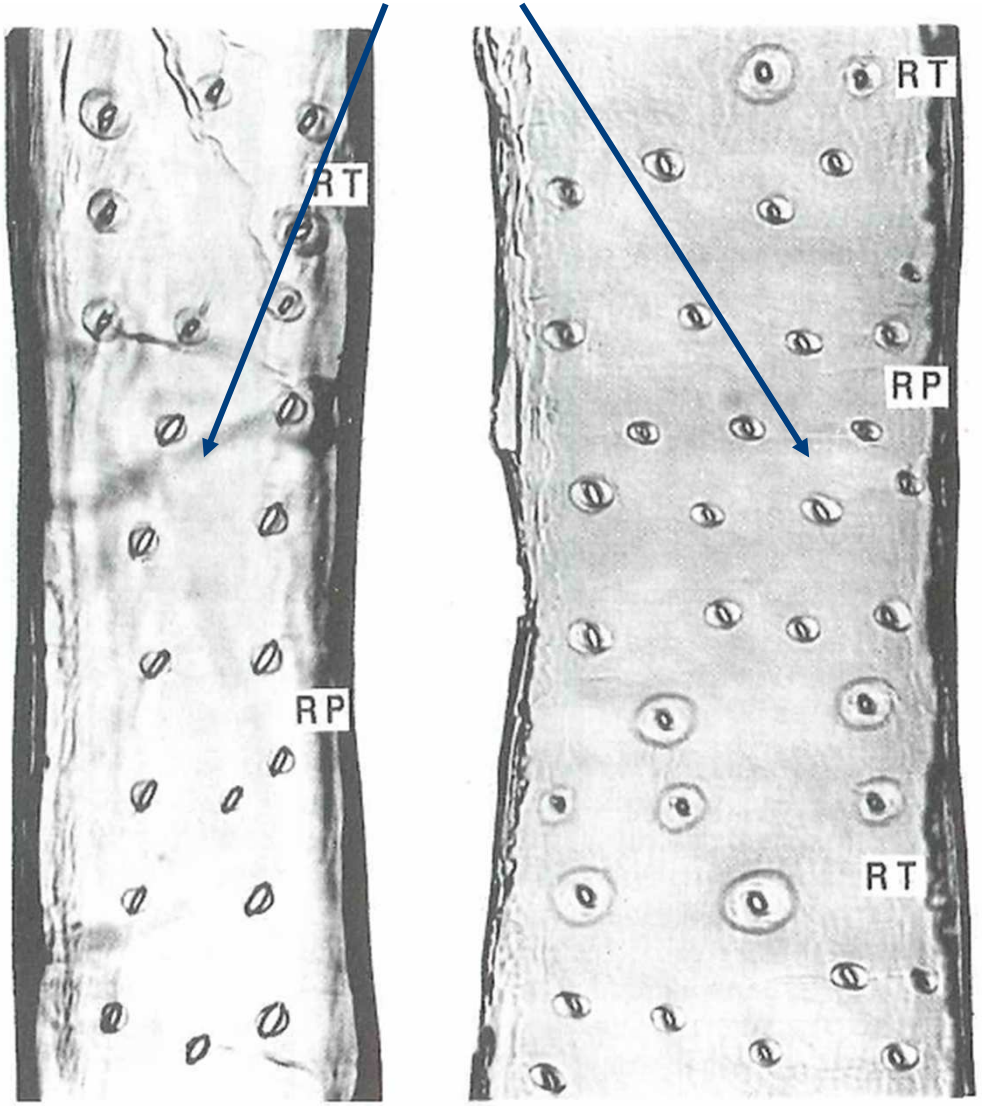
SOFTWOOD
Fibre
cross field pitting
Piceoid pits

Picea abies
Silver fir

Larix occidentalis
Western larch

Ray **P**arenchyma
Ray **T**racheids

Very small – oval to round
2 - 4 / 4 - 6 / cross field



Picea abies

Larix occidentalis

SOFTWOOD
Fibre
cross field pitting

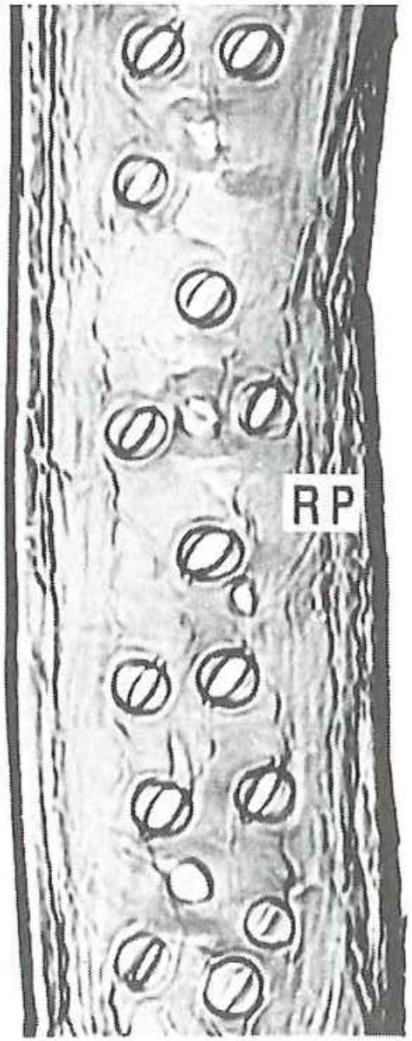
Cupressoid pits

Chamaecyparis obtusa
Japanese cypress

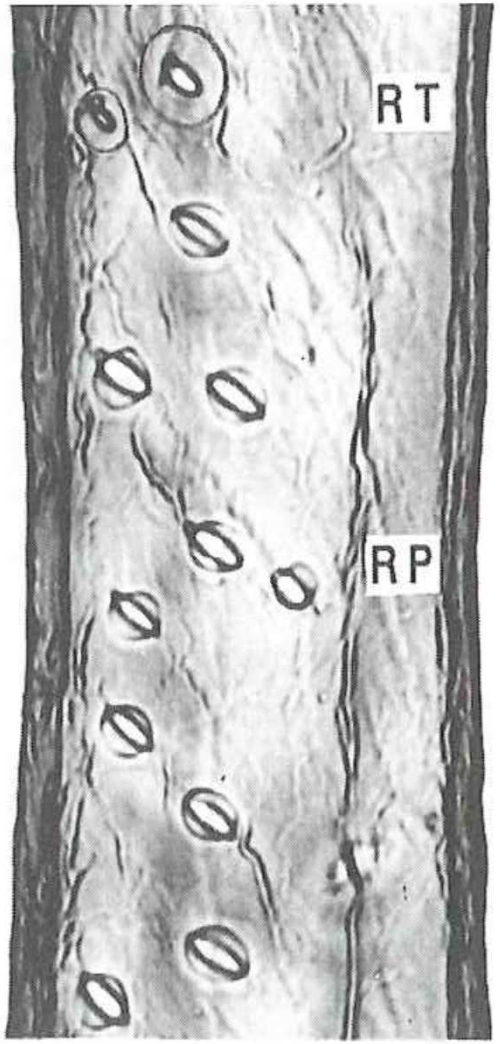
Tsuga heterophylla
Western hemlock

Ray **P**arenchyma
Ray **T**racheids

Small oval / round pits – Uniform
1 – 6 / cross field



Chamaecyparis obtusa



Tsuga heterophylla

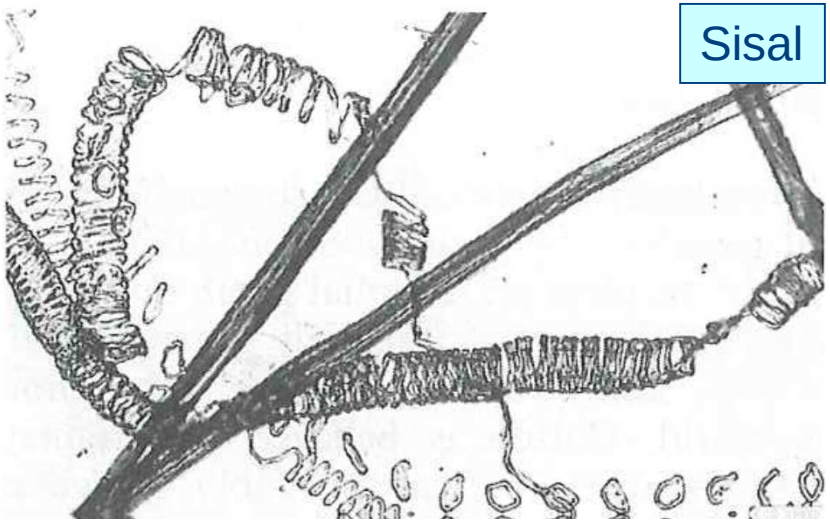
Pseudotsuga – Douglas Fir

Stage 2
Wood Species Analysis

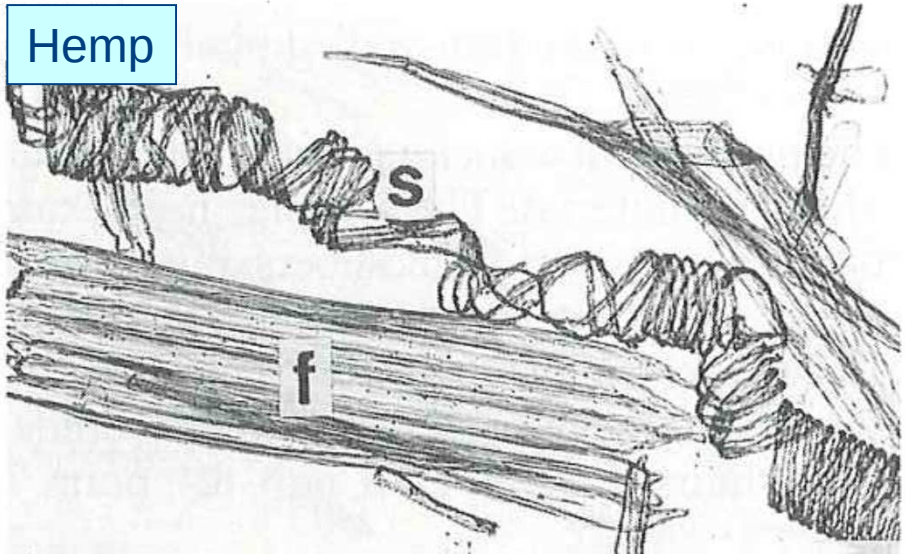
Annual

Annual Fibres

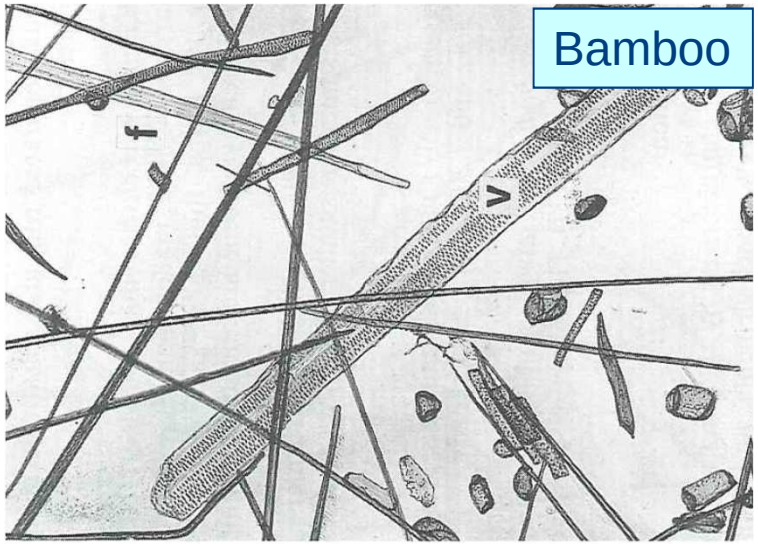
Sisal



Hemp



Bamboo



Cotton

Issues for the analyst

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Difficult to quantify Hardwood species content of furnish

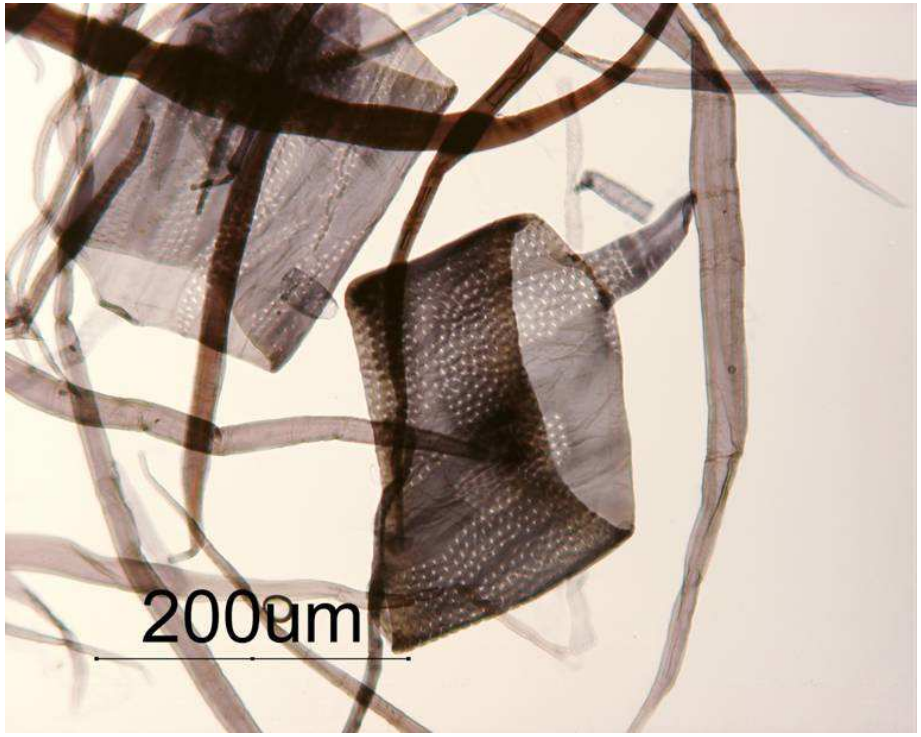
- **No markings on fibres, identification via vessels, number not always proportionate to material present**

Spring / Summer wood differences - quantity and ratio

- **Geography**
- **Species type**
- **Provide differences in identification markings**

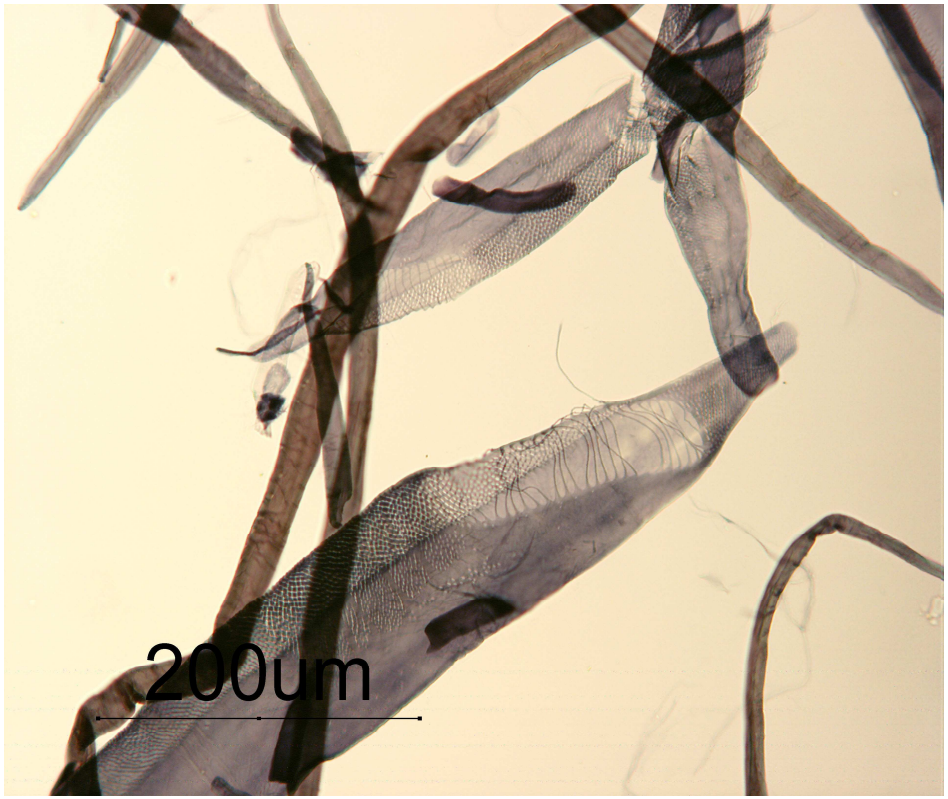
Live samples can look different to references

Issues for the analyst



F - Acacia

Issues for the analyst



B - Betula

Issues for the analyst

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Mechanical / Chemical pulp preparation

- **Degree of conversion / damage to fibre / staining**

Degree of fibre conversion

- **Refining**
- **Recycled fibre**

Chemical make-up of paper influencing fibre staining process

e.g. Filler / Starch / Coatings / Wet strength…..

Lack of suitable fibre reference material – Restricted wood

Unrefined fibres

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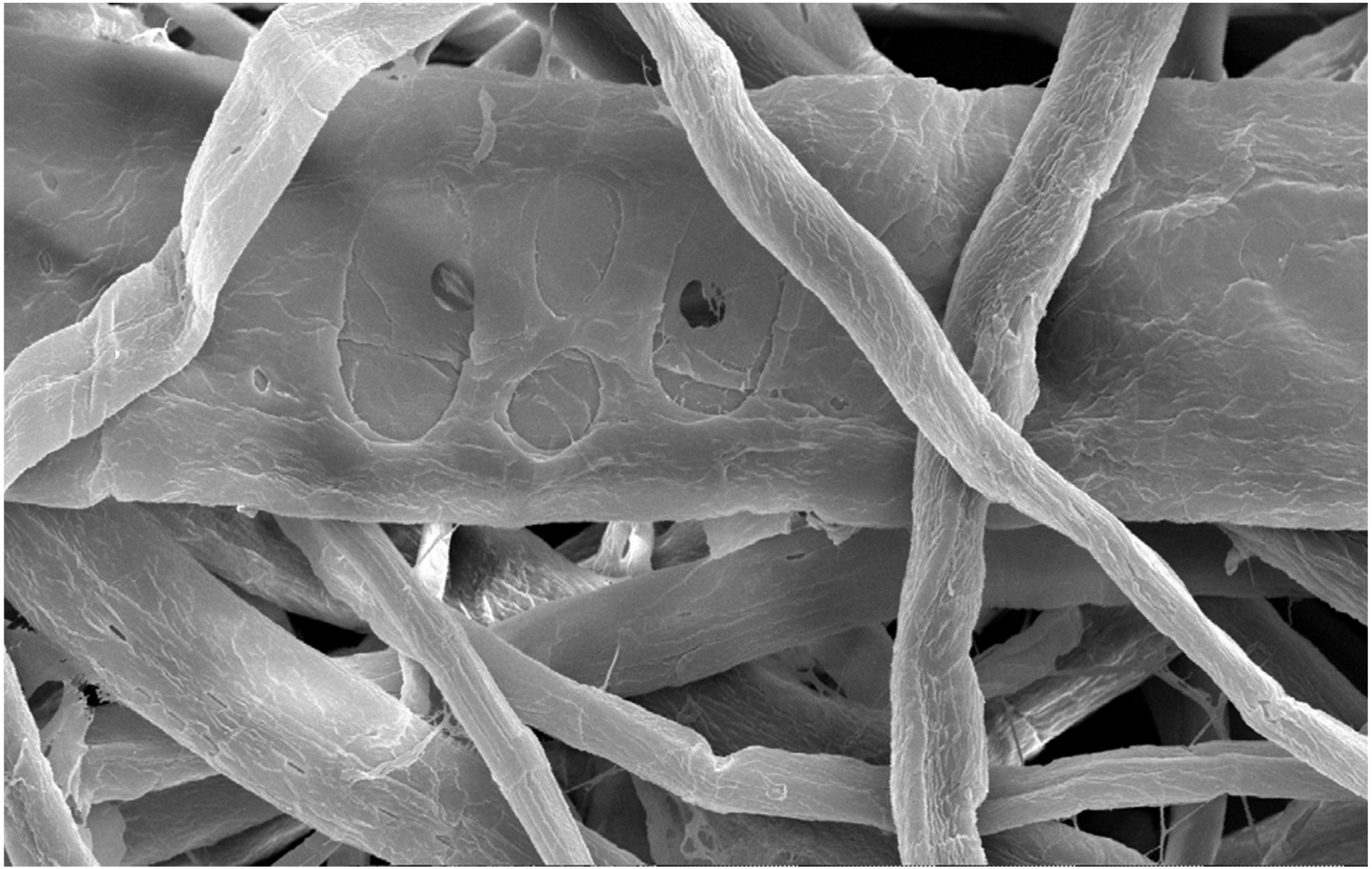

Refined fibres

Thank You

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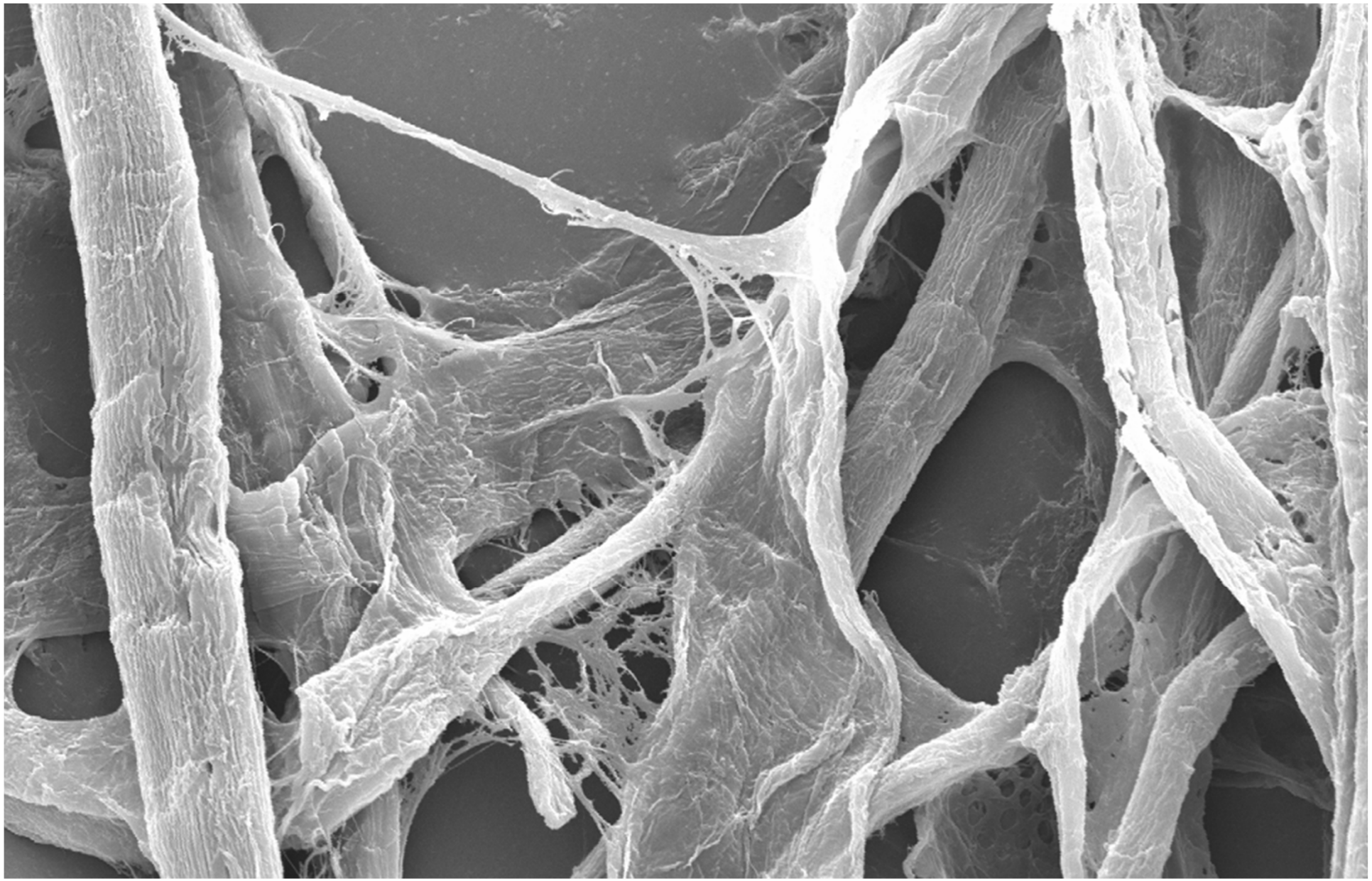

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