

Research

New records on the botanical characteristics of *Utricularia* Pierrei distributed in lam dong province, Vietnam

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Abstract

The botanical characteristics of *Utricularia pierrei* Pellegr. from Ankroet Dam (Lam Dong Province, Vietnam) are described and illustrated. The result reveals that *Utricularia pierrei* exhibits typical traits of the genus *Utricularia* L. while highlighting its distinctions from the closely related species *Utricularia involvens* Ridl., with which it is often confused. Additionally, the study provides supplementary information on the morphological features of the vegetative organs that were not recorded by Taylor (1989).

Keywords *Utricularia* · Lam Dong · Anatomical · Morphological

1 Introduction

The Lentibulariaceae includes three genera: *Pinguicula*, *Genlisea* and *Utricularia*, with about 250 species identified [1]. *Utricularia* are small to medium-sized carnivorous plants with specialized trapping organs known as bladder traps. In Vietnam, 21 species of *Utricularia* have been identified since 1998 [3]. Among these species, *Utricularia pierrei* Pellegr. is one of the species with a narrow distribution range and has been recorded in Be River (Thu Dau Mot city, Binh Duong province) by Pierrei (03/1866); another specimen in Thorel's collection is labelled Bassac (Hau River, Viet Nam—Cambodia or a village in Cambodia), these specimens were gathered over 100 years ago. Hayata's specimen was collected in Dalat (Lam Dong province, Vietnam) in 1921, which is located in the mountains approximately 250 kms northeast of Ho Chi Minh City, at about 1500 m. The newest specimen belongs to Maxwell (1985), which was collected in southeastern Thailand, but the description does not agree very well with Vietnam specimens [11]. At present, the botanical characteristics of this species have only been recorded by Taylor [11], but data on the vegetative organ features are still lacking. In this study, we focus on describing the morphological characteristics of the vegetative and reproductive organs, as well as providing additional information on the anatomical structure of these organs in the species *Utricularia pierrei*.

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2 Methods

2.1 Study sites

The research project was conducted from May 2023 to October 2024, comprising six field surveys carried out during the rainy and dry seasons, with each survey lasting four days. The sampling sites included lake and waterfall areas in Lam Dong Province: Ankroet Dam (Lac Duong District); Hang Cop Waterfall, Cam Ly Waterfall, Da Hiong Waterfall, Tuyen Lam Lake (Da Lat City); ponds at Di Da Pagoda, Dao Nguyen Coc Waterfall (Bao Lam District). The distribution of *Utricularia* L. species was recorded specifically at Ankroet Dam and the pond at Di Da Pagoda.

The distribution of *Utricularia pierrei* was exclusively documented at Ankroet Dam, part of the Dankia – Suoi Vang lake cluster (Lac Duong District).

2.2 Plants collection

Leaves, stolons, and inflorescence stalk samples used in the anatomical study of *Utricularia pierrei* will be preserved in 70° ethanol and transported to the laboratory for structural analysis.

2.3 Specimen treatment and storage

Each collected sample is accompanied by information including specimen number, location, habitat, collection date, collector, coordinates, elevation, and key characteristics that may be lost during the drying process. For flowers and fruits, small pieces of newspaper were used to separate the *Utricularia* specimens from other flowers/fruits or adjacent leaves [13].

Dry sample processing: The processed plant specimen were mounted on thick and sturdy A3 size paper, pasted with glue. Labels were applied on dry specimens as per the TCVN 13531:2022 guidelines for botanical specimens [12].

2.4 Plant species identification

For identification, comparative morphological parameters were studied with the help of literature.

- * Vietnam plants (Cây cỏ Việt Nam), volume III [3]
- * Carnivorous Plants: Physiology, ecology, and evolution by Ellison and Adamec [2]
- * The genus *Utricularia* – a taxonomic monograph [11]

Comparison and validation were conducted against standard specimen collections archived in the online database of the Muséum National d'Histoire Naturelle (Paris).

The scientific nomenclature was verified through an online database: <http://www.worldfloraonline.org> [9].

2.5 Studying anatomical structure

A layer of collodion was applied to the Leave surface to prepare impressions for analysis. The number of stomata and hydropores per square millimetre (1 mm²) of the Leave surface area was counted.

Using a razor blade, transverse sections were made through the stolon, leaves, and inflorescence peduncles of the studied species. Ten leaves, ten stolons, and ten inflorescence peduncles were sectioned separately. For stolons, cross-sections were taken at a segment located within 5 cm from the base of the flowering branch; for leaves, a cross-section is taken from the blade segment located at one-third of the Leave length from the tip. For the inflorescence stalk, cross-sections were taken at segments located within 2 cm from the base upwards and from the apex downwards.

The samples were double-stained using Khanh's method [8], immersed in Javel for 15 min to remove cytoplasmic content, rinsed thoroughly with distilled water, soaked in 1% acetic acid for 5 min, then rinsed again with distilled

Fig. 1 The herbarium specimen of *Utricularia pierrei* distributed in Lam Dong Province [5]



water, stained with 4% carmine solution for 10 min, rinsed with distilled water; counterstained with 0.1% methylene blue solution for 10 s; rinsed with distilled water; mounted on slides and observed under a light microscope Fig. 1

3 Result

3.1 Species identify

Specimens collected from Ankroet Dam, Lac Duong District, Lam Dong Province, were analyzed for the morphological characteristics of vegetative and reproductive organs. These were compared with type specimens and specialized literature to verify the scientific name. The results confirmed the identification of the species as *Utricularia pierrei*.

Scientific name: *Utricularia pierrei* Pellegr.

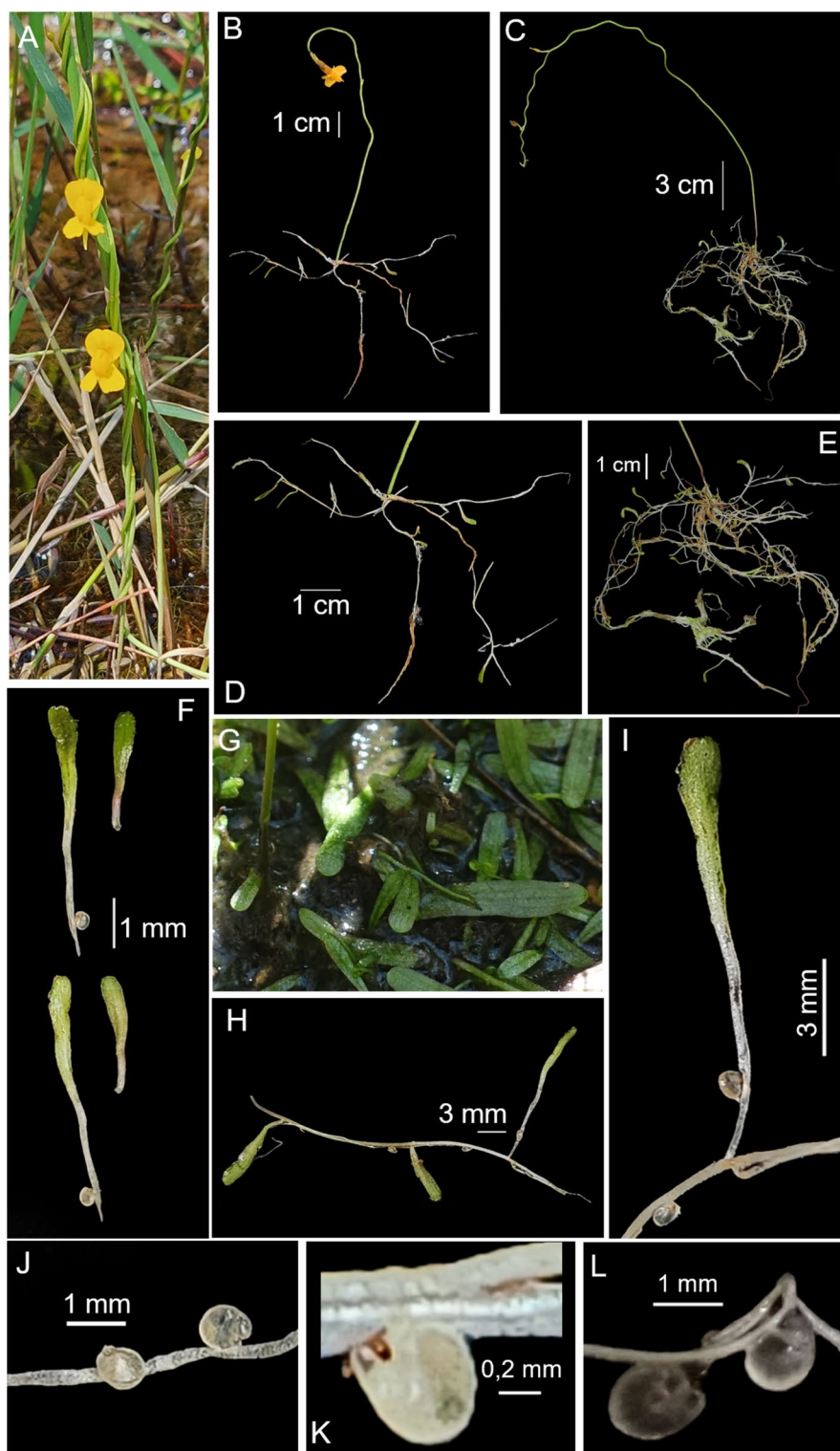
Specimens: **VIETNAM**. Lam Dong province, Lac Duong District, Ankroet Dam, on an exposed rocky outcrop with flowing water, 11°59'30"N, 108°22'09"E, 1408 m, 10/12/2024, T.M. Huy, N.L.A. Kiệt AR 38A.

Reference specimens: **VIETNAM**. Thu Dau Mot District, Be River, 03/1866, L. Pierre 1865 (MNHN-P-P00390551 – syntype). Thu Dau Mot District, Be River, in sabrelosis humidis prope, 12/1866, L. Pierre 3345 (MNHN-P-P00390547). Thu Dau Mot District, Be River, 12/1865, L. Pierre 3348 (MNHN-P-P00390548) [10].

3.2 Morphological characteristics

The raw figure supporting Figs. 2, 3, 4 are publicly available in the Figshare repository as part of this record: <https://doi.org/10.6084/m9.figshare.28212638> [6].

Fig. 2 Vegetative organs of *Utricularia pierrei* (*U. pierrei* Benj.). **A.** Habitat. **B, C.** General morphology. **D, E, H.** Stolons. **F, G, I.** Leaves. **J, K, L.** Traps



3.2.1 Vegetative organs

Aquatic herbaceous plant, living attached to a substrate. The stolons are slender, white, with a diameter of 0.1–0.3 mm, highly branched, and forming mats. Leaves develop from the stolons, slightly curved and flattened, with an obovate blade, green in colour, measuring $8\text{--}10 \times 1.1\text{--}1.3$ mm, with a single midrib running from the base and branching twice to form three parallel veins extending to the Leaf apex, which is rounded. The traps arise from the stolons and leaves,

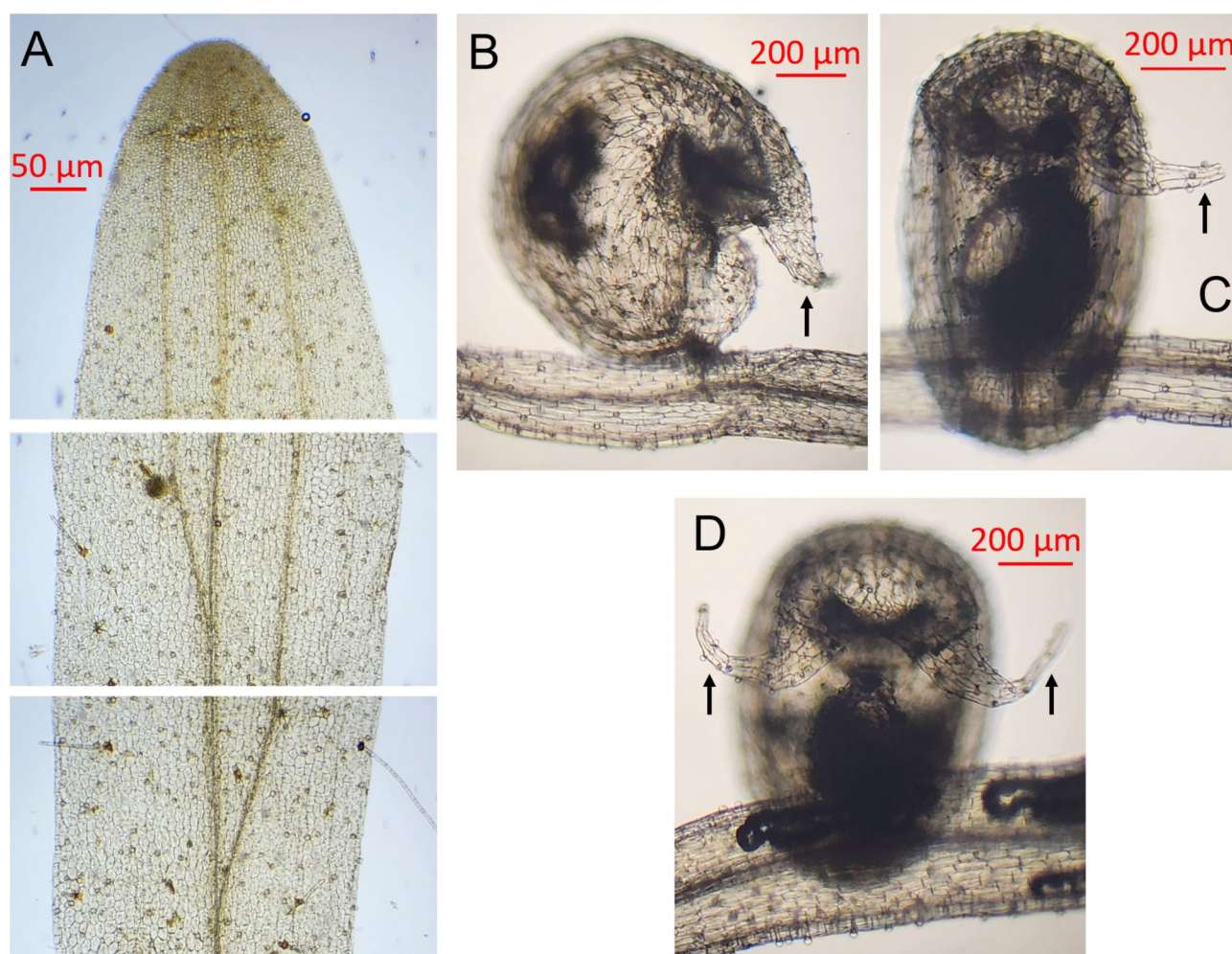


Fig. 3 Leaf veins (**A**) and the surfaces of the trapping sacs (**B, C, D**) of *Utricularia pierrei* observed under a microscope (arrow: antennae)

with a stalk approximately 0.28 mm long. The traps are ovoid, measuring $0.92\text{--}1.12 \times 0.93\text{--}0.95$ mm, with two dorsal bristles at the entrance, 0.67–0.9 mm in length. The antennae are unbranched and bear sessile glands; the outer part of the threshold swells, resembling a chin.

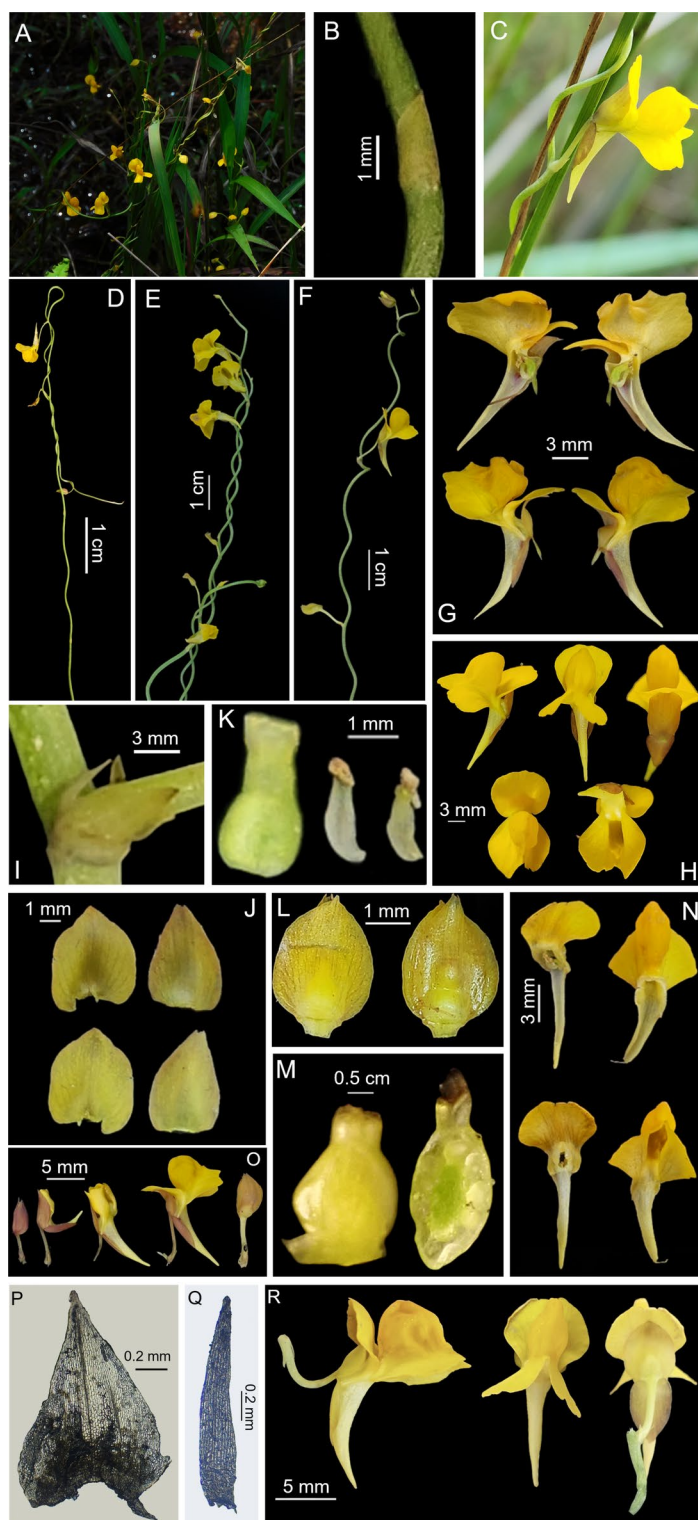
3.2.2 Reproductive organ adaptations

The inflorescence stalk arises from the stolons, twining around the branches of other plant species and extending above the water surface. It is green and cylindrical, measuring 20–30 cm in length and 1–1.2 mm in diameter. Additionally, two flower-bearing branches may climb the same branch and intertwine. The raceme inflorescence typically bears 3–5 flowers, with flowers and fruits distributed along the stalk from the mid-section to the apex. Each time, 1 to 3 flowers bloom near the apex. Each flower has its pedicel, which is light green, cylindrical, 4–7 mm long, and approximately 0.7–0.8 mm in diameter. The inflorescence stalk can elongate and twist upon itself, causing the apex to be positioned below the blooming flowers.

The bracts are ovate, scale-like, with a pointed tip, white, measuring $1.5\text{--}2.5 \times 0.8\text{--}1$ mm, and clasp the base of the flower pedicel. Two small prophylls are located inside the bracts, opposite each other, with pointed tips, white, crescent-shaped, and measuring $1\text{--}1.4 \times 0.1\text{--}0.2$ mm. Scales, which are ovate with pointed tips and yellow-green in colour, measure 2.6–2.8 mm and are scattered along the inflorescence stalk, numbering 2 to 6 scales.

The flower is zygomorphic, bisexual, yellow in colour, measuring $4\text{--}4.2 \times 3.8\text{--}4 \times 7.5\text{--}8.2$ mm. The calyx consists of two sepals, pale yellow, later enveloping the fruit. The sepal opposite the upper lip is the more prominent, broadly ovate, acute apex, measuring $4.3\text{--}4.5 \times 3.5\text{--}3.8$ mm; the other sepal is the ovate, retuse apex, measuring $4.1\text{--}4.2 \times 3\text{--}3.2$ mm.

Fig. 4 Reproductive organs of *Utricularia pierrei*. **A.** Climbing inflorescence. **B.** Scale. **C, H.** Petal. **D.** Self-twining peduncle. **E.** Intertwined peduncles. **F.** Peduncle. **G, R.** Longitudinal section of a flower. **I.** Position of bract and bracteoles. **J.** Calyx. **K.** Stamens and pistil. **L.** Calyx remnant. **M.** Longitudinal section of a fruit. **N.** Cross-section of the corolla tube. **O.** Flower development. **P.** Bract. **Q.** Bracteole



The corolla is yellow and bilabiate, with the upper lip having an elliptic transverse shape, measuring $2.2\text{--}2.4 \times 3.3\text{--}3.5$ mm, undivided, with a rounded apex and slightly wavy margins. The lower lip is round, measuring $3.6\text{--}3.8 \times 3.4\text{--}3.6$ mm, slightly divided into two lobes with obtuse to truncate apices. At the base of the lower lip, a prominent, longitudinally ellipsoidal swelling (palate) is present, the base with a prominent bilobed swelling, orange-yellow in colour, with a rounded apex, measuring $2.1\text{--}2.3 \times 1.5\text{--}1.7 \times 2\text{--}2.2$ mm. Both sides of the lip constrict at the throat of the corolla. The corolla tube is about 4.5–5 mm long, pale yellow, light green to white in colour, with a cylindrical spur, pale yellow, light

green to white, elongated, pointed at the apex, straight or slightly curved but not extending beyond the lower lip, and forming an angle of 95° – 115° with the lower lip.

The androecium comprises two stamens positioned anteriorly, each with a bilocular anther. The anthers are yellow, while the filaments are flattened, light greenish-white, curved, and elongated (1.4–1.7 mm), embracing the ovary. However, the anthers are located behind the stigma. The ovary is superior, formed by two fused carpels, ovate, green, measuring $1.3\text{--}1.5 \times 1.4\text{--}1.6$ mm, unilocular, with numerous ovules attached to a central placenta. The style is short, green, 0.8–1 mm long. The stigma is also brief, green, and bifurcated into two lobes.

The fruit is a capsule enclosed within the remnants of the calyx, ovate, light green to yellow, measuring $1.9\text{--}2.1 \times 1.9\text{--}2.2$ mm, retaining remnants of the stigma. Inside, the capsule contains numerous tiny ovate seeds—the plant flowers and fruits from May to June, rarely in March.

3.3 Anatomical structure of organs

The raw figures supporting Figs. 5, 6, 7 are publicly available in the Figshare repository as part of this record: <https://doi.org/https://doi.org/10.6084/m9.figshare.28212653.v1> [4].

3.3.1 Stolon

The stolons has a nearly circular to circular transverse section, with the stele shifted toward the upper side. Its structure, from the outside to the inside, includes:

Epidermis: A single layer composed of cells of nearly equal size, elongated radially, approximately $33.5\text{ }\mu\text{m}$ thick, interspersed with hydropote glands. A thin cutin layer covers the epidermis.

Cortical parenchyma: Consists of two to four layers of spherical cells on both sides, approximately $72.15\text{ }\mu\text{m}$ thick. The upper and lower parts are destroyed, forming air cavities, leaving only cell wall remnants. Occasionally, one or two layers of cells adjacent to the epidermis on one side are also destroyed. The air cavities on the lower side are larger, causing the stele to shift upward.

Endodermis: A single layer of 10–12 cells with uneven sizes, approximately $14.45\text{ }\mu\text{m}$ thick, elongated tangentially.

Vascular tissue: Composed of one xylem vessel separated from the phloem bundle (which contains two to three minimal sieve elements) by parenchyma cells.

The thickness of tissue layers in the stolons of *Utricularia pierrei* are mentioned in Table 1.

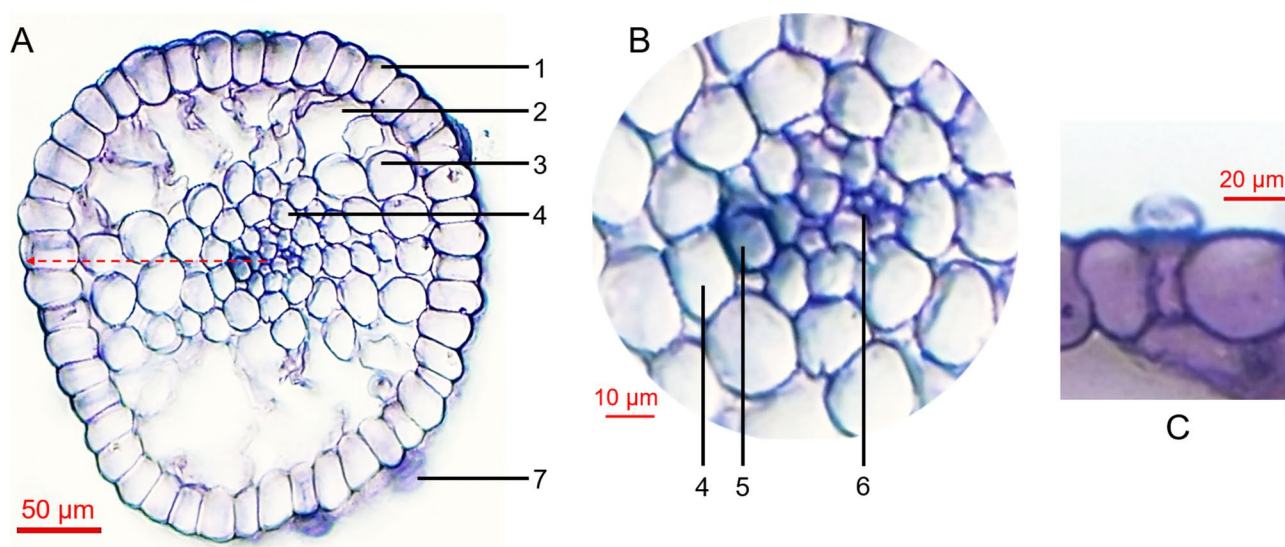


Fig. 5 The anatomical structure of the stolons cross-section of *Utricularia pierrei* Pellegr. (Dashed arrow: one of the measurement directions for the thickness of tissue layers in the stolons). **A**, **B**. Overall microscopic structure. **C**. Detailed structure of vascular bundles. 1. Epidermis. 2. Air space. 3. Cortical parenchyma. 4. Endodermis. 5. Xylem. 6. Phloem. 7. Hydropote gland

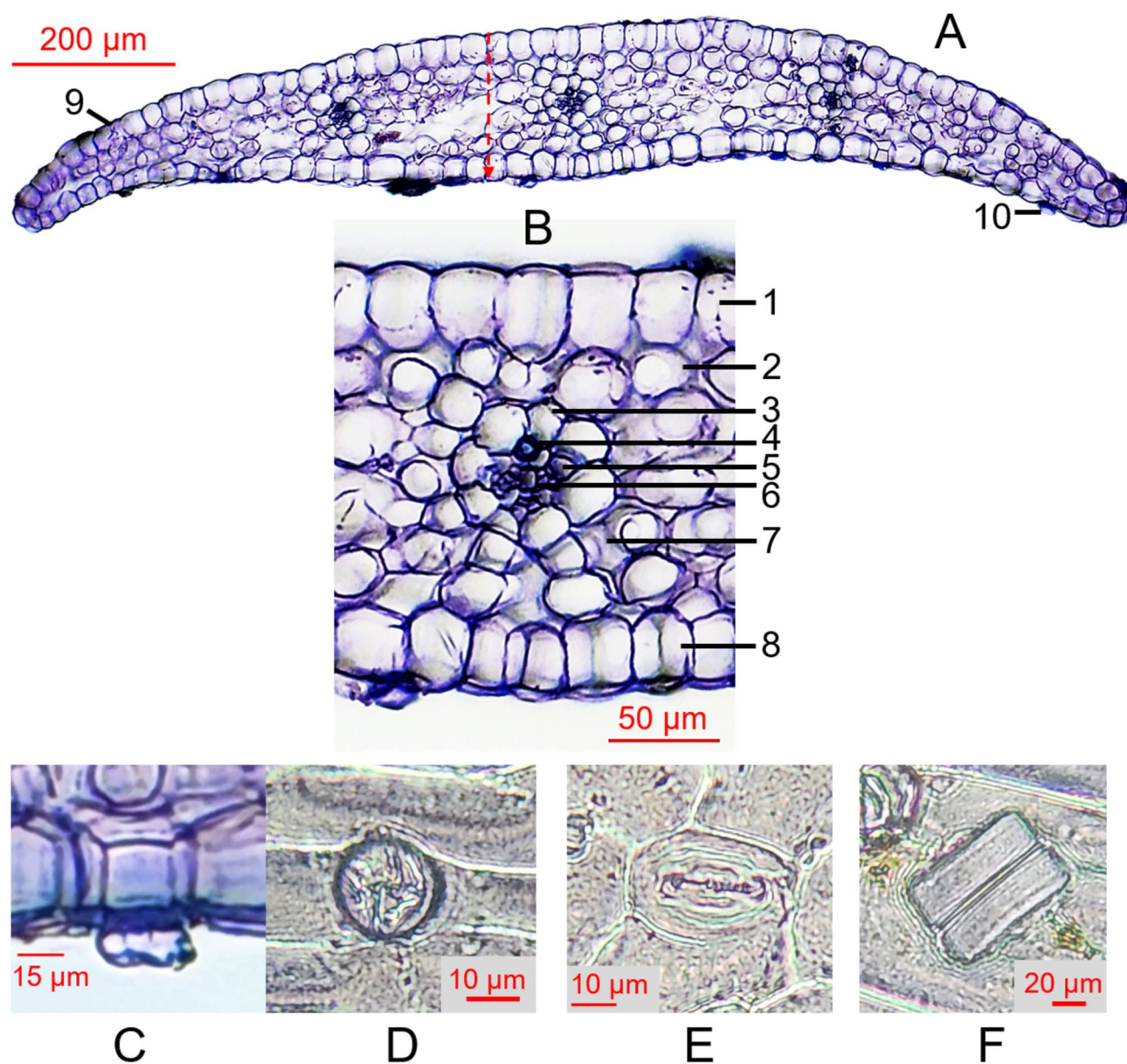


Fig. 6 The anatomical structure of the leaf blade of *Utricularia pierrei* (Dashed arrow: one of the measurement directions for the thickness of tissue layers in the leaf blade). **A.** Overall microscopic structure. **B.** Structure of the central vein. **C, D.** Hydropote glands. **F.** Epiphytic algae on the leaf surface. **E.** Stoma. 1. Upper epidermis. 2. Spongy mesophyll. 3. Vascular bundles. 4. Xylem. 5. Parenchyma cells. 6. Phloem. 7. Air space. 8. Lower epidermis. 9. Stoma. 10. Hydropote gland

3.3.2 Leaf

The transverse section of the leaf is slightly curved, with three nearly equal vascular bundles arranged in a row closer to the upper surface of the leaf. Its structure, from top to bottom, includes:

Upper epidermis: A single layer of large, uniform-sized cells, approximately 32.95 µm thick. It contains very few anomocytic stomata, with a density of 2 stomata/mm². Hydropote glands are scattered at a density of 60 glands/mm². The epidermis is covered by a thin cutin layer, with algae occasionally adhering to its surface.

Spongy mesophyll: Composed of two to six layers of spherical or oval cells of uneven sizes, approximately 81.4 µm thick. It contains intercellular spaces filled with air.

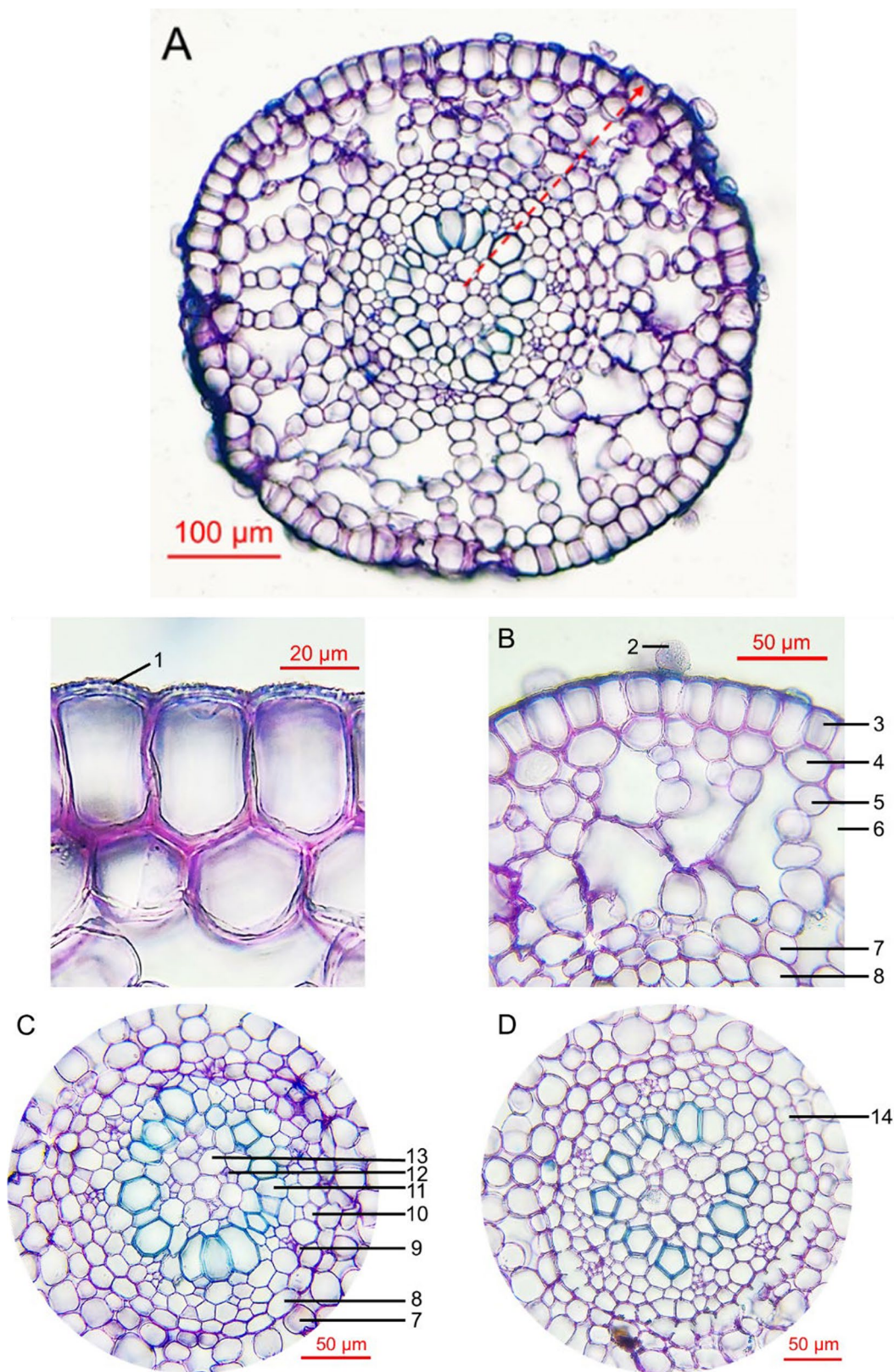


Fig. 7 Anatomical cross-section of the pedicel near the base of the inflorescence in *Utricularia pierrei* (Dash arrow: direction of peduncle thickness measurement; Three angles: Casparian strip). **A.** Overall microscopic structure. **B.** Outer cortex structure. **C, D.** Stele structure. 1. Cutin. 2. Hydropote gland. 3. Epidermis. 4. Outer cortical parenchyma. 5. Middle cortical parenchyma. 6. Air space. 7. Inner cortical parenchyma. 8. Endodermis. 9. Phloem^a. 10. Pericycle. 11. Xylem. 12. Phloem^b. 13. Medullary parenchyma. 14. Perforated endodermal cell

Vascular bundles: Small and underdeveloped, enclosed by a ring of bundle sheath cells that are oval in shape and smaller than the spongy mesophyll cells. Inside, there is one large xylem vessel and multiple tiny phloem vessels grouped into three bundles, separated by parenchyma cells.

Lower epidermis: A single layer of cells slightly elongated horizontally, approximately 32.86 µm thick. It lacks stomata but contains scattered hydropote glands at a density of 57.8 glands/mm². A thin cutin layer covers the epidermis.

The thickness of tissue layers in the leaf blade of *Utricularia pierrei* are mentioned in Table 2.

3.3.3 Pedicel

The cross-section is circular, with the stele slightly shifted to one side. Its structure, from the outside to the inside, includes:

Epidermis: A single layer of radially elongated cells of nearly equal size, approximately 32.31 µm thick. Hydropote glands are interspersed, and a rough cutin layer covers the surface.

Cortical parenchyma: Divided into outer, middle, and inner cortical parenchyma, with a total thickness of 82.97 µm:

Outer cortical parenchyma: A single layer of spherical or rectangular parenchyma cells.

Middle cortical parenchyma: Three to five rows of parenchyma cells of irregular sizes, arranged in a radial pattern, with large air-filled intercellular spaces. Some rows of cells are destroyed, leaving only remnants of cell walls.

Inner cortical parenchyma: A single layer of spherical parenchyma cells.

Endodermis: A single layer of cells with irregular sizes, approximately 16.48 µm thick, elongated tangentially. The walls of adjacent endodermal cells may have perforations, forming interconnected cavities between cells.

Pericycle: Two layers of polygonal cells of unequal sizes, arranged concentrically, with a thickness of approximately 20.17 µm.

Phloem (libe^a): Five to six scattered phloem bundles located within the pericycle, arranged concentrically. A sheath of vascular bundle cells surrounds each bundle.

Xylem: Adjacent to the phloem and pericycle, consisting of 9 to 10 discontinuous bundles arranged concentrically. Each bundle contains 1 to 3 radially elongated xylem vessels.

Phloem and pith parenchyma (libe^b): Composed of spherical or polygonal cells of irregular sizes, with two to four interspersed meristematic or phloem bundles. Each bundle contains rectangular meristematic cells or tiny phloem cells.

The thickness of tissue layers in the peduncle near the base of the inflorescence of *Utricularia pierrei* are mentioned in Table 3.

The raw data tables supporting Tables 1, 2, 3 are publicly available in the Figshare repository, as part of this record: <https://doi.org/https://doi.org/10.6084/m9.figshare.28212278.v1> [7].

4 Discussion

U. pierrei and *U. involvens* both possess slender, white stolons, branching into numerous small offshoots, forming a mat. At the entrance's back, two long, unbranched antennae swell outward near the threshold, resembling a chin. The pedicels arise from the stolons, solitary and spiralling around the branches of other plants, extending above the water surface. It is green and cylindrical in shape. Each flower has one bract and two small bracteoles located inside the bract, positioned opposite each other. The calyx is composed of two sepals, which later envelop the fruit. The upper sepal is more prominent, while the lower sepal has a concave apex. The corolla is yellow and bilabiate. The upper lip has a horizontally elliptical shape, undivided, with a rounded apex. The lower lip is rounded and slightly divided into two lobes, with a prominent inflated node at the base, dividing into two lobes. It also features a cylindrical spur that is elongated and tapered to a sharp point. The androecium consists of two stamens positioned at the front, with an ovary shaped like an oval. Differences in the morphological characteristics of the vegetative and reproductive organs between the two species are expressed in.

Comparison characteristics	<i>Utricularia pierrei</i>	<i>Utricularia involvens</i>
Leave blade	Oblanceolate	Obovate to linear
Inflorescence	20—30 cm	To 60 cm (twice as long as <i>U. pierrei</i>)
Bract	Obovate scale-like form with a pointed apex, white in colour	Broadly ovate-deltoid scale-like form pointed apex, white in colour
Spacing between flowers	4—5 cm	up to 3 cm
Calyx	4.1—4.5 mm. The opposite calyx of the upper lip is broadly obovate; the other is obovate	3—6 mm. Both calyxes are obovate
Calyx length (include two lips)	7.5—8.2 mm	10—15 mm
Upper lip	2.2—2.4 × 3.3—3.5 mm, smaller than the upper lip	Wide to 3 mm, twice as long as the upper calyx
Spur	Straight or slightly curved, not protruding beyond the lower lip, forming an angle of 95°–115° with the lower lip	Curved, forming an obtuse angle with the lower lip

The differences in the calyx characteristics and the curvature of the nectar spur were highlighted by Taylor [11] to distinguish between *U. pierrei* and *U. involvens* based on morphological features. Through further surveys, additional differences between the two species have been identified, including the shape of the Leave blade, the bract, the spacing between flowers, the characteristics of the upper lip, and, notably, the size of the corolla (including both lips) [11].

Table 1 Thickness of tissue layers in the stolons of *Utricularia pierrei* (n = 10, parametre: μm)

Kind of tissue	Thickness (μm)	Proportion (%)
Epidermis	33.5 ± 0.55	23.69%
Cortical parenchyma	72.15 ± 2	51.03%
Endodermis	14.45 ± 1	10.22%
Phloem*	15.25 ± 0.79	10.79%
Xylem*	10.35 ± 0.74	7.32%
Vascular tissue	21.29 ± 0.88	15.06%
Total	141.39 ± 1.53	100.00%

*not included in the total

Table 2 The thickness of tissue layers in the leave blade of *Utricularia pierrei* (n = 10, parametre: μm)

Kind of tissue	Thickness (μm)	Proportion (%)
Upper epidermis	32.95 ± 0.11	22.38%
Spongy mesophyll	81.4 ± 17	55.30%
Xylem*	12.3 ± 0.52	8.35%
Phloem*	21.11 ± 3.42	14.34%
Lower epidermis	32.86 ± 0.48	22.32%
Total	147.2 ± 16.7	100.00%

*: not included in the total

Table 3 The thickness of tissue layers in the peduncle near the base of the inflorescence of *Utricularia pierrei* (n = 10, parametre: µm)

Kind of tissue	Thickness (µm)	Proportion (%)
Cutin	2.54 ± 0.82	1.23%
Epidermis	32.31 ± 1.8	15.64%
Cortical parenchyma	79.36 ± 24.39	38.42%
Endodermis	20.17 ± 1.98	9.77%
Phloem ^{a*}	11.85 ± 0.43	5.74%
Pericycle	22.34 ± 1.49	10.82%
Xylem*	29.61 ± 4.54	14.34%
Phloem ^{b*}	7.6 ± 0.53	3.68%
Medullary parenchyma	32.19 ± 2.66	15.58%
Total	206.55 ± 19.02	100.00%

*: not included in the total

5 Conclusion

The research results provide crucial data on the morphological characteristics and anatomical structure of *Utricularia pierrei*—an endemic species of the Indo-china region that has received little research attention in the past. The findings indicate that *Utricularia pierrei* exhibits typical traits of the genus *Utricularia* and highlights its distinctions from a closely related species, *Utricularia involvens*, with which it is often confused. These results lay the foundation for further exploration into the genetics, biochemistry, or potential practical applications of the species.

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Author contribution Minh Huy Tran: conceptualization, validation, methodology, formal analysis, investigation, data curation, writing—original draft. Le Anh Kiet Nguyen: formal analysis, resources, investigation, data curation, visualization. Van Ngot Pham: validation, formal analysis, supervision, visualization. Nhu Hoa Nguyen: validation, formal analysis, supervision. All authors reviewed the manuscript.

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Data availability No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate Informed consent was obtained from all individual participants included in the study.

Consent for publication We agree to allow the publication of identifiable information, including photographs and videos, as well as details within the manuscript, to be published in Discover Plants. I have discussed this consent form with the authors of this paper. I understand that all Discover Plants journals may be published both in print and online, reaching a broader audience through marketing channels and third parties. Therefore, anyone can access the material published in the journal. I understand that readers may include not only botanists and academic researchers but also journalists and the general public.

Competing interests The authors declare no competing interests.

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