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On the ecological significance of seed-coat patterns in the genus *Tulbaghia* (Alliaceae)

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Abstract - A Scanning Electron Microscopy study in the genus *Tulbaghia* has shown an interesting correlation between the ecology of the species and their seed-coat patterns. The species from dry habitats have a seed-coat composed of loose cells capable of taking up water quickly while the species from wet habitats have seed-coats with cells welded together by ribbon-like sutures somewhat impermeable to water. A number of species have seed-coats of an intermediate type and have an intermediate type of behaviour.

INTRODUCTION

Following the first cytotaxonomic survey of the genus *Tulbaghia* by VOSA (1975), the Scanning Electron Microscopy (SEM) analysis of the seed-coat patterns in this genus was carried out in order to find possible additional characters useful for classification (VOSA 1983). The results of this first SEM study have been very interesting and demonstrated that each one of the nineteen species analysed have their own striking species-specific features. In this context, it was pointed out that such well defined characters may have a certain ecological significance. The present study is an extension of the previous analysis with, in addition, a set of experiments in order to elucidate further the relationship between seed-coat patterns and the strict requirements of the habitat.

MATERIALS AND METHODS

Ripe seeds were collected exclusively from just dehiscent capsules. Seeds from five to ten plants from different collections of each species, were sputter-coated with gold to about 20 nm of thickness with a Polaron E-500 Coating Unit, and examined and photographed with a Cambridge Steroscan S-150 Scanning Electron Microscope.

For the permeabily experiments, carried out at a uniform room temperature of about 22°C, samples of 25 seeds from each species were put in 250 cc pyrex glass beakers, flooded with rain water and monitored for up to 12 hours.

RESULTS AND DISCUSSION

The genus *Tulbaghia* includes about 20 species of perennial cormophytes endemic of Southern Africa (VOSA 1975, 2000). Their habitat ranges from semi-desertic to wet or boggy areas with the majority of the species being found in the summer-rain area with only two species, *T. capensis* and *T. alliacea,* in the winter-rain type of climate. Our study has revealed that the seed-coat patterns of the species living in dry habitats are composed of more or less dome-shaped cells with somewhat loose boundaries (type A, Fig. 1a, b, e). The species living in wet habitats have flat cells delimited by ribbon-like sutures (type B, Fig. 1c, f) while the species from intermediate habitats have not-so flat cells, somewhat resembling those of type A but with evident sutures (type C, Fig. 1d). It is interesting to note that in *T. dregeana* (Fig. le), the only species

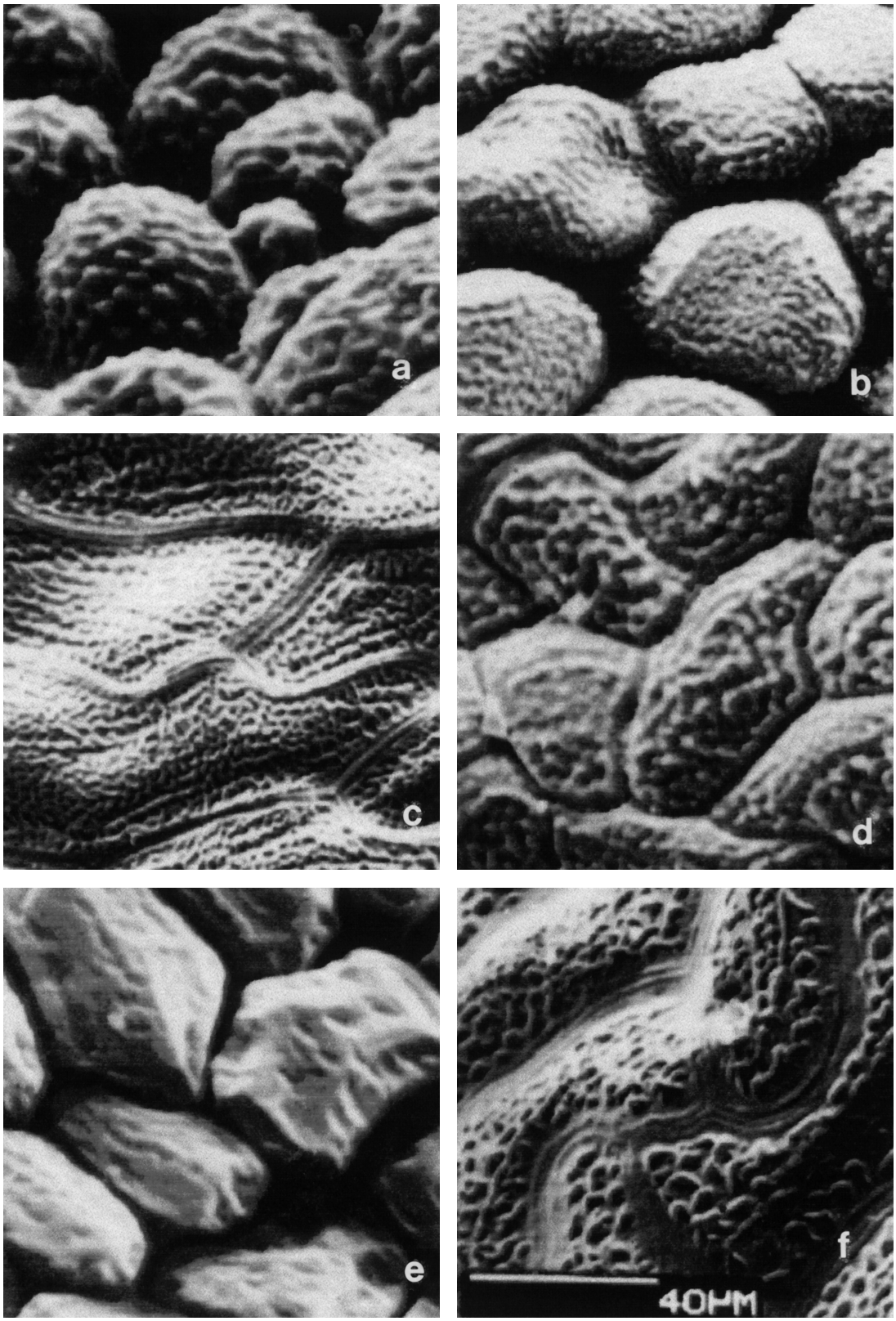

Fig. 1 – Type of seed-coat patterns in *Tulbaghia*: a) *T. cernua* Avé-Lall.: type A; b) *T. transvaalensis* Vosa: type A; c) *T. cominsii* Vosa: type B; d) *T. simmleri* Beauv.: type C; e) *T. dregeana* Bak.: type A; f) *T. violacea* Harv. var. *maritima* Vosa: type B. Note in *T. dregeana* the somewhat polygonal cells with smooth, slightly creased surfaces, very different from the other species of type A. In *T. violacea* var. *maritima,* the cells have peculiar markings on their surfaces and are larger and more elongated than in the other species.

Table 1 - Types of seed-coat patterns in nineteen species and one variety of the genus *Tulbaghia* and their permeability measured as the average time taken before sinking in rain water (see text).

Type A: from 2 to 5 hours	Type B from 8 to 10 hours or more
T. transvaalensis Vosa	*T. violacea* Harv. var. *maritima* Vosa
T. nutans Vosa	*T. cominsii* Vosa
T. macrocarpa Vosa	*T. coddii* Vosa and Burbidge
T. acutiloba Harv.	*T. alliacea* L. f.
T. tenuior Krause et Dinter	Type C from 5 to 8 hours
T. dregeana Kunth	*T. simmleri* Beauv.
T. cernua Avé-Lall.	*T. verdoorniae* Vosa and Burbidge
T. ludwigiana Harv.	*T. galpini* Schl.
T. violacea Harv.	*T. natalensis* Baker
T. leucantha Baker	
T. montana Vosa	
T. capensis L.	

found at the boundary between the winter-rain and the summer-rain regions, the seed-coat is quite different from the other species of type A, with somewhat polygonal cells with almost smooth, slightly creased surfaces. In *T. violacea* var. *maritima* (fig. 1f), the seed-coat cells, with ribbon-like sutures (type B), have peculiar surface markings and are altogether larger and more elongated than in the other species. *T. violacea* var. *maritima* is found near the mouth of a few rivers on the east coast of the Cape Province. The *maritima* variety differs from the normal *T. violacea* which has a type A seed-coat patterns and it is found in dry bush-veld over quite a large area of the Eastern Cape region. The permeability experiments have been made on large samples of seeds from 5 to 10 plants of each species. The results show that type A seeds take up water rather quickly and, in fact, sink in a short time and that type B seeds tend to float usually for a few hours before sinking while type C seeds behave in an intermediate way, taking up water more slowly than type A seeds (Table 1).

The areas inhabited by most of the type A species, with the exception of *T. capensis,* receive their rain usually in the way of heavy showers, interrupted by longish spells of hot and dry weather during the summer. Since the ground dries up in a short time between the showers, it is perhaps indispensable for the seed to take up water as quickly as possible to ensure succesful germination. In the species found in wet or boggy areas (type B), such as *T. cominsii* Vosa, *T. coddii* Vosa and Burbidge and *T. alliacea* L. f., this latter found in the winter-rain type of climate, most of the seeds will fall in the water. Thus, it is essential for them not to sink and to float until the wind, or the flowing of the water itself, may carry them to the edge of the streams or of the temporary ponds where conditions are optimal for germination. The seeds of type C species take advantage of their intermediate type of seed-coat in order to float for a while achieving dispersal carried away perhaps by rivulets created by the showers.

CONCLUSIONS

The demonstration of the close relationship between the morphology of the seed-coat in *Tulbaghia* and the type of habitat is rather interesting and shows that the permeability of the seeds is a very important ecological trait related to germination and to seed dispersal.

In Southern Africa, and generally in the Southern Hemisphere, the climate has been more or less stable even during the last glaciation. The results of these stable climatic conditions have been the evolution of peculiar adaptive features such as the micro-morphological characters of the seed-coat as seen in *Tulbaghia* and, overall, the establishment of the extraordinary number of plant endemisms in the Southern African flora.

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