material is lost before secondary wall deposition and before the formation of perforation plate unlike in *D. alata* [5]

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WATER STRESS INDUCED BY Zn DEFICIENCY IN CABBAGE

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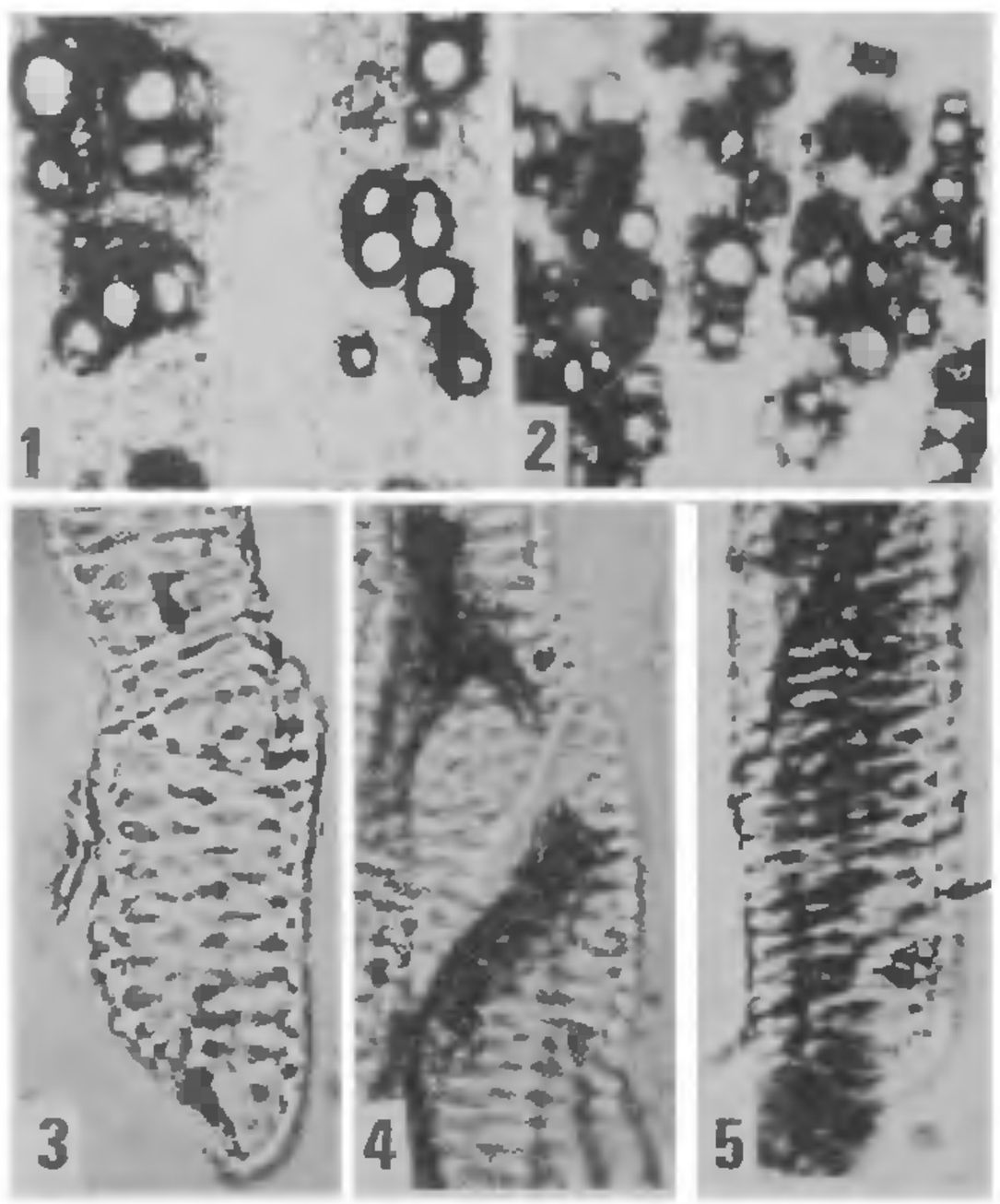
IT has been shown that zinc deficiency lowers osmotic potential, increases water saturation deficit and induces stomatal closure suggesting development of water stress in cabbage[1]. Little is, however, understood about the involvement of zinc in water relations. In this study efforts were made to examine if the water stress in zinc-deficient plants was caused by impediment in water transport from roots to top parts.

Cabbage (*Brassica oleracea* L. var. capitata cv. Pride of India) plants were grown at normal (1 μM) and deficient (0.001 μM) supply of zinc in 5 litre corning glass beakers in half strength Long Ashton nutrient solution[2]. At 2 months growth, zinc deficiency effects were examined on root morphology, stomatal aperture, tissue hydration, water potential (ψ), water saturation deficit and proline content and on water loss (transpiration) from comparable middle leaves (15th to 17th from the base) as described earlier[1]. The freshly cut transverse sections of roots and mechanically isolated xylem vessels from the roots were examined in microscope after some histochemical tests.

Zinc deficiency retarded growth and induced visible symptoms. Middle leaves of zinc deficient plants were small, thick and leathery. Old leaves appeared dull with purplish pigmentation along the margins. Zinc deficient leaves lacked succulence and lustre and were shed premature. The rootlets of zinc deficient plants produced copious mucilage, developed inter-xylary cork and showed more pronounced periderm.

A large number of xylem vessels in the roots of zinc deficient plants contained a yellowish to light brown thick viscous substance (figures 1–5), which was soluble in HNO_3, insoluble in alcohol, ether and acetone, formed crystals upon treatment with NaOH, loosened and oozed out of the vessels upon treatment with HCl, gave positive test with 5% tartaric acid in ethanol and I-KI solution recommended as a histochemical test for alkaloid localisation[3]. The accumulation of this substance, an alkaloid or possibly a glucosinolate derivative, along the perforation plates in xylem vessels of cabbage roots impeded water transport from roots to top parts inducing water stress manifest as poor tissue hydration, high water saturation deficit, low water



Figures 1–5. 1. Xylem elements in transverse section of root of a normal plant. **2.** Xylem elements in transverse section of root of a zinc deficient plant showing blocking of vessels. **3.** A vessel isolated from the root of a normal plant. **4.** A vessel isolated from the root of a zinc deficient plant showing blocking around perforation plate. **5.** A vessel isolated from the root of a zinc deficient plant from which the substance causing blocking is seen oozing out upon treatment with concentrated HCl.

Table 1 *Effect of zinc deficiency on stomatal aperture, tissue hydration, water saturation deficit, water potential and proline content in leaves of cabbage plants grown in solution culture (mean values)*

	Treatment	
	Normal	Zinc deficient
Stomatal pore width (μm)	8	2
Tissue hydration (g water/ g dry wt)	6.76	3.43
Water sturation deficit (%)	5.63	10.49
Water potential (bars)	−5.7	−10.1
Proline (μ moles/g fresh wt)	0.473	1.142

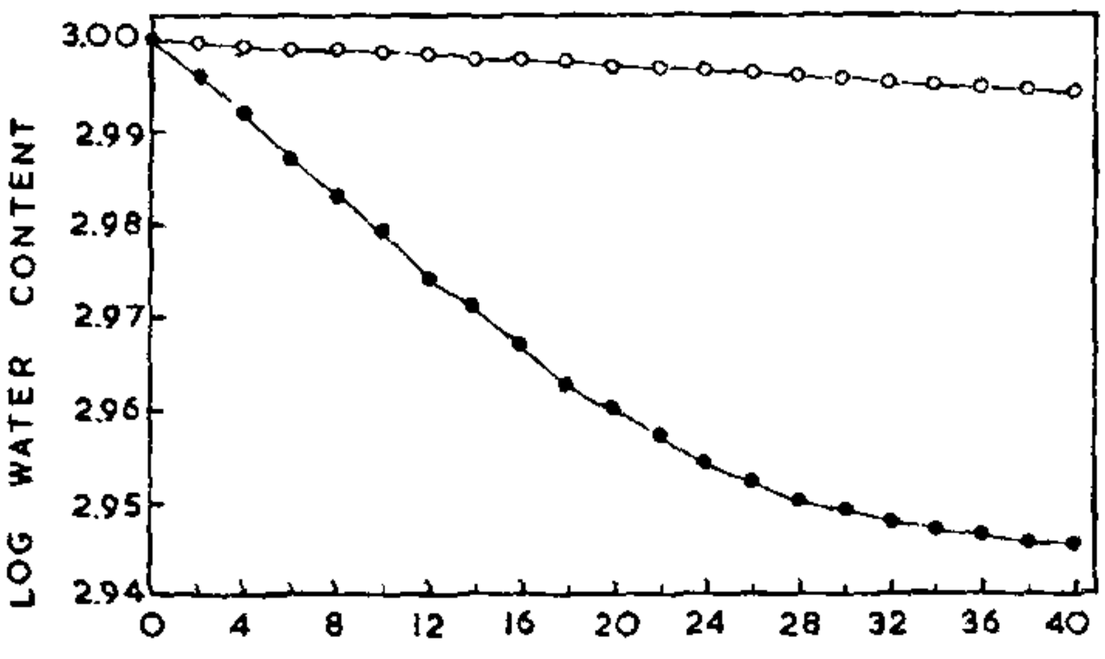


Figure 6. Water loss curves for zinc deficient (open circle) and normal (closed circle) leaves.

potential and accumulation of proline in leaves (table 1).

Compared to normal leaves, a large proportion of stomata in zinc deficient leaves remained closed and this was reflected in marked decrease in water loss (transpiration) by detached leaves of zinc deficient plants. Comparison of water loss curves of normal and zinc deficient leaves (figure 6) suggests loss of hydro-sensitivity of the stomata under zinc deficiency. This may be caused by poor mobilisation of starch to produce organic acids *via* PEP involving carbonic anhydrase[4]. Leaves of zinc deficient cabbage plants were found earlier to show low activity of carbonic anhydrase and increased accumulation of starch[1].

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ON FOLIAR SCLEREIDS IN *ASTEROPEIA* THOU.

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THE utility of foliar sclereids as diagnostic features and their value in assessing the affinities of taxonomic categories are well known[1]. The present paper deals with details of distribution of leaf sclereids and their typology in six species of *Asteropeia*, in addition to providing a key to the species and an evaluation of the totality of useful endomorphic features.

The six species of *Asteropeia* investigated possess diffuse foliar sclereids. Some species have only spheroidal or sub-spheroidal type of sclereids while others have both ramiform and sub-spheroidal types. Their location inside the mesophyll is found to be useful at species levels.

Asteropeia, a genus of anomalous taxonomic status has c.7 species confined to Madagascar. The leaf specimens for this investigation were obtained as a gift through the courtesy of the Director, Museum National D'Histoire Naturelle, Laboratoire De Phanerogamie, (P), Paris. The following vouchered specimens have been examined:-

Asteropeia Thou: *A. ambylocarpa* Tul., Madagascar, R. Capuron 18.932 SF(P); *A. micraster* Hallier., Madagascar, Perinet 5586 SF(P); *A. multiflora* Thou., Madagascar, R. Capuron 8319 SF(P); *A. densiflora* Baker., Madagascar, R. Capuron 11.550 SF(P); *A. rhopaloides* H. Br., Madagascar, R. Capuron 8802 SF(P).

The leaf fragments were partially cleared by soaking in 5% sodium hydroxide overnight at 60°C. They were then thoroughly washed in water and treated by a mixture of trichloroacetic acid and phenol (2:1) for 10–15 min at 60°C[3] till they became perfectly transparent[2]. A few leaf fragments were hand sectioned and