# A taxonomic revision of the genus *Utricularia* L. (Lentibulariaceae) in India supplemented with molecular data

*Thesis submitted to the*
*University of Calicut in partial fulfilment of the*
*requirements for the award of the degree of*

**DOCTOR OF PHILOSOPHY IN BOTANY**

*by*

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# CERTIFICATE

This is to certify that the thesis entitled **A taxonomic revision of the genus *Utricularia* L. (Lentibulariaceae) in India supplemented with molecular data** submitted to the University of Calicut by **Ms. Krishnapriya M. P.**, in partial fulfilment of the award of the degree of Doctor of Philosophy in Botany is a *bona fide* record of the research work carried out by her under my supervision and guidance. No part of the present work has formed the basis for the award of any other degree of diploma previously.

Calicut University
Date:

**Dr. Santhosh Nampy**
(Supervising Teacher)

# DECLARATION

I hereby declare that the work presented in the thesis entitled **A taxonomic revision of the genus *Utricularia* L. (Lentibulariaceae) in India supplemented with molecular data** is based on the original work done by me under the guidance of **Prof. (Dr.) Santhosh Nampy** and has not been included in any other thesis submitted previously for the award of any degree. The contents of the thesis are undergone plagiarism check using iThenticate software at C.H.M.K. Library, University of Calicut, and the similarity index found within the permissible limit. I also declare that the thesis is free from AI generated contents.

Calicut University **Krishnapriya M. P.**
Date:

**Dr. Santhosh Nampy**

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# ABSTRACT

*Utricularia*, the largest and most species-rich genus in the carnivorous plant family Lentibulariaceae, is distributed globally with 284 taxa. The genus is highly intriguing, possessing inimitable traits that set it apart from other angiosperms. These include a unique body plan, ultra-fast suction trapping mechanism, specialized nutritional acquisition strategy, habitat preferences, genome miniaturization, and dynamic nuclear genomes. *Utricularia* lacks true roots, stems and leaves, instead relying on rhizoids, stolons, modified leaves and distinctly specialized traps. Known as '*bladderworts*' these plants use suction-based traps to capture and digest prey. The traps operate beyond human visual perception, demonstrating the remarkable carnivorous adaptation of the genus. *Utricularia* thrives in nutrient poor, open, wet environments, benefiting from its carnivorous nature, which reduces its photosynthetic cost. Notably, genome downsizing, reported in *Genlisea margeretae*, *G. aurea* and *Utricularia gibba*, highlights the evolutionary significance of this group.

This research focuses on the taxonomy of Indian *Utricularia*, supplemented with micromorphological and molecular evidence. The study recognizes 37 species from India, including two new species and one new distributional record. Extensive fieldwork revealed the high habitat specialization and diverse ecological preferences of *Utricularia* species. A comprehensive taxonomic account has been provided, including taxonomic keys for species identification within each section. Lectotypes were selected for three names, and the identities and reinstatements of five species were clarified. Six species previously reported from the region were excluded due to inadequate literature, insufficient data, and the need for further collections.

Among the 37 recognized species, 16 are endemic to India: 12 endemic to the Western Ghats, two endemic to Peninsular India, one endemic to both Peninsular India and Sri Lanka, and one endemic to the Western Ghats and Sri Lanka. Field studies have revealed several potential threats to the habitats of *Utricularia*, such as mining, quarrying, commercial development, tourism, land-use changes, landfilling, pollution, grazing, fires, droughts, floods, and landslides. These activities contribute to habitat fragmentation, degradation and loss. The conservation status of 37 species was assessed, with six species categorized as Critically Endangered (CR,) seven as Endangered (EN), two as Vulnerable (VU,) four as Near Threatened (NT), six as Data

Deficient (DD), and 12 as Least Concern (LC). The study emphasizes the need for a comprehensive conservation approach, including habitat preservation, ongoing research, monitoring, and raising public awareness to safeguard these plants and their habitats.

A micromorphological study of seeds in Indian species revealed diagnostic characters useful for species delimitation. The patterns of seed testa cells, the shape and thickness of anticlinal walls, and ornamentation of the periclinal walls were identified as taxonomically significant, particularly for sectional delimitations and species identification. A strong positive correlation between seed morphology, species habitat and ecology was also observed.

Phylogenetic analysis using the nrITS and *rps*16 intron were carried out to support the morphological data. This is the first comprehensive phylogenetic analysis of Indian *Utricularia*, including 34 of the 37 recognised taxa sampled across the range of each species. Independent phylogenetic analysis with both nrITS and *rps*16 datasets confirmed the distinct taxonomic identity of Indian members. The analysis also supported the correct sectional placement of unclassified Indian endemics, confirmed the identity of *U. nayarii*, *U. purpurascens*, *U. roseopurpurea*, synonymisation of *U. babui*, *U. sunilii* and *U. kamarudeenii*, and highlights the distinctiveness of newly described taxa.

***Keywords*:** Bladderworts, Carnivorous plants, Conservation, Micromorphology, Western Ghats, nrITS, *rps*16.

# പ്രബന്ധ സംഗ്രഹം

സസ്യലോകത്തിലെ ഇരപിടിയൻ ചെടികൾ ഉൾപ്പെടുന്ന ലെന്റിബ്യുലാരിയേസിയെ സസ്യകുടുംബത്തിൽ ഇനങ്ങളുടെ എണ്ണം കൊണ്ടും വൈവിധ്യം കൊണ്ടും ഏറെ സമ്പന്നമായ ഒരു ജനുസ്സാണ് യൂട്രിക്കുലേറിയ. ലോകത്താകമാനമായി 284 ഓളം ഇനങ്ങളുള്ള ഈ ജനുസ്സ് മറ്റ് സപുഷ്പിസസ്യവിഭാഗങ്ങളിൽ നിന്നും പലരീതിയിലും വിഭിന്നമാണ്. വളരെ സവിശേഷമായ ശരീര ഘടന, അൾട്രാ-ഫാസ്റ്റ് സക്ഷൻ ട്രാപ്പിംഗ് മെക്കാനിസം, ആഹാര സമ്പാദന രീതി, ആവാസവ്യവസ്ഥയുടെ പ്രത്യേകത, ജീനോം മിനിയേച്ചറൈസേഷൻ, ഡൈനാമിക് ന്യൂക്ലിയർ ജീനോമുകൾ എന്നിവ യൂട്രിക്കുലേറിയ ജനുസ്സിനെ കൂടുതൽ കൗതുകകരമാക്കുന്നു.

ഇവയ്ക്ക് യഥാർത്ഥ വേരുകൾ, തണ്ടുകൾ, ഇലകൾ എന്നിവയ്ക്ക് പകരം രൂപാന്തരം പ്രാപിച്ച റൈസോയിഡുകൾ, സ്റ്റോലോണുകൾ, ഇലകൾ, കെണികൾ എന്നിവയാണുള്ളത്. വിവിധ തരം ചെറിയ ജീവികളെ പിടികൂടാനും, ഇരയാക്കാനും, ദഹിപ്പിക്കാനും അനുയോജ്യമായ കെണികൾ (ട്രാപ്പ്) ശരീര ഭാഗത്തിലുള്ളതിനാൽ ഇവ 'ബ്ലാഡർവെർട്ട്സ്' എന്ന് അറിയപ്പെടുന്നു. ഇത് അതീവ സങ്കീർണ്ണവും മനുഷ്യന്റെ കാഴ്ച - ഗ്രഹണശക്തിയേക്കാൾ ഏറെ മുകളിലായി പ്രവർത്തിക്കുന്നതുമായ സക്ഷൻ ടൈപ്പ് (വലിച്ചകത്താക്കാൻ കെല്പുള്ള) കെണികൾ ആണ്. പോഷക അപര്യാപ്തതയുള്ളതും നനഞ്ഞതുമായ പ്രദേശങ്ങളിലാണ് ഇത്തരം ചെടികൾ കൂടുതലായും കണ്ടുവരുന്നത്. ഇവ കൂടാതെ ലെന്റിബ്യുലാരിയേസിയെയിലെ മൂന്ന് ചെടികളിൽ (ജെൻലീസിയ മാർഗരീറ്റേ, ജെൻലീസിയ ഓറിയ, യൂട്രിക്കുലേറിയ ഗിബ്ബ) റിപ്പോർട്ട് ചെയ്യപ്പെട്ട ജീനോം ചുരുക്കൽ അല്ലെങ്കിൽ ജീനോം മിനിയേച്ചറൈസേഷൻ, ഈ ഗ്രൂപ്പിന്റെ ഗവേഷണ വ്യാപ്തി ഉയർത്തിക്കാണിക്കുന്നുണ്ട്.

ഈ പ്രബന്ധത്തിൽ, ഇന്ത്യയിലെ യൂട്രിക്കുലേറിയ ജനുസ്സിൽപ്പെടുന്ന ഇനങ്ങളുടെ വൈവിധ്യത്തെക്കുറിച്ചും, അവ വളരുന്ന ചുറ്റുപാടുകളെക്കുറിച്ചും, വ്യാപനത്തെക്കുറിച്ചും, വിതരണത്തെക്കുറിച്ചും, ബാഹ്യരൂപഘടനയെക്കുറിച്ചും സമഗ്രമായി പ്രതിപാദിക്കുന്നു. വിത്തുകളുടെ സൂക്ഷ്മഘടനാ പഠനത്തിന്റെയും, ജനിതക തന്മാത്രാ പഠനത്തിന്റെയും സഹായത്തോടെ ഇന്ത്യൻ യൂട്രിക്കുലേറിയയുടെ വർഗ്ഗീകരണവും വിശദമായി വിശകലനം ചെയ്തിട്ടുണ്ട്. യൂട്രിക്കുലേറിയയുടെ സമ്പൂർണ്ണ വർഗ്ഗീകരണത്തോടൊപ്പം, ഓരോ വിഭാഗത്തിലെയും ഇനങ്ങളെ തിരിച്ചറിയുന്നതിനായി ടാക്സോണമിക് കീകൾ തയ്യാറാക്കി. ഇന്ത്യയിൽ നിന്നും 37 ഇനം യൂട്രിക്കുലേറിയകളെ പഠനത്തിൽ തിരിച്ചറിഞ്ഞിട്ടുണ്ട്. ഇവയിൽ

രണ്ട് പുതിയ ഇനങ്ങളും, ഇന്ത്യയിൽ നിന്ന് ഇതുവരെ റിപ്പോർട്ട് ചെയ്യാത്ത ഒരു ഇനവും ഉൾപ്പെടുന്നു. 37 ഇനം യൂട്രിക്കുലേറിയകളിൽ, 16 ഇനങ്ങൾ ലോകത്തിൽ തന്നെ ഇന്ത്യയിൽ മാത്രം കാണപ്പെടുന്നവയാണ്, അതിൽ 12 ഇനങ്ങൾ പശ്ചിമഘട്ടത്തിൽ മാത്രം ഒതുങ്ങി നിൽക്കുന്നവയാണ്.

വിത്തുകളുടെ ബാഹ്യരൂപ പഠനം സ്പീഷീസുകളെ തരംതിരിക്കാൻ ഒരു പരിധി വരെ സഹായിക്കുന്നു എന്ന് കണ്ടെത്തിയതോടൊപ്പം, ബീജകവചത്തിലെ വിന്യാസം, ഭിത്തികളുടെ ആകൃതിയും കനവും, പെരിക്ലിനൽ ഭിത്തികളുടെ ഓർണമെന്റേഷൻ എന്നിവ പ്രത്യേക പ്രാധാന്യമർഹിക്കുന്നതായി സ്ഥിരീകരിച്ചു. ബാഹ്യരൂപഘടനാ പഠനത്തെ പിന്തുണയ്ക്കുന്നതിനായി nrITS, *rps*16 എന്നീ തന്മാത്രാ സൂചകങ്ങൾ ഉപയോഗിച്ച് ഫൈലോജെനെറ്റിക് വിശകലനവും നടത്തിയിട്ടുണ്ട്.

യൂട്രിക്കുലേറിയയുടെ വൈവിധ്യമാർന്ന ആവാസവ്യവസ്ഥയും ജീവിത ചുറ്റുപാടുകളും മനസ്സിലാക്കാൻ വിപുലമായ ഫീൽഡ് പഠനങ്ങൾ സഹായകമായി. അതോടൊപ്പം, ഖനനം, ക്വാറി, വാണിജ്യ വികസന പ്രവർത്തനങ്ങൾ, ടൂറിസം, ഭൂവിനിയോഗ മാറ്റങ്ങൾ, നിലം നികത്തൽ, മലിനീകരണം, വരൾച്ച, വെള്ളപ്പൊക്കം, തീപ്പിടിത്തം, മണ്ണിടിച്ചിൽ മുതലായ നിരവധി പരിസ്ഥിതി സംബന്ധിയായ ഭീഷണികൾ യൂട്രിക്കുലേറിയയുടെ ആവാസവ്യവസ്ഥയെ സാരമായി ബാധിക്കുന്നുവെന്നും ഇവയുടെ പിന്നീടുള്ള നിലനിൽപ്പിന് വെല്ലുവിളിയാണെന്നും കണ്ടെത്തിയിട്ടുണ്ട്. യൂട്രിക്കുലേറിയയുടെ സംരക്ഷണ നില വിലയിരുത്തിയതിൽ, 15 എണ്ണം ഗുരുതരമായി വംശനാശ ഭീഷണി നേരിടുന്ന വിഭാഗത്തിൽ ഉൾപെടുന്നവയാണെന്ന് കണ്ടെത്തിയിട്ടുണ്ട്. സസ്യജാലങ്ങളെയും അവയുടെ ആവാസവ്യവസ്ഥകളെയും സംരക്ഷിക്കുന്നതിനായി ആവാസവ്യവസ്ഥാ-സംരക്ഷണ പ്രവർത്തനങ്ങൾക്ക് രൂപം നൽകുന്നതിനോടൊപ്പം സർക്കാർ തലങ്ങളിൽ കൃത്യമായ നിരീക്ഷണത്തോടെ പൊതുജനങ്ങളിൽ അവബോധം സൃഷ്ടിക്കാനുള്ള പദ്ധതികൾ ആവിഷ്കരിക്കേണ്ടതിന്റേയും, ആവാസവ്യവസ്ഥയുടെ സംരക്ഷണവും, ഭാവി ഗവേഷണ സാധ്യതകളും സംയോജിപ്പിച്ചു കൊണ്ടുള്ള സമഗ്രമായ സമീപനത്തിന്റെ ആവശ്യകതയെക്കുറിച്ചും ഈ പഠനം വിശദമായി പ്രതിപാദിക്കുന്നു.

**സൂചക പദങ്ങൾ:** പശ്ചിമഘട്ടം, ഇരപിടിയൻ ചെടികൾ, ആവാസവ്യവസ്ഥ, സക്ഷൻ ട്രാപ്പ്, സൂക്ഷ്മഘടനാ പഠനം, ജനിതക തന്മാത്രാ പഠനം.

# PLAN OF THE THESIS

The thesis titled 'A taxonomic revision of the genus *Utricularia* L. (Lentibulariaceae) in India supplemented with molecular data' is presented in 10 chapters:

The thesis begins with an introduction that underscores the intriguing nature of carnivorous plants and providing an overview of the Lentibulariaceae family and its genera. It also outlines the general characteristics of the genus *Utricularia*, discusses the significance of the study, and describes the area of study, emphasizing the biogeographic zones in India. The chapter concludes by listing the major objectives of the study.

Chapter 2 presents a comprehensive review of existing literature on the genus, covering a range of topics such as taxonomy, molecular studies, reproductive mechanisms, micromorphology, cytology, physiology, trap morphology, feeding habits, and ecological considerations.

Chapter 3 details the materials and methods used for the taxonomic study, including sources for literature retrieval, field exploration methodologies, specimen collection and herbarium preparation, as well as wet preservation techniques. The chapter also describes the procedures for species identification and preparation of taxonomic descriptions.

The results of the research are presented across four separate chapters, each corresponding to a specific objective of the study.

Chapter 4 describes the general morphology of the genus *Utricularia*, providing a foundational understanding of its structural features. This is followed by a comprehensive systematic treatment in Chapter 5, which provides a detailed description of the genus. The chapter includes a key to the sections found in India, beginning with a taxonomic treatment of the genus, followed by information on habitat, distribution, etymology, and a key for identification of the species. This is followed by a comprehensive account of each species in alphabetic order, with complete descriptions, details of flowering and fruiting, taxonomic and

nomenclatural notes, habitat information, ecological and distributional data. Each species description is accompanied by type images, colour plates, and distribution maps. A discussion on comparative morphology is presented in chapter 6, further supplemented with relevant photographic plates.

Chapter 7 investigates the micromorphology of seeds, starting with an introduction, followed by a detailed methodology, results, and discussion. This chapter features scanning electron microscope (SEM) images and compares the seed morphology of different species.

The phylogenetic analysis of *Utricularia* is discussed in Chapter 8, which includes an introduction, detailed methodologies, analysis, and discussion. A detailed discussion of the major results is provided, along with phylogenetic trees derived from the analysis.

Chapter 9 presents the results of a comprehensive habitat study of Indian *Utricularia* based on field exploration. It also addresses the major threats to these habitats and proposes potential conservation measures.

Chapter 10 concludes the study by summarizing its major findings, drawing together the results from taxonomy, molecular phylogeny, seed morphology, and conservation status. This is followed by some suggestions for future research and offers recommendations for further investigations.

Finally, an alphabetical listing of all the literature cited in the present study is provided. Additional supporting information, including a list of herbarium acronyms and abbreviations used, excluded taxa, voucher details used for molecular studies, the composition of chemicals used in the molecular characterization, a list of publications, presentations, and award received during the research, are given as appendices at the end of the thesis.

# CONTENTS


| | *Page No.* |
|---|---|
| **PLAN OF THESIS** | i |
| **CHAPTER 1. INTRODUCTION** | **1-12** |
| 1.1. Carnivory | |
| 1.2. Lentibulariaceae Rich. | |
| 1.3. *Utricularia* L. | |
| 1.4. Significance of the study | |
| 1.5. Study area | |
| 1.6. Objectives | |
| **CHAPTER 2. REVIEW OF LITERATURE** | **13-42** |
| 2.1. Overview of Lentibulariaceae | |
| 2.2. History of *Utricularia* L. | |
| 2.3. Molecular studies | |
| 2.4. Reproductive strategies | |
| 2.5. Micromorphology of pollen and seeds | |
| 2.6. Cytology | |
| 2.7. Physiology and trap morphology | |
| 2.8. Carnivory | |
| **CHAPTER 3. MATERIALS AND METHODS** | **43-54** |
| 3.1. Literature survey | |
| 3.2. Herbarium consultation | |
| 3.3. Field exploration and specimen collection | |
| 3.4. Herbarium preparation and wet preservation | |
| 3.5. Plant identification | |
| 3.6. Nomenclature and citations | |
| 3.7. Preparation of descriptions and photo plates | |
| 3.8. Distribution mapping and conservation assessment | |
| 3.9. Presentation of data | |
| **CHAPTER 4. GENERAL MORPHOLOGY** | **55-76** |
| 4.1. Vegetative morphology | |
| 4.2. Reproductive morphology | |
| **CHAPTER 5. SYSTEMATIC TREATMENT** | **77-352** |
| 5.1. Genus *Utricularia* L. | |

5.2. *Utricularia* sect. *Meionula* (Raf.) P.Taylor
5.3. *Utricularia* sect. *Nigrescentes* (Oliv.) Komiya
5.4. *Utricularia* sect. *Oligocista* A.DC.
5.5. *Utricularia* sect. *Phyllaria* (Kurz) Kamienski
5.6. *Utricularia* sect. *Utricularia* P.Taylor
**CHAPTER 6. COMPARATIVE MORPHOLOGY** **353-382**
6.1. Vegetative morphology
6.2. Reproductive morphology
**CHAPTER 7. SEED MICROMORPHOLOGY** **383-404**
7.1. Introduction
7.2. Materials and methods
7.3. Results
7.3.1. Descriptions of seed morphology
7.3.2. Seed characteristics
7.4. Comparative morphological analysis
7.5. Discussion
7.6. Conclusion
**CHAPTER 8. PHYLOGENY OF UTRICULARIA L.** **405-424**
8.1. Introduction
8.2. Materials and methods
8.2.1. Taxon sampling
8.2.2. DNA extraction
8.2.3. Quantification of DNA
8.2.4. Selection and preparation of primers for PCR
8.2.5. PCR Amplification
8.2.6. DNA sequencing
8.2.7. Sequence alignment
8.2.8. Phylogenetic analysis
8.2.8.1. ML and BI analysis for nrITS and *rps*16 sequences
8.3. Results
8.3.1. Phylogenetic analysis based on nrITS data
8.3.2. Phylogenetic analysis based on *rps*16 data
8.4. Discussion
**CHAPTER 9. HABITAT DIVERSITY, THREATS AND CONSERVATION ASSESSMENT** **425-450**
9.1. Introduction

9.2. Habitats of Indian bladderworts
9.3. Threats to the habitats of Indian bladderworts
I. Natural threats
II. Anthropogenic threats
9.4. Conservation assessment
9.4.1. A step to conserve species *ex-situ*
9.4.2. How does *in-situ* conservation work?
9.5. Conclusion
**CHAPTER 10. SUMMARY AND CONCLUSION** **451-456**
10.1. Summary
10.1.1 Taxonomy
10.1.2 Micromorphological study of seeds
10.1.3. Phylogenetic analysis
10.1.4. Conservation status assessment
10.2. Conclusion
**RECOMMENDATIONS AND FUTURE OUTLOOK** **457-458**
**LITERATURE CITED** **459-496**
**APPENDICES** **497-527**

# INTRODUCTION

Nature, the treasure trove of flora and fauna, has been a blessing to humanity since time immemorial. Man has lived in communion with nature, relying on it for everything he needed. Its actual beauty rests in its lush wilderness, where plants and animals coexist in a delicate balance. The word 'nature' is used in a variety of contexts, each with different connotations. Perhaps its apt fitting reference is to the diversity of plants, animals, wildlife, and all that the earth encompasses. Man is thus enchanted and inclined to it as it opened prospects for ever new vistas of knowledge.

Everyone has an innate curiosity and inquisitiveness to explore mysterious wonders which lie hidden in nature. As each plant and animal is unique with their distinctive characteristics, a vast number of inquiries and studies have been conducted to get an in-depth knowledge about them. Nature's influence has heightened people's imagination and creativity, prompting people to fantasize about mysteries beyond their understanding. This fascination has, in turn, led to the creation of fictional accounts, with some focussing on the intriguing concept of man-eating plants.

Likewise, fascinating fables were in vogue about carnivorous plants or insectivorous plants. Charles Darwin's (1875) groundbreaking investigation into carnivorous plants provided experimental evidence to the miraculous man-eating plants depicted in the old fictions and fables. These ancient myths were substantiated by the discovery that certain plants indeed exhibit carnivorous characteristics, and that they can capture insects, reptiles, and other small creatures for fulfilling their nutritional requirements. However, it is a proven truth that they never prey on humans and large animals.

The Venus flytrap, in particular, was described by Darwin (1875) as '*one of the most wonderful plants in the world*,' in his epic work *Insectivorous Plants*. It surprisingly turns to be a monumental reference and has paved a way for more inclusive studies. In the 20th century, further records on carnivorous plants were made by Lloyd (1942)

and Juniper *et al*. (1989), whose comprehensive work *The Carnivorous Plants* remains a major contribution to the field.

**1.1. Carnivory**

Carnivory in plants is a complex and fascinating process involving trapping, killing, digesting, and assimilating of nutrients from animal derived prey. This ability is a remarkable adaptation acquired by plants in their evolutionary lineages. Carnivorous plants attract, capture, and digest animals or animal derived prey to obtain essential nutrients for their survival. The term 'carnivorous plants' is derived from two Latin words, *carnis* (flesh) and *vorare* (swallow). They fall within the category of insectivorous plants, but their diet is not limited to insects. They have no such potential prey organisms; they consume whatever prey comes their way and their diet selectivity is arbitrary hence consumes whatever.

Evolution has equipped these plants to transform their leaves into ingenious structures (the traps), where they can prepare their food to cope deficiencies in their environment. Juniper *et al.* (1989) noticed the poorly developed root system of these plants and concluded that the conversion of leaves into traps was to overcome the fate of weak roots. The 'carnivorous syndrome' helps the plant generate some energy to handle the low photosynthetic capacity and nutrient deficiency.

Darwin's (1875) '*Insectivorous plants*' was a significant milestone in the 17$^{th}$ century research, opening the door for more comprehensive investigations. He explained the morphology and internal structure of the traps, how they capture and digest prey, and how they obtain nutrients. Though his work resolved the mythological facts behind these 'murderous plants', many questions regarding their ecology, physiology, metabolism, and evolution remained. Darwin proposed that carnivory evolved independently at different times during the course of evolution. In the light of Darwin's clues, Lloyd (1942) made a comprehensive study, identifying around 450 species from diverse global regions and categorising six kinds of traps. He elaborated on investigations into the carnivorous nature of plants, their specialized habitats, their trapping structures and mechanisms. These findings subsequently culminated in the study of the various aspects of carnivorous plants.

Though a number of studies have been undertaken worldwide, inquiries about the evolution of botanical carnivory remain unresolved. However, new multidisciplinary approaches have enabled researchers to study every aspect in detail, from trapping structures to evolutionary strategies.

Carnivorous plants are found worldwide, except in polar ice deserts, arid zones, and oceanic islands; with the great diversity and richness in tropical and subtropical regions with warm, wet humid environments (Brewer & Schlauer, 2018). These plants are specifically adapted to live in specialized habitats, usually in open, wet, acidic, low nutrient soils (Darwin, 1875; Givnish *et al*., 1984; Juniper *et al*., 1989) such as bogs, swamps, lateritic plateaus, watercourses, water bodies, granitic outcrops, sandy and peat soils. Like other plants, carnivorous plants use various strategies to attract prey, including the intense colouration of their traps mimicking flowers, the smell of nectar, and the slippery or sticky surface that lure organisms into their traps.

The vividness of carnivorous plants has fascinated botanists, ecologists and general researchers for centuries. There are five types of traps evolved in carnivorous plants: adhesive (flypaper) traps, pitcher (pitfall) traps, snap traps, eel (lobster-pot) traps and suction traps. The adhesive traps consist of sticky glandular leaves like in *Drosera* L., pitcher traps formed from tubular leaves or rosette of leaves forming tank-like pits, snap traps made up of rapidly closing laminar lobes and eel traps forming tubular leaves with internal retrorse hairs. Suction traps are the highly evolved and modified structures commonly found in *Utricularia* (bladderworts).

Though enormous studies have been undertaken in carnivorous families to address the question of origin of carnivory, only latest molecular approach can explain its origin and evolution (Fleischmann *et al*., 2018). The molecular phylogenetic analysis proved that the evolution of carnivory was convergent. Carnivory has been evolved independently in at least ten times in six orders of 13 angiosperm plant families (Givnish & Sytsma, 1997; Ellison & Gotelli, 2001; Muller *et al*., 2004; Givnish *et al*., 2011; Fleischmann *et al*., 2010; Lin *et al*., 2021). It evolved once in Nepanthales and Oxalidales, twice in Ericales and thrice in Lamiales and Poales

(Fleischmann *et al*., 2018). The major carnivorous plant families are Bromeliaceae, Byblidaceae, Cephalotaceae, Droseraceae, Dioncophyllaceae, Lentibulariaceae, Nepenthaceae, Roridulaceae, and Sarraceniaceae (Brewer & Schlauer, 2018). These diverse plant families have an intricate, yet delicate style of adaptation to survive in low nutrient and waterlogged habitats.

### 1.2. Lentibulariaceae Rich.

The family Lentibulariaceae (order Lamiales, APG IV, 2016) comprises of 350 species globally (Rodrigues *et al*., 2017) and is distributed across temperate and tropical countries. The family was described by Richard (1808) in Poiteau & Turpin, '*Flore Parisienne*' as '*Lentibulariae*'. Lentibulariaceae encompasses three genera, *Genlisea* A.St.-Hil., *Pinguicula* L. and *Utricularia* L., of which the latter two genera are found in India. The family possesses remarkable morphological characteristics that may obscure the initial interpretation of the vegetative parts. The inflorescence is typically a raceme, although it can rarely be reduced to a solitary flower. The flowers are zygomorphic, bracteate (except in *Pinguicula* and some species of *Genlisea*), bilabiate, and spurred. The capsules show a great diversity in dehiscence pattern (Taylor, 1989). Owing to carnivorous traits, each genus encompasses its own specialized organ for satisfying the nutritional strategies. *Pinguicula,* also known as butterwort, is the second most diverse group with about 85 species and possesses sticky leaves that function as flypaper type traps (Cieslak *et al*., 2005). The capture system of *Pinguicula* composed of sessile and short stalked mucilage producing glands on the adaxial surface of the rosette leaves, which are used to capture and digest prey (Jobson *et al*., 2003; Muller *et al*., 2006). In contrast, *Genlisea* possesses eel-trap, the funnel-shaped traps or a tubular anchor leaf with two helically twisted arms that guide the prey toward a proximal digestion chamber, earning it the common name '*corkscrew plants*' (Taylor, 1991; Barthlott *et al*., 1998; Muller *et al.,* 2006). *Utricularia* develop "utricles, bladders or suction traps" on vegetative organs, and hence called as bladderworts, and the genus is unique in having ultra-fast suction traps with a complex trap architecture (Reifenrath *et al*., 2006). Unlike other carnivorous plants, one species of *Utricularia* (*U. gibba* L.) shows extreme genome miniaturization and around three whole genome duplications providing insights

into in-depth future researches (Greilhuber *et al*., 2006; Ibarra-Laclette *et al*., 2013). The family remains a fascinating research topic, as its evolution and carnivorous traits are still not fully understood.

### 1.3. Utricularia L.

*Utricularia*, the largest and highly fascinating carnivorous genus, is distributed throughout the world with great species richness and diversity (Taylor, 1989). Besides exhibiting an unusual feature of carnivory, species of this genus has a unique body plan among flowering plants. The vegetative structures are highly varied in which roots, stems, and leaves are highly plastic (Taylor, 1989; Rutishauser & Isler, 2001). They lack identifiable roots at any, and replaced with rhizoids. Most species exhibit heterophylly in which, leaf laminas of the terrestrial species are normal, simple and minute forms rosette at the base of peduncle, while in the aquatic species they are highly dissected. The genus shows a wide range of variation in its life form and habitat. They are mainly aquatic (free-floating or anchored), terrestrial or epiphytic herbs and occurs on wet soils in open areas, boggy ground along stream banks, pools and ponds, paddy fields, moss-covered tree trunks, wet dripping rocks and in association with mosses and grasses. The vegetative parts are usually found concealed in the substratum or sunk in water or soil according to their habitats. The rhizoids are developed from the stem to perform the function of roots (Taylor, 1989) and they may be present or absent partially or completely. The main part of the plant is a stolon or stem, which bears bladders, leaves and inflorescence. The stem or stolon may be horizontal, floating, submerged or growing downward into the soil, and are adapted to anchor the plants in their substratum, to absorb available water and minerals and also meant for propagation. True leaves are absent; instead, poorly developed leaves are present and their shape, size and venation pattern may vary. Traps or bladders are ovoid to globose structures with a mouth opening inward by a disc or door. They feature simple or branched glandular hairs around the mouth and a stalk for attachment (sessile in some species). The racemes may be simple or branched, erect or twining, one- to many-flowered and the corolla is bilabiate and spurred. The fruit is a capsule containing many seeds that are with or without appendages and winged in aquatic species.

The history of *Utricularia* is expected to start with Conrad Gessener, a Swiss Physician and scientist in the 16th century. In his book *Historia Plantarum*, Gessener painted a species of *Utricularia* (now *U. australis* R.Br.) and annotated it '*Lentibullia*' and '*Lentibularia*'. Unfortunately, his work remained incomplete and unpublished due to his untimely demise. The family name Lentibulariaceae was later derived from these annotations (Casper, 2002). The first written reference to *Utricularia* was given by Van Rheede (1678–1693) in his monumental work, "*Hortus Malabaricus*". He described and illustrated '*Nelipu*' (9: 137, t.70, 1689, now *U. reticulata*) in Malayalam, which literally means *Nellu*= *Paddy* and *Poo*= *Flower*, alludes to the plant growing abundantly in association with paddy or in paddy fields. This was the first Indian treatise on *Utricularia* in the pre-Linnean era. Linnaeus (1753) established *Utricularia* in his '*Species Plantarum*' and accommodated seven species, *viz*., *U. vulgaris* L., *U. minor* L., *U. subulata* L., *U. gibba* L., *U. bifida* L., *U. caerulea* L. and *U. foliosa* L. from America, Europe, Virginia, China and Sri Lanka, but none from India. After Linnaeus, quantifiable number of contributions were made by Vahl (1804), Brown (1810), Smith (1819), De Candolle (1844), Oliver (1859), Clarke (1884), Kamienski (1895), etc. The first comprehensive account on *Utricularia* was made by Taylor in 1989, who worked with more than 900 names, recognized 214 species segregated in two subgenera and 35 sections. Since then, a number of species were added globally and the traditional classification was modified by morphological and molecular support (Muller & Borsch, 2005; Reut & Jobson, 2010; Jobson *et al*., 2017; Silva *et al*., 2018). The genus is presently represented by 284 species (POWO, 2025) under three subgenera and 32 sections globally (Silva *et al*., 2018; Krishnapriya *et al*., 2024).

### 1.4. Significance of the study

*Utricularia* is a largest and widely distributed carnivorous genus. Although extensive studies on the taxonomy and biology of this genus are being conducted in other parts of the world, there has been no significant work done in India. Based on morphological data, of the 35 currently recognized sections, only eight sections, namely, *Calpidisca*, *Lloydia*, *Meionula*, *Nigrescentes*, *Oligocista*, *Phyllaria, Setiscapella* and *Utricularia* were represented in India. The latest work on the taxonomy of this genus in India was provided by Janarthanam and Henry (1992), who recognized 35 species

from India without any sectional placement. Since then, a few more species were described from India, bringing the total into 42 (Yadav *et al*., 2000, 2005; Kumar *et al.,* 2018; Arya *et al*., 2020; Biju *et al*., 2020), and some of the previously described ones being now considered synonyms. This suggests that intensive and extensive survey will reveal more species from India and will be helpful in confirming the identity of all described species. The Western Ghats, Deccan Plateau, Alpine Himalaya, etc. provides a congenial ecological niche and an appropriate environment to foster the curious group of plants. Although *Utricularia* shows worldwide distribution, it shows a high degree of endemism.

The genus poses difficulties for identification as the significance of the vegetative parts are not recognized in the field, its tiny size and high degree of variation of characters. As stated by Godfrey and Wooten (1981), "*the rarity of the plant is ascribed by its difficulty to perceive it from the field, rather than to its actual distribution*", the size of many of the *Utricularia* species starts from less than 1 cm reducing the chances to notice it from field. Moreover, it needs microscopic analysis to arrive at a proper identification due to its small size and morphological resemblances among species. Additionally, it requires careful observation at the time of collection process, since the vegetative parts are not always exposed above the surface of the substrate. These parts are usually difficult to analyse from the preserved/ herbarium specimens, yet too these are crucial for species delimitation. Hence a detailed analysis of the Indian species of *Utricularia* based on extensive field survey is required.

Since *Utricularia* species show significant variations at both intra- and inter-specific levels, a detailed morphological study supplemented with micromorphological and molecular phylogenetic data is essential to segregate morphologically similar species and unravelling species relationships within this taxonomically difficult genus in India.

### 1.5. Study area

India, situated between 8°45' and 37°60' N latitude and 68°51' and 97°25' E longitude, covers an area of approximately 328.72 million hectares and is one of the

world's 17 megadiverse countries (Mittermeier *et al.*, 1997; Dash & Mao, 2022). Located at the intersection of three major biogeographical realms (Afro-tropical, Indo-Malayan and Paleo-Arctic), the country exhibits a diverse range of climates that support a multitude of habitats and ecosystems. The rich floristic diversity of India dates back to the geological history and India highlights a wide array of environments, from the arid hot deserts, cold deserts, wettest zones, coldest coniferous forests of eastern Himalaya, grasslands of western Himalaya to icy mountains, riverine or shola grasslands to warm mangrove coastlines (Dash & Mao, 2022). The Indian flora is concentrated in four floristic hotspots: Indo-Burma which includes Mizoram, Manipur, Nagaland, Meghalaya, Tripura and Andaman Islands; the Himalayas encompasses Jammu and Kashmir, Himachal Pradesh, Uttarakhand, the northern part of West Bengal (Darjeeling), Sikkim, the northern part of Assam and Arunachal Pradesh; the Western Ghats includes Tamil Nadu, Kerala, Karnataka, Goa, Maharashtra and Gujarat; and the Sundaland covering the Nicobar Islands (Mittermeier *et al*., 2004; Dash & Mao, 2022). India occupies only 2.4% of the world's total geographical area, yet it is home to nearly 8% of the world's known floral species, with 28% species being endemic to the country (Dash & Mao, 2022). According to Rodger *et al.* (2000), the biogeographic regions are categorised into ten zones (Fig. 1).

### 1.5.1. Biogeographic zones

#### 1. Trans-Himalaya

The Trans-Himalaya zone covers two provinces, the Ladakh mountains covers the parts of Jammu and Kashmir, and the Tibetan Plateau covering upper ridges of the Himachal Pradesh. It is a cold and arid zone to the north of Great Himalayan range lying at 4500–6000 m above sea level, covering 5.6% of the total land area. The Himalayan meadows and streams are home to two species of *Utricularia*, *viz.*, *U. minor* and *U. australis*.

#### 2. Himalaya

Himalayas include all of the world's mountain peaks over 8,000 meters in height, including Mount Everest, the world's tallest peak. This mountain chain is the

youngest and highest on Earth, spanning over 3000 kms in an arc across northern Pakistan, Nepal, Bhutan, the northwestern and northeastern states of India adjoining Myanmar, and the Southwestern China border in the east (Mittermeier *et al*., 2004). The Eastern Himalaya, encompasses areas of Nepal, Bhutan, the northeastern Indian states of West Bengal, Sikkim, Assam, and Arunachal Pradesh, Southeastern Tibet (China), and Northern Myanmar; and the Western Himalaya, includes the Kumaon-Garhwal, northwest Kashmir, and Northern Pakistan (Mani, 1994).

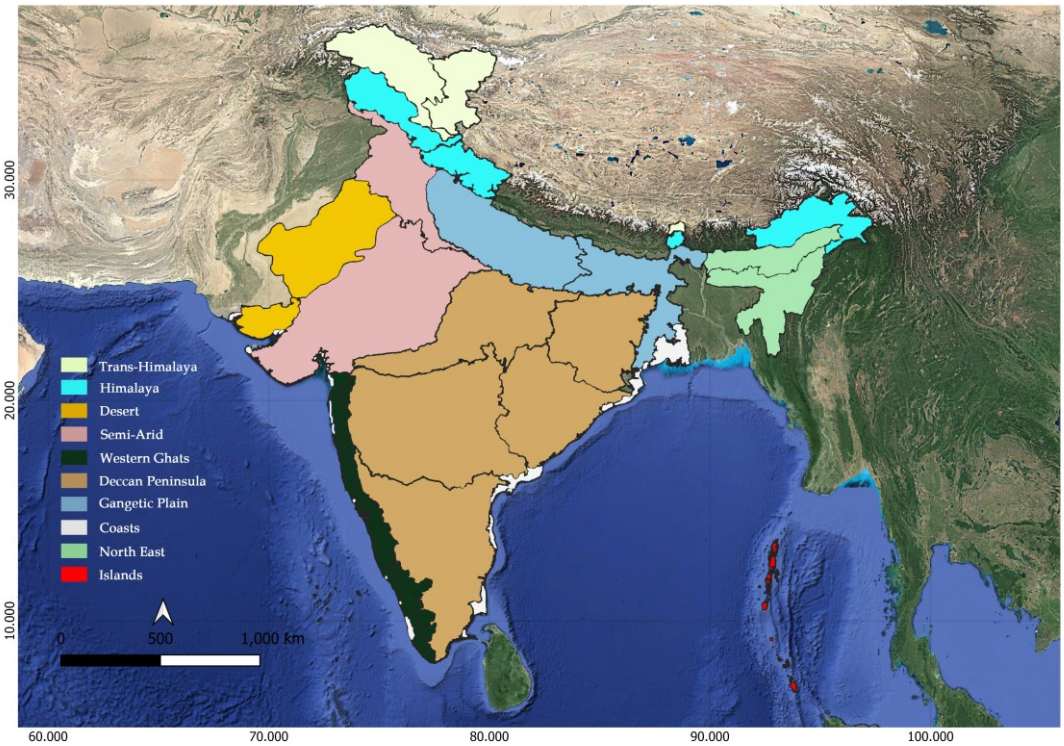


**Fig. 1.** Study area: Biogeographic zone of India.

The Himalaya zone in India covers three biogeographic provinces: the Northwest Himalaya includes Himachal Pradesh and Uttarakhand; the Central Himalaya includes Sikkim, and the Eastern Himalaya covers Arunachal Pradesh. The whole Himalayan region covers 4.3% of the total land area. The meadows and streams in the Himalayan foothills are home to eight species of *Utricularia* (*U. australis, U. brachiata* Oliv., *U. christopheri* P.Taylor, *U. furcellata* Oliv., *U. kumaonensis* Oliv., *U. multicaulis* Oliv., *U. minor* L., and *U. striatula* Sm.). *Utricularia brachiata*, *U. christopheri*, *U. multicaulis* and *U. minor* are restricted to the Temperate or montane zone and Alpine zone of the Eastern Himalayas, above 3000 m.

**3. Desert**

The Indian Desert region includes two biogeographic provinces, Thar and Kachchh covering the states of Rajasthan and Gujarat. The desert ecosystem dominates this region, followed by scrub and grasslands. There are no occurrences of *Utricularia* in this region.

**4. Semi-Arid**

The semi-arid zone covers two provinces such as, Punjab plains, and Gujarat and Rajputana. The former includes Punjab, Haryana and Rajasthan, the latter extends to Rajasthan, Gujarat and parts of Madhya Pradesh. This region covers 16.6% of the total land area. This is a transition zone between desert and dense forest, including savannahs and thorn forests. The distribution of *Utricularia* is comparatively less in this zone, only a few aquatic and terrestrial species such as *U. aurea*, *U. caerulea*, *U. graminifolia* Vahl, *U. janarthanamii* S.R.Yadav *et al.*, *U. scandens* Benj., *U. stellaris* L.f, and *U. striatula* are found in Gujarat and Madhya Pradesh regions.

**5. Western Ghats**

The Western Ghats, also known as the Sahyadri Hills, are formed by the Malabar Plains and the chain of mountains that runs almost parallel to India's western coast, stretching approximately 30–50 km inland and crossing the states of Tamil Nadu, Kerala, Karnataka, Goa, Maharashtra, and Gujarat (Kumar *et al.*, 2004). These mountains cover a distance of over 1600 km, interrupted only by the 30 km Palghat Gap. The Western Ghats reach their highest point at 2699 meters, marking the Anamudi Peak. These mountains play a crucial role in regulating the rainfall patterns of the peninsular region by intercepting monsoon storm systems. The Western Ghats covers only 4% of the total land area and accommodates around 5000 species of flowering plants, belonging to nearly 2200 genera and 217 families; of which around 1700 species (34%) are being endemic (Kumar *et al.*, 2004). Geologically, climate and evolutionary history are rather similar in the Western Ghats of southwestern India and the highlands of southwestern Sri Lanka and this hotspot harbours around 3049 endemic plant species.

The Western Ghats harbours a remarkable number of *Utricularia* species with a sizable percentage of endemism. *Utricularia albocaerulea* Dalzell, *U. bifida*, *U. caerulea*, *U. cecilii* P.Taylor, *U. graminifolia*, *U. janarthanamii*, *U. lazulina* P.Taylor, *U. malabarica* Janarth. & A.N.Henry, *U. minutissima* Vahl, *U. nayarii* Janarth. & A.N.Henry, *U. purpurascens* J.Graham, *U. praeterita* P.Taylor, *U. reticulata* Sm., *U. roseopurpurea* Stapf ex Gamble, *U. scandens*, *U. smithiana* Wight, *U. sainthomia* P.Biju *et al*., *U. striatula*, *U. uliginosa* Vahl, and *U. wightiana* P.Taylor are the common inhabitants in this zone, of which *U. albocaerulea*, *U. cecilii U. lazulina*, *U. malabarica*, *U. nayarii*, *U. purpurascens*, *U. praeterita*, *U. smithiana*, *U. sainthomia*, and *U. wightiana* are the endemics. *Utricularia roseopurpurea* is endemic to both the Western Ghats and Sri Lanka.

**6. Deccan Peninsula**

It is the largest area covering 41.9% of the total land area, and includes five biogeographic provinces, *viz*., Central Highlands, Chota Nagpur, Eastern highlands, Central Plateau and Deccan south. This region lying in the rain shadow of the Western Ghats, covers eight states such as Madhya Pradesh, Jharkhand, Chhattisgarh, Odisha, Maharashtra, Andhra Pradesh, parts of Karnataka and Tamil Nadu. The Deccan peninsula is home to many terrestrial species of *Utricularia.* An extended distribution of the species growing in Western Ghats are found in the Deccan zone. *Utricularia albocaerulea*, *U. aurea*, *U. australis*, *U. bifida*, *U. caerulea*, *U. geoffrayi* Pellerg., *U. gibba*, *U. graminifolia*, *U. hirta* Klein ex Link, *U. janarthanamii*, *U. minutissima*, *U. polygaloides* Edgew., *U. purpurascens*, *U. praeterita*, *U. scandens, U. striatula*, *U. stellaris* are the common inhabitants in this zone.

**7. Gangetic Plain**

The Gangetic Plains includes two provinces: Upper Gangetic plain and Lower Gangetic plain, in which the former covers Uttar Pradesh and latter covers Bihar and West Bengal. It is a fertile plain in the Himalayan foothills holding 10.8% of the total land area. The Upper Gangetic plain harbours *U. kumaonensis* and *U. striatula*, and the lower plain harbours *U. aurea*, *U. australis*, *U. bifida*, *U. gibba* and *U. stellaris*.

**8. Coasts**

The coasts cover West coast region of Gujarat, East coast region of West Bengal, Odisha, Andhra Pradesh and Tamil Nadu and the Lakshadweep coast. The coastline spans around 8000 km including terrestrial and aquatic ecosystems.

**9. Northeast**

Northeast harbours 5.2% of the total land area covering two distinct biogeographic provinces, such as Brahmaputhra valley and Northeast hills. This region includes the non-Himalayan hill ranges, low land and montane vegetation types in which the former province covers Assam and the latter includes Manipur, Meghalaya, Tripura, Nagaland and Mizoram. A considerable diversity in *Utricularia* is also found in Northeast zone which harbours *U. caerulea*, *U. bifida*, *U. furcellata*, *U. hirta*, *U. recta* P.Taylor, and *U. striatula*.

**10. Islands**

The Islands includes Andaman and Nicobar covering only 0.3% of the total land area. This region consists of around 600 islands, and is composed of tropical rain forests covering evergreen, littoral and mangrove forests.

## 1.6. Objectives

1. To explore different parts of India to study the distribution, diversity and habitat requirements, and to collect specimens of *Utricularia*.
2. To identify all species of *Utricularia* and resolve any nomenclatural problems in consultation with relevant type specimens and taxonomic literature.
3. To prepare an updated taxonomic account of the genus in India.
4. To examine the micromorphology of seeds using scanning electron microscopy.
5. To study the molecular phylogeny of *Utricularia* species found in India.
6. To evaluate the conservation status of each species based on the IUCN Red List Categories and Criteria.

# REVIEW OF LITERATURE

Bladderworts are a unique group of carnivorous plants characterized by distinctive morphological traits and intricate structural complexity. They have lost the typical angiosperm structure of roots, stems and leaves, and are highly plastic in their growth patterns, hence, display a range of vegetative morphological characters with uncertain homology (Taylor, 1989; Rutishauser & Isler, 2001). The fascinating traits of bladderworts and their carnivorous behaviour have continued to enthuse and enthrall researchers until now. The intriguing nature of their bladders, the entrapment of materials through rapid trapdoor movements, and the intricate process of digestion that supports their metabolic functions all contribute to their distinct and inimitable nature. For all these reasons, many important accounts were made on Lentibulariaceae family and the genus *Utricularia*, focusing on morphology, anatomy, cytology, palynology, physiology, ecology and molecular biology. The discovery of extreme genome miniaturization and the ultra-fast suction trapping mechanism in Lentibulariaceae members has greatly enhanced future research perspectives. *Utricularia*, with 284 naturally occurring species, is the largest genus in this family (POWO, 2025). This fascinating group has long been a matter of debate among researchers, and it has resulted in a vast number of studies and produced enlightening publications worldwide. The review presented here will cover major aspects and discuss the important findings in detail.

## 2.1. Overview of Lentibulariaceae

Lentibulariaceae was described by Richard (1808) in Poiteau and Turpin's '*Flore Parisienne*'. Bentham and Hooker (1876) treated this family within the order Personales of the series Bicarpellatae, while, Hutchinson (1969) placed the Lentibulariaceae in the order Personales of the division Metachlamydeae. According to Takhtajan (1980), Lentibulariaceae is derived from Scrophulariaceae and was placed in the suborder Scrophulariineae of the order Scrophulariales. In the latest phylogenetic classification (APG IV, 2016), however, Lentibulariaceae is recognized as a monophyletic family within the order Lamiales.

The history of *Utricularia* L. and *Pinguicula* L. dates back to Linnaeus, where he described four species of *Pinguicula* and seven species of *Utricularia* in his '*Species Plantarum*'. Rafinesque (1838) in his '*Flora Telluriana*' described 16 new genera (*Lentibularia* Raf., *Trixapias* Raf., *Askofake* Raf., *Stomoisia* Raf., *Meionula* Raf., *Hamulia* Raf., *Meloneura* Raf., *Nelipus* Raf., *Vesiculina* Raf., *Enskide* Raf., *Cosmiza* Raf., *Megozipa* Raf., *Trilobulina* Raf., *Personula* Raf., *Plesisia* Raf., and *Plectoma* Raf.) in a new family Clythrelia Raf., including the genera *Utricularia* and *Pinguicula*. The extreme generic segregations can readily be placeable in synonymy were eliminated by later authors, and some of the Rafinesquian generic names were used for the designation of sections in *Utricularia*. De Candolle (1844) recognized three genera, *viz*., *Utricularia, Genlisea* and *Pinguicula*, similar to the current classification. He treated 114 species of *Utricularia* under five sections. Benjamin (1847a, b) treated 112 species, segregated under eleven sections in Lentibulariaceae (the former 'Utricularieae'). Though he described 54 new taxa, the circumscriptions and characters used for the segregations contained inaccuracies and were not used for infrageneric classification. Edgeworth (1847) added a new genus, described from Himalaya, *Diurospermum* Edgew. with type species *D. album* Edgew., which was later synonymised under *Utricularia kumaonensis* Oliv. Furthermore, he inferred that the hairs on seeds of *Diurospermum* are a connecting link between the families Lentibulariaceae and Cyrtandraceae. He described four new *Utricularia* species from Bengal, three of them are distributed in India (*U. polygaloides* Edgew., *U. foveolata* Edgew., and *U. rosea* Edgew. = *U. caerulea*).

Kamienski (1895) made a comprehensive study on Lentibulariaceae, and his account was published in Engler and Prantl's *Naturlichen Pflanzenfamilien*. Kamienski (*l.c.*) segregated Lentibulariaceae into two subfamilies: *Utricularieae* and *Biovularieae*. Under *Utricularieae*, recognized four genera, *viz*., *Pinguicula*, *Genlisea*, *Polypompholyx* Lehm. and *Utricularia* (includes 10 sections) and in *Biovularieae*, a single genus *Biovularia* Kam.

The treatment by Barnhart (1916) had 16 genera, *viz*., *Pinguicula*, *Genlisea*, *Cosmiza*, *Meloneura*, *Aranella* Barnh., *Pleiochasia* (Kam.) Barnh., *Pelidnia* Barnh., *Orchyllium* Barnh., *Stomoisia*, *Calpidisca* Barnh., *Avesicaria* (Kam.) Barnh., *Setiscapella* Barnh., *Lecticula* Barnh., *Biovularia*, *Utricularia*, and *Vesiculina*. Barnhart's treatment

of Lentibulariaceae largely repeated four Rafinesquian genera, making combinations for each and providing detailed notes.

Komiya (1973) segregated Lentibulariaceae, described three subfamilies and three genera. Subfamily Pinguiculoideae accommodated *Pinguicula* and recognized four sections, *Isoloba*, *Pionophyllum*, *Orcheosanthus* and *Temnoceras*, while subfamily Genliseoideae encompass *Genlisea* only. Subfamily Utricularioideae comprised of three genera of which, *Utricularia* and *Polypompholyx* falls within the tribe Utricularieae and *Biovularia* in the tribe Biovularieae. He included seven subgenera and 11 sections within *Utricularia*.

Taylor (1989) made a comprehensive treatment of the genus worldwide and segregated *Utricularia* into two subgenera and 35 sections, providing taxonomic information about all species known globally. The integration of morphological data with molecular evidence has resolved the generic and sectional delimitations, leading to a revision of *Utricularia* (Jobson *et al*., 2003; Muller & Borsch, 2005; Muller *et al*., 2006; Silva *et al*., 2018).

## 2.2 History of Utricularia L.

The first written document on *Utricularia* was given by Van Rheede (1678–1693), the Dutch Governor of Cochin in his work, '*Hortus Malabaricus*'. He, fascinated with the flora of Malabar (the present Kerala state), compiled the plant wealth and published a huge compendium in 12 volumes. Rheede (1689-1690) described '*Nelipu*' a Malayalam name (vol. 9: p. 137, t. 70) which literally means the plant growing abundantly in association with paddy or in paddy fields (current *U. reticulata* Sm.; Taylor, 1989; Janarthanam & Henry, 1992; Janarthanam, 1999).

The genus was first described by Linnaeus (1753) in his '*Species Plantarum*', where he listed seven species: *U. bifida*, *U. caerulea*, *U. foliosa*, *U. gibba*, *U. minor*, *U. subulata* and *U. vulgaris*. Linnaeus's *U. caerulea* made confusions since he cited a combination of three specimens. He considered Rheede's illustration as *Utricularia caerulea*, and annotated "*Nelipu. Rheed. mal. 9. p.137. t.70*" along with Hermanns material from Ceylon and a material collected by Koenig from India (*U. parviflora*).

Sir James Edward Smith (1808), a British Botanist in his book '*Economic Botany*', described *U. reticulata* from Rheede's *Nelipu* and solved the erroneous citation, and eventually corrected Linnaeus's *U. caerulea* with Hermann specimen from Ceylon. Later on, Smith (1819) in Rees's '*Cyclopaedia*' enumerated 62 species of *Utricularia* including some new species. Subsequently, Vahl (1804) recognized 34 species along with some Indian representatives while Brown (1810) treated 24 species in '*Prodromus Florae Novae Hollandiae*'. De Candolle (1844) made a comprehensive revision, documented 114 species and 17 uncertain species under five sections: sect. *Megacista*, *Lentibularia*, *Stylotheca*, *Oligocista* and *Orchidioides*.

Robert Wight (1849), an English Surgeon, fascinated with the plant wealth of India, described new species published in the form of a key in *Hooker's Journal of Botany*. Later in 1850, he provided detailed descriptions and illustrations in his '*Icones Plantarum*'. His narrow circumscription created 12 new species of *Utricularia* from Courtallum, Nilgiris, Malabar or Coorg regions of South India. Wight (*l.c.*) described an interesting species from Sispara peak of Silent Valley National Park, namely *U. squamosa* (*U. wightiana* P.Taylor) characterised with numerous scales on the peduncle and, *U. smithiana,* a large twining terrestrial species from Malabar or Coorg. Wight's *U. affinis*, *U. brachypoda* and *U. griffithii* were later recognised as variations of *U. uliginosa*, and were synonymised in subsequent studies. Likewise, *U. conferta*, *U. uliginoides* and *U. pedicellata* were synonymised under *U. graminifolia* Vahl.

Kurz (1874), a German Botanist modified earlier sectional treatment of De Candolle. He redefined sect. *Oligocista* into subgeneric rank and proposed two new subgenera, *Bivalvaria* and *Phyllaria*. Stapf (1904) studied *Utricularia* in Cape, and recognised 13 taxa in Dyer's *Flora Capensis* including three new taxa. Eventually in 1906, Stapf enumerated 32 species in *Flora of Tropical Africa*. Dyer (1905) in Hookers *Icones Plantarum* provided detailed descriptions, and illustrations of 12 species, including Stapf's new species.

Important accounts on *Utricularia* have been conducted in other parts of the world: Sri Lanka (Trimen, 1895), Africa and Madagascar (Taylor, 1964), Pacific Northwest (Ceska & Bell, 1973), Tropical East Africa (Taylor, 1973), Malaysia (Taylor,

1977), Thailand (Maxwell, 1985; Parnell, 2005), Nordic Countries (Thor, 1988), Costa Rica (Crow, 1992), Bolivia (Ritter & Crow, 2000), Bhutan (Noltie, 2001), Taiwan (Chao, 2003), Bangladesh (Rahman, 2005), Nepal (Noltie, 2005), Iran (Naqinezhad *et al*., 2008; Dinarvand, 2012), Peninsular Malaysia (Chew & Haron, 2011), China (Li, 2011), Bavaria (Fleischmann & Schlauer, 2014); Brazil (Costa *et al*., 2016; Coelho *et al*., 2017; Freitas, 2017; Guedes *et al*., 2018; Guedes & Alves, 2020), Rio de Janeiro (Baleeiro *et al*., 2017) and Northeastern Brazil (Guedes *et al*., 2018).

A comprehensive account on this genus in India was provided by Oliver in his conspectus (1859). His attempt to prepare a monograph on *Utricularia* enlisted the occurrence of 26 species in India, including four new species from Sikkim Himalaya. A comprehensive account on *Utricularia* in Bombay was given by Santapau (1950). He described *U. reticulata* var. *parviflora* from Khandala, growing along with *U. reticulata*, but it was actually a variation of the latter, and later reduced it to a synonym. Subramanyam (1979) reviewed the Indian *Utricularia*, providing detailed morphological characterization along with insights into floral anatomy, palynology, cytotaxonomy, embryology, and other relevant conducted in India. Subsequently, in 1981, he discussed the distribution of *Utricularia* in Peninsular India, reporting 24 species, of which nine were found in both Peninsular India and Sri Lanka.

During this period, several new species and distributional records were described and reported from various parts of India during this period by Blatter and McCann (1931), Santapau (1949, 1950), Subramanyam and Balakrishnan (1960), Joseph and Ramamurthy (1961), Saxena (1965, 1966, 1970), Abraham (1966), Subramanyam and Yoganarasimhan (1981), Joseph and Mani (1982, 1983), Joseph and Joesph (1986), Taylor (1984, 1986), Janarthanam and Henry (1986, 1989b, 1990), etc. Papers dealing with typification and nomenclature were also done by various authors (Abraham *et al*., 1974; Basak, 1976, 1979; Bhattacharyya, 1978, 1986; Janarthanam & Henry, 1986, 1989a). Janarthanam and Henry (1992) conducted a major revisionary study, documenting 35 species and two indeterminable species *U. capillacea* Willd. and *U. inflexa* Forssk. from India. Since then, six new species were described from India (Yadav *et al*., 2000, 2005; Kumar *et al*., 2018; Arya *et al*., 2020 and Biju *et al*., 2020).

Documentation of *Utricularia* was carried out by many authors in various regional, district, state floras in India. Roxburgh (1820) in his *Flora Indica* discussed three species. Dalzell and Gibbson (1861) enumerated seven species from Bombay, while Drury (1866) in his account recognized 17 species and 11 varieties from India. Clarke (1884) in Hooker's *Flora of British India* recognized 22 species along with 10 imperfectly known species. Prain (1903) included 10 taxa from Bengal; Cooke (1905) treated 10 species in his *Flora of Presidency of Bombay*; Duthie (1911) included four species for upper Gangetic plains, and Haines (1922) listed nine species from Bihar and Orissa. Gamble (1924) documented 16 species, giving brief descriptions and a key for their identification. Fyson (1932), in his *Flora of South Indian hill stations,* listed seven species, along with short descriptions and an identification key. Kanjilal *et al.* (1939) recorded *Utricularia* species from Assam. Ramaswamy and Razi (1973) documented six taxa from Bangalore while Gandhi (1978) listed 10 taxa from Karnataka. Wadhwa and Chowdhery (1984) reported two aquatic species, *U. aurea* and *U. minor*, of which the latter is a rare species distributed in Alpine Western Himalaya of Himachal Pradesh. Rani and Mattew (1983) enlisted 12 species, including a new taxon from Tamil Nadu with elaborate descriptions, illustrations and detailed key for identification, meanwhile, Chandrasekaran (1987) reported 18 species from there. Nair and Nayar (1987) reported four species from Courtallum. Bennet (1979) reported *U. inflexa* var. *stellaris* (L.f.) P.Taylor from Howrah, while, Sanyal (1994) documented five species and one variety from Bankura district of West Bengal. Ahmedullah and Nayar (1986) listed six species as endemic to India. Pullaiah and Yesoda (1989) reported two species from Anantapur district in Andhra Pradesh, while Pullaiah and Moulali (1997) documented nine species from Andhra Pradesh. Deshpande *et al*. (1993) included eight species from Mahabaleshwar. Srivastava (1997) enumerated 14 species and two varieties from Madhya Pradesh. He reported *U. arenaria* A.DC. and *U. pubescence* Sm. in central India, two tropical and south African species, referencing Saxena (1966). Matthew (1999) enumerated five species from Palni hills of Tamil Nadu. Sardesai *et al*. (2001) reported 23 species while, Londhe (2001) included 14 species from Maharashtra. Mohanan and Sivadasan (2002) documented five species from Agasthyamala. Bhat (2003) included eight species from Uduppi, with descriptions, illustrations and a detailed key. The

distribution of four species from Orissa was reported by Panda and Das (2004). Singh *et al*. (2015) listed 15 endemic species from India.

Apart from the above mentioned treatises, the genus has been appeared in many other floristic treatments (Fyson, 1915; Saldanha & Nicolson, 1976; Sharma & Kachroo, 1981; Arora *et al*., 1981; Manilal & Sivarajan, 1982; Balakrishnan, 1983; Deb, 1983; Guha Bakshi, 1984; Sharma *et al*., 1984; Mukherjee, 1984; Naithani, 1985; Verma, 1985; Rao, 1986; Rao & Sreeramalu, 1986; Rao *et al*., 1986; Kulkarni, 1988; Manilal, 1988; Singh, 1988; Bole & Pathak, 1988; Ramachandran & Nair, 1988; Almeida, 1990; Ellis, 1990; Keshava Murthy & Yoganarasimhan, 1990; Lakshminarasimhan & Sharma, 1991; Misra & Verma, 1992; Karthikeyan & Kumar, 1993; Kothari & Moorthy, 1993; Sanyal, 1994; Sharma & Dhakre, 1995; Matthew, 1995; Samvatsar, 1996; Sasidharan & Sivarajan, 1996; Sivarajan & Mathew, 1996; Lakshminarayana *et al*., 1997; Pullaiah & Moulali, 1997; Samaddar & Roy, 1997; Bhattacharyya & Sarkar, 1998; Murthi & Panigrahi, 1999; Londhe, 2001; Singh *et al*., 2001; Banerjee & Rao, 2001; Suryanarayana & Rao, 2002; Yadav & Sardesai, 2002; Paria & Chattopadhyay, 2005; Anil Kumar *et al*., 2005; Singh & Sharma, 2006; Giri *et al*., 2008; Punekar & Lakshminarasimhan, 2011; Sinha, 2012; Pal, 2013; Datar & Lakshminarasimhan, 2013; Manikandan & Lakshminarasimhan, 2013; Bhat, 2014; Nayar *et al*., 2014; Singh *et al*., 2015; Kavade & Deokule, 2015; Ansari *et al*., 2016; Kullayiswamy *et al*., 2017; Dash & Singh, 2017; Maity *et al*., 2018; Lakshminarasimhan *et al*., 2019; Shukla, 2020; Gogoi *et al*., 2021).

Subramanyam and his colleagues extensively studied various aspects of Indian *Utricularia* and published numerous papers dealing with taxonomy and anatomy (Abraham & Subramanyam, 1965; Subramanyam & Abraham, 1967; Subramanyam & Banerjee, 1968; Subramanyam & Narayana, 1969, 1978; Subramanyam & Yoganarasimhan, 1979, 1981; Subramanyam, 1981). Abraham and Subramanyam (1965) studied the seed morphology of 10 *Utricularia* species occurring in West Bengal, providing a dichotomous key for species identification. They noticed that shape, size, epidermal striations, and wings were key characteristics for distinguishing species. Subramanyam and Banerjee (1968) made a detailed analysis, including illustration and a key, for separating *U. roseopurpurea* from *U. caerulea*.

Subramanyam and Narayana (1969) studied the floral anatomy of *U. caerulea* and *U. stricticaulis* (Koenig ex Oliv.) Stapf ex Gamble, and in 1978, Subramanyam and Narayana assessed the floral anatomy of *U. aurea*, *U. exoleta* R.Br., *U. stellaris* and *U. striatula*.

Though important accounts on *Utricularia* have been produced from different parts, the most significant work to date is Taylor's (1989) world monograph, in which he recognized 214 species under 35 sections. He worked with more than 900 names, and reduced them to 214 species (Fleischmann, 2012). Around 40 years of his passionate work had been published as a huge compendium with detailed descriptions, accompanying notes and illustrations. Following Taylor's (1989) monograph, several novelties were described and re-established from various parts of the world (Gassin, 1993; Lowrie, 1998, 2002; Yadav *et al*., 2000, 2005; Crow, 2001; Hu *et al*., 2007; Bove, 2008; Lowrie *et al*., 2008; Fleischmann & Rivadavia, 2009; Zamudio & Olvera, 2009; Wakabayashi, 2010; Suksathan & Parnell, 2010; Baleeiro & Bove, 2011; Souza & Bove, 2011; Bhowmik & Datta, 2012a,b; Fleischmann 2012, 2015; Jobson, 2012a,b, 2013; Dite *et al*., 2013; Delprete, 2014; Baleeiro *et al*., 2015; Jobson & Baleeiro, 2015; Kadono & Tanaka, 2015; Krajewsky & Plachno, 2015; Baleeiro *et al*., 2017; Coelho *et al*., 2017; Hsu *et al*., 2017; Naive *et al*., 2017; Jobson *et al*., 2018; Kumar *et al*., 2018; Gonella & Baleeiro, 2018; Guedes *et al*., 2019, 2021; Alfasane *et al*., 2020; Arya *et al*., 2020; Biju *et al*., 2020; Gonella *et al*., 2020; Jobson & Davies-Colley, 2020; Jobson & Cherry, 2020; Salazar-Ferriera *et al.,* 2020; Cheng *et al*., 2021; Henning *et al*., 2021; Baleeiro & Jobson, 2022; Singh *et al*., 2022; Jobson & Baleeiro, 2022, 2023; Krishnapriya *et al*., 2024). Nomenclatural notes and typification of some species were also made after Taylor's study (Vitek, 2008; Ohashi & Ueno, 2016; Astuti & Peruzzi, 2018b; Kolte *et al*., 2019; Jobson & Davies-Colley, 2020; Jobson & Baleeiro, 2022; Silva *et al*., 2023).

Despite the abundance of described and discovered species globally, there has been often confusions regarding the identity of some species. Fleischmann (2012, 2015) reviewed the new species described after Taylor's monograph, and it eventually led to the resurrections and synonymisation of some species. He also discussed the status of some Indian species, such as *U. babui* S.R.Yadav, Sardesai &

S.P.Gaikwad, *U. malabarica*, *U. naikii* S.R.Yadav, Sardesai & S.P.Gaikwad, *U. janarthanamii*, and *U. subramanii* Janarth. & A.N.Henry.

Since Taylor (1989), the *Utricularia amethystina* Salzm. ex A.St.-Hil & Girard complex of the neotropical sect. *Foliosa* has remained a matter of debate. As a highly polymorphic species having many morphotypes, Taylor (*l.c.*) included 31 names in its synonymy. However, Baleeiro *et al*. (2015, 2019) made a thorough study of this complex, using morphological and molecular evidence, and resurrected several species previously considered synonyms. Nunn (2022a, b) reviewed the new species discoveries in Australia after Lowrie's (2014) "*Magnum Opus*", and recognized 88 taxa from there. Subsequently, he made an account on the antennae-flowered species of *Utricularia*, enumerated six species, *viz*., *U. albertiana* R.W.Jobson & Baleeiro, *U. antennifera* P.Taylor, *U. capilliflora* F.Muell, *U. dunlopii* P.Taylor, *U. dunstaniae* Lloyd and, *U. lowriei* R.W.Jobson occurring in Australia.

### 2.3. Molecular studies

*Utricularia* belongs to the most recently evolved group of carnivorous plants within the order Lamiales and are diversified in South America (Schaferhoff *et al*., 2010; Silva *et al*., 2017). The morphological and molecular study strongly supported the monophyletic origin of the three genera of Lentibulariaceae, of which *Utricularia* and *Genlisea* were found to be the most divergent lineages from a well-supported sub-clade, sister to *Pinguicula* clade (Jobson & Albert, 2002; Jobson *et al*., 2003; Muller *et al*., 2004; Silva *et al*., 2018). Jobson *et al.* (2003) established a phylogenetic hypothesis for Lentibulariaceae using DNA sequence data from the chloroplast region *trnL-F* and the *rps*l6 intron. The study resulted the monophyly of *Genlisea* and *Pinguicula* and paraphyly of *Utricularia*. Within the genus, subgenus *Utricularia* found paraphyletic due to the inclusion of sect. *Pleiochasia* of subgenus *Polypompholyx*, paraphyly of sections *Oligocista*, *Setiscapella*, *Psyllosperma* and *Foliosa* and the polyphyly of sect. *Utricularia* confirmed. They demonstrated the Lamialean affinities of Lentibulariaceae, and the phylogenetic relationships among the three genera of Lentibulariaceae. The study also focused on how morphological specializations, such as carnivorous behaviour and vegetative forms, habits, capsule dehiscence types,

seed characters, inflorescence features, pollen characters, arose independently within the highly variable genus *Utricularia*. Their results supported the placement of the family within the order Lamiales, the monophyletic origin of Lentibulariaceae, and the sectional delimitations of *Utricularia* clade done by Taylor (1989) based on the morphological characters. The morphological specializations of stoloniferous growth form apparently arose independently within *Genlisea* and *Utricularia* three times. Likewise, the epiphytic habit was evolved independently at least three times, in *Pinguicula*, in *Utricularia* sect. *Phyllaria*, and within the two sections *Orchidioides* and *Iperua*. Similarly, the suspended aquatic habit possibly evolved independently within sections *Utricularia* and *Vesiculina*.

Muller and Borsch (2005) amplified the chloroplast DNA sequences of the *trn*K to reconstruct phylogenetic relationships within *Utricularia* with representatives from all sections. They made changes in Taylor segregation (1989): sect. *Pleiochasia* of subgenus *Utricularia* was moved into subgen. *Polypompholyx*, and subgen. *Oligocista* was treated as synonym of subgen. *Bivalvaria*, and circumscribed it as a section under the subgenus *Utricularia*. Section *Orchidioides* was expanded to include sect. *Iperua*, and sect. *Foliosa* was expanded to include sect. *Psyllosperma*. They revised the classification using the molecular support and proposed three subgenera under *Utricularia*, *viz*., subgen. *Polypompholyx, Bivalvaria* and, *Utricularia*.

Muller *et al*. (2006) reviewed the progress in studying the evolution of Lentibulariaceae, summarizing previous studies to address key questions about its evolution, the relationships between its genera, and its closest relatives. Their study also confirmed the monophyly of the three genera. They used a supertree approach to summarize the *Utricularia* phylogeny and suggested the paraphyly of the subgenus *Utricularia* (sensu Taylor, 1989) due to the inclusion of sect. *Pleiochasia* closest to subgen. *Polypompholyx*. The latter subgenus was then redefined to accommodate sect. *Pleiochasia*. They narrowed down subgen. *Utricularia* to include aquatic and epiphytic sections, and the name *Bivalvaria* was re-circumscribed to subgen. *Bivalvaria* to include the remaining sections. According to Muller *et al.* (*l.c.*), highly enhanced substitutional rates in all genomes played a substantial role in the evolution of *Utricularia* and *Genlisea*.

The findings of the chromosome size in Lentibulariaceae members became a milestone, as they possess chromosome of bacterial sizes. These finding was demonstrated by Greilhuber *et al*. (2006). The results indicate that *Genlisea-Utricularia* clade exhibits one of the highest mutational rates in several genomic regions in angiosperms. Moreover, chromosome size of *Utricularia* species ranges somewhat lower than *Arabidopsis thaliana* (L.) Heynh. They observed the smallest genome in three taxa, which exhibit significantly lowest 1C values, *viz*., *Genlisea margaretae* Hutch. with 63 Mbp, *G. aurea* A.St.-Hil. with 64 Mbp, and *U. gibba* with 88 Mbp.

DNA fingerprinting from PCR based assay ISSR was done by Rahman (2007) to detect the interspecific variation and molecular relationships among the species of sect. *Utricularia*. His study showed that, ISSR markers were potential in molecular characterization and determining the interspecific variation in *Utricularia*. He observed highest number of fingerprints in *U. bremii* Heer ex Koell. followed by *U. gibba*, and highest genetic affinity between the two species.

In the light of the findings of miniature genome of *U. gibba*, Ibarra-Laclette *et al.* (2011) studied the genomic information and the molecular evolutionary rate analysis of *Utricularia*. The minute genome of *Utricularia* contains a deep representation of the complex metabolic pathways and a source of genomic information to explore the structural, functional and evolutionary diversity of the genus. The study of global gene expression analysis shows that, the traps significantly over-express genes involved in respiration and the phosphate uptake occur chiefly through traps, while nitrogen uptake take place through vegetative parts. Later on, Ibarra-Laclette *et al*. (2013) made a comprehensive study pertaining the architecture and evolution of the miniature genome in *U. gibba* and sequenced the tiny sized 82 Mbp genome. They identified three rounds of whole genome duplications (WGDs) in *U. gibba*. The genome architecture reveals that a small fraction of intergenic DNA, with few or no active retrotransposons, was sufficient to regulate and integrate all the processes essential for the development and reproduction of a complex organism. The structure of plastid genome in the three genera of Lentibulariaceae was studied by Wicke *et al.* (2014). They observed the structure similar to non-carnivorous lamiids, and Lentibulariaceae have

accumulated more nucleotide substitutions than indels across all plastid-coding regions.

The genomic GC content evolution and miniaturization of genomes in Lentibulariaceae was studied by Veleba *et al*. (2014). They noted that, the miniaturization of genome size can be occurred through the course of evolution of the family. Exceptional genome miniaturization was noted in *Utricularia*, where ultra-small genome (1C<100 Mbp) has evolved independently. The extreme miniaturization implies that, there may be an additional mechanism along with the deletion and amplification of noncoding DNA.

Silva and her colleagues made inclusive studies on the phylogeny and biogeography of the genus, and a number of papers were published eventually. Silva *et al*. (2016) amplified the complete chloroplast genome sequence of *U. foliosa* L., and found quadripartite structure with a length of 150,851 bp, which comprised of a large single copy region (LSC) of 82,720 bp, a small single copy region (SSC) of 17,481 bp and an inverted repeat region (IRs) of 25, 325 bp.

Silva *et al*. (2016, 2017, 2019) amplified the chloroplast (cpDNA) and mitochondrial (mtDNA) genome of *U. reniformis* A.St.-Hil., and studied its structural and evolutionary characteristics. They compared the genome sequence of terrestrial carnivorous *U. reniformis* against its sister, aquatic species *U. gibba*. Since almost all *Utricularia* cpDNA have typical quadripartite structure and the same genes as most angiosperms, some species exhibit variation, *U. gibba* possesses two complete copies of *ycf 1* and *ndhF* and *U. reniformis*, has a reduced chloroplast size due to several losses in all *ndh* genes that could be found neither in the mitochondrial genome nor in the nuclear DNA. In fact, *U. reniformis* is a terrestrial species, the loss of its *ndh* could be related to terrestrial habit (Silva *et al*., 2017). Further they concluded that, *U. reniformis* possess the eighth largest mtDNA among plants.

Rodrigues *et al*. (2017) studied the phylogeny of 'orchid like' bladderworts (sections *Orchidioides* and *Iperua*) based on four plastid and nuclear DNA sequences. Their results proved the paraphyly of the sect. *Iperua* due to the inclusion of *U. humboldtii* R.H.Schomb. They found that stolon-tuber system in these two sections

have similar anatomical pattern and it serves for water storage, hence to merge sect. *Iperua* under *Orchidioides*.

Silva *et al*. (2018) elaborated the phylogenetic analysis based on plastid (*rbcL*, *matK*, rpl20-rps12, *rps*16, *trnL-trnF*) and nuclear genome (ITS region) sequences. According to Silva *et al*. (*l.c.*), *rps*16 and *trnL-trnF* have more resolution with high supported clade, while ITS has intermediate resolution. The combined tree highly supported the sister group relationship of subgenus *Polypompholyx* with subgen. *Utricularia* + *Bivalvaria*. Results proved the ancestral form of *Utricularia* as terrestrial and, the aquatic species evolved then in at least four times in *Utricularia*. They confirmed the paraphyly of sect. *Oligocista* with the inclusion of sect. *Avesicarioides* and *Benjamina*, and combined these sections within *Oligocista*. Moreover, they included sect. *Iperua* in sect. *Orchidioides,* sect. *Psyllosperma* in sect. *Foliosa* and sect. *Lloydia* in *Calpidisca*.

Silva *et al*. (2019) sequenced the complete chloroplast genomes (cpDNA) of three *U. amethystina* morphotypes, *viz*., purple, white, and yellow-flowered. Their results depicted a typical quadripartite structure of cpDNA in the three morphotypes, with a high degree of intraspecific genetic variability. *Utricularia amethystina* morphotypes retain all the plastid NAD(P)H-dehydrogenase (*ndh*) complex genes confirming that the *ndhs* in terrestrial *Utricularia* were independently lost and regained. Astuti *et al.* (2020) attempted DNA barcoding approach to distinguish the Central European *Utricularia* species. They used nrITS, plastid *trnL-trnF* IGS and *rps*16 intron for the analysis. Owing to the high polymorphism and intraspecific variability of the species, their study became unsuccessful in identifying them with barcoding technique.

Recently, Jobson and Baleeiro (2023) undertook a phylogenetic analysis of Australian species of sect. *Oligocista*. They included 19 of the recognised 37 species including some Indian taxa, and amplified ITS, *rps*16 and *trnD-T* regions. Even if they intended to resolve the section, they only discussed the phylogenetic position of the newly described species *U. irwinica* R.W.Jobson & Baleeiro, which is morphologically

similar to *U. uliginosa* and *U. praeterita*. Their study re-circumscribed the sect. *Oligocista* to include sect. *Benjamina* and sect. *Enskide* to include *Minutae*.

### 2.4. Reproductive strategies

Reproductive biology is crucial for proposing effective conservation strategies. Carnivorous plants exhibit diverse floral traits evolved through interaction with pollinators (Juniper *et al*., 1989). *Utricularia* reproduce sexually by means of seeds produced by self and/or cross pollination. Both cleistogamous and chasmogamous flowers are produced via sexual reproduction. The chasmogamous flowers are adapted for self-as well as cross pollination, while, cleistogamous flowers are only capable of self-pollination. Innumerable studies are evident globally, since researches give importance to reproductive mechanism, floral biology and germination studies.

*Utricularia* display diverse vegetative reproductive strategies via shoot fragmentation, winter buds or turions and bulbs or tubers of which the turions, tubers and thick stolons function as stress resistant organs (Taylor, 1989). Since most of the aquatic species lack roots, they evolved stolons and highly dissected leaves. These stolons form new plantlets via fragmentation and are a common vegetative propagation strategy of aquatic species. Stolon branching and fragmentation are familiar in many terrestrial species.

Aquatic species in subtropical to polar zones facing heavy snowfall and icing (glaciated areas) develops perennating structures or overwintering organs called winter buds or turions (Gluck, 1906; Rossbach, 1939; Taylor, 1989; Adamec, 1999, 2008a; pers. obsv.). Turions are found in aquatic species of at least 14 genera within nine plant families (Adamec, 2018). They are formed by extreme condensation of shoot/ stolon tip bearing leaves, which store starch and act as a reserve material (Taylor, 1989; Adamec, 1999, 2008a, 2018; pers. obsv. in *U. minor* L.). Since these species are vulnerable to fluctuations in environmental conditions, turions are developed to accelerate their vegetative growth compensating winter losses. These turions are extremely tolerant to encounter desiccation and freezing. Propagules begin to sprout soon after the decaying of mother plants or they get detached from

mother plant and fall off to the bottom of water to wait for next sprouting (Adamec, 2008b). Adamec (1999, 2008a,b, 2010, 2011a,b,c, 2018) intensively studied various aspects of turions, their structure, nutrient composition, photosynthetic capacity, aerobic dark respiration, germination and desiccation tolerance, etc.

Darwin (1875) observed tubers in epiphytic *U. montana* Poir. (*U. alpina* Jacq.), and alluded the tubers as thick roots, which can store water and penetrate deep in mosses or embed in mosses. Taylor (1989) reported tubers in species of three sections, *Chelidon*, *Phyllaria* and *Orichidioides*. Of around 20 species of *Utricularia*, mostly epiphytes and some lithophytes, produce bulbs or tubers as perennating structures (carbohydrate storage organs) as well as water storage organs (Taylor, 1989; Rice, 2011). The evolution of storage tubers occurred independently in at least five times in Lentibulariaceae (Plachno *et al*., 2020). Tubers are composed of well-developed parenchyma cells with numerous starch grains. The species growing on mossy beds, possesses a single tuber at the peduncle base (mother tuber) and tubers at each stolon tips (pers. obsv. in *U. brachiata*). These subterranean tubers embedded in mossy beds or soil can tolerate extreme climatic fluctuations such as rise in temperature, drought, icing and fire (Plachno *et al*., 2020).

Holzinger (1893) reported winter buds in *U. intermedia* Hayne, which composed of numerous scales along the tip of branches. He addressed it as "*tuber-like hibernacular buds*", which may be solitary or more than two, on a bare stalk or at the tip of leafy branches. A detailed morphological and anatomical study of *U. brachiata* was done by Compton in 1909. According to his findings, runners at certain points produce rosette leaves and new runners, and the formation of tubers was the swelling up of runners either terminally or at runner's passage. He observed the primary efficiency of carbohydrate storage in tubers and also pointed out that tubers use storage material for germination and then they function as water storage organs.

The morphology and geography of *U. ochroleuca* R.W.Hartm. was studied by Gluck (1913). He observed the distribution of this species in Great Britain, and found that most of the populations were sterile producing only winter buds, serving vegetative propagation. Rossbach (1939) made a comprehensive account of aquatic

*Utricularia* of the Northeastern United States and Eastern Canada. He enumerated two separate identification keys, based on leaf morphology and morphology of winter buds to sort out 10 species. He discussed the preference of each species for acidic or alkaline water and found that all species, except those growing in the coastal plain produce winter buds (*U. biflora* Lam. and *U. fibrosa* Walter).

Katsuhiko Kondo, a Japanese Botanist, studied the seedling anatomy and germination patterns in *Utricularia*, and published a series of papers (Kondo, 1971, 1972a,b,c; Kondo *et al*., 1978). In 1971, Kondo experimented the seed germination mechanism and development of the aquatic *U. cornuta* Michx. and *U. juncea* Vahl. Apart from the soil samples collected from their habitats, he used four media such as Buffer solution, solution of 500 ppm Potassium, Gibberellic acid and Moore's solution for germination studies. Results revealed higher germination rate in Moore's solution, whereas no germination was noted in soil sample with 7.2 pH. He observed that seedlings possess a single chlorophyllous cotyledon and a cotyledon-like structure which transform as rhizome. Later, Kondo (1972a) analysed the morphology of *U. cornuta* and *U. juncea*, two conspecific taxa, and provided detailed description and key. He observed that *U. juncea* produced both chasmogamous and cleistogamous flowers, of which the former have the ability of self-pollination. The early pollen tube growth even from its bud condition probably results in successful self-pollination.

Kondo *et al.* (1978), studied the seed and seedling morphology of six *Utricularia* species. They observed different patterns of seed germination in these species. They noted that either the primary foliar unit emerges from the embryo, from which the primary vegetative shoot arises or, a papilla-like primordium develops from the embryo, from which the primary foliar unit develops. They also noted how the relationship between terrestrial and terrestrial-epiphytic habits and habitats influences developmental patterns. Although, Kondo used the term cotyledon in his earlier studies, he didn't find cotyledons in any of the seedling in this study. Moreover, he did not support the term "coteledonoids" used by Lloyd (1942) to indicate primary foliar units, since the primary and secondary foliar structures were not like cotyledons.

Chormanski and Richards (2012) thoroughly investigated the anatomical and morphological characteristics of *U. gibba*. According to their results, *U. gibba* possesses a shoot apical meristem, from which the stolons, dichotomously branched leaf-like structures and traps develop. The excessive repetition of this branching pattern is the reason for the mat-forming nature of *U. gibba*. They used terminologies to describe its growth pattern which comprises of different types of stolons, primary stolons (S1) and lateral leaf-like structure (LLSs) arranged spirally along S1. They noted two types of branches, *viz*., secondary stolons (S2s) and modified stolons (SMs), of which S2s arose at the axils of LLSs of the S1 and SMs originate from the base of Inflorescence.

Plachno *et al.* (2020) studied the morphological and histochemical analysis of tubers of *U. menziesii* R.Br. and *U. manni* Oliv. The transverse section of tubers of *U. menziesii* showed a well-developed parenchymatous cortex with centrally placed vascular tissues. While in *U. mannii*, parenchymatous cortex with vascular bundles are formed as a ring, along with a large centrally placed additional vascular bundle. Character analysis tracing showed that *Utricularia* tubers are highly homoplasious, occurred in at least 11 times and, the rich carbohydrate content in tubers has evolved at least five times independently in Lentibulariaceae.

*Utricularia* exhibits a diverse floral morphology: the colour of corolla, glandular palate and throat, and its nectariferous spur attracts floral visitors and pollinators. The scope of these studies enlightens and enamours researchers of all times. A detailed morphological analysis of *Utricularia* emphasising floral biology was done by Raynal-Roques and Jeremie (2005). They pointed out the advanced characteristics of *Utricularia* due to the diversity of life-forms, highly adapted flower for cross pollination and xenogamy, and extensive autogamy. Cleistogamous flowers formed underground or submerged are not designed for insect or animal pollination. They observed two types of cleistogamy in *Utricularia*: the opportunistic cleistogamy and architectural cleistogamy. Opportunistic cleistogamy is an advanced reproductive strategy that occurs during unfavourable situations, while architectural cleistogamy does not depend on external features (Raynal-Roques & Jeremie, 2005).

The mass flowering of terrestrial *Utricularia* species in the Indian lateritic plateaus is a mind-blowing sight. Around 50 percentage of the total *Utricularia* diversity is found in these plateaus. Hobbhahn *et al*. (2006) studied the pollination mechanisms in three large-flowered species of sect. *Oligocista*, *U. albocaerulea*, *U. purpurascens* and *U. reticulata*. They observed that over 50 species of pollinators and visitors including bees, butterflies, moths, dipterans, etc. visit owing to the attractiveness created by mass-flowering, though they possess low nectar volume with high sugar concentration. They found that these species are highly self-compatible allowing visitor mediator-selfing and geitonogamy. According to Hobbhahn *et al. (l.c.*) the mass-flowering phenomenon supports an allogamous breeding system, even with less reward. Chaudhary *et al*. (2018) studied the pollination biology of two endemic species, *U. praeterita* and *U. babui*. They observed a delayed selfing in these species probably due to the scarcity of floral visitors and pollinators, other climatic factors or small population size. They inferred that, delayed selfing is a mating strategy in response to limitation of pollinators.

Plachno and his co-workers made extensive studies on floral diversity, floral biology and pollination mechanism. A number of research articles were published recently focusing general morphology to ultra-structural studies. Clivati *et al*. (2014) evaluated the reproductive success of a high elevation endemic plant of Brazil, *U. reniformis*. Their results proved the self-compatibility of *U. reniformis* with low reproductive success. The species was observed as bee-pollinated, and *Xylocopa* and *Bombus* species were identified as potential pollinators. Their study concluded that rarity of visitors causes low reproductive success which in turn affects the genetic diversity and population size of this species.

Plachno *et al*. (2016a) studied the floral micromorphology of *U. dunlopii* and observed pseudocopulation due to its distinct floral features. They observed numerous glandular trichomes on the filiform appendages arising from the upper and lower lips of corolla which may function as osmophores or scent glands. They proposed an alternate term "unguentarius" in spite of osmophores. Eventually, Plachno *et al*. (2016b) examined the floral ultrastructure of *U. cornigera* Studnicka and *U. nelumbifolia* Gardner to study the site of floral scent production and the

distribution of secretory glandular trichomes in flower. They observed a diverse micro-morphology of palate, comprising of unicellular, conical to villiform papillae and multicellular, uniseriate, glandular trichomes that frequently display terminal branching. Some of the multicellular, uniseriate, glandular trichomes of the flower palate act as osmophores in both species. Histochemical study results showed that, trichomes are involved in secretion due to its dense organelle-rich cytoplasm. These trichomes also contain lipid bodies indicating the metabolism of lipids. *Utricularia cornigera* and *U. nelumbifolia* are bee-pollinated and the flower palate provides an olfactory stimulus for attracting pollinators (Plachno *et al*., 2016b).

Plachno *et al*. (2017b), studied the morphology and structure of flower palate in *U. bremii* and *U. minor.* They observed a single type of glandular trichome in both species, which does not produce nectar but may act as scent glands or unguentarium, a structure similar to that described by Plachno *et al*. (2016a). Even though the flowers of *U. bremii* is open type, they checked the floral visitors of sterile plants and reported small hymenopterans. After a while, the floral micromorphology of a bird pollinated carnivorous plant *U. menziesii* was studied by Plachno *et al*. (2019a). Since bee pollination is the common strategy among *Utricularia*, they studied the specialized mechanism of bird pollination in *U. menziesii*. They noted that the shape, red colour of the flower, and large size of the spur are peculiar for bird pollination, and concluded that these characters may have evolved from bee pollinated ancestors.

Meanwhile, Plachno *et al*. (2018) examined the floral micromorphology and nectar trichome structure of the subgenus *Polypompholyx* to determine the nectar sugar concentrations and composition among species, in order to compare nectar structures and their role in pollination. They detected hexose-dominated (fructose + glucose) nectar in *U. multifida* R.Br., *U. tenella* R.Br., and in *U. violacea* R.Br. They observed that the floral nectary consisted of a spur bearing glandular hairs, and that the nectar was produced and stored by spur. Their study suggests that an early ancestor of *Utricularia* had a nectariferous spur, and palate of lower corolla lip favouring bee pollinators with a wide landing platform.

## 2.5. Micromorphology of pollen and seeds

Studies related to pollen morphology of *Utricularia* species were quite scarce. Thanikaimoni (1966) studied the pollen morphology of Indian *Utricularia,* grouped them based on the number of apertures, the presence of endocingulum, and syncolpism. Pollen morphology of four Japanese species of *Utricularia* are given by Sohma (1975a, b). Sohma observed tricolporate to tretracolporate pollen with psilate exine ornamentation in *U. bifida* and *U. racemosa* Wall. ex Walp., while *U. affinis* Wight possess tri-pentacolporate pollen with psilate to scabrate or very finely reticulate exine ornamentation. Aquatic *Utricularia* species possess stephanocolporate grains with transverse furrows in the equatorial girdle. He reviewed the earlier studies on fossil records and described that, the fossil pollen grains have similar morphology with *U. vulgaris* and are "stephanocolporate with a fused transverse furrow at the equatorial girdle with suboblate to oblate spheroidal in equatorial view". Taylor (1989), Lobreau-Callen *et al*. (1999), Tsymbalyuk *et al*. (2008), Bhowmik and Datta (2013), and Beretta *et al*. (2014) conducted palynological studies. Recently, Cruz *et al.* (2018) examined the pollen morphology of 14 taxa of Lentibulariaceae including six *Utricularia* species and observed that the number of apertures varied from four to 18. Based on aperture and endoaperture characteristics and shape, they grouped the pollen grains of *Utricularia* into three types and considered it as a euripalynous genus.

Seed micromorphology has previously been proved to be taxonomically useful for distinguishing species in *Utricularia* and it shows considerable differences in shape and testa ornamentation in light microscopic study (Abraham & Subramanyam, 1965; Taylor, 1989). Even though, light microscopic and scanning electron microscopic analysis can reveal in-depth knowledge of important characters, related works are scanty (Abraham & Subramanyam, 1965; Taylor, 1989; Menezes *et al*., 2014). The seed micromorphology of 10 *Utricularia* taxa was described and illustrated by Abraham and Subramanyam (1965), and prepared a dichotomous key based on seed characters. The seed micromorphology of sections *Psyllosperma* and *Foliosa* was studied with SEM by Menezes *et al*. (2014). They noted that seed shape, ornamentation of periclinal walls, and the shape of testa cells are useful for

identification, but not completely for species delimitation. Moreover, the size of the seed and number of seeds per capsule are not useful traits for delimiting species.

## 2.6. Cytology

The difficulty in obtaining suitable materials, along with the small size of the cells and chromosomes in *Utricularia*, has greatly limited the scope of cytological studies. Despite these challenges, a few studies have been conducted using meiotic preparations. Kondo (1972b) counted the chromosome number of *U. benjaminiana* Oliv. as $n$ = 18, using acetocarmine squash method with young flower buds. His inferences provided the basic chromosome number for *Utricularia* as $n$ = 9. He also noted the chromosomes of *U. subulata* L. and found fifteen bivalents at metaphase 1 of meiosis (1972c).

Subramanyam and Kamble (1968) documented the chromosome numbers of seven species: *U. aurea* with $n$ = 21; *U. baouleensis* A.Chev. with $n$ = 10; *U. caerulea* with $n$ = 20; *U. inflexa* var. *stellaris* (Linn.f.) P.Taylor with $n$ = 21; *U. minutissima* with $n$ = 8; *U. stricticaulis* Stapf with $n$ = 7 and *U. scandens* with $n$ = 6 and 7 from meiotic preparations. They noted two cyto-races in *U. scandens*: $n$ = 6 for a material collected from Salem district of Tamil Nadu, and $n$ = 7 for a material from Shillong, Meghalaya. The chromosome number 7 is possibly of *U. recta*, since, the species was treated as a high altitude variety of *U. scandens* until Taylor (1986) has published it as distinct.

Tanaka and Uchiyama (1988) counted the chromosome number of *U. yakusimensis* Masam. as $2n$ = 16, *U. multispinosa* Miki as $2n$ = 40, *U. aurea* as $2n$ = 80 and *U. tenuicaulis* Miki as $2n$ = 40 from mitotic preparations. Rahman *et al*. (2001) reported the somatic chromosome number of *U. bremii* and *U. dimorphantha* Makino for the first time. They used the shoot tips collected from germinated seeds for obtaining mitotic metaphase and squashed in 2% aceto-orecin. The somatic chromosome number for *U. bremii* was found to be $2n$ = 36, a tetraploid when $n$ = 9, while *U. dimorphantha* was $2n$ = 44, a tetrapolid when $n$ = 11. Yamamoto *et al*. (2012) counted chromosome number for *U. yakusimensis* as $2n$ = 16, the same as that reported by Tanaka and Uchiyama (*l.c.*). The evidences of genomic variability and

extreme genome miniaturization in members of Lentibulariaceae, provide more insights into genomic studies.

## 2.7. Physiology and trap morphology

Innumerable studies were undertaken to study the physiology, trap structure and trap function of *Utricularia* by various authors (Darwin, 1875; Merl, 1922; Llyod, 1929, 1932, 1933, 1942). Darwin (1875) used the terms "*quadrifids*" and "*bifids*" to represent four-armed and two-armed glands respectively. Lloyd (1929, 1932, 1933, 1942) made an in-depth examination on the trapping mechanism and structure of trap entrance. He revealed that, the highly specialized enzyme secreting glands present in the traps, are responsible for digesting prey organisms. In 1932, he made an elaborate study on the structural and functional aspects of the traps of 50 taxa of *Utricularia* and *Polypompholyx*. After Lloyd (1942), Subramanyam and Abraham (1967), Fineran (1980), Taylor (1989), Yang *et al.* (2009), Reifenrath *et al*. (2006), etc. focused on the trap gland morphology.

Thurston and Seabury (1975) examined the trap morphology of *U. biflora* using scanning electron microscopy. The structure and development of traps, especially the size, shape and position of traps, position of mouth, shape and number of appendages, trap door, etc. were analysed by Rutishauser and Brugger (1992). Yang *et al*. (2009) analysed the trap gland morphology of six *Utricularia* species of Taiwan, and the quadrifid geometry was studied by Doyle and Parnell (2003).

Vincent *et al*. (2011) examined the mechanism and functioning of ultra-fast suction traps in *Utricularia*. They found a unique suction trapping of less than milliseconds of duration and stated that trap door movement as buckling and unbuckling process. Vincent and Marmottant (2011) elaborated the study of the spontaneous firing of traps by the triggering of hairs on the trap door. They explained the trap firing as a buckling scenario, in which, an elastic energy was produced when the pressure inside the trap decreases due to the pumping out of water from the trap. This energy is released at the time of firing in turn allow the fast and passive movements of trap doors. Llorens *et al.* (2012) experimented on *U. inflata* Walter, and proposed a dynamic model for *Utricularia* trap. According to their study, the trap

door opens by an extra pressure generated from the displacement of the prey organism and the prey is sucked into the trap.

The anatomy and functions of the trap of subgenus *Polypompholyx* was studied by Plachno *et al*. (2014) and concluded that the trap walls consisted of two to five cell layers, and the number of cell layers may be less significant for the trap firing–resetting efficiency. Plachno *et al*. (2017a) investigated the trap vascularisation in nine *Utricularia* species from the subgenus *Polypompholyx*. They observed well developed xylem and phloem elements in the trap bundles of all investigated species.

The structure and occurrence of velum in the traps of *Utricularia* was studied by Plachno *et al*. (2019b). They observed the presence of two types of velums and defined it as "*cuticle membranes covered by mucilage*". The first type found in the members of sect. *Utricularia*, and sect. *Orchidioides* has a balloon-like structure in which the apices of the terminal cells are not visible. The second type of velum has a honeycomb-shaped structure, and it was characteristic of the members of the subgenus *Polypompholyx*.

As *Utricularia* exhibit most complex and intricate trapping structure, studies concentrating on the mechanism behind prey capturing and nutrient acquisition is still continuing. Friday and Quarmby (1994) made experimental studies to check the uptake and translocation of $^{15}N$ and $^{32}P$ in *U. vulgaris*. They found ~ 30% of $^{15}N$ is readily taken up and translocated by the immature parts of the plants, while, the translocated $^{32}P$ was not retained in mature parts.

Adamec *et al*. (2011) tested extracellular phosphatase and chitinase activity on the different structures of nine *Utricularia* species using fluorescence tagging. They noted a regular distribution of phosphatase in the trap structures, whereas chitinases are almost untagged. This indicated the role of prey derived chitin decomposition by chitinase in traps. The high intensity phosphatase in the internal glands was occurred due to some penetration of the substrate. Astuti and Peruzzi (2018a) analysed the diagnostic value of shoots for the segregation of morphologically sibling species of *Utricularia* occurring in Central Europe using geometric morphometrics.

The rapid turnover of the traps of *U. vulgaris* was determined by Friday (1989) by measuring the rate of production and die-back of new trapping leaves throughout a single season. From the results, it was inferred that the lifespan of trap is strongly related to the size and position of traps on leaves. The ecology and morphology of *U. dichotoma* was analysed by Reut and Fineran (2000) and found that this species growing in specialized wetland habitat display variations in their organ development probably as responses to the fluctuating environmental conditions. Enzymatic activities in the traps of four aquatic species were tested by Sirova *et al*. (2003) and they observed a high activity of phosphatases in empty traps followed by β-glucosidase. Likewise, about 20–25% carbon allocation in trap fluid was evident through a $^{13}C$ labelling experiment (Sirova *et al*., 2010).

The enzyme production and activity of the traps of *U. vulgaris*, *U. australis* and *U. foliosa* was estimated by Adamec (2006). He tested the rate of photosynthesis and respiration of leaves and traps of six *Utricularia* species under optimum conditions. He concluded that, respiration rate of traps was 70–200% greater than that of leaves while, photosynthetic rate was 7–10 times greater in leaves. Hence, traps require high metabolic cost and very low photosynthetic efficiency.

Adamec *et al*. (2010) found that, phosphatase exhibits highest activities in trap. Results indicated that the extracellular enzyme activities in the trap fluid are influenced by the trap age in almost all the aquatic *Utricularia* species. Adamec (2011b) made an exhaustive study on the trap functioning of aquatic *Utricularia* species emphasizing the role of trap commensal organisms. He noted that the spontaneous firing of each trap leads to a significant gain of Nitrogen and Phosphorus for the plant. He revised the commensal relation of trap community and considered them as parasites rather than commensals. Eventually, Adamec (2011c) evaluated the functional characteristics of the traps of aquatic *Utricularia* species. He tested the correlation between the trap thickness, length, the process of spontaneous firing and resetting rates.

Juang *et al*. (2011) studied the absorption and translocation of nutrients by *U. gibba*. They used food dye and a vital tracer carboxyfluorescein diacetate (CFDA) to

monitor the symplastic pathway. They observed the presence of dye in the symplastic pathway within seconds and concluded it as an important transportation process. Haron and Chew (2012) evaluated the role of *Utricularia* as an environmental indicator, and also their potential medicinal uses. The decline in the number of populations indicates complications in their habitat, which may be micro-hydrological changes, water trophicity, biotic, and chemical pollutions, etc. They listed astringent and diuretic properties of some species.

## 2.8. Carnivory

Carnivorous plants have the capacity to capture, kill, and digest their prey organism (Juniper *et al*., 1989; Givnish, 1989). The digested food is an important source of various nutrients and elements such as N, P, K, S and Mg, which sometimes represent 50–80% of the total nitrogen mass of plants (Adamec, 1997; Ellison & Gotelli, 2001; Adamec, 2010). According to Gibbs (1929), "*the traps are like jails, must prevent escape unless the victim is killed at once*". The function of suction traps or bladders is to trap and kill their prey. The trap content constitutes small aquatic animal prey, such as rotifers, copepods, ostracods, cladocerans, and chironomids (Friday, 1989; Knight & Frost, 1991). It also represents various algae, bacteria, fungal spore, pollen grains, cysts, etc. The digested nutrients balance the nutrient poor habitat and that becomes an adaptation strategy for them to survive. In order to find out the fascinating phenomenon behind carnivory, countless studies were undertaken globally. Researches mainly focused on trap architecture, relationship between trap and trap contents, dietary requirements, prey capturing mechanism, ecology, etc. Hegner (1926) made an inclusive experiment to study the feeding habitat of *Utricularia* providing protozoa as prey organism. He observed free living protozoa inside trap fluid, instead of getting digested.

Skutch (1928) made an in-depth analysis of the structure and mechanism of traps, nature and type of prey, prey digestion, absorption and importance of its carnivorous habit. Gudger (1947) provided a note on fish-eating *U. vulgaris*, which was primarily noticed by Simms in 1884. He also observed fingerlings being caught and killed in the traps. Later, the costs of carnivory, measuring investment in

carnivory, bladder number, size and biomass were studied by Friday (1991, 1992), Knight and Frost (1991), Knight (1992), etc.

The occurrence of desmids in the trap was studied by Schumacher (1960) and documented 308 desmids representing 25 taxa. Sorenson and Jackson (1968) conducted an experiment to evaluate the nutritional strategy of *Utricularia* by providing *Paramecium* as prey. They found an apparent increase in the number and length of internodes, and number of traps in the plants grown in nutrient poor environment where *Paramecium* was the only dietary supplement. The function of trap appendages (antennae or bristles) in prey capturing mechanism was studied by Meyer and Strickler (1979). They observed that, the antennae act as "funnels" leading preys towards the trapdoor. Wagner and Mshigeni (1986) studied the association of Cyanophyta with *Utricularia* traps and noted *Anabaena* growing abundantly as nitrogen fixers in majority of traps.

Knight and Frost (1991) analysed the investment of carnivory among different habitats. They found considerable variation of preys among different habitats, and noticed the relation between the bladder numbers and water chemistry rather than the prey organisms. The investment of carnivory in *U. vulgaris*, and changes in trap size, number and leaf size according to seasonal variation was studied by Friday (1992). He found that these three attributes vary independently and the proportion of biomass invested in traps was about 50% in majority of plants.

Jobson *et al*. (2000) demonstrated the role of carnivory in the growth and propagation of terrestrial *U. uliginosa* by providing nitrogen supply to prey organisms. They found that carnivory benefitted its growth even in low level nutrient conditions. The zooplankton abundance of *U. foliosa* was analysed by Guisande *et al*. (2000). They noted a change in the bladder number and size according to the zooplankton abundance. They also found a relative decrease in its nutrient uptake from captured zooplanktons when the mineral nutrient availability of the surrounding water increases. The food composition of three *Utricularia* species was listed by Mette *et al*. (2000). They identified a variety of food (including copepodids,

cladocerans, ostracods rotifers and insect larvae) and noticed a significant variation in the prey composition with regards to its habitat, species and quantity.

Ellison and Gotelli (2001) evaluated the evolutionary ecology and nutritional strategies of carnivorous plants. They found that, *U. vulgaris* derive ~50% of nitrogen from captured preys and the remaining from surrounding water. The bladder function of *U. purpurea* Walter was studied by Richards (2001). He observed a significantly lower rate in prey capturing, implies that the species lost its appetite for meat. According to his results, mutualism is the important association between trap community than the predator–prey interaction.

Gordon and Pacheco (2007) documented the prey composition of *U. inflata* and *U. gibba* growing in the Paria Peninsula and enlisted the zooplankton groups, *viz*., rotifers, cladocerans, copepods, annelids, rhizopodeans, and insects; and the phytoplanktons such as Bacillariophyta, Chlorophyta, Cyanophyta, and Euglenophyta inside the traps. The prey selectivity studied by Guiral and Rougier (2007) noticed variability among prey and periphytic community with regard to the seasons. They concluded that *Utricularia* traps exhibit selective predation, especially cladocerans and cyclopoids.

Peroutka *et al*. (2008) studied the algal diversity inside the traps of European aquatic *Utricularia* species. They found that, up to 80% of the total prey is constituted by killed and degraded algae. Furthermore, they enlisted 45 genera of algae and noted an increase in the percentage of algae with a decrease in electrical conductivity. Alkhalaf *et al*. (2009) identified and enumerated the prey organisms in *U. australis* and *U. vulgaris* naturalised in Northeastern Germany. A total of 169 algal taxa belonging to six genera were reported from traps along with different groups of zooplanktons. The study inferred that, the trap size, algal abundance and richness inside the traps varied largely according to their habitats.

Kurbatova and Yershov (2009) examined the role of crustaceans and rotifers in the dietary patterns of *Utricularia.* They concluded that, prey selectivity is arbitrary, and they accidentally trapped inside while resting on plant body. The role of microbial community in the trap fluid of three aquatic *Utricularia* species was

assessed by Sirova *et al*. (2009). They too observed mutualism as an important interaction inside the trap rather than predator-prey interaction.

Wolowski *et al*. (2011) documented various types of chrysophyte stomatocysts and the taxa of algae associated with *Utricularia* traps. Plachno *et al*. (2012) analysed the relationship between the diversity and abundance of organisms and the trap age of aquatic *U. reflexa* Oliv. Majority of the organisms found inside the trap were commensals or intruders, and the number of organisms increased with the trap age. Plachno *et al*. (2014) examined the composition of algae and prey organisms in the traps of *U. volubilis* R.Br. grown in cultivated and natural habitat. They observed live and killed algal species such as *Menoidium*, *Euglena*, *Petalomonas*, etc. in the traps. Trigger hairs have very little influence on composition of trapped prey.

The bacterial community associated with the traps of the *U. hydrocarpa* Vahl was observed by Caravieri *et al*. (2014). The role of prey organism in the growth and propagation of *Utricularia* was assessed by Peroutka *et al*. (2015). They found that, the immotile particles were accidentally trapped through autonomous firing, whereas fungi, mosses, etc. occurred through by-catch. The prey selectivity, prey morphology and trap morphology of *U. gibba* and *U. vulgaris* was studied by Avery (2017). The prey capturing depends on size of the traps, since smaller traps capture smaller sized and fewer preys compared to larger traps. Poppinga *et al.* (2017) evaluated the prey capturing mechanism in *U. australis*, and observed the capturing events in a laboratory setup. They found a 'forward strike' performed by the traps during suction and observed fully flexible suction traps in which the triggering hairs undergo strong bending deformation to avoid fracture. Simek *et al*. (2017) examined the characteristics of algae-bearing ciliate *Tetrahymena utriculariae*, *Euglena agilis* and *Scenedesmus alternans* associated with the traps of *U. reflexa* and found a commensal relation of the trap community in the trap fluid. Sirova *et al*. (2017) used the traps as a micro-ecosystem, i.e., a model system for assessing the trap-associated microbial community structure, diversity, function and the nutrient recycling potential. They concluded that the complex organic matter derived from the trap is synergistically converted into a source of nutrients for these plants.

The trap diversity, mechanism of trapping and the trap character evolution in *Utricularia* was examined by Westermeier *et al.* (2017). Ellwood *et al*. (2018) made an exhaustive study regarding the role of phytoplankton community in the nutritional requirements of *U. australis*. They found 70% of traps with only phytoplanktons and listed 124 taxa of plankton algal community belonging to eight phyla. They also noted the proliferation of Euglenophyta and Cryptophyta and concluded them as commensals. Lima *et al*. (2018) evaluated the bacterial diversity associated with *U. breviscapa* C.Wight ex Griseb., and isolated six genera of bacterial strains from its vegetative parts. They inferred the potential benefits of these strains in biotechnological and agricultural field and also in bioremediation process.

The periphytic community associated with *Utricularia foliosa* was documented by Santos and Ferragut in 2018. According to them, the variability and richness of periphytic community depend on seasonality and environmental conditions. The microbial ecology and the *Utricularia*-microbiome interactions were studied by Sirova *et al*. (2018). They considered bacteria, algae, fungi, etc. can survive in the traps for prolonged periods, and capable of reproducing there as commensals, while larger rotifers, nematodes and crustaceans as prey organisms. Recently Kurosawa *et al*. (2024) analysed the nutrient acquisition strategies of wetland *Utricularia* species in response to varying nutrient availability. Their experiment with stable isotope analysis ($\delta^{15}N$) revealed that carnivory prevails in nutrient-poor environments, while autotrophy dominates in the nutrient-rich conditions. The shift from carnivory to autotrophy influences the nutrient availability of the aquatic environments.

Botanical carnivory and carnivorous syndrome has been a matter of debate time immemorial. The competitive abilities of carnivorous plants are less compared to other non-carnivores, and it is an adaptation strategy too. Even if, innumerable studies were undertaken globally, botanical carnivory and their feeding strategies still hold many mysteries.

# MATERIALS & METHODS

### 3.1. Literature survey

The literature on *Utricularia* was gathered from both printed and electronic sources, such as Biodiversity Heritage Library (www.biodiversityheritagelibrary.org), Botanicus of Missouri Botanical Garden Library (www.botanicus.org), Plants of the World Online (https://powo.science.kew.org/), Tropicos (https://www.tropicos. org/), World Flora Online (https://www.worldfloraonline.org/), Global Biodiversity Information Facility (https://www.gbif.org/), Biblioteca Digital Real Jardin Botanico (https://bibdigital.rjb.csic.es/), Internet Archive (https://archive.org/details/books), The Wallich catalogue (http://wallich.rbge.info/), JSTOR (https://www.jstor.org), Hathi Trust Digital Library (http://www.hathitrust.org/), International Carnivorous Plant Society (https://www.carnivorousplants.org/), and others. Publications were also accessed through journal archives and institutional libraries. Additionally, all regional and state floristic works done from India were consulted, and occurrences of *Utricularia* were documented.

### 3.2. Herbarium consultation

*Utricularia* specimens housed at fifteen major Indian herbaria (AHMA, ARUN, ASSAM, BSD, BSHC, BSI, BSID, CAL, CALI, DD, FRLH, IFGTB, MH, SUK, and XCH - acronyms as per Thiers, 2025, continuously updated) were consulted. The distribution, phenology and morphological variations of the specimens were studied. All the examined specimens are listed under the "Specimens examined" section, with barcodes incorporated when available. Type specimens available at Indian herbaria were also studied, as well as those available online. Additionally, digitalized specimens from various overseas online herbaria, including A, ASU, B, BM, BE, C, CS, CAS, E, GH, HTTU, K, KATH, L, LSU, LINN, M, MU, MW, MICH, NY, O-V, P, RSA, TAWES, TEX, US, USF, and UMO, were examined. A complete list of the herbaria consulted is given in Appendix III.

### 3.3. Field exploration and specimen collection

Based on herbarium data and available literature, a travel plan covering major areas of distribution and habitats of the species of *Utricularia* in India was prepared. A schedule for exploration was planned after thorough examination, with a primary focus on flowering and fruiting periods, as well as habitat characteristics. Extensive field trips were conducted across India from late June to late March each year from 2018 to 2024 (Fig. 2). More than 260 days were spent in 62 field trips, during which 569 accessions of 34 taxa were collected from 13 states, such as Assam, Arunachal Pradesh, Goa, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Meghalaya, Mizoram, Sikkim, Tamil Nadu, Uttarakhand and West Bengal (Figs. 3–6). The type localities of several taxa were also explored. A thorough examination on habitat preferences, associated taxa, altitudinal ranges, and population sizes were noted in the field. Due to habitat specificity and ephemerality of certain species, several visits were undertaken for collecting small, rare taxa.

Plant materials were collected in plastic zip-lock bags, bottles, or trays, as a patch along with the substratum. Since the leaves, rhizoids and bladders are appressed or immersed in the substratum, trowels and putty blades were used to effectively collect all plant parts. Multiple accessions were collected, and variations within the species and between species were noted, especially for mass flowering species. The collection details of each specimen, such as locality, altitude, vegetative characters, flower and fruit characters, etc. were noted in the field book. Mature fruits were collected for SEM analysis. Due to the high risk of contamination and the difficulty in obtaining leaves, inflorescence tips were collected and kept in silica gel for molecular studies.

**Fig. 2.** Field study in India.

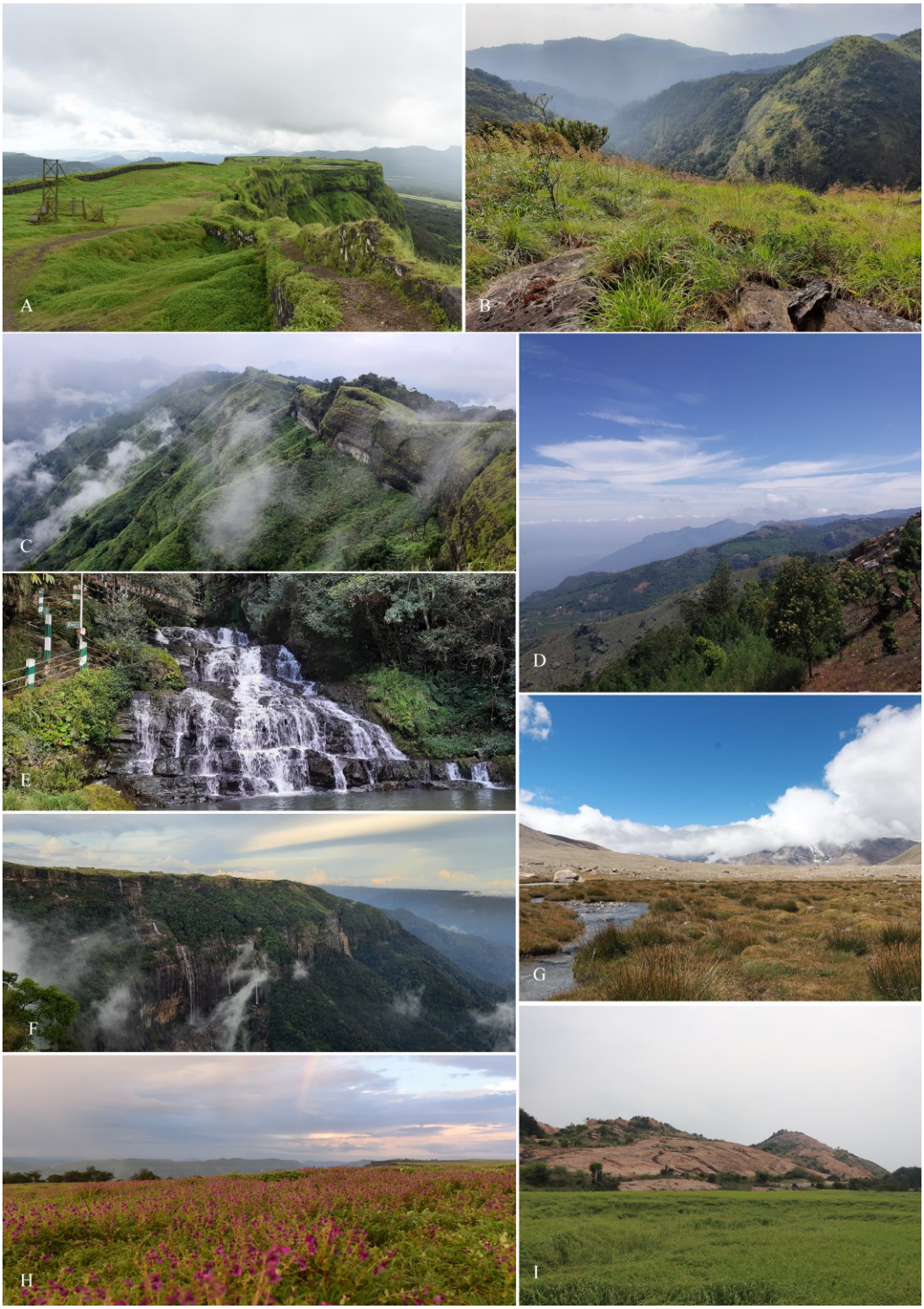


**Fig. 3.** Habitats explored: **A.** Korigad Fort, Maharashtra; **B.** Silent Valley National Park, Kerala; **C.** Reiek Tlang, Mizoram; **D.** Kodanad, Tamil Nadu; **E.** Elephant Falls, Meghalaya; **F.** Cherrapunje, Meghalaya; **G.** Thangu valley, Sikkim; **H.** Kaas Plateau, Maharashtra; **I.** Narthamalai, Tamil Nadu.

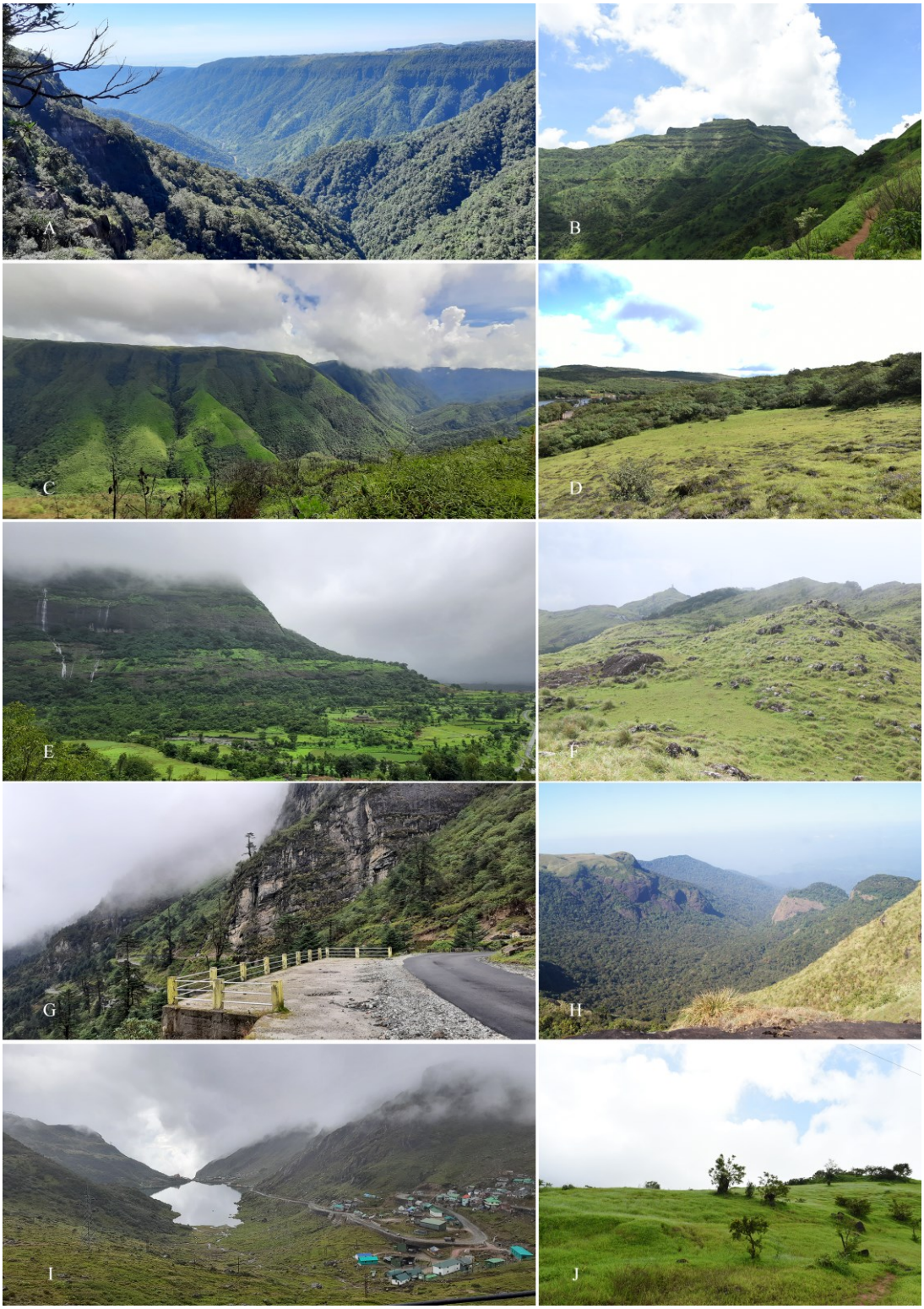


**Fig. 4.** Habitats explored: **A.** Wakhaba, Meghalaya; **B.** Torna Fort, Maharashtra; **C.** Khasi hill range, Meghalaya; **D.** Venna lake, Maharashtra; **E.** Harishchandra gad, Maharashtra; **F**. Ponmudi, Kerala; **G.** Zekuphyak, Sikkim; **H.** Pettimudi, Kerala; **I.** Chhangu, Sikkim; **J.** Mahabaleshwar, Maharashtra.

**Fig. 5.** Habitats explored: **A.** Zuluk, Sikkim; **B.** Mechuka, Arunachal Pradesh; **C.** Amboli Waterfall, Maharashtra; **D.** 13th Mile, East Sikkim; **E.** Nathang Valley, Sikkim; **F.** Siko Dido Waterfall, Arunachal Pradesh; **G.** Kasaragod, Kerala; **H.** Krang Shuri, Meghalaya.

**Fig. 6.** Habitats explored: **A.** Lachen, Sikkim; **B.** Sispara, Kerala; **C.** Nelliyampathy, Kerala; **D.** Wayanad, Kerala; **E.** Maenam Wildlife Sanctury, Sikkim; **F.** Jambu Deep, Madhya Pradesh; **G.** Yumthang Valley, Sikkim; **H.** Sela Pass, Arunachal Pradesh; **I.** Silver falls, Kodaikanal, Tamil Nadu; **J.** Mussoorie, Uttarakhand; **K.** Mukurthi National Park, Tamil Nadu.

### 3.4. Herbarium preparation and wet preservation

Herbarium specimens of the collected samples were prepared using conventional techniques (Bridson & Forman, 1992) and the method adopted by Taylor (1977, 1989). For very delicate species, tissue or soft papers were used for pressing and drying. The dried specimens were mounted on herbarium sheets (29 × 42 cm) and labelled with all relevant information concerning the species. Likewise, specimens were stored in pouches made from butter paper and mounted on sheets. All voucher specimens were deposited in the Calicut University Herbarium (CALI), with around 90% of the collected species digitized. Since, the best preservation for *Utricularia* is liquid preservation (Bridson & Forman, 1992), wet preservation was carried out for all collected species in plastic containers. A solution of 50% alcohol, 5% glycerol and 5% formaldehyde (Taylor, 1989) was used, while aquatic species were preserved in 85% alcohol (Fig. 7).

### 3.5. Plant identification

The identity of each taxon was confirmed in consultation with the type specimen and protologue. Taxonomic keys and descriptions from the monograph (Taylor, 1989) and revision (Janarthanam & Henry, 1992) were utilized for species identification. Additional information was gathered from major floras, monographs, revisionary works, and relevant scientific papers. Protologues were translated using *Botanical Latin* (Stearn, 1983) and Google Translate, when needed.

### 3.6. Nomenclature and citations

Nomenclatural clarifications were made in accordance with the Shenzhen Code (Turland *et al.*, 2018). Citation of the correct name was followed as per IPNI (http://www.ipni.org) and POWO (https://powo.science.kew.org/).

### 3.7. Preparation of descriptions and photo plates

A comprehensive datasheet was prepared, including habitat, habit, nature of racemes, size, and shape of rhizoids, stolons, peduncle shape, leaves, occurrence of traps and reproductive characters especially the colour, size and shape of floral parts.

**Fig. 7.** Herbarium sheets prepared; **B.** Wet preservation; **C.** *Utricularia lazulina* P.Taylor collected as a patch.

Due to the delicate nature of *Utricularia*, features such as the nature and colour of the corolla, the nature of the pedicel, etc. were noted directly from the field. Colour terms followed *The Kew Plant Glossary* (Beentje, 2010). All plant parts were dissected, examined, and images were captured using ZEN 2.3 LITE software on a STEMI 508 stereo microscope, attached with an Axiocam 105 color camera (Zeiss, Germany), and with NIS-Element D software on an SMZ 1500 microscope, paired with a DS-Fi1 camera (Nikon, Japan). Detailed observations of glands in traps, leaf nerves, scales, bracts, bracteoles, and seed surface morphology were noted using LAS core software on a DM 2000 light microscope, attached with a DMC 4500 camera (Leica, Switzerland). The terminology for the descriptions was followed Taylor (1989), Janarthanam and Henry (1992) and Simpson (2010).

For the preparation of photo plates, images were captured in the field using 77D camera (Canon, Japan) and with a 100 mm macro lens for detailed shots of plant parts. Images depicting habitat types, variations in vegetative or floral characters, and all dissected parts were selected, and the final photo plates were prepared using Adobe Photoshop (Version: 21.0.2 20191122.r.57 2019/11/22: e3e4068e635 x64).

**3.8. Distribution mapping and conservation assessment**

The GPS coordinates for all collected accessions were recorded in the field. Additional location details were gathered from herbarium labels and data taken from GBIF. Distribution maps for each species were created using QGIS version 3.24.1 (QGIS Geographic Information System, 2023). Information on habitat size and quality, as well as the number of individuals and potential threats, was also noted in the field. The Area of Occupancy (AOO) and Extant of Occurrence (EOO) were calculated using GeoCAT (http://geocat.kew.org/) based on the recorded coordinates.

The conservation status was assessed using the IUCN Red List Categories and Criteria (IUCN, 2012, 2024). Attempts were made to maintain the collected plants in the Calicut University Botanical Garden (CUBG). However, the ephemeral nature of most of the species and their specific edaphic requirements made conservation challenging.

### 3.9. Presentation of data

The systematic treatment begins with an overview of the genus, including citations, type, detailed description, distribution, and notes. Species are arranged according to the classification of Taylor (1989). Following the genus description, 37 species are presented under five sections, with both the sections and species within each section arranged in alphabetical order. Each section begins with citations, followed by a short description, notes, distribution, and a detailed key for the identification of species.

For each species, citations are provided, followed by a detailed description, flowering and fruiting periods, habitat, distribution, specimens examined, conservation status, and notes. Authentic specimens studied are cited under 'Specimens examined', while confusing or fragmented materials are excluded from citation. Specimens are arranged alphabetically by country, state, district, and specific location with herbarium acronyms barcodes (if available) included in parenthesis. Each species is accompanied by its type, photo plates, and distribution maps.

*** The methodology for micromorphological and phylogenetic studies will be discussed in detail in the respective chapters**

# 4. GENERAL MORPHOLOGY

*Utricularia* is a fascinating genus, known for its unique morphology, anatomy, ecological adaptations, carnivorous habits, and ultra-fast suction traps. Its morphology is diverse and does not conform to the classical descriptions of typical plant organs or structures. Numerous studies have been undertaken to describe and delineate various organs and morphological characteristics of *Utricularia*. According to Rutishauser and Isler (2001), *Utricularia* exhibits a 'Fuzzy Arberian Morphology' (FAM Approach), which complements the 'Classical Morphology Approach' (ClaM) used for vascular plants. The classical plant taxonomic structures (i.e., root, stem and leaf) are clearly defined, with distinct boundaries that do not overlap, while, those having vague borderlines and definitions can be treated under Fuzzy Arberian Morphology. A clear distinction between roots and shoots, stem and leaves have become indistinct in *Utricularia* in the course of its evolution, hence, the Fuzzy Arberian Morphology keeps these structural categories for characterising and interpreting its plant body (Rutishauser & Isler, 2001). According to Bell (1991), the leaves of Lentibulariaceae are difficult to reconcile with conventional morphology, and he included them under 'indeterminate growth'. Bell (*l.c.*) denoted that these plants deviate from the ClaM approach and the classical model, as 'misfits'. Considering this conception, *Utricularia* also exhibits extreme misfits, but it can be better understood within the conceptual framework of FAM (Rutishauser & Isler, 2001). Although the typical definitions of roots, stems, and leaves do not apply to *Utricularia*, Taylor (1989) used a consistent terminology in his descriptions. In this study, the terms 'rhizoids', 'stolons' (stem or runner), 'shoots' (leafy stem) and 'leaves' are used. Taylor's (1989) monograph provides detailed morphological descriptions of all *Utricularia* species. The present study aims to summarize key characteristics to facilitate easy identification.

## 4.1. Vegetative morphology

### Habit

*Utricularia* exhibits diverse lifeforms, including terrestrial, aquatic (both affixed and suspended aquatic), epiphytic, lithophytic, and rheophytic herbs (Fig. 8).

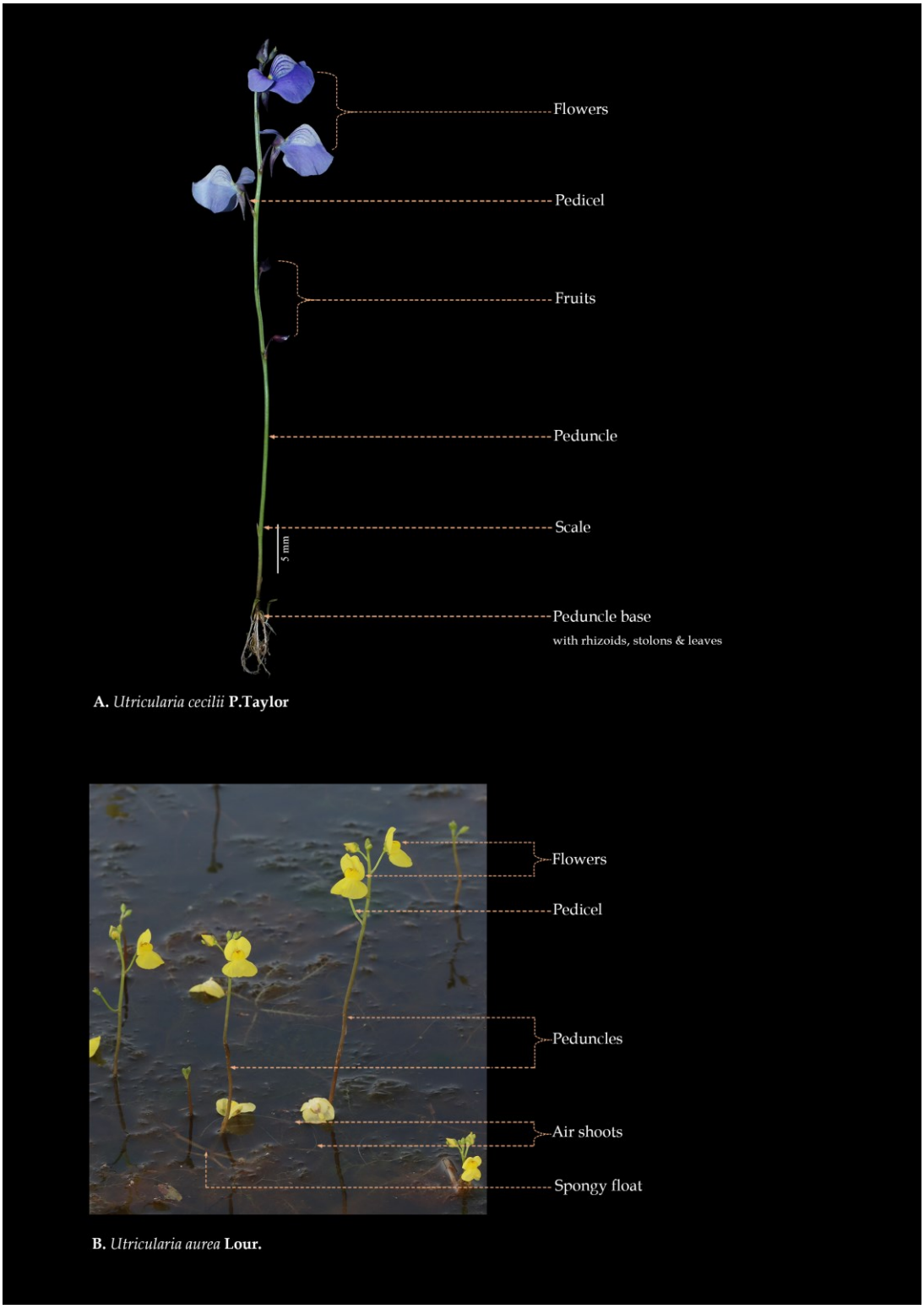


**Fig. 8.** Habit of *Utricularia* L.: **A.** Terrestrial *Utricularia cecilii* P.Taylor; **B.** Aquatic *Utricularia aurea* Lour.

Terrestrials live in moderately wet soils, semi-aquatic soil conditions, and, or in rare cases fully aquatic environments. Aquatic forms, which are completely dependent on water, can be further categorised into two types: suspended or free floating species (e.g., *U. aurea*, *U. australis*, *U. gibba*, etc.) and affixed species (e.g., *U. minor*). Additionally, some species are adapted to both lithophytic as well as epiphytic habitats, such as *U. striatula* and *U. kumaonensis*.

In *Utricularia*, terrestrial life forms are considered primitive, with aquatic lineages evolving as more advanced groups derived from the terrestrial ones (Jobson *et al*., 2018; Silva *et al*., 2018). According to Jobson *et al*. (2003), the shift from terrestrial to lithophytic habits happened independently, within sections *Iperua* P.Taylor, *Lloydia* P.Taylor and *Phyllaria*. Meanwhile, the shift to an epiphytic habit occurred independently at least twice, within in the Afrotropical-Indomalayan-Australasia sect. *Phyllaria* and the Neotropical sections *Iperua* and *Orchidioides* A.DC. These evolutionary changes shaped them with specialized organs, like tubers for water and food storage, allowing them to survive in their epiphytic habitats. Additionally, the affixed aquatic habit has evolved multiple times across *Utricularia* (Jobson *et al*., 2003, 2017, 2018; Reut & Jobson 2010), and the shift to a rheophytic habit has occurred at least twice (Jobson *et al*., 2003; Muller *et al*., 2004).

**Rhizoids**

Carnivorous plants thrive in nutrient poor soils by supplementing their nutrient intake with animal-derived nutrients, a strategy that compensates for their weakly developed root systems (Juniper *et al*., 1989; Adamec, 2005; Adlassnig *et al*., 2005). Aquatic carnivorous plants completely lack roots, whereas most epiphytic species possess a poorly developed root-like system (Adlassnig *et al*., 2005). In *Utricularia*, root-like structures called rhizoids anchor the plant to its wet substrate (Fig. 9). Rhizoids may be either present or absent, when present, they arise from the peduncle base or stolon nodes. These rhizoids may be simple or branched, capillary, tapering, and minutely papillose. In some cases, the rhizoid branches are glandular

or slightly papillose. In sect. *Meionula*, rhizoids develop from the peduncle base nodes and are always unbranched (Fig. 9B). In the sect. *Phyllaria,* rhizoids are usually undifferentiated, but in two species (*U. corynephora* P.Taylor & *U. garrettii* P.Taylor) a few rhizoids are present, each with a small papillose swelling at the terminal end (Taylor, 1989). In the sect. *Oligocista*, rhizoids are simple to variously branched, and minutely or densely papillose (Fig. 9A). The sect. *Utricularia* usually lacks typical rhizoids, and in some species, rhizoids are replaced by air shoots. *Utricularia neottioides* A.St.-Hil. & Girard from sect. *Avesicaria* (Kamienski) Komiya is a rheophyte growing in swift-running waters and possesses stiff, coralloid, claw-like rhizoids (Adamec *et al*., 2015; Plachno *et al*., 2020).

**Stems / stolons**

A well-developed stem, relatively thick and carrot-like, is present in *U. volubilis* R.Br. and *U. benthamii* P.Taylor. In contrast, *U. menziesii* R.Br. features a much more slender and less well defined stem (Taylor, 1989).

The horizontal stems, called stolons, facilitate vegetative growth (Fig. 9). These stolons also facilitate anchorage, usually bear numerous leaves and traps, and rarely produce cleistogamous inflorescence as seen in *U. janarthanamii*, or give rise to new chasmogamous inflorescences. Stolons vary from simple to variously branched. A few members of sect. *Orchidioides* (e.g., *U. reniformis* A.St.-Hil.) develop fleshy stolons (Rodrigues *et al*., 2017). In most terrestrial species, stolons are filiform, ranging from a few millimetres to several centimetres in length. They are simple to variously branched, usually terete and either pale green or hyaline. Stolons in sect. *Utricularia* are more prominent and robust, reaching several meters in length. In aquatic species, stolons are often referred to as leafy shoots or water shoots in some floristic treatments. In many aquatic species (e.g., in *U. gibba*, *U. aurea*, *U. australis*, *U. bremii* Heer ex Kolliker, *U. intermedia*, *U. stellaris* L.f., etc.), shoot branching serves as a successful method of vegetative propagation (Adamec, 2010; pers. obsv.).

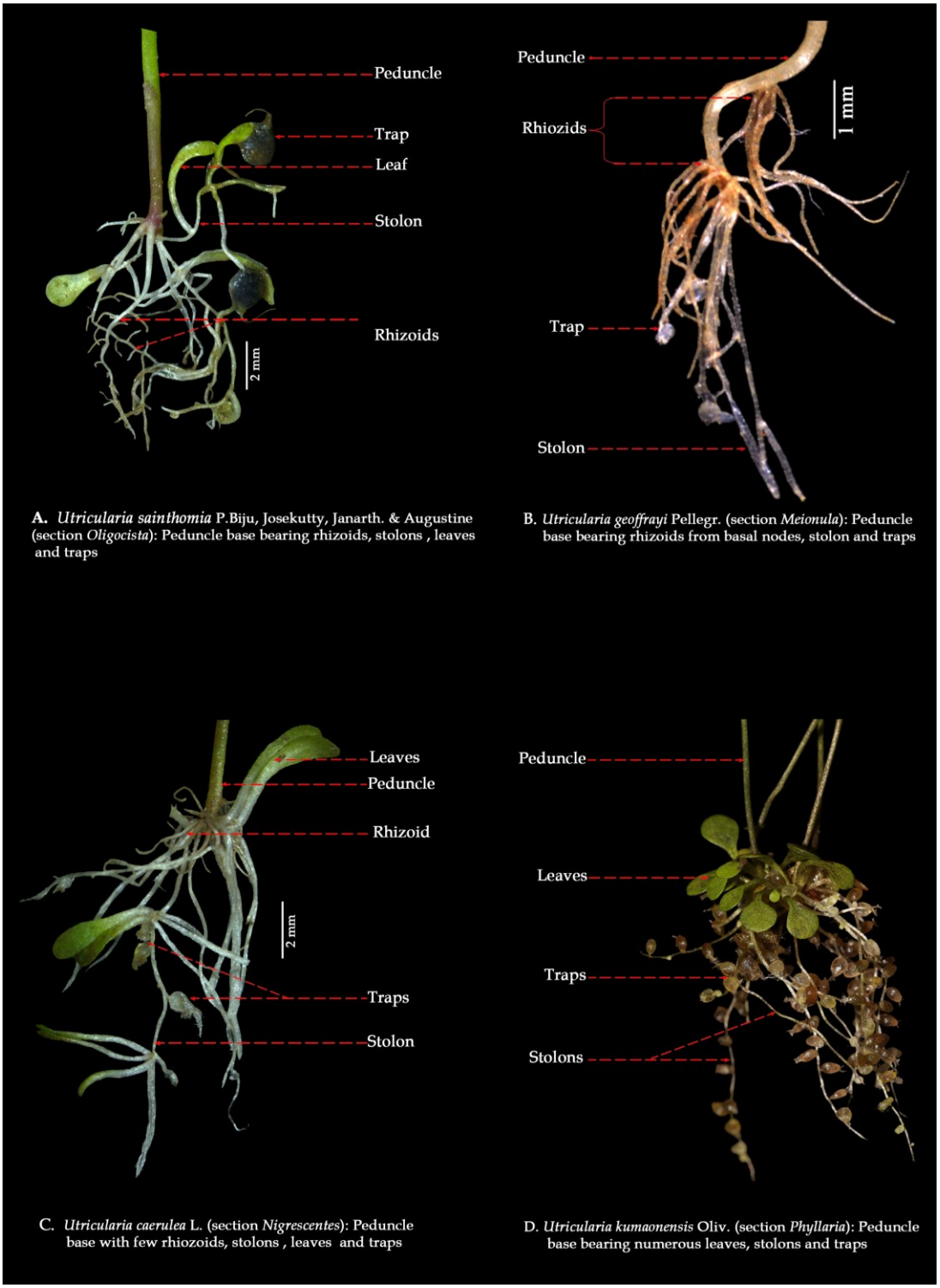


**Fig. 9.** Vegetative parts of *Utricularia* L.: **A.** *Utricularia sainthomia* P.Biju *et al*. (sect. *Oligocista*): Peduncle base bearing rhizoids, stolons, leaves and traps; **B.** *Utricularia geoffrayi* Pellegr. (sect. *Meionula*): Peduncle base bearing rhizoids, stolons, and traps; **C.** *Utricularia caerulea* L. (sect. *Nigrescentes*): Peduncle base with rhizoids, stolons, leaves and traps; **D.** *Utricularia kumaonensis* Oliv. (sect. *Phyllaria*): Peduncle base bearing leaves, stolons and traps.

**Tubers**

Tubers, which serve as perennating or storage organs, are usually found in epiphytic and lithophytic species. Species from sections *Iperua*, *Orchidioides*, and *Phyllaria* usually possess tubers (e.g., *U. alpina* Jacq., *U. brachiata* Oliv., *U. campbelliana* Oliv., *U. christopheri* P.Taylor, *U. geminiloba* Benj., *U. jamesoniana* Oliv., *U. reniformis*, etc.). The water storage organs have evolved at least twice within sections *Iperua* and *Orchidioides* (Rodrigues *et al*., 2017). Tubers are found in various positions on the plant, such as at the peduncle base (*U. christopheri*, *U. endersii* H.J.Reichb., *U. forrestii* P.Taylor, *U. mannii* Oliv., *U. uniflora* R.Br.), as moniliform series of swellings along the stolons (*U. moniliformis* P.Taylor), at the nodes of the stolons (*U. buntingiana* P.Taylor), or terminally on stolon branches (*U. brachiata*). These tubers are usually concealed within their substratum (Taylor, 1989; Rodrigues *et al*., 2017; pers. obsv.) (Fig. 10).

**Fig. 10.** Tuberous *Utricularia brachiata* Oliv. (note the stolon tubers)

**Spongy floats**

Some species in sect. *Utricularia* possess a whorl of floating structures which support the inflorescence above the water. There has been considerable debate on the origin of 'float', whether it is a vegetative feature or a part of the inflorescence (Farooq & Siddiqui, 1966; Taylor, 1989; Rutishauser, 1993). Spongy floats are found in 12 species, including *U. aurea* and *U. stellaris*, which are commonly found in India. These floats form a whorl of 4 to 6, or occasionally up to 10 segments, at various positions on the peduncle sometimes at the base, middle, or below the middle of the peduncle. These floats may be few to several centimetres in length, and each segment can be dorsiventrally flattened, cylindrical, ellipsoid to fusiform, tapering gradually from the base, with numerous dichotomously branched leaf segments (Fig. 11).

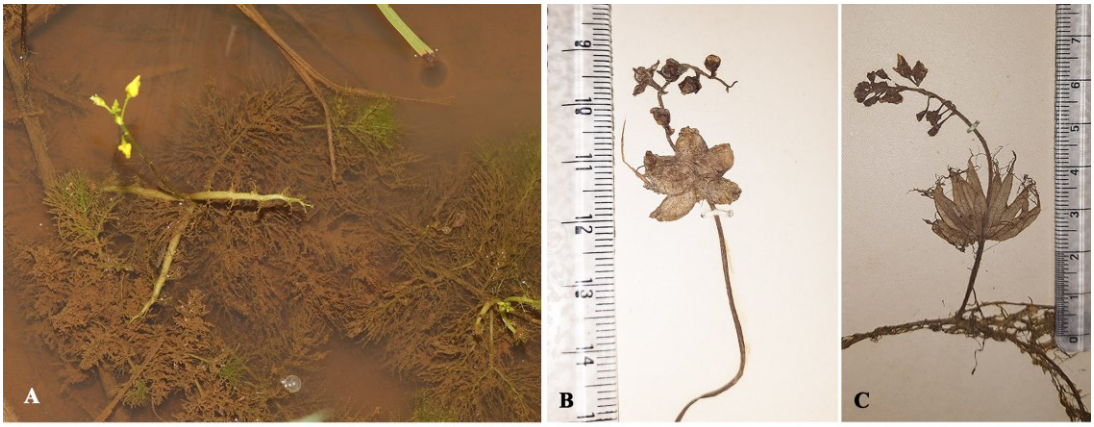


**Fig. 11.** Floats in *Utricularia* L.: **A.** *U. aurea* Lour.; **B.** *U. stellaris* L.f.

**Air shoots**

Air shoots are small, filamentous or thread like, or claw-like structures present in the aquatic sect. *Utricularia* (Taylor, 1989; Rutishauser, 1993). Taylor (*l.c.*) observed these structures in around nine species. According to Rutishauser (1993), these structures function as rhizoids and occur in the absence of floats. But I have noticed air shoots in *U. aurea* both in the presence and absence of floats. They occur below the floats, scattered along the stolons, and even at the young growing tips (Fig. 12).

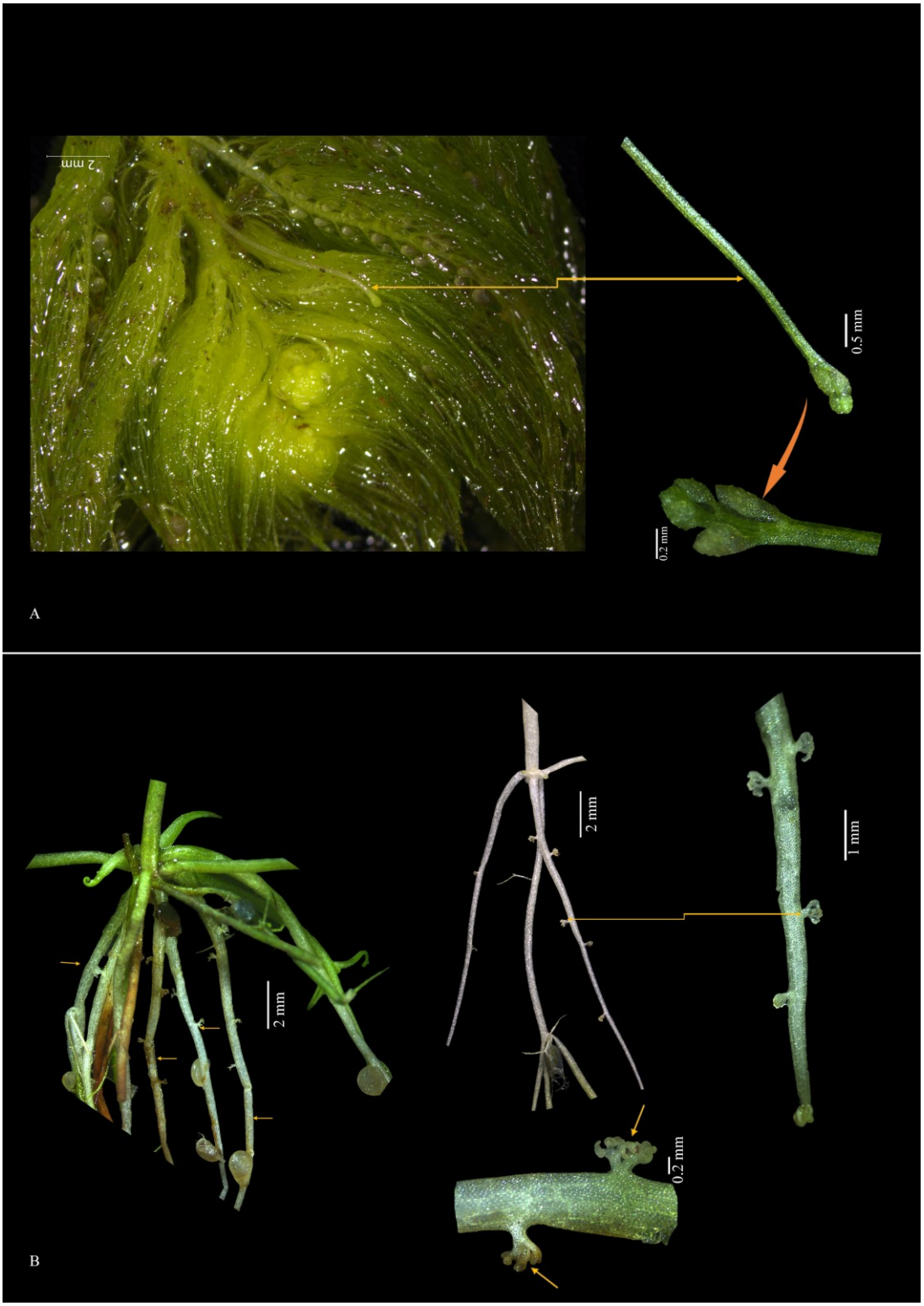


**Fig. 12.** Air shoots in aquatic *Utricularia* L.: **A.** *U. aurea* Lour. (note the thread-like air shoot); **B.** *U. gibba* L. (note the claw-like air shoots).

**Leaves**

Leaves arise from the base of the peduncles, either solitary or a few, sometimes dense, in rosettes, or numerous along stolons. In some treatments of *Utricularia*, these leaves are referred to as 'foliar organs'. Mostly, the leaves are small, ranging from just a few millimetres (≈ 0.5 mm) to a few centimetres (± 65 cm) in length. They are usually petiolate, with a narrowly linear to elliptic, obovate, cordate to reniform lamina, which may be membranous or slightly fleshy, with 1–3-or more veins (Taylor, 1989; Jobson *et al*., 2018) (Fig. 13).

**Fig. 13.** Leaf morphology in *Utricularia* L.: **A.** Simple leaves in terrestrial *Utricularia* (in *U. cecilii* P.Taylor); **B.** Dissected leaf in aquatic *Utricularia* (in *U. aurea* Lour.)

There is a gradual progression from smaller to larger leaves. *Utricularia longifolia* Gardner has the largest leaves, which are thick and leathery, reaching over 1 m in length under favourable growth conditions (Taylor, 1989). Small, peltate leaves are found in *U. pubescens* Sm. *Utricularia neottioides*, which grows in high water currents, has sparsely pinnatisect, filamentous leaves that arise from both the stolons and the lowest scales on the flowering peduncle (Adamec *et al*., 2015). The section *Utricularia* generally possesses highly dissected leaves, divided into capillary segments that end with marginal and apical setulae. The leaves and stolons, usually variously branched, form a mat-like appearance above the water surface.

**Turions**

Turions are modified shoot apices formed by the extreme condensation of shoot/ stolon tips bearing leaves. They store starch and serve as reserve material (Adamec, 1999, 2003, 2008, 2018). These vegetative, more or less spherical sturdy organs are dormant and perennating structures produced by the perennial aquatic species in subtropical to polar zones, and are resistant to frost and drought (Taylor, 1989; Adamec, 1999). Turions are otherwise known 'overwintering organs' or 'winter buds' (Adamec, 1999, 2003, 2018). These are formed and developed in the last phase of growing season as a response to unfavourable ecological conditions such as drought, snowfall and icing (Adamec, 1999, 2003, 2018). Under these conditions, or as the mother shoot decays or decomposes, turions detach from the mother plant and sink to the bottom of the water. When favourable condition return, they float to the surface and sprout into new individuals. Turions are present in species such as *U. australis*, *U. intermedia*, *U. minor*, etc. (Fig. 14).

**Fig. 14.** Turions in aquatic *Utricularia* L.: **A.** *U. intermedia* Hayne; **B. & C.** *U. minor* L. (Photo A. from R.V. Lansdown)

**Traps**

Traps are globose or ovoid, ranging from 0.1 millimetres to 1.2 centimetres long, complex intricate structures of modified leaves (Taylor, 1989; Hedrich & Fukushima, 2021; Freund *et al.*, 2022). Trap characteristics, such as appendages and the position of the mouth, are taxonomically significant and useful for sectional classification (Taylor, 1989). Traps are usually present on stolons, leaves and frequently on rhizoids. Their occurrence and position vary according to the habitat and lifeform of the individual.

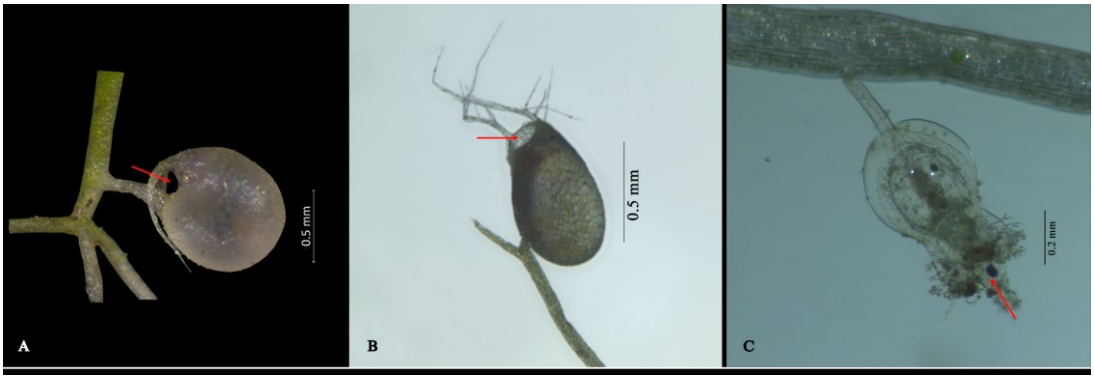


**Fig. 15.** Types of traps in *Utricularia* L.: **A.** Basal trap of *U. lazulina* P.Taylor; **B.** Lateral trap of *U gibba* L.; **C.** Terminal trap of *U. caerulea* L. (note red the arrows directing the mouth).

In general, the trap body consists of a stalk, mouth, and appendage/s. The traps are attached to the organ by a stalk, which may be short to very long, or sometimes sessile. The position of the mouth can be basal, lateral, or terminal in relation to the stalk attachment. When the mouth is adjacent to the stalk, it is termed basal, when opposite the stalk, it is terminal and when located in-between these positions on the ventral side, it is lateral (Fig. 15). Near the mouth, a variety of appendages are present, which may be simple, subulate, or single to variously branched, coiled or flabellate, deeply fimbriate, or gland tipped. Within the genus, *U. neottioides* remains as the only trap-less species (Adamec *et al*., 2015).

**Internal trap glands**: The internal architecture of traps is complex, and the fascinating way in which they function has been well explained in earlier research (Darwin, 1875; Lloyd, 1929, 1933; Sydenham & Findley, 1973, 1975; Fineran, 1985; Sasago & Siboaka, 1985; Reifenrath *et al*., 2006; Yang *et al*., 2009; Chormanski & Richards, 2012; Poppinga *et al*., 2016; Westermeier *et al*., 2017). The glands in the trap are usually of two types: threshold glands and chamber glands. Threshold glands are found just inside the trap door and are either single-armed (monofid) or two-armed (bifids), positioned close together to facilitate successful trapping (Figs. 16 & 17). Chamber glands are found on the rest of the inner wall of the trap and are either two-armed (bifids) or four-armed (quadrifids), secreting digestive enzymes that facilitate the breakdown of captured preys.

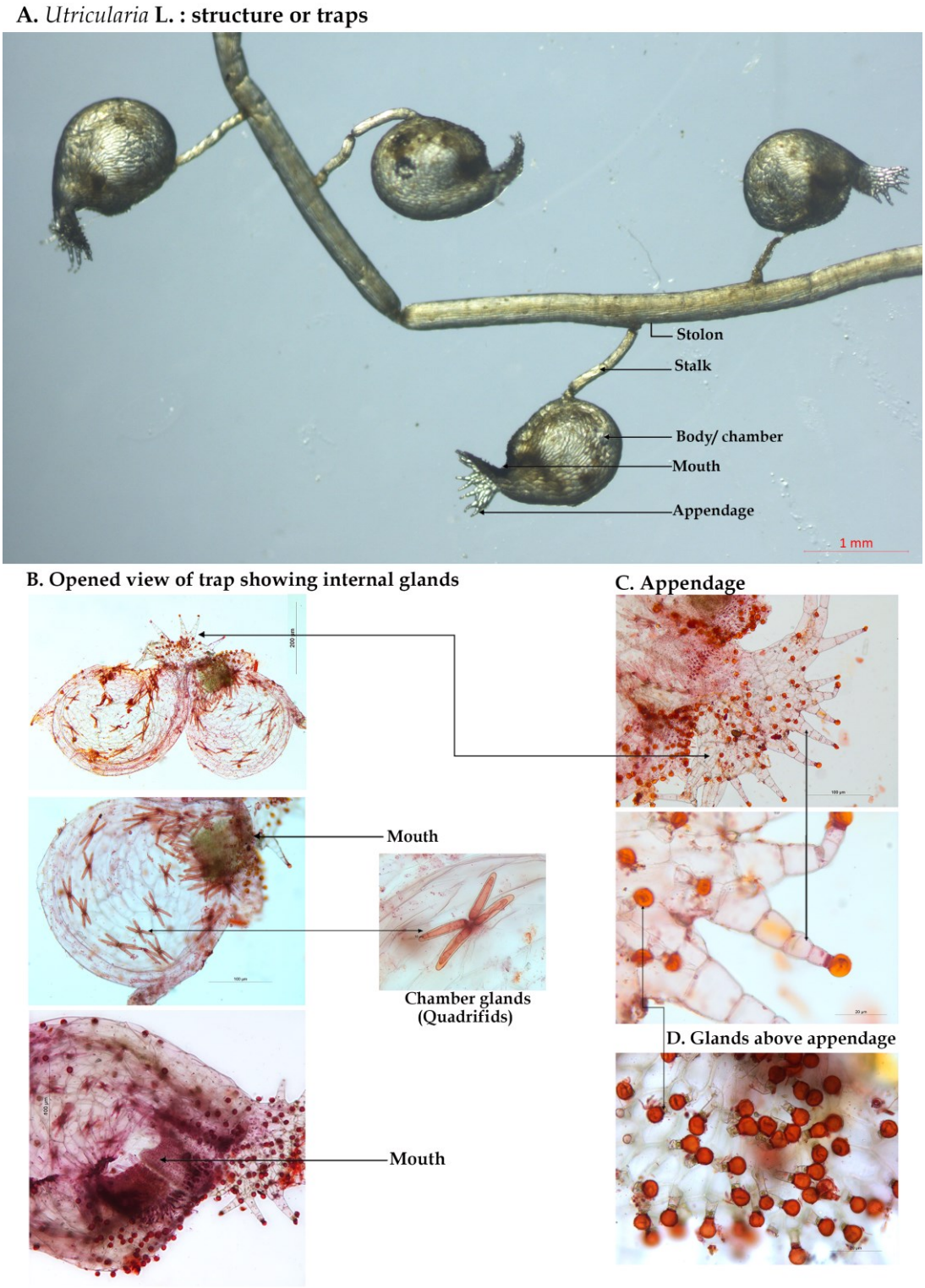


**Fig. 16.** LM image showing the trap architecture of *Utricularia brachiata* Oliv.: **A.** Traps on stolons - parts labelled; **B.** Opened view (note the appendages, mouth and chamber glands); **C.** Appendage and the gland on appendage.

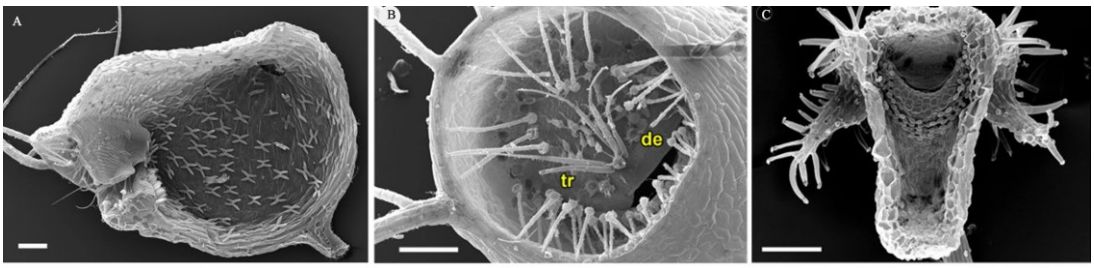


**Fig. 17.** SEM images showing morphological trap characteristics: **A.** Sagittal section of a trap of *U. gibba* L.; **B.** Sagittal section of *U. gibba* through trap entrance with the trigger hairs, the door edge and threshold; **C.** Interior view on the front part of trap of *U. calycifida* Benj. (Adopted from Westermeier *et al*., 2017).

## 4.2. Reproductive morphology

### Inflorescence

Inflorescence is a raceme, usually with many flowers arranged alternately, although it is occasionally reduced to a single flower. The flowers are morphologically diverse and may be arranged in either lax or congested clusters. The length of the racemes varies from very short to up to 1 meter. *Utricularia simmonsii* Lowrie, Cowie & Conran is the smallest known herb, with minute flowers around 1 mm across, within *Utricularia* (Lowrie *et al*., 2008), while *U. minutissima* has the smallest flowers among the Indian species. Flowers are usually arranged in opposite pairs or whorls of three, as seen in the sect. *Pleiochasia* Kamienski (Taylor, 1989). Racemes may be erect, twining or slightly ascending.

**Peduncle**: The peduncle is usually erect, filiform, or stiff, and may be simple or occasionally branched. It can be terete, or angular to winged. The peduncle is mostly glabrous, but completely hairy in *U. hirta* (sect. *Meionula*) and *U. leptorhyncha* O.Schwarz (sect. *Pleiochasia*). In some aquatic species, a whorl of spongy floats appears at various points along the peduncle (see spongy floats above). The peduncle may be bare (lacking scales completely) or covered with scales, which can range from few to numerous. These scales may be fertile, containing dormant buds, or sterile. Scales are completely absent in sections *Pleiochasia* and *Vesiculina* (Raf.) P.Taylor, as well as in some species within sect. *Utricularia* (Taylor, 1989).

**Pedicels**: Pedicels are usually filiform, more or less laterally winged, and often dorsiventrally flattened or compressed. They can be extremely short or very long. Pedicels are usually accrescent, becoming longer and thicker after anthesis. They are erect or ascending at anthesis, and may be erect or ascending or horizontal or, deflexed or decurved in fruiting. A very long pedicel (2–3.5 cm), which is strongly deflexed and sigmoid, is found in *U. petersoniae* P.Taylor, where it elongates to or even below the level of its substratum (Taylor, 1989).

**Scales**

Scales may be present or absent, when present few to numerous on peduncles, either basifixed (attached at base), or basisolute (attached at some point above the base, or below the middle), or medifixed (attached at middle). Typically, scales resemble bracts, but the scales can be either fertile, covering young buds, or sterile. They are found from the base of the peduncle to the lowermost flower. In cases of peduncle damage, new branches can arise from the fertile scales. The rheophytic *U. neottioides* produce numerous filamentous leaves from the lowermost scales on the flowering peduncle (Adamec *et al*., 2015). The scales are basifixed, ovate to deltate and 1–3 (–5) nerved in sect. *Oligocista*, while it is absent in sect. *Phyllaria*. In sect. *Nigrescentes*, the scales are medifixed and more or less rhombic in shape (Fig. 18). In some species of sections *Iperua* and *Orchidioides*, the scales are particularly conspicuous, enlarged, and leaf-like (Taylor, 1989).

**Bract and bracteoles**

**Bracts**: Bracts, present at the base of the pedicels, provide useful characters for sectional and species level segregation (Taylor, 1989). They are single, accompanying with or without bracteoles, mostly basifixed, basisolute or medifixed, and may be ovate or deltate with entire margins or rarely dentate or more or less fimbriate (Fig. 18). Species in sect. *Lecticula* (Barnhart) Komiya has very distinct basifixed tubular bracts (Taylor, 1989). *Utricularia warmingii* Kamienski of sect. *Utricularia* is characterized with three, oblong, equal-sized bracts (Taylor, 1989). The base of the bract is diverse, truncate, or cordate to sub-cordate (e.g., *U. chrysantha* R.Br. of sect. *Enskide* (Raf.) P.Taylor) or auriculate (e.g., *U. nana* A.St.-Hil. & Girard, *U. simulans*

Pilger, etc. of sect. *Aranella* (Barnhart) P.Taylor and *U. bremii*, *U. minor* L., *U. ochroleuca* R.Hartman, *U. vulgaris* L., etc. of sect. *Utricularia*) or peltate and amplexicaule (e.g., in *U. flaccida* A.DC., *U. pusila* Vahl, *U. subulata* L., *U. triloba* Benj. of sect. *Setiscapella* (Barnhart) P.Taylor). Bracts are medifixed or basisolute in sect. *Nigrescentes*, and basisolute in sections *Avesicaria* Kamienski, *Lloydia*, *Mirabiles* P.Taylor, *Phyllaria*, *Oliveria* P.Taylor, *Sprusea* P.Taylor, *Steyermarkia* P.Taylor, etc. and basifixed in sections *Australes* P.Taylor, *Oligocista*, *Meionula*, *Pleiochasia*, *Utricularia*, etc.

**Bracteoles**: Bracteoles are found laterally on either side of the bracts, or sometimes within the bracts themselves, and are generally smaller and morphologically similar to them (Fig. 18). In *U. amethystine* Salzm. ex A.St.-Hil. & Girard, the bracteoles are confluent with the bract basally, forming a distinct three-lobed structure (Taylor, 1989). In some species of sect. *Aranella*, the bracteoles are inserted away from the bract, near the distal end of the pedicel, close to the calyx lobes (Taylor, 1989). The point of attachment of the bracts and bracteoles are similar, which is basifixed in sections *Oligocista* and *Meionula*, basisolute in *Nigrescentes* (except *U. bracteata* R.D.Good, where it is basifixed), *Phyllaria* (except *U. corynephora*, where it is basifixed), etc. Bracteoles are absent in sections *Avesicaria*, *Utricularia*, *Lecticula, Setiscapella,* and *Sprusea* P.Taylor, *Steyermarkia* (Taylor, 1989), and in some species of other sections (e.g., *U. janarthanamii* and *U. heterosepala* Benj. of sect. *Oligocista*).

**Calyx**

The calyx is two lobed in the subgenus *Utricularia* (Fig. 20), and *Biovularia*, while it is four lobed in sections *Polypompholyx* (Lehm.) P.Taylor and *Tridentaria* P.Taylor of the subgenus *Polypompholyx sensu* Müller and Borsch (Taylor, 1989). The calyx varies considerably in size and shape, and the lobes may be more or less identical or sub-similar or dissimilar, sub-equal or unequal in size. It is persistent, often accrescent after anthesis, and the lobes vary much in shape after anthesis. The upper lobe may be larger than the lower, but sometimes the lower lobe exceeds the upper calyx lobe in length and width. The shape of lobes can be ovate, elliptic or rounded.

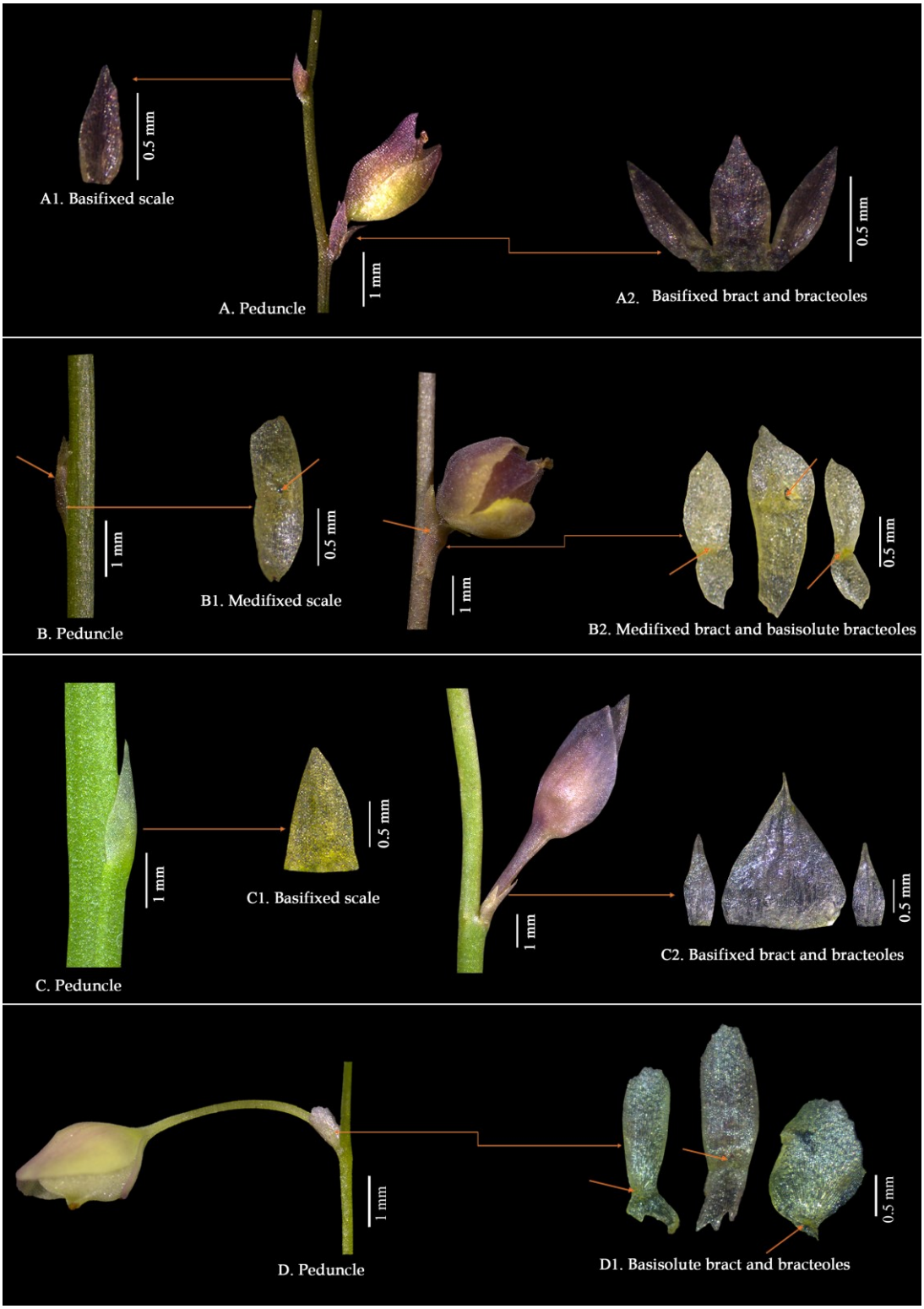


**Fig. 18.** Morphology of scale, bract and bracteoles in *Utricularia* L.: **A.** Basifixed in sect. *Meionula* (*U. geoffrayi* Pellegr.); **B.** Medifixed scale and basisolute bracteoles in sect. *Nigrescentes* (*U. roseopurpurea* Stapf ex Gamble); **C.** Basifixed in sect. *Oligocista* (*U. cecilii* P.Taylor); **D.** Basisolute in sect. *Phyllaria* (*U. striatula* Sm.).

Margins are generally entire, but it can be minutely to prominently dentate or deeply fimbriate. The apex of the upper lobe may be acute to obtuse or rhombic or rounded, while the apex of lower lobe can be entire or more or less 2–3-dentate. The venation is prominent, the nerves may be arranged in parallel and it can be simple or branched, sometimes the lateral nerves show branching from middle or apex, but in some species the nerves are branched to form network.

**Corolla**

*Utricularia* shows extreme diversity in corolla morphology and it is a significant taxonomic character in sectional and species delimitations. Corolla is bilabiate, without an apparent tube, but with a smaller upper lip, and relatively to noticeably larger and broader lower lip (Fig. 20). The upper lip may be small, simple, while the lower lip is more complex and more or less spurred. The junction between the upper and lower lip is the corolla throat, which is more or less sac-like, holds stamens and pistil. The size of the corolla ranges from about 2 mm to 2 cm, and up to 10 cm long (Taylor, 1989). *Utricularia* possesses a wide range of corolla colours, with most species displaying shades of blue-violet, or yellow or a few are white, red, or brown and quite a few combinations of these colours also occur among species or even within a single species.

**Upper lip of corolla**: The upper lip is usually smaller in size and can be oblong, obovate or sub-orbicular or sometimes much reduced (Fig. 20). Numerous glandular hairs are present at the lower margin of the upper lip. A constricted part or a marginal rim is present at the throat of upper lip, which may be at the base or more or less at the middle. The members of sect. *Oligocista* have a constriction above or below the middle, and the shape of upper part (above the constriction) varies from oblong-elliptic-obovate, and the lower part (below the constriction) can be triangular to widely ovate. The apex of the upper lip may be obtuse, rounded, truncate-emarginate or more or less clearly lobed.

**Lower lip of corolla**: The shape, size and pattern of the lower lip vary significantly in *Utricularia* (Fig. 20). The lower lip is spurred, which may be very short or reduced and conspicuously long. The throat margin of lower lip is conspicuously hairy and sometimes ligulate. The palate can be slightly to very conspicuously raised or flat, usually with numerous glandular hairs, clear or ornamented with wrinkles, ridges

or lobes or projections. These are of great taxonomic value and hence significant in species identification. The margin of the lower lip is entire, wavy or considerably lobed. In most of the species of sect. *Oligocista,* the palate is prominently raised or swollen (gibbous) with prominent two-four lobed (bi-gibbous, 4-gibbous) swellings and the margins are usually entire or lobed towards apex. The palate is conspicuously gibbous or swollen in sect. *Utricularia*. In *Phyllaria*, the palate is flat, and the lip is more or less deeply 2–4 or 5-lobed towards apex. A five-lobed lower lip is found in sect. *Pleioschasia* of subgenus *Polypompholyx*. *Utricularia dunlopii* P.Taylor, *U. capilliflora* F.Muell, *U. dunstaniae* F.E.Lloyd, *U. antennifera* P.Taylor and *U. lowriei* R.W.Jobson have flesh-coloured flowers and antennae-like filiform appendages on the corolla (Taylor, 1989; Nunn, 2022b). The antenna-like appendages arise from the lower lip in *U. lowriei*, *U. antennifera* and *U. dunstaniae*, whereas in *U. capilliflora* and *U. dunlopii*, they arise from the upper lip (Taylor, 1989; Jobson, 2013; Lowrie, 2014; Plachno *et al*., 2016).

**Spur**: Spur is more or less conspicuous, sometimes much longer than the lower lip, usually conical to subulate or cylindrical, glabrous or pubescent, with or without a small amount of nectar (Fig. 20). The size, shape and length of the spur in relation to the lower lip of the corolla and the lower calyx lobe have great taxonomic value and are particularly useful for species delimitation. *Utricularia simmonsii* is the only species known to lack a floral spur (Lowrie *et al*., 2008; Lowrie, 2014).

**Stamens**

The stamens are two, and inserted at the junction or throat between the corolla lips and positioned on the ventral side of the ovary (Taylor, 1989). The stamens are similar, with short, flattened and slightly curved filaments and dorsifixed anthers (Fig. 20).

The filaments are flattened and fleshy, may be incurved or slightly twisted at base. Some species possess an apical lateral projection reaching above the anthers (e.g., sect. *Oligocista*), while it is absent in sections *Phyllaria* and *Meionula*. In *U. aurea* of sect. *Utricularia*, glandular hairs are present on the lateral sides of the filament. The monotypic sect. *Stylotheca* A.DC. has very long geniculate filaments (Taylor, 1989). *Utricularia choristotheca* P.Taylor and *U. determannii* P.Taylor of sect. *Choristothecae* P.Taylor have quite distinct anther thecae, separated from each other by a short or a

very long filiform connective (Taylor, 1989). The anthers are two-thecous, more or less distinct or confluent, usually shorter than the filament and dehisce longitudinally.

**Pollen**: Most of the terrestrial species possess pollen with three to six (up to eleven) ectoapertures, and distinct endoapertures (Huynh, 1968a,b; Taylor, 1989). In sections *Polypompholyx*, *Pleiochasia* and *Tridentaria*, the pollen is mostly three-colporate with distinct endoapertures (Taylor, 1989). The pollen is stephanocolporate with larger number of furrows, synorate, and with aperturate apocolpia in sect. *Utricularia* (Taylor, 1989). In sections *Avesicaria*, *Setiscapella*, *Nelipus* (Barnhart) P.Taylor and *Lecticula*, the pollen is synorate, but with somewhat fewer furrows and with or without aperturate apocolpia (Taylor, 1989) (Fig. 19).

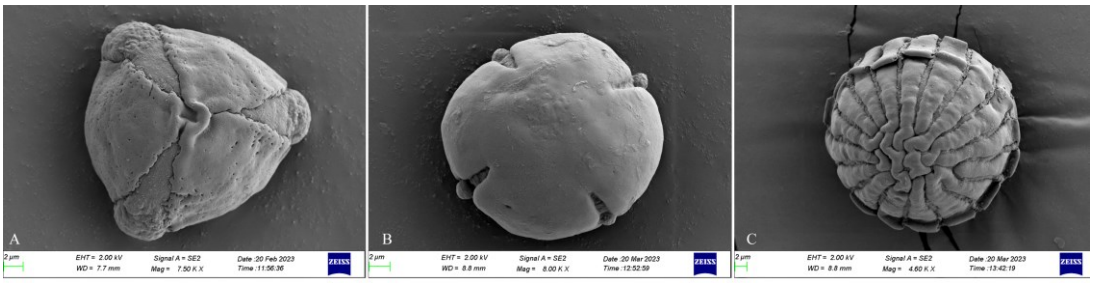


**Fig. 19.** Pollen morphology of *Utricularia* L.: **A.** *U. caerulea* L. (sect. *Nigrescentes*); **B.** *U. polygaloides* Edgew. (sect. *Oligocista*); **C.** *U. aurea* Lour. (sect. *Utricularia*)

**Pistil**

The pistil consists of a sessile, globose or ovoid ovary with a very short or relatively very long style, and a bilabiate stigma (Fig. 20).

**Ovary**: Ovary is superior and unilocular, with few to many ovules on a free basal placenta. The basal part is more or less adnate to the base of the upper calyx lobe especially in members of the sect. *Phyllaria*.

**Placenta**: The placenta may be globose or ovoid and dorsiventrally compressed bearing few to numerous ovules, having a short to relatively long stalk, which is adnate to the base of the ovary (the placenta is sessile and possess only two ovules in *U. olivacea* C.Wright) (Taylor, 1989).

**Style**: Style is simple, thick, short, indistinct or elongate, and ends with a stigma. In sect. *Stylotheca*, the style is much elongated and geniculate (Taylor, 1989).

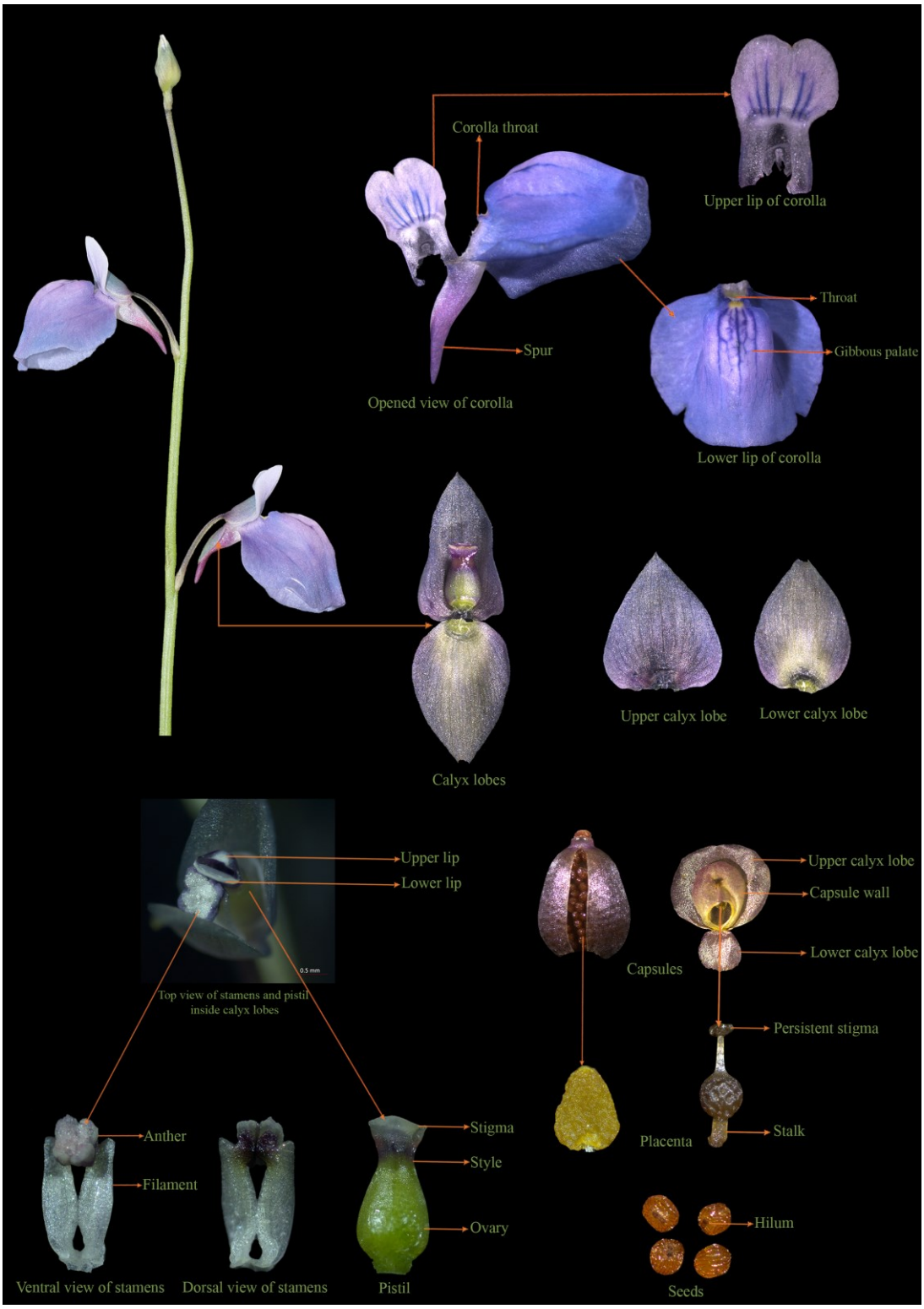


**Fig. 20.** Floral morphology of *Utricularia* L.

**Stigma**: Stigma is bi-lipped and the upper lip is usually smaller than the lower lip. The abaxial surface of the upper lip is ± papillose or glabrous. In sect. *Utricularia*, the upper lip is obsolete and the lower lip is larger, triangular or sub-orbicular and sometimes fringed with unicellular trichomes at the margins (pers. obsv.) In sect. *Oligocista*, the two lips are usually more or less similar in shape and size. The upper lip can be rarely entire, more or less obsolete or reduced to a small subulate lobe, while the lower lips are mostly entire.

**Capsules**

Capsules are globose or ovoid to ellipsoid or oblongoid, and sometimes oblique or dorsiventrally compressed, with persistent stigma (Fig. 20). The capsules are always enclosed within the calyx lobes, and the base of the capsule is more or less adnate to the base of the upper calyx lobe. There is a great diversity in the capsule wall morphology and dehiscing pattern in the genus. The wall of the capsule may be very thin or membranous and more or less transparent to rather thick and firm, or can be thin with a thickening along the dehiscing margin (Taylor, 1989). The placenta is accrescent, relatively large and fleshy with a variously pitted surface and the seeds are imbricate on the placenta, either closely packed or even overlapping. The placenta has a stalk and a more or less conical apical extension in sect. *Phyllaria* (Fig. 20). The capsules are many seeded in *Utricularia*, while, *U. olivacea* is the only one-seeded species within this genus.

The dehiscing pattern of the capsules is also diverse and unique in both at the sectional and specific level (Taylor, 1989). Taylor (1989) recognised 14 kinds of dehiscence patterns in *Utricularia*. The capsule is apparently indehiscent in *U. olivacea* of sect. *Utricularia*, in which the seeds released after the decay or rotting of the capsule wall (Taylor, 1989). The capsules may dehisce by a single longitudinal ventral slit (which starts from the base of stigma to the base of capsule) or longitudinal dorsal as well as ventral slits (looks a laterally bivalvate appearance). Sometimes the capsule wall splits laterally also and gives a four-valvate appearance. In most of the species, the capsule wall dehisces by a marginally thickened longitudinal ventral slit or marginally thickened dorsal as well as ventral slit (common in species of sect.

*Oligocista*). In some cases, the capsule wall gets completely thickened and dehisces by a single, longitudinal, wide ventral slit or both dorsal and ventral slit (in sect. *Nigrescentes*). In sect. *Phyllaria*, the capsule dehisces by a single, ventral, more or less orbicular pore, starting from the middle till the base of the capsule (the upper part will be fused always). The capsules dehisce laterally and the walls are dorsiventrally valvate as in sect. *Foliosa* (Taylor, 1989). In most of the species in sect. *Utricularia*, the capsule dehiscence is circumscissile, where they dehisce equatorially into two valves.

**Seeds**

*Utricularia* exhibit diversity in seeds morphology, and majority are small or very small (0.18–2 mm long), sub-globose or ovoid to ellipsoid or oblongoid, with a reticulate testa and a usually undifferentiated embryo (Fig. 20). Based on the compactness of the seeds inside the capsule, the shape may slightly vary in some species. The testa cells are diverse and the testa characteristics provide valuable information which are useful at both sectional and specific level. The testa may be polygonal, rectangular or somewhat irregular, or more or less isodiametric or slightly to very elongate. The anticlinal boundaries vary considerably, can be raised, sunken or flat, straight or sinuate and the periclinal walls may be convex, concave or flat. The terrestrial species have similar pattern of testa, usually reticulate with raised anticlinal wall and concave periclinal walls. Section *Phyllaria* has numerous testa extensions or hairs on the outer periclinal walls. Some members of the sect. *Lecticula* and *Utricularia* possess prismatic or disc shaped seeds, with more or less well developed narrow wings on the angles. Section *Utricularia* also possess lenticular seeds with an entire surface or denticulate wing, or more or less prominent multicellular outgrowths (Taylor, 1989).

# SYSTEMATIC TREATMENT

## 5.1. GENUS UTRICULARIA L.

**Utricularia** L., Sp. Pl. 1: 18. 1753; R.Br., Prodr. Fl. Nov. Holland. 1: 430. 1810; Sm. in Rees (ed.), Cycl. 37: 597. 1819; A.DC. in DC. (ed.), Prodr. 8: 3. 1844; Drury, Handb. Ind. Fl. 2: 119. 1866; Benth. & F.Muell., Fl. Austral. 4: 523. 1869; Benth. & Hook.f., Gen. Pl. 2(2): 987. 1876; Kamienski in Engl. & Prantl. (eds.), Nat. Pflanzenfam. 4(3b): 119. 1895; Prain, Bengal Pl. 2: 779. 1903; Stapf in Dyer (ed.), Fl. Cap. 4(2): 423. 1904; T.Cooke, Fl. Bombay 2: 315. 1905; Stapf in Dyer (ed.), Fl. Trop. Afr. 4(2): 469. 1906; Duthie, Fl. Gangetic Plain 2: 165. 1911; Barnhart in Small (ed.), Fl. Miami 169. 1913, in Mem. New York Bot. Gard. 6: 60. 1916; Gamble, Fl. Madras 2: 978. 1921; Haines, Bot. Bihar Orissa 4: 643. 1922; Ridl., Fl. Malay Penins. 2(2): 490. 1923; P.Taylor, Kew Bull. 18(1): 23. 1964, Fl. Males., Ser.1, Spermat. 8(2): 276. 1977; N.Rani & K.M.Matthew in K.M.Matthew (ed.), Fl. Tamilnadu Carnatic 3(1): 1109. 1983; P.Taylor, Gen. *Utricularia* 75. 1989; Janarth. & A.N.Henry, Bladderworts India 23. 1992; Noltie in Grierson & D.G.Long (eds.), Fl. Bhutan 2(3): 1336. 2001; S.K.Srivast. & A.N.Shukla, Fl. Cold Desert Western Himalaya 2: 460. 2015; Noltie in Watson *et al.* (eds.), Fl. Nepal (web edn.) 2. 2019. *Type*: *Utricularia vulgaris* L.

*Lentibularia* Seg., Pl. Veron. 3: 128. 1754; Hill, Brit. Herb. 125. 1756; Adans., Fam. Pl. 2: 208. 1763. *Type*: *L. vulgaris* Seg.

*Lentibularia* Raf., Fl. Tellur. 4: 108. 1838. *nom. illeg. homonym*

*Askofake* Raf., Fl. Tellur. 4: 108. 1838. *Type*: *A. recurva* Lour.

*Meionula* Raf., Fl. Tellur. 4: 108. 1838

*Stomoisia Raf.*, Fl. Tellur. 4: 108. 1838; Barnhart in Small (ed.), Fl. Miami 169. 1913, Mem. New York Bot. Gard. 6: 54. 1916; Gleason, Bull. Torrey Bot. Club 56: 404. 1929. *Type*: *S. cornuta* (Michx.) Raf. (= *Utricularia cornuta* Michx.)

*Trixapias* Raf., Fl. Tellur. 4: 108. 1838

*Enskide* Raf., Fl. Tellur. 4: 109. 1838

*Hamulia* Raf., Fl. Tellur. 4: 109. 1838

*Lepiactis* Raf., Fl. Tellur. 4: 109. 1838

*Megozipa* Raf., Fl. Tellur. 4: 110. 1838

*Meloneura* Raf., Fl. Tellur. 4: 109. 1838; Barnhart, Mem. New York Bot. Gard. 6: 50. 1916

*Nelipus* Raf., Fl. Tellur. 4: 109. 1838

*Personula* Raf., Fl. Tellur. 4: 110. 1838

*Vesiculina* Raf., Fl. Tellur. 4: 109. 1838; Barnhart in Small (ed.), Fl. Miami 169. 1913, Mem. New York Bot. Gard. 6: 62. 1916. *Type*: *V. purpurea* (Walter) Raf. (= *Utricularia purpurea* Walter)

*Plectoma* Raf., Fl. Tellur. 4: 110. 1838

*Plesisa* Raf., Fl. Tellur. 4: 110. 1838

*Cosmiza* Raf., Fl. Tellur. 4: 110. 1838; Barnhart, Mem. New York Bot. Gard. 6: 49. 1916. *Type*: *C. multifida* Barnhart (= *Utricularia multifida* R.Br.)

*Trilobulina* Raf., Fl. Tellur. 4: 110. 1838

*Polypompholyx* Lehm., Bot. Zeitung. 2: 109. 1844, Nov. Stirp. Pug. 8: 48. 1844; Benj., Linnaea 20: 316. 1847; Benth., Fl. Austral. 4: 532. 1869; Benth. & Hook.f., Gen. Pl. 2: 988. 1876; Kamienski in Engl. & Prantl. (eds.), Nat. Pflanzenfam. 4(3b): 119. 1895; Komiya, J. Jap. Bot. 48(5): 149. 1973. *Type*: *P. tenella* (R.Br.) Lehm. (= *Utricularia tenella* R.Br.)

*Akentra* Benj., Linnaea 20: 319. 1847. *Type*: *A. inflata* Benj.

*Diurospermum* Edgew., Proc. Linn. Soc. London 1(34): 351. 1847. *Type*: *D. album* Edgew. (= *Utricularia kumaonensis* Oliv.)

*Biovularia* Kamienski, Zap. Novorossijsk. Obsc. Estestvoisp. 12(1): 204. 1890, in Engl. & Prantl. (eds.), Nat. Pflanzenfam. 4(3b): 122. 1895; Barnhart, Mem. New York Bot. Gard. 6: 58. 1916; Komiya, J. Jap. Bot. 48: 153. 1973. *Type*: *B. olivacea* (C.Wright) Kamienski (= *Utricularia olivacea* C.Wright)

*Aranella* Barnhart in Small (ed.), Fl. Miami 171. 1913, Mem. New York Bot. Gard. 6: 49. 1916. *Type*: *A. fimbriata* (Kunth) Barnhart (= *Utricularia fimbriata* Kunth)

*Lecticula* Barnhart in Small (ed.), Fl. Miami 170. 1913; in Britton & Brown, Ill. Fl. ed. 2, 3: 230. 1913; Mem. New York Bot. Gard. 6: 58. 1916. *Type*: *L. resupinata* (B.D.Greene ex Bigelow) Barnhart (= *Utricularia resupinata* B.D.Greene ex Bigelow)

*Setiscapella* Barnhart in Small (ed.), Fl. Miami 170. 1913, in Britton & Brown (eds.), Ill. Fl., ed. 2, 3: 230. 1913, Mem. New York Bot. Gard. 6: 57. 1916. *Type*: *S. subulata* (L.) Barnhart (= *U. subulata* L.)

*Avesicaria* Barnhart, Mem. New York Bot. Gard. 6: 56. 1916. *Type*: *A. neottioides* (A.St.-Hil. & Girard) Barnhart (= *Utricularia neottioides* A.St.-Hil. & Girard)

*Calpidisca* Barnhart, Mem. New York Bot. Gard. 6: 55. 1916; Gleason, Bull. Torrey Bot. Club 56: 404. 1929. *Type*: *C. capensis* (Spreng.) Barnhart (= *Utricularia capensis* Spreng.)

*Orchyllium* Barnhart, Mem. New York Bot. Gard. 6: 53. 1916; Gleason, Bull. Torrey Bot. Club 56: 405. 1929. *Type*: *O. alpinum* Barnhart (= *Utricularia alpina* Jacq.)

*Pelidnia* Barnhart, Mem. New York Bot. Gard. 6: 50. 1916. *Type*: *P. caerulea* Barnhart (= *Utricularia caerulea* L.)

*Pleiochasia* (Kamienski) Barnhart, Mem. New York Bot. Gard. 6: 52. 1916. *Type*: *P. dichotoma* (= *Utricularia dichotoma* Labill.)

Terrestrial, epiphytic or aquatic, annual or perennial herbs. True roots absent; rhizoids usually present, but in some species not clearly differentiated or completely absent, if present capillary, fibrous, rarely thick and fleshy, simple to branched, sometimes tapering, branches papillose. Tubers rarely present at the peduncle base, single or in clusters, or as moniliform thickenings of the stolons, or terminally on stolon branches. Stem rarely present below the base of the peduncle, short, erect or decumbent. Stolons mostly present, short to very long, capillary or thick and fleshy, simple to branched, usually terete and glabrous rarely papillose. Leaves present or rarely absent; rosulate at the base of the peduncle, or numerous at the stolon nodes or stolons; mostly entire, petiolate or sessile; lamina diverse, linear to spathulate or reniform or peltate, or highly dissected or more or less dichotomously or pinnately divided into few to many capillary segments, 1 to many nerved, sometimes glandular. Traps very small, few to numerous on rhizoids, stolons and leaves; hollow, globose or ovoid, or rarely oblate; sessile or stalked, with a mouth either basal or lateral or terminal with a variety of dorsal, lateral or ventral appendages very rarely appendages absent. Inflorescence racemose, 1 to many-flowered; peduncle simple or sometimes branched, erect or twining, very short to long, filiform or sometimes rather stiff, glabrous, sometimes papillose, or glandular. Scales present or absent on the peduncles. A whorl of spongy float present in some suspended aquatic species, completely absent in remaining. Bracts very diverse, basifixed or basisolute; bracteoles on either side of bracts, usually much smaller than bracts, or completely absent in some species. Pedicel very short to relatively very long, often accrescent after anthesis, sometimes reflexed or recurved in fruiting. Calyx 2- or rarely 4-lobed,

the lobes equal or sub-similar or sometimes very unequal in size and shape, always persistent and accrescent. Corolla very diverse, bilabiate, glabrous or rarely externally hairy, the throat more or less closed but sometimes open; upper lip smaller than the lower, entire or rarely lobed at apex; lower lip spurred, palate more or less well defined, often conspicuously swollen or lobed, rarely flat, entire or variously lobed at apex; spur well developed, but very rarely obsolete. Stamens 2, inserted at the junction of corolla throat, at the base of the upper lip of corolla; filaments straight or curved, short or rarely elongate and geniculate; anthers dorsifixed, anther thecae confluent or distinct. Ovary globose or ovoid, unilocular, placentation free basal, ovules anatropous; style short or rarely elongate, persistent; stigma bilabiate, the lower lip much larger than the upper. Capsule globose or ovoid, dehiscing by longitudinal ventral or dorsal slits or sometimes both, or by dorsiventrally or laterally bivalvate, or circumscissile, rarely indehiscent; placenta ovoid or globose, pitted. Seeds few to many, or rarely 1 per capsule, usually very small, diverse in shape, with entire or winged testa or very varied testa outgrowths; embryo undifferentiated.

***Notes***: *Utricularia*, commonly known as bladderworts, is a fascinating group of carnivorous plants. The generic name *Utricularia* was coined by Linnaeus, derived from the Latin word *Utriculus*, meaning 'womb or stomach', in reference to its carnivorous trapping structures. Following Linnaeus' (1753) original description of the genus, numerous studies have been published by researchers worldwide. A comprehensive account of the genus was given by Peter Geoffrey Taylor (1926-2011), a British Botanist at the Royal Botanic Gardens, Kew. Taylor spent over forty years creating an extensive compendium of *Utricularia* globally. In India, the genus has been reviewed by Subramanyam (1979, 1981) and Janarthanam and Henry (1992).

Accurate identification of *Utricularia* species requires comprehensive collection of all plant parts and careful documentation of distinguishing characteristics. Incomplete or fragmented collections often lead to misidentifications, as noted in this study while examining herbarium specimens. Taylor (1989) had

already pointed out the challenges of working with herbarium materials, particularly for species within the section *Oligocista*. As a result, this study involved extensive fieldwork in addition to herbarium consultation.

*Utricularia* comprises approximately 284 accepted species globally (POWO, 2025), 37 species under five sections are found in India, including 16 endemic species.

***Distribution***: The genus is cosmopolitan, mostly occurring in tropical regions, with a few species found in temperate regions (Fig. 21). It is absent from oceanic islands and polar regions (Taylor, 1989; POWO, 2025).

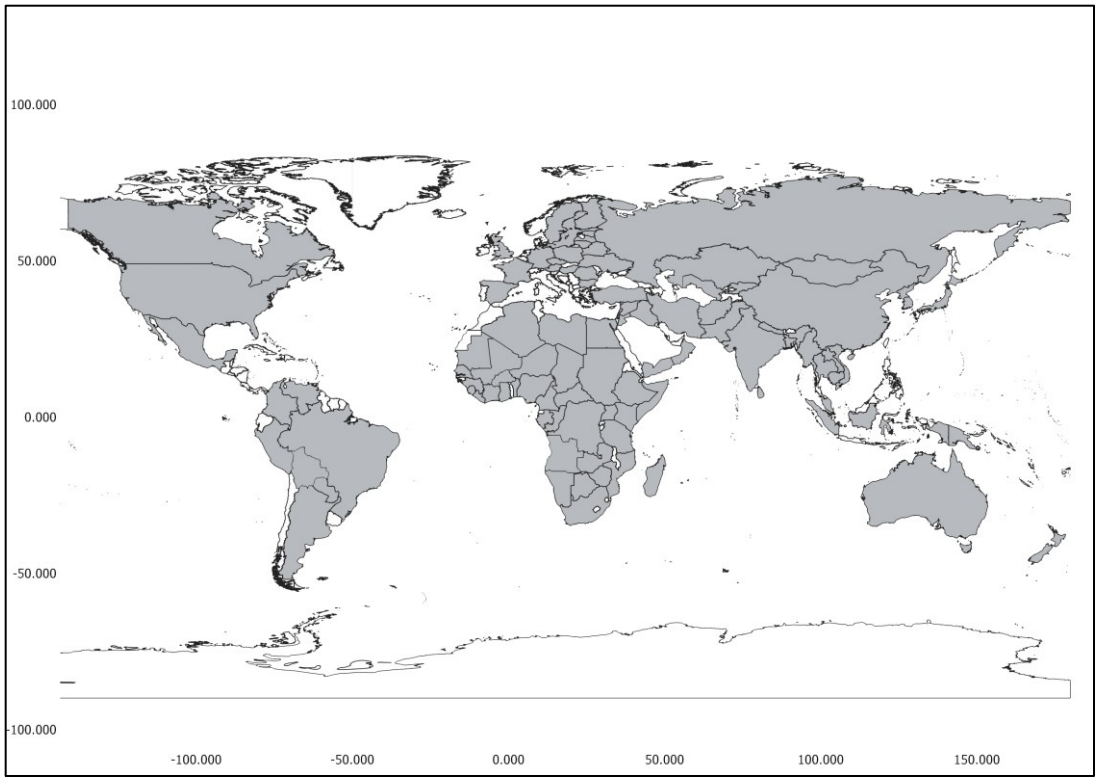


**Fig. 21.** Distribution of genus *Utricularia* L.

**Key to the sections in genus Utricularia in India**

1. Plants aquatic, free-floating or submerged herbs; rhizoids always absent; leaves divided and leaf segments marginally setulose; traps numerous on leaf axils, always lateral; peduncles always terete; bracteoles always absent; seeds winged, thick, lenticular or prismatic ..... **sect. Utricularia**

1. Plants terrestrial, lithophytic or epiphytic herbs; rhizoids mostly present or rarely absent; leaves simple and margins not setulose; traps numerous on stolons, rhizoids and leaves, basal, lateral or terminal; peduncle terete, angular, grooved; bracteoles present, rarely absent; seeds simple or with varied testa hairs ..... **2**

2. Leaves rosulate on peduncle base and stolon nodes; trap mouth lateral or terminal; scales, bracts and bracteoles medifixed, or basisolute..... .**3**

2. Leaves not rosulate on peduncle base, numerous on stolons; trap mouth basal or rarely lateral; scales, bract and bracteoles basifixed ..... **4**

3. Plants lithophytic or epiphytic; tubers present or absent; lamina obovate to rounded or reniform, dichotomously nerved; traps on stolons only, mouth lateral; scales, bracts and bracteoles basisolute; calyx lobes always unequal, upper lobe always large; lower lip of corolla lobed; seeds with various testa hairs. ..... . ..... **sect. Phyllaria**

3. Plants terrestrial to lithophytic herbs; tubers always absent; lamina obovate to spathulate, 1-nerved; traps on rhizoids, stolons and leaves, mouth terminal; scales, bracts and bracteoles medifixed or basisolute; calyx lobes sub-equal; lower lip of corolla entire; seeds simple without testa hairs ..... **sect. Nigrescentes**

4. Leaves always 1-nerved; trap mouth lateral, appendages connate into gland tipped trichomes; palate of the lower lip of corolla flat, more or less 3-lobed at apex..... **sect. Meionula**

4. Leaves 1–3 or more nerved; trap mouth mostly basal, rarely lateral, appendages free, simple or branched, subulate; palate of the lower lip of corolla prominently swollen or raised, entire or rarely lobed at apex ..... **sect. Oligocista**

## 5.2. UTRICULARIA SECT. MEIONULA (RAF.) P.TAYLOR

**Utricularia section Meionula** (Raf.) P.Taylor in Kew Bull. 41: 5. 1986 *p.p. excl. U. simplex*; P.Taylor, Gen. *Utricularia* 169. 1989; *Meionula* Raf., Fl. Tellur 4: 108. 1838. *Type*: *Utricularia minutissima* Vahl

*Trixapias* Raf., Fl. Tellur 4: 108. 1838

Terrestrial, annual or perennial small herbs. Rhizoids numerous, simple, sparsely branched, papillose. Stolons few to numerous, simple or sparsely branched. Leaves petiolate, lamina narrowly linear to obovate, 1-nerved, membranous. Traps numerous on rhizoids, stolons and petiole, ovoid to oblongoid; mouth lateral; appendages 2, multicellular, gland tipped trichomes; internal glands 2–4 armed. Scales numerous, basifixed, fertile, covering young buds. Bracts and bracteoles sub-similar, basifixed. Racemes erect; peduncles simple or branched, glabrous or hairy. Calyx lobes sub-equal. Corolla purple or white; upper lip oblong-obovate, rounded at apex; lower lip sub-orbicular-orbicular or transversely oblong, 3-lobed at apex. Pollen prolate to oblate, 3-colporate. Capsules dehiscing by a single, marginally thickened ventral slit. Seeds sub-globose or oblongoid; testa cells isodiametric, anticlinal wall raised, straight, periclinal wall flat.

***Notes***: The name *Meionula* was originally described by Rafinesque (1838) in his "*Flora Telluriana*" to represent a genus within the family 'Clythrelia Raf.' He alluded this genus with *Utricularia minutissima* Vahl, and placed small plants with tiny flowers under it. In his sectional classification of *Utricularia* Taylor (1989), Taylor adopted Rafinesquian generic name, but reduced it to a section. He included three species in sect. *Meionula*, *viz*., *U. geoffrayi*, *U. hirta*, and *U. minutissima*, two of which have a distribution in India (Janarthanam & Henry, 1992). My exploration has added a new distributional record for *U. geoffrayi*, in India.

***Distribution*:** Tropical and subtropical Asia to tropical Australia (POWO, 2025).

**Key to the species of sect. Meionula**

1. Racemes glabrous, or sometimes sparsely hairy at the peduncle base only; leaves linear to oblanceolate ..... **2**

1. Racemes pubescent, always covered with multicellular hairs, extend up to the calyx lobes and sometimes towards the apex of spur; leaves oblanceolate to obovate .....**U. hirta**

2. Pedicel shorter than bracts and bracteoles; lower calyx lobes three toothed at apex; corolla mauve-purple, throat white, palate white with two yellow dome-like projection; spur horizontal, rounded at apex.....**U. geoffrayi**

2. Pedicel longer than bracts and bracteoles; lower calyx lobes truncate at apex; corolla pink or white, throat white with a pale yellow patch, palate white and flat; spur pointed downwards, truncate to emarginate at apex ..... **U. minutissima**

**1. Utricularia geoffrayi** Pellegr., Bull. Mus. Natl. Hist. Nat. 24: 181. 1920, in Lecomte (ed.), Fl. Indo-Chine 4: 481. 1930; P.Taylor, Gen. *Utricularia* 177. t. 39. 1989; J.Parn., Thai Forest Bull., Bot. 33: 122. 2005. *Lectotype* (designated by Taylor, 1989): CAMBODIA, Kep, 08.09.1904, *M. Geoffray* 432 (P [P00390555 digital image!]).

**Figs. 22–24**

Terrestrial annual herbs. Rhizoids numerous on nodes at peduncle base, 2.5–5.5 × 0.08–0.09 mm, terete, capillary, simple, obscurely branched, papillose. Stolons a few, 2–6 × 0.08–0.1 mm, terete, glabrous, hyaline. Leaves a few on stolons; petioles 5–7 × 0.1–0.2 mm, terete, hyaline; lamina linear-oblanceolate, 3–7 × 0.2–0.4 mm, 1-nerved, green, narrowly attenuate at base, margin entire, rounded at apex. Traps numerous on rhizoids, stolons and petiole, oblongoid, 0.3–0.45 × 0.2–0.3 mm; mouth lateral; stalk *c.* 0.3 mm long, terete; appendages dorsal one beak-like, lateral two rows of multicellular trichomes with gland tipped ends. Racemes erect, 1–8 (–15) cm long, simple or branched, 1–6-flowered, flowers lax; peduncles terete, 0.2–0.3 mm thick, reddish green, sparsely hairy towards base. Scales numerous, deltate, 0.6–0.7 × 0.2–0.3 mm, basifixed, 1-nerved, fertile, greenish purplish, sparsely hairy, truncate at base, acute-acuminate at apex. Bracts ovate, 0.7–0.85 × 0.3–0.35 mm, basifixed, 1-nerved, truncate at base, acute-acuminate at apex; bracteoles lanceolate-ovate, 0.6–

0.8 × 0.2–0.3 mm, basifixed, 1-nerved, similar to bracts, truncate at base, acute at apex. Flowers 3–7 mm long; pedicels 0.35–0.5 × 0.1–0.15 mm, erect, terete, shorter than bract and bracteoles, green to reddish green. Calyx lobes sub-equal, convex, purplish green, sparsely hairy out, glabrous in; upper lobe ovate, 1–1.5 × 0.9–1.27 mm, obtuse-rounded at apex; lower lobe ovate, 1–1.35 × 0.8–1.15 mm, 3-toothed at apex. Corolla mauve-purple; upper lip oblong-obovate, deltate towards base, 1.8–3.2 × 0.6–0.85 mm, constricted at middle, mauve with 4–5 purple streaks, margin hairy, tip inflexed, truncate-rounded at apex; lower lip transversely oblong, 1.62–2.8 × 1.9–3.35 mm, palate white towards throat, purple then with deep purple striations, throat white, raised with two, yellow dome-like projections, glandular hairy, 3-lobed at apex, margins curved in then; spur subulate, 3–4 × 0.6–0.76 mm, twice long as the lower lip of corolla, horizontal, or curved upwards, pale purple at base, darker then, rounded at apex. Stamens 0.8–1 mm long; filaments oblong, 0.59–0.78 × 0.18–0.25 mm, curved towards middle; anther theca distinct, 0.4–0.5 mm long. Pistil 1.1–1.2 mm long; ovary ovoid-ellipsoid, 0.57–0.6 × 0.43–0.5 mm, green; style distinct, 0.2–0.28 mm long, hyaline; stigma 2-lipped, upper lip narrowly triangular, lower lip sub-orbicular. Capsules ellipsoid, 1.3–1.6 mm long, wall uniformly thickened, dehiscing by a single, longitudinal, ventral slit; placenta ellipsoid, 0.7–0.8 × *c.* 0.5 mm. Seeds numerous, obovoid to oblongoid, 0.2–0.25 × 0.13–0.14 mm; hilum latero-terminal.

**Fig. 22.** Lectotype of *Utricularia geoffrayi* Pellegr. [*M. Geoffray* 432 (P00390555)] "© *The vascular plants collection (P) at the Herbarium of the Muséum national d'Histoire Naturelle (MNHN - Paris*".

***Flowering & fruiting***: Flowers from mid-November to the end of January, and fruits from early December to mid-February.

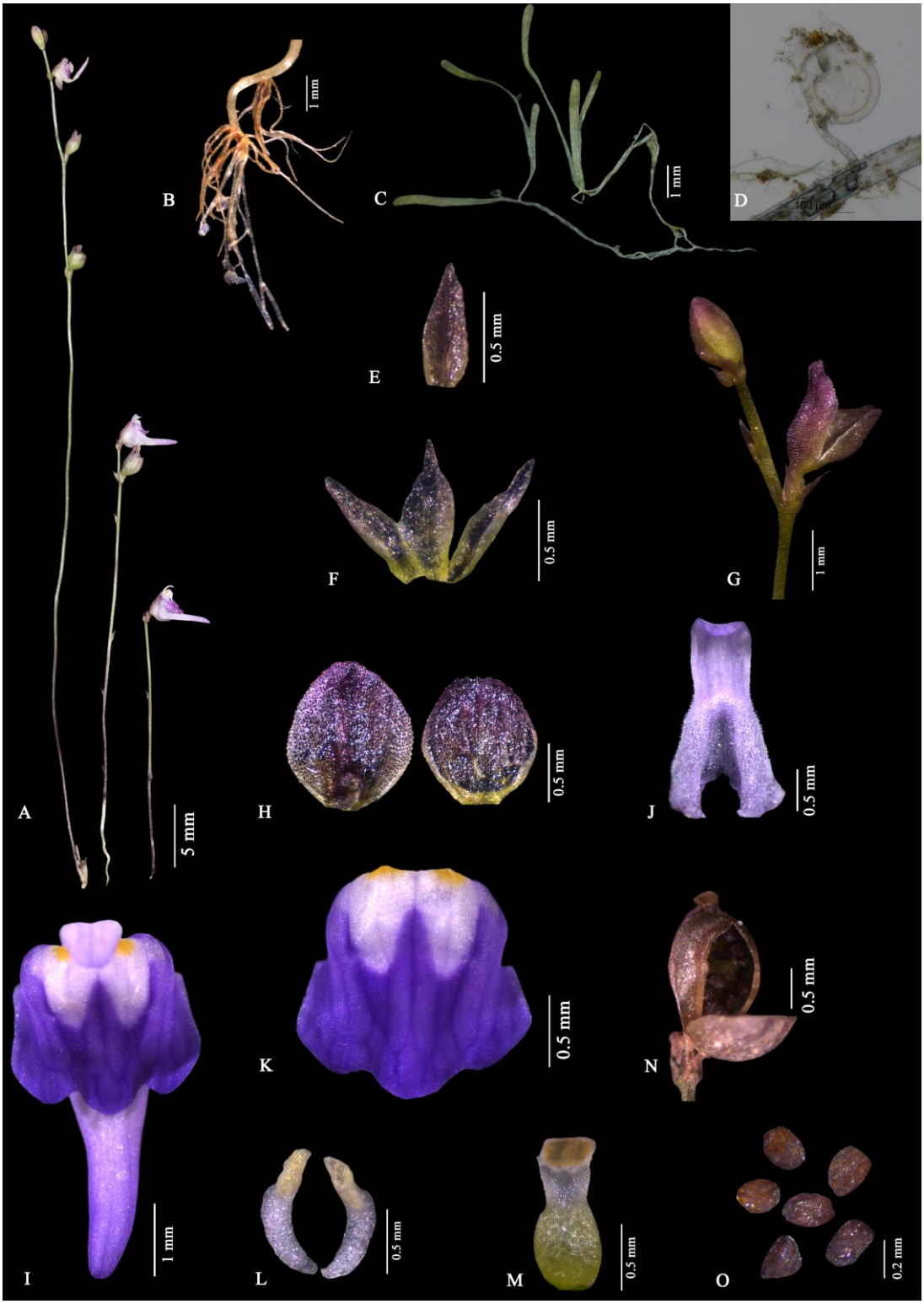


**Fig. 23.** *Utricularia geoffrayi* Pellegr.: **A.** Habit (note the size range); **B.** Peduncle base; **C.** Stolon bearing leaves and traps; **D.** Trap; **E.** Scale; **F.** Bract and bracteoles; **G.** Peduncle bearing young capsule and bud; **H.** Calyx lobes; **I.** Corolla; **J.** Upper lip of corolla; **K.** Lower lip of corolla; **L.** Stamens; **M.** Pistil; **N.** Capsule; **O.** Seeds.

**Fig. 24.** *Utricularia geoffrayi* Pellegr.: **A-C.** Habitat; **D & E.** Habit (note less than 1 cm height in D); **F-G.** Flower - close-up view; **H & I.** Peduncle bearing mature capsules, flower and young buds.

***Habitat***: *Utricularia geoffrayi* is found in the margins of open, swampy, or water-soaked sandy soil patches between rocky outcrops, at an elevation of 50 m above sea level, in association with *U. bifida, U. caerulea*, *U. hirta*, *U. minutissima*, *U. polygaloides*, *Drosera indica* L., *D. burmanni* Vahl (both Droseraceae), *Dopatrium* sp. (Plantaginaceae), *Eriocaulon* spp. (Eriocaulaceae), *Canscora* sp., *Hoppea fastigiata* (Griseb.) C.B.Clarke (both Gentianaceae), *Rhamphicarpa* sp., *Striga angustifolia* (D.Don) C.J.Saldanha (both Orobanchaceae), some grasses and sedges (Fig. 24).

***Distribution***: India, Cambodia, Laos, Thailand and Vietnam (Taylor, 1989; POWO, 2025) (Fig. 25).

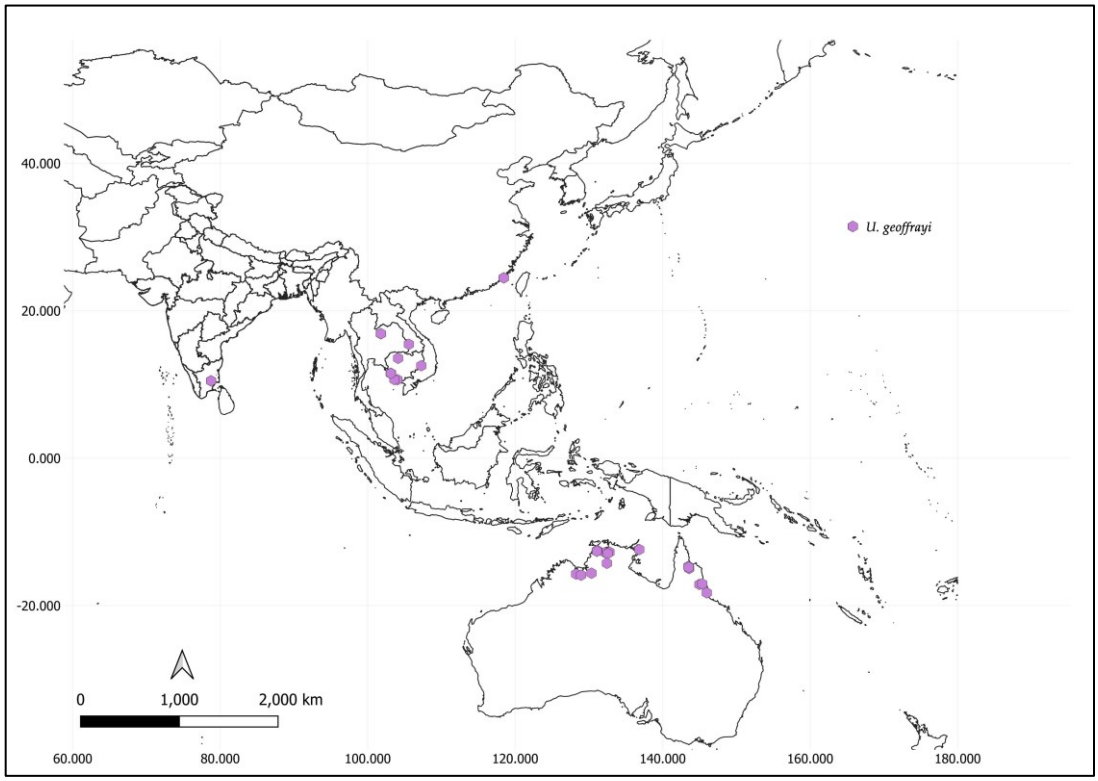


**Fig. 25.** Distribution of *Utricularia geoffrayi* Pellegr.

***Specimens examined***: INDIA, **Tamil Nadu**, Pudukkottai district, Narthamalai, *c*. 50 m, 12.12.2022, *M.P. Krishnapriya* 177210; *Ibid*., ± 50 m, 07.01.2024, *M.P. Krishnapriya* 186089 (CALI).

***Conservation status***: *Utricularia geoffrayi* is found in a small area in Narthamalai of Pudukkottai district, Tamil Nadu. It is restricted to a small patch of less than 70 square meter, located between two sedimentary rocky outcrops. Less than 100 individuals were found, scattered randomly along with six other species of *Utricularia*. During my visits, I observed a rapid decline in both the area and quality of the habitat (Fig. 195N-P). The habitat is under extreme threat due to heavy mining and quarrying activities in the area, as the Government of Tamil Nadu has highlighted the commercial value of Pudukkottai district due to its high limestone deposits (Pudukkottai district survey report, May 2019).

Narthamalai is nearest to the coastal region in the Bay of Bengal, with potential for similar habitats that may support *U. geoffrayi*. It is plausible that this species is distributed in similar habitats in nearby areas, though further investigations are needed to confirm its extended distribution. With the current data, its conservation status cannot be assessed with certainty. Thus, the species is assessed here as Data Deficient (DD).

***Notes***: *Utricularia geoffrayi* is superficially similar to *U. minutissima*, but can be differentiated by differences in the size of the pedicel, bract, and bracteoles as well as the characters of the corolla and spur. This species It has a pedicel shorter than the bract and bracteoles, a white dome-like projection, a prominent yellow colouration of the palate throat, and a horizontal spur. This species is relatively larger (1–8, up to 15 cm) than *U. minutissima*, although, small forms under 10 mm can also be found in the field (Fig. 24D). *Utricularia geoffrayi* is often confused with *U. caerulea* in the field, but the adnation of scale, bracts, and bracteoles provides a clear distinction between the two species.

The epithet 'geoffrayi' honours C. Geoffray, a French botanical collector in colonial French Indochina in the early twentieth century.

**2. Utricularia hirta** J.G.Klein ex Link, Jahrb. Gewachsk. 1(3): 55. 1820; A.DC. in DC. (ed.), Prodr. 8: 25. 1844; Oliv., J. Proc. Linn. Soc., Bot. 3: 183. 1859; Drury, Handb. Ind. Fl. 2: 124. 1866; C.B.Clarke in Hook.f. (ed.), Fl. Brit. India 4: 332. 1884; Prain, Bengal Pl. 2: 781. 1903; Haines, Bot. Bihar Orissa 4: 645. 1925; Pellegr. in Lecomte (ed.), Fl.

Indo-Chine 4: 479. 1930; J.Joseph & Ramam., J. Bombay Nat. Hist. Soc. 58: 832. 1961; Basak, Bull. Bot. Surv. India 17: 102. 1975; P.Taylor in Steenis (ed.), Fl. Males. Ser. 1. Spermat. 8(2): 287. t. 11. 1977; N.Rani & K.M.Matthew in K.M.Matthew (ed.), Fl. Tamilnadu Carnatic 3(1): 1116. f. 85 d. 1983; V.Chandras. in A.N.Henry *et al*. (eds.), Fl. Tamil Nadu Ind. Ser I: Analysis 2: 130. 1987; P.Taylor, Gen. *Utricularia* 174. t. 38. 1989; Janarth. & A.N.Henry, Bladderworts India 72. t. 15. 1992; K.M.Matthew, Excurs. Fl. Central Tamilnadu (reprint ed.) 358. 1995; R.C.Srivast. in Mudgal *et al*. (eds.), Fl. Madhya Pradesh 2: 254. 1997; N.P.Singh *et al*., Fl. Bihar, Analysis 367. 2001; Sauris Panda & A.P.Das, Fl. Sambalpur 260. 2004; J.Parn., Thai Forest Bull. Bot. 33: 126. 2005; K.K.Khanna *et al*., Florsit. Diversity Chhattisgarh 330. 2005; Li in Wu *et al*. (eds.), Fl. China 19: 483. 2011; Govekar & Sardesai, ZOO's Print 26: 24. 2011; P.K.Verma, Carniv. Pl. Newslett. 43(2): 54. 2014; Britto, Fl. Central North Tamil Nadu 3: 2114. 2019; S.K.Mandal & Bhaumik in Lakshmin. *et al*. (eds.), Fl. West Bengal 4: 144. 2019. *Type*: INDIA, *s.loc*., 1797, *Klein s.n.* (holo, B-W [B–W00447-010 digital image!]).

**Figs. 26–28**

*Utricularia capillacea auct. non* Willd.: Vahl, Enum. Pl. 1: 204. 1804

*Utricularia setacea* Wall., Numer. List n. 6389. 1832, *nom. nud. non* Michx. 1803. *Type*: Hb. Madras, *s.d.*, *Wallich* 6398 (K [K001123779 digital image!])

*Trixapias capillacea* Raf., Fl. Tellur. 1: 108. 1836

*Utricularia hirta* var. *elongata* Pellegr. in H.Lecomte (ed.), Fl. Indo-Chine 4: 479. 1930. *Type*: Riviere d' Ubon, *s.d., Thorel s.n.* (holo, P not seen)

*Utricularia tayloriana* J.Joseph & J.Mani, Bull. Bot. Surv. India 24(1–4): 108. 1983. *Type*: INDIA, **Meghalaya**, East Khasi Hills district, 20th mile, Shillong to Pynursla road, near the 2nd check gate, 26.08.1980, *J. Joseph* 73568A (holo, ASSAM [ASSAM0000000139!])

Terrestrial, annual herbs. Rhizoids numerous from nodes at peduncle base, 6–7 × 0.02–0.03 mm, simple, capillary, congested, papillose. Stolons a few, *c.* 10 × 0.08–0.15 mm, filiform, simple or branched, sparsely papillose, hyaline. Leaves numerous on

stolons, 1–10 (–15) mm long, glabrous, green; petioles 0.8–10 mm long, terete, hyaline; lamina oblanceolate-obovate, 0.6–8 × 0.25–0.5 mm, 1-nerved, attenuate at base, margins entire, obtuse-rounded at apex. Traps numerous on rhizoids, stolons and petioles, ovoid-oblongoid, 0.2–0.3 × 0.2–0.35 mm; stalk 0.4–0.5 mm long, terete; mouth lateral; appendages of three connate processes, the one on upper lip subulate, 2 lateral, wing-like hairs with gland tipped apex. Racemes erect, simple or branched, 4–12 (–30) cm long, 1–6-flowered, flowers lax; peduncles terete, 0.2–0.4 mm thick, filiform, ± tomentose with septate hairs. Scales a few, narrowly deltate, 0.5–0.7 × 0.1–0.3 mm, basifixed, 1-nerved, fertile, truncate at base, acute at apex. Bracts ovate-deltate, 0.5–0.8 mm long, basifixed, 1-nerved, pubescent, truncate at base, acute or rarely dentate at apex; bracteoles narrowly lanceolate, 0.4–0.8 mm long, basifixed, 1-nerved, pubescent, truncate at base, acute at apex. Flowers 1.5–8.5 (–10) mm long; pedicels 0.5–1 mm long, erect, terete, longer than bracts, ± pubescent. Calyx lobes sub-equal, convex, purplish green, glabrous in, ± pubescent out with unicellular hairs; upper lobe ovate, 1.4–2 × 0.7–1.3 mm, obtuse-emarginate at apex; lower lobe ovate-widely ovate, 1–1.7 × 0.7–1.5 mm, rounded at apex. Corolla mauve to purple; upper lip obovate, 2.8–4.5 × 1–2 mm, deltate at base, constricted at middle, mauve with 4–6 purple streaks, margin hairy, emarginate-rounded at apex; lower lip transversely oblong-sub-orbicular, 3–5 × 3–6 mm, mauve to purple, palate white, throat hairy, with two dome-like yellow swelling, 3-lobed at apex; spur subulate, 3–6 mm long, slightly constricted at middle, sparsely puberulent, rounded to bidentate at apex.

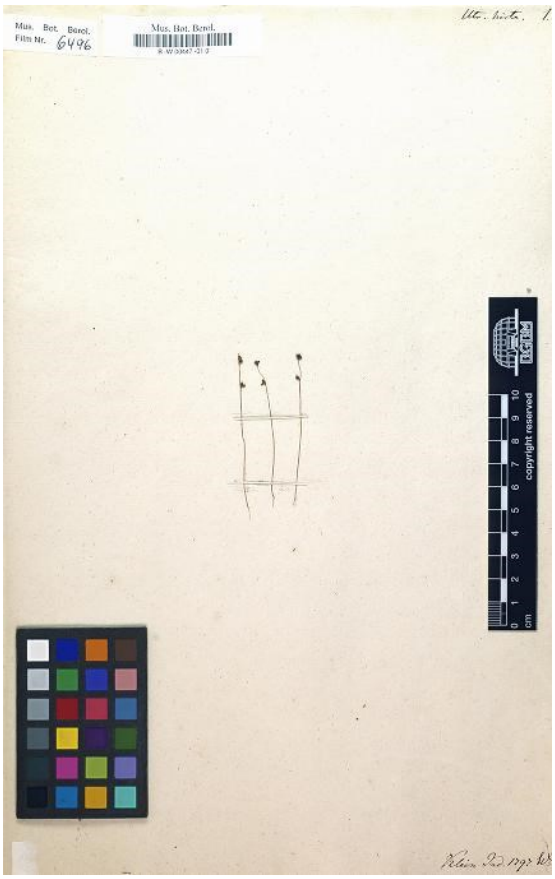


**Fig. 26.** Type of *Utricularia hirta* J.G.Klein ex Link [*Klein s.n.* (B–W00447-010)] "© *Botanic Garden and Botanical Museum Berlin-Dahlem, Freie Universität Berlin*".

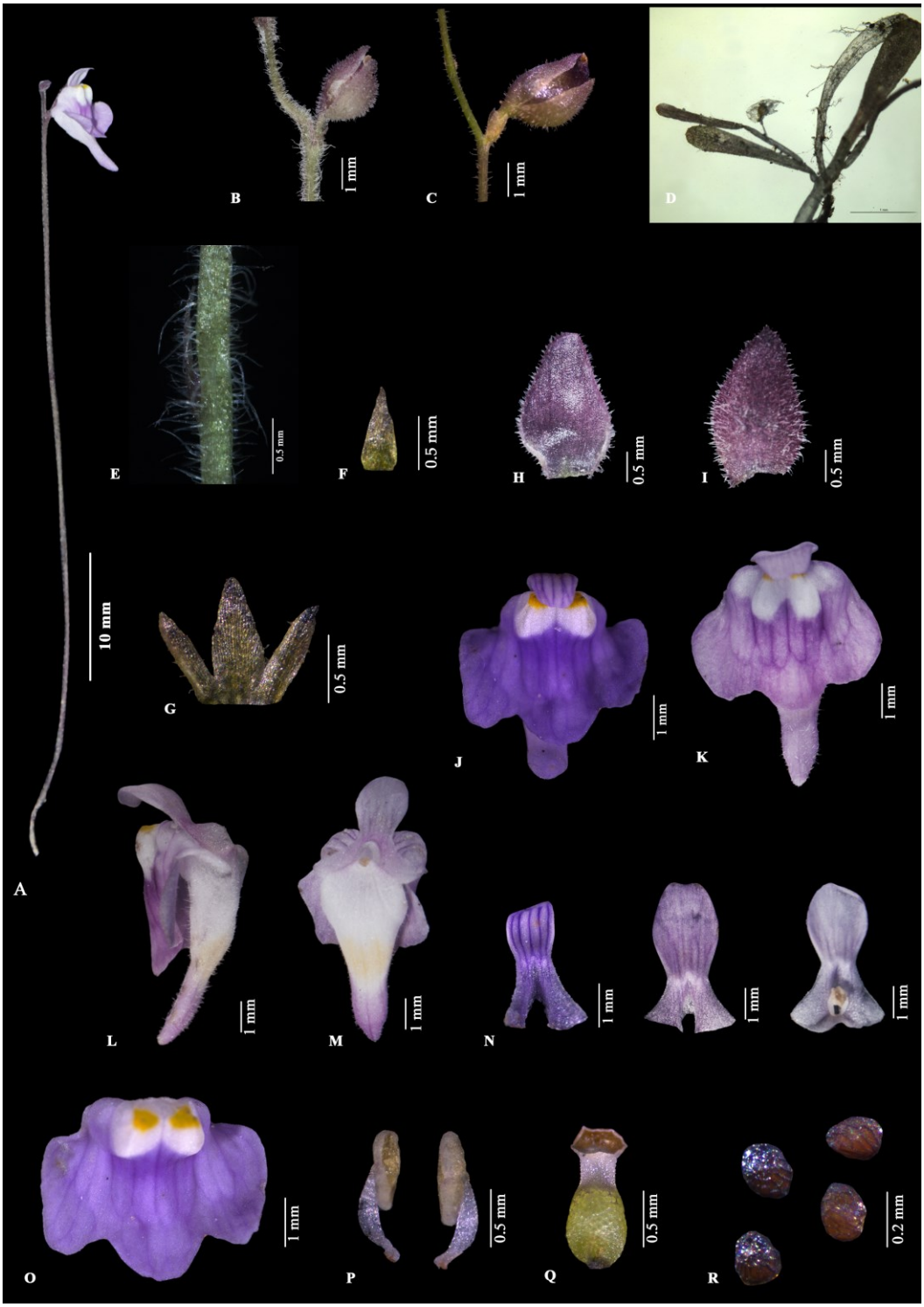


**Fig. 27.** *Utricularia hirta* J.G.Klein ex Link: **A.** Habit; **B & C.** Hairiness in peduncle and pedicel; **D.** Leaves bearing traps; **E.** Hairy peduncle - close-up view; **F.** Scale; **G.** Bract and bracteoles; **H.** Upper calyx lobe; **I.** Lower calyx lobe; **J & K.** Corolla - front view (note the colour and lobing of the lower lip, and shape and size of spur); **L & M.** Corolla - lateral and dorsal view; **N.** Upper lips of corolla; **O.** Lower lip of corolla (note the projection on the palate); **P.** Stamens; **Q.** Pistil; **R.** Seeds.

**Fig. 28.** *Utricularia hirta* J.G.Klein ex Link: **A-C.** Habitat and habit; **D.** Branched peduncle; **E-K.** Variations in the colour of the flower, shape and size of the spur.

Stamens 1–1.3 mm long; filaments 0.4–0.6 × 0.1–0.2 mm, linear, curved; anther thecae distinct, 0.5–0.8 mm long. Pistil 1–1.5 mm long; ovary ovoid-oblongoid, 0.6–0.8 × 0.4–0.6 mm, glabrous, green; style distinct, 0.2–0.3 × 0.2–03 mm, sparsely puberulent, white-pale lilac; stigma 2-lipped, upper lip short, obscurely 3-lobed, lower lip sub-orbicular. Capsules obliquely ovoid, 1.4–1.8 mm long, wall thickened along dehiscing margin, dehiscing by a single, ventral longitudinal slit; placenta *c.* 1 × 1 mm, sub-globose. Seeds ovoid-oblongoid, 0.18–0.25 × 0.15–0.2 mm; surface rough; hilum latero-terminal.

***Flowering & fruiting***: Flowers from late August to early January, and fruits from early September to late January.

***Habitat***: *Utricularia hirta* grows in water-soaked sandy clay loam soil at elevations above 50 m, in association with species, such as *U. bifida, U. caerulea*, *U. minutissima, U. polygaloides*, *Drosera indica*, *D. burmanni* (both Droseraceae), *Eriocaulon* spp. (Eriocaulaceae), *Euphorbia thymifolia* L. (Euphorbiaceae), *Murdannia striatipetala* Faden, *M. vaginata* (L.) G.Bruckn. (both Commelinaceae), *Rhamphicarpa* sp., *Striga angustifolia* (both Orobanchaceae), sedges, and some grasses. In Northeast India, it occurs in sandy plains at altitudes between 800–1350 m, where it grows alongside *U. caerulea*, *Eriocaulon* sp. (Eriocaulaceae), *Melastoma* sp. (Melastomataceae), and some sedges and grasses (Fig. 28).

***Distribution***: India, Bangladesh, Cambodia, Laos, Sri Lanka, Thailand, Vietnam and Borneo (Taylor, 1989; Janarthanam & Henry, 1992; POWO, 2025) (Fig. 29).

***Specimens examined***: INDIA, Cherra Plateau? *s.loc.*, 4500 feet, 29.09.1867, *s.coll.* 5124 (CAL). **Meghalaya**, Mont. Khasia, *s.loc.*, 2-4000 feet, *s.d.*, *J.D. Hooker & T. Thomson s.n.* (GH01977098, L.2828596 digital images, CAL); Jaintia Hills district, way to Dawki, ± 2786 feet, 25.09.2021, *M.P. Krishnapriya & Santhosh Nampy* 175895 (CALI186875; CALI186876); way to Jarain, ± 830 m, 25.09.2021, *M.P. Krishnapriya* 175890 (CALI186871); *Ibid*., ± 1300 m, 23.09.2021, *M.P. Krishnapriya* 175886; *Ibid*, ± 1230 m, 23.09.2021, *M.P. Krishnapriya* 175890 (CALI186872, CALI186873, CALI186874); Jowai, *c.* 1500 m, 31.08.1980, *H. Deka* 77232 (ASSAM0000000141, ASSAM0000000142, ASSAM0000000143); opposite Pine Garden, Shillong to Jowai route, ± 1350 m,

23.09.2021, *M.P. Krishnapriya* 175884 (CALI). **Odisha**, Angul district, Poipal Dalki, 300 feet, 15.12.1940, *H.F. Mooney* 1645 (DD). **Tamil Nadu**, Pudukkottai district, Narthamalai, 30.11.1967, *K.M. Matthew* 8263 (RHT044608, RHT044608); *Ibid*., 12.12.2022, *M.P. Krishnapriya* 186038; *Ibid*., 07.01.2024, *M.P. Krishnapriya* 186092; way to Vijayalaya Choleeswaram Temple, 11.12.2022, *M.P. Krishnapriya* 186035 (CALI). **West Bengal**, Manbhum, *s.d., Revd. J. Campbell* 188 (DD); East Bengal, *s.loc., s.d., Herb Griffith* 4082 (GH01977097).

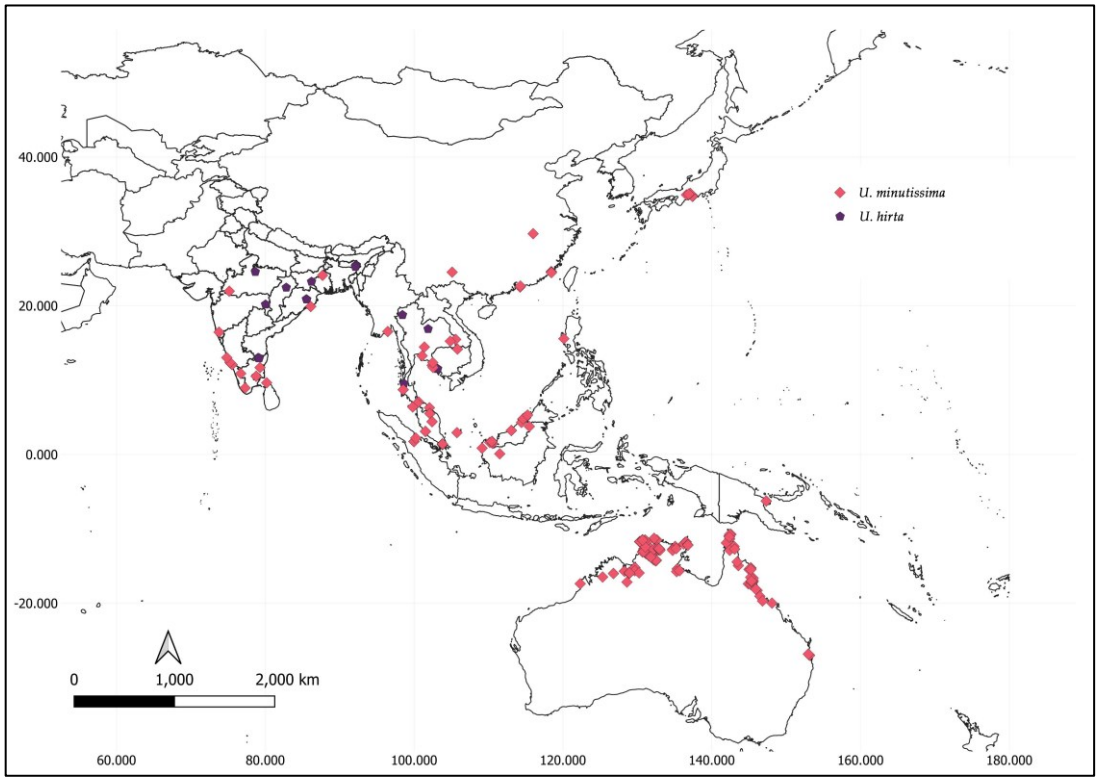


**Fig. 29.** Distribution of *Utricularia hirta* J.G.Klein ex Link and *Utricularia minutissima* Vahl

***Conservation status***: *Utricularia hirta* has a widespread distribution from India to Southeast Asia. Mining and quarrying for coal, sand and stones are the major threat to its habitat. Considering its broad distribution, the status of *U. hirta* is provisionally assessed here as Least Concern (LC).

***Notes***: *Utricularia hirta* is one of the most distinct species in India, due to its variously hairy inflorescence and striking flowers. The size and nature of hairiness vary both among and within populations: in some instances, short septate hairs (*c*. 0.1 mm long)

sparsely cover the peduncle, while in other populations, long septate hairs (up to 4 mm long) densely or sparsely cover the peduncle, with many intermediate hair types in between (Fig. 25E). The long, appressed hairs have a silky appearance on the peduncle, extending up to the calyx lobes, and are rarely found on the spur. It is closely allied to *U. minutissima*, but can be easily differentiated by the characteristics of its hairs.

**3. Utricularia minutissima** Vahl, Enum. Pl. 1. 204. 1804; A.DC. in DC. (ed.), Prodr. 8: 16. 1844; Oliv., J. Proc. Linn. Soc., Bot. 3: 190. 1859; C.B.Clarke in Hook.f. (ed.), Fl. Brit. India 4: 334. 1884; Ridl., Fl. Malay Penins. 2(2): 492. 1923; R.V.Nair, J. Bombay Nat. Hist. Soc. 62(1): 180. 1965; Abraham, J. Bombay Nat. Hist. Soc. 63(2): 459. 1966; Rao & L.K.Banerjee, J. Bombay Nat. Hist. Soc. 64(3): 584. 1967; P.Taylor, Fl. Males. Ser. 1. Spermat. 8(2): 286. t. 10. 1977; N.Rani & K.M.Matthew in K.M.Matthew (ed.), Fl. Tamilnadu Carnatic 3(1): 1117. f. 86e. 1983; P.Taylor, Gen. *Utricularia* 170. t. 37. 1989; Janarth. & A.N.Henry, Bladderworts India 72. t. 20. 1992; K.M.Matthew, Excurs. Fl. Central Tamilnadu (reprint ed.) 358. 1995; K.G.Bhat, Fl. Uduppi 456. 2003; L.K.Banerjee & T.A.Rao, Fl. Mahanadi Delta, Orissa 228. 2001; J.Parn., Thai Forest Bull. Bot. 33: 130. 2005; Sunil, Fl. Alappuzha 519. 2009; Li in Wu *et al*. (eds.), Fl. China 19: 482. 2011; Punekar & Lakshmin. Fl. Anshi Natl. Park 336. 2011; K.G.Bhat, Fl. South Kanara 769. 2014; Ansari *et al*., Aquatic Wetland Fl. Kerala: Fl. Pl. 519. 2016; Britto, Fl. Central North Tamil Nadu 3: 2115. 2019; S.K.Mandal & Bhaumik in Lakshmin. *et al*. (eds.), Fl. West Bengal 4: 144. 2019. *Lectotype* (first-step designated by Taylor, 1989; second-step designated here): Malay Peninsula, 'Malacca', *s.d.*, *J. Koenig s.n.* (C [C10013913 digital image!]). **Figs. 30 & 31**

*Utricularia capillacea* Wight in Wall., Numer. List. n. 6399. 1828 *nom. illeg. superfl*. *Utricularia capillacea* Wight ex Oliv., J. Proc. Linn. Soc. Bot. 3: 184. 1859; Trimen, Handb. Fl. Ceylon 3: 270. 1895. *Type*: INDIA, *s.loc.*, *s.d.*, *Hb. Wight* 6399 (K [K001123780 digital image!])

*Utricularia lilliput* Pellegr., Bull. Mus. Nat. Hist. Nat. 16: 181. 1920; Subr. & N.P.Balakr. Bull. Bot. Surv. India 2(3&4): 347. 1960. *Type*: VIETNAM, Tho Mat, *s.d.*, *Bon* 1825 (holo, P not seen)

Small terrestrial, annual herbs. Rhizoids a few, 0.5–5 × 0.02–0.04 mm, simple, filiform, papillose. Stolons numerous, 4–10 × 0.1–0.2 mm, simple or sparsely branched, capillary, papillose, hyaline. Leaves a few on peduncle base and stolons; petioles 0.1–6 mm long, filiform, hyaline; lamina linear to oblanceolate, 0.5–12 × 0.2–0.5 mm, 1-nerved, membranous, glabrous, attenuate at base, entire at margin, obtuse to rounded at apex. Traps numerous on rhizoids, stolons and petioles, ovoid 0.15–0.25 × 0.1–0.2 mm; stalk 0.2–0.4 mm long; mouth lateral; dorsal appendage subulate, beak-like with 2 ventral pairs of multicellular trichomes with gland tipped ends. Racemes erect, 2–6 cm long, (sometimes reaches only 5 mm), solitary, 1–3-flowered; peduncles terete, 0.1–0.2 (–0.5) mm thick, filiform, usually glabrous, sparsely hairy at base, brownish purple. Scales a few, ovate-lanceolate, 0.1–0.4 × 0.06–0.1 mm, basifixed, acute at apex. Bracts narrowly ovate, 0.3–0.5 × 0.08–0.1 mm, basifixed, purplish green, acute at apex; bracteoles lanceolate, 0.2–0.3 × 0.06–0.07 mm, basifixed, equal to bracts, purplish green, acute at apex. Flowers 2–6 mm long; pedicels 0.5–1 mm long, erect, terete, always longer than bract and bracteoles. Calyx lobes sub-equal, convex, glabrous; upper lobe ovate, 1.2–1.5 × 1–1.25 mm, margin minutely dentate, obtuse at apex; lower lobe elliptic, 1–1.25 × 0.8–1 mm, emarginate at apex. Corolla pink or rarely white; upper lip oblong-obovate, 0.5–2.3 × 0.1–0.4 mm, deltate at base, rounded-emarginate at apex; lower lip sub-orbicular, 2.2–4 × 1.8–3.4 mm, throat pale yellow, palate white, pink then, obscurely 3-lobed at apex;

**Fig. 30.** Lectotype of *Utricularia minutissima* Vahl [*Koenig s.n.* (C10013913)] "© *Reproduced with permission of the Natural History Museum of Denmark*".

**Fig. 31.** *Utricularia minutissima* Vahl: **A, C & D.** Habitat; **B & G.** Peduncle bearing flowers; **E.** Habit; **F.** Growing along with *Drosera indica* L. (Photo A. from Haritha P. Bharathan).

spur subulate, *c.* 0.6 × 0.15–0.8 mm, pointed downward, twice as long than the lower lip of corolla, truncate-emarginate at apex. Stamens 0.7–0.8 mm long; filaments 0.5–0.6 × *c.* 0.1 mm, slightly curved; anther theca distinct, *c.* 0.2 mm long. Pistil *c.* 1 mm long; ovary ovoid, 0.6–0.8 × *c.* 0.25 mm; style distinct, *c.* 0.2 mm long; stigma 2-lipped, upper lip deltate, lower lip widely elliptic, papillose. Capsules obliquely ellipsoid, 1.5–2 mm long, wall uniformly membranous, dehiscing by a single marginally thickened, ventral longitudinal slit; placenta ovoid, *c.* 0.6 × 0.32 mm. Seeds obovoid to oblongoid, 0.2–0.25 × 0.18–0.22 mm; hilum latero-terminal.

***Flowering & fruiting***: *Utricularia minutissima* flowers from mid-July to the end of December, and fruits from August to early January.

***Habitat***: It grows either in seasonally inundated or in open lateritic soils, often in association with *Utricularia sainthomia* P.Biju *et al.*, *Eriocaulon* spp. (Eriocaulaceae), *Drosera indica* (Droseraceae), *Isachne* sp. (Poaceae), *Rhamphicarpa* sp., *Striga angustifolia* (both Orobanchaceae) and some grasses or in water-soaked sandy soils along with *Utricularia bifida*, *U. caerulea*, *U. geoffrayi*, *U. hirta*, *U. polygaloides, Drosera burmanni*, *D. indica* (both Droseraceae), *Dopatrium* sp. (Plantaginaceae), *Eriocaulon* spp. (Eriocaulaceae), *Canscora* sp., *Hoppea fastigiata* (both Gentianaceae), some grasses, and sedges (Fig. 31).

***Distribution***: India, Australia, Borneo, Cambodia, China, Japan, Laos, Malaysia, Myanmar, New Guinea, Philippines, Thailand, Vietnam, Sri Lanka and Sumatra (Taylor, 1989; Janarthanam & Henry, 1992; POWO, 2025) (Fig. 29).

***Specimens examined***: INDIA, **Karnataka**, Dakshina Kannada district, Surathkal-Mangalore, 0.5 m, 14.08.1981, *Cecil J. Saldanha* KPF13474 (JCB). **Kerala**, Kannur district, Aravanchal, Chooral, ± 15 m, 31.07.2022, *M.P. Krishnapriya* 177261 (CALI); Kozhikode district, Vadakara, Iringal, September 1966, *R. Vasudevan Nair s.n.* (MH00126268); near Iringal Railway station, ± 3 m, 25.08.1985, *M.K. Janarthanam* 82934 (MH00126266, MH00126267); Palakkad district, Malampuzha water tank hillock, 15.09.1985, *M.K. Janarthanam* 82939 (MH00126264). **Odisha**, Puri district, Konark Coast, Chandrabhaga, 26.10.1967, *A.K. Mukherjee* 6054 (CAL). **Tamil Nadu**, Kallakurichi district, Uludurpettai, Pulloorkkadu, 11.12.1979, *K.M. Matthew* 25000

(RHT044620); *Ibid*., 11.12.1979, *K.M. Matthew* 25003 (RHT044621); Pudukkottai district, Narthamalai, 125 m, 23.09.1965, *K. Ramamurthy* 25943 (MH00126269); *Ibid*., 12.12.2022, *M.P. Krishnapriya* 186039; *Ibid*., way to Vijayalaya Choleeswaram Temple, 11.12.2022, *M.P. Krishnapriya* 186034 (CALI); Tenkasi district, Courtallum, Main Falls, 433 m, *s.d*., *K. Subramanyam* 5035 (MH00126271). **Uttarakhand**, Dehradun district, Rajpur, 950 m, 01.10.1961, *Hari Om Saxena* 2327B (DD). **West Bengal**, Birbhum district, Deer Park, Shantiniketan, 14.10.1968, *R.K. Basak* 937 (CAL).

***Conservation status***: This species is distributed in Southeast Asia to tropical Australia and has a moderate distribution in India. Potential threats to its habitat include mining, quarrying and other land-reuse practices. Based on current data, this species is assessed here as Least concern (LC).

***Notes***: *Utricularia minutissima*, as the name suggest, is a diminutive herb, with a size range from 0.5 to 50 mm length. Its tiny habit and filiform peduncle make it difficult to locate in the field. Despite its wide distribution, it is poorly represented in Indian herbaria. The species often develops cleistogamous flowers less than 1 mm in size, and in such cases, the plant may be as small as 5 mm length.

***Typification***: Vahl (1804) described *U. minutissima* based on the specimen of Koenig from Malacca. I attempted to locate this specimen at BM (where Koenig's materials are housed, TL2), but was unable to find any of his specimens. Taylor (1989) examined a specimen housed at C and ascribed it as the holotype in his work. While searching the specimens, I found two sheets at C (C10013913, C10013914), each with a slip of Koenig's collection. According to Art. 9.17 of the ICN (Turland *et al.,* 2018), the initial type citation should be accepted as a first-step lectotypification, as it is uncertain which of the sheets at C was selected by Taylor (*l.c.*) as the type. Therefore, to narrow down to a single specimen, I followed a second-step lectotypification according to Art. 9.17 of ICN (Turland *et al*. 2018), and the sheet C10013913 with fruits, is designated here as the lectotype of *U. minutissima*.

## 5.3. UTRICULARIA SECT. NIGRESCENTES (OLIV.) KOMIYA

**Utricularia sect. Nigrescentes** (Oliv.) Komiya, J. Jap. Bot. 48(5): 151. 1973; P.Taylor, Kew Bull. 41(1): 6. 1986, Gen. *Utricularia* 186. 1989; Krishnapriya *et al*., Rheedea 34(1): 23. 2024. *Type*: *Utricularia caerulea* L.

Terrestrial to semi-aquatic herbs. Rhizoids a few, simple or branched. Stolons many, branched. Leaves obovate to spathulate, 1-nerved. Traps numerous on stolons and leaf petiole, ovoid; mouth terminal, extends to an oblique funnel-shaped rim, glandular hairy along margins; internal glands 2–4-armed. Scales and bracts basisolute; bracteoles medifixed or basisolute (basifixed in *U. warburgii*). Inflorescence simple or branched. Calyx lobes sub-equal, minutely papillate. Corolla blue-purple, white or yellow. Pollen 3 or 4-colporate, oblate, spherical or prolate. Capsule wall thickened, dehisce by a ventral slit. Seeds obovoid-oblongoid; testa cells slightly elongate, anticlinal wall concave, periclinal wall convex, surface verrucose or rugulose.

***Notes***: The name '*Nigrescentes*' was first coined by Oliver (1859) to describe a group of *Utricularia* species characterized by shorter pedicels sub-equal to the length of the bracts; medifixed scales, bracts with acute apices, minutely papillate calyx lobes, and a spur that is either shorter or longer than the lower lip of the corolla. Oliver divided this group into two subsections: 1. Corollae calcar labio inferior non longius (short-spurred: *U. rosea* Edgew.), 2. Corollae calcar labium inferius excedens (long-spurred: *U. racemosa* Wall. ex Walp., *U. nivea* Vahl, and *U. filicaulis* Wall.). Komiya (1973) elelvated '*Nigrescentes*' to a formal section, including the species originally treated by Oliver. The section currently includes four species globally, with two species found in India, *U. caerulea* and *U. roseopurpurea*, the latter being endemic to the Western Ghats and Sri Lanka.

***Distribution***: Tropical Africa, Madagascar, Asia to Japan and Australia (Taylor, 1989; Krishnapriya *et al*., 2024; POWO, 2025).

**Key to the species of sect. Nigrescentes**

1. Spur shorter than or equal to the lower lip of corolla; trap appendage coiled; seeds obovoid to oblongoid .....**U. roseopurpurea**

1. Spur longer than the lower lip of corolla; trap appendage beak-like; seeds obovoid to ellipsoid..... **U. caerulea**

**1. Utricularia caerulea** L., Sp. Pl. 1. 18: 1753; Burm.f., Fl. Ind. 11. 1768; Vahl, Enum. Pl. 1: 201. 1804; Wight, Hooker's J. Bot. Kew Gard. Misc. 1: 374. 1849, Icon. Pl. Ind. Orient. 4(4): 11. t. 1583. 1850; Fyson, Fl. S. Ind. Hill Stations 1: 438. 1932; Santapau, J. Bombay Nat. Hist. Soc. 49: 220. 1950; Ramaswamy & Razi, Fl. Bangalore Dist. 546. 1973; Gandhi in C.J.Saldanha & Nicolson (eds.), Fl. Hassan Dist. 564. 1978; N.Rani & K.M.Matthew in K.M.Matthew (ed.), Fl. Tamilnadu Carnatic 3(1): 1112. f. 85c. 1983; D.M.Verma in D.M.Verma *et al.* (eds.), Fl. Raipur, Durg & Rajnandgaon 3: 26. 1985 *excl. syn. U. roseopurpurea*; N.R.Ugemuge, Fl. Nagpur Dist. 273. 1986; V.Chandras. in A.N.Henry *et al.* (eds.), Fl. Tamil Nadu Ind., Ser I: Analysis 2: 129. 1987; Manilal, Fl. Silent Valley 199. 1988; B.G.Kulk., Fl. Sindhudurg 308. 1988; N.P.Singh, Fl. Eastern Karnataka 2: 473. 1988; Taylor, Gen. *Utricularia* 187. 1989 *p.p. excl. syn. U. roseopurpurea*; Vajr., Fl. Palghat Dist. 330. 1990; Kesh.Murthy & Yogan. Fl. Coorg Karnataka 317: 1990 *excl. syn. U. roseopurpurea*; Janarth. & A.N.Henry, Bladderworts India 42. f. 9. 1992; Kothari & Moorthy, Fl. Raigad Dist. 282. 1993; K.M.Matthew, Excurs. Fl. Centr. Tamilnadu 357. 1995; Sasidh. & Sivar., Fl. Pl. Thrissur For. 328. 1996; Naik *et al*., Fl. Marathwada 2: 638. 1998; M.R.Almeida, Fl. Maharashtra 3B: 431. 2001; Londhe in N.P.Singh *et al.* (eds.), Fl. Maharashtra Dicot. 2: 564. 2001; L.K.Banerjee & T.A.Rao, Fl. Mahanadi Delta 227. 2001; N.Mohanan & Sivad., Fl. Agasthyamala 491. 2002; S.R.Yadav & Sardesai, Fl. Kolhapur Dist. 337. 2002; K.G.Bhat, Fl. Uduppi 455. 2003; Subba Rao & Kumari, Fl. Visakhapatnam Dist. 1: 599. 2003; Anil Kumar *et al.*, Fl. Pathanamthitta 367. 2005; Paria & Chattopadh., Fl. Hazaribagh Dist. 2: 797. 2005; Li in Wu *et al.* (eds.), Fl. China 19: 483. 2007 *excl. syn. U. roseopurpurea*; Sunil & Sivad., Fl. Alappuzha Dist. 516. 2009; G.P.Sinha in G.P.Sinha *et al.* (eds.), Fl. Mizoram 2: 194. 2012; Datar & Lakshmin., Fl. Bhagwan Mahavir Natl. Park 175. 2013; K.G.Bhat, Fl.

South Kanara 768. 2014; Nayar *et al*., Fl. Pl. W. Ghats India 1: 584. 2014; S.K.Mandal & Bhaumik in Lakshmin. *et al.* (eds.), Fl. West Bengal 4: 142. 2019; D.Naras. & Sheeba, Fl. Pl. Tamil Nadu 577. 2021 *excl. syn. U. roseopurpurea*. *Lectotype* (designated by Smith, 1808): SRI LANKA (Ceylon), *s.loc.*, *s.d.*, Herb. Hermann 2: 13, No.23 (BM [BM000621547 digital image!]). **Figs. 32–34**

*Utricularia nivea* Vahl, Enum. Pl. 1: 203. 1804; Wall. in Roxb. (ed.), Fl. Ind. 1: 144. 1820; A.DC. in DC. (ed.), Prodr. 8: 21. 1844; Wight, Hooker's J. Bot. Kew Gard. Misc. 1: 372. 1849, Icon. Pl. Ind. Orient. 4(4): 11. t. 1582. 1850; Oliv., J. Proc. Linn. Soc., Bot. 3: 186. 1858; Dalzell, Bombay Fl. 135. 1861; T.Cooke, Fl. Bombay 2: 319. 1905; N.P.Singh, Fl. E. Karnataka 2: 474. 1988. *Type*: SRI LANKA (Ceylon), *s.loc.*, *s.d.*, *J. Koenig s.n.* (holo, C [C10013896 digital image!])

*Utricularia racemosa* Wall. ex Walp., Nov. Actorum Acad. Caes. Leop.-Carol. Nat. Cur. 19 (Suppl. 1): 401. 1843; A.DC. in DC. (ed.), Prodr. 8: 21. 1844; Wight, Hooker's J. Bot. Kew. Gard. Misc. 1: 374. 1849, Icon. Pl. Ind. Orient. 4(4): 11. t. 1584. f. 1. 1850; Oliv., J. Proc. Linn. Soc., Bot. 3: 186. 1858; Fyson, Fl. Nilgiri & Pulney Hill-Tops 1: 308. 1915. *Lectotype* (designated by Taylor, 1989): BANGLADESH, Sylhet (Sillet), *s.loc.*, *s.d.*, *H. Bruce*, Wall. cat. no. 1496.1 (B, not located)

*Utricularia filicaulis* Wall. ex A.DC., Prodr. 8: 21. 1844; Oliv., J. Proc. Linn. Soc., Bot. 3: 186. 1858. *Utricularia racemosa* Wall. ex Walp. var. *filicaulis* (Wall. ex A.DC.) C.B.Clarke in Hook.f. (ed.), Fl. Brit. India 4: 333. 1884. *Utricularia caerulea* L. var. *filicaulis* (Wall. ex A.DC.) Haines, Bot. Bihar Orissa 645. 1922. *Lectotype* (designated by Taylor, 1989): MYANMAR (Burma), Tanintharyi region (Tavoy), *s.d.*, *Gomez s.n.* (G, not located)

*Utricularia rosea* Edgew., Proc. Linn. Soc. London 1: 352. 1847; Oliv., J. Proc. Linn. Soc., Bot. 3: 184. 1858; C.B.Clarke in Hook.f. (ed.), Fl. Brit. Ind. 4: 333. 1884. *Type*: INDIA, **West Bengal**, Bengalia, Burdwan, *s.d.*, *Edgeworth s.n.* (K, not located)

*Utricularia sampathii* Subr. & Yogan., J. Indian Bot. Soc. 60. 123: 1981; M.Ahmed. & M.P.Nayar, Endem. Pl. Indian region 1: 155. 1986. *Type*: INDIA, **Karnataka**, Bangalore district, Dhyanashram, near Bannerghatta, 900 m, 03.11.1976, *K. Subramanyam & S.N. Yoganarasimhan* 123 (holo, CAL [CAL00019121!])

Terrestrial, annual herbs. Rhizoids *c.* 20 mm long, simple, rarely branched, glabrous. Stolons up to 38 mm long, 0.1–0.2 mm thick, terete, glandular, simple or sparsely branched. Leaves rosulate, usually 4 on peduncle base, 1–4 per node on stolons; petioles 1.5–2.5 mm long; lamina narrowly obovate-spathulate, 3.5–8 × 1–1.5 mm, 1-nerved, rounded-obtuse at apex. Traps on petiole base and stolon node, rarely on rhizoids, ovoid, 1–2 mm across, oblique; stalks 0.4–0.5 mm long; mouth terminal, with a triangular, beaked upper lip bearing glandular hairs along margins. Racemes erect, 15–30 (–40) cm long, simple or branched, 1–12 (–20)-flowered, flowers distantly arranged or congested towards apex; peduncles terete, 0.5–1 mm thick, purplish green, glabrous. Scales attached below the middle, elliptic to rhombic, 2–2.5 mm long, 1-nerved, upper acuminate towards apex, lower 2–3-fid. Bracts basisolute, attached just above the middle, elliptic to rhombic, 1.5–3.5 mm long, 1-nerved, acute-acuminate at both apices; bracteoles basisolute, attached just below the middle, rhombic, 1–2.5 mm long, minutely papillate, upper acute at apex, lower 2–3-fid. Flowers 2–7 mm long; pedicels not so prominent, 0.2–0.6 × *c.* 0.4 mm, erect, terete, reflexed in fruit, papillate. Calyx lobes sub-equal, minutely papillose, margin hooded; upper lobe widely ovate to orbicular, 2–2.5 × 1.5–2.5 mm, obtuse-rounded at apex; lower lobe ovate or oblong, 2–2.5 × 1.5–2 mm, rounded at apex. Corolla pale pink to purple or white with a prominent yellow patch at throat; upper lip ovate to oblong, 2–4 × 1.5–1.8 mm, constricted at middle, ciliate along lower margins, truncate or emarginate at apex; lower lip semi-

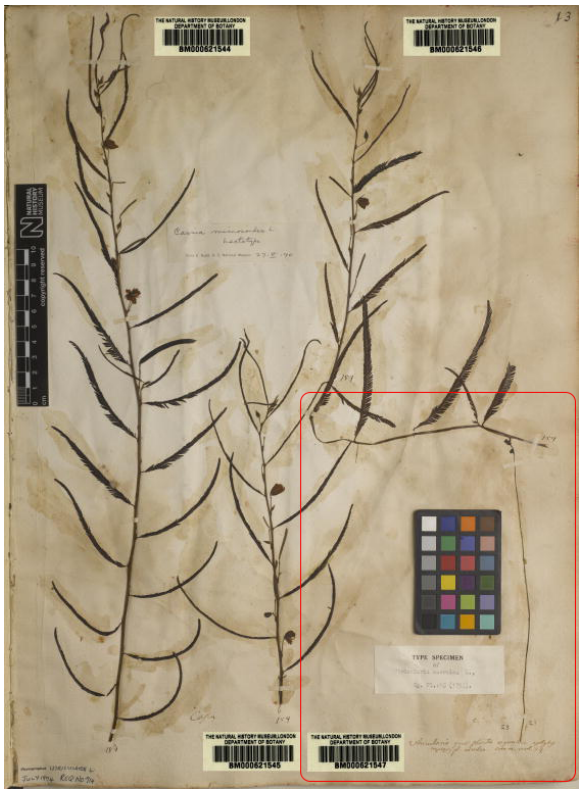

**Fig. 32.** *Lectotype* of *Utricularia caerulea* L. [*Herb. Hermann* 2: 13, No.23 (BM000621547)] "© *The Trustees of the Natural History Museum, London*".

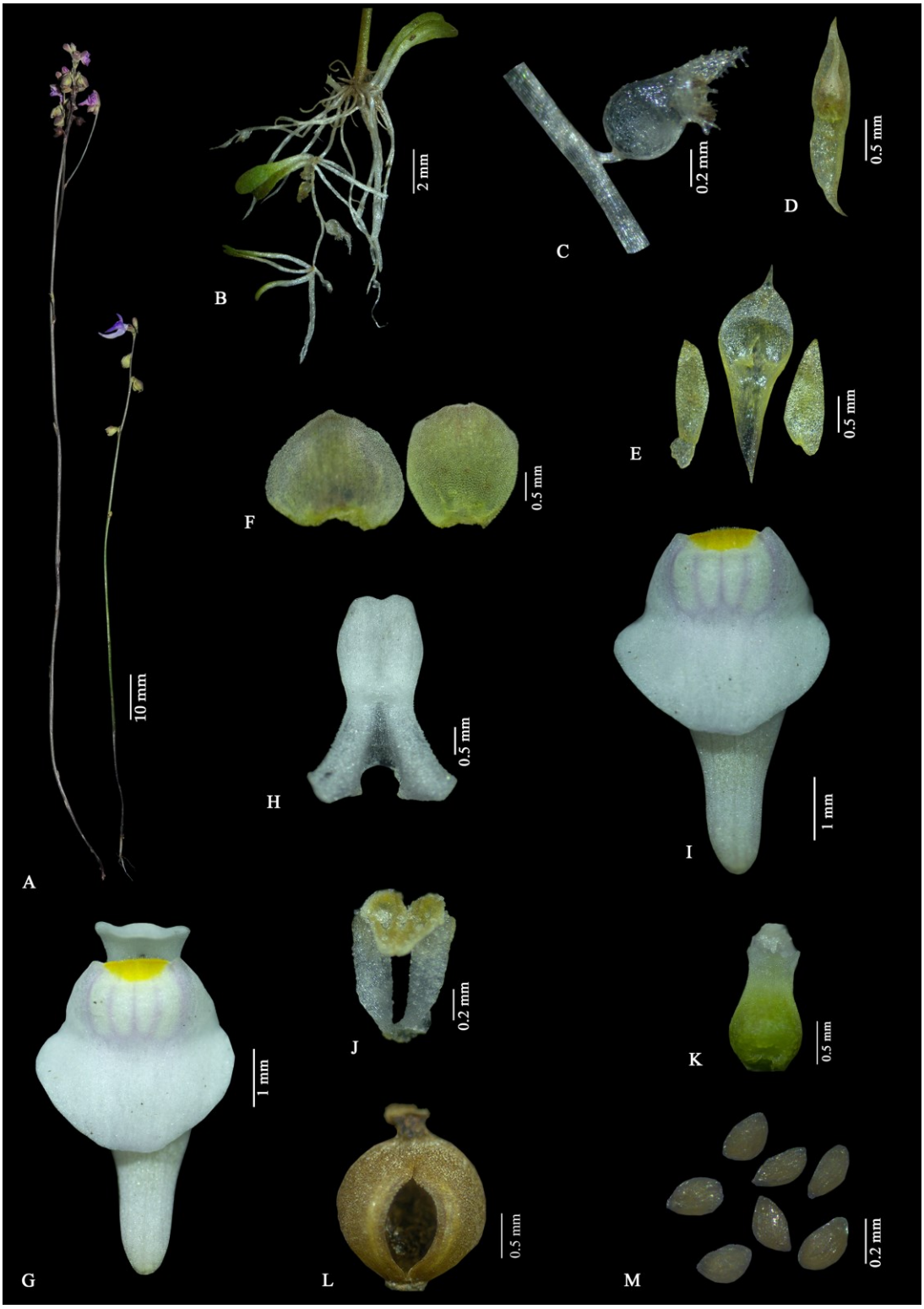


**Fig. 33.** *Utricularia caerulea* L.: **A.** Habit; **B.** Peduncle base bearing rhizoids, stolons, leaves and traps; **C.** Trap; **D.** Scale; **E.** Bract and bracteoles; **F.** Calyx lobes; **G.** Corolla; **H.** Upper lip of corolla; **I.** Lower lip of corolla and spur; **J.** Stamens; **K.** Pistil; **L.** Capsule; **M.** Seeds.

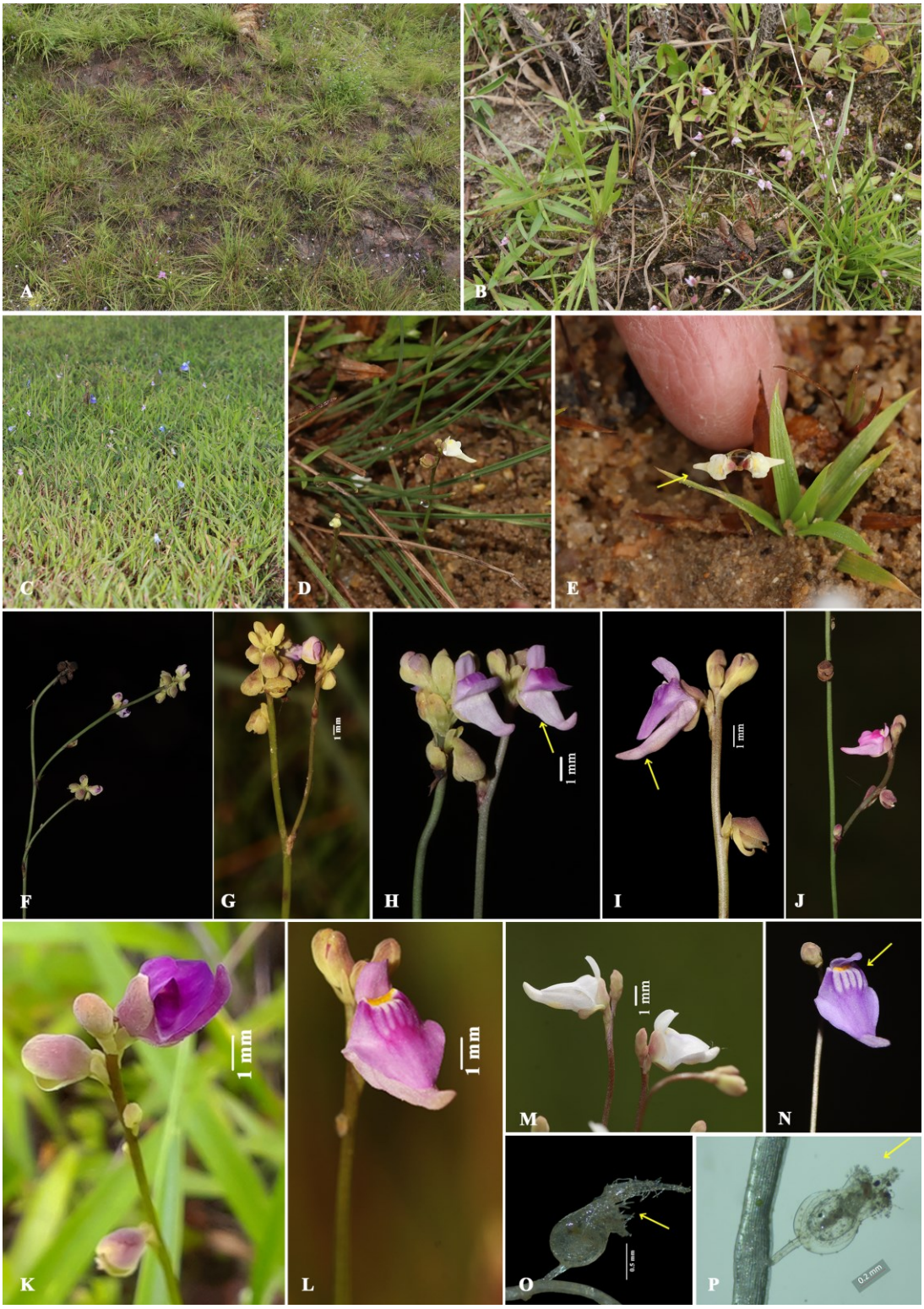


**Fig. 34.** *Utricularia caerulea* L.: **A-E.** Habitat and habit (**D & E.** note the white morphotype); **F-J.** Peduncle bearing mature capsules, flowers and buds (note the arrows - spur longer than the lower lip of corolla); **K-M.** Variation in flower colour (**M.** note the complete white morphotype, **N.** note the four-lobed swelling on the palate); **O & P.** Trap.

orbicular to widely ovate, 2–6 × 2–4.5 mm, hairy at throat, palate raised into 3 or 4 linear swellings, crested at middle, obtuse-rounded at apex; spur conical, straight or often curved forward, up to 6.5 mm long, longer than lower lip of corolla, acute or notched at apex. Stamens *c.* 1.5 mm long; filaments strap-shaped, 0.15–0.2 × 0.7–1 mm, curved or twisted at base; anther thecae distinct, sparsely papillose. Pistil *c.* 1.75 mm long; ovary ovoid, 1–1.5 mm long, pale green-purplish green; style 0.3–0.4 mm long, thick; stigma 2-lipped, lower semi-orbicular and hairy, upper obscurely trifid, deltoid, glandular hairy. Capsules sub-globose to globose, 1.5–2 × 1.4–1.8 mm, wall uniformly thickened, dehiscing by a longitudinal ventral slit; placenta ovate to sub-globose, 0.8–1 × 0.7–0.9 mm, pitted. Seeds numerous, obovoid to ellipsoid, 0.2–0.3 × 0.1–0.18 mm; surface rough; hilum sub-terminal.

***Flowering & fruiting***: Flowers from end of May till December, and fruits from early June till January.

***Habitat***: It grows in seasonally waterlogged depressions on rocky surfaces and along the margins of small seasonal pools on lateritic plateaus, as well as in sandy soils and marshy areas, at elevations between 10–1750 m. It is commonly found in association with *U. bifida*, *U. cecilii*, *U. hirta*, *U. lazulina*, *U. malabarica*, *U. minutissima*, *U. polygaloides*, *U. sainthomia*, *Burmannia coelestis* D.Don (Burmanniaceae), *Drosera indica* (Droseraceae), *Eriocaulon* spp. (Eriocaulaceae), *Geissaspis cristata* Wight & Arn. (Fabaceae), *Isachne veldkampii* K.G.Bhat & Nagendran (Poaceae), *Cyperus* sp., *Fimbristylis* sp., *Fuirena ciliaris* (L.) Roxb. (all Cyperaceae), *Lindernia* sp. (Linderniaceae), *Murdannia semiteres* (Dalzell) Santapau, *M. crocea* subsp. *ochracea* (Dalzell) Faden. (both Commelinaceae), *Neanotis subtilis* (Miq.) Govaerts ex Punekar & Lakshmin. (Rubiaceae), *Rhamphicarpa* sp., *Striga* sp. (both Orobanchaceae), *Rotala malabarica* Pradeep, K.T.Joseph & Sivar. (Lythraceae) and some grasses (Fig. 34 A-E).

***Distribution***: The native range is Tropical and Subtropical Asia, Japan, Madagascar, N. & E. Australia (Krishnapriya *et al.*, 2024; POWO, 2025) (Fig. 35).

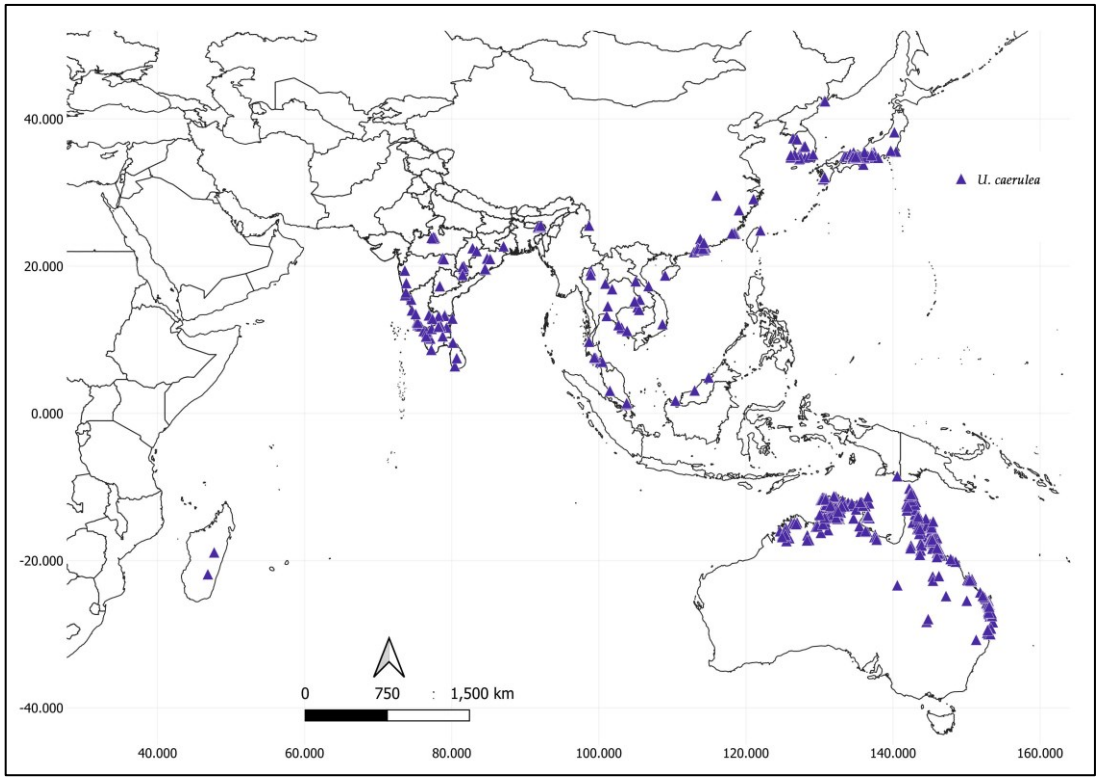


**Fig. 35.** Distribution of *Utricularia caerulea* L.

***Specimens examined***: AUSTRALIA, **Queensland**, Cape York Peninsula, Lockerbie, 10 miles WSW of Somerset, 20 m, 03.05.1948, *L.J. Brass* 18625 (A01977334 digital image); Newcastle Bay, 2.5 miles S of Somerset, 5 m, 05.10.1948, *L.J. Brass* 18736 (A01977333 digital image, CAL); Sanamere Lagoon, Jardine River, 10 m, 19.05.1948, *L.J. Brass* 18863 (A01977328 digital image). BANGLADESH, Silhet, *s.loc.*, *s.d.*, *Wall. Cat.* 1496 (K000779496, GH01977061 digital images). CHINA, **Yunnan**, Yunnan-sen district, *s.loc.*, 1902, *J. Cavalerie* 811 (E00265803 digital image); Chengkang, Monkang, 1450 m, 31.08.1938, *T.T. Yu* 17533 (A01976888 digital image). **Western Yunnan Province**, Tengchong Xian, Jietou Xiang, between Jietou and Datang, 1670 m, 27.10.1998, *Li Heng, Bruce Bartholomew & Dao Zhi-ling* 11059 (GH01976863 digital image). Hong-Kong, 1855, *M. Pabbe Furet s.n.* (P02981582 digital image). INDIA, Malabar, Concan, *s.loc.*, *s.d.*, *J.E. Stocks & J.S. Law s.n.* (GH01977058 digital image, MH00126973); **Andhra Pradesh**, Chittoor district, Akkagarla Gudi, 800 m, 01.10.1974, *G.V. Subba Rao* 45935 (MH00126950, MH00126951); Thirumala, Narayanagiri, ±1100 m, 17.09.1987, *D. Ranga Charyulu* 1654 (MH00126949); Wadanapalli, 27.12.1921,

*C.E.C. Fischer* 4710 (FRCH); Visakhapatnam district, way to Tanjavanam, 1075 m, *G.V. Subba Rao* 42621 (MH00126948, MH00126947). **Chhattisgarh**, Dantewada district, Bailadila, ± 915 m, 09.10.1940, *H.F. Mooney* 1519 (DD); Kanker district, Rajbandha tank, 500 m, 17.11.1958, *K. Subramanyam* 7162 (CAL, MH00126987, MH00126988); Raigarh district, Dharamjaigarh, ±915 m, 19.03.1940, *H.F. Mooney* 1277 (DD). **Dadra and Nagar Haveli and Daman and Diu**, Dadra and Nagar Haveli district, Dadra, 29.09.1963, *M.Y. Ansari* 93837 (CAL, BSI). **Goa**, near Amaldem (Malem), 18.09.1970, *N.P. Singh & B.G. Kulkarni* 124356; Malem, 17.09.1970, *N.P. Singh & B.G. Kulkarni* (BSI). **Karanataka**, Kolar district, Chintamani road, 05.01.1976, *N.P. Singh* 142100 (BSI); Srinivaspur, Royalpal S.F., 04.01.1976, 825 m, *N.P. Singh* 142070 (BSI); Mysuru district, Hardur, River near Hardur Coffee Estate, 10.10.1961, *A.S. Rao* 75043 (CAL); Shivamogga district, Agumbe, Barakana, 16.10.1962, *R. Sundara Raghavan* 83273 (BSI); Agumbe, near Stream, 04.11.1960, *R. Sundara Raghavan* 68169 (BSI); Tumkur district, Gounbinur, Madhugiri road, 28.10.1975, *N.P. Singh* 141103 (BSI). **Kerala**, Idukki district, Valara Waterfalls, near new Dam construction site, 02.10.2021, *K.K. Jeomol & M.P. Krishnapriya* 177218 (CALI); Kannur district, Blathoor, 22.08.2019, *M.P. Krishnapriya* 168092; Chooral, Aravanchal, 31.07.2022, *M.P. Krishnapriya* 177259; Madayipara, near Madayikkavu, 18.12.2010, *C. Pramod* 126618 (CALI); Kasaragod district, Cheemeni, 27.08.2021, *M.P. Krishnapriya* 175820; *Ibid*., near old Cyber park, 20.08.2019, *M.P. Krishnapriya & Santhosh Nampy* 168088; Kanhangad, Ramnagar, 20.08.1985, *M.K. Janarthanam* 82917 (MH00126969, MH00126970, BSID0012614); Kappadampoyil, 27.08.2021, *M.P. Krishnapriya* 175822; Koyithatta lateritic plateau, 27.08.2021, *M.P. Krishnapriya* 175817 (CALI); Mulleria, 21.08.1985, *M.K. Janarthanam* 82923 (MH00126967, MH00126968, BSID0012615); Periya, 20.08.1985, *M.K. Janarthanam* 82919 (MH00126971, MH00126972, BSID0012616); Periye, Lateritic plateau, opposite Central University, 26.08.2021, *M.P. Krishnapriya* 175806 (CALI); Puthrakala, lateritic hillock, 26.08.2021, *M.P. Krishnapriya* 175812; *Ibid*., ± 180 m, 01.08.2022, *M.P. Krishnapriya* 177271 (CALI); Kozhikode district, near Iringal Railway station, 25.08.1985, *M.K. Janarthanam* 82933 (MH00126976, MH00126977, BSID0012620); Kakkayam, Ambalapara, 12.10.2019, *M.P. Krishnapriya & Santhosh Nampy* 164322; way to Urakuzhi Waterfalls, 06.10.2022, *M.P. Krishnapriya* 186018; Ponkunnumala, 04.10.2019, *M.P. Krishnapriya & Santhosh*

*Nampy* 164313 (CALI); Malappuram district, Adyanpara Waterfalls, 03.09.2020, *M.P. Krishnapriya & Santhosh Nampy* 164372; Kodikuthimala, 08.10.2019, *M.P. Krishnapriya* 164317; Poonkavanam Dam, 31.07.2019, *M.P. Krishnapriya* 16807; *Ibid*., 14.09.2019, *M.P. Krishnapriya & Santhosh Nampy* 164306 (CALI); Palakkad district, Malampuzha water tank hillock, 15.09.1985, *M.K. Janarthanam* 82936 (MH00126963, MH00126964, BSID0012621); Pathanamthitta district, Konni Reserve Forest, Perumala, 300 m, 18.11.1976, *M. Chandrabose* 49117 (MH00126961, MH00126962); Kozhenchery, 150 m, 07.12.1979, *C.N. Mohanan* 63705 (MH00126957, MH00126958); Ranni, 325 m, 27.07.1978, *C.N. Mohanan* 58340 (MH00126959, MH00126960); Thrissur district, Athirapilly reserve, 150 m, 13.09.1976, *K. Ramamurthy* 48490 (MH00126995, MH00126956); Irunilamkode Hill, near Temple, 07.09.2020, *M.P. Krishnapriya & Santhosh Nampy* 164378; Kayampoovam, 06.09.2020, *M.P. Krishnapriya* 164376 (CALI); Thiruvananthapuram district, Kottur R.F., 275 m, 27.09.1973, *J. Joseph* 44432 (MH00126952, MH00126953). **Madhya Pradesh**, Chhindwara district, way to Tamia, Seetha Downkei, ± 450 m, 11.11.2021, *M.P. Krishnapriya* 177239 (CALI); Satna district, Satna town, in paddy field, 400 m, 20.09.1959, *K.M. Sebastine* 8899 (MH00126985, MH00126986). **Maharashtra**, Nagpur district, Ambazari tank, 300 m, 18.11.1957, *K. Subramanyam* 4683A (MH00126981); Satara district, Kaas, September 1994, *M.P. Bachulkar Cholekar* 5976 (SUK). **Meghalaya**, Mount Khasia, Regio. trop., *s.loc.,* alt. 3–5000 ped, *s.d., J.D. Hooker & T. Thomson s.n.* (GH01977060 digital image); East Khasi Hills district, Barapani, BSI Experimental Garden, ± 1000 m, 29.10.1986, *M.K. Janarthanam* 83031 (MH00126991, MH00126992, BSID0012665); Cherrapunji, Mawsmai, 30.10.1986, *M.K. Janarthanam* (MH00126989, BSID0012666); way to Cherrapunji, ± 1690 m, 17.09.2021, *M.P. Krishnapriya* 175829; *Ibid*., ± 1171 m, 17.09.2021, *M.P. Krishnapriya* 175834; way to Jowai from Shillong, ± 1340 m, 23.09.2021, *M.P. Krishnapriya & Santhosh Nampy* 175883 (CALI); around Leska, 26.09.2007, *M. Bhaumik 116504* (ASSAM); Mawryngkneng, way to Kut Village, 22.09.2021, *M.P. Krishnapriya & Santhosh Nampy* 175882 (CALI); Pynursla, 1370 m, 17.10.1945, *N.L. Bor s.n.* (DD); Shillong, September 1950, *G.K. Deka* 22985 (ASSAM); Jaintia Hills district, way to Jarain, ± 1360 m, 23.09.2021, *M.P. Krishnapriya* 175887; way from Jowai to Jarain, ± 1235 m, 23.09.2021, *M.P. Krishnapriya* 175889 (CALI); West Jaintia Hills district, Dawki, ± 833 m, 25.09.2021, *M.P. Krishnapriya* 175894; near

Nartiang Durga Temple, ± 1158 m, 22.09.2021, *M.P. Krishnapriya & Santhosh Nampy* 175879 (CALI). **Odisha**, Angul district, Poipal Dalki, 300 feet, December 1940, *H.J. Mooney* 1644 (DD); Ganjam district, Chatrapur, December 1889, *J.S. Gamble* 21560 (DD); Nuapada district, Khariar Estate, Sonahera Plateau, 2150 feet, 02.10.1949, *H.F. Mooney* 3689 (DD); Satkosia Tiger Reserve, Purunakote section, 125 m, 06.09.2014, *K.C. Mohan* 5195 (BSID0010604). **Tamil Nadu**, Chengalapattu district, Vandalur Zoological Park, 15.01.1986, *M.K. Janarthanam* 82975 (MH00127006, MH00127007, BSID0012668); Thandarai, 06.01.2000, *K.T. Augustine* 61751 (RHT044625); Dindigul district, Shenthetty kanal, 6-7000 feet, 20.09.1905, *C.A. Barber* 7531 (MH00127002); Kallakurichi district, Ulundurpettai, Pulloorkkadu Forest Bunglow, 50 m, 30.12.1981, *K.M. Matthew, S.J. Britto & N. Rani* 28791 (RHT044624); Krishnagiri district, Dharmapuri, Denkanikottai, Harur, Chitteri Hills, Alangala malai slopes, 1000 m, 12.01.1976, *N. Venugopal* 20840 (RHT044618); Denkanikotta Thally, Devarbetta, 900 m, 14.11.1979, *K.M. Matthew* 24572 (RHT044619); Pudukottai district, Kulathur, Sathyamangalam, 150 m, 23.12.1978, *Fieldmen* 16087 (RHT); Narthamalai, 125 m, 23.09.1965, *K. Ramamurthy* 25944 (MH00126993, MH0012694); *Ibid*., 150 m, 15.11.1975, *K.M. Matthew* 15064 (RHT044611); *Ibid*., 12.12.2022, *M.P. Krishnapriya* 186042 (CALI); *Ibid*., Pommadimalai, 150 m, 16.12.1982, *K.M. Matthew & N. Rani* 29343 (RHT044614); Sittanavasal, 02.02.1978, *K. Ramamurthy* 53737 (BSI); *Ibid*., 100 m, 02.02.1978, *K. Ramamurthy* 53737 (MH00127000, MH00126444); Salem district, Yercaud, Brooklyn, ± 1260 m, 29.04.1966, *A.V.N. Rao* 27499 (MH00126996, MH00126997); *Ibid*., Shevaroy, foot of the Temple Hill, 1400 m, 10.01.1980, *K.M. Matthew* 25639 (RHT044615); *Ibid*., slopes of Temple, 1500 m, 25.02.1980, *K.M. Matthew* 26809 (RHT044616); *Ibid*., Temple Hill half way up, 1550 m, 15.12.1980, *K.M. Matthew, J.B. Britto & N. Rani* 28032 (RHT044617); Green Hills, Shevaroys, January 1941, *E. Barnes s.n* (DD); Sivaganga district, Sivaganga, Esani Estate, 100 m, 16.12.1964, *K. Ramamurthy* 22732 (MH00126998, MH001269999); *Ibid*., 16.12.1964, *K. Ramamurthy* 22733 (MH00126445, MH00126446); The Nilgiris district, Kinnacoorie, 23.01.1913, *C.E.C. Fischer* 3533; Attakatti, 27.12.1912, *C.E.C. Fischer* 3222 (FRC). INDONESIA, **New Guinea**, *s.loc*., 1920 m, 11.04.1973, *J. Raynal* 17069 (L2829121, L3887064 digital images). **West Papua province**, Anggi Gita Lake, Bivouac Noordpool, 1850 m, 09.01.1962, *Sleumer & Vink* BW14014 (L2827485 digital image); E. foot of Pekeglabro, Kebo, Wissel Lakes, 1760

m, 28.05.1960, *Vink & Schram* BW8976 (L2827285 digital image); Logged Dacrydium Forest near Keb, 1750 m, 27.05.1960, *Vink & Schram* BW8916 (L2827284 digital image); Neentjapaki mountains, Kebar Valley, ± 1100 m, 13.10.1958, *C. Kalkman* 6381 (L2827483 digital image); *Ibid*., ± 810 m, 13.11.1958, *C. Koster* BW8037 (L2827282 digital image). **South Papua province**, Merauke Koerik Camp, *c.* 15 km NE of Koembe Village on north bank of Koembe River, 07.09.1954, *P. van Royen* 4851 (L2827290 digital image); Goenoeng Si Papan (in Concession Kaloebi: Typographic Sheet 41, southeast quarter), 7–14.04.1933, *Rahmat SI Toroes* 3760 (MICH1577903 digital image); Langga Pajoeng (on the Soengei Kanan: Typographic Sheet 41, southeast quarter), 7–30.03.1933, *Rahmat SI Toroes* 3298 (MICH1577905 digital image); *Ibid*., 7–30.03.1933, *Rahmat SI Toroes* 3440 (MICH1577902 digital image). PAPUA NEW GUINEA, Eastern Highlands district, Goroka subdistrict, near Miruma Village, upper Asaro Valley, 19.06.1956, *R.D. Hoogland & R. Pullen* 5395 (US03217131 digital image); Morobe district, Wau subdistrict, Manki Trig, Bulolo, 5000 feet, 08.12.1967, *P. Apini & H. Streimann* NGF30948 (L2827457 digital image); Mount Hagen subdistrict, Ogelbeng, 5600 feet, 12.09.1963, *A.N. Millar & L.A. Garay* 18721 (A01977252, L2827286 digital images); road above Tomba, 8000 feet, 06.07.1957, *R.G. Robbins* 268 (L2827469 digital image); Bog west of Tomba, 2560 m, 27.05.1972, *P.F. Stevens & J.F. Veldkamp* LAE54925 (A01977256 digital image); Sirunki beneath the Village of Nanguris, 14.08.1962, *Walker* ANU 528 (A01977257 digital image); Sepik district, Telefomin, 08.01.1965, *E.E. Henty* NGF20695 (L2827484 digital image). JAPAN, **Kyoto**, Midorogaike, Kamigamo, Kita-ku, Kyoto-shi, 100 m, 11.09.2002, *S. Tsugaru, S. Mitsuta & T. Sawada* 31897 (A01976929 digital image). MYANMAR (Burma and Malay Peninsula), *s.loc*., *s.d*., *Herb. Griffith* 4080 (A01977059, K000779525 digital images); Pegu plains, *s.d*., *S. Kurz* 288; Pegu, Irrawaddy and Sittang Valley, Yangoon Lake, December 1870, *S. Kurz* 2306 (CAL). **Kachin**, Bhamo district, Kantioe Sakan, Kaukkma Valley, 120 m, 27.11.1916, *J.H. Lace* 6056 (CAL). MALAYSIA, Bako National Park, Lintang path, c. 100 m, 03.01.1964, *Paul Chai* S19711 (A01977224 digital image); Kedah, Gunong Jerai (Kedah Peak), 3100–3200 feet, 15.01.1964, *H.M. Burkill* HMB3305 (A01977225 digital image). SRI LANKA, **Sabaragamuwa**, Ratnapura district, Rajjuruwatta on Kalawana-Pedikanda Road, ± 250 m, 02.12.1976, *R.B. Faden & A.J. Faden* 76/441 (US03216805 digital image). **Southern Province**, Galla district,

Talgaswela, 20.02.197, *L.H. Cramer* 2853 (US03216804 digital image). THAILAND, **Chiang Mai**, Bo Luang Tableland, 18°45'N 98°25'E, *c.* 1000 m, 14.12.1969, *C.F. van Beusekom & C. Phengklai* 2509 (P00376754 digital image); Doi Sootep, 720 m, 02.01.1910, *A.F.G. Kerr* 1910 (K000779758); *Ibid.*, 518 m, 05.09.1909, *A.F.G. Kerr* 793 (K000779759 digital image); Siam, *s.d.*, *H. Garrett* 55; *Ibid.*, Chiangmai, 02.01.1910, *A.F.G. Kerr* 918 (CAL).

***Conservation status***: While *U. caerulea* is widely distributed across India, many of its habitats face significant threats, including land clearing, mining, and urban development. Based on its broad distribution and stable population size, *U. caerulea* is assessed as Least Concern (LC).

***Notes***: *Utricularia caerulea* exhibits considerable variation in plant size and nature of corolla (size, shape, and colour). Plants found in lateritic areas at elevations between 10 to 1000 m usually reach up to 12 cm in height, with flowers loosely arranged on simple peduncle. In contrast, plants growing in swampy or sandy soils at elevations between 1100 to 1750 m can grow at a range of 15 to 30 cm tall, with branched peduncles and dense clusters of flowers (Fig. 34F-H). While the corolla is often caerulean blue, it can also vary in colour from pure white to shades of pink and purple (Fig. 34K-N), with all these morphotypes occurring within the same population (Krishnapriya *et al.*, 2024).

**2. Utricularia roseopurpurea** Stapf ex Gamble, Fl. Madras 2: 983. 1924; Fyson, Fl. S. Ind. Hill Stations 1: 438. 1932, as "*Utricularea rosa-purpurea* Staff"; Subr. & L.K.Banerjee, Bull. Bot. Surv. India 10(1): 103. 1968; V.Chandras. in A.N.Henry *et al.* (eds.), Fl. Tamil Nadu Ind., Ser I: Analysis 2: 131. 1987; Janarth. & A.N.Henry, Taxon 38: 141. 1989, Bladderworts India 95. f. 28. 1992; Anil Kumar *et al.*, Fl. Pathanamthitta 368. 2005; Nayar *et al.*, Fl. Pl. W. Ghats India 1: 587. 2014. *Lectotype* (designated by Janarthanam & Henry, 1989): INDIA, Anamalais, Paralai, 07.11.1901, *C.A. Barber* 3982 (MH [MH00002434!]). **Figs. 36–38**

*Utricularia racemosa auct. non* Wall. ex Walp.: Wight, Icon. Pl. Ind. Orient. 4(4): 11. t. 1584. f. 1. 1850

*Utricularia rosea auct. non* Edgew.: Oliv., J. Proc. Linn. Soc., Bot. 3: 184. 1858; C.B.Clarke in Hook.f. (ed.), Fl. Brit. India 4: 333. 1884

Terrestrial or lithophytic annual herbs. Rhizoids up to 35 mm long, *c.* 0.2 mm thick, capillary. Stolons *c.* 75 mm long, terete, glabrous, branches up to 40 mm long. Leaves usually 4–6 on peduncle base, rosulate, numerous on stolons; petioles up to 8 mm long; lamina oblanceolate to oblance-ovate, 6.35–8.8 × 1–1.5 mm, 1-nerved, nerves rarely branched, rounded at apex. Traps more on stolons, few on petiole, oblique, globose, 1.08–1.3 mm across, oblate; stalk 0.3–1 mm long; mouth terminal, body expanded into a circular, coiled appendage, reflexed, glandular hairy along margins. Racemes erect, 4.5–18 cm long, 1–8-flowered, simple or rarely branched; peduncles terete, 0.3–1.3 mm thick, purplish green, glabrous. Scales attached obliquely below the middle, oblong, 1.6–2.3 × 0.6–0.85 mm, 1-nerved, acute at apex, bi-tridentate at lower part, minutely papillate. Bracts basisolute, attached just above the middle, rhombic, 1.25–2.4 × 0.4–0.9 mm, upper acute at apex, lower acute to bi-dentate at apex, minutely papillate; bracteoles basisolute, attached just below the middle, ovate to rhombic, 1.3–1.45 × 0.4–0.6 mm long, 1-nerved, acute at both ends, minutely papillate. Flowers 6–13 mm long; pedicels 0.8–1.2 mm long, erect, terete, slightly reflexed in fruit, papillate. Calyx lobes unequal, greenish-violet, or rarely yellowish green, convex, glabrous within, outer papillate; upper lobe widely ovate, 2.7–4 × 3–4 mm, inflated at middle, acute-obtuse at apex;

**Fig. 36.** *Lectotype* of *Utricularia roseopurpurea* Stapf ex Gamble [*C.A. Barber* 3982 (MH00002434)] *"© The Director, Botanical Survey of India, Kolkata"*.

**Fig. 37.** *Utricularia roseopurpurea* Stapf ex Gamble: **A.** Habit; **B.** Peduncle base bearing rhizoids, stolons, leaves and traps; **C.** Traps - close-up view; **D.** Scale; **E.** Bract and bracteoles; **F.** Calyx lobes; **H.** Corolla; **G.** Upper lip of corolla; **I.** Stamens; **J.** Pistil; **K.** Capsule; **L.** Seeds.

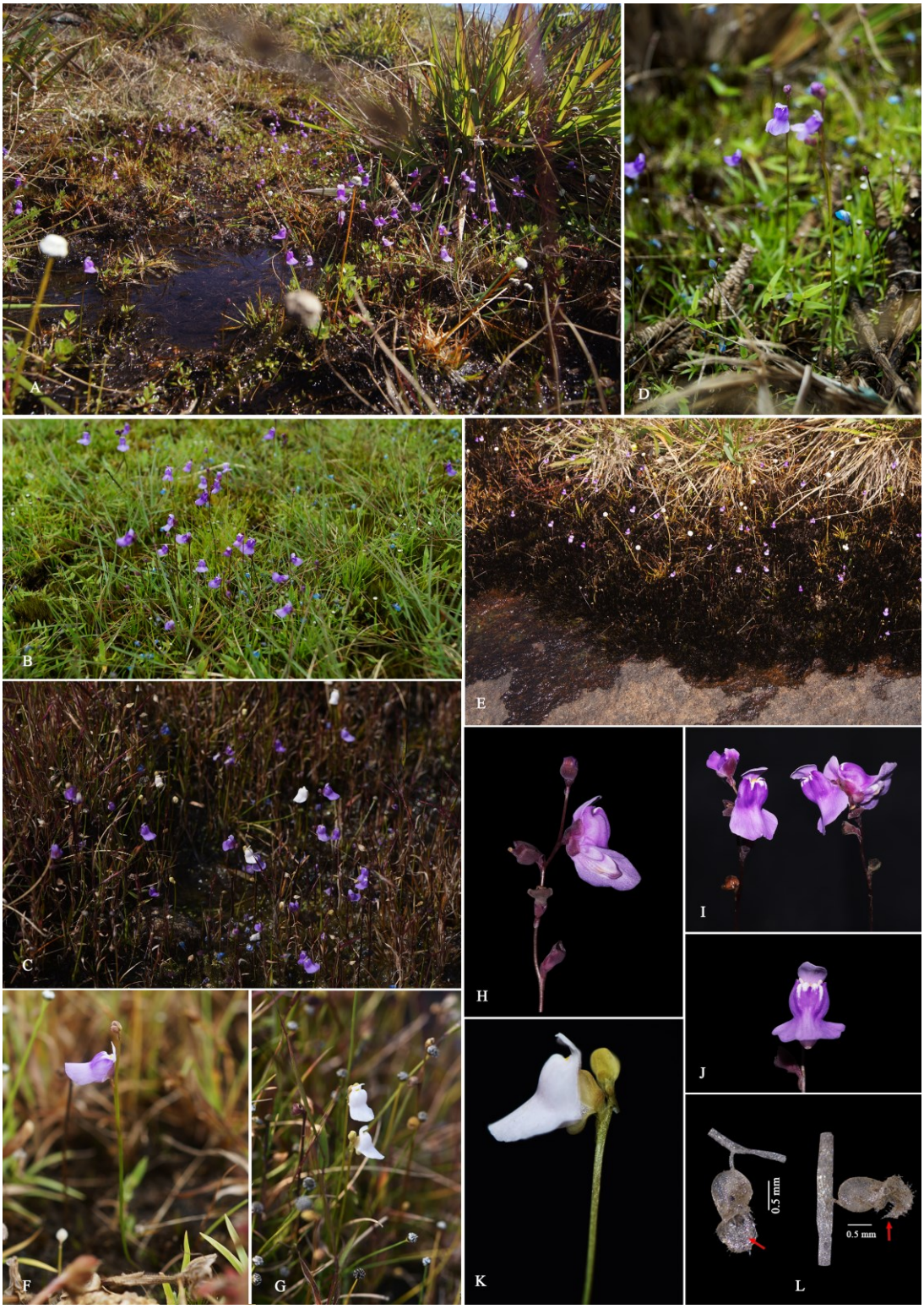


**Fig. 38.** *Utricularia roseopurpurea* Stapf ex Gamble: **A-E.** Habitats (note the purple and complete white morphotype in **C**); **F.** Habit; **G.** White morphotype; **H-J.** Flowers - different view; **K.** White morphotype - close-up view; **L.** Traps (note the coiled rim-like appendage).

lower lobe sub-orbicular, 1.5–2.6 × 2.2–2.7 mm, margins involute, obtuse-rounded at apex. Corolla pink to purple, or rarely greenish white to white; upper lip oblong, 3–10 mm long, galeate, constricted at middle, apical margin undulate, lower margins hairy, truncate-emarginate or rounded at apex; lower lip oblong, 5.5–13 mm long, moderately flared towards tip, purple with a yellow patch at the palate, crested with two hook-like process at margins of throat with glandular hairs, palate extends into a prominent 4-lobed swelling with white patches, expands gradually into a sub-orbicular shape, margin undulate, emarginate-rounded at apex; spur subulate, 5–8.5 mm long, shorter than or slightly equalling the lower lip of corolla, inner surface glandular, outer surface glabrous, obtuse-rounded at apex. Stamens 1.5–2 mm long; filaments flattened, strap-shaped, 1.2–1.6 × 0.3–0.55 mm, twisted at base; anther thecae distinct. Pistil *c.* 2.5 mm long; ovary ovoid-globose, 1.7–2.2 mm long, greenish purple; style *c.* 0.4 mm long, distinct, glandular hairy; stigma 2-lipped, lower lip sub-orbicular, curved inwards, upper lip tri-fid, obsolete, subulate, glandular hairy. Capsules ovoid, 2–3 mm long, wall prominently thickened, dehiscing by both dorsal and ventral longitudinal slits; placenta ovoid, 1–1.5 mm long. Seeds numerous, obovoid-oblongoid, 0.23–0.35 × 0.17–0.23 mm; surface rough; hilum sub-terminal.

***Flowering & fruiting***: Flowering occurs from early September till mid-January, fruiting takes place from late September to the end of January.

***Habitat***: Found in small patches on moss covered wet rocks, stream margins, and marshy areas that are exposed to bright light, usually at elevations between 1000 and 2200 m. It grows in association with *Utricularia nayarii*, *Burmannia munnarensis* Dani & Nampy (Burmanniaceae), *Apocopis mangalorensis* (Hochst. ex Steud.) Henrad, *Arundinella* sp., *Dimeria* sp., *Jansenella griffithiana* (Mull.Hal.) Bor (all Poaceae), *Cyanotis* sp. (Commelinaceae), *Drosera indica* (Droseraceae), *Eriocaulon brownianum* Mart., *E. nairii* Chandrab. & V.Chandras., *E. odoratum* Dalzell, *E. thwaitesii* Korn. (all Eriocaulaceae), *Fimbristylis* sp. (Cyperaceae), *Impatiens raktakesara* M.Vishnu & Nampy (Balsaminaceae), *Laurembergia coccinea* Kanitz. (Haloragaceae), *Smithia racemosa* B.Heyne (Fabaceae) and some other grasses (Fig. 38).

***Distribution***: Endemic to the Western Ghats and Sri Lanka (Janarthanam & Henry, 1992; Krishnapriya *et al*., 2024) (Fig. 39).

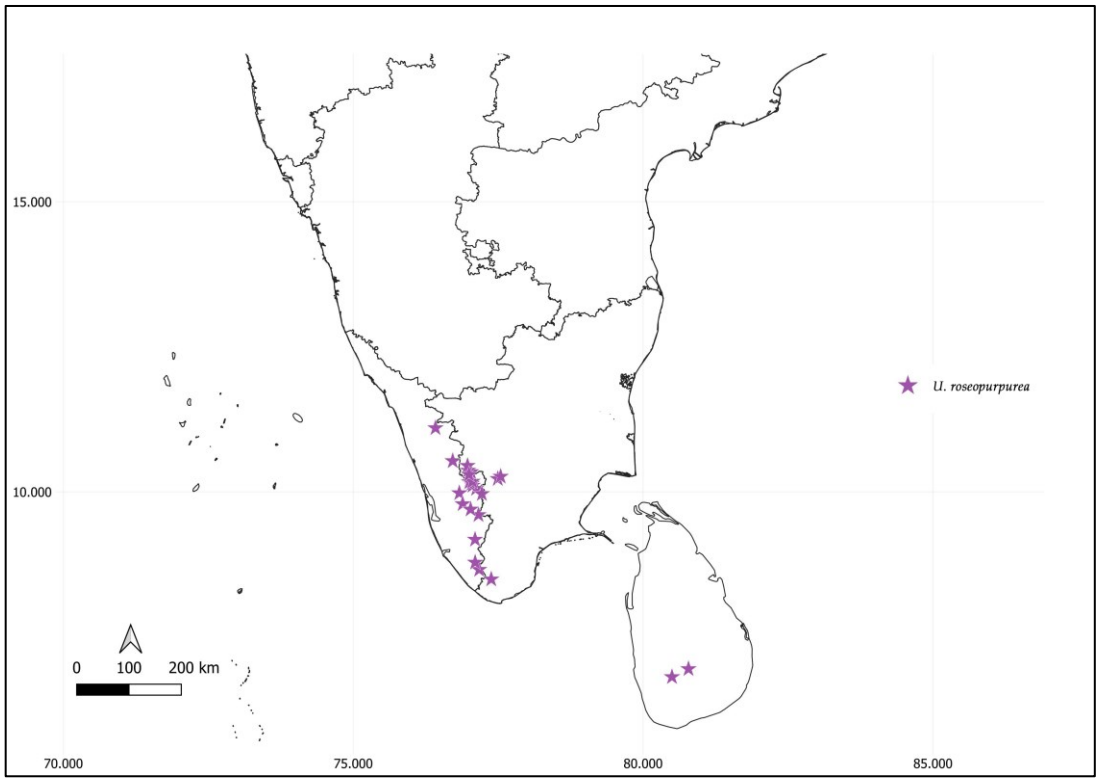


**Fig. 39.** Distribution of *Utricularia roseopurpurea* Stapf ex Gamble

***Specimens examined***: INDIA, **Kerala**, Idukki district, Elaveezhapunchira, 29.10.2020, *Santhosh Nampy & M.P. Krishnapriya* 164389 (CALI); Eravikulam National Park, 2100 m, 29.11.1979, *Nambiar* 1124 (KFRI); *Ibid*., grassy slope, ± 1722 m, 23.12.2019, *M.P. Krishnapriya & Santhosh Nampy* 164338; Kattadikadavu, 07.12.2018, *Santhosh Nampy & M.P. Krishnapriya* 168045 (CALI); Kulamavu, 03.10.1983, *C.N. Mohanan* 79967 (MH00126665); about 15 km from Idukki on the road to Kulamavu, 31.08.1973, *Cook, Rix & Schneller* 67 (P04425315 digital image); Lockhart gap, Devikulam, 1675 m, 12.10.1963, *K.M. Sebastine* 17542 (MH00126663, MH00126966); Kumali road on dripping rocks, 13.12.1985, *M.K. Janarthanam* 82964 (MH00126666, MH00126667, BSID0012642); Mathiketan Shola National Park, Vattachola grassland, 08.11.2018, *Syam Radh & M.P. Krishnapriya* 168033; *Ibid*., 07.12.2018, *Syam Radh & M.P. Krishnapriya* 168044 (CALI); Munnar, 15.11.1961, *C. Saldanha* CS8045 (BLAT); Pettimudi grassland, ± 1800 m, 10.12.2019, *M.P. Krishnapriya & Santhosh Nampy* 164335; *Ibid*., ± 1903 m, 29.12.2019, *M.P. Krishnapriya & Dani Francis* 164341; *Ibid*.,

Hilltop, way to Subran shed, ± 2089 m, 30.12.2019, *M.P. Krishnapriya & Santhosh Nampy* 164344; Subran shed, near Stream, 30.12.2019, *M.P. Krishnapriya* 164348; Upputhara, Vakavanam, 14.09.2019, *Dani Francis & M.P. Krishnapriya* 164308 (CALI); Palakkad district, Nelliyampathy, Hilltop, ± 1175 m, 24.11.2022, *M.P. Krishnapriya* 186028, 186029; *Ibid*., Kaarasoori, ± 1130 m, 23.11.2022, *M.P. Krishnapriya* 186026; Silent Valley National Park, Aruvampara, 12.11.2020, *M.P. Krishnapriya & Santhosh Nampy* 164396 (CALI); Pathanamthitta district, Kokkathode, 08.09.1989, *N. Anilkumar* 2024 (CAL); Thiruvananthapuram district, Agasthyamala, 21.12.2018, *M.P. Krishnapriya* 168053 (CALI); Western slopes of Agasthymala, 1400 m, 06.10.1973, *J. Joseph* 44629 (MH00126954); Ponmudi, opposite Indian Institute of Space Science complex, 02.11.2021, *M.P. Krishnapriya* 177227 (CALI). **Tamil Nadu**, Coimbatore district, Anamalai, around Attakatti, 25.01.1962, *J. Joseph* 13565 (MH00126674); *Ibid*., Konalar, ± 1300 m, 13.12.2018, *S. Resmi & M.P. Krishnapriya* 168050; *Ibid*., December 2019, *S. Resmi* 164329 (CALI); Grass Hills above Iyerpadi, 10.01.1901, *C.A. Barber* 4025 (MH00126676, MH00126677); Poonachi, 10.10.1901, *C.A. Barber* 3716 (MH00127006, MH00127007); Dindigul district, Kodaikanal, new Reservoir, 04.08.1985, *K.M. Matthew* 41687 (RHT RHT044648); Swampy high ground near Lake outflow, 20.05.1987, *Bourne* 16 (K000779503, K000779504 digital images); Blackburn slopes facing Palamalai (Kavalamalai), 1400 m, 11.11.1987, *K.M. Matthew* 48220 (RHT044605); Palni Hills, Lake marsh by south, 08.09.1986, *K.M. Matthew & M. Charles* 46762 (RHT044602); Peak, north of Perumal Peak, 2100 m, 12.12.1986, *K.M. Matthew* 47915 (RHT044603); Madurai district, Lake marsh, 10.05.1986, *s.coll.* 8675 (RHT044594); Tirunelveli district, Agasthyamala, 22.05.1901, *C.A. Barber* 2936 (MH00126670); way to Mahendragiri beyond Sengamal Estate, 1025 m, 05.12.1969, *B.V. Shetty* 33050 (MH00126671, MH00126672); Muthukuzhivayal, ± 1400 m, 29.09.1980, *A.N. Henry* 68866 (MH00126668, MH00126669). SRI LANKA, *s.loc., s.d., s.coll.* CV277 (MH00274881); *s.loc*., 1873, *R.H. Beddome s.n.* (MH00126417); *s.loc.*, 1847, *Gardner* 507 (K000779493, K000779502 digital images). **Central Province**, Kandy district, 4 mi. directly SW of Maskeliya fishing hut area on the margin of the Moray Occurrence group Tea Estate, at the SE base of Adams Peak, 1400 m, 21.11.1974, *Gerrit Davidse & D.B. Sumithraarachchi* 8705 (US03216814 digital image); Nuwara Eliya district, boggy ground along right side of route A-5 near pass going from Hakgala to

Nuwara Eliya, 13.09.1969, *Robert W. Read & P.E. Desautels* 2276 (US03216859 digital image).

***Conservation status***: It grows in a few localities in southern Western Ghats (Kerala and Tamil Nadu) and Sri Lanka in protected areas with an estimated Area of Occupancy (AOO) of 108 $km^2$ and an Extent of Occurrence (EOO) of 60011.492 $km^2$. It is prone to habitat alterations due to landslides and climate change. With the available data and considering the threats, the status is provisionally assessed as Endangered (EN B2ab(ii,iii,iv,v); D).

***Notes***: *Utricularia roseopurpurea* is characterised by a large lower lip of corolla, prominent hook-like process at the throat margin, a spur that is either shorter or equal in length to the lower lip, and the coiled appendage of the traps (Fig. 38H-L). The species often presents white morphs intermixed with purple forms. In the white morph, the peduncles, scales, bracts, bracteoles, and calyx lobes are pale green, and the corolla is white (Fig. 38G & K).

## 5.4. UTRICULARIA SECT. OLIGOCISTA A.DC.

**Utricularia section Oligocista** A.DC. in DC. (ed.), Prodr. 8: 12. 1844; Kamienski in Engl. & Prantl (eds.), Nat. Pflanzenfam. 4(3b): 120. 1895 *p.p.*; P.Taylor, Kew Bull. 41: 9. 1986, Gen. *Utricularia* 304. 1989; Li in Y.F.Deng *et al*. (eds.), Fl. Pan-Himalaya 46: 8. 2020. *Lectotype* (designated by Taylor, 1986): *Utricularia bifida* L.

*Askofake* Raf., Fl. Tellur. 4: 108. 1838. *Type*: *A. recurva* (Lour.) Raf. (= *Utricularia recurva* Lour.)

*Nelipus* Raf., Fl. Tellur. 4: 109. 1838. *p.p.* (*N. bifida* Raf. and *N. spiralis* Raf.)

*Vesiculina* Raf., Fl. Tellur. 4: 108. 1838. *p.p.*

*Utricularia* subgen. *Bivalvaria* S.Kurz, J. Bot. 12: 54. 1874

*Utricularia* sect. *Stomoisia* (Raf.) Komiya, J. Jap. Bot. 48: 151. 1973

Small to medium sized annual or perennial, terrestrial to semi-aquatic or lithophytic herbs. Rhizoids present, usually with short papillose branches. Stolons short or sometimes reach up to 50 cm. Leaves simple, usually narrowly linear, obovate or spathulate, 1 or 3 or more nerved. Traps on rhizoids, stolons and leaves; ± globose; sessile or stalked, stalk distally thickened or not, or appendage on the stalk or below the ventral lip of the mouth; mouth usually basal, rarely lateral, with a pair of usually simple, very rarely branched, subulate ± glandular, dorsal appendage; internal glands always 1 to 2-armed. Scales basifixed, few to numerous, sterile or fertile with young buds. Bracts and bracteoles basifixed; bracteoles always much narrower than the bracts (bracteoles absent in two species, *viz.*, *U. heterosepala* Benj and *U. janarthanamii* S.R.Yadav, Sardesai & Gaikwad). Calyx lobes mostly sub-similar, sub-equal or unequal in size, accrescent. Corolla yellow, shades of blue to purple or violet; lower lip usually galeate, with a ± prominent swelling; spur well developed, mostly conical or subulate, straight or curved, and diverging from the lower lip. Capsules ovoid or oblongoid-ellipsoid; dehiscing by a longitudinal, ventral, or both ventral and dorsal slits, wall membranous or not, dehiscing margins thickened or not. Seeds globose, ovoid or oblongoid-ellipsoid; testa cells isodiametric, elongate, or slightly irregular; the anticlinal walls raised, straight or sinuate; the periclinal walls straight or ± concave; surface smooth or rough, striate or verrucate.

***Notes***: The section *Oligocista* was formally established by AIphonse de Candolle (1844) and includes species characterized by entire leaves, fibrous roots or rhizoids, glandular traps and a single peduncle. It is the largest section, encompassing around 70 species and three varieties. In his classification, de Candolle (*l.c.*) divided *Oligocista* into two sub-groups: one group included species with the lower lip of the corolla that was not gibbous, often 3-lobed, or flat, or with reflexed edges. This group contained species with blue or purple flowers, as well as with yellow flowers. The second group was characterized by a straight peduncle and an intact, gibbous, or convex lower lip of the corolla, further divided based on flower colour into species with blue or purple flowers, or variegated flowers (yellow, blue or purple), and those with yellow or very rarely white flowers. This classification was considered ambiguous, as the characters were broadly interpreted.

Taylor (1989) revised the circumscription of the sect. *Oligocista* and included 37 species distributed across the Old and New World tropics. Since then, approximately 10 additional species have been described from various regions worldwide (Janarthanam & Henry, 1989, 1992; Yadav *et al*., 2000, 2005; Parnell, 2005; Kumar *et al*., 2018; Biju *et al*., 2020; Cheng *et al*., 2021; Jobson & Baleeiro, 2023), bringing the total to 47 species globally. Following Taylor (*l.c.*) work, further taxonomic revisions, including the resurrection and synonymisation of some species, appeared in scattered publications, floristic studies, and world checklists (Janarthanam & Henry, 1992; Parnell, 2005; Li, 2011, 2020; Fleischmann, 2012; Kolte *et al*., 2019; POWO, 2025). After a thorough analysis, consulting relevant literature, protologues, type materials, and both live and herbarium specimens, the number of accepted species in India has been revised to 21, including two new species described in the present study.

The section comprises morphologically similar species that often grow sympatrically, exhibiting a wide range of variations and polymorphism. Flower colour polymorphism is especially common among the mass-flowering, terrestrial species, and dwarf forms of some species can be found growing alongside their normal individuals.

***Distribution***: Asia, Australia, Africa and Madagascar to America (Taylor, 1989; POWO, 2025). In India, 20 species are found in Peninsular India, with one species occurring in the northern regions.

**Key to the species of sect. Oligocista**

1. Corolla yellow ..... **2**

1. Corolla blue, purple, violet or pink ..... **4**

2. Racemes erect; traps without ventral appendage on stalk; pedicels erect or reflexed in fruiting; palate of lower lip of corolla gibbous or bi-gibbous..... **3**

2. Racemes twining; traps with a ventral appendage near distal end of stalk; pedicels horizontal in fruiting; palate of lower lip of corolla 4-gibbous..... ..... **U. scandens**

3. Palate of lower lip of corolla bi-gibbous; pedicels erect in fruiting; fruiting calyx lobes rhombic and caudate at apex; capsule wall thickened along dehiscing margin; seeds sub-globose with minutely papillose surface..... **U. recta**

3. Palate of lower lip of corolla gibbous; pedicels strongly reflexed in fruiting; fruiting calyx lobes ovate and obtuse at apex; capsule wall uniformly membranous; seeds obliquely obovoid with finely straited surface…. **U. bifida**

4. Plants annual ..... **5**

4. Plants perennial ..... **6**

5. Pedicels reflexed in fruit ..... **7**

5. Pedicels erect or ascending or cernuous in fruit. ..... **8**

6. Racemes up to 100 cm long, vigorously twining; leaves 1-nerved.... **U. reticulata**

6. Racemes less than 45 cm long, usually erect rarely twining; leaves 3-or more nerved..... **9**

7. Trap mouth basal..... **10**

7. Trap mouth lateral..... **U. sainthomia**

8. Upper lip of corolla oblong; palate bi-gibbous; capsule wall uniformly membranous along dehiscing margin ..... **U. lazulina**

8. Upper lip of corolla obovate; palate gibbous or bi-gibbous; capsule wall thickened along dehiscing margin ..... **11**

9. Scales a few on peduncle ..... **12**

9. Scales numerous on peduncle..... **U. wightiana**

10. Bracteoles present; only chasmogamous flowers present; upper lip of corolla obovate. ..... **13**

10. Bracteoles absent; both cleistogamous and chasmogamous flowers present; upper lip of chasmogamous corolla oblong ..... **U. janarthanamii**

11. Pedicels erect in fruit ..... **14**

11. Pedicels ascending, horizontal or cernuous in fruit ..... **15**

12. Peduncles terete ..... .**U. graminifolia**

12. Peduncles angular ..... **16**

13. Spur conical, shorter than or equal to the lower calyx lobe ..... **U. albocaerulea**

13. Spur sickle-shaped or tusk-like, very longer than the lower calyx lobe ..... .**17**

14. Peduncles tapering at base; leaves 1-nerved; calyx lobes sub-equal; corolla blue-pink, spur shorter than the lower calyx lobe; capsules ventrally compressed, seeds ellipsoid with deeply concave periclinal wall of testa, surface finely striate .....**U. polygaloides**

14. Peduncles not tapering; leaves multi nerved; calyx lobes unequal with upper calyx lobe always smaller than lower; corolla purple-violet; spur equal to or exceeds the lower calyx lobe; capsules not compressed; seeds sub-globose with flat periclinal wall of testa, surface smooth..... **U. nayarii**

15. Racemes erect, rather stiff; leaves obovate to spathulate, 3-nerved; flowers more than 6 mm long; fruiting pedicel ascending ..... **18**

15. Racemes twining, wiry; leaves linear, 1-nerved; flowers 3–3.5 mm long; fruiting pedicel cernuous ..... **U. foveolata**

16. Calyx lobes sub-equal; upper lip of corolla shorter than or equal to upper calyx lobe; palate gibbous..... **U. uliginosa**

16. Calyx lobe unequal; upper lip of corolla always longer than upper calyx lobe; palate bi-gibbous..... **19**

17. Palate of the lower corolla lip more or less gibbous; spur sickle-shaped; seeds ellipsoid, periclinal wall concave, surface smooth.....**U. purpurascens**

17. Palate of the lower corolla lip bi-gibbous; spur tusk-like; seeds oblongoid; periclinal wall deeply concave, surface of periclinal wall striated with oblique transversal ridges..... **U. malabarica**

18. Pedicels horizontal in fruit; corolla bi-gibbous; capsule wall uniformly membranous ..... **U. ponmudica**

18. Pedicels ascending in fruit; corolla gibbous; capsule wall thickened along dehiscing margin ..... **20**

19. Inflorescence erect; peduncles wiry; lower calyx lobe elliptic; upper lip of corolla obliquely elliptic; spur subulate, curved upwards; ovary ovoid; style 1 mm long .....**U. sisparensis**

19. Inflorescence twining; peduncles flexuous; lower calyx lobe ovate; upper lip of corolla obovate; spur conical, straight; ovary oblongoid; style 0.5 mm long..... ..... **U. smithiana**

20. Racemes up to 30 cm long; lower calyx lobe acute at apex; upper lip of corolla widely obovate; lower lip of corolla 12–15 mm across in spreading. .... **U. cecilii**

20. Racemes up to 15 cm long; lower calyx lobe bi-dentate at apex; upper lip of corolla oblong; lower lip of corolla 6–8 mm across in spreading. .....**U. praeterita**

**1. Utricularia albocaerulea** Dalzell, Hooker's J. Bot. Kew Gard. Misc. 3: 279. 1851; Oliv., J. Proc. Linn. Soc., Bot. 3: 177. 1858; Dalzell & Gibson, Bombay Fl. 135. 1861 *excl. syn. U. smithiana* Wight; Drury, Handb. Ind. Fl. 2: 120. 1866; T.Cooke, Fl. Bombay 2: 317. 1905; Santapau, J. Bombay Nat. Hist. Soc. 49(2): 218. 1950; Bole & M.R.Almeida, J. Bombay Nat. Hist. Soc. 82: 72. 1985; B.G.Kulk., Fl. Sindhudurg 307. 1988; P.Taylor, Gen. *Utricularia* 323. t. 88. 1989; Janarth. & A.N.Henry, Bladderworts India 27. t. 4. 1992; S.D.Deshp. *et al*., Fl. Mahabaleshwar 1: 424. 1993 as '*albo-coerulea*'; Londhe in N.P.Singh *et al.* (eds.), Fl. Maharashtra, Dicot. 2: 563. 2001; S.R.Yadav & Sardesai, Fl. Kolhapur 337. 2002; Punekar & Lakshmin., Fl. Anshi Natl. Park 334. 2011; Kavade & Deokule, Fl. Chandoli Natl. Park 264. 2015. *Type*: INDIA, **Maharashtra**, Bombay, Vingorla (Vengurla), *s.d.*, *Dalzell s.n.* (holo, K [K001097998 digital image!]). **Figs. 40–42**

Annual, terrestrial herbs. Rhizoids 8–12 mm long, up to 0.35 mm thick, few from stolon base, thick at base, tapering towards apex, glabrous, branches up to 1 mm long, papillose. Stolons a few, 10–50 mm long, 0.15–0.2 mm thick, terete, glabrous,

variously branched, internode 1.5–3 mm long. Leaves numerous on stolon, solitary at each stolon nodes; petiole 2.75–5 × 0.3–0.4 mm, flattened, hyaline; lamina obovate-spathulate, 2–3 × 1–1.25 mm, 3-nerved, attenuate at base, rounded at apex. Traps numerous on stolons and leaves, sub-dimorphic; those on leaf lamina small, more or less globose, 0.7–1 mm across, sessile to a short stalk of 0.1–0.2 mm long, uniformly thickened; those on stolons large, sub-globose, 1.2–1.5 × 1–1.2 mm, stalk 0.25–0.7 mm long, distally thickened, glandular hairy; mouth basal; appendages subulate, *c.* 0.6 mm long, glandular hairy.

**Fig. 40.** Type of *Utricularia albocaerulea* Dalzell [*Dalzell s.n.* (K001097998)] "© *Board of Trustees of the Royal Botanic Gardens, Kew*".

Racemes erect, 10–15 cm long, 1–3-flowered; peduncles angular, grooved on one side, 0.8–1 mm thick, simple, glabrous, green-pale brownish green. Scales a few, triangular, 1.2–1.3 × 0.7–0.85 mm, 1-nerved, green, truncate at base, acute at apex. Bracts triangular, 1.7–1.8 × 1.2–1.4 mm, 1-nerved, truncate at base, narrowly acute at apex; bracteoles lanceolate, 0.6–0.7 × 0.15–0.2 mm, acute at apex. Flowers 8–10 mm long; pedicels 4–5 × 0.5–0.65 mm, erect, winged, broader apically, accrescent, 8–10 mm in fruiting, reflexed in fruit, purplish red. Calyx lobes unequal, 14–15-nerved, green; upper lobe ovate-widely ovate, 4.35–4.5 × 3.3–3.7 mm (6–6.5 × 5–5.35 mm in fruit), entire at margin, acute at apex; lower lobe ovate or elliptic, 3.8–4 × 2.5–3 mm (5–5.5 × 3.75–4 mm in fruit), entire at margin, bidentate at apex. Corolla pale to deep blue; upper lip obovate, 6–6.5 × 4.8–5.25 mm, constricted below the middle, broader above the constriction, hairy along lower margins, white, rounded or emarginate at apex; lower lip more or less orbicular, 12–15 mm across, ciliate along throat margin,

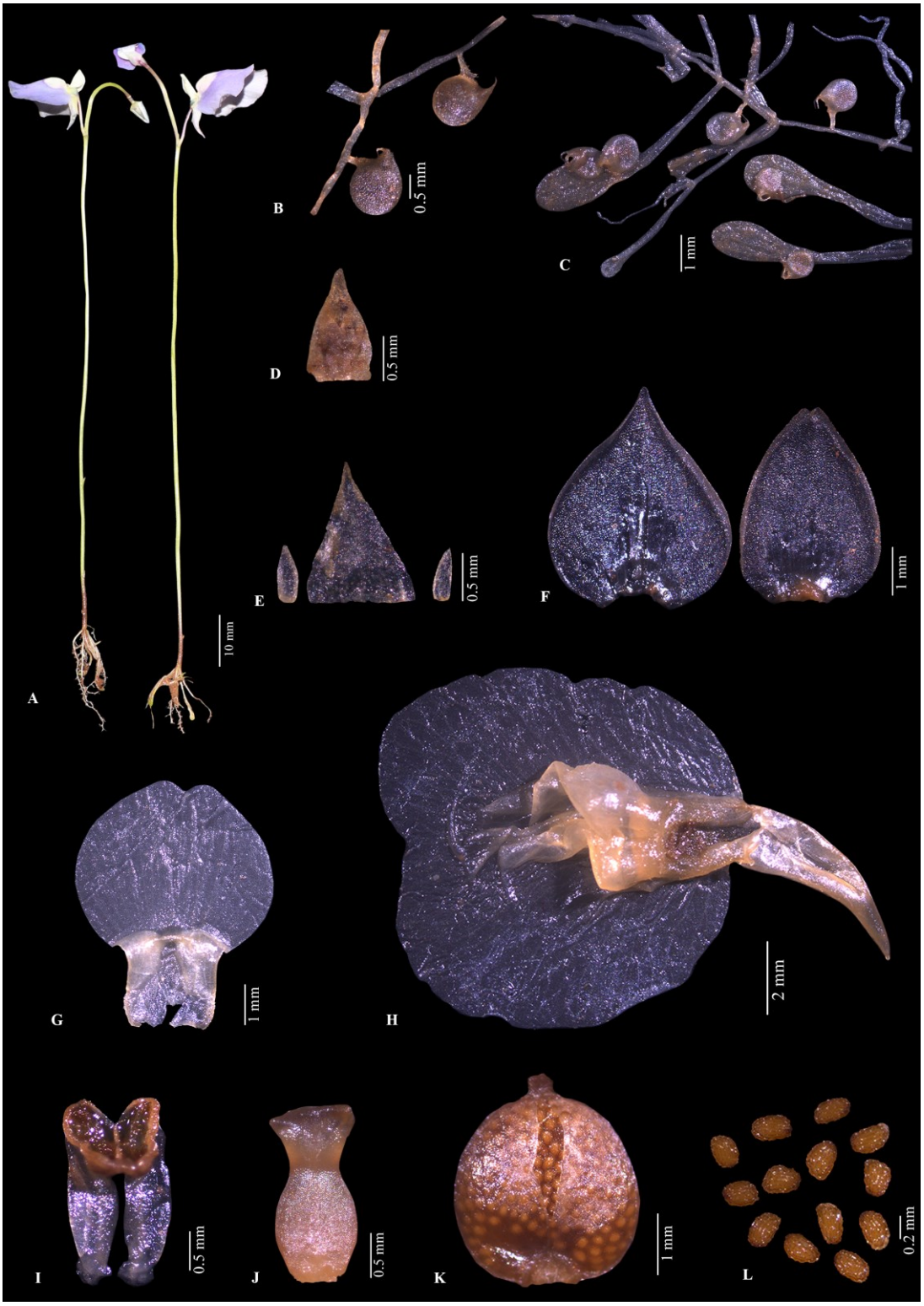


**Fig. 41.** *Utricularia albocaerulea* Dalzell: **A.** Habit; **B.** Traps; **C.** Stolon bearing leaves and traps; **D.** Scale; **E.** Bract and bracteoles; **F.** Calyx lobes; **G.** Upper lip of corolla; **H.** Lower lip of corolla with spur; **I.** Stamens; **J.** Pistil; **K.** Capsule; **L.** Seeds.

**Fig. 42.** *Utricularia albocaerulea* Dalzell: **A-C.** Habitat; **D-H.** Flowers in different view; **J.** Mature fruit (note the deflexed fruiting pedicel).

yellow at throat, palate bi-gibbous, white with blue reticulations, clear blue then, margin entire, truncate to deeply emarginate at apex; spur conical, 3.2–3.5 mm long, straight or rarely slightly curved, narrowly acute at apex. Stamens 1.8–2 mm long; filaments strap-shaped, 1.9–2 × 0.5–0.6 mm, broad at middle, curved at base; anther thecae 0.9–1 mm long. Pistil 1.8–2.2 mm long; ovary ellipsoid, 1–1.2 × 0.7–0.8 mm, compressed; style 0.2–0.25 mm long; stigma bi-lipped; upper lip oblong, lower lip sub-orbicular. Capsules widely ellipsoid, 3.25–3.5 × 3–3.2 mm, compressed, wall uniformly membranous, dehiscing by dorsal and ventral, longitudinal slit; placenta 1.2–1.5 × 1.25–1.5 mm, widely elliptic. Seeds numerous, obovoid-oblongoid, 0.3–0.35 × 0.2–0.25 mm; surface smooth; hilum terminal.

***Flowering & fruiting***: Flowering takes place from mid-August to mid-October, and fruiting occurs from late August until the end of October.

***Habitat***: It grows in open, swampy soil pockets on wet lateritic plateaus and in moist, gravelly soil along the fringes of monsoon puddles in lateritic hillocks, usually found in association with *U. praeterita*, *U. purpurascens*, *Burmannia coelestis* (Burmanniaceae), *Drosera indica* (Droseraceae), *Hoppea fastigiata* (Gentianaceae), *Kohautia aspera* (B.Heyne ex Roth) Bremek. (Rubiaceae), *Rhamphicarpa fistulosa* Benth. (Orobanchaceae), *Eriocaulon xeranthemum* Mart., *E. quinquangulare* L. (both Eriocaulaceae), *Stylidium* sp. (Stylidiaceae) and some sedges and grasses (Fig. 42).

***Distribution***: Endemic to the Western Ghats, India (Fig. 43).

***Specimens examined***: INDIA, *s.loc.*, *s.d.*, *Herb. Dalzell s.n.* (DD); Malabar, Concan, *s.d.*, *J.E. Stocks & J.S. Law s.n.* (E01321521, L.2827618, O2260017, P02981695, P02981696 digital images, MH00126367). **Goa**, North Goa district, Pernem Agarvado, 07.09.1965, *John Cheriyan* 93098 (BSI). **Maharashtra**, Ratnagiri district, Rajapur, 11.08.2022, *M.P. Krishnapriya* 177277 (CALI197437, CALI197438, CALI197439); Rajapur-Padve road, ± 65 m, 11.08.2022, *M.P. Krishnapriya* 177281 (CALI197363, CALI197364, CALI197365, CALI197366, CALI197367); Satara district, Mahabaleshwar, near Venna Lake on lateritic rocks, 05.10.1985, *M.K. Janarthanam* 82942 (MH00126543, MH00126544); Panchgani, first Table land, 07.10.1985, *M.K. Janarthanam* 82945 (BSID0012681, MH00126541, MH00126542); *Ibid.*, 07.10.1985, *M.K.*

*Janarthanam* 82946 (BSID0012680, MH00126539, MH00126540); Table Land, Plateau, 16.09.2018, *M.P. Krishnapriya* 168008 (CALI197459); *Ibid*., Plateau, 13.10.1960, *M.Y. Ansari* 67721 (BSI); Old Mahabaleshwar road, 11.10.1960, *M.Y. Ansari* 67560 (BSI).

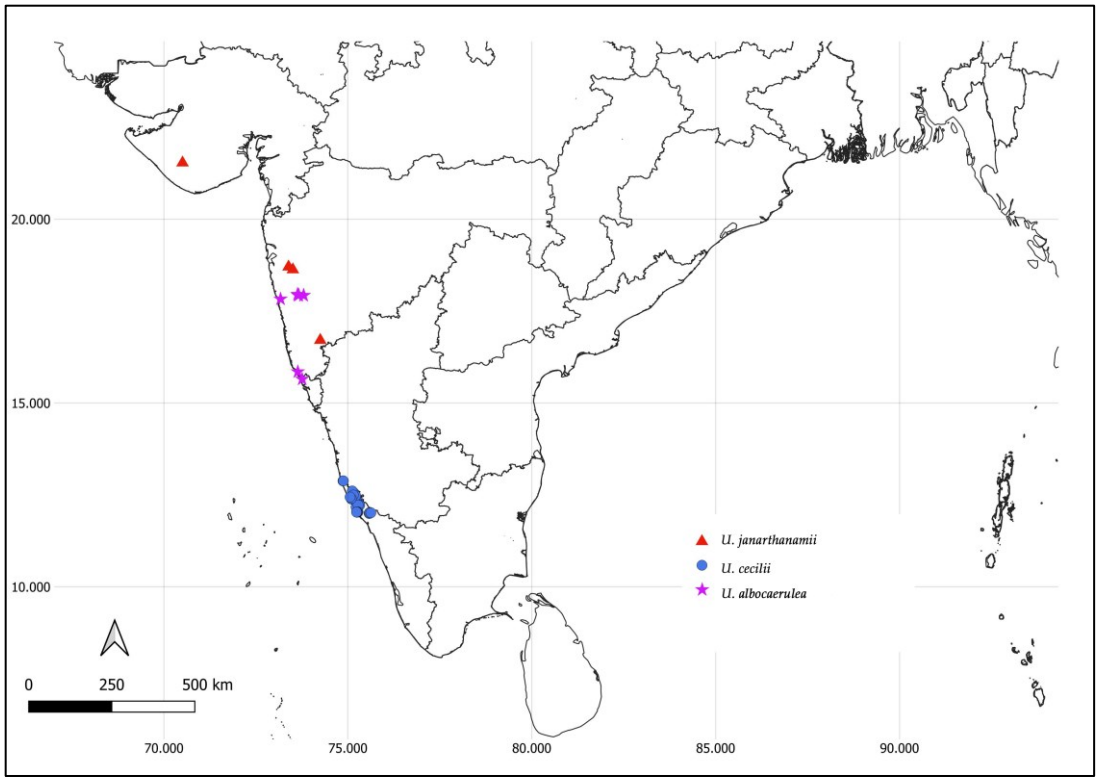


**Fig. 43.** Distribution of *Utricularia albocaerulea* Dalzell; *Utricularia cecilii* P.Taylor; *Utricularia Janarthanamii* S.R.Yadav *et al*.

***Conservation status***: *Utricularia albocaerulea* is an endemic species found primarily in the lateritic plateaus of Goa and Maharashtra. Unlike other mass-flowering species, *U. albocaerulea* has a highly restricted distribution. Field studies indicate that the reduction in both area and quality of its habitat, as well as the shrinking of its population size, can be attributed to various factors, including developmental activities, construction, tourism, and climatic fluctuations. The AOO is estimated at 20 km$^2$, and EOO is 6338.548 km$^2$. Based on the current data, the status of the species is assessed here as Endangered (EN B2b(i,ii,iii,iv)+c(i,ii,iii,iv)).

***Notes***: *Utricularia albocaerulea* is a large flowered species distinguished by its obovate to spathulate leaves, erect inflorescence, reflexed fruiting pedicel, bi-gibbous palate, emarginate lower lip of corolla, and short conical spur (Fig. 42E-J). It is similar to *U.*

*purpurascens*, but can be easily distinguished by its short conical spur, which is either equal or slightly longer than lower calyx lobe, in contrast to the long sickle-shaped spur of *U. purpurascens*, which is approximately three times longer than lower calyx lobe.

Additionally, *U. albocaerulea* has affinities with *U. malabarica* due to the reflexed nature of its pedicels. However, differences such as the size of inflorescence and flowers, the short conical spur, and the smooth surface of the seeds allow for easy differentiation from *U. malabarica.*

**2. Utricularia bifida** L., Sp. Pl. 1: 18. 1753; Sm. in Rees (ed.), Cycl. 37: 597. 1819; A.DC. in DC. (ed.), Prodr. 8: 21. 1844; Oliv., J. Proc. Linn. Soc., Bot. 4. 182. 1859; Dalzell & Gibson, Bombay Fl. 135. 1861; Drury, Handb. Ind. Fl. 2: 123. 1866; Benth. & F.Muell., Fl. Austral. 4: 527. 1869; C.B.Clarke in Hook.f. (ed.), Fl. Brit. India 4: 332. 1884; K.I.Goebel in Treub (ed.), Ann. Jard. Bot. Buitenzorg 9: 66. 1891; Trimen, Handb. Fl. Ceylon 3: 270. 1895; Prain, Bengal Pl. 2: 781. 1903; Merr., Fl. Manila 433. 1912; Haines, Bot. Bihar Orissa 4: 646. 1922; Gamble, Fl. Madras 2: 982. 1924; R.K.Basak, Bull. Bot. Surv. India 14: 104. 1975; P.Taylor, Fl. Males. 1(8): 281. f. 4. 1977; Gandhi in C.J.Saldanha & Nicolson (eds.), Fl. Hassan Dist. (sec. reprint) 563. 1978; Vajr. Fl. Palghat Dist. 330. 1980; N.P.Balakr., Fl. Jowai 341. 1983; N.Rani & K.M.Matthew in K.M.Matthew (ed.), Fl. Tamilnadu Carnatic 3(1): 1112. t. 85b. 1983; B.D.Sharma *et al*., Fl. Karnataka: analysis 195. 1984; D.M.Verma in D.M.Verma *et al.* (eds.), Fl. Raipur, Durg & Rajnandgaon 266. 1985; K.K.N.Nair & M.P.Nayar, Fl. Courtallum 2: 304. 1987; V.Chandras. in A.N.Henry *et al.* (eds.), Fl. Tamil Nadu, Ind., Ser I. Analysis 2: 129. 1987; N.P.Singh, Fl. E. Karnataka 2: 475. 1988; Z.Y.Li, Bull. Bot. Res., Harbin 8(2): 28. 1988; P.Taylor, Gen. *Utricularia* 307. t. 82. 1989; Janarth. & A.N.Henry, Bladderworts India 37. t. 7. 1992; M.N.Sanyal, Fl. Bankura Dist. West Bengal 319. 1994; K.M.Matthew, Excurs. Fl. Central Tamilnadu (repr. ed.) 1: 357. 1995; R.C.Srivast. in Mudgal *et al*. (eds.), Fl. Madhya Pradesh 2: 252. 1997; Moulali in Pull. & Moulali (eds.), Fl. Andhra Pradesh 2: 676. 1997; Naik *et al*., Fl. Marathwada 2: 638. 1998; Londhe in N.P.Singh *et al.* (eds.), Fl. Maharashtra, Dicot. 2: 564. 2001; N.P.Singh *et al*., Fl. Bihar, Analysis 366. 2001; Noltie in Grierson & D.G.Long (eds.), Fl. Bhutan 2(3): 1340. 2001; T.K.Sharma & A.K.Sarkar, Fl. Palmau Dist. 456. 2002; An.Kumar &

P.S.N.Rao, Fl. Indravati Tiger Reserve 207. 2003; Sauris Panda & A.P.Das, Fl. Sambalpur 259. 2004; K.K.Khanna *et al*., Florsit. Diversity Chhattisgarh 329. 2005; Sunil & Sivad., Fl. Alappuzha Dist. 515. t. 43. 2009; Li in Wu *et al*. (eds.), Fl. China 19: 483. 2011; G.D.Pal, Fl. Lower Subansiri Dist. 162. 2013; Deepak Kr Ghosh & Jayanta Kr. Mallick, Fl. Darjeeling Himalaya Foothills 313. 2014; R.Ansari *et al*., Aquatic Wetland Fl. Kerala: Fl. Pl. 506. 2016; Noltie in Watson *et al.* (eds.), Fl. Nepal (web edn.) 6. 2019; S.K.Mandal & Bhaumik in Lakshmin. *et al*. (eds.), Fl. West Bengal 4: 142. 2019. *Nelipus bifida* Raf., Fl. Tellur. 4: 109. 1838. *Lectotype* (designated by Taylor, 1989): CHINA, **Guangdong**, *s.d.*, *P. Osbeck s.n.*, Herb. Linn. No. 34.7 (LINN digital image!).

**Figs. 44–46**

*Utricularia recurva* Lour., Fl. Cochinchina 1: 26. 1790; Sm. in Rees (ed.), Cycl. 37: 601. 1819; A.DC. in DC. (ed.), Prodr. 8: 22. 1844. *Type*: Habitat in rivo Hon mô, non procul ab urbe regiâ Cochinchinæ (*Type*: Not located)

*Utricularia humilis* Vahl, Enum. Pl. 1: 203. 1804; A.DC. in DC. (ed.), Prodr. 8: 22. 1844; Wight, Hooker's J. Bot. Kew Gard. Misc. 1: 372. 1849 *p.p.*, Icon. Pl. Ind. Orient. 4(4): 10. t. 1572 f. 2. 1850. *Type*: India Orientalis *s.d.*, *J. Koenig s.n.* (C [C10013887 digital image!])

*Utricularia wallichiana* Benj., Bot. Zeit. 3: 213. 1845. *Type*: NEPAL, *s.d.*, *N. Wallich* 1498 (K, not seen)

*Utricularia antirrhinoides* Wall. ex Oliv., J. Linn. Soc., Bot. 3: 182. 1859. *Type*: NEPAL (Central Nepal), *s.d.*, *N. Wallich* 1498 B (holo, K not seen)

*Philydrum cavaleriei* H.Lev., Bull. Herb. Boissier Ser. II. vi. 506. 1906. *Type*: CHINA, 07.10.1899, *P.J. Cavalerie s.n.* (holo, E [E00265804 digital image!])

Annual, terrestrial to semi-aquatic herbs. Rhizoids a few, up to 20 mm long, capillary; branches up to 5 mm long, papillose. Stolons 20–30 mm long, terete, glabrous, internodes up to 5 mm long. Leaves numerous from stolon nodes; petioles up to 5 mm long, flat, hyaline; lamina linear to oblanceolate, 5–10 (–20) × 0.8–2 mm, 1-nerved, membranous, green, attenuate at base, margin entire, rounded at apex. Traps obovoid, 0.5–0.8 × 0.5–0.6 mm, usually a few on stolons and leaves; stalk 0.5–0.8 mm long, distally thickened; mouth basal with into short ventral appendage; appendages subulate, inflexed. Racemes erect, simple to branched, 2–12 (–20) cm long, 1–10 (–14)-

flowered; peduncles terete, 0.8–1.2 mm thick, glabrous, green to yellowish green. Scales a few, triangular, 1–1.5 × 0.5–0.8 mm, fertile, 1-nerved, truncate at base, acute at apex, greenish yellow. Bracts triangular, 2–2.5 × 1.2–1.6 mm, greenish yellow, 3-nerved, truncate at base, narrowly acute-acute at apex; bracteoles subulate, 1–1.2 × 0.1–0.2 mm, 1-nerved, shorter than bract, greenish yellow, acute at apex. Flowers up to 8 mm long; pedicels 2–6 × 0.8–1.2 mm, erect or ascending at anthesis, dorsiventrally flattened, broadly winged distally, reflexed in fruit, green-yellowish green. Calyx lobes slightly unequal, accrescent (3.5–4 × 3.2–3.8 mm in fruiting); upper lobe widely ovate, 2.5–3.2 × 2.2–2.7 mm, 10–12-nerved, obtuse at apex in anthesis, rounded at apex in fruiting; lower lobe ovate, 2–2.7 × 1.8–2.25 mm, 8–10-nerved, emarginate-deeply bifid at apex. Corolla yellow, sometimes deep brownish red beneath; upper lip oblong, 2–3.5 × 1–1.5 mm, constricted at middle or below the middle, sometimes broad above the constriction, hairy towards lower margin, rounded at apex; lower lip widely obovate-sub-orbicular, palate prominently gibbous, ciliate along throat margin, rounded to rarely 3-lobed at apex; spur conical, 3.5–4 mm long, usually straight, rarely slightly curved towards apex, longer than lower calyx lobe, acute at apex, yellow, rarely pale purple towards tip. Stamens 1–1.5 mm long; filaments narrowly oblong, 1–1.4 × 0.2–0.25 mm, straight, twisted at base, hyaline; anther theca 0.3–0.4 mm long. Pistil 1.2–1.5 mm long; ovary ovoid, 0.5–0.8 × 0.4–0.6 mm, dorsiventrally compressed, green; style 0.4–0.5 mm long; stigma bi-lipped; upper lip triangular,

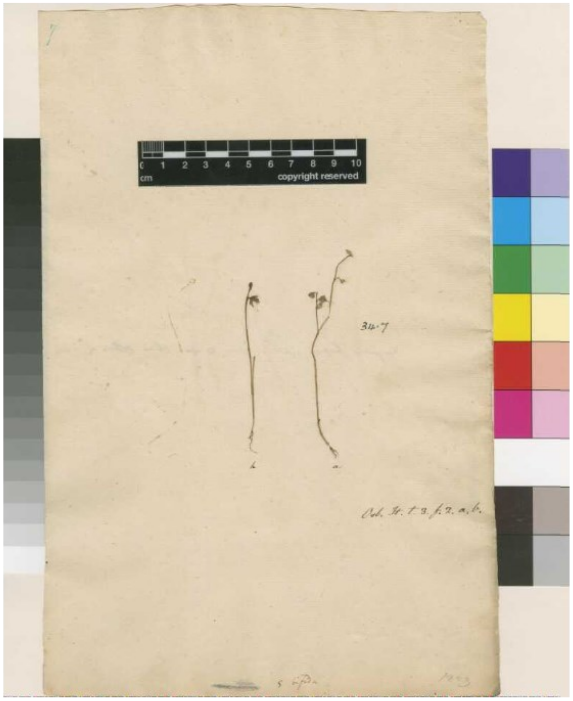


**Fig. 44.** *Lectotype* of *Utricularia bifida* L. [*P.Osbeck s.n. Herb. Linn. No.* 34.7 (LINN)] "© *Reproduced with permission of The Linnean Society of London*".

**Fig. 45.** *Utricularia bifida* L.: **A.** Habit; **B.** Trap; **C1 & C2.** Peduncle bearing scale (with fertile bud); **D.** Bract and bracteoles; **E.** Calyx lobes; **F.** Corolla - lateral view; **G.** Corolla - opened view; **H.** Upper lip of corolla; **I.** Stamens; **J.** Pistil; **K.** Capsule; **L.** Seeds.

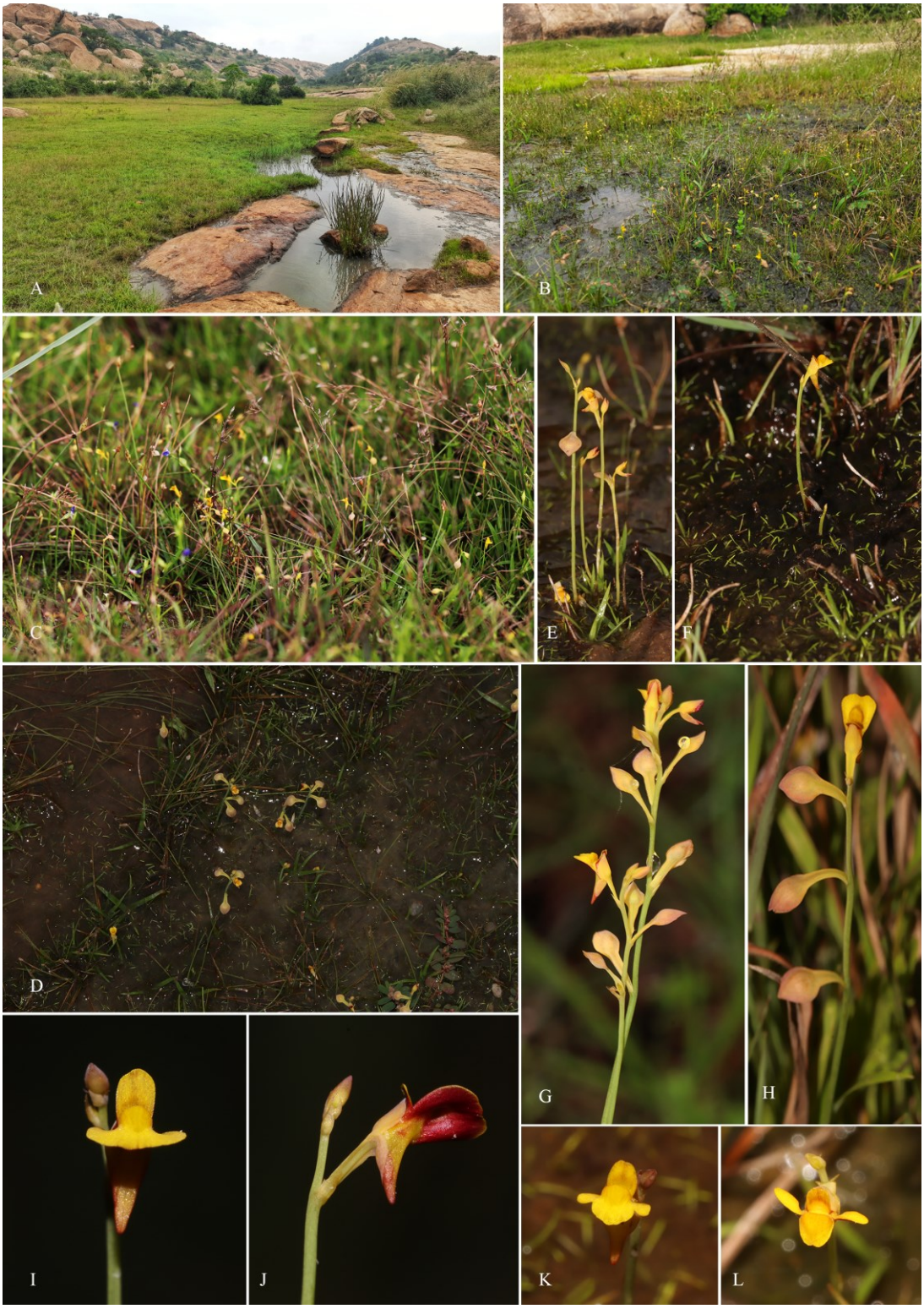


**Fig. 46.** *Utricularia bifida* L.: **A-D.** Habitat; **B-F.** Habit; **G & H.** Peduncle bearing bud, flowers and young and mature capsules; **I-L.** Flowers in different view (**L.** note the 3-lobed lower lip of corolla).

lower lip sub-orbicular, papillose out, incurved. Capsules widely ovoid-ellipsoid, 2.5–3 × 2–2.5 mm, dorsiventrally compressed, wall uniformly membranous, dehiscing by dorsal and ventral, longitudinal slit; placenta ellipsoid, 1.2–1.5 × 1.1–1.2 mm. Seeds numerous, obliquely obovoid, 0.3–0.4 × 0.2–0.3 mm; surface striated with longitudinal ridges; hilum latero-terminal.

***Flowering & fruiting***: Flowering from early September to late January, and fruiting from mid-September till the end of February. Peak flowering is observed during November and December.

***Habitat***: *Utricularia bifida* grows on seasonally inundated sandy soil, slimy rocky surfaces or slopes and swampy lands in sea level to 1800 m. It is often found in association with *U. caerulea*, *U. geoffrayi*, *U. hirta*, *U. minutissima*, *U. polygaloides*, *Drosera indica*, *D. burmanni* (both Droseraceae), *Eriocaulon* spp. (Eriocaulaceae), *Euphorbia* sp. (Euphorbiaceae), *Hoppea fastigiata* (Gentianaceae), *Murdannia semiteres*, *M. vaginata, M. striatipetala* (all Commelinaceae), and some sedges, and grasses (Fig. 46).

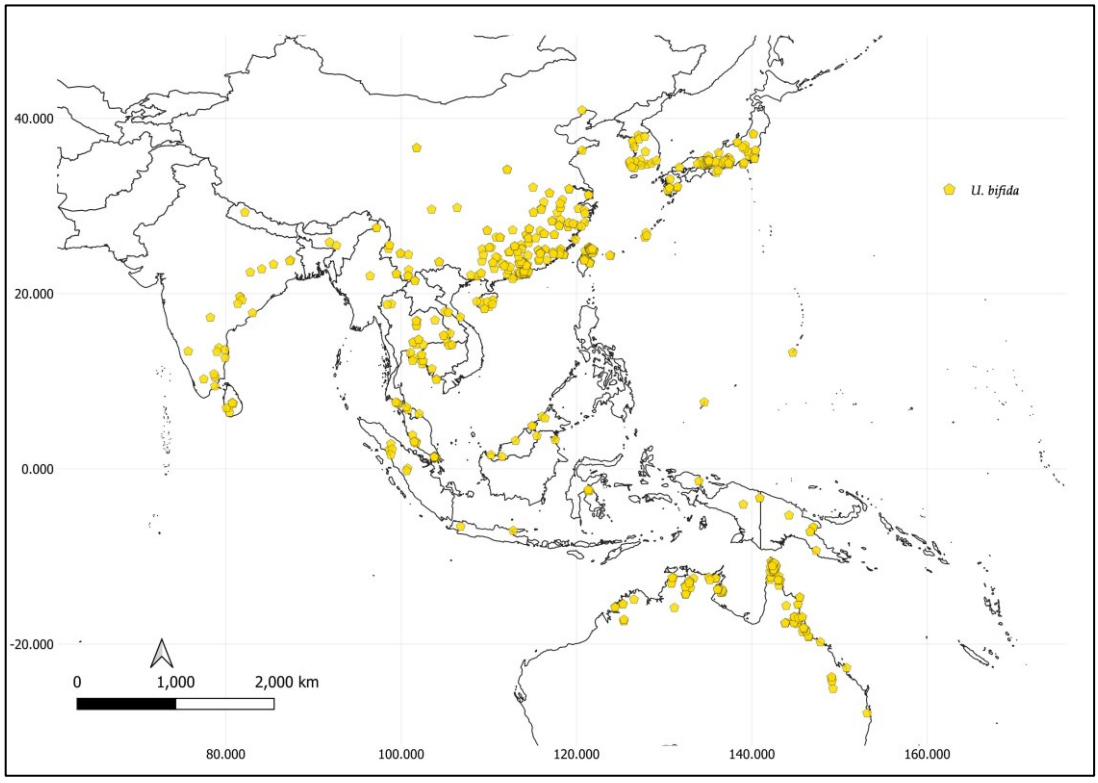


**Fig. 47.** Distribution of *Utricularia bifida* L.

***Distribution***: India, Australia, Bangladesh, Cambodia, China, Indonesia, Japan, Korea, Laos, Malaysia, Myanmar, Nepal, Papua New Guinea, Philippines, Sri Lanka, Thailand and Vietnam (Taylor, 1989; Janarthanam & Henry, 1992; POWO, 2025) (Fig. 47).

***Specimens examined***: CHINA, **Shandong Province**, *s.loc.*, August-September 1862, *A.C. Maingay* 115 (CAL). **Yunnan Province**, Mong-hain or gan-lan-ba Che-li Hsien, 800 m, October 1936, *C.W. Wang* 79938 (A01976848 digital image); Che-li Hsien, 750 m, October 1936, *C.W. Wang* 78843 (A01976849 digital image). INDIA, **Andhra Pradesh**, Chittoor district, near Akkagari Gudi, 800 m, 01.10.1974, *G.V. Subba Rao* 45938 (MH00126699); Seethalam Riverbed, Thandipandal, 225 m, 25.09.1974, *M. Chandrabose* 45099 (MH00126696); Vishakhapatnam district, way to Tanjavanam, 1075 m, 16.10.1972, *G.V. Subba Rao* 92625 (MH00126694, MH00126695). **Assam**, *s.loc., s.d., s.coll.* 155 (ASSAM); Karbi Anglong district, near Garampani south side, 23.08.1968, *N.P. Balakrishnan* 46998 (ASSAM). **Chhattisgarh**, Bastar district, near Dangadamunda Lake, Kondagaon, 767 m, 19.11.1958, *K. Subramanyam* 7211 (MH00126693); Dantewada district, Bailadila, 3500 feet, 06.10.1940, *H.F. Mooney s.n.* (DD); Jashpur district, Surguja, Gurguri, 23.10.1947, *Walter N. Koelz* 19405 (MICH1577922 digital image). **Jharkhand**, Ranchi, *s.loc.*, August 1950, *Mrs. Wright s.n.* (DD). **Karnataka**, Chikkamagaluru district, Mudigere, Devaramane, 08.09.2021, *M.P. Krishnapriya* 186046 (CALI197483, CALI197484, CALI197488). **Meghalaya**, *s.loc., s.d., s.coll.* 156 (ASSAM); Ri-Bhoi district, Nongpoh, Nonglam Forest base, near football ground, *ca.* 3000 feet, 15.10.1980, *J. Joseph* 76947 (ASSAM). **Tamil Nadu**, Chengalpattu district, Kambakkam, *s.d., s.coll. s.n.* (MH00126692); Kambakkam Hills, 06.05.1913, *s.coll.* 8948 (MH00126691); Pudukkottai district, Kulathur, Narthamalai (Bommadimalai), 150 m, 16.12.1982, *K.M. Matthew & N. Rani* 29341 (RHT044595); Narthamalai, 150 m, *s.d.*, *K.M. Matthew* 15063 (RHT044593); *Ibid.*, 30.11.1967, *K.M. Matthew* 8262 (RHT044749); *Ibid.*, ± 131 feet, 12.12.2022, *M.P. Krishnapriya* 186040 (CALI197485, CALI197486, CALI197487, CALI197488, CALI197489); *Ibid.*, way to Vijayalaya Choleswar Temple, ± 184 feet, 11.12.2022, *M.P. Krishnapriya* 186036 (CALI197490, CALI197491, CALI197492, CALI197493, CALI197494); Sathyamangalam, 23.12.1978, *Fieldmen* 16188 (RHT044686); Ramnad district, Esani

Estate, 100 m, 16.12.1964, *K. Ramamurthy* 22731 (MH00126689); Thiruchirapalli district, Trichi, December 1940, *s.coll. s.n.* (RHT044593). **West Bengal**, Birbhum district, Baidyanathpur, 24.10.1970, *R.K. Basak* 1533 (CAL0000009089); Darjeeling district, Darjeeling, 28.11.1923, *J.M. Cowan s.n.* (E01321661 digital image). INDONESIA, **Indonesian Island**, Sumatra, *s.d., H.H. Bartlett* 7885 (MH00127014). JAPAN, **Ryukyu Islands**, Kunigami, Kushi-mura, along Henoko River, 07.08.1951, *E.H. Walker, S. Tawada & T. Amano* 6476 (US03216859, L.2827516 digital images). LAOS, **Khammouane Province**, Koror Palau, one half mile from Sansaro intersection on Babelthuap rock road, 07.09.1968, *Carl A. Salsedo* 8 (US03217144 digital image); Tracks south of Ban Mak Pheuang, 17°50′51′′N 105°22′51′′E, 548 m, *s.d., M.F. Newman, P.I. Thomas, K.A. Armstrong, K. Sengdala & V. Lamxay* LAO693 (L0811367 digital image). MALAYSIA, **Selangor**, Petaling district, Shah Alam, Selangor, 03°05′N 101°30′E, 50 m, 22.02.1987, *R.D. Worthington* 12491 (RSA0229763 digital image). MYANMAR, **Mon State**, Mawlamyine, foothills of southeast Moulmein, 08.03.1908, *Herb R.E.P.* 30417 (BSIS000007293); Pegu, Irrawaddy and Sittang Valley, Yangoon Lake, December 1870, *S. Kurz* 2307 (CAL). PALAU, **Babeldaob Island**, Belau Islands, Southwestern part of Ngetpang state, bauxite mining ruins along road to Ibobang Village at junction with road to Ngechesar, 50 m, 16.07.1991, *Herbst, Stemmermann & Canfield* 9382 (US03217150 digital image). PAPUA NEW GUINEA, **Morobe Province**, Morobe district, Old Lake bed, below Red Hill about 15 miles W. of Lae, 17.01.1962, *Thomas G. Hartley* 9747 (A01977250 digital image). PHILIPPINES, Luzon, September 1913, *M. Ramos* 1454 (L.282794 digital image). SINGAPORE, Railway line near Kranji, off 13.5 msl., Bukit Timah Road, 23.01.1949, *J. Sinclair s.n.* (DD). TAIWAN, **Fukien Province,** Little Quemoy, 27.05.1961, *T.T. Chuang* 283 (A01976841 digital image). THAILAND, **Loei Province**, NE Loei, Phu Kradung, 101°47-49′E 16°53-54′N, 13.10.1984, *Gen Murata & Chamlong Phengklai* T-42188 (A01977022 digital image). **Narathiwat Province,** Tak Bai district, Ku Chum, 14.09.1987, *C. Niyomdham & D. Sriboonma* 1587 (L.4483972, P00379091 digital images). VIETNAM, **Thua Thien Hue Province**, Hue and Vicinity, January-May 1927, *R.W. Squires* 230 (US03216841 digital image).

***Conservation status***: *Utricularia bifida* has a wide distribution across Asia to Northwest Pacific, and tropical Australia. In India, it is commonly found in Andhra Pradesh, Karnataka, Tamil Nadu, and West Bengal. Considering its wide distribution, *U. bifida* is treated here as Least concern (LC).

***Notes***: *Utricularia bifida* is easily recognized by its bright yellow flowers, the prominently gibbous palate of corolla, reddish yellow pedicels and calyx lobes, prominently winged and reflexed fruiting pedicels, more or less rounded fruiting calyx lobes, and the striated testa surface (Figs. 45, 46, 176F). The distinctive yellow flowers alone set it apart from the other 19 species in this section.

Among the three yellow-flowered species, *U. bifida* is morphologically most similar to *U. recta* in having erect peduncles and 1-nerved linear leaves, but can be easily distinguished by the reflexed nature of its fruiting pedicels.

*Utricularia bifida* also shares affinities with *U. scandens*, but can be differentiated by the rather stiff and erect peduncles (as opposed to filiform, twining peduncles of *U. scandens*), the gibbous corolla (*vs*. 4-gibbous corolla), the obtuse upper calyx lobes (*vs*. the acute upper calyx lobes), the reflexed fruiting pedicels (*vs*. the horizontal fruiting pedicels), and the striated testa (see chapter 7) surface with oblique, longitudinal ridges (*vs*. the rough with finely verrucate surface).

**3. Utricularia cecilii** P.Taylor, Proc. Ind. Acad. Sci. Pl. Sci. 93(2): 99. t. 1. 1984; M.Ahmed. & M.P.Nayar, Endemic Pl. Ind. 1: 154. 1986; P.Taylor, Gen. *Utricularia* 319. t. 86. 1989; Janarth. & A.N.Henry, Bladderworts India 47. t. 10. 1992; K.G.Bhat, Fl. South Kanara 768. 2014; Singh *et al*., Endemic Vasc. Pl. India 195. 2015; R.Ansari *et al*., Aquatic Wetland Fl. Kerala: Fl. Pl. 511. 2016. *Type*: INDIA, **Karnataka**, Dakshina Kannada district, Kulshekar, 60 m, 14.08.1981, *P. Taylor* 18020 (holo, K [K000939698 digital image!]). **Figs. 48–51**

Annual, terrestrial to semi-aquatic herbs. Rhizoids numerous, capillary, up to 20 mm long, tapering towards apex, papillose, profusely branched, branches dichotomous,

up to 5 mm long, tapering, papillose. Stolons up to 30 mm long, 0.2–0.3 mm thick, terete, glabrous, branched. Leaves usually 2 on peduncle base, more on stolons, solitary at each stolon node, mat-forming; petioles 2–8 mm long, dorsiventrally flattened; lamina obovate to spathulate, 10–15 × 1.5–2.65 mm, 3-nerved, nerves branched further, attenuate to narrowly cuneate at base, margins entire, rounded at apex. Traps numerous on rhizoids, stolons, and leaves, sub-dimorphic; those on leaves globose, 0.6–0.8 mm across; stalk up to 0.15 mm long, uniformly thickened; those on rhizoids and stolons sub-globose, 1–1.2 mm across; stalk 0.5–0.85 mm long, distally thickened, glandular hairy; mouth basal; appendages subulate, glandular hairy. Racemes erect, up to 30 cm long, 1–8-flowered, simple or, sometimes branched; peduncles angular, grooved on one side, 0.8–1.2 mm thick, slightly winged. Scales a few, triangular, 1.8–2.45 × 1.2–1.4 mm, 1-nerved, truncate at base, acute at apex. Bracts widely ovate, 2.4–2.5 × 1.5–1.7 mm, 3-nerved, truncate at base, acute at apex; bracteoles lanceolate, 1.5–1.7 × 0.2–0.4 mm, 1-nerved, rounded at base, narrowly acute at apex. Flowers 10–15 mm long; pedicels 4–7 × 0.5–0.8 mm, erect at anthesis, dorsiventrally compressed, winged, greenish-purple, slightly ascending in fruit. Calyx lobes sub-equal, green to greenish-purple; upper lobe widely ovate, 4–4.5 × 2.8–3.25 mm, 14-nerved, acute at apex; lower lobe ovate, 4–4.2 × 2.3–2.8 mm, 12–14-nerved, acute at apex. Corolla shades of blue to purple, rarely pale pink or pure white; upper lip widely obovate, 6.5–7.8 × 5.5–6.5 mm, constricted below the middle, hairy along lower margins, blue or violet with dark blue longitudinal streaks, prominent at middle, faint towards both ends (in pale pink-white flowers

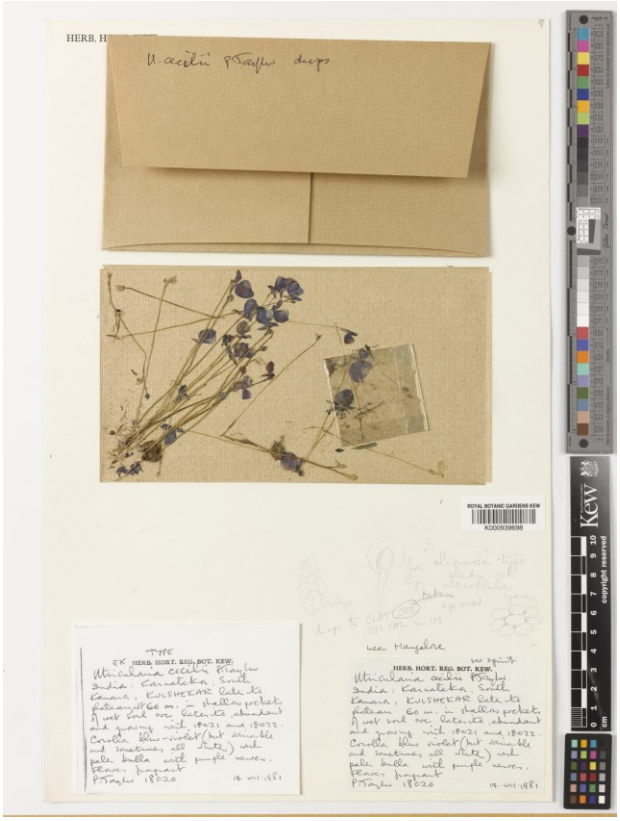


**Fig. 48.** Type of *Utricularia cecilii* P.Taylor [*P.Taylor* 18020 (K000939698)] "© *Board of Trustees of the Royal Botanic Gardens, Kew*".

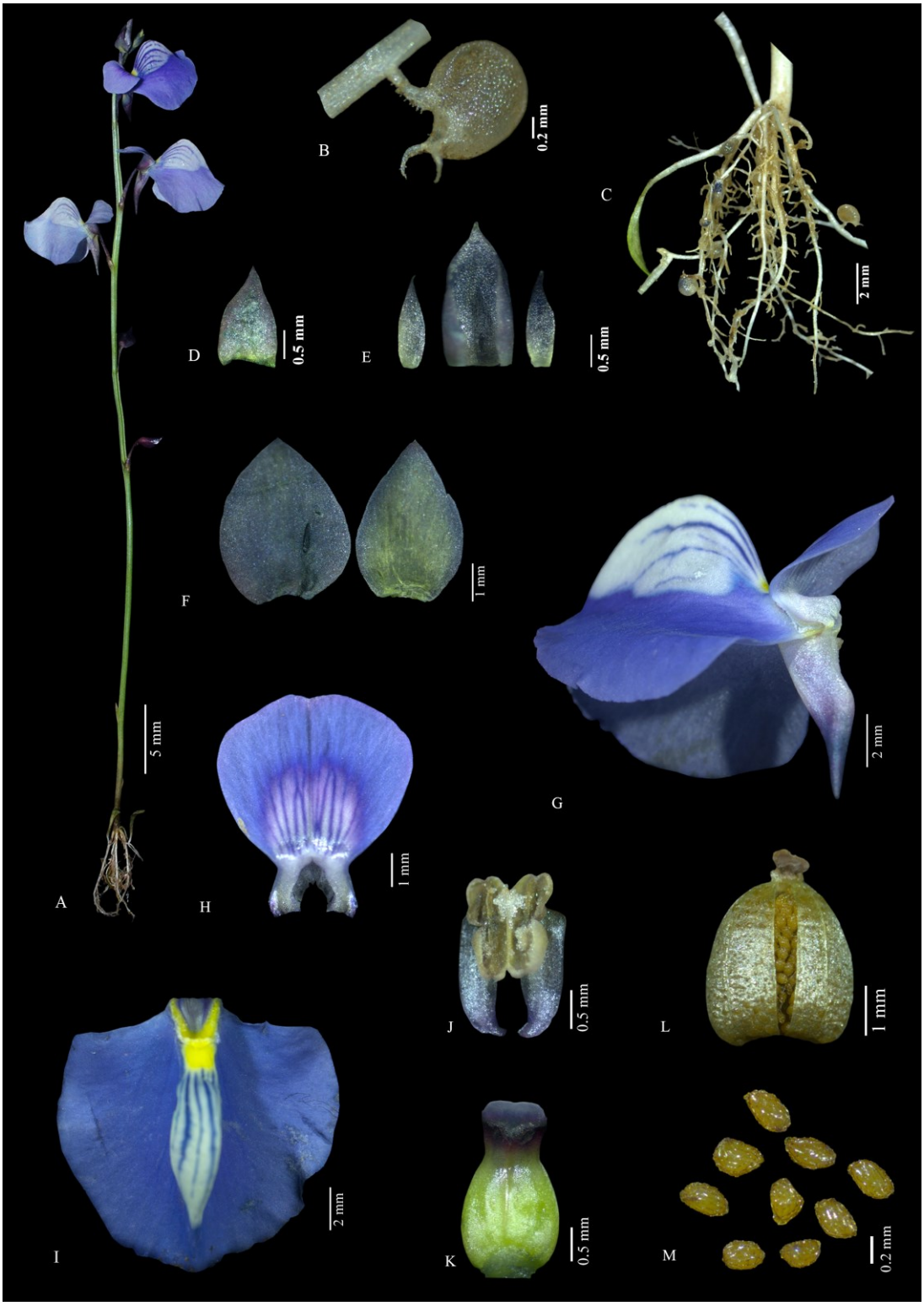


**Fig. 49.** *Utricularia cecilii* P.Taylor: **A.** Habit; **B.** Traps; **C.** Peduncle base with rhizoids, stolons and leaves; **D.** Scale; **E.** Bract and bracteoles; **F.** Calyx lobes; **G.** Corolla; **H.** Upper lip of corolla; **I.** Lower lip of corolla; **J.** Stamens; **K.** Pistil; **L.** Capsule; **M.** Seeds.

**Fig. 50.** Habitat of *Utricularia cecilii* P.Taylor: **A.** Soil filled depressions; **B & C.** Along the margins of small ephemeral pool; **D.** Margin of small ephemeral stream in the plateau; **E & H.** Leaves (note spathulate and linear lamina); **F & G.** Rock crevices.

the streaks were not prominent), rounded-emarginate at apex; lower lip widely obovate to sub-orbicular, 12–15 mm across, ciliate along throat margin, deep yellow patch just above the throat, palate prominently gibbous, white with dark blue longitudinal streaks, clear blue then, margin undulate, rounded at apex; spur subulate, 6–7.5 mm long, lilac-mauve at base, purple towards apex, narrowly acute at apex. Stamens 1.9–2.2 mm long; filaments strap-shaped, 1.5–1.7 × 0.5–0.6 mm, flattened, curved at base, hyaline-pale purple; anther thecae 1–1.5 mm long. Pistil 2–2.5 mm long; ovary ovoid, 1.6–1.8 × 1–1.2 mm, ventrally compressed, green; style 0.2–0.3 mm long, thick, violet; stigma bi-lipped, violet; upper lip obscurely 3-lobed, middle lobe prominent, oblong; lower lip sub-orbicular, papillose out. Capsules widely ovoid-ellipsoid, 3–3.5 × 2.8–3.2 mm, wall uniformly membranous, thickened along dehiscing margin, dehiscing by a single, ventral, longitudinal slit; placenta ovoid, 1–1.2 mm long. Seeds numerous, obovoid-ellipsoid, 0.3–0.35 × 0.2–0.3 mm; surface smooth; hilum latero-terminal.

***Flowering & fruiting:*** Flowering begins in the mid-July till late November, with fruiting from early August to mid-December. Peak flowering is observed during August and September.

***Habitat:*** *Utricularia cecilii* is known for its striking blue flowers and grows luxuriantly in the lateritic plateaus of northern Kerala and Karnataka in the Western Ghats. It usually grows in exposed, seasonally inundated swampy soil patches, along the margins of seasonal pools, and in soil pockets on the lateritic plateaus at an elevation of about 75 m. It is commonly found in association with *U. caerulea*, *U. cecilii*, *U. lazulina*, *U. reticulata*, *Drosera indica* (Droseraceae), *Eriocaulon* spp. (Eriocaulaceae), *Geissaspis cristata* (Fabaceae), *Isachne* sp., *Coelachne* sp. (both Poaceae), *Lindernia* sp. (Linderniaceae), *Murdannia crocea* subsp. *Ochracea* (Dalzell) Faden, *M. semiteres* (both Commelinaceae), *Neanotis subtilis* (Rubiaceae), *Rhamphicarpa* sp. (Orobanchaceae), *Rotala* spp. (Lythraceae), *Smithia* sp. (Fabaceae), etc. and some other grasses and sedges (Fig. 50).

***Distribution***: Endemic to the Western Ghats, India (Fig. 43).

***Specimens examined***: INDIA, **Karnataka**, Dakshina Kannada district, Kulshekar, ± 25 m, 19.08.1985, *M.K. Janarthanam* 82913 (BSID0012689). **Kerala**, Kannur district, Blathoor lateritic plateau, ± 213 m, 19.08.2019, *M.P. Krishnapriya & Santhosh Nampy*

168080 (CALI185482, CALI185483, CALI185484); *Ibid*., 22.08.2019, *M.P. Krishnapriya & Santhosh Nampy* 168090 (CALI197445, CALI197446); *Ibid*., 30.09.2020, *M.P. Krishnapriya & Santhosh Nampy* 164383 (CALI185478, CALI185479, CALI185480, CALI185481); Chooral, Aravanchal, ± 80 m, 31.07.2022, *M.P. Krishnapriya & Santhosh Nampy* 177262 (CALI197412, CALI197416, CALI197417); Kisan Nagar, Peringome, 31.07.2022, *M.P. Krishnapriya* 177263 (CALI197413, CALI197414); Madayipara, 09.12.2010, *C. Pramod* 126614 (CALI128543, CALI128544); *Ibid*., ± 45 m, 20.08.2019, *M.P. Krishnapriya & Santhosh Nampy* 168085 (CALI185485); Lake, way to Madayikkavu, 09.12.2010, *C. Pramod* 126567 (CALI128540, CALI128541, CALI128542); near Madayikkavu, 08.12.2010, *C. Pramod* 126616 (CALI128545, CALI128546); *Ibid*., 17.08.2014, *C. Pramod* 143129 (CALI128551); near KSEB, 01.08.2010, *C. Pramod* 126508 (CALI128550); *Ibid*., 01.08.2010, *C. Pramod* 126517 (CALI128547, CALI128548, CALI128549); Tholeni, 31.07.2022, *M.P. Krishnapriya* 177268 (CALI197411, CALI197466); Urathoor, 19.08.2019, *M.P. Krishnapriya* 168083; *Ibid*., 19.08.2019, *M.P. Krishnapriya* 168093 (CALI); Vypiriyam lateritic plateau, behind Kankol bus stop, 31.07.2022, *M.P. Krishnapriya* 177254 (CALI197415, CALI199574); Kasaragod district, Beemanadi, 250 m, 27.09.1982, *R. Ansari* 74330 (MH00126558, MH00126559); *Ibid*., 27.09.1982, *R. Ansari* 74334 (MH00126560, MH00126561); *Ibid*., Hilltop, 22.08.1985, *M.K. Janarthanam* 82926 (BSID0012625, MH00126566, MH00126567); Cheemeni, ± 65 feet, 27.08.2021, *M.P. Krishnapriya* 175819 (CALI197447, CALI197448); *Ibid*., old Cyber Park ground, 20.08.2019, *M.P. Krishnapriya & Santhosh Nampy* 168089 (CALI198496, CALI198497); *Ibid*., Kappadampoyil, 27.08.2021, *M.P. Krishnapriya & Santhosh Nampy* 175823 (CALI188052, CALI188053, CALI188054); Cherumba, 26.08.2021, *M.P. Krishnapriya & Santhosh Nampy* 175809 (CALI188046, CALI188047, CALI188048, CALI188049); Koyithatta, 27.08.2021, *M.P. Krishnapriya & Santhosh Nampy* 175816 (CALI188050, CALI188051); Mulleriya, 21.08.1985, *M.K. Janarthanam* 82921 (BSID0012624, MH00126562, MH00126563); Pallathadka-Yethadka road, ± 269 feet, 26.08.2021, *M.P. Krishnapriya & Santhosh Nampy* 175810 (CALI188043, CALI188044, CALI188045); Periya, 20.08.1985, *M.K. Janarthanam* 82920 (MH00126564, MH00126565, BSID0012623); Periye, opposite Central University, 26.08.2021, *M.P. Krishnapriya* 175805 (CALI186832, CALI186833, CALI186834).

**Fig. 51.** Flower colour variations in *Utricularia cecilii* P.Taylor

***Conservation status***: *Utricularia cecilii* is a local endemic annual herb, adapted to grow in low-elevation lateritic plateaus. So far, the species has been recorded in the northern part of Kerala (Kasaragod and Kannur districts) and southern Karnataka. Through intensive field studies, it has been found that *U. cecilii* was once fairly distributed in these areas, but its range has significantly diminished. The species faces considerable threats due to large-scale laterite stone mining and other human activities (Figs. 194 & 195). My extensive exploration of northern Kerala over different time periods revealed the extensive damage caused by mining, the dumping of mining waste into fragile plateau areas, construction activities, summer firing, and other developmental pressures. These factors have led to severe habitat destruction. Conservation efforts remain challenging, as much of the land is under the control of various stakeholders.

*Utricularia cecilii* has an AOO of 100 $km^2$ and EOO of 2144.226 $km^2$. While the number of mature individuals in existing populations remains high, the potential threats to its habitat require urgent attention. Given these threats, the species is assessed as Endangered (EN B1b(i,ii,iii,iv,v)+2b(i,ii,iii,iv,v)+c(i,ii,iii)).

***Notes***: *Utricularia cecilii* is a distinct species, known for its large and beautiful blue-purple flowers. Field observations has revealed a wide range of corolla colour variations, including pale to deep blue-purple, lilac, pink, and even pure white (Fig. 51). This species is often confused with *U. uliginosa*, but can be easily differentiated by its rather stiff and fleshy peduncles, larger flowers measuring 10–15 mm in length, obovate-spathulate leaves, and slightly concave periclinal wall of its seeds.

**4. Utricularia foveolata** Edgew., Proc. Linn. Soc. London 1(34): 351. 1848; C.B.Clarke in Hook.f. (ed.), Fl. Brit. India 4: 335. 1884; P.Taylor, Gen. *Utricularia* 394. t. 115. 1989; Janarth. & A.N.Henry, Bladderworts India 53. t. 12. 1992; N.P.Singh *et al*., Fl. Bihar, Analysis 367. 2001; Li in Wu *et al*. (eds.), Fl. China 19: 48. 2011; S.K.Mandal & Bhaumik in Lakshmin. *et al*. (eds.), Fl. West Bengal 4: 143. 2019. *Neotype* (designated by Taylor, 1989): INDIA, **West Bengal** (N. Bengal), Titaliya, *S. Kurz. s.n.* (CAL0000019117!).

Fig. 52

*Utricularia scandens* Oliv., J. Linn. Soc., Bot. 3: 181. 1859, *non* Benj. 1847. *nom. illeg. homonym.*; Drury, Handb. Ind. Fl. 2: 123. 1866; C.B.Clarke in Hook.f. (ed.), Fl. Brit. India 4: 332. 1884; Prain, Bengal Pl. 2: 781. 1903; Haines, Bot. Bihar Orissa 4: 646. 1922; Gamble, Fl. Madras 2: 982. 1924. *Utricularia tenerrima* Merr., Philipp. J. Sci., C 7: 247. 1912, Fl. Manila 433. 1912. *Type*: INDIA, **Tamil Nadu**, Madurae, Madras, *s.d.*, *Herb. Wight s.n.* (holo, K not seen).

*Utricularia baouleensis* A.Chev., Mem. Soc. Bot. France 8: 186. 1912; P.Taylor, Kew Bull. 18(1): 69. t. 21. 1964; R.K.Basak, Bull. Bot. Surv. India 17: 103. 1975; P.Taylor, Fl. Males. 1(8): 284. f. 8. 1977; D.M.Verma in D.M.Verma *et al.* (eds.), Fl. Raipur, Durg & Rajnandgaon 265. 1985; V.Chandras. in A.N.Henry *et al.* (eds.), Fl. Tamil Nadu, Ind., Ser I. Analysis 2: 129. 1987; R.C.Srivast. in Mudgal *et al.* (eds.), Fl. Madhya Pradesh 2: 252. 1997; Naik *et al.*, Fl. Marathwada 2: 637. 1998. *Type*: AFRICA, **Côte d'Ivoire** (Ivory Coast), Baoule, between Langouassou and Mbayakro, 01.08.1909, *A. Chevalier* 22247 (holo, P [P00569091 digital image!]).

Annual, terrestrial herbs. Leaves linear, 4–8 × *c.* 0.5 mm; lamina 1-nerved, obtuse at apex. Racemes twining, 5–15 cm long, 2–6-flowered, flowers lax; peduncles terete, filiform, delicate, green to purplish green. Flowers 3–3.5 mm long; pedicels erect at anthesis, 2–3 mm long, cernuous and winged in fruit. Scales and bracts ovate, acute at apex; bracteoles subulate, acuminate at apex. Calyx lobes sub-equal, ovate, obtuse at apex. Corolla mauve-blue to pale violet; upper lip of corolla oblong, *c.* 1.5 mm long, narrow, truncate-emarginate at apex; lower lip ovate, *c.* 1.5 mm long, palate gibbous, white with blue striations, emarginate-obscurely 3-lobed at apex; spur subulate, *c.* 1.5 mm long, large and broad, longer than the lower calyx lobe, white, obtuse to round at apex. Capsules ovoid. Seeds ovoid-oblongoid.

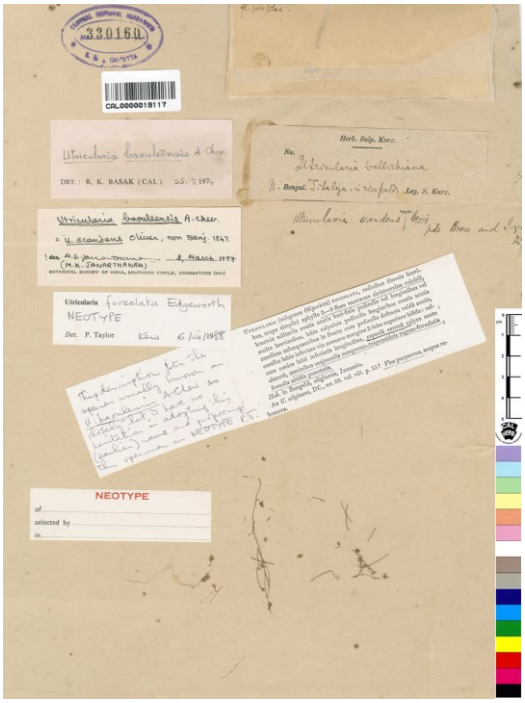


**Fig. 52.** Neotype of *Utricularia foveolata* Edgew. [*S. Kurz. s.n.* (CAL0000019117)] *"© The Director, Botanical Survey of India, Kolkata"*.

***Flowering & fruiting***: Flowering from late August till February and fruiting from early September till mid-March.

***Habitat***: *Utricularia foveolata* is usually found twining among grasses in marshy and swampy grasslands.

***Distribution***: India, Bangladesh, Chad, China, Gabon, Ghana, Guinea, Hainan, Ivory Coast, Jawa, Madagascar, Mali, Mozambique, Nigeria, Northern Territory, Philippines, Queensland, Tanzania, Thailand, Uganda, Zambia and Zaire (Taylor, 1989; POWO, 2025) (Fig. 53).

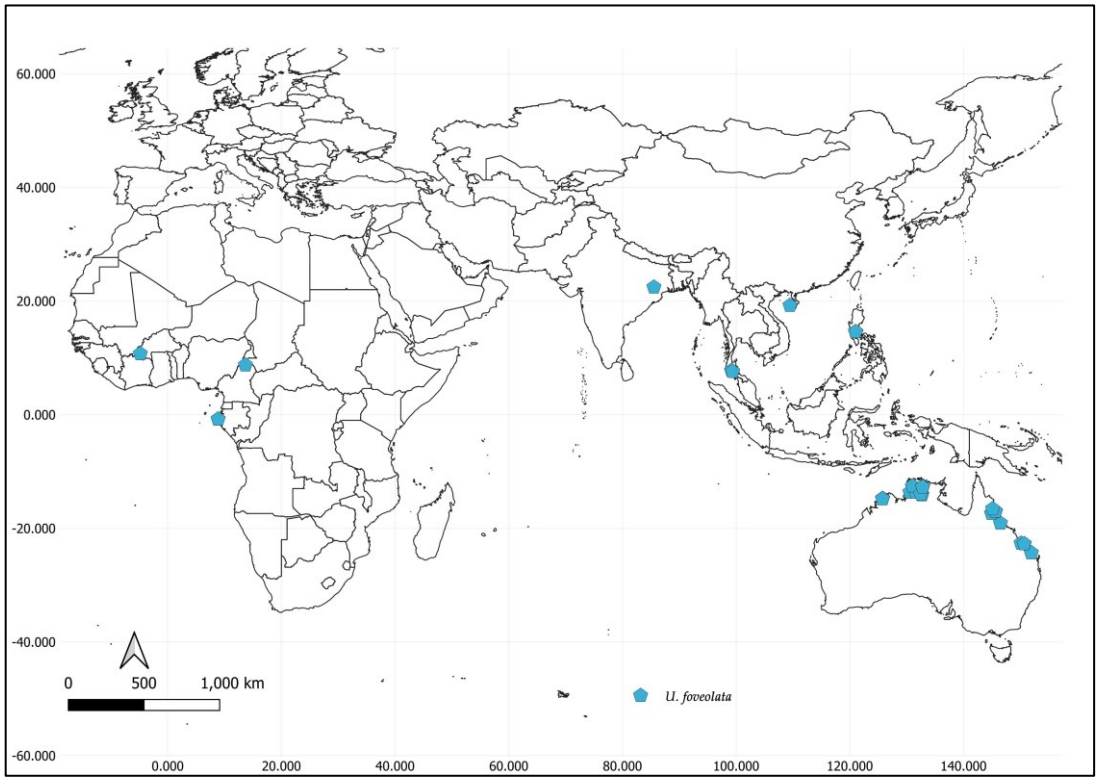


**Fig. 53.** Distribution of *Utricularia foveolata* Edgew.

***Specimens examined:*** INDIA, **Jharkhand**, West Singbhum district, Singbhum, September 1899, *H.H. Hains* 207 (CAL). PHILIPPINES, Luzon, Manila and Vicinity, September 1911, *E.D. Merrill* 8041 (P03575367 digital image).

***Conservation status:*** Although *U. foveolata* has a widespread distribution across tropical Africa, Temperate and tropical Asia, and Australia, voucher specimens are scarce in most herbaria. Similarly, Indian herbaria also lack adequate vouchers of *U. foveolata*. In my field study, I was unable to locate this species. While the IUCN

Criteria and Categories (2012, 2024) assess *U. foveolata* as Least Concern (LC), the status in India remains Data Deficient (DD).

***Notes***: *Utricularia foveolata* is a distinctive species characterised by its filiform, wiry peduncles, small flowers, cernuous fruiting pedicels and capsules. Despite its wide distribution, the species appears to be uncommon, likely due to its small size and minute flowers. While its occurrence is noted in various floristic works in India, voucher materials are not available in herbaria, except a single sheet representing a fragmented specimen.

**5. Utricularia graminifolia** Vahl, Enum. Pl. 1: 195. 1804; Sm. in Rees (ed.), Cycl. 37: 597. 1819; A.DC. in DC. (ed.), Prodr. 8: 16. 1844; Fyson, Fl. S. Ind. Hill Stations 1: 437. 1932; Santapau, J. Bombay Nat. Hist. Soc. 49(2): 218. 1950 *excl. syn. U. purpurascens* J.Graham; Gandhi in C.J.Saldanha & Nicolson (eds.), Fl. Hassan Dist. (sec. reprint) 564. 1978; Vajr., Fl. Palghat Dist. 330. 1980; Yogan. *et al*., Fl. Chikmagalur Dist. 241. 1981; Rani & K.M.Matthew in K.M.Matthew (ed.), Fl. Tamilnadu Carnatic 3(1): 1116. 1983; A.K.Mukh., Fl. Pachmarhi & Bori Reserves 217. 1984; Bole & M.R.Almeida, J. Bombay Nat. Hist. Soc. 82: 72. 1985 *excl. syn. U. purpurascens* J.Graham; R.S.Rao, Fl. Goa, Diu, Daman, Dadra & Nagarhaveli 2: 308. 1986; V.Chandras. in A.N.Henry *et al*. (eds.), Fl. Tamil Nadu Ind., Ser I: Analysis 2: 130. 1987 *excl. syn. U. smithiana* Wight, *U. squamosa* Wight; K.K.N.Nair & M.P.Nayar, Fl. Courtallum 2: 304. 1987; Manilal, Fl. Silent Valley 199. 1988; V.S.Ramach. & V.J.Nair, Fl. Cannanore 323. 1988 *excl. syn. U. smithiana* Wight; P.Taylor, Gen. *Utricularia* 370. t. 106. 1989 *excl. syn. U. purpurascens* J.Graham; Kesh.Murthy & Yogan. Fl. Coorg (Kodagu) Karnataka 317. 1990; S.M.Almeida, Fl. Savantwadi 2: 308. 1990; Janarth. & Henry, Bladderworts India 57. t. 14. 1992; Sivar. & P.Mathew, Fl. Nilambur 481. 1996; Moulali in Pull. & Moulali (eds.), Fl. Andhra Pradesh 2: 677. 1997; K.M.Matthew, Fl. Palni Hills pt. 2: 905. 1999; L.K.Banerjee & T.A.Rao, Fl. Mahanadi Delta 226. 2001; N.Mohanan & Sivad., Fl. Agasthyamala 492. 2002; S.R.Yadav & Sardesai, Fl. Kolhapur Dist. 337. 2002; Subba Rao & Kumari, Fl. Visakhapatnam Dist. 1: 600. 2003 *excl. syn. U. smithiana* Wight & *U. squamosa* Wight; Punekar & Lakshmin., Fl. Anshi Natl. Park 335. 2011; Li

in Wu *et al*. (eds.), Fl. China 19: 483. 2011 *excl. syn. U. purpurascens* J.Graham; Datar & Lakshmin., Fl. Bhagwan Mahavir (Molem) Natl. Park Adjoining, Goa 176. 2013; R.Ansari *et al*., Aquatic Wetland Fl. Kerala: Fl. Pl. 506. 2016. *Vesiculina graminifolia* (Vahl) Raf., Fl. Tellur. 4: 108. 1838. *Utricularia caerulea* L. var. *graminifolia* (Vahl) P.Bhattacharyya, Bull. Bot. Soc. Bengal 30: 76. 1976; R.C.Srivast. in Mudgal *et al*. (eds.), Fl. Madhya Pradesh 2: 253. 1997. *Type*: India Orientalis, *s.d.*, *J. Koenig s.n.* (holo, C [C10013903 digital image!]). **Figs. 54–58**

*Utricularia acuta* Benj., Linnea 20: 314. 1847

*Utricularia conferta* Wight, Hooker's. J. Bot. Kew Gard. Misc. 1: 372. 1849, Icon. Pl. Ind. Orient. 4(4): 10. t. 1575. 1850. *U. caerulea* L. var. *conferta* (Wight) Oliv., J. Proc. Linn. Soc., Bot. 3: 179. 1858; C.B.Clarke in Hook.f. (ed.), Fl. Brit. India 4: 331. 1884. *Type*: INDIA, **Tamil Nadu**, Courtallum, 1835, *Wight* 2417 (iso, E [E00179688 digital image!])

*Utricularia uliginoides* Wight, Hooker's. J. Bot. Kew Gard. Misc. 1: 372. 1849, Icon. Pl. Ind. Orient. 4(4): 10. t. 1573. 1850 as '*uligenoides*'. *U. caerulea* L. var. *uliginoides* (Wight) Oliv., J. Proc. Linn. Soc., Bot. 3: 179. 1858. *Lectotype* (designated by Taylor, 1989): INDIA, **Tamil Nadu**, Courtallum, *s.d.*, *Wight* 2415 (K [K000628547 digital image!])

*Utricularia pedicellata* Wight, Hooker's. J. Bot. Kew Gard. Misc. 1: 373. 1849, Icon. Pl. Ind. Orient. 4(4): 10. t. 1578. f. 2. 1850. *U. caerulea* L. var. *pedicellata* (Wight) Oliv., J. Proc. Linn. Soc., Bot. 3: 179. 1858. *Lectotype* (designated by Taylor, 1989): INDIA, **Tamil Nadu**, Courtallum, *s.d.*, *Wight s.n.* (K [K000628548 digital image!])

*Utricularia caerulea auct. non* L.: Oliv., J. Proc. Linn. Soc., Bot. 3: 179. 1858; C.B.Clarke in Hook.f. (ed.), Fl. Brit. India 4: 331. 1884; Fyson, Fl. Nilgiri & Pulney Hill-Tops 1: 307. 1915 as '*coerulea*'

*Utricularia subrecta* Lace, Bull. Misc. Inf. Kew 9: 405. 1915. *Lectotype* (designated here): MYANMAR (Burma), Maymyo Plateau, 14.10.1911, *J.H. Lace* 5488 (E [E00273688 digital image!])

*Utricularia equiseticaulis* Blatt. & McCann., J. Indian Bot. Soc. 10: 122. 1931; Santapau, J. Bombay Nat. Hist. Soc. 49(2): 221. 1950. *Type*: INDIA, **Maharashtra**, Panchgani, Dalkeith Springs, 03.10.1930, *C. McCann & Fernandez* 3508 (holo, BLAT!)

*Utricularia babui* S.R.Yadav, Sardesai & S.P.Gaikwad, Rheedea 15(1): 71. 2005, ***syn. nov.***; Nayar *et al.*, Fl. Pl. W. Ghats 1: 584. 2014; Singh *et al*., Endemic Vasc. Pl. India 195. 2015. *Type:* INDIA, **Maharashtra**, Ajara district, Kolhapur, Suleran Tal, 04.04.2004, *Milind M. Sardesai* mms003045 (holo, CAL [CAL0000006902!], iso BSI [BSI0000000288!], SUK!)

*Utricularia sunilii* Naveen Kum. & K.M.P.Kumar, Phytotaxa 371(2): 140. 2018, ***syn. nov.*** *Type*: INDIA, **Kerala**, Palakkad district, Nelliyampathy Hilltop, *c.* 1400 m, 30.10.2016, *K.M. Prabhukumar, R. Jagadeesan & C.M. Harinarayanan* 9730 (holo, CMPR not seen)

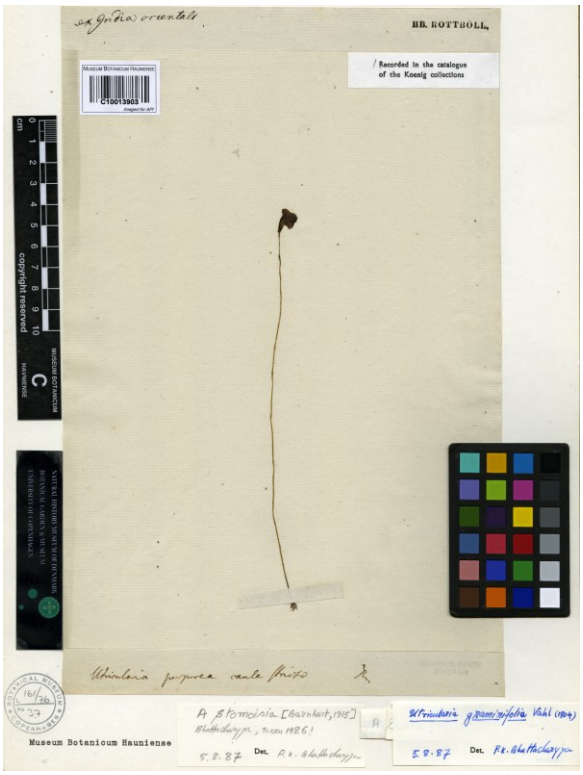


**Fig. 54.** Type of *Utricularia graminifolia* Vahl [*Koenig s.n.* (C10013903)] "© *Reproduced with permission of the Natural History Museum of Denmark*".

Perennial, terrestrial-semi-aquatic to lithophytic herbs. Rhizoids up to 20 mm long, numerous, capillary, papillose, branches 3–5 mm long, papillose. Stolons around 500 mm long, 0.3–0.5 mm thick, terete, numerous on peduncle base, profusely branched, internodes 5–10 mm long, green. Leaves 1 or 2 on peduncle base, numerous on either side of stolons, mat-forming, sessile to shortly petiolate; lamina strap-shaped (or linear, those growing near flowing stream margins), 10–50 × 1.5–3.5 mm, 1–3-nerved, nerves branched further, usually fleshy, rarely thin, glabrous, narrowly cuneate-cuneate at base, margin entire, acute-obtuse or rounded at apex. Traps numerous on rhizoids, stolons, and leaves, more or less globose, 1.5–2.5 mm across, those on lamina sessile to stalked, elsewhere stalked; stalk 0.4–1 mm long, distally thickened; mouth basal; appendages subulate, glandular hairy, curved inwards. Racemes erect or variously twining among themselves, 5–30 (–45) cm long, 2–12-flowered; peduncles terete, 0.8–1.25 mm thick, glabrous, green. Scales a few, triangular, 1–2.3 × 0.7–1.25 mm, 3-nerved, truncate at base, acute at apex. Bracts ovate to widely ovate, 2.2–2.8 × 0.76–1 mm, 3-nerved, narrowly acute at apex; bracteoles lanceolate, 1.2–2 × 0.2–0.4 mm,

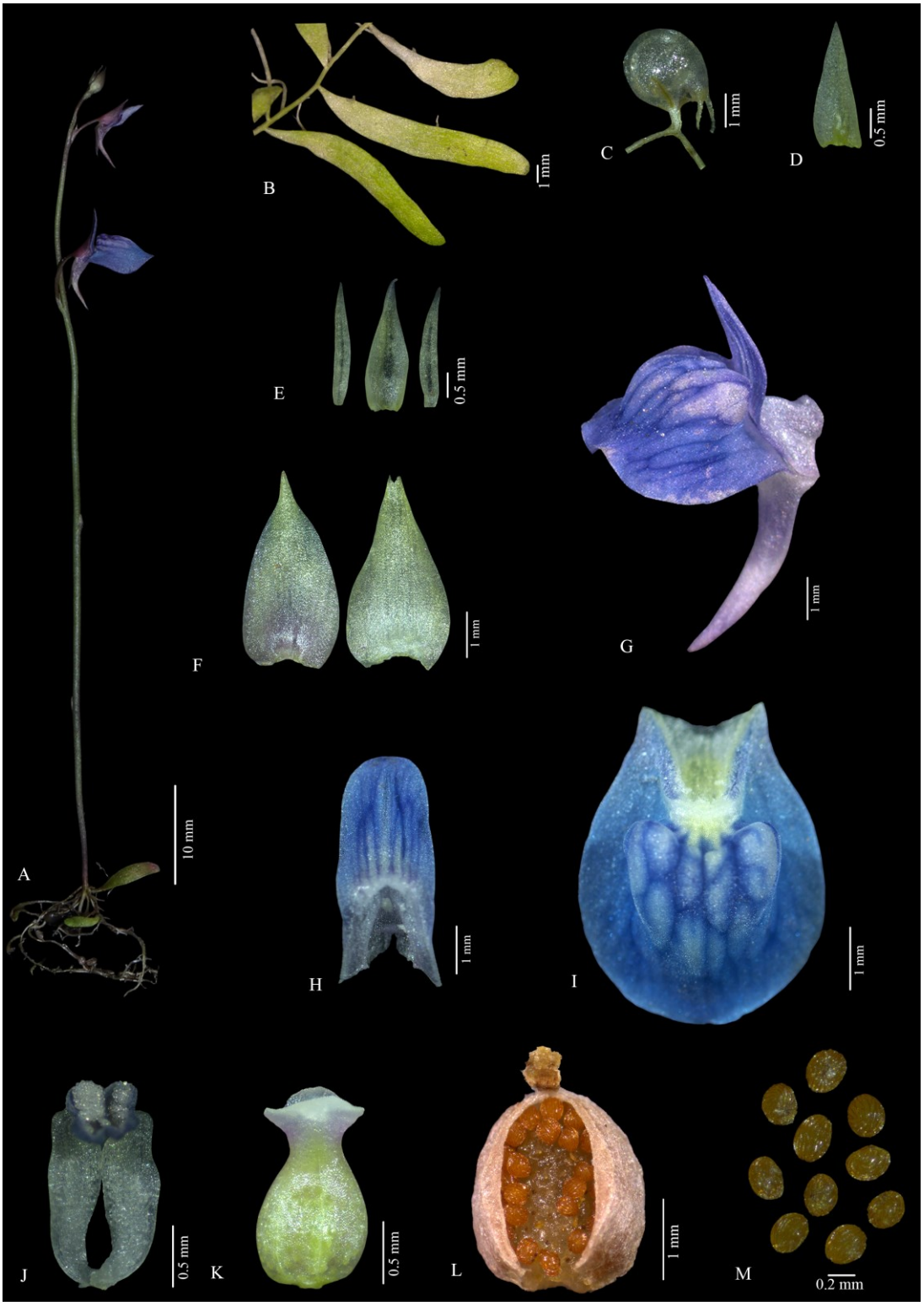


**Fig. 55.** *Utricularia graminifolia* Vahl: **A.** Habit; **B.** Leaves on stolon; **C.** Trap; **D.** Scale; **E.** Bract and bracteoles; **F.** Calyx lobes; **G.** Corolla - lateral view; **H.** Upper lip of corolla; **I.** Lower lip of corolla; **J.** Stamens; **K.** Pistil; **L.** Capsule; **M.** Seeds.

**Fig. 56.** Habitat diversity of *Utricularia graminifolia* Vahl: **A-D.** Lithophytic on wet vertical cuttings and watery slopes; **E & G.** Swampy soil patch above rocks; **F.** On the margin of swiftly flowing water; **G.** Margin of stream.

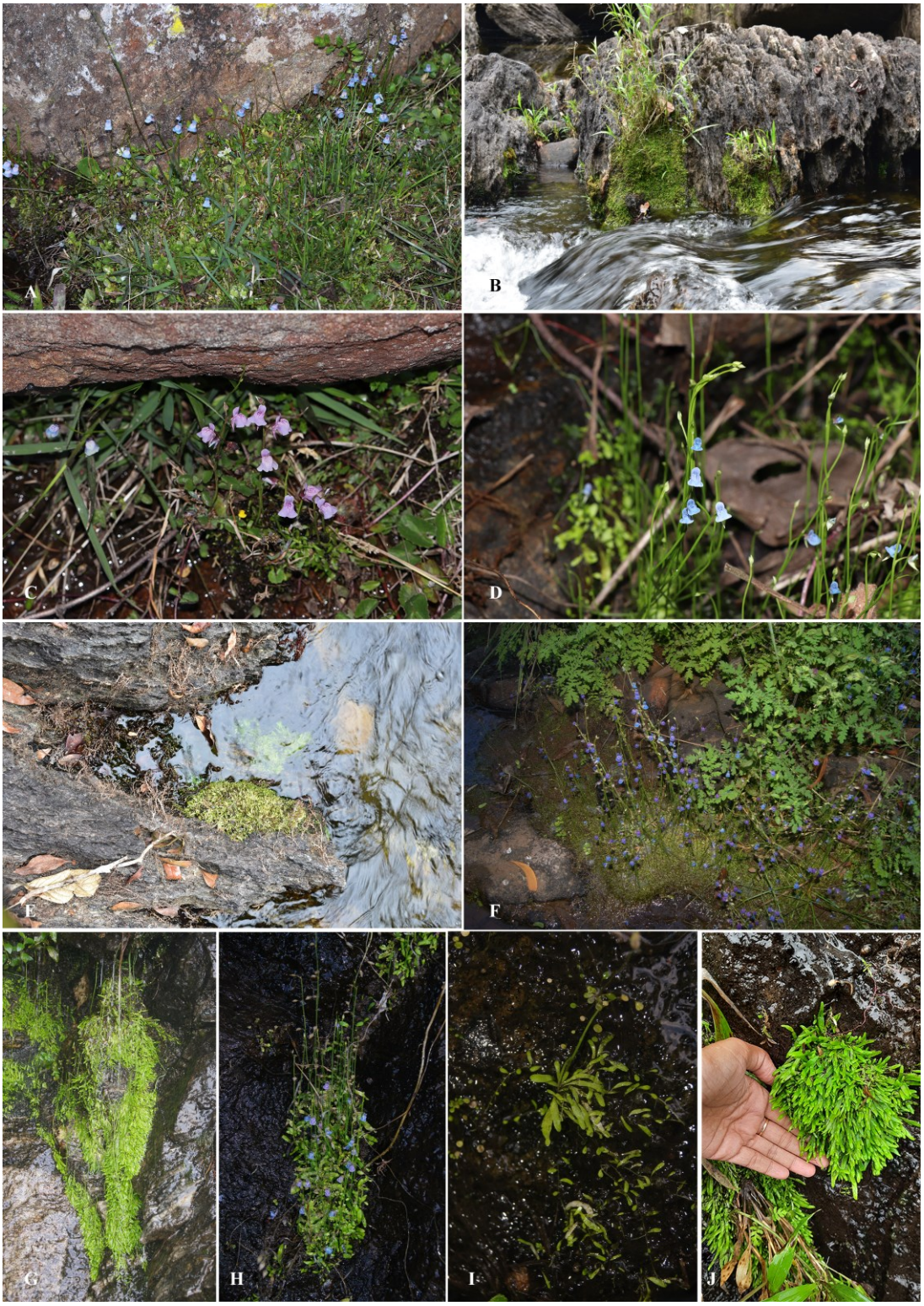


**Fig. 57** Habitat diversity of *Utricularia graminifolia* Vahl: **A & C.** Swampy soil patch above rocks; **B & E.** Margin of stream; **D & F.** Soil filled depression above the rocks**;** **G-J.** In wet, watery cliff (**H & I.** Habit; **J.** Leaves).

1-nerved, narrowly acute at apex. Flowers 8–12 mm long; pedicels 4.5–8 × 0.4–0.6 mm, erect, winged, green to brownish green. Calyx lobes unequal; upper lobe ovate to widely ovate, 2.75–3.5 × 2–2.25 mm, 14–15-nerved, bluish or purplish green, acute to acuminate at apex; lower lobe ovate-elliptic, 2.65–3.3 × 1.45–2.2 mm, 14–nerved, bluish or purplish green, 2–4-dentate at apex. Corolla usually blue, sometimes pink or violet; upper lip oblong, 4–6.5 × 1.3–2.5 mm, constricted at the middle, whitish blue to pale pink or violet with blue-pink streaks above constriction, fade towards apex, hairy along lower margins, rounded or rarely emarginate at apex; lower lip widely elliptic to sub-orbicular, 4–8 mm across, pale yellow at throat, hairy along margins, palate bi-gibbous, with obscurely 4-lobed swelling, bluish white with prominent blue reticulations on palate, fading then, rounded to rarely irregularly lobed at apex; spur conical, 4–6.5 mm long, straight or slightly curved inwards at tip, pale blue-lilac, narrowly acute at apex. Stamens 1.5–1.75 mm long; filaments strap-shaped, 1–1.5 × 0.4–0.5 mm, hyaline, twisted at base; anther thecae 0.5–0.8 mm long, purple. Pistil 1.7–2 mm long; ovary ovoid-ellipsoid, 1–1.2 × 0.7–1 mm, dorsiventrally compressed; style short, 0.3–0.4 mm long, lilac; stigma bi-lipped; upper lip oblong, smaller than lower lip, lower lip sub-orbicular, papillose out, pale purple. Capsules ovoid-ellipsoid, 2.5–3.5 × 1.8–2.2 mm long, wall membranous, thickened along dehiscing margin, dehiscing by a single, ventral, longitudinal slit; placenta ellipsoid, 1.3–1.5 × 0.65–1 mm. Seeds numerous, oblongoid to sub-globose, 0.3–0.4 × 0.2–0.3 mm; surface smooth; hilum latero-terminal.

***Flowering & fruiting***: Flowering starts from late September to mid-April, with fruiting from early October to the end of April. Peak flowering is observed between December and February.

***Distribution***: India, China, Myanmar, Sri Lanka and Thailand (Taylor, 1989; Janarthanam & Henry, 1992; POWO, 2025) (Fig. 58).

***Habitat***: *Utricularia graminifolia* thrives in a wide range of habitats, including wet, dripping rocks, vertical cuttings, slopes, soil patches above rocky surfaces, stream banks, and swampy soils, often in association with *U. scandens* Benj., *U. striatula* Sm., *Drosera burmanni* (Droseraceae); *Eriocaulon* spp. (Eriocaulaceae), *Exacum* sp.

(Gentianaceae), *Impatiens* spp. (Balsaminaceae), *Isachne* sp., *Jansenella griffithiana* (both Poaceae), *Cyanotis* sp., *Murdannia* spp. (both Commelinacae), *Rhynchoglossum notonianum*, *R. scabrum*, *Epithema carnosum* Benth. (all Gesneriaceae), *Rotala* sp. (Lythraceae), *Sonerila rheedei* Wall. ex Wight & Arn., *S. scapigera* Hook. (both Melastomataceae), mosses and ferns like *Riccia* sp. (Ricciaceae), *Selaginella* sp. (*Selaginellaceae*), etc. and some other grasses. It is found in the bottom and margin of medium to slow-running perennial streams in association with members of Podostemaceae and large grasses at an elevation of 600 m and above (Figs. 56 & 57).

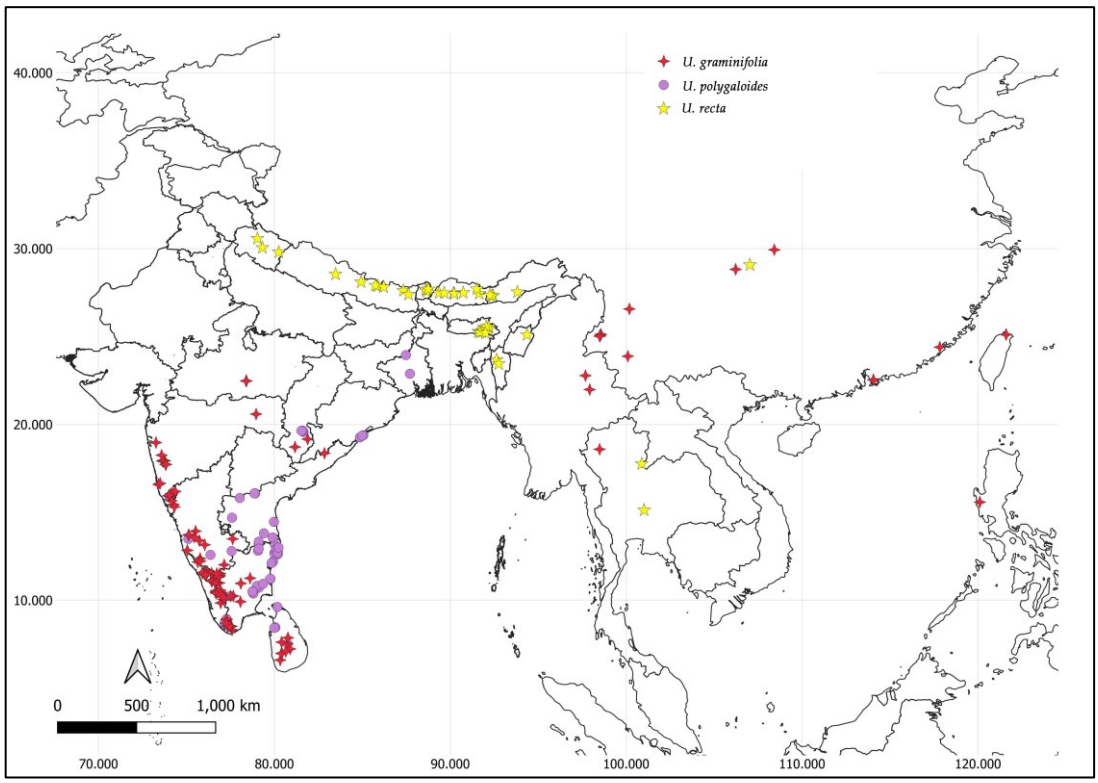


**Fig. 58.** Distribution of *Utricularia graminifolia* Vahl; *U. polygaloides* Edgew. and *U. recta* P.Taylor

***Specimens examined***: INDIA, **Andhra Pradesh,** Vishakhapatnam district, Anjoda-Gengi Gedda, 925 m, 12.03.1965, *G.V. Subba Rao* 22611 (MH00126491, MH00126492, MH00126493). **Chhattisgarh**, Bastar district, Tirathgarh Falls, 600 m, 09.02.1961, *N.P. Balakrishnan & A.N. Henry* 12033 (CAL, MH00126453); Dantewada district, Bailadila, 3000 feet, 09.10.1940, *H.F. Mooney* 1529; *Ibid*, 3500 feet, 1940, *H.F. Mooney* 1462 (DD). **Karnataka**, Chamarajanagar district, Biligirirangan swamps, 5000 feet, 13.02.1907, *C.E.C. Fischer* 1421 (CAL); Chikkamagaluru district, Bidertallu, 900 m, 20.01.1967,

*R.K. Arora* 5711 (CAL); Biligirirangan road from Chikkamagaluru to Dattatreya Peetha, 1600-1700 m, 09.10.1982, *J. Klackenberg & R. Lundin* 317 (NY03858295 digital image); Coorg district, Mercara, 21.10.1961, *A.S. Rao* 74494 (CAL); Riverbed, Kumarahalle, Pushpagiri way, 17.02.1984, *E. Vajravelu* 77785 (MH00126365, MH00126366); Hassan district, near Aglatte Coffee Estate, Hanbal road, 13.11.1971, *S.S. Hooper & K.N. Gandhi* HFP2496 (US03217066, US03217047 digital images); in a stream before Devalkere, 29.05.1969, *C.J. Saldanha* 13736 (US03217062 digital image); road to Hanbal, 29.10.1969, *C.J. Saldanha* 15437 (UMO2326738, US03217063 digital images); Mankanahalli, 10.10.1969, *C.J. Saldanha* 15310 (US03217045 digital image); *Ibid*., 06.10.1970, *F.M. Jarrett, C.J. Saldanha & T.P. Ramamoorthy* HFP844 (US03217064 digital image); Shimoga district, Gubbiga near Yedur, 05.10.1963, *R. Sundara Raghavan* 82989; Kavaledurga, 02.10.1962, *R. Sundara Raghavan* 82904 (BSI). **Kerala**, Muthikulam, South Malabar, 3000 feet, 31.10.1910, *C.E.C. Fischer* 2375 (FRC, CAL); Idukki district, Lockhart Estate, water stagnant place, 13.12.1985, *M.K. Janarthanam* 82970 (MH00126487, MH00126488); Lockhart gap-Kumali road, 03.12.1985, *M.K. Janarthanam* 82966 (BSID0012662, MH00126489, MH00126490); Painavu, 850 m, 22.08.1977, *K. Vivekananthan* 50480 (CAL); *Ibid*., 10.12.0219, *M.P. Krishnapriya* 164332 (CALI); near Thannikudi, 950 m, 08.02.1981, *N.C. Nair* 70154 (MH00126362, MH00126363); Kottayam district, Kurisumala, ± 1000 m, 08.11.1984, *Rev. Fr. Kadavil* 931 (MH00126762); Kozhikode district, Kakkayam, 01.12.2018, *M.P. Krishnapriya & Santhosh Nampy* 168043 (CALI188081); *Ibid*., 12.10.2019, *M.P. Krishnapriya* 164321; Olichuchattom, 09.12.2018, *K.K. Jeomol & M.P. Krishnapriya* 168048 (CALI198506); Thamarassery Churam (Thambracheri ghauh), 21.01.1903, *C.A. Barber* 5707 (MH00126348); *Ibid*., ± 750 m, 12.11.2018, *Manu Philip & M.P. Krishnapriya* 168036 (CALI188079, CALI188080); Palakkad district, Nelliyampathy R.F., Karapara Forest, 1000 m, 19.12.1980, *N.C. Nair* 69649 (MH00126354, MH00126355); Karapara Riverbed, 900 m, 29.10.1976, *E. Vajravelu* 48751 (MH00126350, MH00126351); Nelliyampathy, 1100 m, 01.12.2007, *K.H. Amitha Bachan* 98942 (CALI124770, CALI124771, CALI124773); *Ibid*., Seetharkundu, 15.02.2019, *K.K. Jeomol & Nikhil Krishna* 168059; *Ibid*., ± 977 m, 08.02.2020, *M.P. Krishnapriya & Santhosh Nampy* 164362 (CALI188070, CALI188071, CALI188072, CALI188073); *Ibid*., way to Seetharkundu, ± 970 m, 08.02.2020, *M.P. Krishnapriya & Santhosh Nampy* 164363 (CALI197518, CALI188075,

CALI188076, CALI188077, CALI188078); Hilltop, 24.11.2022, *M.P. Krishnapriya & Santhosh Nampy* 186030; *Ibid*., 24.11.2022, *M.P. Krishnapriya & Santhosh Nampy* 186031; *Ibid*., 24.11.2022, *M.P. Krishnapriya & Santhosh Nampy* 186043; Silent Valley National Park, 27.12.2019, *S. Resmi & M.P. Krishnapriya* 164350 (CALI199571); *Ibid*., 13.01.1988, *N. Venkatasubramanian & K.R. Sasidharan* 13934 (FRC); *Ibid*., Sairandhri, 10.11.2020, *M.P. Krishnapriya* 164391 (CALI); Aruvampara slopes, 850 m, 08.12.1980, *N.C. Nair* 69170 (MH00126359, MH00126421); *Ibid*., 12.11.2020, *M.P. Krishnapriya & Santhosh Nampy* 164395 (CALI188060, CALI188061, CALI188062, CALI188063, CALI188064); Kunthipuzha River, ± 900m, 23.04.1980, *V.J. Nair* 67268 (MH00126357, MH00126725); Valiyaparathode, 07.09.1982, *T. Sabu* 10803 (CALI125926); *Ibid*., 04.02.1982, *C. Sathish Kumar* SV10144 (CALI125400, CALI125401); *Ibid*., 11.12.2020, *M.P. Krishnapriya & Santhosh Nampy* 164394 (CALI197519, CALI197520, CALI197521, CALI197522, CALI197523); *Ibid*., grassy slopes, 1000 m, 12.12.1980, *N.C. Nair* 69564 (MH00126358, MH00126687); Wayanad district, Manikkunnumala, *s.d., M.K. Ratheesh Narayanan* 1979 (CALI162629); Thirunelli, 02.11.1988, *R.T. Balakrishnan* 43653 (CALI162636, CALI162637); *Ibid*., Riverbank, 14.02.1987, *R.T. Balakrishnan* 42781 (CALI162631). **Madhya Pradesh**, Hoshangabad district, Pachmarhi, way to Bee Falls, ± 950 m, 09.11.2021, *M.P. Krishnapriya* 177231 (CALI197515); near Bee Falls, 18.02.1891, *Nair*? 10492 (DD); *Ibid*., 09.11.2021, *M.P. Krishnapriya* 177233 (CALI); Twynam Pool, way to Jambu Deep, 12.11.2021, ± 950 m, *M.P. Krishnapriya* 177240 (CALI197516, CALI197517); Jambu Deep Nala, Stream side, 12.11.2021, *M.P. Krishnapriya* 177243 (CALI199579). **Maharashtra**, Kolhapur district, Suleran near Stream side, 29.01.2020, *M.P. Krishnapriya* 164353; Hiranyakasi River side, 29.01.2020, *M.P. Krishnapriya* 164354 (CALI). Sindhudurg district, Amboli ghat, 22.09.2018, *M.P. Krishnapriya* 168028; *Ibid*., 29.01.2020, *M.P. Krishnapriya & Santhosh Nampy* 164356 (CALI188074); Stream near boarder, 29.01.2020, *M.P. Krishnapriya* 164357; Stream near Kermburni wade, Vishalghat road, 30.01.2020, *M.P. Krishnapriya* 164358; Mansawada-Pandrepani road, 30.01.2020, *M.P. Krishnapriya* 164359 (CALI); Satara district, Mahabaleswhar, Lingmalla Falls, 08.10.1985, *M.K. Janarthanam* 82948 (BSID0012664); *Ibid*., 08.10.1985, *M.K. Janarthanam* 82949 (BSID0012663, MH00126448, MH00126449); *s.loc*., 1873, *R.A. Beddome s.n.* (MH00126318). **Tamil Nadu**, Coimbatore district, Anamalais, *s.d., s.coll. s.n.* (MH00126507); below Sholayar dam, Anamalai, 22.02.1985,

*M.K. Janarthanam* 82902 (MH00126511, MH00126512); Attakkatti, 3400 feet, 27.12.1912, *C.E.C. Fischer* 3222 (FRC); *Ibid*., on water flowing rocky slopes, 26.02.1985, *M.K. Janarthanam* 82908 (BSID0012657, MH00126521, MH00126522); *Ibid*., 875 m, 25.01.1962, *J. Joseph* 13565 (MH); around Attakkatti, 900 m, 25.01.1962, *J. Joseph* 13552 (MH00126506); Avaibetta?, 5500 feet, 22.11.1908, *C.E.C. Fischer* 1315; Kadamparai, marshy areas along stream, 25.02.1985, *M.K. Janarthanam* 82907 (BSID0012658, MH00126523, MH00126524); Monica Estate, 950 m, 23.01.1963, *J. Joseph* 15588 (MH00126517, MH00126518); *Ibid*., 24.02.1985, *M.K. Janarthanam* 82906 (BSID0012659, MH00126525, MH00126526); Rottikkadai, 26.02.1985, *M.K. Janarthanam* 82909 (BSID0012656, MH00126519, MH00126520); Sholayar, submergible area, 1030 m, 25.12.1963, *K. Ramamurthy* 18102 (MH00126513, MH00126514); Valparai, Stanmore Estate, 23.02.1985, *M.K. Janarthanam* 82903 (BSID0012660, MH00126527, MH00126528); *Ibid*., Cinchona, along marshy places, 27.02.1985, *M.K. Janarthanam* 82910 (BSID0012655, MH00126533, MH00126534); *Ibid*., Marshy area below Cinchona factory, 27.02.1985, *M.K. Janarthanam* 82911 (BSID0012654, MH00126531, MH00126532); Varattuparai-near Monica Estate, 575 m, 18.04.1963, *J. Joseph* 16218 (MH00126515, MH00126516); Velliangiri 7th Hilltop, 1700 m, 2.04.1969, *S. Karthikeyan & M. Chandrabose* 31816 (CAL); Dindigul district, Kodaikanal, Perumali malai, towards Palani, 18.12.1987, *K.M. Matthew & M. Charles* 52154 (RH044674); Shembagam Shola, 6000 feet, 13.09.1905, *C.A. Barber* 7280 (MH00126494); 8 km from Thadiankudisai along road to Adalur, 29.12.1987, *K.M. Matthew* 52328 (RHT044675); Tiger Shola, 1900 m, 17.09.1968, *D.B. Deb* 30937 (MH00126499); Kanyakumari district, Kilaviarumalai, ± 500 m, 29.08.1976, *A.N. Henry* 48133; Panagudi, Neerpadu Falls, 630 m, 06.02.1972, *B.D. Sharma* 39974 (MH00126496, MH00126535); *Ibid*., way to Kunnimuthu Estate, 630 m, 02.12.1969, *B.V. Shetty* 33005 (MH00126497, MH00126505); Kilaviarumalai-Balamore, ± 500 m, 29.08.1976, *A.N. Henry* 48133 (MH00126536, MH00126345); Ramanathapuram district, Periyar Rriver, near Naduthottam, Selthur Hills, 1300 m, 11.03.1981, *S.R. Srinivasan* 68043 (MH00126457); Salem district, Attur, Periakalrayans, Kunnur hill Gospel society garden, 1050 m, 11.05.1977, *D.I. Arockiasamy* 7967 (RHT044694); *Ibid*., Nagalur Forest, 11.04.1980, *K.M. Matthew* 47477 (RHT044700); *Ibid*., Nagalur Stream, 900 m, 10.03.1980, *K.M. Matthew* 26943 (RHT044699); Periakalrayans, Vanaru second River of Pattivalavu, 03.12.1976,

*K.M. Matthew & D.I. Arockiasamy* 5496 (RHT044693); *Ibid.*, Kattamthi Stream, 06.0.1979, *K.M. Matthew* 23631 (RHT044698); Tenkasi district, Courtallum, 14.09.1915, *s.coll.* 12186 (MH00126335); *Ibid.*, 500 feet, 21.09.1943, *D. Daniel & R. Raju* 20403 (MH00126454); *Ibid.*, 12.10.1959, *K.M. Matthew* 1273 (RHT044704); *Ibid.*, 20.10.2023, *M.P. Krishnapriya* 164303 (CALI); *Ibid.*, Main Falls, 433 m, 16.12.1957, *K. Subramanyam* 4944 (MH00126331, MH00126339); Tirunelveli district, Kalakkad, Thalaiyodai, 800 m, 08.04.1983, *N. Parthasarathy* 434 (MH00126343); River near Karamandiyamman Temple, 1100 m, 09.03.1963, *J. Joseph* 15859 (CAL); Kothayar near Dam site, 15.02.2019, *S. Resmi* & *M.K. Akhil* 168061; *Ibid.*, 22.09.2021, *K.K. Jeomol* 177212 (CALI); along Kuttiyar River, 1100 m, 25.02.1988, *R. Gopalan* 88648 (MH00126537, MH00126538); Neterikal, 22.09.1916, *s.coll.* 13381 (MH00126325, MH00126326, MH00126327, MH00126338); Neterikal to Sengaltheri, 25.09.1916, *s.coll.* 13588 (MH00126336, MH00126337); *Ibid.*, 25.09.1916, *s.coll.* 13589 (MH00126334); Oothu, 1000 m, 29.05.1963, *A.N. Henry* 16363 (MH00126330, MH00126342); Segaltheri, 18.09.1914, *s.coll.* 10882 (MH00126995); *Ibid.*, 25.09.1916, *s.coll.* 13595 (MH00126321, MH00126322, MH00126323, MH00126333); *Ibid.*, 900 m, 19.09.1967, *E. Vajravelu* 29126 (MH00126341); *Ibid.*, River side, 23.09.2021, *K.K. Jeomol* 177214 (CALI); Shembakadevi Falls, 533 m, 23.04.1957, *K. Subramanyam* 2885 (CAL, MH00126332, MH00126340); Upper Kodayar, 02.09.1981, *K.M. Matthew* 1786 (RHT044705); *Ibid.,* Periyar River from Kutiyar Dam, 1175 m, 24.03.1984, *R. Gopalan* 81429 (CAL, MH00126501, MH00126502); *Ibid.*, 24.03.1984, *R. Gopalan* 81425 (MH00126503, MH00126504); The Nilgiris district, Bangi Halla, 2300 m, 06.06.1970, *B.V. Shetty* 34123 (MH00126466); Coonoor to Marappalam, 1400 m, 01.03.1972, *B.D. Sharma* 40354 ((MH00126475); Ebanad to Anaikatty, 1700 m, 08.09.1970, *G.V. Subba Rao* 36573 (MH00126462, (MH00126474); Glenmorgan Shola, 05.08.2017, *S. Jeevith* 15158 (FRC); way to Iduhathi from Bikkapathimund, 1925 m, 26.03.1972, *G.V. Subba Rao* 40483 (MH00126470, MH00126476); Kateri road to Kundha, 1667 m, 27.03.1957, *K.M. Sebastine* 2705 (MH00126465, MH00126471); Shola near Kodanad Estate, 1950 m, 21.07.1970, *E. Vajravelu* 35006 (MH00126483, MH00126484); Kodanad near water tank, ± 1872 m, 12.03.2020, *M.P. Krishnapriya & S. Resmi* 164368 (CALI188065, CALI188066, CALI188067, CALI188068, CALI188069); Kotagiri, April 1918, *R.D.A.* 370 (MH00126498); Kotagiri - Ooty road, 1900 m, 08.03.1969, *D.B. Deb* 31507

(MH00126464, MH00126473); Kottaicombai, 1933 m, 23.1.1956, *K. Subramanyam* 1099 (CS185888 digital image, CAL, MH00126459); Shola near Kukalthorai, 1500 m, 13.09.1970, *G.V. Subba Rao* 36663 (MH00126482); Lakkadi, 2225 m, 02.06.1970, *B.V. Shetty* 34076 (MH00126467, MH00126480); Marappalam - Burliar road, 1200 m, 07.09.1970, *B.D. Sharma* 36083 (MH00126463, MH00126472); Thiruchiappalli district, Thuraiyur, Pachai Hills between top Sengattupatti and Puthur, 23.01.1980, *K.M. Matthew* 25948 (RHT044689). SRI LANKA (Ceylon), *s.loc.*, *s.d.*, *s.coll. s.n.* (MH00127022); *s.loc.*, *s.d.*, *Thwaites* CV278 (BR0000031019804 digital image, MH00127021). **Central Province**, Matale district, Laggala, ± 1100 m, 14.02.1978, *L.H. Cramer* 5141 (US03217054 digital image); Nuwara-Eliya district, Elk Plains, 2000 m, 03.11.1971, *L.H. Cramer* 3507 (03217050 digital image); Ohiya, ± 2150 m, 11.10.1975, *L.H. Cramer* 4571 (US03217042 digital image). **Uva Province**, Badulla district, Erabedde, ± 1500 m, 15.07.1977, *L.H. Cramer* 4965 (US03217041 digital image); Welimada Kahatapitiya 950 m, 03.03.1978, *L.H. Cramer* 5172 (US03217044 digital image).

***Conservation status***: This species is widely distributed, found from Sri Lanka, India, China to Myanmar and Thailand. Visible threats to this species include the clearing and widening of ghat roads, quarrying, and other human activities. The vegetative growth of this species is rapid, and it is relatively easy to propagate and maintain *ex-situ*. It is often used in aquariums for carpeting. Considering its distribution and population size, *U. graminifolia* is assessed as Least concern (LC).

***Notes***: *Utricularia graminifolia* is a highly variable species, exhibiting differences in the nature and size of the peduncles and the colour of the corolla (Figs. 56–59). It can occur as stunted forms less than 10 cm in length, with erect, stiff peduncles and congested flowers. Alternatively, it can also be found as twining forms reaching up to 45 cm, with wiry peduncles and more lax flowers. The corolla colour varies, displaying shades of blue-purple or pink. A detailed study is necessary to analyze the variations in flower colour and their implications for pollination and the ecology of this species.

Herbarium and live materials collected from the type locality, Courtallum (Tamil Nadu, India), confirmed that *U. uliginoides*, described by Wight (1849), is actually the vigorously twining morphotype of *U. graminifolia*. The filiform peduncles, lax inflorescence, and larger flowers led to confusion, but closer inspection reveals that the calyx lobes, corolla, capsule, and seed all fall within the variation of *U. graminifolia*.

Yadav *et al*. (2005) described *U. babui* from Maharashtra, distinguishing it from *U. graminifolia* based on the 1-nerved leaves. However, upon critical examination of the protologue, type specimens, and live materials from the type locality and other sites, it is clear that *U. babui* is a morphotype of *U. graminifolia*. I observed both small, erect forms as well as large, twining forms in habitats with linear to strap-shaped leaves with 1–3-nerves, which sometimes branched further. Moreover, those growing in perennial stream margins usually possess linear leaves with 1 to 3-nerves. *Utricularia babui* grows in dry, swampy soil patches along the banks of the perennial streams. The stiff peduncles and large flowers are likely due to the edaphic conditions of its habitat. Variations in the nature and size of the peduncle and flowers of *U. graminifolia* were observed in soil rich, swampy areas in Nelliyampathy (Kerala), Pachmarhi (Madhya Pradesh), and Kodanand (Tamil Nadu) (Fig. 59). Furthermore, the micromorphological examination of seeds of *U. babui* not revealed any significant differences from *U. graminifolia* as well. Therefore, based on these data *U. babui* is considered a variation of *U. graminifolia*.

The extended distribution of *U. babui* in Northern Thailand, as reported by Suksathan and Parnell (2010), is also *U. graminifolia*. Their description and taxonomic notes clearly refer to the linear leaves that are 1–3-nerved (rather than 1-nerved), confirming that the plants they studied belong to *U. graminifolia*.

Recently Kumar *et al.* (2018) described *U. sunilii* from Nelliyampathy Hills in Palakkad district, Kerala, India. They compared it to *U. graminifolia*, differentiating it mainly by the three lobed lower lip of corolla. However, observations from the

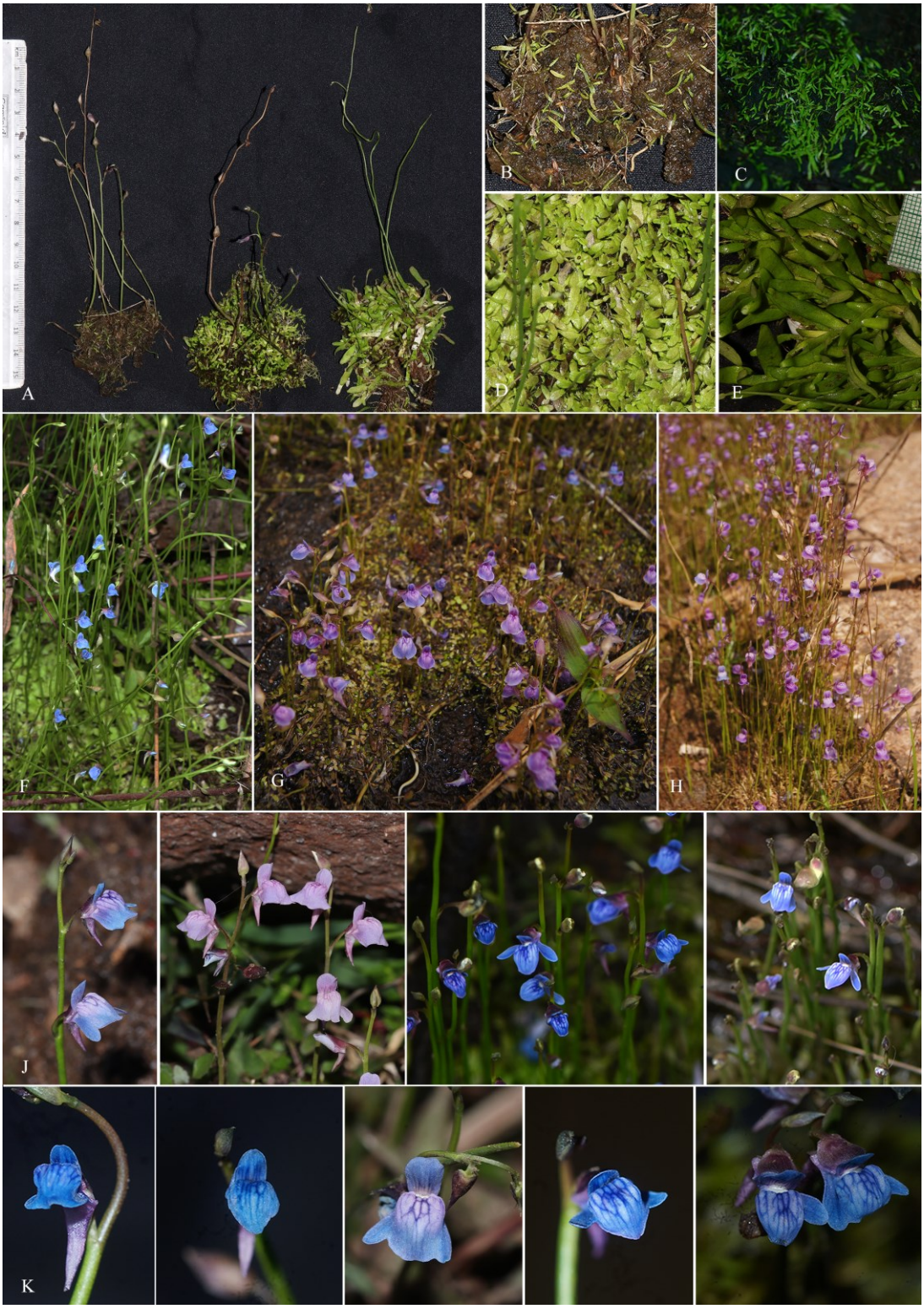


**Fig. 59.** *Utricularia graminifolia* Vahl: variations in habit and leaf morphology; Flower colour variations; Corolla lobing patterns.

type locality revealed extreme variations in corolla shape and lobing. In some individuals, the lobing of the corolla was not constant and appeared to be a deformed feature (Fig. 59J-K). I observed unlobed to 2–3-lobed lower lip of corolla, with occasional lobing on only one side. Isolated populations of *U. graminifolia* sometimes display these atypical morphologies, as I have observed in specimens collected from the Nilgiris district of Tamil Nadu. Therefore, in this study, *U. sunilii* is considered a variation of *U. graminifolia*.

***Typification***: *Utricularia subrecta*, was described by Lace (1915) based on specimens collected by *Collect* 469, and *Lace* 3151, 4845, 5488, and 5505, from Myanmar (Burma). While searching for the type materials, five sheets, collected by Lace were found at E (E00273688, E00273689, E00273690, E00273691, E00273692, and E00273693). A complete specimen (E00273688) with leaves, flowers, fruits and seeds, is designated here as the lectotype.

**6**. **Utricularia janarthanamii** S.R.Yadav, Sardesai & S.P.Gaikwad, Rheedea 10(2): 107. 2000; S.R.Yadav & Sardesai, Fl. Kolhapur Dist. 337. t. 54. 2002; Gadhvi *et al*., Pl. Sci. Today 8(1): 182. 2021. *Type*: INDIA, **Maharashtra**, Kolhapur district, Kolhapur, 17.08.1997, *Milind Sardesai* MMS233A (holo, CAL [CAL0000019120!], iso, K [K000779763 digital image!]). **Figs**. **60 & 61**

Annual, terrestrial herbs. Rhizoids a few, up to 10 mm long, papillose, branched. Stolons 10–40 mm long, 0.2–0.4 mm thick, numerous, profusely branched, internodes 2–5 mm long, minutely papillose. Leaves numerous on stolons, mat-forming; petioles 5.5–8 mm long; lamina oblance-ovate to obovate, 1.25–1.8 × 0.7–1.2 mm, 1–3-nerved, nerves branched further, rounded at apex. Traps numerous on stolons and petiole, sub-globose, 0.6–0.75 mm across; stalk up to 0.45–0.5 mm long, distally thickened, hairy; mouth basal; appendages subulate, glandular hairy. Racemes erect, 6–10 cm long, 2–8-flowered, glabrous; peduncles angular, grooved on one side, 0.5–0.8 mm thick, winged. Scales triangular, 0.8–1 × 0.25–3 mm, a few on peduncle base, fertile, truncate at base, narrowly acute at apex. Bracts widely ovate, 0.8–1.35 × 0.6–0.8 mm, acute or obscurely 3-dentate at apex; bracteoles absent. Flowers chasmogamous and

subterranean cleistogamous; chasmogamous flowers 5–6.5 mm long; pedicels 5–4.5 × 0.3–0.35 mm, erect at anthesis, winged, reflexed in fruit; subterranean cleistogamous flowers numerous on stolons, 0.8–1 mm long, obovoid, never open; pedicels 0.3–0.4 mm long, curved. Calyx lobes unequal, 6–7-nerved; upper lobe ovate, 1.75–2 × 1.25–1.5 mm, always smaller than lower lobe, margin entire, acute or minutely bi-dentate at apex; lower lobe ovate, 2.25–2.5 × 1.45–1.6 mm, acute or bi-dentate at apex. Corolla blue to pink; upper lip oblong, 3.2–3.6 × 1.2–1.45 mm, longer than the upper calyx lobe, crested at middle, white with blue striations, hairy along lower margin, rounded at apex; lower lip sub-orbicular, 2.5–3.2 × 1.6–3 mm, ciliate along throat margin, palate bi-gibbous, palate white with blue reticulations, clear blue to pink then, rounded at apex; spur conical, 2.5–3 mm long, straight, white at base, bluish or pinkish white towards tip, acute at apex. Stamens 1–1.2 mm long; filaments strap-shaped, 0.6–0.65 × 0.15–0.2 mm, slightly curved at base; anther theca 0.5–0.7 mm long. Pistil 1.2–1.5 mm long; ovary ellipsoid, 0.75–0.9 × 0.4–0.5 mm, ventrally compressed; style 0.13–0.15 mm long, short, flat; stigma bi-lipped; upper lip oblong, short; lower lip sub-orbicular, papillose out. Capsules obliquely ovoid, 1.8–2 × 1.3–1.5 mm, 15–20-seeded, wall uniformly membranous, dehiscing by a longitudinal slit; placenta oblongoid, 0.6–0.8 mm long; cleistogamous capsules 1–1.35 mm long, 6-seeded. Seeds few, sub-globose, 0.35–4 mm across; hilum lateral.

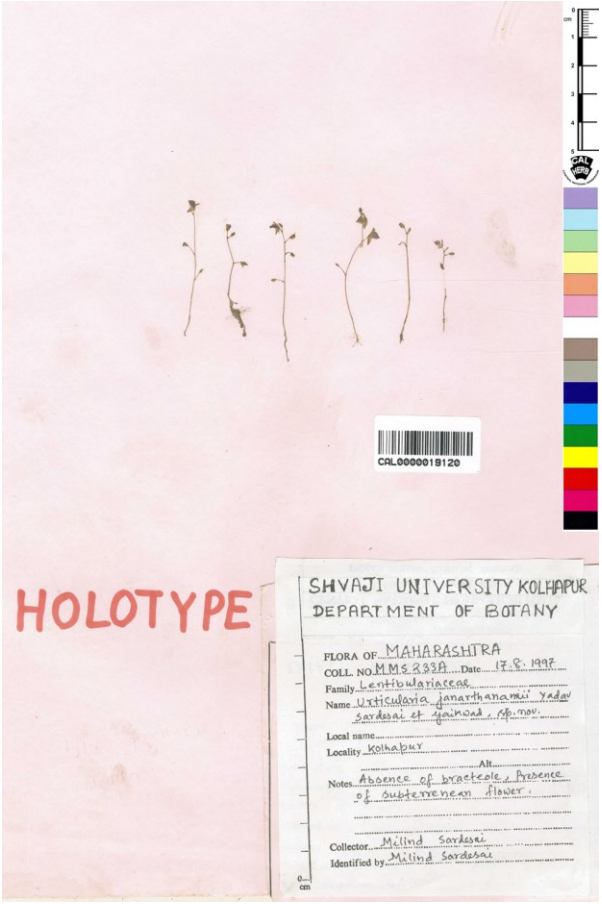


**Fig. 60.** *Type* of *Utricularia janarthanamii* S.R.Yadav *et al*. [*Milind Sardesai* MMS233A (CAL0000019120)] *"© The Director, Botanical Survey of India, Kolkata"*.

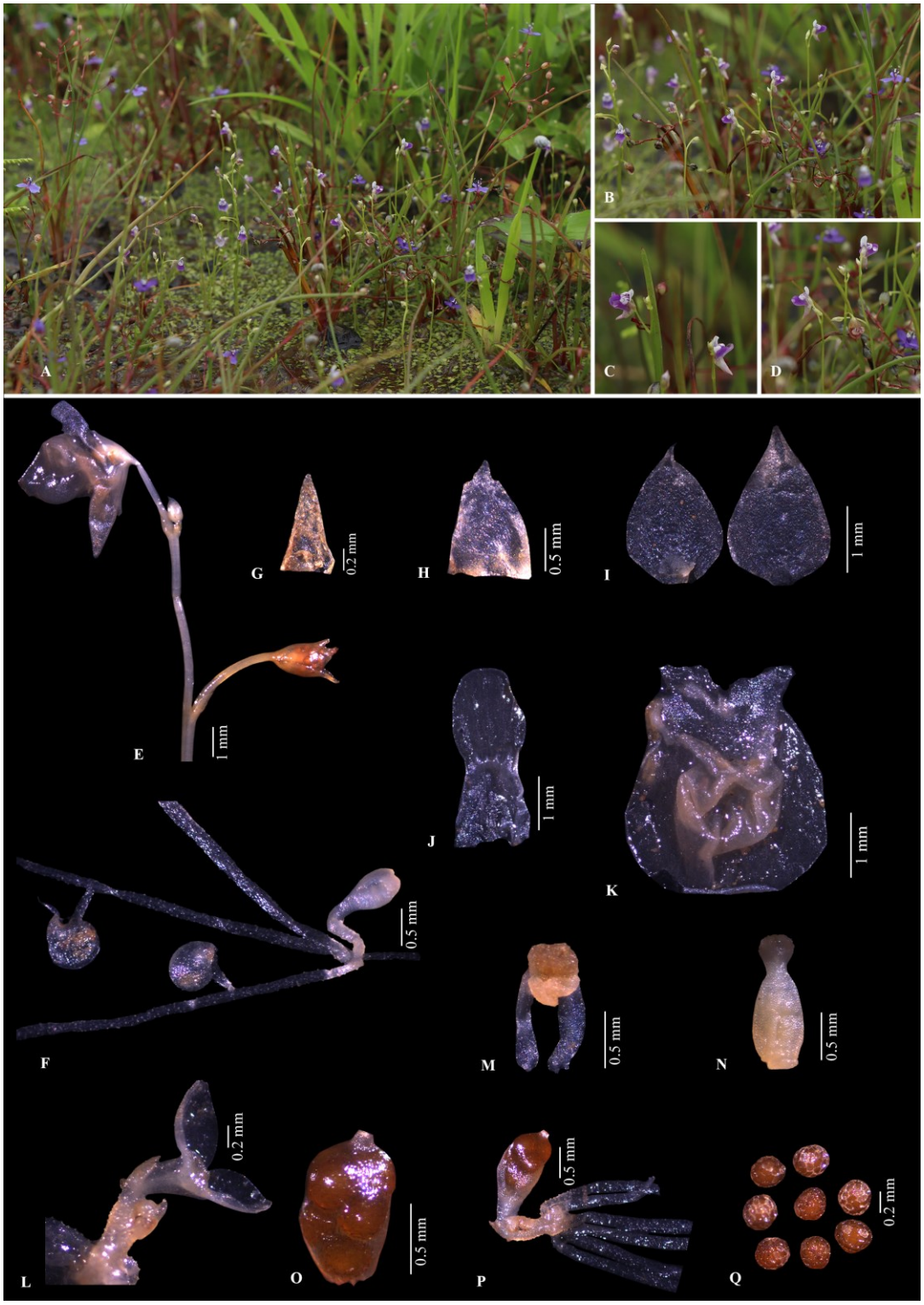


**Fig. 61.** *Utricularia janarthanamii* S.R.Yadav *et al.*: **A-D.** Habitat and habit; **E.** Peduncle bearing a flower and a mature capsule; **F.** Cleistogamous flower and traps on stolon; **G.** Scale; **H.** Bract; **I.** Calyx lobes; **J.** Upper lip of corolla; **K.** Lower lip of corolla; **L.** Cleistogamous inflorescence bearing pedicel and calyx lobes; **M.** Stamens; **N.** Pistil; **O.** Capsule; **P.** Cleistogamous capsule; **Q.** Seeds.

***Flowering & fruiting***: Flowering begins in early August and continues through October, fruiting occurs from mid-August to mid-October.

***Habitat***: The plant grows in small patches on seasonally wet soil, usually found above lateritic rocks and along the margins of seasonal pools, often in association with *Murdannia semiteres* (Commelinaceae), *Eriocaulon* spp. (Eriocaulaceae), *Rotala* sp. (Lythraceae), and some grasses (Fig. 61).

***Distribution***: Endemic to Peninsular India (Fig. 43).

***Specimen examined***: INDIA, **Maharashtra**, Pune district, near Tikona Fort, Gevhande Khadak, 08.10.2023, *Arun Prasanth & Milind M. Sardesai* 186084 (CALI).

***Conservation status***: *Utricularia janarthanamii* is distributed across the Pune and Kolhapur districts of Maharashtra, and the Junagadh district of Gujarat (Gadhvi *et al*., 2021). A more detailed study is required to better understand the distribution of this species. Based on the coordinates obtained from specimens and literature, the species has an AOO of 16 $km^2$, and an EOO of 20227.129 $km^2$. The species is provisionally assessed here as Endangered (EN B1ab(iii,iv,v)+2ab(iii,iv,v)+c(iii)).

***Notes***: *Utricularia janarthanamii* is a distinctive species characterized by the presence of both chasmogamous and subterranean cleistogamous flowers, and the absence of bracteoles (Fig. 61). It produces numerous subterranean cleistogamous flowers on stolons, with fully developed floral parts (Sardesai & Yadav, 2008; pers. obsv.). Chasmogamous flowers occur in erect racemes above the stolon. Seed setting occurs in both flower types, with a relatively lower number of seeds per chasmogamous capsule compared to other species in this section. Chasmogamous capsules contain approximately 20 mature seeds, while cleistogamous capsules contain about 6 seeds each.

*Utricularia janarthanamii* resembles *U. lazulina* in its habit and corolla characters, but can be differentiated by its reflexed fruiting pedicels (*vs*. erect), the upper lobe of the corolla always shorter than the lower lobe (*vs*. the upper lobe being longer), the absence of bracteoles (*vs*. bracteoles present) and the sub-orbicular seeds (*vs*. oblongoid seeds). It also shows an affinity with *U. malabarica* due to its reflexed

fruiting pedicel, but can be easily delimited by its oblong upper lip of the corolla and the absence of bracteoles.

Fleischmann (2012) synonymized *U. janarthanamii* under *U. heterosepala* Benj., a species native to the Philippines. He noted that the absence of bracteoles and the distinctive, finely sinuate seeds of *U. janarthanamii* closely match those of *U. heterosepala*. However, *U. heterosepala* does not produce cleistogamous flowers. Fleischmann speculated that the development of cleistogamous flower in *U. janarthanamii* could be an adaptation to survive in ephemeral habitats. Hsu *et al.* (2017) reported the occurrence of *U. heterosepala* in Taiwan but found no cleistogamous flowers in the Taiwanese material either. This study reinstates *U. janarthanamii* from the synonymy of *U. heterosepala*, as the production of numerous cleistogamous flowers is a unique feature of this species.

**7. Utricularia lazulina** P.Taylor, Proc. Ind. Acad. Sci. Pl. Sci. 93(2): 101. t. 3, 4. 1984; M.Ahmed. & M.P.Nayar, Endemic Pl. Ind. 1: 155. 1986; P.Taylor, Gen. *Utricularia* 325. t. 89. 1989; Janarth. & A.N.Henry, Bladderworts India 67. t. 17. 1992; Punekar & Lakshmin., Fl. Anshi Natl. Park 335. 2011; T.S.Nayar *et al.*, Fl. Pl. W. Ghats India 1: 585. 2014; Singh *et al.*, Endemic Vasc. Pl. India 195. 2015; R.Ansari *et al.*, Aquatic Wetland Fl. Kerala: Fl. Pl. 516. 2016. *Type*: INDIA, **Karnataka**, Dakshina Kannada district (South Kanara), Kulshekar, 14.08.1981, *P. Taylor* 18021 (holo, K [K000628550 digital image!]). **Figs. 62-66**

Annual, terrestrial or lithophytic herbs. Rhizoids numerous on peduncle base and opposite to leaves on stolon nodes, up to 20 mm long, 0.2–0.25 mm thick, filiform, tapering towards apex, profusely branched, branches 1–3 mm long, minutely papillose. Stolons up to 50 mm long, 0.2–0.3 mm thick, glabrous, variously branched, internodes 2–6 mm long. Leaves usually 2 on peduncle base, numerous on stolons, solitary at each node; petiole 0.5–5 mm long, flattened; lamina oblanceolate-obovate, 4.5–10 × 0.5–2.35 mm, 3-nerved, cuneate at base, obtuse-rounded at apex. Traps numerous on petiole, lamina and stolons, rarely a few on rhizoids, sub-globose, 0.8–1.3 × 0.8–1.35 mm, sub-dimorphic; those on lamina more or less oblate, sessile or

short stalked, stalk 0.2–0.35 mm long, uniformly thickened; elsewhere normal, long stalked, stalk 0.6–0.8 mm long, distally thickened, glandular hairy; mouth basal; appendages subulate, strongly incurved, glandular hairy. Racemes erect, rarely twining, 4–15 (–25) cm long, 1–6-flowered, simple; peduncles angular, grooved, 0.6–1 mm thick, winged, stiff or filiform. Scales a few, ovate, 1.4–1.5 × 0.8–0.9 mm, 1-nerved, truncate at base, acuminate at apex. Bracts ovate, 1.5–1.7 × 1–1.25 mm, 3-nerved, truncate at base, acute or acuminate at apex; bracteoles lanceolate, 1–1.2 × 0.2–0.25 mm, narrowly acute at apex. Flowers 8–12 mm long; pedicels 4.5–7 × 0.3–0.45 mm, erect, winged, dorsiventrally compressed, green-purplish green. Calyx lobes slightly unequal, accrescent, 3.5–4 × 2.5–3 mm in fruiting; upper lobe ovate-widely ovate, 3–3.75 × 1.85–2.2 mm, acute or obtuse at apex; lower lobe elliptic, 3.2–3.75 × 1.7–2 mm, acute to bi-dentate at apex. Corolla usually clear blue, sometimes pink or purple, rarely white; upper lip oblong, 4–5.5 × 1.8–2.3 mm, hairy along lower margins, constricted just below the middle, pale blue-lilac with pale blue longitudinal streaks above the constriction, fade towards apex, truncate-emarginate or rarely deeply 2-lobed at apex; lower lip sub-orbicular, 7.5–9.5 × 7.75–10 mm, ciliate along throat margin, yellow at throat, palate bi-gibbous, raised into a transversely triangular to widely rhombic, palate white with deep blue reticulations, clear blue-mauve then, margin undulate, emarginate-rounded or rarely 3-lobed at apex; spur subulate, 5.5–6.5 mm long, longer than lower calyx lobe, lilac, acute or rarely bifid at apex. Stamens 1.5–1.6 mm long; filaments narrowly oblong, 1.3–1.4 × 0.3–0.4 mm, broader

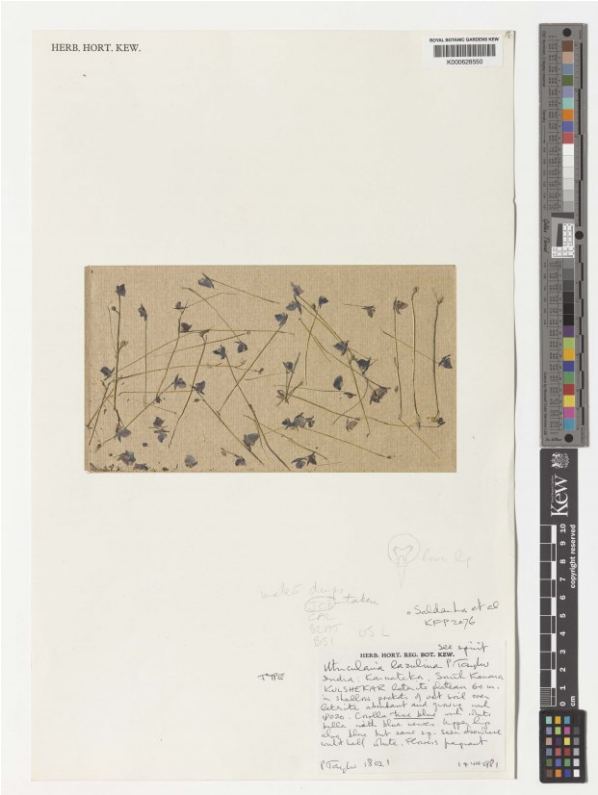


**Fig. 62.** Type of *Utricularia lazulina* P.Taylor [*Taylor* 18021 (K000628550)] "© *Board of Trustees of the Royal Botanic Gardens, Kew*".

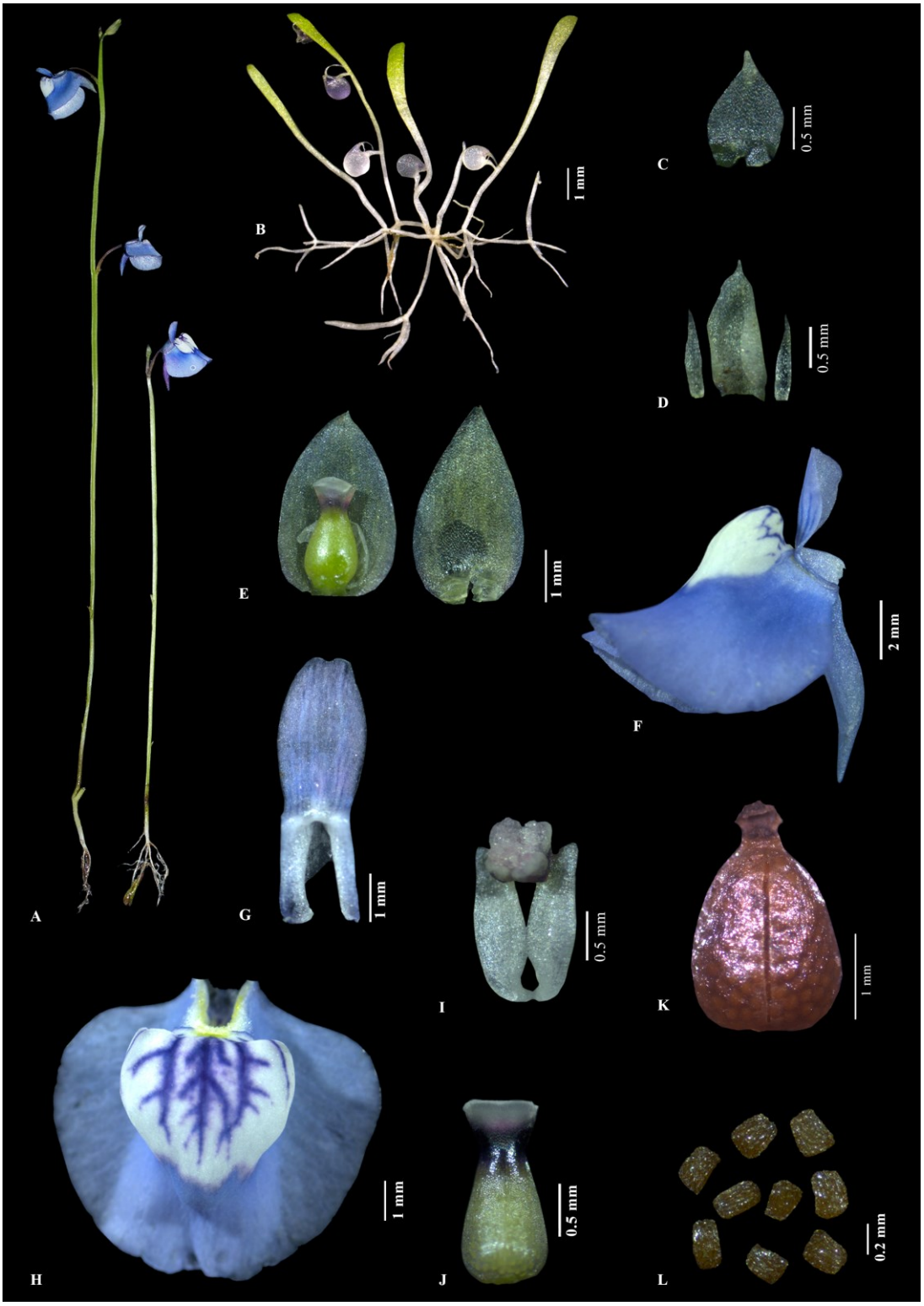


**Fig. 63.** *Utricularia lazulina* P.Taylor: **A.** Habit; **B.** Stolons bearing rhizoids, leaves and traps; **C.** Scale; **D.** Bract and bracteoles; **E.** Calyx lobes; **F.** Corolla; **G.** Upper lip of corolla; **H.** Lower lip of corolla; **I.** Stamens; **J.** Pistil; **K.** Capsule; **L.** Seeds.

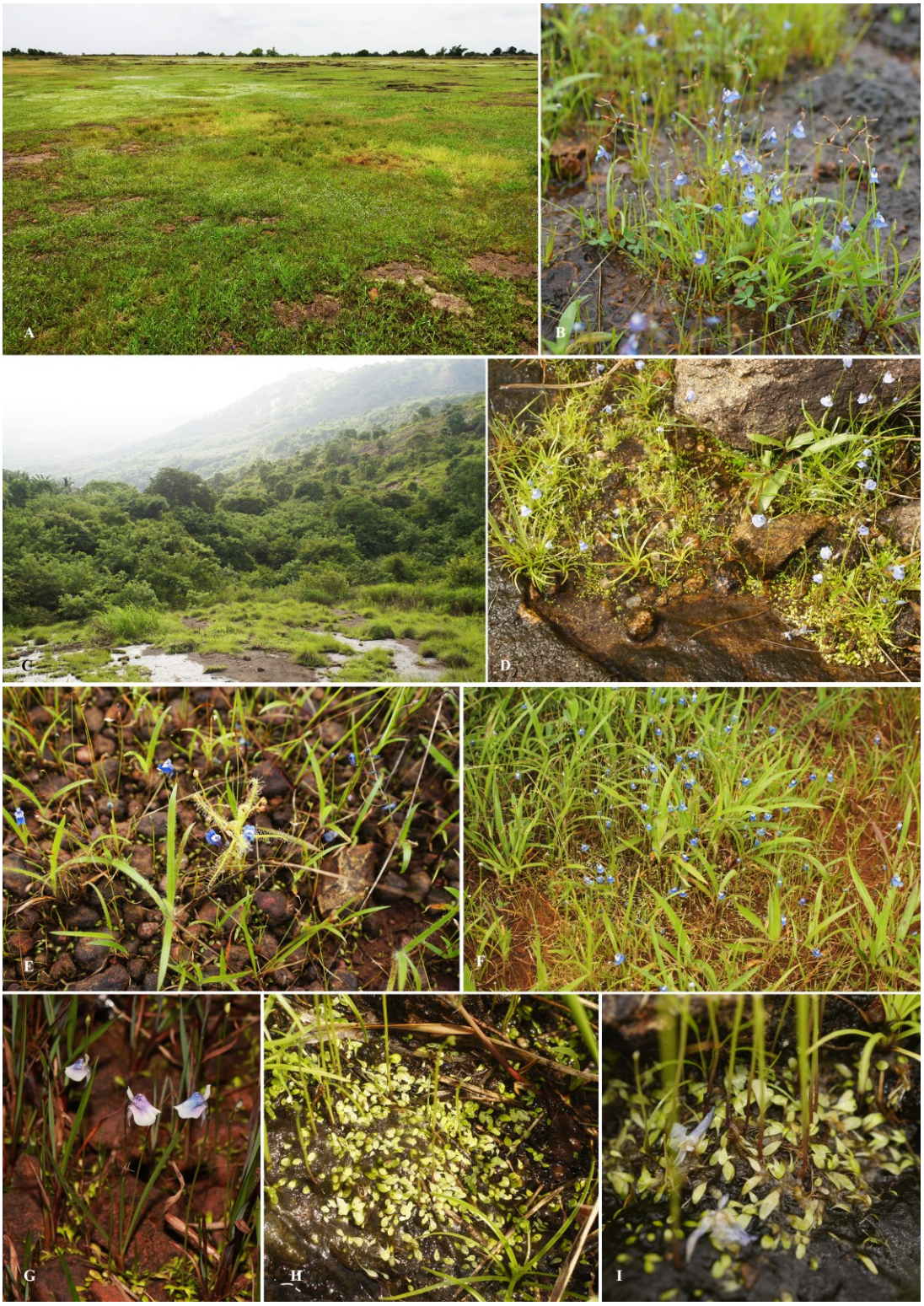


**Fig. 64.** *Utricularia lazulina* P.Taylor: **A-F.** Habitat diversity (**A.** Soil rich area in lateritic plateau; **B.** Rock crevices; **C & D.** Soil covered bedrock; **E.** Exposed lateritic rock surface; **F.** soil rich area); **G.** Habit; **H & I.** Leaves.

at middle, curved at base; anther thecae 0.5–0.6 mm long. Pistil 1.5–1.75 mm long; ovary ovoid-ellipsoid, 1.3–1.5 × 0.8–1 mm, green; style 0.2–0.3 mm long, violet; stigma bi-lipped; upper lip very short or obsolete, hooded, lower lip sub-orbicular, hyaline-pale violet, papillose out. Capsules ovoid, 1.85–2.5 mm long, wall uniformly membranous, dehiscing by a single, ventral longitudinal slit; placenta ovoid, 1–1.2 mm long. Seeds numerous, obovoid-oblongoid, 0.25–0.35 × 0.18–0.22 mm; surface smooth; hilum latero-terminal.

***Flowering & fruiting***: Flowering starts early July to mid-December, while fruiting takes place from mid-July to the end of December. Peak flowering is observed during August and September.

***Distribution***: Endemic to the Western Ghats, India (Fig. 65).

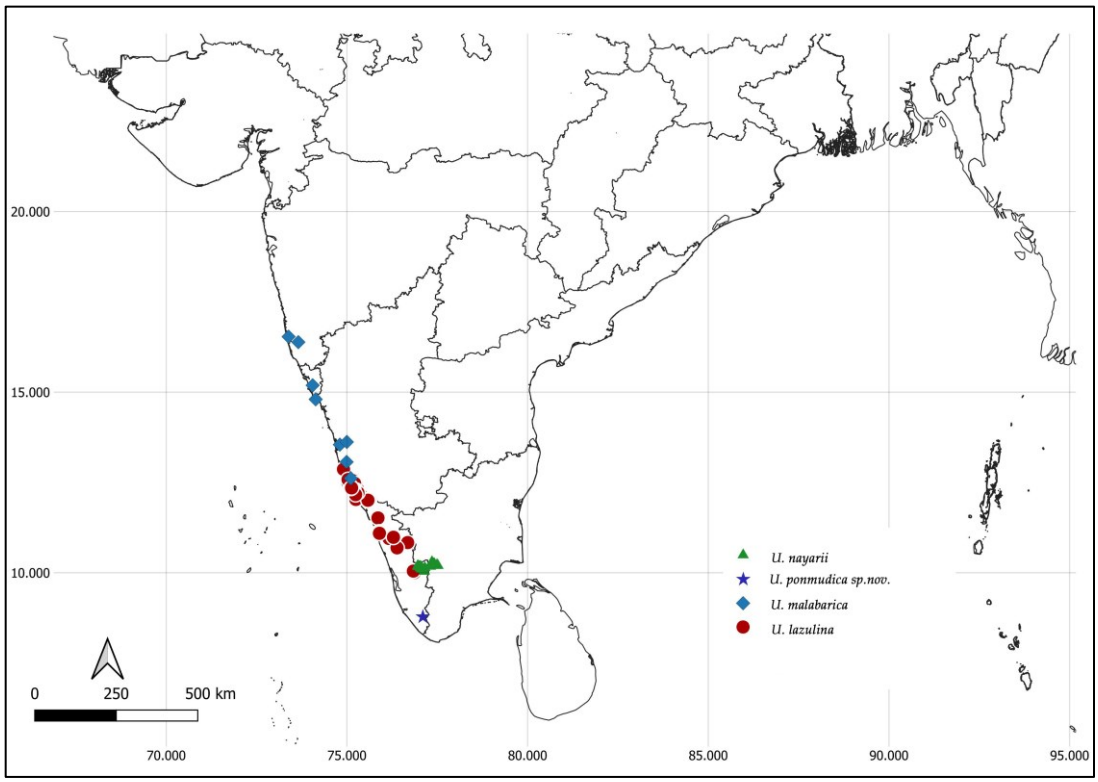


**Fig. 65.** Distribution of *Utricularia lazulina* P.Taylor; *U. malabarica* Janarth. & A.N.Henry; *U. nayarii* Janarth. & A.N.Henry; *U. ponmudica* Krishnapriya & Nampy.

***Habitat***: *Utricularia lazulina* usually grows on wet lateritic soils and along the margins of seasonal pools, often intermingled with *U. caerulea*, *U. cecilii*, *U. reticulata*,

*U. sainthomia, U. uliginosa*, *Ammania* sp., *Rotala* sp. (both Lythraceae), *Burmannia coelestis* (Burmanniaceae), *Chamaecrista* sp., *Geissaspis cristata* (both Fabaceae), *Dopatrium junceum* (Roxb.) Buch.-Ham. ex Benth. (Plantaginaceae), *Drosera indica* (Droseraceae), *Eriocaulon* spp. (Eriocaulaceae), *Euphorbia thymifolia* (Euphorbiaceae), *Lindernia* sp. (Linderniaceae), *Hoppea fastigiata* (Gentianaceae), *Neanotis subtilis* (Rubiaceae), *Rhamphicarpa* sp., *Striga* sp. (both Orobanchaceae), some sedges and grasses. It is also found in wet grasslands and soil patches, above fully exposed rocky outcrops at an elevation of around 700 m (Fig. 64).

***Specimens examined***: INDIA, **Karnataka**, Dakshina Kannada district, Kulshekar, ± 25 m, 19.08.1985, *M.K. Janarthanam* 82914 (BSID0012627, MH00126568, MH00126569). **Kerala,** Idukki district, Kaliyar, 07.12.2018, *Santhosh Nampy & M.P. Krishnapriya* 168046 (CALI187644); New Dam Construction site, Valara Waterfalls, 02.10.2021, *K.K. Jeomol* (177216); Kannur district, Blathoor lateritic plateau, 19.08.2019, *M.P. Krishnapriya & Santhosh Nampy* 168081 (CALI185487, CALI185488); *Ibid*., ± 210 m, 22.08.2019, *M.P. Krishnapriya & Santhosh Nampy* 168091 (CALI185472); Chooral, Arvanachal, ± 80 m, 31.07.2022, *M.P. Krishnapriya & Santhosh Nampy* 177258 (CALI197452, CALI197453, CALI197454); Madayipara lateritic plateau, ± 45 m, 20.08.2019, *M.P. Krishnapriya* 168086 (CALI185486); *Ibid*., Thavarathadam, 17.08.2014, *C. Pramod* 143132; near KSEB, January 2010, *C. Pramod* 126523 (CALI128553, CALI128554, CALI128555); *s.loc*., 17.07.2010, *C. Pramod* 100075 (CALI128556); *s.loc*., *s.d*., *C. Pramod* 100076 (CALI128558, CALI128559); *s.loc*., *s.d*., *C. Pramod* 100077 (CALI128557); Urathoor lateritic plateau, 19.08.2019, *M.P. Krishnapriya* 168083 (CALI); Kasaragod district, Beemanadi, lateritic rocks on Hilltop, 22.08.1985, *M.K. Janarthanam* 82927 (BSID0012631, MH00126580, MH00126581); Cheemeni, ± 65 m, 20.08.2019, *M.P. Krishnapriya & Santhosh Nampy* 168087 (CALI185470, CALI185471); *Ibid*., 27.08.2021, *M.P. Krishnapriya & Santhosh Nampy* 175821 (CALI197451); Kappadampoyil, 27.08.2021, *M.P. Krishnapriya & Santhosh Nampy* 175824 (CALI197449); Kanhangad, Anandashramam, Ramnagar, 20.08.1985, *M.K. Janarthanam* 82916 (BSID0012628, MH00126572, MH00126573); Kuttikol, 27.08.2021, *M.P Krishnapriya* 175813 (CALI197474); Mulleriya, 21.08.1985, *M.K. Janarthanam* 82922 (BSID0012630, MH00126576, MH00126577); Periya, opposite Central

University, 26.08.2021, *M.P. Krishnapriya* 175807 (CALI); Ramnagar, 20.08.1985, *M.K. Janarthanam* 82918 (BSID0012629, MH00126574, MH00126575); Vidhyanagar, opposite to Government College, ± 3 m, 18.08.1985, *M.K. Janarthanam* 82912 (BSID0012626, MH00126578, MH00126579); Kozhikode district, Vayalada, 07.08.2019, *M.P. Krishnapriya & Santhosh Nampy* 168078 (CALI188032, CALI188033); Malappuram district, Calicut University, Botanical Garden, 50 m, 25.08.1978, *Mitha Krishnan* 26143 (CALI141509); *Ibid*., Campus, 21.10.1990, *N.M. Jaffer* 1997 (CALI141508); *Ibid*., 02.09.1991, *C.G. Solly* 4247 (CALI141507); *Ibid*., 27.07.2019, *M.P. Krishnapriya*, 168071 (CALI188029); *Ibid*., near Quarters, ± 35 m, 12.08.2019, *M.P. Krishnapriya* 168079 (CALI187645); Chelari, Thrikannur Shiva Temple, ± 17 m, 21.10.2021, *M.P. Krishnapriya & Santhosh Nampy* 177225 (CALI); Kodikuthimala, ± 500 m, 20.07.2019, *M.P. Krishnapriya* 168070 (CALI185464); *Ibid*., ± 395 m, 29.07.2019, *M.P. Krishnapriya* 168072 (CALI188030, CALI188031); *Ibid*., ± 700 m, 08.10.2019, *M.P. Krishnapriya & Santhosh Nampy* 164316 (CALI197476, CALI197477, CALI197478, CALI197479); Malaparamba, 12.08.2020, *M.P. Krishnapriya* 164371 (CALI); Palakkad district, Malampuzha, base of the hillock, 15.09.1985, *M.K. Janarthanam* 82940 (BSID0012632, MH00126570, MH00126571); Thrissur district, Kaayampoovam, ± 37 m, 06.09.2020, *M.P. Krishnapriya & Santhosh Nampy* 164374 (CALI185493).

***Conservation status***: *Utricularia lazulina* is a locally abundant endemic species. It has a wide distribution, ranging from low elevation plateaus to high altitude hillocks at around 1200 m. Potential threats to its habitat include laterite stone mining, quarrying, developmental activities, summer firing, and landslides. The species has an AOO of 128 $km^2$ and EOO of 12274.318 $km^2$. Based on current data, this species is assessed as Vulnerable (VU B1b(ii,iii,iv)+2b(ii,iii,iv)).

***Notes***: *Utricularia lazulina* is distinctive for its typical lazuli blue flowers, spathulate 3-nerved leaves, erect pedicels, oblong upper lip of the corolla, and oblongoid seeds. It also exhibits a range of corolla colour variations in the field, from the clear lazuli blue to white, mauve, pink, or purple colours (Fig. 66). The apex of the spur can vary from acute to acuminate or bi-dentate, sometimes within a single population or even the same inflorescence. It is often confused with *U. malabarica*, as some floristic works (Bhat, 2003, 2014; Datar & Lakshminarasimhan, 2013) have

**Fig. 66.** Variations in the corolla colour and palate striation patterns in *Utricularia lazulina* P.Taylor

enumerated *U. malabarica* as *U. lazulina.* Key distinguishing features of *U. lazulina* include erect fruiting pedicel (*vs*. reflexed in *U. malabarica*), oblong upper lip of the corolla (*vs*. obovate); straight spur (*vs*. long tusk-like, descending or horizontal), and smooth periclinal wall of seeds (*vs*. transversely striated).

**8. Utricularia malabarica** Janarth. & A.N.Henry, J. Bombay Nat. Hist. Soc. 86(1): 84. 1989, Bladderworts India 69. t. 18. 1992, J. Econ. Tax. Bot. 18(1): 230. 1994; Singh *et al*., Endem. Vasc. Pl. India 195. 2015; R.Ansari *et al*., Aquatic Wetland Fl. Kerala: Fl. Pl. 516. t. 216. 2016; Kolte *et al*., Rheedea 29(3): 215. 2019. *Type*: INDIA, **Kerala**, Kasaragod district, Mulleriya, on lateritic rocks, 21.08.1985, *M.K. Janarthanam* 82924 (holo, CAL [CAL0000019115]; iso, MH [MH00000782, MH00000783, MH00000784, MH00000785]!). **Figs. 67–70**

*Utricularia lazulina auct. non* P.Taylor: K.G.Bhat, Fl. Uduppi 456. 2003, Fl. South Kanara 769. 2014; Datar & Lakshmin., Fl. Bhagwan Mahavir (Molem) Natl. Park Adjoining, Goa 176. 2013

Annual, terrestrial herbs. Rhizoids up to 6 mm long, 0.2–0.25 mm thick, simple to branched, branches 0.3–0.6 mm long, papillose. Stolons 10–30 × 0.1–0.25 mm, 0.2–0.25 mm thick, terete, glabrous, variously branched, internodes 2–6 mm long. Leaves numerous on stolons, solitary at each node; petioles 2–4 mm long, 0.3–0.4 mm thick, flat, hyaline or pale green; lamina widely obovate to spathulate, 2–4 × 1–1.5 mm, 3-nerved, green, narrowly cuneate-cuneate at base, rounded at apex. Traps numerous on stolon, petioles and lamina, sub-dimorphic; those on stolons and petiole small, globose, 0.6–1 mm across, long stalked, 0.5–0.7 mm long,

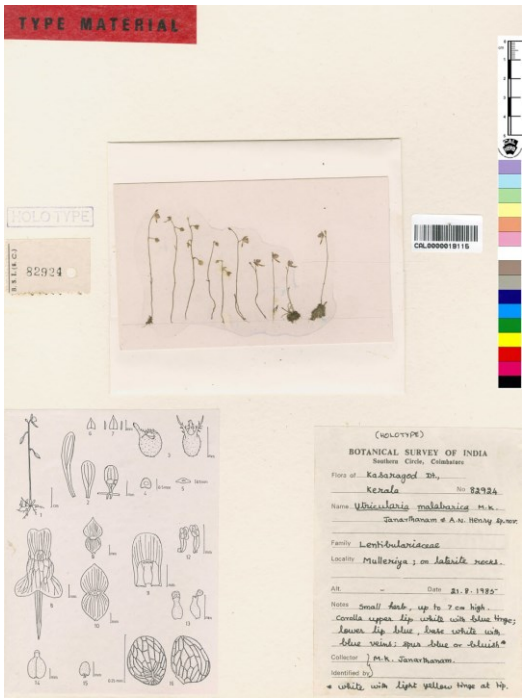


**Fig. 67.** Type of *Utricularia malabarica* Janarth. & A.N.Henry [*M.K. Janarthanam* 82924 (CAL0000019115)] *"© The Director, Botanical Survey of India, Kolkata".*

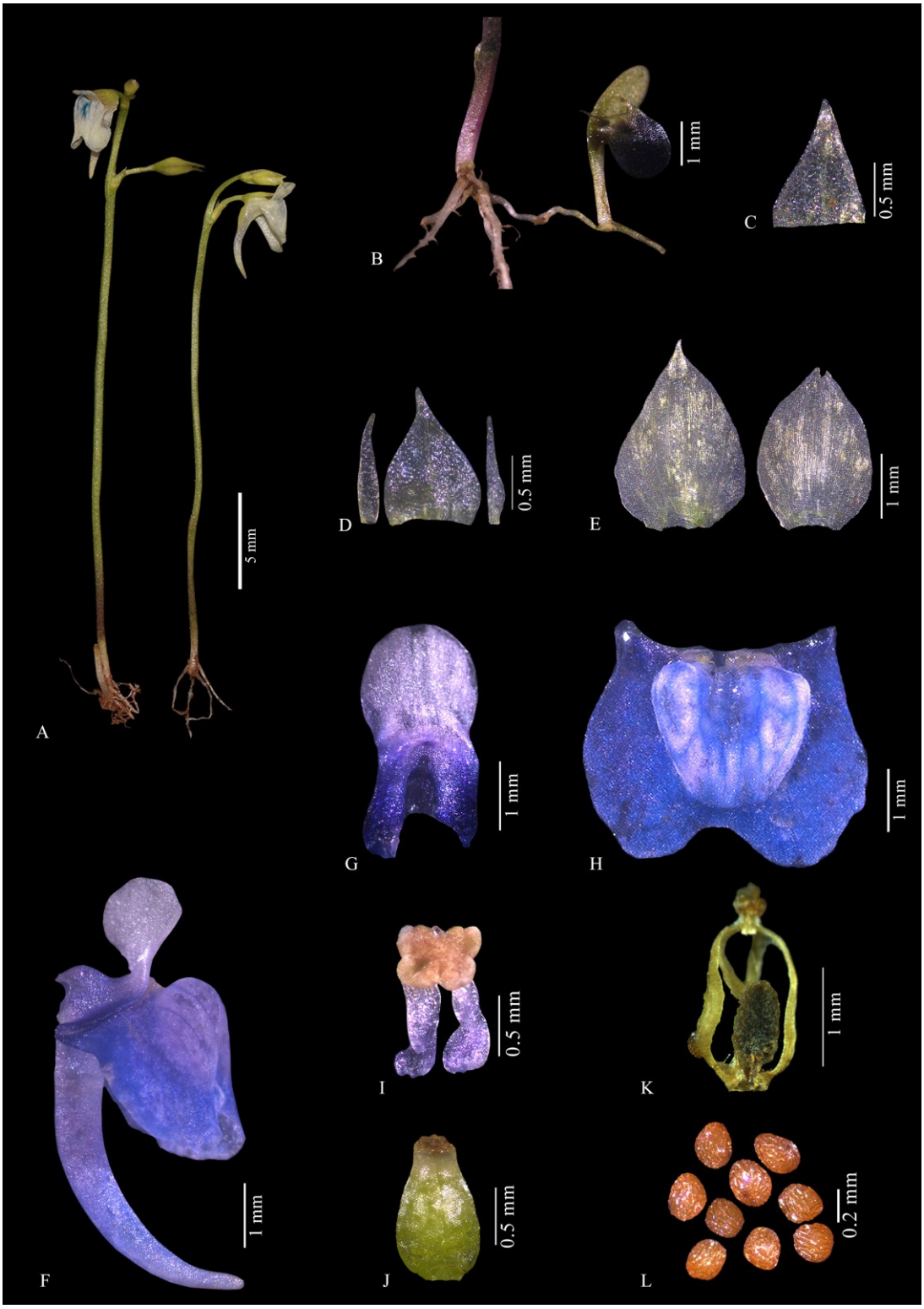


**Fig. 68.** *Utricularia malabarica* Janarth. & A.N.Henry: **A.** Habit; **B.** Peduncle base with rhizoids, stolons, a leaf and trap; **C.** Scale; **D.** Bract and bracteoles; **E.** Calyx lobes; **F.** Corolla; **G.** Upper lip of corolla; **H.** Lower lip of corolla; **I.** Stamens; **J.** Pistil; **K.** Capsule; **L.** Seeds.

**Fig. 69.** Habitat and habit of *Utricularia malabarica* Janarth. & A.N.Henry

stalk distally thickened; those on lamina globose, 1.25–1.5 mm across, sometimes larger than lamina, short stalked, stalk up to 0.3 mm long, terete; mouth basal; appendages subulate, glandular hairy, incurved. Racemes erect, 3–15 cm long, 1–3-flowered; peduncles angular, grooved on two sides, 0.4–0.5 mm thick, pale green. Scales a few, ovate, 1.2–1.3 × 0.65–0.75 mm, fertile, 1-nerved, truncate at base, acute at apex. Bracts triangular, 1.25–1.35 × 0.8–1 mm, 1-nerved, truncate at base, acute at apex; bracteoles lanceolate, 1–1.2 × 0.15–0.2 mm, 1-nerved, acute at apex. Flowers 6–7.5 (–1) mm long; pedicels 1.5–2.5 × 0.3–0.35 mm, erect at anthesis, slightly winged, accrescent, up to 3.5 mm long in fruiting, reflexed in fruit. Calyx lobes unequal, pale green; upper lobe ovate, 2.65–3 × 1.7–2.2 mm, 8–9-nerved, lateral nerves dichotomously branched further, acute at apex; lower lobe ovate, 2.2–2.5 × 1.5–1.75 mm, 8–10-nerved, bidentate at apex. Corolla blue to pink, or rarely white; upper lip obovate, 2.85–3.35 × 1.3–1.65 mm, lower margin hairy, constricted at middle, blue with deep blue streaks, or white, wider than the upper calyx lobe, rounded-emarginate at apex; lower lip transversely oblong, 3.5–3.7 × 2.8–3.2 mm, yellow at throat, ciliate along throat margin, palate bi-gibbous, blue or white with deep blue reticulations, clear blue-pink then, deeply emarginate at apex; spur conical, 4.5–5.25 mm long, straight or tusk-like, descending or horizontal, longer than the lower calyx lobe, longer than the lower lip of corolla, narrowly acute at apex. Stamens 1.2–1.25 mm long; filaments strap-shaped, 1–1.05 × 0.24–0.3 mm, hyaline, curved at base; anther theca 0.5–0.6 mm long. Pistil 1.35–1.45 mm long; ovary ellipsoid, 0.95–1 × 0.5–0.6 mm, green; style 0.12–0.125 mm long; stigma bi lipped; upper lip obsolete, lower lip sub-orbicular. Capsules ellipsoid, 2–2.2 × 1.38–1.45 mm; placenta ellipsoid, 1.3–1.35 × 0.7–0.8 mm. Seeds oblongoid to sub-globose, 0.25–0.3 × 0.17–0.2 mm, few; surface striated with transversal ridges; hilum latero-terminal.

***Flowering & fruiting***: Flowering begins from late July to early September, while fruiting begins in early August and lasts until September.

***Habitat***: Growing in wet, open lateritic plateaus, often in association with *U. caerulea*, *U. cecilii*, *U. minutissima*, *Burmannia coelestis* (Burmanniaceae), *Canscora* sp., *Hoppea fastigiata* (both Gentianaceae), *Desmodium* sp., *Smithia* sp. (both Fabaceae), *Drosera*

*indica* (Droseraceae), *Eriocaulon* spp. (Eriocaulaceae), *Rhamphicarpa* sp. (Orobanchaceae) and some sedges and grasses (Fig. 69).

***Distribution***: Endemic to the Western Ghats, India (Janarthanam, 1994; Kolte *et al*., 2019). (Fig. 65).

***Specimens examined***: INDIA, **Goa**, South Goa district, Quepam, Maina, 26.09.2023, *M.P. Krishnapriya & Santhosh Nampy* 186076; Bhirond Junction, ± 71 m, 26.09.2023, *M.P. Krishnapriya & Santhosh Nampy* 186078 (CALI). **Karnataka**, North Kanara, Karwar, 1887, *W.A. Talbolt* 1579 (CAL). **Kerala**, Kasaragod district, Pallathadka to Yethadka road, 26.08.2021, *M.P. Krishnapriya* 175811 (CALI186828, CALI186829, CALI186830, CALI186831); *Ibid*., Puthrakala Hills, ± 260 m, 01.08.2022, *M.P. Krishnapriya & Santhosh Nampy* 177269; *Ibid*., Hilltop, 01.08.2022, *M.P. Krishnapriya & Santhosh Nampy* 177270 (CALI). **Maharashtra**, Sindhudurg district, Phonda to Nandagaon road, ± 40 m, 11.08.2022, *M.P. Krishnapriya* 177279 (CALI).

***Conservation status***: *Utricularia malabarica* has a comparatively restricted distribution, being collected from northern Kerala, Goa and Maharashtra. It grows in small, solitary patches, with the number of individuals often limited to less than 50. The species faces severe habitat threats due to quarrying and mining for lateritic stones, constructions, and other developmental activities. The species has an AOO of 30 km$^2$ and EOO of 11401.237 km$^2$, and is categorised as Critically Endangered (CR B2ab(ii,iii,iv,v)+c(ii,iii,iv); D).

***Notes***: *Utricularia malabarica* is quite distinct in the field by its long, tusk-like, acuminate spur and reflexed fruiting pedicels. A robust form of *U. malabarica* was observed in the wet lateritic plateaus of Goa and Karnataka. This form features an inflorescence around 15 cm long, with 1–6 large flowers, a deeply emarginate upper lip of the corolla, and an erect, straight spur that may be very short or twice the length of the lower calyx lobes (Fig. 69L-N, 70). The corolla colour varies from pale to deep blue, pink, or white (Fig. 70). While examining herbarium specimens, a sheet collected by W.A. Talbolt in 1887 from Karnataka, identified as *U. albocaerulea*, was found in the CAL herbarium, potentially representing the first known collection of

**Fig. 70.** Floral diversity within *Utricularia malabarica* Janarth. & A.N.Henry (note the size, shape and orientation of spur; corolla colour variations and the deflexed fruiting pedicel in **D.**)

*U. malabarica*. *Utricularia malabarica* is often misidentified as *U. albocaerulea* and *U. lazulina* (live images recorded from Karnataka and Goa available in GBIF [https://www.gbif.org/occurrence/gallery? taxon_key=7438859]). *Utricularia malabarica* is often confused with *U. lazulina* in the field (please see notes under *U. lazulina*). It also has affinity with *U. albocaerulea*, but can be easily distinguished with the longer spur and striated periclinal wall of the testa.

**9. Utricularia nayarii** Janarth. & A.N.Henry, Bull. Bot. Surv. India 28(1): 195. 1986, Bladderworts India 77. t. 21. 1992; Nayar *et al*., Fl. Pl. W. Ghats India 1: 586. 2014; Singh *et al*., Endem. Vasc. Pl. India 195. 2015; R.Ansari *et al*., Aquatic Wetland Fl. Kerala: Fl. Pl. 519. 2016. *Type*: INDIA, **Kerala**, Idukki district, Rajamallay (Rajamala), on dripping rocks, 12.12.1985, *M.K. Janarthanam* 82963 (holo, CAL [CAL0000019114], iso, MH [MH00000765, MH00000766, MH00000767, MH00000768]!). **Figs. 71–74**

Annual, terrestrial to semi-aquatic, herbs. Rhizoids a few on peduncle base, up to 20 mm long, 0.2–0.25 mm thick, papillose, branched further, branches up to 5 mm long, tapering, papillose. Stolons up to 50 mm long, 0.2–0.3 mm thick, sparsely branched, minutely papillose. Leaves usually 2 on peduncle base, numerous on stolons, petioles 5–10 mm long lamina strap-shaped, 10–40 × 2–4 mm, thick, fleshy, multi-nerved, narrowly cuneate at base, rounded at apex. Traps numerous on stolons and leaves, globose, more or less oblate; those on stolons 2.3–2.65 mm across, stalk 1–1.5 mm long, uniform or distally thickened, glandular hairy; those on leaves usually large, 2.5–3 mm across, stalk 0.6–1.5 mm long, uniform or distally thickened, glandular hairy; mouth basal; appendages subulate, incurved, glandular hairy. Racemes erect, up to 20 cm long, 1–5 (–13)-flowered, simple to variously branched; peduncles angular, grooved on one side, 0.8–2 mm thick, winged, fleshy, green. Scales a few, triangular, 1–1.5 × 0.5–1.15 mm, 1-nerved, green-purplish green, truncate at base, acute at apex. Bracts triangular to ovate, 2–2.8 × 0.85–1.5 mm, green-purplish green, 1-nerved, truncate at base, acute-narrowly acute at apex; bracteoles lanceolate, 1.4–2 × 0.2–0.3 mm, 1-nerved, acute at apex. Flowers 8–12 mm long; pedicels 4.5–7 × 0.4–0.5 mm, erect, winged, green to purplish-green. Calyx lobes unequal, upper lobe always wider and smaller than lower lobe, accrescent; upper lobe widely ovate or elliptic, 3–4.25 × 2–3.2 mm, 12-nerved, green-purplish green, margin dentate, acuminate or cuspidate

**Fig. 71.** Type of *Utricularia nayarii* Janarth. & A.N.Henry [*M.K. Janarthanam* 82963 (CAL0000019114)] *"© The Director, Botanical Survey of India, Kolkata"*.

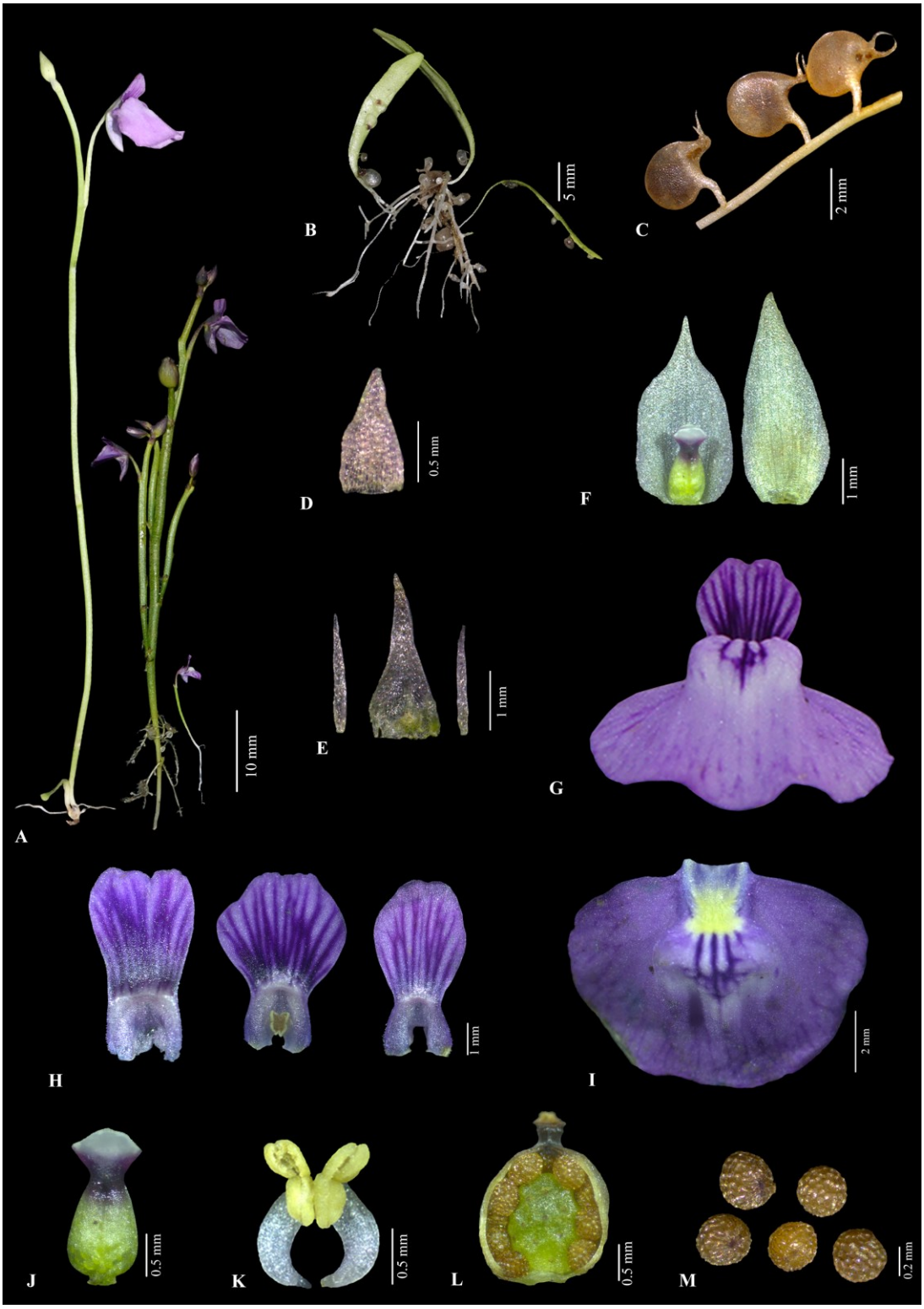


**Fig. 72.** *Utricularia nayarii* Janarth. & A.N.Henry: **A.** Habit (note the simple and variously branched plant); **B.** Peduncle base with rhizoids, stolons, leaves and traps; **C.** Traps; **D.** Scale; **E.** Bract and bracteoles; **F.** Calyx lobes; **G.** Corolla; **H.** Upper lip of corolla (note the variation in shape); **I.** Lower lip of corolla; **J.** Pistil; **K.** Stamens; **L.** Capsule; **M.** Seeds.

**Fig. 73.** Habitat and habit of *Utricularia nayarii* Janarth. & A.N.Henry

at apex; lower lobe ovate to elliptic, 3.5–5 × 2.2–2.5 mm, 10-nerved, green-purplish green, margin dentate, acute or bi-dentate at apex. Corolla purple to violet; upper lip usually obovate, rarely oblong, 4–6 × 2–4 mm, longer and wider than upper calyx lobe, lower margins hairy, constricted below the middle, purple or violet with deep violet longitudinal streaks above the constriction up to the apex, emarginate at apex; lower lip sub-orbicular, 4.5–7.7 × 5–8 mm, ciliate along throat margin, yellow at throat, palate bi-gibbous, palate pale purple with deep purple or violet striations, faint then, margin undulate, rounded or rarely 3-lobed at apex; spur subulate, 3.5–5 mm long, sometimes widen at middle, shorter than or equal to lower calyx lobe, obtuse to bifid at apex. Stamens 1.4–1.65 mm long; filaments strap-shaped, 1.3–1.4 × 0.4–0.53 mm, broader and curved at middle, pale purplish white, twisted at base; anther thecae 0.8–1 mm long, yellow. Pistil 1.5–1.75 mm long; ovary ovoid, 0.8–1.3 × 0.7–0.85 mm, dorsiventrally compressed, green; style 0.15–0.2 mm long, thick, deep violet; stigma bi-lipped; upper lip truncate, hooded; lower sub-orbicular, papillose out. Capsules ovoid-widely ellipsoid, 3–3.5 × 2.2–2.6 mm, wall membranous, thickened along dehiscing margin, dehiscing by dorsal and ventral longitudinal slit; placenta widely ellipsoid, 1.8–2 mm across. Seeds few (less than 30 seeds per capsule), sub-globose, 0.4–0.6 mm across; surface smooth; hilum lateral.

***Flowering & fruiting***: Flowering starts from late September to early March, with fruiting from early October to the end of March. Peak flowering is observed during December and January.

***Habitat***: *Utricularia nayarii* usually thrives in swampy margins of perennial streams, seasonally inundated muddy areas, and moss-covered rocky slopes in high altitude cool places (1700–2200 m), in association with *U. roseopurpurea*, *Burmannia munnarensis* (Burmanniaceae), *Apocopis mangalorensis* (Hochst. ex Steud.) Henrad, *Arundinella* sp., *Dimeria* sp., *Jansenella griffithiana* (all Poaceae), *Eriocaulon brownianum* Mart., *E. nairii* Chandrab. & V.Chandras., *E. odoratum* Dalzell, *E. thwaitesii* Korn. (all Eriocaulaceae), *Fimbristylis* sp. (Cyperaceae), *Impatiens raktakesara* M.Vishnu & Nampy (Balsaminaceae), *Laurembergia coccinea* Kanitz. (Haloragaceae), *Smithia racemosa* B.Heyne (Fabaceae) and some other grasses (Fig. 73).

***Distribution***: Endemic to the Western Ghats, India (Fig. 65).

***Specimens examined***: INDIA, **Kerala,** Idukki district, Anamudi-base camp, 11.12.2019, *M.P. Krishnapriya & Santhosh Nampy* 164336 (CALI199590); *Ibid*., 11.12.2019, *M.P. Krishnapriya & Santhosh Nampy* 164337 (CALI199573); *Ibid*., 03.10.2021, *K.K. Jeomol* 177219 (CALI); Edamalakkudi, near Stream, 19.03.2019, *Dani Francis & M.P. Krishnapriya* 168064 (CALI188035); Eravikulam National Park, 2100 m, 03.12.1987, *M.K. Janarthanam* 83050 (MH00126284, MH00126285); *Ibid*., 2100 m, 03.12.1987, *M.K. Janarthanam* 83051 (MH00126281, MH00126282, MH00126283); *Ibid*., 2100 m, 03.12.1987, *M.K. Janarthanam* 83052 (MH00126279); *Ibid*., 2100 m, 03.12.1987, *M.K. Janarthanam* 83053 (MH00126280, MH00126278); Lockhart gap, 13.12.1985, *M.K. Janarthanam* 82969 (BSID0012676, MH00126272, MH00126273); *Ibid.,* 1675 m, 12.11.1963, *K.M. Sebastine* 17545 (CAL0000019119, MH00000769, MH00000774, MH00000775, MH00000776, MH00000777, MH00000778 paratypes); *Ibid.,* 1675 m, 12.11.1986, *K.M. Sebastine* 17543 (CAL0000019118, MH00000770, MH00000771, MH00000772, MH00000773 paratypes); Old Devikulam, 04.10.2021, *K.K. Jeomol* 177222 (CALI); Pettimudi grassland, 1850 m, 29.12.2019, *M.P. Krishnapriya & Santhosh Nampy* 164342 (CALI185459, CALI197431); *Ibid*., Hill slopes, 12.12.1985, *M.K. Janarthanam* 82961 (BSID0012674, MH00126276, MH00126277); *Ibid*., 12.12.1985, *M.K. Janarthanam* 82962 (BSID0012673, MH00126274, MH00126275); *Ibid*., Hilltop, 2089 m, 30.12.2019, *M.P. Krishnapriya & Santhosh Nampy* 164345 (CALI188036, CALI188037, CALI199595); *Ibid*., 30.12.2019, *M.P. Krishnapriya & Santhosh Nampy* 164346 (CALI197432); *Ibid*., Subran shed, near Stream, 30.12.2019, *M.P. Krishnapriya & Santhosh Nampy* 164347 (CALI188038, CALI188039); Rajamala grassy slopes, 1950 m, 02.02.1970, *B.V. Shetty* 31797 (MH00126286, MH00126287); Silent Valley, 26.11.2018, *Vishnu Mohan & M.P. Krishnapriya* 168041 (CALI188034). **Tamil Nadu**, Dindigul district, Shembaganur, Kodaikanal, 12.09.1959, *K.M. Matthew* 1205 (RH044643); Blackburn Forest, 02.02.1986, *K.M. Matthew & N. Rajendran* 43836 (RHT044651); Blackburn slopes facing Palamalai (Kavalamalai), 01.01.1987, *K.M. Matthew* 48216 (RHT044663); Levinge Path, 1900 m, 07.02.1986, *K.M. Matthew* 44079 (RHT044652), *Ibid*., 07.02.1986, *K.M. Matthew* 44081 (RHT044653); *s.loc*., *s.d*., *s.coll. s.n.* (RHT044712); Konalar (Grass Hill) Bunglow, 1875 m, 20.10.1984, *K.M. Matthew* 18325 (RHT044706);

Mannavanur, Kookal, 24.08.1986, *K.M. Matthew*, *M. Charles & N. Rajendran* 46633 (RHT044660); Kookal shola top, 18.05.1986, *K.M. Matthew & N. Rajendran* 45222 (RHT044656).

***Conservation status***: *Utricularia nayarii* is an endemic species found in the high altitude areas of Idukki district in Kerala and Dindigul district in Tamil Nadu. It occurs in small patches, with populations of about 50 individuals or fewer. My field study, indicates that the locality where the paratypes were collected is no longer exist. The construction of Munnar-Madurai National Highway, along with the illegal mining, severe flooding and landslides in 2018, devastated the Lockhart gap in Idukki district, a hotspot for many endemic species. The aftermath of the flood, coupled with road reconstruction, completely ruined the habitat. Likewise, the land slide in Pettimudi in 2020 also destroyed the habitats of many of the rare and endangered taxa.

The species has an AOO of 23 $km^2$ (the AOO was scaled calculated using 1 × 1 km grid cell) and EOO of 923.858 $km^2$. Considering its highly fragmented habitats and low distribution, *U. nayarii* is assessed as Critically Endangered (CR B2ab(i,ii,iii,iv)+c(i,ii)).

***Notes***: *Utricularia nayarii* is distinctive for its vegetative and floral features, especially the long, thick, fleshy leaves, stiff and fleshy peduncle (which can be simple or branched), unequal calyx lobes with a small upper lobe, erect pedicels, and deep purple to violet flowers (Figs. 72, 74). *Utricularia nayarii* exhibit variations in inflorescence size and morphology. Plants growing on open moss-covered rocky surfaces tend to be dwarf forms, with peduncles reaching a maximum height of 2 cm and bearing either a single flower or 2–3-flowers with all parts reduced in size. In contrast, those growing in swamps or along stream edges can reach heights of up to 20 cm, with peduncles that are single or branched, bearing 1–5 (–13) flowers (Fig. 73). Variations in the shape of the upper lip of the corolla and the apex of the spur occur within a single population or even in the same inflorescence. The upper lip varies from oblong to obovate, or more or less rhombic, and the apex of the spur ranges from acute to obtuse, or bi-dentate.

**Fig. 74.** *Utricularia nayarii* Janarth. & A.N.Henry: **A.** Habit; **B-H.** Inflorescence with flowers in different view.

Taylor (1989) treated *U. nayarii* a synonym of *U. uliginosa*. However, Janarthanam and Henry (1992) re-established *U. nayarii* as a distinct species, Li (2011) in the *Flora of China* and POWO (2025) again treated it as a synonym. *Utricularia nayarii* has a narrower distribution than *U. uliginosa* and can be distinguished by its thick, multi-nerved leaves (*vs*. thin, 3-nerved leaves in *U. uliginosa*), longer pedicels than the calyx lobes (*vs*. shorter or equal), unequal calyx lobes with the upper lobe always shorter than the lower (*vs*. sub-equal with the upper lobe always larger than the lower), an elliptic upper calyx lobe with a cuspidate apex (*vs*. widely ovate with an acute apex), a bi-gibbous lower lip of the corolla (*vs*. gibbous), and a flat periclinal wall of the seed testa (*vs*. deeply concave). Based on these characteristics, *U. nayarii* is treated here as a distinct species.

**10. Utricularia polygaloides** Edgew., Proc. Linn. Soc. London 1(34): 351. 1847; R.K.Basak, Bull. Bot. Surv. India 17: 103. 1975, Taxon 25(1): 189. 1976; N.Rani & K.M.Matthew in K.M.Matthew (ed.), Fl. Tamilnadu Carnatic 3(1): 1118. t. 86f. 1983;

D.M.Verma in D.M.Verma *et al.* (eds.), Fl. Raipur, Durg & Rajnandagaon 267. 1985; K.K.N.Nair & M.P.Nayar, Fl. Courtallum 2: 304. 1987; V.Chandras. in A.N.Henry *et al*. (eds.), Fl. Tamil Nadu Ind., Ser I: Analysis 2: 130. 1987; P.Taylor, Gen. *Utricularia* 359. t. 102. 1989; Janarth. & A.N.Henry, Bladerworts India 79. t. 22. 1992; K.M.Matthew, Excurs. Fl. Central Tamilnadu (repr. ed.) 358. 1995; Moulali in Pull. & Moulali (eds.), Fl. Andhra Pradesh 2: 677. 1997; R.C.Srivast. in Mudgal *et al*. (eds.), Fl. Madhya Pradesh, 2: 254. 1997; L.K.Banerjee & T.A.Rao, Fl. Mahanadi Delta, Orissa 226. 2001; N.P.Singh *et al*., Fl. Bihar, Analysis 367. 2001; P.Umam. & P.Daniel, Fl. Gulf Mannar South India 317: 2001; B.Suryanarayana & A.Sreenivasa Rao, Fl. Nellore Dist. 369. 2002; K.K.Khanna *et al*., Florsit. Diversity Chhattisgarh 329. 2005; Sunil & Sivad., Fl. Alappuzha Dist. 519. 2009; R.Ansari *et al*., Aquatic Wetland Fl. Kerala: Fl. Pl. 522. 2016; S.K.Mandal & Bhaumik, in Lakshmin. *et al*. (eds.), Fl. West Bengal 4: 145. 2019. *Neotype* (designated by Basak, 1976): INDIA, **West Bengal**, Burdwan, January 1837, *Skepwith s.n*. (CAL0000019122!). **Figs. 75–77**

*Utricularia caerulea* L. var. *stricticaulis* Koeing ex Oliv., J. Proc. Linn. Soc., Bot. 3: 181. 1859. *pro. syn*.

*Utricularia stricticaulis* **(**K.D.Koenig ex Oliv.) Stapf ex Gamble, Fl. Madras 2: 981. 1924; V.Abraham & Subr., Proc. Indian Acad. Sci., 62: 100. 1965; H.O.Saxena, J. Bombay Nat. Hist. Soc. 70(1): 233. 1973. *Utricularia reticulata* Sm. var. *stricticaulis* K.D.Koenig ex Oliv., J. Proc. Linn. Soc., Bot. 3: 180. 1859. *p.p., excl. syn. U. uliginosa* Vahl & *U. humilis* H.Heyne.

*Utricularia humilis auct. non* Vahl: Trimen, Handb. Fl. Ceylon 3: 269. 1895

*Utricularia reticulata* Sm. var. *uliginosa* C.B.Clarke in Hook.f. (ed.), Fl. Birt. India 4: 331. 1884; Prain, Bengal Pl. 2: 781. 1903

*Utricularia uliginosa auct. non* Vahl: Pull. *et al*., J. Bombay Nat. Hist. Soc. 84: 716. 1987

Annual, terrestrial to semi-aquatic herbs. Rhizoids up to 40 mm long, numerous on peduncle base, papillose, branched, branches 2–10 mm long. Stolons 20–35 × 0.15–0.25 mm, simple to branched, internodes up to 5 mm long, hyaline, minutely

papillose. Leaves arises from stolon nodes, numerous, mat-forming; petioles 3–4 mm long, flat, hyaline; lamina 1.5–4.5 × 0.15–0.35 mm, linear to strap-shaped, 1-nerved, green, acute-obtuse-rounded at apex. Traps numerous on stolons and petioles, rarely on lamina, dimorphic, globose; those on stolons large, 1.82–3.25 × 1.79–3.2 mm, stalk 0.7–0.9 mm long, distally thickened, distal end glandular hairy; those on lamina small, 0.42–0.78 × 0.34–0.72 mm, short stalked, stalk not thickened, 0.34–0.6 mm long; appendages subulate, incurved. Racemes erect, 6–20 (–30) cm long, 2–16 (–25)-flowered, simple to variously branched usually lax, in clusters; peduncles terete, 1–2.5 mm thick, stiff, glabrous, green, tapering at base, fleshy and thick then. Flowers 8–10 mm long; pedicels 2.8–4 × 1.07–1.55 mm, erect to slightly ascending, winged towards apex, horizontal in fruiting. Scales numerous, triangular, 2.48–2.86 × 1.3–1.42 mm, fertile, covering young buds, 3-nerved, truncate at base, acute at apex. Bracts ovate-triangular, 2.42–3.3 × 0.95–1.24 mm, 5-nerved, truncate at base, acute-bidentate at apex; bracteoles lanceolate, 1.4–1.6 × 0.2–0.28 mm, 1-nerved, acute at apex. Calyx lobes sub-equal, accrescent, (8–10 × 4.5–6.5 mm in fruiting), green; upper lobe ovate-widely ovate, 6–7.25 × 3.5–3.85 mm, 14–16-nerved, acute-bidentate at apex; lower lobe ovate to widely ovate, 5.7–6.75 × 3.4–4.15 mm, 12-nerved, acute to acuminate at apex. Corolla usually deep blue to violet, rarely pink or pure white; upper lip oblong, 3.25–3.82 × 2.45–2.95 mm, shorter than equalling to length of upper calyx lobe, hairy at lower margin, constricted at middle, blue with deep blue streaks, broader above the constriction, obtuse-rounded at apex; lower lip widely elliptic, 4.74–5.75 × 3.95–4.5 mm, ciliate along throat margin, palate gibbous,

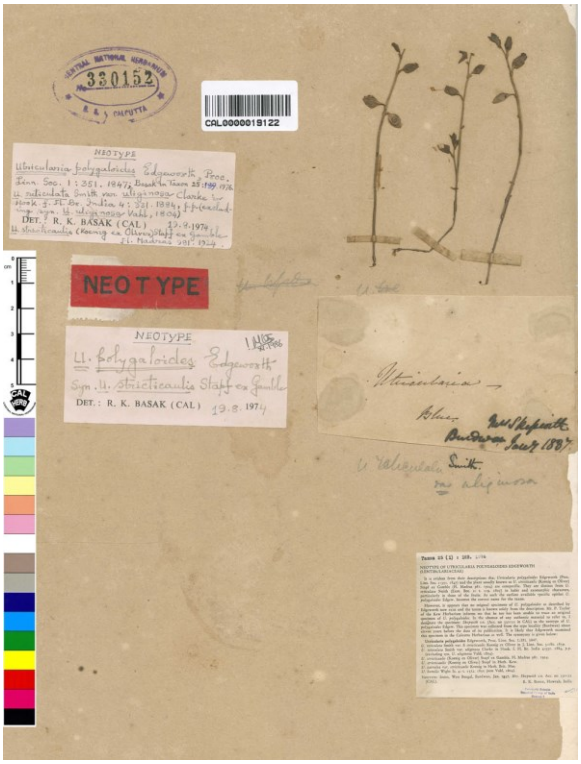


**Fig. 75.** Neotype of *Utricularia polygaloides* Edgew. [*Skepwith s.n.* (CAL0000019122)] *"© The Director, Botanical Survey of India, Kolkata"*.

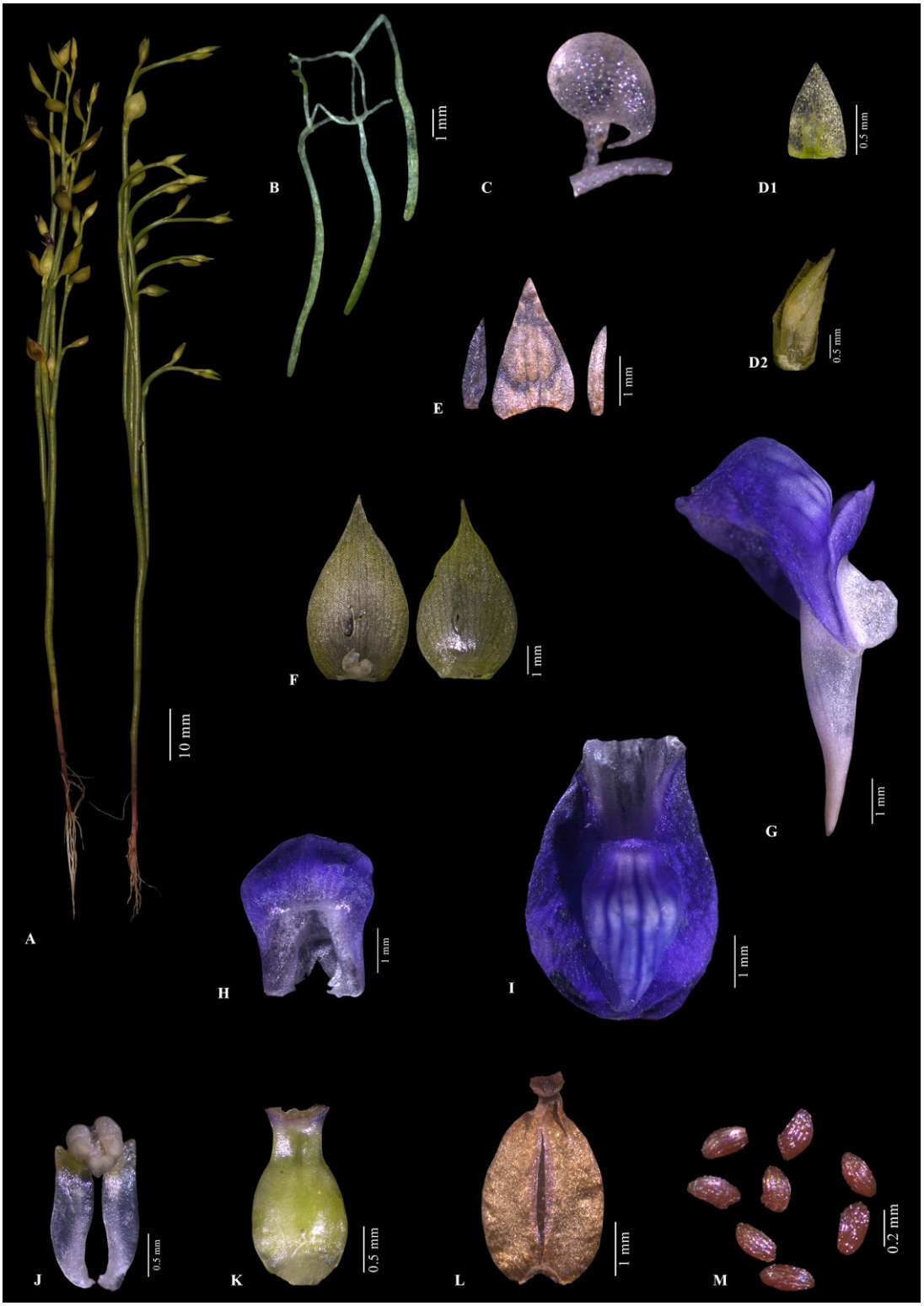


**Fig. 76.** *Utricularia polygaloides* Edgew.: **A.** Habit; **B.** Stolons bearing leaves; **C.** Trap; **D1 & D2.** Scales (**D2.** note the fertile scale covering a young bud); **E.** Bract and bracteoles; **F.** Calyx lobes; **G.** Corolla - lateral view; **H.** Upper lip of corolla; **I.** Lower lip of corolla; **J.** Stamens; **K.** Pistil; **L.** Capsule; **M.** Seeds.

**Fig. 77.** *Utricularia polygaloides* Edgew.: **A-I.** Habitat and habit; **J.** Raceme bearing young capsules and flowers - close up view; **K-M.** Flowers - close up view (**L & M.** note the pink and purple flowers); **N.** Peduncle bearing scales.

palate bluish white with deep blue streaks, clear blue then, margin entire, rarely involute, rounded at apex; spur conical, 3.4–4.45 mm long, erect, off white-pale blue, equal to or shorter than the lower calyx lobe in length, rounded-slightly emarginate at apex. Stamens 1.8–2.2 mm long; filaments strap-shaped, 1.6–1.83 × 0.4–0.52, hyaline, pale yellowish towards apex, curved at base; anther theca 0.62–0.8 mm long. Pistil 2–2.5 mm long; ovary ovoid-ellipsoid, 1.4–2 × 1.14–1.95 mm, ventrally compressed, green; style 0.4–0.52 mm long, thick; stigma bi-lipped, pale violet. Capsules ellipsoid, 3.25–4 × 2.3–3.25 mm, ventrally compressed, wall uniformly membranous, thickened along dehiscing margin, dehiscing by ventral and dorsal, longitudinal slit; placenta oblongoid, 2.5–2.65 × 1.7–1.8 mm. Seeds numerous, ellipsoid, 0.25–0.28 × 0.15–0.16 mm; surface striated with longitudinal ridges; hilum latero-terminal.

***Flowering & fruiting***: Flowering starts from early October to mid-March, while fruiting from the end of October to March. Peak flowering is observed from December to January.

***Habitat***: It generally prefers wet, loose, sandy soils, swamps, and abandoned paddy fields at elevations ranging from 10 to 150 m, usually in association with *U. bifida*, *U. caerulea*, *U. hirta*, *U. minutissima*, *Burmannia coelestis* (Burmanniaceae); *Drosera burmanni*, *D. indica* (both Droseraceae); *Eriocaulon* spp. (Eriocaulaceae), *Murdannia striatipetala*, *M. vaginata* (both Commelinaceae), *Rhamphicarpa* sp. (Orobanchaceae), *Rotala* sp. (Lythraceae) and some sedges and grasses (Fig. 77).

***Distribution:*** Endemic to Peninsular India and Sri Lanka (Fig. 58).

***Specimens examined***: INDIA, Madras, Paddy fields, *s.loc.*, March 1883, *s.coll. s.n.* (MH00126258). **Andhra Pradesh**, Ananathapur district, Garudakona, 350 m, 21.12.1982, *T. Pullaiah* 925 (MH00126294); Chittoor district, Chandragiri Fort, ± 250 m, 04.02.1989, *D. Rangacharyulu* 2275 (MH00126295); Kailasakona, 450 m, 26.06.1969, *G.V. Subba Rao* 32023 (MH00126288, MH00126289); Cuddapah district, Balapalle, 250 m, 23.02.1963, *J.L. Ellis* 15772 (MH00126293, CAL); Kurnool district, Sunnipenta, Srisailam, 550 m, 15.07.1963, *J.L. Ellis* 15772 (CAL); *Ibid.*, Nallamalais, 450 m, 21.10.1964, *J.L. Ellis* 22128 (L.2525174, L.2828174 digital images, MH00126291); *Ibid.*,

550 m, 15.07.1963, *J.L. Ellis* 16893 (MH00126290); Nellore district, Tada, 13.03.1901, *Bourne* 2158 (MH00126292, CAL). **Karnataka**, Maisor & Carnatic, Regio. trop., *s.loc.*, *s.d.*, *G. Thomson s.n.* (U.1360030 digital image); Bangalore district, way to Bannerghatta, Behind Dynashram, 02.12.1978, *C.J. Saldanha & P. Sreenath* KPF4848 (JCB). **Kerala**, Thiruvananthapuram, Forest near Bonacaud Estate, 500 m, 09.10.1973, *J. Joseph* 44649 (MH00126242, MH00126243). **Odisha**, Ganjam district, Chatiapur, December 1889, *J.S. Gamble* 21561 (CAL, DD); Gopalpur, 19.12.1889, *David Prain s.n.* (CAL); Puri district, Puri Coast, 02.12.1965, *W.A. Rao* 5697; *Ibid.*, 31.10.1967, *A.K. Mukherjee* 6086 (CAL). **Tamil Nadu**, Chengalpattu district, Kambakkam Hills, 06.05.1913, *s.coll.* 8949 (MH00126257); Sunnambukulam, Paddy fields near Sea shore, 10.01.1986, *M.K. Janarthanam* 82973 (BSID0012647); Thiruporur R.F., 01.02.1976, *A.N. Henry* 47144 (MH00126253, MH00126254); Vandalur, 01.02.1915, *s.coll.* 11502 (MH00126807); near Vennangupattu, ± 10 m, 08.02.1986, *D. Narasimhan* 974 (MH00126255); Kallakurichi district, Kattumannar-gudi, Ulundurpet near Forest rest house, 60 m, 30.01.1980, *K.M. Matthew* 26208 (RHT044716); Pulloorkadu, Forest residence, 30.12.1981, *K.M. Matthew*, *S.J. Britto & N. Rani* 28790 (RHT044702); *Ibid.*, Vridachalam, 01.02.1980, *K.M. Matthew* 26280 (RHT044717); Kancheepuram district, Mahabalipuram (Mamallapuram), 5 Ratha's area, 10 m, 05.03.2000, *K.T. Augustine* 61881 (RHT044722); *Ibid.*, 07.02.2003, *K.M. Matthew* 74545 (RHT044727); Othiyur, (Sacred groves), 10 m, 04.03.2000, *K.T. Augustine* 61851 (RHT044721); Puzhuthivakkam, 4 km before Vedanthangal, 25 m, 31.01.2000, *K.M. Matthew & J. Jayanthi* 70969 (RHT044723); Krishnagiri district, Dharmapuri, Denkanikotta, Devarbetta, near Village pond, 900 m, 11.12.1980, *T.S. Jayaseelan* 26399 (A01977182 digital image, RHT044715); Nagapattinam district, Puduthurai, 11.02.1931, *V. Narayanasamy* 5214 (MH00126245, MH00126803); North Arcot district, Veerambakkam, 16.01.1986, *M.K. Janarthanam* 82976 (BSID0012646, MH00126262, MH00126263); Pudukkottai district, Narthamalai (Bommadimalai), 100 m, 24.03.1984, *K.M. Matthew* 29932 (C.375028, RHT044714); Narthamalai, ± 138 feet, 11.12.2022, *M.P. Krishnapriya* 186037 (CALI197373, CALI197374, CALI19735, CALI197376, CALI199584); *Ibid.*, ± 131 feet, 12.12.2022, *M.P. Krishnapriya* 186041 (CALI197377, CALI197378, CALI197379, CALI197380, CALI197381); *Ibid.*, way to Vijayalaya Choleswar Temple, ± 184 feet, 11.12.2022, *M.P. Krishnapriya* 186033

(CALI197382, CALI197383, CALI197384, CALI197385, CALI197386); Sittannavasal, 100 m, 02.02.1978, *K. Ramamurthy* 53743 (CAL, MH00126249, MH00126250); Ramnathapuram district, Sivaganga, Esani forest, 100 m, 16.12.1964, *K. Ramamurthy* 22730 (MH00126246, MH00126247); Vani, ± 50 m, 09.02.1987, *V. Balasubramaniam* 1242 (MH00126248); South Arcot district, Karai R.F.- Ginger, 150 m, 20.10.1978, *K. Ramamurthy* 52866 (MH00126260, MH00126261); Marakkanam to Kurumapuram R.F., 10 m, 17.02.1979, *K. K. Ramamurthy* 60251 (MH00126259, MH00126799); Tanjavur district, Ammachathram, 30.01.1969, *K.M. Matthew* 9893 (RHT044713); Thiruvallur district, Kattuppalli near Ennore port wall, 05.02.2003, *K.M. Matthew* 74485 (RHT044726); Kattuppalli-Chindamani Eswaran Koil, 10.12.2001, *K.M. Matthew* 73518 (RHT044725); Tenkasi district, Courtallum, 900 m, 09.11.1984, *K.K. Jayaprabha* 5134 (CALI141410); *Ibid*., 700 m, 18.11.1988, *N.B. Sreedevi* 944 (CALI141506); *Ibid*., 750 m, 19.11.1988, *V. Geetha* 1746 (CALI141536); Viluppuram district, Kaliveli tank, 3 km from EC road by Koolimedu, 01.02.2000, *S. Perianayagam* 71016 (RHT044724); Odiyur, 10 m, 23.02.1999, *K.M. Matthew & K.T. Augustine* 60448 (RHT044719); Tonnadu Malai, 250 m, 10.01.1999, *K.M. Matthew & K.T. Augustine* 60291 (RHT044718); *s.loc*., *s.d*., *Herb. Heyne Wallich N.* 1495 (BR0000031021883 digital image). **West Bengal**, Birbhum district, Baidyanathpur Forest, 24.10.1970, *R.K. Basak* 1532 (CAL); Charicha Forest, 05.11.1969, *R.K. Basak* 1232 (CAL); Nimdaspur, Charicha, 23.12.1969, *R.K. Basak* 1323; Hooghly district, Goghat, 23.11.1961, *P. Hazra* 139 (CAL). SRI LANKA, *s.loc.*, 1799, *M. Vahl s.n.* (P00657240 digital image); **North-Central Province**, Anuradhapura district, Wilpattu, ± 1000 m, 26.08.1970, *L.H. Cramer* 3159 (US03217013, L.2828215 digital images); Wilpattu National Park, Kudapathessa, 24.03.1968, *Tetsuo Koyama* 13381 (NY03858299 digital image); 3 Miles west of office Wilapttu National Park, 10 feet, 14.07.1970, *W. Meijer* 350 (US03217019, L.2828173 digital images); *Ibid*., Mahapathessa, 24.03.1968, *Tetsuo Koyama* 13390 (US03217011 digital image); along banks of Mahapathessa, 14.07.1970, *L.H. Cramer* 3041 (US03217012 digital image). **North-Western Province**, Kurunegala district, Bingiriya, 23.07.1973, *A.H.M. Jayasuriya* 1242 (US03217010 digital image); Kurunegala, 18.07.1970, *L.H. Cramer* 3036 (US03217017, RSA0229780 digital images); Wenduru Wewa, 18.07.1970, *L.H. Cramer* 3058 (US03217016 digital image). **Uva Province**, Ruhuna (Yala) National Park, Block I. Uraniya near Buttawa, 28.01.1968,

*D. Mueller-Dombois & R.G. Cooray* 68012811 (US03217009 digital image). **Western Province**, Colombo district, Kotadeniya, in abandoned paddy field beside Negombo road, 21.09.1970, *L.H. Cramer* 3205 (US03217018 digital image).

***Conservation status***: *Utricularia polygaloides* is primarily distributed in the eastern part of India and Sri Lanka. Herbarium studies revealed that it was once a common species in paddy fields, fallow lands and sandy plains, especially in Andhra Pradesh, Tamil Nadu, and West Bengal. However, the reduction in cultivated fields, increased use of insecticides and pesticides in agricultural lands, as well as construction, quarrying, and mining for sand and rocks, have led to the degradation of its habitats. Considering its distribution and the threats, the status is assessed as Near Threatened (NT).

***Notes***: *Utricularia polygaloides* is quite a distinct species and is unlikely to be mistaken for any other *Utricularia*. Its inflorescence is stiff, fleshy, and shiny, simple to variously branched, with a peduncle that tapers at the base (Figs. 76 & 77). It is characterized by membranous, 1-nerved linear leaves, horizontal pedicels, ventrally compressed capsules, and striated periclinal wall of seed testa with longitudinal ridges (Fig. 177K). Earlier, it was treated as a variation of *U. reticulata*, but the erect, stiff, up to 30 cm long inflorescence (*vs*. vigorously twining, wiry, up to 100 cm long inflorescence of *U. reticulata*), small flowers of 8–10 mm long (*vs*. large flowers of 12–15 (–20) mm long), the short, horizontal fruiting pedicel (*vs*. the long, reflexed) further delimit it apart.

Herbarium consultation reveals that *U. polygaloides* is often mistaken for *U. uliginosa,* but the differences in the nature of leaves (1-nerved linear *vs*. 3-nerved strap-shaped), peduncle (stiff and tapering towards base *vs*. flexible and not tapering) and seed testa (striated with longitudinal ridges *vs*. smooth) clearly distinguish the two species. The variety *U. reticulata* var. *uliginosa* C.B.Clarke (1884), which was earlier treated conspecific with *U. uliginosa*, shares more affinities with *U. polygaloides*, especially in characteristics such as numerous pedicels, acute calyx lobes, and a conic, straight spur as described in the protologue.

**11. Utricularia ponmudica** Krishnapriya & Nampy ***sp. nov.*** *Type*: INDIA, **Kerala,** Thiruvananthapuram district, Ponmudi Hills, Seethatheertham, ± 940 m, 02.11.2021, *M.P. Krishnapriya* 177228 (holo, CALI!). **Figs. 78–80**

**Diagnosis**: *Utricularia ponmudica sp. nov.* resembles *U. smithiana* Wight but can be easily distinguished by its thin leaves with an acute to obtuse apex (*vs*. thick fleshy leaves with a rounded apex), an erect and fleshy peduncle (*vs*. flexuous and filiform), shorter pedicels (2.5–5 mm *vs*. 10–15 mm long), a horizontal fruiting pedicel (*vs*. erect one), bi-gibbous palate of the corolla (*vs*. gibbous); a spur that is either shorter than or just exceed the lower calyx lobe (*vs*. spur about double the length).

Annual terrestrial to semi-aquatic herbs. Rhizoids a few, 5–20 mm, simple to branched, branches up to 5 mm long, tapering, papillose. Stolons numerous, 20–50 mm long, terete, simple to variously branched, hyaline, internodes up to 10 mm long, minutely papillose. Leaves numerous on stolons, mat forming; petiole flat, 1.5–4 mm long, hyaline to pale green; lamina spathulate to strap-shaped, 10–30 × 1.5–3 mm, sometimes wider at middle, 3-nerved, green, attenuate to narrowly cuneate at base, acute-obtuse at apex. Traps numerous on rhizoids, stolons and leaves, globose, 0.9–1.5 mm across; stalk 0.4–0.65 mm long, distally thickened, glandular hairy; mouth basal; appendages subulate, glandular hairy. Racemes erect, 10–26 (–40) mm long, 2–8 (–12)-flowered; peduncles angular, grooved on one side, 0.4–0.5 mm thick, stiff and woody. Scales a few, ovate, 1–1.2 × 0.5–0.6 mm, fertile, 1-nerved, green-greenish violet, truncate at base, acute at apex. Bracts widely ovate, 0.8–1.2 × 0.6–0.75 mm, 3-nerved, truncate at base, obtuse at apex; bracteoles subulate, 0.6–0.7 × 0.1–0.15 mm, 1-nerved, acute at apex. Flowers 8–11 mm long; pedicels 2.5–5 × 0.2–0.4 mm, erect at anthesis, dorsiventrally compressed, winged, horizontal in fruiting, green to greenish purple. Calyx lobes sub-equal, greenish blue; upper lobe widely ovate, 2.2–2.4 × 1.75–2 mm, acute at apex; lower lobe ovate, 2–2.2 × 1.45–1.5 mm, bi-tridentate at apex. Corolla colour varies from blue to purple or pink; upper lip oblong, 4.5–5 × 3.8–4 mm, longer and broader than upper calyx lobe, constricted below the middle, pale blue-lilac with deep blue streaks above the constriction, faint towards apex, rounded to emarginate at apex; lower lip more or less orbicular, 8.5–10 mm across,

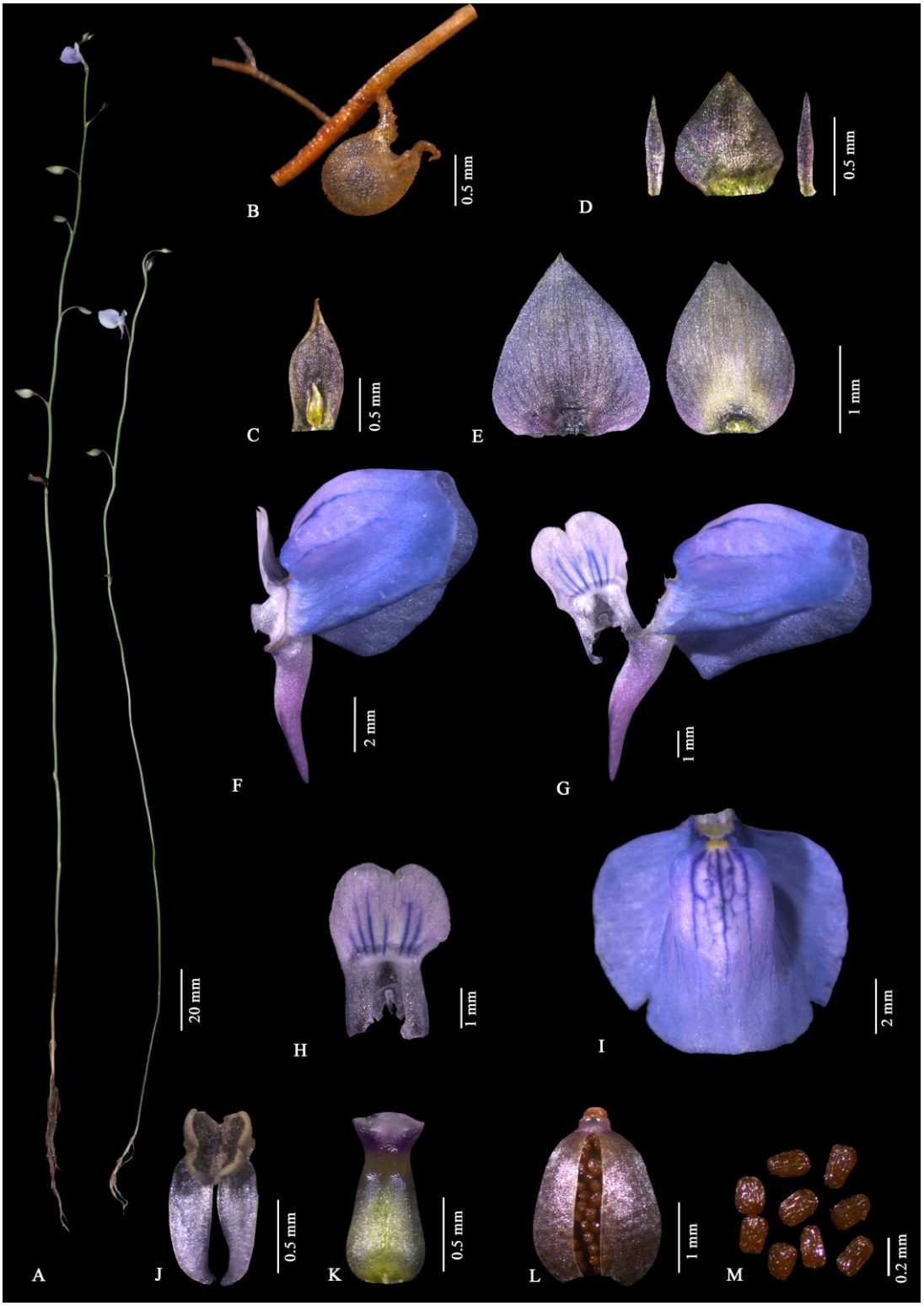


**Fig. 78.** *Utricularia ponmudica* Krishnapriya & Nampy *sp. nov.*: **A.** Habit; **B.** Trap on stolon; **C.** Scale (with young bud); **D.** Bract and bracteoles; **E.** Calyx lobes; **F.** Corolla - lateral view; **G.** Corolla- split opened; **H.** Upper lip of corolla; **I.** Lower lip of corolla; **J.** Stamens; **K.** Pistil; **L.** Capsule; **M.** Seeds.

**Fig. 79.** Habitat and habit of *Utricularia ponmudica* Krishnapriya & Nampy *sp. nov.*

ciliate along throat margin, yellow at throat, palate bi-gibbous, pale bluish or pinkish white with blue-pink reticulations, clear blue or pink then, margins entire, rounded at apex; spur conical, straight, equal to or just exceeds the length of lower calyx lobe, lilac to light purple, rounded at apex. Stamens 1–1.2 mm long; filaments strap-shaped, 0.7–1 × 0.2–0.3 mm, twisted at base, pale purple; anther theca up to 0.5 mm long. Pistil 1–1.25 mm long; ovary ovoid, 0.8–1 × 0.5–0.65 mm, bluish green; style 0.2–0.3 mm long, thick, greenish violet; stigma bi-lipped, deep purple; upper lip short, oblong, lower lip sub-orbicular, papillose out. Capsules ovoid, 2–2.4 × 1.85–2 mm, wall uniformly membranous, thickened along dehiscing margin, dehiscing by dorsal and ventral longitudinal slit; placenta ovoid, 1.4–1.5 mm long. Seeds numerous, oblongoid, 0.2–0.3 × 0.12–0.15 mm; hilum terminal.

***Flowering & fruiting***: Flowering starts from late October to mid-January, while fruiting takes place from early November to the end of January.

***Habitat***: Found in open, swampy soils or along stream margins, often in association with *Desmodium* sp. (Fabaceae), *Emilia sonchifolia* (L.) DC. (Asteraceae), *Eriocaulon* spp. (Eriocaulaceae), *Imaptiens* sp. (Balsaminaceae), *Hydrocotyle* sp. (Araliaceae), *Spermacoce* sp. (Rubiaceae), *Xyris* sp. (Xyridaceae) and some other grasses (Fig. 79).

***Distribution***: Hitherto found only in the Ponmudi Hills of Thiruvananthapuram district, Kerala (Fig. 65).

***Specimens examined***: INDIA, **Kerala**, Thiruvananthapuram district, Ponmudi Hills, Seethatheertham, ± 940 m, 28.11.2021, *M.P. Krishnapriya* 177250 (CALI); *Ibid*., 26.11.2023, *M.P. Krishnapriya* 186083 (CALI).

***Conservation status***: This species has been found only in the type locality, Seethatheertham, a tourist and pilgrim site located on Ponmudi Peak in the Thiruvananthapuram district of Kerala. Ponmudi lies in the southern stretch of the Western Ghats at an altitude of about 940–950 m, nestled between the hill stations of Sabarimala and Agasthyamala. The area features a paid trekking trail and a pilgrim site dedicated to the worship of Goddess "Sita". Seethatheertham is a dainty perennial stream originating from a swampy grass meadow.

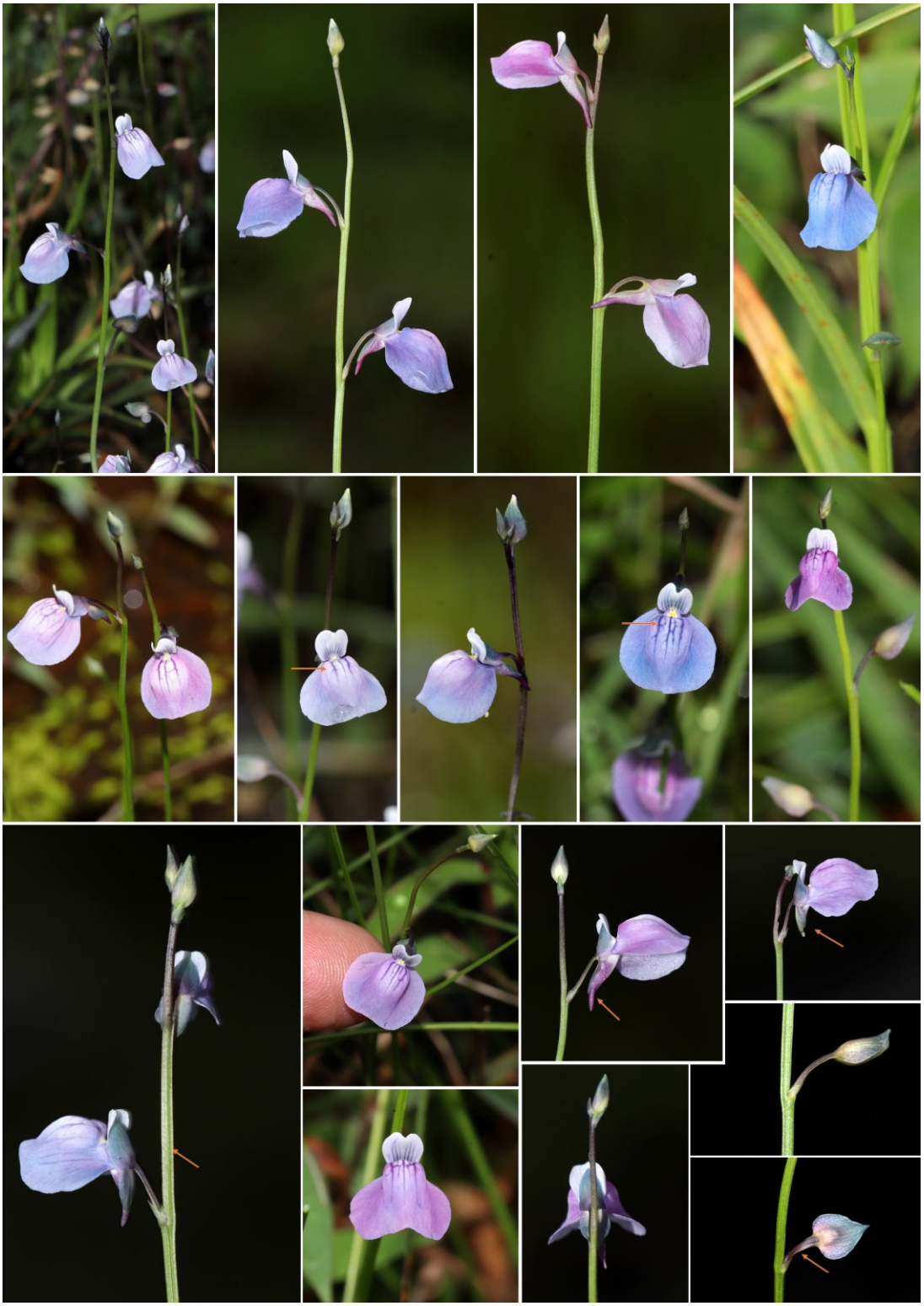

**Fig. 80.** Flower colour variations and corolla variations in *Utricularia ponmudica* Krishnapriya & Nampy *sp. nov.* (note the striation pattern of the palate and variations in the size of the spur).

During the Malayalam calendar month of 'Makaram', the Kani tribes from surrounding areas celebrate the "Pongala" festival near the stream by making stone fireplaces. *Utricularia ponmudica* grows along the margins of this stream and in the adjacent marshy grass meadows. Despite being a protected area under the forest department, human interferences such as trekking and religious rituals pose serious threats to the habitat. Considering the limited population and habitat threats, *U. ponmudica* is assessed as Critically Endangered (CR).

***Notes***: This species exhibits a range of corolla colours in the field, varying from pale to deep blue and pale pink to purple. Additionally, there is variation in the size of the spur, which may be equal to or just exceed the length of the lower calyx lobe in some materials (Fig. 80). It shows similarities to *U. uliginosa*, but can be distinguished by its large flowers, longer and wider upper lip of the corolla, bi-gibbous palate of the corolla, and horizontal fruiting pedicels.

**12. Utricularia praeterita** P.Taylor in K.M.Matthew (ed.), Fl. Tamilnadu Carnatic 3(1): 1120. t. 87. 1983; P.Taylor, Gen. *Utricularia* 321. t. 87. 1989; Janarth. & A.N.Henry, Bladderworts India 81. t. 23. 1992; S.D.Deshp. *et al*., Fl. Mahabaleshwar 1: 425. 1993; Londhe in N.P.Singh *et al.* (eds.), Fl. Maharashtra, Dicot. 2: 565. 2001; S.R.Yadav & Sardesai, Fl. Kolhapur Dist. 339. 2002; Kolte *et al*., Rheedea 29(3): 216. 2019. *Type*: INDIA, **Maharashtra**, Panchgani, Table land, 4400 feet, 23.08.1981, *P. Taylor* 18140 (holo, K [K000939701 digital image!]). **Figs. 81–83**

*Utricularia uliginosa auct. non* Vahl: A.K.Mukh., Fl. Pachmarhi & Bori Reserves 218. 1984

Annual terrestrial herbs. Rhizoids a few, up to 10 mm long, filiform, simple to branched, papillose. Stolons numerous on peduncle base, 30–50 mm long, 0.25–0.3 mm thick, terete, profusely branched, internodes 4–6 mm long. Leaves numerous on stolons, solitary at each node; petioles 2–6 mm long, flat, hyaline; lamina obovate to widely obovate, 2–3.5 × 1.5–2.5 mm, 3-nerved, nerves branched further, attenuate to cuneate at base, rounded at apex. Traps numerous on stolons and leaves, sub-globose, 1–1.5 mm across; stalk 0.5–0.6 mm long, distally thickened, glandular hairy;

mouth basal; appendages subulate, incurved, glandular hairy. Racemes erect, up to 15 cm long, 2–6-flowered, lax; peduncles angular, grooved on one side, 0.6–0.8 mm thick, green. Flowers up to 8 mm long; pedicels 3–4 × 0.5–0.8 mm, erect at anthesis, dorsiventrally flattened, winged, purplish green, accrescent, 6-7 mm in fruit, spreading in fruiting. Scales a few, ovate, 1.2–2 × 0.6–0.85 mm, 1-nerved, acute at apex. Bracts widely ovate, 1.8–2.25 × 0.8–1.1 mm, 3-nerved, truncate at base, acute at apex; bracteoles lanceolate, 1.2–1.5 × 0.2–0.3 mm, 1-nerved, narrowly acute at apex. Calyx lobes sub-equal, bluish green; upper lobe widely ovate, 3–3.25 × 2.3–2.85 mm, 14-nerved, acute-obtuse at apex; lower lobe ovate-elliptic, 2.7–3.2 × 2–2.65 mm, 12-nerved, bi-dentate at apex. Corolla deep blue to purple rarely pink or pure white; upper lip oblong-obovate, 4.5–5.5 × 2–2.75 mm, longer than the upper calyx lobe, hairy along lower margin, constricted just below the middle, pale blue with blue steaks above the constriction, faint towards apex, rounded to emarginate at apex; lower lip widely elliptic to sub-orbicular, 5.7–6 × 4.5–5 mm, ciliate along throat margin, yellow at throat, palate gibbous, palate bluish white with blue striations, clear blue then, rounded at apex; spur conical, 3.5–5 mm long, light purple to mauve, rounded or obscurely 3-lobed at apex. Stamens 1.3–1.4 mm long; filaments strap-shaped, 1–1.2 × 0.3–0.4 mm, hyaline, twisted at base; anther theca up to 0.4 mm long, pale purple. Pistil 1.5–1.65 mm long; ovary oblongoid, 0.85–1 × 0.6–0.8 mm, purplish green; style 0.3–0.35 mm long, pale purple; stigma bi-lipped. Capsules ovoid, 3–3.5 mm long, wall uniformly membranous, dehiscing by dorsal and ventral longitudinal slit; placenta ovoid, 1.2–1.5 mm long. Seeds numerous, ellipsoid, 0.32–0.35 × 0.2–0.22 mm; surface smooth; hilum latero-terminal.

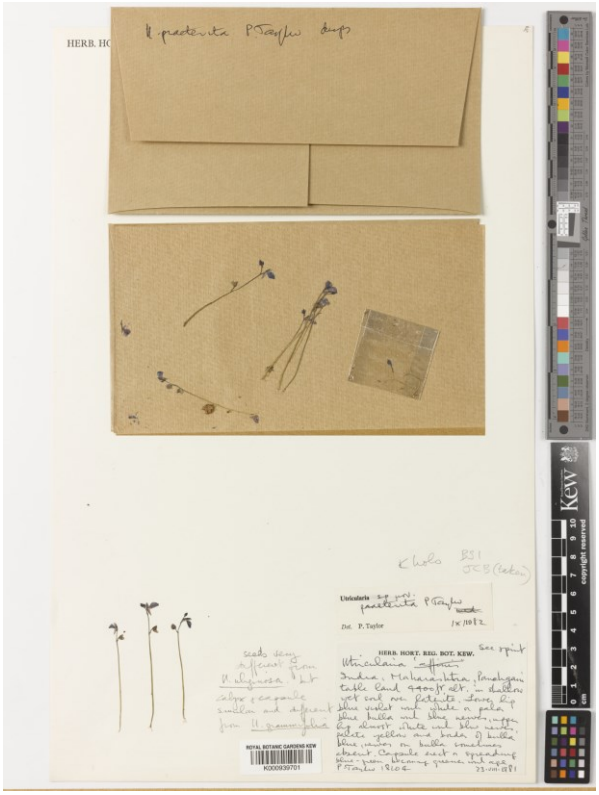


**Fig. 81.** Type of *Utricularia praeterita* P.Taylor [*P. Taylor* 18140 (K000939701)] "© *Board of Trustees of the Royal Botanic Gardens, Kew*".

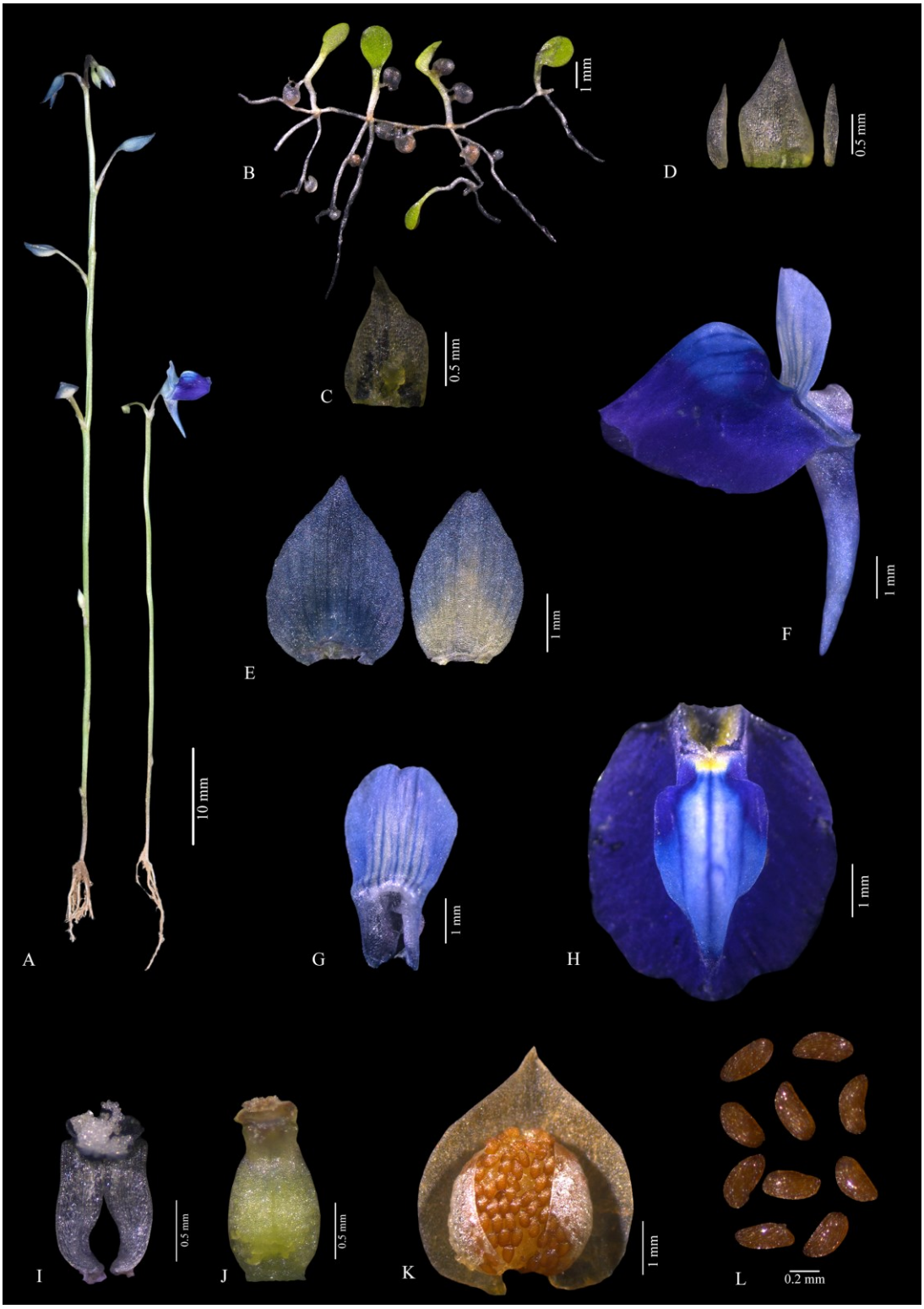


**Fig. 82.** *Utricularia praeterita* P.Taylor: **A.** Habit; **B.** Stolons with rhizoids, leaves and traps; **C.** Scale; **D.** Bract and bracteoles; **E.** Calyx lobes; **F.** Corolla - lateral view; **G.** Upper lip of corolla; **H.** Lower lip of corolla; **I.** Stamens; **J.** Pistil; **K.** Capsule; **L.** Seeds.

**Fig. 83.** *Utricularia praeterita* P.Taylor: Habitat and habit.

***Flowering & fruiting***: Flowering occurs from mid-August to late November, with fruiting taking place from early September till December.

***Habitat***: *Utricularia praeterita* usually grows in soil-filled depressions and along streamlet margins on open lateritic plateaus, as well as in soil covered rocky patches, often in association with *U. albocaerulea*, *U. purpurascens*, *Murdannia brownii* Nandikar & Gurav, *M. versicolor* G.Bruckn. (both Commelinaceae), *Eriocaulon* spp. (Eriocaulaceae), *Exacum lawii* C.B.Clarke (Gentianaceae), *Arundinella* sp., *Isachne* sp., *Jansenella griffithiana* (all Poaceae), *Rhamphicarpa* sp. (Orobanchaceae), *Rotala* spp. (Lythraceae) and other grasses. It also inhabits in the swampy grasslands above the rocky outcrops in high altitude cool places above 1200 m, where it blooms till December (Fig. 83).

***Distribution***: Endemic to Peninsular India (Fig. 84).

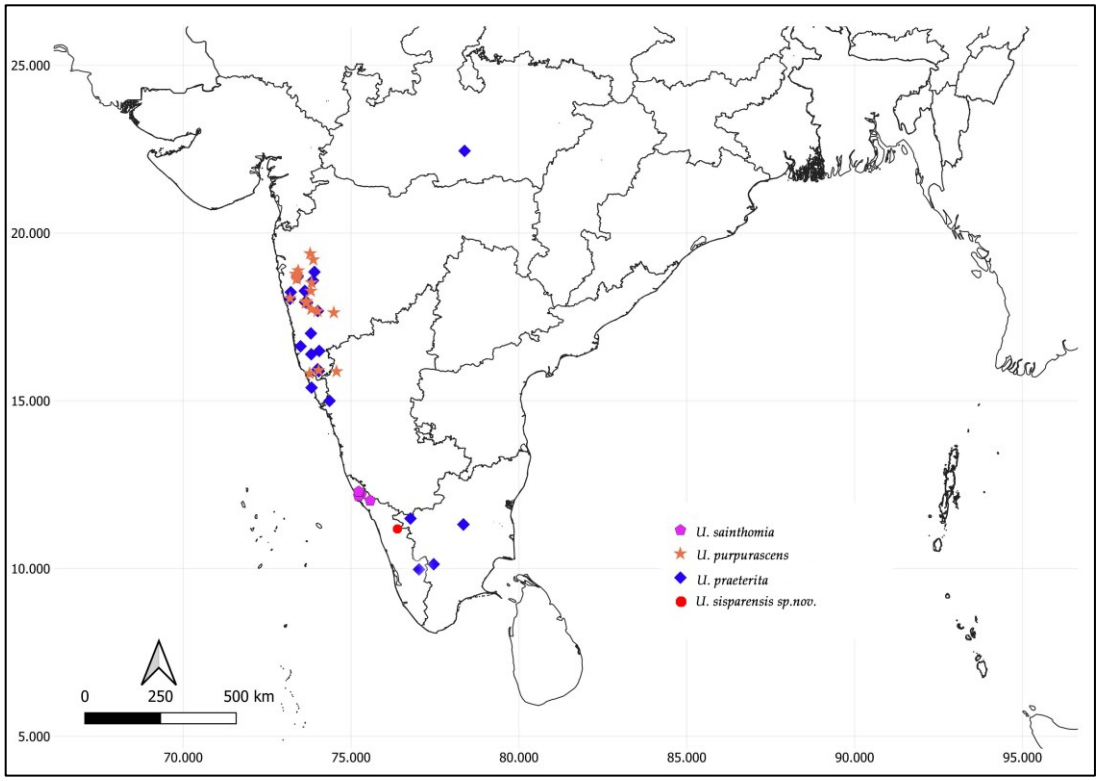


**Fig. 84.** Distribution of *Utricularia praeterita* P.Taylor; *U. purpurascens* J.Graham; *U. sainthomia* P.Biju *et al.* and *U. sisparensis* Krishnapriya & Nampy *sp. nov.*

***Specimens examined***: INDIA, **Goa**, North Goa district, Porvorim, 04.09.1965, *John Cherian* 88550 (BSI). **Kerala**, Idukki district, Pettimudi grassland, ± 1800 m, 29.12.2019, *M.P. Krishnapriya & Santhosh Nampy* 164343 (CALI). **Madhya Pradesh**, Hoshangabad district, Mahadeo Hills, way to Dhupgarh, ± 1095 m, 09.11.2021, *M.P. Krishnapriya* 177230 (CALI). **Maharashtra**, Pune district, Ambavane road, INS Sivaji, 12.10.1985, *M.K. Janarthanam* 82957 (MH00126312, MH00126313); Lonavala, Bushy Hills, 13.10.1985, *M.K. Janarthanam* 82960 (BSID0012682, MH00126314, MH00126315); Torna Fort, 15.09.2018, *M.P. Krishnapriya* 168007 (CALI); Varshav Temple, 11.10.1985, *M.K. Janarthanam* 82954 (BSID0012684, MH00126310, MH00126311); Ratnagiri district, Rajapur-Padve road, ± 65 m, 11.08.2022, *M.P. Krishnapriya* 177283 (CALI); Satara district, Mahabaleshwar, Lingmala Falls, 08.10.1985, *M.K. Janarthanam* 82947 (BSID0012688, MH00126305); *Ibid*., 08.10.1985, *M.K. Janarthanam* 82950 (BSID0012687, MH00126308, MH00126309); Ludwig Point, 16.09.2018, *M.P. Krishnapriya* 168012 (CALI); along a streamlet near Venna Lake, 09.10.1985, *M.K. Janarthanam* 82952 (BSID0012685, MH00126306, MH001263); Venna Lake, opposite hillock, 16.09.2018, *M.P. Krishnapriya* 168009; Sindhudurg district, Amboli, near Police station, ± 640 m, 10.08.2022 *M.P. Krishnapriya* 177274; *Ibid*., 28.09.2023, *M.P. Krishnapriya* 186071 (CALI); Chaukul, ± 740 m, 22.09.2018, *M.P. Krishnapriya & Santhosh Nampy* 168026 (CALI199588); *Ibid*., 28.09.2023, *M.P. Krishnapriya* 186073; Chaukul gav road, ± 745 m, 28.09.2023, *M.P. Krishnapriya* 186074 (CALI); Phonda ghat, 20.09.2018, *M.P. Krishnapriya & Santhosh Nampy* 168020 (CALI). **Tamil Nadu**, Salem district, Namakkal, Kolli Hills, Solakkadu, Thannipparuthi, 16.10.1978, *K.M. Matthew*, *C. Manoharan & Alamelu* 18284 (RHT044731); *Ibid*., 1250 m, 19.12.1979, *K.M. Matthew* 25210 (RHT044732); Sothupparai, upstream, 1200 m, 22.12.1976, *K.M. Matthew* 25368 (RHT044733); The Nilgiris district, Ebanad, Koil Betta slopes, 1725 m, 10.09.1970, *G.V. Subba Rao* 36613 (MH00126303).

***Conservation status***: The habitats of *U. praeterita* pose serious threat due to developmental activities, construction, commercial tourism, grazing, and other human induced factors. The species has an AOO of 108 km$^2$ and EOO of 468065.379 km$^2$. Based on current data, the species is assessed as Vulnerable (VU B1b(ii,iii,iv)+2b(ii,iii,iv)+c(ii,iii)).

***Notes***: *Utricularia praeterita* is quite distinct by its striking flower colour, which resembles peacock blue. It is often confused with *U. uliginosa*, but can be differentiated by the upper lip of the corolla exceeds the upper calyx lobe (*vs*. being shorter or equal in *U. uliginosa*), ellipsoid seeds (*vs*. oblongoid), the elongate testa cells (*vs*. reticulate), and slightly concave periclinal wall (*vs*. deeply concave) (Figs. 173O &177L).

**13. Utricularia purpurascens** J.Graham, Cat. Bomb. Pl. 165. 1839; V.Chandras. in A.N.Henry *et al*. (eds.), Fl. Tamil Nadu Ind., Ser I: Analysis 2: 130. 1987; Janarth. & A.N.Henry, J. Econ. Taxon. Bot. 10: 245. 1987; Janarth. & A.N.Henry, Bladderworts India 85. t. 25. 1992; Londhe in N.P.Singh *et al.* (eds.), Fl. Maharashtra, Dicot. 2: 566. 2001; S.R.Yadav & Sardesai, Fl. Kolhapur Dist. 339. 2002; Datar & Lakshmin., Fl. Bhagwan Mahavir (Molem) Natl. Park Adjoining, Goa 176. 2013; Nayar *et al*., Fl. Pl. W. Ghats India 1: 586. 2014; Singh *et al*., Endemic Vasc. Pl. India 195. 2015; Kavade & Deokule, Fl. Chandoli Natl. Park 264. 2015. *Neotype* (designated by Janarthanam, 1987): INDIA, **Maharashtra**, Satara district, Mahabaleshwar, near Pratapsingh Park, 05.10.1985, *M.K. Janarthanam* 82941(MH00002433!). **Figs. 85–88**

*Utricularia arcuata* Wight, Hooker's J. Bot. Kew Gard. Misc. 1: 372. 1849, Icon. Pl. Ind. Orient. 4(4): 9. t. 1577. f. 1. 1850; Oliv., J. Proc. Linn. Soc. Bot. 3: 178. 1858; Dalzell & Gibson, Bombay Fl. 136. 1861; Drury, Handb. Ind. Fl. 2: 121. 1866; C.B.Clarke in Hook.f. (ed.), Fl. Brit. India 4: 330. 1884; T.Cooke, Fl. Bombay 2: 318. 1905; Gamble, Fl. Madras 2: 981. 1924; Santapau, J. Bombay Nat. Hist. Soc. 49(2): 218. 1950, Fl. Khandala (3rd ed.) 188. 1967; Bole & M.R.Almeida, J. Bombay Nat. Hist. Soc. 82: 72. 1985; M.Ahmed. & M.P.Nayar, Endemic Pl. Ind. 1: 154. 1986; R.S.Rao, Fl. Goa, Diu, Daman, Dadra & Nagarhaveli 2: 302. 1986; P.Taylor, Gen. *Utricularia* 368. t. 105. 1989; S.M.Almeida, Fl. Savantwadi 2: 307. 1990; S.D.Deshp. *et al*., Fl. Mahabaleshwar 1: 424. 1993; S.G.Pradhan & N.P.Singh, Fl. Ahmednagar Dist. 406. 1999. *Type*: INDIA, **Karnataka**, Belgaum, *s.d*., *J.S. Law* 73 (holo K [K000939696 digital image!])

*Utricularia ogmosperrna* Blatt. & McCann, J. Indian Bot. Soc. 10: 123. 1931 (as *U. ogmosperma*); Santapau, J. Bombay Nat. Hist. Soc. 49(2): 221. 1950. *Type*: INDIA, **Maharashtra**, Panchgani, August 1925, *E. Blatter* P70 (holo BLAT!)

*Utricularia albocaerulea auct. non* Dalzell: Nairne, Fl. Pl. W. India 211. 1894

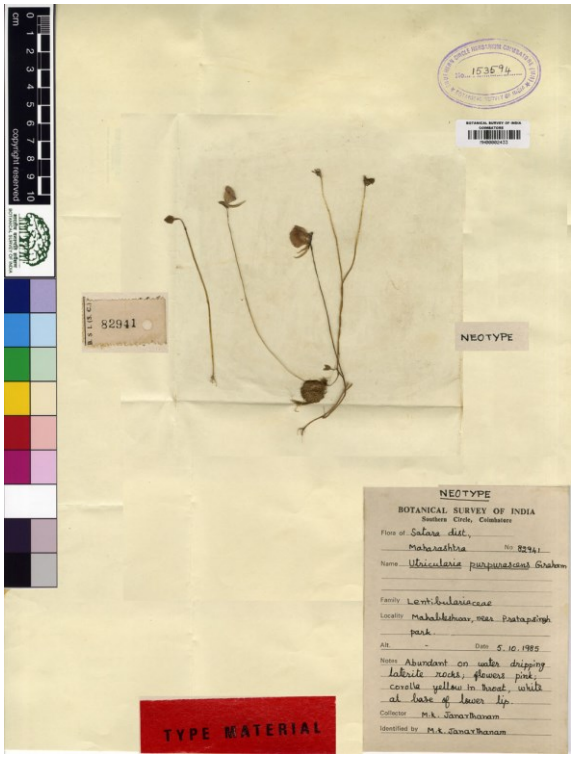


**Fig. 85.** Neotype of *Utricularia purpurascens* J.Graham [*M.K. Janarthanam* 82941 (MH00002433)] "© *The Director, Botanical Survey of India, Kolkata*".

Annual, terrestrial herbs. Rhizoids numerous on peduncle base, up to 5–15 mm long, 0.2–0.3 mm thick, tapering, capillary, branched, papillose. Stolons up to 20 mm long, 0.8–1.5 mm thick, sparsely branched, glabrous. Leaves numerous on stolons, solitary in each node; petioles 2.5–8 mm long, hyaline-pale green; lamina spathulate, 6.4–8 × 1.4–1.6 mm, 1–3-nerved, cuneate at base, rounded at apex. Traps numerous on stolons and lamina, globose, 1–1.35 mm across; stalk 0.5–0.6 mm long, uniform; mouth basal; appendages subulate, incurved, glandular hairy. Racemes erect, 15–25 cm long, 1–6-flowered, simple or branched; peduncles angular, grooved on one side, 0.8–1.5 mm thick, winged, glabrous. Scales a few, triangular, 2.5–3.2 × 2–2.5 mm, 3-nerved, fertile, purplish green, truncate at base, acute-obtuse at apex. Bracts widely triangular, 2.5–3.5 × 2.2–3 mm, 5-nerved, purplish green, truncate at base, acuminate or rarely bi-dentate at apex; bracteoles lanceolate, 1.8–2.8 × 0.3–0.6 mm, 1-nerved, acute-acuminate at apex. Flowers 12–15 mm long; pedicels 7.5–10 × 1–1.2 mm, ascending to slightly reflexed at anthesis, dorsiventrally compressed, winged, purplish green, reflexed in fruiting. Calyx lobes sub-equal, accrescent, (5–7 × 4.5–6.5 in fruiting); upper lobe widely ovate, 3.5–4.7 × 3.25–4.3 mm, 16–18-nerved, greenish purple, obtuse at base, acute at apex; lower lobe ovate, 3.5–4.25 × 2.7–3.2 mm, 14-nerved, greenish purple, obtuse at base, bi-tri-dentate at apex. Corolla blue-purple or pink or

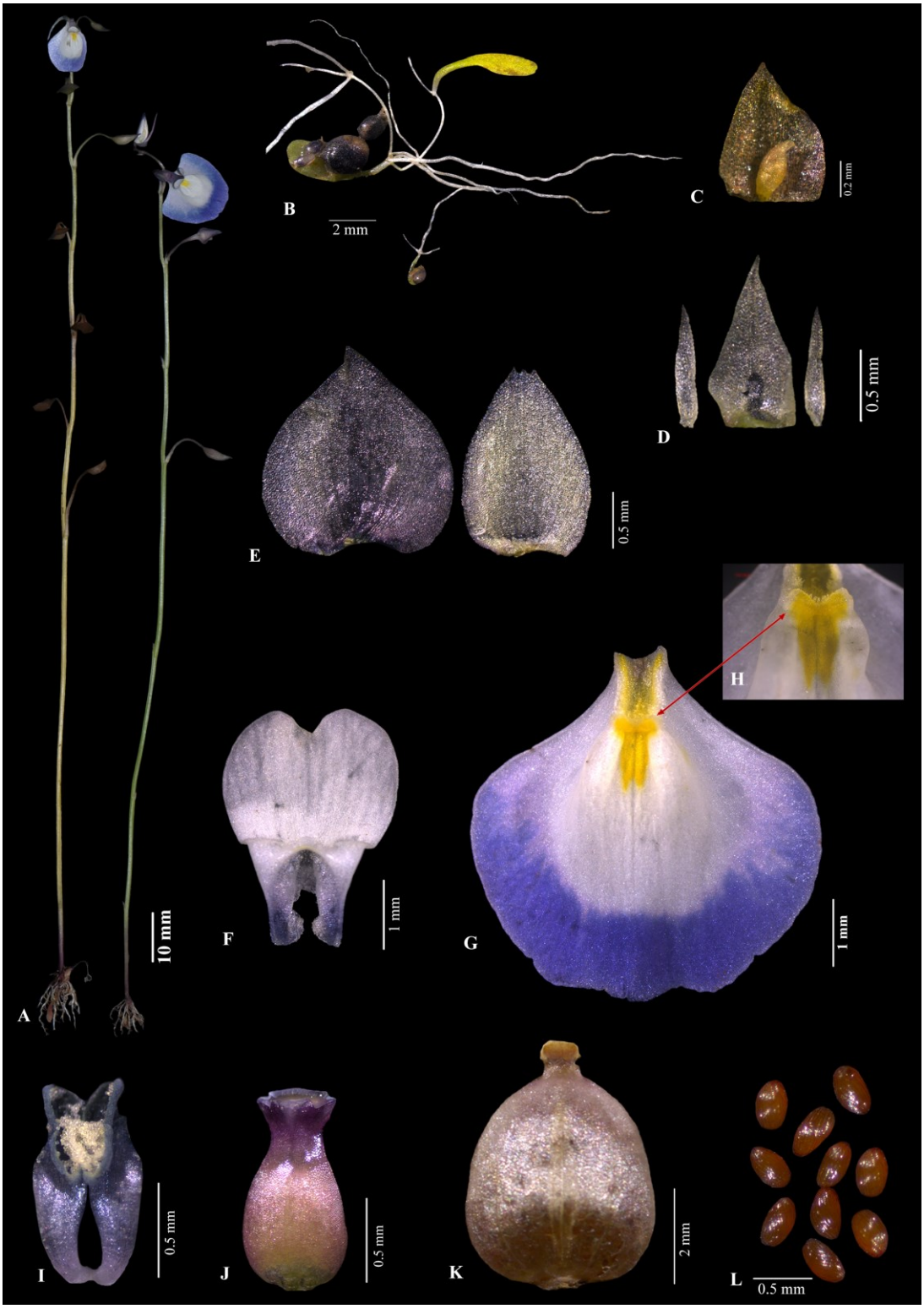


**Fig. 86.** *Utricularia purpurascens* J.Graham: **A.** Habit; **B.** Stolons with rhizoids, leaves and traps; **C.** Scale with young bud; **D.** Bract and bracteoles; **E.** Calyx lobes; **F.** Upper lip of corolla; **G.** Lower lip of corolla; **H.** Ligule in the throat; **I.** Stamens; **J.** Pistil; **K.** Capsule; **L.** Seeds.

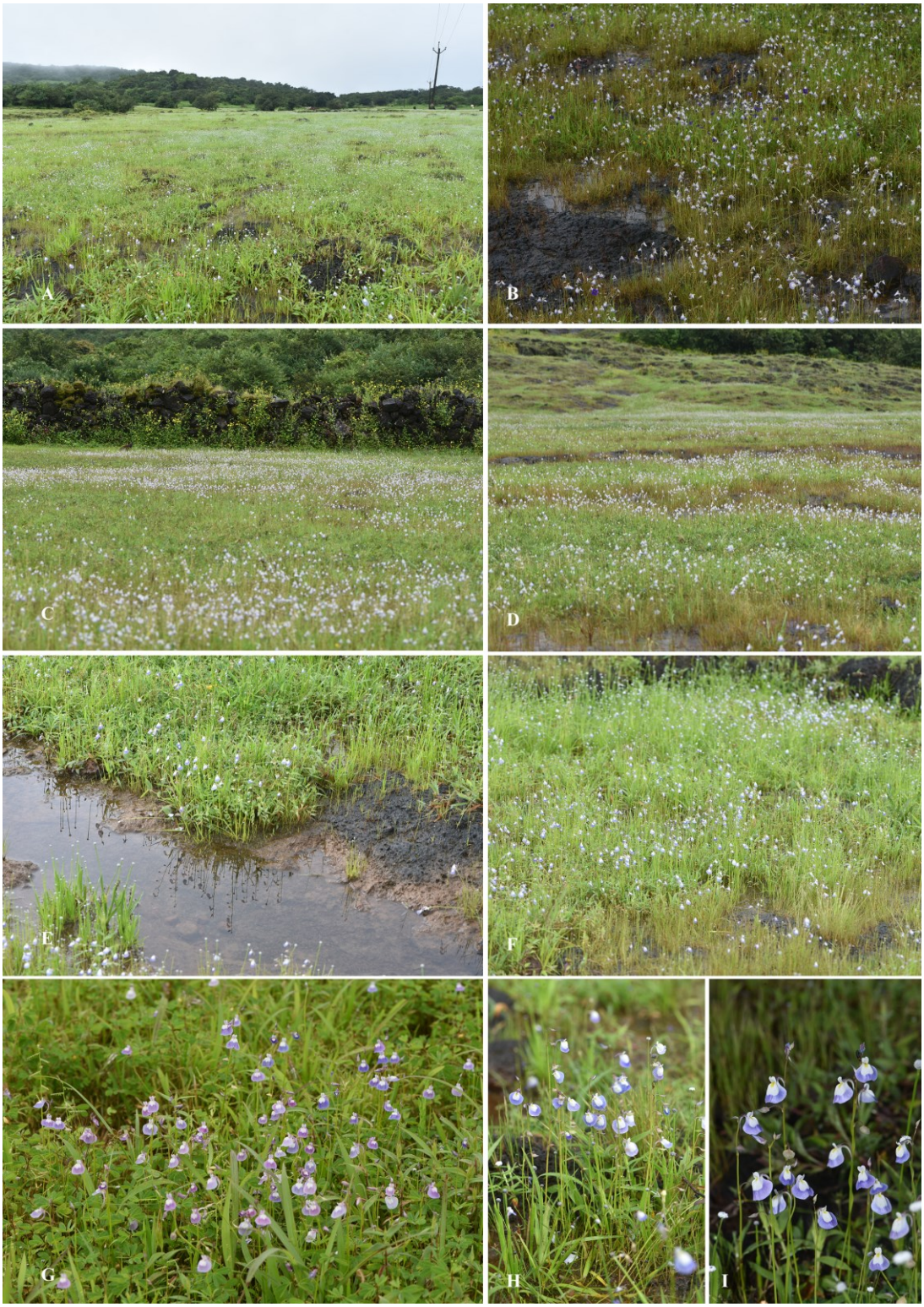


**Fig. 87.** Habitats of *Utricularia purpurascens* J.Graham

rarely white; upper lip obovate, 4.2–5.5 × 3.2–4.15 mm, longer and wider than upper calyx lobe, hairy along lower margin, crested just below the middle, pale blue-white with blue longitudinal streaks, deeply emarginate at apex; lower lip quadrangular to more or less orbicular, 8.5–12.5 × 8–14.5 mm, ciliate along margins, throat yellow, throat ligulate with two prominent teeth-like projection, palate gibbous, white with yellow patch, clear blue or purple then, truncate at apex; spur sickle-shaped, 8–13.5 × 05–0.8 mm, broad at base, narrow towards apex, strongly descending or curved upwards, narrowly acute at apex. Stamens 1.6–2 mm long; filaments strap-shaped, 1.5–1.6 × 0.4–0.6 mm, pale purple, slightly curved at base; anther thecae 0.8–1 mm long, purplish blue. Pistil 1.8–2.2 mm long; ovary ovoid, 1.5–2 × 0.5–0.8 mm, purplish-green; style 0.1–0.2 mm long, pale purple; stigma bi-lipped, deep purple; upper lip obscurely 3-lobed, middle lobe large, oblong, lateral lobes obsolete; lower lip sub-orbicular, margin sinuate, papillose out. Capsules ovoid, 4.5–5.25 × 3.5–4 mm, wall uniformly membranous, thickened along dehiscing margin, dehisce by longitudinal ventral slit; placenta 1.8–2 mm long. Seeds numerous, ellipsoid, 0.3–0.5 × 0.1–0.25 mm; surface smooth; hilum sub-terminal.

***Flowering & fruiting***: Flowering starts from early August till early October, with fruiting taking place from mid-August to October. Peak flowering occurs from late August to mid-September.

***Habitat***: Found on wet lateritic plateaus and soil patches on lateritic rocky slopes at elevations between 600 and 800 m, often intermingled with *U. praeterita*, *Eriocaulon* spp. (Eriocaulaceae), *Exacum pumilum* Griseb., *E. lawii* (both Gentianaceae), *Isachne* sp., *Ischaemum* sp., *Jansenella griffithiana* (all Poaceae), *Impatiens lawii* Hook.f. & Thomson (Balsaminaceae), *Linum mysurense* B.Heyne ex Benth. (Linaceae), *Cyanotis* sp., *Murdannia brownii*, *M. semiteres*, *M. versicolor* (all Commelinaceae), *Oldenlandia* sp., *Neanotis subtilis* (both Rubiaceae), *Senecio* sp. (Asteraceae), *Smithia* sp. (Fabaceae), *Rotala* spp. (Lythraceae) and some sedges, and grasses (Fig. 87).

***Distribution***: Endemic to the Western Ghats, India (Fig. 84).

***Specimens examined***: INDIA, **Karnataka**, Belgaum, 200 feet, *s.d.*, *W.A. Tabolt* 3760 (BSI). **Maharashtra**, *ca.* 1 km S. of Tulsi Hotel on road 31, lateritic plateau, N15º39'34.3'' E74º09'13.5'', *s.loc.*, 26.08.2016, *S.R. Yadav, M.M. Lekhak & D.D. Sokoloff* WG25 (MW0753508 digital image); Ahmednagar district, Harishchandragad, 28.09.1970, *B.M. Wadhawa* 127831 (BSI); Pachnai, Dukar ghat, 24.09.1970, *B.M. Wadhwa* 127519 (BSI); Pune district, Ambavane, INS Shivaji, 12.10.1985, *M.K. Janarthanam* 82956 (BSID0012679, MH00126553, MH00126554); way to top of Fort Ambavane, 06.09.1964, *B. Venkatta Reddy* 99028 (BSI); Behranis Plateau, 29.08.1942, *H. Santapau* 736; *Ibid*., 07.09.1956, *H. Santapau* 21143; *Ibid*., 13.09.1984, *H. Santapau* 924 (BLAT); Junnar, Dhak Plateau, 29.09.1965, *K. Hemadri* 107469; Durga Khila Plateau, 18-19 miles west of Junnar, 29.10.1964, *K. Hemadri* 104209 (BSI); Khandala, September 1919, *E. Blatter* 29674; *Ibid*., 04.09.1941, *H. Santapau* 500A (BLAT); *Ibid*., 13.09.1942, *H. Santapau* 924 (DD); *Ibid.*, 01.10.1943, *H. Santapau* 2815; *Ibid*., 02.09.1949, *H. Santapau* 10267; *Ibid*., 27.09.1954, *C.S. Saldanha* CS1623; *Ibid.*, 08.09.1956, *H. Santapau* 21182; near Convalescent Home, 27.09.1954, *C. Saldanha* CS1621; *Ibid*., 27.09.1954, *C. Saldanha* CS1586; *Ibid*., *s.d., H. Santapau* 18954 (BLAT); *Ibid*., 02.09.1949, *H. Santapau* 10267 (MO1621418 digital image); Korigad Fort, 13.09.2018, *M.P. Krishnapriya & Santhosh Nampy* 168004 (CALI197461, CALI197462, CALI197463, CALI197464); Lonavala hillock, opposite Lonavala Dam 13.09.2018, *M.P. Krishnapriya* 168002 (CALI199586); Saddle, 09.09.1956, *H. Santapau* 21203 (BLAT); Satara district, Kaas Plateau, 16.09.2018, *M.P. Krishnapriya* 168013 (CALI); Mahabaleswar, *s.d*., *T. Cooke* 134 (CAL); near Venna Lake, 09.10.1985, *M.K. Janarthanam* 82951 (BSID0012686, MH00126551, MH00126552); Hillock opposite to Venna Lake, 16.09.2018, *M.P. Krishnapriya* 168008 (CALI); near Prathap Singh Park, 09.10.1985, *M.K. Janarthanam* 82953 (BSID0012678, MH00126549, MH00126550); *Ibid*., 09.10.1985, *M.K. Janarthanam* 82941 (MH00126545, MH00126546); Old Mahabaleshwar road, 06.10.1985, *M.K. Janarthanam* 82944 (BSID0012677, MH00126547, MH00126548); Wilson Point, 16.09.2018, *M.P. Krishnapriya* 168010 (CALI); Sindhudurg district, Chaukul Plateau, 22.09.2018, *M.P. Krishnapriya* 168024; *Ibid.*, 22.09.2018, *M.P. Krishnapriya* 168027 (CALI); *Ibid.*, 10.08.2022, *M.P. Krishnapriya* 177276 (CALI197460); *Ibid*., 28.09.2023, *M.P.*

*Krishnapriya* 186072; Chaukul gav road, 28.09.2023, *M.P. Krishnapriya* 186075 (CALI); Ramghat road, Amboli, 12.08.1971, *B.G. Kulkarni* 131602A (BSI).

***Conservation status***: *Utricularia purpurascens* has been observed in several localities across Maharashtra, where it occurs in large populations with numerous individuals. Herbarium studies indicate that the species grew luxuriantly in the lateritic plateaus of Maharashtra, particularly in Khandala. However, anthropogenic activities such as constructions and other developmental activities, commercial tourism along with mining and quarrying, have led to the rapid reduction and fragmentation of its habitat. Watve (2013) listed Ambavane, Lonavala, and Venna Lake as 'high level disturbed' areas due to commercial tourism and land conversion for housing (Figs. 194–196). The herbaceous vegetation of the lateritic plateaus encounters the same threats, along with seasonal climatic changes, disturb the habitat of this short-lived species. Considering the reduction of habitats, area of occupancy and ongoing threats, *U. purpurascens* is assessed as Near Threatened (NT).

***Notes***: *Utricularia purpurascens* is a distinct and easily recognizable species, remarkable for its large, sickle-shaped spur and the large lower lip of its corolla. It is one of the mass-flowering species widely distributed in Maharashtra and exhibits a range of corolla colours, from blue to purple, pink, or even pure white (Fig. 88). In the protologue of *U. purpurascens*, Graham (1839) described the species as '*A very delicate little plant with beautiful purple-coloured flowers resembling larkspur*' and mentioned the locality 'Mahabaleshwar'. It appears that Graham did not retain any voucher specimens, and no known specimens from his herbarium exists (Staflew & Cowan, 1976; Nimbalkar *et al.*, 2023). Attempts to locate the vouchers of *U. purpurascens* in various herbaria were also unsuccessful. Eventually, Janarthanam and Henry (1987) neotypified *U. purpurascens* and provided a detailed description.

Wight (1849) described *U. arcuata* based on materials collected by Law from Belgaum, Karnataka. Since, the protologue of *U. purpurascens* was insufficient and unclear for subsequent authors, the name *U. arcuata* was simultaneously followed

**Fig. 88.** Flower colour variations in *Utricularia purpurascens* J.Graham

by them (Clarke, 1884; Cooke, 1905; Santapau, 1950 & 1967; Rao, 1986; Almeida, 1990) and treated *U. purpurascens* as a synonym of *U. graminifolia*. Taylor (1989), who had annotated the specimen of *U. arcuata* as *U. purpurascens*, later expressed doubts about the identity of the latter, and considered *U. graminifolia* and *U. purpurascens* conspecific, treating *U. arcuata* as a distinct species. However, Graham's *Utricularia purpurascens* has priority over Wight's name, the former name was appeared in various revisions and floristic treatments (Janarthanam & Henry, 1992; Londhe, 2001; Yadav & Sardesai, 2002; Datar & Lakshminarasimhan, 2013; Nayar *et al*., 2014; Singh *et al*., 2015; Kavade & Deokule, 2015), while in some floristic treatments (Deshpande

*et al*., 1993; Pradhan & Singh, 1999, Li, 2011) and in POWO (2025), it is still treated as a synonym of *U. graminifolia*.

The present study considers *U. purpurascens* as a distinct species. It can be differentiated from *U. graminifolia* in having rather thin, spathulate leaves (*vs*. thick, strap-shaped leaves in *U. graminifolia*), reflexed fruiting pedicels (*vs*. erect), gibbous palate (*vs*. bi-gibbous), ligulate throat of the lower lip of the corolla (*vs*. eligulate throat), and large sickle-shaped spur (*vs*. a small conical spur). *Utricularia purpurascens* also shows affinities with *U. albocaerulea*, but it can be distinguished by tooth like projections at the throat of the lower lip of the corolla (Fig. 86H), gibbous palate, long sickle-shaped spur and elongate testa cells.

Janarthanam and Henry (1992) treated *U. ogmosperrna* as conspecific with *U. albocaerulea*. Upon critical examination of the protologue, illustration, and type, I found that the characters such as the size of the spur, shape of the palate of the corolla, and seed characters fall within the range of *U. purpurascens.* Hence, *U. ogmosperrna* is treated here as a synonym of *U. purpurascens*. However, the erect pedicel as described by Blatter presents some contradictions.

**14. Utricularia recta** P.Taylor, Kew Bull. 41(1): 10. 1986, Gen. *Utricularia* 382. t. 110. 1989; Janarth. & A.N.Henry, Bladderworts India 89. t. 26. 1992; Noltie in Grierson & D.G.Long (eds.), Fl. Bhutan 2(3): 1339. 2001; S.S.Dash & P.Singh, Fl. Kurung Kumey Dist. 385. 2017; Noltie in Watson *et al.* (eds.), Fl. Nepal (web edn.) 5. 2019; Gogoi *et al*., Fl. Sikkim Pict. Guide 267. 2021. *Type*: BHUTAN, Trashiyangtse district, Trashiyangse Dzong, 5400 feet, 13.08.1949, *Ludlow, Sherriff & Hicks* 21023 (holo, K [K000939702 digital image!]; iso, BM [BM000628925 digital image!]; E [E00273685 digital image!]). **Figs. 89–92**

*Utricularia wallichiana* Wight var. *firmula* Oliv., J. Linn. Soc. Bot. 3: 182. 1859; C.B.Clarke in Hook.f. (ed.), Fl. Brit. India 4: 333. 1884. *Utricularia scandens* Benj. var. *firmula* (Oliv.) Subr. & Banerjee, Bull. Bot. Surv. India 10: 106. 1968; Naithani, Fl. Chamoli 2: 478. 1985; H.J.Chowdhery *et al*., Mat. Fl. Arunachal Pradesh 2: 223. 2008; D.Maity *et al*., Fl. Kanchenjunga Biosphere Reserve Sikkim 391. 2018. *Utricularia scandens* subsp. *firmula* (Oliv.) Z.Y.Li, Bull. Bot. Res., Harbin 8(2): 29. 1988; Li in Wu

*et al*. (eds.), Fl. China 19: 485. 2011, in Y.F.Deng *et al*. (eds.), Fl. Pan-Himalaya 46: 13. 2020. *Lectotype* (designated by Janarthanam & Henry, 1992): INDIA, **Sikkim**, 25.10. 1850, *J.D. Hooker s.n.* (K [K000628539 digital image!]) *Residual syntype*: INDIA, **Sikkim**, Lachoong, 10-11000 ped, 25.08.1849, *J.D. Hooker s.n.* (K [K000628540 digital image!])

*Utricularia scandens auct. non* Benj.: N.P.Balakr., Fl. Jowai 343. 1983

*Utricularia bifida auct. non* L.: G.P.Sinha in G.P.Sinha *et al.* (eds.), Fl. Mizoram 193. 2012

*Utricularia jackii* J.Parn., Thai Forest Bull., Bot. 33: 128. 2005. *Type*: THAILAND, **Chiang Mai**, Doi Angka (Doi Inthanon), Pha Ngem South peak, ± 2200 m, 05.08.1927, *H.B.G. Garrett* 437 (holo, BM [BM000834890 digital image!])

*Utricularia lihengiae* C.L.Long & Z.Cheng, Phytokeys 177: 19. 2021. ***syn. nov.*** *Type*: CHINA, **Yunnan Province**, Nujiang Lisu Autonomous Prefecture, Gong-shan Dulong and Nu Autonomous County, Dulongjiang Township, 2844 m, 27°50'36"N, 98°27'48"E, 03.09.2019, *Chun Lin Long & Zhuo Cheng* DXH066 (holo, KUN not seen)

Annual, terrestrial or lithophytic herbs. Rhizoids a few, 6–20 mm long, 0.2–0.25 mm thick, capillary, branched further, papillose. Stolons up to 60 mm long, 0.4–0.5 mm thick, terete, numerously branched, glabrous, hyaline to pale green. Leaves numerous on stolon nodes, mat forming, sessile or shortly petiolate; petioles up to 0.5 mm long, flattened, hyaline or pale green; lamina narrowly oblong to strap-shaped, or sometime spathulate, 5–40 × 0.5–1 mm, 1-nerved, obtuse at base, margin entire, rounded at apex. Traps globose, 0.8–1 mm across, numerous on stolons and leaves, stalked; stalk 0.4–0.6 mm, distally thickened, glandular hairy; mouth basal, appendages subulate, incurved. Racemes erect, 1–30 cm long, 2–8-flowered, stiff, simple or rarely branched, flowers lax or congested; peduncles angular, grooved on one side, 0.5–0.8 mm thick, green to greenish or purplish red. Scales a few on peduncle base, triangular, 1.2–1.4 × 0.45–0.6 mm, fertile, 1-nerved, green or greenish red, acute at apex. Bracts ovate, 1.3–1.65 × 1–1.25 mm, 1-nerved, green or greenish red, truncate at base, acuminate at apex; bracteoles lanceolate, 0.8–1 × 0.15–0.2 mm, 1-nerved, green or greenish red, narrowly acute at apex. Flowers 8–12 mm long; pedicels 4–7 mm long, erect, winged, dorsiventrally compressed. Calyx lobes sub-

equal, accrescent (upper lobe more or less rhombic in fruiting, 5.5–6.5 × 5–6 mm); upper lobe widely ovate, 3–3.65 × 2.2–2.75 mm, 12–13-nerved, lateral nerves branched, cuspidate or caudate at apex; lower lobe oblong-elliptic, 2.8–3.2 × 1.8–2.2 mm, 8–12-nerved, cuspidate at apex, bi to tridentate at tip. Corolla bright yellow; upper lip oblong-obovate, 4.45–5 × 1.8–5 mm, slightly constricted below the middle, hairy along the lower margin, yellow with prominent red streaks above the constricted part, faint towards apex, truncate to rounded at apex, exceeds upper calyx lobe in length; lower lip widely obovate to sub-orbicular, 8–10 × 7.5–12 mm, hairy at throat margin, bi-gibbous, bright yellow with red streaks in palate, emarginate to truncate or rounded at apex; spur subulate, 4.5–6 (–10) mm long, exceeds or longer than the lower calyx lobe, straight or curved inwards distally, narrowly acute at apex. Stamens 1.3–1.5 mm long; anther theca distinct, filament strap-shaped, 1–1.2 × 0.2–0.25 mm, twisted at base. Pistil 1.5–1.6 mm long; ovary ovoid, 1–1.2 × 0.8–0.9 mm, dorsiventrally compressed, pale green; style 0.15–0.3 mm long, pale green; stigma bi-lipped, upper lip short, oblong; lower lip sun-orbicular, papillose out. Capsules widely ovoid, 3–3.15 × 1.85–2 mm, wall uniformly membranous, dehisce by marginally thickened, ventral, longitudinal slit; placenta oblongoid, 1.8–2 × 1–1.2 mm. Seeds numerous, oblongoid to sub-globose, 0.32–0.35 mm across; surface smooth; hilum sub-lateral.

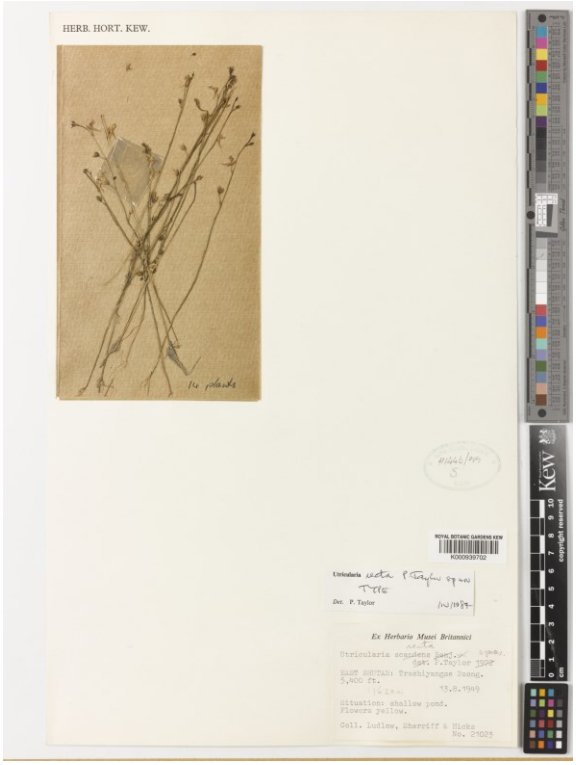


**Fig. 89.** Type of *Utricularia recta* P.Taylor [*Ludlow, Sherriff & Hicks* 21023 (K000939702)] "© *Board of Trustees of the Royal Botanic Gardens, Kew*".

***Flowering & fruiting:*** Flowering occurs from early July to mid-October, while fruiting takes place from mid-July to the end of October. Peak flowering is observed during August to September.

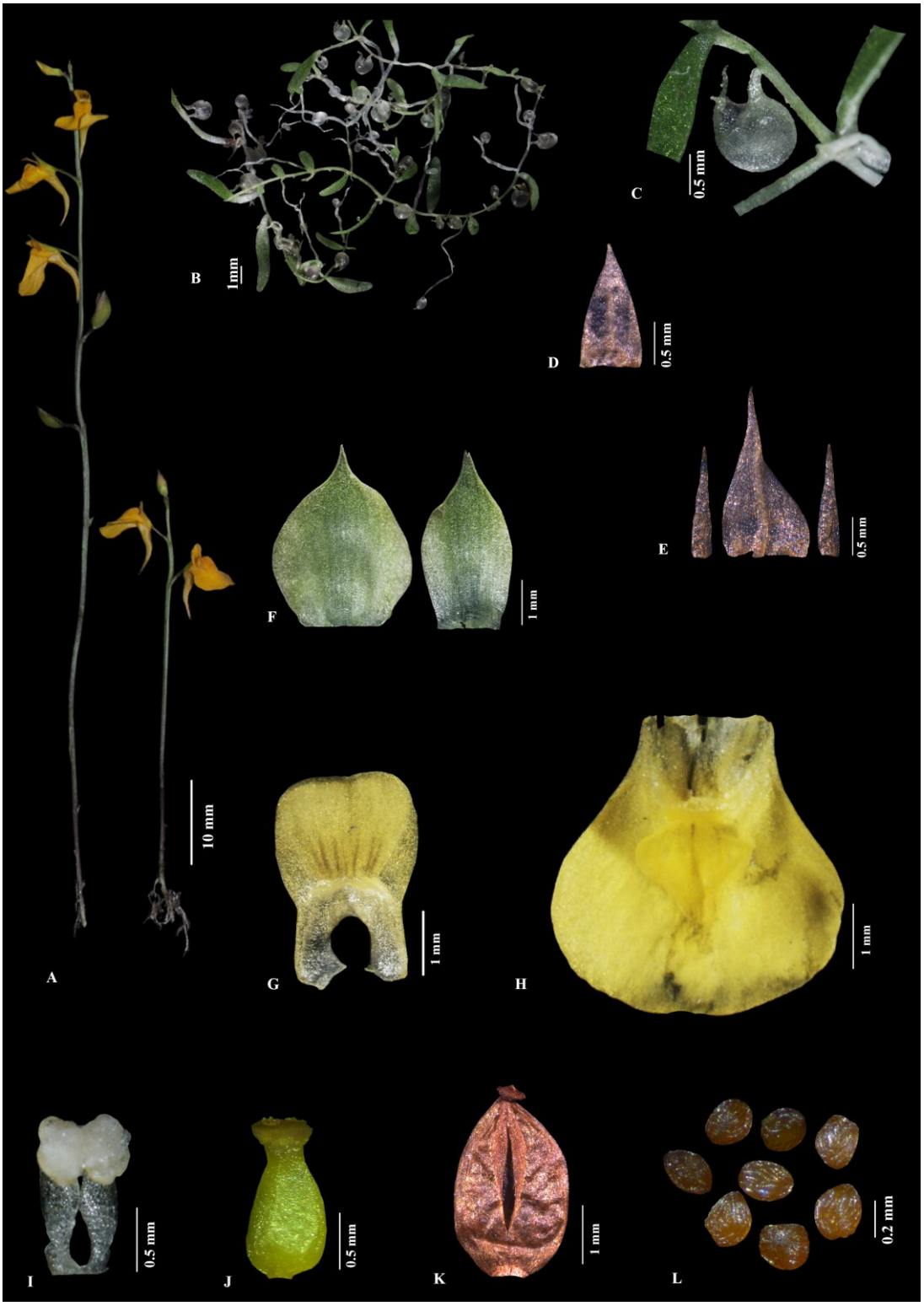


**Fig. 90.** *Utricularia recta* P.Taylor: **A.** Habit; **B.** Stolons with rhizoids, leaves and traps; **C.** Trap on stolon; **D.** Scale; **E.** Bract and bracteoles; **F.** Calyx lobes; **G.** Upper lip of corolla; **H.** Lower lip of corolla; **I.** Stamens; **J.** Pistil; **K.** Capsule; **L.** Seeds.

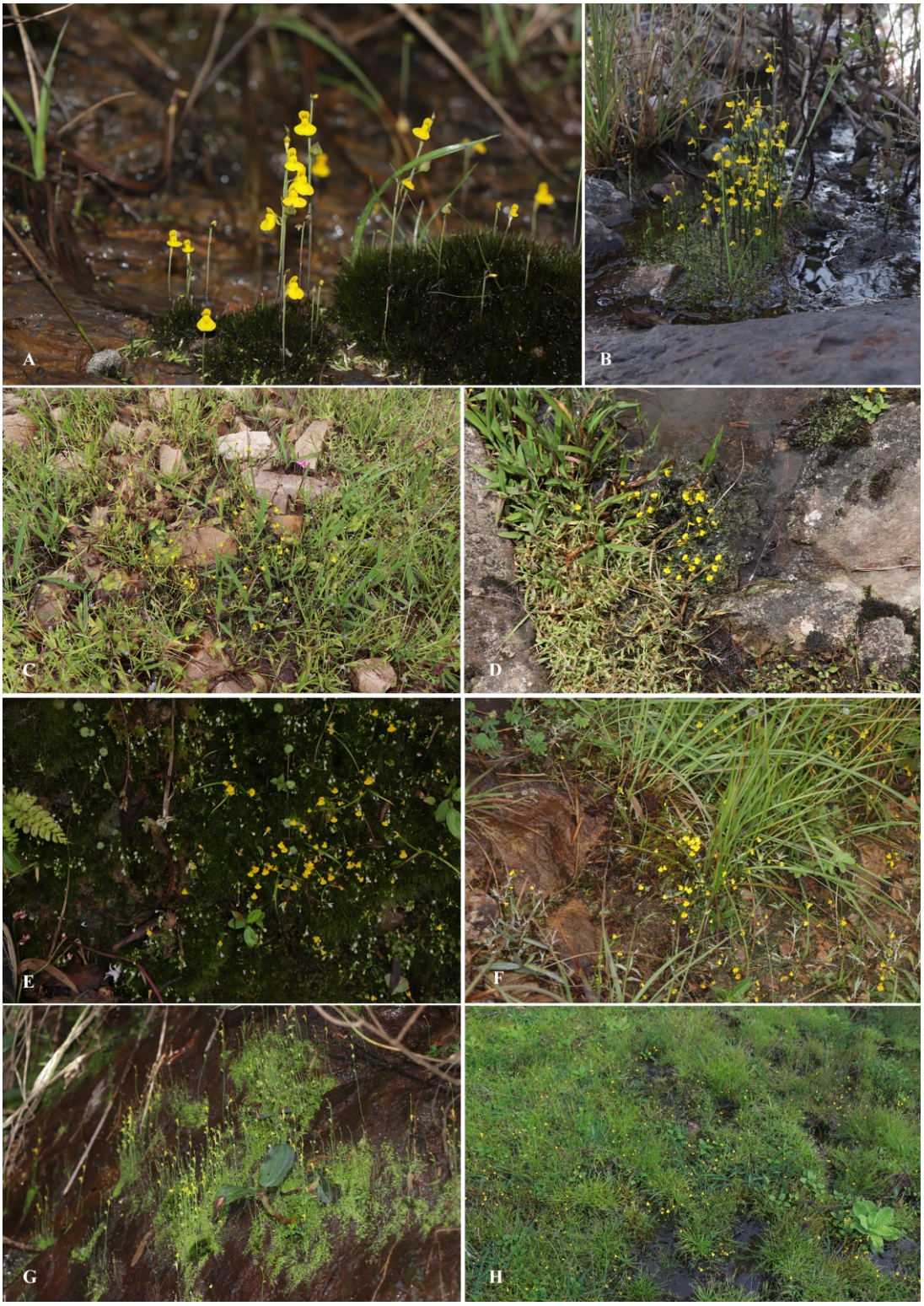


**Fig. 91.** *Utricularia recta* P.Taylor: **A-H.** Habitat and habit; **A.** Lithophytic on the moss-covered limestone; **B & D.** Along the margin of seasonal pool above the rocky outcrop; **C & F.** In a sandy plain; **E.** In moss-covered vertical cutting along with *U. furcellata* Oliv.; **G.** Lithophytic on wet, vertical cutting; **H.** In the swampy meadow in the Alpine Sikkim.

***Habitat***: This species is usually found in open, wet, sandy, swampy soils, along stream margins, and on slimy or moss-covered vertical cliffs or slopes, at elevations of 1700 m and above. It is often seen in association with *U. caerulea*, *U. furcellata*, *U. striatula*, *Burmannia coelestis*, *B. disticha* L. (both Burmanniaceae), *Cyanotis* sp. (Commelinaceae), *Eriocaulon* spp. (Eriocaulaceae), *Impatiens* sp. (Balsaminaceae), *Hydrocotyle* sp. (Araliaceae), *Sonerila arguta* R.Br. ex Naudin, *S. khasiana* C.B.Clarke (both Melastomataceae) and some other grasses, mosses and ferns (Fig. 91).

***Distribution***: India, Bhutan, China, Nepal and Thailand (POWO, 2025) (Fig. 58).

***Specimens examined***: BHUTAN, Paro district, Paro, 2500 m, 18.08.1963, *N.P. Balakrishnan* 1246 (CAL); *Ibid*., 2500 m, 13.10.1963, *S.K. Mukerjee* 5900 (CAL); Thimphu, 26.08.1965, *G. Sen Gupta* 1639 (CAL). CHINA, Dali Xian, E. side of Diancang Shan mountain range, Lower slopes Yinglofeng, directly W of the city of Dali, 12.07.1984, *B. Bartholomew, D.E. Boufford, H.W. Li, C.G. Ma, D.H. Nicolson, T.S. Ying & S.W. Yu* 1021 (CAS650976, US03216944 digital images). INDIA, **Arunachal Pradesh,** Kameng-NEFA, Dum, 2000 m, 18.09.1964, *J. Joseph* 40083 (ASSAM); Subansiri-NEFA, Hapoli, 30.09.1959, *G. Panigrahi* 19848 (ASSAM); West Kameng district, Dirang, ± 1705 m, 21.08.2023, *M.P. Krishnapriya & M. Sreya* (CALI). **Manipur**, Ukhrul district, Ukhrul, 6000 feet, 26.08.1948, *F. Kingdom-Ward* 17994 (NY02652092 digital image). **Meghalaya**, Mount Khasia, regio trop., *s.loc., s.d., J.D. Hooker & T. Thomson s.n.* (BR0000031022163, GH01977149, L.2829228, L.2829230, U.1360023 digital images); East Khasi Hills district, Barapani, 3000 feet, 23.05.1949, *Walter N. Koelz* 22769 (MICH1535321 digital image); *Ibid*., BSI Experimental Garden, 29.10.1986, *M.K. Janarthanam* 83030 (MH00126722, MH00126723); Byrdaw Falls, 25.09.20201, *M.P. Krishnapriya* 175898 (CALI); Cherrarim, 11.08.1962, *D.B. Deb* (ASSAM); way to Cherrapunji, ± 1720 m, 17.09.2021, *M.P. Krishnapriya & Santhosh Nampy* 175831 (CALI186852); *Ibid*., 17.09.2021, *M.P. Krishnapriya & Santhosh Nampy* 175828 (CALI197443); *Ibid*., 17.09.2021, *M.P. Krishnapriya & Santhosh Nampy* 175833 (CALI197441, CALI197442); Environs of Cherrapunji (Tserapundzi) till near Máirong, 2800–4500 feet, 01–30.10.1855, *Schlagintweit* 184 (GH01977148 digital image); near Seven sister Falls, 17.09.2021, *M.P. Krishnapriya & Santhosh Nampy* 175835 (CALI197440); near Cherrapunji, Mawsmai, 30.10.1986, *M.K. Janarthanam*

83032 (BSID0012651, MH00126720, MH00126721); Mawsmai, 4000 feet, 23.10.1871, *C.B. Clarke* 16591B (US03216949 digital image); *Ibid*., near Cave, on the bank of the Stream, 22.08.1967, *P.K. Hajra* 37756 (ASSAM); from Cherrapunji to Mawmluh, 27.09.1956, *G. Panigrahi* 3517 (ASSAM); way to Kut Village, ± 4104 feet, 22.09.2021, *M.P. Krishnapriya & Santhosh Nampy* 175880 (CALI186855, CALI186856); Laitlyngkot, 6000 feet, 27.07.1949, *Walter N. Koelz* 23273 (L.4484735 digital image); Lyngkyrdem, ± 1490 m, 20.09.2021, *M.P. Krishnapriya* 175851 (CALI); *Ibid*., ± 1565 m, 20.09.2021, *M.P. Krishnapriya & Santhosh Nampy* 175848 (CALI186851); Mawphlang, 6000 feet, 14.08.1954, *Takur Rup Chand* 7976 (L.4484134, MICH1535317 digital images); Mawryngneng, 4000 feet, 20.10.1951, *Takur Rup Chand* 4902 (MICH1535322 digital image); way to Mawsynrum, ± 1715 m, 21.09.2021, *M.P. Krishnapriya & Santhosh Nampy* 175873 (CALI186849, CALI186850); *Ibid*., ± 1578 m, 21.09.2021, *M.P. Krishnapriya & Santhosh Nampy* 175875 (CALI199589); way to Mawjymbuin Cave, ± 1410 m, *M.P. Krishnapriya & Santhosh Nampy* 175877 (CALI186857); Mylliem to Cherrapunji, ± 1700 m, 17.09.2021, *M.P. Krishnapriya & Santhosh Nampy* 175830 (CALI186853, CALI186854); Nongrihatb, near Cement factory, ± 1010 m, 26.09.2021, *M.P. Krishnapriya* 177202 (CALI199597); Pynursla, 20.09.2021, ± 1210 m, *M.P. Krishnapriya* 175855 (CALI); *Ibid*., 3 mile from Shillong, 25.08.1956, *G. Panigrahi* 2922 (ASSAM); Shillong, 5000 feet, *s.d*., *Dr. N.L. Bor* 18440 (DD); *Ibid*., 21.07.1949, *F. Kingdom-Ward* 18661 (NY02652091 digital image); *Ibid*., 27.07.1959, *G.K. Deka* 18360 (ASSAM); *Ibid*., near Goul House, 07.09.1956, *G.K. Deka s.n.* (ASSAM); Shillong-Pynursla Road, near check post (20 Km before Pynursla), 31.10.1986, *M.K. Janarthanam* 83034 (BSID0012650, MH00126718, MH00126719); Upper Shillong, 17.09.1917, *Upendranath Kanjilal* 7241 (ASSAM); Ward Lake, 06.07.1971, *N.C. Deori* 38294 (ASSAM); Wahkaba Waterfalls, 26.09.2021, *M.P. Krishnapriya* 175900 (CALI); Jaintia Hills district, Dawki, Madan Langtad, 25.09.2021, *M.P. Krishnapriya* 175893 (CALI); road to Jarain (Jowai area), 29.10.1956, *G. Panigrahi* 4195 (ASSAM); way to Jarain from Jowai, ± 1310 m, 23.09.2021, *M.P. Krishnapriya* 175885 (CALI198472); Jowai, near rest house, 06.09.1980, *J. Joseph* 76941 (ASSAM); Krang Shuri Waterfalls, ± 2884 feet, 23.09.2021, *M.P. Krishnapriya* 175891 (CALI186848); Mynkrem, 05.11.1938, *G.K. Deka* 18537 A (ASSAM); South Garo Hills district, Balpakram, 10.11.2014, *D.K. Roy* 130848 (ASSAM). **Mizoram**, Aizawl district, Hmuifang Tlang, way side, ± 1510

m, 03.10.2021, *M.P. Krishnapriya* 177205 (CALI); Reiek Tlang, ± 1200 m, 02.10.2021, *M.P. Krishnapriya* 177201 (CALI); *Ibid*., Peak, ± 1450 m, 02.10.2021, *M.P. Krishnapriya* 177207 (CAL). **Sikkim**, Sikkim Himalaya, *s.loc*., 1892, *G.A. Gammie s.n.* (DD); Gangtok district, Gangtok, 1900 m, 19.06.1960, *H. Kanai, G. Murata & M. Togashi* 7644 (A09177151 digital image); *Ibid*., 6000 feet, 20.09.1916, *G.H. Cave s.n.* (E01321676 digital image); Mangan district, Chungthang, after Theng Tunnel, ± 1600 m, 01.09.2022, *M.P. Krishnapriya* 177290 (CALI); Khedung, ± 2045 m, 04.09.2022, *M.P. Krishnapriya* 177296 (CALI197457); Lachung, Gumpha road, above Monastery, ± 2870 m, 04.09.2022, *M.P. Krishnapriya* 177297 (CALI197455, CALI197456); near Manul Waterfalls, ± 1395 m, 01.09.2022, *M.P. Krishnapriya* 177289 (CALI198473); Penglong La, 6500 feet, 03.07.1945, *Bor's Collector* 403 (DD); Soreng district, Singling, 4600 feet, 11.08.1913, *R. Cooper* 443 (E01321675 digital image). **Uttarakhand**, Garhwal district, Lohba, 5000 feet, 18.10.1912, *D. Hooper* 38982 (BSIS000007297); Phata, way to Kedarnath, 1500 m, 21.09.1958, *M.A. Rau* 6457 (BSD000063826); Pithoragarh district, Kumaon, Didihat-Naryan Nagar, Birdal Path, 1800 m, 30.08.1968, *Bora* 38817 (BSD000063823); Tehri Garhwal district, Beeras Chaura, 2000 m, 22.09.1979, *A.K. Goel* 67808 (DD). NEPAL, **Bagmati Province**, Eastern Nepal, between Dhaibungket and Ramche, east side of Trisuli River, 1700 m, 15.09.1966, *D.H. Nicolson* 2431 (US03216951 digital image); Dolakha district, Charikot and Patale, ± 6000 feet, 19.09.1964, *M.L. Banerji* 1424 (A01977145 digital image); Juga, 2403 m, *Sangram Karki* J83 (KATH093103 digital image); Murmidanda-Bungim, 1720 m, 09.05.1986, *T.B. Shrestha & P.R. Shakya* 8941 (KATH0129303 digital image); Shemma (1400 m)-Yakuwa (1500 m)-Lamobagar (1100 m), 01.08.1977, *H. Ohashi, H. Kanai, H. Ohba & Y. Teteishi* 773401 (A01977149 digital image); Sindhupalchok district, N. of Thagaon, above Bhotekoshi Nadi, 1775 m, 09.09.2011, *M.F. Watson, C.A. Pendry, D.A. Gray, R.S. Dani & N. Phuyal* EKSIN21 (KATH129335 digital image); Shivapuri, 7000 feet, 10.06.1919, *T.B. Shrestha & A. Upd* 617 (US03216940 digital image); Shivapuri top, 8800 feet, 10.09.1977, *P. Pradhan & N. Shrestha* 66 (KATH129346 digital image); Tamur Valley, Mewa Khola, 7000 feet, 08.08.1956, *John D.A. Stainton* 1300 (A01977152 digital image). **Gandaki Province**, Dhawalangiri Zone, Myagdi district, Jugepani (Natura, 1470 m), Dhola Khola (1420 m), Muri (1820 m), below Dhar (1800 m), 13.09.1996, *M. Mikage, R. Hirano*, *A. Takahashi & K. Yonekura* 9682467 (A01977021 digital image).

***Conservation status***: During field studies, *U. recta* was found to be widely distributed across the Khasi and Jaintia Hills districts of Meghalaya. However, its distribution is more restricted in Arunachal Pradesh, Mizoram and Sikkim. The species usually occurs in small patches along road cuttings, slopes, and sometimes scattered in sandy soils. These areas are highly disturbed. In Arunachal Pradesh and Sikkim, *U. recta* was mainly observed in the vertical cuttings of roadways. In these regions, landslides and the clearing of roadsides are the major threats to the habitats of this species, while in Meghalaya, mining and quarrying for limestone, coal, and sand are the major threats (Figs. 194–195). The habitats are highly disturbed and fragmented due to various anthropogenic activities, and the population sizes are generally small, with fewer than 200 individuals observed per population. Some very small populations were also observed in Arunachal Pradesh and Sikkim. Based on the quality of habitats and the threats it faces, the species is assessed as Near Threatened (NT).

***Notes:*** Herbarium consultations reveal that *U. recta* has long been identified as *U. bifida* and as a variety of *U. scandens* Benj. (= *U. wallichiana* Wight). The taxon has undergone several nomenclatural changes. Initially, it was described as a high-altitude variety of *U. wallichiana* (as *U. wallichiana* Wight var. *firmula* Oliv.) by Oliver (1859). Later, Subramanyam and Banerjee (1968), transferred it to a variety of *U. scandens* (as *U. scandens* Benj. var. *firmula* (Oliv.) Subr. & Banerjee). Taylor (1986) elevated it to a species, and renamed it *U. recta* P.Taylor, since the epithet *firmula* was already occupied. Li (1988), while revising *Utricularia* in China, altered its status to subspecies, as *U. scandens* subsp. *firmula* (Oliv.) Z.Y.Li. Janarthanam and Henry (1992) recognized *U. recta*, and designated a lectotype for *U. wallichiana* var. *firmula*. Li (2020) considered *U. recta* as a synonym of *U. scandens* subsp. *firmula*.

The present study recognizes *U. recta* as a distinct species, characterised by a stiff, erect peduncle, cuspidate-caudate apex of the upper flowering calyx, rhombic upper fruiting calyx, erect fruiting pedicels, and thickened dehiscing margins of the capsules. Dwarf individuals of less than 5 cm (sometimes flowering individual only reach 1 cm high) are common in *U. recta*, with a single flower and small sized parts. The species also exhibits variation in the size of spur, and its orientation (Fig. 92).

**Fig. 92.** Variation of flowers of *Utricularia recta* P.Taylor (note the shape and size of the lower lip of corolla, spur).

*Utricularia recta* is distinct from *U. scandens* and can be distinguished by several features: stiff, erect peduncle (*vs.* wiry and twining), a distally thickened stalk of the traps (*vs.* short stalk with a distal lateral extension), upper corolla lip that exceeds the upper calyx lobe (*vs.* the upper lip being shorter than or equal to the upper calyx lobe), erect fruiting pedicels (*vs.* horizontal) and smooth testa surface (*vs.* rough surface).

Parnell (2005) described *U. jackii* based on a specimen collected by Garrett from Thailand. Fleischmann (2012) synonymised this species, considering it a dwarf

form of *U. recta*. However, in POWO (2025), *U. jackii* is treated as a distinct species. This study confirms that *U. jackii* falls within the morphological range of *U. recta* due to its yellow corolla, 1-nerved leaves, erect pedicels, etc., and it is treated here as a synonym of *U. recta*.

Cheng *et al.* (2021) described *U. lihengiae* from the Eastern Himalayan region of China, differentiating it from *U. bifida* and *U. recta* based on the size of the racemes, nature of peduncles, apex of calyx lobes, and striations on the corolla. However, after communication with KUN herbaria, it was informed that the authors had not deposited the holo- and isotypes as indicated in the protologue. After a thorough examination of the protologue and photo plate, it was found that, *U. lihengiae* matches the characteristics of *U. recta* in having erect peduncle, acuminate apex of the calyx, and purple streaks on the upper and lower lips of the corolla. Therefore, *U. lihengiae* is considered a synonym of *U. recta*.

**15. Utricularia reticulata** Sm., Exot. Bot. 2: 119. t. 119. 1808, in Rees (ed.), Cycl. 37: 600. 1819; A.DC. in DC. (ed.), Prodr. 8: 19. 1844; Wight, Icon. Pl. Ind. Orient. 4(4): 9. t. 1571 f. 2. 1850; Oliv., J. Proc. Linn. Soc., Bot. 3: 180. 1859; Dalzell & Gibson, Bombay Fl. 135: 1861; Drury, Handb. Ind. Fl. 2: 122. 1866 *excl.* var. 1 & 2; C.B.Carke in Hook.f.(ed.), Fl. Brit. India 4: 331. 1884; K.I.Goebel in Treub (ed.), Ann. Jard. Bot. Buitenzorg 9: 79. 1891; Trimen, Handb. Fl. Ceylon 3: 26. 1895; T.Cooke, Fl. Bombay 2: 319. 1905; Gamble, Fl. Madras 2: 982. 1924; Santapau, Bombay Nat. Hist. Soc. 49(2): 219. 1950, Rec. Bot. Surv. India 16 (1): 212. 1953, Fl. Khandala 3rd ed. (revised) 188. 1967; R.K.Arora *et al.*, Bot. South Kanara Dist. 45. 1981; Manilal & Sivar., Fl. Calicut 208. 1982; B.D.Sharma *et al.*, Fl. Karnataka: analysis 196. 1984; D.M.Verma in D.M.Verma *et al.* (eds.), Fl. Raipur, Durg & Rajnandgaon 267. 1985; R.S.Rao, Fl. Goa, Diu, Daman, Dadra & Nagarhaveli 2: 308. 1986; V.Chandras. in A.N.Henry *et al.* (eds.), Fl. Tamil Nadu Ind., Ser I: Analysis 2: 130. 1987; B.G.Kulk., Fl. Sindhudurg 308. 1988; Bole & J.M.Pathak, Fl. Saurashtra part 2: 155. 1988; V.S.Ramach. & V.J.Nair, Fl. Cannanore 324. 1988; P.Taylor, Gen. *Utricularia* 362. t. 103. 1989; S.M.Almeida, Fl. Savantwadi 2: 309. 1990; Janarth. & A.N.Henry, Bladderworts India 91. t. 27. 1992; S.D.Desp. *et al.*, Fl. Mahabaleshwar 1: 425. 1993; Kothari & Moorthy, Fl. Raigad Dist.

282. 1993; M.Mohanan & A.N.Henry, Fl. Thiruvananthapuram 335. 1994; Subram., Fl. Thenmala Div. 254. 1995; Sivar. & P.Mathew, Fl. Nilambur 481. 1996; Londhe in N.P.Singh *et al*. (eds.), Fl. Maharashtra, Dicot. 2: 566. 2001; S.R.Yadav & Sardesai, Fl. Kolhapur Dist. 339. 2002; K.G.Bhat, Fl. Uduppi 456. 2003, Anil Kumar *et al*., Fl. Pathanamthitta 368. 2005; Sunil & Sivad., Fl. Alappuzha Dist. 520. 2009; Punekar & Lakshmin., Fl. Anshi Natl. Park 336. 2011; Datar & Lakshmin., Fl. Bhagwan Mahavir (Molem) Natl. Park Adjoining, Goa 177. 2013; K.G.Bhat, Fl. South Kanara 770. 2014; T.S.Nayar *et al*., Fl. Pl. Western Ghats 1: 586. 2014; Kavade & Deokule, Fl. Chandoli Natl. Park 264. 2015; R.Ansari *et al*., Aquatic Wetland Fl. Kerala: Fl. Pl. 522. 2016. *Type*: Rheede, Hort. Mal. 10: t. 70. 1689. **Figs. 93–97**

*Utricularia graminifolia auct. non* Vahl: J.Graham, Cat. Pl. Bombay. 165. 1839 *excl. syn. U. caerulea* L., *U. uliginosa* Vahl

*Utricularia spiricaulis* Miq. ex Oliv., J. Proc. Linn. Soc., Bot. 3: 180. 1859; *pro. syn. Type*: Pl. Indiae or. (Terr. Canara et confin.), In oryzetis pr. u. Mangalor., *s.d.*, *R.F. Hohenacker* 574 (holo, Fl [Fl009752 digital image!]; iso, E [E00273684 digital image!])

*Utricularia oryzetorum* Miq. ex C.B.Clarke in Hook.f. (ed.), Fl. Brit. India 4: 331. 1884. *pro syn*.

*Utricularia reticulata* Sm. var. *parviflora* Santapau, Kew Bull. 1948. 3: 491. 1949; J. Bombay Nat. Hist. Soc. 49(2): 220. 1950, Fl. Khandala (ed. 3) revised 188. 1967. *Type*: INDIA, **Maharashtra**, Khandala, *s.d.*, *Santapau* 5422 (holo, BLAT)

*Utricularia polygaloides auct. non* Edgew.: N.Mohanan & Sivad., Fl. Agasthyamala 492. 2002

Perennial, terrestrial, semi-aquatic to aquatic herbs. Rhizoids numerous on peduncle base, up to 40 mm long, capillary, branches 1–2 mm long, papillose. Stolons up to 60 mm long, 0.15–0.2 mm thick, profusely branched, branches hyaline, minutely papillose. Leaves numerous on stolons, mat-forming; petioles up to 6 mm long; lamina linear, 15–20 × 0.5–0.6 mm, 1-nerved, attenuate at base, obtuse at apex. Traps sub-globose, 0.8–1.2 (–1.6) × 0.5–1.2 (–1.5) mm, sub-dimorphic; those on leaves short stalked or sub-sessile, stalk 0.15–0.25 mm long, distally thickened; elsewhere stalk 0.4–0.5 mm long; mouth basal; appendages subulate, simple, glandular. Racemes

erect, vigorously twining, up to 100 cm long, up to 20-flowered; peduncles terete, 1–2.5 mm thick, green. Scales numerous, ovate, 1.65–2.2 × 1–1.75 mm, truncate at base, acute at apex. Bracts ovate, 3–3.5 × 0.7–1 mm, oblique, brownish green, truncate at base, acuminate at apex; bracteoles 1.5–2 × 0.3–0.5 mm, lanceolate, 1-nerved, rounded at base, narrowly acute at apex. Flowers 12–15 (–20) mm long; pedicels 6.5–10 × 1.2–1.5 mm, sub-erect in flower, winged, dorsiventrally compressed, accrescent (up to 20 mm long in fruiting), bluish green, reflexed in fruit. Calyx lobes sub-equal, purplish green, accrescent, (10–12 × 6–8 mm in fruiting); upper lobe ovate-elliptic, 6–8 × 3–4.2 mm, 14-nerved, acuminate at apex; lower lobe ovate, 6–8.5 × 3.5–4.5 mm, 14-nerved, bi-dentate at apex. Corolla deep blue, rarely mauve or purple; upper lip widely obovate, 8.5–10 × 7.45–10 mm, lower margin hairy, constricted just above the base, white-lilac with deep blue streaks, clear blue-mauve then, broader at middle, broader and longer than upper calyx lobe, margin entire, rounded or notched at apex; lower lip widely obovate to orbicular, 10–14 × 10–12 mm, ciliate along throat margin, throat yellow, palate prominently gibbous with obscurely 3-ridged swelling, palate white with deep blue-mauve striations, clear blue-purple or mauve then, truncate at apex; spur conical, 6.5–10 mm long, equal to or longer than lower calyx lobe, pale lilac or shiny white, slightly curved, narrowly acute at apex. Stamens 2.7–3 mm long; filaments strap-shaped, 2–2.4 × 0.5–0.7 mm, curved at base; anther thecae up to 1.2 mm long, bluish purple. Pistil 2.8–3 mm long; ovary ovoid-oblongoid, 1.6–2.3 × 1.2–1.4 mm, dorsiventrally compressed, purplish green; style 0.4–0.5 mm long, flat, pale purple; stigma bi-lipped, upper lip obsolete, truncate at apex, lower lip sub-orbicular, inflexed,

**Fig. 93.** Type of *Utricularia reticulata* Sm. Rheede Hort. Mal. 10: t. 70. 1689.

**Fig. 94**. *Utricularia reticulata* Sm.: **A.** Habit; **B.** Stolons with rhizoids, leaves and traps; **C.** Trap; **D.** Scale; **E.** Bract and bracteoles; **F.** Flower - lateral view; **G.** Calyx lobes; **H.** Upper lip of corolla; **I.** Lower lip of corolla with spur; **J.** Stamens; **K.** Pistil; **L.** Capsule; **M.** Seeds.

**Fig. 95.** *Utricularia reticulata* Sm.: Habitat and habit: **A, E & F.** Growing in a swampy land; **B.** Suspended above the water in a perennial pond; **C.** In the lateritic soils; **D.** Raceme - close-up; **G & H.** The mat-forming leaves.

deep violet, papillose out. Capsules ellipsoid, 5–6 × 3.25–4 mm, wall membranous, dehisce by marginally thickened longitudinal dorsal and ventral slits; placenta oblongoid to ellipsoid, 3.5–3.8 × 2–2.25 mm. Seeds numerous, obovoid-ellipsoid, 0.35–0.4 × 0.2–0.25 mm; surface striated with longitudinal ridges; hilum lateral.

***Flowering & fruiting***: Flowering occurs from July to March, with fruiting taking place from mid-August to the end of March. Peak flowering is observed during August to November. In habitats such as perennial watery lands, paddy fields and fallow lands, flowering can occur intermittently throughout the year.

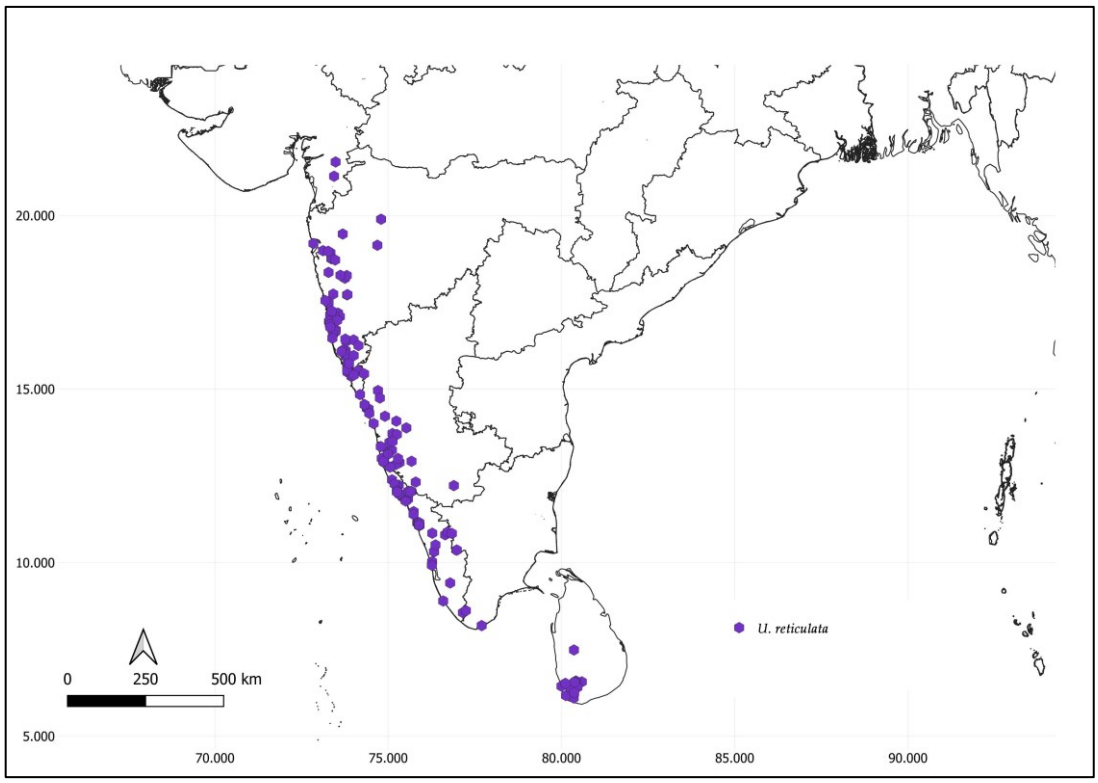


**Fig. 96.** Distribution of *Utricularia reticulata* Sm.

***Habitat***: *Utricularia reticulata* is usually found in fallow lands and along the margins of seasonal pools in lateritic areas. It often twines among itself or grows on paddy culms, sedges, and grasses. This species thrives in seasonally inundated lateritic plateaus, muddy seasonal pools, at elevations ranging from sea level to 1200 m. It can also be found as free floating in ponds and ditches. It is usually found in association with *U. cecilii, U. gibba*, *U. lazulina*, *Eriocaulon* spp. (Eriocaulaceae),

*Lindernia* sp. (Linderniaceae), *Rotala* spp. (Lythraceae), and members of Cyperaceae and Poaceae (Fig. 95).

***Distribution***: Endemic to Peninsular India and Sri Lanka (Punjani *et al*., 2014; POWO, 2025) (Fig. 96).

***Specimens examined***: INDIA, Concan, Regio. trop., *s.loc*., *s.d., J.E. Stocks & J.S. Law s.n.* (A01977129, P03575634, P03575642 digital images, MH00126855); Indea Orientalis, *s.loc*., 1832, *N. Wallich* 1493B (G00147711 digital image); Malabar, *s.loc*., 1805, *R.H. Beddome s.n.* (MH00126852); Peninsula Indiae Orientalis, *s.loc*., 13.11.1869, *Herb. Wight.* 2412, 2414 (A01977132, A01977131, P03575624 digital images). **Goa**, North Goa district, Valpoi, Nandore, 03.05.1953, *K.C. Kanodia* 883755; Vernem, Pelernem, 19.11.1962, *R. Seshagiri Rao* 84947 (BSI); Quepam, Maina, Bhirond Junction, 26.09.2023, *M.P. Krishnapriya* 186077 (CALI). **Karnataka**, Canara, Mangalore, *s.d*., *R.F. Hohenacker* 1847 (A01977123, P03575631, P03575640 digital images); *Ibid*., *s.d*., *R.F. Hohenacker* 1630 (P03575621, P03575623 digital images); *Ibid*., *s.d*., *R.F. Hohenacker* 574 (P03575632 digital image); Dakshina Kannada district, Belthangady, 25.11.1900, *C.A. Barber* 2529 (MH00126429, MH00126434, MH00126435, MH00126436); Kalehar, 19.04.1977, *R.S. Raghavan* 146482; Karakal, 17.05.1915, *s.coll.* 11974 (MH00126430, MH00126431, MH00126433); Mala, 02.10.1976, *R.S. Raghavan* 145720 (BSI); Kulshekar, ± 25 m, 19.08.1985, *M.K. Janarthanam* 82915 (BSID0012667, MH00126978, MH00126979); *Ibid*., Padavu, 50 m, 24.08.1980, *C.J. Saldanha* KPF12122 (JCB digital image); Hassan district, Byrapura, 09.10.1969, *C.J. Saldanha* 15217 (US03216999 digital image); *Ibid*., 16.08.1971, *T.P. Ramamurthy* HPF2049 (US03217002 digital image); Stream before Devalkere, 05.09.1970, *F.M. Jarrett, C. Saldanha & T.P. Ramamoorthy* HPF 689 (US03217005 digital image); Shimoga district, Tirthahalli, Karodi, 28.09.1962, *R. Sundara Raghavan* 82753; Yedur, Kavaledurga, 11.02.1963, *R. Sundara Raghavan* 86018 (BSI); Udupi district, Chittur Forest, 26.08.2007, *P.G. Diwakar & R.Kr. Singh* 191843; Mookambika WLS, Manmanhara Plateau, 17.10.2007, *P.G. Diwakar & R.Kr. Singh* 193201 (BSI); Wandse, 10.03.1916, *s.coll.* 12818 (MH00126428, MH00126432); Uttar Kannada district, *s.loc.*, September 1884, *W.A. Talbot s.n.*; Supa,

10.01.1894, *W.A. Talbot* 3230 (BSI); Yadgir district, Kondapur, 24.08.1892, *L.K. Banerjee & A.R.R. Shastry* 22713; Karwar, *s.d., V.D. Vartak* 124 (CAL). **Kerala**, Alappuzha district, Vembanad Lake, Cherthala, 02.01.1991, *M.S. Swaminathan* 95729 (MH00126797, MH00126798); Ernakulam district, Cochin, 1884, *M.A. Lawson s.n.* (MH00126824); Kannur district, Blathoor lateritic hillock, 30.09.2020, *M.P. Krishnapriya* 164382 (CALI186993, CALI186994); Ettabode, 02.10.1961, *C.J. Saldanha* CS7246 (US03217008 digital image); Kannoth, ± 140 m, 25.02.1979, *V.S. Ramachandran* 61906 (MH00126833, MH001269839); Paddy field near Kannoth R.F., ± 190 m, 18.02.1978, *V.S. Ramachandran* 54038 (MH00126835, MH00126837); Kuthuparambu, 22.09.1913, *s.coll.* 9340 (MH00126847, MH00126848); *Ibid.*, ± 100 m, 20.02.1983, *Rev. Fr. Kadavil* 30 (MH00126840); Paddy field near Kuthuparamba road, 18.11.1977, *V.S. Ramachandran* 52197 (MH00126834, MH00126836); Mambram, ± 75 m, 14.12.1979, *V.S. Ramachandran* 65204 (MH00126849, MH00126851); Pappinissery, 75 m, 04.10.1979, *R. Ansari* 64717 (MH00126845, MH00126850); Thalassery, October 1983, *s.coll. s.n.* (MH00126856); *Ibid.*, in Paddy field, 24.08.1985, *M.K. Janarthanam* 82931 (MH00126974, MH00126975, BSID0012617); Urathoor, Kaliyad, 19.08.2019, *M.P. Krishnapriya & Santhosh Nampy* 168084 (CALI188042); *Ibid.*, ± 215 m, 22.08.2019, *M.P. Krishnapriya & Santhosh Nampy* 168094 (CALI185465, CALI185466, CALI185467, CALI185468, CALI185469); Kasaragod district, Cherumba, 26.08.2021, *M.P. Krishnapriya* 175808 (CALI186988, CALI186989, CALI186990, CALI186991, CALI186992); Koyithatta lateritic plateau, 27.08.2021, *M.P. Krishnapriya & Santhosh Nampy* 175815 (CALI186995, CALI186996, CALI186997, CALI186998); Nileshwaram, 50 m, 11.05.1982, *V.J. Nair* 73835 (MH00126841, MH00126842); Kollam district, *s.loc.*, 04.08.1887?, *s.coll. s.n.* (MH00126862); Ranni, 325 m, 27.07.1978, *C.N. Mohanan* 58339 (MH00126863, MH00126864); Kozhikode district, Chaliyam, 10.12.1988, *N.B. Sreedevi* 1260 (CALI141526); Feroke, *s.d., A.V. Sreeja* 4729 (CALI141532); *Ibid.*, 15.11.1991, *Meera Nair* 1840 (CALI141535); near Iringal Railway station, ± 3 m, 25.08.1985, *M.K. Janarthanam* 82935 (MH00126818, MH00126819, BSID0012618); Kadalundi, 50 m, 03.01.1978, *Mitha Krishnan* 24887 (CALI141520); IISR Peruvannamuzhy, 40 m, 28.08.1996, *James Philip* 55394 (CALI141512, CALI173896); Malappuram district,

Calicut University Campus, 40–60 m, 16.07.1981, *T. Beena Joseph* 147 (CALI141531); *Ibid*., 10.08.1981, *P. Yamuna Bai* 12120 (CALI141521); *Ibid*., 26.10.1987, *A.K. Prasitha* 12885 (CALI141516); *Ibid*., 26.12.1987, *K. Mohanan* 10261 (CALI141524); *Ibid*., 26.12.1987, *P.S. Ajitha* 13520 (CALI141519); *Ibid*., 02.01.1988, *N.P. Surayya Beegam* 13740 (CALI141515); *Ibid*., 18.01.1988, *T. Sujaya* 10923 (CALI141514); *Ibid*., 02.05.1988, *A.C. Jayalakshmi* 12484 (CALI141518); *Ibid*., 45 m, 02.01.1989, *S. Santha* 3351 (CALI141523); *Ibid*., 45 m, 02.01.1989, *V.P. Premalatha* 2948 (CALI141527); *Ibid*., 15 m, 20.07.1990, *K. Aravind* 1408 (CALI141530); *Ibid*., 09.06.1991, *T.P. Sheeja* 3042 (CALI141540); *Ibid*., 11.09.1991, *C. Thulasi* 5411 (CALI141533); *Ibid*., 25.09.1991, *Jaisy Emmanuel* 1412 (CALI141537); *Ibid*., 10.01.1992, *U. Sreekala* 5150 (CALI141534); *Ibid*., 45 m, 04.09.1997, *M.K. Shyja* 52673 (CALI187721); *Ibid*., 45 m, 11.10.1997, *K.C. Sindu* 50553 (CALI187672); *Ibid*., 24.10.2003, *P. Reji* 94140 (CALI160883); *Ibid*., 45 m, 14.11.2003, *A. Swapna Thomas* 94661 (CALI160880); *Ibid*., 14.11.2003, *Jayatha Jayapalan* 94314 (CALI160884); *Ibid*., 03.01.2004, *M. Amritha* 93658 (CALI160882); *Ibid*., 10.10.2009, *P.T. Asha Vasudevan* 125028 (CALI141513); Chelari, Thrikannur Shiva Temple, ± 17 m, 21.10.2021, *M.P. Krishnapriya & Santhosh Nampy* 177224 (CALI185473, CALI185474, CALI185475, CALI185476, CALI185477); Chelembra, 50 m, 19.09.1976, *C.R. Suresh* 22228 (CALI107757, CALI107758, CALI107759, CALI107760, CALI107761); Chettiyarmadu, 12.01.2003, *N. Shylaja* 88410 (CALI160885); *Ibid*., 45 m, *s.d., Sulu Meeran* 96232 (CALI160879); Chovva, 45 feet, 30.12.1988, *M. Beena* 3728 (CALI141517); Engandiyur, 04.08.1991, *T.S. Devi* 1242 (CALI141539 Olipram, 20.10.1988, *K.V. Jayakumar* 851 (CALI141522); Kakkanchery, 5 m, 03.12.1990, *A. Yusuf* 2308 (CALI141529); Olipram Kadavu, 23.07.1988, *E. Jayakumar* 2146 (CALI141528); *Ibid*., 28.10.1988, *P.P. Sudhirkumar* 2634 (CALI141525); Tirur, 11.08.1991. *T. Rajasree* 2775 (CALI141538); Palakkad district, *s.loc*., 21.12.1916, *s.coll.* 14194 (MH00126857, MH00126858, MH00126859, MH00126860, MH00126861); Malampuzha water tank hillock, 15.09.1985, *M.K. Janarthanam* 82938 (MH00126816, MH00126817, BSID0012619); Olavakkode, 75 m, 05.02.1964, *J. Joseph* 17595 (MH00274879, MH00126854); Thiruvananthapuram district, Bonacaud, 22.12.1988, *N. Mohanan* 7951 (CALI123021); Kadinamkulam to Anjuthengu, 04.11.1904, *C.A. Barber* 6772

(MH00126820, MH00126821, MH00126822, MH00126823, MH00126832); Kaviar near Agasthyar peak, 29.09.1978, *M. Mohanan* 54705 (MH00126825, MH00126830); Cultivated field near Kottur R.F., 175 m, 29.09.1973, *J. Joseph* 44463 (MH00126826, MH00126831); Thrissur district, Chalakudi 25 m, 15.09.1976, *K. Ramamurthy* 48532 (MH00126827, MH00126829); *Ibid.*, 100 m, 08.12.1965, *K.M. Sebestine* 26667 (MH00126828, MH00126853). **Maharashtra**, Veral, 18.09.2003, *M.N. Vijay s.n.* (AHMA); Ahmednagar district, Deosade, Kalaye, 19.09.2001, *M.N. Datar* 179053 (BSI); Kolhapur district, Radhanagari, 20.09.2018, *M.P. Krishnapriya & Santhosh Nampy* 168023 (CALI197480, CALI197481, CALI197482); Pune district, Ambavane road, INS Shivaji, 12.10.1985, *M.K. Janarthanam* 82958 (MH00126865, MH00126866, BSID0009229); Lonavala, 12.11.1904, *L.D. Garade s.n.* (BSI); Raireshwar, 3800 feet, 12.12.1958, *V.D. Vartak* 121; near Rahat, 3500 feet, 13.11.1954, *V.D. Vartak* 340 (AHMA); Raigad district, Karnala, *R. Manalavyane* K.1153 (AHMA); Ratnagiri district, Janaule Village, 25.11.1691, *M.Y. Ansari* 78461; Phonda, Devichirai, 03.10.1970, *B.G. Kulkarni* 121379; Rajapur, ± 80 m, 11.08.2022, *M.P. Krishnapriya* 177282 (CALI197483); neighbourhoods of Rajapur, Jaithapur, 10 km, WSW of Rajapur, 70 m, 28.08.2019, *D.D. Sokoloff, Nuraliev M.S., Platonova A.G., Remizowa M.V., Severova E.E., Borude D. & A. Chnadore* 1-60 (MW0758887 digital image); way to Sawantawadi, near Kudal, 26.10.1969, *B.G. Kulkarni* 119042; (BSI); Sawantawadi, 1200 feet, 20.11.1902, *J.H. Burkill* 17566 (BSI000007296 digital image); Sindhudurg district, Achirne, 20.09.2018, *M.P. Krishnapriya & Santhosh Nampy* 168019 (CALI198502, CALI198503); Vengurla, 21.11.1902, *J.H. Burkill* 17588 (BSI000007306 digital image); *Ibid.*, December 1964, *V.D. Vartak*, G-852 (AHMA); near Road 117, N 16˚26'19.6'' E 073˚45'43.4'', 21.08.2016, *S.R. Yadav, M.M. Lekhak & D.D. Sokoloff* WG5 (MW0753509 digital image). **Tamil Nadu**, Coimbatore district, Walayar, 367 m, 01.01.1958, *K. Subramanyam* 5410 (MH00126410, MH00126411). SRI LANKA, *s.loc.*, *s.d.*, *s.coll.* CV2088 (MH00127020); *s.loc.*, *s.d.*, *s.coll.* CV2090 (MH00127019); *s.loc.*, *s.d.*, *s.coll. s.n.* (MH0012718). **Eastern Province**, Batticaloa district, Kalmune road, *c.* 4 miles south of Batticaloa, 16.03.1973, *C.C. Townsend* 73/263 (P03575638 digital image). **Sabaragamuwa Province**, Ratnapura district, Bulutota pass from Rakwana, *c.* 2500 feet, 29.06.1972, *F.N. Hepper,*

*R.H. Maxwell & C. Fernando* 4568 (P03575641 digital image); Karawita Kanda, ± 150 m, 09.01.1979, *L.H. Cramer* 5255 (L.2828199 digital image); Panapole-Sinharaja, ± 250 m, 27.02.1977, *S. Waas* 2072 (MU000309912, US03216995 digital images); Rajjuruwatta on Kalawana-Padikanda road, *c.* 6˚33'N, 80˚23'.40''E, c. 250 m, 02.12.1976, *R.B. Faden & A.J. Faden* 76/444 (US03216990 digital image); Singhajala, Sinharaja Forest, 31.08.1981, *G. Thanikaimoni* GT1705 (HIFP012167 digital image); Watarwa (Singharaja), 30.08.1981, *G. Thanikaimoni* GT1670 (HIFP012166 digital image). **Southern Province**, Galla district, *c.* 1 mile SE of Yakkalamulla at mile post 14 along road to Imaduwa, 100 feet, 21.10.1974, *G. Davidse* 7832 (UMO6132523, L3886295, US03216991 digital images); Gonapinnuwala, 09.10.1969, *L.H. Cramer* 2704 (US03216992 digital image). **Western Province**, Kalutara district, along stream midway between Pahala Hewessa and Ihala Hewessa, *c.* 80˚16'E 6˚23'N, ± 150 m, 17.02.1977, *B. Bremer & K. Bremer* 814 (US03216997 digital image); between Horawela and Moragala, 25.09.1977, *H. Huber* 290 (US03217004 digital image); Matugama, 27.06.1975, *S. Wass* 1269 (UMO2351527, RSA0229782 digital images); Mile marker 30/1, on Alutgama to Matugama road, 27.01.1972, *N. Balakrishnan* NBK1156 (UMO2303109 digital image); Ceylon, 1870, *Thwaites* CV2090 (A01977127; P03575628 digital images).

***Conservation status***: Field studies and herbarium consultations indicate a significant decline in the habitats of *U. reticulata*. Farmers and locals report that this species was once abundant in paddy fields but has diminished due to the widespread use of pesticides, insecticides and chemical fertilizers. Similarly, *U. reticulata* was once common in the lateritic plateaus of northern Kerala, Karnataka Goa and Maharashtra. However, habitat loss and fragmentation from construction, mining, quarrying for laterite stones, and other developmental activities have further reduced its population. Based on data, the species is assessed as Near Threatened (NT).

***Notes***: *Utricularia reticulata* is a robust, distinctive perennial species that inhabits both terrestrial and aquatic habitats. It is known for having the largest and most striking inflorescence of any *Utricularia* species in India. The inflorescence forms a blue

bouquet, usually consisting of 10 to 15 peduncles twining among themselves (Fig. 97). *Utricularia reticulata* was first mentioned as '*Nelipu* by van Rheede (1689) in his *Hortus Malabaricus*'. The species is characterised by its robust, twining peduncles, 1-nerved linear leaves, large flowers with a gibbous palate, and reflexed fruiting pedicels. Linnaeus (1753) mistakenly cited Rheede's illustration under *U. caerulea,* but Smith (1808) corrected this by describing it as *U. reticulata*, based on Rheede's illustration. Smith (*l.c.*) also provided his own illustration when describing the species. Later, *U. reticulata* treated by Taylor (1989) and, Janarthanam and Henry (1992) cited both Smith and Rheede's illustrations as types. However, the correct material based on Smith's name is actually Rheede's *Nelipu*, making Rheede's illustration the type for this species.

**Fig. 97.** *Utricularia reticulata* Sm. showing flower colour variations

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**16. Utricularia sainthomia** P.Biju, Josekutty, Janarth. & Augustine, Rheedea 30(2): 270. 2020. *Type*: INDIA, **Kerala**, Kasaragod district, Koyithatta lateritic plateau, N 12°19'43.7", E 075°15'11.9", 155 m, 12.07.2015, *Biju & Jomy* 1008 (holo CAL not seen; iso MH not seen). **Figs. 98 & 99**

Annual, terrestrial herbs. Rhizoids a few on peduncle base and stolon nodes opposite to leaves, up to 10 mm long, 0.1–0.2 mm thick, simple to branched, branches up to 2 mm long, capillary, tapering towards apex, papillose. Stolons numerous, terete, up to 30 mm long, 0.1–0.3 mm thick, branched, hyaline-pale green. Leaves each on stolon nodes; petioles 2.2–3 × 0.5–0.67 mm, dorsiventrally flattened, hyaline; lamina spathulate to widely obovate, 4–6.5 × 1.2–1.5 mm, 3-nerved, green, narrowly cuneate at base, rounded at apex. Traps numerous on leaves and stolons, more or less oblate; those on leaves larger than lamina, 1.7–3 mm across; stalk terete, 0.2–0.4 mm long, glabrous, those on stolons 1–2 mm across; mouth lateral; appendages subulate, incurved, glabrous. Racemes erect, 3–8 cm long, 1–2 (–4)-flowered, simple, rarely branched; peduncles 0.4–0.6 mm thick, terete at base, angular then, grooved on one side, brownish green. Scales a few towards peduncle base, ovate, 0.8–1 × 0.4–0.7 mm, 1-nerved, truncate at base, acute at apex. Bracts ovate, 1–1.3 × 0.65–1 mm, 1-nerved, truncate at base, acute at apex; bracteoles lanceolate, 0.5–0.6 × 0.15–0.2 mm, acute at apex. Flowers 6.5–7 mm long; pedicels 2.5–3.5 mm long, erect at anthesis, winged, reflexed in fruit, greenish purple. Calyx lobes sub-equal, greenish purple to greenish brown; upper lobe ovate, 3–3.3 × 2.5–2.75 mm, 8–10-nerved, acute at apex; lower lobe ovate, 2.8–3.2 × 2–2.5 mm, 9-nerved, emarginate at apex. Corolla usually pale purple-violet, sometimes pink; upper lip oblong-obovate, 3–3.5 × 2.5–3 mm, constricted at middle, white or lilac with purple streaks, wider than upper calyx lobe, truncate-rounded at apex; lower lip broadly oblong, 3.3–5.5 × 3.5–6 mm, throat yellow, ciliate along margin; palate bi-gibbous, pale to deep purple with dark purplish striations, faint towards margin, margin undulate, emarginate at apex; spur subulate, 3.7–4.5 mm long, descending, longer than lower calyx lobe, lilac-mauve, narrowly acute at

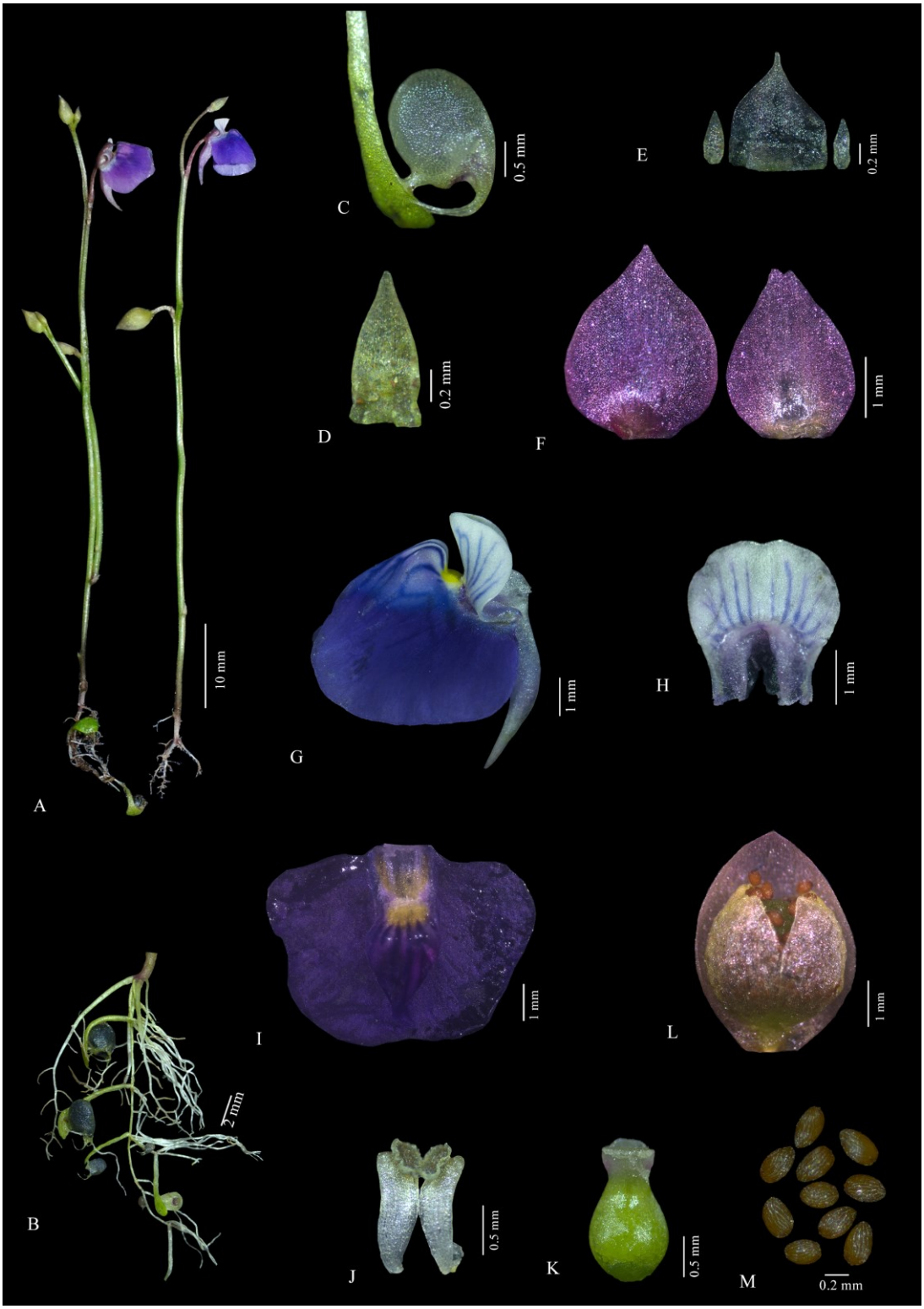


**Fig. 98.** *Utricularia sainthomia* P.Biju *et al.*: **A.** Habit; **B.** Peduncle base bearing stolons with rhizoids, leaves and traps; **C.** Trap; **D.** Scale; **E.** Bract and bracteoles; **F.** Calyx lobes; **G**. Corolla - lateral view; **H.** Upper lip of corolla; **I.** Lower lip of corolla; **J.** Stamens; **K.** Pistil; **L.** Capsule; **M.** Seeds.

**Fig. 99.** *Utricularia sainthomia* P.Biju *et al.*: **A-C.** Habitat and habit; **D-K.** Flower in different view; **L.** Subterraneous leaves and traps.

apex. Stamens up to 1.3 mm long; filaments flattened, 0.85–1.2 × 0.18–0.2 mm, hyaline-pale lilac; anther theca 0.4–0.6 mm long. Pistil 1.5–1.8 mm long; ovary ovoid, 0.8–1 × 0.6–0.8 mm; style 0.1–0.15 mm long, stigma bi-lipped, upper lip obscurely three lobed, lateral lobes obsolete, middle lobe large, oblong, hooded; lower lip sub-orbicular, recurved, papillose out. Capsules widely ellipsoid, 2–2.5 mm across, wall uniformly membranous, dehisce by a ventral longitudinal slit; placenta globose, 1.4–1.6 mm across. Seeds ellipsoid-oblongoid, 0.35–0.4 × 0.2–0.25 mm; surface striated with transversal ridges; hilum terminal.

***Flowering & fruiting***: Flowering occurs from mid-July to late August, and fruiting taking place from the end of July to early September. Peak flowering is observed in August.

***Habitat***: *Utricularia sainthomia* grows in seasonally flooded lateritic plateaus, intermingled with *U. lazulina*, *U. caerulea*, *Drosera indica* (Droseraceae), *Burmannia coelestis* (Burmanniaceae), *Eriocaulon* spp. (Eriocaulaceae), *Murdannia semiteres* (Commelinaceae), *Rhamphicarpa* sp. (Orobanchaceae), *Rotala* spp. (Lythraceae), *Smithia* sp. (Fabaceae) and some sedges and grasses (Fig. 99).

***Distribution*:** Endemic to the Western Ghats, India (Fig. 84).

***Specimens examined***: INDIA, **Kerala**, Kannur district, Blathoor, 19.08.2019, *M.P. Krishnapriya* 168082; Kaliyad, 26.08.2019, *M.P. Krishnapriya* 168095; Kankol, Chooral, 31.07.2022, *M.P. Krishnapriya* 177260 (CALI197409, CALI197410); Kasaragod district, Karindalam, 27.08.2021, *M.P. Krishnapriya & Santhosh Nampy* 175818; *Ibid*., 15.08.2023, *K.P. Vaishnavi* 200016 (CALI); Koyithatta lateritic plateau, 31.07.2022, *M.P. Krishnapriya & Santhosh Nampy* 177265 (CALI197407, CALI197408); Pothamkandam, 15.08.2023, *K.P. Vaishnavi* 200015 (CALI); Tholeni, 31.07.2022, *M.P. Krishnapriya & Santhosh Nampy* 177266 (CALI197406).

***Conservation status***: *Utricularia sainthomia* is a rare and uncommon species found only in the lateritic plateaus of the Kannur and Kasaragod districts in Kerala. It occurs in scattered populations and does not form large groups or extensive patches. During my field study, *U. sainthomia* was first collected in 2019 from the Blathoor Hills of

Kannur district. Unfortunately, this location became unrecognizable within just two years due to large-scale mining and quarrying for laterite stones. The dumping of quarry waste, firing, land reclamation, construction, and other developmental activities also cause serious threats to its habitat. The AOO is calculated to be 7.00 $km^2$ and the EOO is 596.751 $km^2$ (considering the limited population size, 1 × 1 km grid cell was used to scale the AOO). Based on the current data, *U. sainthomia* is categorised as Critically Endangered (CR B1ab(i,ii,iii,iv,v)+ 2ab(i,ii,iii,iv,v)+ c(i,ii,iii,iv); D).

***Notes***: *Utricularia sainthomia* is a small species, usually less than 8 cm long, and is characterized by obovate-spathulate leaves, lateral traps that are larger than the leaf lamina, reflexed fruiting pedicels, a broad upper lip of the corolla, a bi-gibbous palate on the lower lip of the corolla, and a striated testa. It shares affinities with *U. albocaerulea* and *U. malabarica* in having reflexed fruiting pedicels and broad upper lip of the corolla, but its lateral trap distinguishes it from these species. Interestingly, despite being a small herb, *U. sainthomia* possesses the largest traps, which are typically larger than the leaf lamina. Moreover, it has a very short lifespan compared to other species in this section. A more detailed study of its developmental biology, trap anatomy, ecological aspects, and nutrient acquisition strategies would give a better understanding of this interesting species.

**17. Utricularia scandens** Benj., Linnaea 20: 309. 1847; Hutch. & Dalzell (eds.), Fl. W. Trop. Afr. Ed. 2: 378. 1963; P.Taylor, Kew Bull. 18: 46.1964; S.V.Ramaswamy & Razi, Fl. Bangalore Dist. 548. 1973; R.K.Basak, Bull. Bot. Surv. India 17: 104. 1975; P.Taylor, Fl. Males. 1(8): 283. f. 6. 1977; Gandhi in C.J.Saldanha & Nicolson (eds.), Fl. Hassan Dist. (sec. reprint) 565. 1978; Vajr., Fl. Palghat Dist. 331. 1980; N.Rani & K.M.Matthew in K.M.Matthew (ed.), Fl. Tamilnadu Carnatic 3(1): 1120. t. 86g. 1983; A.K.Mukh., Fl. Pachmarhi & Bori Reserves 217. 1984; D.M.Verma in D.M.Verma *et al.* (eds.), Fl. Raipur, Durg & Rajnandgaon 267. 1985; N.P.Singh, Fl. E. Karnataka 2: 474. 1988; P.Taylor, Gen. *Utricularia* 379. t. 109. 1989; J.L.Ellis, Fl. Nallamalais 2: 291. 1990; Kesh.Murthy & Yogan., Fl. Coorg (Kodagu) Karnataka 318: 1990; Janarth. & A.N.Henry, Bladderworts India 97. t. 29. 1992; M.Mohanan & A.N.Henry, Fl. Thiruvananthapuram 335. 1994; K.M.Matthew, Excurs. Fl. Central Tamilnadu (repr.

ed.) 1: 359. 1995; Moulali in Pull. & Moulali (eds.), Fl. Andhra Pradesh 2: 678. 1997; R.C.Srivast. in Mudgal *et al*. (eds.), Fl. Madhya Pradesh 2: 254. 1997; K.M.Matthew, Fl. Palni Hills part 2. 906. 1999; L.K.Banerjee & T.A.Rao, Fl. Mahanadi Delta 227. 2001; N.P.Singh *et al*., Fl. Bihar, Analysis 367. 2001; Londhe in N.P.Singh *et al.* (eds.), Fl. Maharashtra Dicot. 2: 566. 2001; Subba Rao & Kumari, Fl. Visakhapatnam Dist. 1: 601. 2003; K.K.Khanna *et al*., Florsit. Diversity Chhattisgarh 331. 2005; Li in Wu *et al*. (eds.), Fl. China 19: 483. 2011; R.Manik. & Lakshmin. Fl. Rajiv Gandhi Natl. Park 292. 2013; K.Kumar *et al*., Fl. Pl. Shola Grasslands Nilgiris 262. 2013; R.Ansari *et al*., Aquatic Wetland Fl. Kerala: Fl. Pl. 527. 2016; Kullayiswamy *et al*., Fl. Thummalapalle Uranium Mining Area Andhra Pradesh 311. 2017; S.K.Mandal & Bhaumik in Lakshmin. *et al*. (eds.), Fl. West Bengal 4: 146. 2019; A.N.Shukla in G.P.Sinha & A.N.Shukla (eds.), Fl. Uttar Pradesh 2: 255. 2020. *Type*: INDIA, Madras, Arcot, *s.d.*, *Chutter s.n.* (holo, K [K000450588 digital image!]). **Figs. 100–103**

*Utricularia volubilis* Hook ex Benj., Linnea 20: 309. 1847. *pro syn*.

*Utricularia macrolepis* Wight, Hooker's J. Bot. Kew Gard. Misc. 1: 373. 1849, Icon. Pl. Ind. Orient. 4(4): 11. t. 1580. f. 2. 1850 as '*macrolipis*'. *Utricularia wallichiana* Wight var. *macrolepis* (Wight) Gamble, Fl. Madras 982. 1924. *Type*: INDIA, **Tamil Nadu**, Courtallum, 1837, *Wight* 2709-b (holo, K [K000628545 digital image!])

*Utricularia wallichii* Wight, Hooker's J. Bot. Kew Gard. Misc. 1: 372. 1849, Icon. Pl. Ind. Orient. 4(4): 9. t. 1572. 1850 as '*wallichiana*', *nom. illeg*. *homonym*; Oliv., J. Proc. Linn. Soc., Bot. 3: 182. 1858 *p.p. excl. U. wallichiana* var. *firmula* Oliv.; Drury, Handb. Ind. Fl. 2: 124. 1866 *excl.* var. 1 *p.p.*; C.B.Clarke in Hook.f. (ed.), Fl. Brit. India 4: 332. 1884; Prain, Bengal Pl. 2: 781. 1903; Haines, Bot. Bihar Orissa 4: 646. 1922; Fyson, Fl. Nilgiri & Pulney Hill-Tops 1: 307. 1915; Gamble, Fl. Madras 982. 1924; Fyson, Fl. S. Ind. Hill Stations 1: 437. 1932 *Lectotype* (designated here): INDIA, **Tamil Nadu**, Courtallum, 1837, *Wight* 2709-a (K [K000628543 digital image!]). *Residual syntypes*: Serra Mullay, October 1836 (K [K000628544 digital image!]); INDIA, Nilghiris, June 1849, ex *herb*. *Wight* (K [K000628541 digital image!])

*Utricularia wallichiana* Wight var. *scandens* (Benj.) Oliv., J. Proc. Linn. Soc., Bot. 3: 182. 1858

*Utricularia bifida* L. var. *wallichiana* Thwaites, Enum. Pl. Zeyl. 171. 1860

**Fig. 100.** Type of *Utricularia scandens* Benj. [*Chutter s.n.* (K000450588)] "© *Board of Trustees of the Royal Botanic Gardens, Kew*".

Annual, terrestrial herbs. Rhizoids a few, 10–15 mm long, simple to branched, papillose. Stolons numerous, 10–40 mm long, terete, filiform, simple-branched, internodes 4–6 mm long, pale green-hyaline, glabrous. Leaves numerous on stolons; petiole indistinct; lamina linear-oblanceolate, 2.5–6 × 0.3–0.4 mm, 1-nerved, narrowly cuneate at base, rounded at apex. Traps numerous on stolons and leaves, globose, 0.6–1 × 0.65–1 mm, more or less oblate, stalked; stalk 0.1–0.5 mm, thick near mouth with a ventral appendage near distal end of stalk, glandular; mouth basal; appendages subulate. Racemes twining, up to 15 cm long, 1–9-flowered, rarely erect in early blooms; peduncles filiform, 0.25–0.4 mm thick, flexuous, glabrous. Scales numerous, lance-ovate, 0.8–1.2 × 0.3–0.4 mm, ascending or diverging, 1-nerved, fertile, covering young buds, truncate at base, acuminate-caudate at apex. Bracts 1–1.5 × 0.65–0.8 mm, widely ovate, 1-nerved, truncate at base, acuminate-caudate at apex; bracteoles linear to lanceolate, 0.6–0.8 × 0.06–0.1 mm, 1-nerved, narrowly acute at apex. Flowers 4–10 mm long; pedicels 2–4 mm long, erect at anthesis, winged, erect or slightly horizontal in fruiting. Calyx sub-equal, accrescent (3.25–4.2 × 2.5–3 mm in fruit), green-brownish yellow; upper lobe ovate, 2.2–3 × 1.2–1.85 mm, 11-nerved, acuminate at apex; lower lobe ovate, 2–2.8 × 1–1.6 mm, 10-nerved, bi-dentate at apex. Corolla yellow; upper lip oblong, 2.3–3.5 × 1.7–2 mm, hairy along lower margin, constricted at the middle, yellow, shorter than or shortly exceeds upper calyx lobe, rounded to deeply emarginate at apex; lower

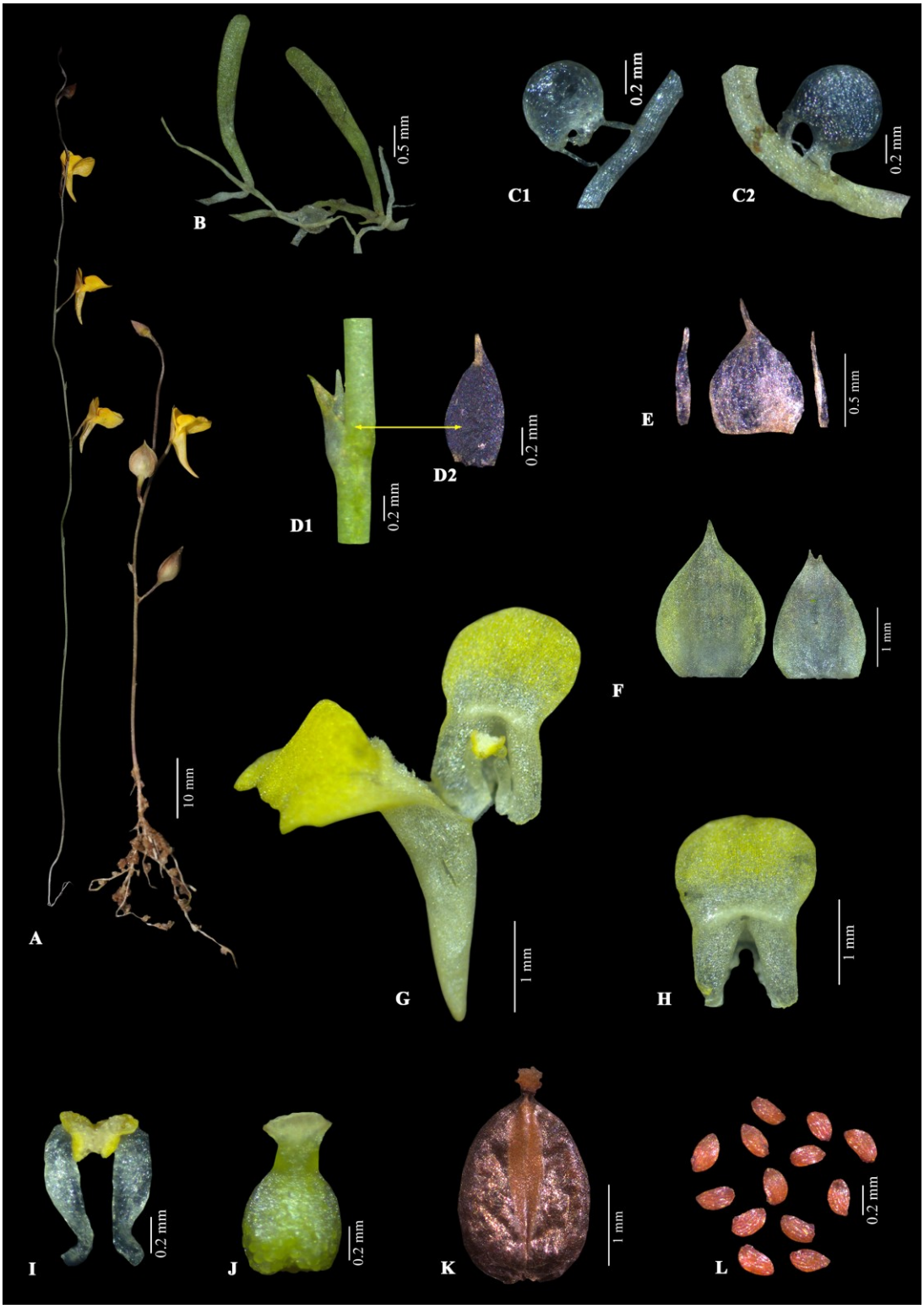


**Fig. 101.** *Utricularia scandens* Benj.: **A.** Habit; **B.** Stolons with leaves and trap; **C1.** Trap on stolon; **C2.** Trap on lamina; **D1. & D2.** Peduncle bearing fertile scale; **E.** Bract and bracteoles; **F.** Calyx lobes; **G.** Corolla opened; **H.** Lower lip of corolla; **I.** Stamens; **J.** Pistil; **K.** Capsule; **L.** Seeds.

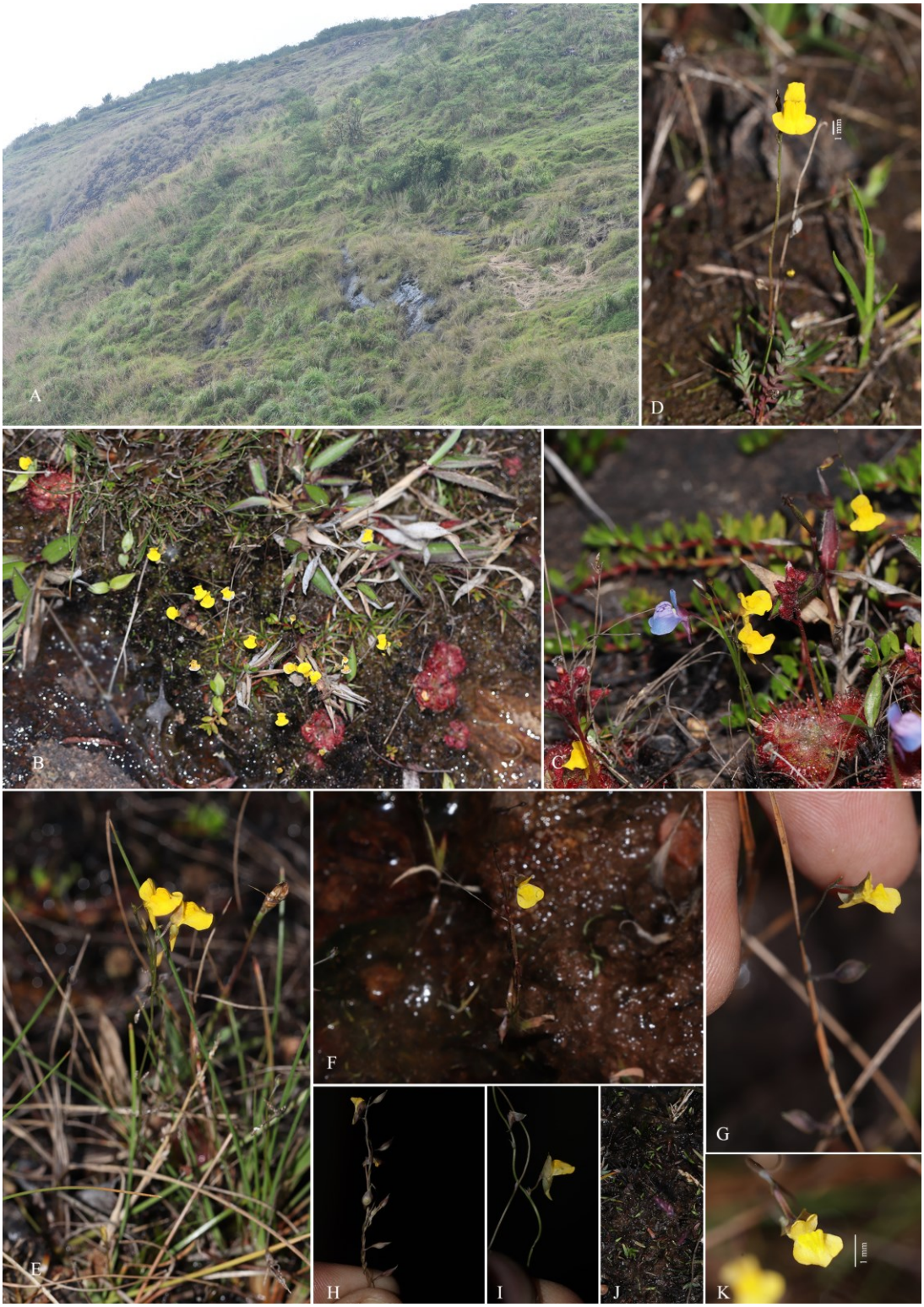


**Fig. 102.** Habitat and habit of *Utricularia scandens* Benj.

lip widely obovate to sub-orbicular, 3.2–4.5 × 2–3.2 mm, ciliate along throat margin, palate raised into prominently four-lobed swelling (4-gibbous), yellow, margin entire, rounded to emarginate at apex; spur 4–6 mm long, subulate or rarely conical, straight or descending, yellow, narrowly acute at apex. Stamens 0.8–1 mm long; filaments oblong, 0.7–0.75 × 0.18–0.2 mm, curved at base, hyaline; anther thecae 0.3–0.35 mm long, yellow. Pistil 1–1.2 mm long; ovary oblongoid-ovoid, 0.6–0.7 × 0.58–0.62 mm, pale green; style 0.2–0.25 mm long, green; stigma bi-lipped, upper lip oblong, lower lip sub-orbicular, papillose out. Capsules ellipsoid, 2.4–2.6 × 1.5–1.65 mm, dorsiventrally compressed, dehiscing by single ventral longitudinal slit, thickened along dehiscing margin; placenta oblong, 1.4–1.5 × 0.9–1 mm, compressed. Seeds numerous, obovoid-ellipsoid, 0.25–0.3 × 0.13–0.15 mm; surface rough; hilum latero-terminal.

***Flowering & fruiting***: Flowering occurs from September to March, with fruiting taking place from mid-September to early April. Peak flowering is observed during December and January.

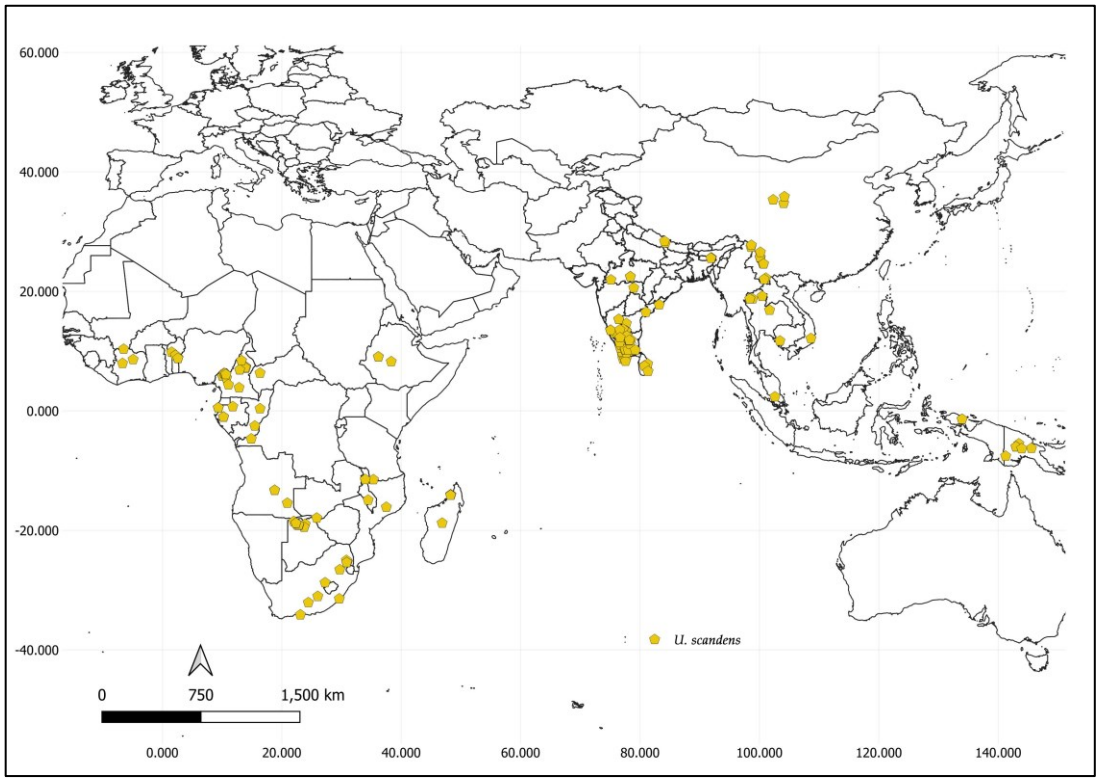


**Fig. 103.** Distribution of *Utricularia scandens* Benj.

***Habitat***: *Utricularia scandens* usually prefers open areas with wet sandy soil, swampy soil, or seasonally wet grassy patches situated above rocky surfaces. It often twines among itself, grasses, or other plants, frequently in association with *U. caerulea, U. cecilii, U. graminifolia, U. uliginosa*, *Drosera indica*, *D. burmanni* (both Droseraceae), *Exacum sessile* (Gentianaceae), *Eriocaulon* spp. (Eriocaulaceae), *Murdannia semiteres*, *M. vaginata* (both Commelinaceae), etc. and some grasses and sedges (Fig. 102).

***Distribution***: India, Angola, Bangladesh, Botswana, Cameroon, Central African Republic, China, Congo, Ethiopia, Gabon, Guinea, Ivory Coast, Laos, Madagascar, Malawi, Mozambique, Myanmar, Nepal, New Guinea, Nigeria, Peninsular Malaysia, Sri Lanka, Sudan, Thailand, Vietnam, Zambia and Zimbabwe (Taylor, 1989; POWO, 2025) (Fig. 103).

***Specimens examined***: INDIA, **Andhra Pradesh,** Anantapur district, Garugudukona, 350 m, 21.12.1982, *T. Pullaiah* 953 (MH00126636); Chittoor district, Puttur to Kailasakona, 450 m, 26.06.1969, *G.V. Subba Rao* 32025 (MH00126638, MH00126639); Kadapa district, Thummalapalli Uranium mining area, 26.01.2014, *Raja K. Swamy* FAP42032 (JCB digital image); Visakhapatnam district, Anjoda-Gengi Gedda, 925 m, 12.03.1965, *G.V. Subba Rao* 22606 (MH00126635, MH00126637). **Karnataka**, Chikkaballapur district, Bagepalli, Ittikaldurg, 28.02.1975, *N.P. Singh* 184586 (BSI); Chikkaballapur to Bangalore Road, 9$^{th}$ mile, 27.02.1975, *N.P. Singh* 134548 (BSI); Hassan district, road to Magge, 29.10.1969, *C.J. Saldanha* 15457 (JCB digital image); Shivamogga district, Agumbe, Onake Abbi Falls, 03.11.1960, *R. Sundara Raghavan* 68102 (BSI); Tumkur district, Gounbinur, Madhugiri road, 28.10.1975, *N.P. Singh* 141104 (BSI); Vijayanagara district, Hampi, 14.11.2022, *M.P. Krishnapriya* 186021 (CALI197444). **Kerala,** Idukki district, Hill View Park, ± 3600 feet, 10.12.2019, *M.P. Krishnapriya, P. Jiji & K.K. Jeomol* 164333 (CALI185499, CALI185500); Kollam district, Pandyanpara Hilltop, Ariankavu, 02.12.1961, *K.N. Subramanian* 77380 (BSI); Palakkad district, Nelliyampathy, Chandramala, 23.11.2022, *M.P. Krishnapriya* 186027 (CALI199587); Thiruvananthapuram district, Forest near Bonacaud Estate, 500m, 09.10.1973, *J. Joseph* 44645 (MH00126621, MH00126724). **Madhya Pradesh**, Hoshangabad district, way to Jambu Deep, 12.11.2021, *M.P. Krishnapriya* 177241 (CALI197495, CALI197496); Jambu Deep Nala, Stream side, 12.11.2021, *M.P.*

*Krishnapriya* 177244 (CALI197497); Pachmarhi, near Bee Falls, 18.02.1891, *Nair* 10493 (DD). **Maharashtra**, Solapur district, Gangevadi, 20.12.2011, *J. Jayanthi* 199375 (BSI). **Tamil Nadu**, Coimbatore district, Anamalai, *s.d.*, *s.coll. s.n.* (MH00126659); *Ibid.*, Poonachi, 10.10.1901, *C.A. Barber* 3732 (MH00126716); *Ibid.*, 1100m, 24.01.1962, *J. Joseph* 13581 (MH00126650, MH00126717); Slopes of Ethuwarai, 21.11.1962, *C.P. Sreemadhavan* CPS311 (MH00126652); Perumalmudi, 1125 m, 21.04.1970, *M.V. Viswanathan* MVV556 (MH00126651, MH00126653); Dharmapuri district, Chitteri hills, Chinna Bottumalai, 1200 m, 09.01.1980, *K.M. Matthew* 25622 (RHT044768); Dindigul district, Kodai Lake banks, 2050 m, 19.06.1988, *K.M. Matthew* 5322 (RHT044746); Kodaikanal, new reservoir, 2250 m, 04.08.1985, *K.M. Matthew* 41685 (RHT044741); above Kumbaikkad, Palani ghat road, 07.02.1985, *K.M. Matthew* 40907 (RHT044645); Mannavanur, Lake exit, 1900 m, 26.10.1988, *K.M. Matthew* 53683 (RHT044747); Palamalai, 1220 m, 19.02.1986, *K.M. Matthew* 44165 (RHT044742); *Ibid.*, 1300 m, 14.08.1986, *K.M. Matthew & M. Charles* 46184 (RHT044743); Palni 09.06.1898, *Bourne* 304 (MH00126657), *Ibid.*, Hills, Lake marsh by south, 2050 m, 08.09.1986, *K.M. Matthew & M. Charles* 46766 (RHT044744); *Ibid.*, ghat road below Malapallam, 1350 m, *K.M. Matthew & N. Rajendran* 50328 (RHT044745); Perumalmalai, ± 2000 m, 25.04.1965, *K. Ramamurthy* 23445 (MH00126656, MH00126658); Sirumalai, 14.05.1958, *J. Pallithanam* JP3291 (RHT044735, RHT044736); *Ibid.*, 07.02.1959, *J. Pallithanam* JP4335 (RHT044737); *Ibid.*, 17.06.1960, *J. Pallithanam* JP6165 (RHT044738); Vilagavi south of Kodaikanal, 11.06.1928, *William Bembower* 246 (MICH1577822 digital image); Krishnagiri district, Denkanikottai, Devarbetta Village beyond RH, 900 m, 11.02.1980, *T.S. Jayaseelan* 26408 (RHT044769); Hosur, 30.12.1916, *s.coll.* 13973 (MH00126625, MH00126633); Namakkal district, Kolli Hills, Ariyur shola, 1400 m, 09.02.1976, *P. Perumal* 21753 (RHT044759); Solaikkadu (Ambalakattu), 1300 m, 13.01.1976, *K.M Matthew & V. Alphonse* 834 (RHT044750); Thannipparuthi, 1200 m, 16.10.1978, *K.M. Matthew*, *C. Manoharan & Alamelu* 18285 (RHT044756); *Ibid.*, 1250 m, 19.12.1979, *K.M. Matthew* 25209 (RHT044762); Salem district, Yercaud, near Kadukkamaram, 1500 m, 08.11.1978, *N. Venugopal* 19099 (RHT044758); *Ibid.*, Kakasholai-Balmadies Estate, 1667 m, 14.09.1958, *K. Subramanyam* 6595 (MH00126629, MH00126632); *Ibid.*, Kongampallam, 1310 m, 15.02.1969, *D.B. Deb* 31426 (MH00126713, MH00126628); *Ibid.*, between Mines and Balmadies Estate, ±

1450 m, 05.11.1965, A.*V.N. Rao* 26953 (MH00126714, MH00126715); *Ibid*., Shevaroys, 1530 m, 05.10.1964, *A.V.N. Rao* 18266 (MH00126630, MH00126631); to Shevaroy Temple, 1500 m, 19.03.1979, *N. Venugopal & T.S. Jayaseelan* 22365 (RHT044760); *Ibid*., Temple below, 1600 m, 29.06.1978, *K.M. Matthew* 23316 (RHT044761); *Ibid*., 1700 m, 12.05.1978, *V. Alphonse Amalraj* 13689 (RHT044755); *Ibid*., slopes of Temple Hills, 1525 m, 25.02.1980, *K.M. Matthew* 26813 (RHT044765); *Ibid.,* Temple near water tank, 1425 m, 29.04.1977, *D.I. Arockiasamy* 7807 (RHT044754); Semmanatham, 1200 m, 06.11.1978, *K.M. Matthew, N. Venugopal & T.S. Jayaseelan* 18916 (RHT044757); The Nilgiris district, Aravankadu, 1900 m, 05.09.1970, *B.D. Sharma* 36043 (MH00126641, MH00126642); Avalanche, November 1883?, *s.coll. s.n.* (MH00126649); Coonoor, May 1883, *s.coll. s.n.* (MH00126640); *Ibid*., 6000 feet, September 1883, *J.S. Gamble* 12718 (DD); Ebanad slopes of Koil Betta, 1725 m, *G.V. Subba Rao* 36610 (MH00126643, MH00126644); Kodanad Valley R.F., 07.05.1963, *K.N. Subramanian* 422 (FRC); *Ibid*., near water tank, 1900 m, 27.01.1972, *E. Vajravelu* 39650 (MH00126645, MH00126646); *Ibid.,* 12.03.2020, *M.P. Krishnapriya & Santhosh Nampy* 164367 (CALI197498, CALI197499, CALI197500); Pykara, 28.12.1900, *C.A. Barber* 2680 (MH00126647, MH00126648); *Ibid*., in swamps near Shola, 22.06.1986, *M.K. Janarthanam* 83005 (BSID0012653, MH00126709, MH00126710); way to Sirur from Ebanad, 1500 m, 23.03.1972, *G.V. Subba Rao* 40536 (MH00126711, MH00126712); Thirunelveli district, Panagudi, Kandakki Estate, 850 m, 03.12.1969, *B.V. Shetty* 33014 (MH00126654, MH00126655). **Uttarakhand**, Dehradun district, Rajpur, 3100 feet, 01.10.1961, *Hari Om Saxena* 2288; *Ibid*., 3000 feet, 03.11.1974, *H.B. Naithani* 221 (DD); Pine Plantation, 3000 feet, 03.11.1974, *H.B. Naithani* 221 (DD). SRI LANKA, Ruhuna (Yala) National Park, Buttawa Beach area, Ureniya Kalapuwal, 3-4 m, 28.01.1968, *Peter L. Comanor* 875 (UMO221973 digital image). PAPUA NEW GUINEA, **Western Highlands**, Laiagam subdistrict, Yobobos grassland area, 8500 feet, 18.08.1960, *R.D. Hoogland & R. Schodde* 7483 (A01977274, L.2828239 digital images); Star Mts, Sibil Valley, 1200-1300 m, 28.05.1959, *C. Kalkman* 4166 (L.2828232 digital image). **Western Province**, Lake Daviumbu, Middle of River, September 1936, *L.J. Brass* 7830 (A01977275 digital image).

***Conservation status***: *Utricularia scandens* is a widely distributed species found across India, Africa to Northern Australia, and Malesia. Considering its broad distribution, *U. scandens* is categorised as Least Concern (LC).

***Notes***: *Utricularia scandens* is characterised by filiform, twining peduncles, the presence of fertile scales, a 4-gibbous lower lip of the corolla, an oblong upper lip of the corolla, and finely verrucate seeds. It sometimes produces very small flowers (*c.* 4 mm long), where the upper lip of the corolla and the spur are smaller than the calyx lobes. In other cases, it produces larger flowers (up to 10 mm long), in which the upper lip of the corolla slightly exceeds the upper calyx lobe, and the spur is about twice the length of the lower calyx lobe.

***Typification***: While describing *U. wallichii*, Wight cited three specimens (Courtallum 1837, *Wight* 2709-a; Serra Mullay, October 1836; Nilghiris, June 1849, ex *herb*. *Wight*). Two sheets from Wight's herbarium, both lacking HRWP labels, but one annotated 'Courtallum, 1837, *Wight* 2709-a' (K000628543), and another labelled 'Serra Mullay, October 1836' (K000628544). A third sheet, from the herbarium of Hooker, bears the annotation 'Nilghiris, June 1849, ex *herb*. *Wight*' (K000628541). Among these syntypes, the specimen from Courtallum (K000628543), which best fits the species, is designated here as lectotype of *U. wallichii* in accordance with article 9.12 of the ICN (Turland *et al*., 2018).

**18. Utricularia sisparensis** Krishnapriya & Nampy ***sp. nov.*** *Type*: INDIA, **Kerala**, Palakkad district, Silent Valley National Park, Sispara, way to Anginda, ± 2040 m, 18.01.2024, *M.P. Krishnapriya* 186095 (holo, CALI!). **Figs. 104 & 105**

*Utricularia uliginosa auct. non* Vahl: Wight, Icon. Pl. Ind. Orient. 4(4): 11. t. 1574. f. 1. 1850. *p.p.*

**Diagnosis**: *Utricularia sisparensis sp. nov.* is similar to *U. smithiana* Wight, but can be easily differentiated by its elliptic lower calyx lobe (*vs.* ovate in *U. smithiana*), oblong and distally oblique upper lip of the corolla (*vs.* obovate and straight), horizontal spur shorter than or equal to the lower calyx lobe (*vs.* straight-slightly bent spur always longer than the lower calyx lobe), ovoid ovary (*vs.* oblongoid), and a distinct style up to 1 mm long (*vs.* up to 0.5 mm long).

Probably perennial, terrestrial to semi-aquatic herbs. Rhizoids few, 10–15 mm long, 0.1–0.2 mm thick, capillary, papillose, variously branched, branches 0.5–1 mm long.

Stolons numerous, up to 50 mm long, 0.4–0.5 mm thick, terete, minutely papillose, branched, branches up to 30 mm long. Leaves usually two on peduncle base, numerous on stolons, up to 70 mm long, thick, mat-forming, sessile-petiolate; petioles 10–40 mm long, flattened, hyaline; lamina oblong to strap-shaped, 8–20 × 1.5–2.5 mm, 3-nerved, rarely branched irregularly towards distal end, or new leaflets arise laterally, attenuate-narrowly cuneate at base, obtuse-rounded at apex. Traps numerous on stolons, and leaf petiole, sub-globose, 0.9–1.5 × 0.85–1.5 mm, glandular; stalk 0.45–0.5 mm long, distally thickened, glandular hairy; mouth basal; appendages subulate, 0.5–0.6 mm long, glandular hairy. Racemes erect, 10–20 cm long, 2–3-flowered, flexuous; peduncles angular, 0.4–0.5 mm thick, winged, green-greenish brown. Scales ovate, 1.8–2.2 × 1–1.2 mm, a few, 3-nerved, sterile, green-purplish green, truncate at base, acute at apex. Bracts 2.8–3.1 × 1.5–1.6 mm, ovate, 3-nerved, truncate at base, margin minutely dentate, narrowly acute at apex; bracteoles lanceolate, 2–2.2 × 0.6–0.7 mm, 1-nerved. Flowers 10–12 mm long; pedicels 7–10 × 0.5–0.6 mm, erect-diverging, flexuous, dorsiventrally flattened, winged, green-purplish green. Calyx lobes unequal, greenish blue; upper lobe ovate-elliptic, 5.2–5.5 × 2.6–2.85 mm, 10-nerved, margin minutely dentate, narrowly acute at apex; lower lobe elliptic, 4.8–5.1 × 2.3–2.5 mm, concave, 8-nerved, margin minutely dentate, acute at apex. Corolla pale blue; upper lip elliptic to oblong, 8.5–9 × 2.8–3.5 mm, oblique, longer than the upper calyx lobe, lower margin hairy, constricted just above the base, lilac-mauve with deep blue striations, faint towards apex, slightly widened at middle, apex reflexed, truncate or obtuse at apex; lower lip more or less orbicular, 10–12 × 9.5–10.8 mm, ciliate along throat margin, throat yellow, palate gibbous, crested with prominent 3-lobed swelling, white with deep blue reticulations, blue then, margin undulate, rounded at apex; spur 5–6.25 × *c*. 2 mm, subulate, descending or horizontal, or curved upwards, shorter than or just exceeds lower calyx lobe, shorter than lower lip of corolla, emarginate-bilobed at apex, lobes unequal. Stamens up to 2.5 mm long; filaments strap-shaped, 1.8–2 × 0.35–0.45 mm, curved at base; anther thecae 0.8–0.9 mm long, dark purple. Pistil 2.6–2.85 mm long, flower vase-shaped; ovary ovoid, 1.28–1.55 × 0.7–1 mm, green, glabrous; style 0.85–1 × 0.45–0.55 mm, green, broader distally; stigma bi-lipped, upper and lower lips sub-orbicular, equal in size, inflexed, purplish white, papillose out. Mature fruits not seen.

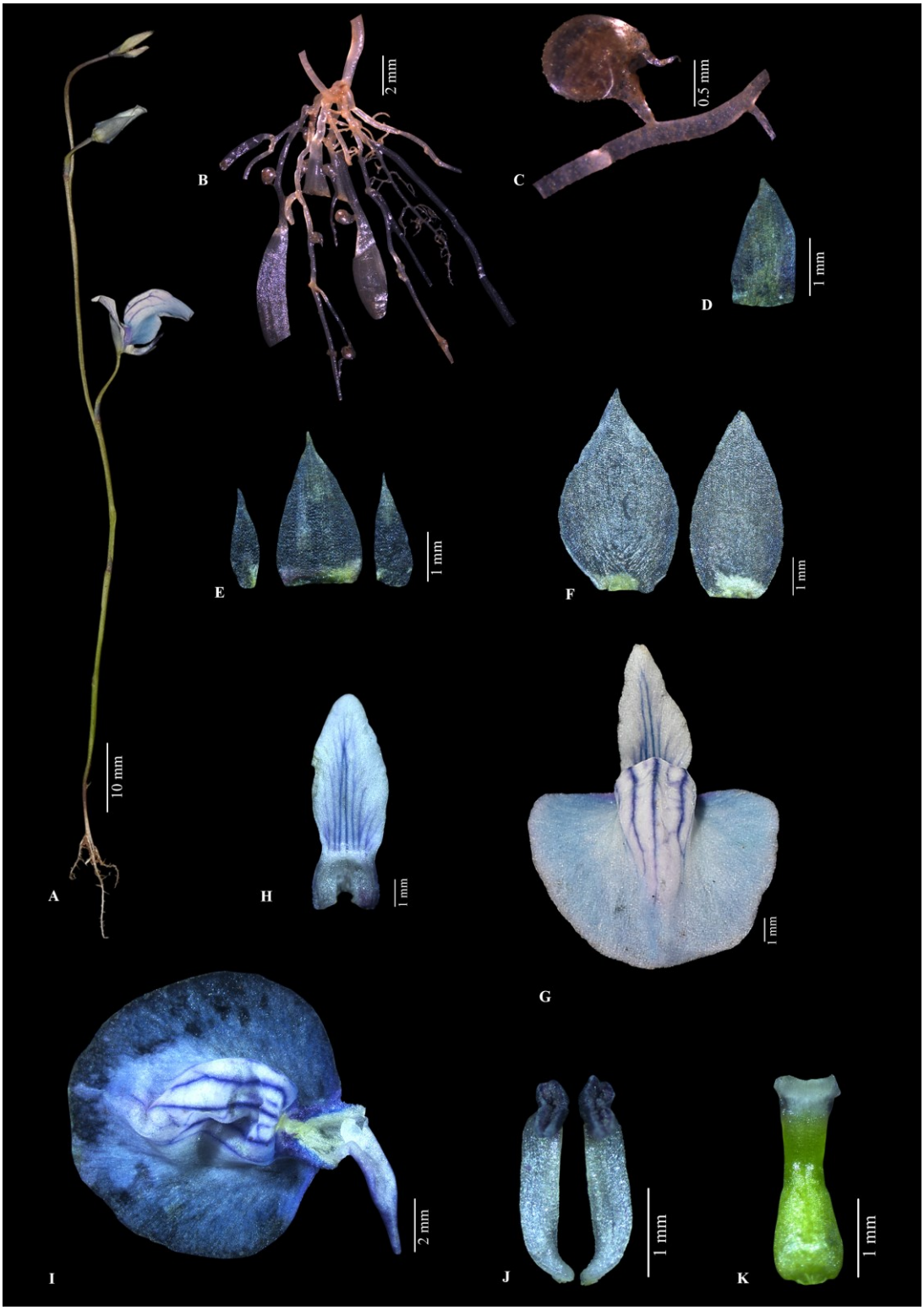


**Fig. 104.** *Utricularia sisparensis* Krishnapriya & Nampy *sp. nov.*: **A.** Habit; **B.** Peduncle base with rhizoids, stolons, leaves and traps; **C.** Trap; **D.** Scale; **E.** Bract and bracteoles; **F.** Calyx lobes; **G.** Corolla - front view; **H.** Upper lip of corolla; **I.** Lower lip of corolla with spur; **J.** Stamens; **K.** Pistil.

**Fig. 105.** *Utricularia sisparensis* Krishnapriya & Nampy *sp. nov.*: **A-F.** Habitat and habit; **G & H.** Leaves (**G.** Leaves in a wet area; **H.** Leaves in the margin of stream); **I-L.** Flowers - different view; **M.** Flexuous pedicel bearing calyx lobes with pistil inside.

***Flowering***: Flowering starts in early January, mature fruits have not been observed in any of the live materials.

***Habitat***: *Utricularia sisparensis* grows in open and shady places in margins of perennial streams and shallow creeks, at an elevation of around 2380 m, often in association with *U. wightiana*, *Eriocaulon robustum* Steud. (Eriocaulaceae), *Osmunda* sp. (Osmundaceae), other ferns, and large grasses (Fig. 105).

***Distribution***: This species has been found only in Anginda, the highest peak of Silent Valley National Park in Palakkad district, Kerala (Fig. 84).

***Specimen examined***: INDIA, **Kerala**, Palakkad district, Silent Valley National Park, Tamil Nadu Boarder, way to Valiya Anginda, 18.01.2024, *M.P. Krishnapriya* 186098 (CALI).

***Conservation status***: *Utricularia sisparensis* was collected from a single locality in a protected area. This locality shares borders with Mukurthi National Park in Tamil Nadu, suggesting the possibility of its distribution extending into Tamil Nadu as well. Its habitat along the margins of perennial streams may enhance its dispersal success and distribution. The population size is small, with fewer than 10 mature individuals found in small patches. Since my visit occurred early in the flowering stage, a more detailed study is essential to better analyse the population size. Hence, the species is currently treated as Data Deficient (DD).

***Notes***: While consulting the literature, I found an illustration by Wight (1850) in *Icones Plantarum* depicting *U. uliginosa* Vahl, which partially matches this new species. Wight's plate (t. 1574) includes three habit illustrations and dissected parts. The left-hand image, with dissected parts, possibly represents this species or a mix of two species. Based on Wight's (*l.c.*) description, the illustration was derived from a specimen collected in the Nilgiris. But, considering the chance of mixing up, the characters mentioned in the description and illustration cannot be solely depended. The new species differs from *U. uliginosa* in having filiform, wiry peduncles, about 10 mm long pedicels, an oblique upper lip of the corolla longer than the upper calyx lobe, horizontal spur, and a long style (up to 1 mm long).

During my field exploration, I was unable to collect mature capsules. Therefore, further exploration, especially during fruiting, is required to gather data on capsules and seeds.

**19. Utricularia smithiana** Wight, Hooker's J. Bot. Kew Gard. Misc. 1: 373. 1849, Icon. Pl. Ind. Orient. 4(4): 10. t. 1577. 1850; Gamble, Fl. Madras 2: 982. 1924; Fyson, Fl. S. Ind. Hill Stations 1: 437. 1932; Taylor, Gen. *Utricularia* 338. t. 93. 1989; Kesh.Murthy & Yogan. Fl. Coorg (Kodagu) Karnataka 318. 1990; Janarth. & A.N.Henry, Bladderworts India 101. t. 30. 1992; M.Mohanan & A.N.Henry, Fl. Thiruvananthapuram 336. 1994; R.Ansari *et al*., Aquatic Wetland Fl. Kerala: Fl. Pl. 527. 2016. *Utricularia caerulea* var. *smithiana* (Wight) C.B.Clarke in Hook.f. (ed.), Fl. Brit. India 4: 331. 1884. *Type*: INDIA, Malabar or Coorg, *s.d.*, *Herb. Wight s.n.* (holo, K [K000939703 digital image!]). **Figs. 106–108**

Annual or perennial, semi-aquatic herbs. Rhizoids numerous, 20–30 mm long, capillary, fibrous, profusely branched, branches up to 10 mm long, papillose. Stolons numerous on peduncle base, up to 50 mm long, terete, branched. Leaves numerous, up to 60 mm long, mat-forming; petioles 6.5–8 mm long; lamina narrowly oblong, up to 50 mm long, 2.5–3.5 mm wide, 3-nerved, irregularly wide sometime, rounded at apex. Traps globose, 1.2–1.6 mm across, numerous on stolons and leaves; stalks 0.4–0.6 mm long, distally thickened, glandular hairy; mouth basal; appendages subulate, glandular hairy. Racemes usually twining or sometimes erect, 20–30 cm long, 2–8-

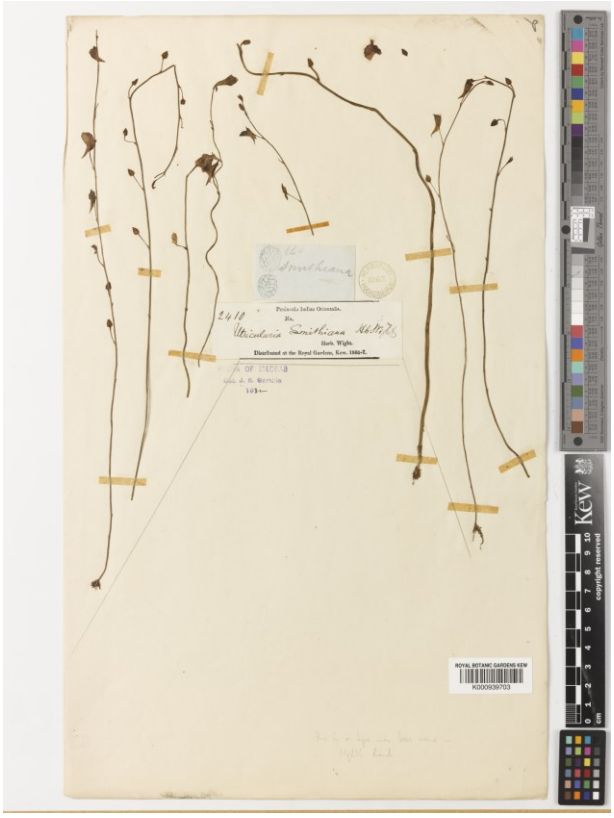

**Fig. 106.** Type of *Utricularia smithiana* Wight [*Herb. Wight s.n.* (K000939703)] "© *Board of Trustees of the Royal Botanic Gardens, Kew*".

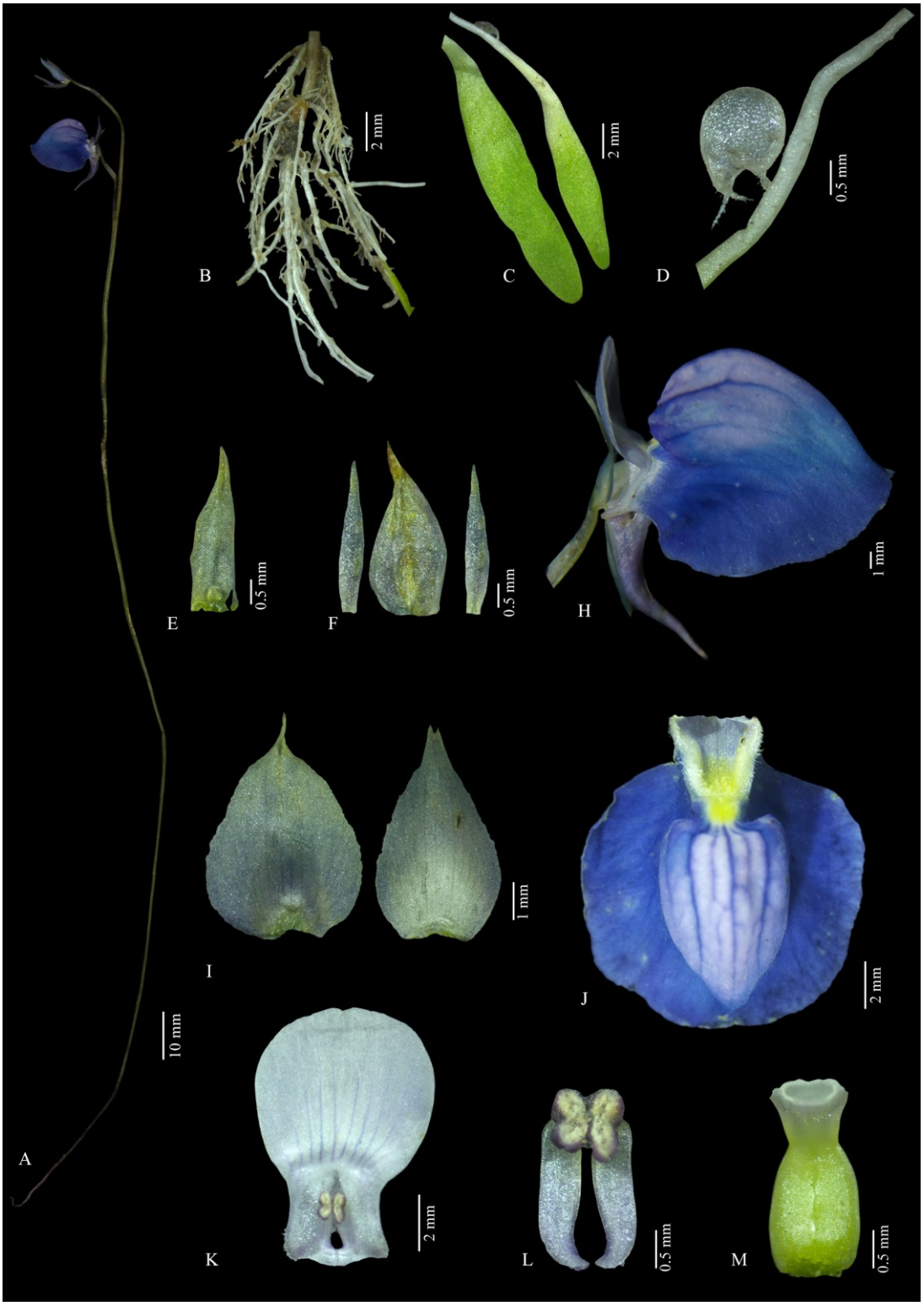


**Fig. 107.** *Utricularia smithiana* Wight: **A.** Habit; **B.** Peduncle base with rhizoids, stolons, and leaves; **C.** Leaves; **D.** Trap; **E.** Scale; **F.** Bract and bracteoles; **H.** Flower - lateral view; **I.** Calyx lobes; **J.** Upper lip of corolla; **K.** Lower lip of corolla; **L.** Stamens; **M.** Pistil.

flowered, lax; peduncles terete at peduncle base, angular and grooved then, 0.5–1 mm thick, flexuous. Scales a few, lance-ovate, 3.5–3.8 × 1.4–1.5 mm, green, truncate at base, acute at apex. Bracts ovate, 3.6–4 × 1.4–1.5, purplish green, truncate at base, narrowly acute apex; bracteoles lanceolate, 2.8–3 × 0.35–0.45 mm, narrowly acute at apex. Flowers 13–15 mm long; pedicels 10–15 mm long, erect, filiform, dorsiventrally compressed, broadly winged. Calyx lobes slightly unequal; upper lobe widely ovate, 6–6.7 × 4–4.8 mm, 16-18-nerved, truncate at base, margin dentate, acuminate-caudate at apex; lower lobe ovate, 5.8–6.4 × 3.25–3.5 mm, 14-nerved, truncate at base, margin dentate, acute to shortly bifid at apex. Corolla usually blue, rarely pale purple; upper lip widely obovate, 8.5–9.5 × 5–6.5, hairy along lower margin, constricted below the middle, broad above the constriction, white-lilac with blue streaks, faint towards apex, rounded at apex; lower lip orbicular in spreading, 11–12 mm across, ciliate along throat margin, yellow at throat, palate gibbous, prominently raised into 6-8 ridges, white-lilac with deep blue striations, clear blue then, margin entire, rounded at apex; spur subulate, 7.8–8.5 mm long, straight or slightly descending, curved towards tip, double than the lower calyx lobe, whitish blue at base, deep blue towards apex, narrowly acute at apex. Stamens 2.3–2.5 mm long; filaments oblong, 2–2.2 × 0.5–0.6 mm; anther thecae 0.6–0.7 mm long. Pistil 2.5–2.8 mm long; ovary oblongoid, 1.8–2 × 1.25–35; style 0.4–0.5 mm long, green; stigma bi-lipped, upper lip short, truncate, inflexed; lower lip sub-orbicular, pale greenish white, papillose out. Capsule ellipsoid-oblongoid, 3.5–4.5 × 2.8–3.25 mm, wall uniformly membranous, dehiscing by a single ventral, longitudinal slit; placenta ovoid, 2–25 mm across. Seeds oblongoid to sub-globose, 0.28–0.32 mm across; hilum terminal.

***Flowering & fruiting***: Flowering begins in early November and continue until April, with fruiting occurring from late November to the end of April.

***Habitat***: This species is found along marshy-swampy lands and near perennial water sources in high altitude, cool areas, usually at elevations of 1000–2000 m. It often grows in association with *Eriocaulon* spp. (Eriocaulaceae), and some large grasses (Fig. 108).

**Fig. 108.** *Utricularia smithiana* Wight: **A, D & E.** Growing in a swampy meadow, **B.** In the margin of a small creek; **C.** Leaves.

***Distribution***: Possibly endemic to the Western Ghats, India (Fig. 109).

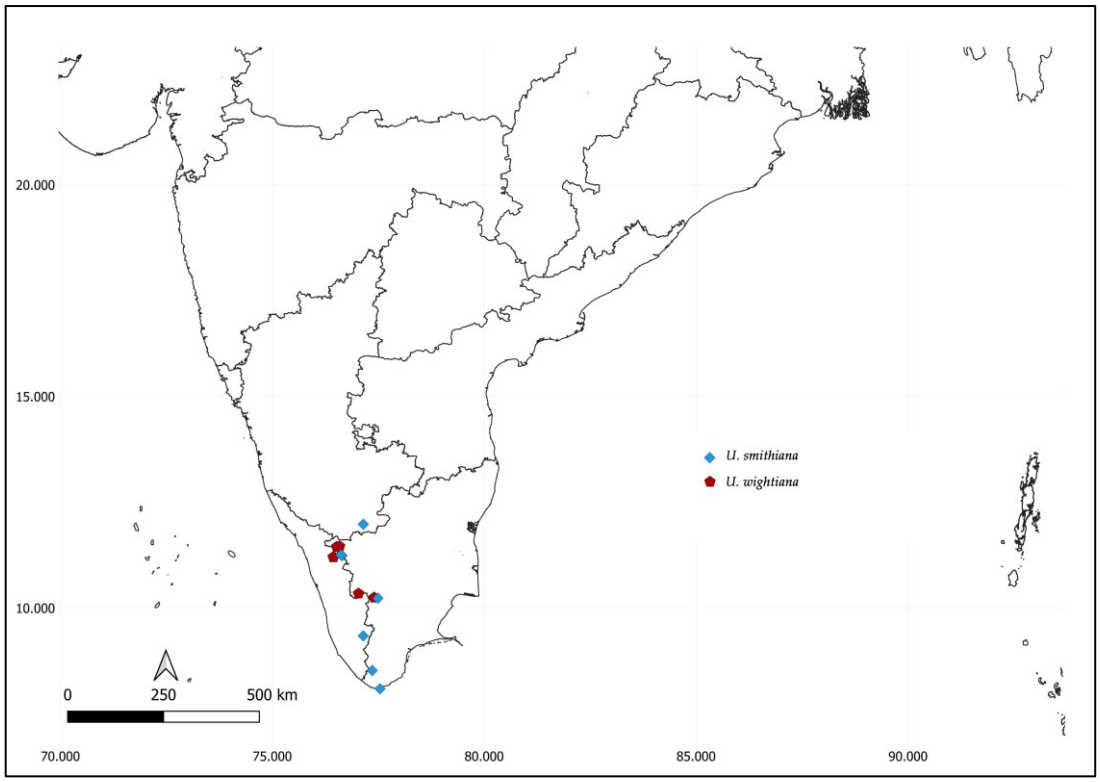


**Fig. 109.** Distribution of *U. smithiana* Wight and *U. wightiana* P.Taylor

***Specimens examined***: INDIA, **Karnataka**, Chamarajanagar district, Bill Hills, December, *E. Barnes s.n.* (DD). **Kerala**, Idukki district, way to Subran Shed, 30.12.2019, *M.P. Krishnapriya & Santhosh Nampy* 164349 (CALI); Kollam district, Pamba Dam to Anathode, 1020 m, 09.11.1975, *K. Vivekananthan* 46573 (MH00126425, MH00126426). **Tamil Nadu**, Dindigul district, Kodaikanal, 09.06.1898, *A.G. Bourne* 17 (DD); Kodaikanal, Lake side, 17.07.1898, *A.G. Bourne s.n.* (CAL); Poombarai swamps, 7500 feet, 02.04.1912, *C.E.C. Fischer* 3318 (FRC); The Nilgiris district, Mukurthi National Park, Bangi Halla (Earthen Dam), 2175 m, 04.04.1972, *K. Vivekananthan* 40690 (MH00126447); Korakuntha, ± 2417 m, 16.03.2020, *M.P. Krishnapriya & S. Resmi* 164369 (CALI); Tirunelveli district, Kalivayalpil, 02.06.1901, *C.A. Barber* 3073 (CAL).

***Conservation status***: I have collected this species from only two locations, where it occurs in very small patches of fewer than 10 individuals. The AOO is calculated as 40 $km^2$ and the EOO is 18736.981 $km^2$. Based on the current data, the species is assessed as Endangered (EN B2b(ii,iii,iv)+c(ii,iii); D).

***Notes***: *Utricularia smithiana* resembles *U. cecilii* in corolla characters, as both species have large flowers with a gibbous corolla. However, it can be easily differentiated based on the nature of inflorescence (erect-twining with a flexuous peduncle in *U. smithiana vs*. erect and stiff peduncle in *U. cecilii*), the shape and margin of the calyx lobes (widely ovate with a dentate margin *vs*. ovate with an entire margin), and the shape of leaves (strap-shaped *vs*. obovate-spathulate). While it is often confused with *U. graminifolia*, the angular, flexuous peduncle, dentate margins of the calyx lobes, obovate upper lip of the corolla and gibbous palate of the lower lip easily distinguish it from the latter.

**20. Utricularia uliginosa** Vahl, Enum. Pl. 1: 203. 1804; A.DC. in DC. (ed.), Prodr. 8: 15. 1844; Haines, Bot. Bihar Orissa 4: 645. 1922; Gamble, Fl. Madras 2: 981. 1924; Santapau, J. Bombay Nat. Hist. Soc. 49(2): 218. 1950, Fl. Khandala (ed. 3) revised 188. 1967; S.V.Ramamurthy & Razi, Fl. Bangalore Dist. 549. 1973; P.Taylor, Fl. Males. 1(8): 282. f. 5. 1977; Gandhi in C.J.Saldanha & Nicolson (eds.), Fl. Hassan Dist. (sec. reprint) 566. 1978; Vajr., Fl. Palghat Dist. 331. 1980; Arora *et al*., Bot. South Kanara 45. 1981; Manilal & Sivar., Fl. Calicut 209.1982; B.D.Sharma *et al*., Fl. Karnataka: analysis 196.

1984; R.S.Rao, Fl. Goa, Diu, Daman, Dadra & Nagarhaveli 309. 1986; V.Chandras. in A.N.Henry *et al*., Fl. Tamil Nadu, Ind., Ser I. Analysis 2: 131. 1987; Pull. & N.Yesoda, Fl. Anantapur 181. 1989; P.Taylor, Gen. *Utricularia* 333. t. 92. 1989 *excl. syn. U. nayarii* Janarth. & A.N.Henry; S.M.Almeida, Fl. Savantwadi 2: 309. 1990; Laksmin. & B.D.Sharma, Fl. Nasik Dist. 350. 1991; Janarth. & A.N.Henry, Bladderworts India 113. t. 34. 1992; S.D.Deshp. *et al*., Fl. Mahabaleshwar 1: 426. 1993; M.Mohanan & A.N.Henry, Fl. Thiruvananthapuram 336. 1994; Sasidh. & Sivar., Fl. Pl. Thrissur For. 328. 1996; R.C.Srivast. in Mudgal *et al*. (eds.), Fl. Madhya Pradesh 2: 256. 1997; Londhe in N.P.Singh *et al.* (eds.), Fl. Maharashtra, Dicot. 2: 567. 2001; N.Mohanan & Sivad., Fl. Agasthyamala 493. 2002; S.R.Yadav & Sardesai, Fl. Kolhapur Dist. 339. 2002; K.G.Bhat, Fl. Udupi 458. 2003; Anil Kumar *et al*., Fl. Pathanamthitta 369. 2005; K.K.Khanna *et al*., Florsit. Diversity Chhattisgarh 331. 2005; Sunil & Sivad., Fl. Alappuzha Dist. 522. t. 43. 2009; Li in Wu *et al*. (eds.), Fl. China 19: 484. 2011 *excl. syn. U. nayarii* Janarth. & A.N.Henry; Datar & Lakshmin., Fl. Bhagwan Mahavir Natl. Park, Goa 177. 2013; K.G.Bhat, Fl. South Kanara 770. 2014; Kavade & Deokule, Fl. Chandoli Natl. Park 265. 2015; R.Ansari *et al*., Aquatic Wetland Fl. Kerala: Fl. Pl. 535. 2016; S.K.Mandal & Bhaumik in Lakshmin. *et al*. (eds.), Fl. West Bengal 4: 147. 2019. *Type*: India Orientalis, *s.d.*, *J. Koenig s.n.* (holo, C [C10013933 digital image!]).

**Figs. 110–112**

*Utricularia graminifolia auct. non* Vahl: R.Br., Prodr. Fl. Nov. Holland 1: 432. 1810 *p.p.*, *nom. illeg. homonym*

*Utricularia cyanea* R.Br., Prodr. Fl. Nov. Holland. 1: 431. 1810; Benth. & F.Muell., Fl. Austral. 4: 527. 1869. *Lectotype* (designated by Taylor, 1989): AUSTRALIA, **New South Wales**, Banks of the Grose River, December 1804, *R. Brown* 2729 (BM [BM001041163 digital image!])

*Utricularia affinis* Wight, Hooker's J. Bot. Kew Gard. Misc. 1: 373. 1849, Icon. Pl. Ind. Orient. 4(4): 11. t. 1580. f. 1. 1850; Drury, Handb. Ind. Fl. 2: 121. 1866; C.B.Clarke in Hook.f. (ed.), Fl. Brit. India 4: 330. 1884; K.I.Goebel in Treub (ed.), Ann. Jard. Bot. Buitenzorg 9: 73. 1891; Trimen, Handb. Fl. Ceylon 3: 269. 1895; T.Cooke, Fl. Bombay 2: 318. 1905. *Type*: INDIA, *s.loc.*, *s.d.*, Herb. Wight, *Niels s.n.* (holo, K [K000628551 digital image!])

*Utricularia brachypoda* Wight, Hooker's J. Bot. Kew Gard. Misc. 1: 373. 1849, Icon. Pl. Ind. Orient. 4(4): 11. t. 1578. f. 1. 1850. *Utricularia affinis* Wight var. β Oliv., J. Proc. Linn. Soc., Bot. 3: 178. 1859. *Utricularia affinis* Wight var. *brachypoda* Drury, Handb.

Ind. Fl. 2: 122. 1866. *Type*: INDIA, **Kerala**, Quilon, June 1836, *Wight* 2411 (holo, K [K000628553 digital image!]; iso, E [E00174036, E00174037 digital images!])

*Utricularia griffithii* Wight, Hooker's J. Bot. Kew Gard. Misc. 1: 373. 1849, Icon. Pl. Ind. Orient. 4(4): 11. t. 1576. 1850. *Utricularia affinis* Wight var. *griffithii* (Wight) Oliv. ex C.B.Clarke in Hook.f. (ed.), Fl. Brit. India 4: 331. 1884. *Type*: Peninsular Malaysia, Malacca, *s.d.*, *Griffith s.n.* (holo, K not seen)

*Utricularia decipiens* Dalzell, Hooker's J. Bot. Kew Gard. Misc. 3: 279. 1851; Dalzell & Gibson, Bombay Fl. 135. 1861. *Utricularia affinis* Wight var. α Oliv., J. Proc. Linn. Soc., Bot. 3: 178. 1859. *Utricularia affinis* Wight var. *decipiens* Drury, Handb. Ind. Fl. 2: 122. 1866. *Type*: INDIA, **Maharashtra**, Vingorla (Vengurla), *s.d.*, *Dalzell* 1969 (holo, K [K001097995 digital image!])

*Utricularia lilacina* Griff., Not. Pl. Asiat. 4: 168. 1854. *Type*: MYANMAR (Burma), Mergue, Kulweng in watery places, August 1834, *Griffith s.n.* (holo, K not seen)

*Utricularia cyanea* var. *alba* Benth. in Benth. & F.Muell. (eds.), Fl. Austral. 4: 528. 1868

Annual terrestrial to semi-aquatic herbs. Rhizoids numerous, up to 50 mm long, 0.15–0.35 mm thick, capillary, tapering towards apex, branches 1.5–10 mm long, papillose. Stolons up to 100 mm long, 0.2–0.3 mm thick, terete, profusely branched, hyaline, internodes up to 10 mm long, minutely papillose. Leaves a few to numerous on stolons, those near peduncle base spathulate, up to 15 mm long, then strap-shaped; petioles 8–10 mm long, flat; lamina strap-shaped, 20–45 × 1.5–6 mm, 3-nerved, nerves branched further, cuneate at base, rounded at apex. Traps numerous on rhizoids, stolons and leaves; sub-globose, 1.2–2 × 1.5–2 mm, glandular, stalked; stalk 0.4–0.6 mm long, distally thickened, glandular hairy; mouth basal; appendages subulate, glandular hairy. Racemes

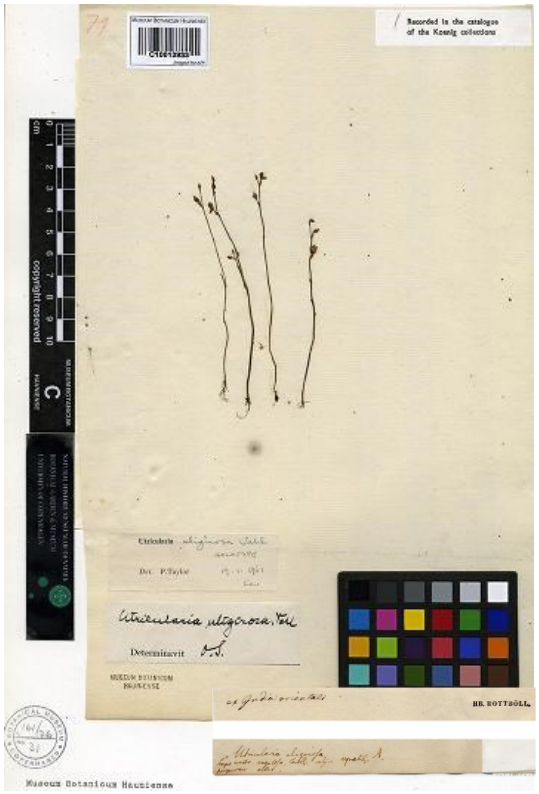


**Fig. 110.** Type of *Utricularia uliginosa* Vahl [*J. Koenig s.n.* (C10013933)].

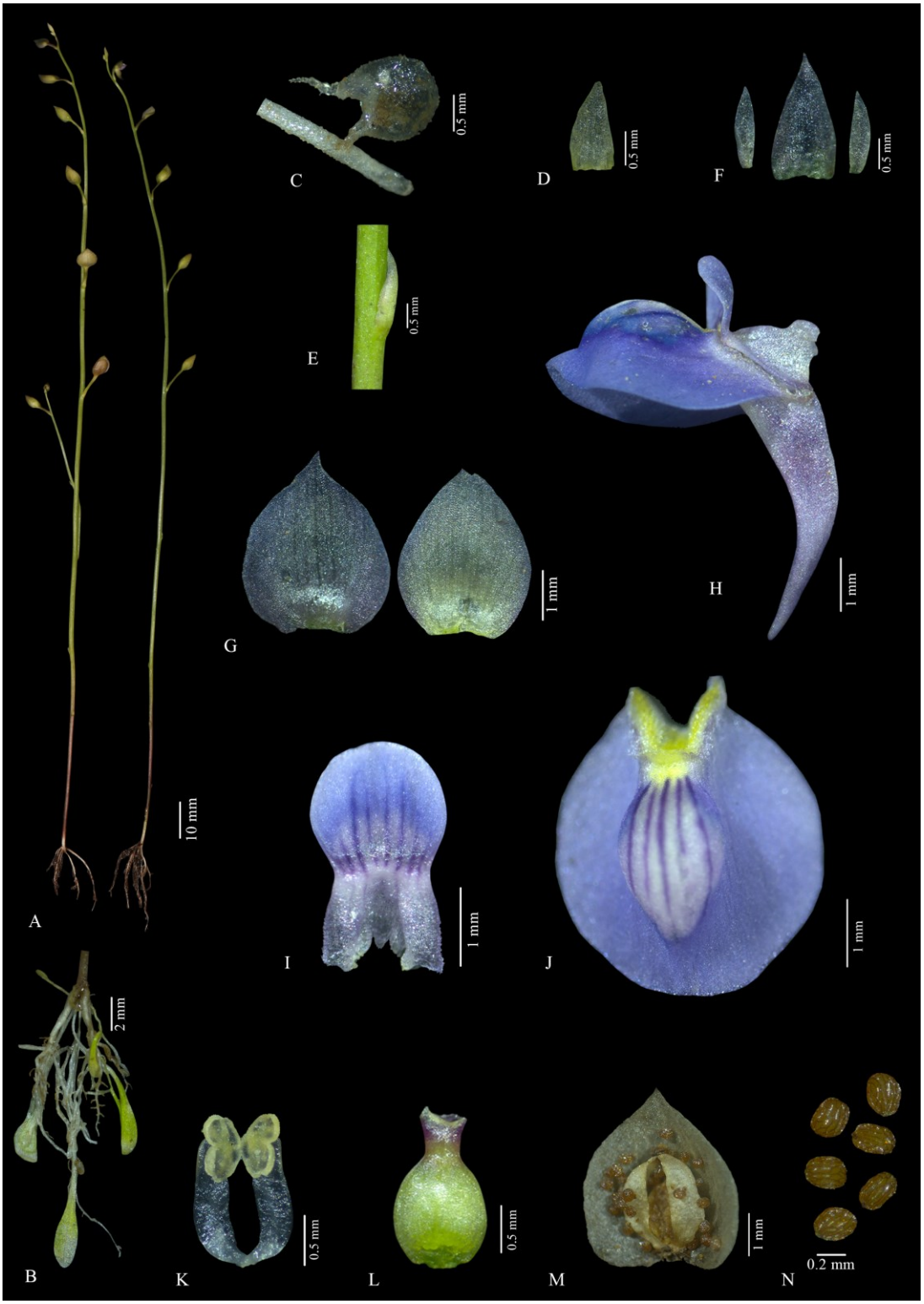


**Fig. 111.** *Utricularia uliginosa* Vahl: **A.** Habit; **B.** Peduncle base with stolons, rhizoids, and leaves; **C.** Trap; **D. & E.** Scale; **F.** Bract and bracteoles; **G.** Calyx lobes; **H.** Corolla – lateral view; **I.** Upper lip of corolla; **J.** Lower lip of corolla; **K.** Stamens; **L.** Pistil; **M.** Capsule; **N.** Seeds.

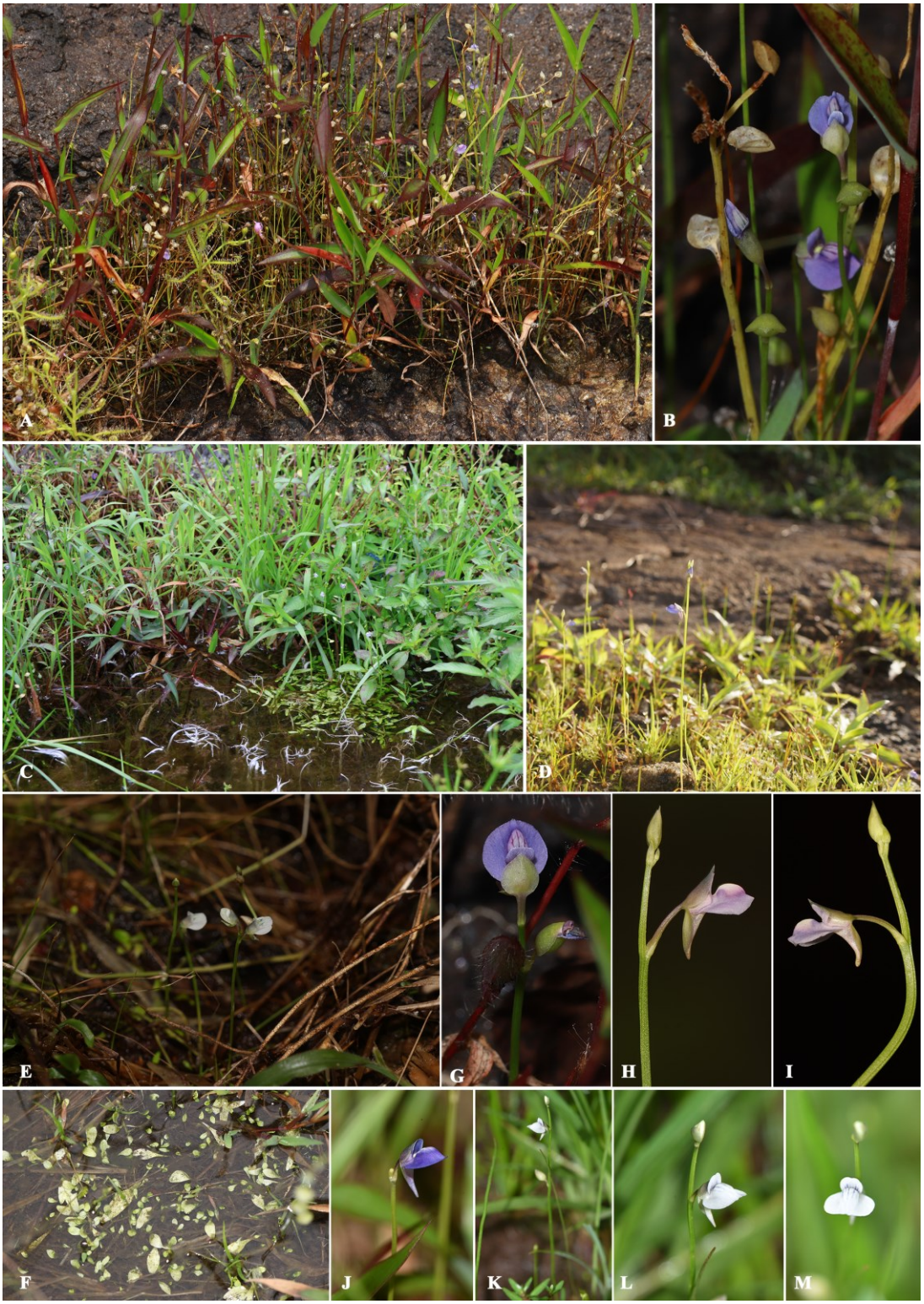


**Fig. 112.** *Utricularia uliginosa* Vahl: **A-E.** Habitat and habit; **F.** Leaves; **G-M.** Peduncle bearing flowers (**L & M.** note the white morphotype).

erect, 5–20 (30) cm long, 1–10-flowered, lax, usually simple, rarely branched, glabrous; peduncles 0.7–0.8 mm thick, filiform, slightly angular, grooved on one side, winged, green. Scales a few, 1.3–1.55 × 0.8–1 mm, ovate to deltate, 3-nerved, truncate at base, acute at apex. Bracts widely ovate, 1.4–1.75 mm long, 5-nerved, truncate at base, acute at apex; bracteoles lanceolate, subulate, 0.6–1.5 × 0.2–0.3 mm, 1-nerved, acute at apex. Flowers 6–8.5 mm long; pedicel sub-erect at anthesis, 1.5–4 mm, winged, horizontal-spreading in fruit. Calyx lobes sub-equal, accrescent (up to 6.5–7.5 × 6–7 mm in fruiting); upper lobe widely ovate, 2.85–3.7 × 2.5–3.2 mm, 14-nerved, margin minutely dentate, acute to obtuse at apex; lower lobe ovate, 2.5–3.5 × 1.85–2.5 mm, 12-nerved, margin minutely dentate, 2–3-dentate at apex. Corolla pale blue to pale violet or rarely pink or pure white; upper lip oblong, 3–3.5 × 1.4–2 mm, hairy along lower margins, constricted at middle, pale blue with deep blue striations above the constriction, faint towards apex, shorter than or equal to upper calyx lobe, emarginate-truncate at apex; lower lip widely elliptic to sub-orbicular, 4–6 × 2.75–5.5 mm, ciliate along throat margin, yellow at throat, palate gibbous, pale blue with deep blue stations, faint then, rounded or rarely obscurely 3-lobed at apex; spur conical, 3.5–6 mm long, lilac, narrowly acute at apex. Stamens 1.2–1.5 mm long; filaments linear, 0.8–1.2 × 0.2–0.25 mm, hyaline, twisted at base; anther thecae 0.4–0.5 mm long. Pistil 1.5–1.7 mm long; ovary ovoid-ellipsoid, 1–1.35 × 0.8–1, slightly compressed, green; style, 0.3–0.35 mm long, purplish green; stigma bi-lipped; upper lip obsolete; lower lip sub-orbicular, papillose out, greenish purple. Capsules ovoid, 2.5–3 × 2.3–2.8 mm, wall uniformly membranous, thickened when dehiscing, dehiscing by dorsal and ventral longitudinal slit; placenta ovoid, 1.2–1.5 × 0.7–1 mm. Seeds numerous, oblongoid to sub-globose, 0.35–0.4 × 0.25–0.35 mm; surface smooth; hilum terminal.

***Flowering & fruiting***: Flowering starts from early August to early December and fruiting occurs from mid-August until late December.

***Habitat***: This species grows along marshy and swampy lands near perennial water sources, usually in association with *U. caerulea*, *U. cecilii*, *U. lazulina*, *U. scandens*, *Drosera indica* (Droseraceae), *Exacum sessile* L. (Gentianaceae), *Eriocaulon* spp. (Eriocaulaceae), *Justicia* sp. (Acanthaceae), *Lindernia* sp. (Linderniaceae), *Ludwigia* sp.

(Onagraceae), *Murdannia* spp. (Commelinaceae), and some grasses and sedges (Fig. 112).

***Distribution***: India, Sri Lanka to Japan and Australia (POWO, 2025) (Fig. 113).

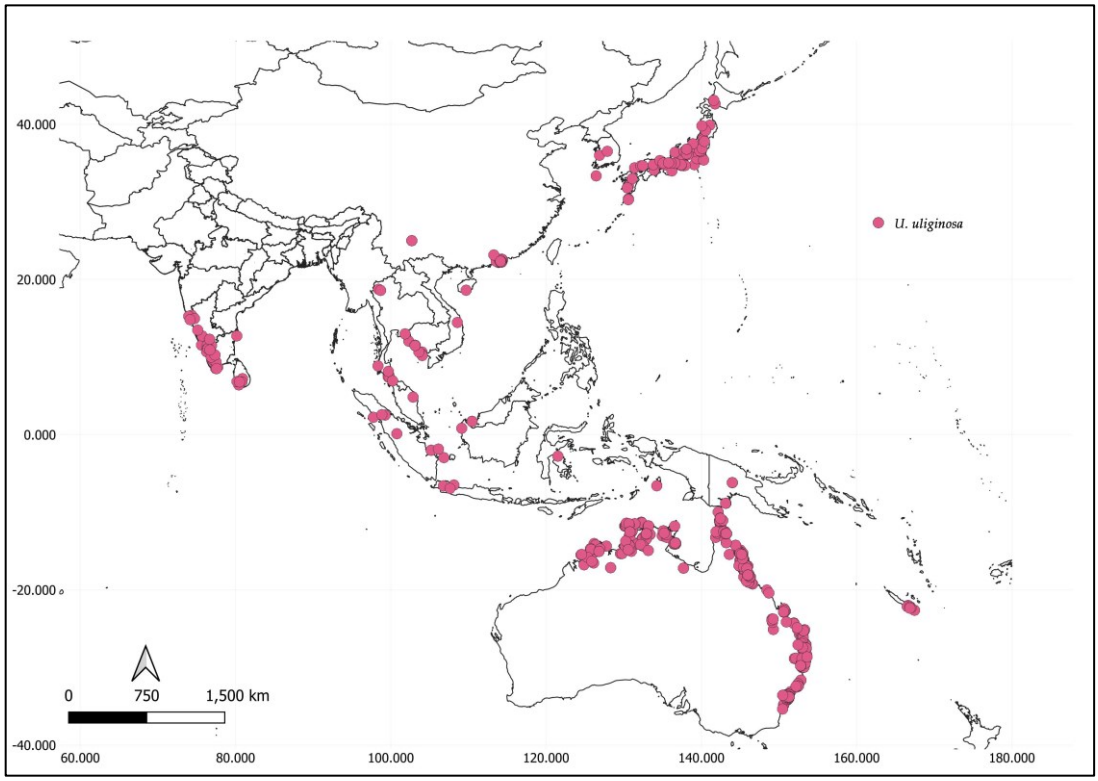


**Fig. 113.** Distribution of *Utricularia uliginosa* Vahl

***Specimens examined***: AUSTRALIA, **Queensland**, Northeastern Rockingham Bay, 1863-1871, *John Dallachy s.n.* (MEL89867, MEL89868, MEL89869 digital images). INDIA, **Karnataka**, Maisor & Carnatic, *s.loc.*, *s.d.*, *G. Thomson s.n.* (L.4484139 digital image); Shimoga district, Kavaledurga, 02.10.1962, *R. Sundara Raghavan* 82882 (BSI); Karwar, 01.08.1885, *W.A. Talbot* 1284 (DD); Hassan district, Athihalli, 10.10.1969, *C.J. Saldanha* 15298 (US03216919 digital image). **Kerala**, Idukki district, Kulamavu channel, 800 m, 30.08.1973, *Cook, Rix & Schneller* 50 (P04425333 digital image); Kuttikanam, Peerumedu, 1050 m, 19.11.1975, *K. Vivekananthan* 46730 (MH00126789, MH00126790, CAL); Kozhikode district, near Iringal Railway station, ± 3 m, 25.08.1985, *M.K. Janarthanam* 82932 (BSID0012633, MH00126795, MH00126796); Kakkayam, way to Ambalapara, 06.10.2022, *M.P. Krishnapriya* 186017 (CALI); Kollam district, Ranni, 325 m, 27.7.1978, *C.N. Mohanan* 58341 (MH00126683, MH00126684);

*Ibid.*, 300 m, 16.05.1980, *C.N. Mohanan* 68373 (MH00126686); Malappuram district, Poonkavanam Dam, 31.07.2019, *M.P. Krishnapriya* 168075 (CALI197475); Palakkad district, Malampuzha water tank hillock, 15.09.1985, *M.K. Janarthanam* 82937 (BSID0012634, MH00126775, MH00126776); Pathanamthitta district, Vallicode-Kottayam, 04.11.1989, *N. Anilkumar* 2120 (CAL); Thiruvananthapuram district, Ponmudi, 19.09.1968, *s.coll.* 9179 (RHT044729); Ponmudi Estate, 750 m, 13.09.1977, *N.C. Nair* 51019 (CAL); Thrissur district, Kaayampoovam, ± 110 m, 06.09.2020, *M.P. Krishnapriya & Santhosh Nampy* 164375 (CALI187783, CALI187784, CALI187785, CALI187786); Mullurkara, Irunilamkode, ± 160 m, 07.09.2020, *M.P. Krishnapriya & Santhosh Nampy* 164379 (CALI187781, CALI187782). **Tamil Nadu**, Coimbatore district, Monica Estate, *s.d.*, *J. Joseph* 15588 (CAL); Sangili road, Pannimedu Estate, 24.02.1985, *M.K. Janarthanam* 82904 (BSID0012648); Muthumudi Estate, 24.02.1985, *M.K. Janarthanam* 82905 (BSID0012649). **West Bengal**, Kolkata district, Kolkata, *s.d.*, *Joh. W. Helfer* 483 (CAL). MYANMAR, Pegu, Irrawaddy and Sittang Valley, Yangoon Lake, December 1870, *S. Kurz* 2308 (DD).

***Conservation status***: *Utricularia uliginosa* has a wide distribution across tropical and temperate Asia, Australia to Northwestern and Southwestern Pacific. This species is frequently found in seasonally inundated soil, wet lateritic soils, and gravelly areas above rocky outcrops. No significant threats have been observed or reported. Considering its wide distribution, the species is categorised as Least Concern (LC).

***Notes***: *Utricularia uliginosa* is a highly variable species that is often confused with *U. graminifolia.* However, it can be easily distinguished by its shorter pedicels, smaller flowers, and a prominently gibbous corolla. It also similar to *U. praeterita*, but it can be differentiated by its 3-nerved leaves with further branching, shorter upper lip of the corolla (equal to or shorter than the upper calyx lobe), erect fruiting pedicels, and sub-globose to oblongoid seeds with deeply concave periclinal walls.

**21. Utricularia wightiana** P.Taylor, Kew Bull. 41(1): 10. 1986, Gen. *Utricularia* 342. t. 95. 1989; Janarth. & A.N.Henry, Bladderworts India 117. t. 35. 1992; T.S.Nayar *et al.*, Fl. Pl. Western Ghats 1: 588. 2014; R.Ansari *et al.*, Aquatic Wetland Fl. Kerala: Fl. Pl. 535. 2016. *Utricularia squamosa auct non*. Benj.: Wight, Hooker's J. Bot. Kew Gard.

Misc. 1: 373. 1849, Icon. Pl. Ind. Orient. 4(4): 11. t. 1579. 1850 *nom. illeg. homonym*; Gamble, Fl. Madras 2: 982. 1921. *Utricularia caerulea* var. *squamosa* (Wight) ex C.B.Clarke in Hook.f. (ed.), Fl. Brit. India 4: 331. 1884; Manilal, Fl. Silent Valley 199. 1988. *Type:* INDIA, **Kerala**, Sispara, *s.d.*, *Herb. Wight* 2413 (holo, K [K000628549 digital image!]). **Figs. 114–117**

*Utricularia caerulea* var. β, Oliv., J. Proc. Linn. Soc., Bot. 3: 179. 1858

*Utricularia graminifolia auct. non* Vahl: V.Chandras. in A.N.Henry *et al*. (eds.), Fl. Tamil Nadu Ind., Ser I: Analysis 2: 130. 1987

Perennial semi-aquatic to aquatic herbs. Rhizoids up to 15 mm long, tapering, dichotomously branched, branches 2–3 mm long, hyaline, papillose. Stolons up to 50 mm long, 0.4–0.5 mm thick, profusely branched, terete, hyaline, minutely papillose. Leaves up to 70 mm long, usually two on peduncle base, numerous on stolons, thick, glabrous, mat-forming, sessile-petiolate; petioles 2–10 mm long, flattened, hyaline; lamina narrowly obovate-strap-shaped, 20–60 × 1.5–2.5 mm, 3-nerved, lamina rarely branched irregularly towards distal end, or new leaflets arise laterally, attenuate-narrowly cuneate at base, rounded at apex. Traps numerous on stolons, rhizoids, and leaves, sub-globose, 1.3–1.5 × 1.2–1.5 mm across, glandular; stalk 0.3–0.5 mm long, distally thickened; mouth basal; appendages subulate, glandular

**Fig. 114.** Type of *Utricularia wightiana* P.Taylor [*Herb. Wight* 2413 (K000628549)] "© *Board of Trustees of the Royal Botanic Gardens, Kew*".

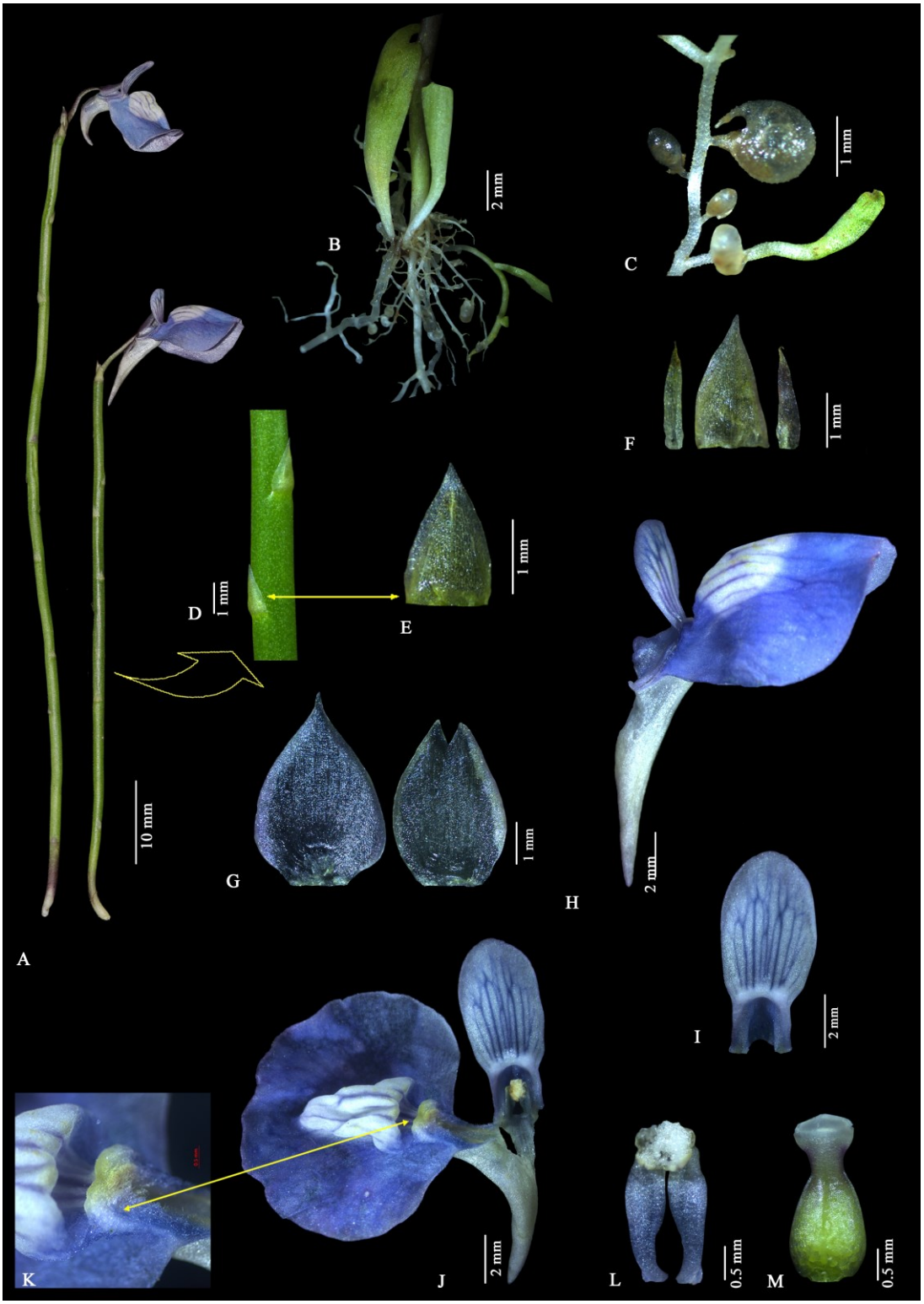


**Fig. 115.** *Utricularia wightiana* P.Taylor: **A.** Habit; **B.** Peduncle base with rhizoids, stolons, leaves and traps; **C.** Leaf and traps; **D.** Scales on peduncle; **E.** Scale; **F.** Bract and bracteoles; **G.** Calyx lobes; **H.** Corolla; **I.** Upper lip of corolla; **J.** Lower lip of corolla; **K.** Ligulate throat (note arrow); **L.** Stamens; **M.** Pistil.

**Fig. 116.** *Utricularia wightiana* P.Taylor: Habitat and habit.

hairy. Racemes erect, or bent upwards, 3–35 cm long, 1–3-flowered; peduncles terete and slightly tapering at base, angular then, grooved on wide side, 1.2–1.5 mm thick, stiff, glossy green-pale purplish green. Scales numerous, from base to tip of peduncle, ovate, 1.5–2 × 1.2–1.6 mm, usually sterile, 3-nerved, green-purplish green, concave, truncate at base, acute at apex. Bracts ovate, 2–2.5 × 1.5–2 mm, 3-nerved, purplish green, truncate at base, acute at apex; bracteoles narrowly triangular, 1.5–2 × 0.3–0.4 mm, 1-nerved, pale green. Flowers 10–16 mm long; pedicels 6–10 × 0.5–0.8 mm, erect, ascending, dorsiventrally flattened, slightly winged, green-purplish green. Calyx lobes sub-equal, green-greenish purple; upper lobe ovate, 4–5.5 × 2.5–3.6 mm, acuminate at apex; lower lobe ovate-elliptic, 3.5–5.5 × 2.5–3.2 mm, bidentate at apex. Corolla blue; upper lip oblong, 5.5–8 × 3.5–4 mm, hairy along lower margin, longer and wider than the upper calyx lobe, constricted below the middle, sometimes widened above the middle, lilac-mauve with deep blue striations, rounded at apex; lower lip widely obovate to orbicular, 10.5–12 × 10–11 mm, throat ligulate, hairy, yellow, palate gibbous, crested with prominent 4-lobed swelling, white with deep blue striations or reticulations, blue-purple then, margin undulate, rounded or slightly emarginate at apex; spur conical, 5–8 mm long, straight or descending, sometimes curved inwards, creamy white-pale purple, acute-acuminate at apex. Stamens 2–2.5 mm long; filaments strap-shaped, 1.8–2 × 0.4–0.5 mm, dorsally grooved, curved at base, pale blue; anther thecae 0.8–1 mm long. Pistil 2.2–2.5 mm long; ovary ovoid 1.5–1.8 × 1.15–1.25 mm, dorsiventrally compressed, green; style 0.45–0.55 mm long, flat, purplish green; stigma bi-lipped, purplish white; upper lip oblong, papillose out; lower lip sub-orbicular, papillose out. Capsules and seeds not seen.

***Flowering & fruiting***: Flowering occurs from early January to April. Mature fruits have not been observed in either live or herbarium materials.

***Habitat***: It usually grows in open swamps within hilly grasslands, as well as along the margins and edges of perennial streams, at elevations ranging from 1800–2400 m. It is commonly found in association with *U. sisparensis*, *Eriocaulon robustum* Steud. (Eriocaulaceae), *Osmunda* sp. (Osmundaceae), other ferns, and large grasses (Fig. 116).

*Distribution*: Endemic to the Western Ghats, India (Fig. 109).

***Specimens examined***: INDIA, **Kerala**, Palakkad district, Attappadi Hills, 5300 feet, 30.01.1911, *C.E.C. Fischer* 2513 (CAL); Silent Valley National Park, way to Anginda, ± 2380 m, 07.02.2022, *K.H. Harishma, M.K. Akhil & M.P. Krishnapriya* 177246 (CALI186863, CALI186864); Anginda, ± 2040 m, 18.01.2024, *M.P. Krishnapriya* 186094 (CALI); Sispara to Walakkad, ± 2000 m, 28.03.1983, *N.C. Nair & P. Bhargavan* 77205 (CAL); Valiya Anginda, Tamil Nadu state boarder, ± 2030 m, 18.01.2024, *M.P. Krishnapriya* 186096 (CALI). **Tamil Nadu**, Coimbatore district, Akkamalai, Grass Hills, 1375 m, 17.04.1963, *J. Joseph* 16191 (CAL); Dindigul district, Kodaikanal, Poombarai, 2200 m, 22.04.1965, *K. Ramamurthy* 23375 (MH00126414, MH00126415); The Nilgiris district, Mudimund, on the banks of Pandiyar River (Punnapuzha), 2000 m, 06.02.1971, *J.L. Ellis* 37886 (MH00126412, MH00126413); Pykara, 27.12.1900, *C.A. Barber* 2679 (CAL, MH00126442); Sispara in swamps, February, *s.coll.* 1442 (A01977153, P03575762, P03575763, P03575764, P03575765, P04425318, L.2828581 digital images); *Ibid.*, April 1884, *s.coll. s.n.* (MH00126416).

***Conservation status***: *Utricularia wightiana* has been reported from three widely separated locations in Kerala and Tamil Nadu. My field observations recorded small, discontinuous patches of *U. wightiana* along stream margins and in swamps, with populations consisting of fewer than 50 mature individuals. Although it occurs in undisturbed protected areas, natural threats, such as fluctuations in climatic conditions and fires, could potentially impact its habitat. This species has an AOO of 7.00 $km^2$ (1 × 1 km grid cell is used here, due to its linear habitat and small population) and EOO of 4079.394 $Km^2$, and is categorised as Critically Endangered (CR B1ab(i,iv,v)+2ab(i,iv,v)+c(iii,iv); D).

***Notes***: Herbarium study reveal that the last collection of *U. wightiana* was made in 1971 from Tamil Nadu, and there have been no subsequent reports. This species is distinctive within the sect. *Oligocista* characterized by comparatively large blue flowers, a crested lower lip of the corolla, and numerous conspicuous scales along the peduncle. It commonly grows at the edges of perennial streams, where its vegetative stage remains submerged throughout the year. Flowering occurs when the water level drops, usually beginning in January.

**Fig. 117.** *Utricularia wightiana* P.Taylor: **A-H.** Variations in racemes; **I-J & L.** Peduncle base bearing numerous stolons and leaves; **K.** Peduncle base with rhizoids; **M-P.** Variations in leaves.

The fruit-setting rate in *U. wightiana* appears to be very low. Live specimens collected in February and herbarium materials collected in March and April all lack mature fruits. Because the herbarium materials were also devoid of mature fruits and seeds, a more detailed study is necessary to understand the mechanisms behind the low rate of fruit maturation and seed setting success, as well as the ecological and pollination factors influencing this species.

The numerous appressed scales on the peduncle are a key diagnostic feature of *U. wightiana.* Wight (1950) described the peduncle as terete, but closer examination of live materials reveals that it is angular and channelled. The stiff, fleshy, and glossy nature of the peduncle can sometimes give the impression of being terete at first glance.

The inflorescence development and flowering pattern are also interesting in this species. In some instances, the peduncle ends with a flower (sub-terminal), and then the peduncle continues to grow laterally, or it may elongate before flowering (Fig. 117A-H). Plants growing in exposed areas tend to have shorter peduncles with more condensed flowers, while those in shaded areas usually exhibit longer peduncle and more spaced-out flowers.

## 5.5. UTRICULARIA SECT. PHYLLARIA (KURZ) KAMIENSKI

**Utricularia sect. Phyllaria** (Kurz) Kamienski in Engl. & Prantl., Nat. Pflanzenfam. 4(3b): 121. 1895; P.Taylor, Gen. *Utricularia* 460. 1989; Li in Y.F.Deng *et al*. (eds.), Fl. Pan-Himalaya 46: 14. 2020. *Utricularia* subgen. *Phyllaria* Kurz. J. Bot. 12: 54. 1874. *Lectotype* (designated by Taylor, 1989): *Utricularia striatula* Sm.

*Meloneura* Raf., Fl. Tellur 4: 109. 1838. *Type*: *M. purpurea* Raf. (= *U. striatula* Sm.)

*Diurospermum* Edgew., Proc. Linn. Soc. London 1(34): 351. 1847. *Type*: *D. album* Edgew. (= *U. kumaonensis* Oliv.)

*Utricularia* L. sect. *Meloneura* (Raf.) Komiya, J. Jap. Bot. 48. 150. 1973

Small epiphytic or lithophytic, annual herbs. Tubers present or absent; solitary or moniliform at the base of peduncle. Rhizoids undifferentiated or absent. Stolons numerous, simple to variously branched. Leaves few to many, rosulate on peduncle base or numerous on stolons, petiolate; lamina broad, obovate to reniform or sub-orbicular to orbicular with dichotomous venation. Traps numerous on stolons, never on leaves, ovoid, stalked; mouth always lateral with single dorsal, flabellate appendage with multicellular glandular hairs; internal glands 4-armed. Scales usually absent, rarely present. Bracts and bracteoles basisolute, unequal. Racemes erect. Calyx lobes very unequal; upper lobe always large; lower always small. Corolla white to shades of purple; upper lip always small; lower lip large, spreading, without gibbous palate, usually lobed. Pollen oblate, 3-4-colporate. Capsules dorsiventrally compressed, dehiscing by a ventral longitudinal or orbicular pore, wall chartaceous, net-veined. Seeds ovoid to obovoid, periclinal wall with numerous testa extensions, short to long strap-shaped, conical, or glochidia-like hairs.

Significant contribution to the understanding of Indian species in this section was given by Oliver (1859) in his conspectus on Indian bladderworts. He described three species, *U. brachiata* Oliv., *U. furcellata* Oliv. and *U. multicaulis* Oliv., from specimens collected by Hooker from the Sikkim Himalaya, along with *U. kumaonensis* Oliv. and *U. striatula* Sm. In his natural grouping, Oliver (*l.c.*) used several key morphological characters, such as reniform, orbicular, or orbicular-spathulate leaves,

highly unequal calyx lobes with the lower lobe smaller, more or less lobed flat lower lip of corolla, and elongate or glochidiate hairs on the testa.

The German Botanist Kurz (1874) described the subgenus *Phyllaria*, characterized by erect, terrestrial herbs with petiolate broad leaves, unequal calyx lobes and a large lower lip of corolla. Kurz speculated that it might represent a distinct genus rather than a subgenus, and included *U. orbiculata* Wall. (now *U. striatula* Sm.) and *U. furcellata* Oliv. in this group. Later, Kamienski (1895) reduced *Phyllaria* to sectional rank and described sect. *Phyllaria* in Engler and Prantl's '*Naturlichen Pflanzenfamilien'*. Taylor (1989) followed Kamienski's treatment in his work and recognized 13 species, distributed from Tropical Asia to New Guinea, most of them which restricted to the Himalayan region. Since then, three additional species were described from various parts of the world (Suksathan & Parnel, 2010; Fleischmann, 2012).

According to Taylor (1989), *Phyllaria* is a natural section that shows affinities with sect. *Oliveria* and *Nigrescentes* due to the narrow apical extension of the placenta, which is adnate to the apex of the ovary wall. Taylor (*l.c.*) reported six species from India: *U. brachiata*, *U. christopheri*, *U. furcellata*, *U. kumaonensis*, *U. multicaulis*, and *U. striatula*), while Janarthanam and Henry (1992) listed only five species (excluding *U. christopheri*) from India, without sectional segregation. In the present treatment, six species are recognized from India, five of which are confined to the Northeast and Himalayan regions (Arunachal Pradesh, Meghalaya, Mizoram, Sikkim, Uttarakhand and West Bengal).

**Key to the species of sect. Phyllaria**

1. Plants tuberous ..... **2**
1. Plants non-tuberous ..... **3**
2. Lower lip of corolla 5-lobed; palate with an yellow spot; spur longer than or equal to the lower lip of corolla, cylindric ..... **U. brachiata**
2. Lower lip of corolla 3-lobed; palate without yellow spot; spur shorter than the lower lip of corolla, conical ..... .**U. christopheri**

3. Spur shorter than the lower lip of corolla; seeds ovoid or ellipsoid with tuft of hairs on both ends or not ..... **4**

3. Spur equal to or exceeding the lower lip of corolla; seeds ovoid with clavate or glochidiate hairs. ..... **5**

4. Lower lip of corolla 4-lobed; seeds ovoid, with a tuft of hairs only at distal end .. ..... . ..... **U. multicaulis**

4. Lower lip of corolla 5-lobed; seeds ellipsoid, with a tuft of hairs at both ends . ..... **U. kumaonensis**

5. Leaves present at peduncle base and on stolons; scales present; lower lip of corolla 5-lobed; spur equal to or shorter than the lower lip ..... **U. striatula**

5. Leaves only at peduncle base, never on stolons; scales absent; lower lip of corolla deeply 4-lobed; spur always longer than the lower lip ..... **U. furcellata**

**1. Utricularia brachiata** Oliv., J. Proc. Linn. Soc., Bot. 3: 187. 1859; C.B.Clarke in Hook.f. (ed.), Fl. Brit. India 4: 333. 1884; Compton, New Phytol. 8(4): 117. 1909; P.Taylor, Gen. *Utricularia* t. 139. 462. 1989; Janarth. & A.N.Henry, Bladderworts India t. 8. 41. 1992 *excl. syn. U. christopheri*; Noltie in Grierson & D.G.Long (eds.), Fl. Bhutan 2(3): 1338. 2001; G.S.Giri *et al*., Mat. Fl. Arunachal Pradesh 2: 223. 2008; Li in Wu *et al*. (eds.), Fl. China 19: 486. 2011; Liden & Bharali, Pleione 8(2): 267. 2014; D.Maity *et al*., Fl. Kanchenjunga 390. 2018; Noltie in Watson *et al.* (eds.), Fl. Nepal (web edn.) 4. 2019; S.K.Mandal & Bhaumik in Lakshmin. *et al*. (eds.), Fl. West Bengal 4: 142. 2019; Li in Y.F.Deng *et al*. (eds.), Fl. Pan-Himalaya 46: 14. 2020; Gogoi *et al*., Fl. Sikkim Pict. Guide 267. 2021. *Lectotype* (first-step designated by Taylor, 1989; second-step designated by Janarthanam & Henry, 1992): INDIA, **Sikkim**, Lachen, 10-11000 ped, 03.08.1849, *J.D. Hooker s.n.* (K [K001081938 digital image!]). **Figs. 118–122**

Lithophytic, perennial, tuberous herbs. Rhizoids absent. Tuber 1 at peduncle base, ovoid-ellipsoid to globose, 1–3 mm across, pink to pale purple, glabrous; stolons, leaves and peduncle develops from tuber. Stolons many, 2–30 mm long, 0.15–0.32 mm thick, simple to branched, glabrous, each stolon end with a tuber; stolon tuber ovoid-oblongoid-globular, 0.8–1.8 mm across, glabrous, green. Traps a few on

stolons, ovoid, 0.9–1.15 × 0.63–0.88 mm, glandular; stalk terete, 0.5–0.8 × 0.1–0.2 mm, glabrous, hyaline; mouth lateral, glandular hairy around mouth; appendage 1, transversely elliptic to flabellate, with multicellular stipitate glands. Leaves 2–8, 4–15 (–23) mm long; petioles terete at base, 3–10 (–20) × 0.23–0.35 mm, glabrous, yellowish green, slightly winged distally; lamina reniform (rarely sub-orbicular), 1.2–3 × 1.92–5.65 mm, 3–4-nerved, nerves branched 2–3 times dichotomously, green to greenish violet or violet, obtuse to reniform at base, margin entire, rounded at apex. Racemes erect, rarely drooping, 2–8.5 cm long, 1–2-flowered; peduncle terete, 0.2–0.45 mm thick, glabrous, green to purplish green. Pedicels 3–10 × 0.2–0.45 mm, terete, greenish violet, erect or slightly reflexed, compressed. Scales ovate, basisolute, obtuse at apex, obscurely 3-lobed at base. Bracts oblong, 1.4–1.8 × 0.55–0.8 mm, basisolute, oblique, greenish violet, margins obscurely dentate, 2–3-lobed towards base, irregularly crenate at apex; bracteoles narrowly elliptic-oblong, 0.9–1.25 × 0.15–0.4 mm, basisolute, rarely attached towards margin, oblique, greenish violet, 2-lobed or rounded at base, rounded or obscurely crenate at apex. Calyx lobes unequal, greenish violet to pale violet, upper always larger; upper lobe sub-orbicular to transversely oblong, 2.1–3.2 × 2.8–3.65 mm, 8–10 nerved, inflexed, reniform at base, emarginate at apex, apex obscurely sinuate, glabrous in, slightly papillose out; lower lobe oblong, 1.5–1.9 × 0.9–1.2 mm, truncate at base, deeply emarginate-bifid at apex. Corolla white; upper lip oblong, 1.95–2.45 × 1.44–2.4 mm, shorter than the upper calyx lobe, constricted above the middle, deeply 2-lobed, lobes truncate at apex, white with a deep purple colouration at margins and

**Fig. 118.** Lectotype of *Utricularia brachiata* Oliv. [*J.D. Hooker s.n.* (K001081938)] "© *Board of Trustees of the Royal Botanic Gardens, Kew*".

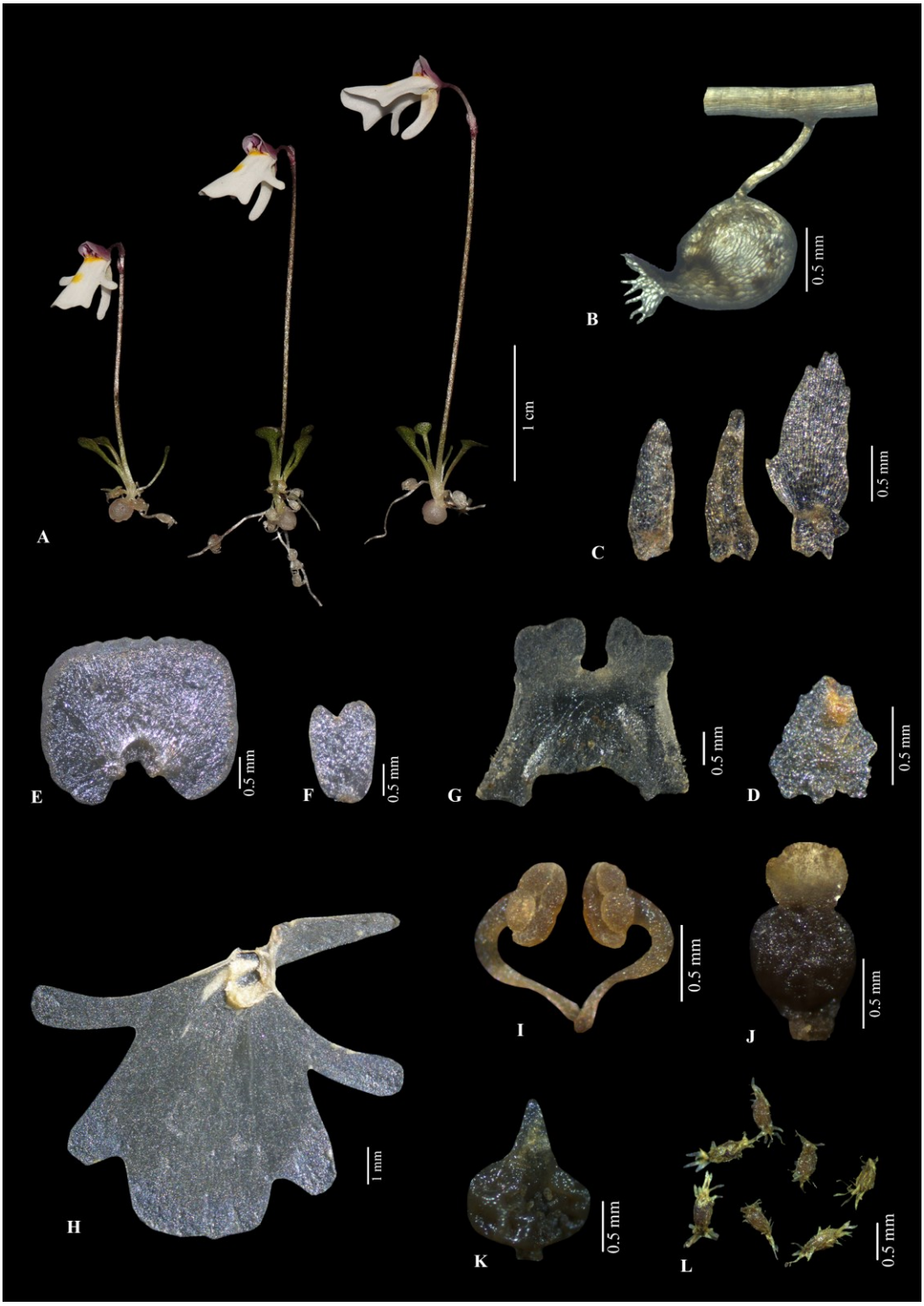


**Fig. 119.** *Utricularia brachiata* Oliv.*:* **A.** Habit; **B.** Trap; **C.** Bracts & bracteoles (left two bracteoles, right bract); **D.** Scale; **E.** Upper calyx lobe; **F.** Lower calyx lobe; **G.** Upper lip of corolla; **H.** Lower lip of corolla with spur; **I.** Stamens; **J.** Pistil; **K.** Placenta; **L.** Seeds.

**Fig. 120.** Habitat and habit of *Utricularia brachiata* Oliv.

central constriction, hairy towards basal margins; lower lip widely elliptic to orbicular, 7–10 × 7.5–9 mm, 5-lobed; lateral lobes 2, oblong, 2.85–3.02 × 1–1.25 mm, diverging, bent upwards, truncate at apex; middle lobe 3-lobed, (rarely a single unit), a large middle lobe in between 2 lateral small lobes, 7.05–8.3 × 5.4–6.4 mm, truncate to rounded at apex, throat yellow with a tuft of glandular hairs, yellow spot at centre of palate; spur narrowly cylindric, 3.5–4 mm long, 3 times longer than lower calyx lobe, white, obtuse to rounded at apex. Stamens 13–1.5 mm long; filament curved at middle, 0.8–1.1 × 0.16–0.17 mm, narrow at base distally thickened; anther theca distinct, 0.5–0.65 mm long. Pistil 1.3–1.45 mm long, greenish violet-violet; ovary ovoid-globose, 0.7–0.8 × 0.7–0.78; style indistinct; stigma 2-lipped, upper lip obsolete; lower lip orbicular, glabrous in, pubescent out. Capsules globose, 2–3 mm long, dehisce through ventral orbicular pore; placenta ovoid; stalk cylindric, terete, *c.* 0.1 mm long; apical extension terete, obtuse at apex. Seeds 6–10 (3–4 aborted), ellipsoid-oblongoid, 0.3–0.4 × 0.2–0.4 mm, a tuft of strap-shaped testa extensions (hairs) at both ends, about as long as body of seeds; hilum lateral.

***Flowering & fruiting***: Flowering occurs from mid-July to mid-September, with fruiting taking place from early August to late September.

***Habitat***: Found in watery, moss-covered cliffs and slopes, as well as mossy meadows within Alpine *Rhododendron* valleys at altitudes ranging from 3000–4200 m above sea level (Fig. 120).

*Distribution*: India (Alpine & Eastern Himalaya), Bhutan, China, and Nepal (Janarthanam & Henry, 1992; Taylor, 1989; POWO, 2025) (Fig. 123).

***Specimens examined***: BHUTAN, Dochula, 10420 feet, 27.09.1964, *P.K. Hajra* 370 (CAL). CHINA, **Yunnan**, Fugong Xian, Lumadeng Xiang, Yaping Cun, SE Amero Pass along the ridge that forms the border between China and Myanmar, E side of Gaoligong Shan, 3460 m, 13.08.2005, *Li Heng, Dao Zhiling, Ji Yunheng, Liu Benxi, Tang Anjun, B. Bartholomew, Lihua Zhou, Jin Hyub-pak & Catherine Bush* 27214 (CAS00122493 digital image); Gongshan, Cikai, Heipu Pass along the road from Gongshan to Dulong Jiang Valley, E. side of Gaoliging Shan, 3490 m, 12.08.2006, *Li Heng, Dao Zhiling, Ji Yunheng, Jin Xiaohua Hu Guangwan, Peter Fritsch, Simon Crutchley,*

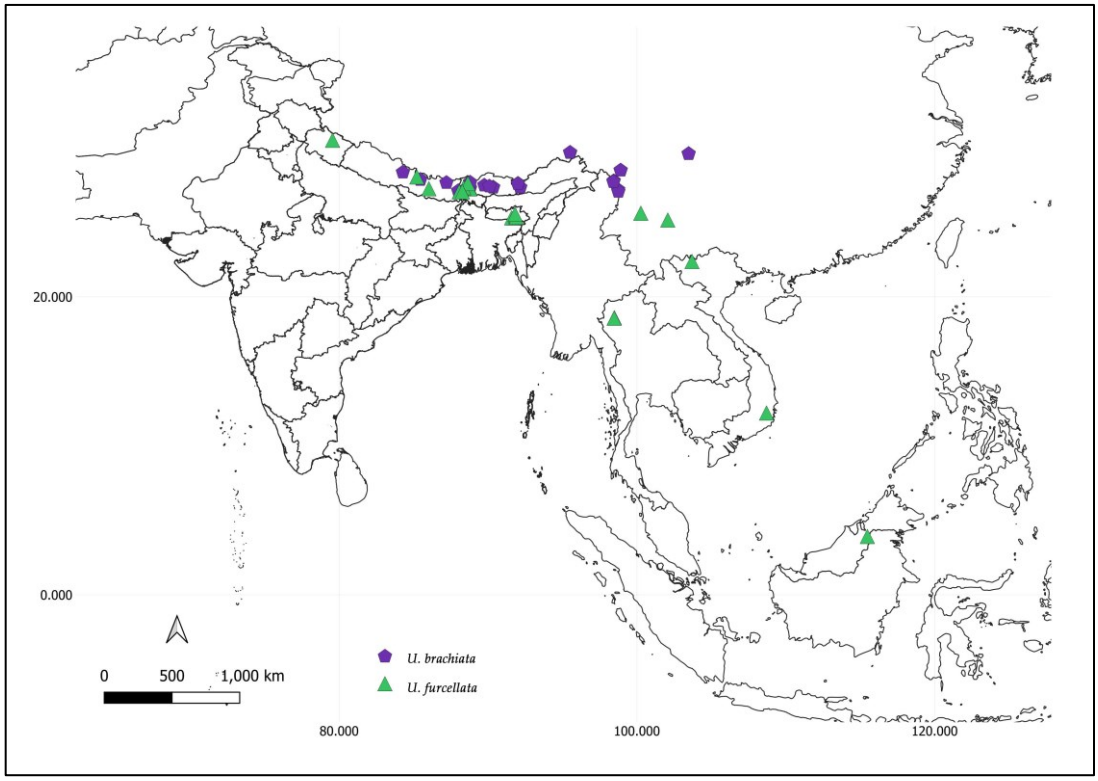


**Fig. 123.** Distribution of *Utricularia brachiata* Oliv. and *U. furcellata* Oliv.

*Jin Hyub-pak & Catherine Bush* 32035 (CAS00122491 digital image); Gongshan Xian, Dulongjiang Xiang, W. side of Gaoligong Shan, W. of Gongshan, on the trail from Qiqi to Bapo in Dulong Jiang Valley, 2700 m, 15.07.2000, *Li Heng, Bruce Bartholomew, Philip Thomas, Peter Fritsch, Dao Zhi-ling, Wang Zhing-lan & Li Rong* 12887 (CAS 00122494, digital image); Meking-Salwin Divide, Sila, 3500 m, 06.08.1938, *T.T. Yu* 22216 (A01976859 digital image). East Himalaya, Gampung, 14000′, 12.08.1913, *Romhoo Lepcha* 853 (E01321663 digital image). INDIA, **Sikkim**, Gangtok district, Gangtok to Nathula, 6 km before Chhangu, ± 3500 m, 08.09.2022, *M.P. Krishnapriya* 186008 (CALI199594); near Kanchenjunga viewpoint, 08.09.2022, *M.P. Krishnapriya* 186006 (CALI); Mangan district, way to Katao, ± 4200 m, 05.09.2022, *M.P. Krishnapriya* 177299 (CALI197389, CALI199593); Katao, ± 4200 m, 05.09.2022, *M.P. Krishnapriya* 177300 (CALI197387, CALI197388); Rhododendron Sanctuary between Lachung and Yumthang, 8200 feet, 12.07.1987, *M. Sanjappa* 18433 (MH00126555); Shingba Rhododendron Sanctury, 18.07.2011, *Mohangbangopadhyay* 36013 (BSHC00043495); *Ibid*., 19.07.2013, *C.S. Purohit* 37321 (BSHC00043494); Zekuphyak,

4000 m, 13.08.2019, *Rajib Gogoi & Norbu Sherpa* 41403 (BSHC00026990; BSHC00026991); *Ibid*., ± 3600 m, 05.09.2022, *M.P. Krishnapriya* 177298 (CALI197390, CALI199581); *Ibid*., ± 3600 m, 05.09.2022, *M.P. Krishnapriya* 186001 (CALI197391, CALI197392, CALI197393); Zemu Valley, 10800 feet, 23.07.1909, *Smith & Cave* 1733 (DD); Pakyong district, Zuluk, ghat region, ± 3000 m, 09.09.2022, *M.P. Krishnapriya* 186010 (CALI198478); West Sikkim district, Phedang to Tsoka, S. of Dzongri, 27°26′N, 88°10′E, 3500 m, 26.07.1992, *D.G.Long, R.J.D. Mcbeath, H.J. Noltie & M.F. Watson* 732 (E01321662 digital image). NEPAL, **Central Nepal**, Gopte 3500–3200m, Thale Patil-3400 m (852281), 26.08.1972, *H. Kanai, H. Hara & H. Ohba* 721973 (A01977036 digital image). **Koshi Province**, Sankhuwasabha district, Khongma (3510 m), Unisha Kharka (3150 m)-Danda Kharka (2875 m)-Bhainsi Kharka (2560 m)-Uttise Kharka (2290 m)-Tashi Gaun (2150m), 3400m, 13.08.1990, *M. Minaki, C. Yonebayashi, F. Miyamoto, H. Takayama, H. Sugita, H. Yagi, M.N. Subedi & M. Ikeda* 90 (KATH129327 digital image); Panghu danda (3120 m), 32.08.1969, *Kanai & Malla* 674678 (KATH129320 digital image). **Sagarmatha Province**, Solukhumbu district, around Rangdu Kharka, 86°48′E 27°38′N, 3300 m, 09.08.1997, *M. Wakabayashi*, *M. Amano*, *M. Mori*, *K.R. Rajbhandari & K. Shinozaki* 9712118 (KATH129324, A01977034 digital images).

***Conservation status*:** *Utricularia brachiata* is a high altitude species found primarily in the Alpine region of Sikkim and Arunachal Pradesh (Liden & Bharali, 2014; Verma *et al*., 2014), with a few localities in China, Nepal and Bhutan. Previously it was known from one or two locations in North and East Sikkim. During a recent field study, I was able to collect this species from two additional locations. However, I was unable to locate it in Arunachal Pradesh, although Liden and Bharali (2014) reported it from Domjee La and Mechuka in Arunachal Pradesh.

Habitat studies indicate that the additional locations do not suggest a wide distribution for the species, instead, they represent remnants of its previously more extensive habitat. In Sikkim, *U. brachiata* found at elevations ranging from 3000 to 4200 m. It usually grows on steep slopes in the alpine zone, particularly on loosely packed, highly eroded vertical or overhanging rocks. Populations are often small, with fewer than 10 individuals per site, and sometimes as few as 2 to 5 individuals.

While there are several suitable areas where the species could potentially occur, these have not been observed to host the species. Habitat destruction, due to landslides, avalanches, and extreme drought, is a major factor contributing to the rarity of *U. brachiata* and the reduction in its population size. Based on current data, the status of this species is being assessed in the Indian context. The species has an AOO of 8 $Km^2$ (1 × 1 Km grid cell is used here, due to its linear habitat) and falls within Critically Endangered (CR B2ab(ii,iii,iv,v); D) category.

**Fig. 121.** *Utricularia brachiata* Oliv.: A. Growing in a mossy bed; **B-D & F.** Peduncle base bearing single basal tuber, stolons, leaves, traps and stolon tuber at the tip; **E.** Stolon tuber; **G.** C.S. of stolon tuber (after iodine test); **H.** Presence of starch grains in the stolon tuber.

***Notes*:** In *U. brachiata*, the leaves, stolons, traps, and young stolon tubers are always concealed within the mossy bed or substrate. Each stolon produces a tuber at its apex, which function as a storage organ. These tubers, composed of well-developed parenchyma cells, are rich in starch grains (Fig. 121). The subterranean tubers, securely embedded in the moss, can withstand extreme climatic fluctuations, such as rise in temperature, drought, fire and icing (Plachno *et al*., 2020). Given that the capsules contain only 4 or 5 fertile seeds, the formation of stolon tuber is not only a reproductive strategy but also facilitates vegetative propagation.

**Fig. 122.** Corolla variations in *Utricularia brachiata* Oliv.

*Utricularia brachiata* was described by Oliver (1859) based on specimens collected by Hooker from the Sikkim Himalaya. In the protologue, Oliver (*l.c.*) noted locations as 'in Himalaya orientali temperate, prov. Sikkim, Lachen, inter muscos, alt. 8-11000 ped., J.D. Hooker!'. Taylor (1989) cited a specimen at K collected by Hooker from Lachen at 10000-11000 feet as the holotype. However, the citation of holotype is obviously an error according to Art. 9.10 (Turland *et al*., 2018), Janarthanam and Henry (1992) corrected this by providing a valid lectotypification.

*Utricularia brachiata* exhibit variations in corolla lobing pattern, in which the lateral lobes can be small or obscurely lobed, or much long, diverged and deeply divided (Fig. 121). Janarthanam and Henry (*l.c.*) also synonymized *U. christopheri* under *U. brachiata*. However, *U. brachiata* is distinct, and can be differentiated from *U. christopheri* by its 5-lobed lower lip of the corolla (*vs*. 3-lobed in *U. christopheri*), the prominent yellow spot at the palate (*vs*. without yellow spot), and the spur, which is three times longer than the lower calyx lobe, and cylindric (*vs.* spur slightly exceeds the lower calyx lobe, and is conical).

**2. Utricularia christopheri** P.Taylor, Kew. Bull. 41(1): 12. 1986, Gen. *Utricularia* t. 140. 464. 1989; Liden & Bharali, Pleione 8(2): 269. 2014; Noltie in Grierson & D.G.Long (eds.), Fl. Bhutan 2(3): 1339. 2001, in Watson *et al.* (eds.), Fl. Nepal web. edn. 4. 2019; Li in Y.F.Deng *et al*. (eds.), Fl. Pan-Himalaya 46: 16. 2020; Gogoi *et al*., Fl. Sikkim Pict. Guide 267. 2021. *Type*: NEPAL, **Koshi Province**, Sankhuwasabha district, Upper Kashwa Khola, Dhap, *c.* 3750 m, 05.09.1981, *Grey Wilson et al*. 4365D (holo, K [K000662810 digital image!]). **Fig. 124**

Lithophytic perennial, tuberous herbs. Rhizoids absent. Tuber 1, at peduncle base, globose. Stolons many, filiform, simple. Traps numerous on stolons, ovoid, *c.* 1 mm long; mouth lateral, glandular hairy around mouth; appendage broadly flabellate. Leaves rosulate from tuber, 2–8 mm long, petiolate; petioles 1.5–6 mm long, slightly winged, glabrous; lamina obovate to sub-orbicular, 1–2 mm long, dichotomously veined, attenuate to cuneate at base, rounded at apex. Racemes erect, 2–5 cm long, rarely drooping, solitary, 1-flowered; peduncle terete, glabrous. Pedicels 2–6 mm long, erect, terete. Scales absent. Bracts ovate to

**Fig. 124.** Type of *Utricularia christopheri* P.Taylor [*Grey Wilson et al.* 4365D (K000662810)] "© *Board of Trustees of the Royal Botanic Gardens. Kew*".

oblong, *c.* 0.6 mm, basisolute, oblique; bracteoles similar to bracts. Calyx lobes unequal; upper lobe orbicular, *c.* 2 mm long; lower lobe oblong, *c.* 1.2 mm long, emarginate at apex. Corolla white; upper lip oblong, obscurely 2-lobed towards apex, 1–1.5 mm long, shorter than upper calyx lobe, hairy towards base margins; lower lip sub-orbicular, *c.* 5 × 8 mm, 3-lobed, lateral lobes united, white, throat yellow with a tuft of glandular hairs, emarginate at apex; spur subulate-narrowly cylindric, *c.* 1 mm long, less than twice or equal to the lower calyx lobe in length, white, rounded at apex. Capsules and seeds not seen.

***Flowering & fruiting***: Flowering from August to September, mature fruits have not been observed in any of the herbarium materials.

***Habitat***: Grows on moss-covered wet rocks, at elevations ranging from 3600 to 4000 m. It is usually found in association with *U. brachiata* and *U. multicaulis* (Li, 2020).

***Distribution***: India (Alpine & Eastern Himalaya - rare) and Nepal (Taylor, 1989; POWO, 2025) (Fig. 125).

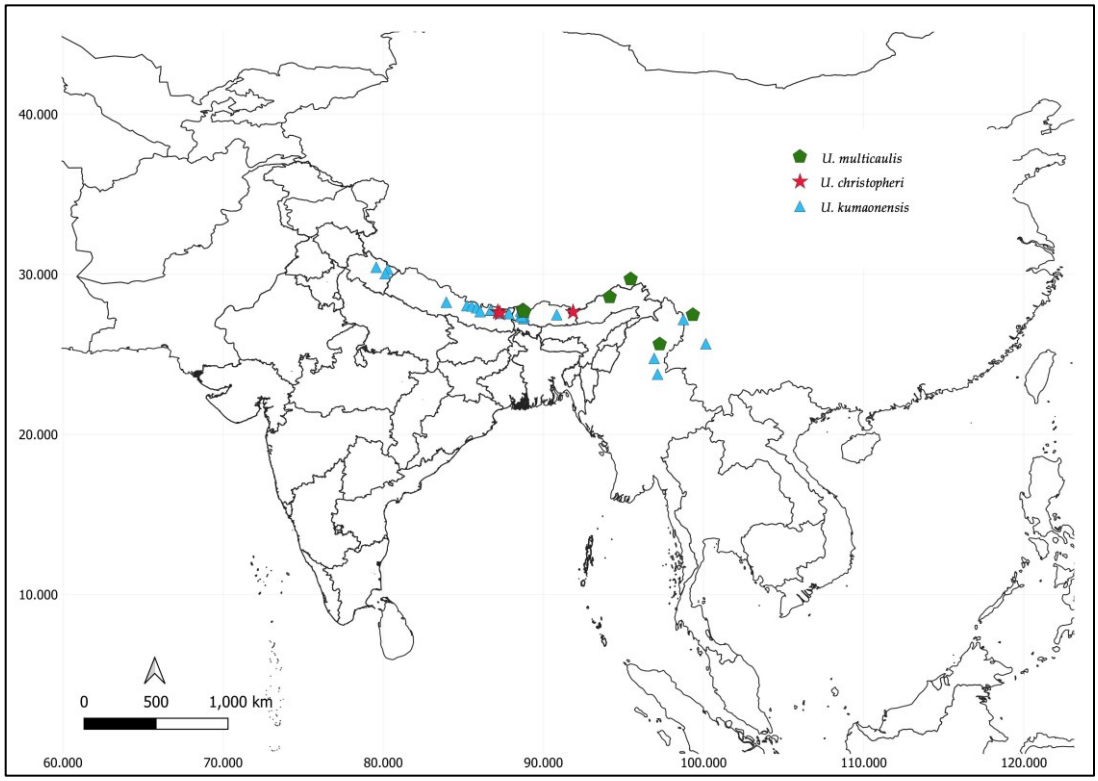


**Fig. 125.** Distribution of *Utricularia christopheri* P.Taylor; *U. kumaonensis* Oliv. and *U. multicaulis* Oliv.

***Specimen examined***: INDIA, **Sikkim**, North Sikkim district, Zekuphyak, 4000 m, 13.08.2019, *Rajib Gogoi & Norbu Sherpa* 41404 (BSHC00026992, BSHC00026993).

***Conservation status***: *Utricularia christopheri* appears to have a rare distribution in India, known only from two locations. Although Gogoi *et al.* (2021) reported its presence in Sikkim, I was unable to relocate the species in the same area. The site where *U. christopheri* was previously collected is located in a region prone to heavy landslides in the Alpine Himalayas. The extreme instability of the land may be a key factor contributing to the gradual disappearance of the species. In the Indian context, *U. christopheri* is considered high risk. Due to the lack of sufficient data on its distribution and population size, the species should be considered as Data Deficient (DD).

***Notes***: *Utricularia christopheri* was described by Taylor (1989) based on a specimen collected from Nepal by Grey-Wilson *et al*. Taylor (*l.c.*) compared the species to *U. brachiata,* but since the type specimen lacked capsules and seeds, he was unable to describe the seed characteristics. Later, Janarthanam and Henry (1992), treated *U. christopheri* as a variant of *U. brachiata.* However, *U. christopheri* is distinct, characterized by a 3-lobed lower lip of the corolla (without yellow spot), and a spur that slightly exceeds the lower calyx lobe. Taylor (*l.c.*) described a 5-lobed lower lip of corolla, but upon reviewing the type specimen, herbarium sheets, and photographs, I found that the lower lip to be clearly 3-lobed (the lateral lobes of the corolla, described by Taylor (*l.c.*) as '5-lobed' are actually lobes at the margins).

Specimens of *U. christopheri* are scarce in Indian herbaria, with only one collection consisting of two sheets at BSHC in Gangtok, Sikkim. These specimens are incomplete, representing single flowered plants with 1 or 2 leaves, but lacking tubers, capsules or seeds. Although, Liden and Bharali (2014) reported its occurrence in Sela of Arunachal Pradesh, no voucher specimens were available instead of photographs.

**3. Utricularia furcellata** Oliv., J. Linn. Soc., Bot. 3: 189. 1859; C.B.Clarke in Hook.f. (ed.), Fl. Brit. India 4: 334. 1884; R.K.Basak, Bull. Bot. Surv. India 17: 104. 1975; J.Joseph & Joseph, Insectiv. Pl. Meghalaya 34. 1986; P.Taylor, Gen. *Utricularia* 476. f. 146. 1989; Janarth. & A.N.Henry, Bladderworts India t. 13. 55. 1992; Noltie in Grierson &

D.G.Long (eds.), Fl. Bhutan 2(3): 1337. 2001; Pandey *et al*., Pleione 7(1): 268. 2013; Deepak Kr. Ghosh & Jayanta Kr. Mallick, Fl. Darjeeling 313. 2014; P.Singh *et al*., Endem. Vasc. Pl. India 195. 2015; S.S.Dash & P.Singh, Fl. Kurung Kumey Dist. 385. 2017; S.K.Mandal & Bhaumik in Lakshmin. *et al*. (eds.), Fl. West Bengal 4: 143. 2019; Noltie in Watson *et al.* (eds.), Fl. Nepal web. edn. 5. 2019; Gyeltshen & Dema, Bhutan J. Nat. Resorces & Develop. 7(1): 52. 2020; Li in Y.F.Deng *et al*. (eds.), Fl. Pan-Himalaya 46: 21. 2020; Gogoi *et al*., Fl. Sikkim, 267. 2021; M.Singh *et al*., J. Japanese Bot. 97(3): 175. 2022. *Utricularia furcellata* Oliv. var. *minor* C.B.Clarke in Hook.f. (ed.), Fl. Brit. India 4: 334. 1884. *Lectotype* (designated by Taylor, 1989): INDIA, **Meghalaya**, Khasia, Boga Panee, 27.10.1850, *J.D. Hooker & T. Thomson* 2534 (K [K000450586 digital image!]). **Figs. 126–128**

Lithophytic, annual herbs. Rhizoids absent. Tubers absent. Stolons numerous on peduncle base, 8–26 mm long, simple or branched, hyaline, glandular. Traps few on stolons, obliquely ovoid-globose, 0.8–1.3 × 0.6–1.2 mm, glandular; stalk terete, 0.1–0.2 mm long; mouth lateral, glandular hairy around mouth; appendage 1, flabellate with long radiating multicellular hairs on either side, short glandular hairs towards middle. Leaves rosulate, 2–5 (–10) at peduncle base, never on stolons; petioles terete at base, 4–8 (–12) mm long, hyaline or pale green, slightly winged towards lamina; lamina widely obovate to orbicular, 1.8–4 × 2–4.5 mm, dichotomously nerved, yellowish green, obtuse to

**Fig. 126.** Lectotype of *Utricularia furcellata* Oliv. (*J.D. Hooker & T. Thomson* 2534 (K000450586)] "© *Board of Trustees of the Royal Botanic Gardens, Kew*".

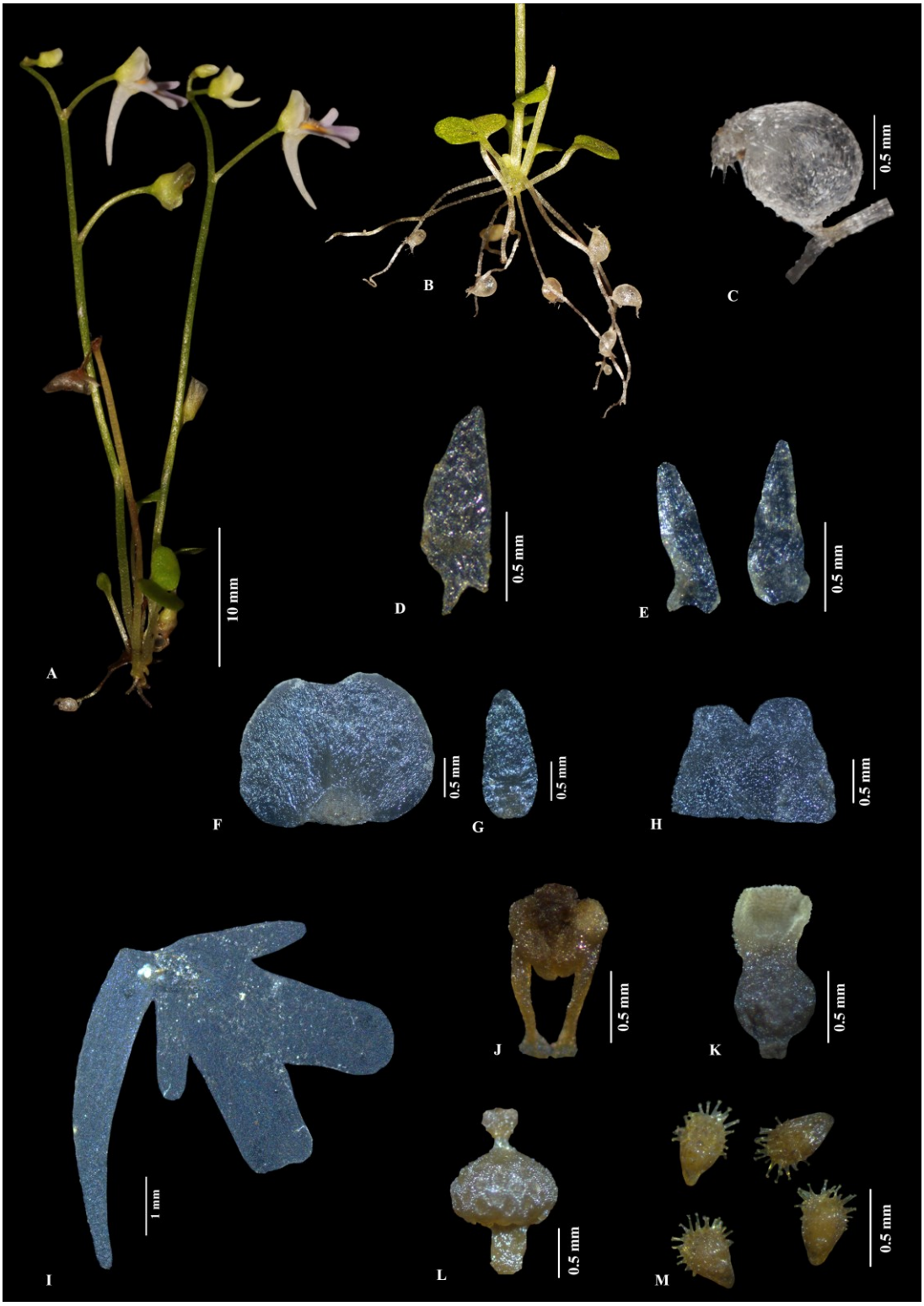


**Fig. 127.** *Utricularia furcellata* Oliv.: **A.** Habit; **B.** Peduncle base with stolons, leaves and traps; **C.** Trap; **D.** Bract; **E.** Bracteoles; **F.** Upper calyx lobe; **G.** Lower calyx lobe; **H.** Upper lip of corolla; **I.** Lower lip of corolla with spur; **J.** Stamens; **K.** Pistil; **L.** Placenta; **M.** Seeds.

**Fig. 128.** Habitat and habit of *Utricularia furcellata* Oliv.

truncate or rounded at base, margin entire, rounded at apex. Racemes erect, 1–8 cm long, often glandular at base, single, 1–5-flowered; peduncles terete, 0.1–0.2 mm thick, yellowish green. Pedicels 1–3.5 (–6) mm long, erect in flower, terete, reflexed in fruit. Scales absent. Bracts lanceolate, 0.7–0.9 × 0.25–0.4 mm, basisolute, yellowish green, deeply emarginate at base, acute at apex; bracteoles ovate-oblong, 0.6–0.8 × 0.2–0.4 mm, basisolute, yellowish green, oblique, rarely attached towards margin. Calyx lobes unequal, papillose, green or yellowish red when young, purplish red with greenish white towards margin after; upper lobe sub-orbicular, 1.5–2.5 × 2–3.7 mm, rounded at base, emarginate at apex; lower lobe oblong, 0.8–1 × 0.25–0.5 mm long, truncate at base, emarginate-rounded at apex. Corolla white to purple, prominent yellow at throat and palate of lower lip; upper lip transversely oblong, 1.2–1.7 × 1.5–2 mm, shorter than the upper calyx lobe, white to mauve, emarginate or obscurely 2-lobed at apex, hairy at lower margin; lower lip oblong, 2–3.5 × 3.5–4 mm, 4-lobed, 2 lateral lobes diverging, distinctly smaller than middle lobes, lobes oblong, rounded at apex, mauve to pale purple yellow at throat with long, eglandular, unicellular hairs; spur subulate, 4–6 mm long, 3 to 4 times longer than lower calyx lobe, mauve-pale purple, papillose, straight, slightly bent towards apex, rounded at apex. Stamens 0.6–0.8 mm long; filaments erect, curved at middle, 0.6–0.75 × 0.08–0.12 mm; anther thecae distinct, 0.1–0.2 mm long. Pistil 0.9–1.2 mm long, green; ovary obliquely ovoid-globose, 0.5–0.7 × 0.3–0.6 mm; style indistinct; stigma 2-lipped; upper lip obsolete, lower lip recurved. Capsules obliquely ovoid to globose, 1.5–2.5 mm long, strongly keeled on ventral side, dehisce through ventral orbicular pore; placenta ovoid 1–1.2 mm long; stalk cylindric, terete, 0.2–0.4 mm long; apical extension bearing stigma. Seeds obovoid, 0.4–0.5 × 0.15–0.2 mm, numerous, long clavate hairs present; hilum lateral or terminal.

***Flowering & fruiting***: Flowering starts from mid-August till late September and fruiting from late August to early October. Peak flowering is observed between late August and mid-September.

***Habitat***: Found on moss-covered dripping rocks, wet vertical cuttings and slopes, at elevations above 1500 m, in association with *U. recta*, *U. kumaonensis*, *Begonia* spp. (Begoniaceae), *Cyanotis* sp. (Commelinaceae), *Persicaria* sp. (Polygonaceae), *Sonerila khasiana* (Melastomataceae), some grasses, mosses and ferns (Fig. 128).

***Distribution***: India, Bhutan (Gyeltshen & Dema, 2020), China (Hu *et al*., 2008), Nepal, Myanmar, Thailand (Suksathan & Parnell, 2010), Peninsular Malaysia (Chew & Haron, 2011), and Vietnam (POWO, 2025) (Fig. 123).

***Specimens examined:*** INDIA, **Meghalaya**, East Khasi Hills district, way to Cherrapunji, ± 1700 m, 17.09.2021, *M.P. Krishnapriya & Santhosh Nampy* 175832 (CALI186861); Elephant Falls, ± 1669 m, 26.09.2021, *M.P. Krishnapriya & Santhosh Nampy* 177203 (CALI187639, CALI187640); Laitlyngkot, ± 1800 m, 20.09.2021, *M.P. Krishnapriya & Santhosh Nampy* 175850 (CALI186860); Langkyrdem, ± 1500 m, 20.09.2021, *M.P. Krishnapriya & Santhosh Nampy* 175852 (CALI186862); way to Mawsynram, ± 1712 m, 21.09.2021, *M.P. Krishnapriya & Santhosh Nampy* 175874 (CALI186858, CALI186859); *Ibid*., ± 1580 m, 21.09.2021, *M.P. Krishnapriya* 175876 (CALI); Pynursla, 02.08.1980, *J. Joseph* 96032 (ASSAM); Wahkaba Waterfalls, ± 1510 m, 26.09.2021, *M.P. Krishnapriya* 175899 (CALI199596). **Sikkim**, Gangtok district, 4th mile, Gangtok to Zuluk route, ± 2200 m, 08.09.2022, *M.P. Krishnapriya* 186002 (CALI197403, CALI199567); *Ibid*., ± 2100 m, 08.09.2022, *M.P. Krishnapriya* 186004 (CALI); Phadamchen, 8000 feet, 19.08.1910, *W.W. Smith* 4400 (CAL); Mangan district, way to Chungthang, 3 Km from Bansoi Bridge, ± 2230 m, 04.09.2022, *M.P. Krishnapriya* 177294 (CALI197400, CALI197401); Lachung, 09.1903, *F.E. Younghusband s.n.* (CAL Acc. No. 330367, 330371); Namchi district, Ravangla, near, Buddha Park, ± 2050 m, 28.08.2022, *M.P. Krishnapriya* 177285 (CALI197404); after Maenem Wildlife Sanctury office, ± 2200 m, 28.08.2022, *M.P. Krishnapriya* 177286 (CALI197402, CALI199568); Pakyong district, Zuluk, 2600 m, 07.09.2019, *Rajib Gogoi & Norbu Sherpa* 41407 (BSHC00026996, BSHC00026984). **West Bengal**, Darjeeling district, Darjeeling, 7000–9000 feet, 09.09.1903, *G.M. Cave s.n.* (CAL Acc. No. 330383, 330384, 330385, 330386, 330372, 330374, 330376, 330377, 330378, 330379, 330380, 330381, 330382); Simana, 7500 feet, 03.10.1906, *I.H. Burkill* 27764 (CAL); Singalila National Park, near Tonglu, 2900 m, 13.10.2003, *M.R. Debta* 33202B (CAL). MYANMAR, **Chin State**, *c.* 10 miles from Mindat between Mindat and Matupi (Mindat-Matupi road), Mindat Township, Natma Taung National Park, *c.* 1800 m, 01.09.2013, *Kazumi Fujikawa, Prachaya Srisanga, Charun Maknoi, Tin Mya Soe, Myint Hlaing & Law Shine* 094889 (MBK0255114 digital image).

***Conservation status***: *Utricularia furcellata* grows on open vertical cliffs and cuttings, especially along roadsides. Its habitat is highly vulnerable to human activities, such as road widening and clearing as well as to natural disasters like landslides and avalanches. Despite being locally abundant, the species faces a high risk of threat. Moreover, *U. furcellata* is ephemeral, if its habitat is destroyed, it is extremely difficult for the species to naturalise either the same or a new area. The AOO is calculated as 76 $Km^2$, and based on the current data, the status of *U. furcellata* is assessed as Endangered (EN B2ab(ii,iii,v)).

***Notes***: *Utricularia furcellata* is morphologically similar to *U. striatula*, but can be distinguished by the deeply 4-lobed lower lip of its corolla. While the seeds of these two species appear similar, *U. furcellata* possesses clavate testa hairs, whereas, *U. striatula* has glochidiate testa hairs (Figs. 179S & 180U).

**4. Utricularia kumaonensis** Oliv., J. Proc. Linn. Soc., Bot. 3: 189. 1859; C.B.Clarke in Hook.f. (ed.), Fl. Brit. India 4: 334. 1884; P.Taylor, Gen. *Utricularia* t. 142. 468. 1989; Janarth. & A.N.Henry, Bladderworts India 65. 1992; Li in Wu *et al*. (eds.), Fl. China 19: 481–491. 2011; Noltie in Watson *et al.* (eds.), Fl. Nepal web. edn. 5. 2019; Li in Y.F.Deng *et al*. (eds.), Fl. Pan-Himalaya 46: 18. 2020; Gogoi *et al*., Fl. Sikkim, Pict. Guide 267. 2021. *Neotype* (designated by P.Taylor, 1989): INDIA, **Uttarakhand**, Pilti River, alt. 7500 feet, *s.d., R. Strachey & J.E. Winterbottom s.n.* (K [K000662811 digital image!]). **Figs. 129–131**

Epiphytic or lithophytic annual herbs. Rhizoids absent. Tubers absent. Peduncle 2–4(–6) from the base, base thick with a persistent seed coat. Stolons numerous (4–18) on peduncle base, 5–30 mm long, 0.21–0.35 mm thick, usually simple, rarely branched, glabrous, hyaline. Traps numerous on stolons, ovoid-oblongoid, 0.8–1.2 × 0.7–1 mm; stalk terete, 0.3–0.45 × 0.08–0.12 mm, glabrous; mouth lateral, glandular hairy; appendage 1, transversely elliptic to flabellate, with multicellular stipitate glands. Leaves rosulate, 4–8 (–12) from the peduncle base, 2.2–14.8 mm long; petioles terete at base, 0.75–9.5 × 0.20–0.38 mm, glabrous, pale green, broader towards lamina; lamina obovate to sub-orbicular or reniform, 1.26–4.5 × 1.06–5.7 mm, 2-nerved,

nerves dichotomously branched, green to purplish green, attenuate to cuneate at base, margin entire, rounded at apex. Racemes erect, rarely drooping, 2–8 (–10) cm long, 1–6-flowered; peduncles terete, 0.3–0.8 mm thick, glabrous, green-reddish green. Pedicels 2–5(–8) × 0.2–0.5 mm, erect at anthesis, terete, reflexed in fruit, yellowish green at anthesis, greenish red then. Scales absent. Bracts ovate-oblong, 0.7–1.2 × 0.3–0.4 mm, basisolute, oblique, green to reddish green, bidentate at base, margins obscurely denticulate, acute-bidentate at apex; bracteoles oblong to narrowly elliptic, 1.08–1.22 × 0.25–0.3 mm, basisolute, rarely obliquely towards margin, green, 2-3-fid at base, acute at apex. Calyx lobes unequal, greenish red to purplish red towards base, off white towards margin; upper lobe always larger, transversely oblong, 1.55–2.2 × 1.8–2.8 mm, 2-nerved, reniform at base, deeply emarginate or bifid at apex, glabrous in, papillose out; lower lobe oblong, 0.8–1.2 × 0.6–0.85 mm, truncate at base, rounded, irregularly crenate at apex. Corolla white with shades of purple at tip of lower lobes, yellow at throat; upper lip transversely widely oblong, 1.3–2 × 2.4–2.6 mm, constricted above the middle, truncate to 2-lobed at apex, hairy towards base margins; lower lip widely oblong to orbicular, 3.5–6 × 3–4.8 mm pure white or white with lavender-lilac towards tip, throat with a band like, prominent, yellow colour at the margin, extends into palate, 2 crests at either side of the throat, a tuft of glandular hairs at the margin of throat, deeply 5-lobed, 2 lateral lobes and 3 middle lobes; lateral lobes oblong, diverging, slightly bent upwards, truncate at apex; 3 middle lobes: a large middle lobe in between 2 small lateral lobes, rounded at apex; spur subulate to conical, 1.4–2 × 0.5–0.8 mm, two times longer than lower calyx lobe, shorter than the lower lip of corolla, white or yellow at base, pale purple

**Fig. 129.** Neotype of *Utricularia kumaonensis* Oliv. [*R. Strachey & J.E. Winterbottom s.n.* (K000662811)] "© *Board of Trustees of the Royal Botanic Gardens, Kew*".

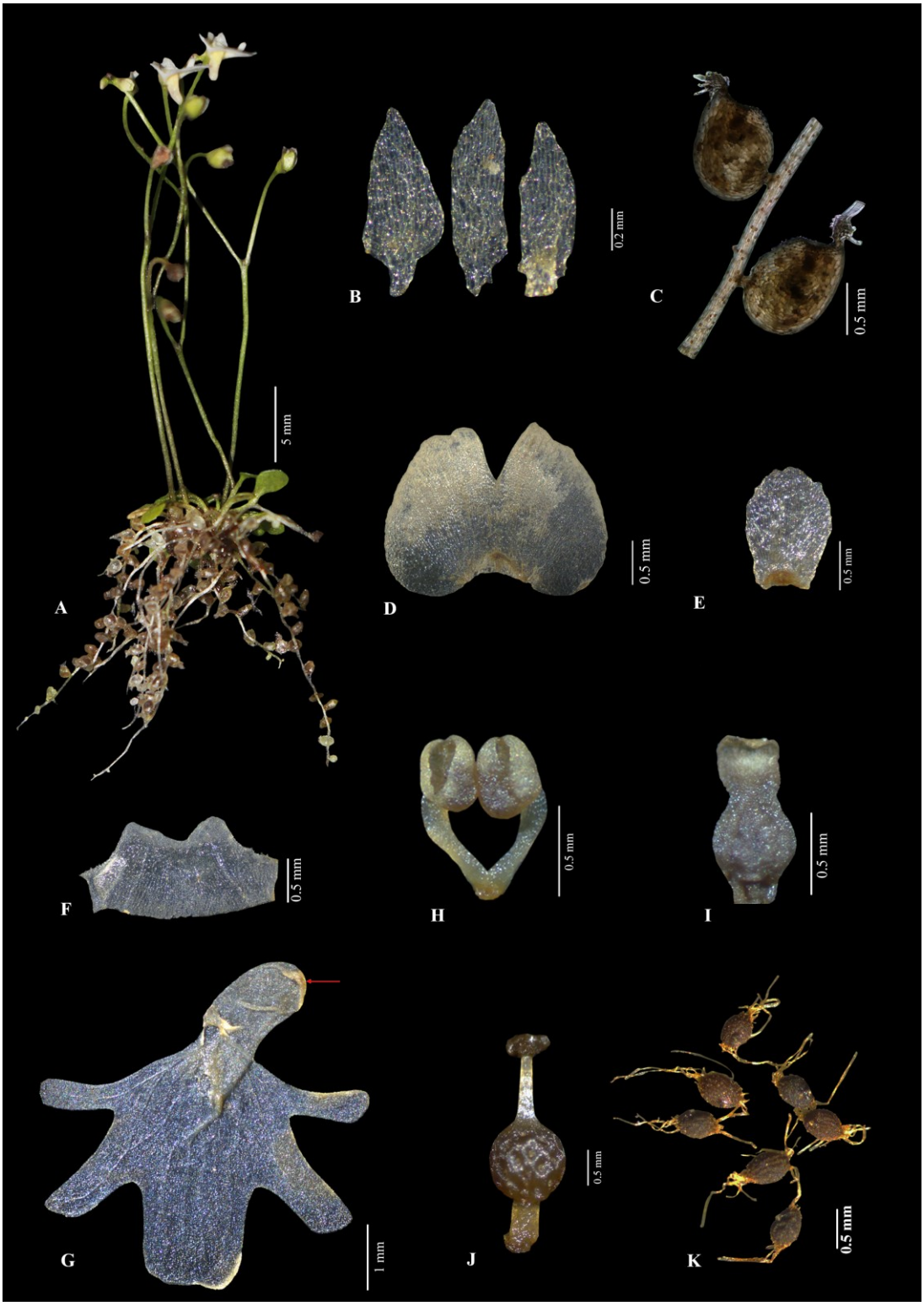


**Fig. 130.** *Utricularia kumaonensis* Oliv.: **A.** Habit; **B.** Bract & bracteoles; **C.** Traps; **D.** Upper calyx lobe; **E.** Lower calyx lobe; **F.** Upper lip of corolla; **G.** Lower lip of corolla with spur; **H.** Stamens; **I.** Pistil; **J.** Placenta; **K.** Seeds.

**Fig. 131.** Habitat and habit of *Utricularia kumaonensis* Oliv.

then, rounded at apex. Stamens 0.8–0.85 mm long; filament slightly curved at middle, 0.3–0.6 × 0.1–0.15 mm, distally thickened, narrow at base; anther theca distinct, 0.4–0.45 mm long. Pistil 1.25–1.32 mm long, green; ovary ovoid-oblongoid, 0.5–0.65 × 0.47–0.65 mm; style indistinct; stigma bi-lipped, upper lip obsolete; lower lip orbicular, 0.45–0.6 × 0.4–0.6 mm, glabrous in, pubescent out. Capsules globose, 2–2.5 × 1.8–2.2 mm, oblique, wall membranous, open through a ventral orbicular pore; placenta oblongoid, with a short basal stalk and a terminal cylindrical projection; stalk cylindric, terete, 0.48–0.8 × 0.3–0.35 mm; middle part orbicular, 1–1.2 × 0.95–1.03 mm; cylindrical projection terete, 0.8–1.1 × 0.15–0.2 mm, glabrous, hyaline. Seeds 6–30, ellipsoid, 0.35–0.45 × 0.4–0.55 mm; a tuft of strap-shaped testa hairs on both end, always longer than the body of seed; hilum lateral.

***Flowering & fruiting***: Flowering from early August to mid-September, with fruiting taking place from mid-August to late September.

***Habitat***: The species thrives on waterlogged, moss-covered cliffs, crevices, wet vertical cuttings, slopes, and mossy tree trunks, usually at elevations ranging from 2000 to 3100 m (Fig. 131).

***Distribution***: India (Alpine & Western Himalaya), Bhutan, China (NW Yunnan), Nepal and Myanmar (Janarthanam & Henry, 1992; Taylor, 1989; POWO, 2025) (Fig. 125).

***Specimens examined***: BHUTAN, Shabjetang, Bumthang Chu, 10000 feet, 23.07.1949, *Ludlow, Sherriff & Hicks* 19508 (A01977105 digital image). INDIA, **Sikkim**, Gangtok district, 15th Mile, Gangtok to Nathula, ± 3200 m, 08.09.2022, *M.P. Krishnapriya* 186007 (CALI198487); near Kanchenjunga viewpoint, ± 3200 m, 08.09.2022, *M.P. Krishnapriya* 186005 (CALI198480); way to Karponang, 21.09.1980, *P.K. Hajra* 746 (BSHC00043493); Kupup, 13000 feet, 03.09.1945, *Bor's collector* 351 (DD); Mangan district, Lachen, Chungthang, after Theng Tunnel, ± 1800 m, 01.09.2022, *M.P. Krishnapriya* 177291(CALI198477); near Taram Chu Bridge, ± 2850 m, 04.09.2022, *M.P. Krishnapriya* 177295 (CALI198479); Lachung, 9500 feet, 08.08.1892, *G.A. Gammie* 693 (CAL, DD); Pakyong district, Zuluk, ± 3000 m, 09.09.2022, *M.P. Krishnapriya* 186009 (CALI198476); Zuluk to Gnathang road, 3000 m, 10.09.2019, *Rajib Gogoi & Norbu*

*Sherpa* 41406 (BSHC00026986, BSHC00026987). **Uttarakhand**, Chamoli district, Garhwal, wet rocks near the Kuari Pass, 10.09.1885, *J.F. Duthie* 4266 (CAL); Kumaon, Bakri Udzar-Chitrla, 3700 m, 12.09.1971, *C.M. Arora* 45681 (BSD000063887); Saba oodien River? near Pilthi Bridge, 3000 m, 21.09.1969, *Pant & Naithani* 39773 (BSD000063886). NEPAL, **Koshi Province**, Sankhuwasabha district, below Chamtang (2070 m)-Deurali (2350 m)-Chumsur (2380 m)-Deurali (2450 m)-Chyangrima (2170 m), 20.08.1998, *S. Noshiro, N. Acharya, K. Kobayashi, Y. Omori, K. Shinozaki & H. Tsukaya* 9820057 (E00156607 digital image).

***Conservation status***: *Utricularia kumaonensis* is confined to high altitude areas in the eastern and Alpine Himalaya. In addition to the type collection from Uttarakhand, *U. kumaonensis* has been previously known from 1 or 2 locations in Uttarakhand and North Sikkim. Although the Alpine Himalaya supports a rich and diverse plant community, these areas face significant natural threats, including landslides, avalanches, and drought. My field expedition identified few additional locations, all in North and East Sikkim, but all are situated in high risk areas.

Although *U. kumaonensis* is fairly common along roadsides between Gangtok to Zuluk, particularly after the Kanchenjunga viewpoint (East Sikkim district and Pakyong district), I only observed a small patch along the roadside ghat slope in Lachen (North Sikkim, district). The habitats are highly exposed and affected by both natural and anthropogenic threats (landslide is of frequent occurrence in these areas, requiring constant road maintenance, clearing, and widening; personal observation). Despite a relatively higher number of individuals, the threats to their habitats remain severe. The AOO calculated is 40.00 $km^2$, and considering the combined threat factors, the species is assessed as Endangered (EN B2ab(ii,iii,v); D).

***Notes***: Following the type collection, only a small number of specimens have been available in herbaria, highlighting the rarity of the species. Although originally described from India, *U. kumaonensis* has been largely overlooked in past few decades, reflecting the scarcity of the specimens and expeditions. Unlike *U. furcellata* and *U. brachiata*, *U. kumaonensis* has more than 2 peduncles (up to 10), arising from a stock (may be a reduced stem), with a persistent seed testa at the base of the

peduncles. It is more closely related to *U. multicaulis* in having a greater number of peduncles from the base but differs in its deeply 5-lobed lower corolla lobe and seeds with testa extensions at both extremities.

**5. Utricularia multicaulis** Oliv., J. Proc. Linn. Soc., Bot. 3: 188. 1859; C.B.Clarke in Hook.f. (ed.), Fl. Brit. India 4: 334. 1884; P.Taylor, Gen. *Utricularia* 470. f. 143. 1989; Janarth. & A.N.Henry, Bladderworts India 75. 1992; Noltie in Grierson & D.G.Long, Fl. Bhutan 2(3): 1337. 2001; Liden & Bharali, Pleione 8(2): 269. 2014; D.Maity *et al*., Fl. Kanchenjunga 391. 2018 *p.p. excl. syn. U. kumaonensis* Oliv.; Noltie in Watson *et al.* (eds.), Fl. Nepal web. edn. 6. 2019;Li in Y.F.Deng *et al*. (eds.), Fl. Pan-Himalaya 46: 19. 2020; Gogoi *et al*., Fl. Sikkim Pict. Guide 267. 2021. *Lectotype* (designated by Taylor, 1989): INDIA, **Sikkim**, *s.d., J.D. Hooker s.n.* (K [K001081939 digital image!]). **Fig. 132**

Terrestrial or lithophytic annual herbs. Rhizoids absent. Tubers absent. Stolons filiform, simple. Traps numerous on stolons, ovoid; short stalked; mouth lateral; appendage 1, dorsal, flabellate, fringed with multicellular stipitate glands. Leaves rosulate at peduncle base, long petiolate; lamina obovate, veins dichotomously branched. Racemes erect, 1–3.5 (–5) cm long, 1–3-flowered; peduncles terete, glabrous. Pedicels terete, bent at anthesis, reflexed and distally thickened in fruit. Scales absent. Bracts oblong, basisolute; bracteoles similar to bracts. Calyx lobes unequal; upper lobe orbicular, apex emarginate; lower lobe oblong. Corolla mauve, yellow at throat and palate; upper lip more or less 2-lobed, white; lower lip 4-lobed, 2 lateral small lobes rounded at apex,

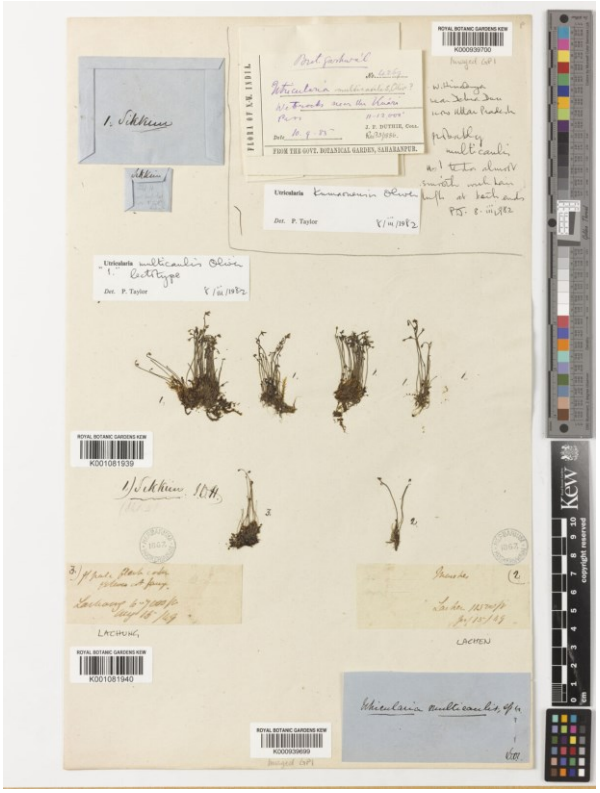


**Fig. 132.** Lectotype of *Utricularia multicaulis* Oliv. [*J.D. Hooker s.n.* (K001081939)] "© *Board of Trustees of the Royal Botanic Gardens, Kew*".

middle lobe large, bilobed at apex, white to mauve towards margin, throat fringed with hairs; spur cylindric, obtuse at apex. Capsule ovoid-globose, oblique, wall membranous, open through a ventral orbicular pore; placenta oblong. Seeds ovoid, *c.* 0.8 mm long, with a tuft of short hairs at one end of body, hairs longer than the body of seed, surface rough, with longitudinal rows of small papillae.

***Flowering & fruiting***: Flowering from late July to mid-August and fruting in early August.

***Habitat***: The species is found in wet, moss-covered vertical cuttings and slopes, as well as open swampy meadows, at elevations ranging from 2000 to 4200 m.

***Distribution***: India (Alpine & Eastern Himalaya- rare), Bhutan, China (NW Yunnan), Myanmar and Nepal (Verma *et al*., 2014; POWO, 2025) (Fig. 125).

***Specimens examined:*** INDIA**, Sikkim**, *s.loc*., 8–10000 feet, *s.d., J.D. Hooker s.n.* (CAL Acc. No. 330366); above Tanya, 15500 feet, 13.08.1909, *Smith & Cave* 2391 (CAL); North Sikkim district, Zekuphyak, 4000 m, 13.08.2019, *Rajib Gogoi & Norbu Sherpa* 41402 (BSHC00026988, BSHC00026989).

***Conservation status***: The distribution of *U. multicaulis* in India is rare, with only 2 to 3 known collections from Sikkim. Liden and Bharali (2014) reported the species from Arunachal Pradesh, but no voucher specimens are available in herbaria. Due to the lack of comprehensive data, a proper conservation assessment is not possible. Therefore, the species is provisionally assessed as Data Deficient (DD).

***Notes***: Compared to other species in this section, *U. multicaulis* is a small plant with relatively small flowers. While it shares a similar floral morphology with *U. kumaonensis*, which can lead to confusion in dried specimens, the two can be easily distinguished by the seeds, which have conical papillae at one end, and by the 3-lobed lower lip of the corolla.

**6. Utricularia striatula** Sm. in A.Rees, Cycl. 37: 17. 1819; Collett, Fl. Siml. 364. 1902; T.Cooke, Fl. Bombay 2: 320. 1905; Gamble, Fl. Madras 2: 983. 1924; Fyson, Fl. S. Ind. Hill Stations. 1: 438. 1932; Santapau, Fl. Khandala 3: 189. 1967; R.K.Basak, Bull. Bot.

Surv. India 17(1–4): 105. 1975; Gandhi in C.J.Saldanha & Nicolson, Fl. Hassan Dist. (sec. reprint) 565. 1978; Vajr., Fl. Palghat Dist. 331. 1980; Yogan. *et al*., Fl. Chikmagalur Dist. 241. 1981; N.Rani & K.M.Matthew in K.M.Matthew, Fl. Tamilnadu Carnatic 3(1): 1123. f. 86h. 1983; N.P.Balakr., Fl. Jowai 2: 341. f. 19. 1983; A.K.Mukh., Fl. Pachamarhi & Bori Reserves 218. 1984; B.D.Sharma *et al*., Fl. Karnataka: analysis 196. 1984; B.D.Naithani 2: 478. 1985; M.Ahmed. & M.P.Nayar, Endemic Pl. Ind. 1: 155. 1986; R.S.Rao, Fl. Goa, Diu, Daman, Dadra & Nagarhaveli 2: 309. 1986; K.K.N.Nair & M.P.Nayar, Fl. Courtallum 2: 304. 1987; V.Chandras. in A.N.Henry *et al*. (eds.), Fl. Tamil Nadu Ind., Ser 1. Analysis 2: 131. 1987; Bole & J.M.Pathak, Fl. Saurashtra pt. 2: 156. 1988; B.G.Kulk., Fl. Sindhudurg 309. 1988; V.S.Ramach. & V.J.Nair, Fl. Cannanore 324. 1988; P.Taylor, Gen. *Utricularia* 479. f. 147. 1989; S.M.Almeida, Fl. Savantwadi 2: 309. 1990; Vajr., Fl. Palghat Dist. 331. 1990; Kesh.Murthy & Yogan., Fl. Coorg (Kodagu) Karnataka 318: 1990; Lakshmin. & B.D.Sharma, Fl. Nasik Dist. 350. 1991; Janarth. & A.N.Henry, Bladderworts India 106. f. 32. 1992; Kothari & Moorthy, Fl. Raigad Dist. 283. 1993; Sasidh. & Sivar., Fl. Pl. Thrissur Forests 328. 1996; Pull. & Moulali, Fl. Andhra Pradesh 2: 678. 1997; R.C.Srivast. in Mudgal *et al*. (eds.), Fl. Madhya Pradesh 2: 255. 1997; M.R.Almeida, Fl. Maharashtra 435. 2001; Londhe in N.P.Singh *et al*. (eds.), Fl. Maharashtra, Dicot. 2: 567. 2001; Noltie in Grierson & D.G.Long (eds.), Fl. Bhutan 2(3): 1337. 2001; N.P.Singh *et al*., Fl. Bihar, Analysis 368. 2001; Mohanan & Sivad., Fl. Agasthyamala 493. 2002; S.R.Yadav & Sardesai, Fl. Kolhapur Dist. 339. 2002; K.G.Bhat, Fl. Uduppi 456. 2003; D.A.Patil, Fl. Dhule 438. 2003; Anil Kumar *et al*., Fl. Pathanamthitta 368. 2005; Punekar & Lakshmin., Fl. Anshi. Natl. Park 337. 2011; G.P.Sinha in G.P.Sinha *et al*. (eds.), Fl. Mizoram 2: 195. 2012; Datar & Lakshmin., Fl. Bhagwan Mahavir Natl. Park 177. 2013; T.S.Nayar *et al*., Fl. Pl. W. Ghats India 1: 587. 2014; Deepak Kr. Ghosh & Jayanta Kr. Mallick, Fl. Darjeeling 313.2014; K.G.Bhat, Fl. South Kanara 770. 2014; Kavade & Deokule, Fl. Chandoli Natl. Park 265. 2015; Noltie in Watson *et al.* (eds.), Fl. Nepal web. edn. 5. 2019; S.K.Mandal & Bhaumik in Lakshmin. *et al*. (eds.), Fl. West Bengal 4: 145. 2019; Li in Y.F.Deng *et al*. (eds.), Fl. Pan-Himalaya 46: 21. 2020; Gogoi *et al*., Fl. Sikkim Pict.

Guide 267. 2021. *Type*: AFRICA, Sierra Leone, 1798, *A. Afzelius s.n.* (holo, LINN [LINN-HS52-2 digital image!]; iso, BM [BM000930787 digital image!]). **Figs. 133–136**

*Utricularia pusila auct. non* Vahl: Graham, Cat. Bomb. Pl. 169. 1839

*Utricularia orbiculata* Wall. ex A.DC. in DC. (ed.), Prodr. 8: 18. 1844; Oliv., J. Proc. Linn. Soc., Bot. 3: 187. 1859; Dalzell & Gibson, Bombay Fl. 136. 1861; C.B.Clarke in Hook.f.(ed.), Fl. Brit. India 4: 334. 1884. *Type*: NEPAL, 1821, *N. Wallich* 1500 (G [G00368527 digital image!])

*Utricularia glochidiata* Wight, Hooker's J. Bot. Kew Gard. Misc. 1: 373. 1849, Icon. Pl. Ind. Orient. 4(4): 11. t. 1581. 1850

Epiphytic or lithophytic, annual herbs. Rhizoids absent. Tubers absent. Stolons many, 1–7 cm long, simple to profusely branched, internodes 3–5(–10) mm long, sparsely papillose, hyaline to pale yellowish green. Traps numerous on stolons, globose to ovoid, 1–1.8 × 0.8–1.2 mm across, oblique, papillose; mouth lateral; appendage flabellate, bifurcated into either side with radiating glandular hairs. Leaves rosulate, usually 4 or 5 on peduncle base, numerous on stolons, sub-sessile to petiolate; petiole terete at base, 1.5–3 mm long, broadly compressed towards lamina, hyaline to pale green; lamina widely obovate–orbicular, 3–4.5 × 2.6–4 mm, nerves dichotomously branched, adaxial surface sparsely verrucate, obtuse to rounded at base, margin entire, rounded at apex. Racemes erect, 1–10(–18) mm long, 1–8-flowered, glabrous; peduncles terete, 0.2–0.3 mm thick, glabrous,

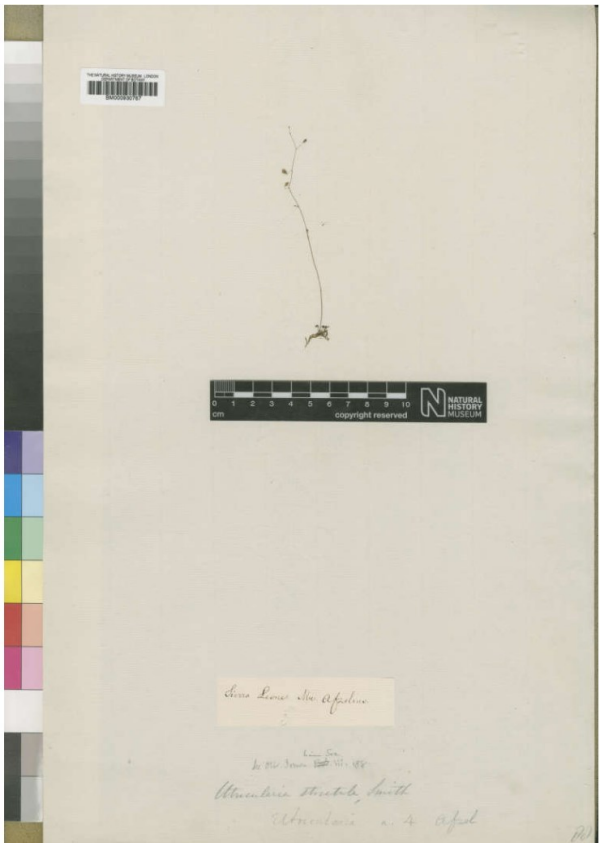


**Fig. 133.** Type of *Utricularia striatula* Sm. [*A. Afzelius s.n.* (LINN-HS52-2)] "© *Reproduced with permission of The Linnean Society of London*".

**Fig. 134.** *Utricularia striatula* Sm.: **A.** Habit; **B.** Leaves; **C.** Trap; **D.** Upper calyx lobe; **E.** Lower calyx lobe; **F.** Upper lip of corolla; **G.** Lower lip of corolla with spur; **H.** Stamens; **I.** Pistil; **J.** Capsule; **K.** Seeds.

**Fig. 135.** Habitat diversity of *Utricularia striatula* Sm. (**B & D.** Epiphytic on wet, moss covered tree trunks and the remaining are lithophytic on vertical cuttings, mossy bedrock etc.)

green to purplish green. Pedicels 3–7(–10) mm long, spreading in anthesis, yellowish green to purplish green, terete, slightly reflexed in fruit. Scales ovate, 0.8–1.5 × 0.15–0.4 mm, basisolute, attached below the middle, 2–3-fid below, acute at apex. Bracts oblong, 0.9–2.64 × 0.4–0.8 mm, attached just below the middle with a constriction having unequal parts; upper part obtuse-rounded at apex, margin sparsely serrate; lower ± 5 dentate; bracteoles obovate-oblong, 0.6–1.85 × 0.3–1.12 mm, oblique, unequal, attached just above the lower distal end with a constriction, upper rounded at apex, margin minutely serrate, lower unequally 2-fid. Calyx lobes very unequal, yellowish green to shades of red, papillate; upper lobe sub-orbicular, 1.3–3.5 × 1–3.3 mm, rounded or emarginate or, rarely truncate at apex; lower lobe ovate-oblong to orbicular, 0.6–1.5 × 0.25–1 mm, distal margin sparely serrate, truncate or rounded at apex. Corolla usually shades of purple, rarely white with a prominent yellow patch at throat; upper lip transversely oblong to sub-orbicular, 1.1–2 × 1.2–2.3 mm, hairy at basal margin, deeply emarginate at apex; lower lip orbicular, 4–6.5 × 3–6 mm, 5-lobed, 2 lateral lobes deeply divided, truncate to rounded at apex, 3 middle lobes shallowly or deeply divided, rarely lobes not distinguishable, hairy at throat, palate raised with hairs, deep yellow at throat, extends into palate; white after, shades of purple towards margin; spur subulate, 3–6.5 × 0.6–0.8 mm, lilac, obtuse-rounded at apex. Stamens 1–1.2 mm long; filaments narrowly oblong, 0.5–0.62 × 0.1–0.2 mm, twisted at base; anther thecae sub-distinct. Pistil 1–1.65 mm long, yellowish green; ovary obliquely ovoid, 0.8–1.5 × 0.6–1.2 mm; style indistinct; stigma 2-lipped, upper lip obsolete, lower lip oblong to semi-orbicular. Capsules obliquely ovoid, 1.5–3.5 mm long, keeled on ventral side, dehisce by a ventral orbicular pore; placenta ovoid, stalk and apical extension obscure, 1 mm long. Seeds numerous, obovoid, 0.3–0.45 × 0.1–0.15 mm, with numerous, long glochidiate hairs; hilum lateral or terminal.

***Flowering & fruiting***: Flowering starts from mid-July to late January, while fruiting takes place from late July to early February.

***Habitat***: This species thrives in exposed, wet, slimy rocky outcrops, moss-covered beds on vertical cliffs, waterlogged slopes, and damp tree trunks, at elevations ranging from 50 m to 2000 m. It is often found in association with *U. graminifolia*, *Begonia* spp. (Begoniaceae), *Cyanotis* spp. (Commelinaceae), *Eriocaulon* sp.

(Eriocaulaceae), *Hydrocotyle* sp. (Araliaceae), *Impatiens* spp. (Balsaminaceae), *Lecanthus peduncularis* (Royle) Wedd., *Sonerila khasiana, S. rheedei*, *S. scapigera* (all Melastomataceae), *Persicaria* sp. (Polygonaceae), *Rhynchoglossum notonianum* (Wall.) B.L.Burtt, *R. scabrum* Dalzell (both Gesneriaceae), some mosses and ferns (Fig. 135).

***Distribution***: India, Angola, Bangladesh, Borneo, Burundi, Cambodia, Cameroon, Central African Republic, Chad, China, East Himalaya, Ethiopia, Gabon, Ghana, Guinea, Indonesia, Ivory Coast, Liberia, Malaya, Myanmar, Nepal, New Guinea, Nigeria, Oman, Philippines, Sierra Leone, Sri Lanka, Taiwan, Tanzania, Thailand, Tibet, Uganda, Vietnam, Zaïre and Zambia (POWO, 2025) (Fig. 137).

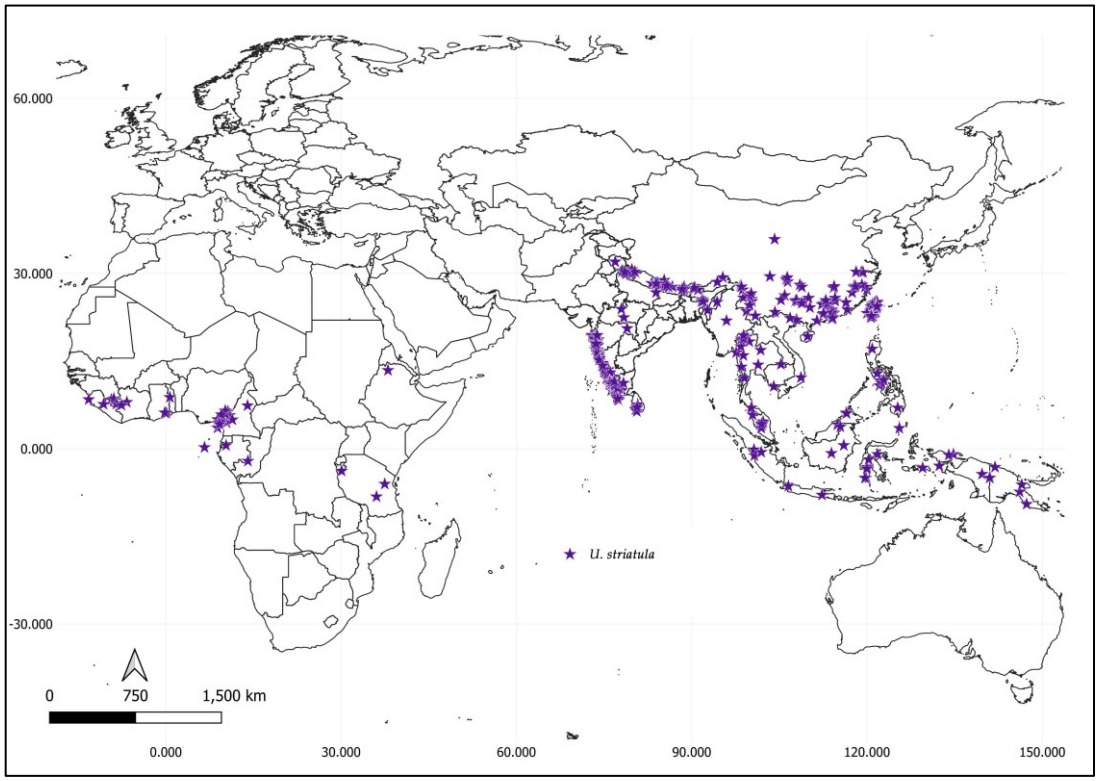


**Fig. 137.** Distribution of *Utricularia striatula* Sm.

***Specimens examined***: INDIA, Malabar, Concan, Regio. trop. *s.loc.*, *s.d.*, *J.E. Stocks & J.S. Law s.n.* (MH00126606). **Andhra Pradesh,** Chittoor district, way to Thirumalai–near Avacharakona, 700 m, 14.10.1958, *K. Subramanyam* 6947 (MH00126736, MH00274876). **Arunachal Pradesh**, Shi-Yomi district, before Tato, ± 1460 m, 25.08.2023, *M.P. Krishnapriya & M. Sreya* 186053 (CALI); West Kameng district, Senge, ± 2657 m, 21.08.2023, *M.P. Krishnapriya & M. Sreya* 186053 (CALI). **Goa**, Quepam,

Chandreshwar Hills, near Temple, 04.09.2019, *S. Resmi* 164304 (CALI). **Himachal Pradesh**, Mandi district, Urla to Drang, 4300 feet, 25.08.1977, *S.K. Murthi & R. Prasad* 62057 (BSD000063874). **Karnataka**, Hassan district, beyond Athihlli, 850 m, 06.08.1970, *C. Saldanha* & *T.P. Ramamoorthy* HFP 433 (JCB, digital image); Jog Falls, 26.09.1965, *John Cherian* 106720 (BSI); Kagenari state Forest, 220 m, 16.08.1971, *T.P. Ramamoorthy* HFP 2052 (MBG 2326560 digital image). **Kerala**, Idukki district, Kozhikanam, 875 m, 11.11.1975, *K. Vivekananthan* 46749 (MH00126612); Kuttikanam-Peerumedu, 1000 m, 27.09.1964, *K. Vivekananthan* 21430 (MH00126609, MH00126611); *Ibid*., 31.05.1964, *K.N. Subramanian* 1482 (FRCH); way to Lockhart gap, ± 1600 m, 05.09.2019, *M.P. Krishnapriya & Santhosh Nampy* 164301 (CALI198500); Lockhart gap, Devicolam, 1675 m, 12.10.1963, *K.M. Sebastine* 17544 (MH00126610, MH00126615); Painavu-roadside, 10.12.2019, *M.P. Krishnapriya & Santhosh Nampy* 164331 (CALI197512); Thadiampadu, 460 m, 24.08.1977, *K. Vivekananthan* 50509 (MH00126608, MH00126614); Thodupuzha, Kaliyar, 09.10.2019, *Santhosh Nampy* 164319 (CALI); Vagamon, 06.10.2019, *M.P. Krishnapriya* 164315 (CALI); *Ibid*., ± 1100 m, 29.10.2020, *Santhosh Nampy* 164387 (CALI185461); Kasaragod district, Beemanadi, 22.08.1985, *M.K. Janarthanam* 82928 (MH00126595, MH00126596); Ranipuram Reserve Forest, ± 600 m, 27.08.2021, *M.P. Krishnapriya* 175814 (CALI); Vellarikundu, 22.08.1985, *M.K. Janarthanam* 82925 (MH00126597, MH00126598); Kollam district, below Moozhiyar, 1000 m, 03.09.1977, *N.C. Nair* 50871 (MH00126588, MH00126590); Kozhikode district, Kakkayam, 12.10.2019, *M.P. Krishnapriya & Santhosh Nampy* 164320 (CALI185460, CALI185462); *Ibid*., Ambalapara, 06.10.2022, *M.P. Krishnapriya* 186019 (CALI); Thamarassery Churam, 09.09.2020, *M.P. Krishnapriya & Santhosh Nampy* 164380 (CALI198504, CALI198505); *Ibid*., ± 600 m, 14.07.2022, *M.P. Krishnapriya* 177252 (CALI); Malappuram district, Kodikuthimala, 08.10.2019, *M.P. Krishnapriya* 164317 (CALI); Palakkad district, below Ayyappan Kovil area, 900 m, 26.01.1976, *E. Vajravelu* 48708 (MH00126605); Mannarkkad Churam, way to Attappady, 12.09.2019, *M.P. Krishnapriya* 164305 (CALI199572); Mukkali Forest, 475 m, 14.10.1965, *E. Vajravelu* 26236 (MH00126594, MH00126604); *Ibid*., 550 m, 11.10.1979, *N.C. Nair* 64521 (MH00126599, MH00126603); Nelliyampathy Hilltop, 24.11.2022, *M.P. Krishnapriya* 186032 (CALI); Panthanthode, 900 m, 21.09.1977, *J. Joseph* 51443 (MH00126593, MH00126602); Silent Valley National Park, Dam site,

Sairandhri, 10.11.2020, *M.P. Krishnapriya & Santhosh Nampy* 164392 (CALI198508); near Dam site, Pulippara, 23.09.1977, *K.N. Subramanian* 7092 (FRCH); Hanging Bridge area, 800 m, 05.10.1979, *N.C. Nair* 64260 (MH00126591, MH00126600); near Kunthipuzha, 03.10.2018, *S. Resmi & M.P. Krishnapriya* 168032 (CALI); Silent Valley, 1000 m, 24.09.1977, *R. Ansari* 51470 (MH00126592, MH00126601); Pathanamthitta district, near Chalakkayam Forest, ± 650 m, 14.08.1988, *R. Chandrasekaran* 89216 (MH00126617); Kakki Dam, 950 m, 25.08.1985, *K.M. Matthew* 18487 (RHT044798); Kakki Forest, ± 1050 m, 09.08.1988, *R. Chandrasekaran* 88523 (MH00126619, MH00126620); Ranni, ± 400 m, 31.08.1977, *N.C. Nair* 50733 (MH00126587, MH00126589); Thiruvananthapuram district, Agasthyamala, 21.12.2018, *M.P. Krishnapriya & Santhosh Nampy* 168054 (CALI198498, CALI198499); Kallar to Ponmudi Forest division, 07.08.1985, *N. Venkatasubramanian & K.R. Sasidharan* 11224 (FRCH); Kottur R.F., 150 m, 25.09.1973, *J. Joseph* 41977 (MH00126583, MH00126584); Ponmudi, 17.09.1968, *s.coll*. 9040 (RHT044795); *Ibid*., 950 m, 03.07.1978, *M. Mohanan* 65180 (MH00126582); *Ibid*., ± 1100 m, 11.10.2019, *S. Resmi, M.P. Krishnapriya & Santhosh Nampy* 164324 (CALI185463); *Ibid*., Forest Estate, 16.09.1985, *K.M. Matthew* 18603 (RHT044627, RHT044631); Thrissur district, Athirappally Reserve, 75 m, 13.09.1976, *K. Ramamurthy* 48492 (MH00126585, MH00126586); Wayanad district, Devala, September 1900, *C.A. Barber* 2035 (MH00126743). **Madhya Pradesh**, Hoshangabad district, Pachmarhi, way to Bee Falls, ± 950 m, 09.11.2021, *M.P. Krishnapriya* 177232 (CALI); way to Jambu Deep, 25.09.1963, *Davindar* 711 (WAG1055661 digital image); Jambu Deep, ± 780 m, 12.11.2021, *M.P. Krishnapriya* 177242 (CALI197506); way to Mahadev Hills, 10.11.2021, *M.P. Krishnapriya* 177235 (CALI). **Maharashtra**, Ahmednagar district, Harishchandragad, Paachnaichi Vaat Path, ± 1400 m, 14.08.2022, *M.P. Krishnapriya* 177275 (CALI); Taramati hill, 28.09.1970, *B.M. Wadhwa* 12776 (BSI); Amravati district, Amraoti and Lewada in the Sipna Valley, between Merki and Manbhang, 2600 feet, 08.10.1908, *I.H. Burkil* 31237 (BSIS000007294); Kolhapur district, 19.08.2018, Amba, near Ganesh Temple, *M.P. Krishnapriya & Santhosh Nampy* 168014 (CALI197507, CALI197508); Amba ghat, Koyma, 03.09.1978, *R.K. Kochhar* 153617 (BSI); Amboli ghat, 21.09.2018, *M.P. Krishnapriya & Santhosh Nampy* 168012 (CALI198482); *Ibid*., 29.01.2020, *M.P. Krishnapriya & Santhosh Nampy* 164355 (CALI187637, CALI187638); *Ibid*., 28.09.2023,

*M.P. Krishnapriya* 186082 (CALI); Gaganbawda, 20.09.2018, *M.P. Krishnapriya & Santhosh Nampy* 168018 (CALI197514); Gaganbawda-bus depot, N16°32'48.3'' E73°49'54.1'', 21.08.2016, *S.R. Yadav & D.D. Sokoloff* WG8 (MW0753512 digital image); Kunkeshwar-Talewadi Rd, N16°33'22.7'' E73°52'17.6'', 21.08.2016, *S.R. Yadav & D.D. Sokoloff* WG7 (MW0753510 digital image); Palghar district, Dahisar, Tak-mak Hilltop, 600 m, 16.09.1968, *K.V. Billore* 116747 (BSI); Pune district, Junnar, Ganesh cave, 27.09.1968, *K. Hemadri* 118153; Malvanddara, 28.09.1965, *K. Hemadri* 107437; Poona, *s.d., s.coll. s.n.* (MH00126739); Ralegaon hill range, 23.09.1965, *K. Hemadri* 107283 (BSI); way to Lonavala, 13.09.2018, *M.P. Krishnapriya & Santhosh Nampy* 168001 (CALI197511); Lonavala, Bushy Hills, 13.10.1985, *M.K. Janarthanam* 82959 (MH00126737, MH00126738); Ludwig Point, 16.09.2018, *M.P. Krishnapriya & Santhosh Nampy* 168011 (CALI197513); Torna Fort, ± 1200 m, 13.09.2018, *M.P. Krishnapriya & Santhosh Nampy* 168006 (CALI197501, CALI197502); Ratnagiri district, Phonda ghat ending, 18.08.1965, *B.G. Kulkarni* 105558 (BSI); Satara district, Bolibar ground, Old Mahabaleshwar road, 14.08.1966, *B.M. Wadhwa* 109510 (BSI); Thana district, Suryamal-vada road, 30.09.1967, *K.V. Billore* 111769 (BSI); Utawada, near Mokhada Vihigaon range, 20.10.1967, *K.V. Billore* 116197 (BSI). **Manipur**, Ukhrul district, Ukhrul, 5000-6000 feet, 22.08.1948, *F. Kingdon-Ward* 17977 (NBGY02652089 digital image). **Meghalaya**, East Khasi Hills district, Elephant Falls, ± 1669 m, 26.09.2021, *M.P. Krishnapriya* 177204 (CALI186865, CALI186866, CALI186867); way to Kut Village, ± 1200 m, 22.09.2021, *M.P. Krishnapriya* 175881 (CALI186868, CALI186869); Laitlyngkot, ± 1800 m, 20.09.2021, *M.P. Krishnapriya* 175849 (CALI); Pomshutia, Byrdaw Falls, ± 440 m, 25.09.2021, *M.P. Krishnapriya* 175896 (CALI186870); Shillong, 5000 feet, 18.08.1949, *F. Kingdon-Ward* 18789 (NBGY 02652090 digital image); *Ibid.*, 15.09.2021, *M.P. Krishnapriya & Santhosh Nampy* 175825 (CALI198489). **Mizoram**, Aizawl district, Aizawl, ± 1090 m, 02.10.2021, *M.P. Krishnapriya & Santhosh Nampy* 177206 (CALI197509). **Sikkim**, Gangtok district, 4th mile, Gangtok to Nathula, ± 2200 m, 09.09.2022, *M.P. Krishnapriya* 186013 (CALI198475, CALI198490); Mangan district, Lachung, September 1903, *Major F.E. Younghusband s.n.* (MH00127015); near Manul Waterfalls, ± 1400 m, 01.09.2022, *M.P. Krishnapriya* 177288 (CALI197503, CALI197504, CALI197505); Namchi district, Ravangla, Buddha Park, ± 2050 m, 28.08.2022, *M.P. Krishnapriya* 177284 (CALI197405); near Monastery, 29.08.2022, *M.P. Krishnapriya*

177287 (CALI199577). **Tamil Nadu**, Coimbatore district, Anaikatti shola top slip, *c.* 700 m, 10.09.1974, *K.M. Matthew* 14688 (RHT044797); Anamalais, Akkamalai Estate, 21.09.1971, *K. Periaswamy* 29595 (MH00126754, MH00126755); below Sholayar Dam, 22.02.1985, *M.K. Janarthanam* 82901 (MH00126760, MH00126761); Sholayar submergible area, 1100 m, 30.07.1963, *K.M. Sebastine* 17298 (MH00126756, MH00126757); Dindigul district, Kodaikanal-ghat region, 03.12.2019, *M.P. Krishnapriya & Santhosh Nampy* 164328 (CALI197510); Kodaikanal, Pulneys, Church Cliff path, 05.12.1898, *Bourne* 2842 (MH00126752); Kanyakumari district, Kothayar Dam, 22.09.2021, *K.K. Jeomol* 177213 (CALI199576); Upper Kothayar, near Valve house, ± 1300 m, 07.08.1977, *A.N. Henry* 49642 (MH00126746, MH00126748); Mahendragiri grassy slopes, 1200 m, 11.09.1969, *B.V. Shetty* 32355 (MH00126747, MH00126749); Madurai district, High way route, 4600 feet, 09.09.1925, *K.C. Jacob* 17647 (MH00126753); near Periyar Dam, 980 m, 19.10.1959, *K. Subramanyam* 9455 (MH00126750, MH00126751); Mysore, Cadamaney?, 08.09.1903, *C.A. Barber* 6081 (MH00126740, MH00126741, MH00126742); Namakkal district, Kolli Hills, Periakkada Aar, above Sothupparai, 1250 m, *s.d.*, *K.M. Matthew* 4636 (RHT044791); Sothupparai up Stream, 1200 m, 22.12.1979, *K.M. Matthew* 25365 (RHT044793); *Ibid.*, 1250 m, 25.11.1987, *S.J. Britto* 30676 (RHT044794); Solakkadu, Pongalkoil shola, 1150 m, 19.12.1979, *K.M. Matthew* 25215 (RHT044792); The Nilgiris district, Nadukani-Gudallur, 16.08.2017, *S. Jeevith* 15104 (FRCH); Naduvatam, wet rocks, 10.1884?, *s.coll. s.n.* (MH00126744); Tirunelveli district, Mahendragiri, 17.09.1911, *s.coll.* 13151 (MH00126726, MH00126727, MH00126728, MH00126729, MH00126730, MH00126731, MH00126735, MH00274877); near Panchavadi Falls, Thulukkamparai, 780 m, 28.11.1969, *B.V. Shetty* 32949 (MH00126734); Chitraruvi, behind Forest rest house, 300 m, 15.12.1957, *K. Subramanyam* 4931 (MH00126732, MH00126733). **Uttarakhand**, Almora district, Tal-Beringa Road, 900 m, 27.08.1968, *Bora* 38804 (BSD000063839); Chamoli district, Chandrapuri-Guptakashi, 21.08.1978, *G. Panigrahi & Wadhwa* 65189 (BSD000063832); Dehradun district, Bindal & Robers Cave, 10.09.1964, *C.R. Babu* 34088 (BSD000063842, BSD000063845); Mussoorie, 7000 feet, 24.08.1958, *K.M. Vaid* M-140 (DD); Garhwal, Joshimath-Pandukeshwar, 1800 m, 02.10.1959, *M.A. Rau* 10419 (BSD000063834, BSD000063843); Mandal, 1650 m, 02.10.1970, *B.D. Naithani* 42017 (BSD000063844); Pithoragarh district, Askot-

Narayana Nagar, Briddle path, 1500 m, 27.09.1975, *C.M. Arora & R. Prasad* 56570 (BSD000063841); Dhauliganga Valley, 1500 m, 10.09.1985, *H.J. Chawdhary & S. Singh* 76284 (BSD000063833); Didihat-Narayana Nagar, Bridal Path, 1800 m, 30.08.1968, *Bora* 38818 (BSD000063829); Kumaon, way to Milam Glacier Valley, 1500 m, 02.09.1969, *Pant & Naithani* 39559 (BSD000063840); Rugalrong Forest, September 1986, *C.L. Malhotra & Bipin Balodi* 83432 (BSD000063830); Tal, 1500 m, 06.08.1970, *Bora* 41403 (BSD000063831); Tawaghat-Dam site, 1400 m, 10.09.1985, *H.J. Chawdhary & S. Singh* 76281 (BSD000063838); Tehri Garhwal district, near bridge on Bhagirati Lambgaon road, 12.08.1992, *B.P. Uniyal* 81198 (BSD000063835); Kund Chetty, 1200 m, 15.10.1965, *N.C. Nair* 35926 (BSD000063846); Tejum-Quiti, 1800 m, 29.09.1969, *Pant & Naithani* 38567 (BSD000063828). SRI LANKA, *s.loc.*, *s.d.*, *s.coll.* CV2084 (MH00127016). NEPAL, Central Development Region, **Bagmati Province,** Sindhupalchok district, N. of Thagaon, above Bhotekoshi Nadi, 1775 m, 09.09.2011, *M.F. Watson, C.A. Pendry, D.A. Gray, R.S. Dani & N. Phuyal* EKSIN22 (KATH129355 digital image). **Koshi Province**, Sankhuwasabha district, Semma (1420 m)-Pathibhara Danda (1520 m)-Yekuwa (1310 m)-Deurali (1260 m)-Gola (1120 m), 14.08.1998, *S. Noshiro, N. Acharya, K. Kobayashi, Y. Omori, K. Shinozaki & H. Tsukaya* 9820015 (KATH129347 digital image).

***Conservation status***: *Utricularia striatula* is a widespread species found in Tropical Africa, the South Arabian Peninsula, Tropical and Subtropical Asia. In India, it has a wide distribution across almost all states. Considering its wider distribution, the species is assessed as Least Concern (LC).

***Notes***: *Utricularia striatula* is closely related to *U. furcellata*, but can be readily recognized by numerous leaves on stolons, the presence of scales, a deeply 5-lobed lower lip of the corolla, a mauve to purple corolla with a yellow patch at the throat extending into the palate, and glochidiate seed testa hairs. Unlike many other Indian species, *U. striatula* shows significant variation in inflorescence size and floral morphology (Fig. 136). The lobing, shape, size, and colour of the corolla varied considerably, but the presence of glochidiate seed testa hairs remains a distinguishing feature.

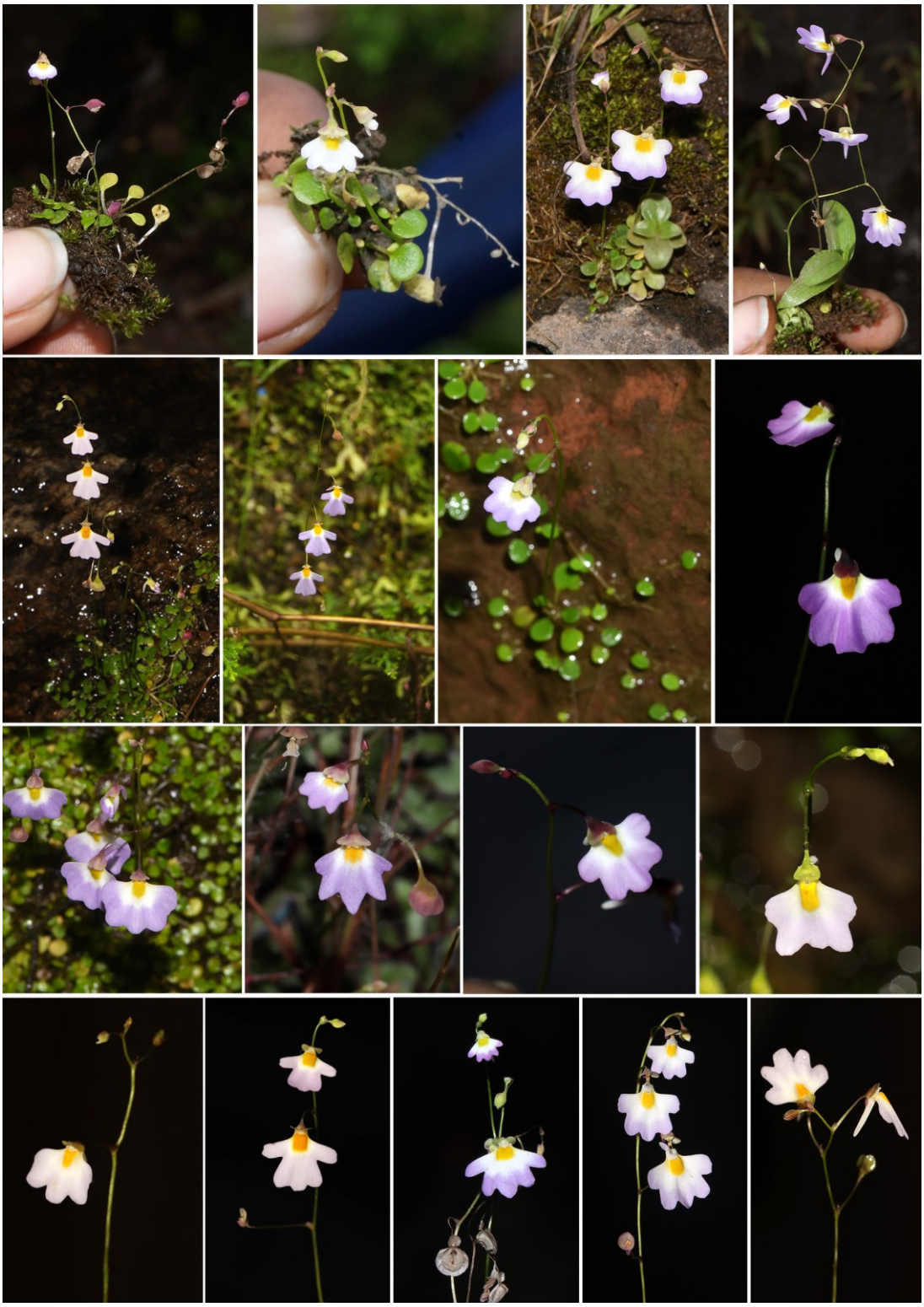

**Fig. 136.** *Utricularia striatula* Sm.: raceme and flower variations (note the lobing pattern of the lower lip of corolla).

## 5.6. UTRICULARIA SECT. UTRICULARIA P.TAYLOR

**Utricularia sect. Utricularia** P.Taylor, Kew Bull. 41: 16. 1986, Gen. *Utricularia* 564. 1989; Li in Y.F.Deng *et al*. (eds.), Fl. Pan-Himalaya 46: 24. 2020. *Type*: *Utricularia vulgaris* L.

*Lentibularia* Seg., Pl. Veron. 3: 128. 1754; Hill, Brit. Herb. 125. 1756; Adan., Fam. Pl. 2: 208. 1763. *Lentibularia* Raf., Fl. Tellur 4: 108. 1838. *nom. illeg. homonym*

*Hamulia* Raf., Fl. Tellur 4: 109. 1838

*Megozipa* Raf., Fl. Tellur 4: 110. 1838

*Trilobulina* Raf., Fl. Tellur 4: 110. 1838

*Plectoma* Raf., Fl. Tellur 4: 110. 1838. *p.p. excl. P. stellata* Raf.

*Vesiculina* Raf., Fl. Tellur. 4: 109. 1838 *p.p.*; Barnhart in Small (ed.), Fl. Miami 169. 1913, Mem. New York Bot. Gard. 6: 62. 1916. *Type*: *V. purpurea* (Walter) Raf. (= *U. purpurea* Walter)

*Utricularia* L. sect. *Megacista* A.DC. in DC. (ed.), Prodr. 3: 3. 1844; Kamienski in Engl. & Prantl. (eds.), Nat. Pflanzenfam. 4(3b): 122. 1895; Komiya, J. Jap. Bot. 48(5): 153. 1973

*Utricularia* L. sect. *Lentibularia* (Seg.) A.DC. in DC. (ed.), Prodr. 3: 4. 1844 *p.p.*; Kamienski in Engl. & Prantl. (eds.), Nat. Pflanzenfam. 4(3b): 122. 1895; Komiya, J. Jap. Bot. 48: 153. 1973

*Utricularia* L. subgen. *Lentibularia* (Seg.) Kurz, J. Bot. 12: 54. 1874

*Biovularia* Kamienski, Zap. Novorossijsk. Obsc. Estestvoisp. 12(1): 204. 1890, in Engl. & Prantl. (eds.), Nat. Pflanzenfam. 4(3b): 122. 1895; Barnhart, Mem. New York Bot. Gard. 6: 58. 1916; Komiya, J. Jap. Bot. 48: 153. 1973. *Type*: *B. olivacea* (C.Wright) Kamienski (= *U. olivacea* C.Wright)

Suspended or ± affixed aquatic herbs. Rhizoids absent or indistinct, and instead air shoots often present. Stolons very long, glabrous, or hairy. Leaves divided into capillary segments, leafy shoots 3 or 4 arises alternately from the stolon nodes, from each leafy shoots leaves dichotomously divided 3 or 4 times, the ultimate segments may be apically and laterally setulose, or sometimes leaves much reduced or apparently completely absent. Traps numerous on leaf segments, obliquely ovoid with the mouth lateral with two dorsal, setiform, simple or branched appendages;

internal glands can be 2- and 4-armed, the arms diverse in shape, proportions and relative position. Peduncle terete, with a whorl of usually inflated leaf-like organs, or sometimes very reduced in length or absent. Scales present or absent on peduncle, basifixed. Bracts may be basifixed, sometimes auriculate, rarely basisolute; bracteoles absent. Calyx lobes sub-equal. Corolla mostly yellow, rarely white, pink or shades of violet. Pollen oblate to prolate, synorate, 10–22-colporate. Capsules globose or ellipsoid, laterally bivalvate, circumscissile or indehiscent. Seeds globose or winged, or lenticular or prismatic.

The members of this section are generally found in warm, shallow, slow-flowing or still freshwater environments. Aquatic *Utricularia* species usually reproduce vegetatively through shoot branching, exhibiting rapid shoot growth (Adamec, 2008, 2009, 2010). These species have developed several ecophysiological adaptations that enable them to grow rapidly in nutrient poor habitats, such as carnivory, the activity of commensal organisms within the traps, nutrient cycling from decaying shoots, a high affinity for mineral nutrient uptake from water, and an elevated photosynthetic rate in their shoots (Richards, 2001; Adamec, 2006, 2008, 2010). Their shoots, stolons, and leaves are highly branched, often forming dense mats, while their sub-aerial parts produce chasmogamous flowers. Some species in this section are also known to form dormant storage organs, called turions (e.g., *U. australis*, *U. minor*, *U. intermedia*), which serve as overwintering structures produced by plants living in subtropical to polar zones (Adamec, 2010). Turions are formed by the extreme condensation of shoot apices, usually appearing as small, globoid structures, ranging in size from less than a millimetre to 2–3 centimetres (Adamec, 1999, 2008, 2010). This adaptation helps species survive low winter temperatures, snow cover, and avalanches. Additionally, turion formation is a vegetative reproductive strategy, usually seen in sterile species, and serves as a means of mass clonal reproduction (Adamec, 2008, 2010).

Taylor (1989) recognized 34 species in this section, with five species reported in India (Janarthanam & Henry, 1992). Since then, an additional species, *U. kamarudeenii*, has been described from India (Arya *et al*., 2020) and is now considered a synonym. The present study reports five species from India.

**Key to the species of sect. Utricularia**

1. Plants submerged or free floating aquatic herbs; palate of the lower lip of corolla prominently raised with rounded to triangular swelling ..... **2**

1. Plants affixed aquatic herbs; palate of the lower lip of corolla without a prominent swelling, usually flat and raised to a marginal rim ..... **U. minor**

2. Spongy float present on peduncle ..... **3**

2. Spongy float completely absent ..... **4**

3. Spongy floats present at the base of peduncle, stalked; persistent style exceeding the capsule ..... **U. aurea**

3. Spongy floats present above the middle of peduncle, sessile; persistent style smaller than capsule ..... **U. stellaris**

4. Ultimate segments on each leaf a few; lamina usually terete, dichotomously divided; peduncle without scales; turions absent; seeds lenticular, broadly winged and margins scaly ..... **U. gibba**

4. Ultimate segments numerous; lamina flattened, palmately divided; peduncle with numerous scales; turions present; seeds prismatic, slightly winged on all angles ..... **U. australis**

**1. Utricularia aurea** Lour., Fl. Cochinch. 1: 26. 1790; Sm. in Rees (ed.), Cycl. 37: 600. 1819; A.DC. in DC. (ed.), Prodr. 3: 8. 1884; Basak, Bull. Bot. Surv. India 17: 99. 1975; T.N.Srivast., Fl. Ghorakpurensis 233. 1976; P.Taylor, Fl. Males. 1(8): 296. t. 21. 1977; Vajr. Fl. Palghat Dist. 329. 1980; B.M.Sharma & Kachroo, Fl. Jammu 1: 243. 1981; S.K.Varma, Fl. Bhagalpur 286. 1981; N.Rani & K.M.Matthew in K.M.Matthew (ed.), Fl. Tamilnadu Carnatic 3(1): 1111. f. 84a: 1983; H.J.Chowdhery & Wadhwa in Wadhwa & H.J.Chowdhery (eds.), Fl. Himachal Pradesh 2: 541. 1984; D.M.Verma in D.M.Verma *et al.* (eds.), Fl. Raipur, Durg & Rajnandgaon 265. 1985; Rao & Sreeramalu, Fl. Srikakulam Dist. 347. 1986; R.S.Rao, Fl. Goa, Diu, Daman, Dadra & Nagarhaveli 2: 308. 1986; V.Chandras. in A.N.Henry *et al*. (eds.), Fl. Tamil Nadu Ind., Ser I: Analysis 2: 129. 1987; S.M.Almeida, Fl. Savantwadi 2: 308. 1990; Kesh.Murthy & Yogan., Fl. Coorg (Kodagu) Karnataka 317. 1990; M.Islam, Fl. Majuli 229. 1990; Janarth. & A.N.Henry, Bladderworts India 30. t. 5. 1992; M.N.Sanyal, Fl. Bankura Dist. West Bengal 318. 1994; Mohanan & A.N.Henry, Fl. Thiruvananthapuram 334. 1994; A.K.Sharma & J.S.Dhakre, Fl. Agra Dist. 203. 1995; K.M.Matthew, Excurs. Fl.

Central Tamilnadu (repr. ed.) 1: 357. 1995; Moulali in Pull. & Moulali (eds.), Fl. Andhra Pradesh 2: 676. 1997; K.K.Singh, Fl. Dudhwa National Park 316. 1997; R.C.Srivast. in Mudgal *et al*. (eds.), Fl. Madhya Pradesh 2: 251. 1997; P.K.Bhattach. & K.Sarkar, Fl. W. Champaran Dist. Bihar 346. 1998; Murti & Panigrahi, Fl. Bilaspur Dist. 2: 427. 1999; R.S.Rao *et al*., Fl. East Godavari Dist. 530. 1999; Londhe in N.P.Singh *et al.* (eds.), Fl. Maharashtra, Dicot. 2: 563. 2001; L.K.Banerjee & T.A.Rao, Fl. Mahanadi Delta 225. 2001; Noltie in Grierson & D.G.Long (eds.), Fl. Bhutan 2(3): 1339. 2001; N.P.Singh *et al*., Fl. Bihar, Analysis 366. 2001; S.R.Yadav & Sardesai, Fl. Kolhapur Dist. 337. 2002; K.G.Bhat, Fl. Uduppi 455. f. 140. 2003; Anil Kumar *et al.,* Fl. Pathanamthitta 367. 2005; K.K.Khanna *et al*., Florsit. Diversity Chhattisgarh 329. 2005; Paria & Chattopadh., Fl. Hazaribagh Dist. 2: 796. 2005; Sunil & Sivad., Fl. Alappuzha 515. 2009; Li in Wu *et al*. (eds.), Fl. China 19: 491. 2011; R.Manik. & Lakshmin., Fl. Rajiv Gandhi Natl. Park 291. 2013; Nayar *et al*., Fl. Pl. Western Ghats India 1: 584. 2014; K.G.Bhat, Fl. South Kanara 768. 2014; S.K.Srivast. & A.N.Shukla, Fl. Cold Desert Western Himalaya 2: 460. 2015; R.Ansari *et al*., Aquatic Wetland Fl. Kerala: Fl. Pl. 506. 2016; Sanjeet Kumar *et al*., Adv. Plants Agric. Res. 9(1): 61. 2019; Noltie in Watson *et al.* (eds.), Fl. Nepal (web edn.) 8. 2019; A.N.Shukla in G.P.Sinha & A.N.Shukla (eds.), Fl. Uttar Pradesh 2: 254. 2020; Li in Y.F.Deng *et al*. (eds.), Fl. Pan-Himalaya 46: 24. 2020. *Type*: '*Habitat in fluvis lentioris curfus in Cochinchina'* (Not located). **Figs. 138–141**

*Utricularia flexousa* Vahl, Enum. Pl. 1: 198. 1804; Oliv., J. Proc. Linn. Soc., Bot. 3: 175. 1858; Drury, Handb. Ind. Fl. 2: 120. 1866; Benth. & F.Muell., Fl. Austral. 4: 525. 1869; C.B.Clarke in Hook.f. (ed.), Fl. Brit. India 4: 329. 1884; K.I.Goebel in Treub (ed.), Ann. Jard. Bot. Buitenzorg 9: 87. 1891; Trimen, Handb. Fl. Ceylon 3: 267. 1895; Prain, Bengal Pl. 2: 780. 1903; T.Cooke, Fl. Bombay 2: 316. 1905; Haines, Bot. Bihar Orissa 4: 644. 1922; Gamble, Fl. Madras 2: 980. 1924; Santapau, J. Bombay Nat. Hist. Soc. 49(2): 218. 1950; Maheshw., Fl. Delhi 256. 1963; Duthie, Fl. Gangetic Plain 2: 166. 1977. *Type*: INDIA, *s.loc., s.d., J. Koenig s.n.* (holo, C [C10013885 digital image!])

*Utricularia fasciculata* Roxb. in Carey & Wall. (eds.), Fl. Ind. 1: 144. 1820, in Carey (ed.), Fl. Ind. 1: 143. 1832; Wight, Icon. Pl. Ind. Orient. 4(4): 9. t. 1568. 1850

*Utricularia inflexa* Forssk. var *stellaris* (L.f.) *auct. non* P.Taylor: Manilal & Sivar., Fl. Calicut 207. 1982 *excl. syn. U. stellaris* L.f.

*Utricularia kamarudeenii* V.S.A.Kumar & Sindu Arya, Phytotaxa 447(1): 71. 2020. ***syn. nov.*** *Type*: INDIA, **Kerala**, Kottayam district, Manarcaud, 05.01.2019, *S. Arya, R. Raju & V.S. Anil Kumar* 7680 (holo, CMPR; iso TBGT, MH not seen)

Perennial, suspended, aquatic herbs. Rhizoids absent. Air shoots present below the spongy floats, numerous on stolons; filiform, thread-like, up to 120 mm long, hyaline-pale green. Stolons 50–80 cm long (up to several meters), 0.2–0.5 mm thick, terete, golden greenish, glabrous or rarely densely covered with simple hairs, variously branched. Spongy float present, verticillate at peduncle base, fusiform, usually 3 or 4–5, 4–7 (–15) cm long, 1–3 mm thick, with filiform branches. Leaves 1.5–6 (–8) cm long, 4–5 primary segments from axils (node) of stolons, semi-verticillate; primary segments pinnately divided into secondary segments; secondary segments dichotomously divided further into numerous segments; secondary leaf segments alternate, 2 from each point; ultimate segments lanceolate capillary, laterally and apically setulose. Traps obliquely obovoid, 2–3 mm across, numerous at axils of leaf segments; shortly stalked, stalk 0.2–0.4 mm long; mouth lateral, oblique; appendages many or rarely absent, subulate, simple. Racemes erect, 5–20 (–30) cm long, glabrous, 5–15-flowered; peduncles terete, 0.5–1.5 mm thick, initially short, elongated in fruiting. Scales absent. Bracts widely ovate-orbicular, 1.2–1.5 mm long, basifixed, rounded at apex, glabrous, green; bracteoles absent. Flowers 7–13 mm long; pedicels 6–10 (–15) mm long, erect at anthesis, terete, glabrous, green, reflexed and thickened in fruit, accrescent, up to 20 mm long in fruiting. Calyx lobes sub-equal, accrescent, fleshy and spreading in fruit, glabrous, green; upper lobe ovate, 2.5–3.5 × 1.8–2.5 mm, obtuse to rounded at apex; lower lobe ovate, 1.5–2 × 1.3–2 mm, obtuse to rounded at apex. Corolla bright yellow, 10–15 mm long; upper lip widely ovate to sub-orbicular, 5.5–6.5 × 5–6 mm, rounded-retuse at apex; lower lip sub-orbicular, 7.5–10 × 7.5–9 mm, hairy at throat, hairs unicellular-uniseriate, palate bi-gibbous, tomentulose out, rounded to emarginate at apex; spur subulate, 3–5 mm long, shorter than or equal to (rarely exceeds) lower lip of corolla, tomentulose, constricted at middle, obtuse to rounded at apex. Stamens 1.5–2 mm long; filaments 1.5–1.75 × 0.5–0.65 mm, broader at apex, narrow then, twisted at base, a tuft of hyaline unicellular hairs near apical margins of filament, obscure towards base, hyaline, pale yellow; anther theca confluent,

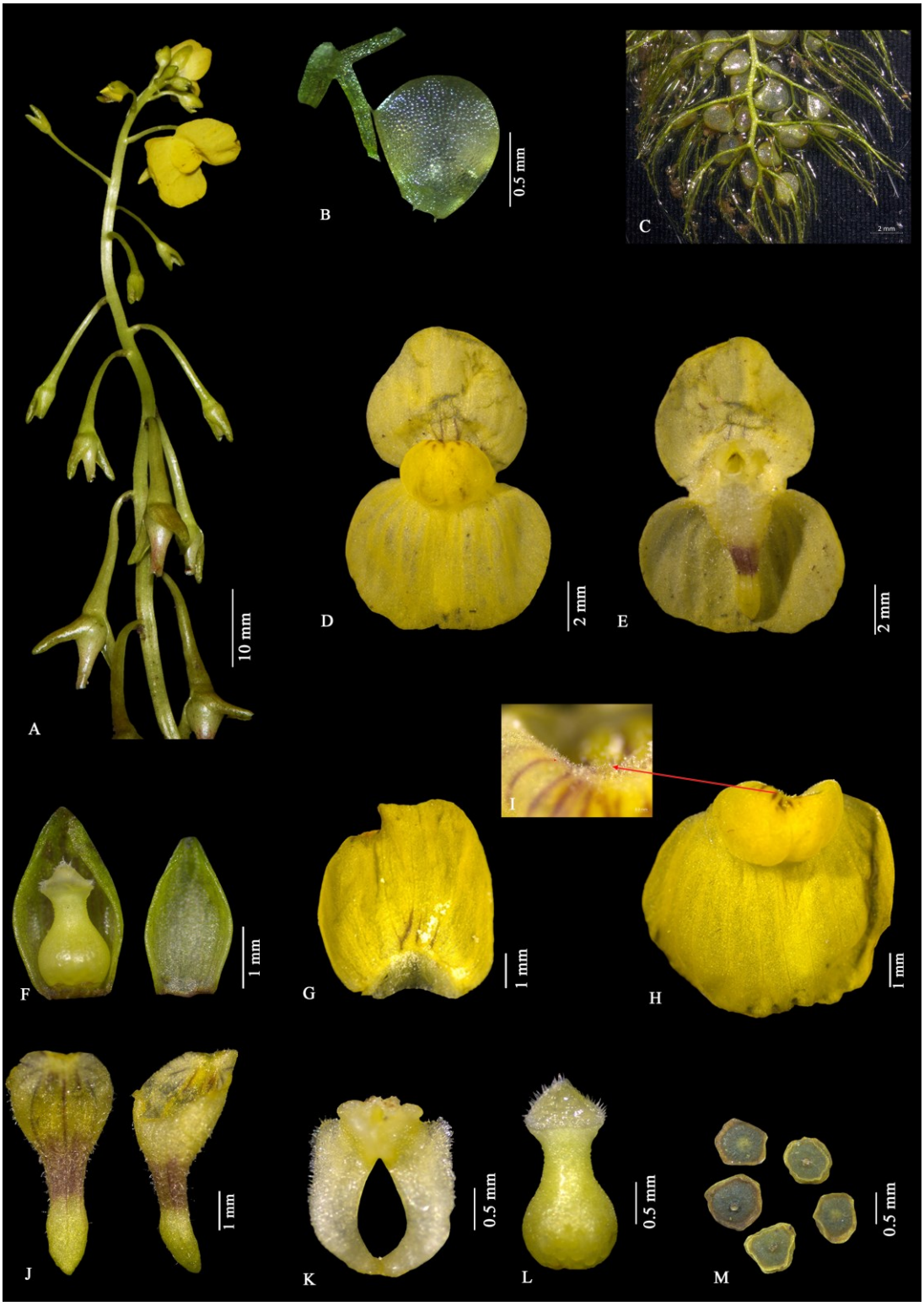


**Fig. 138.** *Utricularia aurea* Lour.: **A.** Habit; **B.** Trap; **C.** leafy shoot**; D & E.** Corolla – front and back view; **F.** Calyx lobes; **G.** Upper lip of corolla; **H.** Lower lip of corolla; **I.** Close up view of throat; **J.** Spur- different view; **K.** Stamens; **L.** Pistil; **M.** Seeds.

**Fig. 139.** *Utricularia aurea* Lour. growing in natural habitats.

yellow. Pistil 2–2.5 × 1–1.5 mm long, pale green; ovary sub-globose, 1–1.3 mm across, green, glabrous; style short, 0.4–0.5 × 0.5–0.6 mm, accrescent after anthesis, thick; stigma bi-lipped, upper lip much shorter or obsolete, lower lip deltate to semi-orbicular, margins with hyaline unicellular hairs. Capsules 7–10 mm long with persistent thick and fleshy style, circumscissile; placenta 3.7–4 mm long. Seeds 0.74–1.5 mm across, 5–6-angled; surface verrucate; hilum at centre of dorsal part.

***Flowering & fruiting***: Flowering begins in late August and continues until the end of April, while fruiting occurs from mid-September to mid-May. In some cases, especially in areas with low water levels, flowering may occur year-round.

***Habitat***: It is found suspended in stagnant or slow running water, or in deeper aquatic habitats such as ponds, ditches, lakes, canals, paddy fields, and fallow land, often seen intermingled with *U. gibba* L., *Cabomba furcata* Schult. & Schult.f. (Cabombaceae), *Ceratophyllum* sp. (Ceratophyllaceae), *Hygrophila* sp. (Acanthaceae), *Ipomoea aquatica* Forssk. (Convolvulaceae), *Isachne* sp., *Oryza sativa* (both Poaceae), *Ludwigia* sp. (Onagraceae), *Nelumbo* sp. (Nelumbonaceae), *Nymphaea* spp. (Nymphaeaceae), *Nymphoides* sp. (Menyanthaceae), *Pontederia crassipes* Mart. (Ponteridaceae), *Persicaria* sp. (Polygonaceae), and some pteridophytes, *viz*., *Azolla* sp., *Salvinia* sp. (both Salviniaceae), *Ceratopteris thalictroides* (L.) Brongn. (Pteridaceae), *Marsilea minuta* E.Fourn. (Marsileaceae), etc. (Fig. 139).

***Distribution:*** India, Australia, Bangladesh, Cambodia, China, Hainan, Indonesia, Japan, Java, Korea, Laos, Malaysia, Myanmar, Nepal, New Guinea, Pakistan, Philippines, Sri Lanka, Sumatra, Taiwan, Thailand, and Vietnam (Taylor, 1989; POWO, 2025) (Fig. 142).

***Specimens examined:*** BANGLADESH, Chittagong, Rangamati, 02.11.1898, *D. Hooper s.n.* (BSIS000007302); Jessore, 08.11.1896, *Mokim s.n.* (DD); Narayanganj, 16.09.1904, *Herb R.E.P.* 21468 (BSIS000007299). INDIA, Peninsula Indiae Orientalis, *s.loc*., February 1849, *Herb. Wight* 2421 (CAL). **Andhra Pradesh,** West Godavari district, Kolleru Lake, 22.01.1958, *K. Subramanyam* 5073 (CAL, MH00126939, MH00126940). **Assam**, Cachar district, Silchar neighbourhood, 06.08.1903, *A.T. Guje s.n.*; Jaboca, Tingalibam Garden, 1898, *Prains Collector M.A. Hoek* 137 (CAL);

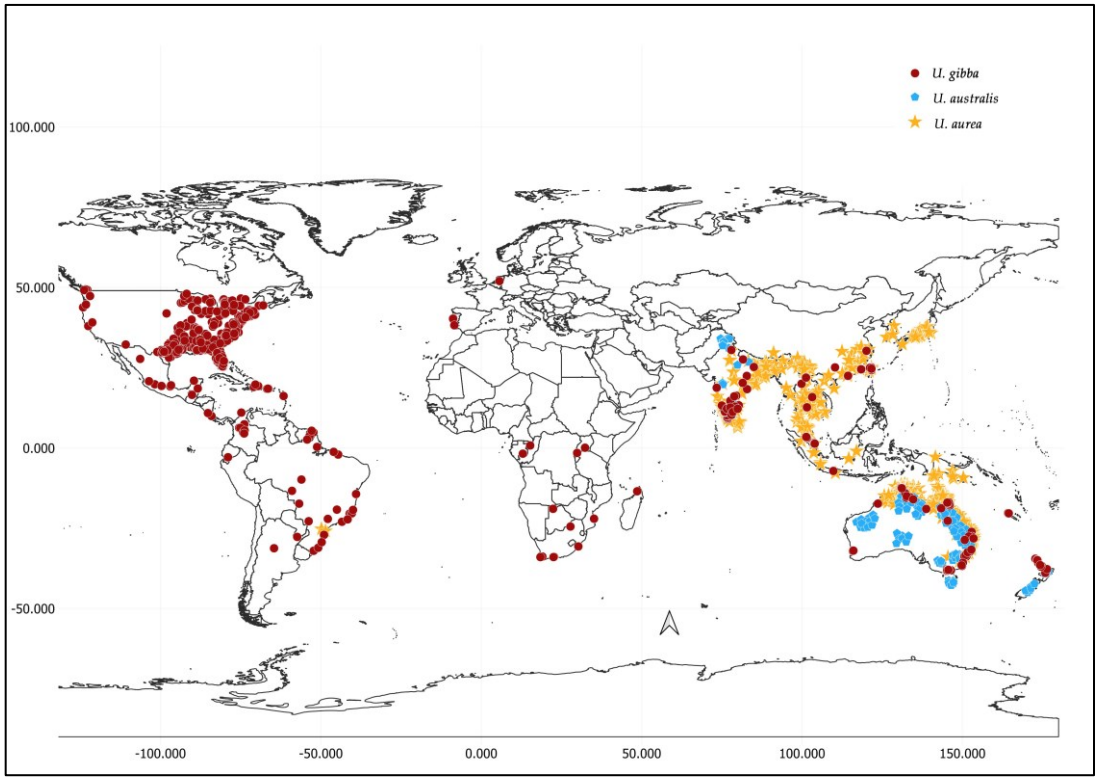


**Fig. 142.** Distribution of *Utricularia aurea* Lour., *U. australis* R.Br. and *U. gibba* L.

Kamrup district, Chandubi Lake, July 1964, *A.S. Rao* 38917 (CAL); Lakhimpur district, Laluk, Adakhana, 18.05.1966, *D.M. Verma* 46463 (ASSAM); Morigaon district, near Taptala, 2 miles west of Nakhola, 20.08.1964, *N.P. Balakrishnan* 39323 (ASSAM, CAL); Sivasagar district, Sibsagar, Sarvpatheri, 31.11.1963, *H. Deka* 35513 (ASSAM); Upper Dehing R.F., 10.07.1959, *G. Panigrahi* 18969 (ASSAM). **Bihar**, Begusarai district, Jai Mangla Garh, Kanvar Lake, 18.02.2012, *Suman Halder* 53610 (CAL); Vaishali district, Baraila wetland, 14.11.2016, *K. Avinash Bharati* 079160 (CAL). **Chhattisgarh**, Kanker district, Rajbanda tank, 500 m, 17.11.1958, *K. Subramanyam* 7148 (CAL, MH00126944, MH00126946). **Jharkhand**, Singhbhum district, Lipighutu, 19.09.2000, *D. Das* 1904 (CAL); Surguja district, Ambikapur, 1900 feet, 31.05.1943, *H.F. Mooney* 2219 (DD). **Karnataka**, Tumkur district, Kunigal Lake, ± 671 m, 03.01.2023, *M.P. Krishnapriya & Santhosh Nampy* 186045 (CALI199591). **Kerala,** Alappuzha district, Arukkutty, 30.12.1990, *M.S. Swaminathan* 95681 (MH00126919, MH00126920); Thottappally, Vembanad Lake, 24.04.1988, *M.S. Swaminathan* 88289 (CAL, MH00126917, MH00126918); Ernakulam district, Cochin, 1884, *M.A. Lawson*

*s.n.* (MH00126916); *Ibid.*, November 1909, *A. Meebold* 12564 (CAL); Elanthikkara, 10.11.2008, *K.H. Amita Bachan* 123496 (CALI115467, CALI115468, CALI115469); Kalamasseri, Palliarankara, 13 m, 13.10.2002, *P.P. Biju* 86860 (CALI190516); Idukki district, Cheruthoni, 19.12.1982, *C.N. Mohanan* 76213 (MH00126395, MH00126396); Kannur district, Madayipara, near Vatukuntha Lake, 17.08.2014, *C. Pramod* 143128 (CALI128539); Kasaragod district, Cheruvathur, 50 m, 30.06.1980, *R. Ansari* 67929 (CAL, MH00126912, MH00126941, MH00126915); Karayamkode, 26.08.2021, *M.P. Krishnapriya & Santhosh Nampy* 175804 (CALI187655, CALI187656, CALI187657); Nileshwaram, 175 m, 29.01.1979, *V.J. Nair* 59977 (CAL, MH00126911, MH0012613); *Ibid.*, 150 m, 09.10.1979, *R. Ansari* 64808 (CAL, MH00126910); Pallam road, 23.08.1985, *M.K. Janarthanam* 82929 (MH00126908, MH00126909); Kollam district, Ochira, 14.01.2019, *S. Syam Radh* 168057 (CALI); Paravur, 07.08.1978, *C.N. Mohanan* 58405 (MH00126897, MH00126898); Kottayam district, Changanassery, *s.d.*, *R. Anathkrishnan s.n.* (RHT044642); *Ibid.*, below 10 m, 19.01.1984, *V.T. Antony* 218 (MH00126875); Kannanchira, 19.01.2023, *M.P. Krishnapriya* 164398 (CALI); Kidangara, 24.10.1984, *V.T. Antony* 890 (MH00126876); Kumarakom, 13.02.1993, *K.C. Joseph* 45894 (CALI141500); *Ibid.*, Chengalam, 19.01.2023, *M.P. Krishnapriya* 164399; South Chengalam, Vayalorakattu, 19.01.2023, *M.P. Krishnapriya* 164400; Manarcadu, Puthupalli, ± 20 m, 18.01.2023, *M.P. Krishnapriya* 175802; Villoonni, Arpookara, 18.01.2023, *M.P. Krishnapriya* 175803 (CALI); Kozhikode district, Azhinjilam, 12.03.2019, *M.P. Krishnapriya* 168099; Feroke, 01.11.1970, *V.V. Sivarajan* 758 (CALI193295); Kottakadavu, 21.10.1987, *K. Mohanan* 10178 (CALI141502); *Ibid.*, 21.10.1987, *P.S. Ajitha* 13278 (CALI141499); Veliyannur Chally-northern side, 04.10.2020, *M.D. Vyshnav* 163975 (CALI165428); Malappuram district, Angadipuram, 12.08.2020, *M.P. Krishnapriya & Santhosh Nampy* 164370 (CALI197419, CALI197420, CALI197420); Calicut University Campus, 05.10.1987, *A.K. Prasitha* 12838 (CALI141503); Nedumkayam, in swamps and pools, 150 feet, 18.11.1916, *C.E.C. Fischer* 4019 (CAL); Thirunavaya, 23.02.2020, *M.P. Krishnapriya & Santhosh Nampy* 164366 (CALI197423, CALI197424, CALI197425, CALI197428); Tirur near Railway station, 27.10.1983, *K.T. Joseph* 27.10.1983 (CALI192834, CALI192838, CALI192839); Valanchery, Pookatiri, in Canal, 21.01.2019, *M.P. Krishnapriya* 168058 (CALI187652, CALI187653, CALI187654); Palakkad district, Olavakode, 75 m, 16.10.1963, *J. Joseph*

17740 (MH00126902, MH00126903); *Ibid*., 17.10.1963, *J. Joseph* 17766 (CAL, MH00126900, MH00126904); Pallipuram, Paruthoor, 06.02.2020, *M.P. Krishnapriya & Santhosh Nampy* 164360 (CALI197426, CALI197427); Peringothukavu, way to Kollengodu, 325 m, 23.11.1973, *E. Vajravelu* 44810 (MH00126899, MH00126901); Shoranur, 23.11.1900, *s.coll. s.n.* (MH00126906); *Ibid*., October 1901, *s.coll. s.n.* (MH00126905); Thiruvananthapuram district, South of Trivandrum, Travancore, 4 m, 07.12.1933, *Eileen W. Erlanson* 5024 (MICH1577821, A01977006 digital images); Thrissur district, Athirapalli R.F., 100 m, 11.12.1965, *K.M. Sebastine* 26741 (CAL, MH00126892, MH00126893); Chelakkara, Soopipadi, 06.09.2020, *M.P. Krishnapriya & Santhosh Nampy* 164377 (CALI187648, CALI187649, CALI187650, CALI187651); Chiklai, 300 m, 29.02.1982, *K. Ramamurthy* 74935 (MH00126888, MH00126889); Engandiyur, 29.12.1991, *T.S. Devi* 1119 (CALI141501); near Guruvayoor, 10 m, 06.09.1976, *K. Ramamurthy* 47654 (CAL, MH00126894, MH00126895); *Ibid*., 06.09.1976, *K. Ramamurthy* 47656 (MH00126884, MH00126885); Koratty-Chalakkudy route, 75 m, 08.02.1984, *K. Ramamurthy* 80433 (CAL, MH00126883, MH00126896); Paliappara side R.F., 350 m, 22.09.1982, *K. Ramamurthy* 74716 (MH00126886, MH00126887); Santhanathode area, 300 m, 26.11.1982, *K. Ramamurthy* 75551 (MH00126890, MH00126891); Wayanad district, Panamaram, 19.11.2018, *M.P. Krishnapriya & M.P. Keerthi* 168042 (CALI187646, CALI187647). **Ladakh**, Leh district, after Leh on Miru road, 31.07.2016, *H.B. Naithani & G.S. Goraya* 5665 (DD). **Madhya Pradesh**, Sagar district, Zalimpur tank near Banda, 500 m, 30.10.1960, *N.P. Balakrishnan* 11347 (CAL, MH00126943, MH00126945). **Maharashtra**, Nagpur district, Sakkardara, 217 m, 16.11.1957, *K. Subramanyam* 4649 (MH00126941, MH00126942). **Manipur**, *s.loc*., 2-3000 feet, April 1882, *Herb. G. Watt.* 7457 (CAL); Bishnupur district, Logtak Lake, 2300 feet, 10.09.1944, *N.L. Bor* 18105 (DD). **Odisha**, Bargarh district, Padmapur, 31.10.1959, *G. Panigrahi* 20560 (CAL); Ganjam district, Khariaguda, 500 feet, January 1884, *J.S. Gamble* 13710 (CAL); Koraridi River Valley, East of Aodhar, 09.12.1962, *G.V.S. Rao* 30146 (ASSAM Acc. No. 35947, 35948); Puri district, Puri, 20.04.1965, *V. Abraham* 329 (CAL); Sundargarh district, Raipur R.F., 15.03.1988, *A. Mukherjee & D. Namhata* MN3360 (CAL). **Rajasthan,** Bharatpur district, Keolado Ghana National Park, 22.03.1982, *P.J. Parmar* 8630 (CAL); Bharatpur Lake, 20.10.1963, *N.D. Bachkheti s.n.* (DD). **Tamil Nadu**, Chengalpattu district, Neithavoyal near Minjur, ± 3 m,

05.04.1984, *D. Narasimhan* 401 (MH00126925); Neithavoyal in a pond, ± 4 m, 02.06.1986, *M.K. Janarthanam* 82984 (MH00126923, MH00126924); Coimbatore district, Anaimalai, Pannimedu, 925 m, 22.01.1963, *J. Joseph* 15564 (MH00126929, MH00126930); Cuddalore district, Kudikadu (8km towards Chidambaram) 29.12.1981, *K.M. Matthew & S.J. Britto* 28719 (RHT044585); Dindigul district, Kodaikanal, Lake marsh (south) 2100 m, 14.14.1989, *Fieldmen* 53713 (RHT044576); Kanyakumari district, near Nagercoil, 15.10.1985, *A.N. Henry & R. Gopalan* 83325 (MH00126400, MH00126401); Krishnagiri district, Denkanikottai, Ahushonei Village, 850 m, 16.12.1978, *K.M. Matthew & N. Venugopal* 20281 (RHT044583); Anchetty R.F., 600 m, 13.02.1980, *T.S. Jayaseelan* 26479 (A01977080 digital image, RHT044584); Salem district, Shevaroys, Yercaud, Omallur, Manjakkuttai, 1400 m, 11.01.1980, *K.M. Matthew* 25711 (RHT044580, RHT044581); *Ibid*., 1500 m, 17.12.1980, *K.M. Matthew, S.J. Britto & N. Rani* (RHT044582); Tirunelveli district, Singampatti, 92 m, 03.03.1958, *K.M. Sebastine* 5503 (MH00126922, MH00126926); Viluppuram district, pond near Marakkanam, 50 m, 09.09.1977, *K. Ramamurthy* 51125 (MH00126927, MH00126928, CAL); Marakkanam, Kollumedu tank II, 25.02.2001, *K.M. Matthew* 72725 (RHT044783). **Tripura**, West Tripura district, Agartala, 600-800 feet, October 1915, *P.M. Debbarman* 813; *Ibid*., 05.03.1963, *D.B. Deb* 2910 (CAL); **Uttar Pradesh,** Bulandshahr district, Daulatabad, 22.10.1962, *N.P. Singh* 25389 (CAL); Maharajganj district, Bardar, Pharenda, 02.11.1963, *C.M. Arora* 1477 (CAL); Pilibhit district, Amaria, 02.10.1970, *C.L. Malhotra* 42397 (CAL). **Uttarakhand**, Dehradun district, Selakui Chakrata road, 29.08.1971, *H.B. Naithani* 3158 (DD). **West Bengal**, Alipurduar district, Chilapata, 30.11.2013, *K. Karthigeyan* 61335 (CAL); Birbhum district, Bhabanandapur, 26.03.1966, *R.K. Basak* 150; Nimdaspur, Cahricha, 03.09.1969, *R.K. Basak* 1127 (CAL); Darjeeling district, Siliguri, November 1879, *J.S. Gamble* 7408 (CAL, DD); Jalpaiguri district, Gareti, 30.11.2009, *V. Ranjan & Anant Kumar* 45397 (CAL); Jalpaiguri, August 1879?, *J.S. Gamble* 7031 (DD), Khunia tower range, 23.09.2008, *V. Ranjan & Anant Kumar* 44665; Gorumara tower range, 21.09.2010, *V. Ranjan & Anant Kumar* 45459 (CAL); Hooghly district, Goghut, *s.d.*, *Suhir Sen s.n.*; *Ibid*., 11.03.1902, *J.D. Nusker* 27 (GH01977008, GH01977010, GH01976999 digital images, CAL); Kamarkundu, 04.08.1963, *B.V. Shetty* 63; Mayapur, 19.12.1964, *M.K. Ghosh* 2672; Polba Village (Bandel) near Mogra Village, 15.11.1962, *M.K. Ghosh* 822; Bandel, 19.12.1964,

*M.K. Ghosh* 2646 (CAL); Medinipur district, Khejuri, 06.12.1975, *S. Majlis* 2544 (CAL); South 24 Parganas district, Budge-Budge, 26.10.1962, *MC Pherh* 996; Near Fort Falta, 17.12.1964, *M.K. Ghosh* 2644 (CAL); Sagar Island, Iswaripur, 15.10.1971, *A.K. Mukherjee* 8765 (CAL); Purulia district, Saheb Bandh, 10.03.1964, *S.N. Biswas* 5 (CAL); West Dinajpur district, *s.d.*, *Suint Mitra* 2777 (CAL); Hili, 27.10.1983, *R.N. Banerjee & M.C. Biswas* 16025 (CAL). MYANMAR, Insein district, Kyaukchaung, 30 feet, *s.d.*, *Po Khant* 1392 (DD); Dawei (Tavoy), December 1900, *Shalk Mokim* 59 (CAL); Mawlamyine, plain of Ataran River, 1904, *I.H. Burkill* 23925 (BSIS000007304); Pegu, *s.d.*, *S. Kurz* 289 (CAL); Shan state, Inle Lake, 22.02.1917, *N. Annandale* 274 (CAL).

***Conservation status***: *Utricularia aurea* has a wide distribution across Tropical and subtropical Asia to Australia and is a common perennial species in India. Considering its extensive populations and wide distribution, the species is categorised as Least concern (LC).

***Notes***: *Utricularia aurea* shows considerable variation in size of shoot length, raceme and flower size, depending on habitat conditions. An inflated, fusiform, spongy float, seen at the base of the peduncle, is very distinctive. *Utricularia aurea* is often separated from *U. stellaris* based on the absence of floats, but in *U. aurea* floats are present, and the size of which ranges from 3–5 cm long, occasionally reaching up to 15 cm. Rarely, the floats may be poorly developed or obscure (Fig. 140).

A wide range of corolla variations from unlobed to lobed patterns has also been noticed in this study (Fig. 141). These variations confirm the synonymisation of a recently described species *U. kamarudeenii* by Arya *et al*. (2020) from Kottayam district of Kerala. As per the original description, it is distinguished from *U. aurea* by having monomorphic traps without appendages and a deeply bilobed lower corolla lip. However, Though, naked traps can be found in some cases in which the trap appendages were small subulate to obscure. Additionally, the slightly unequal calyx lobes, oblong upper lip of corolla with wavy margin, and the deeply bilobed lower lip of corolla (note Fig. 141) are variations within the natural range of *U. aurea*, and hence *U. kamarudeenii* is synonymized here.

**Fig. 140.** *Utricularia aurea* Lour. **A.** Habit; **B.** Young leafy shoot; **C-K.** Development of spongy floats - and variation in its size (note the red arrows).

**Fig. 141.** *Utricularia aurea* Lour. showing variation in flower morphology. Note the lobing pattens (in red arrow).

**2. Utricularia australis** R.Br., Prodr. Fl. Holland. 1: 430. 1810; Sm. in Rees (ed.), Cycl. 37: 599. 1819; A.DC. in DC. (ed.), Prodr. 3: 6. 1844; H.O.Saxena, Indian Forester 249. 1970; P.Taylor, Fl. Males. 1(8): 299. t. 25. 1977; Gandhi in C.J.Saldanha & Nicolson (eds.), Fl. Hassan Dist. 563. 1978; Janarth. & A.N.Henry, Bladderworts India 34. t. 6. 1992; Chenna Kesavulu *et al*., J. Bombay Nat. Hist. Soc. 94: 439. t. 1. 1997; R.C.Srivast. in Mudgal *et al*. (eds.), Fl. Madhya Pradesh 2: 252. 1997; K.M.Matthew, Fl. Palni Hills part 2: 904. 1999; Londhe in N.P.Singh *et al.* (eds.), Fl. Maharashtra, Dicot. 2: 563. 2001; N.P.Singh *et al*., Fl. Bihar, Analysis 366. 2001; Li in Wu *et al*. (eds.), Fl. China 19: 490. 2011; Kullayiswamy *et al*., J. Indian Bot. Soc. 92(1&2): 101. 2013; S.K.Srivast. & A.N.Shukla, Fl. Cold Desert Western Himalaya 2: 460. 2015; Kullayiswamy *et al*., Fl. Thummalapalle Uranium Mining Area Andhra Pradesh 311. 2017; Noltie in Watson *et al.* (eds.), Fl. Nepal (web edn.) 7. 2019; A.N.Shukla in G.P.Sinha & A.N.Shukla (eds.), Fl. Uttar Pradesh 2: 254. 2020; Li in Y.F.Deng *et al*. (eds.), Fl. Pan-Himalaya 46: 28. 2020. *Lectotype* (designated by Taylor, 1973): AUSTRALIA, New South Wales, ponds between Paramatta and Hawksbury, *s.d.*, *R. Brown* 2730 (BM [BM000016304 digital image!]). **Figs. 143 & 144**

Perennial, suspended aquatic herbs. Rhizoids absent; air shoots not observed. Stolons 10–25 cm long, 0.5–0.6 mm thick, filiform, terete, variously branched. Leaves numerous, 1.5–30 mm long, divided into 2 primary segments; primary segments pinnately divided into secondary segments; secondary segments dichotomously divided into further segments; ultimate segments capillary, slightly flattened, margin sparsely denticulate, setulose at apex; turions present. Traps on leaf segments, ovoid, 1–2.5 mm across, mouth lateral or basal; appendages 2, dorsal, simple or branched, setiform, with shorter simple lateral setae. Racemes weakly erect, 10–15(–30) cm long, 3–8(–12)-flowered, glabrous; peduncles terete,

**Fig. 143.** Lectotype of *Utricularia australis* R.Br. [*R. Brown* 2730 (BM000016304)] "© *The Trustees of the Natural History Museum, London*".

1–2 mm thick. Scales numerous on peduncle, ovate to elliptic, 1–1.5 × 0.8–1.2 mm, basifixed, truncate at base, obtuse to rounded at apex. Bracts sub-orbicular, 1.5–2.5 × 1–2 mm, basifixed or more or less auriculate at base, rounded-obscurely tridentate at apex; bracteoles absent. Flowers 10–15 mm long; pedicels 10–12 mm long, erect at anthesis, terete, glabrous, pale green to brownish green, accrescent and decurved in fruit, 15–25 mm long in fruiting. Calyx lobes sub-equal; upper lobe ovate, 1.8–2.5 × 1.2–2 mm, rounded at apex; lower lobe ovate to oblong, 1.2–2 × 1–1.6 mm, emarginate at apex. Corolla yellow; upper lip sub-orbicular, 6–8 mm long, larger than the palate of lower lip, obtuse at apex; lower lip sub-orbicular, 8–10 × 10–12 mm, palate gibbous, ± V-shaped, yellow with reddish brown striations, glabrous, margin undulate, rounded to retuse at apex; spur broadly conic, 4–6 mm long, considerably shorter than lower lip of corolla, obtuse at apex. Stamens *c.* 1.5 mm long. Pistil *c.* 1.5 mm long. Capsules globose, 3–3.5 mm in diameter, circumscissile. Seeds prismatic, 0.4–0.6 mm in diameter, 4–6-angled, slightly winged on all angles; hilum central.

**Fig. 144.** *Utricularia australis* R.Br.: **A-B.** Habitat; **C-F.** Habit (Photo A-C. from R.V. Lansdown).

***Flowering & fruiting***: Flowering begins at the end of March and lasts until November, while fruiting occurs from mid-April to December.

***Habitat***: These plants are seen suspended until or slow running waterways (Fig. 144).

***Distribution:*** India, New South Wales, New Zealand, Northern Territory, Queensland, South Australia, Tasmania, Victoria and Western Australia (Kullayiswamy *et al*., 2013; Taylor, 1989; POWO, 2025) (Fig. 142).

***Specimens examined***: INDIA, **Andhra Pradesh,** Kadapa district, Tummalapalle Uraninum Mining, 673 m, 15.07.2012, *K. Raja Kullayi Swamy* 41861 (CAL). **Himachal Pradesh**, Shimla district, Rohru, 1600 m, 30.07.1965, *N.C. Nair* 36206 (BSD000063873). **Jammu and Kashmir,** Srinagar, May 1964, *V.N. Kaul* 040Z (CAL); Kashmir, Shopian, 2000 m, 09.06.1959, *T.A. Rao* 9380 (BSD000063875). **Ladakh**, Pitug, *s.loc.,* 05-07.08.1933, *W.N. Koelz* 6351 (A01977018); Ranbipur, Indus Valley?, 3400 m, 13.09.1970, *U.C. Bhattacharyya* 41150 (CAL); Shey, August 1982, *P.K. Hajra* 74075 (BSD000063867). **Punjab**, Gurdaspur district, *D.B. Nanak*, 25.08.1969, *U.C. Bhattacharyya* 39263 (BSD000063897). **Tamil Nadu**, Dindigul district, Kodaikanal, Lake, 07.09.1988, *K.M. Matthew* 53499 (RHT044590); Salem district, Namakkal, Kolli Hills near Ariyur shola, paddy fields, 1200 m, 26.04.1984, *K.M. Matthew & S.J. Britto* 30159 (RHT044637). **Uttar Pradesh**, Gorakhpur, 06.05.1898, *Harsukh* 22425 (DD); Hamirpur district, Betatal, 02.04.1962, *U.C. Bhattacharyya* 21417 (BSD000063731, CAL); Mahoba, 30.09.1961, *U.C. Bhattacharyya* 17958 (BSD000063735, BSD000063895, BSD000063896, CAL); *Ibid*., 18.07.1962, *C.L. Malhotra* 21438 (BSD000063734); Hapur district, Garhmukteshwar, 20.12.1959, *T.A. Rao* 10985 (BSD000063733).

***Conservation status***: *Utricularia australis* is widely distributed in temperate and tropical regions, excluding North and South America (Taylor, 1989). It usually occurs in the northern and eastern parts of India, where its distribution is more restricted. The status of the species has been assessed as Least Concern (LC) by the IUCN (Champion, 2014. https://dx.doi.org/10.2305/IUCN.UK.2014-1.RLTS.T163979A21842538.en.)

***Notes***: *Utricularia australis* usually reproduce vegetatively, and flowering is rare or sometimes completely absent (Taylor, 1989; Astuti & Peruzzi, 2018a). Ceschin *et al*. (2022) noted the development of underwater chasmogamous flowers in *U. australis*. Among the suspended species, *U. australis* is easily identified by its numerous scales, and the absence of float on the peduncle.

**3. Utricularia gibba** L., Sp. Pl. 1: 18. 1753; Sm. in Rees (ed.), Cycl. 37: 600. 1819; A.DC. in DC. (ed.), Prodr. 3: 11. 1844; S.K.Varma, Fl. Bhagalpur 286. 1981; P.Taylor, Gen. *Utricularia* 572. t. 179a,b. 1989; M.N.Sanyal, Fl. Bankura Dist. West Bengal 318. 1994; K.G.Bhat, Fl. Uduppi 455. 2003, Fl. South Kanara 769. 2014; Li in Wu *et al*. (eds.), Fl. China 19: 488. 2011; S.K.Mandal & Bhaumik in Lakshmin. *et al*. (eds.), Fl. West Bengal 4: 144. 2019; Noltie in Watson *et al.* (eds.), Fl. Nepal (web edn.) 6. 2019; Li in Y.F.Deng *et al*. (eds.), Fl. Pan-Himalaya 46: 24. 2020. *Utricularia gibba* subsp. *gibba* P.Taylor, Mitt. Bot. Staatssamml. Munchen 4: 98. 1961, Kew Bull. 18(1): 197. t. 81 & 82. 1964. *Vesiculina gibba* (L.) Raf., Fl. Tellur. 4: 109. 1838. *Lectotype* (designated by Taylor, 1964): Habitat in Virginia, *s.d.*, *Clayton s.n.* (BM [BM000098329 digital image!]).

**Figs. 145–147**

*Utricularia exoleta* R.Br. Prodr. Fl. Nov. Holland. 1: 430. 1810; Sm. in Rees (ed.), Cycl. 37: 599. 1819; A.DC. in DC. (ed.), Prodr. 3: 7. 1844; Benth. & F.Muell., Fl. Austral. 4: 526. 1869; K.I.Goebel, in Treub (ed.), Ann. Jard. Bot. Buitenzorg 9: 91. 1891; Trimen, Handb. Fl. Ceylon 3: 268. 1895; Prain, Bengal Pl. 2: 780. 1903; Stapf in Dyer (ed.), Fl. Cap. 4(2): 435. 1904; T.Cooke, Fl. Bombay 2: 317. 1905; Gamble, Fl. Madras 2: 980. 1924; Humbert, Fl. Madagasc. fam. 181. 6. 1936; Santapau, J. Bombay Nat. Hist. Soc. 49(2): 218. 1950; Duthie, Fl. Gangetic Plain 2: 166. 1977; P.Taylor, Fl. Males. 1(8): 294. t. 20. 1977; Gandhi in C.J.Saldanha & Nicolson (eds.), Fl. Hassan Dist. (sec. reprint) 564. 1978; N.Rani & K.M.Matthew in K.M.Matthew (ed.), Fl. Tamilnadu Carnatic 3(1): 1114. f. 84. 1983; A.K.Mukh., Fl. Pachmarhi & Bori Reserves 216. 1984; D.M.Verma in D.M.Verma *et al*. (eds.), Fl. Raipur, Durg & Rajnandgaon 265. 1985; Pull. & Yesoda, Fl. Anantapur Dist. 181. 1989; J.L.Ellis, Fl. Nallamalais 2: 291. 1990; S.M.Almeida, Fl. Savantwadi 2: 308. 1990; B.K.Misra & B.K.Verma, Fl. Allahabad 277. 1992; Janarth. & A.N.Henry, Bladderworts India 49. t. 11. 1992; K.M.Matthew, Excurs. Fl. Central Tamilnadu (repr. ed.) 1: 357. 1995; R.C.Srivast. in Mudgal *et al*. (eds.), Fl. Madhya Pradesh 2: 253. 1997; P.K.Bhattach. & K.Sarkar, Fl. W. Champaran Dist. Bihar 346. 1998; Murti & Panigrahi, Fl. Bilaspur Dist. 2: 428. 1999; Londhe in N.P.Singh *et al.* (eds.), Fl. Maharashtra, Dicot. 2: 565. 2001; N.P.Singh *et al*., Fl. Bihar, Analysis 367. 2001; An.Kumar, Fl. Indravati Tiger Reserve 207. 2003; Sauris Panda & A.P.Das, Fl. Sambalpur 260. 2004; Paria & Chattopadh., Fl. Hazaribagh Dist. 2: 798. 2005; K.K.Khanna *et al*., Florsit. Diversity Chhattisgarh 330. 2005; Harinder Singh & M.Sharma, Fl. Chamba Dist. 323. 2006; Sunil & Sivad., Fl. Alappuzha 518. 2009;

R.Ansari *et al*., Aquatic Wetland Fl. Kerala: Fl. Pl. 511. 2016. *Utricularia gibba* subsp. *exoleta* (R.Br.) P.Taylor, Mitt. Bot. Staatssamml. Munchen 4: 101. 1961, Kew Bull. 18(1): 204. t. 83 & 84. 1964; S.V.Ramaswamy & Razi, Fl. Bangalore Dist. 547. 1973; R.K.Basak, Bull. Bot. Surv. India 17: 100. 1975; T.N.Srivast., Fl. Ghorakpurensis 233. 1976 as *U. gibbosa*; Manilal & Sivar. Fl. Calicut 208. 1982; Deb, Fl. Tripura 2: 304. 1983; M.N.Sanyal, Fl. Bankura Dist. West Bengal 318. 1994; L.K.Banerjee & T.A.Rao, Fl. Mahanadi Delta 225. 2001; A.N.Shukla in G.P.Sinha & A.N.Shukla (eds.), Fl. Uttar Pradesh 2: 255. 2020. *Type*: AUSTRALIA, **New South Wales**, Hawksburg, *s.d.*, *Robert Brown s.n.* (BM [BM001041159 digital image!])

*Utricularia biflora auct. non* Lam.: Roxb. in Carey & Wall. (eds.), Fl. Ind. 1: 144. 1820, Carey (ed.), Fl. Ind. 1: 143. 1832. *nom. illeg. homonym. Utricularia diantha* Roxb. ex Roem & Schult., Mant. 1: 169. 1822; Wight, Hooker's J. Bot. Kew Gard. Misc. 1: 372. 1849, Icon. Pl. Ind. Orient. 4(4): 9. t. 1569. 1850; Oliv., J. Proc. Linn. Soc., Bot. 3: 176. 1858; Drury, Handb. Ind. Fl. 2: 120. 1866. *Type*: INDIA, Bengal, *s.d.*, *Roxburgh s.n.* (BM [BM000997634 digital image!])

*Utricularia elegans* Wall., Numer. List no. 1502. *nom. invalid. Type*: Nepal, 1828, *Wallich* 1502 (holo, K [K001113260 digital image!])

*Utricularia khasiana* J.Joseph & Mani, Bull. Bot. Surv. India 25(1-4): 192. 1983; J.Joseph & Joseph, Insectiv. Pl. Khasi & Jaintia Hills. 16. 1986. *Type*: INDIA, **Meghalaya**, Khasi Hills, *s.d.*, *J. Joseph* 76944 (holo, CAL not seen)

Perennial, suspended or affixed, aquatic herbs. Rhizoids or air shoots very few on peduncle base, up to 20 mm long, tapering, with claw-like appendages, hyaline. Stolons up to 300 mm long, numerously branched, filiform, terete, tapering and coiled at apex, mat-forming, green. Leaves 0.5–15 mm long, on stolon nodes; primary segments 2 or 3, terete, simple or sparsely dichotomously branched into 2–4 ultimate segments; ultimate segments capillary, slightly flattened, margin entire or sparsely denticulate, setulose at apex; young leaves coiled in stolon nodes and tips. Traps ovoid, 1.25–2.5 × 0.8–1.75 mm, a few, each on lateral leaf segments; stalk 0.2–0.8 mm long, terete; mouth lateral; appendages 2, 1.5–2 mm long, dorsal, branched, setiform; simple setae around mouth. Racemes erect, 2–16 cm long, single flowered or sometimes 2–6-flowered; peduncles terete, 0.3–0.6 mm thick, glabrous, green. Scales absent, if present 1 at the middle of peduncle, sub-orbicular, basifixed. Bracts sub-orbicular to transversely oblong, 0.45–0.7 × 0.5–1.4 mm, basifixed, minutely glandular, more or less amplexicaul, truncate to obscurely 3-dentate at apex;

bracteoles absent. Flowers 3.5–7 mm long; pedicels 6–10 (–15) mm long, 0.2–0.4 mm thick, terete, accrescent, erect to spreading in fruiting. Calyx lobes sub-equal, green; upper lobe oblong, 1.45–2 × 1.05–1.4 mm, rounded at apex; lower lobe oblong, 1.4–1.6 × 1–1.3 mm, rounded at apex. Corolla bright yellow, thin; upper lip sub-orbicular, 3–4.5 × 2.5–4 mm, crested at middle, pale yellow at base, yellow then, margin sometimes inflexed, rounded at apex; lower lip sub-orbicular, 3–4 × 3–3.5 mm, palate densely hairy, gibbous, raised with a prominent 2-lobed swelling, yellow with reddish brown streaks, margin wavy or sometimes inflexed, rounded at apex; spur narrowly conical to cylindrical, 2–3.5 × 0.8–1 mm, shorter or longer than lower lip of corolla, sparsely glandular out, yellow, obtuse-rounded at apex. Stamens 0.8–1.5 mm long; filaments 0.75–1.35 × 0.2–0.25 mm, hyaline to pale yellow, twisted at base, narrow at base, broader towards apex; anther theca lateral, 0.2–0.3 mm long, indistinct, yellow. Pistil 1–1.5 mm long; ovary globose, 0.6–0.85 × 0.55–0.72 mm, glabrous, green; style distinct, 0.3–0.4 mm long, pale green-purplish green; stigma bi-lipped; upper lip sub-orbicular, much shorter or obsolete; lower lip deltate, margin dentate. Capsules globose, 1.8–2.5 mm in diameter, 2-valvate, wall uniformly membranous; placenta globose, 0.6–0.7 mm across. Seeds a few, lenticular, 0.8–1 mm across, margin scaly, broadly winged; hilum at centre of dorsal part.

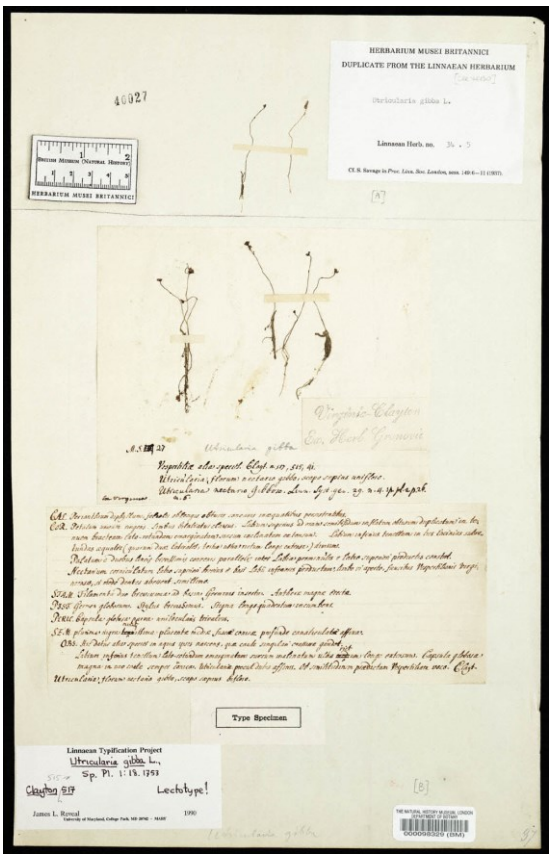


**Fig. 145.** Lectotype of *Utricularia gibba* L. [*Clayton s.n.* (BM000098329)] "© *The Trustees of the Natural History Museum, London*".

***Flowering & fruiting***: Flowering usually starts in early April, and continues till December, while fruiting occurs from late April to December, and in some cases may persist throughout the year.

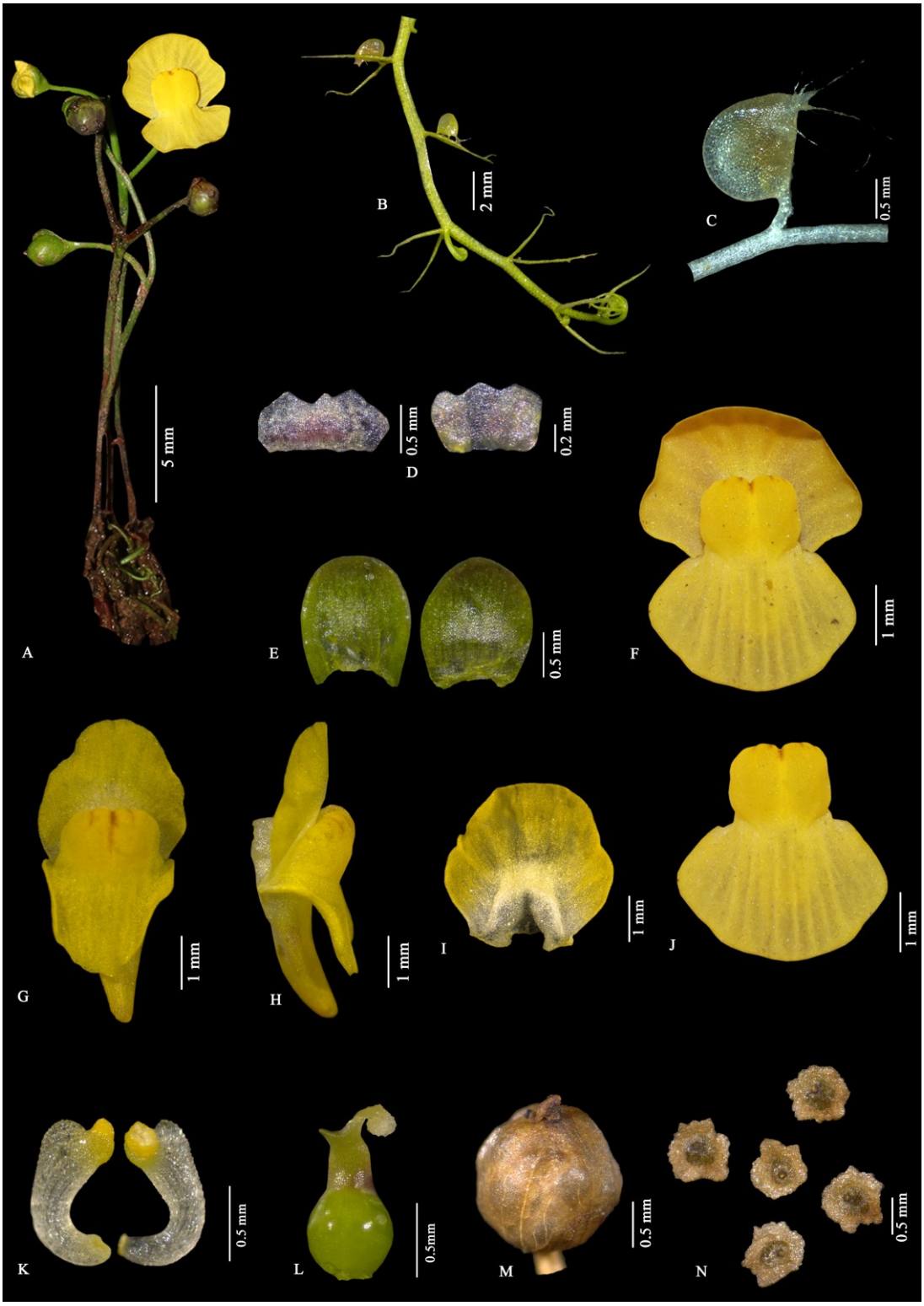


**Fig. 146.** *Utricularia gibba* L.: **A.** Habit; **B.** Leafy shoot; **C.** Trap; **D.** Bracts; **E.** Calyx lobes; **F-H**. Corolla - different view; **I.** Upper lip of corolla; **J.** Lower lip of corolla; **K.** Stamens; **L.** Pistil; **M.** Capsule; **N.** Seeds.

**Fig. 147.** Habitat and habit of *Utricularia gibba* L.

***Habitat***: Found in still or slow running waters, often along with *U. aurea*, *Cabomba furcata* (Cabombaceae), *Centella* sp. (Apiaceae), *Isachne* sp., *Oryza sativa* (both Poaceae), *Hydrilla verticillata* (L.f.) Royle (Hydrocharitaceae), *Ludwigia* sp. (Onagraceae), *Nelumbo* sp. (Nelumbonaceae), *Nymphaea* spp. (Nymphaeaceae), *Nymphoides* sp. (Menyanthaceae), *Pontederia crassipes* (Ponteridaceae), *Azolla* sp. (Salviniaceae), *Marsilea minuta* (Marsileaceae), *Salvinia* sp. (Salviniaceae) and some grasses (Fig. 147).

***Distribution:*** India, Algeria, Angola, Argentina, Bangladesh, Bolivia, Borneo, Botswana, Brazil, British Columbia, Burkina, Cameroon, Central African Republic, China, Colombia, Congo, Costa Rica, Cuba, Ecuador, Egypt, El Salvador, Ethiopia, Florida, French Guiana, Georgia, Ghana, Greece, Guatemala, Guinea, Guyana, Hainan, Haiti, Honduras, Ivory Coast, Jamaica, Japan, Jawa, Laos, Libya, Madagascar, Malaya, Mali, Maryland, Mauritius, Mexico, Morocco, Mozambique, Myanmar, Namibia, Nepal, New Guinea, Nicaragua, Nigeria, Panama, Paraguay, Peru, Philippines, Portugal, Rwanda, Senegal, Sierra Leone, Spain, Sri Lanka, Sudan, Sulawesi, Sumatra, Suriname, Taiwan, Tanzania, Thailand, Trinidad-Tobago, Tunisia, Uganda, United States, Uruguay, Venezuela, Vietnam, Zambia, and Zimbabwe (Taylor, 1989; POWO, 2025) (Fig. 142).

***Specimens examined:*** AUSTRALIA, Darwin area, 14.05.1973, *Dunolp C.R.* 3174 (L.2828661 digital image). BRAZIL, **Bahia**, Mun, de Alcobaca, 23 km, ao S. de Prado, ± 3 km, a W. De Alcobaca, 08.12.1981, *G.P. Lewis & A.M. Carvalho* 801 (US03216266 digital image); Rapids and falls of the Rio feeding into the Lagoa Encantada, Caldeiras, 17.01.1993, *W.W. Thomas, A. de Carvalho, A. Amorim & A. Chautems* 9529 (NY00400619 digital image). FLORIDA, Palm Beach Co., Pond Cypress natural area, 01.02.2022, *Sally Channon* 264 (USF304198 digital image). INDIA, **Andhra Pradesh**, Anantapur district, way to Alur Kona, 350 m, 28.10.1982, *T. Pullaiah* 926 (MH00126409); Kurnool district, Nallamalais, Pathala Ganga, 300 m, 25.03.1965, *J.E. Ellis* 23759 (MH00126407, MH00126408); Srisailam, 460 m, 13.07.963, *J.E. Ellis* 16849 (MH00126403, MH00126404); in a pond, West of Srisailam, Nallamalais, 470 m, *s.d.*, *J.E. Ellis* 23788 (MH00126405, MH00126406); Visakhapatnam district, Araku Valley, 09.06.1952, *D. Daniel Sundararaj* 21390 (MH00126402). **Bihar**, Jahanabad Canal,

10.03.1902, *J.D. Nusker* 3 (CAL). **Chhattisgarh**, Kanker district, Kanker, 500 m, 06.02.1961, *N.P. Balakrishnan & A.N. Henry* 11872 (MH00126393, MH00126394). **Karnataka**, Dakshina Kannada district, Karkala, 16.03.1915, *s.coll.* 11950 (MH00126368, MH00126369, MH00126370, MH00126371, MH00126372); Mysuru district, Gudihattikere, Ketedevargudi, 23.04.1962, *R.S. Rao* 80284 (BSI). **Kerala**, Ernakulam district, Kalamasseri, Pumphouse, 13 m, 08.03.2003, *P.P. Biju* 92036 (CALI190519); Kasaragod district, Kasaragod, 23.08.1985, *M.K. Janarthanam* 82930 (MH00126397, MH00126398); Kottayam district, Kannanchira, Kottarathilkadavu road, 18.01.2023, *M.P. Krishnapriya & Santhosh Nampy* 186048 (CALI197429, CALI197430); Kozhikode district, Azhinjilam, 12.02.2019, *M.P. Krishnapriya & Santhosh Nampy* 177209 (CALI198484); Kayakkodi, Kolatta, 08.04.2017, *Aswathi* 152225 (CALI141504); Kovoor- fallow land, ± 17 m, 01.10.2018, *M.P. Krishnapriya* 168031 (CALI185494, CALI185495, CALI185496); Veliyannur Chally, near Chittari Nada, 5 m, 07.03.2020, *M.D. Vyshnav* 165154 (CALI165381); Malappuram district, Chelari, 12.07.1978, *Mercy Jacob* 24149 (CALI141542); *Ibid*., Thrikannur Shiva Temple, 10.08.2020, *M.P. Krishnapriya & Santhosh Nampy* 164365 (CALI); Pulamanthole, Paloor, 12.12.2018, *M.P. Krishnapriya & Santhosh Nampy* 168049 (CALI188041); Palakkad district, Nelliyampathy, Chandramala Pond, 08.02.2020, *M.P. Krishnapriya & Santhosh Nampy* 164364 (CALI197422); Pallipuram, 06.02.2020, *M.P. Krishnapriya & Santhosh Nampy* 164361 (CALI); Pathanamthitta district, Pamba, 1025 m, 25.06.1968, *D.B. Deb* 30377 (MH00126377, MH00126378); Thiruvananthapuram district, Pulimath, ± 125 m, 28.02.1979, *M. Mohanan* 59430 (MH00126374, MH00126375, CAL). **Maharashtra**, Poona district, Lonavala, near Valwan Dam, 30.09.1964, *B. Venkata Reddi* 100946 (BSI). **Rajasthan**, Ummedganj, Kota, 12.06.1963, *R.S. Gupta s.n.* (BSD000063892). **Tamil Nadu**, Chengalpattu district, Neithavoyal, in a Pond, ± 4 m, 02.06.1986, *M.K. Janarthanam* 82983 (MH00126392, MH00126391); Coimbatore district, Anamalais, Mudis, 06.02.1986, *A.N. Henry* 82979 (MH00126389, MH00126390); Dharmapuri district, Harur, Chitteri Hills, way to Umethi from Chitteri, 13.01.1979, *N. Venugopal* 20913 (RHT044639); Dindigul district, Sirumalai, August 1913, *s.coll*. 9036 (MH00126388); Kanchipuram district, Mamallapuram, 07.02.2003, *K.M. Matthew* 74543 (RHT044575); Krishnagiri district, Denkanikottai, Thally Hills, Devarbetta, 900 m, 11.02.1980, *T.S. Jayaseelan* 26405 (RHT044641); Pond,

Forest rest house, 1000 m, 10.09.1978, *K. M. Matthew & N. Venugopal* 17269 (RHT044638); *Ibid*., 925 m, 20.07.1979, *K.M. Matthew* 23852 (RHT044640); *Ibid*., 900 m, 14.11.1979, *K.M. Matthew* 24572 (RHT044619); Namakkal district, Sammedu, Kolli Hills, Sethupila, 1150 m, 24.04.1979, *K.M. Matthew* 22954 (RHT044634, RHT044635); *Ibid*., 24.02.1980, *K.M. Matthew* 26767 (RHT044636); Pond in between Vasaloor and Sethupila, 07.02.1979, *P. Perumal* 21574 (RHT044633); Tiruchirapalli, 28.01.1960, *K.M. Matthew* 1475 (RHT044632); Thiruvallur district, between Ennore Port Gate and Kattupalli, 04.02.2003, *K.M. Matthew* 74449 (RHT044574); Tirunelveli district, Ambasamudram, 13.05.1899, *C.A. Barber* 281 (MH00126386, MH00126387); Viluppuram district, Maakkanam, Kollumedu Tank II, 25.02.2001, *K.M. Matthew* 72727 (RHT044626). **Uttarakhand**, Dehradun district, Dehra Dun, New Forest, 18.08.1970, *Ram Dayal* 6225; Mangrove Garden behind main building, 18.08.1970, *Ram Dayal* 6225 (DD). **Uttar Pradesh**, Bahraich, Anarkali Tal, 15.02.1963, *C.L. Malhotra* 23693 (BSD000063890, BSD000063891); Mirzapur, T. swamp, 08.02.1961, *U.C. Bhattacharyya* 12888 (BSD000063893). JAPAN, **Okinawa**, Ryukyu Islands, Yaeyama Gunto, Iriomote Island, along the Urauchi River, 22.08.1951, *E.H. Walker & S. Tawada* 6697 (US03216793 digital image). UNITED STATES OF AMERICA, **Maryland,** Atlantic Coastal Plain, Idylwild Wildlife Management area, eastern shore, Marshyhope ponds natural area south of Noble Road, 15.07.2020, *Christopher T. Frye & John Hall* 8142 (TAWES0006093 digital image). **Tennessee**, Sparta, Bridgestone Reserve at Chestnut Mountain, middle of swamp 15 meters off of Wilson Ridge Road, 521 m, 14.06.2019, *Mark Rine & Jared G. Allen* 10 (HTTU035833 digital image). **Texas**, Pond margin in centre of Hidden Springs County Park, Ranchland along CR224 NW of Florence, 13.08.2021, *Arthur C. Gibson & Gary Boyd* 7843 (TEX00572249 digital image).

***Conservation status***: This is a widespread species, and assessed as Least Concern (LC).

***Notes***: *Utricularia gibba* is characterised by its claw-like air shoots, small flowers, large upper lip of the corolla, and lenticular seeds. The stolons and leaves floating above the water surface, give a mat forming appearance. It usually produces flowers when

affixed at low water levels. While it generally develops small flowers, large flowered forms have also been observed in the field (Fig. 147).

**4. Utricularia minor** L., Sp. Pl. 1: 18. 1753; Sm. in Rees (ed.), Cycl. 37: 599. 1819; A.DC. in DC. (ed.), Prodr. 3: 7. 1844; Oliv., J. Proc. Linn. Soc., Bot. 3: 176. 1858; C.B.Clarke in Hook.f. (ed.), Fl. Brit. India 4: 330. 1885; P.Taylor, Fl. Males. 1(8): 2299. t. 26. 1977; H.J.Chowdhery & Wadhwa in Wadhwa & H.J.Chowdhery (eds.), Fl. Himachal Pradesh 2: 542. 1984; P.Taylor, Gen. *Utricularia* 564. 1989; Janarth. & A.N.Henry, Bladderworts India 71. t. 19. 1992; Noltie in Grierson & D.G.Long (eds.), Fl. Bhutan 2(3): 1339. 2001; Li in Wu *et al*. (eds.), Fl. China 19: 490. 2011; S.K.Srivast. & A.N.Shukla, Fl. Cold Desert Western Himalaya 461. 2015; Noltie in Watson *et al.* (eds.), Fl. Nepal (web edn.) 6. 2019; Li in Y.F.Deng *et al*. (eds.), Fl. Pan-Himalaya 46: 31. 2020. *Lentibularia minor* (L.) Raf., Fl. Tellur. 4: 108. 1838. *Lectotype* (designated by Casper, 1969): Habitat in Europae fossis rarius, *s.d.*, *Herb. Linn.* No. 34.3 (LINN digital image!). **Figs. 148–150**

*Utricularia rogersiana* Lace, Bull. Misc. Inform. Kew 405. 1915. *Type*: MYANMAR (Burma), Maymyo Plateau, 1050m, 12.08.1912. *J.H. Lace* 5899. (K [K000779764 digital image!])

*Utricularia nepalensis* Kitam., Acta Phytotax. Geobot. 15(5): 133. 1954. *Type*: NEPAL, **Gandaki Zone**, Manang district, Annapuma Himal, near Pisang, 3150 m, 26.05.1953, *S. Nakao s.n.* (not located)

Perennial, usually affixed aquatic herbs. Rhizoids absent; air shoots not seen. Stolons up to 30 cm long, 0.1–0.3 mm thick, filiform, terete, variously branched, dimorphic, green to greenish purple with dichotomously divided leaves, colourless with reduced leaves, mat forming; sometimes with spherical turions at apex. Leaves alternate, distichous, 0.2–10 mm long, green to purple to greenish purple; lamina linear, flattened, palmately divided from base into 3 linear segments; primary segment dichotomously branched 1–3-times (fork-like), bearing single trap (rarely 2), ultimate segments linear, flattened, 0.1–0.8 mm wide, margins untoothed or sparsely setulose, acute-acuminate at tip. Traps ovoid, 0.8–2.5 mm long, lateral on leaf

segments; stalk 0.2–0.3 mm long; mouth lateral; appendages 2, 1.5–2.2 mm long, branched. Racemes erect, 6–10 (–15) cm long, single, 2–6-flowered; peduncles terete, 0.2–0.5 mm thick, filiform, glabrous, purple. Scales ovate, a few, basifixed, acute or obtuse at apex. Bracts ovate, *c.* 1 mm long, greenish purple, acute or obtuse at apex; bracteoles absent. Flowers 5–8 mm long; pedicels 4–6 mm long, terete, erect at anthesis, reflexed in fruit. Calyx lobes sub-equal, greenish purple; upper lobe ovate-oblong 2–3 mm long, acute or rounded at apex; lower lobe oblong, *c.* 1.8 mm long, rounded at apex. Corolla pale yellow; upper lip widely oblong to sub-orbicular; lower lip broadly obovate, longer than wide, 4–8 mm long, hairy at throat, palate raised with a marginal rim, with or without reddish brown striations, wavy at margins, rounded at apex; spur conical, short, pale yellow with red striation abaxially, rounded at apex. Capsules globose, circumscissile, *c.* 2.3 mm long. Seeds lenticular-prismatic, obscurely winged on all angles, testa isodiametric.

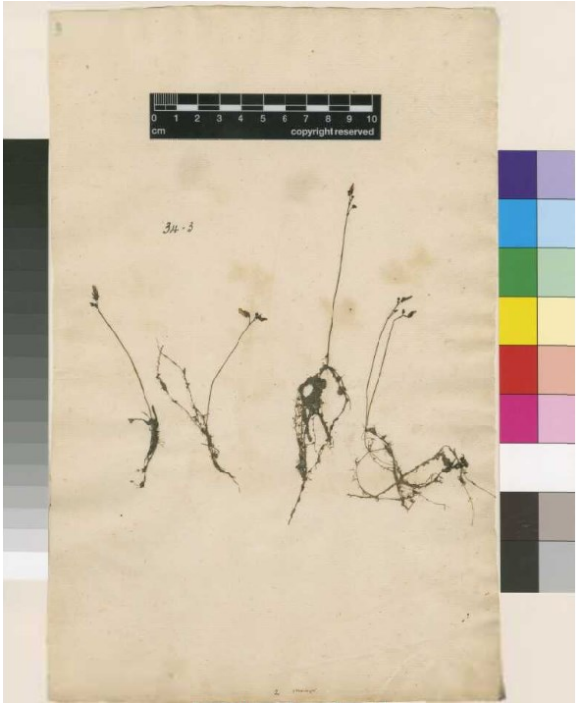


**Fig. 148.** Lectotype of *Utricularia minor* L. [*Herb. Linn. No.* 34.3 (LINN)] "© *Reproduced with permission of The Linnean Society of London*".

***Flowering***: April to September.

***Habitat***: Commonly found in shallow water in boggy meadows, marshes, creeks, and fens, as well as in standing or slow running small streams and ditches, in Alpine foothills at elevations between 3100–4300 m, often in association with *Eriocaulon* sp. (Eriocaulaceae), *Callitriche* sp. (Plantaginaceae) and some small grasses (Fig. 150).

**Fig. 149**. *Utricularia minor* L.: Stolons bearing leaves, traps and turions.

**Fig. 150.** *Utricularia minor* L.: Habitat and habit (Photos **C, E & F.** from R.V. Lansdown)

***Distribution***: India, Afghanistan, Alaska, Albania, Austria, Belgium, British Columbia, Canada, Central European Russia, China, Czechoslovakia, Denmark, Finland, France, Germany, Great Britain, Greece, Greenland, Hungary, Iceland, Iran, Ireland, Irkutsk, Italy, Japan, Kyrgizstan, Korea, Massachusetts, Morocco, Myanmar, Nepal, Netherlands, New Guinea, Norway, Nunavut, Pennsylvania, Poland, Romania, Russia, Siberia, Spain, Sweden, Switzerland, Tadzhikistan, Tibet, Turkey, Ukraine, United States and Uzbekistan (Taylor, 1989; POWO, 205) (Fig. 151).

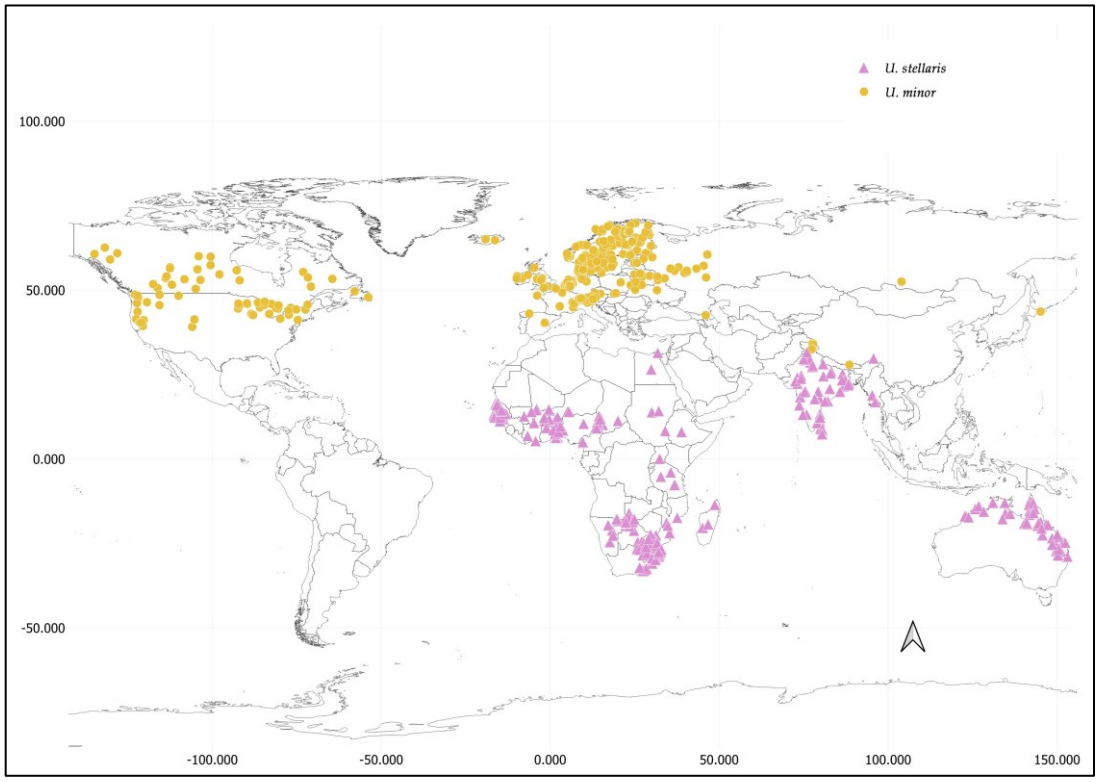


**Fig. 151.** Distribution of *Utricularia minor* L. and *U. stellaris* L.f.

***Specimens examined***: BANGLADESH, Silhet, Regio. temp., *s.loc.*, 11000 ped, *s.d.*, *T. Thomson s.n.* (MH00126418). INDIA, **Himachal Pradesh**, Lahaul & Spiti district, Spiti, Gette, 4300 m, 03.08.1972, *U.C. Bhattacharyya* 49276 (CAL). **Ladakh**, Leh district, Diksit, 3150 m, 21.08.1976, *B.M. Wadhwa* 60035 (BSD000063869); Leh-Upshi road, 3200 m, 04.08.1976, *B.M. Wadhwa* 59471 (BSD000063871); Upshi, 3500-3600 m, 05.08.1976, *B.M. Wadhwa* 59471 (BSD000063870). **Sikkim**, North Sikkim district, Thangu, near Teesta Riverbank, ± 3200 m, 02.09.2022, *M.P. Krishnapriya* 177292 (CALI198471, CALI197397, CALI197398, CALI197399); way to Thangu before Samdong bridge, ±

3230 m, 02.09.2022, *M.P. Krishnapriya* 177293 (CALI197394, CALI197395, CALI197396, CALI197397).

***Conservation status***: Though IUCN assessed *U. minor* as Least Concern (LC), this species has often been overlooked in recent years due to its rarity and peculiar habitat preferences. In India, it is confined to subarctic areas of Himachal Pradesh (Great and Middle Himalayas), Ladakh (Western end of Himalaya) and Sikkim (eastern Himalayas). Herbarium records indicate that the last known collection of this species was made in 1976 from Ladakh, and there have been no subsequent reports from other regions of the country. However, the observed population in Thangu, North Sikkim is extremely small, and its habitat faces significant threats from frequent landslides and avalanches. These threats, combined with hydrologic alterations, may explain the small population size, as it is highly sensitive to the quality of water. Hence, the species is considered as Data Deficient (DD).

***Notes***: *Utricularia minor* has a circumboreal distribution and is less commonly flowering compared to other species in this section. It reproduces vegetatively, often producing turions or winter buds at the tip of its branches, and seldom reproduces sexually by seeds. During winter, when the branches die back, the turions detach and sink to the bottom. These over-wintering turions can sprout new individuals under favourable conditions.

Although it is a globally secure species assessed as least concern, it is exceptionally rare in India, with highly restricted distribution. In many cases, it fails to flowers, which may contribute to its rarity in collections.

**5. Utricularia stellaris** L.f., Suppl. Pl. 86. 1781; Sm. in Rees (ed.), Cycl. 37: 598. 1819; Roxb. in Carey (ed.), Fl. Ind. 1: 143. 1832; A.DC. in DC., Prodr. 3: 3. 1844; Wight, Icon. Pl. Ind. Orient. 4(4): 9. t. 1567. 1850; Oliv., J. Proc. Linn. Soc., Bot. 3: 174. 1858; Dalzell & Gibson, Bombay Fl. 135. 1861; Drury, Handb. Ind. Fl. 2: 119. 1866; Benth. & F.Muell., Fl. Austral. 4: 525. 1869; C.B.Clarke in Hook.f. (ed.), Fl. Brit. Ind. 4: 328. 1884; K.I.Goebel in Treub (ed.), Ann. Jard. Bot. Buitenzorg 9: 89. 1891; Trimen, Handb. Fl. Ceylon 3: 267. 1895; Prain, Bengal Pl. 2: 780. 1903; Stapf in Dyer (ed.), Fl. Cap. 4(2): 433. 1904; T.Cooke, Fl. Bombay 2: 316. 1905; Haines, Bot. Bihar Orissa 4: 644. 1922;

Gamble, Fl. Madras 2: 980. 1924; Santapau, J. Bombay Nat. Hist. Soc. 49(2): 217. 1950; Maheshw., Fl. Delhi 255. 1963; R.K.Basak, Bull. Bot. Surv. India 17: 99. 1975; Duthie, Fl. Gangetic Plain 2: 165. 1977; Gandhi in C.J.Saldanha & Nicolson (eds.), Fl. Hassan Dist. (sec. reprint) 565. 1978; S.K.Varma, Fl. Bhagalpur 286: 1981; N.Rani & K.M.Matthew in K.M.Matthew (ed.), Fl. Tamilnadu Carnatic 3(1): 1122. 1983; Deb, Fl. Tripura 2: 304. 1983; Guha Bakshi, Fl. Murshidabad Dist. 232. 1984 *excl. syn. U. inflexa* Forssk. var. *stellaris* (L.f.) P.Taylor; R.S.Rao *et al*., Fl. W. Godavari Dist. Andhra Pradesh 305. 1986; Bole & J.M.Pathak, Fl. Saurashtra part 2: 156. 1988; B.G.Kulk., Fl. Sindhudurg 308. 1988; M.Islam, Fl. Majuli 229. 1990; B.K.Misra & B.K.Verma, Fl. Allahabad 277. 1992; Janarth. & A.N.Henry, Bladderworts India 102. t. 31. 1992; Karthik. & An.Kumar, Fl. Yavatmal Dist. 180. 1993; M.N.Sanyal, Fl. Bankura Dist. West Bengal 317. 1994; K.M.Matthew, Excurs. Fl. Central Tamilnadu (repr. ed.) 1: 359. 1995; Swati Samvatsar, Fl. W. Tribal Madhya Pradesh 217. 1996; Lakshminarayana *et al*., Fl. Krishna Dist. 221. 1997; Moulali in Pull. & Moulali (eds.), Fl. Andhra Pradesh 2: 678. 1997; R.C.Srivast. in Mudgal *et al*. (eds.), Fl. Madhya Pradesh 2: 255. 1997; Pull. *et al*., Fl. Medak Dist. 171. 1998; Naik *et al*., Fl. Marathwada 2: 639. 1998; Pull. & M.S.Mohammed, Fl. Ranga Reddi Dist. 159. 2000; L.K.Banerjee & T.A.Rao, Fl. Mahanadi Delta 224. 2001; Londhe in N.P.Singh *et al.* (eds.), Fl. Maharashtra, Dicot. 2: 567. 2001; N.P.Singh *et al*., Fl. Bihar, Analysis 368. 2001; B.Suryanarayana & A.Sreenivasa Rao, Fl. Nellore Dist. 369. 2002; K.K.Khanna *et al*., Florsit. Diver. Chhattisgarh 331. 2005; Paria & Chattopadh., Fl. Hazaribagh Dist. 2: 799. 2005; R.Ansari *et al*., Aquatic Wetland Fl. Kerala: Fl. Pl. 530. 2016; S.K.Mandal & Bhaumik in Lakshmin. *et al*. (eds.), Fl. West Bengal 4: 146. 2019; A.N.Shukla in G.P.Sinha & A.N.Shukla (eds.), Fl. Uttar Pradesh 2: 255. 2020; Li in Y.F.Deng *et al*. (eds.), Fl. Pan-Himalaya 46: 37. 2020. *Lepiactis stellaris* (L.f.) Raf. 4: 109. 1838. *Type*: India Orientalis, Coromandel, 1777, *J. Koenig s.n.* (holo, BM [BM000997633 digital image]). **Figs. 152 &153**

*Utricularia stellaris* L.f. var. *coromandeliana* A.DC. in DC. (ed.), Prodr. 3: 4. 1844. *Type*: Coromandel, *Roxburgh* cor 2. t. 180

*Utricularia inflexa* Forssk. var. *stellaris* (L.f.) P.Taylor, Mitt. Bot. Staatssamml. Munchen 4: 96. 1961; S.V.Ramaswamy & Razi, Fl. Bangalore Dist. 548. 1973; Bennet,

Fl. Howrah Dist. 334. 1979; A.K.Sharma & J.S.Dhakre, Fl. Agra Dist. 203. 1995; S.Kumar, Fl. Haryana 278. 2001

Perennial, suspended aquatic herbs. Stolons up to 30 m long, 0.5–1.5 mm thick, variously branched, glabrous. Rhizoids absent; air shoots numerous on stolons, filiform, terete, filamentous, pale green-hyaline. Leaves 10–50 mm long, divided from base into 3–6 semi-verticillate primary segments, secondary segments alternate, pinnate, each pinna dichotomously divided into numerous further segments, ultimate segments capillary, flattened, laterally dentate, setulose at apex. Traps obliquely ovoid, 1–2.5 mm long, laterally on secondary segments, stalked; stalk 0.5–0.6 mm long; mouth lateral, appendages 2, or rarely absent, dorsal, simple or sparsely branched. Racemes erect, 6–10 (–15) cm long, 2–8 (–18)-flowered, flowers congested; peduncle 0.8–1 mm thick, terete, glabrous. Spongy floats ovoid to ellipsoid with apical capillary branches, whorls of 4–12, 10–25 × 4–5 mm, present below the middle or middle of the peduncle, pale green to purplish green. Scales absent. Bracts widely ovate to sub-orbicular, basifixed; bracteoles absent. Flowers 5–8 mm long; pedicels 2–4 mm long, dorsiventrally compressed, winged, erect at anthesis, reflexed and accrescent in fruit, thick and shorter than capsule, up to 6 mm long in fruiting. Calyx lobes sub-equal, glabrous, green, accrescent, wider and covering the capsule, *c.* 6 × 6 mm in fruiting; upper lobe widely ovate, *c.* 3 × 2.8 mm,

**Fig. 152.** Type of *Utricularia stellaris* L.f. [*Koenig s.n.* (BM000997633)] "© *The Trustees of the Natural History Museum, London*".

obtuse at base, obtuse-rounded at apex; lower lobe widely ovate, *c.* 2.8 × 2.72 mm, obtuse at base, retuse-rounded at apex. Corolla yellow, densely covered externally with fine glandular-hairs; upper lip widely obovate-sub-orbicular, yellow or yellow with reddish streaks, emarginate-retuse at apex; lower lip transversely elliptic, palate bi-gibbous, pubescent, yellow with reddish striations at palate, rounded or emarginate at apex; palate; spur cylindrical, horizontal, broader at base, pubescent, yellow with reddish streaks, emarginate-retuse at apex, shorter than lower lip. Capsules globose, 3–6 mm in diameter, circumscissile. Seeds a few, prismatic, 0.8–1.2 mm wide, 4–6 angled; surface verrucate; hilum at centre of dorsal part.

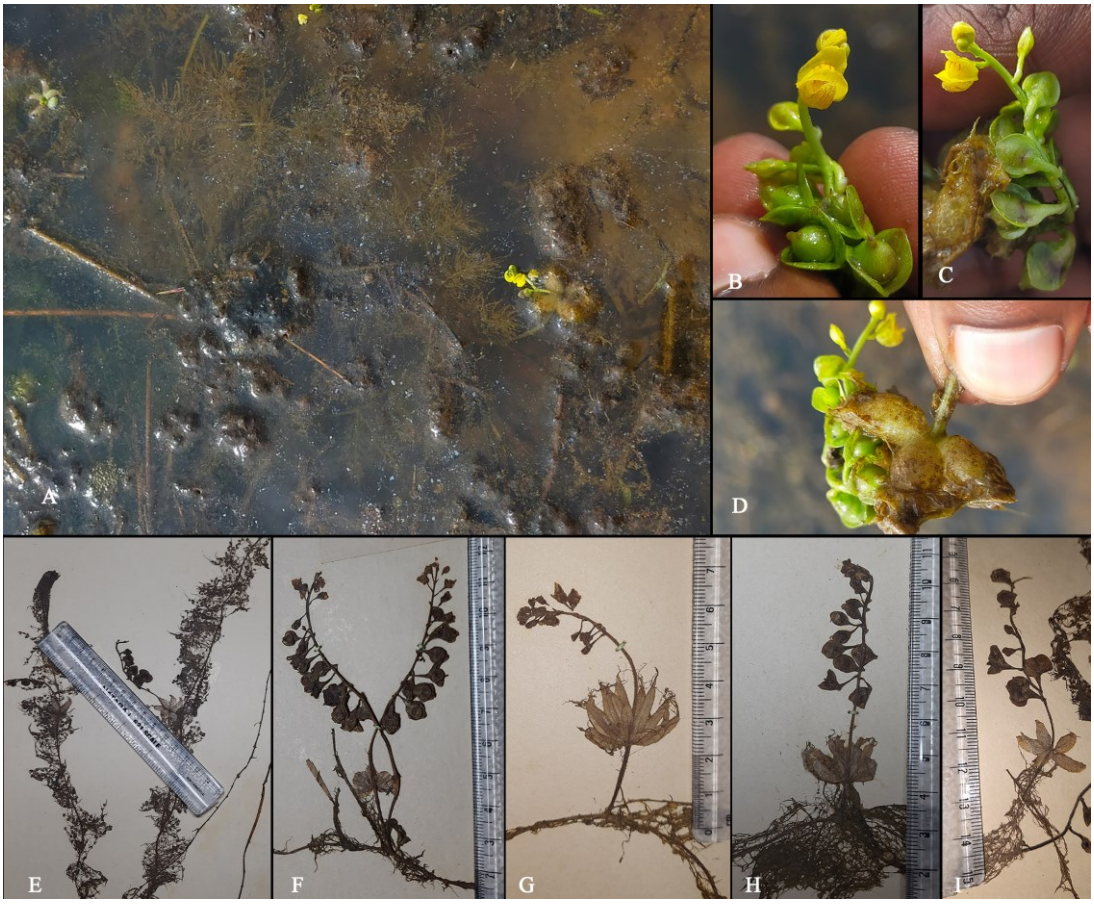


**Fig. 153.** *Utricularia stellaris* L.f.: Habitat and habit (Photo A–D. from Ajay).

***Flowering & fruiting***: *Utricularia stellaris* flowers from early August to February and fruits from late August to early March. It mostly flowers throughout the year, especially in areas with low water volumes.

***Habitat***: *Utricularia stellaris* is usually found suspended in ponds, ditches, paddy fields and fallow lands, other stagnant and slow-running water bodies, often growing in association with *Nelumbo* sp. (Nelumbonaceae), *Nymphaea* spp. (Nymphaeaceae), *Nymphoides* sp. (Menyanthaceae), *Pontederia crassipes* (Ponteridaceae), etc. (Fig. 153).

***Distribution***: India, Angola, Bangladesh, Benin, Botswana, Burkina, Burundi, Cameroon, Central African Republic, Comoros, Ethiopia, Gambia, Ghana, Guinea, Guinea-Bissau, Ivory Coast, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Myanmar, Namibia, Nepal, Niger, Nigeria, , Rwanda, Senegal, Sierra Leone, Somalia, Sri Lanka, Sudan, Tanzania, Uganda, Vietnam, Australia, Zambia, Zaïre, and Zimbabwe (Taylor, 1989; POWO, 2025) (Fig. 151).

***Specimens examined***: INDIA, *s.loc.*, 1797, *Klein s.n.* (B-W00435-010 digital image). *s.loc.*, Bengal, *s.d.*, *S. Kurz s.n.* (CAL); *s.loc.*, 21.08.1815, *Herb. Wallich* 981 (A01977156 digital image); *s.loc., s.d., herb. Hort. Bot. Calcuttensis Cult.* in *Hort. Bot. Cal., s.coll. s.n.* (P03575732 digital image, DD). Malabar, Concan, Regio. trop., *s.loc.*, *s.d., J.E. Stocks & J.S. Law s.n.* (GH01977158, L.2828263 digital images, MH00126871). **Andhra Pradesh**, East Godavari district, Samalkot, 22.12.1924, *G.V. Narayana* 16833 (MH00126935); Warangal district, Pakhala, 290 m, 28.02.1963, *A.N. Henry* 15955 (MH00126931, MH00126933); West Godavari district, Kolleru Lake, 22.01.1958, *K. Subramanyam* 5061 (MH00126932, MH00126934). **Assam**, *s.loc.*, *s.d.*, *S.N. Bal* 247 (CAL). **Bihar**, Munger district, Masumganj, 06.01.2014, *Suman Halder* 53735 (CAL). **Delhi**, South West Delhi district, Najafgarh, September 1963, *Gita* 713 (WAG.1055605 digital image); *Ibid.*, 680 feet, November 1961, *Pushpander* 264 (USF46793 digital image); Najafgarh Lake, 225 m, 12.10.1964, *Ashik Grover* 264 (OBI119750 digital image). **Gujarat**, Chharodi, *s.d.*, *I.H. Burkill* 16349 (BSIS000007300). **Haryana**, Hisar district, Calzara nain, 26.10.1967, *V.J. Nair* 37660 (CAL); Chakaranian, 26.10.1976, *V.J. Nair* 37660 (BSD000063876); Panipat district, Panipat, 16.10.1962, *N.C. Nair* 24725 (BSD000049765); Sirsa district, Chakpa Jhil, 02.12.1961, *N.C. Nair* 18975 (CAL, BSD000063879); Oto bridge, 02.12.1961, *N.C. Nair* 18973 (CAL, BSD000063877). **Karnataka**, Dakshina Kannada district, near Mulki, 10 m, 27.12.1979, *C.J. Saldanha*

KPF10588 (CAL); Hassan district, Belur, 10.11.1978, *S.R. Ramesh & K.R. Keshava Murthy* KPF4689 (CAL); before Byra, 09.10.1969, *C. Saldanha* 15322 (US03216930 digital image). **Madhya Pradesh**, Satna district, Lagargawan, opposite to Railway station, 400 m, 21.09.1959, *K.M. Sebastine* 8921 (CAL, MH00126873, MH00126874). **Maharashtra**, Aurangabad district, Dahegaon, 23.12.1962, *U.R. Nafday* 72 (CAL); Chandrapur, 14.12.1980, *V.D. Vartak s.n.* (AHMA Acc. No. 13872, 13873, 13874); Sindhudurg district, Vengurla, November 1973, *V.D. Vartak* C2389 (AHMA Acc. No. 26901); Khed taluka, Kochala-cha-talao, on Chakan Alandi road, 23.09.1964, *K.P. Janardhanan* 87185; *Ibid*., near the Market place, 09.08.1961, *K.P. Janardhanan* 72353 (BSI). **Odisha**, Balasore district, Chandipur coast, 29.11.1965, *T.A. Rao* 5633 (CAL); Puri district, Balukhand Forest, 13.10.1965, *V. Abraham* 301 (CAL). **Punjab**, Hoshiarpur district, Labbar, 07.09.1970, *O.P. Misra* 41743 (CAL). **Rajasthan**, Banswara district, Banswara, 17.04.1963, *M. Verma* 215; Loharia tank, near Sainavasa vill, 500 feet, 17.10.1976, *V. Singh* 3709 (CAL); Bharatpur district, Bharatpur Lake, 20.10.1963, *N.D. Bachkheti s.n.* (DD). **Tamil Nadu**, Cuddalore district, Chidambaram, Annamalai Nagar, 28.01.1979, *N. Venugopal* 21370 (L.2828257 digital image, RHT044771); *Ibid*., 29.01.1979, *N. Venugopal* 21423 (RHT044773); *Ibid*., 03.01.1979, *K.M. Matthew* 25417 (A01977155 digital image, RHT044774); *Ibid*., Mariappa Nagar, 03.01.1980, *K.M. Matthew* 25419 (RHT044775, RHT044776); *Ibid*, Railway track, 14.01.1977, *K.M. Matthew & D.I. Arockiyasamy* 6153 (RHT044772); *Ibid*., Railway station, 13.01.1981, *K.M. Matthew & N. Rani* 28210 (RHT044777); *Ibid*., enroute to P.S. Pettai, 23.02.2001, *K.M. Matthew* 72677 (RHT044782); Nagapattinam district, EC road, Thlachangudu, Taragmbadi, 20.12.2002, *K.M. Matthew* 74291 (RHT044786); Tharagambadi- Chidambaram road (Akkur), 25.11.1998, *K.M. Matthew & K.T. Augustine* 60190 (RHT044778); Sirkazhi to Poombuhar, 50 m, 26.01.1978, *K. Ramamurthy* 53607 (CAL, MH00126881, MH00126882); Pudukottai district, Narthamalai, ± 130 m, 15.08.1986, *C. Arulappan* 782 (MH00126877); Thanjavur district, Valampuri, 30 m, 15.09.1979, *K. Ramamurthy* 64106 (CAL, MH00126879, MH00126880); Tiruvallor district, Kattupalli, Ennore Port gate, 04.02.2003, *K.M. Matthew* 74447 (RHT044787); Poondi, 19.02.1988, *S. Ragupathy* 560 (CAL, MH00126878); Viluppuram district, Kazhuveli, 13.12.2019, *Pradeep & Balachandiran* K2PB52 (HIFP digital image); Marakkanam, Kaliveli tank, 01.02.2000, *S. Perianayagam*

71036 (RHT044780); *Ibid*., Kollaimedu, 10 m, 13.05.2001, *K.M. Matthew* 72975 (RHT044784); *Ibid*., 11.12.2001, *K.M. Matthew* 73573 (RHT044785). **Telangana**, Medak district, Hamsanpally R.F., ± 550 m, 13.03.2003, *R. Gopalan* 116446 (BSID0004903); Rustumpet, 500 m, 30.01.1998, *R. Gopalan* 96299 (BSID0004899). **Uttar Pradesh**, Azamgarh district, Daulatabad, 22.10.1962, *N.P. Singh* 25388 (BSD000063882, BSD000063883); Lakhimpur Kheri district, Mailani, 17.12.1960, *C.L. Malhotra* 13356 (BSD000063884); Mathura district, Parkham, October 1950, *R.C. Bharadwaja s.n.* (DD); Mirzapur, Robertsganj road, 21.10.1964, *G. Panigrahi* 3678 (CAL); Saharanpur district, Manglore, October 1884, *M.S. Murthy* 1022 (BSD000063885); Varanasi, B.H.U. Engineering college pond, 11.11.1962, *G.S.B. Prasanna Simha Rao s.n.* (CS185887 digital image). **West Bengal**, Bankura district, Simlapal, 80 m, 07.09.1982, *M.N. Sanyal* 1418 (CAL); Chowhati, *s.d.*, *R.L. Mitra* A (CAL); Sonarpur, 07.09.1963, *B.V. Shetty* 73 (CAL); Kolkata district, Kolkata, *s.d., H.E. Drake s.n.* (P03575732 digital image); North 24 Parganas district, Dum Dum, near Kolkata, 20.10.1906, *Kalka Pershad* 26576 (BSIS000007305); Purulia district, Mahatmara, 271 m, 08.04.2022, *Kasthuri Chakrabarty & Avishek Bhattacharyya* 177247 (CALI186643, CALI197421); South 24 Parganas district, Kachuberia, Sagar Islands, 07.09.1968, *A.K. Mukherjee* 7067 (CAL). SRI LANKA, **Northern Province**, Vavuniya district, Veapumkulam, just past Omantai on Jaffna- Kandy Road, east side of road, 90 m, 13.01.1977, *R.B. & A.J. Faden* 77/162 (US03216934 digital image); Puttalam-Kurunegala road, mile 65, Damapale-Wewa tank, 14.07.1970, *W. Meijer* 363 (US03216932 digital image).

***Conservations status***: This species has a wide distribution across Africa, Madagascar, Mauritius and Comoro Islands, India to Vietnam and Northern Australia. The species is well represented in most Indian states. Considering its broad distribution, *U. stellaris* is assessed as Least Concern (LC).

***Notes***: *Utricularia stellaris* is characterised by its ovoid to ellipsoid spongy floats, usually 4–12, which are located above or below the middle of the peduncle. The plant also small yellow flowers. A distinctive feature of the species is its fruiting calyx, which is widened and more or less encloses the capsule.

# COMPARATIVE MORPHOLOGY

A detailed account on the morphology of 37 *Utricularia* species found in India is presented here, based on extensive field study and the examination of large number of specimens housed in Indian herbaria, including virtual collections in overseas herbaria. The majority of the species are annuals, with a few being perennials. These plants have subterranean vegetative organs, usually concealed within the wet substrate, and possess an erect inflorescence.

## 6.1. Vegetative morphology

### Habit and lifeform

*Utricularia* are small terrestrial, epiphytic, lithophytic or aquatic herbs. Species within the sections *Meionula*, *Nigrescentes* and *Oligocista* are terrestrial, semi-aquatic, or lithophytic. In sect. *Meionula*, all species are erect, with simple to branched peduncles. In sect. *Nigrescentes*, *U. caerulea* has highly branched peduncles, while *U. roseopurpurea* has always a simple peduncle. Within sect. *Oligocista*, species like *U. foveolata*, *U. reticulata*, and *U. scandens*, are strictly twining herbs. However, *U. graminifolia*, *U. lazulina* and *U. smithiana* exhibit a twining habit according to their specific habitat. Other species, such as *U. albocaerulea*, *U. bifida*, *U. cecilii*, *U. lazulina*, *U. malabarica*, *U. ponmudica*, *U. purpurascens*, *U. praeterita*, *U. recta*, *U. sainthomia*, *U. uliginosa* and *U. wightiana* are erect simple herbs, while *U. nayarii* and *U. polygaloides* are simple to much branched erect herbs.

Species in sect. *Phyllaria* are either epiphytic or lithophytic, with *U. kumaonensis* and *U. striatula* capable of growing in both epiphytic and lithophytic habitats, while the others are strictly lithophytic. The species in sect. *Utricularia* are purely aquatic, with *U. aurea*, *U. australis*, *U. gibba* and *U. stellaris* being free floating, while *U. minor* is the only affixed species. *Utricularia gibba* grows profusely submerged in water during its vegetative condition and usually blooms when affixed to a substrate, or epiphytically on the roots and stolons of plants like *Salvinia* sp., *Pontederia crassipes*, etc. (Figs. 154 & 155).

**Fig. 154.** Habit of *Utricularia* L.: **A.** *U. geoffrayi*; **B.** *U. hirta*; **C.** *U. caerulea*; **D.** *U. roseopurpurea*; **E.** *U. albocaerulea*; **F.** *U. bifida*; **G.** *U. cecilii*; **H.** *U. graminifolia*; **I.** *U. lazulina*; **J.** *U. malabarica*; **K.** *U. nayarii*; **L.** *U. polygaloides*; **M.** *U. ponmudica*; **N.** *U. praeterita*; **O.** *U. purpurascens*; **P.** *U. recta*.

**Fig. 155.** Habit of *Utricularia* L.: **A.** *U. reticulata*; **B.** *U. sainthomia;* **C.** *U. scandens*; **D.** *U. uliginosa*; **E.** *U. wightiana*; **F.** *U. brachiata*; **G.** *U. furcellata*; **H.** *U. kumaonensis*; **I.** *U. striatula*; **J.** *U. gibba*

Among the Indian species, *U. reticulata* is the largest and tallest, reaching up to 100 cm in length and producing striking, large flowers (12–20 mm long), and *U. minutissima* is the smallest species, reaching just up to 6 cm in length, with beautiful small flowers (± 2 mm long).

**Rhizoids**

Rhizoids are capillary, simple to branched, papillose and usually tapering. They are present in the sections *Meionula*, *Nigrescentes*, and *Oligocista*, but are either indistinct or absent in sections *Phyllaria* and *Utricularia*. Rhizoids develop from the peduncle nodes in sect. *Meionula*, while in sect. *Oligocista*, they usually develop from the base of the peduncle, with a few developing from stolon nodes (Fig. 9). In sect. *Utricularia*, air shoots are present instead of rhizoids, which are filiform and thread-like in *U. aurea* and *U. stellaris*, and claw-like in *U. gibba*.

**Stolons**

Stolons are usually well developed and subterranean in the sections *Meionula*, *Nigrescentes*, *Oligocista* and *Phyllaria*, while submerged or affixed in the sect. *Utricularia*. Stolons play a key role in vegetative growth and anchorage, and usually bear numerous leaves, traps, and chasmogamous inflorescences, rarely cleistogamous inflorescences in *U. janarthanamii*. Stolons vary in length, ranging from few millimetres to several centimetres, and in some cases, even up to few metres (Fig. 9). The stolons are usually terete, simple to much branched. In aquatic species of sect. *Utricularia*, stolons, along with the leaves, contribute to a mat-forming appearance (Fig. 140A). In *U. gibba*, the young leaves and stolon tips grow coiled inwards like circinate vernation (Fig. 146B).

**Tubers**

Tubers are found in two species, *U. brachiata* and *U. christopheri* (sect. *Phyllaria*). In sect. *Orichidioides*, tubers consist of well-developed parenchyma cells and function as water storage organs (Rodrigues *et al*., 2017), while they store starch in *U. brachiata*. Tubers are usually found in plants growing in areas facing extreme

conditions, such as drought, desiccation, snow fall, and icing. These tubers are subterranean, usually grow embedded in mossy beds or wet soil and tolerant to the extreme climatic fluctuations such as rising temperatures, drought, fire, icing, etc.

Previous studies have mentioned the occurrence of only a basal tuber in *U. brachiata* (Compton, 1909; Taylor, 1989; Janarthanam & Henry, 1992). However, in the present study, I noticed that the plant bears a single tuber at the peduncle base (mother tuber) and a single tuber at each stolon tips (stolon tubers). Histochemical analysis revealed that, the mother tuber is devoid of starch grains and meant for water storage (Fig. 121). The stolon tuber possesses numerous starch grains and store carbohydrate meant for vegetative reproduction, giving new individual during favourable conditions in the next growing season. Hence, the development of stolon tubers is found to be an ecological adaptation as well as a strategy for vegetative reproduction.

**Leaves**

Leaves are simple to much dissected in *Utricularia* (Fig. 156). They are simple in the sections *Meionula*, *Nigrescentes*, *Oligocista* and *Phyllaria*, while dissected in sect. *Utricularia*. *Utricularia geoffrayi*, *U. hirta* and *U. minutissima* of sect. *Meionula* possess linear, 1-nerved leaves which may be simple, or laterally or terminally divided. *Utricularia caerulea* and *U. roseopurpurea* of sect. *Nigrescentes* possess obovate to spathulate, 1-nerved leaves which are present in rosulate on peduncle base, and 2 or 3 on each stolon nodes.

Species in the sect. *Oligocista* possess diversity in the shape of lamina. It is linear and 1-nerved in *U. bifida*, *U. polygaloides*, *U. recta*, *U. reticulata* and *U. scandens*, linear to strap-shaped in *U. graminifolia*, and *U. nayarii*. The former has the longest leaves among the Indian species, reaching up to 5 cm. The lamina is obovate to spathulate and 3-nerved in *U. albocaerulea*, *U. cecilii*, *U. janarthanamii*, *U. lazulina*, *U. malabarica*, *U. ponmudica*, *U. purpurascens*, *U. praeterita* and *U. sainthomia*, while it is linear-lanceolate to obovate or spathulate in *U. cecilii*.

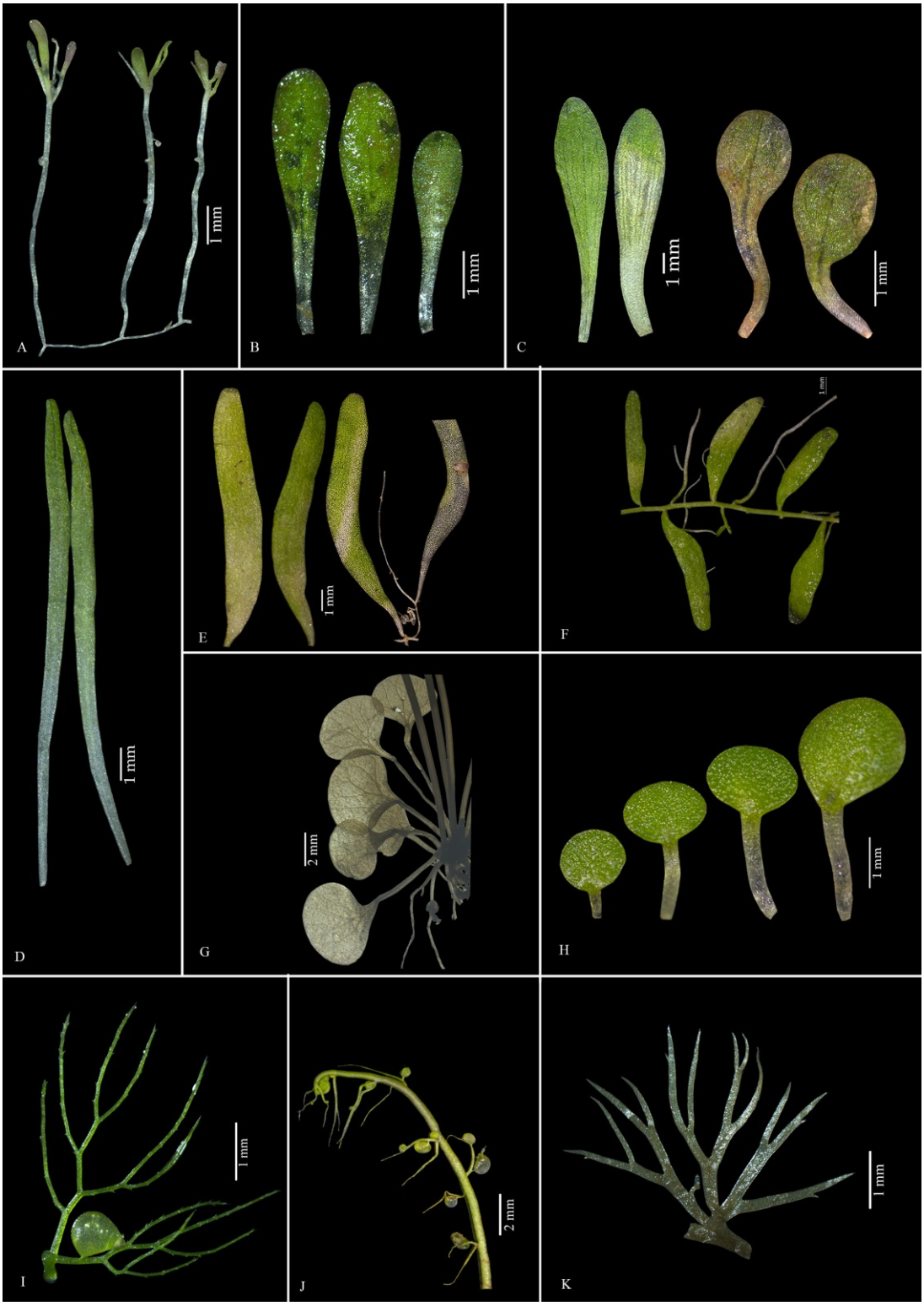


**Fig. 156.** Diversity of leaves in *Utricularia* L.: **A.** *U. hirta*; **B.** *U. roseopurpurea*; **C.** *U. cecilii* & *U. malabarica*; **D.** *U. reticulata*; **E. & F.** *U. graminifolia*; **G.** *U. kumaonensis*; **H.** *U. striatula*; **I.** *U. aurea*; **J.** *U. gibba*; **K.** *U. minor*

Section *Phyllaria* possesses obovate to sub-orbicular or reniform leaves with reticulate venation. The leaves are rosulate on peduncle base in *U. brachiata*, *U. furcellata, U. kumaonensis*, and *U. striatula*, in which the latter have numerous leaves on the stolons. The sect. *Utricularia* is characterised by dissected leaves, in which the primary segment is again palmately or dichotomously divided further. The leaves are palmately divided and flattened in *U. minor*, while they are filiform, terete and 2 or 3-divided in *U. gibba*. The leaves are 3–4-times dichotomously divided in *U. aurea* and *U. stellaris*, with marginally setulose ultimate segments.

**Traps**

Traps usually occur on stolons and leaves, and a few on the rhizoids. The species in sect. *Meionula* possess gland-tipped lateral traps on rhizoids, stolons and leaf petioles (Fig. 23D). Section *Nigrescentes* possesses terminal traps on stolons and leaf petioles, in which *U. caerulea* has a simple, beak-like appendage with glandular hairs, whereas *U. roseopurpurea* has a simple, coiled appendage with glandular hairs (Figs. 157A & B, 34O & P, 38L). The sect. *Phyllaria* possesses traps only on stolons, with lateral mouth and a single, dorsal, dorsiventrally flattened, flabellate appendage (Fig. 158G-J).

In sect. *Oligocista*, traps are found on rhizoids, stolons and leaves. They are mostly basal (rarely lateral as in *U. sainthomia* Fig. 158A) with a pair of simple, dorsal, glabrous or glandular, incurved, subulate appendages, and a stalk (Figs. 157C-L & 158B-F). Sometimes a single ventral appendage is present in *U. bifida* and *U. scandens*, which may be simple, bifid or reduced to a chin-like swelling either adjacent to the mouth or at the distal end of the stalk (Taylor, 1989; pers. obsv., Figs. 157D & 158B). The stalk of the trap is uniform in most of the species, but distally thickened in *U. janarthanamii*, *U. ponmudica, U. praeterita, U. recta, U. sisparensis*, *U. smithiana* and *U. wightiana*. Dimorphic traps are found in *U. albocaerulea*, *U. cecilii*, *U. lazulina*, *U. malabarica*, *U. polygaloides* and *U. nayarii*, in which the traps have both uniform and distally thickened stalk.

**Fig. 157.** Traps in *Utricularia* L.: **A.** *U. caerulea*; **B.** *U. roseopurpurea*; **C.** *U. albocaerulea*; **D.** *U. bifida*; **E.** *U. cecilii*; **F.** *U. graminifolia*; **G.** *U. janarthanamii*; **H.** *U. nayarii*; **I.** *U. polygaloides*; **J.** *U. ponmudica*; **K.** *U. recta*; **L.** *U. reticulata*

**Fig. 158.** Traps in *Utricularia* L.: **A.** *U. sainthomia*; **B.** *U. scandens*; **C.** *U. sisparensis*; **D.** *U. smithiana*; **E.** *U. uliginosa*; **F.** *U. wightiana*; **G.** *U. brachiata*; **H.** *U. furcellata*; **I.** *U. kumaonensis*; **J.** *U. striatula*; **K.** *U. aurea*; **L.** *U. gibba*

In most of the aquatic species, the traps arise laterally on the leaves, leaf segments, between adjacent segments or on free ends of stolon branches (Taylor, 1989). Section *Utricularia* possess obliquely ovoid traps found laterally on leaf segments with a terminal mouth and a simple to branched antennae-like appendages. The appendages are small, setiform and unbranched in *U. aurea*, whereas long and branched in *U. gibba* and *U. minor* (Fig. 158K & L).

**6.2. Reproductive morphology**

**Inflorescence**

The inflorescence is always a raceme with 1 to many-flowers (Figs. 154 & 155). They may vary in size and nature, and the flowers are either lax or condensed near the tip. The shape of peduncle may be terete, angular, or grooved. Peduncle is terete in the sections *Meionula*, *Nigrescentes*, *Phyllaria* and *Utricularia*, while terete or angular and grooved in sect. *Oligocista*. *Utricularia hirta* (sect. *Meionula*) is unique for its entirely hairy raceme, with these hairs covering the entire plant body, except for the upper and lower lips of the corolla. In contrast, *U. geoffrayi*, also from the same section, features only sparse, small hairs, mainly at the peduncle base.

Within the sect. *Nigrescentes*, *U. caerulea* has simple, small (less than 10 cm long) racemes, as well as large (up to 45 cm long), branched racemes, in which the flowers are generally lax in the former and are congested near the tip in the latter. The peduncle is always simple in sections *Utricularia* and *Phyllaria*, while it is simple or branched in other sections.

In sect. *Oligocista*, species such as *U. bifida*, *U. foveolata*, *U. graminifolia*, *U. polygaloides* and *U. reticulata* have terete peduncles, while, the remaining species have angular peduncles, which can be grooved to slightly winged on one side. The racemes are erect in most cases, whereas it is strictly twining in *U. foveolata*, *U. reticulata*, and *U. scandens*. The peduncle is rather stiff and fleshy in *U. graminifolia*, *U. ponmudica*, *U. polygaloides*, *U. nayarii*, *U. recta*, and *U. wightiana*, while less stiff or filiform in *U. sisparensis*, *U. smithiana* and *U. uliginosa*. *Utricularia graminifolia* is a variable species, and has erect, stunted, as well as twining forms. In stunted

condition, the peduncle is erect and rather stiff, reaches less than 10 cm long with congested flowers, whereas, the twining form reaches up to 45 cm with wiry peduncles and more lax flowers. In *U. nayarii* and *U. polygaloides,* the racemes are typically much branched, while other species rarely produce branches unless the peduncle is damaged.

**Scales**

Scales are found in most species across all sections, with only a few exceptions (Fig. 18). The sect. *Meionula* have ovate to deltate, basifixed scales which are usually fertile, covering young buds. Scales are medifixed in sect. *Nigrescentes*, which are elliptic to rhombic and narrowly acute at both ends in *U. caerulea*, whereas they are oblong in *U. roseopurpurea* with acute or bidentate apex. They are few to numerous and present in all species in sect. *Oligocista*, which are ovate or deltate, 1–3-nerved, basifixed, fertile covering young buds, or sterile with or without an abortive bud. Scales are 3-nerved in *U. graminifolia*, *U. polygaloides*, *U. purpurascens*, *U. sisparensis*, *U. uliginosa* and *U. wightiana*, whereas it is 1-nerved in rest of the species. *Utricularia wightiana* is the only species characterized by numerous, conspicuous scales found throughout the peduncle, extending up to the tip. In sect. *Phyllaria*, the scales are basisolute and are seen only in *U. brachiata* and *U. striatula*. They are basifixed in sect. *Utricularia* and are found in *U. australis, U. minor* and rarely in *U. gibba*, while the scales are absent in *U. aurea* and *U. stellaris*.

**Bract and bracteoles**

Bracts, along with a pair of bracteoles, are present at the base of the petiole in members of all five sections. Bracts and bracteoles are ovate to rhombic, and basisolute in *U. caerulea* and *U. roseopurpurea*, whereas they are basisolute and ovate to oblong in all the species in sect. *Phyllaria* (Fig. 18B & D).

Bracts are triangular-ovate, 1–3(–5)-nerved and basifixed in sect. *Oligocista* (Fig. 18C). Bracteoles are found in both side of the bract except in *U. janarthanamii*, where the bracteoles are completely absent. In sections *Meionula* and *Utricularia*, the bracts are basifixed, but the Indian members of the latter section lack bracteoles.

**Flowers**

The flowers are showy and exhibit a considerable diversity in both colour and morphology (Fig. 159). The colour ranges from shades of blue-violet or white or yellow. Majority of the species in sect. *Oligocista* have blue to violet flowers, and a few species like *U. bifida*, *U. recta* and *U. scandens* have yellow flowers. Species in the sections *Meionula*, *Nigrescentes*, and *Phyllaria* have small flowers in shades of pink or mauve, or purple, while the Indian species in sect. *Utricularia* have yellow flowers.

**Pedicels**

The pedicels are sub-sessile, small or up to 15 cm long, terete or flattened or winged. The sections *Meionula* and *Nigrescentes* have flowers on small, terete pedicels, sometimes smaller than the bracts and bracteoles. Within the sect. *Meionula*, the pedicels are shorter than the bracts and bracteoles in *U. geoffrayi*, whereas it is larger than the bracts and bracteoles in *U. minutissima*. In *U. hirta*, the pedicels, and bracts and bracteoles are equal in length, but can be characterised by the hairiness of the pedicels and the outer surface of the bracts and bracteoles. The fruiting pedicels are erect in sect. *Meionula*, while slightly reflexed in sect. *Nigrescentes*. In sect. *Phyllaria*, the pedicels are terete and erect in flowering, but more or less reflexed in fruiting.

In sect. *Oligocista*, the pedicels are usually winged, flattened or dorsiventrally compressed and accrescent. It is erect or slightly ascending at anthesis, while erect, ascending, reflexed or recurved, or cernuous in fruiting. A recurved or reflexed fruiting pedicel is found in *U. albocaerulea*, *U. bifida*, *U. janarthanamii*, *U. malabarica*, *U. purpurascens*, *U. praeterita*, *U. reticulata*, *U. sainthomia* and *U. scandens*, and a cernuous one is found in *U. foveolata*. The fruiting pedicels are ascending or horizontal in *U. cecilii*, *U. ponmudica* and *U. polygaloides*, while erect in other species. The pedicels are terete and accrescent in sect. *Utricularia*, becoming thick and fleshy in *U. aurea* and *U. stellaris*.

**Fig. 159.** Diversity of flowers in *Utricularia* L.: **A.** *U. geoffrayi*; **B.** *U. hirta*; **C.** *U. minutissima*; **D.** *U. caerulea*; **E.** *U. roseopurpurea*; **F.** *U. albocaerulea*; **G.** *U. bifida*; **H.** *U. cecilii*; **I.** *U. graminifolia*; **J.** *U. janarthanamii*; **K.** U. *lazulina*; **L.** *U. malabarica*; **M.** *U. nayarii*; **N.** *U. polygaloides*; **O.** *U. ponmudica*; **P.** *U. praeterita*; **Q.** *U. purpurascens*; **R.** *U. recta*; **S.** *U. reticulata*; **T.** *U. sainthomia*; **U.** *U. scandens*; **V.** *U. sisparensis*; **W.** *U. smithiana*; **X.** *U. uliginosa*; **Y.** *U. wightiana*; **Z.** *U. brachiata*; **A1.** *U. furcellata*; **B1.** *U. kumaonensis*; **C1.** *U. striatula*; **D1.** *U. aurea*; **E1.** *U. gibba*

**Calyx lobes**

Calyx lobes are sub-equal to slightly unequal in size in sections *Meionula*, *Nigrescentes*, *Oligocista* and *Utricularia*, whereas strongly unequal in sect. *Phyllaria* (Figs. 160 & 161)

Calyx lobes are sub-equal and ovate to elliptic in sections *Meionula* and *Nigrescentes* (Fig. 160A-E). Calyx lobes in sect. *Oligocista* are sub-equal or unequal, ovate to widely ovate or elliptic, with an acute to acuminate or obtuse, or 2–4-dentate apex (Figs. 160F-R & 161A-G). The upper lobe is larger than the lower lobe in most of the species in this section, except for *U. janarthanamii* and *U. nayarii*, where the upper lobe is smaller than the lower. The upper lobe is ovate in *U. malabarica* and *U. sainthomia*; ovate to widely ovate in *U. albocaerulea*, *U. graminifolia*, *U. lazulina* and *U. polygaloides*; widely ovate in *U. bifida*, *U. cecilii*, *U. ponmudica*, *U. praeterita*, *U. purpurascens*, *U. recta*, *U. smithiana* and *U. uliginosa*; ovate to elliptic in *U. sisparensis* and *U. wightiana*, and widely ovate to elliptic in *U. janarthanamii* and *U. reticulata*. The lower lobe is ovate in *U. bifida*, *U. cecilii*, *U. malabarica*, *U. ponmudica*, *U. purpurascens*, *U. reticulata*, *U. sainthomia*, *U. smithiana* and *U. uliginosa*; ovate to widely ovate in *U. polygaloides*; ovate to elliptic in *U. albocaerulea*, *U. graminifolia*, *U. janarthanamii*, *U. praeterita* and *U. wightiana*; elliptic in *U. lazulina* and *U. sisparensis* and oblong to elliptic in *U. recta*.

Apex of the upper lobe in sect. *Oligocista* is entire, acute-obtuse or acuminate, while those of the lower lobe is acute-obtuse or acuminate or bifid or bi-dentate. The lower lobe is bifid or bidentate, or 2–3 or 4-dentate in *U. albocaerulea*, *U. bifida*, *U. graminifolia*, *U. malabarica*, *U. janarthanamii*, *U. ponmudica*, *U. praeterita*, *U. purpurascens*, *U. recta*, *U. reticulata*, *U. sainthomia*, *U. sisparensis*, *U. smithiana*, *U. uliginosa* and *U. wightiana*, and acute to obtuse or acuminate in other species. The nerves in the calyx lobes are prominent in this section, and the number of veins varies among species.

In sect. *Phyllaria*, the upper lobe is more or less orbicular in *U. christopheri* and *U. furcellata*, sub-orbicular in *U. striatula*, sub-orbicular to transversely oblong in *U. brachiata* and transversely oblong in *U. kumaonensis*. The lower lobe is oblong in most of the species such as *U. brachiata*, *U. christopheri*, *U. furcellata* and *U. kumaonensis*, and oblong to orbicular in *U. striatula* (Fig. 161J-M).

**Fig. 160.** Calyx lobes of *Utricularia* L.: **A.** *U. geoffrayi*; **B.** *U. hirta*; **C.** *U. minutissima*; **D.** *U. caerulea*; **E.** *U. roseopurpurea*; **F.** *U. albocaerulea*; **G.** *U. bifida*; **H.** *U. cecilii*; **I.** *U. graminifolia*; **J.** *U. janarthanamii*; **K.** *U. lazulina*; **L.** *U. malabarica*; **M.** *U. nayarii*; **N.** *U. polygaloides*; **O.** *U. ponmudica*; **P.** *U. praeterita*; **Q.** *U. purpurascens*; **R.** *U. recta*

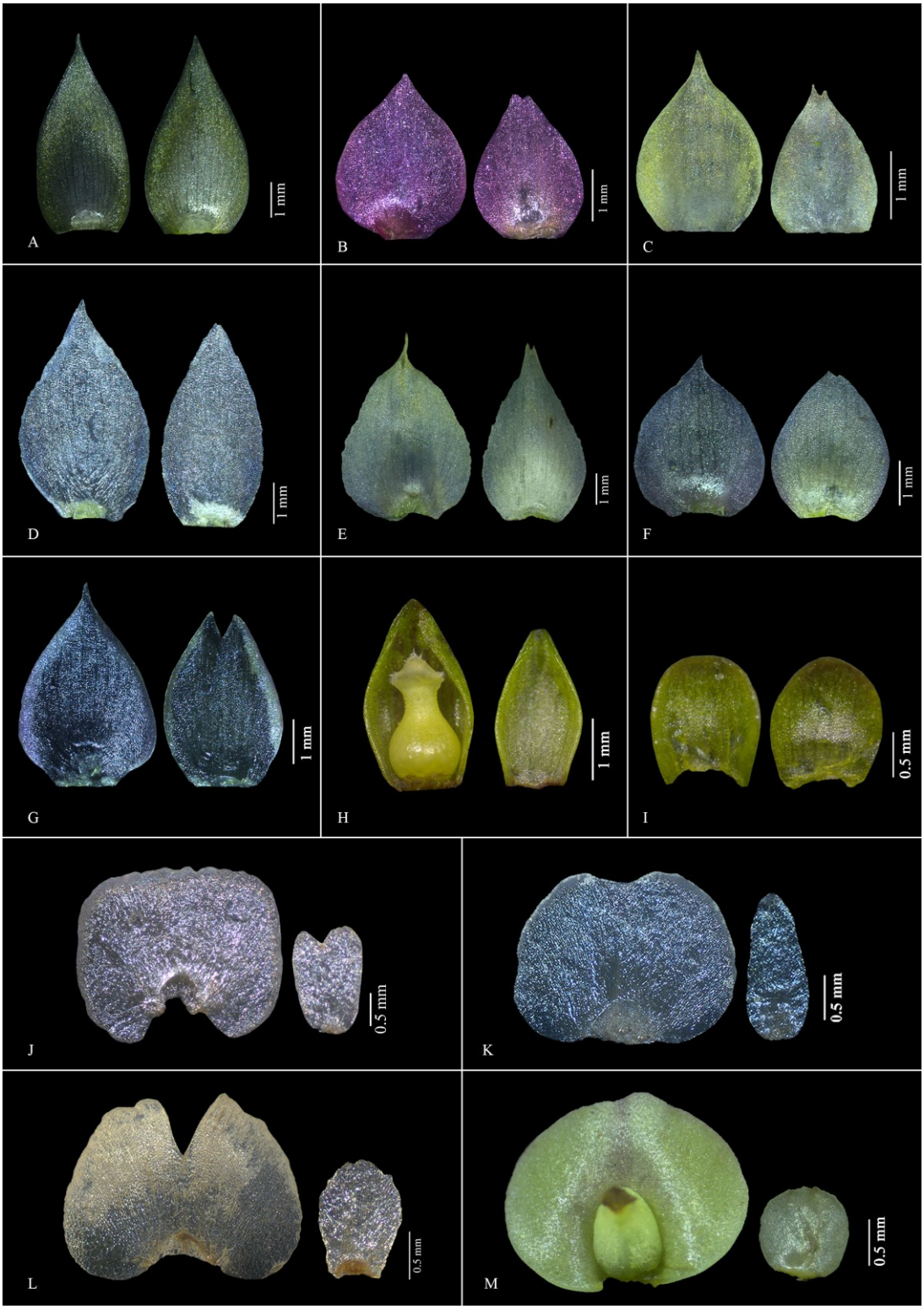


**Fig. 161.** Calyx lobes of *Utricularia* L.: **A.** *U. reticulata*; **B.** *U. sainthomia*; **C.** *U. scandens*; **D.** *U. sisparensis*; **E.** *U. smithiana*; **F.** *U. uliginosa*; **G.** *U. wightiana*; **H.** *U. aurea*; **I.** *U. gibba*; **J.** *U. brachiata*; **K.** *U. furcellata*; **L.** *U. kumaonensis*; **M.** *U. striatula*

Section *Utricularia* has sub-equal calyx lobes, and are generally ovate to oblong with obtuse or rounded apex. The upper and lower lobes are ovate in *U. aurea* and oblong in *U. gibba*. The upper lobe is ovate and lower lobe is ovate to oblong in *U. australis*, whereas both the lobes are widely ovate in *U. stellaris* (Fig. 161H & I).

**Corolla**

The size, shape, and colour of the corolla vary significantly both between species and among different sections (Figs. 162–165).

**Upper lip of corolla**: Upper lip of the corolla is oblong to obovate, and always longer than the upper calyx lobes in sections *Meionula* and *Nigrescentes* (Fig. 162A-D). The upper lip is considerably smaller than the upper calyx lobe in sect. *Phyllaria*. It is usually oblong, deeply 2-lobed or emarginate at apex, and white or pale lilac to mauve (Fig. 163I-K).

The shape of the upper lip varies in sect. *Oligocista* and it is obovate to widely obovate in *U. albocaerulea*, *U. cecilii*, *U. malabarica*, *U. nayarii*, *U. purpurascens*, *U. reticulata* and *U. smithiana*; oblong in *U. bifida*, *U. foveolata*, *U. graminifolia*, *U. janarthanamii*, *U. lazulina*, *U. polygaloides*, *U. ponmudica*, *U. scandens*, *U. uliginosa* and *U. wightiana*; oblong to obovate in *U. praeterita*, *U. recta* and *U. sainthomia*, and elliptic to oblong in *U. sisparensis* (Figs. 162E-P & 163A-H).

Upper lip is conspicuously larger and wider than the upper calyx lobe, and sometimes than the lower lip of corolla in sect. *Utricularia*. The upper lip is widely ovate to sub-orbicular with obtuse to rounded apex in both *U. aurea* and *U. gibba* (Fig. 163M & N).

**Lower lip of corolla**: Lower lip exhibits much diversity in shape, size, and pattern (Figs. 164 & 165). It is always spurred, with the spur varying from very short or reduced or conspicuously long. The lower lip is oblong to sub-orbicular and more or less 3-lobed in sect. *Meionula*. Within this section, the spur is longer than the lower lip and is horizontal in *U. geoffrayi*, while it is longer and directed downward in *U. hirta* and *U. minutissima*.

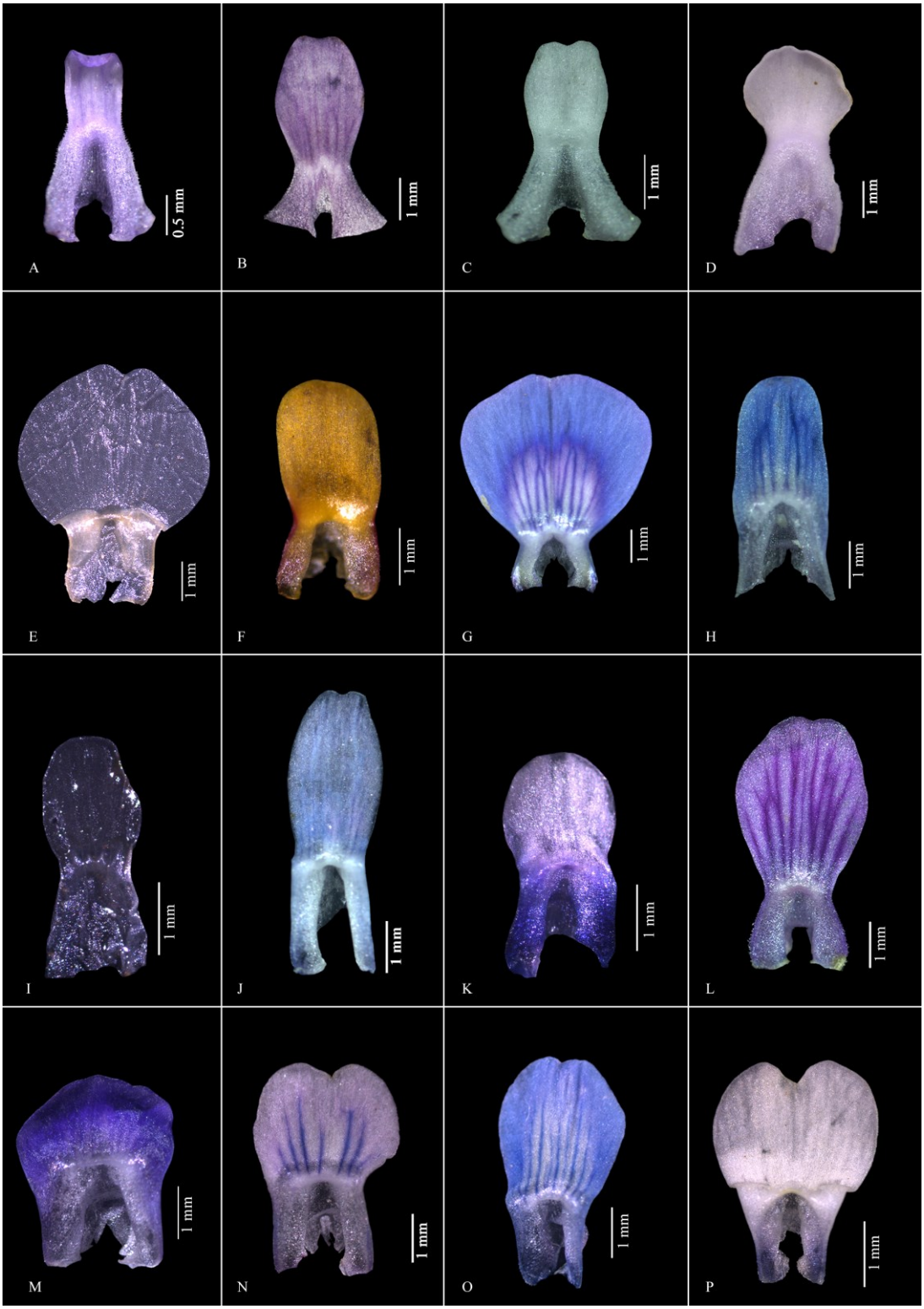


**Fig. 162.** Upper lip of corolla in *Utricularia* L.: **A.** *U. geoffrayi*; **B.** *U. hirta*; **C.** *U. caerulea*; **D.** *U. roseopurpurea*; **E.** *U. albocaerulea*; **F.** *U. bifida*; **G.** *U. cecilii*; **H.** *U. graminifolia*; **I.** *U. janarthanamii*; **J.** *U. lazulina*; **K.** *U. malabarica*; **L.** *U. nayarii*; **M.** *U. polygaloides*; **N.** *U. ponmudica*; **O.** *U. praeterita*; **P.** *U. purpurascens*

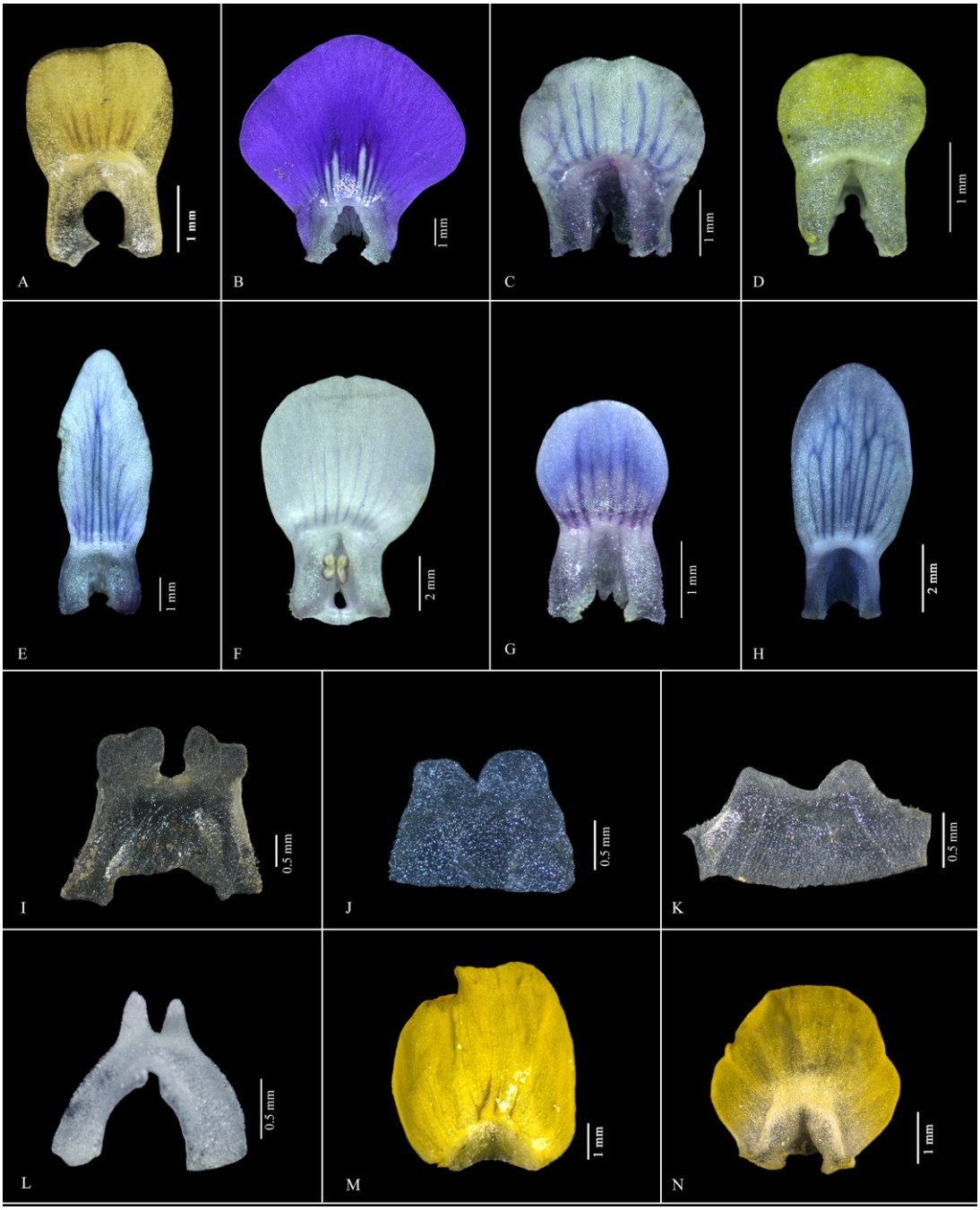


**Fig. 163.** Upper lip of corolla in *Utricularia* L.: **A.** *U. recta*; **B.** *U. reticulata*; **C.** *U. sainthomia*; **D.** *U. scandens*; **E.** *U. sisparensis*; **F.** *U. smithiana*; **G.** *U. uliginosa*; **H.** *U. wightiana*; **I.** *U. brachiata*; **J.** *U. furcellata*; **K.** *U. kumaonensis*; **L.** *U. striatula*; **M.** *U. aurea*; **N.** *U. gibba*

Likewise, in sect. *Nigrescentes*, the lower lip is oblong, with the spur always shorter than the lower lip in *U. roseopurpurea*. In contrast, the lower lip is sub-orbicular to widely ovate and the spur always longer than the lower lip in *U. caerulea*.

In sect. *Oligocista,* the lower lip is prominently swollen at base. The throat margin of the lower lip is conspicuously hairy. A conspicuous ligule is present at the throat in *U. purpurascens*, *U. wightiana* and rarely in *U. uliginosa*. The palate of the lower lip is prominently raised or swollen (gibbous), with 2-4-lobed (bi-gibbous, four-gibbous) swellings and its margins are entire or lobed obscurely towards apex. The palate is gibbous in *U. bifida*, *U. cecilii*, *U. foveolata*, *U. polygaloides*, *U. praeterita*, *U. reticulata*, *U. sisparensis*, *U. smithiana*, *U. uliginosa* and *U. wightiana*, bi-gibbous in *U. albocaerulea*, *U. graminifolia*, *U. janarthanamii*, *U. lazulina*, *U. malabarica*, *U. nayarii*, *U. ponmudica*, *U. recta* and *U. sainthomia*, and four-gibbous in *U. scandens*. Most of the species have oblong-obovate to sub-orbicular lower lip with entire margin, while lobing of the corolla is common in species like *U. bifida*, *U. graminifolia* and *U. praeterita*, but this is a variable character.

Lower lip varies among and within species in sect. *Oligocista*, and is more or less orbicular in *U. albocaerulea*, *U. sisparensis* and *U. smithiana*, whereas sub-orbicular in *U. janarthanamii*, *U. lazulina*, *U. nayarii* and *U. ponmudica*. The lower lip is widely obovate to sub-orbicular in *U. bifida*, *U. cecilii*, *U. recta*, *U. reticulata* and *U. wightiana*; widely elliptic in *U. polygaloides*; widely elliptic to sub-orbicular in *U. graminifolia*, *U. praeterita* and *U. uliginosa* and transversely or broadly oblong in *U. malabarica* and *U. sainthomia*.

Within this section, spur is subulate or conical in most of the species except *U. purpurascens*. This species has the longest spur, which is sickle-shaped and narrowly acute at apex. The spur is conical in *U. albocaerulea, U. bifida*, *U. graminifolia*, *U. janarthanamii*, *U. malabarica*, *U. polygaloides*, *U. ponmudica*, *U. praeterita*, *U. uliginosa* and *U. wightiana*, whereas subulate in *U. cecilii*, *U. lazulina*, *U. nayarii*, *U. recta*, *U. sainthomia*, *U. sisparensis* and *U. smithiana.*

Section *Phyllaria* usually has lobed lower lip (Fig. 165C-F). The palate of the lower lip is usually flat and lobed, and is widely oblong, elliptic or sub-orbicular in general outline. The lower lip is 3-lobed in *U. christopheri* and *U. multicaulis* and clearly 5-lobed in *U. brachiata*, *U. kumaonensis* and *U. striatula*. *Utricularia brachiata* and *U. striatula* exhibit a range of variations in corolla lobing, of which the latter

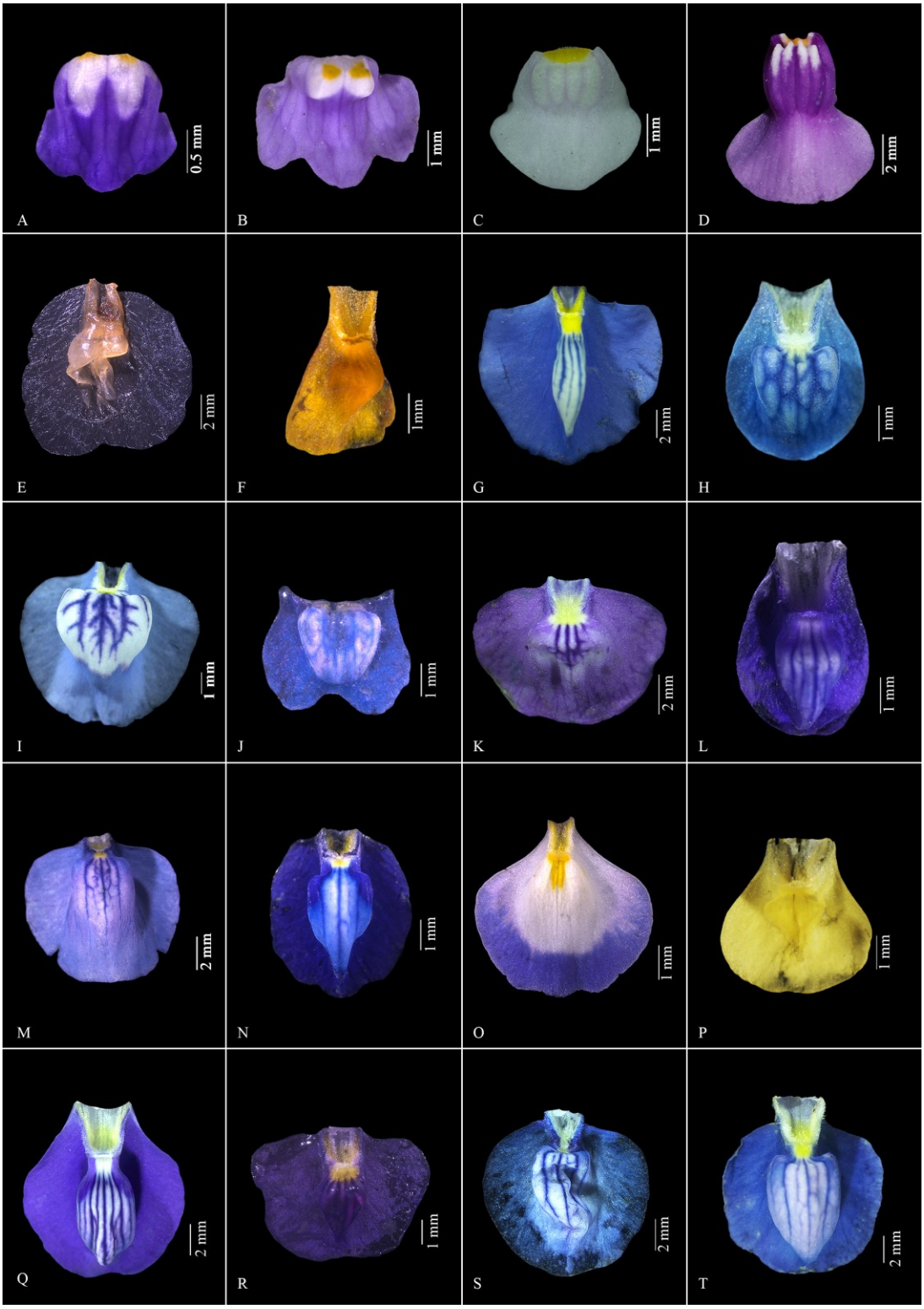


**Fig. 164.** Lower lip of corolla in *Utricularia* L.: **A.** *U. geoffrayi*; **B.** *U. hirta*; **C.** *U. caerulea*; **D.** *U. roseopurpurea*; **E.** *U. albocaerulea*; **F.** *U. bifida*; **G.** *U. cecilii*; **H.** *U. graminifolia*; **I.** *U. lazulina*; **J.** *U. malabarica*; **K.** *U. nayarii*; **L.** *U. polygaloides*; **M.** *U. ponmudica*; **N.** *U. praeterita*; **O.** *U. purpurascens*; **P.** *U. recta*; **Q.** *U. reticulata*; **R.** *U. sainthomia*; **S.** *U. sisparensis*; **T.** *U. smithiana*

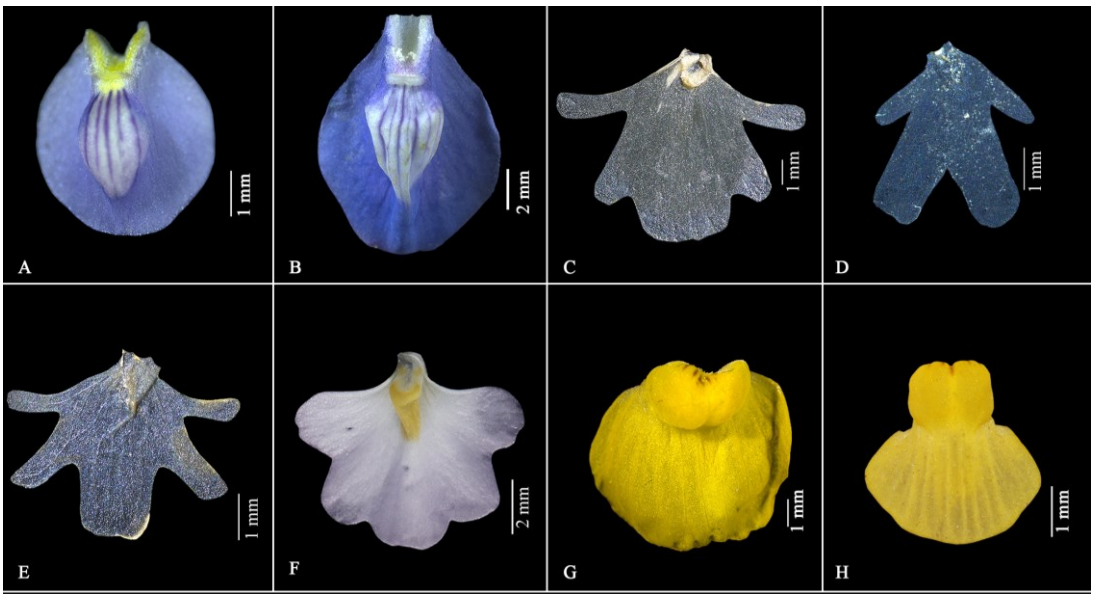


**Fig. 165.** Lower lip of corolla in *Utricularia* L.: **A.** *U. uliginosa*; **B.** *U. wightiana*; **C.** *U. brachiata*; **D.** *U. furcellata*; **E.** *U. kumaonensis*; **F.** *U. striatula*; **G.** *U. aurea*; **H.** *U. gibba*

presents small unlobed to shallowly or deeply 3 to 4 or 5-lobed lower lip of corolla. The spur may be shorter than, equal to or longer than the length of the lower lip of corolla. It is shorter than the lower lip in *U. christopheri*, *U. kumaonensis* and *U. multicaulis*, whereas it is equal to or longer than the lower lip in *U. brachiata*, *U. furcellata* and *U. striatula*.

In sect. *Utricularia*, the lower lip is prominently gibbous to bi-gibbous. The lower lip is sub-orbicular and bi-gibbous in *U. aurea* and more or less gibbous in *U. australis* and *U. gibba*, whereas broadly obovate and flat in *U. minor* and transversely elliptic and bi-gibbous in *U. stellaris*.

**Stamens**

Stamens are usually similar in appearance with short, flattened and slightly curved filaments and dorsifixed anthers (Figs. 166 & 167). Filaments are oblong to strap-shaped, and incurved or slightly twisted at the base. Some species, such as *U. cecilii*, *U. lazulina*, *U. polygaloides*, *U. praeterita* and *U. sainthomia* (sect. *Oligocista*) possess an apical lateral projection on the filament. In the aquatic sect. *Utricularia*, *U. aurea* possesses a tuft of hyaline unicellular hairs near the apical margins of the filament, whereas hairs are absent and the filaments are prominently twisted at the base in *U. gibba*. The anthers are two-thecous, more or less distinct in sections *Meionula*, *Nigrescentes*, *Oligocista* and *Phyllaria*, but are more or less confluent in sect. *Utricularia*.

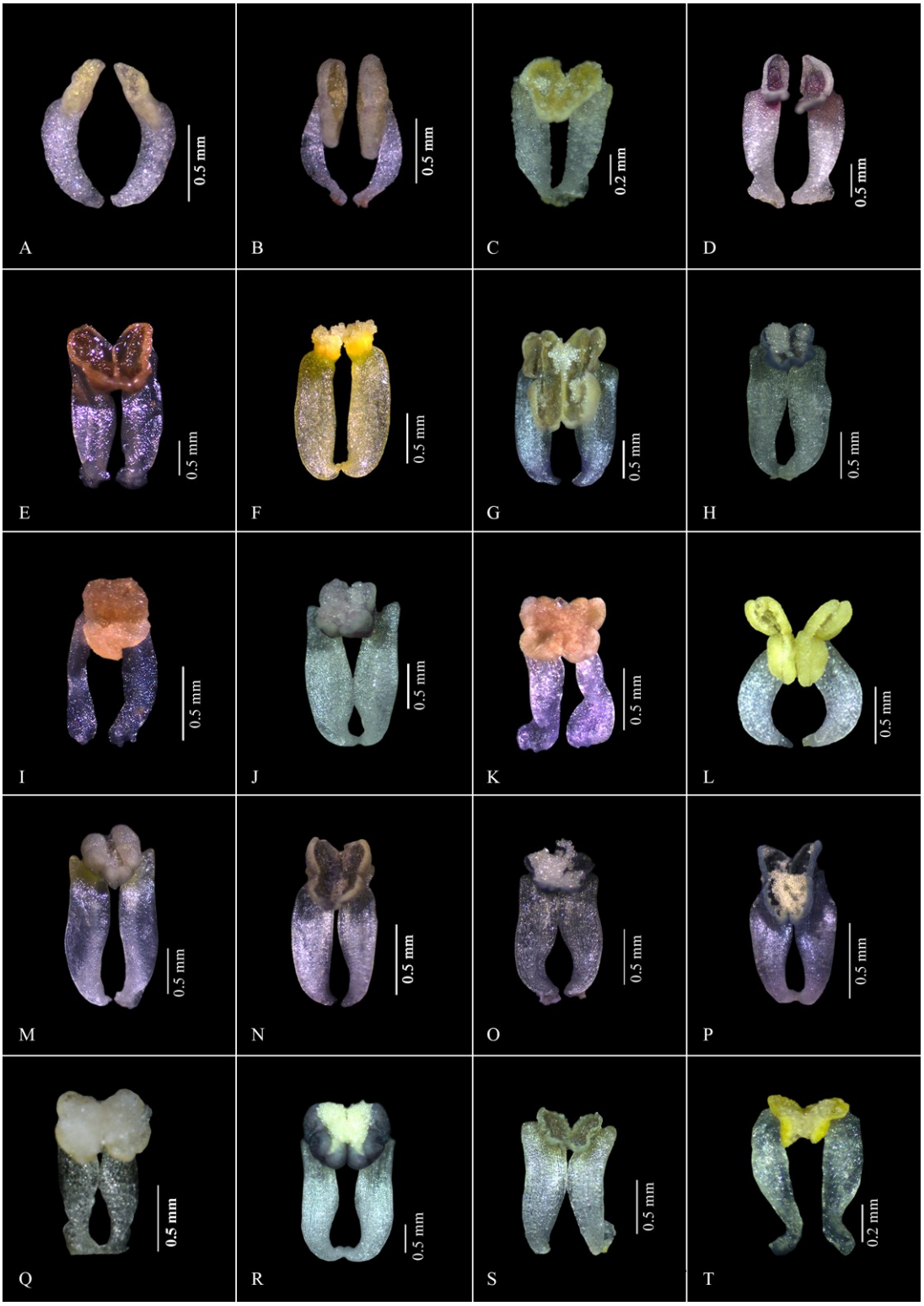


**Fig. 166.** Stamens of *Utricularia* L.: **A.** *U. geoffrayi*; **B.** *U. hirta*; **C.** *U. caerulea*; **D.** *U. roseopurpurea*; **E.** *U. albocaerulea*; **F.** *U. bifida*; **G.** *U. cecilii*; **H.** *U. graminifolia*; **I.** *U. janarthanamii*; **J.** U. *lazulina*; **K.** *U. malabarica*; **L.** *U. nayarii*; **M.** *U. polygaloides*; **N.** *U. ponmudica*; **O.** *U. praeterita*; **P.** *U. purpurascens*; **Q.** *U. recta*; **R.** *U. reticulata*; **S.** *U. sainthomia;* **T.** *U. scandens*

**Fig. 167.** Stamens of *Utricularia* L.: **A.** *U. sisparensis*; **B.** *U. smithiana*; **C.** *U. uliginosa*; **D.** *U. wightiana*; **E.** *U. brachiata*; **F.** *U. furcellata*; **G.** *U. kumaonensis*; **H.** *U. striatula*; **I.** *U. aurea*; **J.** *U. gibba*

**Pistil**

Pistil consists of a sessile, globose or ovoid ovary with a very short, or relatively very long style, and a bilabiate stigma (Figs. 168 & 169).

**Ovary**: Ovary is ovoid, ellipsoid, oblongoid or sub-globose to globose. It is ellipsoid to oblongoid in sect. *Meionula*, ovoid to globose in sections *Nigrescentes* and *Phyllaria*, and more or less globose in sect. *Utricularia*. In sect. *Oligocista*, the ovary is ovoid in *U. lazulina*, *U. nayarii*, *U. ponmudica*, *U. purpurascens*, *U. recta*, *U. sisparensis* and *U. wightiana*; ovoid to ellipsoid in *U. bifida*, *U. cecilii*, *U. graminifolia*, *U. polygaloides*, *U. reticulata*, *U. scandens*, and *U. uliginosa*; ovoid to sub-globose in *U. sainthomia*; ellipsoid in *U. albocaerulea*, *U. janarthanamii* and *U. malabarica*, and oblongoid in *U. praeterita* and *U. smithiana*.

**Fig. 168.** Pistil of *Utricularia* L.: **A.** *U. geoffrayi*; **B.** *U. hirta*; **C.** *U. minutissima*; **D.** *U. caerulea*; **E.** *U. roseopurpurea*; **F.** *U. albocaerulea*; **G.** *U. bifida*; **H.** *U. cecilii*; **I.** *U. graminifolia*; **J.** *U. janarthanamii*; **K.** *U. lazulina*; **L.** *U. malabarica*; **M.** *U. nayarii*; **N.** *U. polygaloides*; **O.** *U. ponmudica*; **P.** *U. praeterita*; **Q.** *U. purpurascens*; **R.** *U. recta*; **S.** *U. reticulata*; **T.** *U. sainthomia*

**Fig. 169.** Pistil of *Utricularia* L.: **A.** *U. scandens*; **B.** *U. sisparensis*; **C.** *U. smithiana*; **D.** *U. uliginosa*; **E.** *U. wightiana*; **F.** *U. brachiata*; **G.** *U. furcellata*; **H.** *U. kumaonensis*; **I.** *U. striatula*; **J.** *U. aurea*; **K.** *U. gibba*

**Style**: A distinct style is present in sections *Meionula*, *Nigrescentes*, *Oligocista* and *Utricularia*, while it is less distinct or indistinct in sect. *Phyllaria*.

**Stigma**: Stigma is usually bi-lipped, and the lower lip is prominently well developed and more or less sub-orbicular in all the sections. In sect. *Nigrescentes*, the upper lip is obscurely 3-lobed, of which the lateral lobes are obsolete, and the middle lobe is subulate. In sections *Meionula* and *Phyllaria*, the upper lip is obsolete. In sect. *Oligocista*, the upper lip is also reduced in size or obsolete, obscurely 3-lobed with a larger middle lobe and obsolete or indistinct lateral lobes. Within sect. *Utricularia*, the upper lip is obsolete and the lower lip is triangular to sub-orbicular with marginal hairs in *U. aurea*. Moreover, *U. aurea* possess a prominently elongated and persistent

stigma in capsules. In *U. gibba*, the upper and lower lips of stigma are sub-orbicular, but the upper lip is comparatively very smaller than the lower lip.

**Capsules**

Capsules are globose, ovoid, ellipsoid or oblongoid with persistent stigma, which are sometimes oblique or dorsiventrally compressed (Figs. 170 & 171). They are always enclosed within the calyx lobes, and the base of the capsule is more or less adnate to the base of the upper calyx lobe. There is a great diversity in the capsule wall morphology and its dehiscence pattern in this genus. The wall can be very thin or membranous and more or less transparent to rather thick and firm, with or without a thickening along the dehiscence margin (Taylor, 1989). The dehiscence pattern of the capsules is also diverse, and is unique in both at the sectional and specific level (Taylor, 1989).

Capsules are ovoid to ellipsoid and dehisce by a ventral longitudinal slit in sect. *Meionula*. In this section, the seeds are ellipsoid in *U. geoffrayi*, obliquely ovoid in *U. hirta* and ellipsoid in *U. minutissima*. In sect. *Nigrescentes*, the capsules are globoid and the wall is prominently thick and firm. Within this section, the capsule dehisces by a longitudinal ventral slit in *U. roseopurpurea*, whereas it dehisces by both dorsal and ventral longitudinal slits in *U. caerulea*.

Within sect. *Oligocista*, the capsule is ellipsoid in *U. malabarica*, *U. polygaloides*, *U. reticulata* and *U. scandens*; widely ellipsoid in *U. albocaerulea* and *U. sainthomia*; ovoid in *U. lazulina*, *U. ponmudica*, *U. praeterita*, *U. purpurascens* and *U. recta*; obliquely ovoid in *U. janarthanamii*; ovoid to ellipsoid in *U. graminifolia* and widely ovoid to ellipsoid in *U. bifida, U. cecilii* and *U. nayarii*.

A variety of capsule wall structures and dehiscing patterns can be found in sect. *Oligocista*. The capsule wall is thin or thick, and sometimes the wall is thin with a thickening along the dehiscing margin. The capsule dehisces by a single, uniformly membranous, ventral longitudinal slit in *U. cecilii*, *U. janarthanamii*, *U. lazulina*, and *U. sainthomia*, while it dehisces by uniformly membranous dorsal as well as ventral slits in *U. albocaerulea*, *U. bifida* and *U. praeterita*.

**Fig. 170.** Capsule diversity of *Utricularia* L.: **A.** *U. geoffrayi*; **B.** *U. caerulea*; **C.** *U. roseopurpurea*; **D.** *U. albocaerulea*; **E.** *U. bifida*; **F.** *U. cecilii*; **G.** *U. graminifolia*; **H.** *U. janarthanamii*; **I.** *U. lazulina*; **J.** *U. malabarica*; **K.** *U. nayarii*; **L.** *U. polygaloides*; **M.** *U. ponmudica*; **N.** *U. praeterita*; **O.** *U. purpurascens*; **P.** *U. recta*

**Fig. 171.** Capsule diversity of *Utricularia* L.: **A.** *U. reticulata*; **B.** *U. sainthomia*; **C.** *U. scandens*; **D.** *U. uliginosa*; **E.** *U. kumaonensis*; **F.** *U. striatula*; **G.** *U. gibba*

The capsule dehisces by a single, marginally thickened ventral longitudinal slit in *U. graminifolia*, *U. purpurascens* and *U. recta*, whereas it dehisces by marginally thickened dorsal as well as ventral slits in *U. malabarica*, *U. nayarii*, *U. polygaloides*, *U. ponmudica* and *U. reticulata*.

The species in sect. *Phyllaria* possess obliquely ovoid to globose capsules, which dehisce by a single, ventral more or less orbicular pore starting from the middle till the base of the capsule (i.e., the upper part is fused always) (Fig. 171E & F). In sect. *Utricularia*, the capsule dehiscence is circumscissile in *U. aurea* and *U. stellaris*, whereas it is 2-valvate in *U. gibba* (Fig. 171G).

**Placenta**: Placenta is accrescent, relatively large and fleshy within the capsule, ovoid to ellipsoid with a short stalk attaching at the base of the capsule wall and a variously pitted surface. Seeds are imbricate on the placenta, and closely packed or even overlapping. Stalk of the placenta is more or less prominent in sections *Meionula*, *Nigrescentes*, *Oligocista* and *Utricularia*. The sect. *Phyllaria* is unique with a prominent stalk and a more or less conical apical extension in the placenta.

# SEED MICROMORPHOLOGY

## 7.1. Introduction

Micromorphological and ultrastructural studies offer valuable insights into the evolution and classification of seed plants. Seed morphological characteristics have played a significant role in classification, as well as in identifying taxonomic relationships and boundaries within angiosperms at various taxonomic levels (Barthlott, 1981; Behnke & Barthlott, 1983). Scanning electron microscopy facilitates high-resolution imaging and detailed examination of surface sculpturing, providing essential data for micromorphological studies.

The seeds of *Utricularia* are minute and dust-like, making them difficult to distinguish with naked eye, and hence their taxonomic characters need microscopic examination. Martin (1946) classified seeds smaller than 0.2 mm in length as micro seeds and those between 0.3–2 mm as dwarf seeds. Eriksson and Kainulianen (2011) provided characteristics of dust seeds, which are extremely small, sometimes less than 0.9 mm, with an undifferentiated embryo and minimal amount of endosperm. Dust seeds are usually more numerous and are highly adapted for successful dispersal, colonization of new habitats, germination, etc. Their low weight allows them to disperse individually, regardless of the shape, facilitating wide dispersal. According to Eriksson and Kainulianen (*l.c.*), dust seeds have evolved independently several times among angiosperms, and at least ten times in dicots across different lineages. The presence of dust seeds has been observed in in three families of Lamiales: Gesneriaceae, Orobanchaceae, and Scrophulariaceae. However, due to the limited studies on seed morphology in Lentibulariaceae, particularly within *Utricularia*, the occurrence of dust-like seeds has not been previously recorded. Most *Utricularia* species produce small seeds, ranging from 0.15 to 2.0 mm in length (Abraham & Subramanyam, 1965), which should also be classified as dust seeds. *Utricularia* usually produces numerous seeds per capsule, enabling them to effectively colonize their habitats and disperse over long distances.

Although seed micromorphological characters hold significant taxonomic value, studies focused on the seed characters of *Utricularia* are limited (Abraham & Subramanyam, 1965; Taylor, 1989; Menezes *et al*., 2014). Abraham and Subramanyam (1965) discussed and illustrated the seed morphology of ten taxa from West Bengal using light microscopy. This pioneering study provided information on Indian materials, highlighting the importance of seed coat structure and ornamentation in species delimitation. Taylor (1989) summarised the seed characters of 48 species of *Utricularia* using SEM images.

Seed micromorphology has a strong relation with the habitat and ecology of plants. Since, the variations in seed shape and structure are related to dispersal (Harper *et al*., 1970), studying the habitat and ecological influences on seed morphology is crucial. However, the seed data and their implications in taxonomy and ecology of *Utricularia* remain largely unexplored.

The present study aims to analyse the micromorphological characteristics of seeds using scanning electron microscopy (SEM), with a focus on their significance at both sectional and species level delimitation within *Utricularia*. Additionally, the study intends to evaluate the diagnostic value of seed characters to infer their probable habitat and ecological adaptations. Both light microscopy and scanning electron microscopy are carried out to examine the seed shape, structure of testa cells and ornamentation pattern.

**7.2. Materials and methods**

Mature and ripe capsules from 30 species, representing the sections *Meionula* (2 sp.), *Nigrescentes* (2 sp.), *Oligocista* (14 sp.), *Phyllaria* (4 sp.) and *Utricularia* (3 sp.), were collected. They were examined using a light microscope (LM), with 25 of them also being analysed under a scanning electron microscope (SEM).

For LM, 25–30 dried seeds from each species were examined using ZEN 2.3 lite software equipped with Stemi 508 stereo microscope (Zeiss, Jena, Germany) attached with Axiocam color Camera (Zeiss, Jena, Germany), as well as LAZ VZ Core software equipped with DM 2000 LED microscope attached with DMC 4500 camera (Leica, Wetzlar, Germany). For SEM, dried seeds were mounted on aluminium stubs

and coated them with 10–15 nm of gold with an SC7620 mini sputter coater (Emitech Quorum, PA, USA). Approximately 20 seeds from each sample were examined with a filament voltage of 1.5 to 2 kV and were imaged using Gemini 300 field emission scanning electron microscope (Zeiss, Jena, Germany). The morphology and orientation of testa cells, the position of hilum, morphology and ornamentation of the anticlinal and periclinal walls, etc. were noted. The LM and SEM images were processed and compiled using Adobe Photoshop (Version: 21.0.2 20191122.r.57 2019/11/22: e3e4068e635x64) and Microsoft Power Point 2021.

### 7.3. Results

The results of light microscopy and scanning electron microscopy is presented below. These findings are valuable for delimiting sections and species within *Utricularia* (Fig. 172–179). The features of the seeds, such as the shape of seeds and testa cells, nature of anticlinal and periclinal wall and position of the hilum are of diagnostic value (Fig. 172).

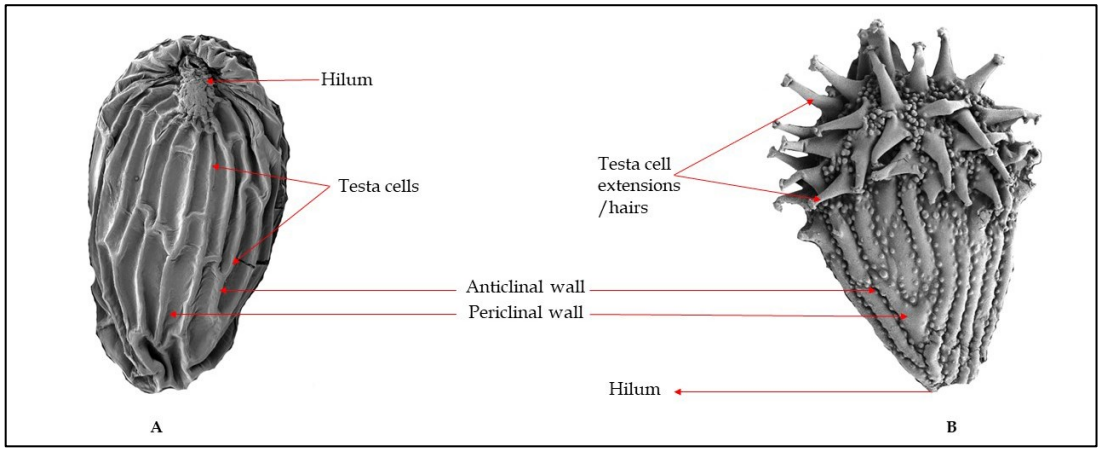


**Fig. 172.** *Utricularia* seeds with various parts labelled.

#### 7.3.1. Seed morphological description

**I. Section Meionula**

**Utricularia geoffrayi** Pellegr.

Seeds obovoid to oblongoid, 0.2–0.25 × 0.14–0.17 mm; testa cells isodiametric; anticlinal wall raised; periclinal wall flat; hilum latero-terminal (Fig. 173A).

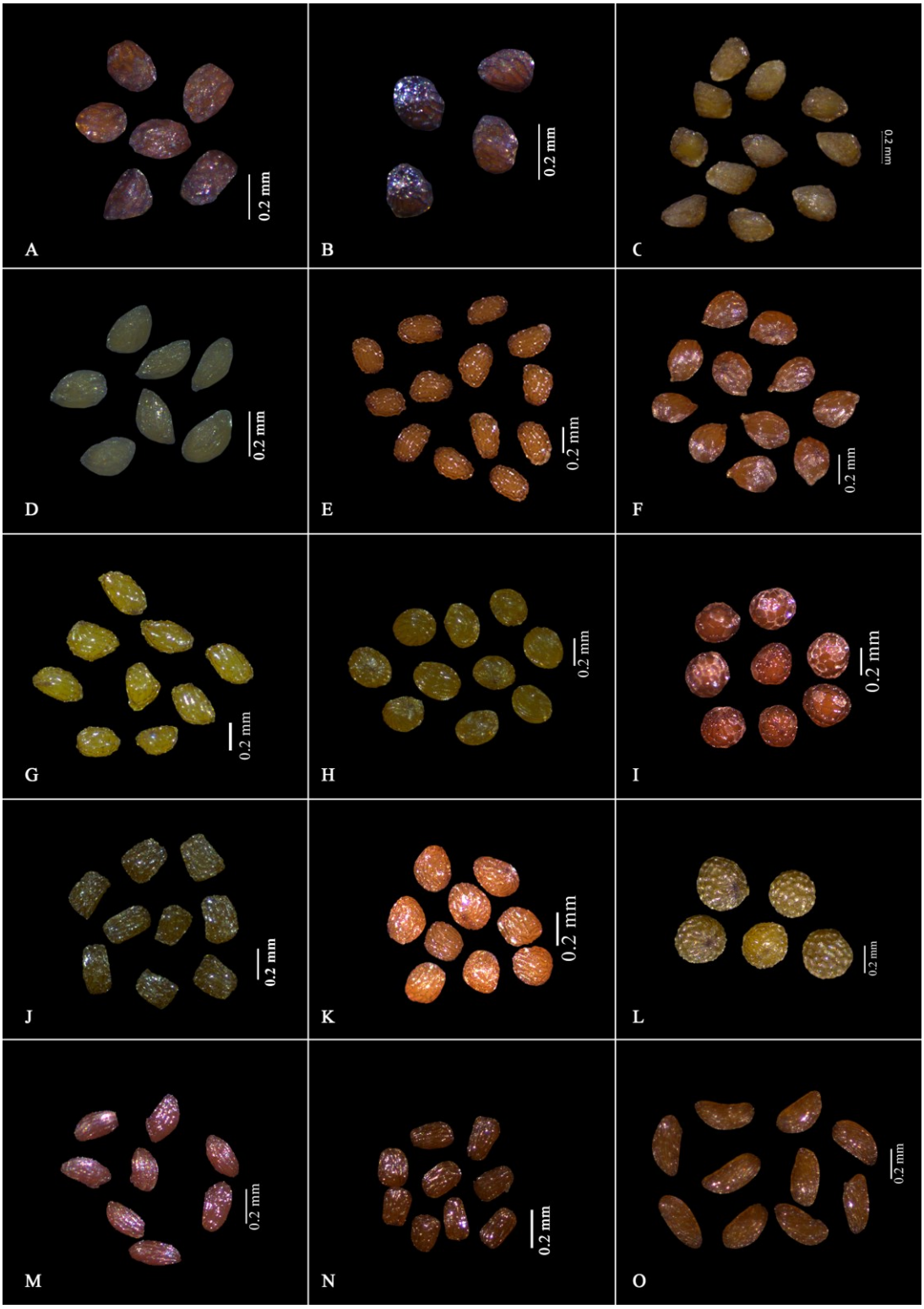


**Fig. 173.** LM images of *Utricularia* seeds: **A.** *U. geoffrayi*; **B.** *U. hirta*; **C.** *U. caerulea*; **D.** *U. roseopurpurea*; **E.** *U. albocaerulea*; **F.** *U. bifida*; **G.** *U. cecilii*; **H.** *U. graminifolia*; **I.** *U. janarthanamii*; **J.** U. *lazulina*; **K.** *U. malabarica*; **L.** *U. nayarii*; **M.** *U. polygaloides*; **N.** *U. ponmudica*; **O.** *U. praeterita*

**Fig. 174.** LM images of *Utricularia* seeds: **A.** *U. purpurascens*; **B.** *U. recta*; **C.** *U. reticulata*; **D.** *U. sainthomia;* **E.** *U. scandens*; **F.** *U. uliginosa*; **G.** *U. brachiata*; **H.** *U. furcellata*; **I.** *U. kumaonensis*; **J.** *U. striatula*; **K.** *U. aurea*; **L.** *U. gibba*

**Utricularia hirta** Klein ex Link

Seeds obovoid to oblongoid, 0.2–0.22 × 0.15–0.18 mm; testa cells isodiametric; anticlinal wall slightly raised, straight, thick, finely verrucate; periclinal wall flat, surface rough, finely verrucate; hilum latero-terminal (Figs. 173B & 175A1-A3).

**Utricularia minutissima** Vahl

Seeds obovoid to oblongoid, 0.2–0.24 × 0.16–0.18 mm; testa cells isodiametric; anticlinal wall prominently raised, straight, thick, finely verrucate; periclinal wall flat to slightly concave, surface rough, finely verrucate; hilum latero-terminal (Fig. 175B1-B3).

**II. Sect. Nigrescentes**

**Utricularia caerulea** L.

Seeds obovoid to ellipsoid, 0.2–0.3 × 0.1–0.18 mm; testa cells elongate, congested around hilum; anticlinal wall concave, straight, thick, granulated; periclinal wall convex, domed, surface rough, granulated; hilum sub-terminal (Figs. 173C & 175C1-C3).

**Utricularia roseopurpurea** Stapf ex Gamble

Seeds obovoid to oblongoid, 0.25–0.32 × 0.17–0.22 mm; testa cells irregular, folded and smaller near hilum, larger in remaining part; anticlinal walls concave, uneven, thick, scrobiculate; periclinal walls convex, raised into cylindrical tubercles, surface rough, finely verrucate; hilum sub-terminal (Figs. 173D & 175D1-D3).

**III. Sect. Oligocista**

**Utricularia albocaerulea** Dalzell

Seeds obovoid to oblongoid, 0.3–0.35 × 0.2–0.25 mm; testa cells polygonal, corners thickened; anticlinal walls prominently raised, slightly undulate, thick, without intercellular space, smooth; periclinal walls deeply concave, surface smooth; hilum terminal (Figs. 173E & 176E1-E3).

**Utricularia bifida** L.

Seeds obliquely obovoid, 0.3–0.4 × 0.2–0.3 mm; testa cells polygonal, corners not thickened; anticlinal walls prominently raised, straight, thick, without intercellular space, surface striated; periclinal walls deeply concave, surface striated with oblique longitudinal ridges; hilum latero-terminal (Figs. 173F & 176F1-F3).

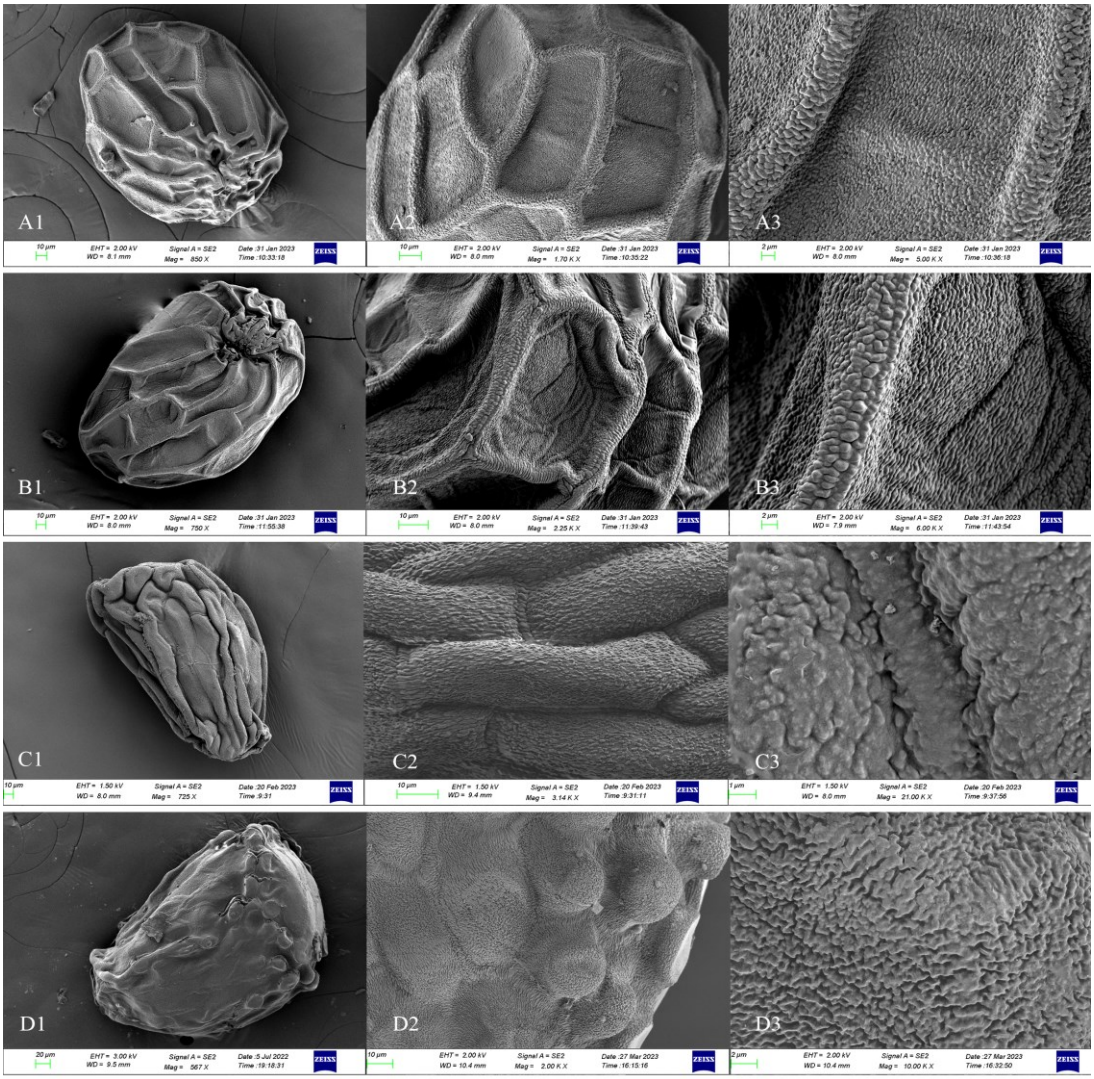


**Fig. 175.** SEM micrographs of seeds of *Utricularia*: **A1–A3.** *U. hirta*; **B1–B3.** *U. minutissima*; **C1–C3.** *U. caerulea*; **D1–D3.** *U. roseopurpurea*

**Utricularia cecilii** P.Taylor

Seeds obovoid to ellipsoid, 0.3–0.35 × 0.2–0.3 mm; testa reticulate, cells polygonal, corners thickened; anticlinal walls prominently raised, straight, thick, without intercellular space; periclinal walls slightly concave, surface smooth; hilum latero-terminal (Figs. 173G & 176G1-G3).

**Utricularia graminifolia** Vahl

Seeds oblongoid to sub-globose, 0.3–0.4 × 0.2–0.3 mm; testa cells more or less elongate; anticlinal walls prominently raised, straight, thin, without intercellular space; periclinal walls deeply concave, surface smooth; hilum latero-terminal (Figs. 173H & 176H1-H3).

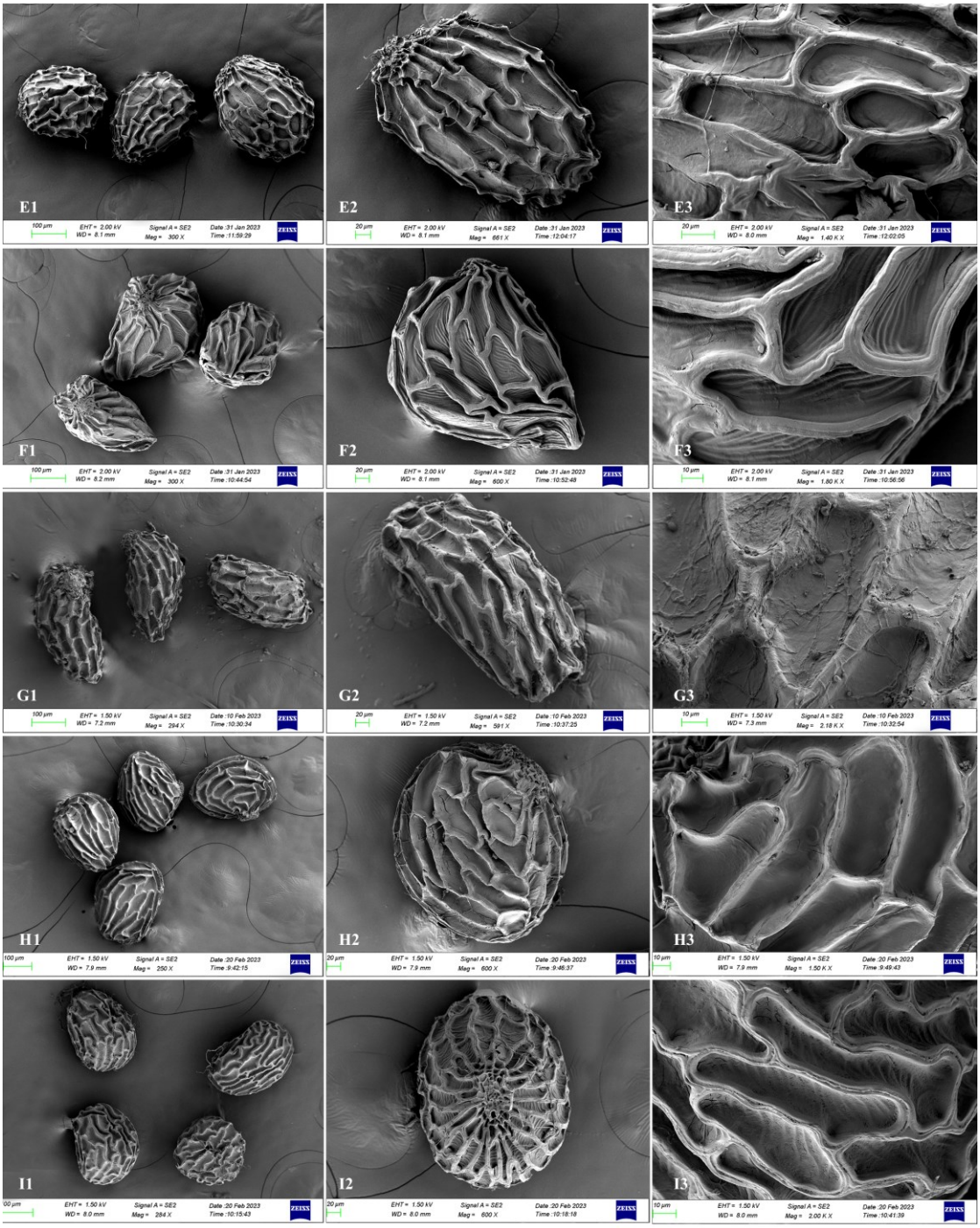


**Fig. 176.** SEM micrographs of seeds of *Utricularia*: **E1–E3.** *U. albocaerulea*; **F1–F3.** *U. bifida*; **G1–G3.** *U. cecilii*; **H1–H3.** *U. graminifolia*; **I1–I3.** *U. malabarica*

**Utricularia janarthanamii** S.R.Yadav, Sardesai & S.P.Gaikwad

Seeds sub-globose, 0.35–0.4 mm across; testa cells more or less isodiametric; anticlinal walls convex, sinuate; periclinal walls concave; hilum lateral (Fig. 173I).

**Utricularia lazulina** P.Taylor

Seeds obovoid-oblongoid, 0.25–0.35 × 0.18–0.22 mm; testa cells elongate; anticlinal walls prominently raised, more or less sinuate, thick, without intercellular space; periclinal walls deeply concave, surface smooth; hilum latero-terminal (Fig. 173J).

**Utricularia malabarica** Janarth. & A.N.Henry

Seeds oblongoid to sub-globose, 0.25–0.3 × 0.17–0.2 mm; testa cells more or less elongate; anticlinal walls prominently raised, slightly wavy, thick, with intercellular space; periclinal walls deeply concave, surface striated with transversal ridges; hilum latero-terminal (Figs. 173K & 176I1-I3).

**Utricularia nayarii** Janarth. & A.N.Henry

Seeds sub-globose, 0.4–0.6 mm across; testa cells isodiametric; anticlinal walls slightly raised, slightly wavy, corners thickened, with intercellular space, smooth; periclinal walls flat, surface smooth; hilum lateral (Figs. 173L & 177J1-J3).

**Utricularia polygaloides** Edgew.

Seeds ellipsoid, 0.25–0.28 × 0.15–0.16 mm; testa cells elongate; anticlinal walls slightly raised, straight, thick, without intercellular space, longitudinally striated; periclinal walls slightly concave, surface finely striated with longitudinal ridges having indistinct bullate process; hilum latero-terminal (Figs. 173M & 177K1-K3).

**Utricularia ponmudica** Krishnapriya & Nampy *sp. nov.*

Seeds oblongoid, 0.2–0.3 × 0.12–0.15 mm; testa cells more or less elongate; anticlinal walls prominently raised, slightly wavy, thick, without intercellular space, smooth; periclinal walls deeply concave, smooth; hilum terminal (Figs. 173N & 178).

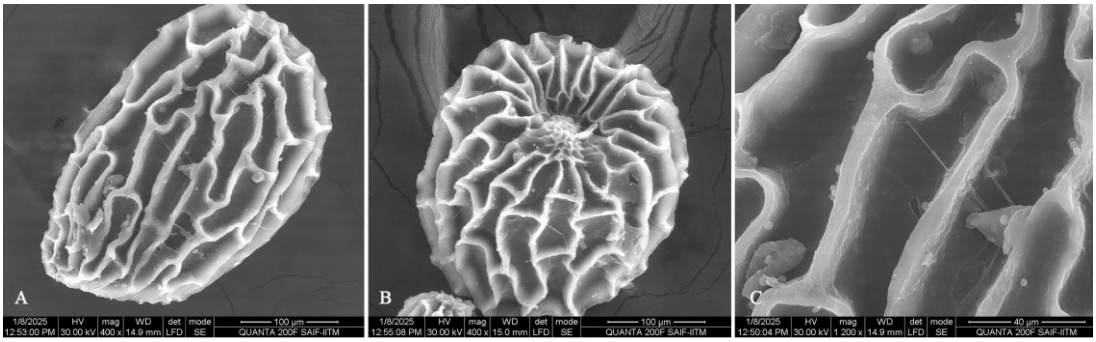


**Fig. 178.** SEM micrographs of seeds of *Utricularia ponmudica*

**Utricularia praeterita** P.Taylor

Seeds ellipsoid, 0.3–0.32 × 0.2–0.22 mm; testa cells elongate, slightly oblique, compact, corners slightly thickened; anticlinal walls slightly raised, straight, thick, without intercellular space, smooth; periclinal walls slightly concave, surface smooth; hilum latero-terminal (Figs. 173O & 177L1-L3).

**Utricularia purpurascens** J.Graham

Seeds ellipsoid, 0.3–0.35 × 0.1–0.25 mm; testa cells elongate, oblique, compact, corners not thickened; anticlinal walls prominently raised, straight, very thick, without intercellular space, smooth; periclinal walls deeply concave, surface smooth; hilum sub-terminal (Figs. 174A & 177M1-M3).

**Utricularia recta** P.Taylor

Seeds oblongoid to sub-globose, 0.32–0.35 mm across; testa reticulate, cells slightly elongate; anticlinal walls slightly raised, slightly wavy, thick, with intercellular space, smooth; periclinal walls slightly concave, surface smooth and obscurely bullate; hilum sub-terminal (Figs. 174B & 177N1-N3).

**Utricularia reticulata** Sm.

Seeds obovoid to ellipsoid, 0.35–0.4 × 0.2–0.25 mm; testa cells elongate, compact; anticlinal walls slightly raised, straight, thick, without intercellular space, striated; periclinal walls slightly concave, surface striated with longitudinal ridges, unevenly bullate; hilum lateral (Figs. 174C & 179O1-O3)

**Utricularia sainthomia** P.Biju, Josekutty, Janarth. & Augustine

Seeds ellipsoid to oblongoid, 0.35–0.4 × 0.2–0.25 mm; testa cells elongate; anticlinal walls prominently raised, thick, without intercellular space, smooth; periclinal walls deeply concave, surface striated with transversal ridges; hilum terminal (Fig. 174D).

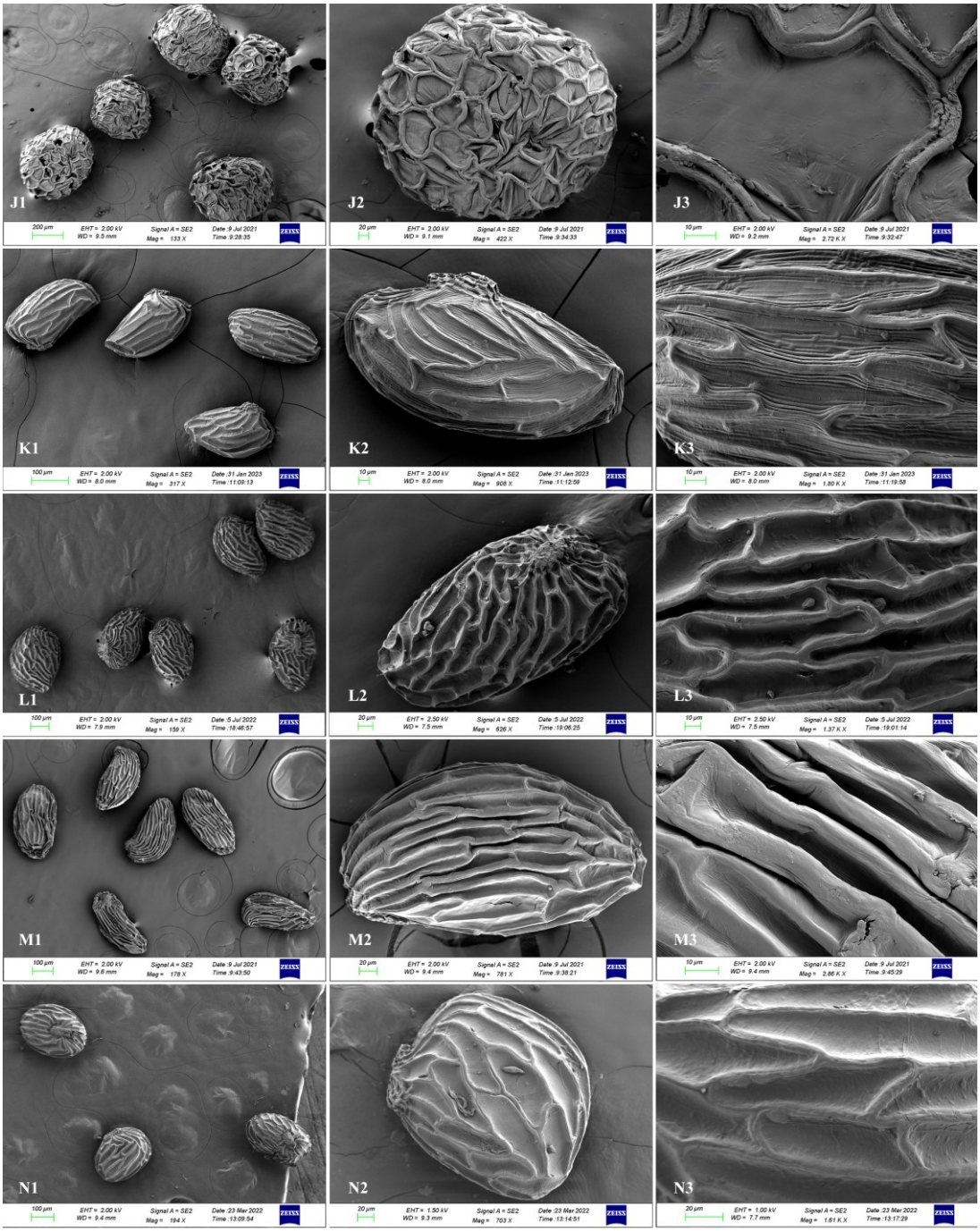


**Fig. 177.** SEM micrographs of seeds of *Utricularia*: **J1–J3.** *U. nayarii*; **K1–K3.** *U. polygaloides*; **L1–L3.** *U. praeterita*; **M1–M3.** *U. purpurascens*; **N1–N3.** *U. recta*

**Utricularia scandens** Benj.

Seeds obovoid to ellipsoid, 0.25–0.3 × 0.13–0.15 mm; testa cells more or less elongate; anticlinal walls prominently raised, wavy, very thick, with intercellular space,

surface rough, finely verrucate; periclinal walls deeply concave, surface rough, finely verrucate; hilum latero-terminal (Figs. 174E & 179P1-P3).

**Utricularia smithiana** Wight

Seeds oblongoid to sub-globose, 0.28–0.32 mm across; testa cells isodiametric; anticlinal walls raised; periclinal walls concave, surface smooth; hilum terminal.

**Utricularia uliginosa** Vahl

Seeds oblongoid to sub-globose, 0.35–0.4 × 0.25–0.35 mm; testa cells rectangular; anticlinal walls prominently raised, slightly wavy, corners thickened with intercellular space, smooth; periclinal walls deeply concave, surface smooth; hilum terminal (Figs. 174F & 179Q1-Q3).

**IV. Sect. Phyllaria**

**Utricularia brachiata** Oliv.

Seeds ellipsoid, 0.3–0.4 × 0.2–0.4 mm, with a tuft of strap-shaped periclinal (extensions) hairs at both ends, length about the body of seeds, 0.3–0.6 mm long, finely striated; periclinal walls of the body with small papillae, irregularly folded; anticlinal walls concave, sinuate, shortly papillate, surface finely striated with vermiform ridges; hilum lateral (Figs. 174G & 179R1-R3).

**Utricularia furcellata** Oliv.

Seeds obovoid, 0.4–0.5 × 0.15–0.2 mm; apex rounded with long clavate periclinal hairs, the other end sub-acute; periclinal walls of the body convex, with short conical or irregular papillae, surface finely striated with vermiform ridges; anticlinal walls deeply concave, sinuate, with short conical or irregular papillae, surface finely striated with vermiform ridges; hilum lateral or terminal (Figs. 174H & 179S1-S3).

**Utricularia kumaonensis** Oliv.

Seeds ellipsoid, 0.35–0.45 × 0.4–0.55 mm, with a tuft of strap-shaped hairs on both ends, always longer than body, 0.7–2 mm long, strap shaped, surface finely striated;

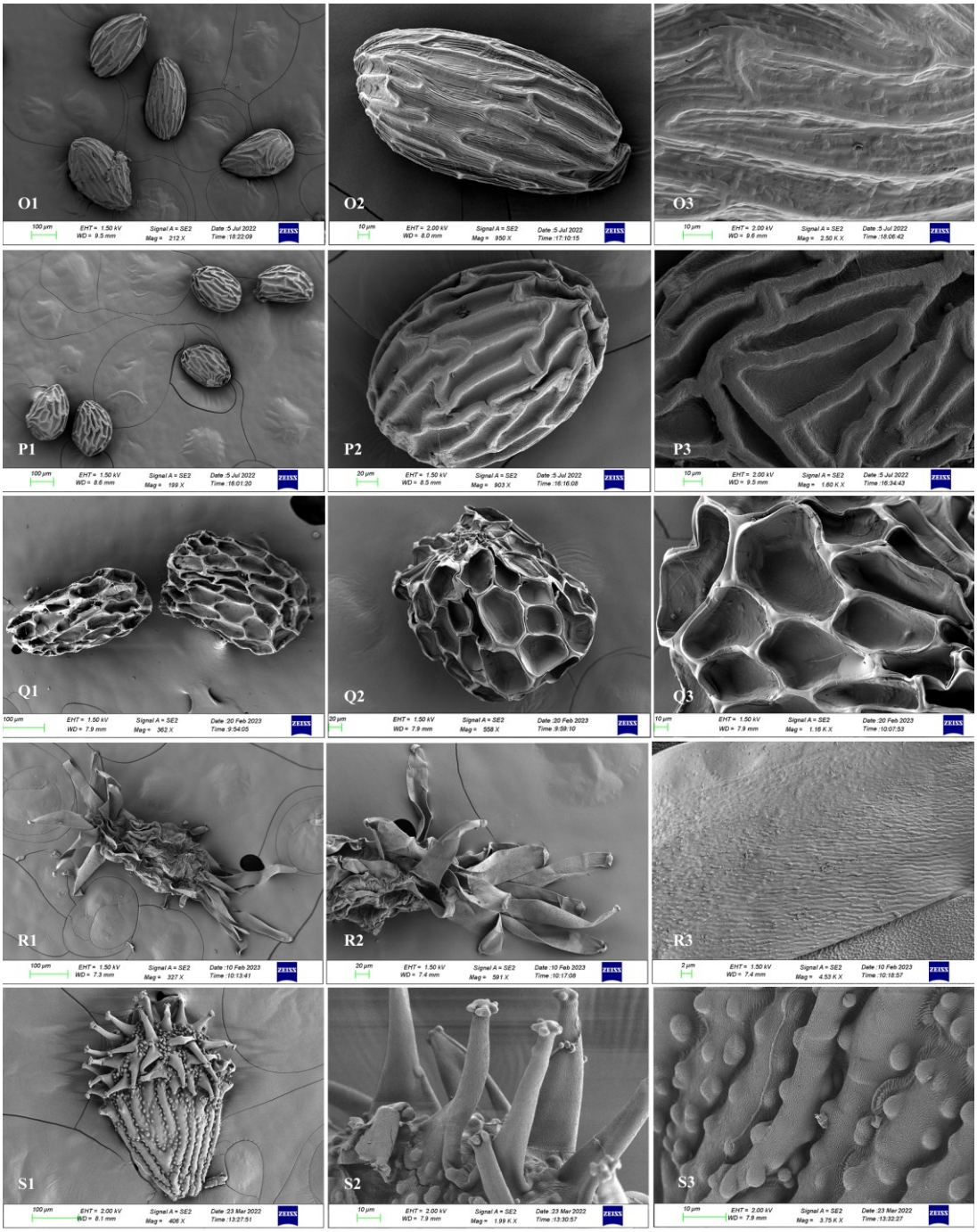


**Fig. 179.** SEM micrographs of seeds of *Utricularia*: **O1–O3.** *U. reticulata*; **P1–P3.** *U. scandens*; **Q1–Q3.** *U. uliginosa*; **R1–R3.** *U. brachiata*; **S1–S3.** *U. furcellata*

periclinal walls of the lateral testa with short conical papillae, surface striated with vermiform ridges; anticlinal boundaries concave, finely sinuate, irregularly folded with small papillae, surface striated with vermiform ridges; hilum lateral (Figs. 174I & 180T1-T3).

**Utricularia striatula** Sm.

Seeds obovoid, 0.3–0.45 × 0.1–0.15 mm, major end rounded with numerous, long glochidiate hairs, the other end sub-acute with short glochidiate hairs, surface rough; periclinal walls convex with short unequal conical papillae or clavate warts, surface with fine vermiform ridges; anticlinal walls deeply concave, sinuate, with small conical papillae, surface granulose; hilum lateral or terminal (Figs. 174J & 180U1-U3).

**V. Sect. Utricularia**

**Utricularia aurea** Lour.

Seeds disc-shaped, 0.8–1.5 mm across, 5–6-angled, thick, margins narrowly winged; testa cells elongate; anticlinal walls slightly raised, straight, densely covered with irregular papillae; periclinal walls flat to slightly concave, surface rough, densely tuberculate; hilum at centre of dorsal part (Figs. 174K & 180V1-V3).

**Utricularia gibba** L.

Seeds lenticular, 0.8–1 mm across, obovate in dorsal view, broadly winged, margin thick and irregularly dentate; ventral side compressed, ornamented with smooth conical papillae; testa cells slightly elongate; anticlinal walls raised; periclinal walls flat or slightly concave; margin winged densely scaly with numerous, smooth, conical papillae; hilum at centre dorsally (Figs. 174L & 180W1-W3).

**Utricularia stellaris** L.f.

Seeds disc-shaped, 0.8–1 mm across, 4–6 angled, margins narrowly winged; testa cells elongate; anticlinal walls slightly raised, straight, finely verrucate; periclinal walls flat, ± concave, surface thinly or densely papillate; hilum at centre dorsally(Fig. 180X1-X3).

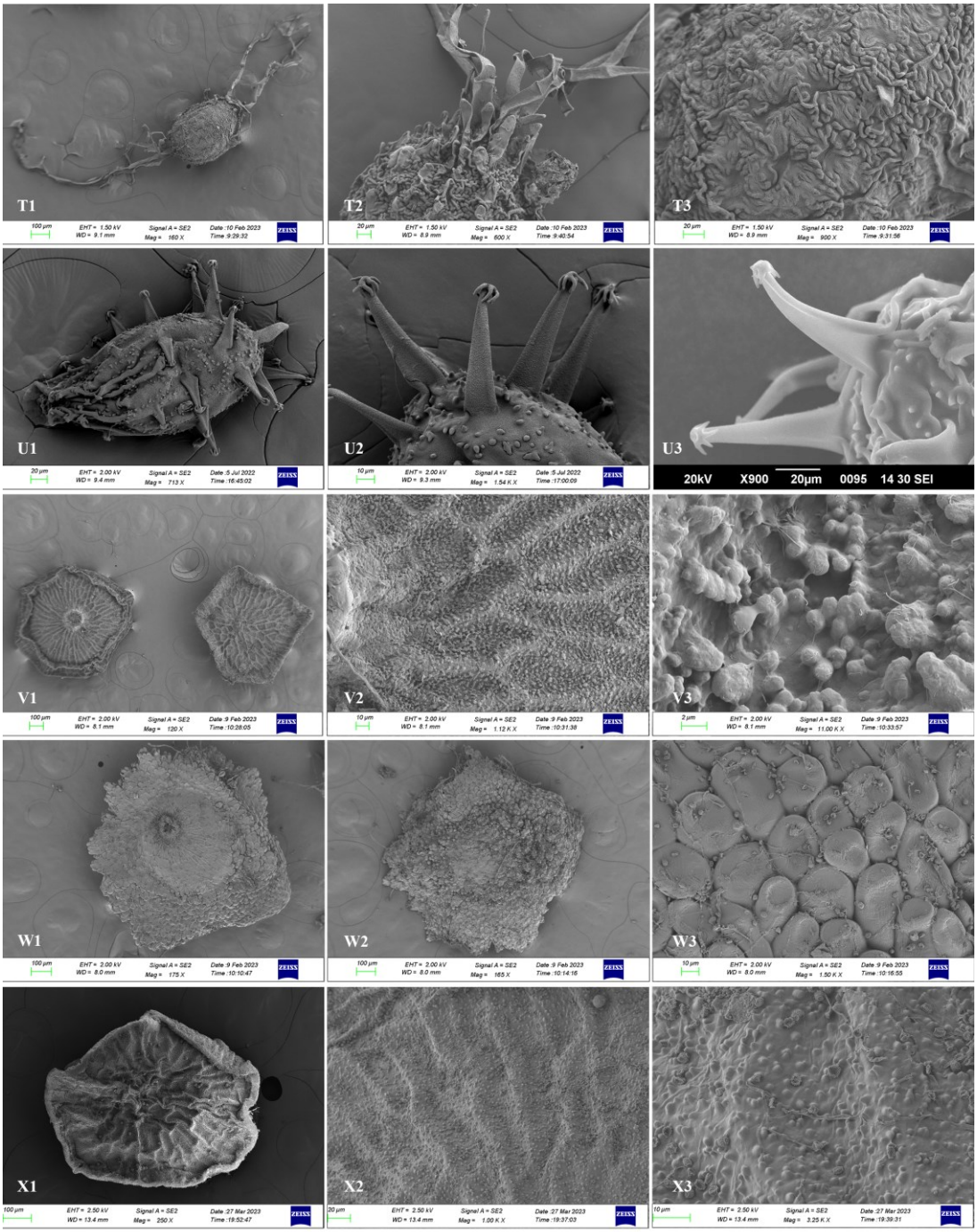


**Fig. 180.** SEM micrographs of seeds of *Utricularia*: **T1–T3.** *U. kumaonensis*; **U1–U3.** *U. striatula*; **V1–V3.** *U. aurea*; **W1–W3.** *U. gibba*; **X1–X3.** *U. stellaris*

### 7.3.2. Seed characteristics

#### a. Seed shape

The seeds are very small, ranging from 0.2–0.4 (–1.5) mm in length and exhibit considerable variation among different sections. They are generally obovoid to

oblongoid, or elliptic or sub-globose or disc shaped or lenticular. Within sect. *Meionula*, *Nigrescentes* and *Oligocista*, seed shapes range from obovoid to oblongoid or ellipsoid, or sub-globose. In sect. *Utricularia*, the seeds are flat or thick, winged, lenticular or prismatic, whereas in sect. *Phyllaria* they are obovoid to ellipsoid with prominent testa hairs.

**b. Testa**

The gross sculpturing in most species is typically reticulate, with the shape of the testa cells varying from isodiametric to polygonal, or elongate, or irregular (Fig. 181A &B).

**Anticlinal wall**

The anticlinal walls of the testa cell are mostly raised, ranging from slightly to prominently raised, concave, straight to wavy or sinuous. These walls can vary in thickness, being thin or evenly or unevenly thickened, with or without intercellular space. The raised wall can be smooth, rough or striated.

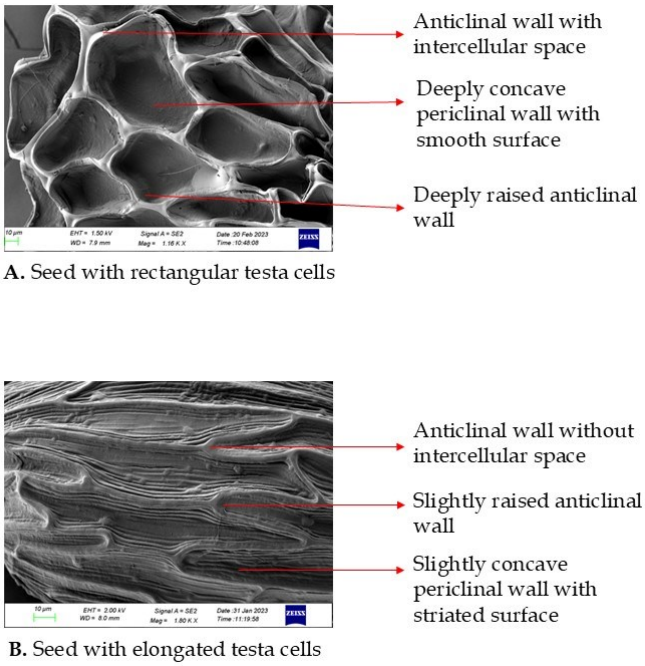


**Fig. 181.** Morphology and orientation of testa cells: **A.** Rectangular testa cells in *U. uliginosa*; **B.** Elongated testa cells in *U. polygaloides*

**c. Periclinal wall**

The periclinal walls of the testa cell may be flat, concave, or convex. They may range from slightly to deeply concave and may be smooth or variously ornamented.

**d. Ornamentation**

The surface ornamentation may be smooth, rough or striated. The rough surface can be finely verrucate or papillate and the striations may be longitudinal, transversal or obliquely longitudinal ridges.

**e. Hilum**

The position of the hilum is a key characteristic, being prominent in most species and slightly protruding. It may be terminal, lateral, latero-terminal, sub-terminal, or central.

### 7.4. Comparative morphological analysis

In sect. *Meionula* (*U. geoffrayi*, *U. hirta* and *U. minutissima*), the seeds are obovoid-oblongoid in shape. The size, ornamentation, and position of the hilum are consistent across all species and hold less significance in species delimitation. The size ranges from 0.18 to 0.25 mm in diameter. The testa of three species studied in this section is reticulate, with raised anticlinal walls and flat periclinal walls. The ornamentation is finely verrucate in *U. hirta* and *U. minutissima* (Fig. 175A3 & B3). The position of the hilum is latero-terminal in all species.

The seeds of *U. caerulea* are obovoid to ellipsoid, while those of *U. roseopurpurea* are obovoid to oblongoid. *Utricularia caerulea* possess elongate testa cells with concave, straight and granulated anticlinal walls and granulated, domed periclinal walls (Fig. 175C2 & C3). In contrast, the anticlinal walls of *U. roseopurpurea* are concave and irregular, while the periclinal walls are convex and raised into cylindrical tubercles (Fig. 175D2) with a finely verrucate surface (Fig. 175D3). The hilum is sub-terminal in both species.

The seed size of the ranges from 0.2–0.4 mm in sect. *Oligocista*, with shapes varying from obovoid-ellipsoid-oblongoid to sub-globose. In *U. nayarii* (Fig. 177J1-J2) and *U. janarthanamii* the seeds are sub-globose, while they are oblongoid to sub-globose in *U. graminifolia* (Fig. 176H1-H2), *U. malabarica* (Fig. 176I1-I2), *U. recta* (Fig. 177N1-N2), *U. smithiana* and *U. uliginosa* (Fig. 179Q1–Q2). The seeds are ellipsoid in *U. polygaloides* (Fig. 177K1-K2), *U. praeterita* (Fig. 177L1-L2), *U. purpurascens* (Fig. 177M1-M2) and ellipsoid to oblongoid in *U. sainthomia*, while obovoid to ellipsoid in *U. cecilii* (Fig. 176G1-G2) and *U. reticulata* (Fig. 179O1-O2) and *U. scandens* (Fig. 179P1-P2). *Utricularia bifida* has obliquely obovoid seeds (Fig. 176F1-F2), whereas they are obovoid to oblongoid in *U. albocaerulea* and *U. lazulina*.

Most of the species analysed in sect. *Oligocista* exhibit a reticulate testa with elongate cells. The anticlinal walls vary widely, being slightly or deeply raised, straight, sinuate or wavy, thin or thick, and with or without intercellular gaps. The anticlinal boundaries are slightly raised in *U. nayarii*, *U. polygaloides*, *U. recta*, and *U. reticulata* (Figs. 177J3, K3 & N3, & 179O3), whereas prominently raised in *U. albocaerulea*, *U. bifida*, *U. cecilii*, *U. graminifolia*, *U. lazulina*, *U. malabarica*, *U. ponmudica*, *U. sainthomia, U. scandens* and *U. uliginosa* (Figs. 176E3, F3, G3, H3 & I3, 179P3 & Q3). The anticlinal walls are sinuate in *U. lazulina* and *U. janarthanamii*.

The cell corners are thick in *U. albocaerulea*, *U. cecilii*, *U. nayarii* and *U. uliginosa*, while they are nearly uniform in the other species. Intercellular gaps between the anticlinal walls are present in *U. malabarica* (Fig. 176I3), *U. nayarii* (Fig. 177J3), *U. recta* (Fig. 177N2), *U. scandens* (Fig. 179P2), and *U. uliginosa* (Fig. 179Q3), but are absent or unclear in the remaining species. Most species have smooth anticlinal walls, while striated in *U. bifida*, *U. polygaloides*, *U. reticulata,* and rough in *U. scandens*.

The periclinal walls are flat in *U. nayarii*, slightly concave in *U. cecilii*, *U. polygaloides*, *U. praeterita*, U. *reticulata*, and *U. recta*, deeply concave in *albocaerulea*, *U. bifida*, *U. graminifolia*, *U. lazulina*, *U. malabarica*, *U. ponmudica*, *U. sainthomia*, *U. scandens* and *U. uliginosa*. The surface is smooth in *U. albocaerulea*, *U. cecilii*, *U. graminifolia*, *U. lazulina*, *U. nayarii*, *U. ponmudica*, *U. praeterita*, *U. purpurascens* and *U. uliginosa*, and rough in *U. scandens*. Five species show striated ornamentation, in which *U. bifida* (Fig. 176F3), *U. polygaloides* (Fig. 177K3) and *U. reticulata* (Fig. 179O3) exhibit longitudinal ridges, while *U. malabarica* (Fig. 176I3) and *U. sainthomia* display transverse ridges. *Utricularia bifida* has oblique longitudinal ridges (Fig. 176F3), and *U. polygaloides* and *U. reticulata* feature longitudinal ridges with indistinct bullate processes (Figs. 177K3 & 179O3).

The hilum is terminal in *U. albocaerulea*, *U. ponmudica*, *U. sainthomia*, *U. smithiana* and *U. uliginosa*, sub-terminal in *U. purpurascens* and *U. recta*, lateral in *U. janarthanamii*, *U. nayarii*, *U. reticulata* whereas latero-terminal in *U. bifida*, *U. cecilii*, *U. graminifolia*, *U. lazulina*, *U. malabarica*, *U. polygaloides, U. praeterita* and *U. scandens*.

Species of sect. *Phyllaria* usually possess various testa cell extensions of outer periclinal walls. Seeds are obovoid in *U. furcellata* and *U. striatula* whereas ellipsoid in *U. brachiata* and *U. kumaonensis*. Strap-shaped, finely striated hairs are found at both ends of the seeds in *U. brachiata* and *U. kumaonensis*, which are equal in length to the length of the body in *U. brachiata* (Fig. 179R1 & R2) but much longer than the body in *U. kumaonensis* (Fig. 180T2). The periclinal walls in both species are covered with small conical papillae, irregularly folded and adorned with vermiform ridges (Fig. 180T3). The anticlinal walls in both species are concave and sinuate, with short conical papillae, that are finely striated and display vermiform ridges. *Utricularia furcellata* (Fig. 179S2) and *U. striatula* (Fig. 180U2, U3) bears clavate and glochidiate testa hairs, respectively. The anticlinal walls are deeply concave, sinuate, and marked with wrinkled papillae in *U. striatula* and *U. furcellata* (Fig. 179S3). Among the four species, *U. brachiata* and *U. kumaonensis* have a lateral hilum, while *U. furcellata* and *U. striatula* may have either lateral or terminal hilum.

In sect. *Utricularia*, the seeds are usually dorsiventrally compressed and winged. In *U. aurea* and *U. stellaris* (Fig. 180V1, X1), the seeds are disc-shaped and share a similar morphology, though the surface of *U. aurea* is tuberculate (Fig. 180V3) and that of *U. stellaris* is papillate. The seeds of *U. gibba* are broadly winged and feature numerous conical papillae (Fig. 180W1, W3). All species in this section have a central hilum.

**7.5. Discussion**

The study highlights the remarkable diversity of seed morphology in *Utricularia*, focusing on seed shape, position of hilum, testa cell characteristics such as cellular pattern, the structure of anticlinal and periclinal walls, and ornamentation. The seeds exhibit wide range of shapes, from sub-globose or ovoid to oblongoid or ellipsoid, with a reticulate testa (Taylor, 1989). Although, the seeds size varies, it is not much useful for species identification and delimitation. In contrast, the pattern of testa ornamentation, the shape of the testa, and the characteristics of the anticlinal and periclinal walls exhibit significant variation at the sectional level, and useful for delimitation and identification of the taxa studied.

The results on testa pattern are congruent with previous studies by Abraham and Subramanyam (1965) and Taylor (1989). The testa is usually reticulate, with polygonal, rectangular, isodiametric, elongate, or irregular shaped cells. Anticlinal walls may be slightly to prominently raised or concave, and can be straight or sinuate, thin or thick, with or without intercellular space. Periclinal walls are usually slightly or deeply concave, convex or flat.

Species within sect. *Phyllaria* are characterised by well-developed testa extensions or hairs on the outer periclinal walls. These hairs may be located at one or both ends of the seed and can be strap-shaped, clavate, or glochidiate, and of varying size. These periclinal hairs hold considerable taxonomic value for species delineation. Similar testa extensions or hairs are found in members of the Orchidaceae, where they slow seed descent and aid to adhere to the substrate (Chase & Pippen, 1988). Additionally, species of Gesneriaceae, especially in the tribe Trichosporeae, also possess testa hairs, which have strong taxonomic implication (Mendum *et al*., 2001). Given that members of sect. *Phyllaria* are usually epiphytic or lithophytic, the presence of glochidiate hairs, clavate hairs and long strap-shaped hairs enhance the seed dispersal and supports seedling establishment in their specialized habitats.

Terrestrial species exhibit several features, such as shape of seeds and testa characteristics, raised anticlinal walls, and concave periclinal walls. These species usually produce seeds with reticulate or elongate testa cells, with or without ornamentation. Within sect. *Oligocista*, the characteristics of anticlinal walls, periclinal walls, and ornamentation are found to be taxonomically useful. However, the seed data can only be considered as supporting information for delimiting species, as it alone is insufficient for confirming identity. For example, the seeds of *U. reticulata* and *U. polygaloides* share many common characters, and the available seed is not sufficient to definitely distinguish between these two species. Similarly, *U. cecilii* and *U. praeterita* share similar seed traits, making their delimitation difficult based exclusively on seed morphology.

Although Abraham and Subramanyam (1965) reported striated ornamentation in three species, *U. bifida*, *U. foveolata* and *U. polygaloides,* the present

study corroborates their findings. *Utricularia bifida* is the only species that shows slightly concave periclinal walls with oblique longitudinal ridges. In contrast, *U. polygaloides* and *U. reticulata* features slightly concave periclinal walls with longitudinal ridges and indistinct bullate processes. Furthermore, I found deeply concave periclinal walls with transverse ridges in *U. malabarica*, the same pattern was reported by Biju *et al.* (2020) in *U. sainthomia*. Among the studied species, *U. scandens* is unique for its rough surface with finely verrucate ornamentation.

When comparing with the aquatic and epiphytic species of *Utricularia*, terrestrial species usually produce numerous small seeds per capsule. This strategy enhances the chances of seed dispersal into new environments, promoting colonization (Gordon, 1998), and may explain the widespread distribution mass growth of *Utricularia.* Moreover, the large testa cells and periclinal walls in terrestrial species favour water dispersion by trapping air bubbles (Menezes *et al*., 2014), which may aid in buoyancy and contribute to the ability of seeds to float and germinate.

Species in sect. *Utricularia* are characterized by dorsiventrally compressed, lenticular, prismatic, or disc-shaped seeds with well-developed narrow wings. These species produce fewer seeds per capsule, and their seeds are usually larger than those of other sections typically ranging from 0.8 to 1.5 mm in diameter. Similar results were reported by Abraham and Subramanyam (1965) in *U. gibba*, *U. aurea* and *U. inflexa* var. *stellaris*. However, the seed size alone has little diagnostic value. The development of winged seeds is in aquatic species is an ecological adaptation that facilitates effective seed dispersal. The buoyancy of winged seeds allow them to float and easily glide through the water, remaining suspended for long periods and facilitating long distance dispersal.

**7.6. Conclusion**

The study elucidated the micromorphology of seeds of Indian *Utricularia* to evaluate their taxonomic significance. All species studied produce numerous small seeds, typically less than 2 mm diameter. While seed characteristics such as shape and size alone are not fully reliable for species identification. However, the pattern

of testa cells, shape and nature of anticlinal and periclinal walls, position of hilum and ornamentation of testa, emerge as valuable diagnostic characters for sectional and species-level delimitation.

The production of numerous dust seeds, which facilitate rapid colonization, represents an important ecological adaptation of *Utricularia*. The reticulate testa pattern, observed in many terrestrial species, is an intriguing characteristic that may be linked to the ecology and evolution of the species. Members of sect. *Phyllaria*, which usually grow in epiphytic and lithophytic environments, are characterized by the presence of testa hairs. These periclinal hairs hold both diagnostic and ecological value, likely playing a crucial role in seed dispersal. By aiding in the attachment of seeds to suitable substrates, these hairs help ensure that seeds reach suitable locations for seedling establishment. Similarly, the winged seeds found in aquatic species are an adaptation for effective dispersal through water, enhancing long-distance seed transport.

Give that the micromorphological evidence highlights the ecological significance of these features, further research focused on seed structure in relation to growth forms, dispersal strategies, and seedling mechanisms would give deeper insights into the ecology and evolutionary processes of *Utricularia*.

# PHYLOGENY OF UTRICULARIA L.

## 8.1. Introduction

Phylogeny refers to the historical development of a group of taxa from their common ancestors, while molecular phylogeny examines the relationships among organisms or genes by comparing homologues of their DNA (Patwardhan *et al.*, 2014). In recent decades, molecular phylogenetic studies in angiosperms have received considerable attention, largely due to the availability of molecular markers and whole genome sequence data. The internal transcribed spacer (ITS) region of the 18S–5.8S–26S nuclear ribosomal cistron is universal, composed of both highly conserved and variable domains. It is widely considered as the most suitable sequence for determining phylogenetic relationship at both the generic and infrageneric levels in plants (Alvarez & Wendel, 2003). The ITS region is widely used in phylogenetic analysis due to its universality, biparental inheritance, and simplicity (Alvarez & Wendel, 2003). While molecular phylogenetic analyses of *Utricularia* have received considerable attention globally, sequence data for Indian species remain scarce. The present study provides nrITS and *rps*16 intron data for Indian *Utricularia* species, aiming to clarify their phylogenetic relationships, the position of each taxon, and the identity and position of Indian endemics.

## 8.2. Materials and methods

### 8.2.1. Taxon sampling

For the present phylogenetic analysis, sequences of 85 accessions representing 33 taxa of *Utricularia* were newly generated (Appendix V, table 6), while the sequences for the remaining accessions were retrieved from GenBank, form the ingroup (Appendix VI & VII, table 7 & 8). Species from *Pinguicula* and *Genlisea*, both members of the family Lentibulariaceae, were selected as outgroup taxa. Fresh inflorescence tips were used for DNA extraction, in order to prevent chances of contamination while using subterraneous leaves. The young inflorescence tips

collected in the field were placed in fresh tea bags and preserved in silica gel containers. Materials collected in plastic containers or ziplock collection bags were transferred into aluminium foil and stored in a refrigerator at 4°C. The nrITS region from species such as *U. janarthanamii*, *U. scandens* and *U. smithiana* failed to amplify and were excluded from the study. Similarly, *U. janarthanamii* and *U. sisparensis* were also excluded due to difficulties in amplifying the *rps*16 region. A wide sampling of most available species, representing various sections of the genus, was carried out to find out the complete range of variation of infraspecific variation and to get a more resolved phylogeny.

**8.2.2. DNA extraction**

Fresh and silica dried inflorescence tips were used for DNA extraction (Fig. 182). The DNA was extracted manually using a modified CTAB (Cetyltrimethylammonium bromide) method by Doyle and Doyle (1987). The protocol used in this study is given below:

**Pre-extraction setup**: Prior to initiating DNA extraction, the water bath was set to 65°C, and 1 ml of 2% CTAB buffer with 2µl of β- mercaptoethanol per ml was preheated at 65°C.

1. Approximately 100 mg of fresh plant tissue was placed in a mortar and ground with liquid nitrogen using a pestle. In the absence of liquid nitrogen, the mortar and pestle were pre-chilled in the refrigerator for about an hour before grinding the tissue.

2. 1 ml of the preheated extraction buffer (1ml 2% CTAB buffer + 2µl β-mercaptoethanol) and a pinch of PVPP (Polyvinylpolypyrrolidone) were added to the ground tissue. The mixture was gently mixed and then transferred into a clean 2 ml micro-centrifuge tube.

3. The sample was incubated at 65°C for 1 hour in a water bath, with gentle shaking at regular intervals during the incubation.

4. After incubation, the tube was removed from the water bath and allowed to cool for 1–2 minutes at room temperature.

5. 500 µl of chloroform: IAA (24:1) mixture was added to the tube, and the contents were gently shaken to form a momentary single phase.

6. The sample was centrifuged at 13,000 rpm for 10 minutes in a 4°C centrifuge.

7. The upper layer of supernatant was collected into a clean 1.5 ml micro-centrifuge tube, and the remaining was discarded.

8. 600 µl of ice-cold isopropanol (2-propanol) was added to the supernatant and gently shaken to precipitate the DNA. The tube was placed in the freezer overnight to allow complete DNA precipitation.

9. A white or off-white DNA pellet formed at the bottom of the tube. The pellet was collected by centrifuging the tube at 13,000 rpm for 10 minutes.

10. The supernatant was removed, and 500 µl of 70% alcohol (wash buffer) was added to the pellet. The tube was vigorously agitated to release the pellet from the bottom and left to rest for 30 minutes at room temperature.

11. The tube was centrifuged again for 5 minutes at 13,000 rpm at 4°C. The supernatant was decanted, and the tube was inverted to drain any remaining wash buffer.

12. The pellet was allowed to dry at room temperature.

13. The dried pellet was dissolved in 100 µl of 1X TE buffer and mixed well.

14. The extracted DNA sample was stored at -20°C in a deep freezer for long term preservation.

**Fig. 182**. **A.** Molecular biology laboratory setup; **B.** Samples stored in silica; **C.** DNA extraction setup; **D.** Amplification reaction in PCR thermal cycler; **C.** Quantification using agarose gel electrophoretic unit

### 8.2.3. Quantification of DNA

The concentration and purity of the extracted genomic DNA were analysed using a Nanodrop Analyzer and agarose gel electrophoresis.

**a. Using Nanodrop Analyser**

The isolated genomic DNA was quantified, and its purity was determined using a Nanodrop Analyzer (DeNovix DS-11 Spectrophotometer, USA). The absorbance values at 260 nm and 280 nm were used to determine the purity of nucleic acids. The ideal A260/A280 ratio is 1.8 (up to 2.0). The A260/A230 ratio is another important measure of purity, indicating the presence of contaminants such as unwanted organic compounds, with the ideal range of 2.0–2.2.

**b. Agarose gel electrophoresis**

The genomic DNA was usually run on a 0.7% agarose gel to determine the quality and quantity of the extracted DNA. To prepare the gel, 0.75 g agarose was weighed and dissolved in 75 ml IX TAE buffer. The solution was then poured into a gel casting tray and allowed to solidify. The electrophoresis tank (ENDURO™, Labnet) was filled with 750 ml of 1XTAE buffer, and 18 µl of Ethidium bromide was added for DNA visualization. 2 µl of the extracted genomic DNA samples, mixed with 2 µl of 6X gel loading dye (Himedia), were loaded into the wells of the agarose gel. The size of the isolated DNA was quantified by loading 2 µl of a 100bp DNA ladder (Invitrogen) into the first well. The gel was run for 45 minutes at 70 V and 120 mA. After electrophoresis, the gel was transferred into the Gel Documentation system (ENDURO™ GDS1302, Labnet), and visualized under UV light. The gel image was captured using the Enduro GDS software, and DNA samples showing intense intensity bands were taken for PCR amplification.

**8.2.4. Selection and preparation of primers for PCR**

In the present study, two genomic DNA regions, nrITS and *rps*16, were used for phylogenetic analysis. The internal transcribed spacer (ITS) region has been widely used for resolving phylogenies between closely related species (Tan *et al*., 2020) and within populations of the same species (Simon *et al*., 2012). ITS also serves as a complementary DNA barcode in the Barcode of Life Data Systems (BOLD) for plants (China Plant BOL Group, 2011; Tripathi *et al*., 2013; Li *et al*., 2015) and is employed in metabarcoding for biodiversity assessment and quality control in DNA

applications (Kolter *et al.*, 2021). The *rps*16 region has also been widely used in phylogenetic analysis. The *rps*16 intron primer was used following the method described by Oxelman *et al.* (1997).

**Table 1:** Primers used for PCR amplification and sequencing

| | DNA region | Primer region | Primer sequences | References |
|---|---|---|---|---|
| 1 | nrITS | ITS5P | 5′- GGA AGG AGA AGT CTA ACA AGG - 3′ | Moller & Cronk, 1997 |
| | | ITS8P | 5′ – CAC GCT TCT CCA GAC TAC A – 3′ | |
| 2 | *rps*16 | *rps*F | 5′ - GTG GTA GAA AGC AAC GTG CGA CTT -3′ | Oxelman *et al.*, 1997 |
| | | *rps*16 | 5′- TCG GGA TCG AAC ATC AAT TGC AAC-3′ | |

### 8.2.5. PCR Amplification

The PCR amplification of the isolated genomic DNA was performed using nrITS and *rps*16 intron primers (table. 1). The basic PCR reaction had a total volume of 25 µl, consisting of 24 µl of reaction mixture and 1µl of template DNA. The amplification was performed in a Veriti Thermal Cycler (Applied Biosystems, USA). The reaction mixture was composed of various reagents (table 2).

**Table 2:** Mastermix composition of 25 µl PCR reaction

| Reagents | nrITS | *rps*16 |
|---|---|---|
| Forward primer | 1.25 µl | 1.25 µl |
| Reverse primer | 1.25 µl | 1.25 µl |
| 10X buffer | 2.5 µl | 2.5 µl |
| Dntp | 2.0. µl | 2.0. µl |
| DMSO | 1.25 µl | 1.25 µl |
| Taq polymerase | 0.2 µl | 0.2 µl |
| Nuclease free $H_2O$ | 15.55 µl | 15.55 µl |

The PCR thermal profiles for nrITS and *rps*16 are given below (table 3).

**Table 3:** PCR conditions for target sequences

| **ITS** | | | ***rps*16** | | |
|---|---|---|---|---|---|
| 95°C | 5 min | | 94°C | 2 min | |
| 95°C | 45 sec | 35 cycles | 94°C | 30 sec | 35 cycles |
| 55.4°C | 1 min | | 58°C | 40 sec | |
| 72°C | 1 min | | 72°C | 30 sec | |
| 72°C | 10 min | | 72°C | 10 min | |
| 4°C | Infinity | | 4°C | Infinity | |

The amplified PCR products were subjected to gel electrophoresis. 2 µl of PCR product and 2 µl of gel loading dye were loaded into the wells and electrophoresed (Figs. 183 & 184).

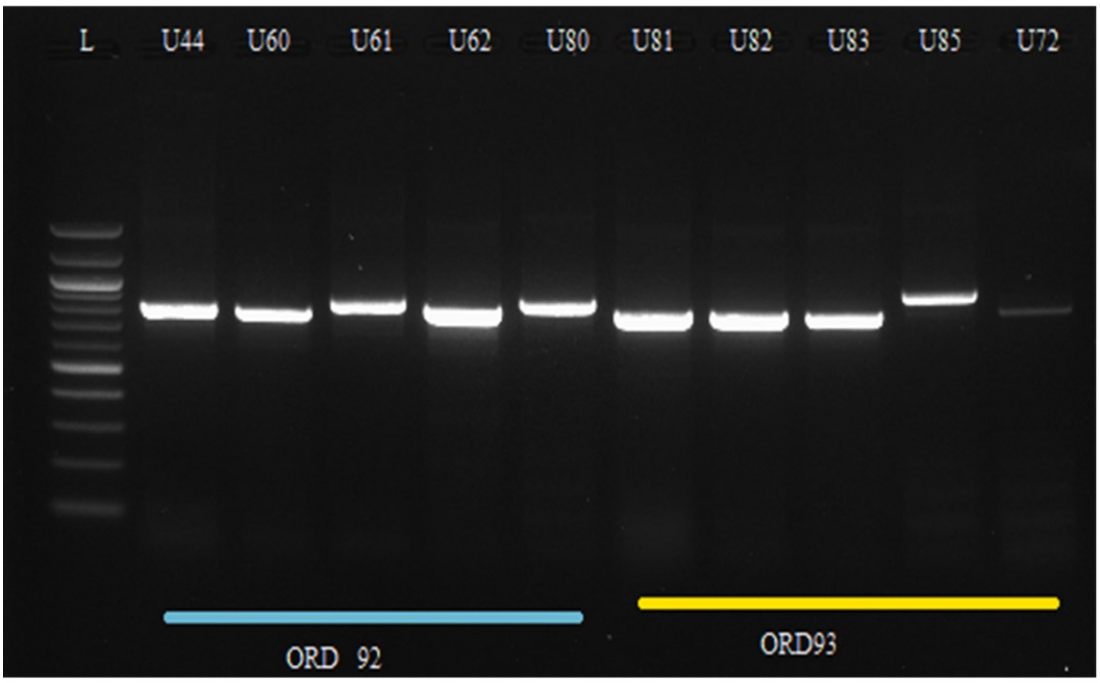


**Fig. 183.** Gel image of ITS amplified PCR products; L is the ladder and U44-U72 represents the samples.

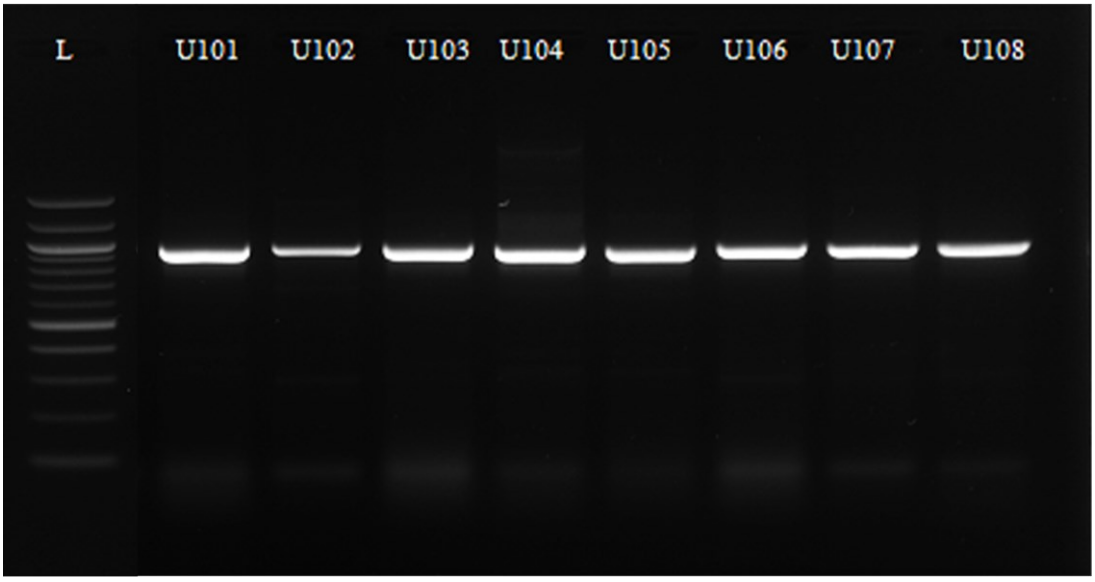


**Fig. 184.** Gel image of *rps*16 amplified PCR products; L is the ladder and U8-U108 represents the samples.

### 8.2.6. DNA sequencing

The sequencing was performed commercially at AgriGenome Cochin and GeneSpec Cochin. The sanger sequencing method (Sanger *et al*., 1977) was employed. Amplified PCR products were purified using the Nucleopore SureExtract Kit (Genetix, New Delhi, India), and sequenced with the BigDye™ Terminator v.3.1 Cycle Sequencing kit (Applied Biosystems, Waltham, USA), following the manufacturer's protocols.

### 8.2.7. Sequence alignment

All obtained sequences were checked in GenBank using the BLASTN program to identify those with highest identity. The newly generated sequences were aligned, edited, and the strands were combined using Sequencher v.4.14. (Gene Codes Corporation, Ann Arbor, Michigan, USA). For the nrITS matrix, sequences were aligned using MAFFT v.7 online (Katoh *et al*., 2019). The *rps*16 sequences were aligned and trimmed using MUSCLE (Edgar, 2004), embedded in MEGA v.11 (Tamura *et al*., 2021).

### 8.2.8. Phylogenetic analysis

To construct phylogenetic trees, Maximum likelihood (ML) and Bayesian Inference (BI) analyses were used to infer the phylogenetic relationships among

*Utricularia* species. Maximum accessions from the range of each species were included in the study to ensure broad sampling. Since the ILD test indicated incongruence between nuclear and plastid data, a combined analysis was not performed. However, the individual trees provided better overall topology and moderate to high support values for the nodes. Consequently, individual trees were analysed, and the results are presented and discussed here.

**8.2.8.1. ML and BI analysis for nrITS and *rps*16 sequences:**

Maximum likelihood analysis for each gene alignment was conducted using IQTREE v.2.1.2 (Minh *et al*., 2021) with 10,000 ultrabootstrap replicates. Model selection was performed using Modelfinder (Kalyaanamoorthy *et al*., 2017) based on the Akaike Information Criterion (AIC). The general time reversible (GTR)+ proportion of invariable sites (I)+ and gamma distribution (G), GTR+I+G (lset nst=6, rates=invgamma) was used for the nrITS dataset, while GTR+F+G4 (lset nst=6, rates=gamma) was used for the *rps*16 dataset.

Bayesian inference analysis was performed using MrBayes v.3.2.7a x86_64 (Ronquist *et al*., 2012). Two runs with four chains (one 'cold' and three 'heated') were performed using Markov Chain Monte Carlo (MCMC) algorithm, running for 10 million generations with sampling every 1000 generations. Convergence was assessed by checking whether the standard deviation of split frequencies dropped below 0.01. The nucleotide substitution model for BI analysis was selected using jModelTest 2.1.10 (Darriba *et al*., 2012), based on the Bayesian Information Criterion for each dataset. The GTR+I+G model was selected for nrITS dataset, while GTR+F+G4 was selected for the *rps*16 dataset (the same models as used in ML analysis). The first 25% of trees (burninfrac=0.25) were discarded as burn-ins, and the remaining trees were used to summarise the posterior probability (PP) using a 50% majority-rule consensus. Trees were visualized and partially edited in FigTree v.1.4.3 (Rambaut, 2012) and iTOL v6 (Letunic & Bork, 2024).

**8.3. Results**

The phylogenetic analysis based on the nuclear ITS and *rps*16 intron, incorporating a wide sampling of Indian materials, is presented here for the first

time. The nrITS dataset analysis included representatives from 14 of the 32 recognized sections of two subgenera, while the *rps*16 dataset analysis included 21 sections from three subgenera. Phylogenetic analyses for both regions were conducted using Maximum Likelihood (ML) and Bayesian Inference (BI) methods. Since, the ML and BI analysis resulted in trees with similar topologies, the single trees with ML and BI values are discussed here. In the ML trees, clades with bootstrap percentages (BP) of 50% and above are represented, with BP values categorized as weak (50–74%), moderate (75–89%), and strong (90–100%).

### 8.3.1. Phylogenetic analysis based on nrITS data

The nrITS dataset included 195 sequences from 62 taxa, including the outgroup. The matrix contained 924 characters, of which 197 were constant sites, 685 were parsimony informative sites, and 42 were singletons. Gaps were treated as missing data. The resulting phylogenetic tree resolved into two major clades (Fig. 185): clade I consisted of sect. *Oligocista* of subgen. *Bivalvaria*, and clade II included sections *Meionula*, *Nigrescentes*, *Calpidisca, Australes, Phyllaria Orchidioides*, *Iperua*, *Psyllosperma*, *Foliosa*, *Vesiculina*, *Avesicaria*, *Setiscapella* and *Utricularia*. Clade II further bifurcated into two subclades with moderate ML bootstrap support (BS=77) and posterior probability (PP=0.89). Subclade I of clade II was represented by sections *Meionula*, *Nigrescentes*, *Calpidisca, Australes* and *Phyllaria* (of subgen. *Bivalvaria*), while subclade II consisted sections *Orchidioides*, *Iperua*, *Psyllosperma*, *Foliosa*, *Vesiculina*, *Avesicaria*, *Setiscapella* and *Utricularia* (of subgen. *Utricularia*).

**Clade I:** The *Oligocista* clade is characterized by simple leaves, mostly basal traps, basifixed scales, bracts and bracteoles, galeate palate, and a majority of terrestrial species. This clade consisted of *U. bifida*, *U. involvens*, *U. circumvoluta*, *U. recta*, *U. reticulata*, *U. polygaloides*, *U. foveolata*, *U. albocaerulea*, *U. sainthomia*, *U. malabarica, U. cecilii*, *U. praeterita*, *U. ponmudica*, *U. sisparensis*, *U. uliginosa*, *U, lazulina*, *U. nayarii*, *U. wightiana*, *U. purpurascens*, *U. graminifolia*, *U. sunilii*, and *U. babui*. Phylogenetic analysis reveals a strong separation of most species, except for *U. graminifolia* and the closely allied *U. babui* and *U. sunilii*, which form an unresolved polytomy. Notably,

the lobed and unlobed samples of *U. sunilii*, along with *U. babui* and *U. graminifolia*, cluster together in both phylogenetic and morphological analyses.

*Utricularia albocaerulea*, *U. sainthomia* and *U. malabarica* are resolved as distinct species in a strongly supported clade (BS=100; PP=1), underscoring their distinctiveness, which is consistent with differences in trap morphology and seed micromorphology. Moreover, accessions of the white, blue and pink morphotypes of *U. malabarica* cluster with the typical morphotype, further supporting the morphological data. The *U. uliginosa* clade forms a sister clade to *U. cecilii*, *U. praeterita*, *U. ponmudica* and *U. sisparensis*, with strong support (BP=100; PP=1), resolving their distinctiveness. This sister clade also shows strong support (BP=98; PP=0.99) with a group consisting of *U. lazulina*, *U. nayarii*, *U. wightiana*, *U. purpurascens* and the *U. graminifolia* complex.

**Clade II:** This clade comprises two moderately supported sister clades, with BS=77 and PP=0.89. Subclade I includes species from sections *Meionula*, *Nigrescentes*, *Calpidisca, Australes* and *Phyllaria* of subgen. *Bivalvaria*. The analysis indicates that subgen. *Bivalvaria* is paraphyletic. Subclade II includes sections *Psyllosperma*, *Orchidioides*, *Iperua*, *Foliosa*, *Vesiculina*, *Avesicaria*, *Setiscapella*, and *Utricularia* of subgen. *Utricularia*.

**Subclade I:** This moderately supported clade (BS=82; PP=0.96) further bifurcates into two sister groups (subclade IA and subclade IB). Within this, clades A and B form a weakly supported sister clade (BS=70; PP=0.71), which together are sister to clades C, D, and E. Clade A, a strongly supported group (BS=100; PP=1), is represented by section *Meionula*, including *U. hirta*, *U. minutissima*, and *U. geoffrayi*. This clade is characterized by small herbs with 1-nerved leaves, basifixed scales, bracts and bracteoles, and gland-tipped appendages of the traps. Within this clade, *U. hirta* forms a sister group to *U. minutissima* and *U. geoffrayi*.

Clade B is also strongly supported (BS=100; PP=1) and consists of sect. *Phyllaria*, which includes epiphytic or lithophytic herbs. These species are characterized by basisolute bracts and bracteoles, obovate or reniform dichotomously veined leaves, flabellate appendages on the lateral traps, unequal

calyx lobes, and a lobed corolla. This clade includes species *U. striatula*, *U. kumaonensis*, *U. brachiata*, and *U. furcellata*.

Clade C of subclade IB consists of sect. *Calpidisca*, and within which *U. sandersonii* forms a strongly supported sister clade (BS=100; PP=1) to *U. arenaria*. Clade D represents *U. lateriflora* of sect. *Australes,* which is moderately supported as a sister clade (BS=86; PP=0.79) to sect. *Nigrescentes* (clade E). Within clade E, *U. caerulea* and *U. roseopurpurea* are resolved as distinct sister clades with strong support (BS=100; PP=1).

**Subclade II:** This subclade is moderately supported, with BS=83 and PP=0.92, and represents sections *Psyllosperma*, *Orchidioides*, *Iperua*, *Foliosa*, *Vesiculina*, *Avesicaria*, *Setiscapella*, and *Utricularia*. It is further bifurcated into two unsupported clades. Clades A, B, and C form an unsupported sister group to clades D,E,F,G,H, and I. Clade A consists of *U. longifolia*, *U. praelonga* and *U. hispida*, which group together in an unsupported clade with sections *Orchidioides* (clade B) and *Iperua*. The tree reveals paraphyly within sect. *Psyllosperma*, where *U. calycifida* nests with sect. *Foliosa*. Clade F, composed of *U. purpurea* and *U. cucullata* from sect. *Vesiculina*, forms a moderately supported sister clade (BS=82; PP=0.94) with *U. neottioides* of sect. *Avesicaria* (clade G) and *U. subulata* and *U. nervosa* from sect. *Setiscapella*. Clade I includes members of section *Utricularia*, where *U. gibba* is the earliest diverging lineage, sister to the remaining species. This clade represents species *U. stellaris*, *U. aurea*, *U. radiata*, *U. breviscapa*, *U. inflata*, *U. minor*, *U. intermedia*, *U. geminiscapa*, and *U. macrorhiza*. Within this clade, all species are recovered as distinct, except *U. aurea* and *U. kamarudeenii*, which are unresolved and clustered together, and consistent with the morphological findings.

### 8.3.2. Phylogenetic analysis based on *rps*16 data

The *rps*16 dataset included 211 sequences from 86 taxa, including the outgroup. The matrix included 951 aligned characters, of which 407 were constant sites, 412 were parsimony-informative sites and 132 were singletons. Gaps were treated as missing data. The present phylogenetic analysis revealed three major clades: subgen. *Polypompholyx*, subgen. *Bivalvaria* and subgen. *Utricularia* (Fig. 186).

These findings support previous phylogenetic studies of the genus (Moller & Borsch, 2005; Reut & Jobson, 2010; Jobson *et al*., 2017; Silva *et al*., 2018). The strict consensus tree demonstrated that subgen. *Polypompholyx* forms a strongly supported monophyletic lineage (BS=97; PP=1), sister to both subgen. *Bivalvaria* and *Utricularia*.

**Utricularia subgen. Polypompholyx clade (Clade I)**

This strongly supported clade (BS=100; PP=1) consists of two sections: sect. *Polypompholyx* and *Pleiochasia*. The members of this clade share similar general characteristics, including the absence of scales, and four-lobed calyx (Taylor, 1989). The sect. *Pleiochasia* clade consists of *U. uniflora, U. menziesii*, *U. violacea*, *U. volubilis*, and *U. monanthos*, which form a sister group to *U. multifida* of sect. *Polypompholyx*. The results indicate that the sect. *Pleiochasia* is paraphyletic, with sect. *Polypompholyx* nested within it.

**Utricularia subgen. Utricularia clade (Clade II)**

This is strongly supported clade (BP=94; PP=1) contains species from nine sections: *Avesicaria*, *Foliosa*, *Iperua*, *Nelipus*, *Orchidioides*, *Psyllosperma*, *Setiscapella*, *Vesiculina*, and *Utricularia*. All sections were recovered as monophyletic, except for sect. *Setiscapella*, which was paraphyletic. Within this clade, two strongly supported subclades were formed. Subclade I, a polytomous clade (BS=98 and PP=1), consists of species from sections *Orchidioides*, *Psyllosperma*, *Iperua*, and *Foliosa*.

Subclade II is bifurcated into two strongly supported clades (BS=98; PP=1), clades A and B. Clade A, with BS=100 and PP=1, consists of four sections *Nelipus*, *Setiscapella*, *Avesicaria*, and *Vesiculina*, which are sister to the sect. *Utricularia* clade (clade B). Within this, sect. *Vesiculina* forms a clade (BS=100; PP=1), sister to the sects. *Setiscapella* + *Avesicaria*, but this relationship remains unresolved.

Clade B is also strongly supported (BS=100; PP=1). Within this clade, *U. gibba* is resolved as a distinct lineage with strong support (BS=100; PP=1), sister to the remaining species of sect. *Utricularia*: *U. radiata*, *U. inflata*, *U. stellaris*, *U. aurea*, *U. geminiscapa*, *U. minor*, *U. intermedia*, *U. bremii*, *U. australis*, and *U. macrorhiza*. Species like *U. minor*, *U. intermedia*, *U. bremii*, *U. australis*, and *U. macrorhiza* formed a strongly

supported polytomous clade, possibly due to a low phylogenetic signal, though they are morphologically distinct. The accessions of *U. aurea* and *U. kamarudeenii* collected in this study, nested within a network of clades, alongside other GenBank accessions, revealing the uniqueness and providing additional support for the morphological data.

**Utricularia subgen. Bivalvaria clade (Clade III)**

This is strongly supported clade (BS=98; PP=1), includes representatives from nine sections. Within this clade, two major subclades are formed. Subclade I is represented by five monophyletic sections: *Australes*, *Calpidisca*, *Meionula*, *Nigrescentes*, and *Phyllaria*. Subclade II consists of four sections: *Aranella*, *Stomoisia*, *Benjamina*, and *Oligocista*. In subclade I, sects. *Australes* and *Calpidisca* (clade A) form a strongly supported clade (BS=97; PP=0.98), which is sister to sections *Meionula* (clade B), *Nigrescentes* (clade C), and *Phyllaria* (clade D). Clade A is represented by *U. lateriflora*, which forms a strongly supported sister clade (BS=99; PP=1) with *U. pubescens*, *U. bisquamata*, *U. sandersonii*, and *U. livida* of sect. *Calpidisca*.

Clade B, representing sect. *Meionula*, forms a strongly supported sister group (BS=98; PP=1) with clades C and D. Clade B consists of three species: *U. minutissima*, *U. geoffrayi*, and *U. hirta*, all of which are characterized by 1-nerved leaves, gland-tipped trap appendages, and basifixed scales, bracts and bracteoles. Clades C and D are strongly supported monophyletic sister clades (BS=100; PP=1), and both are characterized by the extension of the placenta. In clade C, *U. warburgii* Goebel forms a sister clade to *U. caerulea* + *U. roseopurpurea*, all of which have a terminal trap mouth, and basisolute or medifixed scales, bracts and bracteoles. Clade D consists of *U. pulchra* P.Taylor, *U. striatula U. brachiata*, *U. furcellata*, and *U. kumaonensis*, which are characterized by a lobed lower lip of the corolla, unequal calyx lobes, a large upper lip of corolla, lateral trap mouth with flabellate appendages, and seeds with various types of testa hairs. Within clade D, *U. pulchra* forms a strongly supported sister clade with *U. striatula*, and together they are sister to *U. brachiata*, *U. furcellata*,

and *U. kumaonensis* (BS=98; PP=1). All species in this section were recovered as distinct.

Subclade II consisted of four sections: *Aranella*, *Stomoisia Benjamina*, and *Oligocista*. The results indicate that sect. *Aranella* is the early diverging monophyletic clade (clade A, BS=89; PP=0.82). This section is represented by *U. laciniata* and *U. purpureocaerulea*, which form a sister group with sect. *Stomoisia* (clade B), sect. *Benjamina* (clade C), and sect. *Oligocista* (clade D-H). Within subclade II, sect. *Oligocista* is resolved as a paraphyletic clade due to the inclusion of *U. nana* from the monotypic sect. *Benjamina*, with strong support (BS=95; PP=1).

Within this section, *U. nana* A.St.-Hil. & Girard, *U. adpressa* Salzm. ex A.St.-Hil. & Girard, *U. meyeri* Pilg., and *U. erectiflora* A.St.-Hil. & Girard form clade C, all of which are yellow-flowered. Clade D consists of yellow-flowered Asian/African/Australasian species, such as *U. prehensilis* E.May, *U. scandens*, *U. circumvoluta* P.Taylor, *U. recta*, *U. involvens* Ridl., *U. odorata* Pellegr., and *U. bifida*. Clades E-H consist of remaining blue-purple or violet-flowered taxa.

Within clade E, *U. foveolata*, together with *U. polygaloides*, and *U. reticulata* form a well-supported sister clade to clades F, G and H. These three clades (F, G. and H) form a strongly supported polytomy (BS=96; PP=1). Cade F consists of *U. purpurascens*, *U. wightiana*, *U. nayarii*, and *U. graminifolia*, along with *U. babui* and *U. sunilii*. Clade G includes three endemic species, *U. sainthomia*, *U. albocaerulea*, and *U. malabarica*, which are grouped together primarily due to their shared feature of deflexed fruiting pedicels, even though their morphology might not suggest a close relationship. Clade H, which is well-supported (BS=100; PP=1), consists of *U. praeterita*, *U. ponmudica*, *U. smithiana*, *U. lazulina*, *U. cecilii*, and *U. uliginosa*. Within this clade, *U. praeterita* forms a strongly supported sister clade (BS=99; PP=1) with *U. ponmudica* and *U. smithiana*, which together are sister to *U. lazulina*, *U. cecilii* and *U. uliginosa*.

**Status of Utricularia babui and U. sunilii**

*Utricularia babui* (Yadav *et al*., 2005) and *U. sunilii* (Kumar *et al*., 2018), both described from the Western Ghats are morphologically very close to *U. graminifolia*. The latter is a highly variable species with different habitat preferences, showing significant variation in the nature of peduncle, the shape and colour of the corolla, and leaves. A thorough morphological analysis has revealed that *U. babui* and *U. sunilii* represent merely variations within *U. graminifolia* (see chapter 5). The phylogenetic trees presented here clearly displays a polytomous network formed by the various accessions, and strongly supports (BS=100; PP=1) the inclusion of both species within *U. graminifolia*.

**Status of Utricularia nayarii**

Janarthanam and Henry (1986) described *U. nayarii* from the Idukki district of Kerala, and differentiated it from the *U. graminifolia* in having shorter spur, uniformly membranous capsule wall and a scrobiculate testa with more or less isodiametric cells. Taylor (1989) synonymized *U. nayarii* with *U. uliginosa*. In contrast, Janarthanam and Henry (1992) re-established *U. nayarii* as a distinct species. Li (2011) in the *Flora of China* and *Plants of the World Online* (POWO) database (2025) again treated it as a synonym of *U. uliginosa*.

*Utricularia nayarii* can be readily distinguished from *U. uliginosa* by its thick, multi-nerved pedicels that are longer than the calyx lobes, unequal calyx lobes with the upper lobe always shorter than the lower, an elliptic upper calyx lobe with a cuspidate apex, a bi-gibbous lower lip of the corolla, and a flat periclinal wall of the seed testa. The phylogenetic analysis presented in this study also supports the distinctiveness of *U. nayarii*, with strong support (BS=100; PP=1), confirming its separation from *U. uliginosa*.

**Status of Utricularia purpurascens**

*Utricularia purpurascens* was described by Graham (1839) from Mahabaleshwar. Taylor (1989) treated *U. purpurascens* as conspecific with *U. graminifolia*, placing it under synonymy. However, it is treated as a distinct species in

various revisions and floristic treatments (Janarthanam & Henry, 1992; Londhe, 2001; Yadav & Sardesai, 2002; Datar & Lakshminarasimhan, 2013; Nayar *et al*., 2014; Singh *et al*., 2015; Kavade & Deokule, 2015). Some floristic treatments (Deshpande *et al*., 1993; Pradhan & Singh, 1999, Li, 2011) and POWO (2025), in contrast, treated it as a synonym of *U. graminifolia*.

Morphologically, *U. purpurascens* is quite distinct from *graminifolia* in having rather thin spathulate leaves, reflexed fruiting pedicels, ligulate throat of the lower lip of the corolla, and large sickle-shaped spur. The current phylogenetic analysis further confirms the distinctiveness of *U. purpurascens*, with strong support (BS=100; PP=1), confirming its status as a separate species from *U. graminifolia*.

**Status of Utricularia roseopurpurea**

Taylor (1989) considered *U. roseopurpurea* to be a minor variant of *U. caerulea*. However, Janarthanam and Henry (1992) recognized *U. roseopurpurea* as distinct. Despite this, Li (2007), Narasimhan and Sheeba (2021), and POWO (2025), treated it again as a synonym of *U. caerulea*.

The present study, combining morphological and phylogenetic evidences, however, provide strong evidence for the differentiation between these two species, with strong support (BS=100; PP=1), confirming the distinctiveness of *U. roseopurpurea*.

**Status of Utricularia kamarudeenii**

*Utricularia kamarudeenii* was recently described by Arya *et al.* (2020) from Kerala. According to them, this species was differentiated from *U. aurea* in having shorter stolons, monomorphic traps, a deeply lobed lower lip of the corolla, and hexagonal seeds. However, a thorough morphological study of *U. aurea*, along with live materials collected from the type locality, revealed that *U. kamarudeenii* is, absolutely identical to *U. aurea* (see chapter 5). Further, no molecular divergence is observed between *U. aurea* and *U. kamarudeenii*, concluding that the latter is only a synonym of the former.

**Status of new species described**

The present study recognizes two new species of *Utricularia* from India.

*Utricularia sisparensis sp. nov.* is similar to *U. smithiana*, but can be differentiated by its elliptic lower calyx lobes, an oblong and distally oblique upper lip of the corolla, a horizontal spur shorter than or equal to the lower calyx lobe, an ovoid ovary, and a distinct style up to 1 mm long. The phylogenetic analysis presented here strongly supports the distinctiveness of *U. sisparensis* as a new taxonomic entity.

Similarly, *U. ponmudica sp. nov.*, another species compared with *U. smithiana*, can be easily distinguished by its thin leaves with an acute to obtuse apex, a shorter horizontal fruiting pedicel, a bi-gibbous palate of the corolla, and a spur that is either shorter than or just exceed the lower calyx lobe. The phylogenetic analysis also strongly supports the novelty of this species.

**8.4. Discussion**

This analysis represents the first detailed phylogenetic study of *Utricularia* with a broad sampling, including the Indian endemics. Earlier studies, which used a multilocus approach to resolve the phylogeny of *Utricularia*, did not include Indian endemics in their sampling (e.g., Muller & Borsch, 2005; Silva *et al*., 2018). For the nrITS analysis, representatives from 14 of the 32 recognized sections across two subgenera were included, and most sections were recovered as monophyletic, except sect. *Psyllosperma*. Similarly, the *rps*16 analysis included 21 of the 32 sections from three subgenera and recovered all sections as monophyletic, except for sections *Oligocista* and *Setiscapella*. This study provides valuable insights, particularly regarding the sections that represent Indian species.

The phylogenetic trees supported the distinctiveness of all species enumerated in the systematic part. It also supported the inclusion of previously unassigned Indian endemics within sect. *Oligocista*, such as *U. scandens*, *U. recta*, *U. polygaloides*, *U. reticulata*, *U. albocaerulea*, *U. sainthomia*, *U. malabarica*, *U. purpurascens*, *U. wightiana*, *U. nayarii*, *U. praeterita*, *U. cecilii*, *U. ponmudica* and *U. lazulina*.

Additionally, individual analysis of both loci showed that *U. graminifolia*, *U. babui*, and *U. sunilii* nested within a dichotomy. Since, *U. graminifolia* exhibits extreme variations in habit depending on the habitat, the inclusion of *U. sunilii* and *U. babui* within the range of variation of *U. graminifolia* was supported by both morphological and molecular data.

The *rps*16 tree resolved into three major clades, strongly supporting subgen. *Polypompholyx* as the sister group to subgen. *Bivalvaria* and *Utricularia* (I, II & III). These results were congruent with previous studies by Jobson *et al.* (2003), Muller and Borsch (2005), Reut and Jobson (2010), Jobson *et al*. (2017), and Silva *et al*. (2018). However, the present phylogenetic analysis using the nrITS dataset alone did not resolve the relationship between the subgenera. The nrITS tree revealed the paraphyly of subgen. *Bivalvaria* and sect. *Psyllosperma* of subgen. *Utricularia*.

While the combined tree supports the subgeneric relationships within *Utricularia*, unresolved polytomies were observed in the individual *rbcL*, ITS, and *rpl20-rps12* dataset analyses (Silva *et al.*, 2018). In the present phylogenetic reconstruction using *rps*16 dataset, some species in certain sections were placed in unresolved polytomies (clades F, G, and H of subclade II of clade III, subgenus *Bivalvaria* clade, and clade B of subclade II of clade II, subgenus *Utricularia* clade). This may be due to low phylogenetic signal in these regions.

The results from both the individual nrITS and *rps*16 analyses were congruent regarding the strongly supported clades, which included sections *Meionula*, *Nigrescentes*, *Oligocista*, *Phyllaria*, and *Utricularia*. Earlier phylogenetic studies placed sect. *Oligocista* as paraphyletic due to the inclusion of *U. nana* from the monotypic sect. *Benjamina* (Jobson *et al*., 2003; Silva *et al*., 2018). However, Jobson *et al.* (2024) re-circumscribed sect. *Oligocista* to include species from section *Benjamina*. The results of the *rps*16 dataset analysis presented here corroborate this re-circumscription, supporting the inclusion of *U. nana* within sect. *Oligocista* and recovering it as monophyletic (Fig. 186).

Previous phylogenetic studies included only a few representatives from sect. *Oligocista*, while Jobson *et al.* (2023) included 21 recognized taxa, including 10 species

from India. In contrast, the present study based on the *rps*16 dataset included 29 taxa, with 20 Indian taxa, while the nrITS analysis included 22 taxa, 19 of which were from India. Owing to the broader sampling of Indian taxa, slight incongruencies were observed in the phylogenetic positioning of some species within this section compared to Jobson *et al.* (2023). However, the present analyses using both loci recovered all species in sect. *Oligocista* as distinct entities, except for the *U. graminifolia* complex.

Moreover, the distinctiveness of *U. nayarii*, *U. purpurascens*, *U. recta*, and the unassigned Indian endemics, such as *U. lazulina*, *U. malabarica*, *U. albocaerulea*, *U. sainthomia*, *U. praeterita*, *U. cecilii*, *U. sisparensis*, and *U. ponmudica*, was confirmed in both analyses. The unsupported clades formed by a few species within this section may be due to the genetic divergence, which is further supported by morphological data (see chapter 5).

According to Silva *et al*. (2018), the inclusion of *U. pubescens* from the monotypic sect. *Lloydia* within the sect. *Calpidisca* was resolved with the re-circumscription of the latter section. The present results based on the *rps*16 dataset corroborate this finding, with sect. *Calpidisca* being recovered as monophyletic with the inclusion of *U. pubescens*. Besides, previous phylogenetic studies included only a single, widespread representative *U. striatula* from sect. *Phyllaria*. This study, however, is the first phylogenetic analysis to include five species from this section, *U. brachiata*, *U. furcellata*, *U. kumaonensis*, *U. striatula*, and *U. pulchra*, and all species were recovered as distinct entities.

# HABITAT DIVERSITY, THREATS AND CONSERVATION ASSESSMENT

## 9.1. Introduction

Rich biodiversity reflects the prosperity and health of diverse ecosystems and the diversity of life. Natural forests, mountains, wetlands, marine habitats, and other ecosystems hold some of its most valuable resources. It provides the essential and inevitable elements like food, pure water, air, energy, shelter, medicine, etc. Habitat is a fundamental requirement for all the living organisms encompassing the physical and biological setting in which the organism lives along with all the other components.

*Utricularia* species are found in wet, nutrient-deficient habitats and hence they are habitat specialists. In India, they are found in lateritic plateaus, mountains, wetlands, sandy soil plains, basaltic outcrops, rocky cliffs, etc. The lateritic plateaus are unique habitats with several micro-habitats of especially specialised communities having high species richness, diversity and endemism (Torpe & Watve, 2015; Aphale *et al.*, 2019; Pramod & Pradeep, 2021; Kulkarni *et al.*, 2023). The plant species in these habitats are often ephemerals and short-lived. The elemental composition of each plateau is different in which the Western Ghats escarpment of Maharashtra has basaltic as well as lateritic plateau (Aphale *et al.*, 2019). Torpe and Watve (*l.c.*) recognized the ferricretes in the northern Western Ghats as the fragile habitats with high endemic species. The specialized microhabitats in the lateritic plateaus of northern Kerala possess diverse species composition, of which mostly are endemics (Pramod & Pradeep, 2021).

Of the 37 recognized taxa, 16 (43%) are being endemic to the study area. The Western Ghats serves as the primary diversity centre of *Utricularia* hosting 15 endemic species. The lateritic plateaus in the Western Ghats alone harbour nine endemic species and the others inhabit the mountains, wetlands and basaltic outcrops. Some of the *Utricularia* species in the Western Ghats have distribution in the Deccan Plateau, Eastern Ghats and Northeast India as well, *viz.*, *U. bifida*, *U. caerulea*, *U. hirta*, *U. scandens*, *U. stellaris* and *U. striatula*. Northeast India and the

Himalayan region harbour 16 species, of which seven are restricted only to that region. The aquatic species have comparatively wide distribution in most of the states in India.

According to Myers (1988), endemic species are more vulnerable to extinction when their restricted habitats get destroyed or when reduced to small populations. Myers (*l.c.*) used the term 'hotspot' to indicate biologically rich areas and enlisted 10 major hotspots, including Eastern Himalayas, one of the rich hotspots. According to Myers (*l.c.*), the Western Ghats and the southwestern Sri Lanka are the severely threatened, small areas with rich biodiversity. Though, biodiversity hotspots are rich with endemic species, they are under extremely threatened by human activities (Cincotta *et al*., 2000). The size of the geographical distribution of an ecosystem is affected when it is challenged with a threat or disaster (Keith *et al*., 2013, 2018). Hence, widely distributed ecosystems which exist across multiple independent patches have a lower risk of collapse from threats when compare with an ecosystem having restricted geographical distribution (IUCN, 2024). But it is not wholly applicable particularly in the case of endemic *Utricularias*, as they are less susceptible to threats.

During field studies, I observed severe threats affecting most of the *Utricularia* habitats. Habitat loss and fragmentation being the major threats, and the habitats are found to be heavily degraded and destroyed due to many natural as well as anthropogenic activities. Habitat degradation and loss mainly resulted from excessive mining and quarrying for mineral deposits such as Iron ore, Bauxite, Manganese, Limestone, Granite, coal, etc. Commercial constructions and other developmental activities, land filling and land-use changes, tourism, pollution as well as natural hazards also accelerate the fragmentation and destruction of habitats.

**9.2. Habitats of Indian bladderworts**

***Habitats of terrestrial species***: The terrestrial species enjoy wet, open areas of nutrient poor habitats such as lateritic plateaus, hillocks, basaltic rocky outcrops, swamps or marshes in grasslands, water-soaked sandy plains, etc. (Figs. 187 & 188). *Utricularia albocaerulea*, *U. caerulea*, *U. cecilii*, *U. janarthanamii*, *U. lazulina*, *U. malabarica*, *U. minutissima*, *U. purpurascens*, *U. praeterita*, *U. reticulata* and *U. sainthomia* are the common inhabitants growing sympatrically in lateritic plateaus. Species such as *U. wightiana, U. nayarii*, *U. ponmudica*, and *U. sisparensis* thrive on the margins of

streams emanating from hill slopes, shallow creeks in the grasslands, shallow swamps in the slopes, edges of grassy hills, etc. *Utricularia bifida*, *U. polygaloides, U. hirta, U. caerulea, U. geoffrayi*, *U. recta* and *U. scandens* are usually found in inundated sandy plains. *Utricularia graminifolia* is a perennial species commonly growing in just receding seasonal floodwaters, margin or bottom of streams, watery vertical cuttings, swampy soil patches of perennial streams, etc. I observed this species growing in all these habitats, blooming at the beginning of the dry season with pale pink to deep blue flowers.

Until the monsoon, the lateritic plateaus lie barren and abandoned, but with the first downpours, they undergo a miraculous transformation, the lands metamorphose into verdant heaven with full of greenery and vivacious blooms. The species which are particularly found in lateritic plateaus grow in different microhabitat types like, ephemeral flush vegetation (EFV), exposed rock surfaces (ERS), seasonal pools (SP) and soil covered areas (SCA) (Watve, 2008, 2013; Lekhak & Yadav, 2012). *Utricularia* species can thrive in all these microhabitat types especially in the soil pockets, in the fringes of monsoon puddles, margins of seasonal pools, laterite rocky slopes and swampy soil patches, at an elevation of ± 50 to 800 m. They usually grow in association with small herbs such as *Burmannia* sp. (Burmanniaceae), *Drosera indica*, *D. burmanni* (Droseraceae), *Eriocaulon* spp. (Eriocaulaceae), *Canscorinella* sp., *Exacum* spp., *Swertia* sp. (all Gentianaceae), *Isachne* spp., *Coelachne* spp., *Fimbristylis* sp., *Jansenella* sp. (all Poaceae), *Impatiens* spp. (Balsaminaceae), *Lindernia* sp. (Linderniaceae), *Linum mysorense* (Linaceae), *Cyanotis* spp., *Murdannia brownii*, *M. crocea* subsp. *ochracea, M. semiteres*, *M. versicolor* (all Commelinaceae), *Neanotis* sp., *Oldenlandia* sp. (both Rubiaceae), *Rhamphicarpa fistulosa*, *Striga angustifolia* (both Orobanchaceae), *Senecio* spp. (Asteraceae), *Smithia* spp. (Fabaceae), *Rotala* spp. (Lythraceae) and many other sedges, grasses, mosses and ferns. Some species like *U. purpurascens*, *U. cecilii*, *U. reticulata, U. praeterita* and *U. lazulina*, are mass blooming with their large, gorgeous blue-purple flowers, which grow luxuriantly in lateritic plateaus of Western Ghats. In the monsoon, lateritic plateaus mesmerize our eyes with their greenery and blue-purple lawns and floral carpets intermingled with white *Eriocaulon* heads.

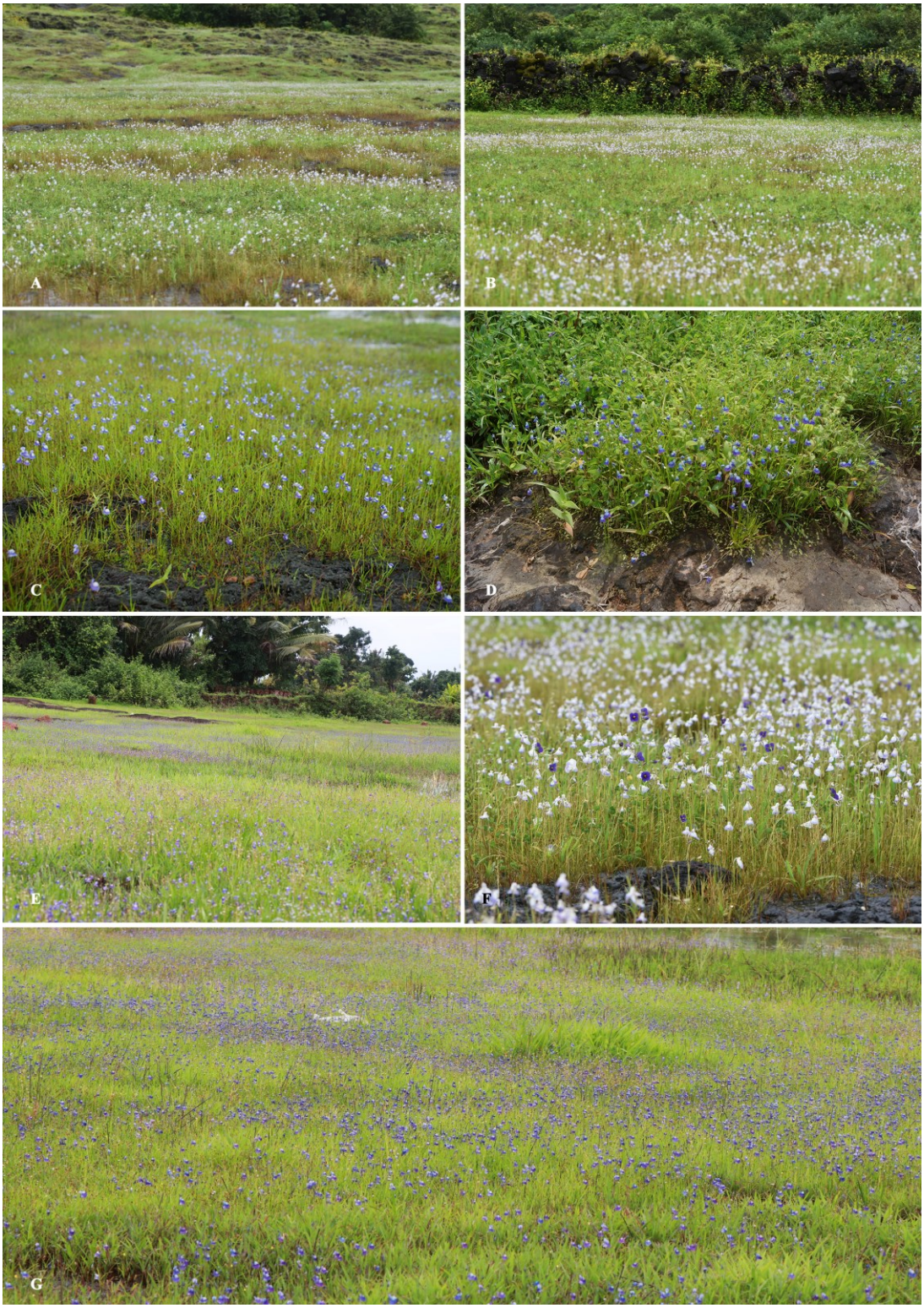


**Fig. 187.** Habitats of terrestrial *Utricularia* L.

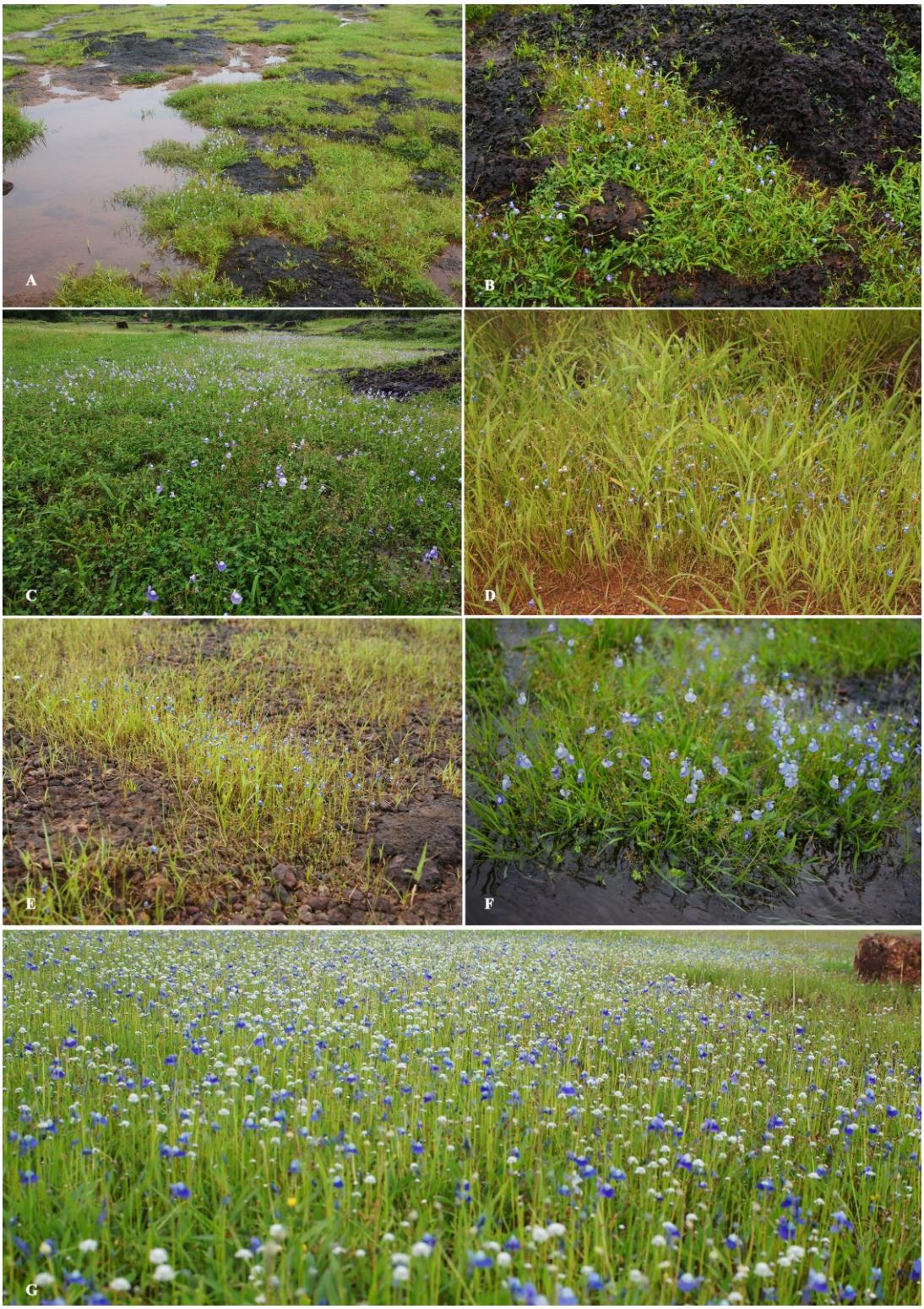


**Fig. 188.** Habitats of terrestrial *Utricularia* L.

***Habitats of aquatic species***: The aquatic species are usually found in still, permanent waters or slow-running water courses, such as paddy fields, fallow lands, ponds, ditches, canals, streams, abandoned flood plains, etc. (Figs. 189 & 190). *Utricularia aurea*, *U. australis*, *U. gibba*, *U. minor* and *U. stellaris* are the common inhabitants in these habitats. Sometimes, *U. reticulata* grows along with *U. aurea* and *U. gibba* in these habitats. They usually grow in association with *Cabomba furcata* (Cabombaceae), *Callitriche* sp. (Plantaginaceae), *Ceratophyllum* sp. (Ceratophyllaceae), *Hygrophila* sp. (Acanthaceae), *Ipomoea aquatica* (Convolvulaceae); *Isachne* sp., *Oryza sativa* (both Poaceae), *Ludwigia* sp. (Onagraceae); *Nelumbo* sp. (Nelumbonaceae), *Nymphaea* spp. (Nymphaeaceae), *Nymphoides* sp. (Menianthaceae), *Pontederia crassipes* (Ponteridaceae), *Persicaria* sp. (Polygonaceae), and some pteridophytes, namely *Azolla* sp. (Azollaceae), *Salvinia* sp. (Salviniaceae), *Ceratopteris thalictroides* (Pteridaceae), *Marsilea minuta* (Marsileaceae), etc.

***Habitats of epiphytic and lithophytic species***: *Utricularia kumaonensis* and *U. striatula* grow in epiphytic in wet, moss-covered tree trunks, mossy beds on decayed woods, etc. usually at elevations above 800 m (Figs. 191 & 192). The common associates of epiphytic *Utricularia* are *Impatiens* sp. (Balsaminaceae), *Cyanotis* sp. (Commelinaceae), *Lecanthus peduncularis* (Urticaceae), etc. some mosses and small ferns. They can also survive in lithophytic habitats as well. The lithophytic species can be found in large, open, wet, exposed rocks or on the soil-covered or moss-covered rocks in the edges, slopes, cuttings or cliffs, creeks, vertical cuttings and slopes of roadways, ghats, etc. of the basalt rocky outcrops or limestones (Fig. 192). *Utricularia brachiata*, *U. furcellata*, *U. graminifolia*, *U. recta*, *U. roseopurpurea* and *U. striatula* are lithophyte forms growing in association with *Begonia* spp. (Begoniaceae), *Eriocaulon* spp. (Eriocaulaceae), *Exacum* sp. (Gentianaceae), *Impatiens* spp. (Balsaminaceae), *Epithema carnosum*, *Rhynchoglossum notonianum*, *R. scabrum* (all Gesneriaceae), *Sonerila arguta, S. khasiana, S. rheedei* (all Melastomataceae), some grasses, mosses and ferns.

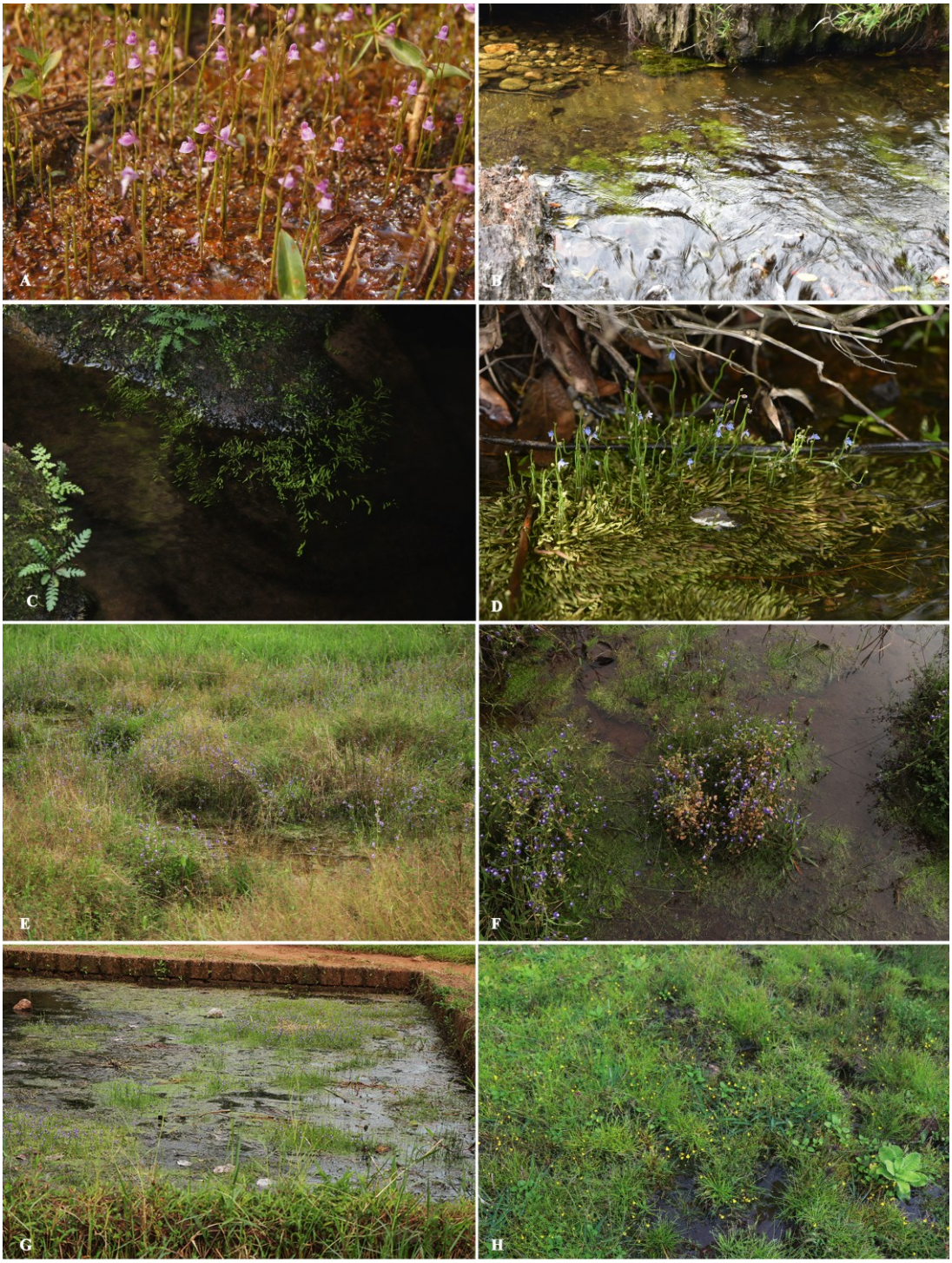


**Fig. 189.** Habitats of aquatic *Utricularia* L.: *Utricularia gibba*, *U. graminifolia*, *U. reticulata*, growing in the perennial swamps, streams and ponds.

**Fig. 190.** Habitats of aquatic *Utricularia* L.: *Utricularia aurea*, *U. gibba* and *U. minor* growing in paddy fields, fallow lands, ponds, ditches and streams.

**Fig. 191.** Habitats of epiphytic and lithophytic *Utricularia* L.: **A-E.** *Utricularia striatula* and *U. kumaonensis* growing epiphytic on wet, moss-covered tree trunks and mossy beds on decayed woods; **F-H.** *U. graminifolia*, *U. striatula* growing lithophytic on watery vertical cuttings

**Fig. 192.** Habitats of lithophytic *Utricularia* L.: *Utricularia brachiata*, *U. furcellata, U. graminifolia, U. kumaonensis, U. nayarii, U. recta, U. roseopurpurea,* and *U. striatula* growing in wet, exposed rocks, slopes, vertical cuttings or cliffs, creeks, or on the soil-covered or moss-covered rocks.

### 9.3. Threats to the habitats of Indian bladderworts

Field visits conducted during 2018 to 2024 into the various habitats of *Utricularia* across India, revealed serious natural and anthropogenic threats detrimentally affecting the survival of many species. Habitat loss and fragmentation, reduction in the quantity and quality of habitats, and declining population size occur predominantly due to human activities. Fragmentation refers to the breaking up of a more continuous distribution into patches which become smaller over time (IUCN, 2024). It resulted from the anthropogenic activities such as the development of urban and industrial infrastructure, commercial tourism, mining, quarrying and other land re-uses, agriculture, pollution, etc. The huge mining and quarrying for the laterite stone, limestone and other mineral deposits along with land conversions and landfilling for commercial developmental activities, commercial tourism, firing, pollution, etc. lead to the total destruction of many habitats (Figs. 193–196). The threats to the habitats of *Utricularia* are enlisted below and the assessment is done based on direct observation during the field study and relevant literature.

**I. Natural threats**

**1. Landslide**

Landslide, a common hazard in the fragile areas of Arunachal Pradesh, Sikkim, Meghalaya, etc. seriously affects the habitats of *Utricularia* (Fig. 194). These landslides coupled with further clearing, especially in roadways completely wipe off the entire habitat, hindering the re-establishment of annual and ephemeral species. *Utricularia brachiata* collected earlier from Singbha of North Sikkim and other adjacent areas were found preserved only in herbaria. Unfortunately, I was unable to locate a single individual from there, since I too witnessed severe landslide in the Singbha Rhododendron Sanctuary and Yumthang Valley during my visit in early September 2022 (Fig. 194C & D). The species, including *Utricularia brachiata*, *U. furcellata*, *U. kumaonensis* and *U. recta* were found to be the most affected ones in North India. *Utricularia furcellata* and *U. kumaonensis* were observed as fragmented patches along the roadways to Zuluk, Sikkim, but the landslides and further

clearing poses challenges to the survival of these species. Nowadays, landslides are frequent in hilly areas in most of the states.

**2. Avalanche**

Extreme climatic fluctuations like, snow avalanches and extreme drought disrupt the establishment of *U. brachiata* and *U. minor* growing in the Alpine Sikkim, above 4000 meters.

**II. Anthropogenic threats**

**1. Mining and quarrying**

Heavy mining and quarrying for natural deposits like laterite stone, limestone, sand, granite and other mineral elements, etc. are noticed from the various habitats of *Utricularia* (Fig. 195). The commercial large-scale mining and quarrying for laterite stone, frequent in Kasaragod, Kannur and Malappuram districts of Kerala resulted in the absolute wiping off of the habitats (as in Blathoor, Kerala). The dumping of quarry wastes in plateau results in the fragmentation and gradual destruction of habitat integrity hindering the natural re-establishment and colonization of native plants (Fig. 195A-F).

The impacts of mining on various habitats were investigated by many authors and conservation specialists across the country. Torpe and Watve (2015) reviewed the potential threats to the habitats due to the large-scale mining of ferricretes from the ferricrete plateaus in Maharashtra. The extensive mining for coal, limestone, clay and gypsum in Meghalaya poses serious threat to natural habitats, as it is an unscientific and unorganized activity (Singh *et al*., 2011; Sarma & Yadav, 2013; Sameer *et al*., 2015). The hills in West Jaintia have been devastated by rat-hole mining, while open quarrying for limestone and sand-mining have impacted other regions in Meghalaya (Fig. 195I & M). The soluble materials from the coal mines get

**Fig. 193.** *Utricularia* conservation concerns: unsustainable land use and habitat encroachment

**Fig. 194.** Threats to the habitats of *Utricularia* L.: **A & B.** Landslides in Thangu valley, North Sikkim; **C & D.** Landslides in Singbha Rhododendron Sanctuary, Yumthang; **E.** Landslide in East Khasi Hills district of Meghalaya; **F.** Road clearing in Zuluk ghat of Sikkim; **G-I.** Road widening in East Khasi Hills district of Meghalaya; **J.** Road widening in Rajapur, Maharashtra; **K & M.** Road widening in northern Kerala; **L.** Landfilling in Kottayam.

dissolved in the rain water, leaching into the nearby areas lead to deadly pollution with the accumulation of hazardous chemicals (Sarma & Yadav, 2013; Sameer *et al*., 2015). Sand and limestone mining is ever common in Khasi Hills district and several remanences of abandoned mines were observed across Meghalaya. Recently, The Hindu daily reported the denudation and vanishing of large hillocks due to the relentless mining activities and the potential threats persisting in the Meghalaya state (Konwar, 10.12.2023). The West Jaintia Hills in Meghalaya are experiencing escalating heat during summer and soil erosion due to fast paced deforestation. The dumping of coal and limestone causes multisource pollution in water, soil and air, accelerating biodiversity degradation and other looming environmental perils.

The eastern region of Tamil Nadu and Andhra Pradesh encounter huge mining and quarrying for the hefty limestone and granite deposits and, the government of Tamil Nadu has highlighted the commercial value of Pudukkottai district due to its rich limestone deposits (Pudukkottai district survey report, May 2019). During visits to this area, I witnessed the extremely degraded habitats and the abandoned mining sites in Pudukkottai area in Tamil Nadu (Fig. 195N-P).

**2. Land conversion and developmental activities**

In the context of economic expansion and infrastructure growth, a huge unplanned land use transitions are being undertaken across India. Land conversion for various purposes such as developmental activities, constructions, road widening, tourism, farming, etc. adversely affects the habitats of many *Utricularia* species. Since the naturalization into another habitat becomes challenging or impossible in the case of *Utricularia*, the survival prospects of those growing in disturbed areas are less. The changes in the natural landscaping break the normal flow of water through the plateaus and thus adversely affect the population size and the associated species communities growing in that area as well. The construction of buildings, housings, commercial factories and other constructions for business, tourism, etc. also lead to fragmentation and loss of natural habitats.

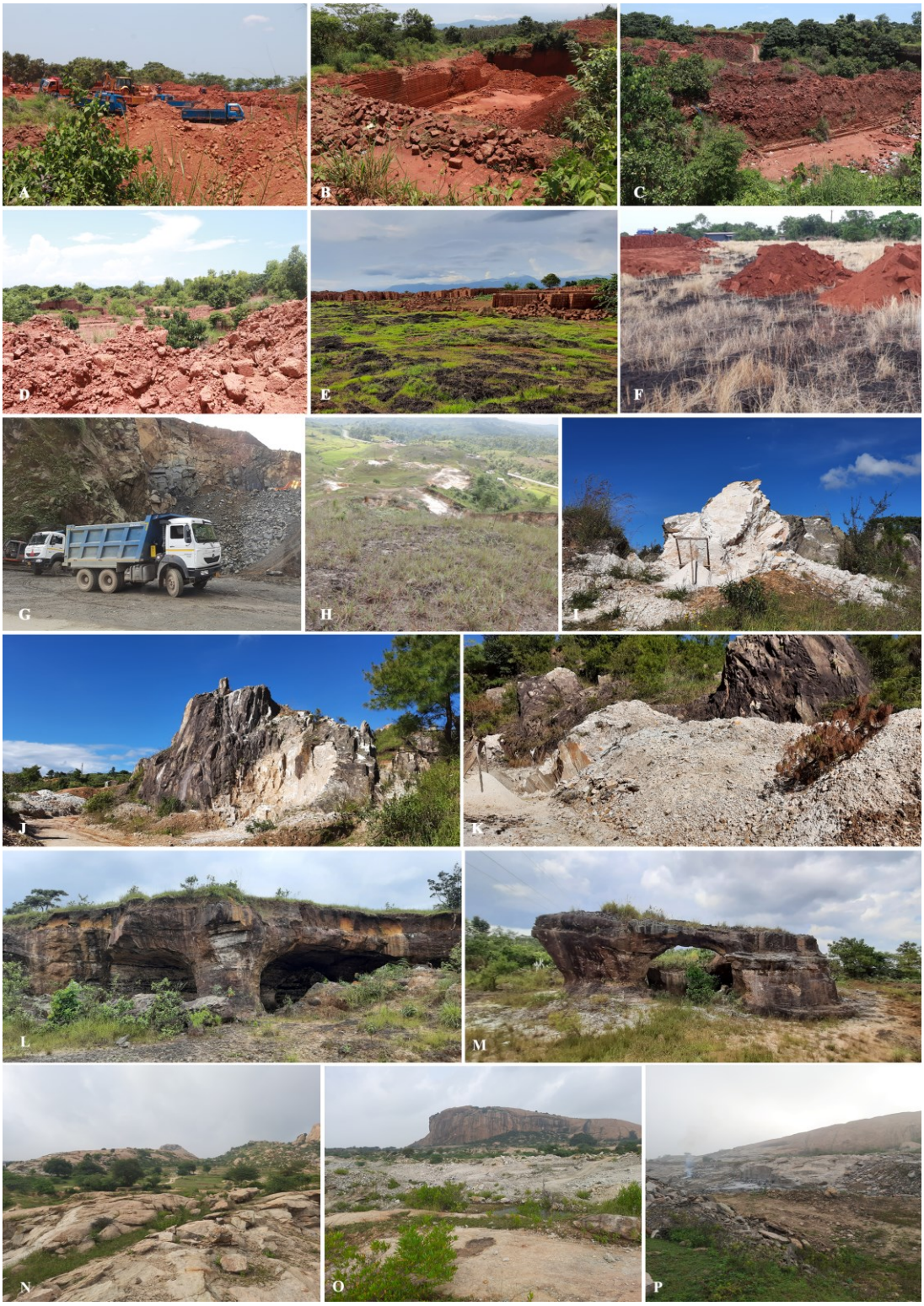


**Fig. 195.** Threats to the habitats of *Utricularia* L.: **A-F.** Mining and quarrying for laterite stone in northern Kerala lateritic plateaus; **J-K.** Limestone and sand mining in Meghalaya; **L & M.** Abandoned rat-hole mines in Jaintia Hills district of Meghalaya; **N-P.** Devastated limestone mines in Pudukkottai district of Tamil Nadu.

Road widening activities mainly affect the plants growing in the rocky cuttings, slopes in the roadways and other plains (Fig. 194). The construction and further clearing of waysides and road margins affect habitats of *U. graminifolia*, *U. striatula*, *U. furcellata*, *U. kumaonensis*, *U. brachiata*, *U. recta*, etc. Road clearing is common in North India, especially in the ghat areas as well as in the areas prone to landslides or avalanches. Since most of the species are growing in open slopes of these cuttings or cliffs, the clearing and cleaning of roadways cause considerable reduction of population in the next generations. Since *U. furcellata, U. kumaonensis* and *U. recta* are common on the moss-covered rocks in the roadside cuttings, clearing leads to complete habitat loss.

Herbarium study revealed that *U. nayarii* was common in the Lockhart Gap of Idukki district of Kerala. The Munnar-Madurai National Highway construction along with the severe flood and land sliding happened in 2018 and their impacts, partially ruined the natural habitat of Lockhart Gap, a hotspot of many endemic species.

*Utricularia aurea*, *U. stellaris*, *U. australis*, *U. reticulata*, *U. bifida*, *U. polygaloides*, etc. were once fairly common in agricultural fields, but the landfilling of fallow lands and abandoned fields along with huge conversion and reduction of agricultural land, pollution in permanent waterbodies, etc. led to fragmentation and widespread habitat loss.

**3. Tourism**

Tourism and other leisure activities contribute much to the reduction in the quantity and quality of habitats. Landscaping for tourism is a major cause for the deterioration and destruction of many habitats. During the field visit, highly disturbed areas of lateritic habitats were observed in Mahabaleshwar, Panchgani, Table Land, Amba, Amboli, Kaas, Venna Lake, etc. in the Maharashtra state (Fig. 196D-G). The hill station tourism as well as temple tourism in various regions of Kerala such as Idukki, Wayanad, Kozhikode, Ponmudi, Madayipara lateritic plateau of Kannur, etc. disturb natural habitats posing significant threats to the flora and fauna. The Hindu Bureau

(2024) reported the threats encountered by the Madayipara lateritic plateau due to increased encroachment of tourists who litter the place with food waste and plastics. Their footprints and tire prints trample the tiny herbaceous flora and fauna, unfortunately it is not a solitary case, as it is common in most of the large lateritic plateaus and hillocks in northern Kerala, Karnataka and Maharashtra. Land conversion and other developmental activities promoting tourism and trekking also adversely affect the habitats of those species growing in the high altitude hilly regions in Kerala, Karnataka, Tamil Nadu, Meghalaya and Sikkim.

**4. Pollution**

Increased usage of chemical insecticides and pesticides, dumping of plastics and other non-biodegradable wastes, wastes from industries and mining and quarrying areas, etc. percolate into the soil and water bodies and completely deteriorate the natural quality of the ecosystem (Fig. 196). The dumping of mining and quarry wastes into the nearby lands and plateaus, primarily hinder the natural flow of rainwater. When mixed up with the soil, it alters the edaphic factors and the soil microbiota and thus decline the quality of the habitat leading to absolute habitat degradation. The hydrologic alteration of wetlands and water bodies degrades the quality of the habitats of aquatic species such as *U. aurea*, *U. gibba*, *U. australis*, *U. stellaris*, etc.

**5. Firing**

Fires usually break out in the peak summer months due to natural or anthropogenic interventions. It destroys the germplasm stored securely in the soil bed, altering and declining the quality of the habitat which in turn results in massive population size reduction. Since, most of the *Utricularia* are ephemeral annuals, they store large quantities of dust seeds for their successful colonization in the forthcoming generation. In plateaus, fires destroy their germplasms which are stored within a thin layer of mulches above rock sediments and soil covered patches, and lead to the reduction in population size and quality of the habitat.

**Fig. 196.** Threats to the habitats of *Utricularia* L.: **A-C.** Land filling and constructions in Kerala; **D-F.** Tourist destinations, Kaas plateau and Table plateau of Maharashtra; **G, I & J.** Grazing in plateaus; **H.** Wastes dumped in a Kunigal lake, Karnataka.

**6. Grazing**

Lateritic plateaus and hillocks are remarkable habitats which undergo miraculous transformation at the onset of monsoon after peak summer. During the summer, the landscape appears barren, but with the first downpours, most of the herbaceous plants germinate into beautiful lush vegetation. Grazing is found to be the major threat affecting the *Utricularia* species growing in lateritic plateaus. It is observed that, the lateritic habitats get heavily disturbed by trampling, fouling, grazing and pugging the wet soil by the livestock (Fig. 196). Overgrazing poses a major concern to annual herbaceous plants including *Utricularia* species, as it destroys the plants at their various developmental stages. It results in a gradual decline in the size of populations and number of individuals in the following generations.

**9.4. Conservation assessment**

In contrast with other plants, *Utricularia* are carnivorous plants having extreme nutrient specialization, habitat preferences and specificity. Hence *in-situ* conservation is the feasible strategy for *Utricularia* owing to their peculiarities and preferences, which also concurrently delimit the possibilities of *ex-situ* conservation measures. The mass flowering species presents more than thousands of individuals in an area forming large populations. But it is not logically reasonable to conclude the species as least concern just by considering its population size and number of individuals per population. The field study revealed various types of extreme threats haunting the habitats of *Utricularia*. Highly disturbed and fragmented habitats were observed with extreme reduction in the size and quality of the habitats and complete habitat loss.

The conservation assessment of each species was prepared based on the Guidelines of the IUCN Red List Categories and Criteria version 16 of the IUCN Standards and Petitions Committee (2012, 2024, https://www.iucnredlist.org/documents/RedList Guidelines.pdf.). The Area of Occupancy (AOO) and Extent of Occurrence (EOO) of each species was calculated using the GPS coordinates taken from the field during collection, herbarium labels and from the occurrences noted in

authentic floras as well. It is recommended to scale estimates of AOO using 2 × 2 km grid cells to ensure valid use of the criteria and maintain consistency of Red List assessments across taxa (IUCN, 2024). But in the case of a few species like, *U. brachiata*, *U. kumaonensis*, and *U. nayarii* with restricted small population size, AOO was scaled using 1 × 1 km grid cells. A comprehensive note on the threats and conservation status of each species was given along with species descriptions. The conservation status of *Utricularia* assessed as per IUCN guidelines (2012, 2024) is listed in the table 4 given below.

**Table 4. Conservation status of *Utricularia***

| Sl. No. | Name of species | Conservation status | Endemic status |
|---|---|---|---|
| 1 | *Utricularia albocaerulea* | EN | Endemic to Western Ghats |
| 2 | *Utricularia aurea* | LC | – |
| 3 | *Utricularia australis* | LC | – |
| 4 | *Utricularia bifida* | LC | – |
| 5 | *Utricularia brachiata* | CR | – |
| 6 | *Utricularia caerulea* | LC | – |
| 7 | *Utricularia cecilii* | EN | Endemic to Western Ghats |
| 8 | *Utricularia christopheri* | DD | – |
| 9 | *Utricularia foveolata* | DD | – |
| 10 | *Utricularia furcellata* | EN | – |
| 11 | *Utricularia geoffrayi* | DD | – |
| 12 | *Utricularia gibba* | LC | – |
| 13 | *Utricularia graminifolia* | LC | – |
| 14 | *Utricularia hirta* | LC | – |
| 15 | *Utricularia janarthanamii* | EN | Endemic to Peninsular India |
| 16 | *Utricularia kumaonensis* | EN | – |

| | | | |
|---|---|---|---|
| 17 | *Utricularia lazulina* | VU | Endemic to Western Ghats |
| 18 | *Utricularia malabarica* | CR | Endemic to Western Ghats |
| 19 | *Utricularia minor* | DD | – |
| 20 | *Utricularia minutissima* | LC | – |
| 21 | *Utricularia multicaulis* | DD | – |
| 22 | *Utricularia nayarii* | CR | Endemic to Western Ghats |
| 23 | *Utricularia polygaloides* | NT | Endemic to Peninsular India and Sri Lanka |
| 24 | *Utricularia ponmudica* | CR | Endemic to Western Ghats |
| 25 | *Utricularia praeterita* | VU | Endemic to Peninsular India |
| 26 | *Utricularia purpurascens* | NT | Endemic to Western Ghats |
| 27 | *Utricularia recta* | NT | – |
| 28 | *Utricularia reticulata* | NT | Endemic to Peninsular India and Sri Lanka |
| 29 | *Utricularia roseopurpurea* | EN | Endemic to Western Ghats and Sri Lanka |
| 30 | *Utricularia sainthomia* | CR | Endemic to Western Ghats |
| 31 | *Utricularia scandens* | LC | – |
| 32 | *Utricularia sisparensis* | DD | Endemic to Western Ghats |
| 33 | *Utricularia smithiana* | EN | Endemic to Western Ghats |
| 34 | *Utricularia stellaris* | LC | – |
| 35 | *Utricularia striatula* | LC | – |
| 36 | *Utricularia uliginosa* | LC | – |
| 37 | *Utricularia wightiana* | CR | Endemic to Western Ghats |

### 9.4.1. A step to conserve species *ex-situ*

Along with field collection, preservation and conservation efforts were undertaken to preserve most of the collected species as live in the Calicut University

Botanical Garden (CUBG). The perennial, semi-aquatic to aquatic species such as *U. graminifolia, U. reticulata, U. aurea* and *U. gibba* have exhibited relatively successful re-establishment in CUBG (Fig. 197). Some of the annual, ephemeral species including *U. bifida, U. lazulina*, *U. polygaloides, U. hirta, U. praeterita U. purpurascens, U. sainthomia* and *U. caerulea* were also re-planted along with a patch of its substratum. They exhibited considerably slow growth and failed to re-establish in the *ex-situ* site. This instance indicates that, *ex-situ* conservation strategies have limitations in the case of *Utricularia*, since their naturalization into another habitat is challenging. Hence, proper *in-situ* conservation measures should be implemented to conserve them.

### 9.4.2. How does *in-situ* conservation work?

*In-situ* conservation refers to the preservation and conservation of species in their natural habitats allowing them to thrive in the ecosystems where they have evolved. *In-situ* conservation becomes successful if and only if the area is under protected category. Unfortunately, in the case of *Utricularia*, most of its habitats are unprotected vulnerable areas. *Utricularia*, being a sensitive, habitat specific, annual or perennial carnivorous group, encounter significant habitat degradation and destruction due to uncontrolled and aggravated anthropogenic interventions. In conjunction with this, natural hazards like landslides, floods, drought, climatic fluctuation, etc. also pose challenges to *in-situ* conservation measures.

In India, relentless mining and quarrying for mineral deposits has completely ruined many habitats of rare and endemic plants including *Utricularia* (Singh *et al*., 2011; Sarma & Yadav, 2013; Sameer *et al*., 2015; Thorpe & Watve, 2015). Under the Environment Protection Act (EPA, 1986), the Government of India has implemented an important management tool, i.e., Environmental Impact Assessment (EIA) for safeguarding the optimal use of natural resources for sustainable development. Though, the EIA approval remains mandatory for undertaking mining projects, the mitigation of the impacts of mining stay futile due to its implementing and monitoring lapse (Thorpe & Watve, 2015). Hence, strict governance seems mandatory to ensure the implementation of supportive legal and policy frameworks.

**Fig. 197.** A step to *in-situ* conservation of *Utricularia* L.

Habitat conservation via establishing protected areas can help to maintain ecological integrity. Chandran *et al*. (2012) in the ENVIS technical report, proposed to protect two plateaus in Uttara Kannada (Bhatkal Plateau in Bhatkal taluk and Mugali Plateau in Honavar taluk) under the conservation category "*Conservation Reserves*" with the provisions of the Ministry of Environment and Forests (MoEF), India. Recently, Pramod and Pradeep (2021) recommended to declare the Madayipara lateritic plateau and such similar habitats in northern Kerala as Conservation Reserve. It seems an effective strategy for conserving unprotected species rich areas of Least Concern, to restore and maintain natural habitats.

As habitat restoration, reversion and revitalization are challenging tasks, continuous monitoring of species composition, size of populations and habitats are essential to assess the effectiveness of conservation efforts.

Promoting sustainable land-use practices can mitigate environmental impacts to an extent. It can be envisaged by creating awareness campaigns about the various ecological issues, emphasizing their social responsibilities, reducing unsustainable practices along with strict governmental regulations and monitoring. Also, innovative conservation action plans should be implemented in governmental levels to reduce human-caused species extinctions.

**9.5. Conclusion**

Safeguarding biodiversity is essential for the sustenance of life on earth. The reckless anthropogenic interventions result in significant biodiversity loss, making it essential to take action to 'reverse the red' and address conservation challenges. *Utricularia* species, being habitat specialists, are particularly vulnerable as they thrive in specific, often fragile environments like open, wet, nutrient-deficient habitats. Field studies have revealed several threats to these habitats, such as mining, quarrying, commercial development, tourism, land use changes, landfilling, pollution, grazing, fires, droughts, floods and landslides. These factors contribute to habitat fragmentation, degradation, and in some cases, complete loss, further endangering the survival of these species.

The conservation status of 37 *Utricularia* species was assessed, revealing that six are classified as CR, seven as EN, two as VU, four as NT, six as DD, and 12 as LC. This implies that 15 species fall within the threatened categories. Additionally, 16 species assessed as NT and LC are considered to have some extinction risk, but at a lesser level than those in more critical threat categories (IUCN, 2024). The six species evaluated as DD are lacking proper distribution data, have restricted distribution within the study area, and require further exploration to better understand their conservation needs. The habitat study and conservation assessment of *Utricularia* underscores the need for a comprehensive approach that combines habitat conservation, future research prospects, monitoring across various governmental levels, and public awareness initiatives. Effective conservation efforts should focus on long-term goal of global biodiversity, ensuring the preservation of both species and their ecosystems for future generations.

# SUMMARY AND CONCLUSION

## 10.1. Summary

The present research provides a comprehensive account of the genus *Utricularia* in India by integrating morphological, micromorphological, and molecular data. This study identifies 37 species across India (see table 5 below), primarily distributed in the Western Ghats and Northeast India. The major findings of the research are discussed below:

### 10.1.1. Taxonomy

**1. Field exploration**

Extensive field studies revealed that *Utricularia* species have highly specialized and diverse habitat preferences. Notable variations in plant size, flower size, and corolla colour were observed across different habitats. Furthermore, certain species exhibited variations according to their varying habitats.

**Table 5. List of *Utricularia* species in India**

| Sl. No. | Section | Name of taxa |
|---|---|---|
| 1 | ***Meionula*** | *Utricularia hirta* Klein ex Link |
| 2 | | *Utricularia geoffrayi* Pellegr. |
| 3 | | *Utricularia minutissima* Vahl. |
| 4 | ***Nigrescentes*** | *Utricularia caerulea* L. |
| 5 | | *Utricularia roseopurpurea* Stapf ex Gamble |
| 6 | ***Oligocista*** | *Utricularia albocaerulea* Dalzell |
| 7 | | *Utricularia bifida* L. |
| 8 | | *Utricularia cecilii* P.Taylor |
| 9 | | *Utricularia foveolata* Edgew. |
| 10 | | *Utricularia graminifolia* Vahl |
| 11 | | *Utricularia janarthanamii* S.R.Yadav, Sardesai & S.P.Gaikwad |

| | | |
|---|---|---|
| 12 | | *Utricularia lazulina* P.Taylor |
| 13 | | *Utricularia malabarica* Janarth. & A.N.Henry |
| 14 | | *Utricularia nayarii* Janarth. & A.N.Henry |
| 15 | | *Utricularia polygaloides* Edgew. |
| 16 | | *Utricularia ponmudica* Krishnapriya & Nampy *sp. nov.* |
| 17 | | *Utricularia praeterita* P.Taylor |
| 18 | | *Utricularia purpurascens* J.Graham |
| 19 | | *Utricularia recta* P.Taylor |
| 20 | | *Utricularia reticulata* Sm. |
| 21 | | *Utricularia sainthomia* P.Biju, Josekutty, Janarth. & Augustine |
| 22 | | *Utricularia scandens* Benj. |
| 23 | | *Utricularia sisparensis* Krishnapriya & Nampy *sp. nov.* |
| 24 | | *Utricularia smithiana* Wight |
| 25 | | *Utricularia uliginosa* Vahl |
| 26 | | *Utricularia wightiana* P.Taylor |
| 27 | ***Phyllaria*** | *Utricularia brachiata* Oliv. |
| 28 | | *Utricularia christopheri* P.Taylor |
| 29 | | *Utricularia furcellata* Oliv. |
| 30 | | *Utricularia kumaonensis* Oliv. |
| 31 | | *Utricularia multicaulis* Oliv. |
| 32 | | *Utricularia striatula* Sm. |
| 33 | ***Utricularia*** | *Utricularia aurea* Lour. |
| 34 | | *Utricularia australis* R.Br. |
| 35 | | *Utricularia gibba* L. |
| 36 | | *Utricularia minor* L. |
| 37 | | *Utricularia stellaris* L.f. |

## 2. Nomenclature

All specimens were identified by consulting protologues, types, authentic collections, and relevant literature. The correct name for each species were provided

in accordance with the ICN (Turland *et al*., 2018), and synonyms were listed accordingly. A detailed taxonomic description, photo plates, distribution maps, and a key to Indian species were provided for easy identification.

**3. New taxa described**

Two new species, *Utricularia ponmudica* Krishnapriya & Nampy *sp. nov*. and *Utricularia sisparensis* Krishnapriya & Nampy *sp. nov*., were described in this study.

**4. New distribution record**

*Utricularia geoffrayi* Pellegr., native to Indochina, is reported for the first time from India, from Tamil Nadu.

**5. Reinstatement and taxonomic identity**

*Utricularia christopheri* P.Taylor, previously considered conspecific with *U. brachiata* Oliv. has been reinstated; *U. janarthanamii* was resurrected from synonymy of *U. heterosepala* Benj.; *U. nayarii* Janarth. & A.N.Henry and *U. purpurascens* J.Graham previously synonymized under *U. uliginosa* Vahl and *U. graminifolia* Vahl, respectively, were re-established, and *U. roseopurpurea* Stapf ex Gamble was resurrected from synonymy of *U. caerulea* L.

**6. New synonyms**

*Utricularia babui* S.R.Yadav, Sardesai & S.P.Gaikwad and *U. sunilii* Naveen Kum. & K.M.P.Kumar were synonymized with *U. graminifolia*, while *U. kamarudeenii* V.S.A.Kumar & Sindhu Arya was reduced to the synonymy of *U. aurea* Lour. Furthermore, *U. lihengiae* C.L.Long & Z.Cheng was treated as conspecific with *U. recta* P.Taylor.

**7. Recollections**

*Utricularia brachiata* Oliv., *U. kumaonensis* Oliv., *U. minor* L. and *U. wightiana* P.Taylor were represented by only fragmented materials in Indian herbaria. Live specimens were collected, and voucher specimens from these collections were deposited at CALI for future reference.

**8. Endemism**

Sixteen species are endemic to India or both India and Sri Lanka. These include *U. albocaerulea*, *U. cecilii*, *U. lazulina*, *U. malabarica*, *U. nayarii*, *U. ponmudica*, *U. purpurascens*, *U. sainthomia*, *U. sisparensis*, *U. smithiana*, and *U. wightiana*, all endemic to the Western Ghats; *U. janarthanamii* and *U. praeterita*, endemic to Peninsular India; *U. polygaloides*, endemic to India and Sri Lanka; *U. reticulata*, endemic to Peninsular India and Sri Lanka, and *U. roseopurpurea*, endemic to the Western Ghats and Sri Lanka.

### 10.1.2. Micromorphological study of seeds

The micromorphological study of seeds revealed diagnostic characters useful for species delimitation. Seed characteristics such as the shape and thickness of anticlinal walls, as well as the ornamentation of the periclinal walls, were identified as significant for identifying species. For example, seeds of the section *Phyllaria* can be distinguished by the presence of testa hairs, and seeds of the section *Utricularia* are notable for their winged testa. Terrestrial species often exhibit seeds with reticulate or elongated testa cells, with or without surface ornamentation. A deeper study of ecological characteristics, seed dispersal mechanisms, and germination strategies is essential for conservation efforts.

### 10.1.3. Phylogenetic analysis

This study represents the first detailed phylogenetic analysis of *Utricularia*, encompassing representatives from all available sections, including Indian endemics. Maximum likelihood (ML) and Bayesian Inference (BI) analysis were used to infer phylogenetic relationship. The analysis using individual trees revealed some incongruence regarding the phylogenetic positioning of certain sections and species. For the nrITS analysis, representatives from 14 of the 32 recognized sections within two subgenera were included, with most sections recovered as monophyletic, except for sect. *Psyllosperma*, which was paraphyletic. The *rps*16 analysis included 21 sections and confirmed monophyly of most sections. Three major clades were supported by the *rps*16 tree, indicating that subgen. *Polypompholyx* is the sister group to subgen. *Bivalvaria* and *Utricularia* (I,II & III), and each of which was strongly

supported. The nrITS dataset did not clearly resolve the relationship between subgenera *Utricularia* and *Bivalvaria*.

Both phylogenetic trees supported the distinctiveness of all species, with strong support for the monophyly of the five Indian sections. The *rps*16 analysis confirmed that the largest sect. *Oligocista* is monophyletic, including *U. nana* from sect. *Benjamina*, and supported the inclusion of previously unassigned Indian endemics within this section. The analysis also confirmed the phylogenetic placement of *U. scandens*, *U. recta*, *U. polygaloides*, *U. reticulata*, *U. albocaerulea*, *U. sainthomia*, *U. malabarica*, *U. purpurascens*, *U. wightiana*, *U. nayarii*, *U. praeterita*, *U. cecilii*, *U. ponmudica*, *U. sisparensis*, and *U. lazulina*. Both loci analysis revealed that *U. graminifolia*, *U. babui* and *U. sunilii* nested together, supporting morphological data. The phylogenetic study also affirmed that *U. kamarudeenii* should be included under *U. aurea*.

### 10.1.4. Conservation status assessment

*Utricularia* species are generally habitat specialists, thriving in open, wet, nutrient-deficient habitats. Field studies revealed several potential threats to their habitats, such as mining, quarrying, commercial development, tourism, land-use changes, landfilling, pollution, grazing, fires, droughts, floods, and landslides. These activities contribute to habitat fragmentation, degradation and total loss. The conservation assessment underscores the need for a comprehensive approach combining habitat conservation strategies, future research, governmental monitoring and public awareness.

The conservation status of 37 species of *Utricularia* was assessed. Of these, six species (16%) are classified as CR, seven species (19%) as EN, two species (5%) as VU, four species (11%) as NT, six species (16%) as DD, and 12 species (33%) as LC. This indicates that 15 species fall within threatened categories. Sixteen species assessed as NT and LC have a lower extinction risk but still require monitoring. Six species were evaluated as DD due to insufficient distribution data and limited range, requiring further exploration.

## 10.2. Conclusion

The present research represents the first comprehensive study of the genus *Utricularia* in India, focusing on the taxonomy and phylogenetic relationships across all species found in this region. This study recognizes 37 species in India, including two new species, and one new distributional record. Additionally, the study reveals sixteen species as endemic to India, or both India and Sri Lanka. Habitat studies and conservation status assessments indicate the threatened status of 15 species, underscoring the urgent need for conservation measures.

Seed micromorphological data has proven to be a valuable tool for the delineation of *Utricularia* species. Characteristics such as shape and thickness of anticlinal walls, as well as the ornamentation of the periclinal walls are useful for distinguishing species. The phylogenetic study covered more than 50% of the species, representing 21 of the 32 sections proposed by Taylor (1989), including all five Indian sections. This phylogenetic study supports the distinctiveness of the species covered in the systematic treatments, and supports the synonymisation of some species as well.

# RECOMMENDATIONS AND FUTURE OUTLOOK

*Utricularia* is the largest and one of most fascinating carnivorous plant genera, with around 284 species distributed globally, exhibiting significant diversity. In addition to their remarkable carnivorous behaviour, species of this genus possess a unique body plan among flowering plants and exhibit extreme genome miniaturization. The genus has garnered particular interest due to its evolutionary dynamics, diversification, habitat specialization, nutritional strategies, and genome size reduction. The present study explores the diversity, distribution, and taxonomy of the Indian *Utricularia*. It covers 37 species across five sections, with the greatest species richness observed in section *Oligocista*, the largest section, which accommodates 21 species from India. Of these 20 species are found in the Western Ghats and Peninsular India, while one species in Northeast India. Of the 37 recognized taxa, 16 are endemic to the study area, underscoring the Western Ghats as a key centre of diversity, harbouring 15 endemic species.

The habitat and conservation analysis of *Utricularia* species revealed a high risk for Indian endemics due to significant habitat loss and fragmentation resulting from anthropogenic activities. Approximately 40% of Indian species are categorized within threatened categories. Lateritic plateaus in the Western Ghats and granitic outcrops in the Deccan Peninsula face severe threats due to large-scale mining and quarrying for laterite stone and granite. As these areas are home to many endemic *Utricularia* species, I recommend protecting the plateau habitats as 'conservation reserves', initiating efforts to emphasize the conservation importance of lateritic plateaus through species status assessments.

The study observed that the endemic species *U. sainthomia* and *U. malabarica* exhibit unique microhabitat specificity and a notable reduction in plant size. A comprehensive study is recommended, including whole-genome analysis, ecological studies, nutritional strategies, and trap architecture for these species. Moreover, *U. sainthomia* is the sole member of its section with lateral traps that are comparatively larger than those in other species. Therefore, an in-depth genomic study focusing on trap character evolution is planned for future research.

Among the Indian species, *U. janarthanamii* is unique in section *Oligocista* for developing both cleistogamous and chasmogamous flowers. I recommend an ecological study to examine the pollination mechanism behind this phenomenon. The study also recognized significant variations in certain species, which change with their habitats. Future research will focus on understanding how habitat shifts influence these variations, with *U. graminifolia* selected as a model species for such studies, incorporating genomic data.

The present study includes molecular data for all Indian species, including endemics, and provides a phylogenetic analysis. Although the phylogenetic study was conducted with a broad sampling of species, including representatives from all available sections, the phylogenetic analysis was carried out using individual nrITS and *rps*16 genes. In this phylogeny, I observed some inconsistencies in the placement of some sections and species. To improve resolution and achieve a more robust phylogeny, a broader sampling across the genus' boundaries, along with the inclusion of additional plastid regions, would be beneficial. Moreover, the diversification and the endemic radiation of the Indian lineage remains unclear. Therefore, this research recommends further studies on the origin and diversification of Indian *Utricularia* lineages, using molecular dating and ancestral area reconstruction to reveal the process of endemic radiation. *Utricularia* continues to be a fascinating and challenging group to study, and we are progressing toward a more comprehensive phylogeny to better understand its relationships, evolution, and diversification.

This study provides a comprehensive data on Indian *Utricularia*, laying the groundwork for future research to uncover new insights and perspectives across various aspects of this fascinating genus. A collaborative research programme on the phylogenomics of *Utricularia* with Sao Paulo State University (UNESP), Brazil, has been initiated. The team focus on a multidisciplinary approach, including systematics, genetics, genomics, phylogeny, and reproduction within the Lentibulariaceae family. This collaboration is expected to significantly contribute to our understanding of the evolution of *Utricularia*, particularly regarding Indian endemics.

# LITERATURE CITED


**Abraham V. 1966.** *Utricularia minutissima* Vahl. A new record for North India. *Journal of Bombay Natural History Society* 63: 459–460.

**Abraham V. & K. Subramanyam 1965.** Studies on seeds of various taxa of *Utricularia* occurring in West Bengal. *Proceedings/Indian Academy of Sciences* 62(2): 97–102. New Delhi, Springer India.

**Abraham V., Mitra R.L. & K. Subramanyam 1974.** The identity and nomenclature of *Utricularia nivea* Vahl. *Current Science* 43: 571–572.

**Adamec L. 1997.** Photosynthetic characteristics of the aquatic carnivorous plant *Aldrovanda vesiculosa*. *Aquatic Botany* 59(3-4): 297–306. https://doi.org/10.1016/S0304-3770(97)00054-5

**Adamec L. 1999.** Turion overwintering of aquatic carnivorous plants. *Carnivorous Plant Newsletter* 28(1): 19–24. https://doi.org/10.55360/cpn281.la532

**Adamec L. 2003.** Ecophysiological characterization of dormancy states in turions of the aquatic carnivorous plant *Aldrovanda vesiculosa*. *Biologia Plantarum* 47: 395–402. https://doi.org/10.1023/B:BIOP.0000023883.62127.5e

**Adamec L. 2006.** Respiration and photosynthesis of bladders and leaves of aquatic *Utricularia* species. *Plant Biology* 8(6): 765–769. https://doi.org/10.1055/s-2006-924540

**Adamec L. 2008a.** Respiration of turions and winter apices in aquatic carnivorous plants. *Biologia* 63(4): 515–520. https://doi.org/10.2478/s11756-008-0073-4

**Adamec L. 2008b.** Survival of dried turions of aquatic carnivorous plants. *Carnivorous Plant Newsletter* 37(2): 52–56. https://doi.org/10.55360/cpn372.la273

**Adamec L. 2009.** Photosynthetic $CO_2$ affinity of the aquatic carnivorous plant *Utricularia australis* (Lentibulariaceae) and its investment in carnivory. *Ecological Research* 24: 327–333. https://doi.org/10.1007/s11284-008-0510-4

**Adamec L. 2010.** Tissue mineral nutrient content in turions of aquatic plants: does it represent a storage function? *Fundamental and Applied Limnology* 176(2): 145–151. https://doi.org/10.1127/1863-9135/2010/0176-0145

**Adamec L. 2011a.** Dark respiration and photosynthesis of dormant and sprouting turions of aquatic plants. *Fundamental and Applied Limnology-Archiv fur Hydrobiologie* 179(2): 151–158. https://doi.org/10.1127/1863-9135/2011/0179-0151

**Adamec L. 2011b.** The smallest but fastest, ecophysiological characteristics of traps of aquatic carnivorous *Utricularia*. *Plant Signalling & Behavior* 6(5): 640–646. https://doi.org/10.4161/psb.6.5.14980

**Adamec L. 2011c.** Functional characteristics of traps of aquatic carnivorous *Utricularia* species. *Aquatic Botany* 95: 226–233. https://doi.org/10.1016/j.aquabot. 2011.07.001

**Adamec L. 2015.** Is long-term survival of dried turions of aquatic carnivorous plants possible? *Carnivorous Plant Newsletter* 44: 189–194. http://dx.doi.org/10.55360/cpn444.la373

**Adamec L. 2018.** Ecophysiological characteristics of turions of aquatic plants: A review. *Aquatic Botany* 148: 64–77. https://doi.org/10.1016/j.aquabot.2018.04.011

**Adamec L., Vrba J. & D. Sirova 2011.** Fluorescent tagging of Phosphatase and Chitinase activity on different structures of *Utricularia* traps. *Carnivorous Plant Newsletter* 40: 68–73. http://dx.doi.org/10.55360/cpn402.la656

**Adamec L., Sirova D., Vrba J. & E. Rejmankova 2010.** Enzyme production in the traps of aquatic *Utricularia* species. *Biologia* 65(2): 273–278. https://doi.org/10.2478/s11756-010-0002-1

**Adlassnig W., Peroutka M., Lambers H. & I.K. Lichtscheidl 2005.** The roots of carnivorous plants. *Plant and Soil* 274(1): 127–140. https://doi.org/10.1007/s11104-004-2754-2

**Ahmedullah M. & M.P. Nayar 1986.** *Endemic plants of the Indian region*. Volume 1. Botanical Survey of India, Kolkata.

**Alfasane M.A., Bhuiyan R.A. & M.K. Eusufzai 2020.** *Utricularia geminiscapa* Benj. (Lentibulariaceae): a new angiospermic record for Bangladesh. *Bangladesh Journal of Plant Taxonomy* 27(1): 191–194. https://doi.org/10.3329/bjpt.v27i1.47580

**Alfasane M.A., Hassan M.A. & R.A. Bhuiyan 2020.** *Utricularia rosettifolia* Alfasane & Hassan *sp. nov.* (Lentibulariaceae) - a new species from Bangladesh. *Bangladesh Journal of Plant Taxonomy* 27(2): 205–211. https://doi.org/10.3329/bjpt.v27i2.50661

**Alkhalaf I.A., Hubener T. & S. Porembski 2009.** Prey spectra of aquatic *Utricularia* species (Lentibulariaceae) in northeastern Germany: The role of planktonic algae. *Flora* 204: 700–708. https://doi.org/10.1016/j.flora.2008.09.008

**Almeida S.M. 1990.** *Flora of Savantwadi Maharashtra, India.* Scientific Publishers, Jodhpur.

**Alvarez I.J.F.W. & J. Wendel 2003**. Ribosomal ITS sequences and plant phylogenetic inference. *Molecular phylogenetics and evolution* 29(3): 417–434. https://doi.org/10.1016/S1055-7903(03)00208-2

**Ansari R., Jeeja G. & R. Prakashkumar 2016.** *Aquatic and wetland flora of Kerala: flowering plants.* Malabar Botanical Garden and Institute for Plant Sciences, Kozhikode, Kerala.

**Anilkumar N., Sivadasan M. & N. Ravi 2005.** *Flora of Pathanamthitta, Western Ghats, Kerala.* Daya Publishing House, Delhi.

**APG 2016.** An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG IV. The Angiosperm Phylogeny Group. *Botanical Journal of the Linnean society* 181(1): 1–20. https://doi.org/10.1111/boj.12385

**Aphale P., Meshram D.C. & D.M. Mahajan 2019**. Comparative assessment of trace and major elements from the microhabitats of Basalt and Lateritic Plateaus of Western Ghats, Maharashtra. *International Journal of Allied Practice, Research and Review* 6(5): 1–12.

**Astuti G. & L. Peruzzi 2018a.** Are shoots of diagnostic value in Central European bladderworts (*Utricularia* L., Lentibulariaceae)? *Plant Biosystems - An International Journal Dealing with all Aspects of Plant Biology* 152(6): 1214–1226. https://doi.org/10.1080/11263504.2018.1435573

**Astuti G. & L. Peruzzi 2018b.** Notes on the typification of the names *Utricularia bremii* Heer and *U. intermedia* Dreves & Hayne (Lentibulariaceae). *Phytotaxa* 350(2): 172–176. https://doi.org/10.11646/phytotaxa.350.2.7

**Astuti G., Petroni G., Adamec L., Miranda V.F.O. & L. Peruzzi 2020.** DNA barcoding approach fails to discriminate Central European bladderworts (*Utricularia*, Lentibulariaceae), but provides insights concerning their evolution. *Plant Biosystems-An International Journal Dealing with all Aspects of Plant Biology* 154(3): 326–336. https://doi.org/10.1080/ 11263504. 2019.1610112

**Arora R.K., Wadhwa B.M. & M.B. Raizada 1981.** *The botany of South Kanara district*. Bishen Singh Mahendra Pal Singh, Dehra Dun.

**Arya S., Raju R., Arunraj P.T., Vishnu W.K., Biju P. & V.N.S. Anilkumar 2020.** *Utricularia kamarudeenii* (Lentibulariaceae): a new species from Kerala, India. *Phytotaxa* 447(1): 68–72. https://doi.org/10.11646/phytotaxa.447.1.7

**Avery L.N. 2017.** *Prey selectivity in Utricularia gibba*. PhD Thesis, submitted to California State University (unpublished).

**Balakrishnan N.P. 1983.** *Flora of Jowai and vicinity Meghalaya*. Volume 2. Botanical Survey of India, Howrah. p. 666.

**Baleeiro P.C. & C.P. Bove 2011**. A new species of *Utricularia* (Lentibulariaceae) from Chapada dos Veadeiros (Central Brazil). *Systematic Botany* 36(2): 465–469. https://doi.org/10.1600/036364411X569642

**Baleeiro P.C. & R.W. Jobson 2022.** Redescription of *Utricularia singeriana* and a new species *Utricularia baliboongarnang* Baleeiro & R.W.Jobson for north-eastern Western Australia. *Telopea* 25: 63–73. https://doi.org/10.7751/telopea15647

**Baleeiro P.C., Jobson R.W. & P.T. Sano 2015.** Morphometric approach to address taxonomic problems: The case of *Utricularia* sect. *Foliosa* (Lentibulariaceae). *Journal of Systematics and Evolution* 54(2): 175–186. https://doi.org/10.1111/jse.12186

**Baleeiro P.C., Sano P.T. & R.W. Jobson 2019.** Molecular phylogeny of the *Utricularia amethystina* complex (*Utricularia* sect. *Foliosa*) assessed using plastid and nuclear sequence data. *Systematic Botany* 44: 398–404. https://doi.org/10.1600/036364419X15562052252045

**Baleeiro P.C., Moreira A.D.R., Silva N.G.D. & C.P. Bove 2017.** Flora of Rio de Janeiro: Lentibulariaceae. *Rodriguesia* 68(1): 59–71. https://doi.org/10.1590/2175-7860201768111

**Banerjee L.K. & T.A. Rao 2001.** *Flora of the Mahanadi Delta, Orissa.* Botanical Survey of India, Kolkata. p. 307.

**Barnhart J.H. 1916.** Segregation of genera in Lentibulariaceae. *Memoirs of the New York Botanical Garden* 6: 39–64.

**Barthlott W. 1981.** Epidermal and seed surface characters of plants: Systematic applicability and some evolutionary aspects. *Nordic Journal of Botany* 1: 345–355. http://dx.doi.org/10.1111/j.1756-1051. 1981.tb00704.x

**Barthlott W., Porembski S., Fischer E. & B. Gemmel 1998.** First protozoa-trapping plant found. *Nature* 392: 447. https://doi.org/10.1038/33037

**Basak R.K. 1976.** Neotype of *Utricularia polygaloides* Edgeworth. *Taxon* 25: 189. https://doi.org/10.2307/1220445

**Basak R.K. 1979.** On the typifications of *Utricularia caerulea* L. and few allied species. *Bulletin of the Botanical Survey of India* 21(1-4): 216–218. https://doi.org/10.20324/nelumbo/v21/1979/75499

**Beentje H. 2010.** *The Kew plant glossary an illustrated dictionary of plant terms*. Royal Botanic Gardens, Kew.

**Behnke H.D. & W. Barthlott 1983.** New evidence from the ultrastructural and micromorphological fields in angiosperm classification. *Nordic Journal of Botany* 3(1): 43–66. https://doi.org/10.1111/j.1756-1051.1983.tb01444.x

**Bell A.D. 1991.** *Plant form: an illustrated guide to flowering plant morphology*. Oxford University Press, Oxford. p. 341.

**Benjamin L. 1847a.** Neue Generen und arten der Utricularieen nebst einer neuen Eintheilung der Gattung *Utricularia*. *Linnaea* 20: 299–320.

**Benjamin L. 1847b.** Lentibulariaceae. *Linnaea* 20: 485–489.

**Bennet S.S.R. 1979.** *Flora of Howrah district*. International Book Distributors, Dehra Dun.

**Bentham G. & J.D. Hooker 1876.** *Genera Plantarum*. *Stylidieas-Plantagineas*. Volume 2. Part 2. Reeve & Co., Covent Garden, London. https://doi.org/10.5962/bhl.title.747

**Beretta M., Rodondi G., Adamec L. & C. Andreis 2014.** Pollen morphology of European bladderworts (*Utricularia* L., Lentibulariaceae). *Review of Palaeobotany and Palynology* 205: 22–30. https://doi.org/10.1016/j.revpalbo.2014.02.009

**Bhat K.G. 2003.** *Flora of Uduppi.* Manipal Press Limited, Manipal. p. 913.

**Bhat K.G. 2014.** *Flora of South Kanara (Dakshina Kannada and Udupi districts of Karnataka).* Aakrithi Prints, Light House Hill Road, Mangalore. p. 928.

**Bhattacharyya P.K. 1978.** What is *Utricularia caerulea*? *Bulletin of the Botanical Society of Bengal* 30: 73–87.

**Bhattacharyya P.K. 1986.** Proposal to reject the name *Utricularia caerulea* L. (Lentibulariaceae). *Taxon* 35: 750–755. https://doi.org/10.2307/1221646

**Bhattacharyya P.K. & K. Sarkar 1998.** *Flora of West Champaran district Bihar.* Botanical Survey of India, Kolkata. p. 534.

**Bhowmik S. & B.K. Datta 2012a.** Extended distribution of *Utricularia bifida* Linn. (Lentibulariaceae) from India. *Researcher* 4(3): 58–61.

**Bhowmik S. & B.K. Datta 2012b.** *Utricularia caerulea* L. (Lentibulariaceae) - a new record from Tripura, North East India. *NeBIO* 3(1): 35–38.

**Bhowmik S. & B.K. Datta 2013.** Pollen Morphology of some carnivorous plants from Tripura, India. *International Journal of Fundamental & Applied Sciences* 2(2): 36–38.

**Biju P., Josekutty E.J., Janarthanam M.K. & A. Jomy 2020**. *Utricularia sainthomia* (Lentibulariaceae), a remarkable carnivorous species from the lateritic plateau of northern Kerala, India. *Rheedea* 30(2): 270–277. http://dx.doi.org/10.22244/rheedea.2020.30.02.02

**Blatter E.J. & Mc Cann 1931.** Two new *Utricularia* from the Western Ghats. *Journal of Indian Botanical Society* 10: 122–125.

**Bole P.V. & J.M. Pathak 1988.** *Flora of Saurashtra*. *Part II (Asteraceae to Casuarinaceae)*. Botanical Survey of India, Kolkata. p. 302.

**Bove C.P. 2008.** A new species of *Utricularia* (Lentibulariaceae) from Central Brazil. *Revista Brasileira de Botanica* 31: 555–558. https://doi.org/10.1590/S0100-84042008000400002

**Brewer J.S. & J. Schlauer 2018.** Biogeography and habitats of carnivorous plants. *In:* **Ellison A. & L. Adamec** (eds.), *Carnivorous plants: physiology, ecology, and evolution.* Oxford University, New York, USA. pp. 7–21.

**Bridson D. & M. Forman 1992.** *The Herbarium Handbook*. Revised edition. The Royal Botanic Gardens Kew.

**Brown R. 1810.** *Prodromus Florae Novae Hollandiae et Insulae van-diemen*. Volume 1. London. https://doi.org/10.5962/bhl.title.6720

**Caravieri F.A., Ferreira A.J., Ferreira A., Clivati D., Miranda V.F.O. & W.L. Araujo 2014.** Bacterial community associated with traps of the carnivorous plants *Utricularia hydrocarpa* and *Genlisea filiformis*. *Aquatic Botany* 116: 8–12. http://dx.doi.org/10.1016/j.aquabot.2013.12.008

**Casper S.J. 2002.** Conrad Gessner and *Pinguicula* – a nearly forgotten aspect of the pre-Linnean history of Lentibulariaceae and *Pinguicula* L. *Carnivorous Plant Newsletter* 31(1): 10–13. https://doi.org/10.55360/cpn311.jc925

**Ceschin S., Pelella E., Azzella M.M., Bellini A. & N.T.W. Ellwood 2022.** Unusual underwater flowering of *Utricularia australis* populations: a botanical enigma? *Aquatic Botany* 178: 103487. https://doi.org/10.1016/ j.aquabot. 2021.103487

**Ceska A. & M.A.M. Bell 1973.** *Utricularia* (Lentibulariaceae) in the Pacific Northwest. *Madrono* 22(2): 74–84.

**Champion P. 2014.** *Utricularia australis*. *The IUCN Red List of Threatened Species* 2014: e.T163979A21842538. Available at: https://dx.doi.org/10.2305/IUCN. UK.2014-1.RLTS.T163979A21842538.en. (Accessed on 20 September 2024).

**Chandran S.M.D., Ramachandra T.V., Joshi N.V., Rao G.R., Prakash N.M., Balachandran C. & N.D. Sumesh 2012.** Conservation Reserve status to lateritic plateaus of Coastal Uttara Kannada. *Environmental Information System technical report 51.* November 2012. Centre for Ecological Sciences, Indian Institute of Science, Bangalore, India.

**Chandrasekaran V. 1987.** Lentibulariaceae. *In*: **Henry A.N., Kumari G.R. & V. Chithra** (eds.), *Flora of Tamil Nadu, India*. Series I: Analysis. Volume 2. Botanical Survey of India, Coimbatore. pp. 129–131.

**Chao Y.S. 2003.** *A taxonomic study on Lentibulariaceae of Taiwan*. Master thesis submitted to National Sun Yat-sen University (unpublished).

**Chase M.W. & J.S. Pippen 1988.** Seed morphology in the Oncidiinae and related subtribes (Orchidaceae). *Systematic Botany* 13(3): 313–323. https://doi.org/ 10.2307/2419295

**Chaudhary A., Yadav S.R. & R. Tandon 2018.** Delayed selfing ensures reproductive assurance in *Utricularia praeterita* and *Utricularia babui* in Western Ghats. *Journal of Plant Research* 131: 599–610. https://doi.org/10.1007/s10265-018-1016-y

**Cheng Z., Fang Q., Wang F. & C.L. Long 2021.** *Utricularia lihengiae* (Lentibulariaceae), a new species from Northwest Yunnan, China. *PhytoKeys* 177: 17–24. https://doi.org/10.3897/phytokeys.177.63346

**Chew M.Y. & N.W. Haron 2011.** *Utricularia* (Lentibulariaceae) habitat diversity in peninsular Malaysia and its implications for conservation. *Garden's Bulletin of Singapore* 63(1&2): 451–464.

**China Plant BOL Group: Li D.Z., Gao L.M., Li H.T., Wang H., Ge X.J., Liu J.Q., Chen Z.D., Zhou S.L., Chen S.L., Yang J.B., Fu C.X., Zeng C.X., Yan H.F., Zhu Y.J., Sun Y.S., Chen S.Y., Zhao L., Wang K., Yang T. & G.W. Duan 2011.** Comparative analysis of a large dataset indicates that internal transcribed spacer (ITS) should be incorporated into the core barcode for seed plants. *Proceedings of the National Academy of Sciences* 108(49): 19641–19646. https://doi.org/10.1073/pnas.1104551108

**Chormanski T.A. & J.H. Richards 2012.** An architectural model for the bladderwort *Utricularia gibba* (Lentibulariaceae). *The Journal of the Torrey Botanical Society* 139(2): 137–148. https://doi.org/10.3159/TORREY-D-11-00088.1

**Cieslak T., Polepalli J.S., White A., Müller K., Borsch T., Barthlott W., Steiger J., Marchant A. & L. Legendre 2005.** Phylogenetic analysis of *Pinguicula* (Lentibulariaceae): chloroplast DNA sequences and morphology support several geographically distinct radiations. *Systematics and Phytogeography* (10): 1723–1736. https://doi.org/10.3732/ajb.92.10.1723

**Cincotta R.P., Wisnewski J. & R. Engleman 2000.** Human populations in the biodiversity hotspots. *Nature* 404: 990–992. https://doi.org/10.1038/35010105

**Clarke C.B. 1884.** Lentibulariaceae. *In*: **Hooker J.D.** (ed.), *The flora of British India*. Volume 4. L. Reeve & Co. London. pp. 328–335.

**Clivati D., Cordeiro G.D., Płachno B.J. & V.F.O. Miranda 2014.** Reproductive biology and pollination of *Utricularia reniformis* A.St.-Hil. (Lentibulariaceae). *Plant Biology* 16(3): 677–682. https://doi.org/10.1111/plb.12091

**Coelho N., Gomes-Klein V.L. & M.V. Dantas-Queiroz 2017.** Lentibulariaceae from Serra dos Pireneus, Goias, Brazil. *Rodriguesia* 68(4): 1347–1356. https://doi.org/10.1590/2175-7860201768416

**Compton R.H. 1909.** The morphology and anatomy of *Utricularia brachiata* Oliver. *The New Phytologist* 8(4): 117–130. https://doi.org/10.1111/j.1469-8137.1909.tb05512.x

**Cooke T. 1905.** *The Flora of Presidency of Bombay. Compositae–Gramineae*. Volume 2. Taylor and Francis, Fleet Street, London. p. 1083. https://doi.org/10.5962/bhl.title.10884

**Costa S.M., Bittrich V. & M.C.E. Amaral 2016.** Lentibulariaceae from the Virua National Park in the northern Amazon, Roraima, Brazil. *Phytotaxa* 258(1): 001–025. http://doi.org/10.11646/phytotaxa.258.1.1

**Crow G.E. 1992.** The genus *Utricularia* (Lentibulariaceae) in Costa Rica. *Brenesia* 38: 1–18.

**Crow G.E. 2001.** *Utricularia myriocista* (Lentibulariaceae) in Costa Rica: A new record for Central America. *Rhodora* 103(914): 227–232.

**Cruz D., Dominguez Y., Valdes C.M.P., Miranda V.F.O. & E.C. Gasparino 2018.** Pollen morphology of selected species of Lentibulariaceae Rich. from Western Cuba based on light microscopy and its taxonomic implications. *Phytotaxa* 350(2): 187–200. https://doi.org/10.11646/phytotaxa.350.2.10

**Dalzell N. & A. Gibbson 1861.** *The Bombay flora or, short descriptions of all the indigenous plants hitherto discovered in or near the Bombay presidency together with a supplement of introduced and naturalised species*. Education Society's Press, Byculla, Bombay. p. 332. https://doi.org/10.5962/bhl.title.33061

**Darriba D., Taboada G.L., Doallo R. & D. Posada 2012.** jModelTest 2: more models, new heuristics and parallel computing. *Nature Methods* 9(8): 772. https://doi.org/10.1038/nmeth.2109

**Darwin C. 1875.** *Insectivorous plants*. D. Appleton & Company, New York. p. 462. https://doi.org/10.5962/bhl.title.17335

**Dash S.S. & A.A. Mao 2022.** Status, Issues and Challenges of Biodiversity: Higher Plants. *In:* **Kaur S., Batish D.R., Singh H.P. & R.K. Kohli** (eds.), *Biodiversity in India: Status, Issues and Challenges*. Springer Nature. pp.25–44. https://doi.org/10.1007/978-981-16-9777-7_3

**Dash S.S. & P. Singh 2017.** *Flora of Kurung Kumey district.* Botanical Survey of India, Ministry of Environment, Forest and Climate Change, Kolkata. p. 782.

**Datar M.N. & P. Lakshminarasimhan 2013.** *Flora of Bhagwan Mahavir (Molem) National Park and Adjoinings, Goa.* Botanical Survey of India, Ministry of Environment & Forests, Kolkata. p. 314.

**De Candolle A.P. 1844.** Lentibulariaceae. *In*: **De Candolle** (ed.), *Prodromus systematis naturalis regni vegetabilis*. Volume 8. Masson & Associates, Paris. pp. 2–25. https://doi.org/10.5962/bhl.title.286

**Deb D.B. 1983.** *Flora of Tripura state*. Buddlejaceae–Gramineae. Volume 2. Today & Tomorrow's Printers and Publishers, New Delhi.

**Delprete P.G. 2014.** *Utricularia julianae* (Lentibulariaceae), a new species from the savannas of the Oyapock river, French Guiana. *Phytotaxa* 156(2): 74–78. https: //doi.org/10.11646/phytotaxa.156.2

**Deshpande S., Sharma B.D. & M.P. Nayar 1993.** *Flora of Mahabaleshwar and Adjoinings, Maharashtra*. Volume 1. Botanical Survey of India. Kolkata. p. 431.

**Dinarvand M. 2012.** A taxonomic revision of *Utricularia* (Lentibulariaceae) for aqua flora of Iran. *The Iranian Journal of Botany* 18(2): 191–195.

**Dite D., Hrivnak R. & P. Elias 2013.** *Utricularia bremii* (Lentibulariaceae) rediscovered in Slovakia. *Polish Botanical Journal* 58(2): 653–658. http://dx.doi.org/10.2478/pbj-2013-0052

**Doyle J.J. & J.L. Doyle 1987.** A rapid DNA isolation procedure for small quantities of fresh leaf tissue. *Phytochemical Bulletin* 19: 11–15.

**Doyle A.M. & J. Parnell 2003.** Geometry and bladderworts: quadrifids of Irish *Utricularia* species. *The Irish Naturalists Journal* 27(6): 213–222. https://www.jstor.org/stable/25536470

**Drury H. 1866.** *Hand-book of the Indian Flora; being a guide to all the flowering plants hitherto described as indigenous to the continent of India*. Volume 2. Trabancore Sircar Press (Madras?). p. 659. https://doi.org/10.5962/bhl.title.54658

**Duthie J.F. 1911.** *Flora of Upper Gangetic Plain, and of the Adjacent Siwalik and Siwalik and Sub-Himalayan Tracts. Plumbaginaceae to Plantaginaceae*. Volume 2. Superintendent Government Printing, Kolkata.

**Dyer W.T. 1905.** *Hooker's Icones Plantarum, or figures, with descriptive characters and remarks, of new and rare plants, selected from the Kew Herbarium.* Series 4. Volume 8. Dulau & Co. Soho square, London. https://doi.org/10.5962/bhl.title.16059

**Edgar R.C. 2004.** MUSCLE: multiple sequence alignment with high accuracy and high throughput. *Nucleic acids research* 32(5): 1792–1797. https://doi.org/10.1093/nar/gkh340

**Edgeworth M.P. 1847.** Description of a new genus of Lentibulariae, with remarks on some Indian species of *Utricularia*. *Proceedings of the Linnean Society of London* 1: 351–353.

**Ellis J.L. 1990.** *Flora of Nallamalais.* Volume 2. Botanical Survey of India, Kolkata. p. 490.

**Ellison A.M. & N.J. Gotelli 2001.** Evolutionary ecology of carnivorous plants. *Trends in Ecology & Evolution* 16(11): 623–629. https://doi.org/10.1016/S0169-5347(01)02269-8

**Ellwood N.T.W., Congestri R. & S. Ceschin 2018.** The role of phytoplankton in the diet of the bladderwort *Utricularia australis* R.Br. (Lentibulariaceae). *Freshwater Biology* 64(1): 233–243. https://doi.org/10.1111/fwb.13212

**Eriksson O. & K. Kainulainen 2011.** The evolutionary ecology of dust seeds. *Perspectives in Plant Ecology, Evolution and Systematics* 13(2): 73–87. http://dx.doi.org/10.1016/j.ppees.2011.02.002

**Farooq M. & S.A. Siddiqui 1966.** Anatomy of the floats of *Utricularia inflexa* Forsk. var. *inflexa* Taylor. *Bulletin of the Torrey Botanical Club* 93(5): 301–305. https://doi.org/10.2307/2483443

**Fineran B.A. 1980.** Ontogeny of external glands in the bladderwort *Utricularia monanthos*. *Protoplasma* 105: 9–25. https://doi.org/10.1007/BF01279846

**Fineran B.A. 1985.** Glandular trichomes in *Utricularia*: a review of their structure and function. *Israel Journal of Plant Sciences* 34(2-4): 295–330. https://doi.org/10.1080/ 0021213X.1985.10677028

**Fleischmann A. 2012.** The new *Utricularia* species described since Peter Taylor's monograph. *Carnivorous Plant Newsletter* 41(2): 67–76. https://doi.org/10.55360/cpn412.af309

**Fleischmann A. 2015.** Taxonomic *Utricularia* news. *Carnivorous Plant Newsletter* 44(1): 13–16. https://doi.org/10.55360/cpn441.af290

**Fleischmann A. & F. Rivadavia 2009.** *Utricularia rostrata* (Lentibulariaceae), a new species from the Chapada Diamantina, Brazil. *Kew Bulletin* 64: 155–159. https://doi.org/10.1007/s12225-008-9086-y

**Fleischmann A. & J. Schlauer 2014.** Die Gattung *Utricularia* in Bayern. *Berichte der Bayerischen Botanischen Gesellschaft* 84: 65–90.

**Fleischmann A., Schlauer J., Smith S.A., Givnish T.J., Ellison A. & L. Adamec 2018.** Evolution of carnivory in angiosperms. *In:* **Ellison A.M. & L. Adamec** (eds.), *Carnivorous plants: physiology, ecology, and evolution.* Oxford University Press, New York, USA. pp. 22–42.

**Fleischmann A., Schäferhoff B., Heubl G., Rivadavia F., Barthlott W. & K.F. Mueller2010.** Phylogenetics and character evolution in the carnivorous plant genus *Genlisea* A.St.-Hil.(Lentibulariaceae). *Molecular Phylogenetics and Evolution* 56(2): 768–783. https://doi.org/10.1016/j.ympev.2010.03.009

**Freitas H.D., Baleeiro P.C. & M. Trovo 2017.** Lentibulariaceae from the Itatiaia National Park, Brazil. *Rodriguesia* 68(1): 223–231. https://doi.org/10.1590/ 2175-7860201768127

**Freund M., Graus D., Fleischmann A., Gilbert K.J., Lin Q., Renner T., Stigloher C., Albert V.A., Hedrich R. & K. Fukushima 2022.** The digestive systems of carnivorous plants. *Plant physiology* 190(1): 44–59. https://doi.org/10.1093/ plphys/kiac232

**Friday L.E. 1989.** Rapid turnover of traps in *Utricularia vulgaris* L. *Oecologia* 80(2): 272–277. https://doi.org/10.1007/bf00380163

**Friday L.E. 1991.** The size and shape of traps of *Utricularia vulgaris* L. *Functional Ecology* 5(5): 602–607. https://doi.org/10.2307/2389478

**Friday L.E. 1992.** Measuring investment in carnivory: seasonal and individual variation in trap number and biomass in *Utricularia vulgaris* L. *The New Phytologist* 121(3): 439–445. https://doi.org/10.1111/j.1469-8137.1992.tb02944.x

**Friday F. & C. Quarmby 1994.** Uptake and translocation of prey-derived $^{15}N$ and $^{32}P$ in *Utricularia vulgaris* L. *The New Phytologist* 126(2): 273–281.

**Fyson P.F. 1915.** *The flora of the Nilgiri & Pulney Hill-Tops*. Volume 1. Superintendent, Government Press, Madras.

**Fyson P.F. 1932.** *The flora of the South Indian Hill stations.* Volume 2. Today & Tomorrow's Printers & Publishers, New Delhi.

**Gadhvi K., Gamit S., Dudhagara D., Vyas S. & R. Yadav 2021.** A new distributional record of bladderwort species *Utricularia janarthanamii* for Gujarat state. *Plant Science Today* 8(1): 182–184.

**Gamble J.S. 1924.** *Flora of the Presidency of Madras*. Adlard & Son Ltd., London.

**Gandhi K.N. 1978.** Lentibulariaceae. *In*: **Saldanha C.J. & D.H. Nicolson** (eds.), *Flora of Hassan district Karnataka, India*. Amerind Publishing Co. Pvt. Ltd. New Delhi. pp. 562–566.

**Gassin R. 1993.** *Utricularia beaugleholei* (Lentibulariaceae: subgenus *Utricularia*: section *Pleiochasia*), a new species from south-eastern Australia. *Muelleria* 8: 37–42. https://doi.org/10.5962/p.198491

**Gibbs R.D. 1929.** The trap of *Utricularia*. *Torreya* 29(4): 85–96.

**Giri G.S., Pramanik A. & H.J. Chowdhery 2008.** *Materials for the flora of Arunachal Pradesh (Asteraceae–Ceratophyllaceae)*. Volume 2. Botanical Survey of India, Ministry of Environment & Forests, Kolkata. p. 491.

**Givnish T.J. 1989.** Ecology and evolution of carnivorous plants. *In*: **Abramson W.G.** (ed.), *Plant-animal interactions*. McGraw-Hill Publishers, Toronto. pp. 243–290.

**Givnish T.J. & K.J. Sytsma 1997.** Consistency, characters, and the likelihood of correct phylogenetic inference. *Molecular Phylogenetics and Evolution* 7(3): 320–330. https://doi.org/10.1006/mpev.1997.0409

**Givnish T.J., Burkhardt E.L., Happel R.E. & J.D. Weintraub 1984.** Carnivory in the bromeliad *Brocchinia reducta*, with a cost/benefit model for the general

restriction of carnivorous plants to sunny, moist, nutrient-poor habitats. *The American Naturalist* 124(4): 479–497.

**Givnish T.J., Barfuss M.H., Van Ee B., Riina R., Schulte K., Horres R., Gonsiska P.A., Jabaily R.S., Crayn D.M., Smith J.A.C. & K. Winter 2011.** Phylogeny, adaptive radiation, and historical biogeography in Bromeliaceae: insights from an eight-locus plastid phylogeny. *American journal of botany* 98(5): 872–895. https://doi.org/10.3732/ajb.1000059

**Gluck H. 1906.** *Biologische und morphologische Untersuchungen über Wasser- und Sumpfgewächse*. 2. Teil Gustav Fischer Verlag, Jena.

**Gluck H. 1913.** Contributions to our knowledge of the species of *Utricularia* of Great Britain with special regard to the morphology and geographical distribution of *Utricularia ochroleuca*. *Annals of Botany* 27(108): 607–620.

**Godfrey R.K. & J.W. Wooten 1981.** *Aquatic and wetland plants of southeastern United states*, Dicotyledons. Athens. p. 728.

**Gogoi R., Sherpa N., Benjamin J.H.F., Agrawala D.K. & S.S. Dash 2021.** *Flora of Sikkim a pictorial guide*. Botanical Survey of India Kolkata, and Forest & Environment Department, Sikkim. p. 566.

**Gonella P.M. & P.C. Baleeiro 2018.** *Utricularia biceps* (Lentibulariaceae), a new carnivorous species endemic to the *campos rupestres* of Brazil. *Phytotaxa* 376(5): 214–222. http://dx.doi.org/10.11646/phytotaxa.376.5.4

**Gonella P.M., Barbosa-Silva R.G., Fleischmann A., Zappi D.C., Baleeiro P.C. & C.O. Andrino 2020.** Hidden biodiversity of Amazonian white-sand ecosystems: two distinctive new species of *Utricularia* (Lentibulariaceae) from Pará, Brazil. *PhytoKeys* 169: 75–98. https://doi.org/10.3897/phytokeys.169.57626

**Gordon E. 1998.** Seed characteristics of plant species from riverine wetlands in Venezuela. *Aquatic Botany* 60(4): 417–431.

**Gordon E. & S. Pacheco 2007.** Prey composition in the carnivorous plants *Utricularia inflata* and *U. gibba* (Lentibulariaceae) from Paria Peninsula, Venezuela. *Revista de biología tropical* 55(3-4): 795–803. https://doi.org/10.15517/rbt.v55i3-4.5956

**Graham J. 1839.** *A catalogue of the plants growing in Bombay and its vicinity: Spontaneous, cultivated or introduced, as far as they have been ascertained*. Government Press, Bombay. p. 521. https://doi.org/10.5962/bhl.title.45206

**Greilhuber J., Borsch T., Müller K., Worberg A., Porembski S. & W. Barthlott 2006.** Smallest angiosperm genomes found in Lentibulariaceae, with chromosomes of bacterial size. *Plant Biology* 8(6): 770–777. https://doi.org/10.1055/s-2006-924101

**Gudger E.W. 1947.** The only known fish-catching plant: *Utricularia*, the bladderwort. *The Scientific Monthly* 64: 369–384.

**Guedes F.M. & M. Alves 2020.** Lentibulariaceae in the Atlantic Forest of northeastern Brazil. *Phytotaxa* 470(1): 31–76. https://doi.org/10.11646/phytotaxa.470.1.2

**Guedes F.M., Coan A.I., Araujo G.B. & M. Alves 2021.** The identity of *Utricularia trinervia* (Lentibulariaceae): Taxonomic re-establishment and unpublished descriptions of trap morphology. *Taxon* 70(4): 854–865. https://doi.org/10.1002/ tax.12496

**Guedes F.M., Garcia G.S., Araujo G.B., Coan A.I. & M. Alves 2019.** Rediscovery of *Utricularia cutleri* Steyerm. (Lentibulariaceae) in Rio Grande do Norte, Brazil: taxonomic reestablishment, geographic distribution, and notes on pollen and bladder-trap micromorphology. *Systematic Botany* 44(3): 708–718. https://doi.org/10.1600/036364419X15620114943864

**Guedes F.M., Garcia G.S., Versieux L.M., Matias L.Q. & M. Alves 2018.** Insights on underestimated Lentibulariaceae diversity in northeastern Brazil: new records and notes on distribution, diversity and endemism in the family. *Brazilian Journal of Botany* 41(4): 867–887. https://doi.org/10.1007/s40415-018-0497-1

**Guha Bakshi 1984.** *Flora of Murshidabad district*. Scientific publishers, Jodhpur, India.

**Guiral D. & C. Rougier 2007.** Trap size and prey selection of two coexisting bladderwort (*Utricularia*) species in a pristine tropical pond (French Guiana) at different trophic levels. *International Journal of Limnology* 43(3): 147–159. https://doi.org/10.1051/limn:2007009

**Guisande C., Andrade C., Granado-Lorencio C., Duque S.R. & M. Nunez-Avellaneda 2000.** Effects of zooplankton and conductivity on tropical *Utricularia foliosa* investment in carnivory. *Aquatic Ecology* 34: 137–142. https://doi.org/10.1023/A:1009966231287

**Gyeltshen P. & S. Dema 2020.** *Utricularia furcellata* (Lentibulariaceae): a new record to Bhutan. *Bhutan Journal of Natural Resources and Development* 7(1): 51–54.

**Haines H.H. 1922.** *The Botany of Bihar and Orissa.* Part IV. Gamopetalae. Adlard & Son and West Newman, Ltd., London. p. 1350. https://doi.org/10.5962/ bhl.title.11031

**Haron N.W. & M.Y. Chew 2012.** Medicinal and environmental indicator species of *Utricularia* from Montane Forest of Peninsular Malaysia. *The Scientific World Journal* 2012: 1–5. https://doi.org/10.1100/2012/234820

**Harper J.L., Lovell P.H. & K.G. Moore 1970.** The shapes and sizes of seeds. *Annual Review of Ecology and Systematics* 1: 327–356. https://doi.org/10.1146/ annurev.es .01.110170.001551

**Hedrich R. & K. Fukushima 2021.** On the origin of carnivory: molecular physiology and evolution of plants on an animal diet. *Annual review of plant biology* 72(1): 133–153. https://doi.org/10.1146/annurev-arplant-080620-010429

**Hegner R.W. 1926.** The interrelations of protozoa and the utricles of *Utricularia*. *Biological Bulletin* 50(3): 239–270. https://doi.org/10.2307/1536673

**Henning T., Allen J.P & Rodriguez-Rodriguez 2021.** A new species of *Utricularia* Sect. *Orchidioides* (Lentibulariaceae) from the Amotape-Huancabamba Zone of North Peru. *Darwiniana, nueva serie* 9(2): 299–311. http://dx.doi.org/10.14522/darwiniana.2021.92.955

**Hobbhahn N., Kuchmeister H. & S. Porembski 2006.** Pollination biology of mass flowering terrestrial *Utricularia* species (Lentibulariaceae) in the Indian Western Ghats. *Plant Biology* 8(06): 791–804. https://doi.org/10.1055/s-2006-924566

**Holzinger J.M. 1893.** The winter buds of *Utricularia*. *Bulletin of the Torrey Botanical Club* 20(7): 288–290.

**Hsu T.C., Chen Z.H. & Y.S. Chao 2017.** New additions of the bladderworts (Lentibulariaceae) in Taiwan. *Taiwania* 62(1): 99–104. https://doi.org/10.6165/ tai.2017.62.99

**Hu G.W., Long C.L. & K.M. Liu 2007.** *Utricularia mangshanensis* (Lentibulariaceae), a new species from Hunan, China. *Annales Botanici Fennici* 44(5): 389–392.

**Hu G.W., Zhe C. & C. Long 2008.** A newly recorded Species of *Utricularia* (Lentibulariaceae) to China and a newly recorded species of *Nervilia* (Orchidaceae) to Mainland China. *Plant Diversity* 30(2): 146. http://dx.doi.org/10.3724/SP.J.1143.2008.00146

**Hutchinson J. 1969.** *Evolution and phylogeny of flowering plants*. Academic Press Inc., London. p. 717.

**Huynh K.L. 1968a.** Morphologie du pollen des Tropaeolacées et des Balsaminacées. I. *Grana* 8(1): 88–184.

**Huynh K.L. 1968b.** Morphologie du pollen des Tropaeolacées et des Balsaminacées II. *Grana* 8(2-3): 277–516.

**IUCN 2012.** *IUCN Red List categories and criteria*. Version 3.1. Second edition. IUCN, Gland and Cambridge. p. 32.

**IUCN 2024.** Guidelines for using the IUCN Red List Categories and Criteria. Version 16. prepared by the Standards and Petitions Committee. Available at: https://www.iucnredlist.org/documents/RedListGuidelines.pdf

**IUCN 2024.** Guidelines for the application of IUCN Red List of Ecosystems Categories and Criteria. Version 2.0. **Keith D.A., Ferrer-Paris J.R., Ghoraba S.M.M., Henriksen S., Monyeki M., Murray N.J., Nicholson E., Rowland**

**J., Skowno A., Slingsby J.A., Storeng A.B., Valderrabano M. & I. Zager** (eds.), IUCN, Gland, Switzerland. Available at: https://doi.org/10.2305/CJDF9122

**Ibarra-Laclette E., Albert V.A., Perez-Torres C.A., Zamudio-Hernandez F., Ortega-Estrada M.D.J., Herrera-Estrella A. & L. Herrera-Estrella 2011.** Transcriptomics and molecular evolutionary rate analysis of the bladderwort (*Utricularia*), a carnivorous plant with a minimal genome. *BMC Plant Biology* 11: 101. http://dx.doi.org/10.1186/1471-2229-11-101

**Ibarra-Laclette E., Lyons E., Hernandez-Guzman G., Perez-Torres C.A., Carretero-Paulet L., Chang T.H., Lan T., Welch A.J., Juarez M.J.A., Simpson J., Fernandez-Cortes A., Arteaga-Vazquez M., Gongora-Castillo E., Acevedo-Hernandez G., Schuster S.C., Himmelbauer H., Minoche A.E., Xu S., Lynch M., Oropeza-Aburto A., Cervantes-Perez S.A., de Jesus Ortega-Estrada M., Cervantes-Luevano J.I., Michael T.P., Mockler T., Bryant D., Herrera-Estrella A., Albert V.A. & L. Herrera-Estrella 2013.** Architecture and evolution of a minute plant genome. *Nature* 498: 94–98. http://dx.doi.org/10.1038/nature12132

**Janarthanam M.K. 1994.** Distributional and ecological note on *Utricularia malabarica* (Lentibulariaceae) - a recently described bladderwort. *Journal of Economic and Taxonomic Botany* 18(1): 230–232.

**Janarthanam M.K. 1999.** Comments from an ICPS Correspondent:" Nelipu" of van Rheede. *Carnivorous Plant Newsletter* 28(2): 44–46. https://doi.org/10.55360/cpn282.mj891

**Janarthanam M.K. & A.N. Henry 1986.** A new *Utricularia* L. (Lentibulariaceae) from Kerala, India. *Nelumbo* 28(1-4): 195–197. https://doi.org/10.20324/nelumbo/v28/1986/74726

**Janarthanam M.K. & A.N. Henry 1987.** Neotypification of *U. purpurascens* Graham Lentibulariaceae. *Journal of Economic and Taxonomic Botany* 10(1): 245–246.

**Janarthanam M.K. & A.N. Henry 1989a.** Lectotypification of *Utricularia roseopurpurea* (Lentibulariaceae). *Taxon* 38(1): 141.

**Janarthanam M.K. & A.N. Henry 1989b.** *Utricularia malabarica sp. nov.* (Lentibulariaceae). A terrestrial bladderwort from southern India. *Journal of Bombay Natural History Society* 86: 84–85.

**Janarthanam M.K. & A.N. Henry 1990.** A new *Utricularia* (Lentibulariaceae) from peninsular India. Journal of *Bombay Natural History Society* 87: 441–442.

**Janarthanam M.K. & A.N. Henry 1992.** *Bladderworts of India*. Botanical Survey of India, Coimbatore.

**Jobson R.W. 2012a.** *Utricularia corneliana* R.W.Jobson (Lentibulariaceae), a new species from the North Kennedy district of Queensland. *Austrobaileya* 8(4): 601–607.

**Jobson R.W. 2012b.** A new species of *Utricularia* (Lentibulariaceae) from northern Queensland, Australia. *Telopea* 14: 49–57. https://doi.org/10.7751/telopea2012008

**Jobson R.W. 2013.** Five new species of *Utricularia* (Lentibulariaceae) from Australia. *Telopea* 15: 127–142. https://doi.org/10.7751/telopea2013017

**Jobson, R.W. & V.A Albert 2002.** Molecular rates parallel diversification contrasts between carnivorous plant sister lineages 1. *Cladistics* 18(2): 127–136. https://doi.org/10.1111/j.1096-0031.2002.tb00145.x

**Jobson R.W. & P.C. Baleeiro 2015.** Two new species of *Utricularia* (Lentibulariaceae) from the northwest region of Western Australia. *Telopea* 18: 201–208. http://dx.doi.org/10.7751/telopea8894

**Jobson R.W. & P.C. Baleeiro 2022.** Recircumscription of *Utricularia leptorhyncha* and *U. lasiocaulis* and three related new species for northern Australia. *Telopea* 25: 363–338. https://doi.org/10.7751/telopea16750

**Jobson R.W. & P.C. Baleeiro 2023.** Molecular phylogenetic study of *Utricularia* section *Oligocista* in Australia and a new Cape York endemic species. *Telopea* 26: 145–158. https://doi.org/10.7751/telopea17500

**Jobson R.W. & W. Cherry 2020.** *Utricularia gaagudju*, a new species for the Northern Territory, and a recircumscription of *U. kimberleyensis* C.A.Gardner. *Telopea* 23: 61–68. https://doi.org/10.7751/telopea14168

**Jobson R.W. & T. Davies-Colley 2020.** Redescription of the suspended aquatic *Utricularia aurea* Lour. (sect. *Utricularia*) and a new species *U. adamsii* for northern Australia. *Telopea* 23: 21–33. https://doi.org/10.7751/telopea14301

**Jobson R.W., Baleeiro P.C. & M.D. Barrett 2018.** Six new species of *Utricularia* (Lentibulariaceae) from Northern Australia. *Telopea*. 21: 57–77. https://doi.org/10.7751/telopea12630

**Jobson R.W., Baleeiro P.C. & M.S. Reut 2017.** Molecular phylogeny of subgenus *Polypompholyx* (*Utricularia*; Lentibulariaceae) based on three plastid markers: diversification and proposal for a new section. *Australian Systematic Botany* 30(3): 259–278. http://dx.doi.org/10.1071/SB17003

**Jobson R.W., Morris E.C. & S. Burgin 2000.** Carnivory and nitrogen supply affect the growth of the bladderwort *Utricularia uliginosa*. *Australian Journal of Botany* 48: 549–560.

**Jobson R.W., Playford J., Cameron K.M. & V.A. Albert 2003.** Molecular phylogenetics of Lentibulariaceae inferred from plastid *rps*16 intron and *trnL-F* DNA sequences: implications for character evolution and biogeography. *Systematic Botany* 28: 157–171. https://doi.org/10.1043/0363-6445- 28.1.157

**Joseph J. & J. Mani 1982.** One new species and one new record from India in the genus *Utricularia*. *Bulletin of the Botanical Survey of India* 24(1-4): 108–111. https://doi.org/10.20324/nelumbo/v24/1982/75292

**Jospeh J. & J. Mani 1983.** *Utricularia khasiana* (Lentibulariaceae) – an interesting new species and insectivorous plant from Shillong, Khasi hills, Meghalaya, India. *Bulletin of the Botanical Survey of India* 25(1-4): 192–194. https://doi.org/10.20324/nelumbo/v25/1983/75142

**Jospeh J. & K.M. Joseph 1986.** *Insectivorous plants of Khasi and Jaintia hills Meghalaya, India* (*A Preliminary Survey*). Botanical Survey of India. Kolkata.

**Joseph J. & K. Ramamurthy 1961.** Occurrence of *Utricularia hirta* Klein in South India. *Journal of Bombay Natural History Society* 58: 701–703.

**Juang T.C.C, Juang S.D.C. & Z.H. Liu 2011.** Direct evidence of the symplastic pathway in the trap of the bladderwort *Utricularia gibba* L. *Botanical Studies* 52: 47–54.

**Juniper B.E., Robins R.J. & D.M. Joel 1989.** *The Carnivorous Plants.* 1st edition. Academic Press Limited, London. p. 353.

**Kadono Y. & J. Tanaka 2015.** Identity of *Utricularia siakujiiensis* (Lentibulariaceae). *The Journal of Japanese Botany* 90(6): 399–403. http://dx.doi.org/10.1093/jxb/erp349

**Kalyaanamoorthy S., Minh B., Wong T., Haeseler A. & L.S. Jermiin 2017.** ModelFinder: fast model selection for accurate phylogenetic estimates. *Nature Methods* 14: 587–589. https://doi.org/10.1038/nmeth.4285

**Kamienski F. 1895.** Lentibulariaceae. *In*: **Engler A. & K. Prantl** (eds.), *Die naturlichen pflanzenfamilien* Teil IV. 3b. Leipzig. pp. 108–123.

**Kanjilal U.N., Kanjilal P.C., Das A., Dey R.N. & N.L. Bor 1939.** *Flora of Assam.* Volume 3. Government of Assam, Shillong.

**Karthikeyan S. & A. Kumar 1993.** *Flora of Yavatmal district, Maharashtra*. Botanical Survey of India, Kolkata. p. 344.

**Katoh K., Rozewicki J. & K.D. Yamada 2019.** MAFFT online service: multiple sequence alignment, interactive sequence choice and visualization. *Briefings in bioinformatics* 20(4): 1160–1166. https://doi.org/10.1093/bib/bbx108

**Kavade S.P. & S.S. Deokule 2015.** *Flora of Chandoli National Park, Western Ghats – Maharashtra, India*. Applied Science Innovations Pvt. Ltd. Pune, Maharashtra.

**Keith D.A., Akcakaya H.R. & N.J. Murray 2018.** Scaling range sizes to threats for robust predictions of risks to biodiversity. *Conservation Biology* 32(2): 322–332.

**Keith D.A., Rodríguez J.P., Rodríguez-Clark K.M., Nicholson E., Aapala K., Alonso A., Asmussen M., Bachman S., Basset A., Barrow E.G. Benson J.S., Bishop M.J., Bonifacio R., Brooks T.M., Burgman M.A., Comer P., Comin F.A., Essl F., Langendoen D.F., Fairweather P.G., Holdaway R.J., Jennings M., Kingsford R.T., Lester R.E., Nally R.M., McCarthy M.A., Moat J., Oliveria-Miranda M.A., Pisanu P., Poulin B., Regan T.J., Riecken U., Spalding M.D. & S.Z. Martinez 2013.** Scientific foundations for an IUCN Red List of Ecosystems. *PLOS one* 8(5): p.e62111. https://doi.org/10.1371/journal.pone.0062111

**Keshava Murthy K.R. & S.N. Yoganarasimhan 1990.** *Flora of Coorg.* Vimsat Publishers, Bangalore.

**Knight S.E. 1992.** Costs of carnivory in the common bladderwort, *Utricularia macrorhiza*. *Oecologia* 89(3): 348–355. https://doi.org/10.1007/BF00317412

**Knight S.E. & T.M. Frost 1991.** Bladder control in *Utricularia macrorhiza*: Lake-specific variation in plant investment in carnivory. *Ecology* 72(2): 728–734. https://doi.org/10.2307/2937212

**Kolte R.R., Deshpande A.S., Pillai P.M. & M.K. Janarthanam 2019.** Taxonomic identity of *Utricularia malabarica* (Lentibulariaceae), a species endemic to the lateritic plateaus of the Western Ghats, India. *Rheedea* 29(3): 215–217. http://dx.doi.org/10.22244/rheedea.2019.29.3.04

**Kolter A. & B. Gemeinholzer 2021.** Internal transcribed spacer primer evaluation for vascular plant metabarcoding. *Metabarcoding and Metagenomics* 5: p.e68155. https://doi.org/10.3897/mbmg.5.68155

**Kothari M.J. & S. Moorthy 1993.** *Flora of Raigad district, Maharashtra*. Botanical Survey of India, Kolkata. p. 581.

**Kondo K. 1971.** Germination and developmental morphology of seeds in *Utricularia cornuta* Michx. and *Utricularia juncea* Vahl. *Rhodora* 73(796): 541–547.

**Kondo K. 1972a.** A comparison of variability in *Utricularia cornuta* and *Utricularia juncea*. *American Journal of Botany* 59(1): 23–37. https://doi.org/10.1002/j.1537-2197.1972.tb10059.x

**Kondo K. 1972b.** The Chromosome number of *Utricularia denticulata* Benjamin. *Annals of the Missouri Botanical Garden* 59(3): 474–478. https://doi.org/10.2307/2395159

**Kondo K. 1972c.** Chromosome number of *Utricularia subulata* L. *The Journal of Japanese Botany* 47(1): 31–32.

**Kondo K., Segawa M. & K. Nehira 1978.** Anatomical studies on seeds and seedlings of some *Utricularia* (Lentibulariaceae). *Brittonia* 30(1): 89–95. https://doi.org/ 10.2307/2806465

**Komiya S. 1973.** New subdivisions of the Lentibulariaceae. *The Journal of Japanese Botany* 48(5): 147–153.

**Krajewsky K. & B.J. Plachno 2015.** *Utricularia bremii* (Lentibulariaceae) in Poland. *Polish Botanical Journal* 60(1): 1–5.

**Krishnapriya M.P., Silva S.R., Miranda V.F.O. & S. Nampy 2024.** Revisiting *Utricularia* section *Nigrescentes* (Lentibulariaceae) in India and re-instating *Utricularia roseopurpurea*, integrating morphological and molecular data. *Rheedea* 34(1): 20–38. https://dx.doi.org/10.22244/rheedea.2024.34.01.02

**Kulkarni B.G. 1988.** *Flora of Sindhudurg.* Botanical Survey of India, Kolkata.

**Kulkarni A., Shigwan B.K., Vijayan S., Watve A., Karthick B. & M.N. Datar 2023.** Indian rock outcrops: review of flowering plant diversity, adaptations, floristic composition and endemism. *Tropical Ecology* 64: 408–424. https://doi.org/10.1007/s42965-022-00283-5

**Kullayiswamy K.R., Ramanjaneyalu D., Rani S.S. & T. Pullaiah 2013.** *Utricularia australis* R.Br. (Lentibulariaceae) a new distributional record from Eastern Ghats, India. *Journal of Indian Botanical Society* 92(1&2): 101–103. http://dx.doi.org/10.13140/RG.2.1.2379.4002

**Kullayiswamy K.R., Rani S.S., Sadasivaiah & T. Pullaiah 2017.** *Flora of Thummalapalle Uranium Mining Area Andhra Pradesh, India*. Regency Publications, Astral International Pvt. Ltd., New Delhi.

**Kumar A., Rohan P. & M. Divya 2004.** Western Ghats and Sri Lanka. *In:* **Mittermeier R.A. Gil P.R., Hoffmann M., Pilgrim J., Brooks T., Mittermeier C.G., Lamoreux J. & G.A.B. Da Fonseca** (eds.), *Hotspots revisited*. Cemex books on Nature. CEMEX. pp. 152–156.

**Kumar V.V.N., Prabhukumar V.M., Jagadeeshan R., Harinarayanan C.M., Nair M.C., Janarthanam M.K. & I. Balachandran 2018.** *Utricularia sunilii* (Lentibulariacecae), a striking new species from southern Western Ghats, Kerala, India. *Phyotaxa* 371(2): 140–144. https://doi.org/10.11646/phytotaxa.371.2.9

**Kurbatova S.A. & I.Y. Yershov 2009.** Crustaceans and rotifers in the predatory feeding of *Utricularia*. *Inland Water Biology* 2(3): 271–275. https://doi.org/10.1134/S1995082909030122

**Kurosawa E., Wells N.S., Gibson R., Lyons Z., Kesseli R. & J.M. Oakes 2024.** To eat or not to eat: novel stable isotope models reveal a shift in carnivory with nutrient availability for aquatic *Utricularia* spp. *Annals of Botany* mcae119: 1–15. https://doi.org/10.1093/aob/mcae119

**Kurz W.S. 1874.** Description of *Utricularia nivea* Vahl. *Journal of Botany, British and Foreign* 12: 53–54.

**Lace J.H. 1915.** Some new species from Burma. *Bulletin of Miscellaneous Information, Royal Gardens, Kew* 9: 393–407.

**Lakshminarasimhan P. & B.D. Sharma 1991.** *Flora of Nasik District*. Botanical Survey of India, Kolkata. p. 644.

**Lakshminarasimhan P., Dash S.S., Singh P. & H.J. Chowdhery 2019.** *Flora of West Bengal, Convolvulaceae – Ceratophyllaceae.* Volume 4. Botanical Survey of India, Ministry of Environment, Forest and Climate Change, Kolkata. p. 734.

**Lakshminarayana K., Venkanna P. & T. Pullaiah 1997.** *Flora of Krishna District, Andhra Pradesh*. MD Publications Pvt. Ltd, New Delhi.

**Lekhak M.M. & S.R. Yadav 2012.** Herbaceous vegetation of threatened high altitude lateritic plateau ecosystems of Western Ghats, southwestern Maharashtra, India. *Rheedea* 22(1): 39-61. https://dx.doi.org/10.22244/rheedea.2012.22.01.12

**Letunic I. & P. Bork 2024.** Interactive Tree of Life (iTOL) v6: recent updates to the phylogenetic tree display and annotation tool. *Nucleic Acids Research* 52(W1): W78–W82. https://doi.org/10.1093/nar/gkae268

**Li Z.Y. 1988.** A revision of the genus *Utricularia* in China. *Bulletin of Botanical Research* 8(2): 25–29.

**Li Z.Y. 2011.** Lentibulariaceae. *In*: **Wu Z.Y., Raven P.H. & D.Y. Hong** (eds.), *Flora of China*. Volume 19. Science Press, Beijing, China & Missouri Botanical Garden Press, St. Louis, USA. pp. 480–491.

**Li Z.Y. 2020.** Lentibulariaceae. *In*: **Deng Y.F., Li Z.Y., Wang Q. & H. Peng** (eds.), *Flora of Pan-Himalaya.* Volume 46. Science Press, Beijing, China. pp. 1–38.

**Li X., Yang Y., Henry R.J., Rossetto M., Wang Y. & S. Chen 2015.** Plant DNA barcoding: from gene to genome. *Biological Reviews* 90(1): 157–166. https://doi.org/10.1111/brv.12104

**Lin Q., Ane C., Givnish T.J. & S.W. Graham 2021.** A new carnivorous plant lineage (*Triantha*) with a unique sticky-inflorescence trap. *Proceedings of the National Academy of Sciences* 118(33): e2022724118. https://doi.org/10.1073/pnas.2022724118

**Liden M. & P. Bharali 2014.** Notes on *Utricularia* sect. *Phyllaria* (Kurz) Kamienski (Lentibulariaceae) in Arunachal Pradesh, India. *Pleione* 8(2): 267–270.

**Lima F.R., Ferreira A.J., Menezes C.G., Miranda V.F.O., Dourado M.N. & W.L. Araujo 2018.** Cultivated bacterial diversity associated with the carnivorous plant *Utricularia breviscapa* (Lentibulariaceae) from floodplains in Brazil. *Brazilian Journal of Microbiology* 49: 714–722. https://doi.org/10.1016/j.bjm.2017.12.013

**Linnaeus C. 1753.** *Species Plantarum* Volume 1. Stockholm.

**Llorens C., Argentina M., Bouret Y., Marmottant P. & O. Vincent 2012.** A dynamical model for the *Utricularia* trap. *Journal of the Royal Society Interface* 9: 3129–3139. https://doi.org/10.1098/rsif.2012.0512

**Lloyd F.E. 1929.** The mechanism of the water tight door of the *Utricularia* trap. *Plant Physiology* 4(1): 87–102.

**Lloyd F.E. 1932.** The range of structural and functional variety in the traps of *Utricularia* and *Polypompholyx*. *Flora* 126: 303–328.

**Lloyd F.E. 1933.** The structure and behavior of *Utricularia purpurea*. *Canadian Journal of Research* 8(3): 234–252.

**Llyod F.E. 1942.** *The Carnivorous plants*. Chronica Botanica. The Ronald Press Co., New York.

**Londhe A.N. 2001.** Lentibulariaceae. *In*: **Singh N.P., Lakshminarasimhan P., Karthikeyan S. & P.V. Prasanna** (eds.), *Flora of Maharashtra state Dicotyledons*. Volume 2. Botanical Survey of India, Kolkata. pp. 561–568.

**Lowrie A. 1998.** A new species of *Utricularia* (Lentibulariaceae) from the south-west of Western Australia. *Nuytsia* 12: 37–41.

**Lowrie A. 2002.** *Utricularia petertaylorii* (Lentibulariaceae), a new species from the south-west of Western Australia. *Nuytsia* 14: 405–410.

**Lowrie A. 2014.** *Carnivorous plants of Australia: Magnum Opus*. Redfern Natural History Productions, Poole, UK.

**Lowrie A., Cowie I.D. & J.G. Conran 2008.** A new species and section of *Utricularia* (Lentibulariaceae) from northern Australia. *Telopea* 12(1): 31–46. http://dx.doi.org/10.7751/telopea20085802

**Lobreau-Callen D., Jeremie J. & M. Suarez-Cervera 1999.** Morphologie et ultrastructure du pollen dans le genre *Utricularia* L. (Lentibulariaceae). *Canadian Journal of Botany* 77(5): 744–767. https://doi.org/10.1139/b99-029

**Maity D. Maiti G.G. & A.S. Chauhan 2018.** *Flora of Kanchenjunga Biosphere Reserve Sikkim*. Botanical Survey of India, Kolkata. p. 888.

**Mani M.S. 1994.** The Himalaya, its ecology and biogeography: a review. *In*: **Pangtey Y.P.S. & R.S Rawal** (eds.), *High altitudes of the Himalaya: biogeography, ecology and conservation*. Gyanodaya Prakashan. Nainital, India. p. 418.

**Manikandan R. & P. Lakshminarasimhan 2013.** *Flora of Rajiv Gandhi National Park, Karnataka.* Botanical Survey of India, Ministry of Environment & Forests, Kolkata. p. 524.

**Manilal K.S. 1988.** *Flora of Silent Valley*. The Mathrubhumi Press, Calicut.

**Manilal K.S. & V.V. Sivarajan 1982.** *Flora of Calicut*. Bishen Singh Mahendra Pal Singh, Dehra Dun.

**Martin A.C. 1946.** The comparative internal morphology of seeds. *The American Midland Naturalist* 36(3):513-660. https://doi.org/10.2307/2421457

**Matthew K.M. 1995.** *An Excursion Flora of Central Tamilnadu, India*. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

**Matthew K.M. 1999.** *The flora of the Palni Hills, South India*. Part 2. The Rapinat Herbarium, St. Joseph's College, Tiruchirappalli, Tamil Nadu.

**Maxwell J.F. 1985.** Taxonomic revision of *Utricularia* L. (Lentibulariaceae) in Thailand. *Songklanakarin Journal of Science and Technology* 7: 409–424.

**Menezes C.G., Gasparino E.C., Baleeiro P.C. & V.F.O. Miranda 2014.** Seed morphology of bladderworts: a survey on *Utricularia* sect. *Foliosa* and sect. *Psyllosperma* (Lentibulariaceae) with taxonomic implications. *Phytotaxa* 167(2): 173–182. http://dx.doi.org/10.11646/phytotaxa.167.2.3

**Mendum M., Lassnig P., Weber A. & F. Christie 2001.** Testa and seed appendage morphology in *Aeschynanthus* (Gesneriaceae): phytogeographical patterns and taxonomic implications. *Botanical Journal of the Linnean Society* 135: 196–213. DOI: 10.1006/boj1.2000.0406

**Merl E.M. 1922.** Biologische Studien über die Utriculariablase. *Flora oder Allgemeine Botanische Zeitung* 115(1): 59–74.

**Mette N., Wilbert N. & W. Barthlot 2000.** Food composition of aquatic bladderworts (*Utricularia*, Lentibulariaceae) in various habitats. *Beitrage zur Biologie der Pflanzen* 72: 1–13.

**Meyers D.G. & J.R. Strickler 1979.** Capture enhancement in a carnivorous aquatic plant: function of antennae and bristles in *Utricularia vulgaris*. *Science* 203(4384): 1022–1025

**Minh B.Q., Schmidt H.A., Chernomor O., Schrempf D., Woodhams M.D., Von Haeseler A. &R. Lanfear 2020.** IQ-TREE 2: new models and efficient methods for phylogenetic inference in the genomic era. *Molecular Biology and Evolution* 37: 1530–1534. https://doi.org/10.1093/molbev/msaa015

**Misra B.K. & B.R. Verma 1992.** *Flora of Allahabad district, Uttar Pradesh, India*. Bishen Singh Mahendra Pal Singh, Dehra Dun.

**Mittermeier R.A., Gil P.R. & C.G. Mittermeier 1997.** *Megadiversity. Earth's biologically wealthiest nations*. CEMEX, Mexico City, Mexico.

**Mittermeier R.A., Gil P.R., Hoffman M., Pilgrim J., Brooks T., Mittermeier C.G, Lamoureux J. & G.A.B. da Foncesca 2004.** *Hotspots revisited: Earth's biologically richest and most endangered terrestrial ecoregions*. Harrison Ford, CEMEX, Mexico. p. 392.

**Mohanan N. & M. Sivadasan 2002.** *Flora of Agasthyamala.* Bishen Singh Mahendra Pal Singh, Dehra Dun.

**Möller M. & Q.C. Cronk 1997.** Origin and relationships of *Saintpaulia* (Gesneriaceae) based on ribosomal DNA internal transcribed spacer (ITS) sequences. *American journal of botany* 84(7): 956–965. https://doi.org/10.2307/2446286

**Mukherjee A.K. 1984.** *Flora of Pachmarhi & Bori Reserves, Madhya Pradesh.* Botanical Survey of India, Kolkata. p. 413.

**Muller K. & T. Borsch 2005.** Phylogenetics of *Utricularia* (Lentibulariaceae) and molecular evolution of the trnK intron in a lineage with high substitutional rates. *Plant Systematics and Evolution* 250: 39–67. http://dx.doi.org/10.1007/s00606-004-0224-1.

**Muller K., Borsch T., Legendre L., Porembski S., Theisen I. & W. Barthlott 2004.** Evolution of Carnivory in Lentibulariaceae and the Lamiales. *Plant Biology* 6: 477–490. http://dx.doi.org/10.1055/s-2004-817909.

**Muller K.F., Borsch T., Legendre L., Porembski S. & W. Barthlott 2006.** Recent progress in understanding the evolution of carnivorous Lentibulariaceae (Lamiales). *Plant Biology* 8: 748–757. http://dx.doi.org/10.1055/s-2006-924706.

**Murthi S.K. & G. Panigrahi 1999.** *Flora of Bilaspur district, M.P.* Volume 2. Botanical Survey of India, Kolkata. p. 906.

**Myers N. 1988.** Threatened biotas: "Hot spots" in tropical forests. *The Environmentalist* 8(3): 187–208. Doi: 10.1007/bf02240252

**Nair K.K.M. & M.P. Nayar 1987.** *Flora of Courtallum.* Volume 2. Botanical Survey of India, Kolkata. p. 442.

**Naithani B.D. 1985.** *Flora of Chamoli.* Volume 2. Botanical Survey of India, Kolkata. p. 795.

**Naive M.A.K., Buenavista D.P. & N.P. Mendez 2017.** New distributional records of *Utricularia striatula* Smith (Lentibulariaceae) in Mindanao, Philippines. *Philippine Journal of Systematic Botany* 11(2): 1–4.

**Narasimhan D. & J.I. Sheeba 2021.** Flowering plants of Tamil Nadu: A compendium. Care Earth Trust, Chennai. pp. 576–579.

**Naqinezhad A., Rice B.A., Attar F. & A. Jalili 2008.** *Utricularia* (Lentibulariaceae) of Iran. *Carnivorous Plant Newsletter* 37(1): 4–10.

**Nayar T.S., Beegam R.A. & M. Sibi 2014.** *Flowering plants of the Western Ghats India.* Volume 1. Dicots. Jawaharlal Nehru Tropical Botanic Garden and Research Institute, Thiruvananthapuram, Kerala.

**Nimbalkar V.V., Roy B., Manudev K.M. & M.M. Sardesai 2023.** An *Ariopsis* (Araceae) Nomenclator. *Kew Bulletin* 78(4): 641–646. https://doi.org/10.1007/ s12225-023-10113-z

**Noltie H.J. 2001.** Lentibulariaceae. *In*: **Grierson A.J.C. & D.G. Long** (eds.), *Flora of Bhutan; Including a record of plants from Sikkim and Darjeeling*. Volume 2(3). Huddersfield, UK. pp. 1336–1337.

**Noltie H. 2005.** Lentibulariaceae. *In*: **Watson M.F., Akiyama S., Ikeda H., Pendry C.A., Rajbhandari K.R. & K.K. Shrestha** (eds.), *Flora of Nepal*. Royal Botanic Garden Edinburgh, UK. pp. 1–8 (Available at www.floraofnepal.org).

**Noltie H. 2019.** Lentibulariaceae. *In*: **Watson M.F., Akiyama S., Ikeda H., Pendry C.A., Rajbhandari K.R. & K.K. Shrestha** (eds.), *Flora of Nepal* (web edition). Royal Botanic Garden Edinburgh, UK.

**Nunn R. 2022a.** New Australian *Utricularia* taxa published since Allen Lowrie's Magnum Opus. *Carnivorous Plant Newsletter* 51(1): 51–69. https://doi.org/10.55360/cpn511.rn472

**Nunn R. 2022b.** An account of the antennae-flowered *Utricularia* of northern Australia. *Carnivorous Plant Newsletter* 51(3): 133–142. https://doi.org/10.55360/cpn513.rn967

**Ohashi H. & Y. Ueno 2016.** Lectotypification of *Utricularia dimorphantha* (Lentibulariaceae). *The Journal of Japanese Botany* 91(2): 112–114.

**Oliver D. 1859.** The Indian species of *Utricularia*. *Journal of Linnean Society of Botany* 3: 170–190.

**Oxelman B., Liden M. & D. Berglund 1997.** Chloroplast *rps*-16 intron phylogeny of the tribe Sileneae (Caryophyllaceae). *Plant Systematics and Evolution* 206: 393–410. https://doi.org/10.1007/BF00987959

**Pal G.D. 2013.** *Flora of Lower Subansiri district, Arunachal Pradesh (India)*. Volume 1. Botanical survey of India, Kolkata. p. 471.

**Panda S. & A.P. Das 2004.** *Flora of Sambalpur* (Orissa). Bishen Singh Mahendra Pal Singh, Dehra Dun.

**Paria N.D. & S.P. Chattopadhyay 2005.** *Flora of Hazaribagh district, Bihar*. Volume 2. Botanical Survey of India, Kolkata. p. 1299.

**Parnell J.A. 2005.** An account of the Lentibulariaceae of Thailand. *Thai Forest bulletin (Botany)* 33: 101–144.

**Patwardhan A., Ray S. & A. Roy 2014.** Molecular markers in phylogenetic studies-a review. *Journal of Phylogenetics & Evolutionary Biology* 2(2): 131–140. Doi:10.4172/2329- 9002.1000131

**Peroutka K.M., Lendl T., Watzka M. & W. Adlassnig 2015.** Capture of algae promotes growth and propagation in aquatic *Utricularia. Annals of Botany* 115: 227–236. https://doi.org/10.1093/aob/mcu236

**Peroutka K.M., Adlassnig W., Volgger M., Lendl T., Url W.G. & I.K. Lichtscheidl 2008.** *Utricularia*: A vegetarian carnivorous plant? Algae as prey of bladderwort in oligotrophic bogs. *Plant Ecology* 199: 153–162. https://doi.org/10.1007/s11258-008-9420-3

**Plachno B.J., Adamec L. & I. Kaminska 2014.** Relationship between trap anatomy and function in Australian carnivorous bladderworts (*Utricularia*) of the subgenus *Polypompholyx*. *Aquatic Botany* 120: 290–296. https://doi.org/10.1016/j.aquabot.2014.09.008

**Plachno B.J., Kaminska I., Adamec L. & P. Swiatek 2017a.** Vascular tissue in traps of Australian carnivorous bladderworts (*Utricularia*) of the subgenus *Polypompholyx*. *Aquatic Botany* 142: 25–31. https://doi.org/10.1016/j.aquabot.2017.06.003

**Plachno B.J., Lukaszek M., Wolowski K., Adamec L. & P. Stolarczyk 2012.** Aging of *Utricularia* traps and variability of microorganisms associated with that microhabitat. *Aquatic Botany* 97: 44–48. https://doi.org/10.1016/j.aquabot.2011.11.003

**Plachno B.J., Stpiczynska M., Swiatek P. & K.L. Davies 2016a.** Floral micromorphology of the Australian carnivorous bladderwort *Utricularia dunlopii*, a putative pseudocopulatory species. *Protoplasma* 253(6): 1463–1473. https://doi.org/10.1007/s00709-015-0900-8

**Plachno B.J., Stpiczynska M., Davies K.L., Swiatek P. & V.F.O. Miranda 2016b.** Floral ultrastructure of two Brazilian aquatic-epiphytic bladderworts: *Utricularia cornigera* Studnicka and *U. nelumbifolia* Gardner (Lentibulariaceae). *Protoplasma*. Doi: 10.1007/s00709-016-0956-0

**Plachno B.J., Stpiczynska M., Krajewski L., Swiatek P., Adamec L. & V.F.O. Miranda 2017.** Flower palate structure of the aquatic bladderworts *Utricularia bremii* Heer and *U. minor* L. from section *Utricularia* (Lentibulariaceae). *Protoplama* 254: 2007–2015. https://doi.org/10.1007/s00709- 017-1097-9

**Plachno B.J., Stpiczynska M., Miranda V.F.O. & P. Stolarczyk 2019b.** The structure and occurrence of a velum in *Utricularia* traps (Lentibulariaceae). *Frontiers in Plant Science* 10: 1–15. https://doi.org/10.3389/fpls.2019.00302

**Plachno B.J., Wolowski K., Fleischmann A., Lowrie A. & M. Lukaszek 2014.** Algae and prey associated with traps of the Australian carnivorous plant *Utricularia volubilis* (Lentibulariaceae: *Utricularia* subgenus *Polypompholyx*) in natural habitat and in cultivation. *Australian Journal of Botany* 62: 528–536. https://doi.org/10.1071/BT14176

**Plachno B.J., Stpiczynska M., Adamec L., Miranda V.FO. & P. Swiatek 2018.** Nectar trichome structure of aquatic bladderworts from the section *Utricularia* (Lentibulariaceae) with observation of flower visitors and pollinators. *Protoplasma* 255:1053–1064. https://doi.org/10.1007/s00709-019-0141-2

**Plachno B.J., Stpiczynska M., Swiatek P., Lambers H., Miranda V.F.O., Nge F.J., Stolarczyk P. & G.R. Cawthray 2019a.** Floral micromorphology of the bird-pollinated carnivorous plant species *Utricularia menziesii* R.Br.

(Lentibulariaceae). *Annals of Botany* 123:213–220. https://doi.org/10.1093/aob/mcy163

**Plachno B.J., Silva S.R., Swiatek P., Dixon K.W., Lustofin K., Seber G.C. & V.F.O. Miranda 2020.** Structural features of carnivorous plant (*Genlisea*, *Utricularia*) tubers as abiotic stress resistance organs. *International Journal of Molecular Sciences* 21(14): 1–20. https://doi.org/10.3390/ijms21145143

**Poppinga S., Weisskopf C., Westermeier A.S., Masselter T. & T. Speck 2016.** Fastest predators in the plant kingdom: functional morphology and biomechanics of suction traps found in the largest genus of carnivorous plants. *AoB Plants* 8: p.plv140. https://doi.org/10.1093/aobpla/plv140

**Poppinga S., Daber L.E., Westermeier A.S., Kruppert S., Horstmann M., Tollrian R. & T. Speck 2017.** Biomechanical analysis of prey capture in the carnivorous southern bladderwort (*Utricularia australis*). *Nature* 7: 1776. Doi:10.1038/s41598-017-01954-3

**POWO 2025**. *Plants of the World Online*. Facilitated by the Royal Botanic Gardens, Kew. Available at: http://www.plantsoftheworldonline.org/

**Prain D. 1903**. *Bengal Plants : a list of the phanerogams, ferns and fern-allies indigenous to, or commonly cultivated in, the Lower provinces and Chittagong, with definitions of the natural orders and genera, and keys to the genera and species.* Volume 2. Apocynaceae–Selaginellaceae. Botanical Survey of India, Kolkata. https://doi.org/10.5962/bhl.title.50150

**Pradhan S.G. & N.P. Singh 1999.** *Flora of Ahmednagar district (Maharashtra)*. Bishen Singh Mahendra Pal Singh. *Dehradun. India.*

**Pramod C. & A.K. Pradeep 2021.** Observations on the flowering plant diversity of Madayippara, a southern Indian lateritic plateau from Kerala, India. *Journal of Threatened Taxa* 13(2): 17780–17806. https://doi.org/10.11609/jott.3883.13.2.17780-17806

**Pullaiah T. & N. Yesoda 1989.** *Flora of Anantapur District (Andra Pradesh, India).* Bishen Singh Mahendra Pal Singh, Dehra Dun, India.

**Pullaiah T. & D.A. Moulali 1997.** *Flora of Andra Pradesh.* Volume 2. Scientific Publishers, Jodhpur, India.

**Punekar S.A. & P. Lakshminarasimhan 2011.** *Flora of Anshi National Park. Western Ghats-Karnataka.* Biosphere publications, Pune, India.

**Punjani B., Patel S., Desai P. & V. Pandey 2014.** Genus *Utricularia* L. in Sabarkanth district, Gujarat. *Jalaplavit* 5(3): 65–68.

**Rafinesque C.S. 1838.** *Flora Telluriana.* Part 4. H. Probasco. Philadelphia. p. 135.

**Rahman M.O. 2005.** A taxonomic account of *Utricularia* Linn. from Bangladesh. *Bangladesh Journal of Plant Taxonomy* 12(2): 63–70.

**Rahman M.O. 2007.** DNA fingerprinting in *Utricularia* L. section *Utricularia* as revealed by PCR based assay. *International Journal of Botany* 3(1): 56–68.

**Rahman M.O., Adamec L. & K. Kondo 2001.** Chromosome number of *Utricularia bremii* and *Utricularia dimorphantha* (Lentibulariaceae). *Chromosome Science* 5: 105–108.

**Rambaut A. 2017.** FigTree- version 1.4.3, a graphical viewer of phylogenetic trees. Computer program distributed by the author. Available at: http://tree.bio.ed.ac.uk/software/figtree.

**Ramachandran V.S. & V.J. Nair 1988.** *Flora of Cannanore*. Botanical Survey of India, Kolkata.

**Ramaswamy S.V. & B.A. Razi 1973.** *Flora of Bangalore district*. Prasaranga, University of Mysore.

**Rani N. & K.M. Matthew 1983.** Lentibulariaceae *In*: **Matthew K.M.** (ed.), *The Flora of the Tamilnadu Carnatic*. The Rapinet Herbarium, St. Joseph's College, Thiruchirapalli. pp. 1109–1123.

**Rao R.S. 1986.** *Flora of Goa, Diu, Daman, Dadra & Nagar Haveli*. Volume 2. Botanical Survey of India, Howrah. p. 544.

**Rao R.S. & S.H. Sreemalu 1986.** *Flora of Srikakulam district Andhra Pradesh, India*. Indian Botanical Society, Meerut.

**Rao R.S., Venkanna P. & T.A. Reddy 1986.** *Flora of East Godavari district, Andhra Pradesh, India*. Indian Botanical Society, Meerut.

**Raynal-Roques A. & J. Jeremie 2005.** Biologic diversity in the genus *Utricularia* (Lentibulariaceae). *Acta Botanica Gallica* 152(2): 177–186. https://doi.org/10.1080/12538078.2005.10515468

**Reifenrath K., Theisen I., Schnitzler J., Porembski S. & W. Barthlott 2006.** Trap architecture in carnivorous *Utricularia* (Lentibulariaceae). *Flora* 201(8): 597–605. https://doi.org/10.1016/j.flora.2005.12.004

**Reut M.S. & B.A. Fineran 2000.** Ecology and vegetative morphology of the carnivorous plant *Utricularia dichotoma* (Lentibulariaceae) in New Zealand. *New Zealand Journal of Botany* 38(3): 433–450. https://doi.org/10.1080/0028825X.2000.9512695

**Reut M.S. & R.W. Jobson 2010.** A phylogenetic study of subgenus *Polypompholyx*: a parallel radiation of *Utricularia* (Lentibulariaceae) throughout Australasia. *Australian Systematic Botany* 23(3): 152–161. https://doi.org/10.1071/SB09054

**Rice B. 2011.** Tuberous organs in *Utricularia*, and new observations of sub-tuberous stolons on *Utricularia radiata* Small. *Carnivorous Plant Newsletter* 40(3): 88-91. https//doi.org/10.1055360/cpn403.br.389

**Richard L.C.M. 1808**. Lentibulariae. *In*: **Poteau A. & P.J.F. Turpin** (eds.), *Flore Parisienne: contenant la description des plantes qui crossent naturellement aux environs de Paris*. Volume 1. p. 23.

**Richards J.H. 2001.** Bladder function in *Utricularia purpurea* (Lentibulariaceae): is carnivory important? *American Journal of Botany* 88(1): 170–176.

**Ritter N.P. & G. E. Crow 2000**. Notes on the Lentibulariaceae in Bolivia: a new genus record (*Genlisea*) for the country, with two additional species records in the genus *Utricularia*. *Rhodora* 102(910): 217–224.

**Rodgers W.A., Panwar H.S. & V.B. Mathur 2000.** Wildlife Protected Area Network in India: A review. Wildlife Institute of India. Dehra Dun.

**Rodrigues F.G., Marulanda N.F., Silva S.R., Płachno B.J., Adamec L. & V.F.O Miranda 2017.** Phylogeny of the 'orchid-like' bladderworts (gen. *Utricularia* sect. *Orchidioides* and *Iperua*: Lentibulariaceae) with remarks on the stolon–tuber system. *Annals of Botany* 120(5): 709–723. https://doi.org/ 10.1093/aob/mcx056

**Ronquist F., Teslenko M., Van Der Mark P., Ayres D.L., Darling A., Höhna S., Larget B., Liu L., Suchard M.A. & J.P. Huelsenbeck 2012.** MrBayes 3.2: efficient Bayesian phylogenetic inference and model choice across a large model space. *Systematic biology* 61(3): 539–542.

**Roxburgh W. 1820.** *Flora Indica: or, descriptions of Indian Plants.* Volume 1. Mission Press. Serampore. https://doi.org/10.5962/bhl.title.589

**Rossbach G.B. 1939.** Aquatic Utricularias. *Rhodora* 41(484): 113–128.

**Rutishauser R. 1993.** The developmental plasticity of *Utricularia aurea* (Lentibulariaceae) and its floats. *Aquatic botany* 45(2-3): 119–143. https://doi.org/10.1016/0304-3770(93)90018-R

**Rutishauser R. & J. Brugger 1992.** Structural and developmental diversity of *Utricularia* traps. *Carnivorous Plant Newsletter* 21: 68–74.

**Rutishauser R. & B. Isler 2001.** Developmental genetics and morphological evolution of flowering plants, especially bladderworts (*Utricularia*): fuzzy Arberian morphology complements classical morphology. *Annals of Botany* 88(6): 1173–1202. https://doi.org/10.1006/anbo.2001.1498

**Salazar-Ferreira M., Gonella P.M. & E.A. Guarconi 2020.** New records of *Utricularia* (Lentibulariaceae) for the state of Maranhao, Brazil. *Check List* 16(1): 121–125. https://doi.org/10.15560/16.1.121

**Saldanha C.J. & D.H. Nicolson 1976.** *Flora of Hassan District, Karnataka*. Amerind Publishers, Delhi.

**Samaddar U.P. & B. Roy 1997.** *Additional elements in Indian flora*. Volume 1. Botanical survey of India, Kolkata. p. 632.

**Sambrook J., Fritsch E.F. & T. Maniatis 1989.** *Molecular cloning: a laboratory manual*. 2rd edition, Cold Spring Harbor Laboratory Press, Cold Spring Harbour, New York, USA. pp. 9.31–9.57

**Sameer K.T., Raj. K.S., Singh J.S., Gupta A.K., Bartaya S.K. & S.K. Rai 2015**. Impact of limestone mining activities on major ion geochemistry of Kem Markhyrdop water, Meghalaya, India. *Himalayan Geology* 36(1): 74–80.

**Samvatsar S. 1996.** *The flora of Western Tribal Madhya Pradesh* (India). Scientific publishers, Jodhpur.

**Sanger F., Nicklen S. & A.R. Coulson 1977.** DNA sequencing with chain-terminating inhibitors. *Proceedings of the National Academy of Science of the United States of America* 74(12): 5463–5467. https://doi.org/ 10.1073/pnas. 74.12.5463

**Santapau H. 1949.** Novelties Bombayensis. *Kew Bulletin* 1948: 485–492.

**Santapau H. 1950.** Notes on Lentibulariaceae of Bombay. *Journal of Bombay Natural History Society* 49: 217–221.

**Santapau H. 1967**. *The flora of Khandala on the Western Ghats of India*. 3rd edition. Botanical Survey of India, Kolkata. pp. 188–190.

**Santos T.R. & C. Ferragut 2018.** Changes in the taxonomic structure of periphytic algae on a free-floating macrophyte (*Utricularia foliosa* L.) in relation to macrophyte richness over seasons. *Acta Botanica Brasilica*. 32(4): 595–601. https://doi.org/10.1590/0102-33062018abb0031

**Sanyal M.N. 1994**. *Flora of Bankura district West Bengal*. Bishen Singh Mahendra Pal Singh, Dehra Dun.

**Sardesai M.M. & S.R. Yadav 2008.** Floral dimorphism in *Utricularia janarthanamii*. *Carnivorous Plant Newsletter* 37(1): 12–14.

**Sardesai M.M., Bhuskute S.M. & S.R. Yadav 2001.** Lentibulariaceae in Maharashtra. *Journal of Economic and Taxonomic Botany* 25(3): 687–702.

**Sarma K. & P.K. Yadav 2013.** Relentless Mining in Meghalaya, India. *Conservation Science* 1(2013): 2–12.

**Sasago A. & T. Sibaoka 1985.** Water extrusion in the trap bladders of *Utricularia vulgaris*: I. A possible pathway of water across the bladder wall. *The botanical magazine= Shokubutsu-gaku-zasshi* 98: 55–66.

**Sasidharan N. & V.V. Sivarajan 1996.** *Flowering Plants of Thrissur Forest (Western Ghats, Kerala, India)*. Scientific Publishers.

**Saxena H.O. 1965.** *Utricularia pubescens* Sm.- A new record for India. *Indian Forester* 91: 73–75.

**Saxena H.O. 1966.** *Utricularia arenaria* A.DC.– A new record for India from Pachmarhi (Madhya Pradesh). *Indian Forester* 92: 493–494.

**Saxena H.O. 1970.** *Utricularia australis* R.Br.– A new record for India from Indore (Madhya Pradesh). *Indian Forester* 96: 240–250.

**Schaferhoff B., Fleishmann A., Fischer E., Albach D.C., Borch T., Heubl G. & K.F. Muller 2010.** Towards resolving Lamiales relationships: insights from rapidly evolving chloroplast sequences. *BMC Evolutionary Biology* 10(1): 352–374. https://doi.org/10.1186/1471-2148-10-352

**Schumacher G.J. 1960**. Further notes on the occurrence of desmids in *Utricularia* bladders. *Castanea* 25(1): 62–65.

**Sequencher® version 5.4.6.** DNA sequence analysis software, Gene Codes Corporation, Ann Arbor, MI USA. http://www.genecodes.com

**Sharma A.K. & J.S. Dhakre 1995.** *Flora of Agra district*. Botanical Survey of India, Kolkata. p. 356.

**Sharma B.M. & P. Kachroo 1981.** Flora of Jammu and plants of neighbourhood. Volume 1. Bishen Singh Mahendra Pal Singh, Dehra Dun, India.

**Sharma B.D., Singh N.P., Raghavan R.S. & U.R. Deshpande 1984**. *Flora of Karnataka analysis*. Botanical survey of India, Howrah. p. 395.

**Shukla A.N. 2020.** Lentibulariaceae. *In*: **Sinha G.P. & A.N. Shukla** (eds.), *Flora of Uttar Pradesh: Araliaceae – Ceratophyllaceae.* Volume 2. Botanical Survey of India, Kolkata. pp. 254–255.

**Silva S.R., Gibson R., Adamec L., Domingueze Y. & V.F.O. Miranda 2018.** Molecular phylogeny of bladderworts: A wide approach of *Utricularia* (Lentibulariaceae) species relationships based on six plastidial and nuclear DNA sequences. *Molecular Phylogenetic and Evolution* 118: 244–264. http://dx.doi.org/10.1016/j.ympev.2017.10.010.

**Silva S.R., Diaz Y.C.A., Penha H.A., Pinheiro D.G., Fernandes C.C., Miranda V.F.O., Michael T.P. & A.M. Varani 2016**. The chloroplast genome of *Utricularia reniformis* sheds light on the evolution of the *ndh* gene complex of terrestrial carnivorous plants from the Lentibulariaceae family. *PLOS ONE* 11(10). e0165176. https://doi.org/10.1371/ journal.pone. 0165176

**Silva S.R., Moraes A.P., Penha H.A., Juliao M.H.M., Domingues D.S., Michael T.P., Miranda V.F.O. & A.M. Varani 2019.** The terrestrial carnivorous plant *Utricularia reniformis* sheds light on environmental and life-form genome plasticity. *International Journal of Molecular Sciences* 21(1): 3. http://doi.org/10.3390/ijms21010003

**Silva S.R., Pinheiro D.G., Penha H.A., Plachno B.J., Michael T.P., Meer E.J., Miranda V.F.O. & A.M. Varani 2019.** Intraspecific variation within the *Utricularia amethystina* species morphotypes based on chloroplast genomes. *International Journal of Molecular Sciences* 20:6130. http://dx.doi: 10.3390/ijms20246130

**Silva S.R., Alvarenga D.O., Aranguren Y., Penha H.A., Fernandes C.C., Pinheiro D.G., Oliveira M.T., Michael T.P., Miranda V.F.O. & A.M. Varani 2017.** The mitochondrial genome of the terrestrial carnivorous plant *Utricularia reniformis* (Lentibulariaceae): structure, comparative analysis and evolutionary landmarks. *PLoS ONE* 12 (7): e0180484. https://doi.org/10.1371/journal.pone.0180484

**Silva S.R., Miranda V.F.O, Michael T.P., Plachno B.J., Matos R.G., Adamec L., Pond S.L., Lucaci A.G., Pinheiro D.G. & A.M. Varani 2023.** The phylogenomics and evolutionary dynamics of the organellar genomes in carnivorous *Utricularia* and *Genlisea species* (Lentibulariaceae). *Molecular Phylogenetics and Evolution* 181: 107711. https://doi.org/10.1016/j.ympev.2023.107711

**Simek K., Pitsch G., Salcher M.M., Sirova D., Shabarova T., Adamec L. & T. Posch 2017**. Ecological traits of the algae-bearing *Tetrahymena utriculariae* (Ciliophora) from traps of the aquatic carnivorous plant *Utricularia reflexa*. *Journal of Eukaryotic Microbiology* 64(3): 336–348. https://doi.org/10.1111/jeu.12368

**Simms J. 1884.** A fish-eating plant, *Utricularia*. *Fishing Gazette May 31.* p.1884.

**Simon U.K., Trajanoski S., Kroneis T., Sedlmayr P., Guelly C. & H. Guttenberger 2012.** Accession-specific haplotypes of the internal transcribed spacer region in *Arabidopsis thaliana*—a means for barcoding populations. *Molecular Biology and Evolution* 29(9): 2231–2239. https://doi.org/10.1093/molbev/mss093

**Simpson M.G. 2010.** *Plant Systematics*. Elsevier Academic press, USA.

**Singh N.P. 1988.** *Flora of Eastern Karnataka*. Volume 1. Mittal Publications, Delhi.

**Singh H. & M. Sharma 2006.** *Flora of Chamba district (Himachal Pradesh)*. Bishen Singh Mahendra Pal Singh, Dehra Dun, India.

**Singh M., Negi H. & S. Singh 2022.** *Utricularia furcellata* (Lentibulariaceae)—A rare species newly recorded from Western Himalaya, India. *The Journal of Japanese Botany* 97(3): 175–179.

**Singh A.K., Prabhakar S. & S.P. Sane 2011.** The biomechanics of fast prey capture in aquatic bladderworts. *Biology letters* 7(4): 547–550. Doi: 10.1098/rsbl.2011.0057

**Singh P., Karthigeyan K., Lakshminarasimhan P. & S.S. Dash 2015.** *Endemic vascular plants of India*. Botanical Survey of India, Kolkata. p. 339.

**Singh B., Phukan S.J., Sinha B.K., Singh V.N. & S.K. Borthakur 2011.** Conservation strategies for *Nepenthes khasiana* in the Nokrek Biosphere Reserve of Garo Hills, Northeast, India. *International Journal of Conservation Science* 2(1): 55–64.

**Singh N.P., Mudgal V., Khanna K.K., Srivastava S.C., Sahoo A.K., Bandapadhyay S., Aziz N., Das M., Bhattacharya R.P. & P.K. Hajra 2001.** *Flora of Bihar Analysis.* Botanical Survey of India, Kolkata. p. 778.

**Sinha G.P. 2012.** Lentibulariaceae. *In*: **Sinha G.P., Singh D.K. & K.P. Singh** (eds.), *Flora of Mizoram*. Volume 2. Botanical Survey of India, Kolkata. pp. 193–195.

**Sirova D., Adamec L. & J. Vrba 2003.** Enzymatic activities in traps of four aquatic species of the carnivorous genus *Utricularia*. *The New Phytologist* 159(3): 669–675. https://doi.org/10.1046/j.1469-8137.2003.00834.x

**Sirova D., Barta J., Borovec J. & J. Vrba 2018.** *The Utricularia-associated microbiome: composition, function, and ecology. In*: *Carnivorous Plants: Physiology, ecology, and evolution*. Oxford University Press. pp. 349–358. Doi: 10.1093/oso/9780198779841.003.0025

**Sirova D., Barta J., Simek K., Posch T., Pech J., Stone J., Borovec J., Adamec L. & J. Vrba 2017.** Hunters or gardeners? Linking community structure and function of trap-associated microbes to the nutrient acquisition strategy of a carnivorous plant. bioRxiv. p.197020. https://doi.org/10.1101/197020

**Sirova D., Borovec J., Cerna B., Cerna B., Rejmankova E., Adamec L. & J. Vrba 2009.** Microbial community development in the traps of aquatic *Utricularia* species. *Aquatic Botany* 90: 129–136. Doi: 10.1016/j.aquabot.2008.07.007

**Sirova D., Borovec J., Santruckova H., Santrucek J., Vrba J. & L. Adamec 2010.** *Utricularia* carnivory revisited: plants supply photosynthetic carbon to traps. *Journal of Experimental Botany* 61(1): 99–103. https://doi.org/10.1093/jxb/erp286

**Sivarajan V.V. & P. Matthew 1996.** *Flora of Nilambur, Western Ghats, Kerala*. Bishen Singh Mahendra Pal Singh, Dehra Dun, India.

**Skutch A.F. 1928**. The capture of prey by the bladderwort. *New Phytolgist* 27(5): 261–297.

**Smith J.E. 1808.** *Exotic Botany: consisting of coloured figures, and scientific descriptions of such new, beautiful, or rare plants as are worthy of cultivation in the gardens of Britain; with remarks on their qualities, history, and requisite modes of treatment*. Volume 2. Richard Taylor and Co., Fleet Street, London. p. 123.

**Smith J.E. 1819.** *Utricularia*. *In*: **Rees A.** (ed.), *The cyclopaedia; or, universal dictionary of Arts, Science, and Literature*. Volume 37. Longman, Hurst, Rees, Ormne & Brown, London. https://doi.org/10.5962/bhl.title.59683

**Sohma K. 1975a.** Pollen morphology of the Japanese species of *Utricularia* L. and *Pinguicula* L. with notes on fossil pollen of *Utricularia* from Japan (1). *The Journal of Japanese Botany* 50: 164–179.

**Sohma K. 1975b.** Pollen morphology of the Japanese species of *Utricularia* L. and *Pinguicula* L. with notes on fossil pollen of *Utricularia* from Japan (2). *The Journal of Japanese Botany* 50: 193–208.

**Sorenson D.R. & W.T. Jackson 1968.** The Utilization of *Paramecia* by the carnivorous plant *Utricularia gibba*. *Planta* 83(2): 166–170. https://doi.org/10.1007/BF00385021

**Souza P.C.B. & C.P. Bove 2011.** A new species of *Utricularia* (Lentibulariaceae) from Chapada dos Veadeiros (Central Brazil). *Systematic Botany* 36(2): 465–469. https://doi.org/10.1600/036364411X569642

**Srivastava R.C. 1997.** Lentibulariaceae. *In*: **Mudgal V., Khanna K.K. & P.K. Hajra** (eds.), *Flora of Madhya Pradesh*. Volume 2. Botanical Survey of India, Kolkata. pp. 249–256.

**Staflew F.A. & R.S. Cowan 1976.** *Taxonomic literature - A selective guide to botanical publications and collections with dates, commentaries and types*. Volume 1: A–G. 2nd edition. Bohn, Scheltema & Holkema, Utrecht. Netherlands. p. 978. https://www.biodiversitylibrary.org/page/33121109

**Stapf O. 1904.** Lentibulariaceae. *In*: **Dyer W.T.** (ed.), *Flora Capensis*. Volume 4. Lovell Reeve & Co. Ltd. London. pp. 423–436. https://doi.org/10.5962/bhl.title.821

**Stapf O. 1906.** *Utricularia*. *In*: **Dyer W.T.** (ed.), *Flora of Tropical Africa*. Volume 4. Lovell Reeve & Co. Ltd. London. pp. 468–496. https://doi.org/10.5962/bhl.title.42

**Stearn W.T. 1983.** *Botanical Latin*. 3rd edition, revised. David & Charles Inc. Vermont, USA.

**Subramanyam K. 1979.** Studies on the Indian *Utricularia*, a review. *Journal of Indian Botanical Society* 58: 1–16.

**Subramanyam K. 1981.** Distribution of *Utricularia* L. in Peninsular India, south of the Vindyas. *Bulletin Botanical Survey of India* 23(3&4): 155–164.

**Subramanyam K. & V. Abraham 1967.** Studies on the traps of some Indian species of *Utricularia* L. *Nelumbo* 9(1–4): 201–205. https://doi.org/10.20324/nelumbo/v9/1967/76138

**Subramanyam K. & N.P. Balakrishnan 1960.** *Utricularia lilliput* Pellegrin– a new record for India. *Bulletin Botanical Survey of India* 2(3&4): 347–348.

**Subramanyam K. & L.K. Banerjee 1968.** *Utricularia roseo-purpurea* Stapf ex Gamble (Lentibulariaceae) a little known species. *Bulletin Botanical Survey of India* 10: 103–106.

**Subramanyam K. & N.P. Kamble 1968.** Chromosome numbers in certain Indian species of *Utricularia* L. (Lentibulariaceae). *Proceedings of the Indian Academy of Sciences* 68: 221–224. https://doi.org/10.1007/BF03051771

**Subramanyam K. & L.L. Narayana 1969.** Floral anatomy of *Utricularia caerulea* L. and *U. stricticaulis* Stapf (Lentibulariaceae). *Bulletin of the Torrey Botanical Club* 96(1): 107–113.

**Subramanyam K. & L.L. Narayana 1978.** Studies on the Indian *Utricularia* L. 2. Floral anatomy of *Utricularia aurea* Lour., *U. exoleta* R.Br., *U. stellaris* Linn.f. and *U. striatula* Sm. *Journal of the Indian Botanical Society* 57: 244–252.

**Subramanyam K. & S.N. Yoganarasimhan 1979.** Open dichotomous venation in the leaves of *Utricularia striatula* (Lentibulariaceae). *Plant Systematics and Evolution* 131: 133–142.

**Subramanyam K. & S.N. Yoganarasimhan 1981.** A new species of *Utricularia* L. (Lentibulariaceae) from Bangalore district, Karnataka. *Journal of Indian Botanical Soc*iety 60: 123–127.

**Suksathan P. & J.A.N. Parnell 2010.** Three new species and two new records of *Utricularia* L. (Lentibulariaceae) from Northern Thailand. *Thai Forrest Bulletin (Botany)* 38: 23–32.

**Suryanarayana B. & A.S. Rao 2002.** *Flora of Nellore district, Andhra Pradesh*. Gurudev Prakashan, Ahmednagar, Maharashtra.

**Sydenham P.H. & G.P. Findlay 1973.** The rapid movement of the bladder of *Utricularia* sp. *Australian Journal of Biological Sciences* 26(5): 1115–1126. https://doi.org/10.1071/BI9731115

**Sydenham P.H. & G.P. Findlay 1975.** Transport of solutes and water by resetting bladders of *Utricularia*. *Functional Plant Biology* 2(3): 335–351. https://doi.org/10.1071/PP9750335

**Takhtajan A.L. 1980.** Outline of the classification of flowering plants (Magnoliophyta). *The Botanical Review* 46(3): 225–356. https://doi.org/ 10.1007/ bf02861558

**Tamura K., Stecher G. & S. Kumar S. 2021.** MEGA11: molecular evolutionary genetics analysis version 11. *Molecular biology and evolution*, 38(7): 3022–3027. https://doi.org/10.1093/molbev/msab120

**Tan W.H., Chai L.C. & C.F. Chin 2020.** Efficacy of DNA barcode internal transcribed spacer 2 (ITS 2) in phylogenetic study of *Alpinia* species from Peninsular Malaysia. *Physiology and Molecular Biology of Plants* 26(9): 1889–1896. https://doi.org/10.1007/s12298-020-00868-1

**Tanaka R. & H. Uchiyama 1988.** Chromosomes of four species of *Utricularia* in Japan. *The Journal of Japanese Botany* 63(60): 219–223.

**Taylor P. 1964.** The genus *Utricularia* L. (Lentibulariaceae) in Africa (South of the Sahara) and Madagascar. Kew Bulletin 18(1): 1–245. https://doi.org/ 10.2307/ 4115510

**Taylor P. 1973.** Lentibulariaceae. *In*: **Plohill B.M.** (ed.), *Flora of Tropical East Africa*. London & Tonbridge. pp. 1–28.

**Taylor P. 1977.** Lentibulariaceae. *In*: **Steenis C.G.G.J. van** (ed.), *Flora Malesiana* 8: 275–300. https://doi.org/10.5962/bhl.title.40744

**Taylor P. 1984.** Two new bladderworts from South India. *Proceedings of the Indian Academy of Science* 93: 99–103. https://doi.org/10.1007/BF03052993

**Taylor P. 1986.** New taxa in *Utricularia* (Lentibulariaceae). *Kew Bulletin* 41(1): 1–18. https://doi.org/10.2307/4103020

**Taylor P. 1989.** *The genus Utricularia - a taxonomic monograph*. Kew Bulletin Additional Series, XIV. London. Royal Botanic Garden, Kew. p. 724

**Taylor P. 1991.** *Utricularia* in North America North of Mexico. *Carnivorous Plant Newsletter* 20: 8–20.

**Thanikaimoni G. 1966.** Pollen morphology of the genus *Utricularia*. *Pollen et Spores* 8(2): 265–284.

**Thor G. 1988.** The genus *Utricularia* in the Nordic countries, with special emphasis on *U. stygia* and *U. ochroleuca*. *Nordic Journal of Botany* 8(3): 213–225. https://doi.org/10.1111/j.1756-1051.1988.tb01713.x

**Thorpe C.J. & A. Watve 2015.** Lateritic Plateaus in the Northern Western Ghats, India; a Review of Bauxite Mining Restoration Practices. *Journal of the Ecological Society* 2015: 25–44. https://doi.org/ 10.11609/JoTT.o3038.3589-602

**Thiers B.M. 2025.** (continuously updated). *Index Herbariorum: a global directory of public herbaria and associated staff, New York Botanical Garden's Virtual Herbarium*. Available at: http://sweetgum.nybg.org/ih/ (Accessed on 20.10.2024).

**Thurston E.L. & F. Seabury 1975.** A scanning electron microscopic study of the utricle trichomes in *Utricularia biflora* Lam. *Botanical Gazette* 136(1): 87–93.

**Trimen H. 1895.** *A hand-book to the Flora of Cyelon. Valerianaceae-Balanophoraceae*. Part 3. Dulau & Co., Soho Square, London. pp. 266–271.

**Tripathi A.M., Tyagi A., Kumar A., Singh A., Singh S., Chaudhary L.B. & S. Roy 2013.** The internal transcribed spacer (ITS) region and *trnH-psbA* are suitable candidate loci for DNA barcoding of tropical tree species of India. *PloS ONE* 8(2): p.e57934. https://doi.org/10.1371/journal.pone.0057934

**Tsymbalyuk Z.M., Mosyakin S.L. & L.G. Bezusko 2008.** Comparative morphological characterization of pollen grains of species of *Pinguicula* L. and *Utricularia* L. in the flora ukraine. *Ukranian Botanical Journal* 65: 520–534.

**Turland N. 2019.** *The Code Decoded: A user's guide to the International Code of Nomenclature for algae, fungi, and plants*. Advanced Books. https://doi.org/10.3897/ab.e38075

**Turland N.J., Wiersema J.H., Barrie F.R., Greuter W., Hawksworth D.L., Herendeen P.S., Knapp S., Kusber W.-H., Li D.-Z., Marhold K., May T.W., McNeill J., Monro A.M., Prado J., Price M.J. & G.F. Smith (eds.), 2018.** *International Code of Nomenclature for algae, fungi, and plants (Shenzhen Code) adopted by the Nineteenth International Botanical Congress Shenzhen, China, July 2017. Regnum Vegetabile 159*. Koeltz Botanical Books, Glashütten.

**Vahl M. 1804.** *Enumeratio Plantarum*. Volume 1. Impenis Auctoris, & prostat apud JH Schubothe. https://doi.org/10.5962/bhl.title.7564

**Van Rheede D.H. 1689-1690.** *Hortus Indicus Malabaricus: Continens Regni Malabarici Apud Indos cereberrimi Onmis Generis Plantas Rariores. Latinas, Malabaricis, Arabicis, Brachmanum Charactareibus Hominibusque Expressas*. Volume 9. Tab. 70. pp. 137. Amstelaedami, sumptibus Johannis van Someren, et Joannis van Dyck. https://doi.org/10.5962/bhl.title.707

**Veleba A., Bure S.P., Adamec L., Smarda P., Lipnerov A.I. & A.L. Horov 2014.** Genome size and genomic GC content evolution in the miniature genome-sized family Lentibulariaceae. *New Phytologist* 203(1): 22–28.

**Verma D.M. 1985.** *Utricularia. In*: **Verma D.M., Pant P.C. & M.I. Hanfi** (eds.), *Flora of Raipur, Durg, Rajnandgaon*. Botanical Survey of India, Howrah. pp. 264–267.

**Verma P.K., Schlauer J., Rawat K.K. & K. Giri 2014.** Status of insectivorous plants in Northeast India. *Carnivorous Plant Newsletter* 43: 49–58.

**Vincent O. & P. Marmottant 2011.** Carnivorous *Utricularia* The buckling scenario. *Plant Signaling & Behavior* 6(11): 1752–1754.

**Vincent O., Weisskopf C., Poppinga S., Masselter T., Speck T., Joyeux M., Quilliet C. & P. Marmottant 2011.** Ultra-fast underwater suction traps. *Proceedings of the Royal Society B*. 278: 2909–2914. https://doi.org/10.1098/rspb.2010.2292

**Vitek E. 2008.** Lectotype of *Utricularia endresii* Rchb.f. (Lentibulariaceae). *Annalen des Naturhistorischen Museums in Wien. Serie B für Botanik und Zoologie* 110: 259.

**Wadhwa B.M. & H.J. Chowdhery 1984.** Lentibulariaceae. *In*: **Chowdhery H.J. & B.M. Wadhwa** (eds.), *Flora of Himachal Pradesh analysis*. Volume 2. Botanical Survey of India, Howrah. pp. 541–542.

**Wagner G.M. & K.E. Mshigeni 1986.** The *Utricularia*-Cyanophyta association and its nitrogen-fixing capacity. *Hydrobiologia* 141: 255–261.

**Wakabayashi H. 2010.** *Utricularia linearis* (Lentibulariaceae), a new species from the Howard Springs, Northern Territory, Australia. *The Journal of Insectivorous Plant Society* 61: 88–92.

**Watve A. 2008.** Rocky outcrops as special habitats in North Western Ghats, Maharashtra. *Special Habitats and Threatened Plants of India* 11(1): 147–153.

**Watve A. 2013.** Status review of rocky plateaus in the northern Western Ghats and Konkan region of Maharashtra, India with recommendations for conservation and management. *Journal of Threatened taxa* 5(5): 3935–3962. https://doi.org/10.11609/JoTT.o3372.3935-62

**Westermeier A.S. Fleischmann A., Muller K., Schaferhoff B., Rubach C., Speck T. & S. Poppinga 2017.** Trap diversity and character evolution in carnivorous bladderworts (*Utricularia*, Lentibulariaceae). *Scientific Reports* 7(12052): 1–24. https://doi.org/10.1038/s41598-017-12324-4

**Wicke S., Schaferhoff B., Depamphilis C.W. & K.F. Muller 2014.** Disproportional plastome-wide increase of substitution rates and relaxed purifying selection in genes of carnivorous Lentibulariaceae. *Molecular Biology and Evolution* 31(3): 529–545. https://doi.org/10.1093/molbev/mst261

**Wight R. 1849.** Indian Utriculariae. *Hooker's Journal of Botany and Kew Garden Miscellany London* 1: 372–374.

**Wight R. 1850.** *Icones plantarum Indiae Orientalis: or figures of Indian plants.* Volume 4. Messrs. France and Co. Madras. https://doi.org/10.5962/bhl.title.92

**Wolowski K., Piatek J. & B.J. Plachno 2011.** Algae and stomatocysts associated with carnivorous plants. First report of chrysophyte stomatocysts from Virginia, USA. *Phycologia* 50(5): 511–519. https://doi.org/10.2216/10-94.1

**Yadav S.R. & M.M. Sardesai 2002.** *Flora of Kolhapur district.* Shivaji University. Kolhapur, Maharashtra.

**Yadav S.R., Sardesai M.M. & S.P. Gaikwad 2000.** Two new species of *Utricularia* L. (Lentibulariaceae) from Peninsular India. *Rheedea* 10: 107–112. https://dx.doi.org/10.22244/rheedea.2000.10.02.04

**Yadav S.R., Sardesai M.M. & S.P. Gaikwad 2005.** A new species of *Utricularia* L. (Lentibulariaceae) from the Western Ghats, India. *Rheedea* 15: 71–73. https://dx.doi.org/10.22244/rheedea.2005.15.01.02

**Yamamoto N., Ikeda H. & T. Hoshino 2012.** Cytotaxonomical studies of flowering plants in Yakushima Island, Kagoshima Prefecture, Japan. *Journal of Phytogeography and Taxonomy* 60: 11–20. https://doi.org/10.24517/00053396

**Yang Y.P. Liu H.Y. & Y.S. Chao 2009.** Trap gland morphology and its implications in Taiwan *Utricularia* (Lentibulariaceae). *Flora* 204: 692–699. Doi: 10.1016/j.flora.2008.09.009

**Zamudio S. & M. Olvera 2009.** A new species of *Utricularia* (Lentibulariaceae) from Guerrero, Mexico. *Brittonia* 61(2): 119–125. https://doi.org/10.1007/s12228-008-9063-7

**Pudukkottai district survey report, May 2019.** (Available at: https://pudukkottai.nic.in/document-category/mineral-survey-report/)

**The Hindu. 10 December 2023. Konwar R.R.** Crumbling hills of Meghalaya. (Available at: https://www.thehindu.com/photos/meghalaya-in-pictures-crumbling-hills-illegal-coal-and-limestone-mining/article67623895.ece).

**The Hindu. 21 July 2024 07:34 pm IST-Kannur. The Hindu Bureau.** Madayipara's deep blue flower bloom thrills tourists but faces environmental threats. (Available at: https://www.thehindu.com/news/national/ kerala/ madayiparas-deep-blue flower-bloom-thrills-tourists-but-faces-environmental-threats/article68428909.ece)

# APPENDICES

## Appendix I

### TAXA EXCLUDED IN THE PRESENT STUDY

1. **Utricularia arenaria** A.DC. in DC. Prodr. 8: 20. 1844; P.Taylor, Kew Bull. 18(1): 107. t. 39, 40 & 41. 1964; H.O.Saxena, Indian Forester 493. 1966; R.C.Srivast. in Mudgal *et al*. (eds.), Fl. Madhya Pradesh 2: 251. 1997.

   ***Notes***: The species was originally described from Tropical Africa and was restricted to South Africa and Madagascar (Taylor, 1989; POWO, 2024). Saxena (1966) reported its occurrence in Jambu Deep, Pachmarhi, Madhya Pradesh, extending the distribution of this species to India. Upon examining the voucher specimen housed at DD, it is clear that Saxena initially identified it as *U. lilliput* Pellgr., but later determined it as *U. arenaria* (from the annotation on the specimen at DD: Dehradun, Rajpur, 950 m, 01.10.1961, *Hari Om Saxena* 2327(B)). The incomplete illustration and overlapping characteristics in the description of *U. arenaria* caused confusion regarding its occurrence in India. Since then, the occurrence of *U. arenaria* in India has remained uncertain. Although, Srivastava (1997) included *U. arenaria* in the flora of Madhya Pradesh, this was solely based on Saxena's earlier report (1966). I visited Pachmarhi and nearby sandy plains in search of this species, but found no trace of it. Upon examining the specimen at the DD herbarium, I observed morphological similarities to *U. minutissima*. However, the fragmented and incomplete material made proper identification challenging. Therefore, *U. arenaria* is excluded from this study.

2. **Utricularia pubescens** Sm. in Rees (ed.), Cycl. 37. 53. 1819; P.Taylor, Kew Bull. 18(1): 101. t. 36–38. 1964; H.O.Saxena, Indian Forester 73. 1965; A.S.Rao & J.Joseph, Indian Forester 93(1). t.1. 1967; Raizada & H.O.Saxena, J. Bombay Nat. Hist. Soc. 64(1): 87. 1976; A.K.Mukh., Fl. Pachmarhi & Bori Reserves 217. 1984; R.C.Srivast. in Mudgal *et al*. (eds.), Fl. Madhya Pradesh 2: 254. 1997; S.K.Mandal & Bhaumik in Lakshmin. *et al*. (eds.), Fl. West Bengal 4: 145. 2019.

   ***Notes***: Rao and Joseph (1967) reported *U. pubescens* from Barapani in the Khasi Hills district of Meghalaya (earlier Assam). This represented an extension of its native distribution from South America and Africa to India. They provided a detailed description (based on 35 live materials collected from the field), noting the rarity of the species in the area. Srivastava (1997) also mentioned its rare occurrence in boggy open grounds near Sal forests of Madhya Pradesh, but no voucher specimens were available. Although the species is cited in some floristic works, voucher specimens are lacking. Due to the absence of additional information and recollection, *U. pubescens* is excluded from this study.

***Specimen examined***: INDIA, **Meghalaya**, Khasi Hills district, Barapani B.S.I. Experimental Graden grounds, 1000 m, 16.08.1966, *A.S. Rao* 45172 (ASSAM).

3. **Utricularia subramanii** Janath. & A.N.Henry, J. Bombay Nat. Hist. Soc. 87: 441. 1990, Bladderworts India 112. t. 33. 1992; Anil Kumar *et al*., Fl. Pathanamthitta 368. 2005. *Type*: INDIA, **Kerala**, Pathanamthitta district (Quilon district), Pathanamthitta, *c.* 325 m, 30.07.1978, *C.N. Mohanan* 58342 (holo, CAL [CAL0000019113!], iso, MH [MH00000779!]).

   ***Notes***: This species was based on a collection by C.N. Mohanan from Pathanamthitta district (earlier the Quilon district) of Kerala. He identified the material as *U. graminifolia* Vahl, describing it as a marshy herb with yellow flowers on the herbarium sheet. Despite an extensive field study in Pathanamathitta and surrounding areas, the species could not be located. Species with similar morphological characters were found, but the characteristics such as a ligulate lower lip of the corolla and yellow flowers were absent in the collected samples. However, *U. subramanii* differs from the rest in having its diagnostic ligule, shorter pedicels and oblongoid seeds with scrobiculate testa, is considered here as a distinct species. According to personnel communication with the author of this species, it is presumed to have gone extinct in the wild. As such, *U. subramanii* is excluded from this study.

4. **Utricularia subulata** L. Sp. Pl. 1: 18. 1753; P.Taylor, Kew Bull. 18(1): 81. t. 27. 1964 & Gen. *Utricularia* 524. t. 165. 1989.
   *Utricularia stanfieldii auct. non* P.Taylor: J.Joseph & Mani, Bull. Bot. Surv. India. 24: 109. 1982.
   ***Notes***: This species was wrongly identified and described as *U. stanfieldii* P.Taylor by Jospeh and Mani (1982) from the open, moist sandy soils in Jarain, Meghalaya. They also noted its rarity in that area. Since then, no further reports have emerged regarding its presence in the study area. Despite my own expeditions to find out *U. subulata* in similar habitats in Meghalaya, I was unable to locate the species. Therefore, *U. subulata* is excluded from this study.

**Doubtful species:**

1. **Utricularia inflexa** Forssk., Fl. Aegypt.-Arab. 9. 1775; Vahl, Enum. Pl. 1: 196. 1805; Sm. in Rees, Cyclop. 37: 29. 1819; A.DC. in DC. (ed.), Prodr. 3: 4. 1844; P.Taylor, Fl. Trop. E. Afr., 16. 1973; R.K.Basak, Bull. Bot. Surv. India 17: 99. 1975; M.Islam, Fl. Majuli 229. 1990. *Utricularia stellaris* L.f. var. *inflexa* (Forssk.) C.B.Clarke in Hook.f. (ed.), Fl. Brit India 4: 329. 1884; Prain, Bengal Pl. 2: 780. 1903; Maheshw., Fl. Delhi 256. 1963.
   ***Notes***: *Utricularia inflexa* shares many morphological similarities with *U. stellaris*, but can be distinguished by its white corolla with blue-violet streaks, long cylindrical floats, long styles, and capsules that are shorter than the calyx lobes. During my field study, I did not observe live specimens, though images of the species are available on virtual flora groups and social media platforms in India. Taylor (1989) mentioned its occurrence in India but noted that these were likely

intermediate forms. Both *U. inflexa* and *U. inflexa* var. *stellaris* have been reported in some floristic treatments, but confirming their identity from the fragmented materials was challenging. Therefore, this species is excluded from the present study due to its uncertain status.

2. **Utricularia naikii** S.R.Yadav, Sardesai & Gaikwad, Rheedea 10: 110. t. 1. 2000; S.R.Yadav & Sardesai, Fl. Kolhapur Dist. 339.t. 53. 2002; Punekar & Lakshmin., Fl. Anshi Natl. Park 336. 2011; Kavade & Deokule, Fl. Chandoli Natl. Park 263. 2015. *Type*: INDIA, **Maharashtra**, Amboli district, Sindhudurg, 29.09.1999, *Milind M. Sardesai* MMS1911 (holo, CAL [CAL0000019111!], iso, BSI [BSI0000000290, BSI000000029!], K, [K000779762 digital image!]).

   ***Notes***: Yadav *et al*. (2000) described *U. naikii* and compared it to *U. nayarii*, noting differences such as unequal calyx lobes, absence of bracteoles, a minute corolla that rarely opens and an obliquely ovoid fruit that dehisces by a longitudinal ventral slit. From the type locality, I collected a specimen morphologically very similar to *U. praeterita*. The materials examined had bracteoles and fully opened flowers, and their characteristics align more closely with *U. praeterita*. The features described in the protologue, such as unequal calyx lobes, lack of bracteoles, and unopened corolla were unsatisfactory for identifying the specimen collected from the type locality. As result, *U. naikii* is considered a doubtful species and is excluded from this study. Fleishmann (2012) synonymized *U. naikii* as a cleistogamous form of *U. praeterita*. However, it has been treated as a distinct species in some later floristic works (Yadav & Sardesai, 2002; Punekar & Lakshminarasimhan, 2011; Kavade & Deokule, 2015) and in POWO (2024).

**Appendix II**

## SYMBOLS AND ABBREVIATIONS USED

List of signs, symbols abbreviations and Latin words used in the text are given below, and data referred from Stearn's *Botanical Latin* and Turland's *Code*. (Stearn, 1992; Turland, 2019).

| | | |
|---|---|---|
| ! | : | a specimen has been seen |
| ° | : | degree of temperature |
| ± | : | *plus minusve*, more or less |
| **A** | | |
| aff. | : | *affinis* -akin to, related to |
| Art. | : | Article |
| *auct. non* | : | *auctorum non,* of authors, not….., |
| **B** | | |
| bp | : | base pair |
| BI | : | Bayesian inference |
| BS | : | Bootstrap |
| **C** | | |
| *c.* | : | *circa* - about |
| cm | : | *centimetrum* -centimetre |
| µm | : | micrometer |
| **D** | | |
| Doi | : | digital object identifier |
| **E** | | |
| e.g. | : | *exempli gratia* - for example |
| ed. | : | *editio* - edition |
| etc. | : | *et cetera* – and the rest |
| *excl. sp.* | : | *exclusa specie* (*exclusis speciebus*), with species excluded |
| *et al.* | : | *et aliorum* - and of others |

**F**

| | | |
|---|---|---|
| f., Fig. | : | *figura* - figure, illustration |

**H**

| | | |
|---|---|---|
| herb. | : | herbarium |
| holo. | : | *holotypus* -holotype |

**I**

| | | |
|---|---|---|
| i.e. | : | *id est* - that is |
| iso. | : | *isotypus* - isotype |
| *Ibid*. | : | *ibidem* - in the same place |
| in | : | *in*, used in bibliographic citation |
| in herb. | : | *in herbario*, in herbarium |

**L**

| | | |
|---|---|---|
| *l.c.* | : | *in loco citato* - in the cited place |
| lecto. | : | *lectotypus* - lectotype |

**M**

| | | |
|---|---|---|
| mm | : | millimetre |
| ML | : | Maximum likelihood |

**N**

| | | |
|---|---|---|
| neo | : | *neotypus*, neotype |
| no. | : | *numero* - number |
| *non* | : | not |
| *nom. nud.* | : | *nomen nudum* – naked name, without a validating description or diagnosis or reference |
| *non. illeg.* | : | *nomen illegitimum* - illegitimate name |
| *nom. illeg. superfl.* | : | *nomen illegitimum superfluum* - name that is illegitimate because it was nomenclaturally superfluous when published |

**P**

| | | |
|---|---|---|
| p. | : | *pagina* - page |
| *p.p.* | : | *pro parte* - in part |

| | | |
|---|---|---|
| PP | : | Posterior probability |
| *pro syn.* | : | *pro synonymo* - as a synonym |
| **S** | | |
| *s.n.* | : | *sine numero* - without number |
| *s.d.* | : | *sine die* - without day, undated |
| *s.loc.* | : | *sine loco* - without locality name |
| *s.coll.* | : | *sine collectore* - without collector |
| sp. | : | species |
| *sp. nov.* | : | *species nova* - new species |
| syn. | : | *synonymon, synonymia* - synonym, synonymy |
| *syn. nov.* | : | *synonymum novum* - new synonym |
| sect. | : | *sectio* – section |
| subgen. | : | *subgenus* |
| subsp. | : | subspecies |
| **T** | | |
| t. | : | *tabula* – plate, illustration |
| TL-2 | : | *Taxonomic literature*, ed. 2 |
| **V** | | |
| *vs.* | : | versus, against, opposed to |
| var. | : | *varietas* - variety |
| vol. | : | *volume* - volume |
| viz. | : | *videlicet* - namely |

## Appendix III

### HERBARIUM ACRONYMS USED

The following are the list of herbaria consulted during the present work arranged in alphabetical order of acronyms.

| | | |
|---|---|---|
| A | : | Herbarium of the Arnold Arboretum, Harvard University, Cambridge, U.S.A |
| ASU | : | Herbarium Arizona State University, U.S.A. |
| AHMA | : | Agharkar Research Institute, Pune, Maharashtra, India |
| ARUN | : | Botanical Survey of India, Arunachal Pradesh Regional Centre, Itanagar |
| ASSAM | : | Botanical Survey of India, Eastern Regional Centre, Shillong, Meghalaya |
| B | : | Herbarium ZE Botanischer Garten und Botanisches Museum, Freie Universität Berlin, Germany (B-W) |
| BM | : | The Natural History Museum, England, U.K. |
| BR | : | Meise Botanic Garden, Meise, Belgium |
| BSD | : | Botanical Survey of India, Northern Regional Centre, Dehra Dun, Uttarakhand |
| BSI | : | Botanical Survey of India, Western Regional Centre, Pune, Maharashtra |
| BLAT | : | Blatter Herbarium, St. Xavier's College, Mumbai, Maharashtra |
| BSHC | : | Botanical Survey of India, Sikkim Himalayan Regional Centre, Gangtok |
| BSID | : | Botanical Survey of India, Deccan Regional Centre, Hyderabad, Telangana |
| BSIS | : | Botanical Survey of India, Industrial Section Indian Museum, West Bengal |
| C | : | University of Copenhagen, Denmark |
| CS | : | Colorado State University, Colorado, U.S.A. |
| CAL | : | Central National Herbarium, Howrah, India |
| CAS | : | California Academy of Sciences, California, U.S.A. |
| CALI | : | University of Calicut, Kerala, India |

| | | |
|---|---|---|
| DD | : | Forest Research Institute, Indian Council of Forestry Research and Education, Dehra Dun, Uttar Pradesh, India |
| E | : | Royal Botanic Garden Edinburgh, England, U.K. |
| FRC | : | Institute of Forest Genetics and Tree Breeding, Tamil Nadu, India |
| G-DC | : | Conservatoire et Jardin botaniques de la Ville de Genève, Geneva, Switzerland |
| GH | : | Harvard University, Massachusetts, U.S.A. |
| HIFP | : | French Institute, French Ministry of Foreign Affairs, Pondicherry, India |
| HTTU | : | Tennessee Technological University, Tennessee, U.S.A. |
| JCB | : | Indian Institute of Science (IISc), Karnataka, India |
| K | : | Royal Botanic Gardens, U.K. |
| KATH | : | National Herbarium and Plant Laboratories, Nepal |
| L, U & WAG | : | Naturalis Biodiversity Center, Leiden, Netherlands |
| LSU | : | Louisiana State University, U.S.A. |
| MH | : | Botanical Survey of India, Southern Regional Centre, Coimbatore, Tamil Nadu, India |
| MO | : | Missouri Botanical Garden, Missouri, U.S.A. |
| MU | : | Miami University, Oxford, U.S. |
| MW | : | Moscow State University, Moscow, Russia |
| MBK | : | Makino Botanical Garden, Kochi, Japan |
| MEL | : | National Herbarium of Victoria, Australia |
| MICH | : | University of Michigan, Michigan, U.S.A. |
| NY | : | The New York Botanical Garden, New York. U.S.A. |
| O-V | : | University of Oslo (O), Norway |
| P | : | Muséum National d'Histoire Naturelle, Paris, France. |
| RSA | : | California Botanic Garden, California. U.S.A. |
| RHT | : | St. Joseph's College, Tamil Nadu, India |
| RSA-POM | : | California Botanic Garden, California, U.S.A. |
| SUK | : | Shivaji University, Maharashtra, India |
| TEX | : | University of Texas at Austin, Texas, U.S. |
| TAWES | : | Maryland Department of Natural Resources, Maryland, U.S.A. |

| | | |
|---|---|---|
| US | : | United states National Herbarium, Smithsonian Institution, Washington, U.S.A. |
| USF | : | University of South Florida, Florida, U.S.A. |
| UMO | : | University of Missouri, U.S.A. |

## Appendix IV

### COMPOSITION OF STOCK SOLUTIONS FOR MOLECULAR ANALYSIS

**1. Composition of CTAB (Cetyl Trimethyl Ammonium Bromide) extraction buffer (Sambrook *et al.*, 1989).**

| Sl. No. | Reagent | 1 L | 100 ml |
|---|---|---|---|
| 1 | 1M Tris, pH 8 | 100 ml | 10 ml |
| 2 | 5M NaCl | 280 ml | 2 8ml |
| 3 | 0.5M EDTA | 40 ml | 4 ml |
| 4 | CTAB | 20 gm | 2 gm |
| 5 | DD $H_2O$ | Makeup to final volume 1 L | Makeup to final volume 100 ml |

**2. 1M Tris, pH 8**

| Sl. No. | Reagent | 1 L | 100 ml |
|---|---|---|---|
| 1 | Tris base | 121.1 g | 12.11 g |
| 2 | DD $H_2O$ | Makeup to final volume 1 L | Makeup to final volume 100 ml |

Tris base is dissolved in DD $H_2O$ about 80% of the final volume. Adjust the pH by adding conc. HCl drop by drop. After cooling volume make up to final with DD $H_2O$.

**3. 0.5M EDTA (Ethylene Diamine Tetra Acetic acid) pH 8**

| Sl. No. | Reagent | 1 L | 100 ml |
|---|---|---|---|
| 1 | EDTA | 186.12 g | 18.612 g |
| 2 | DD $H_2O$ | Makeup to final volume 1 L | Makeup to final volume 100 ml |

EDTA will not dissolve until solutions pH 8. NaOH pellets were added to adjust the pH

**4. 5M NaCl**

| **Sl. No.** | **Reagent** | **1 L** | **100 ml** |
|---|---|---|---|
| 1 | NaCl | 292.2 g | 29.22 g |
| 2 | DD $H_2O$ | Makeup to final volume 1 L | Makeup to final volume 100 ml |

Mix NaCl to 70% of the final volume of DD $H_2O$. Bring final volume after saturation

**5. 10X TE (Tris EDTA) buffer (Sambrook *et al.*, 1989)**

| Sl. No. | Reagent | 100 ml |
|---|---|---|
| 1 | 1M Tris, pH 8 | 1 ml |
| 2 | 0.5M EDTA | 0.2 ml |
| 3 | DD $H_2O$ | 98.8 ml |

**6. 50X TAE (Tris Acetic acid EDTA) buffer (Sambrook *et al.*, 1989)**

| Sl. No. | Reagent | 1 L | 100 ml |
|---|---|---|---|
| 1 | Tris base | 242 g | 24.2 g |
| 2 | Glacial Acetic acid | 57.1 ml | 5.71 ml |
| 3 | EDTA | 100 ml | 10 ml |
| 4 | DD $H_2O$ | Makeup to final volume 1 L | Makeup to final volume 100 ml |

Tris base was dissolved in 60% of the final volume of DD $H_2O$ and EDTA and Acetic acid was added to the solution. The volume brought with DD $H_2O$.

**Appendix V**

**Table 6. Details of sequences newly generated**

| Sl. No. | Taxa | Voucher details | ITS | rps16 |
|---|---|---|---|---|
| 1 | *Utricularia gibba* L. | *M.P. Krishnapriya* 168031 | * | * |
| 2 | *Utricularia gibba* L. | *M.P. Krishnapriya & Santhosh Nampy* 186048 | * | * |
| 3 | *Utricularia kamarudeenii* Arya *et al.* | *M.P. Krishnapriya* 175803 | * | * |
| 4 | *Utricularia kamarudeenii* Arya *et al.* | *M.P. Krishnapriya* 175802 | * | * |
| 5 | *Utricularia aurea* Lour. | *M.P. Krishnapriya & Santhosh Nampy* 164360 | - | * |
| 6 | *Utricularia aurea* Lour. | *M.P. Krishnapriya* 164398 | * | - |
| 7 | *Utricularia aurea* Lour. | *M.P. Krishnapriya & Santhosh Nampy* 186045 | * | * |
| 8 | *Utricularia minutissima* Vahl | *M.P. Krishnapriya* 177260 | * | * |
| 9 | *Utricularia minutissima* Vahl | *M.P. Krishnapriya* 186039 | * | * |
| 10 | *Utricularia geoffrayi* Pellegr. | *M.P. Krishnapriya* 177210 | * | * |
| 11 | *Utricularia geoffrayi* Pellegr. | *M.P. Krishnapriya* 186089 | * | * |
| 12 | *Utricularia hirta* J.G.Klein ex Link | *M.P. Krishnapriya* 175884 | * | * |
| 13 | *Utricularia hirta* J.G.Klein ex Link | *M.P. Krishnapriya* 186035 | * | * |
| 14 | *Utricularia roseopurpurea* Stapf ex Gamble | *M.P. Krishnapriya* 186029 | * | * |
| 15 | *Utricularia roseopurpurea* Stapf ex Gamble | *M.P. Krishnapriya & Santhosh Nampy* 164338 | * | * |
| 16 | *Utricularia roseopurpurea* Stapf ex Gamble | *M.P. Krishnapriya & Santhosh Nampy* 164344 | * | * |
| 17 | *Utricularia caerulea* L. | *M.P. Krishnapriya* 177259 | * | * |
| 18 | *Utricularia caerulea* L. | *M.P. Krishnapriya & Santhosh Nampy* 168088 | * | * |
| 19 | *Utricularia caerulea* L. | *M.P. Krishnapriya & Santhosh Nampy* 175882 | * | * |
| 20 | *Utricularia caerulea* L. | *M.P. Krishnapriya* 175834 | * | * |
| 21 | *Utricularia striatula* Sm. | *M.P. Krishnapriya & Santhosh Nampy* 164392 | * | * |
| 22 | *Utricularia striatula* Sm. | *M.P. Krishnapriya* 175881 | * | * |
| 23 | *Utricularia brachiata* Oliv. | *M.P. Krishnapriya* 177299 | * | * |

| | | | | |
|---|---|---|---|---|
| **24** | *Utricularia brachiata* Oliv. | *M.P. Krishnapriya* 186010 | * | * |
| **25** | *Utricularia furcellata* Oliv. | *M.P. Krishnapriya & Santhosh Nampy* 175832 | * | * |
| **26** | *Utricularia furcellata* Oliv. | *M.P. Krishnapriya & Santhosh Nampy* 175874 | * | * |
| **27** | *Utricularia kumaonensis* Oliv. | *M.P. Krishnapriya* 186009 | * | * |
| **28** | *Utricularia kumaonensis* Oliv. | *M.P. Krishnapriya* 186005 | * | * |
| **29** | *Utricularia scandens* Benj. | *M.P. Krishnapriya & Santhosh Nampy* 164367 | - | * |
| **30** | *Utricularia scandens* Benj. | *M.P. Krishnapriya* 186021 | - | * |
| **31** | *Utricularia scandens* Benj. | *M.P. Krishnapriya* 177241 | - | * |
| **32** | *Utricularia recta* P.Taylor | *M.P. Krishnapriya* 177296 | * | * |
| **33** | *Utricularia recta* P.Taylor | *M.P. Krishnapriya* 177201 | * | * |
| **34** | *Utricularia recta* P.Taylor | *M.P. Krishnapriya & Santhosh Nampy* 175830 | * | * |
| **35** | *Utricularia bifida* L. | *M.P. Krishnapriya* 186040 | * | * |
| **36** | *Utricularia bifida* L. | *M.P. Krishnapriya* 186036 | * | * |
| **37** | *Utricularia reticulata* Sm. | *M.P. Krishnapriya & Santhosh Nampy* 168084 | * | * |
| **38** | *Utricularia reticulata* Sm. | *M.P. Krishnapriya & Santhosh Nampy* 177224 | * | * |
| **39** | *Utricularia polygaloides* Edgew. | *M.P. Krishnapriya* 186033 | * | * |
| **40** | *Utricularia polygaloides* Edgew. | *M.P. Krishnapriya* 186041 | * | * |
| **41** | *Utricularia purpurascens* J.Graham | *M.P. Krishnapriya* 177276 | * | * |
| **42** | *Utricularia purpurascens* J.Graham | *M.P. Krishnapriya* 186072 | * | * |
| **43** | *Utricularia purpurascens* J.Graham | *M.P. Krishnapriya* 186075 | * | * |
| **44** | *Utricularia wightiana* P.Taylor | *M.P. Krishnapriya* 186094 | * | * |
| **45** | *Utricularia wightiana* P.Taylor | *M.P. Krishnapriya* 186096 | * | * |
| **46** | *Utricularia nayarii* Janarth. & A.N.Henry | *M.P. Krishnapriya & Santhosh Nampy* 164347 | * | * |
| **47** | *Utricularia nayarii* Janarth. & A.N.Henry | *M.P. Krishnapriya & Santhosh Nampy* 164345 | * | * |
| **48** | *Utricularia nayarii* Janarth. & A.N.Henry | *M.P. Krishnapriya & Santhosh Nampy* 164342 | * | * |
| **49** | *Utricularia sunilii* Naveen Kum. & K.M.P.Kumar | *M.P. Krishnapriya* 186050 | | * |
| **50** | *Utricularia sunilii* Naveen Kum. & K.M.P.Kumar | *M.P. Krishnapriya & Santhosh Nampy* 186043 | * | * |
| **51** | *Utricularia sunilii* Naveen Kum. & K.M.P.Kumar | *M.P. Krishnapriya & Santhosh Nampy* 186031 | * | * |

| | | | | |
|---|---|---|---|---|
| **52** | *Utricularia graminifolia* Vahl | *M.P. Krishnapriya & Santhosh Nampy* 164356 | * | * |
| **53** | *Utricularia graminifolia* Vahl | *M.P. Krishnapriya & Santhosh Nampy* 164395 | * | * |
| **54** | *Utricularia graminifolia* Vahl | *M.P. Krishnapriya* 164321 | * | * |
| **55** | *Utricularia graminifolia* Vahl | *M.P. Krishnapriya & S. Resmi* 164368 | * | * |
| **56** | *Utricularia graminifolia* Vahl | *M.P. Krishnapriya & Santhosh Nampy* 164363 | * | - |
| **57** | *Utricularia graminifolia* Vahl | *M.P. Krishnapriya & Santhosh Nampy* 186030 | * | - |
| **58** | *Utricularia babui* S.R.Yadav, Sardesai & S.P.Gaikwad | *M.P. Krishnapriya* 164358 | * | * |
| **59** | *Utricularia babui* S.R.Yadav, Sardesai & S.P.Gaikwad | *M.P. Krishnapriya* 164353 | * | * |
| **60** | *Utricularia sainthomia* P.Biju *et al.* | *M.P. Krishnapriya* 168095 | * | - |
| **61** | *Utricularia sainthomia* P.Biju *et al.* | *M.P. Krishnapriya* 177265 | * | * |
| **62** | *Utricularia sainthomia* P.Biju *et al.* | *M.P. Krishnapriya* 177260 | * | * |
| **63** | *Utricularia albocaerulea* Dalzell | *M.P. Krishnapriya* 168008 | * | * |
| **64** | *Utricularia albocaerulea* Dalzell | *M.P. Krishnapriya* 177281 | * | * |
| **65** | *Utricularia malabarica* Janarth. & A.N.Henry | *M.P. Krishnapriya* 177269 | - | * |
| **66** | *Utricularia malabarica* Janarth. & A.N.Henry | *M.P. Krishnapriya & Santhosh Nampy* 186076 | * | * |
| **67** | *Utricularia malabarica* Janarth. & A.N.Henry | *M.P. Krishnapriya* 175811 | * | * |
| **68** | *Utricularia malabarica* Janarth. & A.N.Henry | *M.P. Krishnapriya* 177279 | * | * |
| **69** | *Utricularia malabarica* Janarth. & A.N.Henry | *M.P. Krishnapriya* 177270 | * | * |
| **70** | *Utricularia praeterita* P.Taylor | *M.P. Krishnapriya* 186074 | * | * |
| **71** | *Utricularia praeterita* P.Taylor | *M.P. Krishnapriya* 177283 | * | * |
| **72** | *Utricularia ponmudica* Krishnapriya & Nampy sp. nov. | *M.P. Krishnapriya* 177228 | * | * |
| **73** | *Utricularia ponmudica* Krishnapriya & Nampy sp. nov. | *M.P. Krishnapriya* 186083 | * | * |
| **74** | *Utricularia smithiana* Wight | *M.P. Krishnapriya & Santhosh Nampy* 164349 | - | * |
| **75** | *Utricularia smithiana* Wight | *M.P. Krishnapriya & S. Resmi* 164369 | - | * |
| **76** | *Utricularia sisparensis* Krishnapriya & Nampy sp. nov. | *M.P. Krishnapriya* 186095 | * | - |
| **77** | *Utricularia sisparensis* Krishnapriya & Nampy sp. nov. | *M.P. Krishnapriya* 186098 | * | - |
| **78** | *Utricularia lazulina* P.Taylor | *M.P. Krishnapriya & Santhosh Nampy* 168087 | * | * |
| **79** | *Utricularia lazulina* P.Taylor | *M.P. Krishnapriya & Santhosh Nampy* 177258 | * | * |

| | | | | |
|---|---|---|---|---|
| **80** | *Utricularia lazulina* P.Taylor | *M.P. Krishnapriya* 168079 | * | * |
| **81** | *Utricularia cecilii* P.Taylor | *M.P. Krishnapriya & Santhosh Nampy* 164383 | * | * |
| **82** | *Utricularia cecilii* P.Taylor | *M.P. Krishnapriya* 175819 | * | * |
| **83** | *Utricularia cecilii* P.Taylor | *M.P. Krishnapriya* 168093 | * | * |
| **84** | *Utricularia uliginosa* Vahl | *M.P. Krishnapriya* 168075 | * | * |
| **85** | *Utricularia uliginosa* Vahl | *M.P. Krishnapriya* 186017 | * | * |

## Appendix VI

**Table 7. Details of nrITS sequences retrieved from GenBank**

| Sl. No. | Taxa | GenBank accession numbers | Voucher details |
|---|---|---|---|
| 1 | *Genlisea violacea* A.St.-Hil. | MG027716 | *V.F.O. Miranda* 1636 (JABU) |
| 2 | *Genlisea violacea* A.St.-Hil. | MG027715 | *V.F.O. Miranda* 1632 (JABU) |
| 3 | *Pinguicula alpina* L. | DQ438100 | *Steiger* P0017 (JE) |
| 4 | *Pinguicula alpina* L. | DQ438092 | *Schmidt s.n* (JE) |
| 5 | *Pinguicula vulgaris* L. | DQ438093 | *Steiger* P0038a (JE) |
| 6 | *Pinguicula vulgaris* L. | DQ438086 | *Schmidt s.n.* (JE) |
| 7 | *Utricularia bifida* L. | MG027739 | *V.F.O. Miranda* S/N (JABU) |
| 8 | *Utricularia bifida* L. | LC682651 | *M. Muramatsu s.n.* 10.08.2012 |
| 9 | *Utricularia involvens* Ridl. | OR142164 | *R.W. Jobson* 2205 18.04.2014 (NSW) |
| 10 | *Utricularia circumvoluta* P.Taylor | OR142175 | *R.W. Jobson* 2837 18.07.2015 (NSW) |
| 11 | *Utricularia foveolata* Edgew. | OR142133 | *R.W. Jobson* 3566 28.04.2019 (NSW) |
| 12 | *Utricularia uliginosa* Vahl | OR142179 | *R.W. Jobson* 3262 02.10.2016 (NSW) |
| 13 | *Utricularia uliginosa* Vahl | OR142178 | *R.W. Jobson* 3219 22.04.2016 (NSW) |
| 14 | *Utricularia uliginosa* Vahl | OR142173 | *R.W. Jobson* 3161 14.04.2016 (NSW) |
| 15 | *Utricularia uliginosa* Vahl | OR142174 | *R.W. Jobson* 2021 10.07.2013 (NSW) |
| 16 | *Utricularia uliginosa* Vahl | OR142176 | *R.W. Jobson* 1779 20.04.2013 (NSW) |
| 17 | *Utricularia uliginosa* Vahl | OR142172 | *R.W. Jobson* 1913 05.07.2013 (NSW) |
| 18 | *Utricularia uliginosa* Vahl | OR142168 | *R.W. Jobson* 2673 16.04.2015 (NSW) |

| | | | |
|---|---|---|---|
| 19 | *Utricularia uliginosa* Vahl | OR142165 | *R.W. Jobson* 2279 26.04.2014 (NSW) |
| 20 | *Utricularia babui* S.R.Yadav, Sardesai & S.P.Gaikwad | MK617628 | *Chaudhary* DUH14459 23.02.2019 (DUH) |
| 21 | *Utricularia graminifolia* Vahl | MK617627 | DUH14457 (DUH) |
| 22 | *Utricularia striatula* Sm. | KF016004 | *Yanthan et al. s.n.* |
| 23 | *Utricularia striatula* Sm. | KF015999 | *Yanthan et al. s.n.* |
| 24 | *Utricularia striatula* Sm. | MW218508 | *K. Gadhavi s.n.* |
| 25 | *Utricularia striatula* Sm. | MK617623 | DUH14461 (DUH) |
| 26 | *Utricularia furcellata* Oliv. | KF016001 | *Yanthan et al. s.n.* |
| 27 | *Utricularia furcellata* Oliv. | KF016006 | *Yanthan et al. s.n.* |
| 28 | *Utricularia sandersonii* Oliv. | MG027735 | *R. Gibson* 467 (NSW) |
| 29 | *Utricularia sandersonii* Oliv. | MG027734 | *S.R. Silva* 17 (NSW) |
| 30 | *Utricularia arenaria* A.DC. | MG027729 | *S.R. Silva* 15 (JABU) |
| 31 | *Utricularia arenaria* A.DC. | MG027733 | *S.R. Silva* 13 (JABU) |
| 32 | *Utricularia arenaria* A.DC. | MG027731 | *S.R. Silva* 12 (JABU) |
| 33 | *Utricularia lateriflora* R.Br. | MG027736 | *R. Gibson* 545 (NSW) |
| 34 | *Utricularia caerulea* L. | OR142161 | *R.W. Jobson* 1945 |
| 35 | *Utricularia caerulea* L. | OR142153 | *R.W. Jobson* 1275 07.06.2011 |
| 36 | *Utricularia caerulea* L. | OR142141 | *R.W.* Jobson 3748 |
| 37 | *Utricularia caerulea* L. | OR142167 | *R.W.* Jobson 2669 |
| 38 | *Utricularia caerulea* L. | OR142154 | *Wannan* 6323 |
| 39 | *Utricularia caerulea* L. | OR142140 | *R.W. Jobson* 3436 |
| 40 | *Utricularia caerulea* L. | OR142156 | *R.W. Jobson* 1789 |

| | | | |
|---|---|---|---|
| 41 | *Utricularia caerulea* L. | MK617625 | DUH14455 (DUH) |
| 42 | *Utricularia caerulea* L. | OR142135 | *R.W. Jobson* 3974 |
| 43 | *Utricularia caerulea* L. | OR142158 | *R.W. Jobson* 1836 |
| 44 | *Utricularia caerulea* L. | OR142144 | *R.W. Jobson* 2685 1 |
| 45 | *Utricularia caerulea* L. | OR142134 | *R.W. Jobson* 3956 |
| 46 | *Utricularia longifolia* Gardner | MG027773 | *C.G. Menezes* 40 (JABU) |
| 47 | *Utricularia longifolia* Gardner | MG027774 | *C.G. Menezes* 50 (JABU) |
| 48 | *Utricularia longifolia* Gardner | KY689718 | *V.F.O. Miranda* 16803 |
| 49 | *Utricularia praelonga* A.St.-Hil. & Girard | MH036229 | *R.W. Jobson* UQ73 |
| 50 | *Utricularia hispida* Lam. | MG027781 | *V.F.O. Miranda* 1637.2 (JABU) |
| 51 | *Utricularia hispida* Lam. | MG027782 | *V.F.O. Miranda* 1637.3 (JABU) |
| 52 | *Utricularia hispida* Lam. | MG027780 | *V.F.O. Miranda* 1637.1 (JABU) |
| 53 | *Utricularia alpina* Jacq. | MH036230 | *R.W. Jobson* UQ120 |
| 54 | *Utricularia alpina* Jacq. | AB212117 | *K. Kondo & H. Shimai* 708-LPCGS (HIRO) |
| 55 | *Utricularia nephrophylla* Benj. | KY689707 | *V.F.O. Miranda* 20473 |
| 56 | *Utricularia nelumbifolia* Gardner | KY689708 | *V.F.O. Miranda* 20553 |
| 57 | *Utricularia reniformis* A.St.-Hil. | MG027776 | *V.F.O. Miranda* 1500.1 (JABU) |
| 58 | *Utricularia reniformis* A.St.-Hil. | MG027779 | *V.F.O. Miranda* 1559.2 (JABU) |
| 59 | *Utricularia reniformis* A.St.-Hil. | MG027778 | *V.F.O. Miranda* 1559.1 (JABU) |
| 60 | *Utricularia calycifida* Benj. | MG027741 | *S.R. Silva* 20 (JABU) |
| 61 | *Utricularia calycifida* Benj. | MG027740 | *V.F.O. Miranda* 1653 (JABU) |
| 62 | *Utricularia tridentata* Sylvén | MH036201 | *F.L. Rivadavia* 2516 (SPF) |

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|---|---|---|---|
| 63 | *Utricularia tricolor* A.St.-Hil. | MH036223 | *G. Heiden* 1764 (SPF) |
| 64 | *Utricularia tricolor* A.St.-Hil. | MG027728 | *S.R. Silva* 34.3 (JABU) |
| 65 | *Utricularia tricolor* A.St.-Hil. | MG027726 | *V.F.O. Miranda* 1546 (JABU) |
| 66 | *Utricularia purpurea* Walter | PP868710 | *Fewless* 14018 (UWGB39065) |
| 67 | *Utricularia purpurea* Walter | PP868709 | *Fewless et al*. 11122 (UWGB28452) |
| 68 | *Utricularia cucullata* A.St.-Hil. & Girard | MG027771 | *V.F.O. Miranda* 1651.4 (JABU) |
| 69 | *Utricularia cucullata* A.St.-Hil. & Girard | MG027768 | *V.F.O. Miranda* 1651.1 (JABU) |
| 70 | *Utricularia neottioides* A.St.-Hil. & Girard | MG027759 | *V.F.O. Miranda* 1307 (JABU) |
| 71 | *Utricularia subulata* L. | MG027764 | *V.F.O. Miranda* 1625 (JABU) |
| 72 | *Utricularia subulata* L. | MG027763 | *V.F.O. Miranda* 1616 (JABU) |
| 73 | *Utricularia nervosa* Weber ex Benj. | MG027761 | *V.F.O. Miranda* 1649.3 (JABU) |
| 74 | *Utricularia nervosa* Weber ex Benj. | MG027760 | *V.F.O. Miranda* 1544 (JABU) |
| 75 | *Utricularia gibba* L. | LC682655 | *M. Muramatsu s.n.* 28.08.2012 |
| 76 | *Utricularia stellaris* L.f. | MT248971 | *R.W. Jobson* 2324 (NSW) |
| 77 | *Utricularia stellaris* L.f. | MT248970 | *R. Dowling* WP128 (NSW) |
| 78 | *Utricularia stellaris* L.f. | MT248968 | *R.W. Jobson* 1405 (NSW) |
| 79 | *Utricularia stellaris* L.f. | MT248969 | *R.W. Jobson* 1255 (NSW) |
| 80 | *Utricularia stellaris* L.f. | MT248975 | *R.W. Jobson* 3109 (NSW) |
| 81 | *Utriculariastellaris* L.f. | MT248949 | *R.W. Jobson* 3702 (NSW) |
| 82 | *Utricularia aurea* Lour. | MT24898 | *R.W. Jobson* 2887 (NSW) |
| 83 | *Utricularia aurea* Lour. | MT248953 | *R.W. Jobson* 1381 (NSW) |
| 84 | *Utricularia aurea* Lour. | MT248980 | *R.W. Jobson* 3861 (NSW) |

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|---|---|---|---|
| 85 | *Utricularia aurea* Lour. | MG027742 | CP25840 (JABU) |
| 86 | *Utricularia aurea* Lour. | KY689714 | TS000267 (JABU) |
| 87 | *Utricularia radiata* Small | PP868705 | *Stebbins & Wahi s.n.* 25.08.2021 (CAES) |
| 88 | *Utricularia radiata* Small | PP868706 | *Wysocki & Schock s.n.* 12.09.2014 (CAES) |
| 89 | *Utricularia radiata* Small | PP868703 | *Stebbins & Rackie s.n.* 03.09.2019 (CAES) |
| 90 | *Utricularia breviscapa* C.Wright ex Griseb. | MG027757 | *S.R. Silva* 402 (JABU) |
| 91 | *Utricularia breviscapa* C.Wright ex Griseb. | MG027756 | *S.R. Silva* 401 (JABU) |
| 92 | *Utriculariainflata* Walter | PP868699 | *Stebbins & Rackie s.n.* 19.07.2019 (CAES) |
| 93 | *Utriculariainflata* Walter | PP868695 | *Franck* 5975 (FLAS) |
| 94 | *Utricularia inflata* Walter | PP868696 | *Stebbins & Velazquez s.n.* 20.07.2020 (CAES) |
| 95 | *Utricularia inflata* Walter | PP868694 | *Scanlon* 337 (FLAS207099) |
| 96 | *Utricularia minor* L. | LC682658 | *M. Muramatsu s.n.* |
| 97 | *Utriculariaminor* L. | LC682662 | *M. Muramatsu s.n.* |
| 98 | *Utricularia minor* L. | KY689721 | TS0002683 (JABU) |
| 99 | *Utricularia minor* L. | MH051695 | *G. Astuti* minorITT3 |
| 100 | *Utricularia minor* L. | MH051698 | *G. Astuti* minorRUB3 |
| 101 | *Utricularia minor* L. | MH051693 | *G. Astuti* minorAD |
| 102 | *Utricularia minor* L. | MT150757 | *P.A. Volkova & M.O. Ivanova s.n.* 28.08.2018 |
| 103 | *Utriculariaminor* L. | MT150767 | *O.A. Mochalova* MAG0002565, IBIW67514 24.06.2017 |
| 104 | *Utricularia minor* L. | MT150763 | *P.A. Volkova, M.O. Ivanova & I.A. Dadykin* IBIW63694 26.07.2019 |

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|---|---|---|---|
| 105 | *Utricularia minor* L. | MT150756 | *L.A. Abramova, M.O. Ivanova & N.P. Tikhomirov* IBIW63689 29.06.2018 |
| 106 | *Utricularia intermedia* Hayne | PP868663 | *Tippery* 1372 (UWW) |
| 107 | *Utricularia intermedia* Hayne | PP868667 | *Fewless* 10190 (UWGB27472) |
| 108 | *Utricularia intermedia* Hayne | PP868666 | *Fewless* 11974 (UWGB34032) |
| 109 | *Utricularia geminiscapa* Benj. | MT248956 | *R.W. Jobson* UQ197 (BRI) |
| 110 | *Utricularia geminiscapa* Benj. | PP868654 | *Fewless* 11055 (UWGB28186) |
| 111 | *Utricularia geminiscapa* Benj. | PP868653 | *Fewless* 10524 (UWGB28101) |
| 112 | *Utricularia macrorhiza* Leconte | PP868677 | *Bugbee s.n.* 04.08.2023 (CAES) |
| 113 | *Utricularia macrorhiza* Leconte | PP868680 | *Selsky & Deeds s.n.* 14.07.2005 (CAES) |
| 114 | *Utricularia macrorhiza* Leconte | PP868676 | *Bugbee & Pakalnis s.n.* 27.08.2021 (CAES) |
| 115 | *Utricularia australis* R.Br. | MT248972 | *R.W. Jobson* 1391 (NSW) |
| 116 | *Utricularia australis* R.Br. | MF543812 | UTAUAV11-190713 |
| 117 | *Utricularia australis* R.Br. | LC682654 | *M. Ogiso* P2172 |

## Appendix VII

**Table 8. Details of *rps*16 sequences retrieved from GenBank**

| Sl. No. | Taxa | GenBank accession numbers | Voucher details |
|---|---|---|---|
| 1 | *Genlisea aurea* A.St.-Hil. | FN641744 | *F.L. Rivadavia & V. Batista* 2609 (SPF) |
| 2 | *G enlisea uncinate* P.Taylor & Fromm | FN641718 | *F.L. Rivadavia* 471 (SPF) |
| 3 | *G enlisea violacea* A.St.-Hil. | FN641725 | *F.L. Rivadavia* 1947 (SPF) |
| 4 | *Pinguicula ehlersiae* Speta & F.Fuchs | AF482547 | *R.W. Jobson* 266 (BRI) |
| 5 | *Pinguicula agnata* Casper | AF482543 | *R.W. Jobson* 225 (BRI) |
| 6 | *Pinguicula moranensis* Kunth | HQ385146 | *R.G. Olmstead* 97-5 (WTU) |
| 7 | *Pinguicula gracilis* Zamudio | AF482548 | *R.W. Jobson* 245 (BRI) |
| 8 | *Utricularia uniflora* R.Br. | KY243534 | *R.W. Jobson* 1184 (NSW) |
| 9 | *Utricularia uniflora* R.Br. | KY243536 | *R.W. Jobson* 1213 (NSW) |
| 10 | *Utricularia multifida* R.Br. | AF482583 | *R.W. Jobson & B. Denton* 2A (BRI) |
| 11 | *Utricularia multifida* R.Br. | KY243502 | *B.G. Briggs* 10126 (NSW) |
| 12 | *Utricularia monanthos* Hook.f. | KY243499 | *R.W. Jobson* 1238 (NSW) |
| 13 | *Utricularia monanthos* Hook.f. | MK264142 | *R.W. Jobson* 2118 (NSW) |
| 14 | *Utricularia monanthos* Hook.f. | MK264133 | *D.E. Murfet* 5202 (AD) |
| 15 | *Utricularia monanthos* Hook.f. | KY243500 | *D.E. Murfet* 5856 (AD) |
| 16 | *Utricularia violacea* R.Br. | AF482603 | *R.W. Jobson* 9 (BRI) |
| 17 | *Utricularia violacea* R.Br. | KY243538 | *R.W. Jobson* 1605 (NSW) |
| 18 | *Utricularia volubilis* R.Br. | KY243539 | *R.W. Jobson* 1603 (NSW) |
| 19 | *Utricularia volubilis* R.Br. | KY243540 | *R.W. Jobson* 1582 (NSW) |
| 20 | *Utricularia menziesii* R.Br. | KY243497 | *B. Archer* 35 (MELB) |
| 21 | *Utricularia menziesii* R.Br. | KY243498 | *R. Gibson* 309 (NSW) |
| 22 | *Utricularia asplundii* P.Taylor | MH030257 | *R.W. Jobson* UQ125 (BRI) |

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|---|---|---|---|
| 23 | *Utricularia alpina* Jacq. | AF482556 | *R.W. Jobson & D. Evans* 120 (BRI) |
| 24 | *Utricularia alpina* Jacq. | MH030258 | *R.W. Jobson* UQ120 (BRI) |
| 25 | *Utricularia calycifida* Benj. | MH030265 | *R.W. Jobson* 3119 (NSW) |
| 26 | *Utricularia longifolia* Gardner | MH030255 | *R.W. Jobson* UQ76 (BRI) |
| 27 | *Utricularia longifolia* Gardner | AF482580 | *R.W. Jobson* 76 (BRI) |
| 28 | *Utricularia hispida* Lam. | MH030215 | *P.C. Baleeiro* 255 (SPF) |
| 29 | *Utricularia praelonga* A.St.-Hil. & Girard | MH030256 | *R.W. Jobson* UQ73 (BRI) |
| 30 | *Utricularia praelonga* A.St.-Hil. & Girard | AF482591 | *R.W. Jobson* 73 (BRI) |
| 31 | *Utricularia nephrophylla* Benj. | AF482588 | *F.L. Rivadavia & J. Mullins* 547 (SPF) |
| 32 | *Utricularia nephrophylla* Benj. | MH030259 | *F.L. Rivadavia* 547 (SPF) |
| 33 | *Utricularia reniformis* A.St.-Hil. | MH030260 | *F.L. Rivadavia* 120 (SPF) |
| 34 | *Utricularia nelumbifolia* Gardner | AF482586 | *F.L. Rivadavia et al.* 519 (SPF) |
| 35 | *Utricularia tridentata* Sylvén | MH030228 | *F.L. Rivadavia* 2516 (SPF) |
| 36 | *Utricularia tricolor* A.St.-Hil. | MH030243 | *P.C. Baleeiro* 335 (SPF) |
| 37 | *Utricularia tricolor* A.St.-Hil. | MH030250 | *P.C. Baleeiro* 341 (SPF) |
| 38 | *Utricularia amethystina* Salzm. ex A.St.-Hil. & Girard | MH030262 | *P.C. Baleeiro* 378 (SPF) |
| 39 | *Utricularia amethystina* Salzm. ex A.St.-Hil. & Girard | MH030263 | *P.C. Baleeiro* 384 (SPF) |
| 40 | *Utricularia amethystina* Salzm. ex A.St.-Hil. & Girard | MH030266 | *F.L. Rivadavia* 2109B (SPF) |
| 41 | *Utricularia biloba* R.Br. | AF482561 | *R.W. Jobson* 175 (BRI) |
| 42 | *Utricularia flaccida* A.DC. | AF482569 | *R.W. Jobson* 169 (BRI) |
| 43 | *Utricularia subulata* L. | AF482599 | *S. Orzell* 16213 (NY) |
| 44 | *Utricularia neottioides* A.St.-Hil. & Girard | AF482587 | *F.L. Rivadavia & M. Peixoto* 870 (SPF) |
| 45 | *Utricularia cucullata* A.St.-Hil. & Girard | AF482566 | *F.L. Rivadavia & R.K. Sato* 941 (SPF) |
| 46 | *Utricularia purpurea* Walter | PP868938 | *Stebbins s.n.* 07.07.2022 (CAES) |
| 47 | *Utricularia purpurea* Walter | PP868934 | *Whitten* 4120 (FLAS242437) |
| 48 | *Utricularia purpurea* Walter | PP868941 | *Fewless & Whitehouse* 11168 (UWGB28320) |
| 49 | *Utricularia gibba* L. | PP868869 | *Mamick s.n.* 17.08.2023 (UWW) |
| 50 | *Utricularia gibba* L. | PP868868 | *Warman s.n.* 05.09.2023 (UWW) |

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|---|---|---|---|
| 51 | *Utricularia gibba* L. | PP868870 | *Warman s.n.* 10.10.2023 (UWW) |
| 52 | *Utricularia gibba* L. | PP868867 | *Warman s.n.* 16.07.2023 (UWW) |
| 53 | *Utricularia radiata* Small | PP868923 | *Stebbins & Rackie s.n.* 03.09.2019 (CAES) |
| 54 | *Utricularia radiata* Small | PP868920 | *Bugbee & Stebbins s.n.* 16.07.2015 (CAES) |
| 55 | *Utricularia radiata* Small | PP868927 | *Wysocki & Schock s.n.* 12.08.2014 (CAES) |
| 56 | *Utricularia inflata* Walter | PP868887 | *Stebbins s.n.* 11.07.2022 (CAES) |
| 57 | *Utricularia inflata* Walter | PP868881 | *Scanlon* 337 (FLAS207099) |
| 58 | *Utricularia inflata* Walter | PP868884 | *Stebbins & Velazquez s.n.* 20.07.2020 (CAES) |
| 59 | *Utricularia inflata* Walter | PP868888 | *Stebbins s.n.* 12.08.2022 (CAES) |
| 60 | *Utricularia stellaris* L.f. | MT278864 | *R.W. Jobson* 1405 (NSW) |
| 61 | *Utricularia stellaris* L.f. | MT278850 | *R.W. Jobson* 3702 (NSW) |
| 62 | *Utricularia stellaris* L.f. | MT278865 | *R.W. Jobson* 1255 (NSW) |
| 63 | *Utricularia aurea* Lour. | MT278872 | *R.W. Jobson* 2784 (NSW) |
| 64 | *Utricularia aurea* Lour. | MT278871 | *R.W. Jobson* 3184 (NSW) |
| 65 | *Utricularia aurea* Lour. | MT278851 | *R.W. Jobson* 3588 (NSW) |
| 66 | *Utricularia aurea* Lour. | MT278875 | *R.W. Jobson* 3861 (NSW) |
| 67 | *Utricularia aurea* Lour. | MT278854 | *R.W. Jobson* 1381 (NSW) |
| 68 | *Utricularia geminiscapa* Benj. | PP868863 | *Balfour & Soufrine s.n.* 30.09.2009 (CAES) |
| 69 | *Utricularia geminiscapa* Benj. | PP868865 | *Fewless* 11055 (UWGB28186) |
| 70 | *Utricularia geminiscapa* Benj. | MT278856 | *R.W. Jobson* UQ197 (BRI) |
| 71 | *Utricularia minor* L. | MH051590 | *G. Astuti s.n.* |
| 72 | *Utricularia minor* L. | MH051589 | *G. Astuti s.n.* |
| 73 | *Utricularia minor* L. | MH051593 | *G. Astuti s.n.* |
| 74 | *Utricularia intermedia* Hayne | PP868895 | *Cibulka & Castellanos* ON02748 (UWGB44458) |
| 75 | *Utricularia intermedia* Hayne | PP868893 | *Stebbins s.n.* 08.07.2022 (CAES) |
| 76 | *Utricularia intermedia* Hayne | MH051582 | *G. Astuti s.n.* |
| 77 | *Utricularia intermedia* Hayne | PP868897 | *Bassett* 13-24 (OSC248493) |
| 78 | *Utricularia bremii* Heer ex Koelliker | MH051575 | *G. Astuti s.n.* |

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| 79 | *Utricularia bremii* Heer ex Koelliker | MH051571 | *G. Astuti s.n.* |
| 80 | *Utricularia bremii* Heer ex Koelliker | MH051574 | *G. Astuti s.n.* |
| 81 | *Utricularia australis* R.Br. | MH051565 | *G. Astuti s.n.* |
| 82 | *Utricularia australis* R.Br. | MH051566 | *G. Astuti s.n.* |
| 83 | *Utricularia australis* R.Br. | MT278867 | *R.W. Jobson* 1391 (NSW) |
| 84 | *Utricularia macrorhiza* Leconte | PP868912 | *Gibbons & Cavadini s.n.* 30.09.2011 (CAES) |
| 85 | *Utricularia macrorhiza* Leconte | PP868904 | *Bugbee s.n.* 04.08.2023 (CAES) |
| 86 | *Utricularia macrorhiza* Leconte | PP868901 | *Reeps & Soufrine s.n.* 31.07.2008 (CAES) |
| 87 | *Utricularia macrorhiza* Leconte | PP868900 | *Gibbons & Wysocki s.n.* 30.08.2013 (CAES) |
| 88 | *Utricularia macrorhiza* Leconte | PP868913 | *Wagner* m1757 (OSC208934) |
| 89 | *Utricularia lateriflora* R.Br. | OR141414 | *R.W. Jobson* 3338 |
| 90 | *Utricularia lateriflora* R.Br. | OR141373 | *R.W. Jobson* 1631 |
| 91 | *Utricularia pubescens* Sm. | AF482593 | *R.W. Jobson & M. Hochberg* 56A (BRI) |
| 92 | *Utricularia bisquamata* Schrank | AF482562 | *R.W. Jobson* UQ51 12.03.1998 (BRI) |
| 93 | *Utricularia sandersonii* Oliv. | AF482596 | *R.W. Jobson & M. Hochberg* 55B (BRI) |
| 94 | *Utricularia livida* E.Mey. | AF482579 | *R.W. Jobson* 54A (BRI) |
| 95 | *Utricularia hirta* J.G.Klein ex Link | MK560769 | *A. Chaudhary & R. Tandon s.n.* |
| 96 | *Utricularia warburgii* K.l.Goebel | OR141331 | *R.W. Jobson* 4055 14.04.2022 |
| 97 | *Utricularia caerulea* L. | KY243543 | *R.W. Jobson* 1257 (NSW) |
| 98 | *Utricularia pulchra* P.Taylor | OR141384 | *Johns* 9554 |
| 99 | *Utricularia striatula* Sm. | AF482598 | *R.W. Jobson & P. Gelinaud* 147B (BRI) |
| 100 | *Utricularia striatula* Sm. | MK560770 | *A. Chaudhary & R. Tandon s.n.* |
| 101 | *Utricularia laciniata* A.St.-Hil. & Girard | AF482577 | *F.L. Rivadavia* 652 (SPF) |
| 102 | *Utricularia purpureocaerulea* A.St.-Hil. & Girard | AF482594 | *F.L. Rivadavia & C.N.G. de Araujo* 663 (SPF) |
| 103 | *Utricularia cornuta* Michx. | AF482564 | *P.A. Fryxell* 4946 01.04.1986 (NY) |
| 104 | *Utricularia cornuta* Michx. | PP868857 | *Fewless* 7810 (UWGB26280) |
| 105 | *Utricularia cornuta* Michx. | PP868858 | *Fewless* 10438 (UWGB27822) |
| 106 | *Utricularia cornuta* Michx. | PP868859 | *Fewless* 10525 (UWGB28102) |

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|---|---|---|---|
| 107 | *Utricularia nana* A.St.-Hil. & Girard | AF482585 | *F.L. Rivadavia & M. Peixoto* 883 02.04.1999 (SPF) |
| 108 | *Utricularia adpressa* Salzm. ex A.St.-Hil. & Girard | AF482555 | *F.L. Rivadavia & R.K. Sato* 1003 01.05.1999 (SPF) |
| 109 | *Utricularia meyeri* Pilg. | AF482582 | *F.L. Rivadavia & R.K. Sato* 1014 02.05.1999 (SPF) |
| 110 | *Utricularia erectiflora* Pilg. | AF482568 | *F.L. Rivadavia & R.K. Sato* 1044 3/05/1999 (SPF) |
| 111 | *Utricularia prehensilis* E.Mey. | AF482592 | *R.W. Jobson* UQ56A 26.09.1999 (BRI) |
| 112 | *Utricularia circumvoluta* P.Taylor | OR141408 | *R.W. Jobson* 2797 16.07.2015 (NSW) |
| 113 | *Utricularia circumvoluta* P.Taylor | OR141409 | *R.W. Jobson* 2837 18.07.2015 (NSW) |
| 114 | *Utricularia involvens* Ridl. | OR141368 | *R.W. Jobson* 2205 18.04.2014 (NSW) |
| 115 | *Utricularia involvens* Ridl. | OR141369 | *R.W. Jobson* 2230 20.04.2014 (NSW) |
| 116 | *Utricularia bifida* L. | MK560767 | *Chaudhary* DUH1465 23.02.2019 (DUH) |
| 117 | *Utricularia bifida* L. | OR141343 | *R.W. Jobson* 1762 20.04.2013 (NSW) |
| 118 | *Utricularia odorata* Pellegr. | OR141383 | *R.W. Jobson* 2212 19.04.2014 (NSW) |
| 119 | *Utricularia odorata* Pellegr. | KY243567 | *R.W. Jobson* 2705 (NSW) |
| 120 | *Utricularia odorata* Pellegr. | OR141397 | *R.W. Jobson* 2705 19.04.2015 (NSW) |
| 121 | *Utricularia foveolata* Edgew. | AF482570 | *R.W. Jobson* UQ115 12.03.1999 (BRI) |
| 122 | *Utricularia graminifolia* Vahl | AF482573 | *R.W.* Jobson UQ106 26.09.1999 (BRI) |
| 123 | *Utricularia graminifolia* Vahl | MK560774 | *Chaudhary* DUH14457 23.02.2019 (DUH) |
| 124 | *Utricularia babui* S.R.Yadav, Sardesai & S.P.Gaikwad | MK560772 | *Chaudhary* DUH14459 23.02.2019 (DUH) |
| 125 | *Utricularia uliginosa* Vahl | OR141412 | *R.W. Jobson* 3219 22.04.2016 (NSW) |
| 126 | *Utricularia uliginosa* Vahl | OR141413 | *R.W. Jobson* 3262 2.10.2016 (NSW) |
| 127 | *Utricularia uliginosa* Vahl | OR141393 | *R.W. Jobson* 2673 16.04.2015 (NSW) |
| 128 | *Utricularia uliginosa* Vahl | OR141388 | *R.W. Jobson* 2279 26.04.2014 (NSW) |
| 129 | *Utricularia uliginosa* Vahl | OR141411 | *R.W. Jobson* 2856 18.07.2015 (NSW) |
| 130 | *Utricularia uliginosa* Vahl | OR141336 | *Handsen* s105 04.06.2017 (BRI) |
| 131 | *Utricularia uliginosa* Vahl | OR141410 | *R.W. Jobson* 1779 20.04.2013 (NSW) |

## Appendix VIII

### LIST OF PUBLICATIONS

1. **Krishnapriya M.P.**, Silva S.R., Miranda V.F.O. & S. Nampy 2024. Revisiting *Utricularia* section *Nigrescentes* (Lentibulariaceae) in India and re-instating *Utricularia roseopurpurea*, integrating morphological and molecular data. *Rheedea* 34(1): 20–38. https://dx.doi.org/10.22244/rheedea.2024.34.01.02

2. **Krishnapriya M.P.**, Akhil M.K., Harishma K.H., Alan T.S., Krishnaraj T.P. & S. Nampy 2023. *Burmannia decurrens* (Burmanniaceae): a new record for India. *Rheedea* 33(2): 83-86. https://dx.doi.org/10.22244/rheedea.2023.33.02.05

3. Sreekutty T.K., Harishma K.H., **Krishnapriya M.P.** & S. Nampy 2023. *Murdannia vaginata* var. *glabrisepala* (Commelinaceae): a new record for India inferred from morphological and molecular data. *Rheedea* 33(2): 53-63. https://dx.doi.org/10.22244/rheedea.2023.33.02.02

4. Resmi S., Nampy S., Cellinese N. & **M.P. Krishnapriya** 2022. *Sonerila lundinii*, a new species of Melastomataceae from southern Western Ghats with notes on *Sonerila pedunculosa*, a less known taxon from Sri Lanka. *Rheedea* 32(4): 280–287. https://dx.doi.org/10.22244/rheedea.2022.32.04.03

### PROCEEDINGS/ BOOK CHAPTER

- **Krishnapriya M.P.**, Nampy S., Vaishnavi K.P. & M. Sreya 2024. Botanical carnivores: an overview of Indian Bladderworts. *In*: Nampy S., Pramod C., Manju C.N. & P. Sunojkumar (eds.), *Glimpses of Diversity: Fungi and Plants*. Proceedings of the International Seminar on Plant Systematics: Present Status and Future Prospects. IAAT, University of Calicut. pp. 246–259.

### PAPERS PRESENTED

- **Krishnapriya M.P.** & Santhosh Nampy. **Revisiting *Utricularia* section *Oligocista* (*Utricularia* L., Lentibulariaceae) based on morphological and molecular evidences**. XXXIII Annual conference of the Indian Association for Angiosperm Taxonomy and International seminar on Advances in Plant Systematics, Biogeography and Biodiversity Conservation. Organized by Department of Botany, University of Calcutta, West Bengal during 25–27 November 2023.

- **Krishnapriya M.P.** & Santhosh Nampy. ***Utricularia* section *Phyllaria* (Kurz) Kamienski (Lentibulariaceae) in India with notes on little know tuberous *U. brachiata* Oliv**. XXXII Annual conference of the Indian Association for

Angiosperm Taxonomy and National Symposium on "The contribution of Angiosperm Diversity to Human Wellbeing and the Risks Associated with its Decline. Organized by Karnataka University's Karnataka Science College Dharwad during 11–13 November 2022.

- **Krishnapriya M.P.** & Santhosh Nampy. **"Diversity, patterns of distribution and endemism of *Utricularia* section *Oligocista* (Utricularia L.; Lentibulariaceae) in the Western Ghats, India"**. 2nd International E-Conference on Plant Sciences and Biology. Organized by United Research Forum, UK on April 18, 2022.
- **Krishnapriya M.**P. & Santhosh Nampy. **Indian Bladderworts: An overview**. XLII All India Botanical Conference of the Indian Botanical Society & National Symposium on "Innovations and Inventions in Plant Science Research". Organized by Department of Botany, University of Calicut during November 06–08, 2019.
- **Krishnapriya M.P.** & Santhosh Nampy**. "Prey composition of *Utricularia exoleta* R.Br. (Lentibulariaceae): An aquatic carnivorous plant"**. National seminar on Plant Sciences: Current Challenges & Perspectives. Organized by Department of Botany, University of Calicut during February 28– March 1 & 2, 2019.

**AWARD RECEIVED**

- **Fr. Antony Mukkath – Prof. K.S. Manilal Award** for the best paper presentation in Modern Techniques in Plant Taxonomy during the 33rd Annual conference of Indian Association for Angiosperm Taxonomy (IAAT) held at the Department of Botany, University of Calcutta, West Bengal during 25–27 November 2023.