

Contributions to the Leaf and Stem Anatomy of *Tradescantia fluminensis*: an Alien Species New to the Flora of Turkey

Özgür EMİNAĞAOĞLU¹, Melahat ÖZCAN², Şükran KÜLTÜR³

¹ Artvin Çoruh University Faculty of Forestry Department of Forest Engineering, Artvin

² Artvin Çoruh University Faculty of Science and Arts Department of Biology, Artvin

³ İstanbul University Faculty of Pharmacy Department of Pharmaceutical Botany, İstanbul

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Corresponding author: Özgür EMİNAĞAOĞLU, e-mail: oceminagaoglu@artvin.edu.tr

ABSTRACT

Tradescantia fluminensis Vell. (Commelinaceae) has been recorded as a new naturalised alien species for the flora of Turkey from NE Anatolia. Its description, detailed leaf and stem anatomical properties, measurements, and photographs are presented in this paper. It was observed that the stems have a primary structure, the central cylinder comprises 2 concentric rings of closed collateral vascular bundles, and the leaves are bifacial and hypostomatic, with tetracytic stomata cells. In addition, it was determined that the thickness of the leaf lamina is $326 \pm 4.79 \mu\text{m}$ and average of stomatal length and stomatal index in the abaxial surface of the leaf is $51.70 \pm 0.33 \mu\text{m}$ and 12.54 ± 1.33 , respectively.

Keywords: Anatomy, Commelinaceae, new record, *Tradescantia*, Turkey.

Türkiye Florası İçin Yabancı Yeni Bir Tür Olan *Tradescantia fluminensis*'in Yaprak ve Gövde Anatomisine Katkıları

Eser Bilgisi:

Araştırma makalesi

Sorumlu yazar: Özgür EMİNAĞAOĞLU, e-mail: oceminagaoglu@artvin.edu.tr

ÖZET

Tradescantia fluminensis Vell. (Commelinaceae), Türkiye florası için doğallaşmış yabancı bir tür olarak ilk kez Kuzeydoğu Anadolu'dan kaydedilmektedir. Bu çalışmada türün betimlemesi, yaprak ve gövdesinin detaylı anatomik özellikleri, ölçümler ve fotoğraflar sunulmaktadır. Gövdelerin primer yapılı, merkezi silindirik iki konsentrik halkalı, kapalı kollateral iletim demetleri içerdiği ve yaprakların bifasial, hipostomatik, tetrasitik tip stomalı olduğu gözlenmiştir. Ayrıca yaprak laminasının kalınlığı $326 \pm 4.79 \mu\text{m}$ ve yaprağın alt yüzeyinde ortalama stoma uzunluğu ve stoma indeksi sırasıyla $51.70 \pm 0.33 \mu\text{m}$ ve 12.54 ± 1.33 olarak tespit edilmiştir.

Anahtar Kelimeler: Anatomi, Commelinaceae, yeni kayıt, *Tradescantia*, Türkiye.

INTRODUCTION

Tradescantia Rupp. ex L., a genus of an estimated 71 species, belongs to the subtribe *Tradescantiinae*, tribe *Tradescantieae*, and subfamily *Commelinoideae* of the family Commelinaceae (Faden and Hunt 1991).

Tradescantia fluminensis Vell. (Comelinaceae) is native to South America (Esler 1978) and has naturalised in New Zealand (Kelly and Skipworth, 1984), Russia (Tolkach et al. 1990), the south-eastern USA (Farr et al. 1989; Wunderlund, 1998), Eastern Australia, Spain, Italy, Japan, Kenya, Portugal,

Puerto Rico, and Florida (Standish 2001). In its native range, *T. fluminensis* occurs in rainforests and other damp, humid, and shaded places including roadsides and gardens. Outside its native range, it also occurs in damp, humid, and shaded places such as gardens, parks, banks, stream-sides, and forest remnants. It spreads most rapidly in floodplain forests and similar moist, semi-shady bottomlands (Standish et al. 2001).

The aims of the present study were to demonstrate that *T. fluminensis* grows widely in natural habitats of Artvin Province (Turkey) and to contribute to the knowledge of the vegetative anatomy of this species.

MATERIALS and METHODS

Plant materials were collected from Kemalpaşa District of Hopa, Artvin, Turkey, at 90 m-120 m in April. Morphological analyses were carried out in living or herbarium specimens. Plant samples were deposited at the Herbarium Artvin (Faculty of Forestry, Artvin Çoruh University).

For the anatomical studies the plant parts were first fixed in formalin-acetic acid-alcohol and then they were deposited in 70% alcohol. Transverse sections from stems and leaves were taken by hand using razor blades (Algan 1981). The leaves epidermises were peeled off and paradermal sections were also prepared. The sections were stained in hematoxylin for about 10-15 min and semi-permanent slides were mounted in glycerine. Well-stained sections were examined under light microscopy and photographed using a Zeiss Primostar with digital camera attachment Axiocam ERC 5S.

Five cross-sections from at least 3 different individual plants were measured to assess the consistency of anatomical characters

and to calculate the means and standard error among different cross-sections. Five paradermal slides were prepared and 25 stomatal lengths were measured under $\times 40$ magnification using a light microscope with an ocular micrometer using surface sections obtained from the abaxial parts. The stomatal index was calculated according to the method described by Meidner and Mansfield (1968). Different reference books were used for anatomical knowledge (Tomlinson 1969; Rudall 1994; Yentür 2003; Cutler et al. 2007).

RESULTS and DISCUSSION

During fieldwork in Kemalpaşa District (Hopa, Artvin), some interesting specimens belonging to Commelinaceae were collected by the first author in April 2011. These specimens were identified as *T. fluminensis* using the *Flora of Turkey* (Tan 1984) and other floras (Deyuan and DeFilipps 2000; Faden 2006; eFloras 2008). Consequently, *T. fluminensis* was described as a new alien record by authors for the flora of Turkey (Tan 1984; Anşin et al. 1997; Güner et al. 2000; Eminağaoğlu and Anşin 2002, 2003, 2004, 2005; Özhatay and Kültür 2006; Eminağaoğlu et al. 2008; Eminağaoğlu 2009; Özhatay et al. 2009; Manvelidze et al. 2009; Eminağaoğlu and Akpulat 2010; Özhatay et al. 2011). This identification was confirmed by comparison with a herbarium specimen housed at ISTE. Recently, many new species and new records to the flora of Turkey have been described (Ecevit Genç et al. 2012; Eminağaoğlu et al. 2012; Hamzaoglu 2012; Koyuncu 2012; Mutlu and Karakuş 2012). The description was written with the aid of *Flora of China* (Deyuan and DeFilipps 2000) and *Flora of North America* (Faden 2006; eFloras 2008).

Tradescantia Rupp. ex L., Sp. Pl. 1: 288 (1753).

Syn: *Separotheca* Waterf., Rhodora 61: 138 (1959); *Cymbispatha* Pichon, Notul. Syst. (Paris) 12: 224 (1946); *Neomandonia* Hutch., Fam. Fl. Pl., Monocot. 57 (1934); *Neotreleasea* Rose, Contr. U.S. Natl. Herb. 8: 6 (1903); *Setcreasea* K.Schum. and Sydow, Just's Bot. Jahresber. 1899, 27 (1): 452 (1901); *Treleasea* Rose, Contr. U.S. Natl. Herb. 5: 207 (1899); *Skofitzia* Hassk. and Kanitz, Oesterr. Bot. Z. 22: 147 (1872); *Mandonia* Hassk., Flora 54: 260 (1871); *Disgrega* Hassk. Flora 49: 215 (1866); *Knowlesia* Hassk. Flora 49: 215 (1866); *Rhoeo* Hance, Ann. Bot. Syst. (Walpers) 3 (4): 659 (1852); *Gonatandra* Schltdl., Linnaea 24: 659 (1852); *Heterachthia* Kunze, Bot. Zeitung (Berlin) 8: 1 (1850); *Zebrina* Schnizl., Bot. Zeitung (Berlin) 7: 870 (1849); *Heminema* Raf., Fl. Tellur. 2: 17 (1837); *Sarcoperis* Raf., Fl. Tellur. 2: 16 (1837); *Tropitria* Raf., Fl. Tellur. 3: 68 (1837); *Etheosantes* Raf., Neogenyton 3 (1825); *Campelia* Rich., Anal. Fruit. 46 (1808); *Zanonia* Cram., Disp. Syst. 75 (1803); *Ephemerum* Mill., Gard. Dict. Abr., ed. 4. (1754); Druce in Rep. Bot. Exch. Cl. Brit. Isles, 3: 431 (1913).

Tradescantia fluminensis Vell., Fl. Flumin. 140 (1829).

Syn.: *Tradescantia fluminensis* Vell. f. *tenella* (Kunth) Voss, Vilm. Blumengärtn., ed. 3. 1: 1143 (1895); *Tradescantia decora* W.Bull., Cat. 3 (1892); *Tradescantia fluminensis* var. *pubescens* C.B.Clarke, Monogr. Phan. 3: 295 (1881); *Tradescantia fluminensis* var. *tenella* (Kunth) C.B.Clarke, Monogr. Phan. 3: 295 (1881); *Tradescantia mundula* var. *scabrida* Seub., Fl. Bras. 3(1): 249 (1855); *Tradescantia albiflora* Kunth, Enum. Pl. 4: 84 (1843); *Tradescantia mundula* Kunth,

Enum. Pl. 4: 84 (1843); *Tradescantia tenella* Kunth, Enum. Pl. 4: 84 (1843); *Tradescantia laekenensis* L.H.Bailey and E.Z.Bailey, Hortus: 616 (1930).

T. fluminensis is the first species of the genus *Tradescantia* to have become established in Turkey. *T. fluminensis* belongs to the section *Austrotradescantia* D.R.Hunt of the genus *Tradescantia* (Hunt 1980). It has been collected as a persistent garden outcast on wasteland in Hopa (Artvin) in native communities (Figure 1). However, *T. zebrina* Heynh. and *T. pallida* (Rose) D.R.Hunt are listed as exotic species in Turkey (Tan 1984).

T. fluminensis grows on damp, humid, and shaded places including roadsides and forest sides at 50-100 m with *Chrysosplenium dubium* Gay ex Ser., *Primula megaseifolia* Boiss. et Bal. ex Boiss., *Epimedium pinnatum* Fisch. subsp. *colchicum* (Boiss.) Busch, *Viola alba* Besser, *Sambucus ebulus* L., and *Lonicera caprifolium* L.

Examined specimens: *Tradescantia fluminensis*: A8 Artvin: Hopa, Kemalpaşa, Sovil, damp roadside, grassland, 90 m, 41°28'39"N, 41°31'18"E, 27.iv.2011, Ö.Emin. 8732; A8 Artvin: Hopa, Kemalpaşa, Sovil, streamside, damp place, 120 m, 41°28'30"N, 41°31'30"E, 27.iv.2011, Ö.Emin. 8733; A8 Artvin: Hopa, near forest, 70 m, 41°23'14"N, 41°24'50"E, 27.iv.2011, Ö.Emin. 8745; A2(E) İstanbul: Dolmabahçe Sarayı, A.Baytop s.n. (ISTE 49962); *Tradescantia zebrina*: A2(E) İstanbul, Yıldız parkı, A.Baytop s.n. (ISTE 49652); A2(A) İstanbul: Maltepe, A.Baytop s.n. (ISTE 26720); *Tradescantia pallida*: A2(E) İstanbul: Dolmabahçe Sarayı, A.Baytop s.n. (ISTE 49963); A2(A) İstanbul: Maltepe, A.Baytop s.n. (ISTE 26721).



Figure 1 Natural view of *Tradescantia fluminensis*

Morphological Characteristics

Creeping, decumbent, trailing, subsucculent perennial herbs, prostrate stems rooting freely at nodes. Leaves 2-ranked; blade lanceolate-elliptic to ovate-lanceolate, 2.5-5 x 1 - 2 cm (distal leaf blades wider or narrower than sheaths when sheaths opened, flattened), parallel-veined, alternate, simple, glabrous or with ciliate margins, apex acute. Inflorescences terminal, becoming leaf-opposed, sometimes axillary. Cyme 1-2 pairs per stem; bracts mostly foliaceous, occasionally reduced. Flowers distinctly pedicillate; pedicels 1-1.5 cm, glandular-pilose; sepals 3, separate, usually with a line of hairs, 5 -7 mm, midrib pilose with eglandular hairs; petals 3, distinct, white, not clawed, 8 - 9 mm. Stamens 6, free; filaments white, densely bearded with white hairs. Ovary 3-celled, 6-seeded. Fruits small, 3-parted capsules; seeds black, pitted. *Fl: 3-10. On woods, roadsides, and open areas, at an altitude of 30-1000 m.*

Anatomical Characteristics

Stem anatomy

A cross section was taken from the middle parts of several plant samples. In cross sections, stem is round. The stem has a primary structure and primary vascular tissue in scattered bundles. It presents, from the exterior towards the interior, the epidermis, the cortex, and the central cylinder. The epidermis contains a single layer of cells. It is surrounded by a thin cuticle layer and has uniseriate and multicellular trichomes. Below the epidermis there is an angular collenchyma, interrupted at the level of the stomata with the chlorenchyma. Calcium oxalate crystals are present in the parenchyma of the stem. Cortical region is marked off from the medullary by a sclerenchymatous sheath, in which is embedded the outer ring of bundles. Central cylinder comprises 2 concentric rings of closed collateral vascular bundles. The larger bundles are present nearer the centre. The

central bundles are different from the cortical one with the presence of a lysigenous lacuna (Figure 2).

Leaf anatomy

Leaf surfaces are almost glabrous, but a lot of unicellular trichomes with pointed tip are present in the leaf margins. The cuticle is thin. Epidermal cells of both surfaces are arranged in a single layer. In terms of size, adaxial epidermal cells of the lamina are bigger than those of abaxial ones. Average length of epidermal cells is 143.115 ± 3.12 (\pm : standard error) μm in the upper epidermis, and $84.62 \pm 0.81 \mu\text{m}$ in the lower one; average width of epidermal cells in the upper and lower part is $108.62 \pm 3.85 \mu\text{m}$ and $91.03 \pm 2.48 \mu\text{m}$, respectively. The leaf is bifacial (dorsiventral mesophyll) with 1 layer of palisade cells and 2 layers of spongy cells (Figure 2). Thickness of leaf lamina is $326 \pm 4.79 \mu\text{m}$. In paradermal sections, the isodiametric epidermal cells have straight anticlinal walls. Stomata cells only occur on the abaxial surface (hypostomatic). Average of stomatal length and stomatal index is $51.07 \pm 0.62 \mu\text{m}$ and 12.54 ± 1.33 , respectively. Stomata type is tetracytic (the 2 guard cells are surrounded by 4 subsidiary cells and the subsidiary cells are in all 4 directions) (Cutler et al. 2007). This type has also been reported by Chimpan and Şipoş (2009) in *Tradescantia pallida* cv. *purpurea*. Tetracytic stomata type is commonly found in *Commelinaceae* (Abid et al. 2007) and it was also previously reported by Raunkiaer (1937).

One previous study was conducted, by Scott and Priestley (1925), on the anatomy

of *T. fluminensis*. In that study, some characters were mentioned such as the features of vascular bundles, sclerenchyma formation during light periods, and leaf development and reaction to etiolation in the species. Our study presents detailed leaf and stem anatomical characters and measurements of *T. fluminensis* for the first time. Our findings concerning the features of vascular bundles are in accordance with the previous paper.

Chimpan and Şipoş (2009) studied the anatomy of *T. pallida* cv. *purpurea*. In that study, primary stems, hypostomatic leaves, and tetracytic stomata in *T. pallida* cv. *purpurea* were reported. In addition, it was reported that the leaves of this species have hypodermal layers. Our findings in *T. fluminensis* are mostly similar to the findings in *T. pallida* cv. *purpurea*, but hypodermal layers are not observed in *T. fluminensis*.

T. fluminensis is closely related to *Commelina communis* morphologically. Leaf and stem anatomical features of *C. communis* were reported by Shuying et al. (1996). In their study, it was reported that vascular bundles are scattered in the stem, the leaf is 2-sided, and the mesophyll is composed of palisade cells and sponge cells, and mucus cells and crystal cells are present in the leaf and in the stem. Our anatomical findings for *T. fluminensis* are also similar to those for *C. communis*. However, in *T. fluminensis*, mucus cells are not detected in parenchymatic tissue of the leaf and stem, while crystal cells are observed in the parenchymatic tissue of the stem and leaf in the present study.

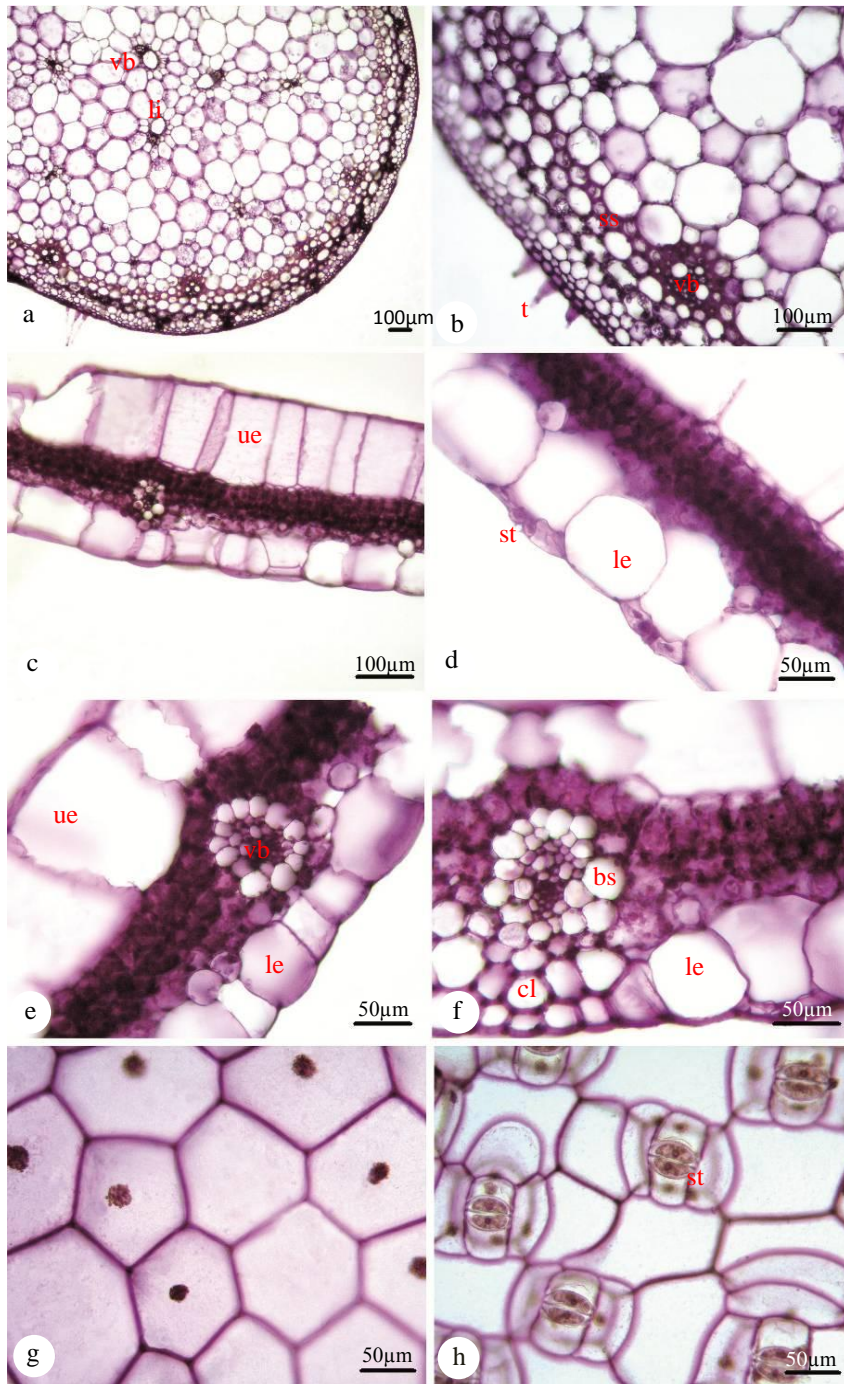


Figure 2 Anatomy of *Tradescantia fluminensis*. a - b: Cross section of stem, c - f: Cross section of leaf, g: Fragment of leaf adaxial epidermis, h: Fragment of leaf abaxial epidermis. bs: Bundle sheath, cl: Collenchyma, le: Lower epidermis, li: Lysigenous lacuna, st: Stomata, t: Trichome, ue: Upper epidermis, vb: Vascular bundle, ss: Sclerenchymatous sheath

CONCLUSIONS

T. fluminensis, recorded as a new naturalised alien species for the flora of Turkey, grows in Artvin Province. Detailed anatomical characteristics and measurements of some structures of this species are given for the first time in the present study. It is observed that this species has a primary structure and primary vascular tissue in scattered bundles in the stem and it has bifacial and hypostomatic leaves. Thickness of leaf lamina is $326 \pm 4.79 \mu\text{m}$. Average of stomatal length and stomatal index is $51.07 \pm 0.62 \mu\text{m}$ and 12.54 ± 1.33 , respectively. The leaves do not have hypodermal layers, unlike *T. pallida* cv. *purpurea*. However, calcium oxalate crystals are found in the parenchymatic tissue of stem and leaf in this species, like *T. pallida* cv. *purpurea* and *C. communis*.

T. fluminensis is grown as a garden plant or houseplant in many places and is considered an invasive species (Standish et al. 2001). There was a significant negative relationship between the presence of *T. fluminensis* and the presence of native tree seedlings, indicating that regeneration of natives may be inhibited by the dense ground cover of *T. fluminensis*. It is capable of changing nutrient cycling regimes where it invades, increasing litter decomposition rates and soil nutrient availabilities (Kelly and Skipworth 1984; Standish et al. 2001). If its prevalence is not controlled, it can be harmful to generations of tree seedlings.

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