



Morpho-anatomical study of the cladodes of *Homalocladium platycladum* (F.J. Muell.) L.H. Bailey (Polygonaceae)

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RESUMO: “Estudo morfoanatômico dos cladódios de *Homalocladium platycladum* (F.J. Muell.) L.H. Bailey (Polygonaceae)”. *Homalocladium platycladum*, popularmente conhecido como fita-de-moça ou solitária, é um táxon pertencente à família Polygonaceae, tendo importância como espécie ornamental e medicinal, de acordo com a medicina tradicional oriental e brasileira. O objetivo do presente trabalho foi avaliar a morfoanatomia dos cladódios de *H. platycladum*. O material botânico foi fixado, seccionado e preparado segundo as técnicas habituais de microscopia fotônica e eletrônica de varredura. O cladódio revelou células epidérmicas revestidas por cutícula espessada e estriada. A epiderme uniseriada apresentou estômatos paracíticos e tricomas glandulares localizados em pequenas depressões. Os tricomas foram descritos como capitados, com pedicelo curto e porção apical pluricelular. A região cortical do cladódio revelou faixas descontínuas de colênquima, alternadas com esclerênquima, também encontrado como faixa subjacente. Após a faixa esclerenquimática, limitando internamente o córtex, verificou-se a presença de uma bainha amilífera. O cilindro vascular foi constituído de feixes colaterais. A medula revelou a presença de células parenquimáticas e idioblastos contendo drusas de oxalato de cálcio.

Unitermos: *Homalocladium platycladum*, Polygonaceae, cladódio, morfoanatomia.

ABSTRACT: *Homalocladium platycladum* is a Polygonaceae species, popularly known as fita-de-moça or solitária that has been used as ornamental and medicinal plant, according to Oriental and Brazilian traditional medicine. The aim of this work was to evaluate the morpho-anatomy of the *H. platycladum* cladodes. The botanical material was fixed, sectioned and prepared according to usual light and scanning microtechniques. The cladode presented epidermal cells coated with thick and striate cuticle. The uniseriate epidermis showed paracytic stomata and glandular trichomes inserted in small depressions. These trichomes were capitate and presented short stalk and multicellular head. The cortex showed strands of chlorenchyma alternating with sclerenchyma that was an extension of a sclerenchymatic sheath. An internal boundary of the cortex was represented by a starch sheath. The vascular system consisted of collateral bundles and the pith showed parenchymatic cells and idioblasts containing calcium oxalate druses.

Keywords: *Homalocladium platycladum*, Polygonaceae, cladode, morpho-anatomy.

INTRODUCTION

The Polygonaceae family comprises approximately 40 genera and 800 species located in tropical, subtropical and temperate regions with tree, shrub, liana and predominately herb habit (Barroso, 1978; Cronquist, 1981; Joly, 1998). Morpho-anatomical aspects of Polygonaceae species were previously reported by Metcalfe and Chalk (1950), Inamdar (1969), Kapoort et al. (1971), Mitchell (1971), Esau (1974), Mauseth (1988), Fahn (1990), Lersten and Curtis (1992), Rocha and Rocha (1994), Rudall (1994) and Silva-Brambilla and Moscheta (2001).

In Polygonaceae, *Antigonon guatemalense*

Meissn., *A. leptopum* Hook. et Arn., *Homalocladium platycladum* (F.J. Muell.) L.H. Bailey, *Muehlenbeckia complexa* Meissn., *Polygonum capitatum* Buch-Ham. and *P. orientale* L. are used as ornamental plants (Lorenzi; Souza, 1999).

Nevertheless, medicinal and chemical studies have been conducted mainly in the *Polygonum* species (Mors et al., 2000; Cardoso et al., 2006). *Polygonum* spp. are popularly known as erva-de-bicho in Brazil, e.g., *P. acre* H.B.K., *P. spectabile* Mart., *P. acuminatum* H.B.K., *P. hydropiper* L. and *P. hydropiperoides* Michx. (Corrêa, 1974; 1984). These species are used internally as antihemorrhoidal, astringent and antirheumatic (Martins et al., 1995; Mors et al., 2000) and as antiseptic for topical

use (Gupta, 1995). Extracts of *P. acre* (synonym of *P. punctatum* Elliott) are employed as a topical haemostatic and in the treatment of internal hemorrhages (*e.g.*, in uterus and hemorrhoids). The extracts of the aerial organs of *P. hydropiper* have demonstrated haemostatic action similar to *P. acre*, however with lower efficiency (Joachimovits, 1959). The leaf extract of *P. stelligerum* Cham. has showed the presence of rutin, particularly known for its antibacterial activity (Sartor, 1997). Jácome et al. (2004) reported the presence of triterpenes and/or steroids, coumarins, flavonoids, polyphenols, tannins and saponins in the aerial organs of *P. hydropiperoides* and *P. spectabile*. The study also showed variations on the polyphenol and tannin contents in samples of *P. hydropiperoides* collected in autumn and spring. In addition, it has been reported that *P. multiflorum* Thumb MeOH extracts inhibit the enzyme acetylcholinesterase (Barbosa-Filho et al., 2006a) and the angiotensin converting enzyme (Barbosa-Filho et al., 2006b).

H. platycladum is a one species in genus, native to the Solomon Islands and Papua New Guinea (Liberty Hyde Bailey Hortorium, 1976). This taxum is employed in Chinese traditional therapy (Ryu et al., 2001). In Malay herbal medicine, it is named jarilipan and externally applied to skin wounds caused by arthropods (Ong; Norzalina, 1999). In Brazil, it is popularly known as fita-de-moça or solitária (Lorenzi; Souza, 1999) and its indication is similar to *Polygonum* species. Although few studies have been carried out, mostly devoted to ecological aspects, Ryu et al. (2001) prepared an alcoholic extract of *H. platycladum* and screened its inhibitory activity against nitric oxide (NO) production in lipopolysaccharide (LPS)-activated macrophages. *H. platycladum*, as whole plant, showed 52% of inhibitory activity on the LPS-activated NO production in RAW 264.7 cells at 50 µg.mL⁻¹. This inhibitor may be a useful candidate for the treatment of inflammatory diseases accompanied by the overproduction of NO.

The lack of available data about the morphology of *H. platycladum* has led to this investigation, which described the morpho-anatomy of the cladodes, contributing to the species identification for pharmacognostic purposes.

MATERIAL AND METHODS

The botanical material was collected from cultivated specimens in Umuarama, Paraná, Brasil (altitude: 475 m, latitude: 23° 47' 57" S and longitude: 53° 18' 50" W), in January 2005. The species was identified by the voucher ICN 127138 stored at the herbarium from the Instituto de Ciências Naturais, at Universidade Federal do Rio Grande do Sul. Cladode fragments were fixed in FAA 70 (Johansen, 1940) and kept in 70% ethanol solution (Berlyn; Miksche, 1976). Transverse and longitudinal freehand sections were stained either with toluidine blue (O'Brien et al., 1965) or astra blue and basic fuchsin

(Roeser, 1962). As additional data, the histochemical tests employed were: iodine-iodide to detect starch (Berlyn; Miksche, 1976), ferric chloride for phenolic compounds (Johansen, 1940), Sudan IV for lipophilic substances (Foster, 1949), hydrochloric phloroglucin for lignified elements (Sass, 1951) and sulphuric acid for calcium oxalate crystals (Oliveira et al., 1989). Photos were taken by Olympus BX40 light microscope attached to the control unit PM20. For scanning electron microscopy (SEM) analysis (Souza, 1998), cladodes fixed in FAA 70 were dehydrated in a graded ethanolic series and critical point dried in a Bal-Tec CPD-030, coated with gold in a Balzers SCD-030 and examined by Jeol JSM- 6360LV microscope.

RESULTS

H. platycladum is a perennial shrub, semi-herbaceous, measuring up to 2 m height. Its stem is modified and forms plain, articulate, slightly striate and greenish cladodes (Figure 1) which have no leaves or bear reduced ones.

The cladode is flattened in transverse view (Figures 2 and 3) and exhibits uniseriate epidermis coated with a thick (Figure 6) and slightly striate cuticle (Figure 4). Paracytic stomata are encountered on the same level of surrounding epidermal cells and glandular trichomes are located in small epidermal depressions. These trichomes (Figures 5 and 6) are capitate and present a multicellular head, composed of 4 cells, and a short stalk.

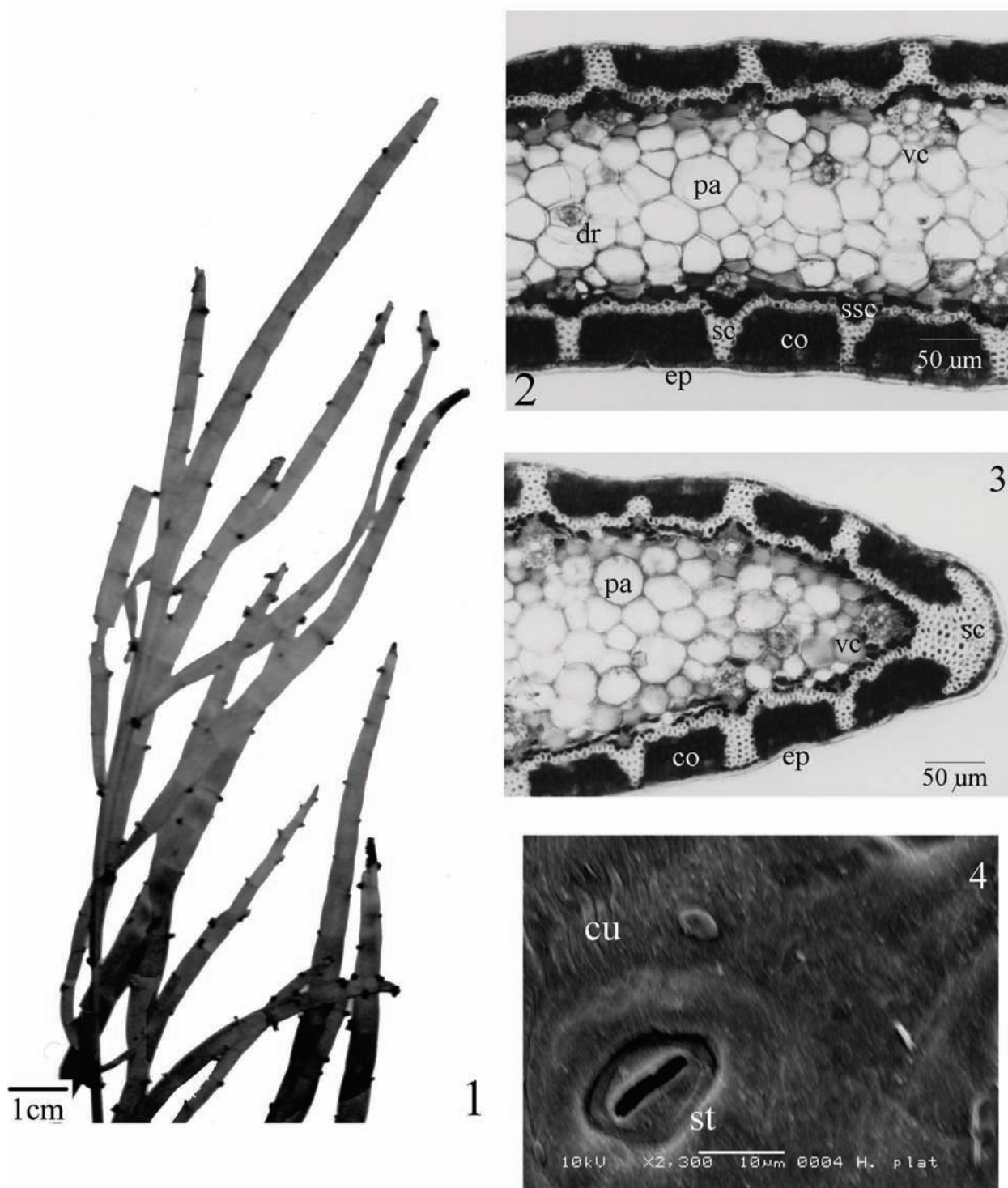
The cortex has strands of chlorenchyma alternating with sclerenchyma (Figures 2 and 3). The latter is an extension of a sclerenchymatic sheath which is formed by 1 or 2 rows of fibers (Figures 2, 3 and 7). An internal boundary of the cortex is represented by a starch sheath, usually single-layered (Figures 2 and 7).

The vascular system (Figures 2, 3 and 7) consists of collateral bundles equidistantly distributed around the pith. This central region comprehends relatively large parenchymatic cells (Figures 2, 3 and 8), as comparing to the others cladode structures, and idioblasts containing druses of calcium oxalate (Figures 2 and 8).

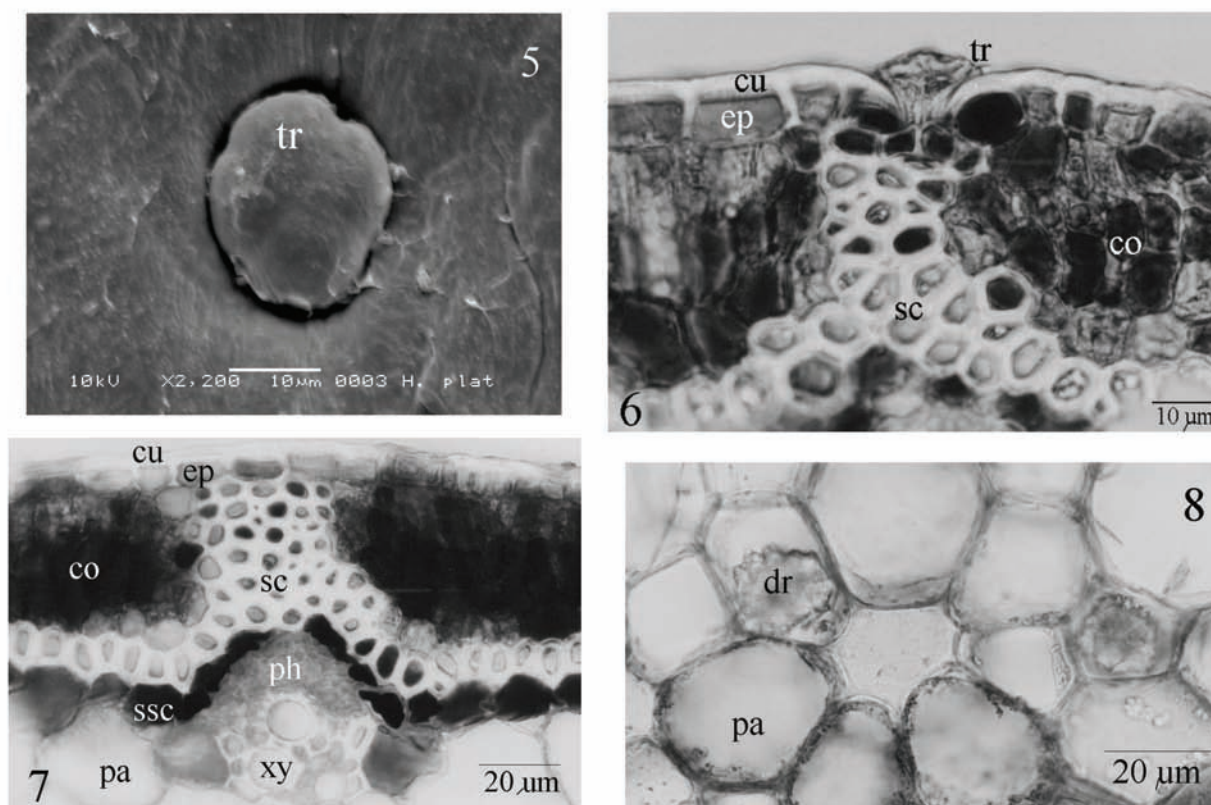
DISCUSSION

H. platycladum differs from other species of Polygonaceae due to the modified caulinar structure which is constituted by cladodes. These cladodes are not leaves, but swollen water-storing and photosynthetic stem segments. The absence of other species in the *Homalocladium* genus avoid the morpho-anatomical discussion in this level, but may be compared with anatomical structures with similar functions for others taxa in the Polygonaceae family.

In general, Polygonaceae species have anomocytic stoma complex (Metcalfe; Chalk, 1950). Lersten and Curtis (1992), when analyzing the stomata



Figures 1-4. *H. platycladum* - 1. apical branches constituted by cladodes. 2-3. transections of the cladode in the medium and in the border, respectively. 4. Epidermis in the surface view (SEM). (co - chlorenchyma, cu - cuticle, dr - druse, ep - epidermis, pa - parenchyma, sc - sclerenchyma, ssc - starch sheath cells, st - stomatum, vc - vascular system).



Figures 5-8. *H. platycladum* - 5. detail of the head of a glandular trichome inserted in an epidermal depression (SEM). 6. cladode transection, showing the epidermis and the cortex. 7. detail of the sclerenchyma and a collateral vascular bundle. 8. parenchymatic cells and idioblasts of the pith. (co - chlorenchyma, cu - cuticle, dr - druse, ep - epidermis, pa - parenchyma, ph - phloem, sc - sclerenchyma, ssc - starch sheath cells, tr - capitate trichome, xy - xylem).

in *Polygonum*, mentioned the absence of an anatomical pattern in the genus. Silva-Brambilla and Moscheta (2001) found a predominance of paracytic stomata in seven species of *Polygonum*. Nevertheless, in *Ruprechtia laxiflora* Meis. and *Triplaris americana* L., the same authors reported anomocytic stomata. In this study, *H. platycladum* shows paracytic stomata, contrasting with the usual findings in the family.

Lersten and Curtis (1992) stated that the glandular trichomes are often encountered in Magnoliopsida, also including the Polygonaceae. Several authors reported their presence in *Polygonum* (Inamdar, 1969; Kapoort et al., 1971; Mitchell, 1971; Rocha; Rocha, 1994). According to Silva-Brambilla and Moscheta (2001), glandular trichomes in *Polygonum* spp. have a head with 4 or 8 cells and are eventually inserted in epidermal depressions. In *H. platycladum*, similar glandular trichomes are seen, however only with a 4-celled head.

Stems of Magnoliopsida often present amyloplasts in the innermost layer of the cortex, recognized as a starch sheath (Esau, 1974; Rudall, 1994). This starch sheath was also evidenced in *H. platycladum*. Crystals of various forms and sizes have been reported in different groups of plants (Mauseth, 1988) and the calcium

oxalate ones have been the most frequent (Fahn, 1990). Silva-Brambilla and Moscheta (2001) found calcium oxalate crystals in *Polygonum*, *Ruprechtia* and *Triplaris*. Accordingly, druses of calcium oxalate are observed in the pith of *H. platycladum*.

The aspects of stomata and trichomes described in this work correspond with other Polygonaceae leaves (Inamdar, 1969; Kapoort et al., 1971; Mitchell, 1971; Rocha; Rocha, 1994; Silva-Brambilla; Moscheta, 2001).

As a combined analysis, the presence of cladodes associated to their anatomical organization can be applied for the *H. platycladum* identification and quality control.

ACKNOWLEDGMENTS

The authors are thankful to Nelson Ivo Matzenbacher from the ICN/UFRGS for the species identification, and to the CME/UFPR for the scanning electron micrographs.

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