Ultrastructural Features of the Starch Sheath Cells of the Primary Pulvinus After Gravistimulation of the Sensitive Plant (*Mimosa pudica* L.)

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Summary

In *Mimosa pudica* the primary and secondary motor organs (pulvini) of fully grown leaves are capable of graviresponse. These organs possess sedimentable amyloplasts in their starch sheath cells.

In the primary pulvinus these cells are characterized by a structural polarity induced by the localization of nucleus at their (morphologically) apical part and the localization of amyloplasts at their (physically) basal part. These cells also display structural peculiarities including plasmodesmatal disposition, little development of the endoplasmic reticulum and an absence of vacuolar tannins; moreover, the sedimentation of the amyloplasts, induced by gravistimulation, is accompanied by the variation of localization of the cytoplasm, vacuole and mitochondria and by structural modifications of the nucleus and endoplasmic reticulum.

Keywords: Gravistimulation; *Mimosa pudica*; Pulvinus ultrastructure.

1. Introduction

The influence of gravity on the direction of growth in developing plant parts has been the subject of many studies, but few works have been concerned with the graviresponse of fully grown dicotyledonous leaves possessing motor organs (pulvini). Such studies made, have been carried out by Preffer (1912), Arslan (1949), and in *Mimosa pudica*, by Gavaudan and Roblin (1969).

In parallel with the studies concerning movement expression we were interested by the problem of gravity perception. In various plant parts capable of gravicurvature (namely in roots, coleoptiles and stems), sedimentable starch granules have been observed by Noll (1900), Nemec (1900) and Haberlandt (1903) who postulated that these organelles play a role in graviperception.
This statolith theory of graviperception was criticized, but later was revived and given a new credibility. Achieved in three hours, the foliar graviresponse of an inverted sensitive plant is considerably longer than those induced by other stimuli; the gravicurvature itself is realized in the primary and secondary motor organs, the innermost cortical layer of which constitutes a starch sheath. Present studies deal with the cytophysiology of this starch sheath in the primary pulvinus.

2. Material and Methods

Plants were grown in a mixture of garden soil, mould, sand and peat in the percentages of 50, 20, 15, and 15 respectively; conditions during cultivation were as such; temperature was kept at $28 \pm 1^\circ C$, relative humidity at $70 \pm 5\%$, light was provided, between 7 a.m. and 9 p.m. by a fluorescent source "Phyto" (ACEC Charleroi, Belgium) which gave $5,600 \text{ ergs cm}^{-2} \text{ s}^{-1}$ at the apex of the plants. The studied leaves, of basifuge number 7, belonged to plants possessing 10 leaves which were sensitive to mechanical stimuli. Pulvini were fixed in 3% glutaraldehyde in 0.05 M cacodylate buffer pH 7.2 for 1 hour; this chemical fixation was realized in a device which retained them in the direction they had held on the plant when they were taken. These pulvini, washed overnight in buffer, were post fixed in 1% cacodylate buffered osmium tetroxide pH 7.2 for 1 hour, dehydrated in an ethanol-propylene oxide series and embedded in an Araldite-Epon mixture. Thin sections were stained with uranyl acetate and lead citrate.

Plate I. Ultrastructural variations in the starch sheath cells of the primary pulvinus of *Mimosa pudica* after gravistimulation. (The double arrow shows g direction; the thin arrow, which is pointed towards the petiole, is parallel to the symmetry plan of the pulvinus; the thick arrow indicates the orientation of the plant apex)

Fig. 1. Portion of a longitudinal section of primary pulvinus showing starch sheath cells (Ss) abutting phloem collenchyma cells (Co) and cortical parenchyma cells (Cp); pa amyloplasts

Fig. 2. Pulvinar starch sheath cells of a plant placed in the normal position. Amyloplasts (pa) are located in the morphologically basal cell part, the nucleus (N) in the morphologically apical cell part and the vacuole (v) in the middle cell part. d dictyosome, m mitochondria, mb microbody, N nucleus, pa amyloplasts, pl plasmodesmata, triangle = endoplasmic reticulum

Figs. 3 and 4. Detail of cell similar to those in Fig. 2. Nucleus (N) with few lobes and vacuole (v) without tannins (Fig. 3). Short profiles of endoplasmic reticulum (triangle) surrounded by some vesicles (white arrow) (Fig. 4)

Fig. 5. Starch sheath cell of a pulvinus belonging to a plant inversed for 10 minutes. Amyloplasts (pa) and the major part of the cytoplasm are localized in the physically basal cell part near the sinuous nucleus (N) whereas the vacuole (v) is now at the physically apical cell part. Co collenchyma cells of phloem, m mitochondria, pl plasmodesmata, triangle = endoplasmic reticulum, white arrow = vesicles

Figs. 6-8. Details of Fig. 5. Existence of a nuclear extrusion (open arrow) and of contiguities (curved arrows) between organelles [amyloplasts (pa), nucleus (N) and mitochondria (m)] (Fig. 6). Close contiguity (curved arrow) between the plasmalemma and an evagination of the external nuclear membrane (Fig. 7). Presence of many vesicles (white arrow) in the vicinity of the dilatated endoplasmic reticulum profiles (triangle) and along the plasmalemma (Fig. 8)