PLASTIDS FEATURES AND TRANSFER CELLS OCCURRENCE IN THE PHLOEM OF *PORTULACA MUCRONATA* AND *P. HIRSUTISSIMA* (PORTULACACEAE)

MARIA EMÍLIA MARANHÃO ESTELITA, TEREZA CRISTINA MARINHO

Department of Botany, Institute of Biosciences,
University of São Paulo, C.P. 11461, 05422-970, São Paulo, Brazil.

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ABSTRACT

The species of the *Portulacaceae* of the Serra do Cipó, State of Minas Gerais, Brasil, were studied. In *Portulaca mucronata* and *P. hirsutissima* transfer cells are companion and phloem parenchyma cells; they have the same secondary cell wall features, that is, short papillate protuberances which are uniformly distributed around the primary cell wall. These features are similar in both species but they are very distinct from others referred in the literature; this could be useful in Taxonomy. The phloem plastids have a globular protein in crystalloid, surrounded by proteinaceous filaments. In *P. hirsutissima* few starch grains may also be present, and this occurrence is considered primitive in the phylogenetic scale. These features agree with presumptive evolution of those of leaf structure: *P. hirsutissima* has C₃ photosynthesis structure, and *P. mucronata* C₄ or Kranz anatomy.

KEY WORDS: Phloem plastids, transfer cells, *Portulaca*, *Portulacaceae*.

INTRODUCTION

The minor veins of the leaves play a major role in the transport of water and food (Esau 1977) and distribute the transpiration streams through the mesophyll (Tanton and Crowdy 1972). These minor veins have special features, differing from the rest of the vascular bundles. In the minor veins, transfer cells can occur, with the function of intensive solute transport (Gunning and Pate 1969). This function is associated with developed ingrowths of the secondary wall, consequently increasing the surface area of the plasma membrane. On the other hand, plastids occur in all of the sieve elements; the structure of plastids is considered a character of proved taxonomic value (Behnke 1972) and is used in modern taxonomic systems.

Within the genus *Portulaca* a number of species have been reported as C₄ plants (Hatch et al. 1975, Sprey and Laetsch 1978; Ku et al. 1981), and in several species the structure of phloem plastids were analysed (Behnke 1975 and Behnke et al 1975). However, transfer cells were not registered and relations between plastids and photosynthesis were not observed.

In this paper, the sieve-element plastids and transfer cells were investigated in view of obtaining basis for some phylogenetic and physiological considerations.

MATERIAL AND METHODS

Portulaca mucronata Link. e *P. hirsutissima* are the only native species from Serra do Cipó, State of Minas Gerais

(Giulietti et al. 1987). Leaf pieces were fixed for 8 h in 4% glutaraldehyde buffered with sodium phosphate. After washing, the pieces were postfixed for 2 h in 1% OsO₄. The tissues were then dehydrated in an ethanolic series, and embedded in Spurr (Spurr 1969). Sections were post-stained in uranyl acetate and lead citrate.

RESULTS AND DISCUSSION

The transfer cells of *P. hirsutissima* and *P. mucronata* have the secondary wall with short papillate protuberances (Figs. 1 and 2); therefore, they could be included in the simplest class defined by Pate and Gunning (1972). The protuberances are uniformly distributed around the primary cell wall. Because of their shortness, they are not seen by light microscopy, as in many species of the *Asteraceae* such as *Ammobium alatum*, *Pulicaria vulgaris* and *Osteospermum vaillantii* (Gunning and Pate 1969; Pate and Gunning 1969).

Changes in the protuberances in late cell differentiation stages were not observed, as referred by Peterson and Young (1975) in *Hieracium floribundum*; these authors found that the number of wall protuberances decreased concomitantly with the differentiation of the phloem transfer cells.

In the species studied here, the transfer cells are companion and phloem parenchyma cells. However, these cells show distinct features in relation with the classification of Pate and Gunning (1969); the companion cells seem to be of type A, (A type are companion cells with wall ingrowths around the cell periphery, but ingrowths have a reduced frequency on the

Fig. 1. *P. hirsutissima*. Electron micrograph showing transfer cells. (C – companion cell; P – phloem parenchyma cell; T – wall protuberance; D – dictyosome; arrow-artifact) 12.000 x.

Fig. 2. *P. mucronata*. Protuberances of the transfer cell wall. 25.000 x.

Fig. 3. *P. mucronata*. PIIIa plastid. 30.000 x (L – plastid; V – vesiculated thylakoid; R – crystalloid; F – protein filaments; H – half-plasmodesma; arrows-artifacts).

Fig. 4. *P. hirsutissima* PIIIas. 20.000 X. (L – plastid; R – crystalloid; F – protein filaments; S – starch).

wall adjacent to sieve element, probably due to the presence of plasmodesmata fields), but there is no reduction of the number of wall protuberances in swollen plasmodesmata fields. The plasmodesmata occur only in one cell wall (Fig. 3), that is, they are half-plasmodesmata, according to Robards and Lucas (1990). On the other hand, the transfer cells of the phloem parenchyma do not show polarized distribution of the wall protuberances (Fig. 1) as emphasized by those authors to characterize type B. (B type are phloem parenchyma cells with polarized distribution of the wall ingrowths). In the cells of the species studied here, a great number of mitochondria, polysomes and dictyosomes was observed (Fig. 1); these features are registered by Gunning and Pate (1969) for several Angiosperms and by Peterson and Yeung (1975) for *Hieracium floribundum*.

In the *Caryophyllales*, order which includes *Portulacaceae*, Pate and Gunning (1969) have analysed ten families among twelve of the Cronquist classification system; the authors have not found those cells in the vascular system. In the phylogenetic scale, *Plumbaginaceae* is the nearest family, and it presents type A and A and B cells, so what, this family belongs to the order *Plumbaginales*.

The transfer cells, when occurring in vascular system are a questionable taxonomic feature. However, in this work, the features of transfer cells are similar in both species, but they differ considerably from those transfer cells described in literature. This fact could have taxonomic value for the family *Portulacaceae*.

The plastids of the sieve elements of *P. mucronata* and *P. hirsutissima* show protein inclusions consisting of a globular, central crystalloid, surrounded by protein filaments (Fig. 3). These features characterize the type PIIIa, of the plastid, according to the Walker (1979) classification. This author considers PIII plastids to be restricted to the order *Caryophyllales*, where they are the only kind known. The PIIIa plastid is the most common subtype. The plastids of *P. hirsutissima* present starch (Fig. 4) a characteristic of the sub-type PIIIas. As referred by Walker (1979), this last type rarely occurs; however, this author found it in *Phytolacca dioica* and *Bougainvillea* sp. According to Behnke (1972, 1975) this does not have systematic significance.

Vesiculated thylakoids were also observed; they are situated between proteinaceous filaments (Fig. 3); these thylakoids are more numerous in *P. mucronata*. Behnke et al. (1975) referred the occurrence of these thylakoids in *Portulacaceae* (*Calandrinia compressa* and *Portulacaria afra*), but they lack in *Portulaca foliosa*. According to these authors, the vesiculated thylakoids are frequent in the plastids of several taxa. Behnke (1975) believes that the plastids with starch are more primitive than the plastids without starch, in view of starch being the most common accumulation product in sieve-elements of lower vascular plants and *Gymnospermae*. Thus, it could be suggested that *P. hirsutissima* plastids are less specialized than *P. mucronata* ones; these features agree with the features of leaf structure: *P. hirsutissima* has leaves with C₃ photosynthesis structure, and *P. mucronata* with C₄ or Kranz structure (Marinho and Estelita 1994), that is, the second metabolism type is considered the more specialized (Moore 1982).

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CECHY PLASTYDÓW I WYSTĘPOWANIE KOMÓREK TRANSFEROWYCH
W ŁYKU *PORTULACA MUCRONATA* I *P. HIRSUTISSIMA* (*PORTULACACEAE*)

STRESZCZENIE

Zabowano gatunki należące do rodziny *Portulacaceae* z rejonu Serra do Cipó, stanu Minas Gerais w Brazylii. U *Portulaca mucronata* i *P. hirsutissima* komórkami transferowymi są komórki przyrurkowe oraz komórki miększu łykowego. Posiadają one identyczne cechy wtórnej ściany komórkowej jakimi są krótkie brodawkowate wyrostki rozmieszczone równomiernie dookoła ściany pierwotnej. Cechy te są podobne u obydwu gatunków i odróżniają je od innych opisywanych w literaturze. Tym samym mogą mieć zastosowanie w taksonomii. Plastidy komórek łyka zawierają kulisty krystaloid białkowy otoczony białkowymi włóknami. U *P. hirsutissima* występują również nieliczne ziarna skrobi, ich obecność jest uważana za cechę ewolucyjnie pierwotną. Wszystkie te cechy pozostają w zgodzie z przypuszczalnym kierunkiem ewolucji innych cech budowy liścia. *P. hirsutissima* odznacza się strukturą liścia charakterystyczną dla roślin o fotosyntezie typu C3 podczas gdy *P. mucronata* ma anatomię liścia typu C4 (anatomia Kranza).

SŁOWA KLUCZOWE: plastidy łyka, komórki transferowe, *Portulaca*, *Portulacaceae*.