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Ontogeny of the pericarp of *Serjania communis* Camb. and *Urvillea ulmacea* Kunth (Sapindaceae) with emphasis on the dispersion apparatus

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ABSTRACT. The pericarp development of *Serjania communis* Camb. and *Urvillea ulmacea* Kunth was described to expand the structural knowledge of Sapindaceae fruit. Ovaries and fruits were analyzed with usual techniques in plant anatomy. Ovary is structurally similar and the occurrence of glandular and non-glandular trichomes varies between species. In *S. communis,* the samaroid schizocarp has proximal wings and distal cavities; in *U. ulmacea*, the fruit presents septicidal and septifragal passive dehiscence and each seed chamber presents a dorsal wing. The unistratified exocarp has long pluricellular, uniseriate and sparse trichomes in *U. ulmacea*. The mesocarp is spongy, parenchymatous and in *S. communis* it presents three distinguished regions. Dorsal, lateral and ventral vascular bundles are more developed in *S. communis* and fiber caps on the phloem in the lateral bundles have an important role on the mericarp separation. The endocarp derives from the adaxial meristem and its oblique and tangentially elongated cells become lignified. The wings originate from a more active meristem – at the ovarian edges – and by intense divisions of ovarian mesophyll in this region. Fruit of *U. ulmacea* can represent a transition state between the samaroid schizocarp formed by *Serjania* and the septifragal capsule produced by *Cardiospermum*.

Keywords: development, fruit, Sapindaceae, samara, capsule.

Ontogênese do pericarpo de *Serjania communis* Camb. e *Urvillea ulmacea* Kunth (Sapindaceae) com ênfase no aparelho de dispersão

RESUMO. O presente estudo descreve aspectos morfológicos e o desenvolvimento do pericarpo de *Serjania communis* Camb. e *Urvillea ulmacea* Kunth ampliando o conhecimento estrutural dos frutos de Sapindaceae. Foram coletados e analisados ovários e frutos seguindo técnicas usuais em anatomia vegetal. O ovário estruturalmente similar e a ocorrência de tricomas glandulares e não glandulares varia entre as espécies. Em *S. communis,* o esquizocarpo samaroide apresenta ala proximal e cavidade distal; em *U. ulmacea*, o fruto apresenta deiscência passiva septicida e septifraga e cada cavidade seminal apresenta uma ala dorsal. O exocarpo uniestratificado tem tricomas pluricelulares longos, unisseriados e esparsos em *U. ulmacea*. O mesocarpo é parenquimático e esponjoso e em *S. communis* apresenta três regiões distintas. Os feixes vasculares dorsais, laterais e ventrais são mais desenvolvidos em *S. communis* e as calotas de fibras sobre o floema nos feixes laterais participam da separação dos mericarpos. O endocarpo deriva do meristema adaxial e suas células oblíqua e tangencialmente alongadas tornam-se lignificadas. As alas originam-se de um meristema mais ativo – nas arestas do ovário – e por divisões intensas no mesofilo ovariano nessa região. O fruto de *U. ulmacea* pode representar a transição entre o esquizocarpo samaroide de *Serjania* e a cápsula septifraga de *Cardiospermum*.

Palavras chave: desenvolvimento, fruto, Sapindaceae, sâmara, cápsula.

Introduction

Lianas are important structural components and represent a significant part of the flora in tropical forests. However, studies concerning these species are few, specially, those describing the ontogenesis of their fruit.

Serjania Miller comprises approximately 230 species, while *Urvillea* Kunth ca. 16 species – both native woody lianas from tropical and subtropical regions of the New World. Most species occurs in places of dense, opened or drought vegetation, like the Brazilian 'cerrado', at higher altitudes in 'campo rupestre' and coastal dune forests, as well as occurring in a large percentage of gallery forests. The primarily climbing habit, the presence of stipules, modified peduncles as tendrils and

nectariferous disk modified into four protruding glands include these genera within *Cardiospermum* and *Paullinia*, in Paullinicae (ACEVEDO-RODRIGUEZ, 1993; FERRUCCI, 2006).

The most comprehensive studies involving morphological and anatomical characters of Sapindaceae fruit and their application in taxonomy were conducted by Radlkofer (1892-1900) over one hundred years ago, whose classifications concerning *Paullinia* and *Serjania* (Paullinicae) were based on the pericarp structure. In addition to vegetative and floral characters, the author provided information on the shape of fruit and seeds as well as about the indumentum and anatomy of the pericarp (ACEVEDO-RODRIGUEZ, 1993; WECKERLE; RUTHISHAUSER, 2005).

According to Acevedo-Rodriguez (1993) and Weckerle and Ruthishauser (2005) the genera and species in Paullinieae are separated mainly by fruit characters. *Houssayanthus*, *Lophostigma* and *Serjania* are characterized by schizocarpic fruit with winged (samaroid) mericarps, *Cardiospermum* and *Urvillea*, by papery, inflated capsules, and *Paullinia* by capsules. They also highlighted that the floral and vegetative characteristics usually do not allow a clear identification of the taxa.

Preliminary cladistic analyses based on morphological characters limit Paullinieae to two major clades (ACEVEDO-RODRIGUEZ, 1993). One is the '*Serjania* group', comprising schizocarpic genera like *Serjania*, *Houssayanthus* and *Lophostigma*, and the other clade ('*Paullinia* group') consists of the mainly septifragal genera *Paullinia*, *Cardiospermum* and *Urvillea* (WECKERLE; RUTISHAUSER, 2005).

Acevedo-Rodriguez (1993) affirmed that the identification of *Serjania* species and other genera of Paullinieae is particularly difficult, because of their vegetative similarity. The fruit presence is essential for the identification. This author defines sections of the genus based mainly on fruit morphology.

Weckerle and Rutishauser (2005), in a detailed research regarding the structures of the gynoecium, the fruit and seed in Paullinieae, concluded that the type of transmission tissue, indument of inner and outer surface of carpels, anatomy of ovary wall and pericarp are among the new described characters with taxonomic potential. They highlighted that detailed morphological analyses of more species of the two large genera of the tribe – *Paullinia* and *Serjania* – as well as the smaller genera are needed to find accurate circumscriptions of the generic sections and to test the preliminary results of Acevedo-Rodriguez (1993) who grouped Paulliniae into two monophyletic subclades.

Although Weckerle and Rutishauser (2005) have described the structure of the gynoecium and the fruit ontogenesis of nine Paullinieae species including *Urvillea ulmacea*, detailed descriptions and illustrations concerning the separation system of mericarp and of dehiscence are lacking.

The present study examined two species of lianas, which belong to Paullinieae, *Serjania communis* Camb. and *Urvillea ulmacea* Kunth, in order to provide detailed morphological and anatomical information regarding their fruit in development and enhance the knowledge about such organs in Sapindaceae.

Material and methods

The sampling sites of *Serjania communis* Camb. and *Urvillea ulmacea* Kunth (Sapindaceae) were urban forest remnants: Forest Garden 'Dr. Luiz Teixeira Mendes' (23º 26' 01, 47" S and 51º 57' 56, 21" W) and 'Bosque dos Pioneiros' (23º 26' 04, 36" S and 51º 56' 33, 04" W), both in the Maringá city, Paraná State, Brazil. Vouchers of the species were deposited as taxonomic document at the Herbarium of State University of Maringá (Huem), registered by the numbers 11,741 and 11,743, respectively.

Flower and fruit in different developmental stages were fixed in FAA 50 (JOHANSEN, 1940) and stored in 70% alcohol (JENSEN, 1962).

The anatomical study was carried in sections taken at several levels, freehand or in rotary microtome.

Some fixed samples were embedded in hydroxyethyl+methacrylate Leica™, according to the manufacturer protocol. The sections were stained in 0.05% Toluidine Blue in buffer acetate, pH 4.7 (O'BRIEN et al., 1964 with modifications). The botanical material was also embedded in paraffin, sectioned and stained in Astra Blue and Safranin (GERLACH, 1969). Both cases used synthetic resin.

The following histochemical tests were conducted: phloroglucinol with hydrochloric acid to detect lignin (SASS, 1951); Sudan IV for lipid substances; Lugol for starch; ferric chloride with addition of sodium carbonate for phenolic compounds (JOHANSEN, 1940) and Ruthenium Red for mucilage (STRASBURGER, 1924).

The terminology adopted to define the pericarp layers is in agreement with Roth (1977), and fruit type description was based on Barroso et al. (1999).

The drawings of morphological aspects were made with the aid of a camera lucida coupled to a Leica Wild M32 stereomicroscope. The anatomical documentation was performed through photomicrographs obtained through animage capture system connected to the Olympus BX 50 optical microscope and Image Pro-Plus program 4.0 (Media Cybernetics®). The scales regarding the illustrations were obtained under the same optical conditions used to each case, using ocular micrometer.

Results

Ovary at anthesis

The ovary structure is similar in *Serjania communis* and *Urvillea ulmacea*. It presents regular outline, is superior, tricarpelar, trilocular, and the shape is triangular in cross section (Figure 1A). The carpels are completely joined up to about half of the ovary length and partially separated from the upper middle part on and in the style. The stigma is tripartite and presents numerous very long papillae similar to unicellular trichomes (Figure 1B). Each carpel has an erect ovule in an axial placenta in the locular base (Figures 1C and D).

The outer ovarian epidermis is uniseriate, composed of juxtaposed cuboid cell, with thin walls (Figure 1E) and visible nucleus.

The ovarian mesophyll is constituted by around four or five layers of parenchymatous cells of several dimensions and shapes, some slightly elongated towards the radial direction, and interwoven by large secretory idioblasts adjacent to outer epidermis. Those cells present large nucleus and present intense division in the anticlinal direction, mainly near the ovary edges (Figures 1E and 1F).

Vasculature is limited to three dorsal and three ventral bundles. Besides these bundles, two laterals bundles for each carpel are found differentiated. The bundles are collateral, being the caliber of lateral and ventral bundles larger than the dorsal ones (Figure 1A).

The inner ovarian epidermis present cells in tabular format, is unistratified, turning from bi into pluristratified on the edge direction, reduced to a voluminous dorsal cell. The layer increase is a result of the activity of adaxial meristem, originated by periclinal divisions in the inner epidermis, which action is more intense in the edges. The inner epidermal cells have thin walls, are vacuolated and present evident nuclei (Figures 1E and 1F).

Both species present a large amount of glandular trichomes, formed by short bicellular peduncle and ovoid pluricellular head with cells containing phenolic compounds. Those trichomes, in *U. ulmacea*, occur as much inner as outer epidermis (Figures 1B and 1D) and in *S. communis* just in the outer epidermis (Figure 1C). Unicellular trichomes with thin walls and obvious nucleus (Figure 1D) occur in the inner epidermis of both species. In *U. ulmacea* those trichomes are less in number than the glandular one.

Fruit development

During the fruit development, the outer ovarian epidermis originates the exocarp, which remains unistratified, initially with cells radially elongated, with thin walls, dense content and visible nucleus in an intense anticlinal division in *S. communis* (Figure 2A). The cells, in *U. ulmacea,* are a little less radially elongated, are also found in anticlinal division, and unicellular non-glandular trichomes, with thick walls and thin ends, occur in large amount (Figure 2B).

Originated by the ovarian mesophyll, the mesocarp remains parenchymatous, showing an increase in the number of layers and cellular expansion. In the mesocarp of *S. communis,* initially, three regions can be verified: the first is made up of hypodermic layer presenting from cuboids to cylindrical cells and two layers of isodiametric cells inside this hypoderm, both presenting phenolic content, where volumous secretor idioblasts are immersed into; the second with a variable number of layers of isodiametric cells, most of them with phenolic content; and the third, more internally located, with around three little layers of isodiametric cells, vacuolated and with evident nucleus (Figures 2A and 2C). Histochemical tests did not identify the content of the secretory idioblasts. In *U. ulmacea,* the mesocarp is uniform, constituted by isodiametric cells (Figure 2B).

Vascular bundles are distributed all around mesocarp; the lateral and ventral bundles are more differentiated. At this time, ventral bundles are more central than in the ovary, positioned at the fruit axial region and surrounded by spongy tissue (Figures 2D and 2E). The lateral bundles in *S. communis* are separated by an invagination that appears on the septum (Figure 2D).

The endocarp – originated from the ovary inner epidermis by the adaxial meristem activity – presents large number of layers in *S. communis*. The cells show pronounced tangential elongation, some with oblique arrangement in relation to the fruit longitudinal axis (Figures 2C and 2D). In this stage, trichomes become sparse due to the fruit development.

The wings are accentuated because of intense anticlinal divisions and to the adaxial meristem division – more pronounced in the edge since the ovary (Figures 1A, 1E, 2C and 2E).

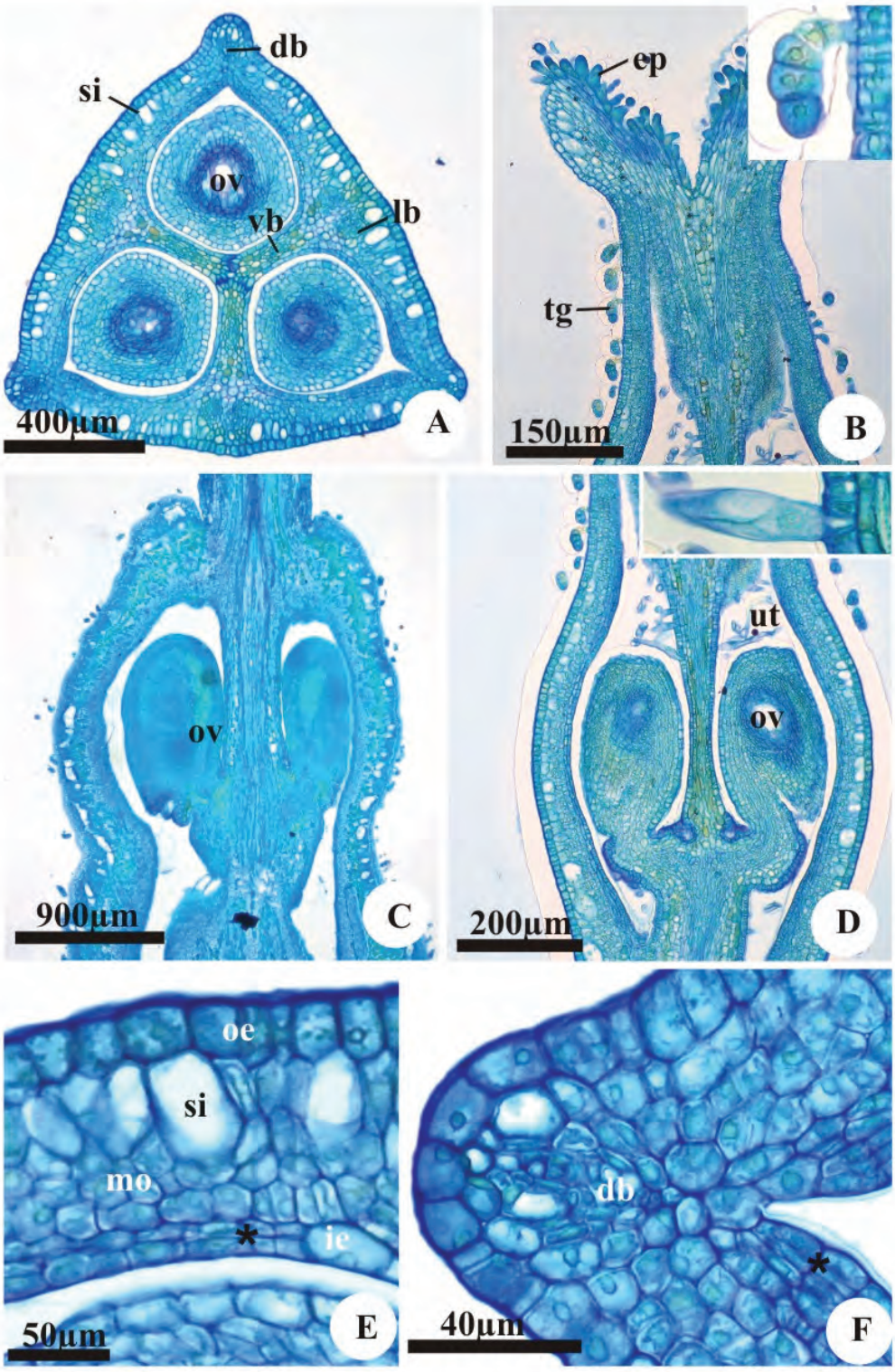

Figure 1. Cross (A, E-F) and longitudinal (B-D) sections from ovary of flowers at anthesis of *Serjania communis* (A, C, E-F) and *Urvillea ulmacea* (B, D). A- General view in the free central region, showing the dorsal, ventral and lateral vascular bundles. B- General view of the top region, evidencing stigmatic papillae similar to unicellular trichomes, and detail of glandular trichome. C- General view. D- General view and detail of the unicellular trichome in the inner epidermis. E- Detail of the wall, showing the outer epidermis, secretory idioblasts in the mesophyll and inner epidermis in division (asterisk). F- Detail of the edge region, showing the dorsal bundles and inner epidermis in division (asterisk). (db-dorsal bundle; ep- stigmatic papil; gt-glandular trichome; ie-inner epidermis; lb-lateral bundle; mo- mesophyll; oe-outer epidermis; ov-ovule; si-secretory idioblast; ut-unicellular trichome; vb-ventral bundle).

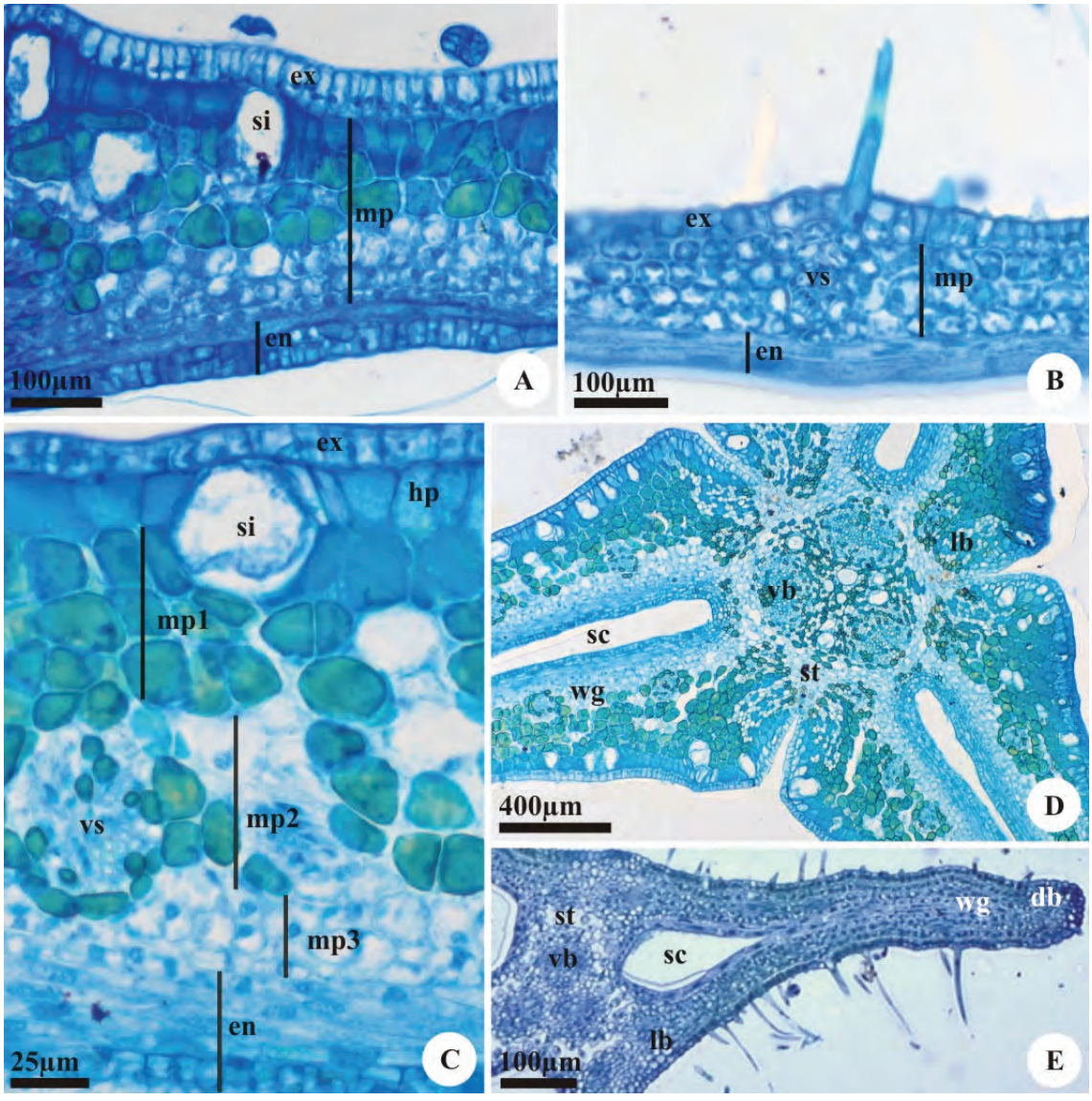

Figure 2. Cross sections of the fruit in development of *Serjania communis* (A, C-D) and *Urvillea ulmacea* (B, E). A-B- Detail of the pericarp in the median region of the wing. C- Detail of the pericarp, evidencing the mesocarp constituted by three regions (mp1, mp2, mp3). D-E-General view of the axial region and of one wing. (db-dorsal bundle; en-endocarp; ex-exocarp; hp-hipodermis; lb-lateral bundle; mp-mesocarp; sc-seed chamber; si-secretory idioblast; st-spongy tissue; vb-ventral bundle; vs-vascular bundle; wg-wing).

Ripe fruit

Fruit of *S. communis* and *U. ulmacea* are dried and winged (Figures 3A and 3B) and the pericarp is developed earlier than the seeds. Three indehiscent mericarp occur in *S. communis* (Figure 3C), monospermic, which are dispersed separately; each mericarp contains a proximal marginal wing and a distal seed chamber where the seeds are located (Figure 3A). With the mericap separation, kept in the axial region a carpophore (Figure 3C). The fruit, that is green when young, becomes brown-reddish when unripe and brown when ripe. The fruit, in *U. ulmacea*, develops dorsal marginal wings, less conspicuous than in *S. communis,* and inflated seed chamber, also monospermic (Figure 3B and 3D). The fruit shows greenish color when unripe, becoming brown-reddish and brown when ripe, easily separated along the septum when handled. However, no open fruit was observed in the field.

The uniseriate exocarp of both species shows cells with thin walls and cuticles. In *S. communis*, cells have cubic format (Figures 4A and 4C), and in *U. ulmacea*, cells become tabular. The trichomes are present in *U. ulmacea*, distributed sparsely on the fruit surface, showing a glabrous aspect. In this stage, the thick wall of this trichome is lignified (Figures 4D and 4F). The glandular trichomes undergo abscission during development and are not present in the ripe fruit.

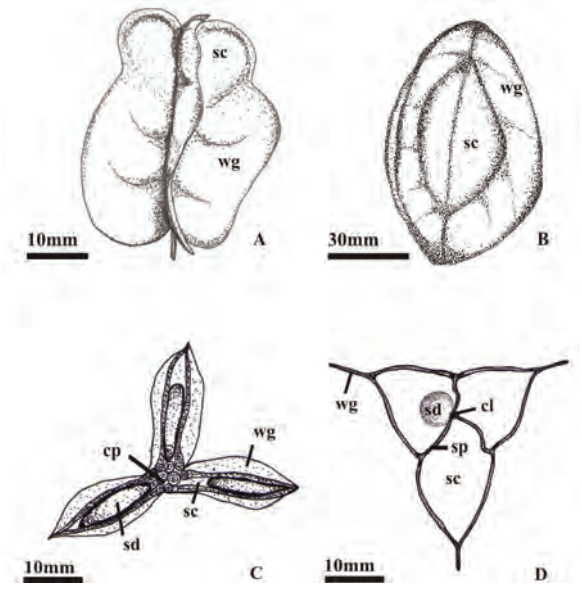

Figure 3. Pre-dispersal fruit of *Serjania communis* (A, C) and *Urvillea ulmacea* (B, D). A-B- Morphology of the developed fruit. C-D- Cross section at the seed chamber (cl-columella; cp-carpophore; sc-seed chamber; sd-seed; wg-wing).

The mesocarp becomes spongy, in *S. communis*, with many cellular layers and large space (Figure 4B). This space is less conspicuous on most part of the mesocarp, in *U. ulmacea*, but is quite pronounced on the septa (Figures 4E and 4F).

Collateral vascular bundles are found along the mesocarp and the secretory idioblasts undergo lysis, decreasing in number, becoming almost absent in the ripe fruit (Figures 4B and 4F).

The endocarp in *S. communis* become fibrous with many layers of tangentially elongated cells forming a sharp and thick strip (Figure 4B), when compared to the *U. ulmacea*, in which are observed limiting the seed chamber with around two or three cell layers (Figure 4E).

The tension forces that appear in the ripe stage of the fruit in *S. communis* are related to the large number of fibers that are externally differentiated to the phloem in the lateral bundles and the greatest differentiation of ventral bundles. The presence of cells with lignified walls on these bundles at ripeness, associated with the spongy tissue – mechanically more fragile at this region – and the invagination – occurred in early stages among lateral bundles – caused the separation of the mericarps, remaining the carpophore in the fruit axial region (Figure 4C).

The easiness in the *U. ulmacea* fruit opening when handled, characterizing a passive dehiscence, is caused by the tissue fragility developed in the septal region. However, no division line is observed along the entire fruit and the exocarp – located towards the lateral bundles –and the non-lignified endocarp - delimiting the seed chamber at the septal region -are the only tissues offering resistance. After the occurrence of the exocarp disruption and the split between the lateral bundles and along the septum, occurs a transverse disruption of the septum near to the ventral bundles. Thus, the three ventral bundles immersed in the parenchyma remain on the fruit axial region – comprising the columella – typical of septifragal capsules (Figures 3D, 4F to 4H).

Discussion

Fruit morphological characteristics observed in *S. communis* corroborate with the species descriptions performed by Reitz (1980) and Acevedo-Rodriguez (1993). In the same way, the characteristics observed by Weckerle and Rutishauser (2005) for *U. ulmacea* were observed herein, except the fruit active dehiscence stated by the authors for this species.

Fruit of *S. communis* and *U. ulmacea* present one or more structural similarities during the pericarp development with other species of Paullinieae, such as *Paullinia alata* G. Don, *P. clavigera* Schltdl., *P. obovata* (Ruiz and Pav.) Pers., *P. pachycarpa* Benth., *P.* aff. *Caloptera* Radlk., *P. dasystachya* Radlk., *Cardiospermum halicacabum* L., *Serjania altissima* (Poepp.) Radlk. and *Urvillea ulmacea* Kunth. according to the descriptions of Weckerle and Rutishauser (2005).

The results obtained in this research corroborate with the conclusions of the above mentioned authors, mainly, with regard to the occurrence and types of trichomes in the inner and outer surfaces of carpels. In *U. ulmacea*, glandular trichomes occur both in the outer and in the inner epidermis and in *S. communis*, only in the outer epidermis. Unicellular and elongated trichomes occur on the inner epidermis of both species and were not described by Weckerle and Rutishauser (2005) for *U. ulmacea* in none of the development stages.

In the ovary of *S. altissima,* pluri and unicellular elongated glandular trichomes are found distributed along the outer surface, and the inner epidermis is hairless (WECKERLE; RUTISHAUSER, 2005), unlike the observed in *S. communis* in this research.

The structure of the ovary wall in *S. communis* and *U. ulmacea* is similar, but the differences appear associated with the pericarp development. Both species have triangular ovaries in cross section, tricarpellary with one erect ovule per loculus, fixed at the basal region and of axial placentation, as verified by Weckerle and Rutishauser (2005).

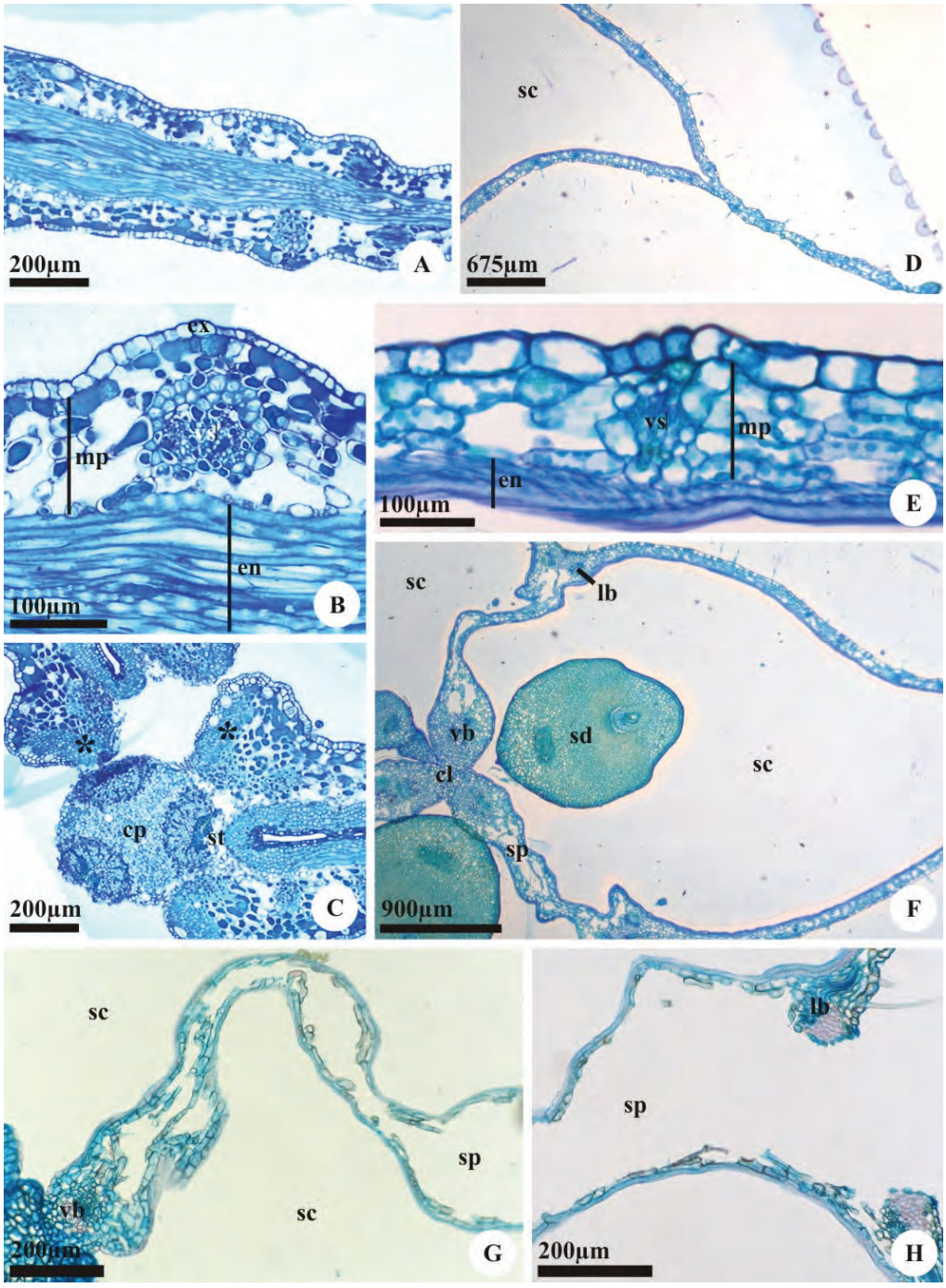

Figure 4. Cross sections of the developed pericarp of *Serjania communis* (A-C) and *Urvillea ulmacea* (D-H). A- General view in the wing region. B- Detail of the pericarp showing the spongy mesocarp and endocarp constituted by a number of layers of elongated cells with thick walls and oblique orientation. C- Detail of the carpophore region, showing the mericarp split (asterisk). D- General view of the wing region, evidencing part of the inflated seed chamber. E- Detail of the pericarp evidencing the spongy mesocarp. F- General view of the seed chamber evidencing the spongy tissue in the region of the septum. G-H – General view of the dried fruit evidencing the passive split in the septum (cl-columella; cp-carpophore; en-endocarp; ex-exocarp; lb-lateral bundle; mp-mesocarp; sc-seed chamber; sd-seed; sp-septum;vb-ventral bundle; vs-vascular bundle; wg-wing).

The total fusion of carpels until the middle of the ovary length (synascidiate), the partial division on the upper side and on the style (symplicate) and the trifid stigma were characteristics observed in this study for both species and described for all the studied species by Weckerle and Rutishauser (2005). Nevertheless, it is necessary to highlight that the gynoecium is syncarpous, evidenced by the complete fusion of ventral bundles, which are three at the ovary central axis. This aspect corroborates

with the descriptions of Acevedo–Rodriguez (1993) that the syncarpous gynoecium of *S. communis* consisted of three fused carpels. The author also describes the glabrous or pubescent ovary with three lobes, corroborating with that observed in this research.

According to Weckerle and Rutishauser (2005), the vascular model of the ovarian wall is different between species. In most of studied taxa, including *Urvillea ulmacea* and the *Serjania* genera, dorsal and synlateral bundles are present, but in *S. altissima*, lateral bundles occur separately probably due to the late process of the schizocarpic fruit, which is separated in winged mericarps. In most of studied species, a net of secondary lateral bundles is found (*Paullinia alata, P. clavigera, P.* aff. *caloptera, P. dasystachia*, *P. obovata, P. pachycarpa*); and, in minor level in *S. altissima* and *U. ulmacea*, corroborating with the findings of the present research for the last species and to *S. communis*. Within Paullinieae, fruit are schizocarpic, separating into samaroid mericarps or septifragal capsules which expose the seeds. *Serjania, Lophostigma* and *Houssayanthus* present schizocarpic fruit with a carpophore (ACEVEDO–RODRIGUEZ, 1993). These descriptions are in accordance with our observations in the present study for *S. communis*, whose fruit is included into the classification of Barroso et al. (1999) – into 'esquizocarpáceo', subtype 'samarídio'.

Paullinia, Cardiospermum and *Urvillea* have septifragal capsules (ACEVEDO-RODRIGUEZ, 1993; BARROSO et al., 1999) and the last two mentioned are most closely related (FERRUCCI, 2006). According to Weckerle and Rutishauser (2005) in *Cardiospermum*, fruit are septifragal capsules with septa containing numerous oxalate calcium crystals along the dehiscence line; in *C. halicacabum,* each septum is divided into two separated layers, one remain fixed to the ovary central axis, and in this way, the septifragal capsule in this genera species could display additionally septicidal dehiscence; in *U. ulmacea*, these authors described that any line of dehiscence is formed by oxalate crystals and fruit are easily separated by hands into winged mericarps seeming to be exclusively septifragal capsules and the schizocarpic fruit description for this species is incorrect.

The ontogenetic study of *U. ulmacea* fruit, performed herein, did not evidence any preexisting dehiscence line. However, the spongy tissue that developed along the septum, which becomes conspicuous on the ripeness, offers little resistance and the unistratified exocarp towards the lateral bundle direction becomes the only tissue that hinders the rupture on this zone. Posteriorly, the exocarp is disrupted and the lateral bundles are separated, continuing the opening along the septum through the spongy tissue. In this sense, the *U. ulmacea* fruit has a passive septicidal opening. It is important to say that there is no impediment to the rupture of the thin endocarp in the inner portion of the septum, which could result in a septifragal opening as well.

Besides the previous description, no open fruit of this species was observed in field. The spongy tissue arrangement along the septum makes this region extreme fragile, which can explain the description of Weckerle and Rutishauser (2005) that *U. ulmacea* fruit are easily separated into three winged mericarps when handled.

Considering, the dehiscence as passive, the fruit of *U. ulmacea* is a septicidal capsule and additionally septifragal, like in *Cardiospermum.* Otherwise, the fruit of *U. ulmacea* would be suitable for the definition of Barroso et al. (1999), as 'nucóide', subtype 'nucáceo', similar to *Balfourodendron* (Rutaceae), in which the fruit is transported as a unity constituted of 4-5 locules and dorsally developing wings.

In agreement with Weckerle and Rutishauser (2005), in Paullinieae, schizocarpic fruit or septifragal capsules are structurally similar and, as in the ovarian wall, the pericarp gives useful anatomical characters to the generic and infrageneric grouping in Sapindaceae. These anatomical characters are known also from other sapindaceous genera and play an important role in the classification of Sapindaceae proposed at first by Radlkofer (1892-1900).

The above mentioned authors classified some diagnostic characters in the pericarp structure, like: the sclerenchyma sheathes around the numerous and inconspicuous vascular bundles or around the secondary lateral bundles; parenchymatous or spongy mesocarp; and endocarp with strongly lengthen cells or of crossed fiber arrangement.

Comparing both species studied in this work with the anatomical descriptions of the species studied by Weckerle and Rutishauser (2005), including *U. ulmacea*, is confirmed the diagnosis importance of the aspects considered by the authors as the pericarp structure in Sapindaceae, highlighting: the marginal proximal wing position in *S. communis* and marginal dorsal wings in *U. ulmacea*; the presence of carpophore in the samaroid schizocarp of *S. communis*; the presence of trichomes in the exocarp; the less conspicuous spongy mesocarp and the inflated seed chamber in *U. ulmacea*, aspect that could make the fruit lighter,

aiding the dispersion, given the facilitated opening by the spongy tissue in the septum; and fibrous endocarp with many elongated cells layers organized in variable plans in *S. communis* and around two or three cellular layers in *U. ulmacea*.

The anatomical characteristics generalized by Acevedo-Rodriguez (1993) for the *Serjania* fruit from the descriptions made by the author for *S. communis* are similar to the observed in the present research, despite the author's presentation of a different definition for the pericarp layers. However, some characteristics were not confirmed, like: cuticle lack; spongy parenchyma lack; sclereid sheath; exocarp becoming strongly suberized, collapsed and sometimes separated from mesocarp; mesocarp constituted by a middle layer, unistratified of small parenchymatous cells, containing prismatic crystals; and the inner layer of endocarp suberized.

Weckerle and Rustishauser (2005) observed, in *S. altissima*, the exocarp with regular epidermal cells with thick periclinal walls, the mesocarp of parenchymatous tissue and the endocarp with crossed fiber layers also separated from mesocarp by a layer of oxalate crystals, which confirmed Acevedo-Rodriguez (1993) who argued that the structure is common in *Serjania*. In spite of structural similarity in other aspects, this layer of crystals was not observed in this work for *S. communis*.

According to Weckerle and Rutishauser (2005), fruit of *U. ulmacea* show the pericarp structure similar to *Serjania inflata*. The genera of both studied species are considered phylogenetically related by many authors (ACEVEDO–RODRIGUEZ, 1993; FERRUCCI, 2000; HARRINGTON et al., 2005; WECKERLE; RUTISHAUSER, 2005). The presence of dorsal wings, lighter spongy tissue, inflated locules and the easy opening by the spongy tissue in the septa of *U. ulmacea* could represent a transition state between the samaroid schizocarp formed by *Serjania* and the septifragal capsule produced by *Cardiospermum*. Further researches with other *Urvillea* species can elucidate this affirmation, because the absence of a predetermined line of dehiscence in *U. ulmacea* could not be a general rule to the genus.

Conclusion

In conclusion, *S. communis* has a samaroid schizocarp fruit with proximal wings and distal cavities. The fruit of *U. ulmacea* presents septicidal and septifragal passive dehiscence and each seed chamber presents a dorsal wing. This structure can represent a transition state between the samaroid schizocarp formed by *Serjania* and the septifragal capsule produced by *Cardiospermum*.

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