

Anatomical Properties of Medicinal Plant *Hypericum orientale* L.

Öznur ERGEN AKÇİN^{1*}

Merve Yasemin ALTINTAŞ¹

Tuğba ÖZBUCAK¹

Yaşar AKÇİN²

¹Department of Biology, Faculty of Science and Art, Ordu University, Ordu, Turkey

²Department of Horticulture, Faculty of Agriculture, Ordu University, Ordu, Turkey

*Corresponding author:
E-mail: oakcin@gmail.com

Received: February 23, 2016
Accepted: April 07, 2016

Abstract

In this study, the morphological, anatomical and some micromorphological characteristics of vegetative and generative organs of *Hypericum orientale* L. were investigated. Also secretory structures of root, stem, leaf, sepal, petal and ovary were examined. The leaf is ecvifacial type. Stomata are anisocytic on the adaxial surface, anomocytic and anisocytic on the abaxial surface. There are different types of secretory canals in vegetative and generative organs of *H. orientale*.

Keywords: *Hypericum orientale*, Hypericaceae, anatomy, morphology, micromorphology

INTRODUCTION

Hypericum L. (Hypericaceae) consists of more than 490 species in the world. This genus is represented by 94 taxa (78 species) in Turkey. *Hypericum* has about 43 endemic species. *Hypericum* species, especially *H. perforatum* L., is known as 'binbirdelikotu, kılıçotu, kantaron' in Turkish, St. John's Wort in English [1,4].

Hypericum L. is characterized by the presence of different types of secretory structure including translucent glands, black nodules and secretory canals. The secretory structures, which are sites of synthesis and/or accumulation of biologically active substances, are important for discrimination among taxa [5,6].

Hypericum genus is an important medicinal plants and used as traditional medicines for the purpose of pain relief, parasite reduction and wound healing [1]. Some *Hypericum* species produces «hypericins» and «hyperforine». Hypericins and hyperforine can act as anti-cancer, anti-viral, anti-depressant and fungicidal agents [7,8]. *Hypericum* tea and pills have also been used for depression. Many species are cultivated as ornamentals. The dots are conspicuous when held up to the light [9,10].

Anatomy and micromorphology of *H. orientale* have not been studied previously. Therefore, the present study aims to investigate morphological, anatomical and some micromorphological features of the vegetative and generative organs in *H. orientale*.

MATERIALS and METHODS

Plant specimens were collected from different localities in Black Sea Region of Turkey. The specimens have been stored in Ordu University. Taxonomical descriptions of the specimens were made according to Davis [11]. Collection data for the studied species are given in below.

A6 Ordu: Keyfalan Plateau (40° 24' 44" N, 37° 52' 24" E, 1769.9 m, June 2014, Altıntaş 15); Mesudiye, Yeşilce (40° 33' 3.3480" N, 37° 47' 58.7760" E, 1500 m, June 2014, Altıntaş 17)

A7 Giresun : Sis Mountain (40° 55' 4" N, 39° 7'58" E, 1319.5 m, June 2014, Altıntaş 20)

Anatomic materials were fixed in 70% alcohol. Cross and surface sections of root, stem, leaf and flower were

cut freehand and they were covered with glycerine-gelatin [12]. Slides were photographed with a Nikon FDX-35 microscope (with NIS - Elements,3.00 SP5). Stomata index was calculated according to the method described by Meidner and Mansfield [13]. Observations on the types of secretory structures were made as in Ciccarelli et al. [5].

For scanning electron microscopy, dried mature leaves were mounted on stubs using double-sided adhesive tape. Samples were coated with 12.5–15 nm of gold. Coated materials were examined and photographed with a JMS-6060 LV scanning electron microscope.

RESULTS

Morphological Properties

Stem is erect, 13-23 cm. Leaves are 1.5-3.8 cm, oblong, oblanceolate, yellow-green in color, edge of leaves are with gland. Sepals are narrow oblong, ovate or elliptic obovate. Petals are 11-13 mm, without black gland. Fruit is capsule, 7-11 mm, ovoide ovoide-cylindric.

Anatomical Properties

Root

Periderm is multilayered (7-9 layered). Phellem cells are brown and light brown. Phellogen is distinguishable. Cortex is multilayered and parenchymatic. Phloem is clear and 6-8 layered. There are type A glandular canals in the cortex and phloem. Cambium cells are 1 to 2 layered, flat and distinguishable. Xylem is composed of sclerenchymatic cells and tracheary elements. The pith rays in the root are composed of 1 and 2 rowed rectangular cells. The pith consists of xylem cells. Type A secretory canals were seen in the root (Table 1, Figure 1).

Stem

Cuticle layer is thick on the stem. Unilayered epidermis is present on the stem. Collenchyma is multilayered. Parenchyma cells with thick walled are 7-13 layered. Endodermis is distinguishable and unilayered. Xylem and phloem elements are clear. Cambium is undistinguishable. Tracheids cells are dense in xylem tissue. Pith cells are large and cylindrical. The pith rays are clear and 1-2 rows. In cross-section, the stem has a profile from circular to elliptical with two clear and big wings (Table 1, Figure 1).

Leaf

The upper and lower epidermal layers are covered with a thick cuticle layer. Both epidermises consist of uniseriate, oval or rectangular cells. The leaf is ecvifacial type. Mesophyll region is composed of 2-3 layers of elongated rectangular palisade cells on the adaxial surface and 1 layer on the abaxial surface and 2-3 layers of irregular spongy parenchyma cells. Vascular bundles are collateral and surrounded by a bundle sheath. Below the uniseriate epidermis, there are collenchymatous cells in midrib. Type A secretory canals were seen in the vascular bundles. Type C secretory canals were seen in the mesophyll.

Stomata are present on both adaxial and abaxial sides in the studied species. Stomata are anisocytic on the adaxial surface, anomocytic and anisocytic on the abaxial surface. SEM observations showed that the stomata are slightly sunken. Stomata index is 27.06 for adaxial surface and 31.9 for abaxial surface. There are a few glandular hair (Table 1-2, Figure 1).

Sepal

The upper and lower epidermal layers are covered with a thick cuticle layer. Both epidermises consist of uniseriate epidermis cells. Mesophyll region is composed of 4-5 layers of parenchymatic cells. There are collateral vascular bundles. Type C secretory canals were seen in the sepal (Table 3, Figure 2).

Petal

Both epidermises are uniseriate and upper epidermis has papillae. Mesophyll is homogeneous and composed of 5-9 layers of parenchymatic cells. There are collateral vascular bundles. In the petal mesophyll may be occur secretory structures. There are Type B glandular canals in petal (Table 3, Figure 2).

Anther

Anthers of *H. officinale* have four microsporangia arranged in pairs of two lobes; each pair is separated by parenchymatous and vascular tissue at the connective site of the anther. The tissues surrounding the anther consist of a surface epidermis, endothecium, middle layers and a tapetum (Table 3, Figure 2).

Ovary

Ovary wall has big epidermis cells. Wall supports the ovary. Ovary has 3 carpels and also 3 locules. There are a lot of ovule. Placentation type is axile. There are Type C glandular canals in ovary (Table 3, Figure 2).

DISCUSSION

In *Hypericum* species, the stem structure, shape and wings are important features. *H. orientale* has wavy circular to elliptical stem with two big wings. Lignified stem with four clear small wings are seen in *H. bitynicum* [14]. There are lignified wavy elliptical stem with two long and thin wings in *H. hircinum* L. Two small slightly prominent wings are found in *H. perforatum* [15].

Metcalfe and Chalk pointed out that the Hypericaceae family have both bifacial and ecvifacial leaves [16]. In our study, leaves are ecvifacial. *H. triquetrifolium* Turra, *H. montbretii* Spach. and *H. sechmenii* Ocak & Koyuncu species have ecvifacial leaf types [15,17,18]. Dorsiventral leaf type are seen in *H. perforatum*, *H. perfoliatum* L. and *H.*

bitynicum species [14,15].

Metcalfe and Chalk reported that there is anomocytic, anisocytic and paracytic stomata in Hypericaceae [16]. Stomata are present on both adaxial and abaxial sides in the studied species. Stomata are anisocytic on the adaxial surface, anomocytic and anisocytic on the abaxial surface in *H. orientale*. It was reported that stomata are anisocytic and anomocytic in *H. montbretii*, *H. perforatum* [17]. According to Yaylacı et al. dominant stomatal type is anomocytic in *H. sechmenii* [18]. Anomocytic and anisocytic stomata are found in *H. Bitynicum* [14].

Hypericum L. is characterized by the presence of different types of secretory structure including translucent glands, black nodules and secretory canals [5,6]. There are type A, Type B and Type C glandular canals and translucent gland in *H. orientale*. Type A, type B glandular canals, translucent gland and black gland are seen in *H. bitynicum* [14]. All secretory structures are found in *H. perforatum* species [5,6].

We believe that important findings unearthed during the study of anatomy and morphology will lead to a better understanding of the species, and provide a contribution to any further study.

ACKNOWLEDGEMENTS

The work was supported by the Scientific Research Project Unit of Ordu University under grant (TF-1314).

REFERENCES

- [1] Baytop T., 1999. Türkiye'de Bitkilerle Tedavi. Nobel Tıp Yayınevi. 2. Baskı. İstanbul, s:256.
- [2] Hışıl Y., Şahin F., Omay S., 2005. Kantaronun (*Hypericum perforatum* L.) Bileşimi ve Tıbbi Önemi. Uluslararası Hematoloji Onkoloji Dergisi. Sayı : 4:15.
- [3] Güner A., Özhatay N., Ekim T., Başer, H.C. 2000. Flora of Turkey and the East Aegean Islands, Vol.11, Edinburgh Univ. Pres. Edinburgh.
- [4] Güner A., Aslan S., Ekim T., Vural M., Babaç MT., 2012. Türkiye Bitkileri Listesi (Damarlı Bitkiler). Nezahat Gökyiğit Botanik Bahçesi ve Flora Araştırmaları Derneği Yayını. İstanbul.
- [5] Ciccarelli D., Andreucci AC., Pagni AM., 2001. Translucent glands and secretory canals in *Hypericum perforatum* L. (Hypericaceae): morphological, anatomical and histochemical studies during the course of ontogenesis. Annals of Botany 88: 637±644, 2001.
- [6] Ciccarelli D, Andreucci AC, Pagni AM. 2001. The 'black nodules' of *Hypericum perforatum* L. subsp. *perforatum*: morphological, anatomical and histochemical studies during the course of ontogenesis. Israel Journal of Plant Sciences 49: 33-40.
- [7] Colasanti A1, Kisslinger A, Liuzzi R, Quarto M, Riccio P, Roberti G, Tramontano D, Villani F. 2000. Hypericin photosensitization of tumor and metastatic cell lines of human prostate. Journal of Photochemistry and Photobiology . Volume 54, Issues 2–3, 29 February 2000, Pages 103–107.
- [8] Reichling J, Weseler A, Saller R.A current review of the antimicrobial activity of *Hypericum perforatum* L. Pharmacopsychiatry. 34 Suppl 1:S116-8, 2001.
- [9] Strzelecka H, Kowalski J. 2000. Encyklopedia ziołolecznictwa i ziołolecznictwa. Warszawa: Wydawnictwo Naukowe PWN.

- [10] Ernst E, ed. 2003. *Hypericum: the genus Hypericum*. London and New York: Taylor & Francis Group.
- [11] Davis P.H., (1978- 1988). *Flora of Turkey and the East Aegean Islands II*. p:355-400 Edinburg University Press, Edinburg.
- [12] Vardar Y., 1987. *Botanikte Preparasyon Tekniği*. Ege Üniversitesi Fen Fakültesi Kitaplar serisi No.1. Bornova-İzmir.
- [13] Meidner H, Mansfield TA. (1968). *Physiology of stomata*. edn. New York : McGraw-Hill. p 140-143
- [14] Altuntaş MY. 2015. Ordu ve Giresun'da yayılış gösteren Bazı *Hypericum L.* (Hypericaceae) türleri üzerinde morfolojik, anatomik ve mikromorfolojik bir araştırma. Ordu Üniversitesi. Fen Bilimleri Enstitüsü, 146 sayfa.
- [15] Perrone R., De Rosa P., De Castro O. ve Colombo P. 2013. Leaf and stem anatomy in eight *Hypericum* species (Clusiaceae). *Acta Bot. Croat.* 72 (2), 269–286, 2013.
- [16] Metcalfe CR, Chalk L (1979). *Anatomy of Dicotyledons II*. Oxford University Press, London.
- [17] Erkara Potoğlu İ. and Tokur S., 2004. Morphological and anatomical investigations on some *Hypericum L.* species growing naturally in and around Eskisehir. *Trakya Univ J Sci*, 5(2): 97-105.
- [18] Yaylacı ÖK., Özgüşi K., Sezer O., Orhanoğlu G., Öztürk D., Koyuncu O., 2013. Anatomical studies and conservation status of rare endemic *Hypericum sechmenii* Ocak & Koyuncu (Sect: Adenosepalum) from Eskişehir-Turkey. *Journal of Selçuk University Natural and Applied Science*. 2(1): 1-11 (2013).

Table 1. Anatomical measurements of various tissue of vegetative organs of *H. orientale*.

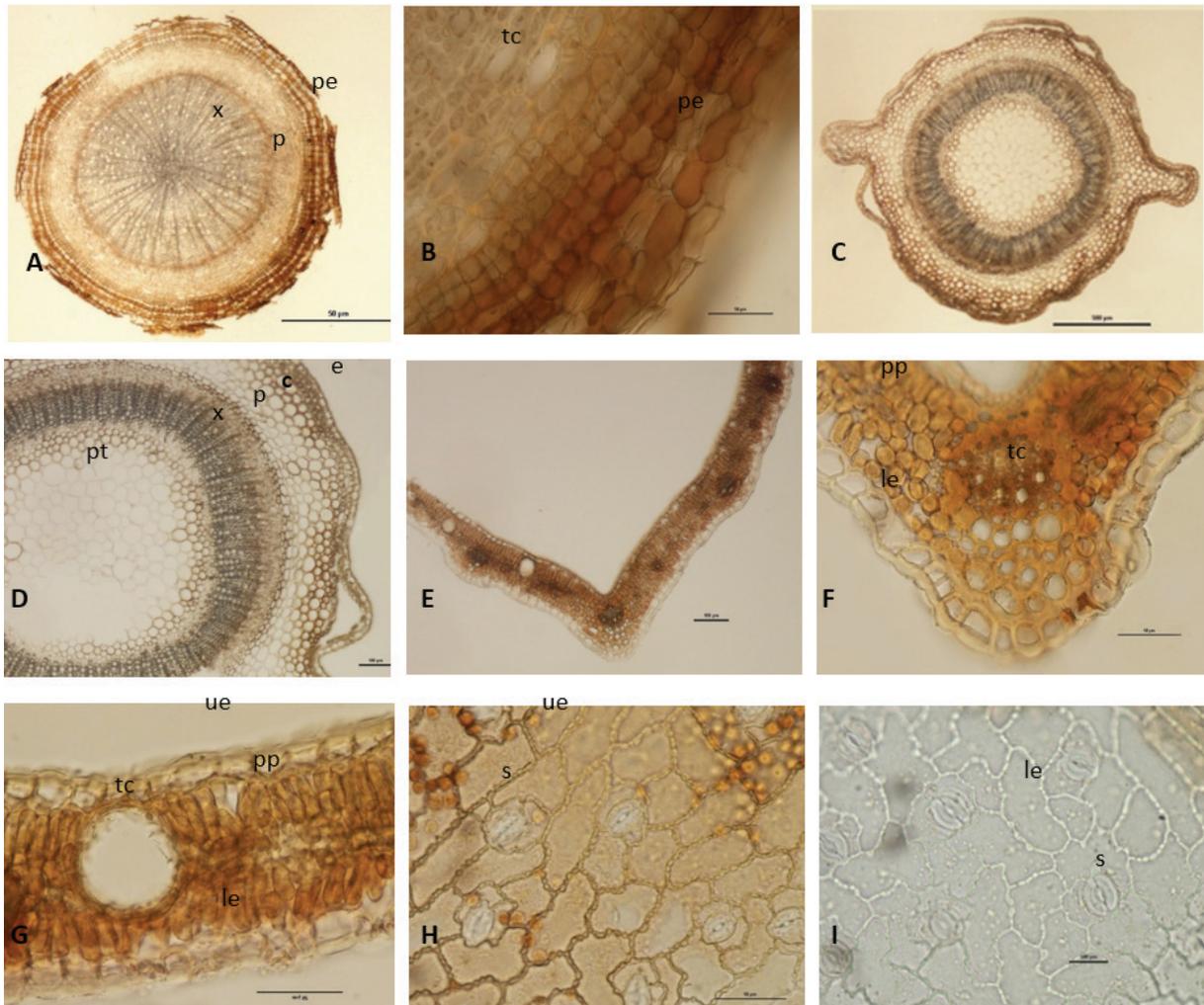
Parameter	Width (µm) Mean±SE	Length (µm) Mean±SE
Root		
Peridermis cell	22.91 ± 1.62	14.91 ± 0.78
Parenchyma cell	29.05 ± 1.12	14.14 ± 0.65
Pith ray cell	7.35 ± 0.44	12.53 ± 0.57
Phloem	12.87 ± 1.18	7.89 ± 0.55
Trachea	15.33 ± 0.52	
Stem		
Epidermis cell	18.56 ± 0.72	14.10 ± 0.46
Parenchyma cell	35.97 ± 1.42	23.26 ± 1.24
Phloem	9.71 ± 0.64	5.26 ± 0.35
Trachea	11.42 ± 0.71	-
Pith ray cell	3.90 ± 0.20	7.30 ± 0.52
Pith cell	37.07 ± 1.37	-
Leaf		
Upper epidermis cell	14.94 ± 0.46	10.97 ± 0.38
Lower epidermis cell	19.55 ± 1.12	14.40 ± 0.64
Palisade parenchyma cell	9.38 ± 0.26	28.71 ± 0.98
Spongy parenchyma cell	10.75 ± 0.42	12.21 ± 0.58
Phloem	4.14 ± 0.21	3.31 ± 0.18
Xylem	3.84±0.23	-
Secretory canal	3.90 ± 0.20	7.30 ± 0.52

Table 2. Stomata features on the adaxial and abaxial surface of *H. orientale*.

Parameter	Adaxial surface Mean±SE	Abaxial surface Mean±SE
Number of stomata (1 mm ²)	180	260
Number of epidermis cells (1 mm ²)	485	555
Stoma width (µm)	19.21 ± 0.27	22.22 ± 0.41
Stoma length (µm)	24.08 ± 0.44	22.30 ± 0.38
Stoma index	27.06	31.90

Table 3. Anatomical measurements of various tissue of generative organs of *H. orientale*.

Parameter	Width (μm) Mean \pm SE	Length (μm) Mean \pm SE
Sepal		
Upper epidermis cell	22.74 \pm 1.03	16.37 \pm 1.03
Lower epidermis cell	30.01 \pm 1.36	17.24 \pm 1.07
Parenchyma cells	15.88 \pm 1.19	26.39 \pm 1.70
Secretory canal	62.17 \pm 6.35	-
Petal		
Upper epidermis cell	12.45 \pm 0.76	11.76 \pm 0.44
Lower epidermis cell	12.86 \pm 0.60	23.44 \pm 0.86
Parenchyma cells	13.16 \pm 0.43	26.39 \pm 1.70
Secretory canal	45.19 \pm 5.40	-
Anther		
Epidermis cell	22.25 \pm 1.21	12.06 \pm 0.34
Endotesyum cell	3.38 \pm 0.17	14.38 \pm 0.56
Ovary		
Upper epidermis cell	16.22 \pm 1.04	11.76 \pm 0.44
Lower epidermis cell	12.86 \pm 0.60	23.44 \pm 0.86
Parenchyma cells	13.16 \pm 0.43	26.39 \pm 1.70
Secretory canal	45.19 \pm 5.40	-

**Figure 1.** Cross-section and surface-section of the vegetative organs of *H. orientale*. A-B) Root, C-D) Stem, E-I) Leaf. e: epidermis, pe: periderm, c: cortex, x: xylem, p: pith, tc: translucent canal, pt: pith, ue: upper epidermis, le: lower epidermis, pp: palisade parenchyma, s: stoma.

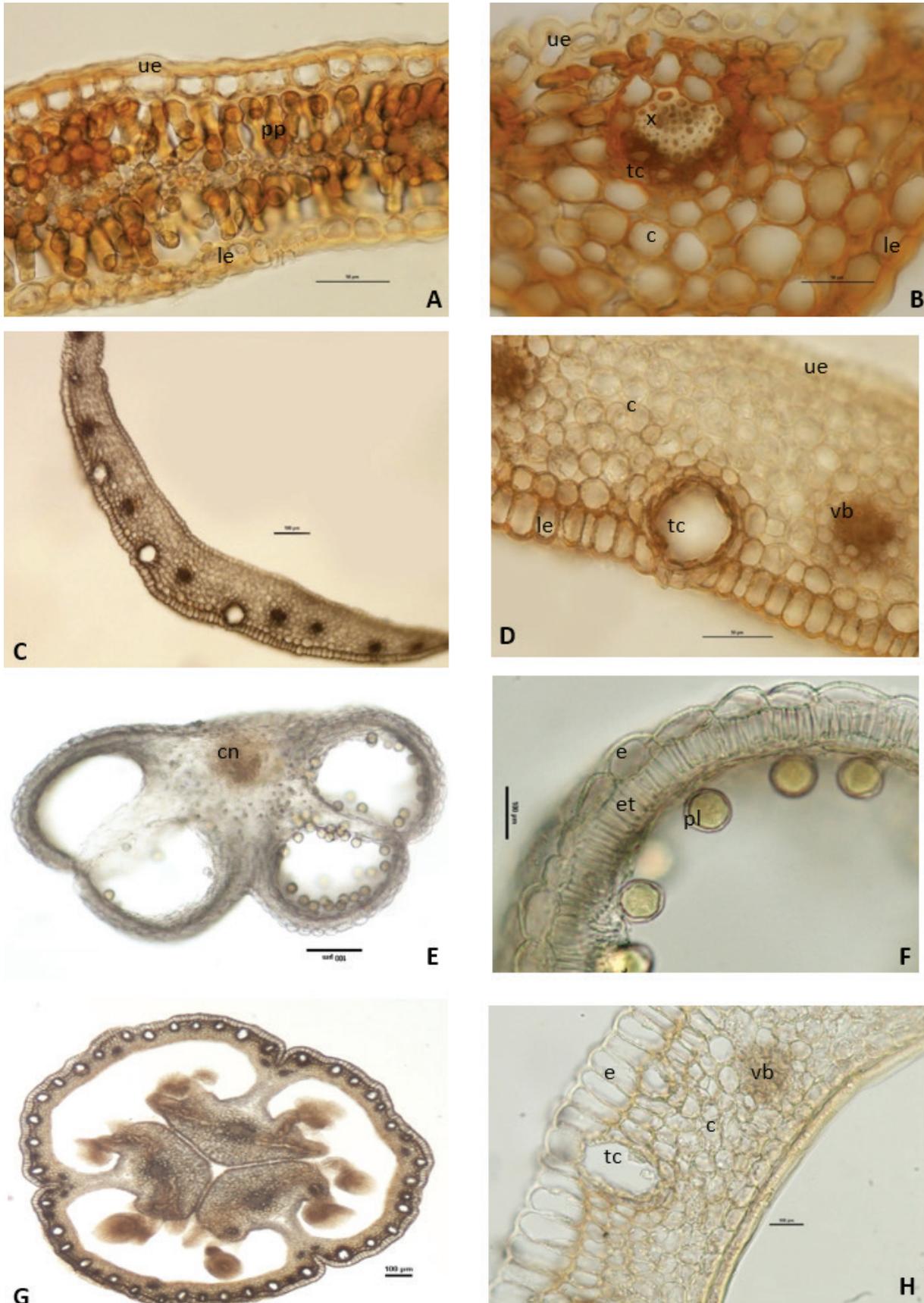


Figure 2. Cross-section of the generative organs of *H. orientale*. A-B) Sepal, C-D) Petal, E-F) Anther, G-H) Ovary. e: epidermis, p: parenchyma, c: cortex, vb: vascular bundle, et: endothecium, pl: pollen.