

Silica distribution in various bamboos species and its effects on plant growth

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Introduction

Bamboos are distributed throughout the world's temperate, tropical and subtropical regions. They are widely used in industry, as fresh edible shoots, paper maker, building and even in medicine. Bamboos also play multiple ecologic functions such as soil and water conservation and erosion control¹. Bamboos have generally high silicon (Si) content². Silicon is known to have beneficial effects on plants and alleviate various stresses³ (salinity, metal toxicities...). Silicon concentration ranges from 0.3 to 41 % SiO₂ of dry matter (DM)^{2,4}.

Objectives

- 1 - Quantify the Si uptake and distribution among plant organs in various bamboos species.
- 2 - Investigate the effects of Si on the plant growth.
- 3 - Examine the Si deposition and localization in different organs: leaf and root.

Results

Inventory of Si tissue content in several bamboos species growing at the Reunion Island (France, Indian Ocean)

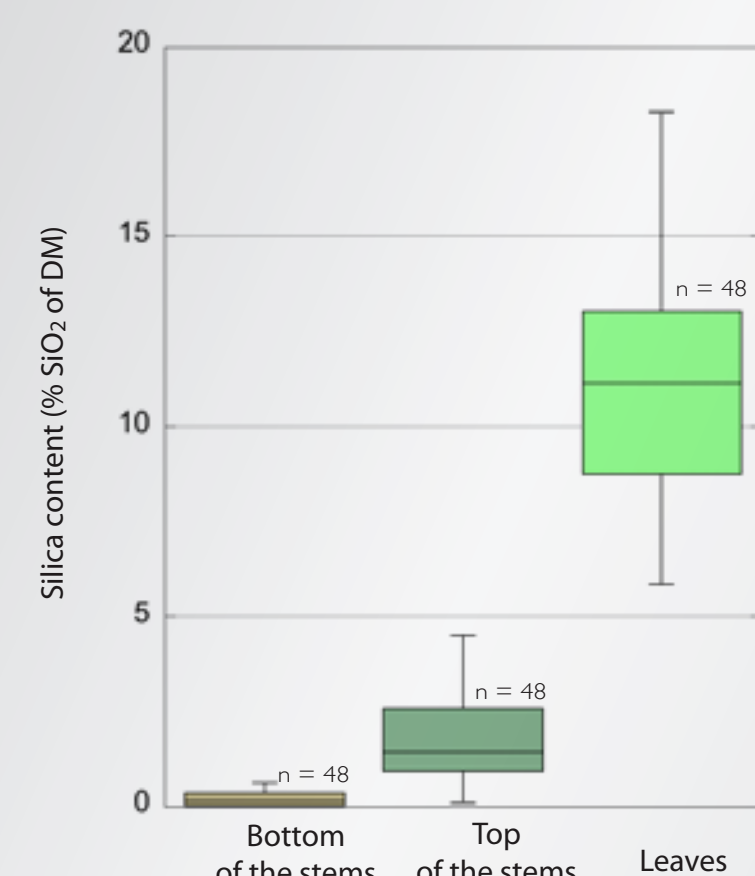


Sympodial bamboos *Dendrocalamus giganteus*

Sampling of 16 species of bamboos:
10 sympodial bamboos with leptomorph rhizomes and 6 monopodial bamboos with pachymorph rhizomes.

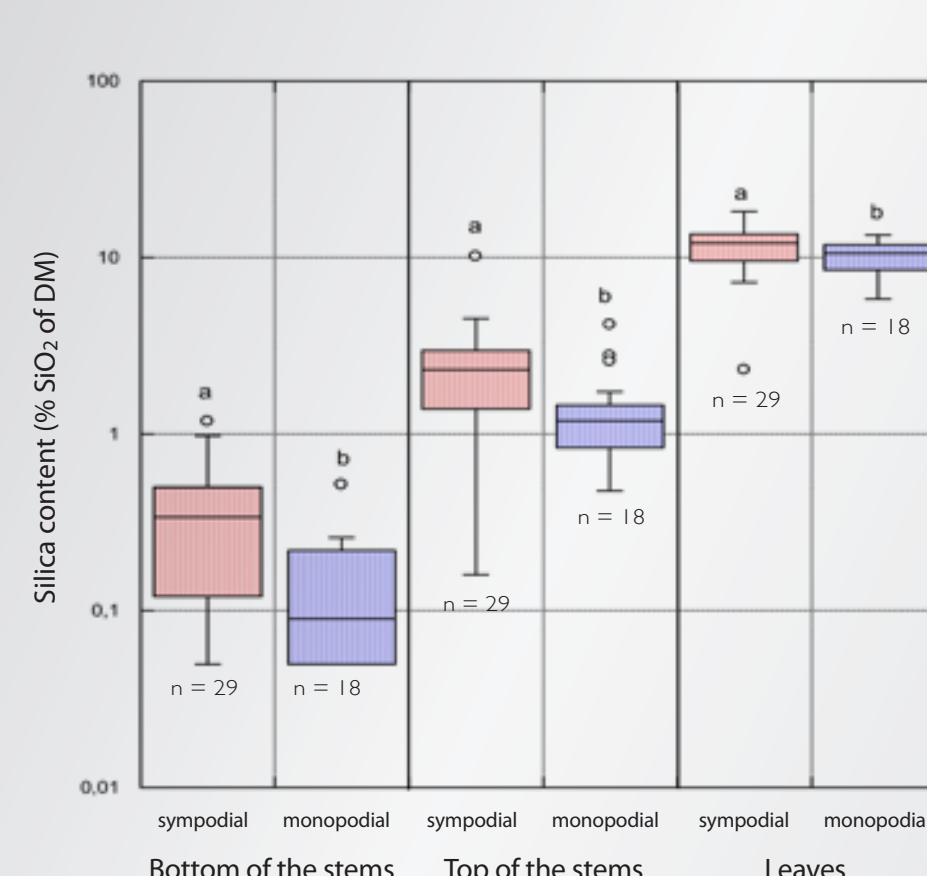
Quantification of Si in leaves, in the bottom and the top of the stems, and in soils.

Distribution of Si in aerial parts of bamboos



Accumulation of Si in leaf ranges from 6 to 17 % DM. Si concentration gradient in stem.

Influence of species



In all organs, sympodial bamboos accumulate more Si than monopodial bamboos.

Various bamboos grown on a soil were used to determine natural Si content.

Effects and distribution of silicon in bamboo under controlled conditions



Hydroponic culture of a sympodial bamboo *Gigantocloa* sp « Malay Dwarf »

Gigantocloa sp « Malay Dwarf » were grown for 6 months under optimal conditions in hydroponics. Bamboos were submitted to a wide range of Si supply: 0; 0.33; 0.75; 1.13; 1.5 mM Si.

All leaves and stems were counted in order to evaluate the development of each bamboo. Chlorophyll fluorescence measurements on leaves were recorded each weeks.

At the end of the experiment, Si and other nutrients (N, P, K, Ca, Mg, Fe, Mn, Cu, Zn) contents were determined in roots, stems and leaves.

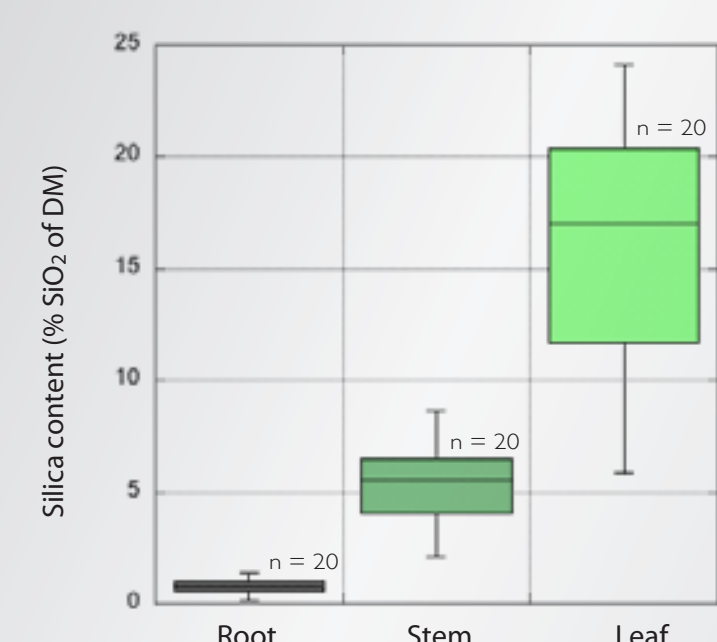
Hydroponics were used to determine the effects of Si on bamboo growth.

Impact of Si on bamboo growth

- no effects on the growth
- no effects on the concentration of nutrients in leaves and roots
- no effects on the photosynthesis

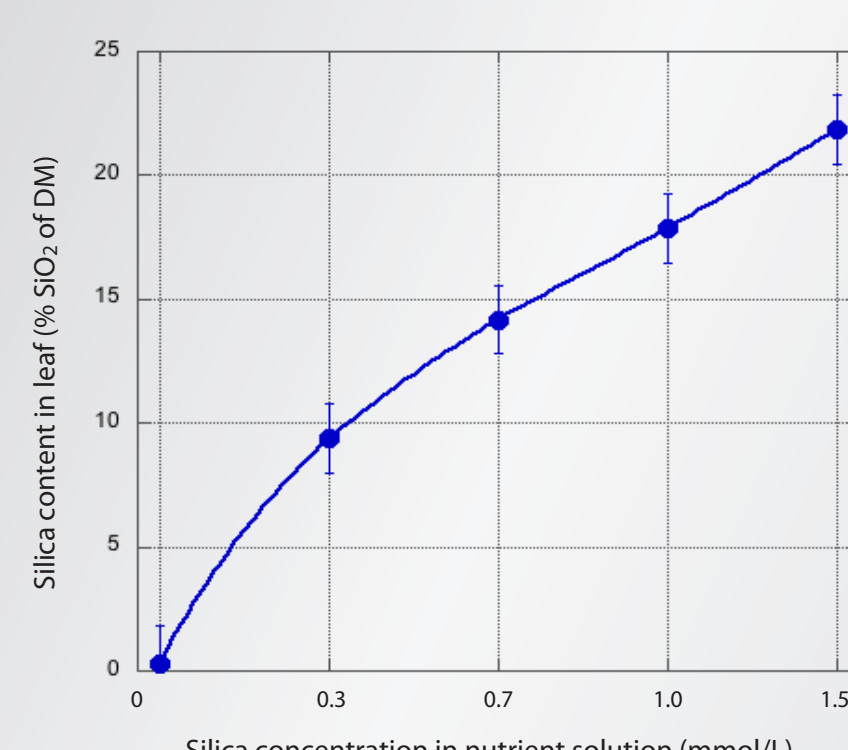
Si has no effect on growth on the whole concentration range tested.

Si gradient in bamboo



Roots have the lower Si content.

Si concentration in leaf as a function of Si concentration in the nutrient solution



Bamboo accumulates up to 24% Si in the leaves. The uptake is proportional to the supply of Si.

Conclusions

- The various species exhibit significant differences in their silicon accumulation.
- Silica content of bamboo increases from roots, through the stem, to leaves. This distribution points out the major role of the transpiration in silicon accumulation and thus the importance of passive mechanisms for the transport of Si in bamboo².
- Silica is accumulated mainly in epidermis in leaves and in endodermis in roots.
- Our results did not reveal any positive effect arising from Si supply even if the Si concentration in plant tissues increased markedly with the Si supply.

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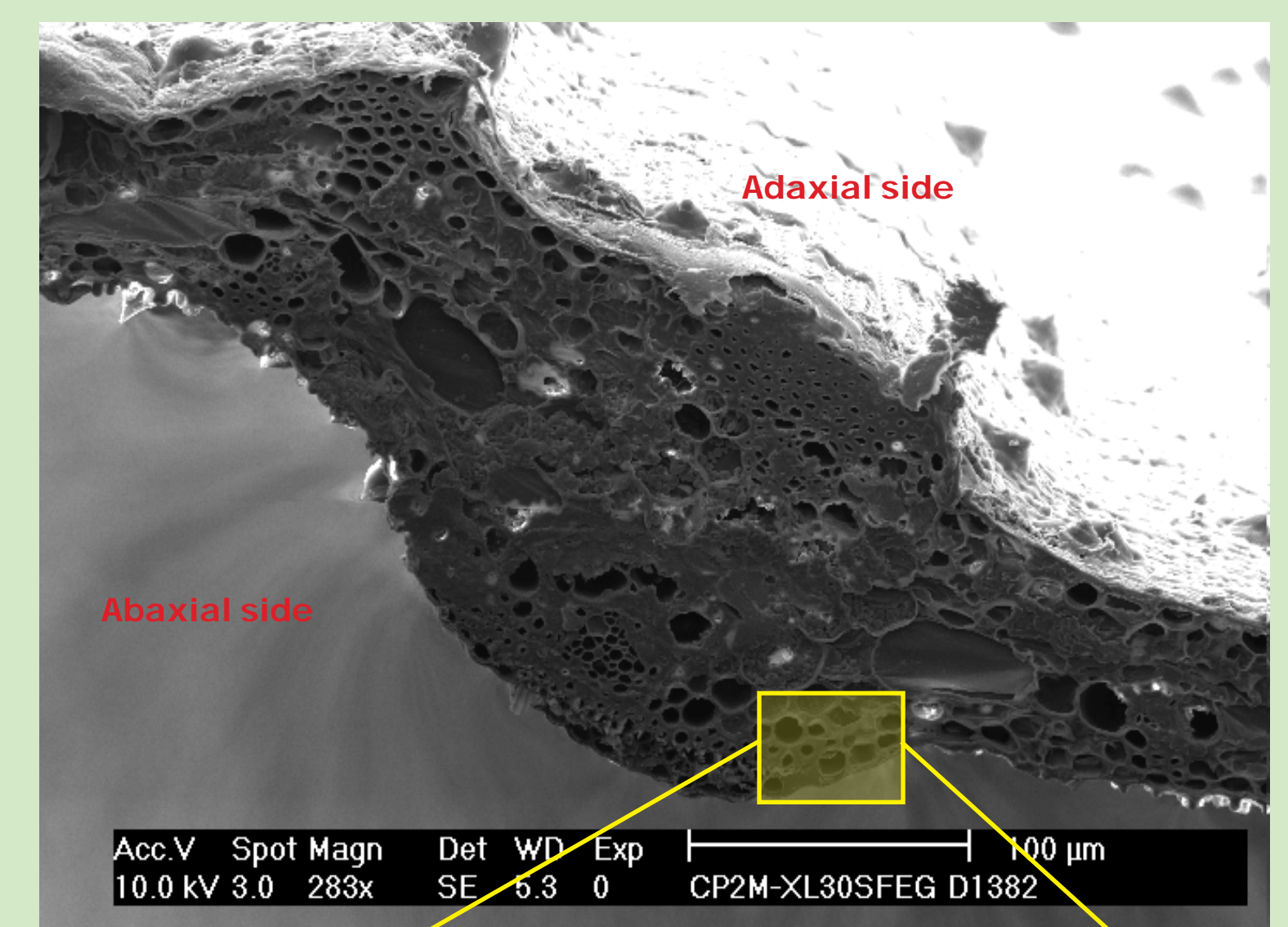
Ueda and Ueda (1961) have shown that application of silicic acid has a positive effect on bamboo growth⁵. In this study we examined the genotypic variability for Si concentration, the distribution of Si in the plant and the importance of concentration of Si nutrition on growth. Such knowledge is important to better understand the mechanism of plant Si uptake and allocation.



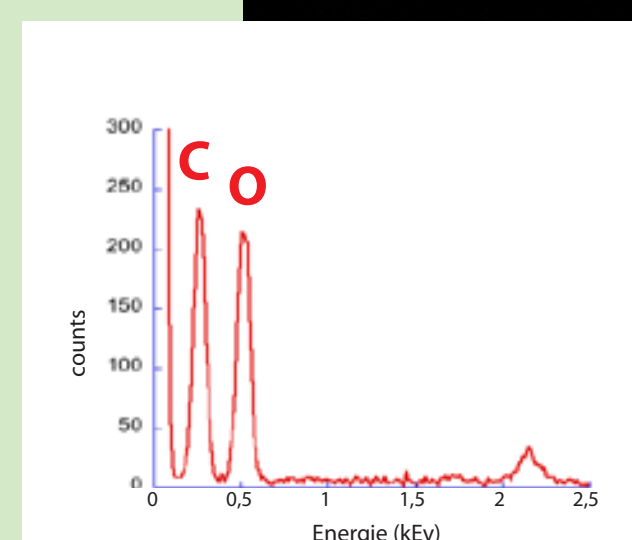
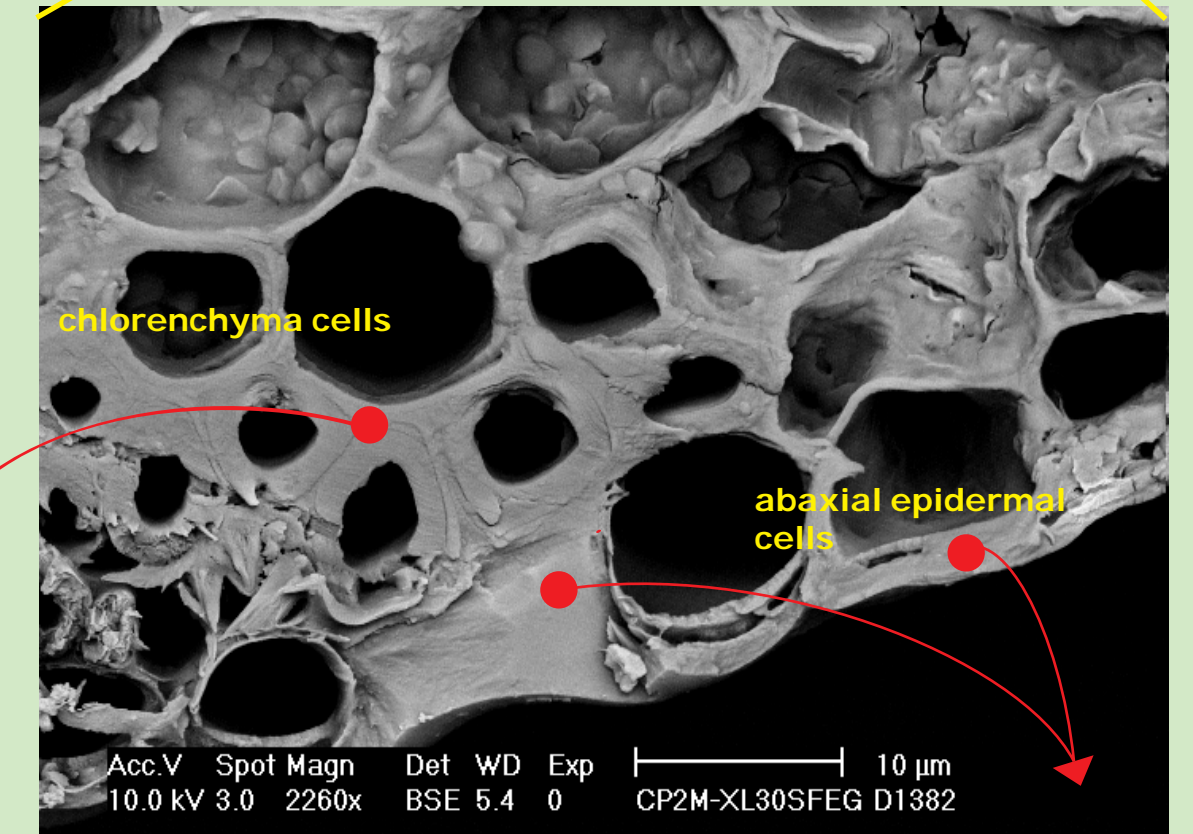
Silica deposition in leaf and root

Leaves and roots were examined using cryo-Scanning Electron Microscopy, coupled with an Energy Dispersive Spectrometer (SEM-EDS)

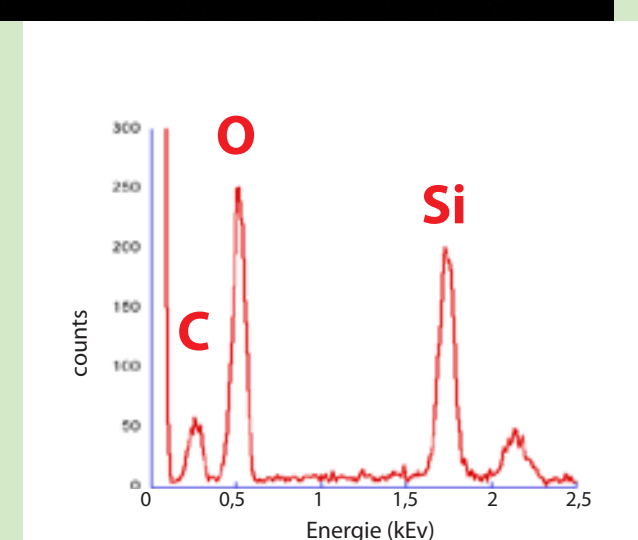
SEM micrograph of a leaf section of *Gigantocloa* sp « Malay Dwarf » growing in hydroponic culture with 1,5 mM Si during 1 month:



ZOOM



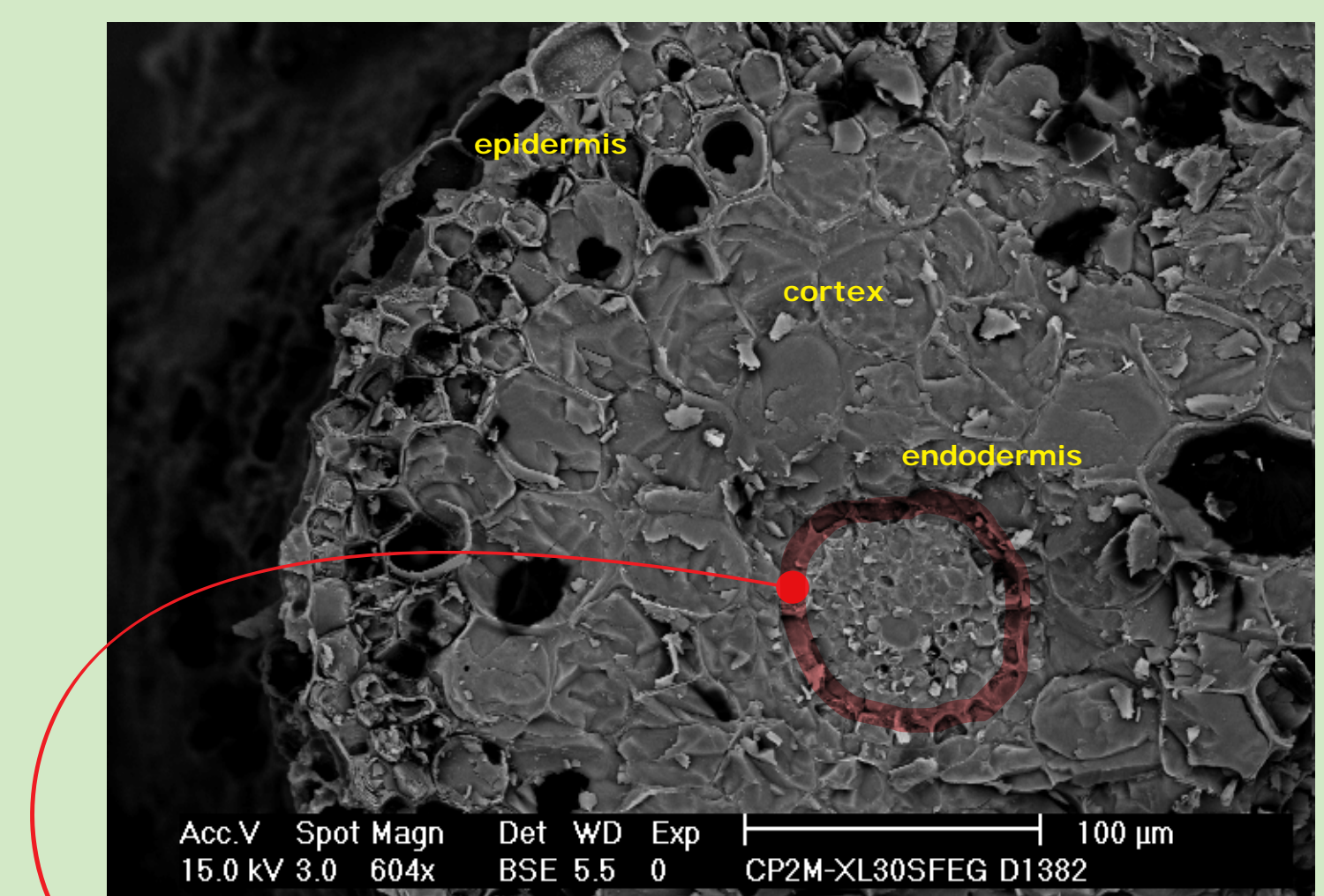
No Si deposition in chlorenchyma cells



Large amount of Si detected in epidermal cells

Silica deposition occurs mainly in the epidermis (outer periclinal cell wall, bulliform cell, hair...).

SEM micrograph of a root section of *Gigantocloa* sp « Malay Dwarf » growing in hydroponic culture with 1,5 mM Si during 6 months:



Silica was detected exclusively in the single layer of endodermal cells.

Silica deposition occurs in the endodermis.

Literature

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