

**Internal Leaf Structure
of Vetiver Grass
Supporting the Potentially
C Sequestration**

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Research objective

**to describe
the internal leaf structures
(leaf anatomy) of
11 vetiver provenances**

2 species of vetivers

Chrysopogon nemoralis (Balan.) Holtt. Camus



high land vetiver

C. zizanioides (L.) Roberty



low land vetiver

2 species of vetiver

Chrysopogon nemoralis, (high land vetiver)

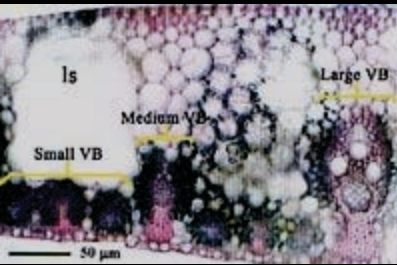
- 1) Kamphaeng Phet 1 (KP1)
- 2) Loei (LI)
- 3) Nakhon Sawan (NS)
- 4) Prachuabkhirikhan (PK)
- 5) Ratchaburi (RB)
- 6) Roi Et (RE)

Chrysopogon zizanioides, (low land vetiver)

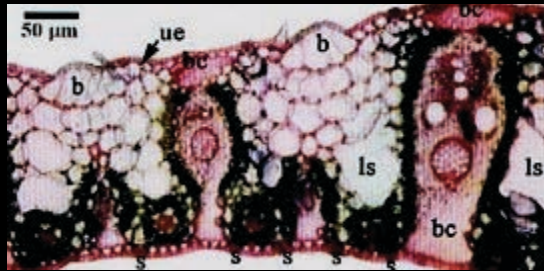
- 7) Kamphaeng Phet 2 (KP2)
- 8) Praratchathan (PT)
- 9) Songkhla 3 (SK3)
- 10) Sri Lanka (SL)
- 11) Surat Thani (ST)

Result of the Study

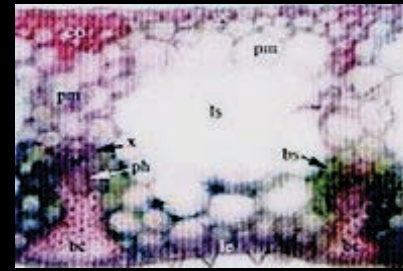
leaf anatomy



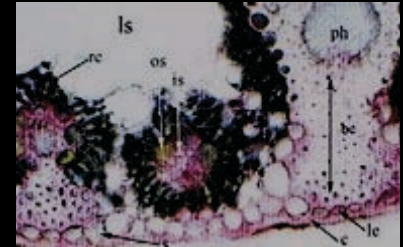
Kamphaeng Phet 1



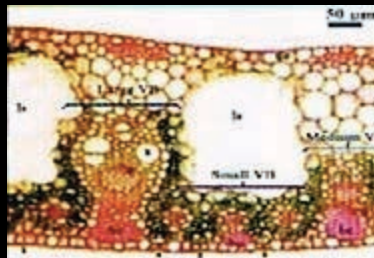
Loei



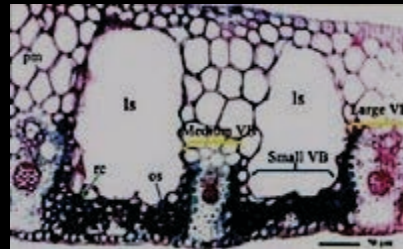
Nakhon Sawan



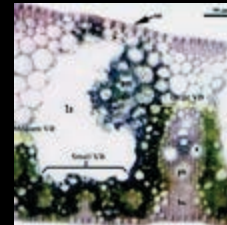
Prachuabkhirikhan



Ratchaburi



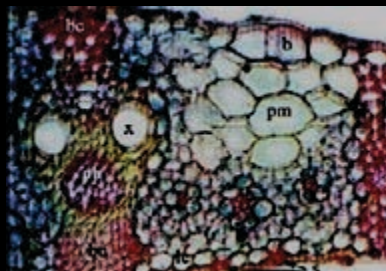
Roi Et



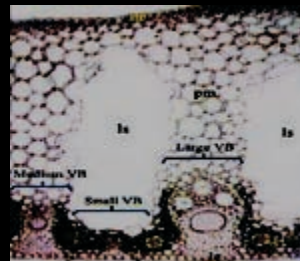
Kamphaeng Phet



Praratchathan



Songkhla3



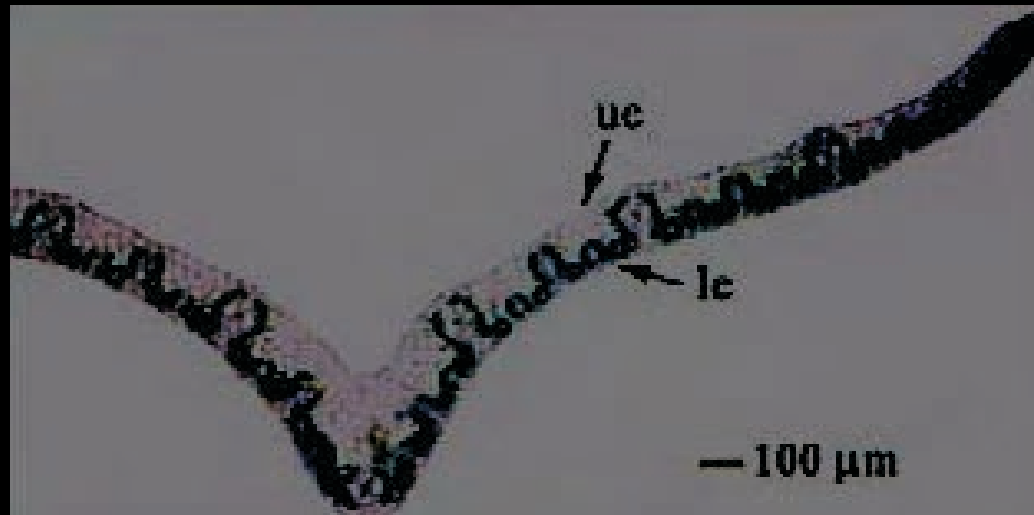
Sri Langka



Surat Thani

Result of the Study

1. Vascular bundle arrangement



large: small: medium :small: large

1: 3: 1: 3: 1

S: L: S: M: S: L

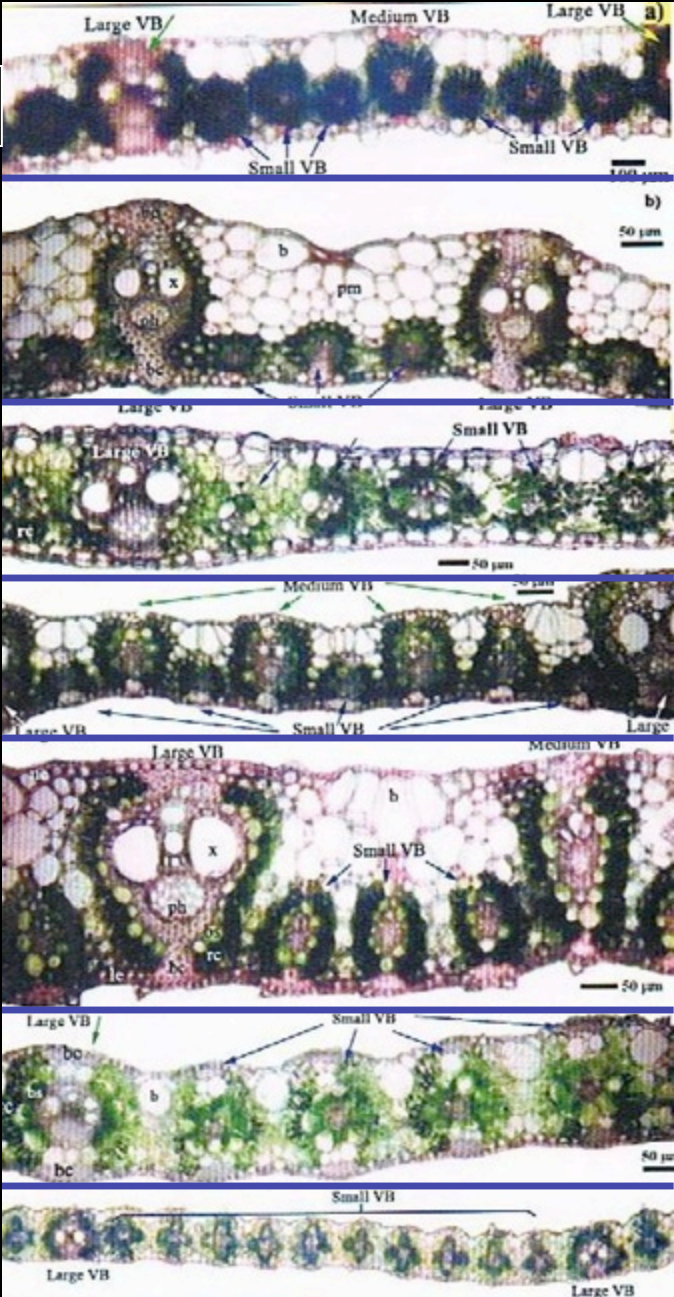
L: S: L

L: S: L

L: S: M: S: L

L: S: L

L: S: L



1) *Brachiaria mutica* (Forsk.Staph

2) *Cymbopogon citratus* (DC.Staph

3) *Zea may* (Linn)

4) *Impertata cylindrica* (L.) P. Beauv.

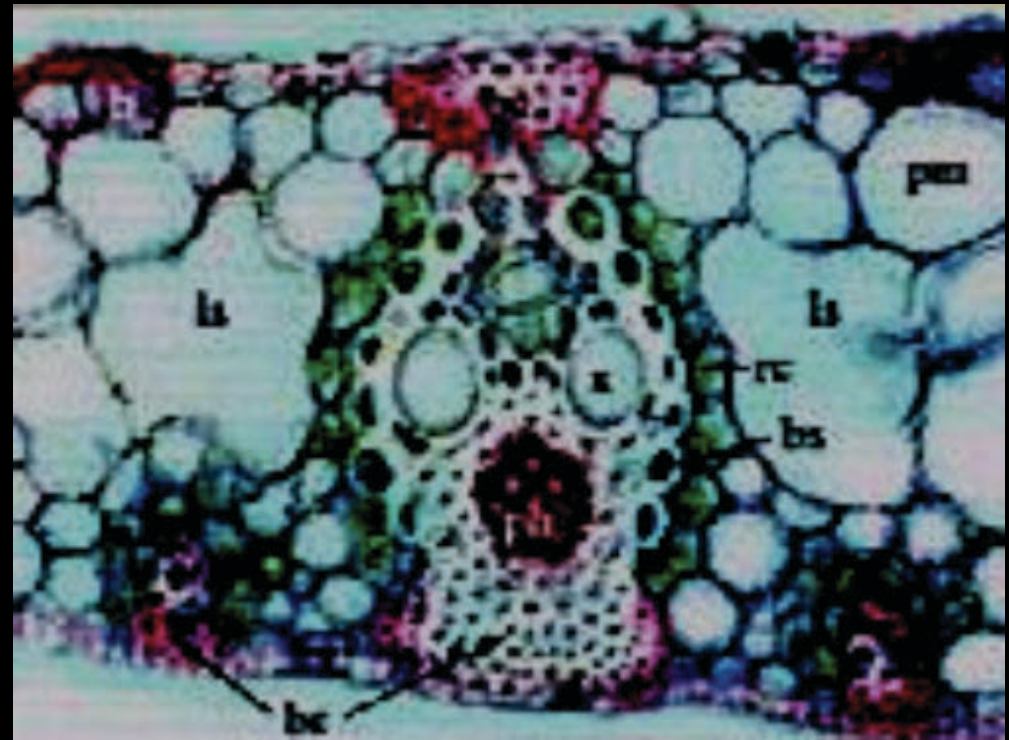
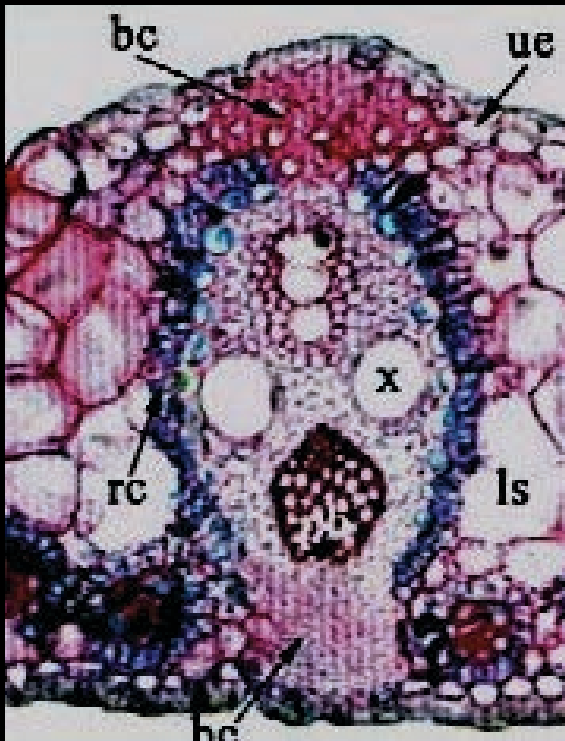
L: S: M: S: M: S: M: S: M:L

5) *Sacharum officinarum* Linn

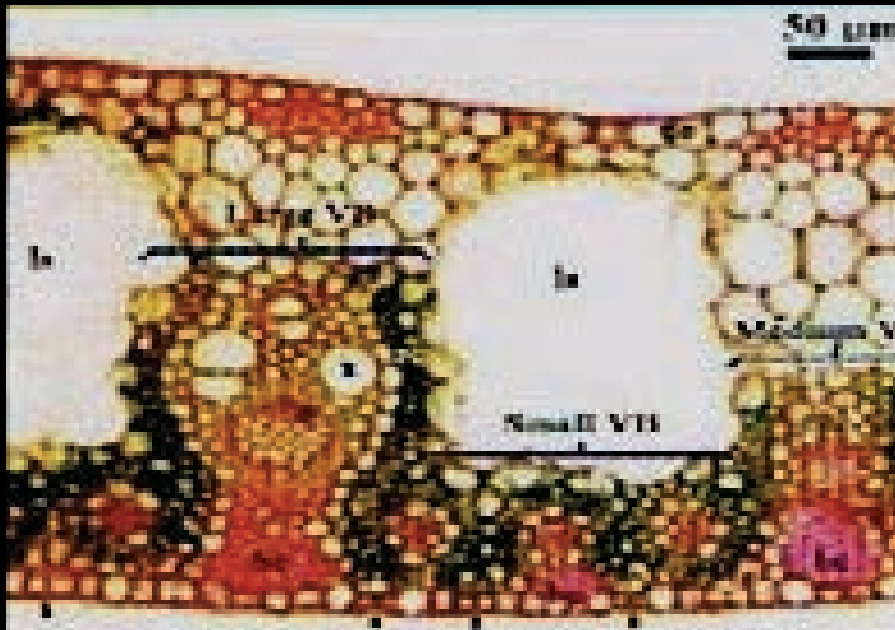
6) *Eleusine indica* (L.) Gaertn

7) *Panicum maximum* (Jacq.)

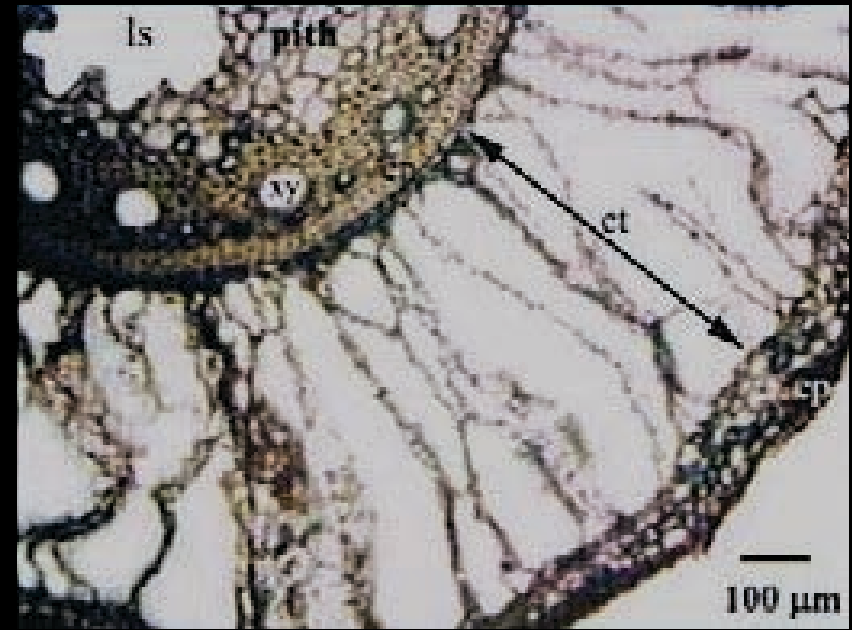
2. vascular bundle with Kranz structure which is similar to C4 plant



3. Internal structure show the structure of aquatic plant

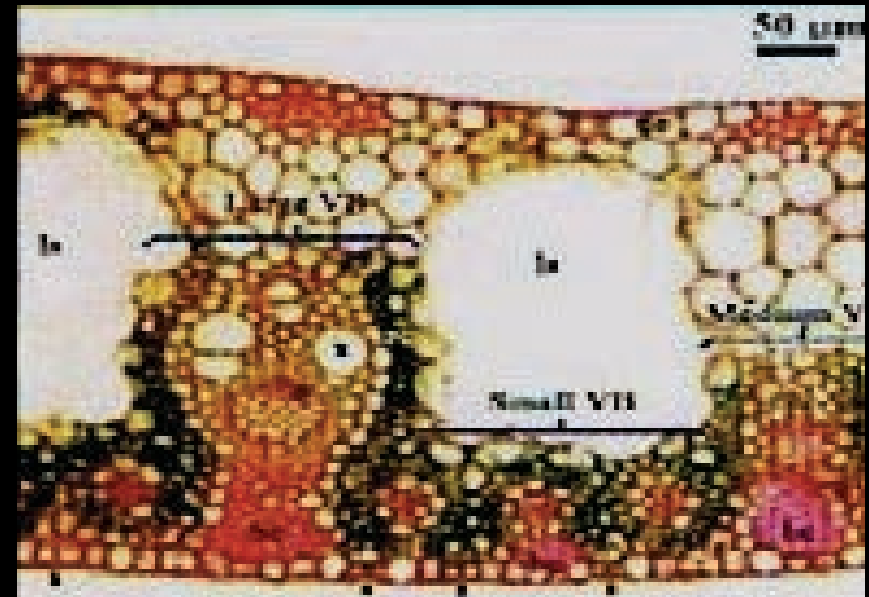
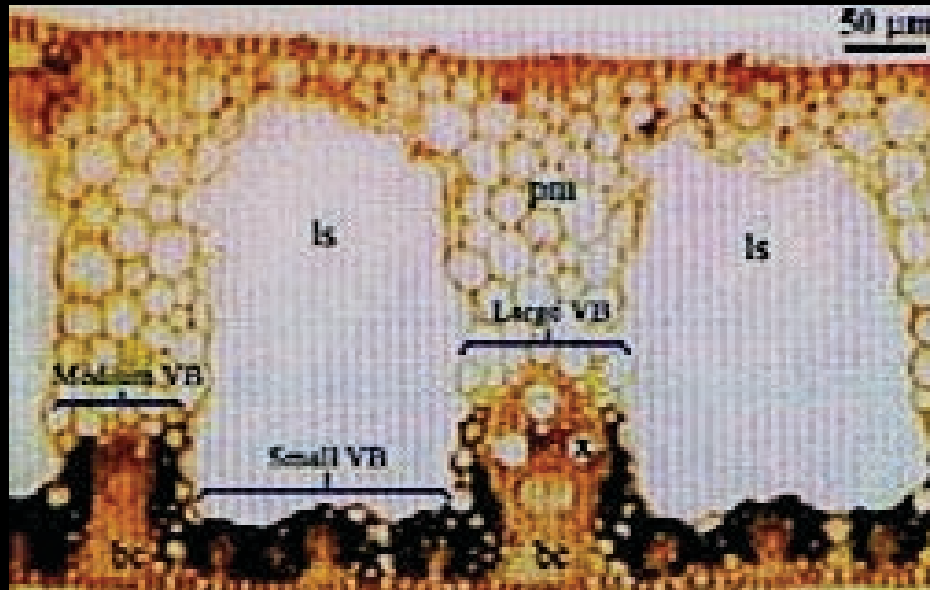


Leaf

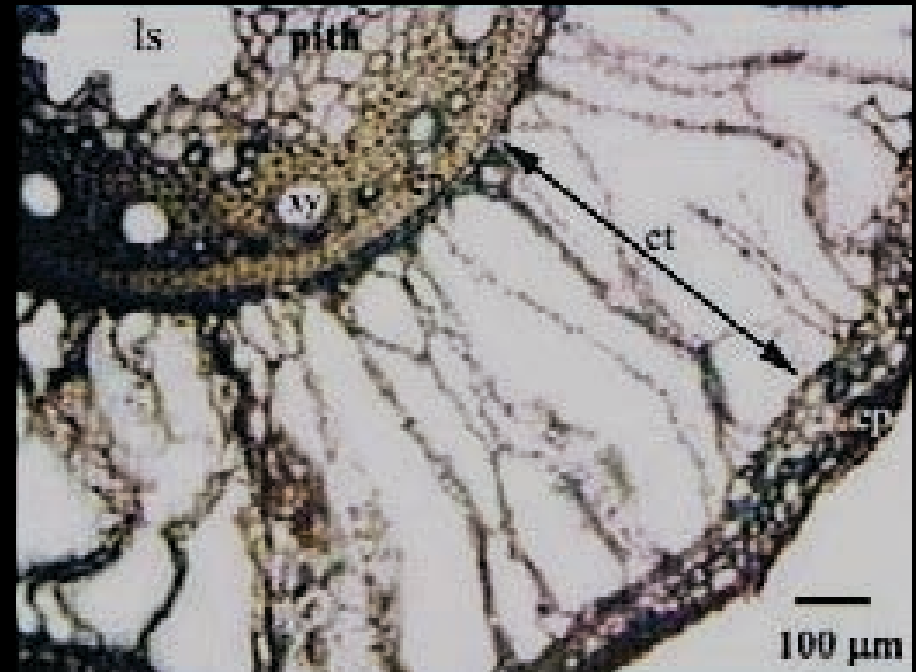
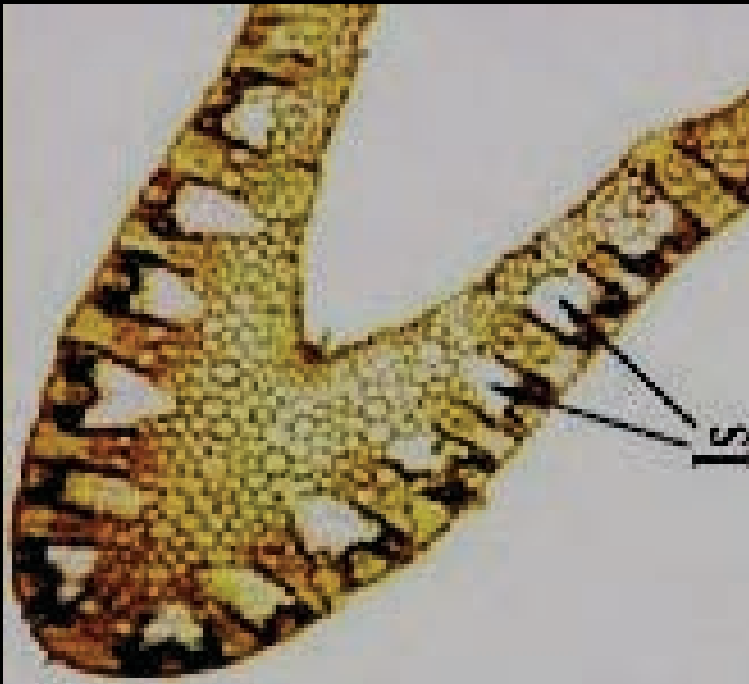


Root

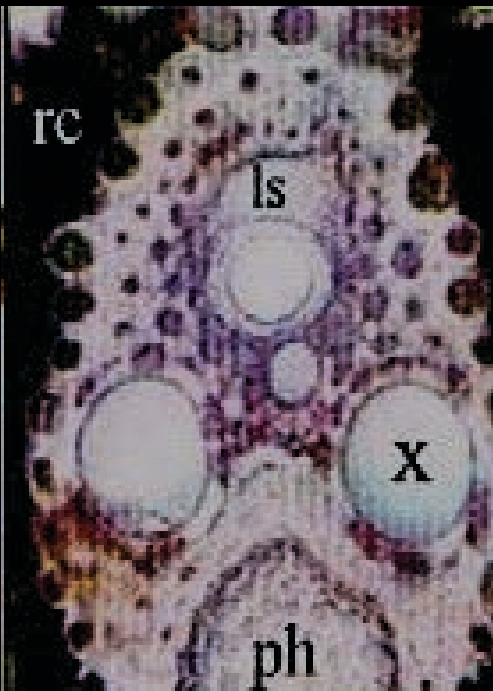
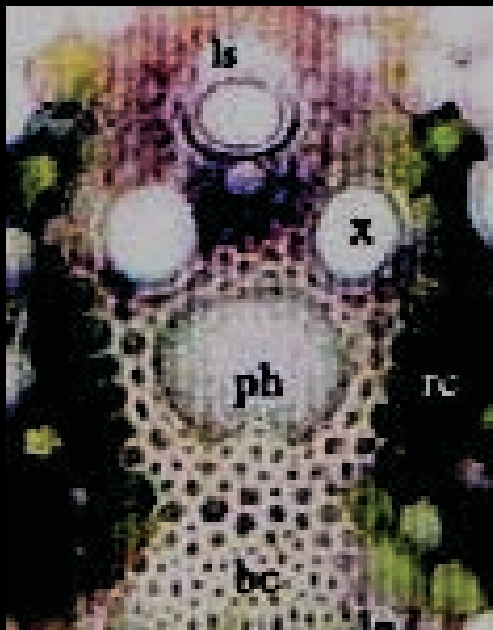
4. Large lysigenous intercellular space strongly related aeration system



5. Evident of aeration system could confirm gas circulation from the leaves to the root

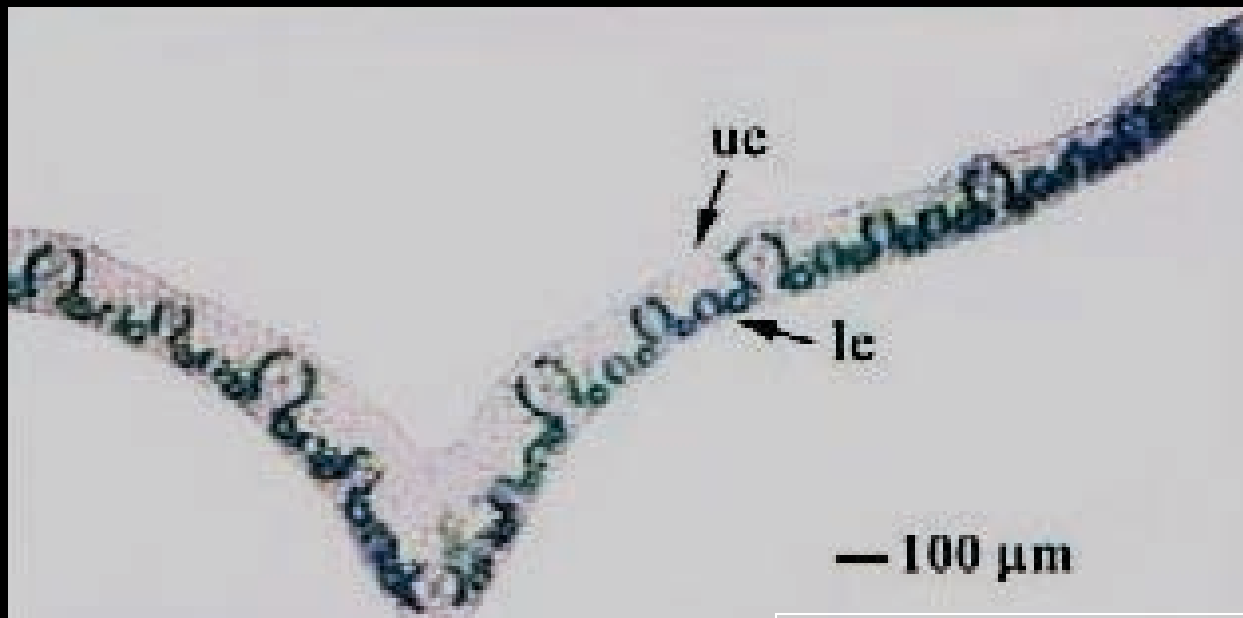


6. Aeration root system encouraged deeply root layer penetration and avoid hypoxia condition



7. Fiber at bundle sheath and also at bundle cap believed playing a dual function of mechanic and hydraulic which could retain stomata open and longer gas exchange.

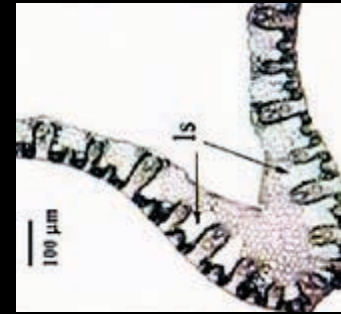
8. Angle of leaf wings reflected an adaptive high radiation and also was useful for provenance classification



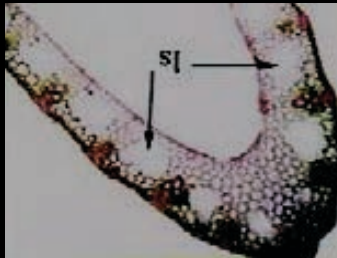
Roi Et, (~ 60°)



Kamphaeng Phet 1, (~ 45°)



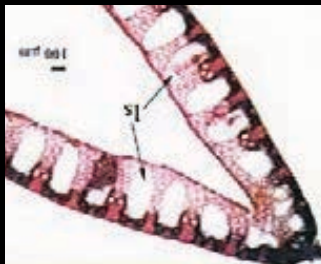
Loei, (~ 45°)



Nakhon Sawan, (~ 45°)



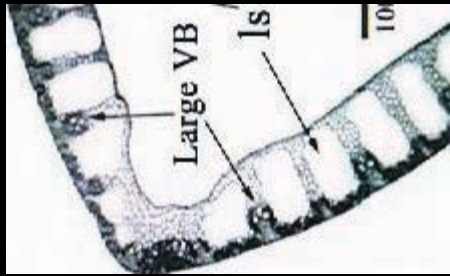
Prachuabkhirikhan, (~ 45°)



Ratchaburi, (~ 45°)



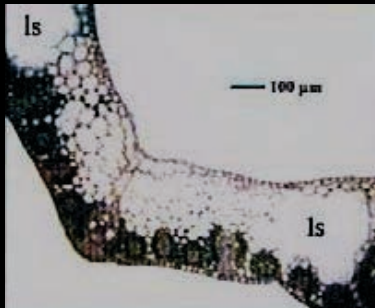
Roi Et, (~ 60°)



Kamphaeng Phet 2 , (~ 60°)



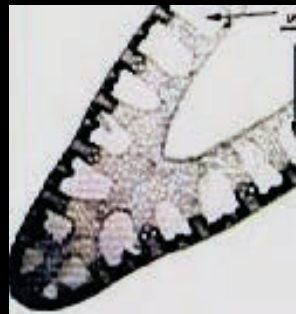
Praratchathan, ~ (45°)



Songkla 3 (>90°)



Sri Langka 3 (~45°)



Sura Thani (<45°)

9. Humidity and venturi induced convection were assumed as a strategy to gain more gas circulation of vetiver



Leaves of two species conifer and cycad show hydraulic flow path (midrib to stomata) facilitate by water-conducting vessel

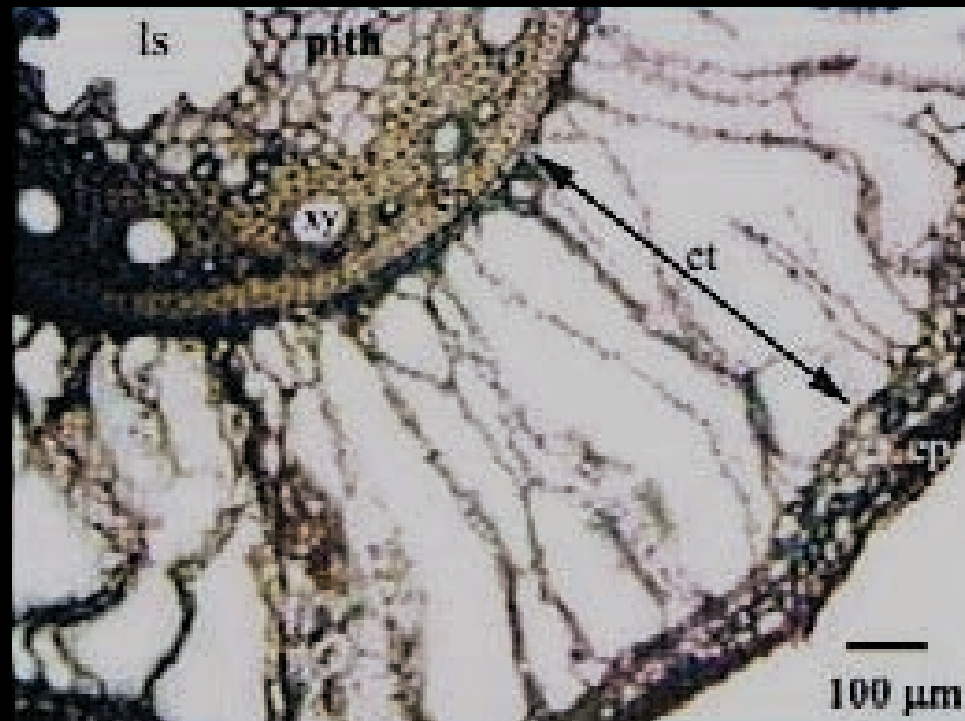
CONCLUSIONS

Conclusions

1. Internal leaf structure of 11 vetiver provenances were different.

- 2. Like C4 plants, all 11 provenances had uniformly and regularly vascular bundle arrangement with the ratio of $1:3:1:3:1$ (Large: Small: Medium: Small: Large)**

3) Consistently, we found that aerenchyma at root cortex and air cavity at pith were strong evidence of aeration system from leaves to roots



4) Large lysigenous intercellular spaces were found in mature leaf, which suggested relative gas circulation in root and encouraged deeply root penetration

5) To avoid hypoxia/anoxia, large lysigenous intercellular spaces at lamina were a character of aquatic plants or long term flooding-tolerant plants by transporting O_2 from leaves to roots

Conclusions

**6. Angles of leaf wings.
of 11 vetiver provenances were
different.**

These internal leaf structures of all 11 vetiver promote function of organic compounds synthesis, such as cellulose, lignin which are difficult to decompose.

Thank you

Appendix 1

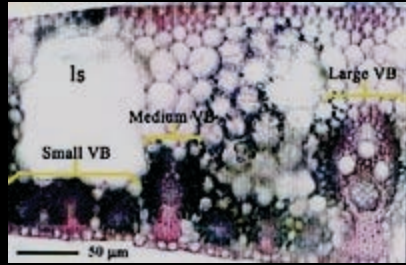
Angle of leaf wings was different among 11 provenances, it could be benefit in provenance classification

Classification of vetiver provenances based on the angle of leaf wing

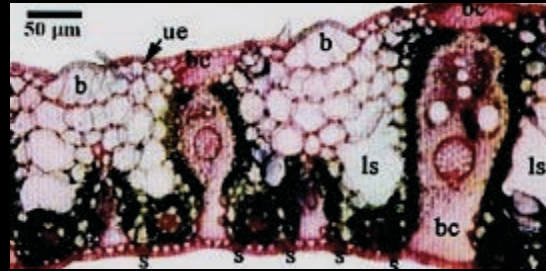
Angle of leaf wing	Vetiver provenance
< 45°	Surat Thani
~ 45° without curve wings	Ratchaburi and Praratchathan
~ 45° with curve wings (from middle to end)	Loei and Prachuabkirikhan
~ 45° with curve wings (at the ends)	Kamphang Phet1 and Sri Lanka
~ 60° without curve wings	Kamphang Phet 2
~ 60° with curve wings (from middle to end)	Roi Et
~ 90°	Songkla 3
U shape upside down	Nakhon Sawan

Appendix 2

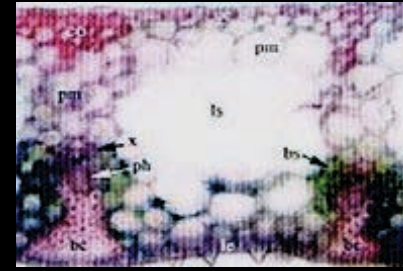
Internal structure



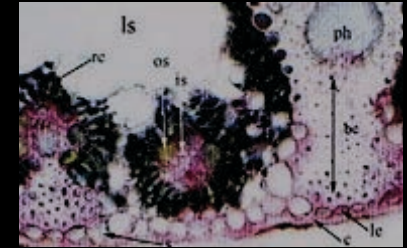
Kamphaeng Phet 1



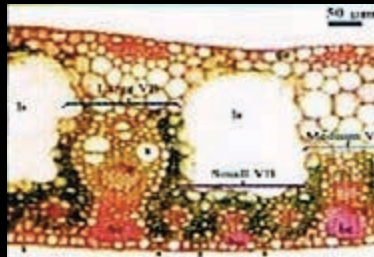
Loei



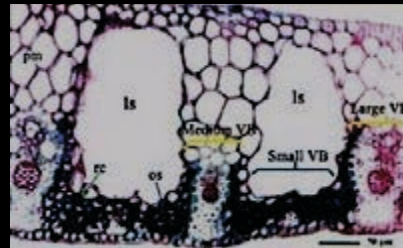
Nakhon Sawan



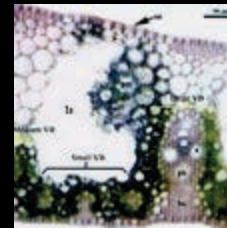
Prachuabkhirikhan



Ratchaburi



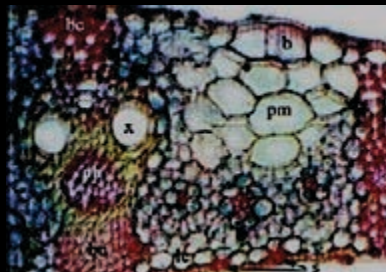
Roi Et



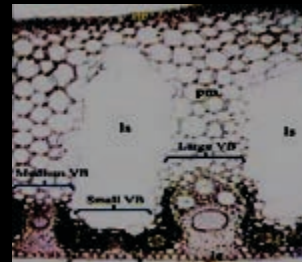
Kamphaeng Phet



Praratchathan



Songkhla3



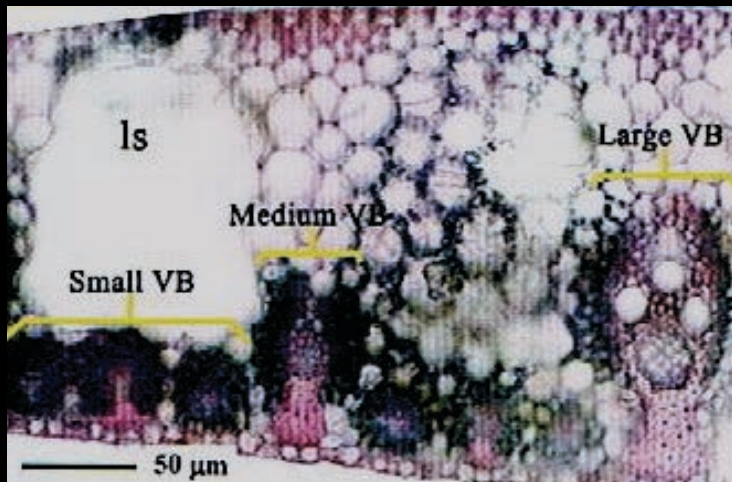
Sri Langka



Surat Thani

Internal structure

1) Kamphaeng Phet 1 provenance



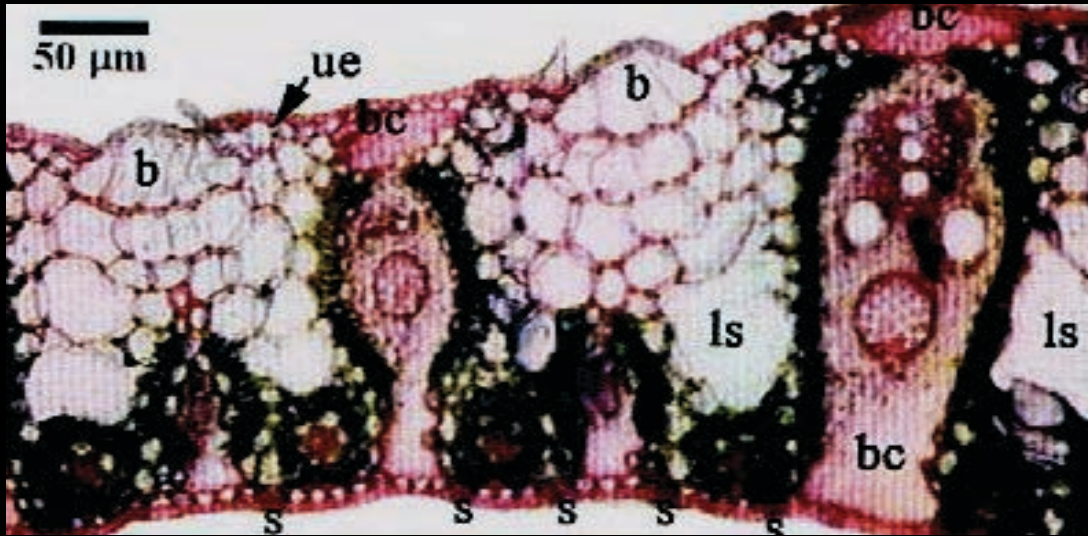
lamina vein



lamina angle

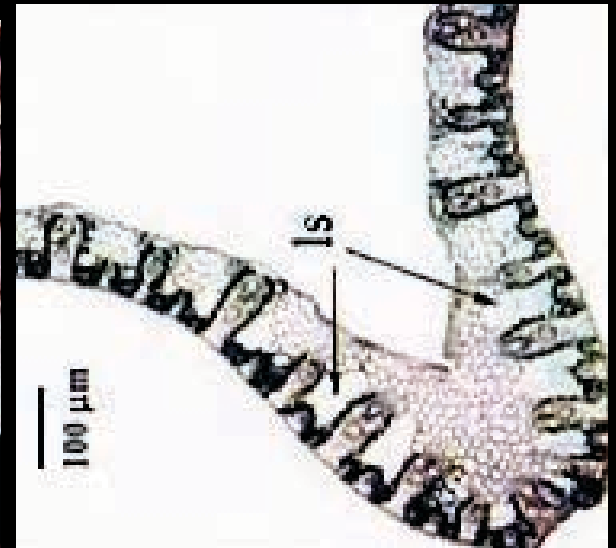
Internal structure

2) Loei provenance



lamina

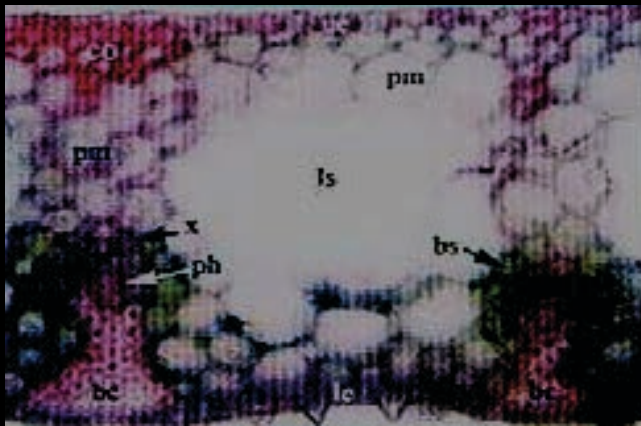
vein



lamina angle

Internal structure

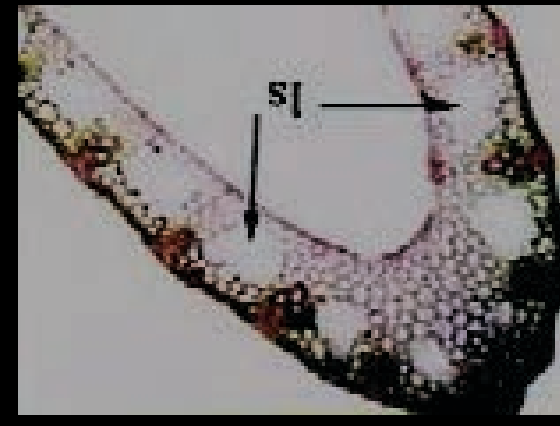
3) Nakhon Sawan provenance



lamina



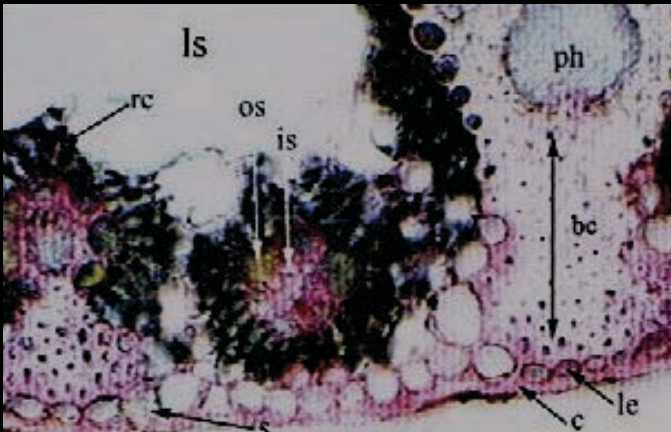
vein



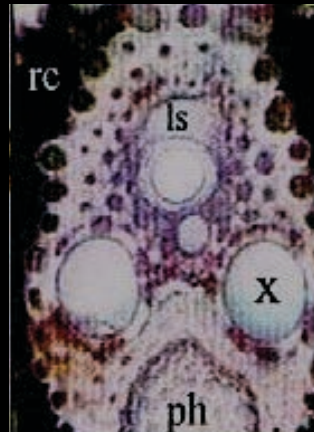
lamina angle

Internal structure

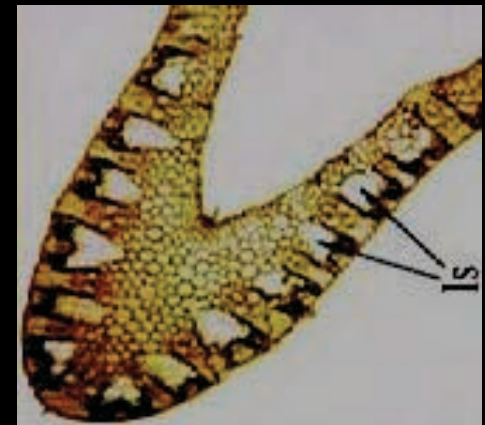
4) Prachuabkhirikhan provenance



lamina



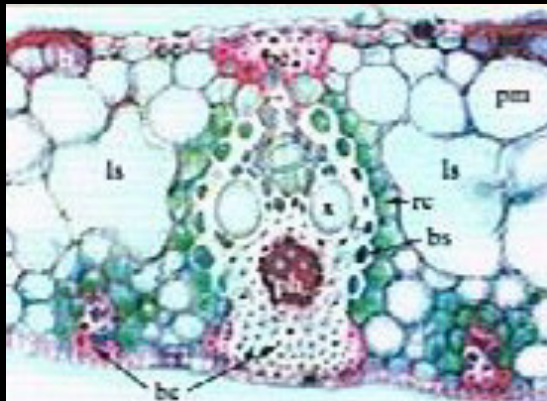
vein



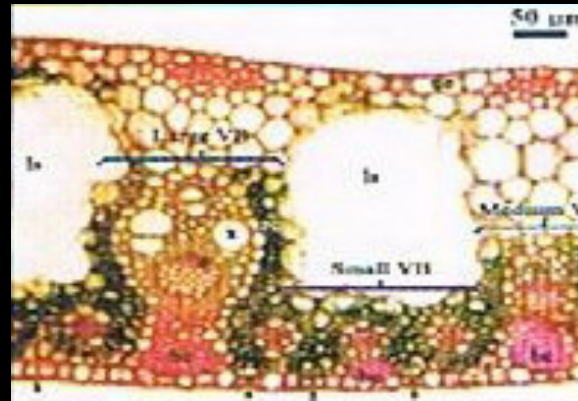
lamina angle

Internal structure

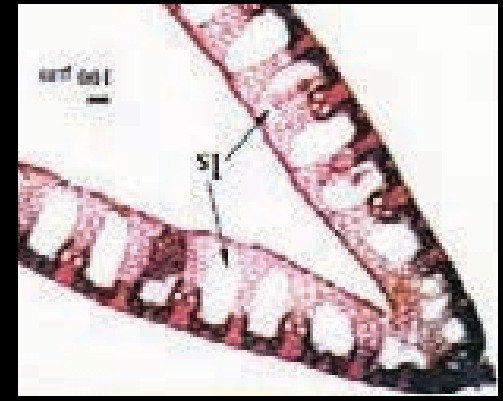
5) Ratchaburi provenance



lamina



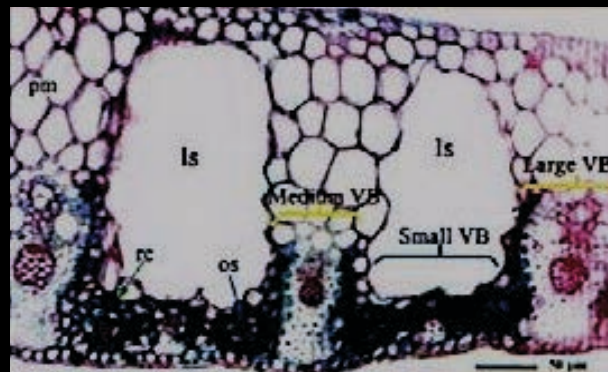
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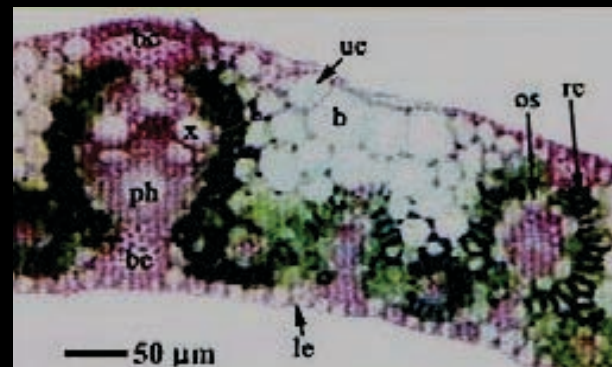
lamina angle

Internal structure

6) Roi Et provenance



lamina



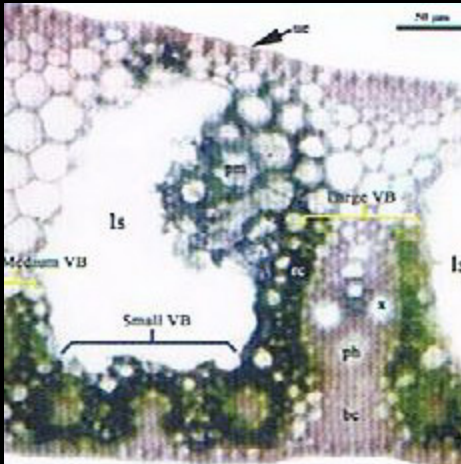
vein



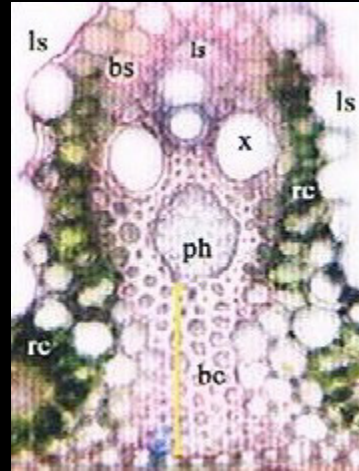
Lamina angle

Internal structure

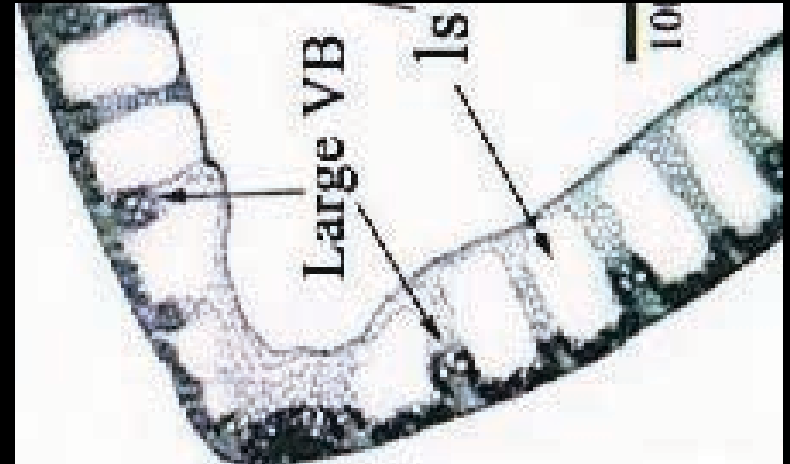
7) Kamphaeng Phet provenance



lamina



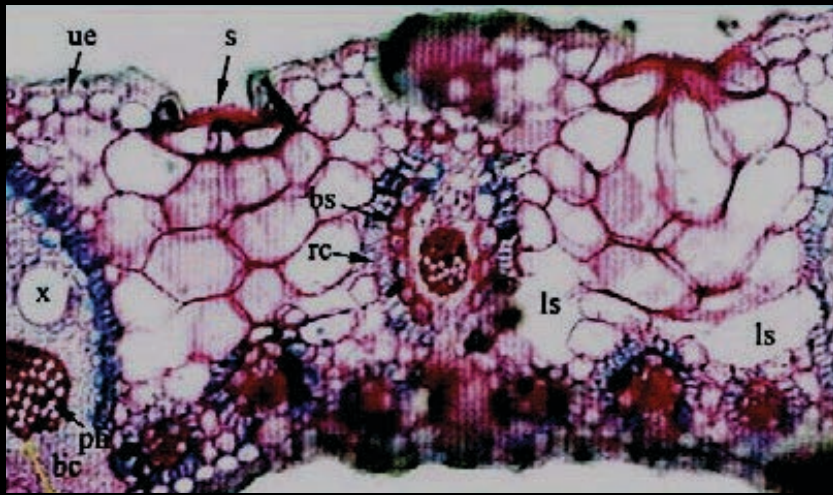
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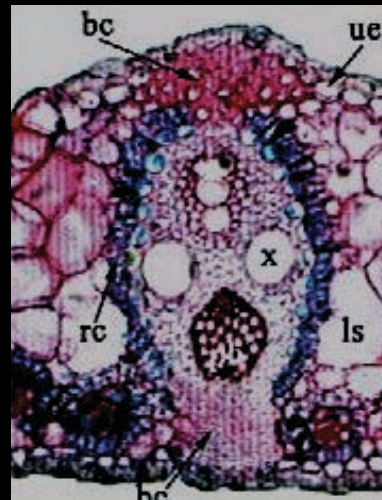
lamina angle

Internal structure

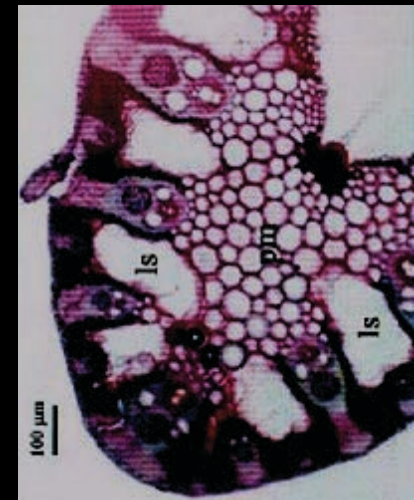
8) Praratchathan provenance



lamina



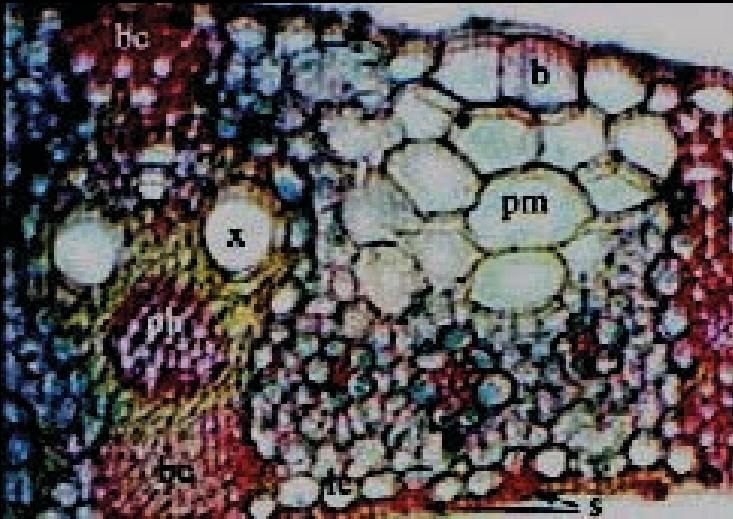
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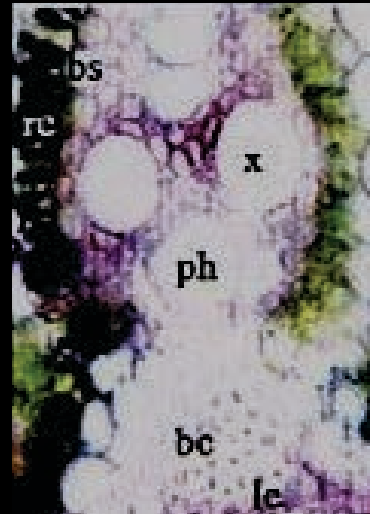
lamina angle

Internal structure

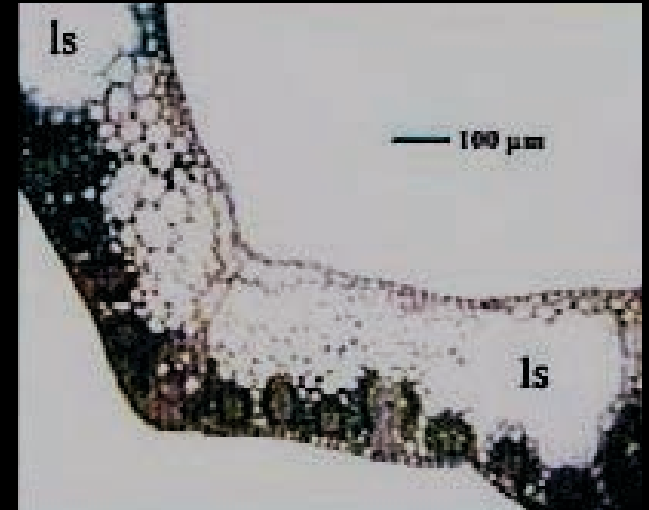
9) Songkhla3 provenance



lamina



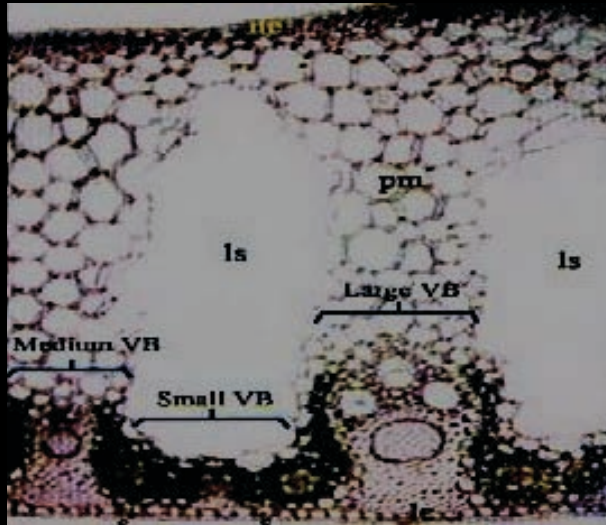
vein



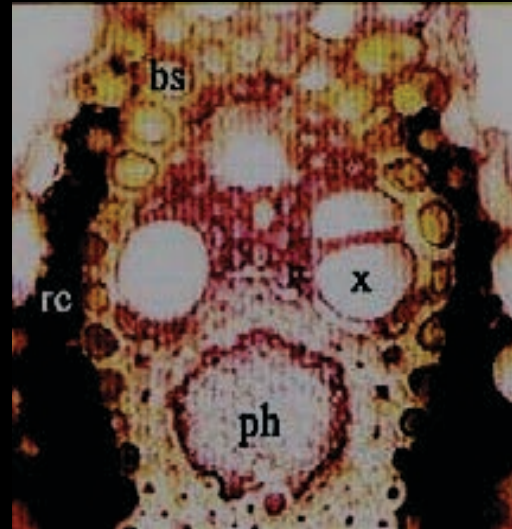
lamina angle

Internal structure

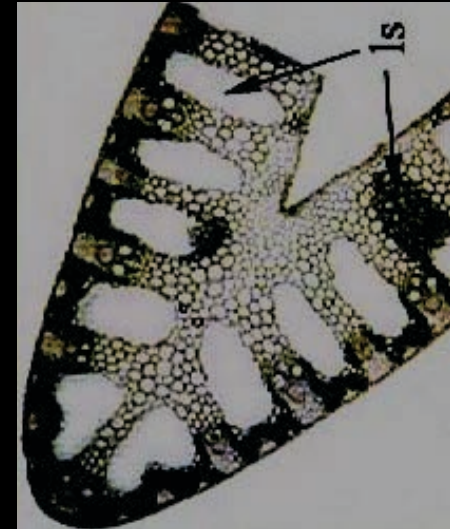
10) Sri Langka provenance



lamina



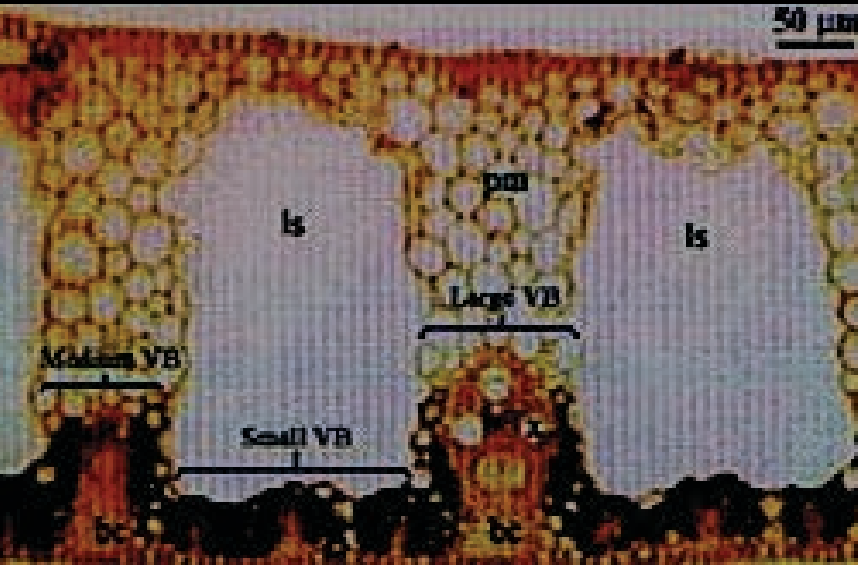
vein



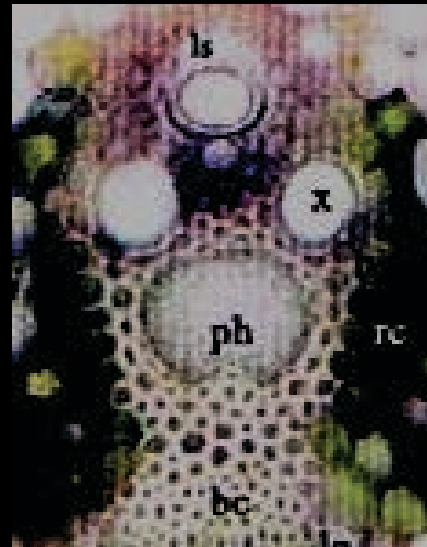
lamina angle

Internal structure

11) Surat Thani provenance



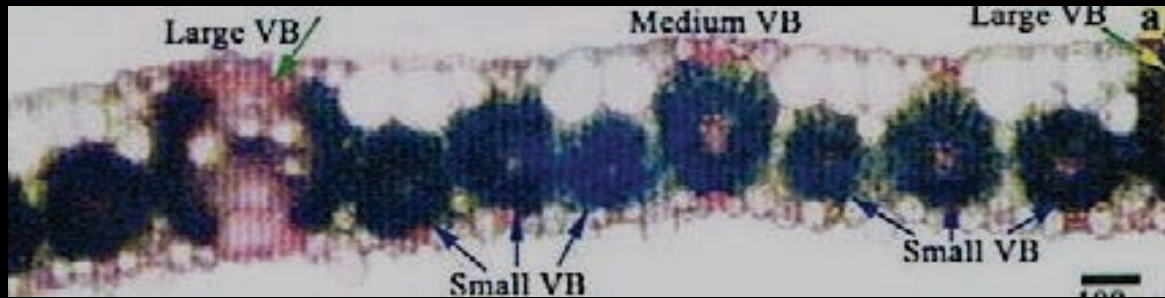
lamina



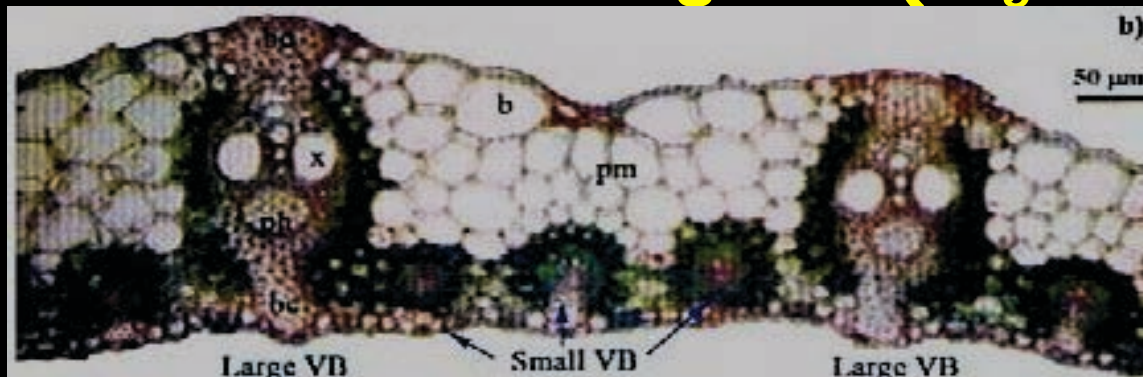
vein



lamina angle



Para grass (หญ้าขน)



Lemon grass (ตะไคร้)

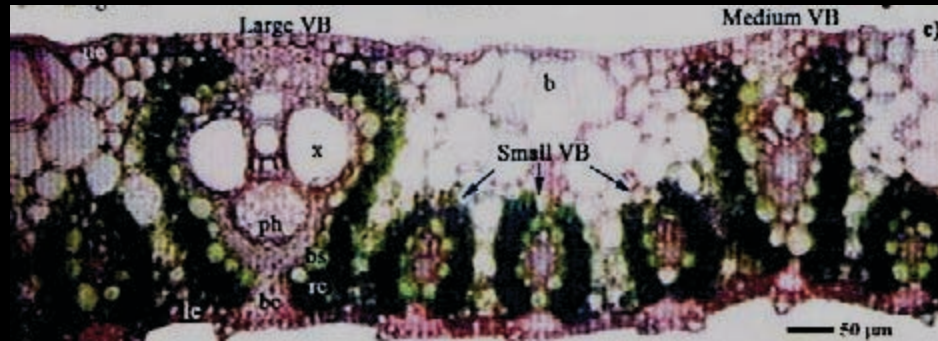
Appendix 3



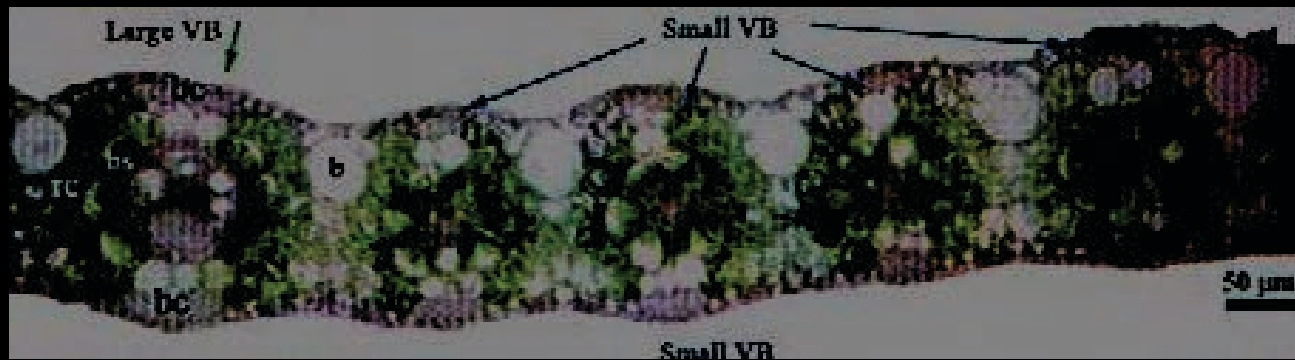
Maize (ข้าวโพด)



Imperata cylindrica ,Cogon grass, (หญ้าคา)



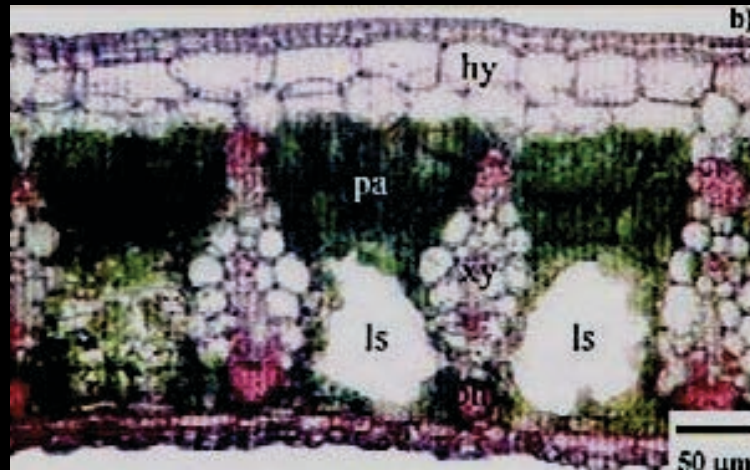
Sugarcane (อ้อย)



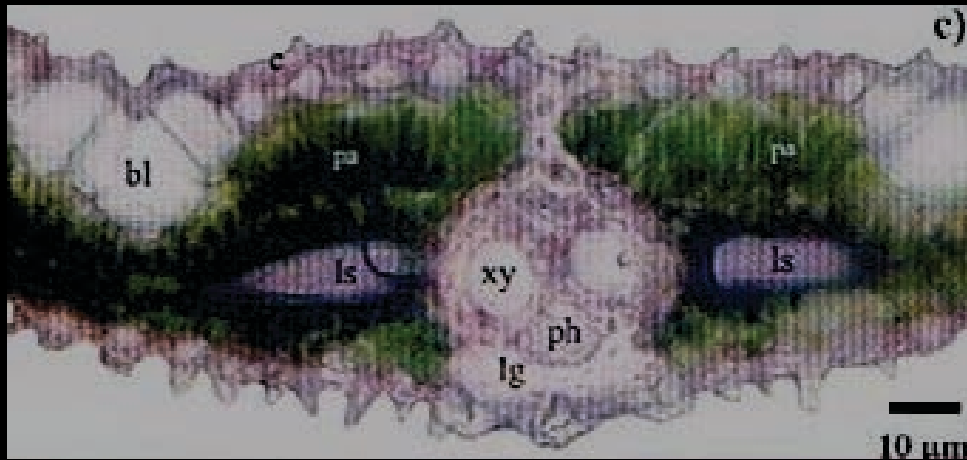
Goose grass (หญ้าตีนกา)



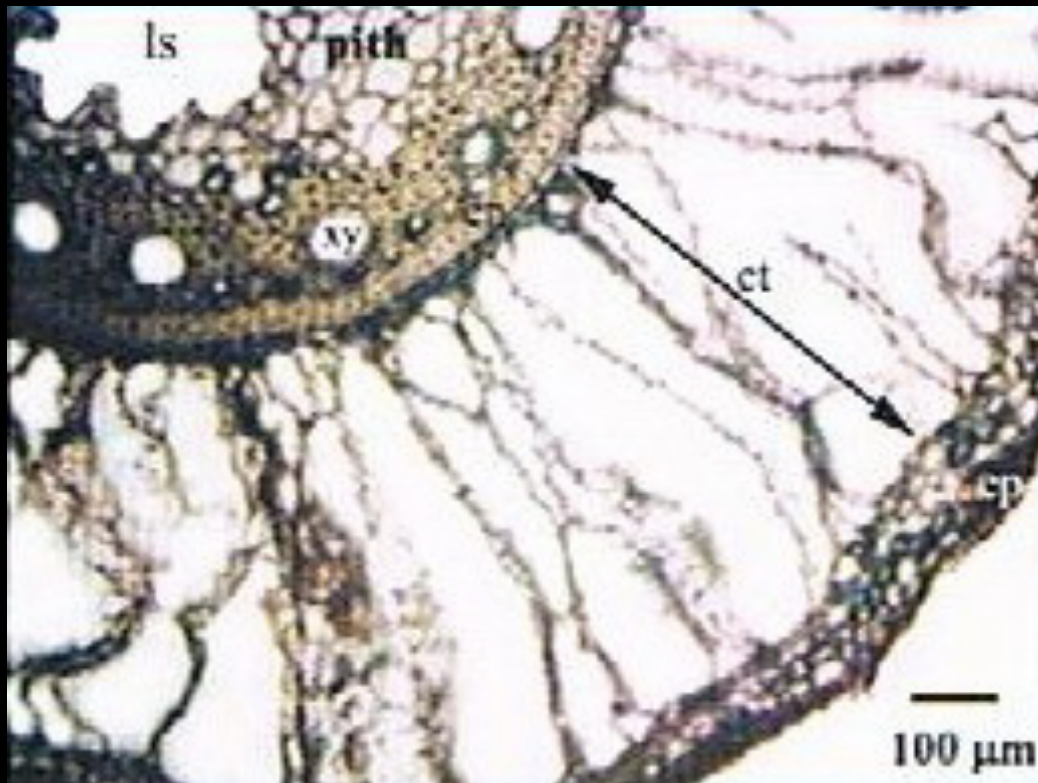
Guinea grass (หญ้่ากีนี)



***Musa sapientum* Linn. (กล้วย)**

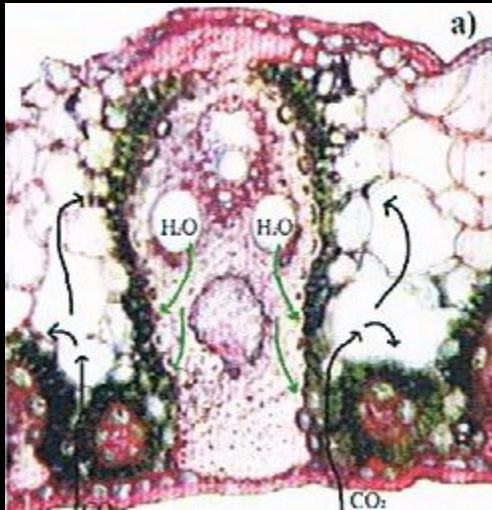


***Thyrsostachys siamensis* Gamble. (ไผ่รวก)**

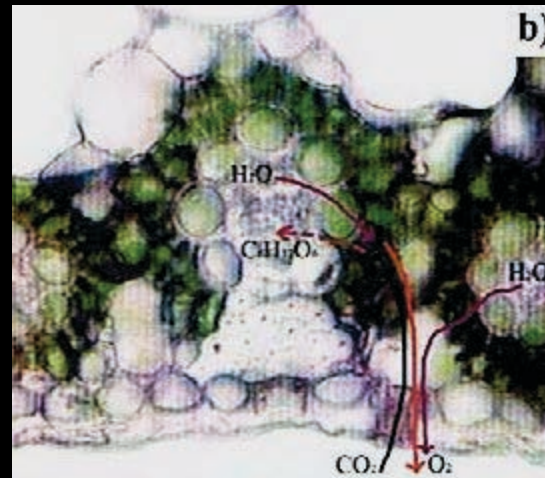


Vetiver root

CO₂ and H₂O distribution to photosynthesis site



Large VB



Small VB

Cogon grass



Leaves of two species conifer and cycad show hydraulic flow path (midrib to stomata) facilitate by water-conducting sclereids