

## Stem and root anatomy of *Mnesithea selloana* (Hack.) de Koning & Sosef

### Anatomía de tallos y raíces de *Mnesithea selloana* (Hack.) de Koning & Sosef

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**Abstract.** The objective of this study was to analyze the anatomy of stems and roots of *Mnesithea selloana*. Free hand cross sections were made from fresh material of reproductive stems and adventitious roots; they were colored with safranin and mounted on glycerin jelly. Observations were made using an Olympus CH2 light microscope and photographed. In cross section, the stems were circular towards the distal end of the synflorescence and semicircular toward the proximal end, and have two ribs. A uniseriate, continuous epidermis presenting a smooth and thick cuticle and no hairs was observed. Parenchyma cells increased in size towards the pith; they have slightly thickened walls close to the epidermis and thin, non-lignified walls near the pith. Vascular bundles formed an atactostele, with 3-4 concentric rings; externally, small bundles enclosed within a continuous ring of sclerenchyma, and toward the center larger bundles without the ring were observed. The pith was hollow. The roots presented rhizodermis with unicellular hairs, exodermis with markedly thickened walls, aerenchymatous parenchyma with well differentiated aeriferous spaces, and endodermal cells with markedly thickened inner tangential walls. The vascular cylinder presented a uniseriate pericycle, with polyarch structure exhibiting between 13 and 16 xylematic poles, and pithy parenchyma.

**Keywords:** *Mnesithea selloana*; Anatomy; Stem; Roots; Poaceae.

**Resumen.** Se planteó como objetivo estudiar la anatomía de tallos y raíces de *Mnesithea selloana*. Se utilizó material fresco realizándose transcortes, a mano alzada, de tallos reproductivos y raíces adventicias, coloreados con safranina, montados en gelatina glicerinada. Las observaciones se realizaron con un microscopio óptico Olympus CH2 y fotografiados. Los tallos presentaron sección circular hacia el extremo distal de la sinflorescencia y semicircular hacia la zona proximal presentando dos costillas. Se observó una epidermis uniestratificada, continua, sin pelos y con cutícula lisa y gruesa. Las células parenquimáticas cercanas a la epidermis presentaron paredes ligeramente engrosadas aumentando de tamaño hacia la médula con paredes delgadas no lignificadas. Haces vasculares conformando una atactostela, con 3-4 anillos concéntricos, externamente haces pequeños incluidos dentro de un anillo continuo de esclerenquima y hacia el centro haces de mayor tamaño sin el mencionado anillo. Médula hueca. Las raíces presentaron rizodermis con pelos unicelulares, exodermis con paredes marcadamente engrosadas y parénquima aerenquimatoso con espacios aeríferos bien diferenciados, células endodérmicas con paredes tangenciales internas marcadamente engrosadas. Cilindro vascular presentando periciclo uniseriado, con estructura poliarca, presentando entre 13 y 16 polos xilemáticos y parénquima medular.

**Palabras clave:** *Mnesithea selloana*; Anatomía; Tallo; Raíces; Poácea.

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## INTRODUCTION

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The family Poaceae comprises 651 genera and about 10000 species worldwide (Clayton & Renvoize, 1986). The genus *Mnesithea* has about 32 species distributed worldwide (Veldkamp et al., 1986). Four species are present in Argentina, of which two occur in Entre Ríos province: *Mnesithea selloana* (Hack.) de Koning & Sosef and *M. balansae* (Hack.) de Koning & Sosef (Burkart, 1969; Anton & Zuloaga, 2012).

*Mnesithea selloana* (commonly known as “cola de lagarto” or “teyú ruguay”), a species distributed in Argentina, Brazil, Paraguay, and Uruguay, is a forage grass occurring in natural fields in Entre Ríos. It is a tufted grass exhibiting profuse tillering and a spring-summer-autumn cycle (megathermal). Although it has been cited for different sites in the region, it is currently restricted to reduced areas.

Watson & Dallwitz (1992) provided a brief description of the genus *Mnesithea* Kunth and the species *M. laevis* and *M. mollicoma*, which are distributed in India, Indochina and Malaysia. Those descriptions included aspects about morphology, anatomy, physiology, photochemistry, cytology, taxonomy and pathogens. In Argentina, several works have addressed *Mnesithea selloana*, such as the description of its synflorescence and characteristics of its spikelets and diaspores, reproductive aspects related to species dispersal, caryopsis germination with and without floral structures, and leaf anatomy (Burkart, 1969; Anton, 1975; Quarín, 1979; Vegetti, 1997; Galussi et al., 2012a; Galussi et al., 2012b; Moya et al., 2012; Moya et al., 2015). The aim of this work was to describe the stems and roots in cross sections in order to complete the anatomical studies of *M. selloana*.

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## MATERIALS AND METHODS

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The material was obtained from individuals collected and identified from a natural area (31° 49' 18.62" S; 60° 32' 57.33" W) as part of the research project of *M. selloana* (PID UNER n°2132). They were transplanted and cultivated in the Experimental Field (31° 49' 59.51" S; 60° 31' 21.84" W) of the Facultad de Ciencias Agropecuarias UNER (Galussi et al., 2012a). Stems that had synflorescences in their tips and adventitious roots were removed from the plants. Free hand cross sections were made at different positions of each stem and root. Sections were cleared by immersion in 50% sodium hypochlorite for 2 minutes and then washed with abundant distilled water. They were stained with 1% safranin for 3 minutes with the aim of visualizing sclerosed walls and finally were mounted between slides with glycerin jelly (D'Ambrogio de Argüeso, 1986). Observations were made under a light microscope Olympus CH2 equipped with a MotiCAM 2000Motic Images Plus 2.0ML camera, which was connected to a computer. Numerous micrographs of each of the cross sections were recorded for further analysis.

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## RESULTS

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**Stem.** The stem exhibited circular section in the most distal internodes to the synflorescence, becoming semicircular towards the proximal part. It exhibits two marked ribs at the ends of the semicircle. In cross section, three clearly differentiated tissue systems were observed: epidermal, parenchymatous and vascular. The epidermis was unistratified and continuous, with sclerosed epidermal cells, without hairs and with a smooth and thick cuticle (Fig. 1 A).

A subepidermal sclerenchyma ring was observed, ranging between 3-6 layers of very thick walled cells (Fig. 1B). The cells of the subepidermal parenchyma exhibited slightly thickened walls; these cells increased their size towards the center of the section, exhibiting non-lignified thin walls forming the pith (Fig. 1B) or forming a pith cavity when cells were disintegrated.

The vascular system was composed of several typical closed collateral bundles (Fig. 1C), which were dispersed throughout all the parenchyma, forming an atactostele, arranged in 3-4 concentric rings, with the outer one composed of smaller bundles included in a continuous sclerenchyma ring (Fig. 1D). The remaining cycles of vascular bundles were located in the inner parenchyma (transition parenchyma) and each one exhibited a sclerified cell sheath. The latter small bundles occasionally joined with those of the contiguous ring through their sclerenchyma sheaths (Fig. 1E). The solid stems have a parenchyma pith with cells of circular to polygonal outline, whereas in the hollow stems, a big pith lacuna was observed.

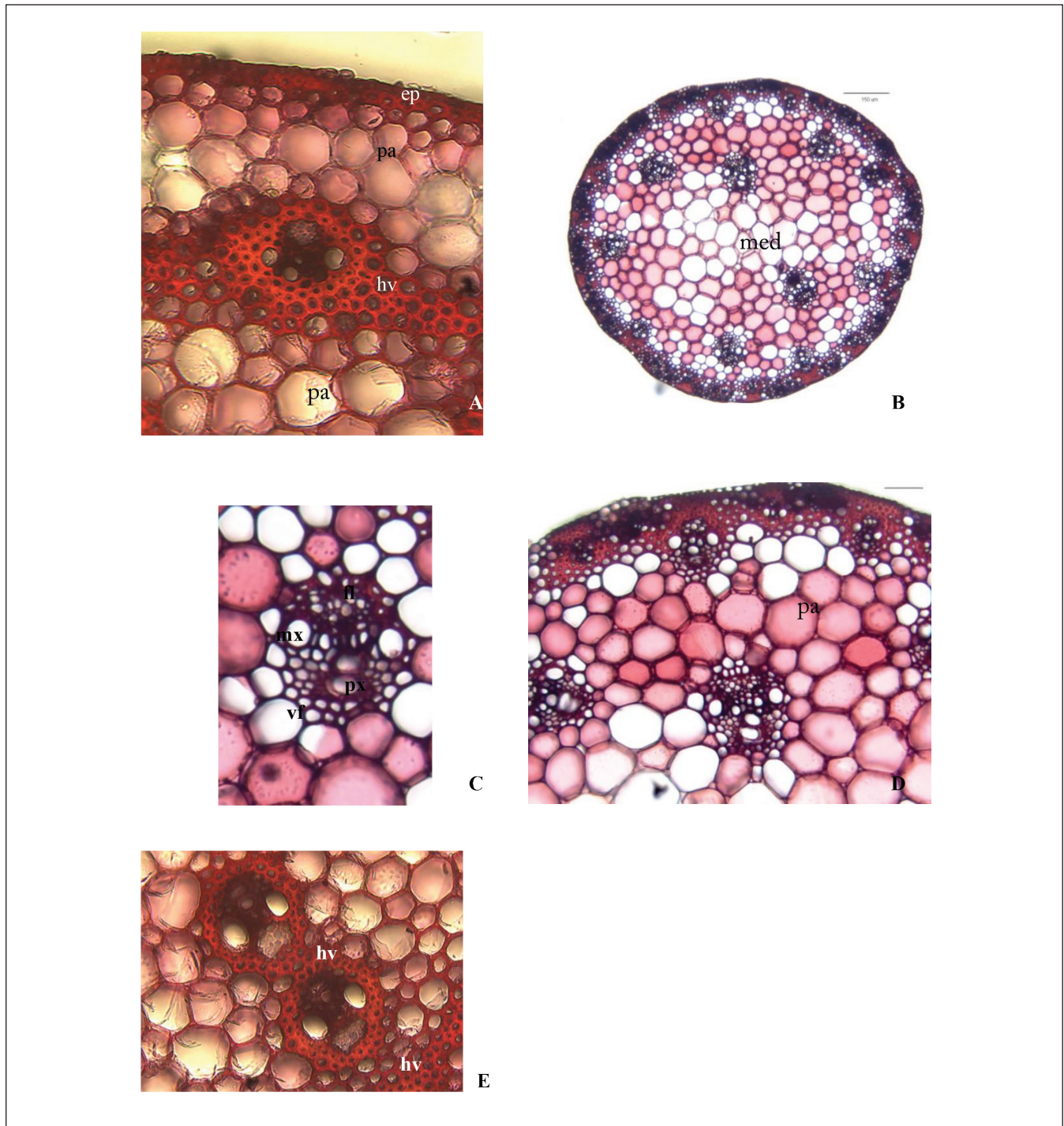
**Root.** In cross section, a one-layered rhizodermis with one-layered hairs is observed (Fig. 2A). One-layered exodermis with markedly thickened walls (Fig. 2B); below the exodermis is the aeriferous parenchyma instead of a cortical parenchyma, forming an aerenchymatous parenchyma with well differentiated aeriferous spaces, and with circular to polygonal outlined cells. The spatial arrangement of the aerenchyma, i.e. arrangement of lacunae and spaces, resembled the shape of a bicycle wheel (Fig. 2C). The endodermis exhibited cells with markedly thickened internal tangential cells (Fig. 2D). A uniseriate pericycle was observed in the vascular cylinder; polyarch vascular bundles exhibited between 13 and 16 xylem poles (Fig. 2E) and a medullary parenchyma (Fig. 2F).

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## CONCLUSIONS

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The study of *M. selloana* revealed an anatomical structure of the reproductive stem characterized by a circular section in the basal part, and a semicircular section near the synflorescence. The vascular bundles were distributed in several rings; and hollow and pithy stems were observed. These anatomical characteristics are present in most of Poaceae plants, and agree with the descriptions of Jensen & Salisbury (1988). The closed

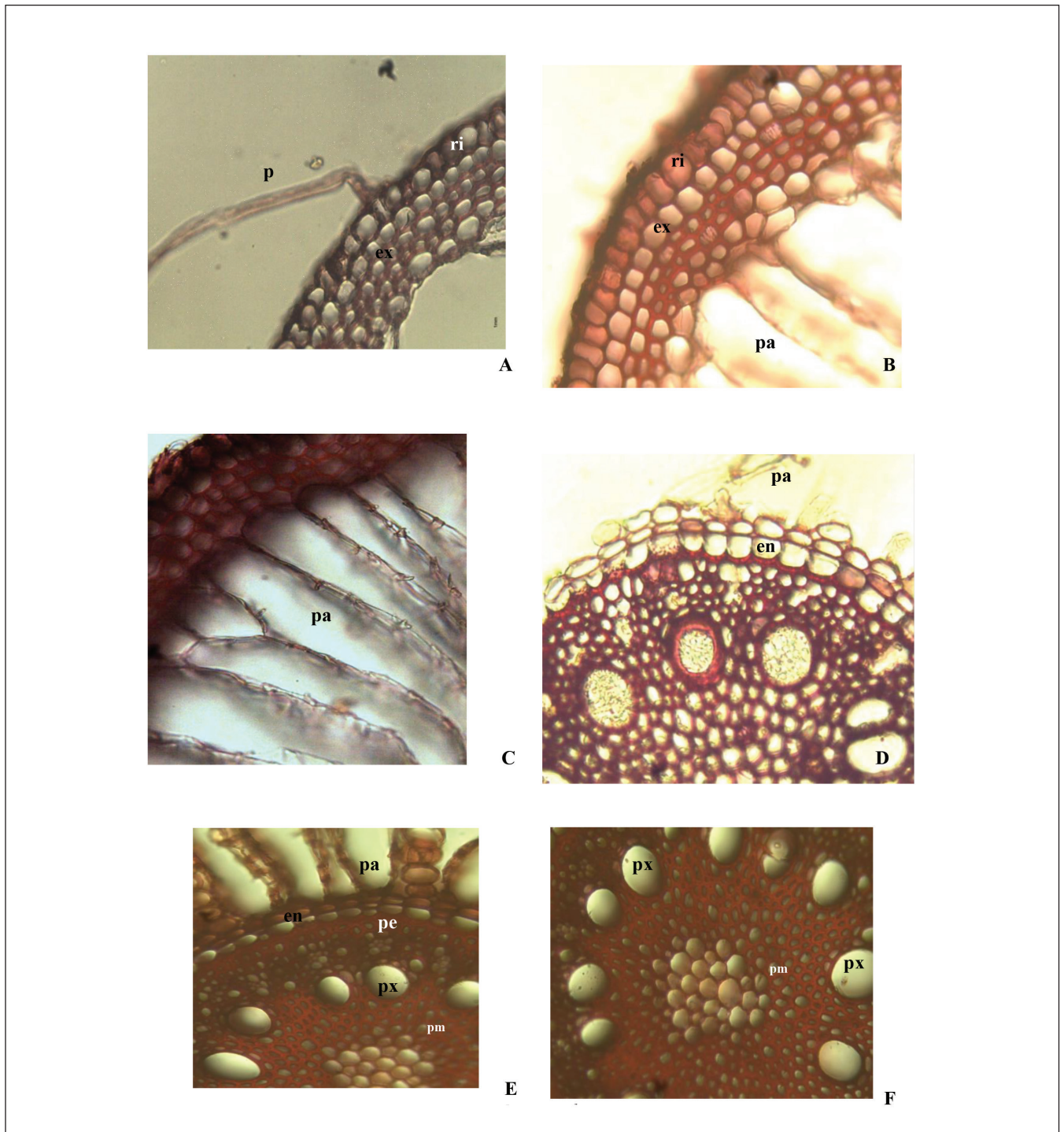


**Fig. 1.** Photographs of cross sections of stem under LM: (A) unistratified epidermis and vascular bundle of the outer ring, 30x; (B), subepidermal sclerenchymatous ring and arrangement of vascular bundles, 4x; (C) detail of closed, collateral vascular bundle, 10x; (D) atactostele 10x; (E) small vascular bundles joined with those of the contiguous ring by their sclerenchyma sheath, 30x.

Abbreviations: ep: epidermis, fl: phloem, hv: vascular bundles, med: pith, mx: metaxylem, pa: parenchyma, px: protoxylem, vf: fibrous sheath.

**Fig. 1.** Fotos de transcortes de tallo con MO: (A) epidermis uniestratificada y haz vascular del anillo más externo, 30x; (B) anillo esclerenquimático subepidérmico y disposición haces vasculares, 4x; (C) detalle haz vascular, colateral cerrado, 10x; (D) atactostela 10x; (E) hacecillos unidos con los del anillo contiguo por sus vainas de esclerénquima, 30x.

Abreviaturas: ep: epidermis, fl: floema, hv: haz vascular, med: médula, mx: metaxilema, pa: parénquima, px: protoxilema, vf: vaina de fibras.



**Fig. 2.** Photographs of cross sections of roots under LM. (A) rhizodermis with hairs, 10x; (B) exodermis with markedly thickened walls, 20x; (C) aeriferous parenchyma, 20x; (D) endodermal cells with markedly thickened internal tangential walls, 20x; (E) vascular cylinder with uniseriated pericycle, 20x; (F) pithy parenchyma, 20x.

Abbreviations: en: endodermis, ex: exodermis, p: hair, pa: aeriferous parenchyma, pm: pithy parenchyma, pe: pericycle; px: xylematic poles.

**Fig. 1.** Fotos de transcortes de raíz con MO: (A) rizodermis con pelos, 10x; (B) exodermis con paredes marcadamente engrosadas, 20x; (C) parénquima aerífero, 20x; (D) células endodérmicas con paredes tangenciales internas marcadamente engrosadas, 20x; (E) cilindro vascular presentando periciclo uniseriado, 20x; (F) parénquima medular.

Abreviaturas: en: endodermis, ex: exodermis, p: pelo, pa: parénquima aerífero, pm: parénquima medular, pe: periciclo, px: polos xilemáticos.

collateral vascular bundles, which were regularly distributed in the stem due to its sinuous longitudinal trajectory, formed an atactostele. This variant of the eustele, typical of monocotyledons, agrees with the findings reported by Esau (1987).

The root cortex of grasses from relatively dry habitats exhibits aerenchyma. According to its mode of origin, the aerenchyma may be schizogenous and lysigenous (Jackson & Armstrong, 1999; Seago et al., 2005). The former, the one of interest in this work, is formed due to selective death of cells of the root cortex, leaving air spaces (Kawai et al., 1998). This type of aerenchyma is found in several cultivated species, such as barley (Arikado & Adachi, 1955), wheat (Trought & Drew, 1980), and rice (Justin & Armstrong, 1991). The aerenchyma of the roots of *M. selloana* resembles that of a bicycle wheel, which is consistent with one of the four anatomical typologies mentioned by Justin & Armstrong (1987) and Seago et al. (2005) for grasses.

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