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Morphological and anatomical characteristics of *Ludwigia* species (Onagraceae) in Can Tho city

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ABSTRACT

This study was conducted to provide information on the morphological characteristics and anatomical structures of species belonging to the genus *Ludwigia*, serving as a scientific basis for the taxonomical classification of this genus for more effective exploitation and utilization of plant resources in Can Tho City. In this study, plant samples were collected, morphological characteristics were described, anatomical structures were examined, and specimens were prepared for observation and photography under an optical microscope. The results showed that *L. adscendens* differs from other species in the genus *Ludwigia* by having a stem with spongy roots, white flowers, and abundant spongy parenchyma in the anatomical structure of its stem and leaves. The remaining four species are distinguished by the morphological characteristics of the stem (angled, branched, with or without trichomes), leaves (shape, presence or absence of trichomes), flowers (shape of petals and sepals, number of stamens), and fruit (shape, presence or absence of angles, color). Anatomically, the species can be differentiated by the shape of the stem and fruit cross-sections, while the tissue structure and arrangement in the stem and leaves are quite similar.

1. INTRODUCTION

The Onagraceae family exhibits a global distribution, ranging from boreal to tropical regions (Xu & Deng, 2017). Within this family, the genus *Ludwigia* includes 87 accepted species, which are mainly herbs, rarely shrubs (POWO, 2024). Representatives of the genus *Ludwigia* are commonly found in wet or flooded areas, growing on lakes and riverbanks, with some species being primarily aquatic (Rocha & Melo 2020). Several traditional medicinal applications have been documented for *Ludwigia* species, including

antidiabetic (Lin et al., 2017), antioxidant, antimicrobial (Smida et al., 2018), antidiarrheal (Mohammad et al., 2003), and anti-inflammatory activities (Praneetha et al., 2018).

In Viet Nam, species of the genus *Ludwigia* are widely distributed in different habitats, including rice fields, canals, and wet and muddy places (Nguyen, 2003). In addition, six species and one subspecies of the genus *Ludwigia* have been recorded in Viet Nam (Pham, 2000), five of which have been documented in the Mekong Delta. These include *L. adscendens* (L.) Hara, *L. hyssopifolia* (G.

Don) Exell, *L. octovalvis* (Jacq.) P.H. Raven, *L. prostrata* Roxb., and *L. perennis* L. (Dang & Pham, 2022). Many species of the genus *Ludwigia* are used as vegetables and as medicine to treat various diseases, including fever, cough, diarrhea, dysentery, sore throat, joint pain, deworming, etc. (Vo, 2018). However, identifying and classifying these species in nature is very difficult. Except for *L. adscendens*, which has distinct morphological characteristics, including an aquatic stem with white spongy roots, the remaining species differ only in a few morphological traits. In order to identify and classify species of the genus *Ludwigia* more effectively, in addition to relying primarily on morphological characteristics, we also supplemented data on the anatomy of the species, as anatomical studies have also been shown to be an

important tool related to taxonomic studies among plants (Peter et al., 2000; Sharmila & Rajeswari, 2017).

2. RESEARCH METHODS

2.1. Sample collection

Five species, *L. adscendens*, *L. hyssopifolia*, *L. octovalvis*, *L. prostrata*, and *L. perennis* were sampled from six habitats across nine districts in Can Tho City. Three samples were collected for each species from three separate locations (Table 1). All samples comprised the entire above-ground plant, including stems, leaves, flowers, and fruits. Photographs were taken, and morphological characteristics of both vegetative and reproductive organs were documented in the field.

Table 1. Location, coordinates, and habitat of five *Ludwigia* species in Can Tho city

No.	Species name	Sampling location	Coordinates	Habitat
1	<i>Ludwigia adscendens</i>	Ninh Kieu, Co Do, Vinh Thanh	10°02'10.0"N, 105°45'08.0"E 10°11'57.8"N, 105°29'26.20"E 10°11'2.08"N, 105°21'47.86"E	Wetland
2	<i>Ludwigia hyssopifolia</i>	Ninh Kieu, Thot Not, Co Do	10°01'9.24"N, 105°45'8.67"E 10°13'24.69"N, 105°35'42.98"E 10°7'0.31"N, 105°25'24.84"E	Unused land, Canalside, Unused land
3	<i>Ludwigia octovalvis</i>	Phong Dien, Binh Thuy, Vinh Thanh	10°0'12.11"N, 105°43'11.50"E 10°04'57.0"N, 105°43'20.0"E 10°10'2.56"N, 105°20'13.89"E	Canalside, Lotus pond, Unused land
4	<i>Ludwigia perennis</i>	O Mon, Thoi Lai, Thot Not	10°06'54"N, 105°38'29"E 10°03'23.4"N, 105°33'41.3"E 10°18'16"N, 105°29'33"E	Rice field, Canalside, Rice field
5	<i>Ludwigia prostrata</i>	Cai Rang, Binh Thuy, O Mon	9°59'10.11"N, 105°44'19.41"E 10°01'28"N, 105°44'17"E 10°04'03"N 105°37'55"E	Canalside, Swamp, Rice field

2.2. Morphological characteristics

According to Pham (2000), some key morphological characteristics used for *Ludwigia* species classifications were described, including stems (herbaceous, shrubby, branched or not, color, size, edged or not, trichome or not), leaves (shape, size, growth pattern, trichome or not), flowers (color, shape and size of sepals and corollas, number of stamens, number of carpels of ovary), fruits (shape, size, color, pedicel length, trichome or not). These morphological traits were observed using naked eye and a stereomicroscope (Motic SMZ-171). Toupview software (ToupTeck Inc, China) integrated with the stereomicroscope was used to measure the sample size. By comparing the morphological traits of the sample in our study with previous studies, e.g., Pham (2000), Barua (2010),

Rocha and Melo (2020), the *Ludwigia* species was identified.

2.3. Anatomical method

According to Tran (1980) and Nguyen (2010), the anatomical structure of leaves, stems, and ovaries was observed under a microscope after sectioning. The plant material was cut into thin slices with a razor blade and then soaked in Javelle solution and acetic acid before double-staining with carmine-green iodine dye (Mondolot et al., 2001). The slices were observed under an optical microscope equipped with a digital camera (Olympus CX40) to take pictures and record anatomical features.

3. RESULTS AND DISCUSSION

3.1. Morphological characteristics

3.1.1. Stems

All species of the genus *Ludwigia* present in Can Tho city are herbaceous, from 30 to over 150 cm tall, commonly inhabit high-humidity environments such as canals, ditches, swamps, and rice fields, and are sometimes found in unused lands. Among these, *L. adscendens* differs in its characteristic white spongy root system and aquatic life. The remaining

four species are distinguished by some morphological characteristics: The stem of *L. perennis* has edges in its early growth stages, reddish brown, unbranched, and non-trichomes. The stem of *L. hyssopifolia* has edges that resemble wings, and it is heavily branched and *non-trichomes*. The stem of *L. octovalvis* are edgeless trichomes and often becomes woody at the base of the stem, which allows it to grow vigorously to over 150 cm in height. *L. prostrata* is characterized by bright red branches, often non-trichomes or sparsely trichomes (Figure 1).



Figure 1. The *Ludwigia* species in Can Tho city

A. *L. adscendens*; B. *L. octovalvis*; C. *L. hyssopifolia*; D. *L. prostrata*; E. *L. perennis*

3.1.2. Leaf

The leaf morphology of *Ludwigia* species may vary due to environmental influences; however, certain distinctive features remain consistent. Leaves generally display an alternate phyllotaxy, while in *L. adscendens*, the leaves are arranged in a whorled pattern near the apical region. The leaf base is narrow and wedge-shaped, tapering to an acute apex; venation follows a pinnate pattern, with the

primary vein often prominently visible. Detailed characteristics of the leaves are summarized in Table 1 and Figure 2.

Based on the results in Table 1 and Figure 2, it can be observed that the leaves of *L. adscendens* are oval, while the leaves of *L. hyssopifolia* are slightly rounded in the middle. Both *L. prostrata* and *L. perennis* have lanceolate-shaped leaves.

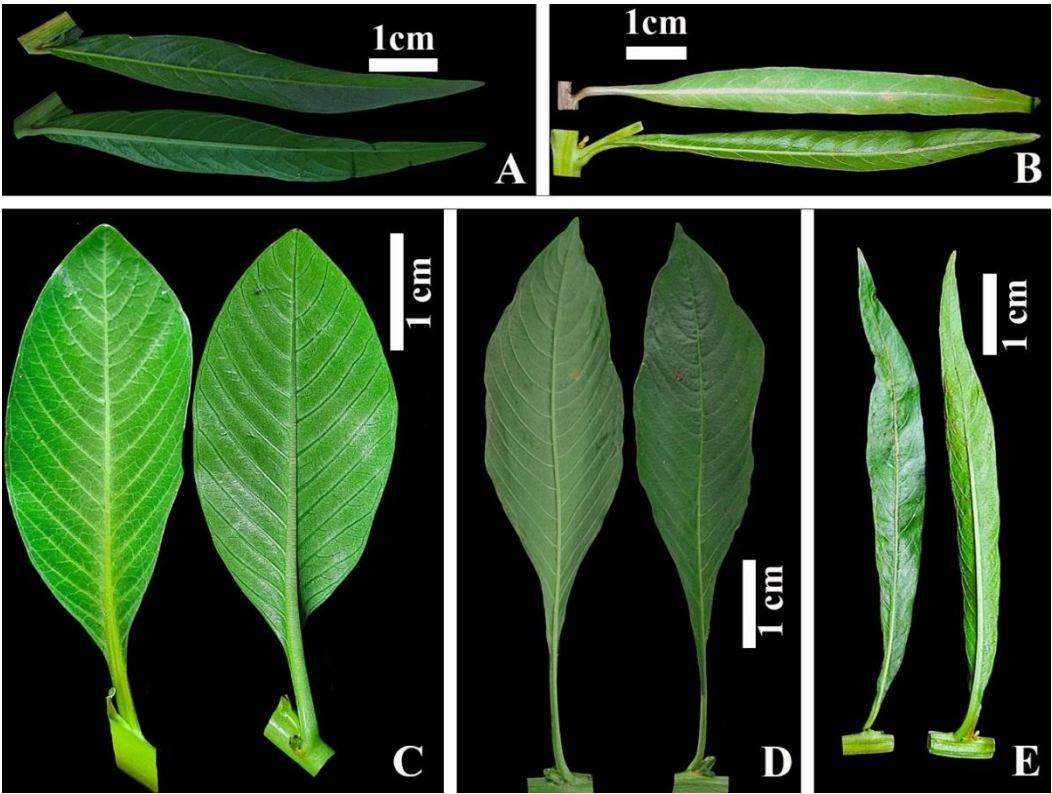


Figure 2. Characterization of *Ludwigia* species's leaf. A. *L. prostrata*; B. *L. perennis*; C. *L. adscendens*; D. *L. hyssopifolia*; E. *L. octovalvis*

Table 2. Morphological leaves of *Ludwigia* spp.

Species name	<i>L. adscendens</i>	<i>L. hyssopifolia</i>	<i>L. octovalvis</i>	<i>L. prostrata</i>	<i>L. perennis</i>
Shape	Oval blade	Narrow-bladed to slightly ovate	Narrow blade	Tapered blade, gradually narrowing on the petiole	Tapered blade, with a gradually narrowing base on the petiole
Leaf size (cm)	1-7 x 0,8-5	1-10 x 0,4-3	2-14 x 0,5-4	1-13 x 0,5-2,7	1-11 x 0,5-2,7
Lateral nerves	6–13	10–17	10–20	6–12	8–22
Leaf tip	Slightly rounded	Pointed	Pointed	Pointed	Pointed
Trichome	Abundant	No	Few	No	Few

3.1.3. Flower

L. adscendens has white flowers with yellow at the base of the petals, while other species have flowers ranging from yellow to pale yellow. The flowers are hermaphroditic, growing solitarily in the axils of leaves. The calyx forms a tubular structure that adheres to the ovary. Flower sizes among the species are classified into two categories: The large-flowered group includes *L. adscendens*, known for its triangular shape and distinctive coloration, followed by *L. octovalvis*, characterized by petals ranging in shape from ovate to cordate. The remaining species belong to the small-flowered category, where *L. hyssopifolia* has spoon-shaped

petals with an acute apex, *L. prostrata* displays spoon-shaped flowers, and *L. perennis* exhibits lanceolate and slender petals (Figure 3).

Figure 3 shows that only the flowers of *L. adscendens* have five sepals and five petals; the remaining species all have 4 sepals and 4 petals. The sepals can vary in length, appearing shorter, longer, or equal to the petals, with forms ranging from triangular to acutely triangular. In *L. octovalvis* and *L. adscendens*, the sepals are shorter and smaller than the petals. While *L. hyssopifolia* features sepals equal to or longer than the petals, *L. perennis* has large sepals equal to the petals, and *L. prostrata* has small sepals equal to the petals.

A crucial characteristic for distinguishing *Ludwigia* species is the number of stamens. *L. hyssopifolia* and *L. octovalvis* have eight stamens, twice as many as the number of petals, while other species usually have an equal number of stamens and petals, both four. The anthers are usually attached to the dorsal

filament. Pollen grains may occur as single grains (*L. adscendens*, *L. hyssopifolia*) or four-grained grains (*L. octovalvis*, *L. perennis*, *L. prostrata*). The gynoecium of *Ludwigia* species typically comprises four carpels.

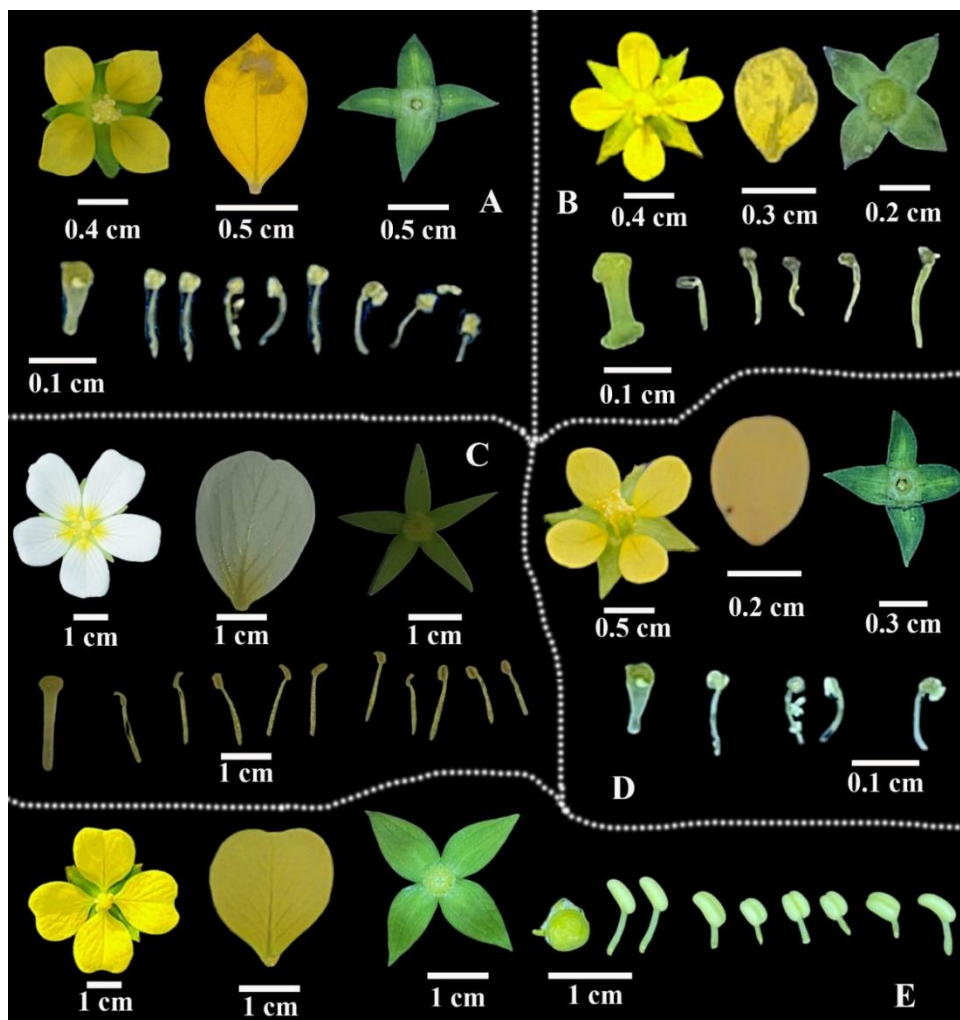


Figure 3. Characterization of *Ludwigia* species's flower

A. *L. hyssopifolia*; B. *L. perennis*; C. *L. adscendens*; D. *L. prostrata*; E. *L. octovalvis*.

3.1.4. Fruit

The fruits of *Ludwigia* species are typically capsule-fruit, cylindrical or terete shaped with or without angles, green, yellow-green, red or reddish-brown coloration, growing solitarily or in clusters in the leaf axils. *L. perennis* is characterized by its reddish-brown, angular fruits; *L. prostrata* has bright red, angular fruits; *L. hyssopifolia* has yellow-green fruits; and the others have green fruits. Overall, the

fruits of these species are relatively small, ranging in length from 1 to 4 cm. Larger fruits are commonly found in *L. octovalvis* and *L. adscendens*, and under favorable environmental conditions, *L. hyssopifolia* can produce fruits that exceed the typical size, reaching up to 3 cm. Notably, *L. perennis* has a characteristic fruit size of less than 1.5 cm, which is a distinguishing feature compared to *L. prostrata*. All characteristics are shown in Table 2 and Figure 4.

Table 3. Morphological characteristics of fruits of *Ludwigia* species in Can Tho city

Species name	<i>L. adscendens</i>	<i>L. hyssopifolia</i>	<i>L. octovalvis</i>	<i>L. prostrata</i>	<i>L. perennis</i>
Shape	Terete shape	Smooth cylindrical shape	Octagonal cylindrical shape	Quadrangular cylindrical shape	Cylindrical to clavate shape
Fruit size (mm)	15-35 x 3-4	7-30 x 1,5-2	15-30 x 3-6	15-25 x 1	8-15 x 3-4
Color	Green	Green, brown	Green, brown	Green, red	Brown
Peduncle	Large	No	Short	No	No
Trichome	Abundant	No	Few	No	No

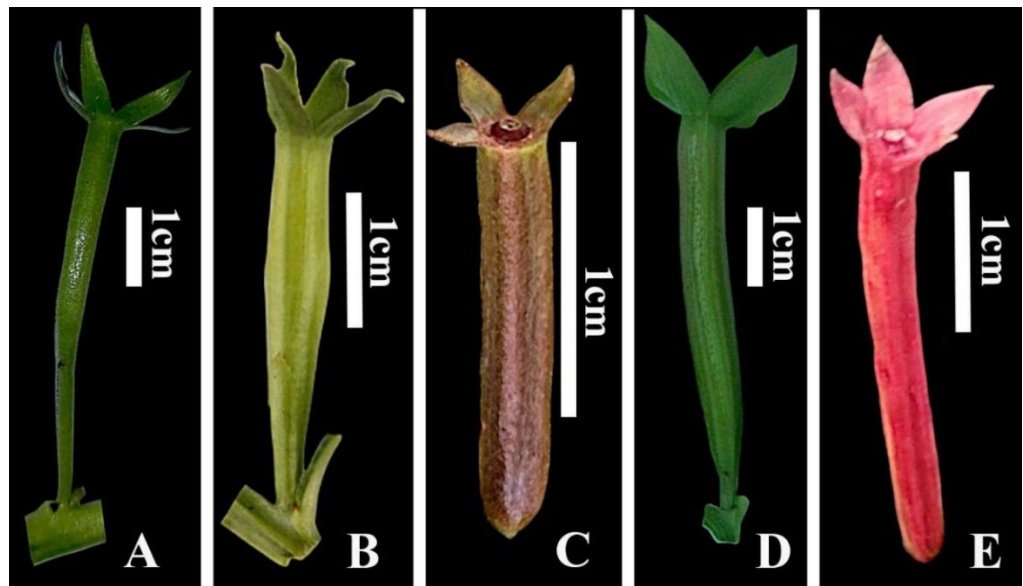


Figure 4. Characterization of *Ludwigia* species's fruit

A. L. adscendens; *B. L. hyssopifolia*; *C. L. perennis*; *D. L. octovalvis*; *E. L. prostrata*.

3.2. Anatomical characters

3.2.1. Stem

In a comprehensive examination of the microanatomical cross-sections of the stems of *Ludwigia* species found in Can Tho city, it was observed that most specimens were polygonal, except for *L. adscendens*, which was round to slightly oval. All species possess a single layer of irregular polygonal epidermal cells that are tightly packed. Beneath this, there are 1-2 layers of polygonal hypodermal cells. The thickened cortical tissue consists of rounded cells, while the sclerenchyma is organized into non-continuous concentric rings surrounding the vascular bundles.

The primary phloem appears rectangular, whereas the secondary phloem is polygonal. The secondary xylem comprises irregular polygonal cells with large, uneven vessel elements, while the primary xylem shows minimal remnants. The parenchyma comprises large, irregular, polygonal cells arranged with small intercellular spaces. Most microanatomical samples exhibit a thin layer of cortical parenchyma; however, in *L. adscendens*, the cortical parenchyma contains a large vacuole. Most microanatomical specimens contain unicellular trichomes, except for *L. hyssopifolia* and *L. adscendens*, which lack these trichomes (Figure 5).

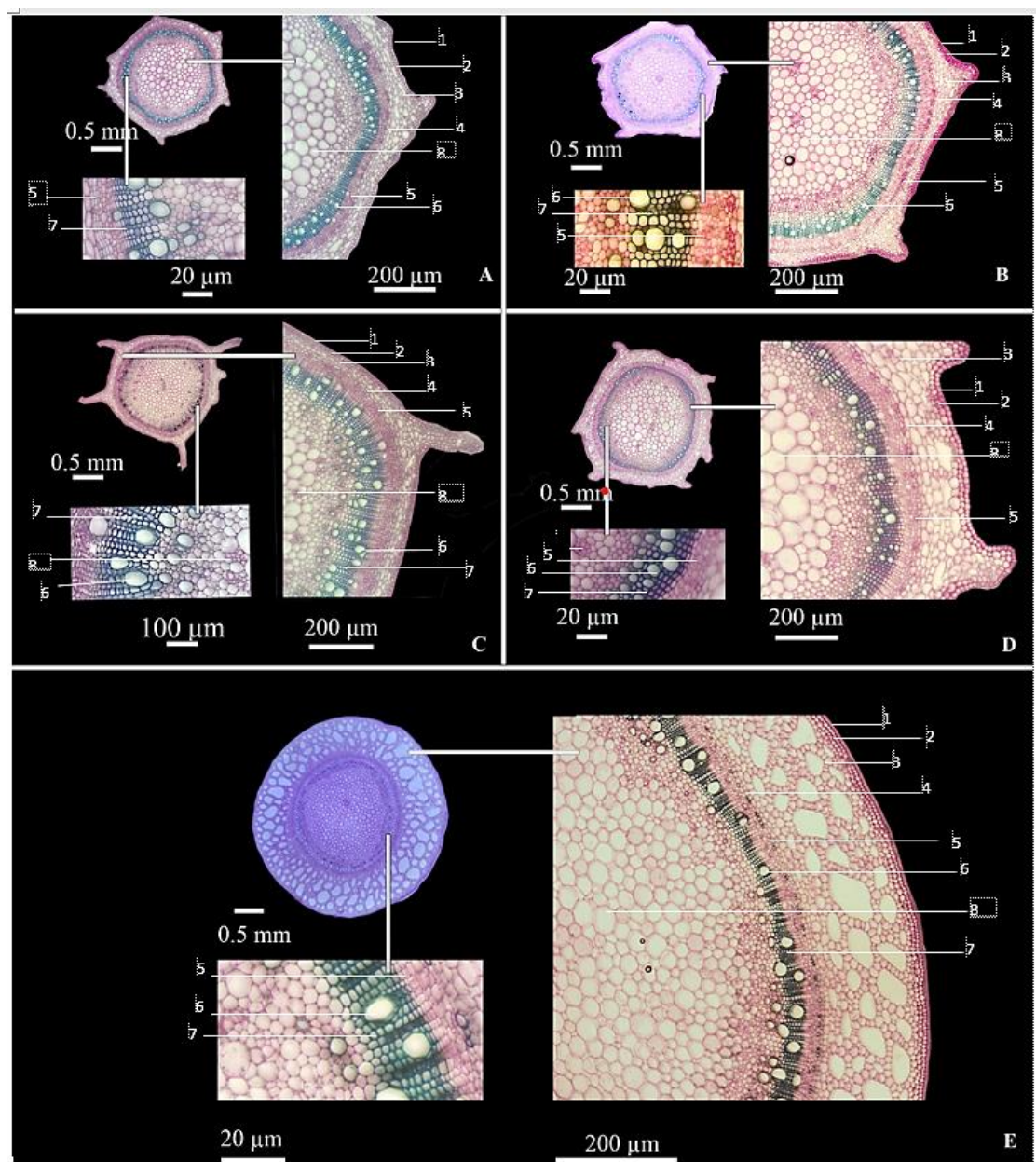


Figure 5. Anatomical of *Ludwigia*'s stem

A. L. perennis; *B. L. octovalvis*; *C. L. hyssopifolia*; *D. L. prostrata*; *E. L. ascendens*. 1. Epidermis; 2. Hypodermis; 3. Spongy parenchyma; 4. Endodermis; 5. Secondary phloem; 6. Secondary xylem; 7. Xylem rays; 8. Pith parenchyma

The epidermis comprises a single layer of polygonal cells with cellulose walls and a thick cutin layer on the surface. The hypodermis is made up of 1-2 layers of polygonal cells. The cortical parenchyma is lacunar. The endodermis forms clusters of sclerenchyma cells that do not create a continuous ring around the vascular bundles. The primary

phloem comprises disorganized polygonal cells closely packed together, while the secondary phloem consists of rectangular cells arranged in radial rows. The secondary xylem forms a continuous ring with large, unevenly sized vessels. The xylem parenchyma consists of polygonal cells arranged in radial rows. The perimedullary phloem

is divided into small clusters arranged discontinuously around the ring. The pith parenchyma is parenchymatous.

The anatomical adaptations of the stem and leaves of *Ludwigia* to the aquatic environment have been documented and are consistent with previous studies (Vo & Nguyen, 2021; Ana & Santiago, 2015).

In *L. adscendens*, several distinctive anatomical features are observed: the cross-section is egg-shaped or nearly circular, with slightly undulating margins (in contrast to the other five species, which have polygonal shapes with multiple angles), and there are no protective trichomes on the stem. The cortical parenchyma occupies nearly half of the cross-sectional area of the stem (in contrast, it occupies only one-quarter of the area in the other five species). The angular collenchyma consists of 1-2 layers of irregular polygonal cells. The cortical parenchyma inside the collenchyma consists of 14-16 layers of slightly rounded, irregular cells, with intercellular air spaces. The vascular system of the stem follows a stacked arrangement, with the phloem located on the outside and the xylem on the inside. These microanatomical features are consistent with those in previous studies (Van et al., 2021; Mousa et al., 2024).

The findings on stem microanatomy also reveal differences in the size of xylem vessels among species, with *L. octovalvis* having the longest xylem rays, while *L. hyssopifolia* has the shortest. This observation is consistent with the previous study (Folorunso et al., 2014).

3.2.2. Leaf

In an anatomical examination of leaf samples from species of the genus *Ludwigia* in Can Tho, several common anatomical features were observed. The upper and lower epidermis consist of a single layer of irregularly shaped, tightly packed ovoid cells covered by a thin cuticle. There are angular collenchyma tissues at the upper and lower parts of the leaf. The endodermis comprises polygonal cells, and the main vascular bundle is centrally located, forming an arc shape. Scattered clusters of laticifers

are found in the upper part of the vascular bundle. The xylem is positioned above, and the phloem below, accompanied by medullary rays. In most species, the large polygonal parenchyma cells belong to the aerenchyma type, with small lacunar parenchyma interspersed on both sides of the cross-section. However, in *L. adscendens*, the lacunar parenchyma dominates, while aerenchyma is concentrated near the center, close to the main vascular bundle. There are significant differences in the cross-sectional shape of the species. In *L. octovalvis*, the cross-section resembles an egg shape, while in *L. adscendens*, it has a bean-like shape. The remaining samples exhibit an elliptical shape. In terms of structure, *L. adscendens* and *L. hyssopifolia* are notable for having a depression in the middle of the upper part of the cross-section. Most of the samples possess protective trichomes, except for *L. hyssopifolia*. Furthermore, most species have unicellular trichomes, except for *L. octovalvis*.

The transverse sections of the petioles from five species exhibit variation in cross-sectional shape, but relatively similar structures in terms of parenchyma and vascular bundle structure. In four species including *L. prostrata*, *L. hyssopifolia*, *L. perennis* and *L. octovalvis*, the large polygonal parenchyma cells belong to the aerenchyma type, with small amounts of lacunar parenchyma interspersed on both sides of the cross-section.

However, in *L. adscendens*, the lacunar parenchyma is predominant, while aerenchyma is concentrated in the center, near the main vascular bundle. The main vascular bundle is centrally located and consists of multiple closely packed vascular tissues arranged in an arc. Scattered clusters of laticifers are found in the upper part of the vascular bundle. The xylem is positioned above, and the phloem below, accompanied by medullary rays.

The leaf microanatomy of the genus *Ludwigia* exhibits distinctive features that can aid in identifying different species, as mentioned in previous studies (Keating, 1982; Ana & Santiago, 2015).

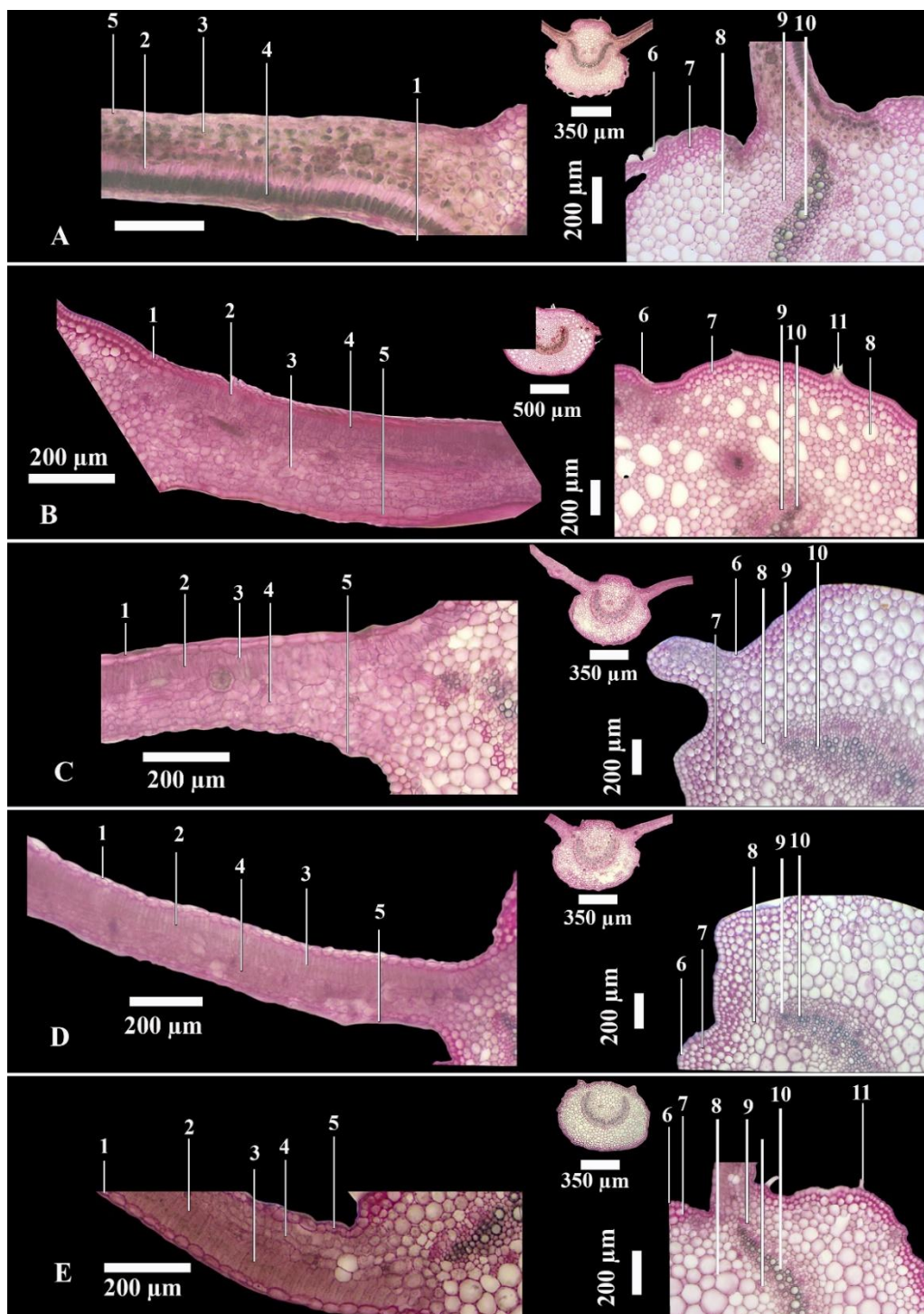


Figure 6. The anatomical structure of *Ludwigia* leaf

A. *L. adscendens*; B. *L. octovalvis*; C. *L. prostrata*; D. *L. hyssopifolia*; E. *L. perennis*; 1. Upper epidermis; 2. Palisade mesophyll; 3. Chloroplast; 4. Spongy mesophyll; 5. Lower epidermis; 6. Epidermal cell; 7. Collenchyma; 8. Spongy parenchyma; 9. Phloem; 10. Xylem cell; 11. Trichome;

3.2.3. Fruit

The results of the fruit anatomy of *Ludwigia* species have provided important insights to distinguish species in the genus *Ludwigia* (Figure 7). The fruit of *Ludwigia* species is formed from ovaries consisting of 4 to 5 fused carpels, forming 4 to 5 cells. Each cell contains one to several rows of ovules attached to the center. Specifically, *L. adscendens* has a club-shaped ovary with five angles and sparse hair, with seeds arranged in a single row within each locule. These seeds are firmly attached to the lignified inner wall of the fruit, and the funicle is minimally developed. *L.*

hyssopifolia displays numerous inverted egg-shaped seeds, characterized by multiple grooves and a brownish color, with some seeds having wings. In *L. octovalvis*, seeds are small, round, and brown, with two grooves arranged in multiple rows within each locule; they are free within the fruit and possess a highly developed funicle nearly as long as the seed itself. *L. prostrata* has single-row seeds within each locule, free, brownish, and marked with speckles or narrow transverse dark brown stripes, with a narrow, ribbon-like funicle. Finally, *L. perennis* exhibits seeds arranged in multiple rows, brown, oval to crescent-shaped, and with a very narrow funicle.



Figure 7. Anatomical structure of *Ludwigia* fruit

A. L. prostrata; B. L. octovalvis; C. L. hyssopifolia; D. L. perennis; E. L. adscendens.

4. CONCLUSIONS

Based on the morphological characteristics of the stems, leaves, and flowers, five *Ludwigia* species distributed in Can Tho City can be distinguished. Among them, *L. adscendens* is characterized by stems with white spongy roots, white flowers, and a 5-merous structure. The other species have yellow flowers and a four-numerous structures and can be differentiated by key characteristics such as angled stem and fruit, presence or absence of pubescence, fruit color, leaf blade shape, petal shape, and the number of stamens. Anatomical characteristics are useful for species differentiation only when examining cross-sections of the stems and fruits, as

REFERENCES

- Ana, M. B., & Santiago, M. (2015). Evolution of the aquatic habit in *Ludwigia* (Onagraceae): Morpho-anatomical adaptive strategies in the Neotropics. *Aquatic Botany*, 120, 352–362.
<https://doi.org/10.1016/j.aquabot.2014.10.005>
- Barua, I. C. (2010). The genus *Ludwigia* (Onagraceae) in India. *Rheedea*, 20(1), 59–70.
<https://dx.doi.org/10.22244/rheedea.2010.20.01.14>
- Dang, M. Q. & Pham T. B. T. (2022). *Plant taxonomy*. Can Tho University Publishing House (pp. 205–207).
- Folorunso, A. E., Adelalu, K. F., & Oziegbe, M. (2014). Use of foliar and stem anatomical characters in the identification of *Ludwigia* (Linn.) species in Nigeria. *International Journal of Biological and Chemical Sciences*, 8(5), 2232–2243.
<https://doi.org/10.4314/ijbcs.v8i5.26>
- Keating, R. C. (1982). The evolution and systematics of Onagraceae: leaf anatomy. *Annals of the Missouri Botanical Garden*, 69, 770–803.
<https://doi.org/10.2307/2398996>
- Lin, W. S., Lo, J. H., Yang, J. H., Wang, H. W., Fan, S. Z., Yen, J. H., & Wang, P. Y. (2017). *Ludwigia octovalvis* extract improves glycemic control and memory performance in diabetic mice. *Journal of Ethnopharmacology*, 207, 211–219.
<https://doi.org/10.1016/j.jep.2017.06.044>
- Mohammad, S., Sitesh C. B., Joydeb K. K., Farida B., Uddin M. A., Suvash C. R., & Mohammad T. H. K. (2003). Antidiarrheal activity of the methanol extract of *Ludwigia hyssopifolia* Linn. *Pakistan journal of Pharmaceutical Sciences*, 16(1), 7–11.
- Mondolot, L., Roussel, J. L., & Andary, C. (2001). New applications for an old lignified element staining reagent. *The Histochem Journal*, 33, 379–385.
- Mousa, M. A., Sadek, A. M., & Elkady, A. A. (2024). Biotechnological and Illustration study of *Ludwigia adscendens* aquatic plant growing in Sewage. *Egyptian Journal of Aquatic Biology & Fisheries*, 28(3), 609–619.
<https://doi.org/10.21608/ejabf.2024.358925>
- Nguyen, T. B. (2003). *Checklist of plant species of Vietnam (Vol.2)*. Agricultural Publishing House, 932–934.
- Nguyen, B. (2010). *Plant morphology* (2nd ed.). Vietnam Education Publishing House.
- Peter, K.E., Pieter, B., & Mary, G. (2000). Systematic plant morphology and anatomy - 50 years of progress. *Taxon*, 49(3), 401–434.
<https://doi.org/10.2307/1224342>
- Pham, H. H. (2000). *An illustrated flora of Vietnam (Vol. 2)*. Youth Publishing House (pp. 68–69).
- POWO. (2024). *Plants of the world online. Facilitated by the Royal Botanic Gardens, Kew*.
<https://powo.science.kew.org/taxon/urn:lsid:ipni.org:names:30000573-2>
- Praneetha, P., Reddy, Y. N., & Kumar, B. R. (2018). *In vitro* and *In vivo* hepatoprotective studies on methanolic extract of aerial parts of *Ludwigia hyssopifolia* G. Don Exell. *Pharmacognosy Magazine*, 14(59), 546–553.
https://doi.org/10.4103/pm.pm_85_18
- Rocha, A. M. & de Melo, J. I. M. (2020). Diversity and distribution of *Ludwigia* (Onagraceae) in Paraíba State, Northeastern Brazil. *European Journal of Taxonomy*, 639, 1–24.
<https://doi.org/10.5852/ejt.2020.639>
- Sharmila, M., & Rajeswari, M. (2017). Anatomical studies on the leaf of *Ludwigia perennis* L. *World Journal of Pharmacy and Pharmaceutical Sciences*, 6(5), 668–678.
- Smida, I., Sweidan, A., Souissi, Y., Rouaud, I., Sauvager, A., Torre, F., Calvert, V., Le Petit J., Tomasi, S. J. I. J. P., & Research P. (2018). Anti-acne, antioxidant and cytotoxic properties of *Ludwigia peploides* leaf extract. *International*

the structure and arrangement of tissue types in the stems and leaves are largely similar.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

Journal of Pharmacognosy and Phytochemical Research, 10(7), 271–278.

Tran, C. K. (1981). *Practice plant morphology and anatomy*. University and Professional High School Publishing House.

Van, T. D., Huynh, N. V. A., Pham, V. N., & Dang, T. N. T. (2021). Morphology, microscopic anatomy and bacterial inhibition of extracts of *Ludwigia adscendens* (L.) H. Hara plants growing in Lang Sen Wetland Reserve, Long An province, Vietnam. *GSC Biological and Pharmaceutical Sciences*, 17(3), 160–170.
<https://doi.org/10.33545/26646188.2021.v3.i1a.20>

Vo, V. C. (2018). *Dictionary of Vietnamese medicinal plants (Vol. 2, 2nd ed.)*. Medical Publishing House.

Vo, T. T. P., & Nguyen, T. T. V., (2021). Morphological, anatomical and phytochemical properties of *Ludwigia hyssopifolia* (G. Don) Exell at Can Tho province, Vietnam. *International Journal of Clinical Biology and Biochemistry*, 3(1), 38–43.

<https://doi.org/10.30574/gscbps.2021.17.3.0361>

Xu, Z., & Deng, M. (2017). *Onagraceae*. In *Identification and Control of Common Weeds*, 2, 785–813. Dordrecht: Springer Netherlands.
<https://doi.org/10.1007/978-94-024-1157-7>