Taxonomy and molecular phylogeny of the genus *Aeschynanthus* Jack (Gesneriaceae) in India

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Submitted by

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CERTIFICATE

This is to certify that the thesis entitled **Taxonomy and molecular phylogeny of the genus *Aeschynanthus* Jack (Gesneriaceae) in India**, submitted to the University of Calicut by **Mr. Akhil M.K.**, 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 him under my supervision and guidance. No part of the present work has formed the basis for the award of any other degree or diploma previously.

Calicut University
07.12.2024

Dr. Santhosh Nampy
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DECLARATION

I hereby declare that the work presented in the thesis entitled **Taxonomy and molecular phylogeny of the genus *Aeschynanthus* Jack (Gesneriaceae) in India** is based on the original work done by me under the guidance of **Prof. 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 **Akhil M.K.**
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ABSTRACT

The present study in India, unveils the taxonomy and molecular phylogeny of *Aeschynanthus* Jack – the largest epiphytic genus of the family Gesneriaceae. The genus is commonly called 'lipstick plants' or 'blush-worts' and is principally distributed in Southeast Asia. Globally about 182 species were recognised and show a strong biogeographical distribution pattern; from the Western Ghats and Sri Lanka to the eastern Himalayas through Southeast Asia to the Solomon Islands by crossing the Wallace's Line. The study recognized20 *Aeschynanthus* species in India, and its species diversity seems to be maximum in Northeast India (18 species; 90%) and the remaining two species were found in South India and Andaman and Nicobar Islands respectively. The genus is characterized mainly by the epiphytic habitat, fleshy, opposite leaves, roots originating from nodes, brightly coloured (occasionally green, white, or yellow), tubular corolla, pair wise coherent stamens, long, narrow capsules and hair-like appendaged tiny seedsprone to wind dispersal.

An integrative approach including morphology, seed micromorphology, palynology, and molecular studies was made here to sort out existing taxonomic problems within the genus, especially for the Indian taxa. A taxonomic key was prepared, and morphological descriptions included detailed colour photo plates for the easy identification of species and to understand variations within the species. During the study, two new species were described from the study area, and three names were lectotypified. The micromorphological studies of seeds along with molecular data reveal that the existing sectional classification was primarily laid on the seed characters which have low molecular support. The palynological studies revealed that the genus was stenopalynous and had no significance in species delineation. Next to pollen, an additional microstructure produced by stamens called orbicules is reported here for the first time in the genus.

For the molecular studies, Sanger sequencing and a newly developed Amplicon sequencing pipeline was used. The analysis includes two nuclear (ITS and ETS) and eight chloroplast markers (*trn*LF, *ndh*F, *mat*K, *rps*16, *psb*A-*trn*H, *rpl*32-*trn*L, *rpl*20-*rps*12, and *ndh*F-*rpl*32)and generated 382 sequences. The Parsimony and Bayesian analysis supported the monophyly of the genus and was resolved into two major clades, of which all Indian species nested in Clade I. The analysis supports the current synonymisation of the Sri Lankan taxa *A. ceylanicus* under the South Indian taxa *A. perrottetii* as well as earlier synonymisation of *A. sikkimensis* under *A. parviflorus*, *A. austroyunnanensis* under *A. micranthus*, and *A.*

*deleiensis*and *A. mimetes* under *A. parasiticus* as well as the status of newly described species *A. reiekensis*.

Several ecological adaptations were undertaken by *Aeschynanthus* species in nature for the establishment, survival, and reproduction, which include tolerance to desiccation, prevention of herbivory, bird pollination syndromes, wind dispersal of seeds, etc., of which the Batesian mimicry and vivipary were reporting for the first time in the genus.

The conservation status of all the species was assessed according to the IUCN criteria (Version 16, 2024). Among the 20 species, two species each come under Critically Endangered (CR) and Endangered (EN) categories, thirteen under Least Concern (LC), and three under the Data Deficient (DD) category. Due to its floral and foliage beauty, *Aeschynanthus* has popularised among gardeners and plant enthusiasts by the recent arrival of many exotic species and hybrids to the country. The Indian native *Aeschynanthus* species prefers particular climatic conditions and was difficult to establish in a different geographical area. Attempts have been made to conserve the wild germplasm at Calicut University Botanical Garden (CUBG) and is resulted in the establishment of the Western Ghat-Sri Lankan endemic species *A. perrottetii*.

Key words: Adaptations, Conservation, Micromorphology, Palynology, Phylogeny, Taxonomy

പ്രബന്ധ സംഗ്രഹം

ജസ്നേറിയസിയെ സസ്യകുടുംബത്തിലുൾപ്പെടുന്ന ഏറ്റവും വലിയ എപ്പിഫൈറ്റ് വിഭാഗമായ എസ്കിനാന്തസ് ജനുസ്സിന്റെ ഇന്ത്യയിലെ സമഗ്രമായ വർഗ്ഗീകരണ പഠനമാണ് നടത്തിയിട്ടുള്ളത്. സാധാരണയായി 'ലിപ്സ്റ്റിക് പ്ലാന്റുകൾ' അല്ലെങ്കിൽ 'ബ്ലഷ്-വേർട്ട്സ്' എന്നറിയപ്പെടുന്ന ഈ ജനുസ്സിന്റെ വിതരണ മേഖല പ്രധാനമായും ഏഷ്യയുടെ തെക്കുകിഴക്കൻ ഭാഗങ്ങളിലാണ്. ലോകത്താകമാനമായി 182 ഇനങ്ങളുള്ള ഈ വിഭാഗത്തിൽ 20 ഇനങ്ങൾ ഇന്ത്യയിൽ കാണപ്പെടുന്നതായി ഈ പഠനത്തിലൂടെ വ്യക്തമായിട്ടുണ്ട്. അവയിൽ ബഹുഭൂരിഭാഗവും വിന്യസിക്കപ്പെട്ടിട്ടുള്ളത് ഇന്ത്യയുടെ വടക്കുകിഴക്കൻ പ്രദേശങ്ങളിലും ബാക്കിയുള്ളവ ദക്ഷിണേന്ത്യയിലും ആൻഡമാൻ നിക്കോബർ ദ്വീപുകളിലുമാണ്. ഇവയുടെ ഇലകൾ മാംസളവും വിപരീത രീതിയിൽ ക്രമീകരിച്ചിട്ടുള്ളവയുമാണ്. കാണ്ഡങ്ങളിലെ നോഡുകളിൽ നിന്ന് ഉത്ഭവിക്കുന്ന വേരുകൾ, കാറ്റു മാർഗം വിത്തുവിതരണം പ്രാപ്യമാക്കാൻ കെൽപ്പുള്ള നീണ്ട രോമങ്ങളോടുകൂടിയ ചെറിയ വിത്തുകൾ, പക്ഷികൾ വഴി പരാഗണം നടത്തുവാൻ ഉതകുന്ന കടും നിറങ്ങളിലുള്ള പൂക്കൾ, രണ്ട് ജോഡിയായി കാണുന്ന കേസരങ്ങൾ എന്നിവയാണ് ഈ ജനുസ്സിൻ്റെ പ്രധാന സവിശേഷതകൾ.

ചെടികളുടെ ബാഹ്യഘടന, വിത്തുകളുടെ സൂക്ഷ്മഘടന, പരാഗ രേണുക്കളുടെ ശാസ്ത്രീയ പഠനം, ജനിതക തന്മാത്രാ പഠനം എന്നിവയുടെ ആകെത്തുകയാണ് ഈ പ്രബന്ധം. പഠനത്തിന്റെ നാൾ വഴികളിൽ ഈ ഇനത്തിൽ പെട്ട രണ്ട് ചെടികളെ പുതിയതായി കണ്ടെത്തിയിട്ടുണ്ട്. വിത്തുകളുടെ സൂക്ഷ്മഘടനാ പഠനവും തന്മാത്രാ പഠനവും സംയോജിപ്പിക്കുമ്പോൾ ഈ ജനുസ്സിലെ നിലവിലുള്ള വർഗീകരണം ഫലപ്രദമല്ലെന്ന് വിലയിരുത്തി. കൂടാതെ പരാഗരേണുക്കൾക്ക് ഇനങ്ങളെ തരം തിരിക്കാനുതകുംവണ്ണം മാറ്റങ്ങളില്ല എന്നും കണ്ടെത്തി. ഈ പഠനത്തിലൂടെ ആദ്യമായി പൂമ്പൊടിയെ കൂടാതെ സൂക്ഷമായ മറ്റൊരുതരം രേണുക്കൾ (ഓർബിക്യൂൾസ്) കൂടി എസ്കിനന്തസിന്റെ കേസരത്തിനകത്തുണ്ടെന്ന് കണ്ടെത്തിയിട്ടുണ്ട്.

ജനിതക തന്മാത്രാ പഠന പ്രകാരം ലോകത്തിലെ എസ്കിനാന്തസുകൾ രണ്ടു വിഭാഗങ്ങളായി തിരിയുന്നുവെന്നും അവയിൽ ഒന്നാമത്തെ വിഭാഗത്തിൽ ഇന്ത്യയിലെ ഇനങ്ങൾ ഉൾപ്പെടുന്നുവെന്നും വ്യക്തമായിട്ടുണ്ട്. കൂടാതെ, ശ്രീലങ്കയിൽ കാണപ്പെടുന്ന ഇനം ദക്ഷിണേന്ത്യയിലുള്ളതിൽ നിന്നും തികച്ചും വ്യത്യസ്തമല്ല എന്നും ഇതേപോലെ വ്യത്യസ്ത ഇനങ്ങളായി തിരിച്ച പല ഇനങ്ങളും യഥാർത്ഥത്തിൽ ഒരേ ഇനത്തിൽ പെടുന്നവയാണെന്നും പുതിയതായി മിസോറാമിൽ നിന്നും കണ്ടെത്തിയ ഇനം മറ്റുള്ളവയിൽ നിന്നും വ്യത്യസ്തമാണെന്നും കണ്ടെത്തിയിട്ടുണ്ട്. ഈ പഠനങ്ങൾ പത്തോളം തന്മാത്രാ സൂചകങ്ങൾ (ITS, ETS, *trn*LF, *ndh*F, *mat*K, *rps*16, *psb*A-*trn*H, *rpl*32-*trn*L, *rpl*20-*rps*12, and *ndh*F-*rpl*32) ഉപയോഗിച്ചും പുതിയതരം ആംപ്ലിക്കോൺ സീക്വൻസിങ് രീതിയുപയോഗിച്ചുമാണ് നടത്തപ്പെട്ടിട്ടുള്ളത്.

എസ്കിനാന്തസ് അവയുടെ ആവാസവ്യവസ്ഥയിൽ നിലനിന്നു പോകുവാൻ ഒട്ടനവധി മാർഗങ്ങൾ സ്വീകരിച്ചിട്ടുണ്ട്. അതിൽ മറ്റു ജന്തുജാലങ്ങൾ ഭക്ഷണമാക്കാതിരിക്കുവാൻ വേണ്ടി വിഷാംശമുള്ള ഒരുതരം ചെടിയുടെ രൂപത്തെ അനുകരിക്കുന്നുണ്ടെന്നതും (ബാറ്റേസിയൻ മിമിക്രി) വംശവർദ്ധനവ് ഉറപ്പിക്കുവാനായി ചെടികളിൽ വെച്ചുതന്നെ വിത്ത് മുളച്ച് തൈകളാകുന്ന (വിവിപാരി) മാർഗം സ്വീകരിക്കപ്പെടുന്നുണ്ടെന്നതും പുതിയ കണ്ടെത്തലുകളാണ്.

ഐ.യു.സി.എൻ മാനദണ്ഡങ്ങൾ (IUCN, 2024) അനുസരിച്ച്, എസ്കിനാന്തസിലെ എല്ലാ ഇനങ്ങളുടെയും സംരക്ഷണ പ്രാധാന്യം വിലയിരുത്തിയിട്ടുണ്ട്. അവയിൽ നാലിനങ്ങൾ അതീവ സംരക്ഷണ പ്രാധാന്യം അർഹിക്കുന്നവയാണ് (2 CR & 2 EN).

പൂക്കളുടെ ഭംഗികൊണ്ട് മാത്രമല്ല അവയുടെ ഇലകളുടെ ഭംഗികൊണ്ടും അടുത്തിടെയായി മറ്റു രാജ്യങ്ങളിൽ നിന്നും പല ഇനം എസ്കിനാന്തസ് ചെടികൾ ഇന്ത്യയിലെ പൂന്തോട്ടങ്ങൾ മനോഹരമാക്കി തുടങ്ങിയിട്ടുണ്ട്. പക്ഷെ നമ്മുടെ തനത് ഇനങ്ങൾ അവയുടെ ആവാസ വ്യവസ്ഥകളിൽ മാത്രം സ്വാഭാവിക വളർച്ച കാണിക്കുന്നവയാണ്. ജൈവസംരക്ഷണ പ്രാധാന്യം മുൻ നിർത്തി പല ഇനങ്ങളെയും സർവകലാശാലയുടെ സസ്യോദ്യാനത്തിൽ (CUBG) വളർത്താനുള്ള ശ്രമങ്ങൾ നടത്തിയിട്ടുണ്ട്. അതിൽ പശ്ചിമഘട്ടത്തിൽ വളരുന്ന ഇനം നല്ല വളർച്ച കാണിക്കുന്നതായി കാണുന്നു.

സൂചക പദങ്ങൾ: വർഗ്ഗീകരണം, ബാഹ്യഘടന, സൂക്ഷ്മഘടന, ജനിതക തന്മാത്ര, സംരക്ഷണം.

CONTENTS

PLAN OF THE THESIS

The thesis entitled ‘Taxonomy and molecular phylogeny of the genus *Aeschynanthus* Jack in India’ is presented in 14 chapters:

The thesis begins with an introduction, highlighting the general features of the genus *Aeschynanthus*, significance of the study, and the area of study emphasizing the biogeographic zones in India. This is followed by the major objectives of the research.

Chapter 2 provides an extensive review of existing literature on the genus, detailing key investigations on taxonomy, cytology, palynology, seed micromorphology, embryology, ethnobotany, and molecular studies.

Materials and methods used for the taxonomic study are presented in chapter 3. It includes details of field explorations, specimen collection, preservation, herbarium preparation and the identification & description protocol.

The outcomes of major objectives are presented in four separate chapters.

Chapter 4 presents the general morphology of the genus *Aeschynathus*, providing a foundation for understanding the species-level distinctions. This is followed by a comprehensive systematic treatment in Chapter 5. This chapter contains detailed information about each species found in India. It begins with a taxonomic treatment of the genus, followed by data on habitat, distribution, etymology, and a key for identification of the species. This is followed by a complete account of species treated in alphabetic order, providing a complete description, flowering and fruiting, nomenclatural notes, note on their habitat, ecology and distribution. This part is accompanied with the type image, colour photoplates and distribution map. The morphological discussion is presented in chapter 6, supplemented with comparative photoplates.

Chapter 7 explores the seed micromorphology, beginning with an introduction, followed by a detailed methodology, results, and discussions. The chapter includes SEM images and comparison with other species.

The infra-generic classification is detailed in chapter 8. The comprehensive examination of the pollen morphology is covered in Chapter 9. This chapter begins with an introduction, followed by the methodology, results, pertinent photographs, and a comprehensive discussion.

Chapter 10 is dealing with the phylogenetic analysis of *Aeschynanthus*. It starts with an introduction, followed by detailed methodology, result and discussion. The major results of the study are discussed in detail with the phylogenetic trees obtained from the analysis.

Based on field observations, the various ecological adaptions exhibited by the genus are discussed in chapter 11. Chapter 12 highlight the horticultural significance of *Aeschynanthus*, focussing on its ornamental potential and the efforts towards germplasm conservation at Calicut University Botanical Garden (CUBG).

This concluding chapter 13 provides a brief summary of the major findings from the study, drawing together the results from the taxonomy, molecular phylogeny, seed micro morphology, and ecological adaptations. Future directions for research, including recommendations for further investigations are presented in chapter 14.

The supporting information, such as voucher details used for molecular studies, composition of chemicals used in the molecular characterization, a list of publications and presentations, and details of fellowships and awards received during the research, are given at the end as appendices.

CHAPTER- 1

INTRODUCTION

INTRODUCTION

Plants are superb opportunists,

making the most of different combinations of water, air, soil, and climate.

Their grip on the planet, their capacities for colonization, and their integration

with the environment are due to an astounding diversification and variety.

-Anthony Huxley, Plant and Planet, 1975

The pulse of life is as old as the history of the Earth itself. Over the ages, living organisms have emerged and evolved in response to the ongoing changes in nature. Green plants, including the unicellular algal forms to the highly diversified angiosperms, play a crucial role in maintaining the Earth's biological richness. Plants may lack bones, shells, muscles, blood, or nerves, but their lifestyles bear a remarkable resemblance to ours. This exploration unveils their entire life cycle from germination to death, highlighting their lifestyles, chemistry, structure, colonization abilities, opportunistic behavior, and fascinating reproductive processes - all grounded in water, air, and soil, and driven by their extraordinary ability to transform light into energy (Huxley, 1975). The flowering plants originated in the early Cretaceous Period (130 million years ago) and had a breakthrough during the fourth major mass extinction event that occurred recently (66 million years ago) on the Earth. In effect, this extinction resulted in the massive loss of species that existed at that time, meanwhile, angiosperms began to assert their dominance over other plant groups by establishing new habitat preferences (Raven, 2021). In the end, whether one is a botanist, gardener, or simply a human being, our dependence on plants is undeniable, while they thrive independently of us. This dominant life form is both different from and similar to us in fascinating ways, yet our understanding of it remains surprisingly limited (Huxley, 1975). From the origin of the human race itself, they have been classifying plants and animals based on their usefulness, characteristics, their experiences and observations in nature. Theophrastus, the father of Botany, classified plants based on their habit and was the pioneer approach for plant classification or taxonomy. Later many approaches were taken into consideration for the classification and are laid upon the similarity or dissimilarity indices. Apart from the morphological appearance, the modern era of science mostly concentrates on genomic diversity, because it exhibits great variation in size, composition, and complexity among different organisms (Soltis & Soltis, 2021). But the ongoing discovery of new species indicates that the taxonomic catalogue is still far from being complete. Unfortunately, our knowledge about most of the identified species remains limited, often encompassing only a few of their traits and some information about their habitats. According to the Angiosperm Phylogeny Group IV classification (APG IV), there are 64 orders and 416 families of angiosperms. Around two-thirds of plant species are found in tropical regions, while the rest are in temperate areas.

Christopher Columbus, credited as the discoverer of the New World made the first unintentional statement about the canopy-adapted flora of tropical forests "The trees are different here than at home: many have the most diverse twigs and leaves and yet everything originates from a root. It is a true miracle" (Gessner, 1956).

The vascular epiphytes constitute perhaps the most characteristic synusia of tropical moist forests and have attracted the attention of botanists and ecologists since the first scientific expeditions to the tropics (Benzing, 2004). According to Gentry and Dodson (1987), the epiphytic habit seems a very widespread and successful lifestyle, represented by 29,000 vascular plants (*c.* 10%) in 876 genera. The majority of vascular epiphytes are ferns and monocots (orchids, bromeliads, aroids, etc.) and relatively few are dicots (ericads, gesneriads, peperomias, etc.) (Krömer & Gradstein, 2016). The epiphytic habit evolved independently in different vascular plant lineages (Benzing, 1987; Gentry & Dodson, 1987; Kremer & van Andel, 1995). In terms of the absolute number of epiphytic species occurring under a family, Gesneriaceae ranks among the top 10 with about 20% epiphytism (Gentry & Dodson, 1987) and are distributed in circumglobal tropical regions (Neotropics, Paleotropics, and Australasia) and belong to the two mains subfamilies, viz. Gesnerioideae Burnett and Cyrtandroideae Burnett (= Didymocarpoideae Arn.) (Wiehler, 1983).

The Gesneriaceae family, of the order Lamiales, includes around 3,750 species, under 150 families. Approximately one-third of these species are found in the Neotropics, while two-thirds are in the Paleotropics, with some species also present in Europe and the Southern Hemisphere (Weber *et al.*, 2013; Ranasinghe *et al.*, 2024). The family was initially recognized by French botanists L.C.M. Richard and A.L. de Jussieu (Jussieu, 1804) and was formally named by A.P. de Candolle (1816). The name was derived from the genus *Gesneria* L., and was provided in honour of Swiss botanist and naturalist Conrad Gesner (1516–1565). The family initially included only neotropical plants. Later George Don (1838) and Robert Brown (1839) merged the then-established Old World families Didymocarpeae (=Didymocarpaceae) (Don, 1822) and Cyrtandreae

(=Cyrtandraceae) (Jack, 1823) under this. The initial records of the family in India were documented by C.B. Clarke in 1884 in the "*Flora of British India*," listing 20 genera. Since then, the classification of several genera has changed, with some being merged, and others segregated or resurrected (Möller *et al*., 2017). Gesneriaceae contribute to the richness of Indian flora with 24 genera and 157 species (Akhil *et al.*, 2024; GRC, 2024). The members of the family exhibit a wide range of habit diversity including perennial herbs, shrubs, small trees, and climbers. India has two epiphytic genera, viz. *Aeschynanthus* Jack and *Lysionotus* D.Don under the family.

Aeschynanthus (Gesneriaceae; subfamily Didymocarpoideae; tribe Trichosporeae, subtribe Didymocarpinae; Weber *et al.*, 2013), the largest epiphytic genus in the family Gesneriaceae, is an important component of the Southeast Asian tropical forest. The genus is popularly known as 'lipstick plants' due to the superficial similarity of the flower bud to a tube of lipstick or as called 'blush-worts' referring to the shy nature of its corolla tube. The name *Aeschynanthus* is derived either from the Greek αισχυνη, aischyne = shame, αισχυνω, aischynó = to be ashamed and ανθός, anthose = flower, alluding to the usually red corolla colour, or from αίσχύνειν, aischýnein = deform, ανθός, anthose = flower, referring to the unusual form of the corolla.

William Roxburgh (1820) distinguished an intriguing native plant species, analogous to the parasitic *Loranthus* Jacq. species from the Garo Hills of India, and subsequent observations at the Calcutta Botanical Garden confirmed that the plant has the nature of epiphyte rather than a parasite and described it as *Incarvillea parasitica* Roxb. in 1820 along with the detailed exquisiteness of the blossoms and a beautiful illustration.

Based on the characteristic feature of hair-like appendages on the seeds, David Don described the genus *Trichosporum* D.Don in the family Gesneriaceae in 1822 with two species namely, *Trichosporum grandiflorum* D.Don and *T. parviflorum* D.Don in reference to the collections of Wallich from Nepal and treated the name *Incarvillea parasitica* Roxb. under *T. grandiflorum* D.Don. A year after, the Scottish botanist and medical practitioner, William Jack (1795–1822), established the genus *Aeschynanthus* with two species, viz. *Aeschynanthus volubilis* Jack and *A. radicans* Jack, from the Indonesian Island, Sumatra in 1823. The unexpected farewell of Jack at the age of 27 to the depths of the Sumatran Sea, resulted in the posthumous publication of the genus with the significant effort of a British Botanist, Aylmer Bourke Lambert (Jack, 1823). Even though later many species were described in both genera, more taxa were often recorded in *Aeschynanthus* than in *Trichosporum*. Centred on the interest of stability, Sprague (1929) proposed the conservation of the name *Aeschynanthus* against *Trichosporum* and was accepted in Cambridge code (1935).

The genus is currently represented by 182 species globally (GRC, 2024) and is spread over a phytogeographically wide area from the Western Ghats to the eastern Himalayas through Southeast Asia to the Solomon Islands by crossing Wallace's Line and showing strong biogeographical patterns (Denduangboripant & Cronk, 2000). Earlier studies by Bhattacharyya and Goel (2015), and Sinha and Datta (2016) reported 28 species from India, particularly distributed in the Eastern Himalayan regions, Andaman and Nicobar Islands, and the Western Ghats.

The genus is characterized mainly by the epiphytic habit, they root superficially in moss on branches or in debris accumulated in crotches, fern roots, etc. Some species may germinate on the ground and then the slender sapling climb on the host plant, eventually becoming established as epiphytes. When conditions are suitable, species may grow on rocks or cliffs as lithophytes (Burtt & Woods, 1975). The branches may be pendulous, creeping, arching, or erect, and adventitious roots may form at the nodes. The leaves are typically opposite, and rarely whorled, the presence of thin-walled, large water-storing cells of the hypodermis creates a thick and leathery appearance and provides a measure of protection from desiccation to which epiphytic plants can be prone (Weber, 2004). Inflorescences are borne in solitary or few-flowered clusters in the axils along the vine, or as pseudo terminal clusters. In most species, the peduncle is very short or absent, and likewise, the bracteoles are mostly short, stiff, and deciduous (Middleton, 2007). However, the calyx characters may be extremely variable in some species like *A. parviflorus* (D.Don) Spreng. and *A. parasiticus* (D.Don) Wall. It may serve as one of the valuable diagnostic tools for the delineation of closely related taxa by the extent of the fusion of the calyx lobes. The calyx matures well before the corolla and may fill with water in those species having a tubular calyx and acting as a water-calyx (Burtt & Woods, 1975). This allows the corolla to develop in a miniature bath and perhaps serves as protection from herbivory (Carlson & Harms, 2007).

The corolla characters seem to be most adapted for bird pollination. The brightly coloured, often red, arcuate corolla tube, strong protandry, downwardly shedding pollens from the exserted stamens, and the production of copious nectar with low-sucrose content support ornithophily (Porsch, 1924; Faegri & Pijl, 1966; Burtt & Woods, 1975). The gynophore often associated with the slender streamlined ovary helps the protection of ovules from damages caused by the bird's beak (Grant, 1950). Similar to the calyx characters, the corolla also serves a significant role in species diagnosis, however, it will be extremely complicated when a species itself shows a greater degree of variations in the colour pattern and hairiness. The stamens are strongly protandrous and are generally coherent in pairs or rarely all anthers fused at their apices. An annular or weakly crenate disc is present in the genus and the hairiness of the ovary and style is useful for species recognition. The ovules are anatropous, arranged in parietal placentation. The seeds develop in a long, narrow capsule with at least two appendages; one or more at the hilar end, to which the seeds are attached to the capsule, and one at the apical end. For the sectional delimitation in *Aeschynanthus*, seeds serve as the primary source of characters. The appendages may help wind dispersal and to anchor the seeds to a suitable substrate when in contact with water (Burtt & Woods, 1975; Middleton, 2007).

Study area

The distinctive Indian biota is a mix of Gondwanan, Southeast Asian, African, and Palearctic components that reflect its relationships with those of various landmasses over the course of geological history. Gondwanaland broke up 180–160 million years ago (Jokat *et al*., 2003), and the Indian plate drifted northward across the Indian Ocean crossing the equator and became a part of Asia about 55 million years ago (Mani, 1974). Now India is the seventh-largest country in the world with an area of 3,287,263 sq. km (2.42% of the total world land area) lies between latitudes 8°4′ and 37°6′ North and between longitudes 68°7′ and 97°25′ East; located latitudinally in the Northern hemisphere (North of the equator) and longitudinally in the Eastern hemisphere (east of the Prime Meridian or the Greenwich Line). The Tropic of Cancer (23°30′ North) passes through the centre and divides the country into South India and North India. According to the geographical zone, South India belongs to the tropics and North India belongs to the subtropic region. India shares its 15,200 km long land frontier with Pakistan in the west, Afghanistan in the north-west, China, Nepal, and Bhutan in the north, and Bangladesh and Myanmar in the east. The ~6,100 km long coastline of India is bordered on three sides by the Indian Ocean and its two arms namely the Arabian Sea in the west and the Bay of Bengal in the east. India along with the countries of Myanmar, Bangladesh, Pakistan, Nepal, Bhutan and Sri Lanka is called the Indian subcontinent (also referred to as South Asia) and is biogeographically rich in diversity, separated from the rest of Asia by the Great Wall of the Himalayas, which acts as a physical barrier on the northern border and blocks the cold winter storms from East Asia and also obstructs the south-west monsoon winds to shed their moisture content mostly on the Indian subcontinent itself (Khullar, 1999) and altogether represents a tropical climate or the monsoon climate. The Western Ghats and the Eastern Ghats, which edge the Indian peninsula along the West Coast and East Coast provide rain on their windward slopes. The Southwest Monsoon or the Summer monsoon, blows from the sea to land after crossing the Indian Ocean, and the Northeast Monsoon, or the Winter monsoon blows from land to sea and are the two seasonal winds affecting the Indian climate (Krishnamurti, 2024).

As per the assessment of Conservation International, India accounts for 7–8% of the world's species with about 45,500 plant species and twice as many animal species making it one of the world’s 17 mega-diversity countries with four biodiversity hotspots (Fig. 01), viz. the Himalayas, Indo-Burma, the Western Ghats and Sri Lanka, and the Sundaland (Myers *et al*., 2000).

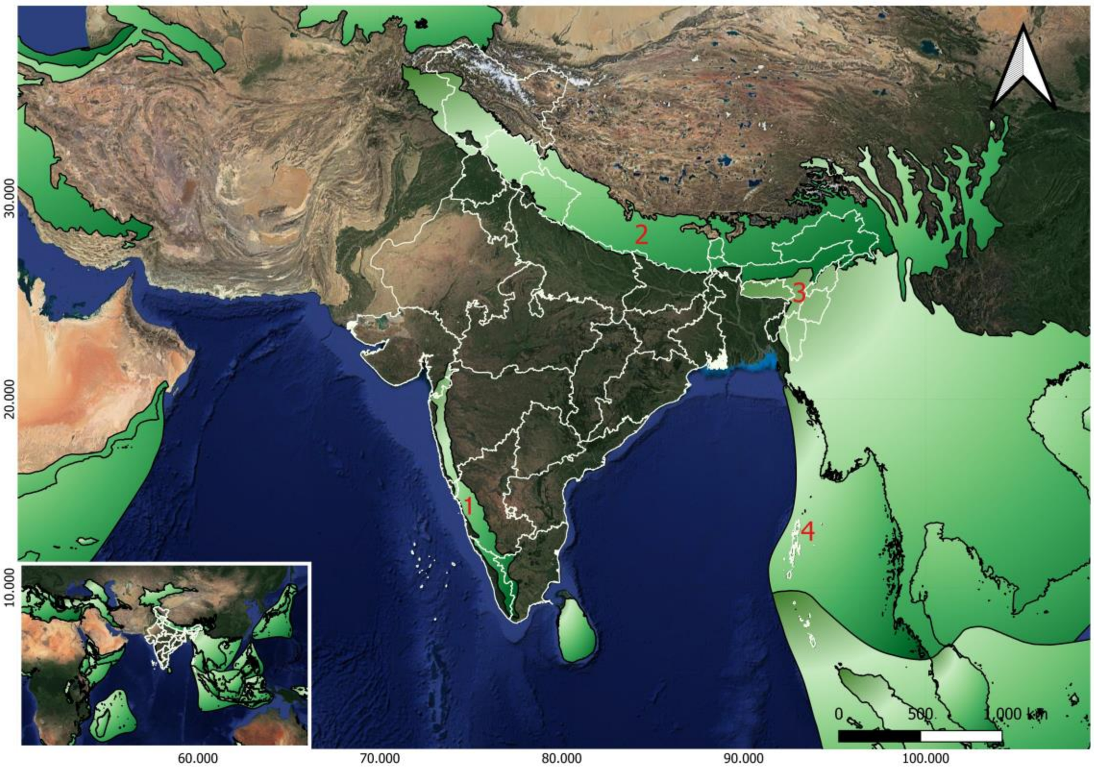


Fig. 01. Study area: Map of India showing the mega biodiversity hotspots: 1. Western Ghats and Sri Lanka; 2. Himalayas; 3. Indo-Burma; 4. Sundaland.

Rodgers *et al.* (2002) recognise ten biogeographic zones in India (Fig. 02), in which the genus *Aeschynanthus* is distributed particularly in the Northeast, the Western Ghats, and the Andaman and Nicobar Islands (Bhattacharyya & Goel, 2015; Akhil, this study). The Northeast region (Manipur, Meghalaya, Mizoram, Nagaland, and Tripura) along with the Andaman group of islands is a part of the Indo Burma biodiversity hotspot, and the state Sikkim, the northern part of Assam, and Arunachal Pradesh are part of the Himalayas. The Western Ghats stretches along the southwestern Indian states (Karnataka, Kerala, Goa, Gujarat, Maharashtra, and Tamil Nadu) and is part of the Western Ghats and Sri Lankan biodiversity hotspot and the Nicobar Island is part of the Sundaland biodiversity hotspot (Myers, 1988; Myers *et al.*, 2000).

Table 01. Biogeographic zones of India after Rodgers *et al.* (2002)

Name of the Zone	**Zone area (sq. km)**	**Percentage of India's land area**
Trans-Himalaya	184,823	5.62%
Himalaya	210,662	6.41%
Desert	215,757	6.56%
Semi-arid	545,850	16.60%
Western Ghats	132,606	4.03%
Deccan Plateau	1,380,380	41.99%
Gangetic Plain	354,782	10.79%
North East Region	171,341	5.21%
Islands	8,249	0.25%
Coastal Region	82,813	2.52%

The Northeast region

The Northeast region of India constitutes eight states, Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, and Tripura. The Brahmaputra and Barak are the two major river basins of this region and are represented by tropical, subtropical, temperate, sub-montane, montane, sub-alpine, and alpine plant components. There are more than 225 indigenous tribal groups in this area, and they all rely heavily on the resources of the forest for their subsistence (Jain, 2016). The forest resources in these states account for 23.75 percent of the total forest cover of the country (FSI, 2022).

The area is characterised by an array of climate patterns and is heavily reliant on the Southwest monsoon. It is one of the wettest regions of the country receiving one of the highest rainfalls in the world (Dikshit & Dikshit, 2014). Mani (1974) subdivided this region into seven hill areas (Naga Hills, Patkai Hills, Khasi Hills, Jaintia Hills, Garo Hills, Lusai Hills, and Mikir Hills) and Chandra *et al.* (2021) divided it into two biotic provinces, the Brahmaputra Valley and the North-eastern Hills.

The Western Ghats

The Western Ghats stretch from the Tapti River in the North to Kanyakumari in the South, along the West coast of Peninsular India through the states of Gujarat, Maharashtra, Goa, Karnataka, Tamil Nadu, and Kerala (WorldAtlas, 2024). Despite making up less than 6% of the country's total geographical area, this region is home to more than 30% of the nation's biodiversity due to factors such as highly varying altitude, and the monsoon-dominated climate with 2,000 to 8,000 mm of annual rainfall (CEPF, 2016). Evergreen, semi-evergreen, moist deciduous, and dry deciduous forests are the four major types in this zone. In addition to the biodiversity richness, the Western Ghats are home to a wide range of social, religious, and linguistic communities. The water needs of over 365 million people residing in the seven Indian states are satisfied by rivers originating in the Western Ghats alone and by which support the well-being of one out of every twenty people on the earth (Bharti *et al.*, 2021). About 4,000 species of flowering plants occur in the region with high levels of endemism notably in the moist deciduous and evergreen forests by the prolonged isolation of the land over other similar habitats on the Indian subcontinent (Bharti *et al.*, 2021).

Andaman and Nicobar Islands

The Andaman and Nicobar Islands are one of the Union territories of India with a group of elongated north-south oriented 348 islands in the southern part of the Bay of Bengal stretching from southwestern Burma to northwestern Sumatra, traditionally treated as an insular subdivision of the Indian subregion (Champion & Seth, 1968; Mani, 1974). The physical isolation between the islands and the unique geographical setup gives rise to the evolution of rich biological diversity in the region, with high endemism (Nayar, 1996). Almost 81% of the region is covered by forests and the major forest types include tropical wet evergreen, tropical semi-evergreen, tropical moist deciduous, and littoral and swamp forests. About 2,300 vascular plant species were recorded from this region (Arisdason & Lakshminarasimhan, 2013).

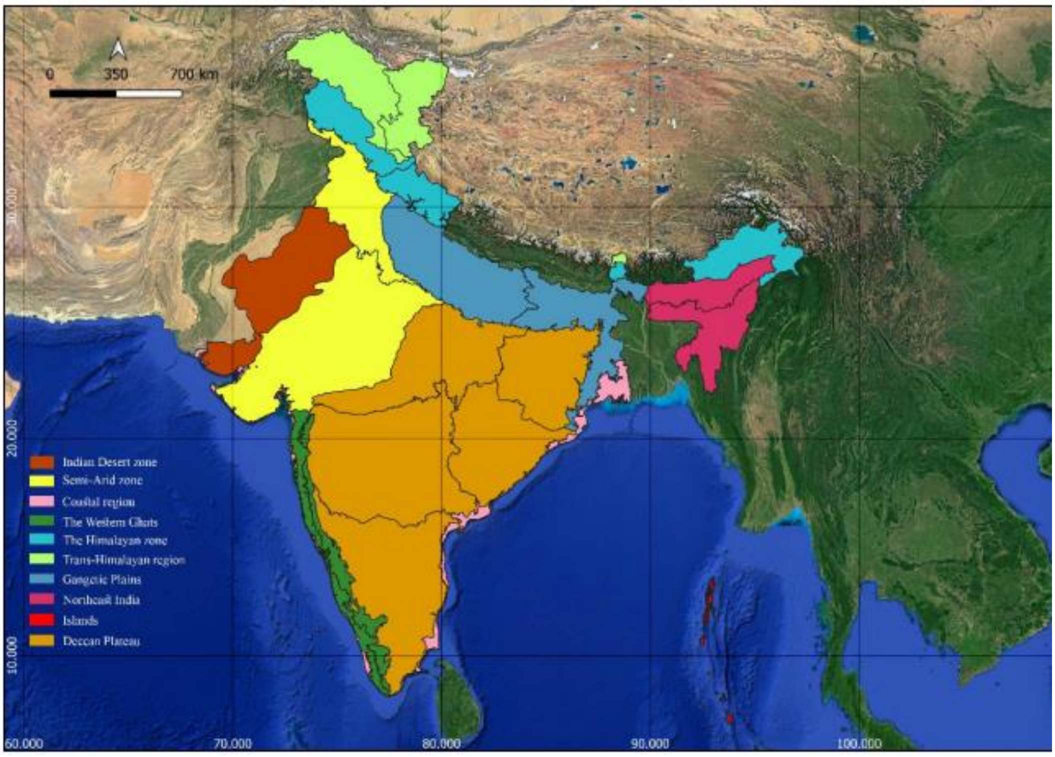


Fig. 02. Biogeographic zones of India

Study context

Gesneriaceae, with around 150 genera and 3,800 species, is fairly well known for the neotropics whereas the exploration of paleotropical gesneriads lags behind. Being a part of the Old World, for India too, modern floristic treatments for gesneriads are not available. The family is represented by 24 genera and 157 species in India of which *Aeschynanthus* is the third largest genus (Möller *et al.*, 2017; Akhil *et al.*, 2024; GRC, 2024). The existing taxonomic studies on *Aeschynanthus* from India are based on macro-morphological characters (Clarke, 1884; Bhattacharyya & Goel, 2015; Sinha & Datta, 2016) and discrepancies exist in species delineation: Clarke (1884) reported 15 species from India, while Bhattacharyya and Goel (2015) reported 26 species and one variety (many species were synonymised earlier by Middleton, 2007, 2009), but treated *A. kingii* C.B.Clarke as a doubtful taxon. Sinha and Datta (2016) listed 16 species from Northeast India, which included *A. angustioblongus* W.T.Wang and *A. philippinensis* C.B.Clarke, not included in Bhattacharyya and Goel (*l.c.*). Möller *et al.* (2017) suggested additional work in this genus in India is required. Mendum *et al*. (2001) studied the testa and seed appendage morphology of 99 taxa including 16 Indian species. The study of evolutionary relationships among species in the genus by Denduangboripant *et al.* (2001) included only three representatives from India. Even though molecular phylogenetic studies on the genus were carried out in other countries, a similar attempt has not been undertaken in India to date. It is in this context, that an integrative revision of the genus in India based on the combination of morphological, palynological, and molecular approaches has been undertaken to revisit the taxonomy of the Indian species.

Objectives

1. To explore different parts of India to study the diversity, distribution, and habitat requirements of species of the genus *Aeschynanthus* and to collect specimens.

2. To identify all species occurring in India and to update their nomenclature.

3. To prepare an updated taxonomic monograph of the genus in India.

4. To study the micromorphology of pollen grains and seeds using scanning electron microscopy.

5. To study the molecular phylogeny of *Aeschynanthus* in India.

6. To assess the status of all species occurring in India using the IUCN Red List Categories and Criteria.

CHAPTER- 2
REVIEW OF LITERATURE

REVIEW OF LITERATURE

Taxonomy

The British Botanist, Mr. David Don (1822) described the genus *Trichosporum* under the family Cyrtandraceae (=Gesneriaceae) based on an earlier publication of a species *Incarvillea parasitica* Roxb., which was erroneously placed in the family Bignoniaceae (Roxburgh, 1820). The name *I. parasitica* first appeared in the *Hortus Bengalensis* (Roxburgh, 1814) and was an invalid name because the name was mentioned along with specimen details but lack any description. Don described the genus *Trichosporum* with two species from Nepal, viz. *T. grandiflorum* and *T. parviflorum* are strictly based on the characteristics of capsules and seeds. A year later, William Jack (1823) established another genus *Aeschynanthus*, based on two Sumatran species *A. volubilis* and *A. radicans*, under the family by raising the distinctive characteristics such as awned seeds, crimson flowers, and exserted stamens. Taxonomically, both generic names represent the same taxon, but without knowing this, botanists later added several species under each name. Even though *Trichosporum* was the first published name, more species were added under *Aeschynanthus,* which led to the conservation of the later name (Sprague, 1929).

For the enumeration of Cyrtandraceae of the Islands of Java, Robert Brown (1839) treated 12 species under the name *Aeschynanthus*. Later, De Candolle (1845), accounted 18 species of *Aeschynanthus* and based on the position of inflorescence and the number of flowers, classified them into four sections. In 1874, C.B. Clarke proposed a better classification based on the number of seed hairs and subdivided the genus into three sections, and the work included eight Bengal species with good lithographic plates. A formal infrageneric classification for the genus was proposed by Bentham in 1876 using the characters of calyx and seed appendages and later, Clarke (1883) elaborated the same classification with an additional section and inclusion of 68 species. For the *Flora of British India*, Clarke (1884) enumerated 23 species and followed the then-existing sectional classification.

Marry Mendum (1945–2004), the British taxonomist and botanical illustrator provided major contributions towards the taxonomy of *Aeschynanthus* from the late 20th to the early 21st century. She published many important papers on *Aeschynanthus* and described about 15 species from various parts of Indonesia, the Philippines, and Borneo

(Mendum, 1995, 1998, 1999, 2001; Mendum & Madulid, 1995; Mendum & Woods, 1997; Mendum *et al.*, 2006). Later, Middleton undertook various regional revisions and recognized 21 species in Thailand, 18 species together in Cambodia, Laos, and Vietnam, four species in Singapore, and 14 species in Peninsular Malaysia, including seven new species (Middleton, 2007, 2009, 2016).

Apart from this, regional revisions have been published for the countries, China (Wang *et al*., 1998) and India (Bhattacharyya & Goel, 2015). Checklists have been published for Singapore (Turner, 1993; Chong *et al*., 2009), Peninsular Malaysia (Turner, 1997), Myanmar (Kress *et al*., 2003), Sulawesi (Mendum & Atkins, 2003) and Sumatra (Tjitrosoedirdjo *et al*., 2009).

The first authentic account of *Aeschynanthus* in India was published by Clarke (1884) in the *Flora of British India*. He reported 15 species from the present political boundary of the country. Gamble (1924) documented only two species in the *Flora of the Presidency of Madras*. The genus was treated in various state/ regional floras: Kanjilal *et al*., 1939; Saldanha & Nicolson, 1976; Babu, 1977; Yoganarasimhan *et al.*, 1981; Balakrishnan, 1983; Deb, 1983; Naithani, 1985; Nair & Nair, 1987; Kulkarni, 1988; Haridasan & Rao, 1987; Henry *et al.*, 1987; Keshavamurthy & Yoganarasimhan, 1990; Hajra & Rao, 1999; Chaturvedi & Moaakum, 2008; Pullaiah *et al.*, 2011; Ganeshaiah & Western Ghat Team, 2012; Sinha, 2012; Ambrish, 2013; Krishnakumar *et al.*, 2013; Pal, 2013; Nayar *et al.*, 2014; Mao & Gogoi, 2016; Dash & Singh, 2017; Ranjan & Kumar, 2020 and Gogoi *et al*., 2021) Bhattacharyya and Goel (2015) in their revision, recognized 25 taxa in India but many species were synonymised earlier by Middleton (2007, 2009). Meanwhile, Sinha and Datta (2016) gave an account of the family Gesneriaceae of Northeast India, in which they reported 16 species of *Aeschynanthus*.

Lectotypification of several Indian names under the genus was carried out by Middleton (2007, 2009, 2016), Datta *et al*. (2016) and Akhil and Nampy (2020). Taram and Borah (2021) reported *A. lineatus* Craib as a new record for India, while Chowlu *et al.* (2022) rediscovered *A. monetarius* Dunn, after a century from Northeast India.

Recently several new species were published from various parts of Vietnam, the Philippines, China, and India (Middleton & Atkins, 2018; Olimpos & Mansibang, 2021; Qin *et al.*, 2023; Lalhlupuii *et al*., 2023; Debta *et al*., 2024) and the total number of species is 182 (GRC, 2024). As per GRC (2024), the countrywise distribution of the genus is as follows: Bangladesh (1), Bhutan (9), Brunei (10), Cambodia (3), China (31), India (23), Indonesia (45), Japan (1), Laos (10), Malaysia (28), Myanmar (18), Nepal (6), Papua New Guinea (25), Philippines (32), Singapore (3), Solomon Islands (1), Sri Lanka (2), Taiwan (1), Thailand (22), Vietnam (20).

Cytology

For the representation of the chromosome count in the tribe Trichosporeae of Gesneriaceae, Rogers (1954) analysed the somatic chromosome count for two *Aeschynanthus* species. The following studies by Eberle (1956, 1957), Fussel (1958), Lee (1962), Ratter (1963), Borgmann (1964), Ratter and Prentice (1964, 1967), Ratter and Milne (1970), Milne (1975), Ratter (1975), Malla *et al.*, (1978), Hellmayr (1989) and Möller and Pullan (2015) provided chromosome numbers of 30 species and two synthetic hybrids, and recognized the basic chromosome numbers as x=14, x=15, and x=16. Ratter (1975) reported the smallest (less than 1 /µm) chromosomes in *Aeschynanthus* and *Cyrtandra*. The haploid number in the genus is less uniform (n= 14, 15, 16, 30, 32, and 48) and appears to be more susceptible to dysploidy, likewise up to three levels of ploidy are also found in some species (*A. ellipticus* K.Schum. & Lauterb., n= 16, 32 and 48).

Kiehn and Weber (1997) arranged all cytologically known species (25) based on the existing sectional classification, and argued that the basic chromosome numbers do not precisely match with the sectional classification. A similar approach was taken by Denduangboripant *et al*. (2001) by mapping the chromosome number onto a phylogeny, and found no congruence. Rashid *et al.* (2001), reported the chromosome counts for nine species and confirmed the occurrence of a third basic number, x= 14, in the genus, already hinted at by Eberle (1956). Diversification of species under the Type A seeds (particularly in sects. *Aeschynanthus* and *Microtrichium*) is mainly due to polyploidy. Whereas dysploidy played an important role in the Type B seeds (2n=28 and 2n=30 perhaps through dysploid reduction from an ancestral 2n=32). Based on seed morphology and molecular data for around 50 species, Type B species appear to be derived (Denduangboripant *et al*., 2001). Recently, karyological studies were carried out in Japan and reported a diploid chromosome number for *A. acuminatus*, 2n= 32 (Kokubugata & Yokota, 2017).

The nucleolar organizer regions (NOR) are responsible for the formation of nucleoli in dividing cells. Möeller *et al.* (2008) studied the evolution of this region in some members of Gesneriaceae by using 45S nuclear ribosomal DNA (45S-nrDNA) clusters comprising the 18S-, 5.8S-, and 26S-nrDNA with the aid of fluorescent in situ hybridization technique. Seven species of *Aeschynanthus* were analysed, which are diploid or tetraploid, possessing one or two 45S-nrDNA loci in each genome and showed that the duplications were the result of polyploidization and the intragenomic changes occurred early in the diversification of the genus.

Table 02: Cytological data of Indian *Aeschyananthus* species

Species	***x***	***n***	**2*n***	**References**
A. parasiticus (Roxb.) Wallich	16	16		Malla *et al.* (1978)
A. parasiticus (Roxb.) Wallich	15		30	Rogers, in Lee (1962)
A. parasiticus (Roxb.) Wallich	16	16		Eberle (1956)
A. parviflorus (D.Don) Spreng.	16		32	Ratter (1963)
A. parvifolius R. Br.	16		64	Ratter & Milne (1970)
A. sikkimensis Stapf.	16		32	Ratter (1963); Ratter & Milne (1970)
A. micranthus C.B.Clarke	15	15		Lee (1962)
A. bracteatus Wall. ex DC.	16		32	Rashid *et al.* (2001)
A. ceylanicus Gardner	16		32	Rashid *et al.* (2001)
A. gracilis Parish ex. C.B.Clarke	14		28	Rashid *et al.* (2001)
A. hookeri C.B.Clarke	16		32	Rashid *et al.* (2001)
A. acuminatus Wall. ex A.DC	16		32	Kokubugata & Yokota (2017)

Molecular studies

Monophyly of the family Gesneriaceae under core Lamiales has been well established through the studies of Oxelman *et al.* (1999, 2005), Backlund *et al.* (2000), Olmstead *et al.* (2001), and Bremer *et al.* (2002). The phylogenetic studies of Didymocarpoid Gesneriaceae by Möller *et al.* (2009) revealed the incongruence between traditional classification and tribal relationships with natural relatedness in the subfamily.

For amplifying the nuclear ribosomal internal transcribed spacer region (ITS), they used modified primers originally published by White *et al.* (1990) for fungi, and named them ITS5P and ITS8P, along with the original primer ITS4 for ITS amplification, and ITS3P and ITS2G (Möller & Cronk, 1997) as modified internal primers for phylogenetic studies at species-level.

Denduangboripant and Cronk (2000) made a first attempt at performing a phylogenetic analysis of *Aeschynanthus*, using ITS sequences. To get around the issue of polymorphism at the template DNA level and due to the presence of two diverging nucleolar organiser regions (NORs) (Möller *et al.*, 2008), they cloned the PCR product and sequenced two clones of each sample rather than performed direct sequencing of PCR products (Möller & Cronk, 1997a, b). To represent all the sections (except sect. *Xanthanthos*) and geographical areas, 50 species of *Aeschynanthus* were selected as ingroup, and *Lysionotus* and *Cyrtandra* were selected as outgroup. Molecular results confirmed that the 23 species form a monophyletic group with two well-supported major clades, of which clade I comprise the sections *Haplotrichium*, *Diplotrichium* and *Polytrichium,* mainly from the continental western area, and clade II comprises the sections *Aeschynanthus* and *Microtrichium* mainly from eastern Malesia. But the species, *A. buxifolius* (sect. *Microtrichium*) positioned in clade I and *A. argentii* (sect. *Haplotrichium*) positioned in clade II is a deviation from the expected results. They also proposed a preliminary model of the geographic pattern of evolution in the genus, implying a combination of ancient vicariance, recent dispersal, and coalescence events in the region.

Sanger sequencing (Sanger *et al.*, 1977) has long been used for sequencing for a wide range of applications, from species identification to phylogenetic studies (Hollingsworth *et al.*, 1999). Over recent decades, molecular marker systems were developed, and universal PCR primers designed in conserved sequence regions in all three plant genomes, mitochondria, plastid, and nuclear to obtain robust, homologous sequence information (White *et al.*, 1990; Taberlet *et al.*, 1991; Demesure *et al.*, 1995). Recent advances in sequencing technologies, so-called next-generation sequencing (NGS) methods, changed the molecular data acquisition landscape. NGS can generate vast amounts of data at a gigabyte scale (Shendure & Ji, 2008) at ever-reducing costs (Tan *et al.*, 2017).

The biogeographic history of Gesneriaceae was recently studied by Ranasinghe *et al*. (2024) by generating molecular phylogenies based on four plastid gene regions (*ndh*F, *mat*K, *rps*16 and *trn*L-F). This study includes 143 Gesneriaceae genera and 355 species (six *Aeschynanthus* species) and the results revealed that the family originated in the Early Palaeocene (67 mya) in Central America & Andean South America, then originated in the Old World (Indian plate) by a long-distance dispersal event. This lineage then dispersed to Malesia and later East Asia, and ultimately became a major centre of diversity.

Pollen and Pollination biology

For the Old World Gesneriaceae, Luegmayr (1993) examined the pollen characters of 108 species from 18 genera of subfamily Cyrtandroideae and made a comparison with subfamily Gesnerioideae in terms of pollen morphology. Her studies implied that the exine structure and sculpture provided the most distinctive characteristics and are useful at the generic, subgeneric, and/or species level. Ten exine types were distinguished in the studies, of which *Aeschynanthus* shows Type-2 exine patterns: Mesocolpia reticulate proceeding to perforate at the polar region (apocolpia perforate); lumina at the mesocolpia conspicuously irregular, supratectate sculptural elements absent; occasionally rod-like luminal processes present. Palee *et al*. (2003) updated the existing exine patterns with an addition of five types to accommodate 34 species in the 16 genera of Thailand Gesneriaceae and also included six *Aeschynanthus* species. The palynological studies of different collections of *A. hildebrandii* Hemsl. contradicted the statement of Luegmayr (1993) as the genus is stenopalynous. Zhi-jian *et al*. (1997), studied the pollen morphology of the tribe Trichosporeae from China and revealed that the size, colpus characters and ornamentation of pollen grains vary between species and genera. In *Aeschynanthus*, these are usually subangular or circular in polar view with the colpus membrane having dense granular processes protruding in the middle or not and are finely or coarsely reticulate. The lumina may be circular, subcircular, elliptical, or irregular. Generally, they are small in sections *Haplotrichium* and *Diplotrichium* in contrastn to sects. *Microtrichium*, *Xanthanthos* and *Aeschynanthus*.

The arcuate corolla tube, strong protandry, exserted anthers with downwardly shedding, often brightly coloured pollen, and a considerable quantity of nectar productions are the main character syndromes associated with bird pollination in *Aeschynanthus* (Porsch, 1924). Burtt and Woods (1975) also argued that the slender streamlined ovary with a gynophore will be for the protection of ovules from a bird's beak, as suggested by Grant (1950). In some Malayan species of *Aeschynanthus* the nectar sugar composition has been studied. The low sucrose content and the roughly 1:1 ratio of fructose to glucose proved to be in accordance with typical bird-flowers (Freeman *et al.*, 1991; Perret *et al.*, 2001). Rahman (2009) identified that the protandrous nature of flowers leads to the self-incompatibility in *A. pulcher*, and the three possible factors influence pollen limitation index were interspesific co-flowering competition, general flowering behaviour, and pollinator-nectar robber competition. Later he (Rahman, 2011) studied the floral biology of four epiphytic Malesian Gesneriads, including three *Aeschynanthus* species (*A. horsfieldii* R.Br., *A. pulcher* (Blume) G.Don, and *A. longiflorus* A.DC.) and concluded that all floral traits such as pollen and stigma development, nectar production, and fruit setting were different among the taxa and all were associated with ornithophily, and provided an evidence for the pollination shift in *A. horsfieldii* by bumble bees (*Bombus rucifes*). Gandadikusumah *et al.* (2017) analysed the germination of pollen grains in *A. tricolor* Hook. Visit of three different species of spider hunter birds to the flowers of an unidentified *Aeschynanthus* species in Peninsular Malaysia were noted by McClure (1966). Chen *et al*. (2019) studied the pollination biology of *A. acuminatus* in countries like Taiwan, where the specialized nectarivorous sunbirds are absent, and found that three species of generalist passerines such as Grey-cheeked Fulvetta (*Alcippe morrisonia*), White-eared Sibia (*Heterophasia auricularis*) and Taiwan Yuhina (*Yuhina brunneiceps*), were visiting the flowers. They also quantified the pollination effectiveness by conspecific pollen presence on stigmas and natural fruit sets. The specializations of floral traits (the reddish-green flowers and a wide-open corolla tube, with a shift in the flowering time from summer to winter and high fruiting success to match the generalist bird pollination) appear crucial in the successful colonization of islands like Taiwan. Damayanti *et al.* (2021) studied the flower development, pollen viability and storability of *A. radicans* and found that the fresh pollen germinated best at 20% sucrose concentration and pollen viability was maximum at the first day of anthesis and dichogamy is well observed in the genus by the early maturation of the androecium (protandry) and is well explained with an illustrated example of *A. hookeri* by Iyengar (1924). Self-incompatibility has never been reported yet, even though some cultivated species like *A. evardii* exhibit a developmental arrest of female organs towards the end of the flowering season (Burtt & Woods, 1975).

Seedling morphology and somatic embryogenesis

The seedling stages of *Aeschynanthus* were studied by Burtt and Woods (1958) and they recorded the formation of anisocotyly by the enlargement of one of the cotyledons, and in older seedlings there occurs a transition of hairy to glabrous leaves. Cui *et al.* (2009) regenerated plants of *A. radicans* 'Mona Lisa' through direct somatic embryogenesis from the cut edges of leaves and stems.

Ethnobotany and phytochemistry

The knowledge about the traditional use of plants for medicinal purposes is well documented. The Gesneriads have a long history of ethnobotany, mainly known from Central and South America (Kvist, 1984; Kvist & Holm-Nielsen, 1987; Weihler, 1995). *Aeschynanthus* has a paleotropic distribution, and is ethnobotanically used mainly by the tribal people in India, Malaysia, Nepal, and Sumatra. In Peninsular Malaysia, various species of *Aeschynanthus* (*A. lamponga* Miq., *A. longicaulis* R.Br., *A. radicans* Jack) are used as a vermifuge in children, and also to alleviate headaches (Lemmens & Bunyapraphatsara, 2003). In North Sumatra, Karonese people use the leaves of *A. parvifolius* to treat tuberculosis (Aththorick & Berutu, 2018). In Nepal, *A. parviflorus* is used as a fertility promotor (Gesneriad reference web).

In India, the rootstock, leaves and flowers of Stapf. (=*A. parviflorus* (D.Don) Spreng) are used against fever and pain. The juice of crushed leaves is applied for inflammatory glands and an infusion of flowers is taken against tonsilitis (Rai & Lalramnghinglova, 2010). Caffeic acid, isolated from the leaves of *A. longiflorus* (Blume) DC. and *A. pulcher* (Blume) G. Don, has been linked to dermatitis, but the allergenic compounds remain unknown (Lemmens & Bunyapraphatsara, 2003). Li *et al*. (2008) studied the chemical constitution of *A. bracteatus* and stated that they have weak anti-inflammatory activities. GC-MS analysis of the methanol extract of *A. sikkimensis* reveals the presence of various phytochemical compounds in leaves, some of which possess properties such as antioxidant, antimicrobial, antipyretic, anti-arthritic, anti-inflammatory, anti-cancer, and anti-diabetic activities (Nepal *et al.*, 2021). Further, Nepal *et al.* (2022) studied the anti-diabetic activities of *A. sikkimensis* in streptozotocin-induced hyperglycemic rats and the result shows a notable reduction in blood glucose level.

Economic Botany

Aeschynanthus species are mainly valued for their vividly coloured flowers and mottled foliage and are very easy to propagate from stem cuttings rather than growing from seeds (Burtt & Woods, 1975). In temperate regions, several species are grown as ornamental plants and indoor pot plants (Lemmens & Bunyapraphatsara, 2003).

CHAPTER- 3

MATERIALS & METHODS

MATERIALS AND METHODS

1. Taxonomic study:

1.1 **Literature survey**: A detailed literature survey was carried out to gather detailed information on the gesneriads, with a particular focus on the genus *Aeschynanthus*. Various libraries and information retrieval systems were consulted to get the relevant data. Online resources, including the Biodiversity Heritage Library (https://www.biodiversitylibrary.org/), BnF digital library – Gallica (http://www.bnf.fr/en/collections_and_services/digital_libraries_gallica.html), Gesneriaceae cytology database by Möller *et al*. (2002) (http://elmer.rbge.org.uk/webcyte), Gesneriad Reference web (https://gesneriads.info/gesneriad-genera/), JSTOR (https://www.jstor.org), Missouri Botanical Garden Libraries (http://www.botanicus.org and http://www.tropicos.org), Plants of the World Online (https://powo.science.kew.org/), RBGE Gesneriaceae Resource Centre (GRC) (https://padme.rbge.org.uk/grc/welcome), Shodhganga@INFLIBNET Centre (https://shodhganga.inflibnet.ac.in/), UGC-Infonet digital library consortium, and Wallich catalogue details (http://Wallich.rbge.info) of Royal Botanic Garden, Edinburgh, were accessed to get the historical and recent research on the genus.

1.2 **Field explorations**: Based on the pre-assigned travel plan, an extensive field survey was conducted across India, focusing on South India and Northeast India, from 2019 to 2023. About 200 days were spent in the field in 25 collection trips, exploring ten states, viz. Arunachal Pradesh, Assam, Karnataka, Kerala, Meghalaya, Mizoram, Nagaland, Sikkim, West Bengal, Tamil Nadu). Live samples of 17 species were collected from different populations to study the variation and molecular analysis. An extensible garden pole was used to collect the epiphytic plants from large trees. Several accessions of the collected specimens were introduced to the Calicut University Botanic Garden (CUBG). For the molecular studies, leaves samples were preserved in silica gel.

1.3 **Herbarium consultation**: To collect data on the variation, ecology, phenology, and distribution of each taxon, specimens from the following herbaria were consulted: ARUN, ASSAM, BM, BSHC, CAL, CALI, E, K. Additionally, the virtual databases of B, BR, C, G, L, MEL, P, U, US, SING and W were accessed (acronyms as per Thiers, 2023 continuously updated).

Fig. 03. Areas explored: **a.** Ganga Lake, Itanagar; **b.** Dawki, Meghalaya; **c.** Hayuliang, Arunachal Pradesh; **d.** Cherrapunji, Meghalaya; **e.** Lurh Tlang, Mizoram; **f.** Pulie budze, Nagaland; **g.** Sally Lake, Arunachal Pradesh; **h.** Roing, Arunachal Pradesh; **i.** Darjeeling, West Bengal; **j.** Hmuifangtlang, Mizoram; **k.** Agasthyamala, Kerala; **l.** Farkawn, Mizoram; **m.** Changtlang, Arunachal Pradesh; **n.** Pkyong, Sikkim; **o.** Chemunji, Kerala; **p.** Mawsynram, Meghalaya; **q.** Wayanad, Kerala; **r.** Silent Valley National Park, Kerala.

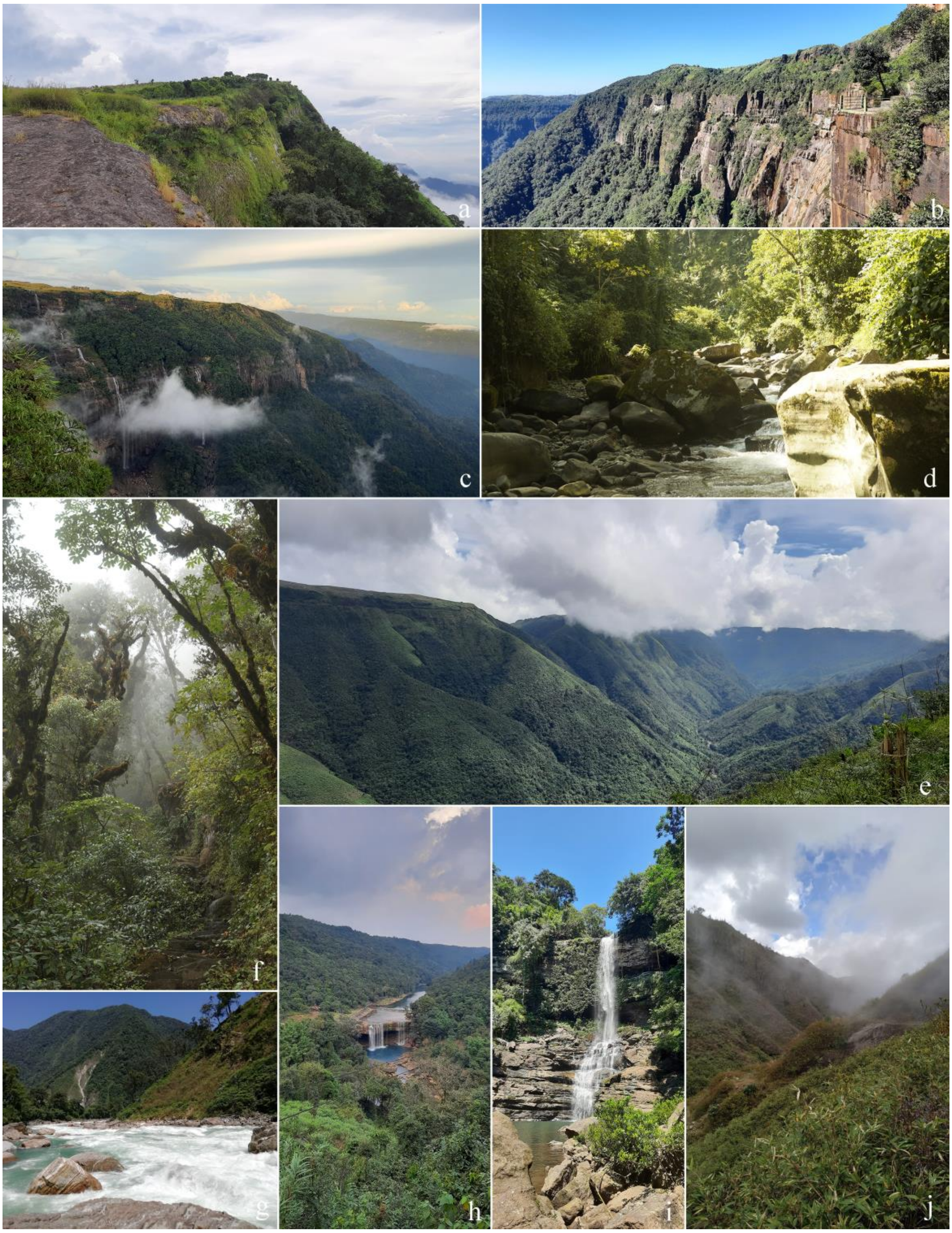


Fig. 04. Areas explored: **a.** Reiek Tlang, Mizoram; **b.** Wah Kaba Falls, Meghalaya; **c.** Cherrapunji, Meghalaya; **d.** Khonsa, Arunachal Pradesh; **e.** Khasi Hills, Meghalaya; **f.** Jampfu peak, Nagaland; **g.** Etalin, Arunachal Pradesh; **h.** Krang Suri Falls, Meghalaya; **i.** Byrdaw Falls, Meghalaya; **j.** Dzukou Valley, Nagaland.

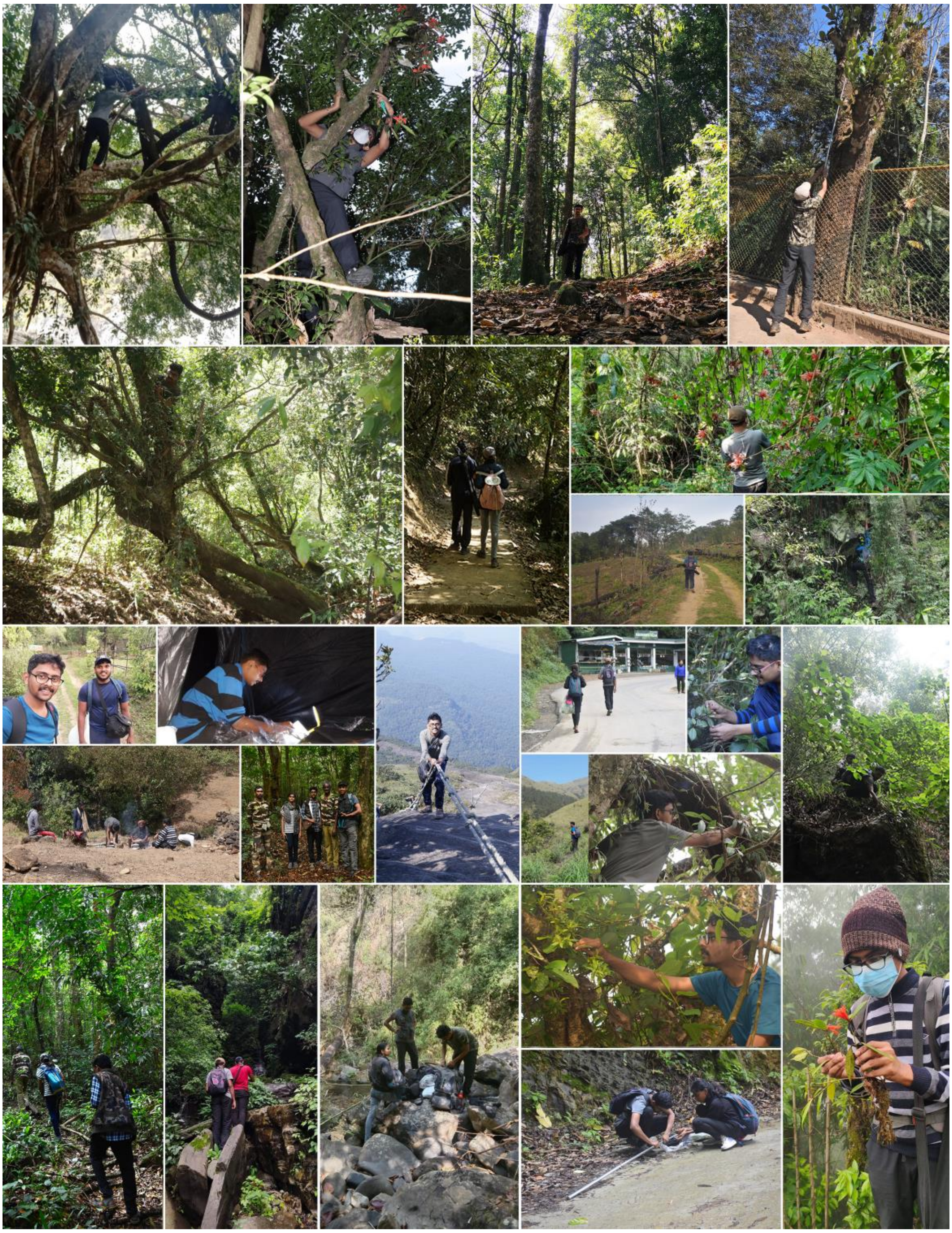


Fig. 05. Glimpses from the field explorations to different parts of India.

1.4 **Herbarium preparation**: Herbarium specimens of the collected samples were prepared using conventional techniques (Forman & Bridson, 1989). The collected plant materials with relevant parts, were first treated with formalin, then pressed and dried in a hot air oven. After proper drying, the specimens were mounted on handmade sheets (28 × 42 cm) and labelled with relevant information. The voucher specimens were deposited at Calicut University Herbarium (CALI) for future reference.

1.5 **Description photoplates, and distribution maps preparations**: A data sheet was prepared for each population studied, containing detailed information on habitat, ecology, habit, size and shape of leaves, position of inflorescence, nature of peduncle, size and colour of calyx, corolla, androecium and gynoecium, and seed features. Detailed morphological analysis was done using all the available materials, and a description of each taxon was prepared based on the terminology followed by Stearn (1992) and Beentje (2010).

Field photographs were captured using an EOS 66 digital camera (Cannon, Japan), while microphotographs were taken with an EZ 4HD 3.0-megapixel digital stereo microscope (Leica, Switzerland) and a Stemi 508 stereo microscope (Zeiss, Germany) affixed with an Axiocam 105 colour camera. Photoplates were prepared using Adobe Photoshop CS6 software (Adobe Systems, 2012).

Distribution maps were generated using QGIS version 3.22.1 (QGIS, 2024) based on data collected in the field, herbarium labels and information from GBIF (https://www.gbif.org/). Data on phenology was gathered from field observations, literature sources and herbarium specimens.

1.6 **Identification, nomenclature, and citation:** Taxonomic identification was accomplished by consulting with types and protologues. The nomenclature of each species was updated according to the Shenzhen code (Turland *et al.*, 2018). The citations of taxa followed the International Plant Name Index (http://www.ipni.org), Plants of the World Online (https://powo.science.kew.org/), and RBGE Gesneriaceae Resource Centre (GRC) (https://padme.rbge.org.uk/grc/welcome).

Fig. 06. a. Various tools used for the collection and photography; **b-i.** Herbaria consultations: **b & c.** Royal Botanic Garden Edinburgh, UK (E); **d & e.** Natural History Museum, London, UK (BM); **f & g.** Royal Botanic Garden Kew, UK (K); **h & i.** Central National Herbarium, Botanical Survey of India, Kolkata (CAL); **j.** Herbarium sheets deposited at Calicut University Herbarium (CALI); **k-l.** Prepared herbarium sheets.

1.7 **Conservation status assessment:** To find out the Extent of Occurrence (EOO) and Area of Occupancy (AOO) for each species, all the available distribution data (geo-coordinates) were compiled into a CSV (comma-separated values) format. This data was then uploaded into the GeoCAT software (http://geocat.kew.org/) for further analysis. Based on the values of AOO, EOO and an analysing of various probable threats, conservation assessment was carried out following the guidelines of the IUCN Red List Categories and Criteria (IUCN, 2012, 2024).

Methodology of seed micromorphology, palynology and molecular phylogeny will be discussed in detail under respective chapters.

CHAPTER- 4

GENERAL MORPHOLOGY

GENERAL MORPHOLOGY

Habit

Aeschynanthus includes epiphytic perennial herbs or under shrubs, which, under suitable growth conditions, can also grow as lithophytes. The branches may be arching, pendulous, hanging, creeping, or, less commonly erect. Adventitious roots often emerge from the nodes, providing additional support to the plant.

Leaves

The leaves typically exhibit opposite phyllotaxy, though rarely ternate arrangements can occur. The leaf pairs at each node are usually of equal size and may be either petiolated, or sub-sessile. The petioles are often adaxially grooved or canaliculated. The lamina shows a wide range of variation in shape (as well as in size) from orbicular or linear to elliptic/lanceolate or oblong. A prominent feature is the large, thin-walled hypodermis, which serves as a water store tissue. This adaptation contributes to the thick, fleshy, and leathery texture of the leaves, helping the plant to overcome desiccation.

Inflorescence

The typical pair-flowered cymes found of Gesneriaceae (the terminal flower of each cyme unit is associated with an additional flower, without a subtending bracteole in the frontal position) (Weber, 1973, 1982, 1995, 2004, 2013) was difficult to recognise in *Aeschynanthus*. In contrast, the inflorescences in *Aeschynanthus* emerge as solitary or few-flowered cymes from the leaf axils, or in a pseudoterminal cluster, without arresting the apical growth of the shoot. The pseudoterminal inflorescences can develop in various ways (Middleton, 2007):

(1) Two cymes arising from the terminal leaf axils of a shoot together form a cluster or
(2) Two cymes arising from the axils of scale-like bracts at the shoot apex together form a cluster or
(3) By the combination of (1) and (2) mentioned above. i.e., cymes originating from leaf and bract combine to form a terminal cluster.

The inflorescence may be either pedunculate or sessile. Solitary flowers typically arise from the reduction of the cyme.

Fig. 07. Epiphytic habit of *Aeschynanthus* Jack: **a.** *A. perrottetii* (Idukki, Kerala); **b.** *A. monetaria* (Hayuliang, Arunachal Pradesh); **c.** *A. gracilis* (Dhiku, Arunachal Pradesh); **d.** *A. parasiticus* (Cherrapunji, Meghalaya); **e.** *A. parasiticus* (Mawsmai, Meghalaya); **f.** *A. parasiticus* (Birdaw, Meghalaya); **g.** *A. superbus* (Pynursla, Meghalaya).

Fig. 08. Lithophytic habit of *Aeschynanthus* Jack: **a.** *A. perrottetii* (Silent Valley National Park, Kerala); **b.** *A. perrottetii* (Nelliyampathy, Kerala); **c.** *A. bracteatus* (Pynursla, Meghalaya); **d.** *A. parviflorus* (Cherrapunji, Meghalaya); **e.** *A. micranthus* (Hayliang, Arunachal Pradesh); **f.** *A. perrottetii* (KMTR, Tamilnadu).

The bracts and bracteoles vary in size and prominence; in some species, they are small, inconspicuous, or completely reduced, while in others, they are prominent and brightly coloured. They may also be caducous or deciduous.

Flowers

The flower consists of four principal whorls of floral organs: sepals (calyx), petals (corolla), stamens, and carpels (two carpels always fused to form a syncarpous pistil). The flowers are bisexual, 5-merous, pedicellate, and zygomorphic.

Calyx

The calyx consists of five sepals, which are either free to the base or fused to varying degrees. When the fusion extends above the middle, the calyx assumes a tubular appearance. Generally, the sepals are fairly equal in size. The shape, size, and hairiness may vary from species to species and within a species. In some species, such as *A. volubilis*, the tubular calyx matures well before the corolla, and is filled with a slimy secretion of the sepals, possibly mixed with rainwater. This secretion fills the calyx and creats a “water bath” in which the flower buds develop, offering protectiond against desiccation and herbivory (Carlson & Harms, 2007).

Corolla

The tubular corolla is formed by the fusion of five petals. The tube is always curved, with the longest portion on the upper surface. It may vary in shape, being narrow, gently or abruptly widening, or having a gibbous base. The limb is bilabiate, consisting of two upper lobes, two lateral lobes, and a lower lobe. The mouth may be either oblique or symmetrical. Usually, the corolla is brightly coloured (generally red or orange, but white, and green occur less commonly). The hairiness, additional striations and markings on the petals may also vary across different taxa.

Stamens

The male floral whorl is represented by four stamens and a single staminode (non-fertile). Each stamen has a filament and an anther with four pollen chambers. The stamens are arranged in two pairs on the dorsal surface of the corolla tube: a posterior pair with shorter filaments situated at the upper position and an anterior pair with longer filaments at the lower position. Each pair of stamens is often connate or coherent at the anther apices by the interlocking and fusion of the apical epidermal cells. In species like *A. chiritoides*, the stamens are all coherent by the fusion at the anther apices, forming a cross-like structure. The stamens are usually well exserted (rarely included) from the corolla tube, and the cross-like or pairwise fusion helps to hold the anthers in a stable position during pollination. The filaments are curved to position the anther properly and may coil after the pollen is shed.

As a strategy to prevent self-pollination, *Aeschynanthus* is strongly protandrous (androecium matures first, withers, and then only gynoecium matures).

Gynoecium

Being bird-pollinated, *Aeschynanthus* has a prominent nectary or disk that provides nectar as a reward to the pollinators. The nectary disk is generally complete, annular, or shallowly lobed at the rim (5-crenate) and adnate to the base of the ovary.

The pistil consists of a long, cylindrical, superior ovary with two fused carpels (bi-carpellary). Numerous ovules are arranged on the parietal placenta, and the pistil has a linear style with a distinctly capitate stigma. The basal part of the ovary contains a sterile placenta which is represented by a narrow, tapering stipe. The individual placenta is very thin and maintains cosistent thickness along its length, curving back slightly at the distal end. The length of the pistil can vary vary depending on the stage of flower development, and the hairiness may differ between species.

Fruit

After fertilization, the stipe portion of the ovary remains as a non-seeded basal area, known as the stalk, and its length can vary. The fruit is generally an elongated capsule, which dehisces loculicidally along longitudinal slits.

Seeds

The seeds consist of a small central grain with a papillose or warty surface. Each seed has one apical appendage and one or more hilar appendages (where the seed attaches to the capsule), which are adapted for wind dispersal. The apical appendage points towards the base of the capsule and can be either long and filiform or short and stout. The hilar appendages are generally long and filiform, though they can be intermediate in length or short and stout when solitary. In some species, the hilar end of the seed is furnished with a cluster of inflated cells called bubble cells, which may aid in seed dispersal (see chapter 07).

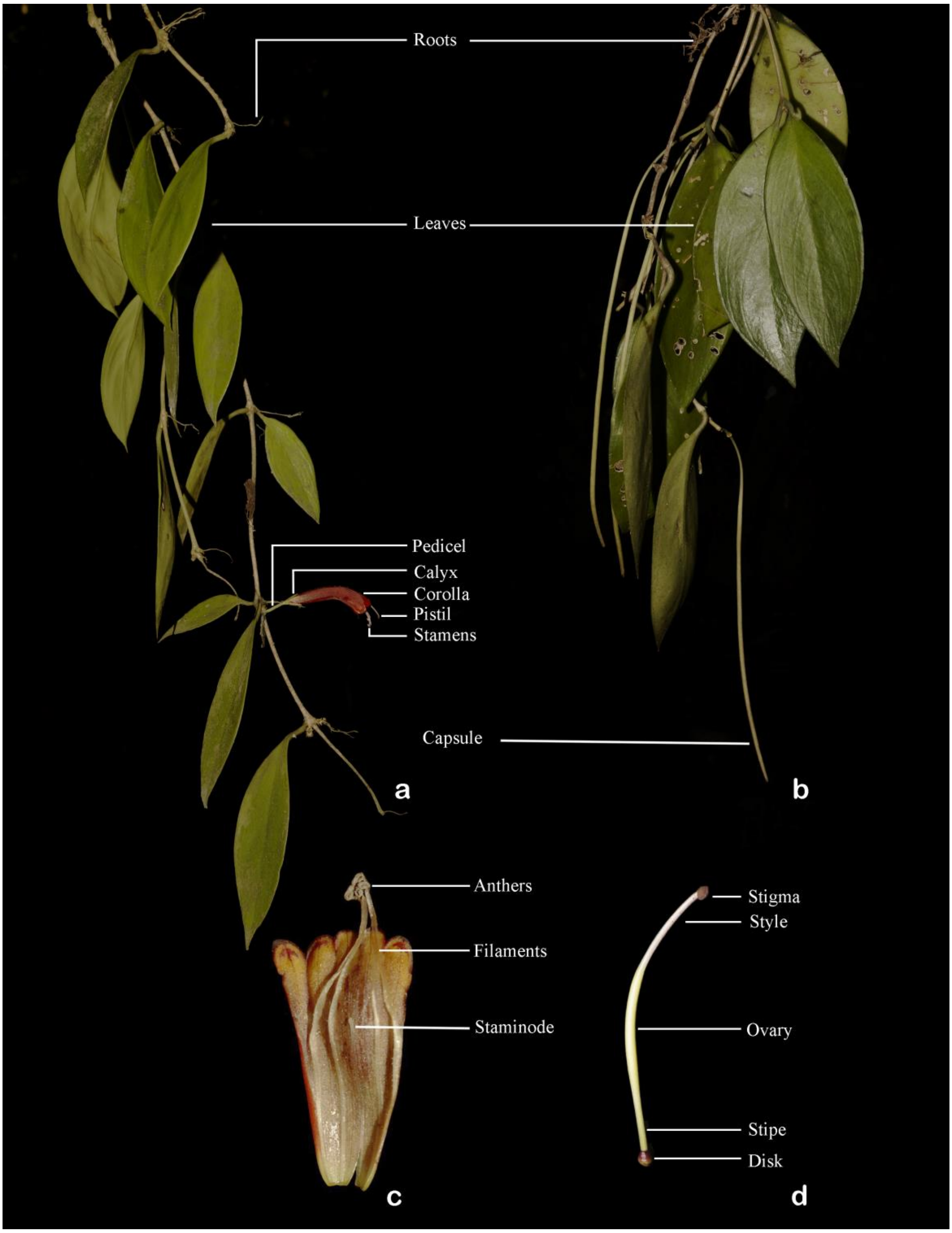


Fig. 09. General morphology of *Aeschynanthus* Jack: **a–d**. *A. micranthus* C.B.Clarke; **a.** Flowering twig; **b.** Fruiting twig; **c.** Corolla split-open, showing stamens and staminode; **d.** Pistil.

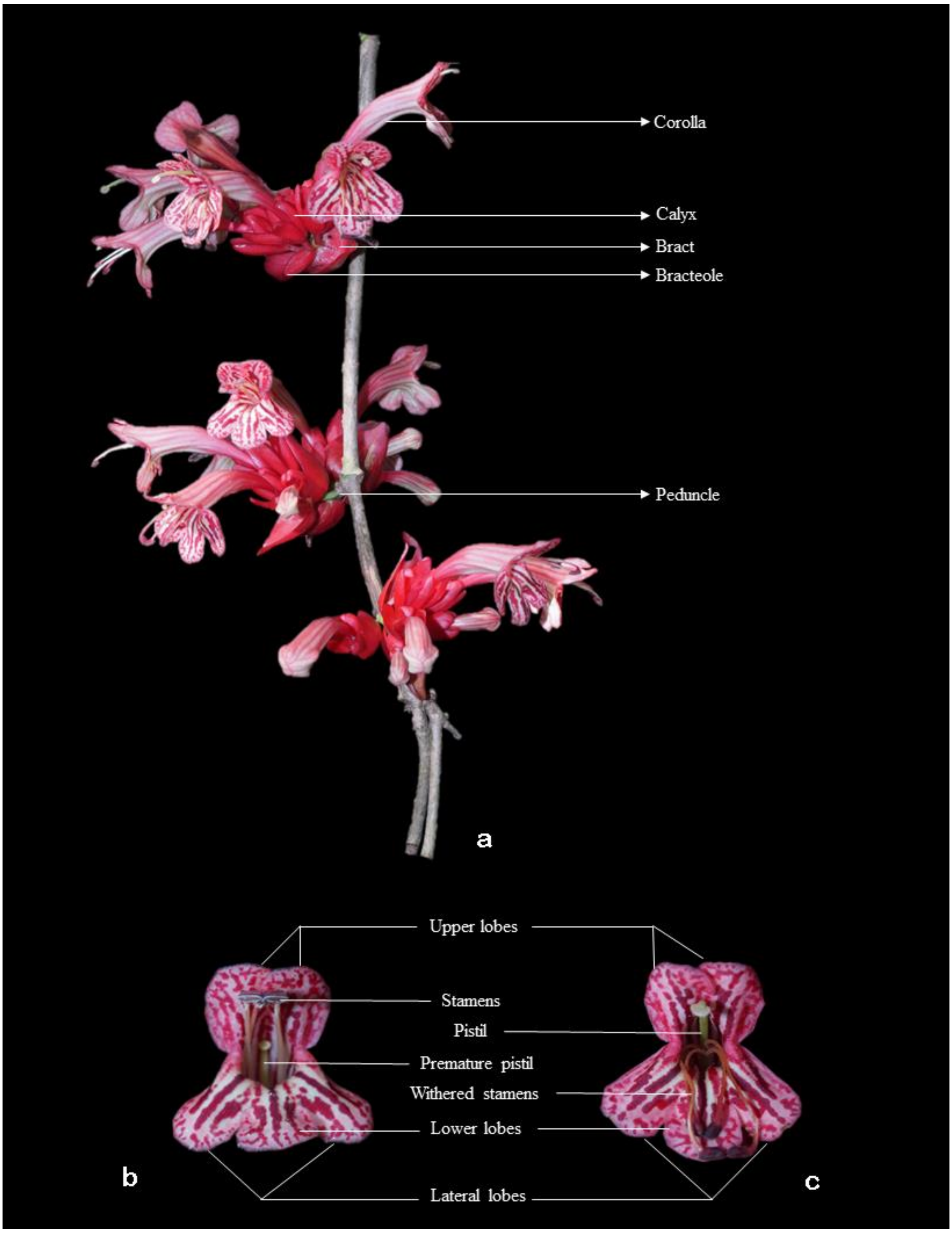


Fig. 10. General morphology of *Aeschynanthus* Jack: **a–d**. *A. superbus* C.B.Clarke; **a.** Inflorescence; **b & c.** Corolla mouth; **b.** Flower with mature stamens; **c.** Flower with mature pistil.

CHAPTER- 5

SYSTEMATIC TREATMENT

Aeschynanthus Jack, *nom. cons.*

Aeschynanthus Jack, Trans. Linn. Soc. London 14: 42. 1823 *nom. cons.*; R.Br. in Benn., Pl. Jav. Rar. 115. 1840; A.DC., Prodr. 9: 260. 1845; C.B.Clarke, Commelyn. Cyrtandr. Bengal 69. 1874, in A.DC. & C.DC., Monogr. Phan. 5(1): 18. 1883, in Hook.f., Fl. Brit. India 4: 337. 1884; Trimen, Handb. Fl. Ceylon 3: 272. 1895; Gamble, Fl. Madras 2: 984. 1924; Kanjilal *et al.*, Fl. Assam 3: 387. 1939; B.L.Burtt & P.Woods, Notes Roy. Bot. Gard. Edinburgh 33(3): 471. 1975; W.L.Theob. & Grupe in Dassan. & Fosberg, Rev. Handb. Fl. Ceylon 2: 81. 1981; N.P.Balakr., Fl. Jowai 2: 344. 1983; Harid. & R.R.Rao, Forest Fl. Meghalaya 2: 650. 1987; W.T.Wang *et al.*, Fl. China 18: 375. 1998; B.L.Burtt, Thai Forest Bull., Bot. 30: 167. 2002; Hilliard in Grierson & D.G.Long., Fl. Bhutan 3: 1298. 2002; A.Weber in Kubitzki, Fam. Gen. Vasc. Pl. 7: 145. 2004; Z.Y.Li & Y.Z.Wang, Gesneriaceae China 363. 2004; T.S.Nayar *et al.*, Fl. Pl. Kerala 342. 2006; D.J.Middleton, Edinburgh J. Bot. 64(3): 363. 2007, Edinburgh J. Bot. 66(3): 391. 2009, Edinburgh J. Bot. 68(1): 1. 2016; U.C.Bhattach. & Goel, Phytotaxonomy 14: 2. 2015; B.K.Sinha & Su.Datta, Nelumbo 58: 1. 2016; Bh.Adhikari & Mich.Möller in M.F.Watson, Fl. Nepal (Web ed.). 2023. *Type*: *Aeschynanthus volubilis* Jack.

Trichosporum D.Don, Edinburgh Philos. J. 7: 82. 1822; Blume, Bijdr. Fl. Ned. Ind. 1826. *Type* (designated by Middleton, 2007): *Trichosporum parviflorum* D.Don (= *Aeschynanthus parviflorus* [D.Don] Spreng.).

Rheitrophyllum Hassk., Flora 25 (2): Beibl. 56. 1842. *Type*: *Rheitrophyllum subverticillatum* Hassk. (= *Aeschynanthus angustifolius* [Blume] Steud.).

Euthamnus Schltr., Bot. Jahrb. Syst. 58(3): 284. 1923. *Type*: *Euthamnus papuanus* Schltr. (= *Aeschynanthus papuanus* [Schltr.] B.L.Burtt).

Oxychlamys Schltr., Bot. Jahrb. Syst. 58(3): 286. 1923. *Type*: *Oxychlamys pullei* Schltr. (= *Aeschynanthus oxychlamys* Mendum).

Micraeschynanthus Ridl., Fl. Malay Penins. 5: 324. 1925. *Type*: *Micraeschynanthus dischidioides* Ridl. (= *Aeschynanthus dischidioides* [Ridl.] D.J.Middleton).

Epiphytic or lithophytic perennial herbs or under shrubs. Stems branched, arching, pendulous or climbing, hanging or erect; rooting at nodes. Leaves simple, opposite, rarely ternate or whorled; petiole terete, canaliculated above, glabrous to pilose or rarely sessile; lamina size and shape variable, green, apex obtuse to acuminate, base attenuate to rounded, margins entire to sub-entire or undulate, coriaceous to fleshy, glabrous to pilose; midvein prominent on abaxial surface, venation pinnate, obscure or visible on drying. Inflorescences a solitary flower on axils or few-flowered axillary cymes or many-flowered pseudoterminal cymes; pedunculate or not. Flowers strongly protandrous; pedicels terete or angular, glabrous to pilose. Bracts vary in size and shape. Calyx of 5 sepals, free or fused, fusion may be near base, or variously along the length, when fused tubular or cup-shaped, green to red, glabrous to pubescent. Corolla zygomorphic, tubular, widening towards lobes, curved to various degrees, sometimes distinctly inflated at the base, glabrous to variously pubescent; lobes 5; upper lip 2-lobed, small, erect; lower lip 3-lobed (2-laterals and 1-lower), comparatively larger, reflexed or not; variable in colour (various shades of red or orange, rarely green or yellow or white). Stamens 4; anthers basifixed, fused in two pairs (rarely whole coherent) at apex, long exserted or included at maturity, filaments attached to the middle or above the middle of the corolla tube inside, positioned in the upper curve of the flowers. Staminode 1, clavate or turbinate, positioned below the upper lobes; anthers oblong-elliptic, each pair attached by their apices. Disk 5-crenate or annular. Pistils develop after withering filaments, positioned in the upper curve of the corolla tube, consisting of a sterile stipe at the base, ovary, style, and stigma; ovary linear or linear-oblong, 1-loculed, placentas 2, variously pubescent; style linear, variously pubescent; stigma capitate; ovules many, anatropous. Capsules long narrow, base tapered, apex acute, dehisce loculicidally by two valves. Seeds numerous, tiny, apical appendage a solitary hair; hilar appendages 1 or 2 or many.

Distribution: Principally a Southeast Asian genus with about 182 species globally, 20 species in India. It is distributed in Sri Lanka, India (including Andaman and Nicobar Islands), Nepal, Bhutan, Bangladesh, southern China, Southeast Asia (Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand and Vietnam) to the Solomon Islands, from ±20 m to ±2400 m altitude from above sea level (Fig. 11).

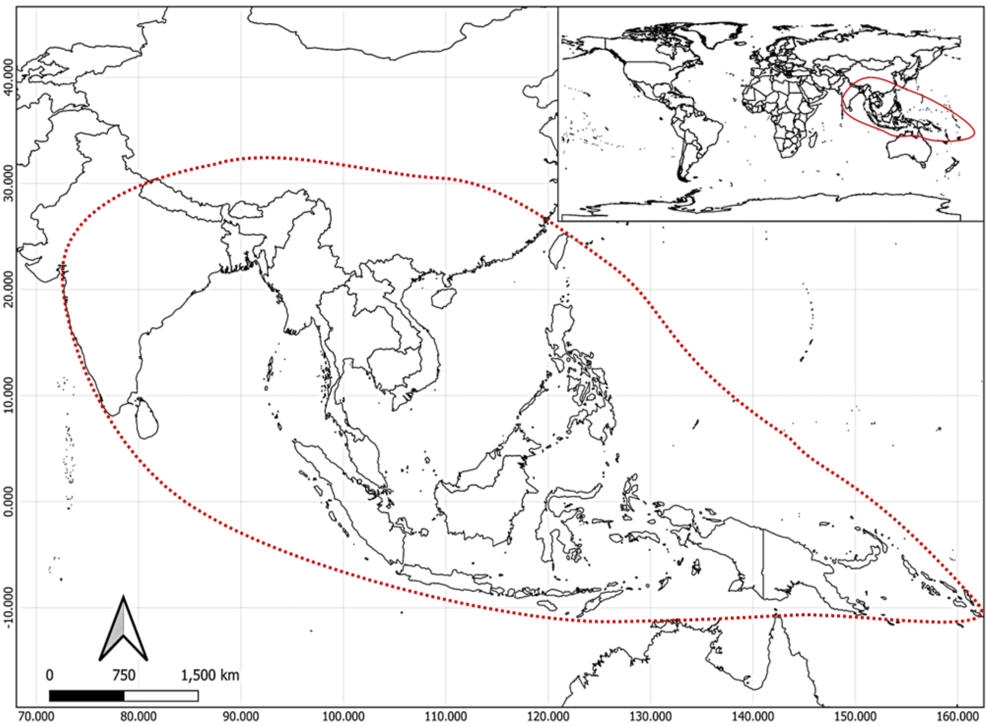


Fig. 11. Distribution of *Aeschynanthus* Jack

Habitat: An epiphyte that grows on medium to large trees, often in association with mosses or fern roots, but can also establish in humus-rich crochets. It shows no preference for specific host plants, thriving even on *Areca* palm trunks and conifers. When growth conditions are favourable, it can also grow as a lithophyte on large rocks or cliff faces. Generally, it prefers cool, semi-shady environments within evergreen forests.

Etymology: The name *Aeschynanthus* is derived either from the Greek words αισχυνη (aischyne), meaning "shame", and ανθός (anthose) meaning "flower", possibly referring to the usually red colour of the corolla, or from αίσχύνειν (aischýnein) meaning "to deform", and ανθός (anthose), referring to the unusual form of the corolla.

Key to the species in India

1. Plants hanging, creeping or repent herbs or erect under shrubs with sub-woody base …………………………………………………………………………………………2

1. Plants arching or pendulous under shrubs or suffruticose ……………………………… 8

2. Corolla white or pale-yellow; stamens all coherent, included ……….. ***A. chiritoides***

2. Corolla in various shades of red or green; stamens coherent in two pairs, long exserted …………………………………………………………………………………………… 3

3. Inflorescence pedunculate; calyx lobed from above middle; seeds with bubble cells at hilar end ………………………………………………………………. ***A. volubilis***

3. Inflorescence epedunculate; calyx lobes free or slightly fused at base; seeds without bubble cells at hilar end …………………………..……………………..…….. 4

4. Stems villous; corolla mouth oblique, lateral lobes 0.8–1 cm wide, lower lobe > 0.6 cm long, strongly reflexed …………..……………………………..…. ***A. gracilis***

4. Stems glabrous; corolla mouth not oblique, lateral lobes 0.2–0.3 cm wide, lower lobe ≤ 0.5 cm long, slightly reflexed or straight ……………………..….…………… 5

5. Leaves orbicular or discoid, apex rounded, midvein weakly visible abaxially; lateral lobe of corolla truncate at apex ……………………………..……… ***A. monetaria***

5. Leaves elliptic or ovate to oblanceolate or oblong, apex acute to acuminate or obtuse, midvein prominent abaxially; lateral lobe of corolla obtuse to rounded at apex ………………………………..……..……………….……………….…… 6

6. Leaves opposite or ternate, densely approximate towards apex; calyx lobe acuminate at apex, without cilia …………..………………..……………………… ***A. mannii***

6. Leaves strictly opposite, distally placed; calyx lobe acute to obtuse at apex, ciliate …………………………………………………….……..…...…………….. 7

7. Leaves pubescent abaxially; pedicels ≥1 cm long, sparsely pubescent; sepals linear to lanceolate ……………………………………..………..….…. ***A. tirapensis***

7. Leaves glabrous; pedicels < 1 cm long, glabrous; sepals narrowly triangular to narrowly elliptic ………………………………….……………….. ***A. micranthus***

8. Inflorescence distinctly pedunculate (≥1 cm long) ……………….…………… 9

8. Inflorescence epedunculate or short pedunculate (< 0.8 cm long) …..……….…... 13

9. Calyx lobes reflexed; corolla usually green to yellow green or rarely reddish green; style glabrous …………………….………..…….….…………… ***A. acuminatus***

9. Calyx lobes straight; corolla in various shades of pink, orange or red; style pubescent ………...…………………….……………………………..…… 10

10. Calyx < 1 cm long, lanceolate, maroon or greenish maroon; corolla tube gibbous at base ………………………….…………………..… ***A. stenosepalus***

10. Calyx > 1.2 cm long, narrowly ovate, elliptic, obovate or oblong, rose-red or red; corolla tube straight at base ………………………………….…… 11

11. Leaves linear to oblanceolate; bracts < 0.3 cm long, lanceolate, green; stamens included; hilar appendage < 1.5 mm long ………………..…...……. ***A. linearifolius***

11. Leaves elliptic or ovate; bracts > 1.5 cm long, elliptic or ovate, rose-red or red; stamens long exserted; hilar appendage > 2.5 mm long …………………………. 12

12. Calyx free to base; lobes obtuse to rounded at apex; corolla > 6 cm long, pink or pinkish-red; filaments > 2.5 cm long; pistils > 6 cm long; capsules > 25 cm long ………………………………………………………………………...… ***A. superbus***

12. Calyx lobed from below middle; lobes acute at apex; corolla < 4.5 cm long, orange to bright red; filaments < 2.5 cm long; pistils < 4 cm long; capsules < 15 cm long …………………………………………………………..……..… ***A. bracteatus***

13. Bract margins incurved and become boat-like; corolla mouth oblique, lateral lobes always reflexed; staminodes turbinate ……………………………………… ***A. maoi***

13. Bract margins straight; corolla mouth not oblique, lateral lobes straight or slightly reflexed; staminodes clavate …………………………………………………….….. 14

14. Calyx always free to base; lobes narrowly lanceolate, pubescent inside……………… .... ***A. angustioblongus***

14. Calyx free or slightly fused (at least 0.1 cm) or to above middle; lobes linear, triangular, elliptic or oblong, glabrous inside …………………..…………...…. 15

15. Seeds with a solitary hilar appendage ……………………………….……………. 16

15. Seeds with 2 or more hilar appendages …………………………………….…. 17

16. Calyx tube 1–2 cm long; lateral lobes of corolla deltoid, orange to crimson red out, dark red stripes running down from the centre ……………………......... ***A. fulgens***

16. Calyx tube absent or *c.* 0.1 cm long; lateral lobes of corolla oblong or ovate, pinkish to red or greenish shade out, devoid of any dark stripes running down from the centre ……...…………………...…………………………….………..………. ***A. perrottetii***

17. Leaves linear to narrowly lanceolate, < 0.6 cm wide; bracts triangular, maroon; corolla < 2.9 cm long, lobes devoid of any markings out …………..…. ***A. reiekensis***

17. Leaves linear lanceolate to elliptic lanceolate or elliptic to ovate, > 1.2 cm wide; bracts linear, elliptic to lanceolate, green or dark purple; corolla < 2.9 cm long, lobes with dark stripes running down to the tube out …………………………………… 18

19. Bracts linear; calyx lobed from middle or below middle, acuminate at apex, sparsely papillose to glandular pubescent outside ……………..……………… ***A. parviflorus***

19. Bracts elliptic to lanceolate; calyx lobed from middle or above middle, acute to obtuse or rounded at apex, glabrous outside ……………..……..……………… 20

20. Calyx lobes elliptic to triangular; inside of corolla tube base with numerous multicellular coarse hairs …………………………………………… ***A. parasiticus***

20. Calyx lobes oblong; inside of corolla tube glabrous …………………… ***A. hookeri***

1. Aeschynanthus acuminatus Wall. ex A.DC., Prodr. 9: 263. 1845; Steud., Nomencl. Bot. ed. 2, 1: 32. 1840, *nom. nud*.; C.B.Clarke, Commelyn. Cyrtandr. Bengal. t.45. 1874, in A.DC. & C.DC., Monogr. Phan. 5(1): 30. 1883, in Hook.f., Fl. Brit. Ind. 4: 341. 1884; W.T.Wang, Phytologia 45: 311. 1980; H.W.Li, Acta Bot. Yunnan. 5(1): 28. 1983; N.P.Balakr., Fl. Jowai 2: 345. 1983; W.T.Wang, Fl. Reipubl. Popularis Sin. 69: 502. 1990; W.T.Wang *et al.*, Fl. China 18: 377. 1998; B.L.Burtt, Thai Forest Bull. (Bot.) 29: 83. 2001; Hilliard in Grierson & D.G.Long, Fl. Bhutan 3: 1300. 2002; Kress *et al.*, Checkl. Myanmar 261. 2003; Z.Y.Li & Y.Z.Wang, Gesneriaceae China 366. 2004; D.J.Middleton, Edinburgh J. Bot. 64(3): 373. 2007, Edinburgh J. Bot. 66(3): 399. 2009; Y.G.Wei, Gesneriaceae S. China 687. 2010; G.P.Sinha, Fl. Mizoram 2: 197. 2012; G.D.Pal, Fl. Lower Subansiri District, Arunachal Pradesh 2: 163. 2013; U.C.Bhattach. & Goel, Phytotaxonomy 14: 5. 2015; B.K.Sinha & Su.Datta, Nelumbo 58: 5. 2016; S.S.Dash & P.Singh, Fl. Kurung Kumey District 2: 352. 2017; A.A.Mao *et al.*, Check List Fl. Nagaland 96. 2017; Bh.Adhikari & Mich.Möller in M.F.Watson, Fl. Nepal (Web ed.). 2023. *Trichosporum acuminatum* (Wall. ex A.DC.) Kuntze, Revis. Gen. Pl. 477. 1891. *Lectotype* (designated by Middleton, 2009): BANGLADESH, Sylhet ('Sillet'), *s.d., W. Gomez* 6397 (G-DC [G00133079 digital image!]; isolecto BR [BR0000013520762 digital image!], CGE [CGE00080064 digital image!], G [G00133135 digital image!], K-W [K000831876!]).

Aeschynanthus chinensis Gardner & Champ., Hooker's J. Bot. Kew Gard. Misc. 1: 328. 1849. *Aeschynanthus acuminatus* var. *chinensis* (Gardner & Champ.) C.B.Clarke in A.DC. & C.DC., Monogr. Phan. 5(1): 31. 1883. *Lectotype* (designated by Middleton, 2007): CHINA, **Hong Kong**, *s.d., J.G. Champion s.n.* (K [K000831866!]; isolecto K [K000831864!, K000831865!]).

Aeschynanthus bracteatus auct. non Wall. ex A.DC.: Benth., Fl. Hongk. 258. 1861.

Figs. 12 & 14

Epiphytic or lithophytic perennial under shrubs. Stems branched, pendulous, pale green when young, straw-coloured at maturity, glabrous, rooting at nodes. Nodes slightly swollen; internodes 2.8–9.5 cm long. Leaves opposite; petioles 0.2–1 cm long, terete, canaliculated above, green, glabrous; lamina 6.5–12 × 1.8–5.2 cm, elliptic, obovate or

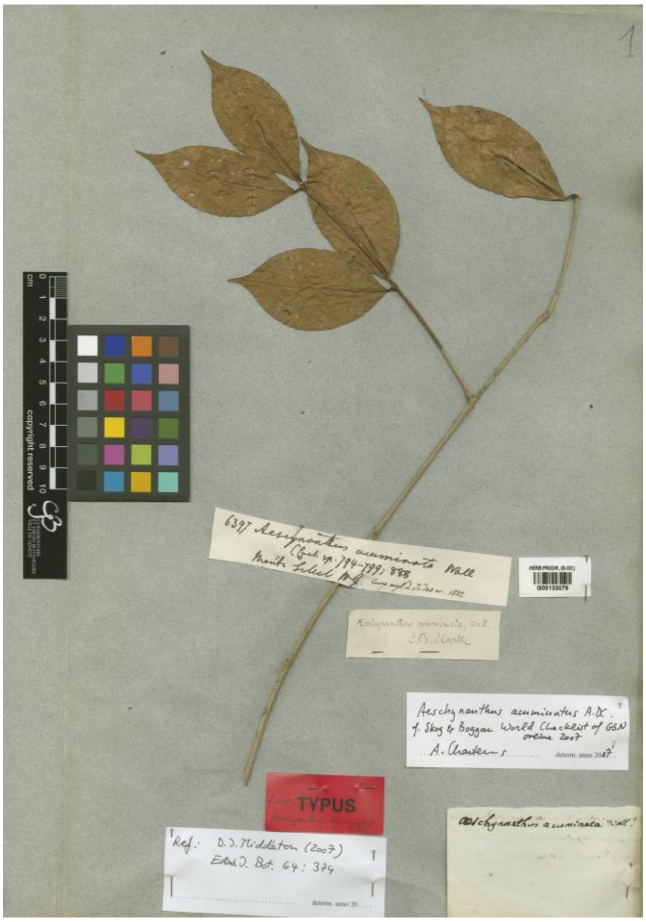


Fig. 12. Lectotype of *Aeschynanthus acuminatus* Wall. ex A.DC. (G [G00133079]). © Conservatory and Botanical Garden of the City of Geneva. Reproduced with permission.

lanceolate, slightly fleshy, glabrous, green above, pale green to greenish white beneath, apex acuminate, base cuneate to obtuse, margins entire; midvein slightly sunken adaxially, prominent abaxially; lateral veins generally 5–8 pairs, weakly visible or obscure. Inflorescences axillary or pseudoterminal, 2–5-flowered; peduncles usually solitary or rarely up to 4 arising in an axil, 1.5–6.5 cm long, terete, green or greenish purple, glabrous, sometimes primary peduncle subtended with a secondary peduncle, 0.5–1 cm long, terete, green or greenish purple, glabrous. Bracts 0.8–1.3 × 0.6–1.3 cm, ovate to widely ovate, green with a purplish or reddish tinch, apex obtuse, margins entire, faintly 5–7-nerved, persistent. Pedicels 0.8–0.9 cm long, angular, green or greenish purple, glabrous. Calyx free to base; lobes 0.2–0.5 × 0.1–0.3 cm, elliptic or elliptic-oblong, green or purplish green, apex rounded, margins entire, spreading or completely reflexed back at maturity and become campanulate, glabrous. Corolla 1.4–2.5 cm long; tube 0.8–1.5 cm long, 0.5–0.7 cm wide at base, then slightly inflated towards the throat with 0.8–1 cm, straight, outside green, yellowish-green, or reddish green with faint brown lines, glabrous; inside pale green, with a dark purple line running down from the filaments, sparsely glandular hairy; mouth strongly oblique and consequently large; lobes outside green, arched with reddish green or brown, sparsely pubescent; inside brown-red or reddish green, glabrous or gland dotted, ciliate; upper lobes 0.4–0.7 × 0.3–0.6 cm, oblong or elliptic, apex rounded, erect; sinus 0.3–0.5 cm deep; lateral lobes 0.5–0.8 × 0.6–0.8 cm, ovate or deltoid, apex rounded or obtuse, reflexed; lower lobe 0.5–0.9 × 0.3–0.6 cm, oblong or elliptic, apex rounded, reflexed. Stamens, fused in two pairs, long exserted; anterior filaments 1.3–1.5 cm long, inserted at 0.3–0.5 cm from corolla base; posterior filaments 1.6–1.8 cm long, inserted at 0.6–0.7 cm from corolla base, filaments white at base, purple higher up, glabrous or sparsely gland dotted; anthers *c.* 0.3 × 0.1 cm, oblong, purple; pollen cream. Staminode 0.1–0.2 cm long, clavate, inserted 0.7–0.8 cm from corolla base. Disk 0.1–0.2 cm high, 5-crenate, purple at base, yellow green higher up. Pistils 1.5–2 cm long; stipe 0.3–0.6 cm long, pale green, glabrous; ovary 1–1.5 cm long, linear, pale green to whitish green, glabrous or gland dotted; styles 0.5–0.7 cm long, linear, green, glabrous; stigma *c.* 0.2 cm across, capitate, green. Capsules 10.5–22 × 0.2–0.3 cm, green. Seeds 0.7–1.4 × *c.* 0.2 mm, testa cells sunken at centre, edges slightly raised, oriented slight to moderately clockwise; apical appendage 2.9–3.7 mm long; hilar appendage a solitary hair, 3–3.2 mm long, appendages not papillose.

Vernacular names: Tapering-leaf blushwort, Chinese blushwort.

Flowering & fruiting: Flowering from October to January and fruiting from January to March.

Habitat: An epiphyte on medium to large trees or as a lithophyte, in cool and open areas of evergreen forests.

Distribution: Bangladesh, Bhutan, China, India, Myanmar, Taiwan, Thailand and Vietnam (GRC, 2024) (Fig. 13), however, I was unable to find any specimens from Bhutan from the herbaria I consulted.

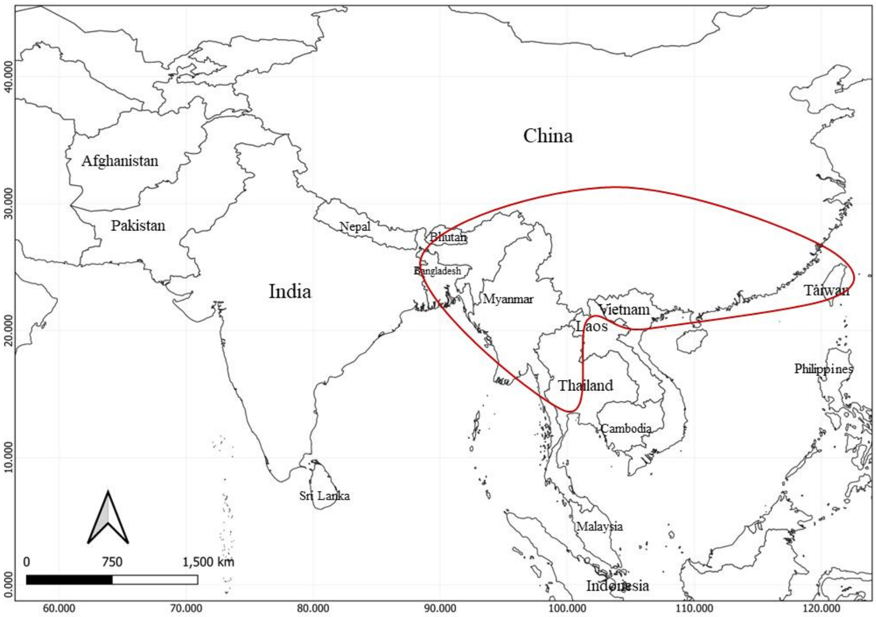


Fig. 13. Distribution of *Aeschynanthus acuminatus* Wall. ex A.DC.

Fig. 14. *Aeschynanthus acuminatus* Wall ex A.DC.: **a** & **b.** Habit; **c–f.** Single flower, **c.** Front view; **d.** Back view; **e.** Side view; **f.** Corolla - split open and showing stamens and pistil (Images a & b. by Akshath Shenoy; c–f. from living collection @ RBGE; images © Royal Botanical Garden, Edinburgh).

Specimens examined: BANGLADESH, Mount Silhet, *s.loc.*, February 1829, *W. Gomez* 6397 (BR [BR0000013520762 digital image], K [K001123778]); *Ibid.*, 1832, *W. Gomez* 6397 (K [K000831876]); *Ibid.*, Pundua, 1824, *F. De Silva* 794 (G [G00133142 digital image]). CHINA, **Guangdong (Kwangtung)**, Boluo, Luo-fu Shan, 08.05.1978, *K'tung* 78 6087 (L [L.2821341 digital image]); Sin-fung district, Wa Mei Tong, Sha Lo Shan, 31.01.1937, *Y.W. Taam* 177 (BR [BR0000036398829 digital image], L [L.2821345 digital image]). **Hainan**, Diaoluoshan, 900 m, 24.11.1991, *Nooteboom & Ye* 5650 (L [L.2821340 digital image]). **Hong Kong**, *s.loc.*, 1853, *C. Wright s.n.* (NYBG [NYBG 00525348 digital image]); *Ibid., s.d., C. Wright s.n.* (US [US 00586560 digital image]); *Ibid., s.d., J.G. Champion s.n.* (K [K000831864]); *Ibid., s.d., J.G. Champion s.n.* (K [K000831865]); *Ibid., s.d., C. Ford s.n.* (US [US 00586559 digital image]); Kadoorie Farm, 20.03.1970, *S.Y. Hu* 9692 (US [US 00586562 digital image]); *Ibid.*, 02.03.1972, *S.Y. Hu* 11583 (US [US 00586561 digital image]); Ravines Mt. Victoria & Mt. Parker, *s.d.*, *J.G. Champion s.n.* (K [K000831866]); Saiwan, 03.04.1941, *Y.W. Taam* 1996 (US [US 00586558 digital image]); Tai Mo Shan, 30.01.1994, *N.H. Li* 226 (L [L 0215603, L.2821359 digital image]). **Hualien Hsien**, Fuli Hsiang, N 121°17'50", E 23°11'02", 465–580 m, *s.d.*, *Chi-Hsiung Chen, Tsui-Ya Liu & Tseng-Pin Chiang* 388 (E [E00067594]). **Yunnan**, Szemoa, *s.d.*, *A. Henry* 11984 (E [E00067593], US [US 00586557 digital image]). INDIA, *s.loc.*, *s.d.*, *Griffith s.n.* (BM [BM011025801]). **Arunachal Pradesh,** Anjaw district, Nara to Hayuliang, 378–491 m, 19.11.1957, *R.S. Rao* 10734; Kameng, Baha Hill, 10.05.1958, *G. Panigrahi* 15318; Brukpalancher, 16.05.1958, *G. Panigrahi* 15681 (ASSAM); Kra Daadi district, Subansiri Forest Division, Palin to Rish Village, 17.11.1964, *A.R.K. Sastry* 40706 (CAL, L [L.2821353 digital image]); Kurung Kumey district, Palin to Yanglang, 09.09.2009, *S.S. Dash* 31179 (ARUN); Lohit district, around Glow Village, 19.12.1969, *J. Joseph* 48548 (ASSAM, CAL); Siang district, Boleng-Sangam, 400 m, 16.11.2013, *M. Bhaumik* 29806 (ARUN); Upper Siang district, Tuting to Koppu, 666–800 m, 07.11.1958, *R.S. Rao* 17406 (CAL); West Siang district, Nyodu to Sibe near Basar, 650 m, 28.11.2010, *M. Bhaumik* 25559 (ARUN). **Assam**, *s.loc.*, *s.d.*, *Griffith* 1120 (BM [BM000883942]); *s.loc.,, s.d., Simons* 4 (L [L.2821355 digital image]); Cachar district, Barak Res., 05.12.1914, *U. Kanjilal* 4828 (CAL); Goalpara district, Khalasi block, 13.02.1915, *U. Kanjilal* 5117 (ASSAM); Kamrup district, Hill near Guwahati, January 1887, *s.coll.* 672 (CAL); Lakhimpur district, Dulong R.F., 2 miles inside the forest from Bagjam bridge, 10.03.1962, *G. Panigrahi* 27714 (ASSAM); Sonitpur district, Balipara Tehsil, Charduar, March 1877, *G. Mann s.n.* (BM [BM011025800], CAL); Durrang, March 1877, *Dietritch* 725 (CAL); Tinsukia district, Digboi, 500 ft, January 1891, *G. Mann s.n.* (CAL); *Ibid.*, 06.02.1914, *U. Kanjilal* 3331 (ASSAM). **Meghalaya**, Khasia, *s.d., Griffith s.n.* (BM [BM000833368]); Mahadeo, 3000 ft, 09.10.1886, *C.B. Clarke* 44908 (CAL); *Ibid.*, 09.10.1886, *C.B. Clarke* 44908 B (BM [BM010760875]); Mount Khasia, 0–4000 ft, *s.d.*, *J.D. Hooker & T. Thomson s.n.* (BM [BM000883881], CAL, E [E00630367], G [G00492506 digital image], L [L.2821344 digital image], US [US 00444743 digital image]); *Ibid*, 3000 ft, 26.01.1886, *C.B. Clarke* 42840; *Ibid*, October 1877, *C.B. Clarke* 14479 (CAL); *Ibid*, 09.12.1871, *C.B. Clarke* 14479R (BM [BM010760876]); *Ibid*, 09.12.1871, *C.B. Clarke* 14479I (BM [BM011025799]); *Ibid*, 09.12.1871, *C.B. Clarke* 14479E (L [L.2821358 digital image]); *Ibid*, 09.12.1871, *C.B. Clarke* 14479F (L [L.2821365 digital image]); East Garo Hills district, Nokrek Biosphere Reserve, Nabogre to Patalgre, 29.03.2008, *V.N. Singh & B. Singh* 116856; Near Simsang river in Simsangre, 29.03.2008, *V.N. Singh & B. Singh* 116852 (ASSAM); East Khasi Hills district, Mawryngkneng, 4000 ft, 30.10.1951, *T.R. Chand* 5128 (E [E00630363], MICH [MICH 1197497 digital image]); Pynursla, 04.11.1938, *R.N. Dc. Forest* 17867; *Ibid.*, 28.12.2013, *R. Kumar* 131338 (ASSAM); Ri-Bhoi district, Nongpoh, Umraw, 24.10.1937, *S.R. Sharma* 15922 (CAL); West Jaintia Hills district, Dawki, 02.03.1938, *G.K. Deka* 16353; 42 miles Dawki to Shillong Road, 20.08.1935, *S.R. Sarma* 12156 (ASSAM). **Mizoram**, Aizwal district, Lushai Hills, 3500 ft, 28.03.1951, *Walter N. Koelz* 27398 (L [L.2821361 digital image], MICH [MICH 1197619 digital image]); *Ibid.*, 2500 ft, 17.02.1953, *G.K. Deka* 23357; *Ibid.*, 17.02.1953 *G.K. Deka* 23359 (ASSAM); Lunglei district, South Vanlaiphai, 3000–4000 ft, 06.02.1953, *Walter N. Koelz* 32638 (E [E00630365]; MICH [MICH 1197498 digital image]). **Nagaland**, Mon district, Jaboka, Naga Hills, February 1899, *Dr. Prain's collector* 754 (CAL). **Sikkim**, Pakyong district, Rangpo, *S. Kurz* 1; *Ibid.*, 1000 ft, October 1877, *G. King* 5133 (CAL). **West Bengal**, Darjeeling district, *s.d.*, *R.H. Beddome s.n.* (BM [BM000883882]); Mongpo, 2000 ft, 15.11.1870, *s.coll.* 13778; *Ibid.*, 3000 ft, 05.10.1908, *W.W. Smith* 206 (CAL); Ryong, 1500 m, 12.11.1870, *C.B. Clarke* 13699 (L [L.2821354 digital image], US [US 00444741 digital image]). MYANMAR, Upper Burma, Uoan, 1450 m, January 1912, *Capt. S.M. Toppin R.A.* 6012; Nya uka ugaw uka, 1300–1400 m, January 1912, *Capt. S.M. Toppin R.A.* 4351 (CAL); Burma-Tibet frontier, 1200 ft, 19.12.1930, *F. Kingdon Ward* 9051 (BM [BM000883880], E [E00630370]). **Kachin**, Hills south of Kanang, 3800 ft, 15.01.1962, *J. Keenan, U. Tun Aung & U. Tha Hla* 3431 (E

[E00630369]); Mapi-Zup Confluence, 4–5000 ft, 17.01.1962, *J. Keenan, U. Tun Aung & U. Tha Hla* 3283 (E [E00630368]). TAIWAN, **Chiayi Hsien**, Su-tzu-lu, 07.01.1964, *M.T. Kao* 5632 (US [US 00586563 digital image]). **Hualien Hsien**, Fuli Hsiang, N 23°11'02", E 121°17'50", 580–465 m, 02.12.1993, *Chi-hsiung Chen, Tsui -Ya Liu & Tseng-Pin Chiang* 388 (L [L.2107630 digital image]). **Kaohsiung Hsien**, Taoyuan Hsiang, Tengchih Forest Recreation Area, N 23°04'16", E 120°45'22", 03.02.1994, *Yih-Ren Lin, Yu-Wen Sang, Yu-Chuan Lu & Shi-Ju Liu* 314 (L [L.202620 digital image]). THAILAND, **Chiang Mai Province**, Doi Suthep, 3000 ft, 14.01.1912, *A.F.G. Kerr* 2302 (K). **Chaiyaphum Province**, Fankamang, 800 m, 16.12.1971, *C.F. Van Beusekom, C. Phengklai, R. Greesink* & *B. Wongwan* 4147 (K). **Ranong Province**, Klong Naka Wildlife Sanctuary, N 9°30, E 98°20', 100–600 m, 14.01.1990, *Scott Hoover* 5600 (E [E00190284]). VIETNAM, **Danang Province** (Tourane), Coldesnuges, *c.* 500 m, 11.02.1960, *Smitinad T. & E.C. Abbe* 6426 (K). **Hoa Binh province**, Da Bac district, 4–6 km to the N of Doan Ket Village, N 20°55'48", E 105°02'52", 800–1000 m, 30.03.2001, *N.T. Hiep, L. Averyanov & P.K. Loc* HAL455 (E [E00435175]); Mai Chau district, Hang Kia, N 20°43'39", E 104°53'43", 1000–1100 m, 08.04.2001, *N.T. Hiep, L. Averyanov* & *P.K. Loc* HAL762 (E [E00435176]). **Kon Tum province**, Kon Plong district, Hieu, Mang La forest enterprise, N 14°39', E 108°25', 1100–1200 m, 03.04.2000, *L. Averyanov* VH 5589 (E [E00435178]). **Son La province**, Ngoc Chien, Ban Chomkhon, 02.10.2008, *N.V. Du et al.*, 2230 (K [K000735625]); Phu Yen, Suoi To, Suoi Khang Village, 07.10.2008, *N.V. Du et al.*, HNK2685 (K [K000735624]). **Vinh Phuc Province**, Tam Duong, Ho Son, N 21°27'51", E 105°38'27", 930 m, 27.11.2003, *P. Thomas & N.D.T. Luu* 68 (E [E00311075]). *s.loc., s.d., Anon s.n.* (G00133039 digital image), *s.loc., s.d., F. De Silva* 794 (G [G00133135 digital image]).

Conservation status: *Aeschynanthus acuminatus* is a widely distributed species found across eight countries, with an Extent of Occurrence (EOO) of 34,79,811 km^2 and an Area of Occupancy (AOO) of 1200 km^2. It generally grows within evergreen forests, and the threat from habitat destruction is relatively low. Hence, it is provisionally assessed here as Least Concern (LC).

Notes: Middleton (2007) selected a sheet at G (G00133079) as the lectotype of *A. acuminatus* and provided the collection details as “Bangladesh, Sylhet, *N. Wallich* 6397 (lecto G-DC, designated here; iso BR, CGE, G, K-W)”. Upon reviewing the Wallich catalogue and herbarium labels, it appears that Wall. Cat. No. 6397 is associated with the collections by W. Gomez. While the K and CGE have good specimens (K000831876, K001123778, CGE00080064) with both vegetative and floral parts, it remains unclear why Middleton selected a specimen at G (G00133079), which only contains vegetative part, as the lectotype. No further typification is required since the syntypes provide all the necessary data.

In contrast to the general floral morphology associated with ornithophily in *Aeschynanthus*, such as long, narrow, tubular corolla with bright colours (scarlet or crimson), *A. acuminatus* has short, yellowish or reddish-green wide-open corolla. According to Chen *et al.* (2019), this species is adapted to effective pollination by a shift in flowering time from summer to winter (October to March) and the production of copious nectar.

While *A. acuminatus* is easily distinguished from other species in India by its widely ovate greenish bracts, reflexed calyx lobes (in mature specimens), yellowish or reddish-green corolla with a short, wide-open tube, strongly reflexed lower corolla lobes, and glabrous styles, it is often confused with *A. bracteatus*, likely because of their similar vegetative features. Some specimens in the Wall. Cat. No. 794 labelled as *A. bracteatus* (G00133135, G00133142), actually refers to *A. acuminatus* only.

Gardner (1849) described *A. chinensis* from Hong Kong, whereas Clarke (1874) regarded it conspecific with *A. acuminatus*. However, Clarke in 1883 treated it as a variety of *A. acuminatus*, which was later synonymised by Middleton (2007). A careful examination of the type specimens at K during the present study revealed no significant differences to recognize it as a distinct species or variety.

2. Aeschynanthus angustioblongus W.T.Wang, Acta Phytotax. Sin. 13: 64. 1975; Wang *et al*., Fl. China 18: 381. 1998; Z.Y.Li & Y.Z.Wang, Gesneriaceae China 371. 2004; Su.Datta *et al*., Phytotaxonomy 14: 23. 2015; Sinha & Datta, Nelumbo 58: 5. 2016. *Type*: CHINA, **Yunnan**, Gongshan Xian, 1500 m, 25.09.1938, *T.T. Yu* 20424 (holo PE [PE0004802 digital image!]; iso PE [PE00032297 digital image!], E [E00062755, E00062756, E00062757 photos!).

Fig. 15

Epiphytic perennial under shrubs. Stems branched, climbing, green, glabrous, rooting at nodes. Nodes slightly swollen; internodes 2–5 cm long. Leaves opposite; petioles 0.2–0.5 cm long, terete, canaliculated above, green, glabrous; lamina 3–6 × 0.5–1.5 cm, narrowly elliptic to oblong-lanceolate, fleshy, green, apex acute to acuminate, base attenuate, margins entire, glabrous; midvein sunken adaxially, prominent abaxially; lateral veins obscure. Flower solitary, axillary or sub-terminal; peduncles absent. Bracts 0.2–0.3 × *c.* 0.1 cm, linear to ovate, green, apex acute to obtuse, margins entire, nerves obscure, deciduous. Pedicels 0.8–2.2 cm long, angular, green, glabrous. Calyx free to base; lobes 0.6–0.8 × 0.1–0.2 mm, narrowly lanceolate, green, apex acute, margins entire, straight, glabrous out, pubescent in. Corolla 2–3.2 cm long, tube 1.8–2.9 cm long, 0.3–0.4 cm wide at base, gradually inflated towards the throat with 0.6–0.8 cm, slightly curved, outside red, pubescent, inside yellowish, glabrous; mouth not oblique; lobes outside red, dark striation running down from the middle of lobes, sparsely pubescent, inside glabrous, ciliate; upper lobes, 0.2–0.3 × 0.2–0.25 cm, oblong, apex obtuse to rounded, not reflexed; sinus 0.1–0.2 cm deep; lateral lobes, 0.2–0.3 × 0.2–0.3 cm, oblong, apex rounded, not reflexed; lower lobes 0.3–0.4 × 0.2–0.3 cm, elliptic, apex rounded, not reflexed. Stamens fused in two pairs, long exserted; anterior filaments 1.8–2 cm long, inserted at 0.8–1 cm from corolla base; posterior filaments 1.6–1.8 cm long, inserted at 1–1.3 cm from corolla base, filaments white at base, purple higher up, sparsely pubescent; anthers 0.1–0.3 × *c.* 0.1 cm, elliptic, purple, pollen grey. Staminode *c.* 0.05 cm long, clavate, inserted *c.* 0.8 cm from corolla base. Disk *c.* 0.1 cm high, annular. Pistils *c.* 3.5 cm long; stipe *c.* 0.5 cm long, glabrous; ovary 2–2.3 cm long,

Fig. 15. Holotype of *Aeschynanthus angustioblongus* W.T.Wang (PE [PE0004802]). © Institute of Botany, Chinese Academy of Sciences. Reproduced with permission.

linear, glabrous; styles 1.3–1.5 cm long, linear, sparsely pubescent; stigma *c*. 0.2 cm across, capitate. Capsules and seeds not seen.

Vernacular name: Narrow-leaf blushwort.

Flowering & fruiting: Flowering from June to September; fruits not seen.

Habitat: An epiphyte on trees in dense forests.

Distribution: China and India (GRC, 2024) (Figs. 16).

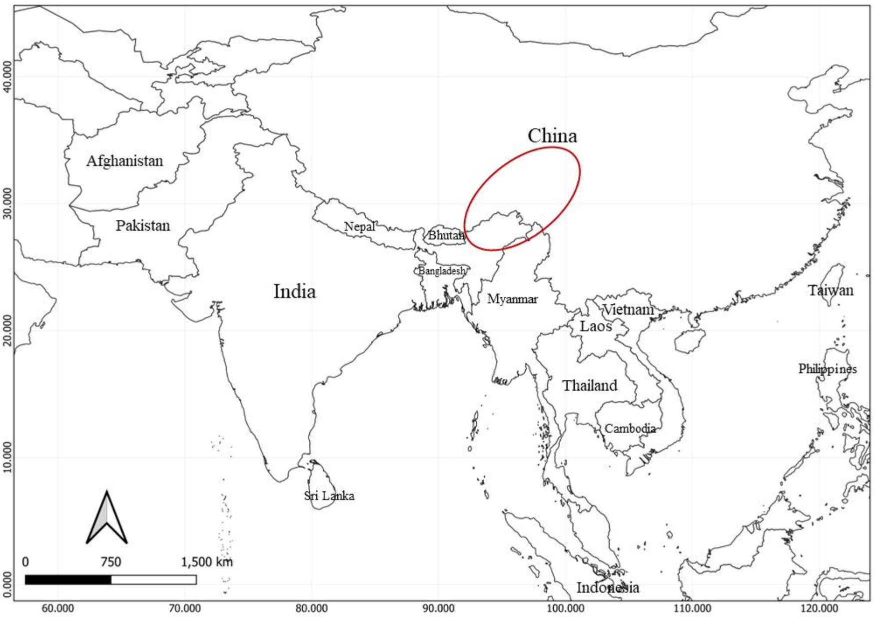


Fig. 16. Distribution of *Aeschynanthus angustioblongus* W.T.Wang

Specimens examined: INDIA, **Arunachal Pradesh**, Changlang district, Changlang, 27.06.1961, *D.B. Deb* 26181 (CAL); Lower Dibang Valley district, Tiwari Goam, 1109 m, 10.09.2021, *Momang Taram & Ojam Taku* 5007 (ARUN). **Nagaland**, Kohima, July 1886, *D. Prain s.n.* (CAL).

Conservation status: *Aeschynanthus angustioblongus* is found only in southern China (Yunnan) and Northeast India (Arunachal Pradesh and Nagaland). Although its EOO exceeds the threshold for the threatened categories (EOO=5,50,815.037 km^2), the current data on its AOO is very low (AOO=40 km^2). Due to insufficient information regarding the population size or potential threats, the species is treated here as Data Deficient (DD).

Notes: *Aeschynanthus angustioblongus* was first described by Wang from China in 1975. Although specimens of this species had been collected earlier from India in 1886 and 1961 by Prain and Deb, respectively, these specimens were wrongly identified under different taxa, until Datta *et al.* correctly reported it in 2015 from India.

Aeschynanthus angustioblongus can be easily distinguished from its morphologically similar *A. lineatus* Craib and *A. lasianthus* W.T.Wang by its narrowly oblong leaves and acuminate, ciliate calyx lobes.

3. Aeschynanthus bracteatus Wall. ex A.DC., Prodr. 9: 261. 1845 [Wall., Num. List 794. 1829; R.Br., Cyrtandreae 116. 1839, *nom. nud*.; Steud., Nomencl. Bot. ed. 2, 1: 32. 1840, *nom. nud*.; R.Br in Bennett, Pl. Jav. Rar. 116. 1840, *nom. nud*.]; Miq., Fl. Ned. Ind. 2: 718. 1858; C.B.Clarke, Commelyn. Cyrtandr. Bengal. t. 43. 1874, in A.DC. & C.DC., Monogr. Phan. 5: 31. 1883, in Hook.f., Fl. Brit. Ind. 4: 342. 1884; Kanjilal *et al.*, Fl. Assam 3: 391. 1939; B.L.Burtt & R.Davidson, Notes Roy. Bot. Gard. Edinburgh 21: 229. 1955; W.T.Wang, Phytologia 45: 311. 1980; N.P.Balakr., Fl. Jowai 2: 345. 1983; Harid. & R.R.Rao, Forest Fl. Meghalaya 2: 651. 1987; W.T.Wang, Fl. Reipubl. Popularis Sin. 69: 504. 1990; W.T.Wang *et al.*, Fl. China 18: 378. 1998; Hilliard in Grierson & D.G.Long, Fl. Bhutan 3: 1301. 2002; Kress *et al.*, Checkl. Myanmar 261. 2003; Z.Y.Li & Y.Z.Wang, Gesneriaceae China 368. 2004; D.J.Middleton, Edinburgh J. Bot. 66(3): 402. 2009; G.D.Pal, Fl. Lower Subansiri District, Arunachal Pradesh 2: 164. 2013; U.C.Bhattach., Phytotaxonomy 14: 6. 2015; B.K.Sinha & Su.Datta, Nelumbo 58: 5. 2016; S.S.Dash & P.Singh, Fl. Kurung Kumey District 2: 352. 2017; A.A.Mao *et al.*, Check List Fl. Nagaland 96. 2017; Gogoi *et al.*, Fl. Sikkim. Pict. Guide. 220. 2021; Souvann. *et al.*, Gard. Bull. Singapore 73(2): 448. 2021; Bh.Adhikari & Mich.Möller in M.F.Watson, Fl. Nepal (Web ed.). 2023. *Trichosporum bracteatum* (Wall. ex A.DC.) Kuntze, Revis. Gen. Pl. 477. 1891. *Lectotype* (designated by Middleton, 2009): BANGLADESH, Pundua, *s.d.*, *Wallich* 794 (G-DC [G00133086 digital image!]); isolecto (BM [BM000883860 digital image!], G [G00370740 digital image!], GZU [GZU000273692 digital image!], K [K00096767], L [L 0414373 digital image!]).

Aeschynanthus peelii Hook.f. & Thomson, Ill. Himal. Pl. t. 17. 1855; Anthony, Notes Roy. Bot. Gard. Edinburgh 18: 190. 1934; Hilliard, Fl. Bhutan 2(3): 1301. 2001. *Aeschynanthus bracteatus* var. *peelii* (Hook.f. & Thomson) C.B.Clarke, Commelyn. Cyrtandr. Bengal. t. 44. 1874. *Lectotype* (designated by Middleton, 2009): Hook.f., Ill. Himal. Pl. t. 17. 1855.

Figs. 17, 19 & 20

Epiphytic or lithophytic perennial under shrubs. Stems dichotomously branched, arching to pendulous, green to dark green when young, straw-coloured at maturity, glabrous, rooting at nodes. Nodes slightly swollen; internodes 1–3 cm long. Leaves opposite; petioles 0.5–1.5 cm long, terete, canaliculated above, green to dark green, glabrous; lamina 4–11 × 1.2–4.2 cm, elliptic or ovate to lanceolate, slightly fleshy or dry, dark green to green above, pale green beneath, apex acuminate to caudate, curved, base cuneate to rounded, margins entire, reflexed on drying, glabrous; midvein sunken adaxially, prominent abaxially; lateral veins generally 4–9 pairs, clearly visible. Inflorescences axillary or pseudoterminal, 2–6-flowered; peduncles 2–8 cm long, terete, green to reddish brown, glabrous. Bracts 1.5–3 × 0.5–2 cm, elliptic or ovate, red, apex acute, margins serrate, faintly 5–7-nerved, base concaved, persistent; bracteoles 1.5–2 × 0.5–0.8 cm, elliptic to lanceolate, red, apex acuminate, margins sub-entire, inflexed to form boat-like structure, nerves obscure, persistent; pedicels 0.8–1.5 cm long, terete to angular, dark red, glabrous. Calyx lobed from below middle; tube 0.3–0.5 cm long, red, glabrous; lobes 1.5–2.5 × 0.4–0.6 cm, narrowly ovate or narrowly elliptic, red, apex acuminate, margins entire, straight, glabrous. Corolla 3–4.5 cm long; tube 2.8–4 cm long, slightly bulged at base, 0.3–0.5 cm wide, narrowing above with 0.2–0.3 cm width, gradually widen towards the throat with 0.8–1 cm, inflated about the middle of the upper surface, curved with an obtuse angle, outside orange-red to bright red with dark red striations along length, glabrous, inside yellowish to orange red, glabrous; mouth slightly oblique; lobes outside orange to pinkish-red or bright red, pubescent, inside red with cream and dark markings on lower 3 lips, otherwise pale red, glabrous or sparsely pubescent, ciliate; upper lobes 0.5–0.7 × 0.2–0.5 cm, oblong or

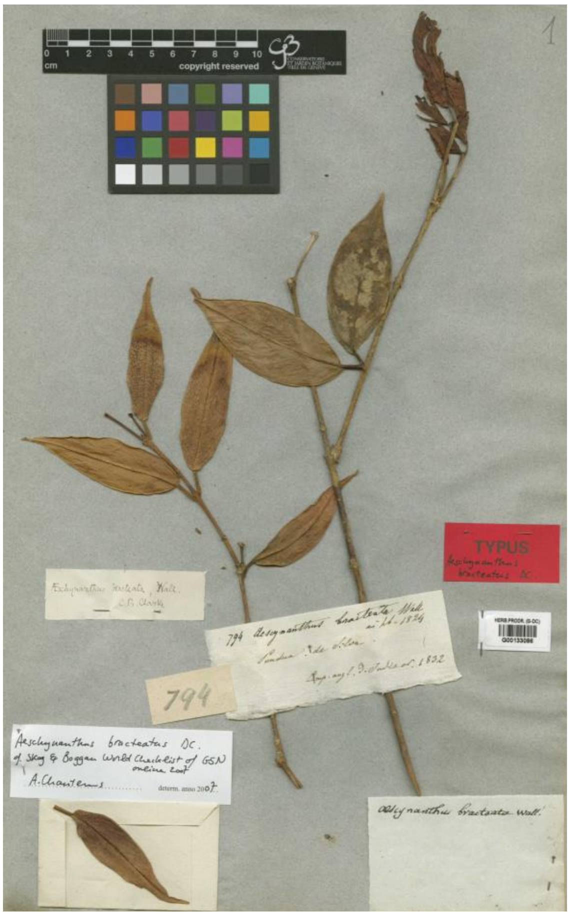


Fig. 17. Lectotype of *Aeschynanthus bracteatus* Wall. ex A.DC. (G-DC [G00133086]). © Conservatory and Botanical Garden of the City of Geneva. Reproduced with permission.

elliptic, apex rounded, reflexed or spreading; sinuses 0.2–0.4 cm deep; lateral lobes 0.5–0.8 × 0.2–0.5 cm, oblong, apex rounded, reflexed; lower lobe 0.3–1 × 0.4–0.7 cm, elliptic-oblong, apex rounded, margins incurved, slightly reflexed or spreading. Stamens fused in two pairs, long exserted; anterior filaments 2–2.5 cm long, inserted at 1.5–2 cm from corolla base; posterior filaments 1.5–2.5 cm long, inserted at 1.6–2.2 cm from corolla base; filaments white at base and red or purple higher up, glandular hairy; anthers *c.* 0.3 × 0.1 cm, elliptic to oblong, purple; pollen yellow. Staminode 0.1–0.2 cm long, clavate, inserted 1.8–2.2 cm from corolla base. Disk *c.* 0.1 cm high, 5-crenate or annular, cream. Pistils 2–4 cm long; stipe 0.5–2 cm long, pale green, glandular pubescent or gland dotted; ovary 1–2.5 cm long, linear, greenish white, glandular pubescent or gland dotted; styles 0.5–1 cm long, linear, green, puberulent; stigmas *c.* 0.2 cm across, capitate, purple or white. Capsules 7–15 × 0.2–0.3 cm, green to straw coloured. Seeds 0.8–1.5 × 0.2–0.25 mm, testa cells strongly papillose, papillae formed towards the end of the cell, slight to moderate clockwise orientation; apical appendage 2.5–3.5 mm long; hilar appendage a solitary hair, 2.5–3.8 mm long, appendages slightly papillose.

Vernacular name: Bracted blushwort.

Flowering & fruiting: Flowering from August to October and fruiting from October to December.

Habitat: An epiphyte on large trees or pendulous lithophytes near streams.

Distribution: Bhutan, China, India, Myanmar and Vietnam (GRC, 2024) (Fig. 18).

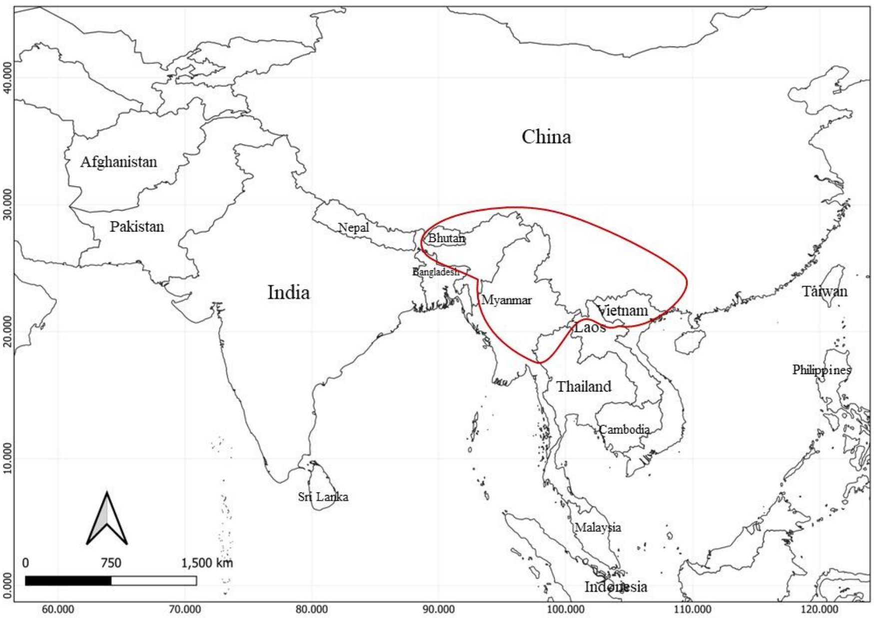


Fig. 18. Distribution of *Aeschynanthus bracteatus* Wall ex A.DC.

Fig. 19. *Aeschynanthus bracteatus* Wall. ex A.DC.: **a–c.** Habit; **d & e.** Bracts; **f.** Single flower; **g.** Corolla - lateral view; **h.** Corolla - upper view; **i.** Calyx; **j & k.** Corolla - split open; **j.** Showing basal tube and stamens front view, **k.** Showing corolla lobes and stamens back view; **l.** Inflorescence with capsule; **m.** Pistil with calyx.

Fig. 20. *Aeschynanthus bracteatus* Wall. ex A.DC. in its natural habitats.

Specimens examined: BHUTAN, **Eastern Bhutan**, Road to Jashigong 2 km from Wamrung, 15.10.1965, *N.P. Balakrishnan* 43906 (ASSAM). CHINA, **Tsarung province**, Mountains of Tjonatong, Salwin, 7000 ft, June-July 1932, *Joseph F. Rock* 22347; *Ibid*., Salwin-Kiu Chiang divide, N 28°24', E 98°24', 8000 ft, July 1921, *G. Forrest* 20092 (K). **Yunnan**, Maglagi, 6000 ft, *A. Henry* 9221; Syemao furata, 4000 ft, *s.d., A. Henry* 12611; *Ibid*., *s.d., A. Henry* 12184A; *Ibid*., *s.d*., *A. Henry* 12247; *Ibid*., *s.d., A. Henry* 9221A; Teng-yueh, *s.d*., *Wang Wentsai* 114 (K). INDIA, East Bengal, *s.loc*., *s.d*., *Griffith* 3807 (G [G00492469 digital image], K, U [U.1600057 digital image]). East Himalaya, *s.loc*., *s.d*., *Griffith* 3808 (G [G00492416 digital image], U [U.1600056 digital image]). **Arunachal Pradesh**, Anjaw district, Delei Valley, 5000 ft, 28.05.1928, *F. Kingdon Ward* 8274; *Ibid*., 28.05.1928, *F. Kingdon Ward* 8478; Tirap district, Raho to Vakamoska, 26.08.1958, *G. Panigrahi* 16835; *Ibid*., 26.08.1958, *G. Panigrahi* 16840 (ASSAM); West Kameng district, Rupa, 12.04.1952, *G. Panigrahi* 6792 (ASSAM, CAL); Sela Forest, 2000 m, 15.09.1964, *J. Joseph* 39991 (ASSAM). **Manipur**, Kaplu, 5–6000 ft, November 1907, *A. Meebold* 6743 (CAL). **Meghalaya**, Khasia Hills, *s.d., s.coll. s.n.* (L [L.2821186 digital image]); *Ibid*., *s.d., T. Thomson s.n.* (L [L.2821188 digital image]); *Ibid*., 1865, *s.coll. s.n.* (G [G00492407 digital image]); *Ibid.*, 4–6000 ft, *s.d., J.D. Hooker & T. Thomson s.n.* (G [G00492572 digital image], L [L.2821196 digital image]); *Ibid.*, 4500 ft, 28.09.1867, *C.B. Clarke* 10177 (L [L.2821198 digital image]); *Ibid.*, *s.d., R. Wight s.n.* (L [L.2821199 digital image]); East Khasi Hills district, Cherrapunji, *s.d., Griffith s.n.* (L [L.2821195 digital image]); *Ibid*., 4000 ft, November 1878, *Geo Gallatly* 702 (CAL); Cherrapunji to Mairang, 2800–4500 ft, October 1855, *Sachlagintweit s.n.* (L [L.2821194 digital image]); *Ibid*., (Sohra Corkhill), 4300 ft, 06.11.1872, *C.B. Clarke* 18913 (K); Cherrapunji Circuit house, 28.09.1956, *G. Panigrahi* 3661 (CAL); Dympep, 20.07.1930, *P.C. Kanjilal* 8222; Laitlyngkot, 25.09.1930, *Scoter Dogman* 8572; *Ibid*., 07.10.1930, *S.R. Sharma* 2623; Mawlong, 13.09.1931, *P.C. Kanjilal* 9423 (ASSAM); Mawmluh, 400 ft, 09.10.1886, *C.B. Clarke* 45016 (CAL); Mawphlang, 21.09.1958, *G. Panigrahi* 17151 (ASSAM); Mawsmai, 28.09.1956, *G. Panigrahi* 3661 (ASSAM, CAL); near Mawsmai Cave, towards river side, 22.09.1967, *H. Deka* 37749 (ASSAM); way to Mawsynram, 1250 m, 08.10.2017, *Vishnu Mohan & Santhosh Nampy* 156829 (CALI); Pynursla, 04.11.1938, *K. Biswas* 4001 (CAL); *Ibid*., 06.09.1941, *R.N. Dc. Forest* 20594; *Ibid*., 25.11.1956, *G. Panigrahi* 4612 (ASSAM); *Ibid*., 16.10.1957, *G. Panigrahi* 10190 (ASSAM, CAL); way to Pynursla, N 25°19'57", E 91°53'56", 1350 m, 20.09.2021, *M.K. Akhil & Santhosh*

Nampy 186405; *Ibid*., N 25°23'30", E 91°54'25", 1350 m, 20.09.2021, *M.K. Akhil & Santhosh Nampy* 186409 (CALI); Pynursla to Dawki, 26.11.1956, *G. Panigrahi* 4729 (ASSAM, CAL); Sohrarim, 17.10.1964, *A.S. Rao* 37785; *Ibid.*, 17.10.1967, *A.S. Rao* 37785 (ASSAM); *Ibid.*, 5000 ft, 28.10.1871, *C.B. Clarke* 16441 (CAL); Near Sohrarim, 600 ft, 16.09.1913, *U. Kanjilal* 2578 (ASSAM, CAL); *Ibid.*, 5000 ft, 12.09.1885, *C.B. Clarke* 40406; Shillong peak forest, 18.11.1954, *s.coll. s.n.*; Upper Shillong, 10.09.1913, *U. Kanjilal* 312. P.T.C.; *Ibid.*, 15.09.1913, *U. Kanjilal* 294 PIC; *Ibid.*, 28.10.1936, *S.R. Sharma* 15031 (ASSAM); way to Wah-Kaba waterfalls, N 25°18'71", E 91°43'93", 1300 m, 26.09.2021, *M.K. Akhil & Santhosh Nampy* 186428; *Ibid*., N 25°19'71", E 91°42'93", 1300 m, 26.09.2021, *M.K. Akhil & Santhosh Nampy* 186429 (CALI); Jaintia Hills district, Jarain, 4000 ft, September 1886, *G. Mann s.n.*; Jarain to Jowai, 07.08.1962, *M.R. Stalin* 28641 (ASSAM); West Jaintia Hills district, 4000 ft, September 1886, *G. Mann s.n.* (CAL). **Nagaland**, Kohima, 7000 ft, 29.08.1937, *N.L. Bor* 16256 (ASSAM); way to Dzuku valley, N 25°33'30", E 94°06'18", 2452 m, 30.10.2021, *M.K. Akhil & Santhosh Nampy* 186441 (CALI); Naga Hills, Takubama, *c.* 7000 ft, August 1950, *Walter N. Koelz* 25713 (L [L.2821187 digital image]). **Sikkim**, *s.loc.*, *s.d.*, *Griffith* 3808 (K); *Ibid*., 09.10.1868, *S. Kurz s.n.* (CAL); *Ibid*., July 1984, *N.L. Bor* 19917; *Ibid*., 7–9000 ft, *J.D. Hooker s.n.* (CAL, G [G00492566 digital image], K [K000096768, K000096769], L [L.2821197 digital image]); *Ibid., s.d.*, *T. Thomson s.n.* (L [L.2821189 digital image]); *Ibid.*, 6000 ft, 07.10.1874, *G. King s.n.* (CAL); 5000 ft, 28.07.1875, *G. King* 27 (CAL); Sikkim Himalaya, *s.loc.*, 700 ft, 25.08.1872, *G. King s.n.* (CAL); West Sikkim district, Hilley Reserve Forest, 2700 m, 22.08.1994, *P. Singh* 14043 (CAL). **West Bengal**, Darjeeling district, *s.loc*., 1904, *Drummond* 20994 (K); *Ibid*., 7800 ft, 07.08.1875, *C.B. Clarke* 26872 (L [L.2821190 digital image]); 7000 ft, August 1881, *J.S. Gamble* 9622 (K); *Ibid.*, 28.07.1874 *s.coll. sn.* (K); Lepchajagat, 7000 ft, 04.09.1902, *J.H. Lace* 2366 (CAL); Ramam, 2400 m, 05.08.1972, *H. Kanai*, *H. Ohashi*, *H. Hara*, *K. Iwatsuki & H. Ohba* 881272 (L [L.2107629 digital image]); Runglee, 6000 ft, 17.08.1869, *C.B. Clarke* 8650 (L [L.2821193 digital image]); Tonglu, 8–10000 ft, *s.d.*, *S. Kurz s.n.* (CAL); *Ibid*., 03.08.1862, *T. Anderson* 972 (CAL). MYANMAR, **Kachin**, Chawngmaw, 7000–8000 ft, 10.08.1919, *F. Kingdon Ward* 3476 (E [E00096777]); Hpawte woods, 6–7000 ft, 22.08.1919, *R. Farrer* 1257 (E [E00096765]); *Ibid.*, 22.08.1919, *R. Farrer* 1258 (E [E00096766]); Myitkyina, 1 mile from Kangfang, 20.08.1938, *Naw Mu Pa* 17452 (K); Valley of Naung Chaung, 6000–7000 ft, 22.08.1914, *F. Kingdon Ward* 3476 (E [E00096778]); North Triangle (Tama Burn), 6000–7000 ft, 10.10.1953, *F. Kingdon*

Ward 21436 (BM [BM000883933]); ridge above Laktang, 8000 ft, 29.05.1919, *F. Kingdon Ward* 3113 (E [E00096769]); Putao, Nam Tamai Valley, 4000 ft, 17.09.1926, *F. Kingdon Ward* 7398 (K); *Ibid*., 17.09.1926, *F. Kingdon Ward* 7414 (K); Between Sadon and the Yunnan Chinese boarder at Changtifang and Kambaiti, November 1922, *J.F. Rock* 7426 (US [US00444739 digital image]); descent from Sansi gorge to Sadon, 8000 ft, September 1912, *G. Forrest* 9102 (E [E00087183]); *Ibid.*, 7000 ft, September 1912, *G. Forrest* 9149 (E [E00096767]); Valley of Senghku, 7000 ft, 05.08.1926, *F. Kingdon Ward* 7242 (K); *Ibid*., 21.09.1926, *F. Kingdon Ward* 7434 (K). VIETNAM, **Cao Bang,** Massif du Pia Houac, Namkep–Cao Houac, July 1922, *A. Petelot* 705 (P [P 00444738 digital image]). **Ha Giang**, Vi Xuyen, Cao Bo, Tam Ve Village, 1250 m, 08.09.2000, *Harder D.K., Lok P.K., Du N.V. & N.Q. Hieu* 5310 (E [E00435278], SING). **Lao Cai**, Sa Pa district, on the track to Fansifan Peak from Ton Station, 2000 m, 13.09.2005, *Vu Xuan Phuong et al.* HNK295 (K [K000610685]); Khoang Village, 1700 m, 11.09.2005, *Vu Xuan Phuong et al.* HNK45 (K [K000610686]); *Ibid*, 11.09.2005, *Vu Xuan Phuong et al.* HNK113 (K [K000610639]); Sin Chai, 1377 m, 15.09.2005, *Vu Xuan Phuong et al.* HNK471 (K); Ta Phin, Tseng Seng Village, 1308 m, 17.06.2006, *P.K. Loc, N.T. Vinh & N.S. Khang* 8854 (E00435279). **Thanh Hoa**, Ba Thuoc district, Co Lung, Khuyn Village, 16.09.2003, *L. Averyanov, P.K. Lok, D.T. Doan, J. Regalado & N.T. Vinh* 2948 (E [E00435174]). *s.loc., s.d., Griffith s.n.* (L [L.2821192 digital image]); *s.loc.*, 29.08.1950, *s.coll. s.n.* (G [G00492445 digital image]).

Conservation status: *Aeschynanthus bracteatus* is distributed across five countries, with an EOO of 19,47,908.560 km^2. Based on current data, its AOO is below 500 km^2, however, no severe threats to its habitat or population have been identified. The species is therefore provisionally assessed as Least Concern (LC).

Notes: Wallich (1829) was the first to use the name *Aeschynanthus bracteatus* for a plant collected from Pundua (probably part of Bangladesh). This name was later adopted by Brown (1839, 1840), Steudel (1840), and others, but it remained invalid until de Candolle (1845) formally recognized it.

Hooker and Thomson (1855), subsequently, collected specimens from the cooler, higher elevations of Darjeeling (Jillapahar, now Jalpahar). These plants had ovate-lanceolate leaves, and two flowers per pair of bracts, which they described as *A. peelii* Hook.f. & Thomson, and provided a beautiful illustration. The most noticeable feature was the vivid red colour of the peduncles, pedicels, bracts, and flowers, contrasted with the deep glossy green leaves. They also noticed similar specimens from the lower altitudes of the Khasia Mountains, which had linear leaves and many flowers per pair of bracts. Hooker and Thomson (*l.c.*), suggested that these specimens could represent a variety of *A. peelii.* Later, Clarke (1874) treated *A. peelii* as a variety of *A. bracteatus* and concluded that the specimens from the Khasia Mountains were simply *A. bracteatus*.

Anthony (1934) revisited the *A. bracteatus–A. peeli* complex, examining a broader range of morphological features, such as leaf shape, the proportion of peduncle to petiole size, and the size and shape of calyx lobes and corolla. Based on these observations, he resurrected *A. peeli* from synonymy and described a new variety *A. peelii* var. *oblanceolata* J.Anthony (currently considered a synonym of *A. linearifolius*; see notes under *A. linearifolius*).

However, Burtt and Davidson (1955) re-examined this species complex and found no consistent correlation between variations in leaves and flowers, nor between geographical and morphological differences. They concluded that *A. peelii* should not be treated as a distinct species. The present study, based on live collections from different geographical regions and an extensive herbarium study, supports this conclusion.

The specific epithet 'bracteatus' refers to the distinctive red bracts of this species, which are almost equal or exceed the calyx and remain persistent even in mature fruit.

Ethnobotanically, *A. bracteatus* holds significance for its traditional medicinal use by the Yao people of China, who have long utilized the plant in medicinal baths to treat rheumatoid arthritis and aid postpartum convalescence (Li *et al.*, 2008).

4. Aeschynanthus chiritoides C.B.Clarke in A.DC. & C.DC., Monogr. Phan. 5: 28. 1883, in Hook.f., Fl. Brit. Ind. 4: 341. 1884; Hilliard in Grierson & D.G.Long, Fl. Bhutan 3: 1300. 2002; Kress *et al.*, Checkl. Myanmar 261. 2003; U.C.Bhattach. & Goel, Phytotaxonomy 14: 7. 2015; B.K.Sinha & Su.Datta, Nelumbo 58: 6. 2016. *Trichosporum chiritoides* (C.B.Clarke) Kuntze, Revis. Gen. Pl. 477. 1891. *Lectotype* (designated by Middleton, 2009): INDIA, **Arunachal Pradesh**, *s.d.*, Booth *s.n.* (K [K000096758!]); *residual syntype*: INDIA, **Assam** (East Bengal), *s.d.*, *Griffith* 3810 (K [K000190149!]).

Aeschynanthus pusillus Prain, J. Asiat. Soc. Bengal 67(2): 299. 1898. *Lectotype* (designated by Middleton, 2009): MYANMAR (BURMA), Kachin Hills, January 1898, *Shaik Mokim s.n.* (K [K000096762!]).

Aeschynanthus denticuliger W.T.Wang, Acta Phytotax. Sin. 13(2): 65. 1975; W.T.Wang, Phytologia 45: 315. 1980; H.W.Li, Acta Bot. Yunnan. 5(1): 31. 1983; W.T.Wang, Bull. Bot. Res. Harbin 4(1): 29. 1984; Fl. Republ. Popularis Sin. 69: 519. 1990; W.T.Wang *et al.*, Fl. China 18: 383. 1998. *Type*: CHINA, **Yunnan**, Xichou, Fadou, 1200 m, 12.12.1939, *C.W. Wang* 85615 (holo PE; E [E00062767] photo!).

Figs. 21–22

Epiphytic or lithophytic perennial herbs. Stems slender, branched, hanging, green to brownish green, pubescent, rooting at nodes. Nodes not swollen; internodes 1.5–2.5 cm long. Leaves opposite or ternate; petioles 0.1–0.6 cm long, terete, green, pilose; lamina 0.8–2.3 × 0.4–0.8 cm, elliptic, fleshy, green above, pale green beneath, apex obtuse to rounded, base cuneate, margins entire to weakly dentate, pilose above, pilose to pubescent below, ciliate; midvein not prominent, lateral veins obscure. Flowers axillary, solitary or in pairs; peduncles absent. Bacts deciduous; pedicels 0.3–0.6 cm long, terete, yellowish green, pilose. Calyx free to base; lobes 0.4–0.8 × 0.1–0.3 cm, narrowly triangular or narrowly lanceolate, pale green, apex acute to acuminate, margins entire, pilose out, glabrous in, ciliate. Corolla 2.8–3.2 cm long; tube 2.4–2.8 cm long, slightly bulged at base, 0.2–0.3 cm wide,

Fig. 21. Lectotype of *Aeschynanthus chiritoides* C.B.Clarke (K [K000190149]). © The Board of Trustees for the Royal Botanic Gardens, Kew. Reproduced with permission.

narrowing above with 0.1–0.2 cm wide, gradually widen towards the middle with 1–1.2 cm, again shrink to 0.8–1 cm towards the throat, obliquely swollen about the middle of the lower surface, often curved at upper surface, outside white or yellowish-white with a few thin purple streaks along the length, puberulous, inside white on upper side, white with yellow on lower throat with purple streaks running along the length and extends to the lower lobes, sparsely puberulous; mouth slightly oblique; lobes outside white, pubescent, inside white with three interrupted purple streaks on lower lips, glabrous, ciliate; upper lobes 0.5–0.6 × 0.4–0.7 cm, ovate or oblong, apex obtuse to rounded, spreading; sinus *c.* 0.5 cm deep; lateral lobes 0.5–0.8 × 0.5–0.7 cm, ovate, apex rounded, spreading; lower lobe 0.5–0.8 × 0.4–0.6 cm, oblong, apex rounded, spreading. Stamens all coherent by their tips, not exserted; anterior filaments 1–1.3 cm long, inserted at 1.2–1.5 cm from corolla base, posterior filaments 0.9–1.4 cm long, inserted at 1.5–1.8 cm from corolla base; filaments white, sparsely glandular-hairy at tip; anthers 0.2–0.3 × 0.1–0.2 cm, oblong, maroon; pollen cream. Staminode *c.* 0.2 cm long, clavate, inserted at *c.* 2 cm from corolla base. Disk 0.1–0.3 cm high, 5-crenate or annular, pale green. Pistils 2.6–3.5 cm long; stipe 0.8–0.9 cm long, yellowish green, glandular puberulent; ovary 2–3 cm long, linear, purple, sub-sessile, glandular hairy; styles 0.9–1.1 cm long, linear, pale purple, glandular-pubescent; stigmas *c.* 0.1 cm across, capitate, greenish white. Capsules 6–12 × 0.5–0.6 cm, green. Seeds *c.* 0.1 × 0.03 cm, warty, apical appendage, 1.6–2 cm long; hilar appendage a solitary filiform hair, 1.2–1.7 cm long; appendages papillose.

Flowering & fruiting: Flowering from November to December and fruiting from December to March.

Habitat: An epiphyte on small trees, or large fallen trees or as a lithophyte on large rocks inhabited by mosses and other plants in evergreen forests.

Distribution: Bhutan, China, India, Laos, Myanmar and Vietnam (GRC, 2024) (Fig. 23), however, I was unable to find any specimens from Bhutan and Laos from the herbaria I consulted.

Specimens examined: INDIA, **Arunachal Pradesh**, East Siang district, Rotung, 1300 m, 17.01.1912, *I.H. Burkil* 36089 (CAL); Tirap/Changlang district, Tirap Forest Division, Longsek hillock (Cherplang), 1500 m, 18.06.1961, *D.B. Deb* 25751(CAL). **Assam,** Dibrugarh district, Makum Dihing River, 16.03.1894, *G.A. Gammie* 66 (CAL); Siam, March 1883, *s.coll.* 331177, 331178 (CAL); Hailakandi district, Nunai, Bhutan

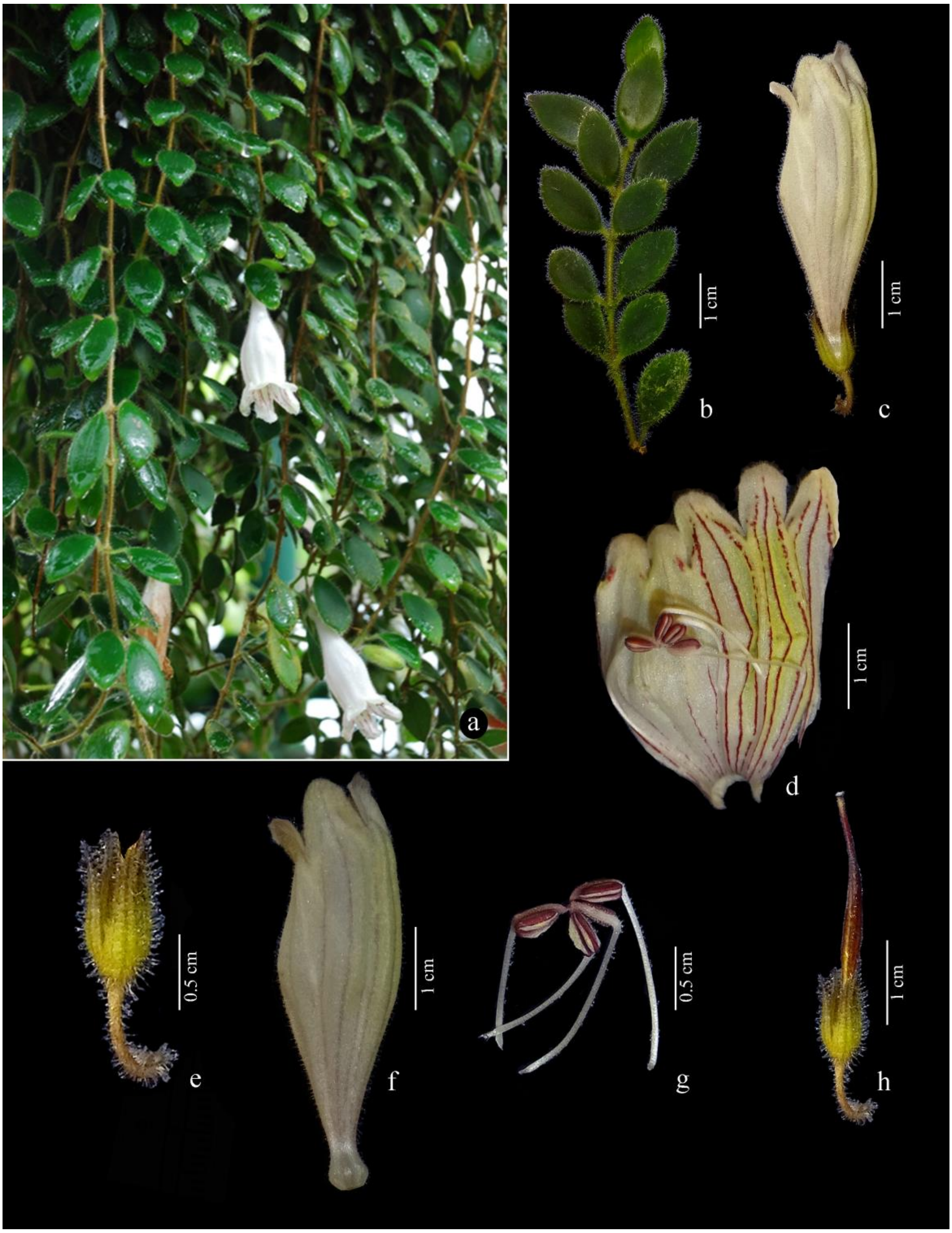


Fig. 22. *Aeschynanthus chiritoides* C.B.Clarke: **a.** Habit; **b.** Habit showing leaves; **c.** Single flower; **d.** Corolla - split open, **e.** Calyx; **f.** Corolla - lateral view; **g.** Stamens; **h.** Pistil with calyx.

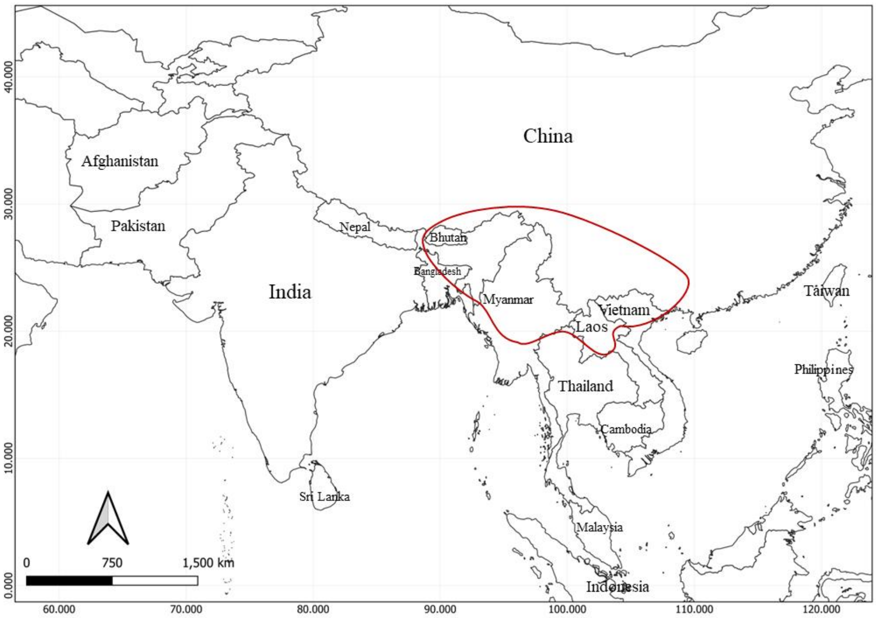


Fig. 23. Distribution of *Aeschynanthus chiritoides* C.B.Clarke

road, 1100–1300 m, 22.04.1958, *B.K. Nath* 13227 (CAL); Lakhimpur district, Kakoi R.F., 15.03.1962, *G. Panigrahi* 27904 (CAL). **Manipur**, Barak, 3000 ft, November 1907, *A. Meebold* 6418 (CAL). **Meghalaya**, Khasia, *s.d., s.coll. s.n.* (K [K000190150]); *Ibid*, 1219 m, *s.d., J.D. Hooker & T. Thomson s.n.* (K [K000190147]); East Khasi Hills district, Cherrapunji, 12.08.1960, *G. Panigrahi* 21947 (CAL); Kharrang, May 1899, *Dr. Prain's collector s.n.* (CAL); Shillong, 09.12.1969, *J. Joseph* 48519; *Ibid.*, 2000 ft, 05.10.1879, *G. King M.B.* 145 (CAL). **Nagaland**, Kohima district, 6000 ft, February 1906, *A. Meebold* 5221; Mokokchung district, Chungliyimsen, 1000 ft, 30.03.1834, *s.coll.* 329 (CAL). **Sikkim**, *s.loc*., *s.d., R.S. Rao* 42, 77 (CAL); Sikkim Himalaya, 1878, *G. King* 331169 (CAL); Mangan district, Mangan, 3000 ft, 29.05.1959, *S.K. Mukerjee* 5037 (CAL). LAOS, **Louang Namtha,** Nam Mai–Vienphoukha, 31.05.1936, *E. Poilane* 26366 (P). MYANMAR, **Kachin**, Sumprabum, 3000 ft, 04.02.1953, *F. Kingdon Ward* 20474 (BM [BM011025814]); Mali Itba, 3000 ft, 28.12.1930, *F. Kingdon Ward* 9064 (BM [BM000883876]); North Triangle (Mashaw), 2000–3000 ft, December 1953, *F. Kingdon Ward* 21658 (BM [BM011025815]); Putao, 2000–3000 ft, 10.12.1937, *F. Kingdon Ward* 13574 (BM [BM000883875]). VIETNAM, **Ha Giang**, Hoang Su Phi district, Ho Thau, 1200–1500 m, 10.03.2005, *L.V. Averyanov, P.K. Lôc, N.T. Vinh & A. Averyanova* HAL6635 (E [E00653266]); Yen Minh, Lao Va Chai Commune, 1450 m, 13.11.2002, *M.F. Gardner, P. Thomas & N.D.T. Luu* 163 (E [E00630605]). **Lao Cai**, Van Ban district, Nam Xe, Nam Xi Tan, 700–1113 m, 26.02.2001, *D.K. Harder, P.K. Lôc, N.T. Hiep, G.E. Schatz, S. Bodine & N.Q. Hieu* 6898 (E [E00435236]). **Vinh Phu**, Massif du Tam-Dao, 1000 m, December 1930, *A. Petelot s.n*. (E [E00630604]). *s.loc.*, *s.d*., *N.L. Bor s.n.* (ASSAM).

Conservation status: *Aeschynanthus chiritoides* is found in six countries, with an EOO of 6,78,510.028 km^2. Based on current data, its AOO is estimated at 104 km^2, and no significant threats to its habitat or population have been identified. The species is therefore provisionally assessed as Least Concern (LC).

Notes: The species description was originally based on specimens collected by Nuttall from Bhutan (now part of Arunachal Pradesh), Griffith from Assam, and Hooker and Thomson from Khasia. Clarke (1883) relied on features, such as phyllotaxy and the nature of the corolla tube, to distinguish this species from the closely allied *A. gracilis*. Until Middleton (2009), nobody else (Clarke, 1884; Hilliard, 2001), commented on the most distinguishing characteristics, such as its white or yellow corolla and the fully-coherent anthers.

King and Prain (1898) and Wang (1975) described *A. pusillus* Prain and *A. denticuliger* W.T.Wang respectively, from Myanmar and Yunnan Province of China. Wang (1984) even established a new section, *Aeschynanthus* sect. *Xanthanthos* W.T.Wang, based on the white or yellow corolla and non-exserted stamens of *A. denticuliger*.

Middleton (2009) after detailed examination of specimens from China, Yunnan and other regions, including Northeast India, Thailand, and Vietnam found that the hairiness of the calyx and ovary are merely variations of *A. chiritoides*, and synonymised *A. pusillus* and *A. denticuliger* under it.

Although Clarke (1883) considered the ternate leaf as a major characteristic of this species, a more detailed examination revealed that this character is not always consistent. In the vegetative or fruiting stages, *A. chiritoides* can be easily confused with *A. gracilis* (see notes under *A. gracilis*).

The specific epithet '*chiritoides*' refers to the superficial similarity of its corolla to that of *Chirita* (= *Henckelia*), in contrast to the generally bright, tubular corolla found in *Aeschynanthus*.

5. Aeschynanthus fulgens Wall. ex R.Br., Cyrtandreae 115. 1839; Steud., Nomencl. Bot. ed. 2, 1: 32. 1840; R.Br. in Bennett, Pl. Jav. Rar. 115. 1840; A.DC., Prodr. 9: 261. 1845; C.B.Clarke in A.DC. & C.DC., Monogr. Phan. 5: 21. 1883, in Hook.f., Fl. Brit. Ind. 4: 338. 1884; Kress *et al.*, Checkl. Myanmar 261. 2003; Middleton, Edinburgh J. Bot. 64: 381. 2007; U.C.Bhattach. & Goel, Phytotaxonomy 14: 8. 2015. *Trichosporum fulgens* (Wall. ex R.Br.) Kuntze, Revis. Gen. Pl. 477. 1891. *Lectotype* (designated by Middleton, 2007): MYANMAR, **Tanintharyi**, Dawei (Tavoy), *s.d.*, W. Gomez in *Wallich* 797 (K [K001111916!]; isolecto BM [BM000883874!], E [E00259870!, E00259871!], G [G00370743 digital image!], K [K000831871!, K000831872!, K000831873!]).

Aeschynanthus evrardii Pellegr., Bull. Soc. Bot. France 72: 824. 1926 (1925); Pellegr., Fl. Indo-Chine 4: 499. 1930. *Lectotype* (designated by Middleton, 2007): VIETNAM, **Lam Dong**, Ang Kroet, 26.10.1920, *F. Evrard* 358 (P [P00492372 digital image!]; isolecto P [P00606317, P00606318 digital images!]).

Aeschynanthus stenosiphonius W.T.Wang, Bull. Bot. Res. Harbin 3(4): 49. 1983; Smitinand, Thai Pl. Names ed. 2, 15. 2001; Burtt, Thai Forest Bull. (Bot.) 29: 84. 2001. *Type*: LAOS, Vieng Pa Pow Tha Kaw, 02.11.1921, *B. Hayata s.n.* (holo TI; iso TI).

Figs. 24–25

Epiphytic perennial under shrubs. Stems branched, arching and pendulous, green or olive-green with purple blotches, glabrous, rooting at nodes. Nodes swollen; internodes 4.5–12 cm long. Leaves opposite; petioles 0.5–1.8 cm long, terete to angular, canaliculated above, green, glabrous; lamina 9–17 × 1.8–5 cm, elliptic, oblong or ovate, coriaceous to fleshy, light to dark green above, pale green beneath, apex acuminate, base cuneate to rounded, margins entire, glabrous; midvein sunken adaxially, prominent abaxially; lateral veins 5–6 pairs, weakly visible to obscure. Inflorescences pseudoterminal or axillary, 3–16-flowered; peduncles absent. Bracts 0.2–1 cm long, ovate or linear, green, apex acute, margins entire, nerves obscure, glabrous, deciduous; pedicels 0.5–0.9 cm long, terete to angular, green or yellowish green with a purple tinch, glabrous. Calyx lobed from above middle; tube 1–2 cm long, green, yellowish green or brown, glabrous; lobes 0.5–1 × 0.3–0.6 cm, triangular, green to brownish red, apex acute to acuminate, margins entire, glabrous, ciliate. Corolla 4.5–7 cm long; tube 4.2–6.5 cm long, 0.2–0.3 cm wide at base to middle, strikingly inflated towards the throat with 1.2–1.5 cm wide after above middle, curved evenly, outside yellowish green at base to middle, crimson red higher up, glandular pubescent, inside yellowish to cream, glabrous; mouth slightly oblique, lobes outside orange to crimson red with dark central lines running down to the throat, pubescent; inside orange, margins arched with reddish brown arrow, ciliate; upper lobes 0.3–0.7 × 0.3–0.7 cm, deltoid, apex acute to obtuse, not reflexed; sinus 0.3–1 cm deep; lateral lobes 0.3–0.8 × 0.5–0.9 cm, deltoid, apex acute to obtuse; not reflexed, lower lobe 0.5–1.4 × 0.3–0.6 cm, oblong or elliptic, apex obtuse or rounded, slightly reflexed. Stamens fused in two pairs, long exserted; anterior filaments 2–5 cm long, inserted at 3–4.8 cm from corolla base; posterior filaments 2.5–4.2 cm long, inserted at 3.2–5 cm from corolla base; filaments white at base, reddish to purple higher up, glandular pubescent; anthers 0.4–0.6 × 0.08–0.09 cm, elliptic, purple or grey; pollen grey. Staminode *c.* 0.1 cm long, clavate, inserted *c.* 4 cm from corolla base. Disk 0.1–0.2 cm high, 5-crenate or annular, pale green. Pistils 2–8 cm long; stipe 1–2 cm long, green or cream, glabrous; ovary 1–3.5 cm long, linear, green or cream, glabrous or gland dotted; styles 1–4 cm long, linear cream or white, glandular pubescent, stigmas *c.* 0.2 cm across, capitate, white to pink. Capsules 15–40 × 0.2–0.5 cm, green. Seeds 0.8–2 × *c.* 0.3 mm, testa cells warty; apical appendage 1.5–3 cm long; hilar appendage a solitary hair, 1.3–3.5 cm long, appendages papillose.

Fig. 24. Lectotype of *Aeschynanthus fulgens* Wall. ex R.Br. (K [K001111916]). © The Board of Trustees for the Royal Botanic Gardens, Kew. Reproduced with permission.

Fig. 25. *Aeschynanthus fulgens* Wall. ex R.Br.: **a.** Habit; **b.** Inflorescence; **c.** Single flower; **d.** Corolla - lateral view; **e.** Calyx - in; **f.** Calyx - out; **g.** Corolla - split open; **h.** Pistil (Images from living collection @ RBGE).

Flowering & fruiting***: Flowering from May to August and fruiting from August to September.

Habitat: An epiphyte in primary or disturbed evergreen, mixed deciduous, or mossy forests.

Distribution: Cambodia, India, Laos, Malaysia, Myanmar, Thailand, and Vietnam (GRC, 2024) (Fig. 26).

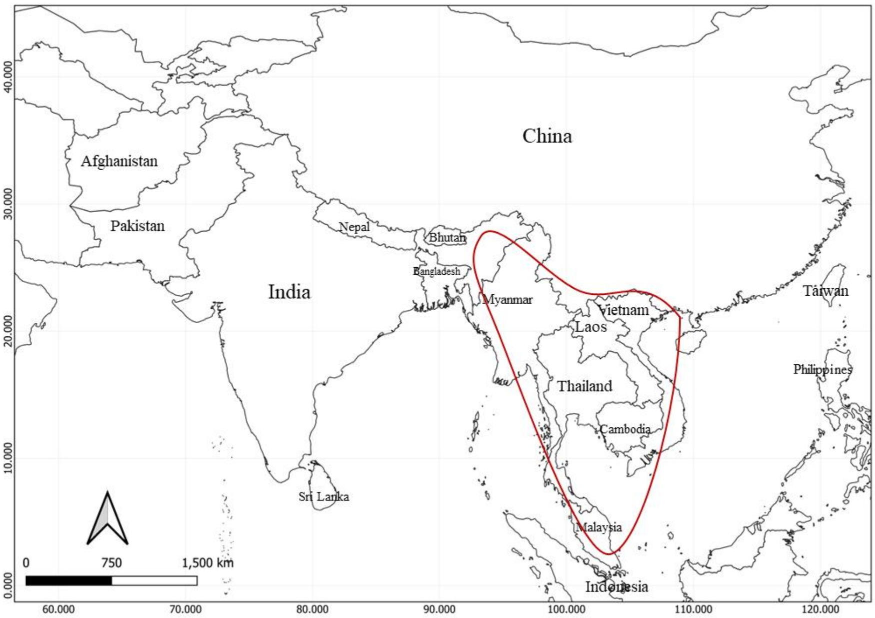


Fig. 26. Distribution of *Aeschynanthus fulgens* Wall. ex R.Br.

Specimens examined: CAMBODIA, **Ratanakiri,** Virachay National Park, O'Tayak River, 303 m, 17.12.2005, *P. Thomas, Koun Theah, Thon Sokhon, Seth Teng, Srun Sokhon & Yan Bounsoeung* 84 (E [E00221143]). INDIA, **Nagaland,** Mokokchung district, Santong (Changtongya), May 1895, *G. Watt* 11680 (CAL). LAOS, **Khammouan**, Nong Sa Mek, 556 m, 11.02.2005, *M.F. Newman, P.I. Thomas, K.E. Armstrong, K. Sengdala & V. Lamxay* LAO 89 (E [E00214067]). MALAYSIA, **Kedah,** Gunung Jerai, 23.11.1999, *Kiew R.* RK4862 (SING). MYANMAR, **Tavoy**, Hills west of Paungdaw Power Station, 2400 ft, August 1961, *J. Keenan, U. Tung Aung & R.H. Rule* 805 (K); In Hinde Tin Mine area, 750 ft, September 1961, *J. Keenan, U. Tung Aung & R.H. Rule* 1897 (K). THAILAND, **Chiang Mai province**, Chiang Dao, Doi, SE foothills at Ban Yang Pong Luang, 525 m, 06.01.1989, *J.F. Maxwell* 89-23 (L [L.2821787 digital image]); *Ibid.*, 550 m, 29.10.1989, *J.F. Maxwell* 89-1316 (L [L.2821792 digital image]); *Ibid.*, 575 m, 15.02.1990, *J.F. Maxwell* 90-207 (L

[L.2821793 digital image]); Mae Dtang, Bah Bae village, 850 m, 21.01.1992, *J.F. Maxwell* 92-47 (L [L.2821789 digital image]). **Chiang Rai province**, Pahn, Doi Luang National Park, 1350 m, 07.10.1998, *P. Palee* 432 (L [L.2821781 digital image]); *Ibid.*, 1400 m, 28.10.1997, *J.F. Maxwell* 97-1250 (L [L.2821791 digital image]). **Kanchanaburi province**, Huay Bankav, 750 m, N 14°55', E 90°45', 09.11.1971, *C.F. van Beusekon, C. Phengkhlai., R. Geesink & B. Wongwan* 3577 (L [L.2821786 digital image]); *Ibid.*, 10.11.1971, *C.F. van Beusekon, C. Phengkhlai, R. Geesink & B. Wongwan* 3659 (L [L.2821785 digital image]); Thong Pha Phum, 700 m, 16.09.2006, *S. Sudee, N. Tetsana, M. Phuphat, T. Phutthai & M. Thanaros* 2881 (E [E00320134]). **Lampang province**, Muang Bahn, Jae Sawn National Park, 525 m, 04.12.1995, *C.F. van Beusekon, C. Phengkhlai, R. Geesink & B. Wongwan* 3577 (L [L.2821788 digital image]). **Pangnga province**, Khao Pawta luang keow, 1000–1200 m, 27.11.1974, *R. Geesink, P. Hiepko & C. Phengklai* 7630 (L [L.2821787 digital image]); Toong Yai Naresuan Wildlife Reserve, Ban Saheh Pawng, 400 m, 10.10.1993, *J.F. Maxwell* 93-1190 (L [L.2821784 digital image]). VIETNAM, **Lam Dong**, Di Linh district, Bao Thuan commune, N 11°34' 20'', E 108°10'17'', 1461 m, 09.11.2003, *P. Thomas & N.D.T. Luu* 40 (E [E00311077]); Langbiang area, 1500 m, 20.09.2001, *s.coll.* 239 (E [E00144823]).

Conservation status: *Aeschynanthus fulgens* is distributed across seven countries, with an EOO of 16,97,847.784 km^2. In India, this species has been recorded at only a single location in Nagaland, though it is more widespread outside the country. Based on current data, the AOO is estimated at 148 km^2, with no significant threats identified to its habitat or population. The species is therefore provisionally assessed as Least Concern (LC).

Notes: Bhattacharyya and Goel (2015) recorded *A. fulgens* from India, based on a specimen collected by Watt in 1895 from the Naga Hills (CAL, Acc. No. 11680). Taram (2023) recently collected this species from Namdapha National Park, Arunachal Pradesh, and opined that the specimens cited by Chauhan (1996) in his treatment are more likely to be *A. fulgens* rather than *A. hookeri*. Furthermore, Taram argued that the image provided by Sinha and Dutta (2016) to represent *A. hookeri*, actually depicts *A. fulgens*. After examining live collections of *A. fulgens* at the Royal Botanic Garden Edinburgh, I confirmed that the image in Sinha and Dutta (2016) attributed to *A. hookeri* does not depict either *A. hookeri* or *A. fulgens*, but instead appears to be a variation of

A. parasiticus. Furthermore, I have not seen the specimen from Namdapha collected by Taram, as mentioned above.

Middleton (2007) noted that *A. fulgens* is highly variable, particularly in calyx character, corolla colour, and hairiness. After consulting herbarium specimens at K and E, I agree with Middleton's (2007) synonymization of *A. evrardii* Pellegr. and *A. stenosiphonius* W.T.Wang under *A. fulgens*.

6. Aeschynanthus gracilis C.S.P.Parish ex C.B.Clarke, Commelyn. Cyrtandr. Bengal. 75. t. 48A. 1874, in A.DC. & C.DC., Monogr. Phan. 5(1): 27. 1883, in Hook.f., Fl. Brit. Ind. 4: 340. 1884; Kanjilal *et al.*, Fl. Assam 3: 390. 1939; Wang *et al.*, Fl. China 18: 382. 1998; Hilliard in Grierson & D.G.Long, Fl. Bhutan 2(3): 1299. 2001; Z.Y.Li & Y.Z.Wang, Gesneriaceae China 375. 2004; B.Singh *et al.*, Indian J. Pl. Sci. 1: 69. 2012; G.P.Sinha, Fl. Mizoram 2: 197. 2012; G.D.Pal, Fl. Lower Subansiri District, Arunachal Pradesh 2: 164. 2013; B.K.Sinha & Su.Datta, Nelumbo 58: 6–7. 2016; S.S.Dash & P.Singh, Fl. Kurung Kumey District 2: 352. 2017; Gogoi *et al.*, Fl. Sikkim. Pict. Guide 220. 2021. *Aeschynanthus novogracilis* W.T.Wang, Acta Phytotax. Sin. 13(2): 65. 1975, *nom. illeg.*; Bull. Bot. Res. Harbin. 4(1): 27. 1984; U.C.Bhattach. Phytotaxonomy 14: 12–13. 2014. *Lectotype* (designated by Middleton, 2007): MYANMAR (BURMA), **Mon**, Moulmein, *C.S.P. Parish s.n.* (K [K000096757!]).

Aeschynanthus setosus Kranzl., Repert. Spec. Nov. Regni Veg. 24. 1928. *Type*: INDIA, Eastern region, *s.loc*., *s.d*., *T. Lobb s.n.* (holo W [W 1889-0160696 digital image!]; iso K!).

Figs. 27–28

Epiphytic or lithophytic perennial herbs. Stems dichotomously branched, slender, hanging, light green when young, yellowish brown at maturity, white or brown villous, rooting at nodes; nodes slightly swollen, internodes 1–2.5 cm long. Leaves opposite, rarely ternate, superposed; petioles 0.1–0.2 cm long, terete, pilose; lamina 1–3 × 0.5–1 cm, elliptic to elliptic-lanceolate, coriaceous to fleshy, mid-green above, pale to light green or greenish white beneath, apex acute, base rounded, margins entire to sub-entire, glabrous to sparsely hairy above, pilose beneath; midvein obscure adaxially, visible abaxially; lateral veins obscure. Flowers axillary, solitary; bracts 0.1–0.15 × *c.* 0.05 cm, lanceolate, green, apex acute, margins entire, pubescent, nerves obscure, deciduous; pedicels 0.5–2.5 cm long, terete, pale green, pilose. Calyx free to base; lobes 0.6–1 × 0.1–0.2 cm, linear to narrowly triangular, green, apex acuminate, margins entire, pilose out, glabrous in. Corolla 2.3–2.8 cm long; tube 1.8–2.5 cm long, 0.4–0.5 cm wide at base, slightly inflated towards the throat with 0.5–0.6 cm, lower surface abruptly curved at middle, outside orange-red to red with many dark red striations along length, puberulous, inside pale orange or yellow, glabrous in, mouth oblique; lobes outside orange to crimson red, pubescent, inside pale orange or yellow arched with dark band, three interrupted dark red stripes on lower lips, glabrous, ciliate; upper lobes 0.3–0.5 × 0.1–0.2 cm, oblong, apex rounded, not reflexed; sinuses 0.2–0.4 cm deep; lateral lobes 0.4–0.5 × 0.8–1 cm, deltoid, apex obtuse, reflexed; lower lobe 0.6–0.9 × 0.3–0.5 cm, elliptic to oblong, apex rounded, reflexed. Stamens fused in two pairs, long exserted; anterior filaments 1.6–1.8 cm long, inserted at 1–1.3 cm from corolla base; posterior filaments 1.8–2 cm long, inserted at 1.2–1.4 cm from corolla base; filaments white to pale orange, glandular pubescent; anthers *c.* 0.2 × 0.1 cm, elliptic, purple; pollen gray. Staminode *c.* 0.1 cm long, clavate, inserted 1–1.5 cm from corolla base. Disk *c.* 0.1 cm high, irregularly crenate, green. Pistils 2.5–4 cm long; stipe 0.4–0.5 cm long, green, glabrous; ovary 0.9–1.8 cm long, linear, green, sparsely pubescent; styles 1–1.8 cm long, green to yellowish green, sparsely glandular pubescent; stigmas *c.* 0.2 cm across, capitate, white to grey. Capsules 9–15 × *c.* 0.2 cm, green. Seeds 0.65–0.9 × 0.12–0.3 cm, testa cells warty, straight orientation; apical appendage 1.5–1.8 cm long; hilar appendage a solitary hair, 1.8–2 cm long, appendages papillose.

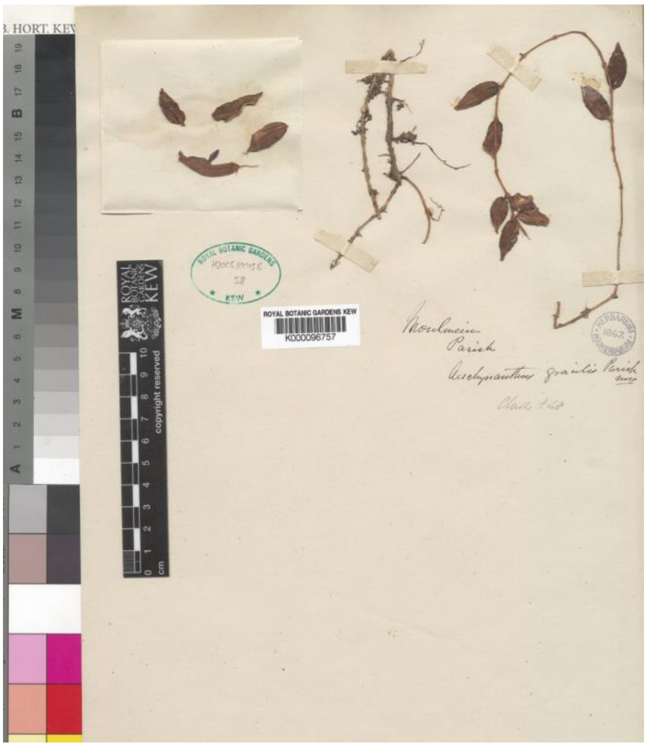


Fig. 27. Lectotype of *Aeschynanthus gracilis* C.S.P.Parish ex C.B.Clarke (K [K000096757!]). © The Board of Trustees for the Royal Botanic Gardens, Kew. Reproduced with permission.

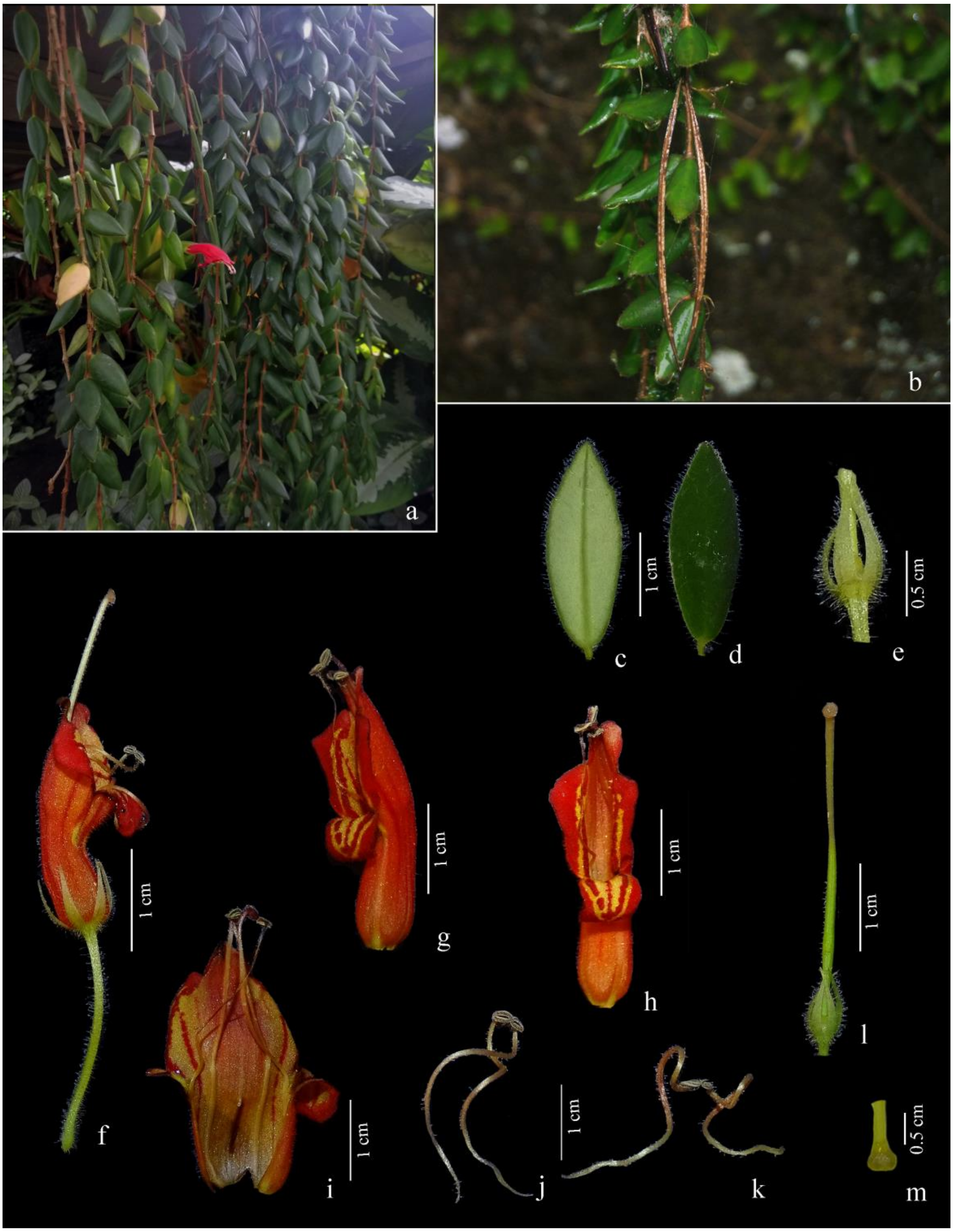


Fig. 28. *Aeschynanthus gracilis* C.S.P.Parish ex C.B.Clarke: **a & b.** Habit; **c.** Leaf - abaxial view; **d.** Leaf - adaxial view; **e.** Calyx; **f.** Single flower; **g.** corolla - lateral view; **h.** Corolla - front view; **i.** Corolla - split open; **j & k.** Stamens; **l.** Pistil; **m.** Disk.

Flowering & fruiting: Flowering from March to May and fruiting from May to June.

Habitat: Hanging herbs on moss-covered wet rocks or on medium to large trees near streams, lakes, or rivers.

Distribution: Bangladesh, Bhutan, China, India, Myanmar, Nepal and Thailand (GRC, 2024) (Fig. 29), however, I was unable to see any specimens from Bangladesh and China from the herbaria I consulted.

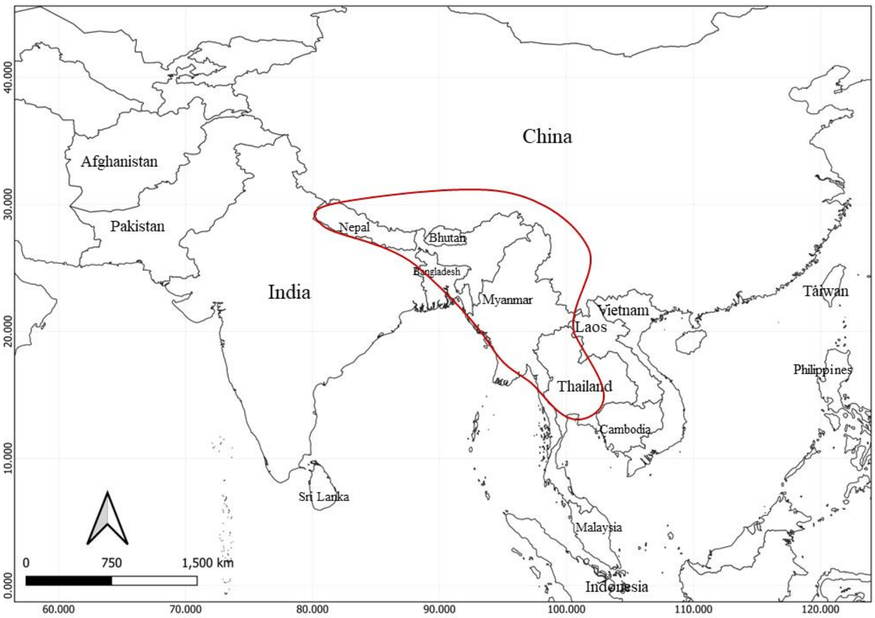


Fig. 29. Distribution of *Aeschynanthus gracilis* C.S.P.Parish ex C.B.Clarke

Specimens examined: BHUTAN, Gaylegphug district, Jaldoka Valley, 3000 ft, March 1875, *J.S. Gamble* 3492A (K); Karai Khola above Aie bridge, 510 m, 22.03.1982, *A.J.C. Grierson & D.G. Long* 3945 (E [E00630401]); Rang Khola, 4 km NE of Surey, 980 m, 29.03.1982, *A.J.C. Grierson & D.G. Long* 4125 (K [K001279098]); Sarpang district, Singi Khola, 10 km SW of Sarbhang, 390 m, 09.03.1982, *A.J.C. Grierson & D.G. Long* 3607 (E [E00630399], K [K001279097]). INDIA, **Arunachal Pradesh,** East Kameng district, Kimi to Seppa, 500 m, N 27°21'41", E 93°02'36" 28.06.2019, *M.K. Akhil, P. Javad & Santhosh Nampy* 169374 (CALI); Lohit district, Shoeliang to Paya, 15.11.1957, *R.S. Rao* 10620 (ASSAM); Tirap district, Khonsa, 1215 m, N 26°59'43", E 95°29'41", 09.11.2021, *M.K. Akhil & Santhosh Nampy* 186480 (CALI). **Assam**, Hailakandy district, Nunai to Bhutan road, 22.04.1958, *B.K. Nath* 13227 (ASSAM); Karbi Anglong district, *s.d., Griffith* 638 (BM [BM000833367]); Lakhimpur district, Kakoi Reserve Forest, 15.03.1962, *G. Panigrahi* 27904 (ASSAM); Lakhimpur, Jeypore, 25.05.1956, *G.K. Deka s.n.* (ASSAM); Makum, 12.04.1885, *C.B. Clarke* 37865 (BM [BM000883871]); Udalguri district, Khalingduar R.F., Nunai Bhutan road, 1100–1300 ft, 22.04.1958, *B.K. Nath* 13227 (E [E00630398]). **Meghalaya**, East Khasi Hills district, Cherrapunji, 12.08.1960, *G. Panigrahi* 17867 (ASSAM); Khasia Hills, 1865, *s.coll. s.n.* (GDC [G00492415 digital image]); *Ibid*., May 1899, *Dr. Prain's collector s.n.* (BM [BM 000883872]); *s.loc., s.d., R.S. Baruah* 114155 (ASSAM); *Ibid, s.d., Griffith s.n.* (L [L.2821706 digital image]); West Garo Hills district, Nokrek Biosphere Reserve, Daribokgre and adjoining area, 05.03.2007, *Singh B. & V.N. Singh* 114819 (ASSAM); *s.loc., s.d., s.coll. s.n.* (L [L.2821800 digital image]). **Manipur**, Barapa, 3000 ft, November 1907, *A.E. Meebold* 6418 (K). **Mizoram**, Aizawl district, Lushai Hills, 3500 ft, 21.03.1951, *Walter N. Koelz* 27342 (E00630392); *Ibid*., 2500 ft, 17.02.1953, *G.K. Deka* 23357; *Ibid.*, 17.02.1953, *G.K. Deka* 23359 (ASSAM). **Sikkim**, *s.d., Rolla Seshagiri Rao* 77 (CAL); *Ibid.*, 3–4000 ft, March 15, *J.D. Hooker s.n.* (BM [BM011025816]); *Ibid.*, April 13, *J.D. Hooker s.n.* (GDC [G00492390 digital image], L [L.2821708 digital image]); *Ibid.*, 3000 ft, 28.04.1876, *C.B. Clarke* 27684 (L [L.2821705 digital image]); 900–1200 m, 1861, *F. Hooker s.n.* (GDC [G00492390 digital image]); Gangtok district, Gangtok to Dikchu, 2010 ft, 13.05.1945, *K. Biswas* 6708; Pakyong, N 27°14'25", E 88°36'07", 1331 m, 02.06.2022, *M.K. Akhil & T.P. Krishnaraj* 160625; near Rongo Chu, below Pakyong, 2000 ft, 28.04.1917, *Lacaita* 340 (BM [BM011025817]); North Sikkim district, Mangan, Teesta valley, below Singhik, 3500 ft, 28.03.1938, *F.H. Leiter* 40 (K). **West Bengal**, 1000 ft, 25.01.1905, *H.H. Haines* 1046 (E [E00630395], K); Darjeeling district, Sivok Hills, March 1874, *J.S. Gamble* 3493A (K). MYANMAR (BURMA), *s.loc., s.d., Griffith* 3810 (K [K000096756]). **Kachin**, Hponkan Razi, 1665 m, 14.10.2014, *G. Miehe, P. Nowak, L. Shein, Z.N. Hitun, D.S. Kayin, A.S. Lanwan, D.R. Lanwan, P. Lanwan & P. Sana* 14-042-164 (E [E01045140]); *Ibid.*, 1661 m, 17.10.2014, *G. Miehe, P. Nowak, L. Shein, Z.N. Hitun, D.S. Kayin, A.S. Lanwan, D.R. Lanwan, P. Lanwan & P. Sana* 14-032-181 (E [E01045141]); Kawng, Ngawchang, 30.01.1912, *J.H. Lace, s.n.* (E [E00630394]); Northwest of Putao, 649 m, 09.11.2014, *G. Miehe, P. Nowak, L. Shein, Z.N.Hitun, D.S. Kayin, A.S. Lanwan, D.R. Lanwan, P. Lanwan & P. Sana* 14-070-223 (E [E01045147]). **Southern Shan**, Tabolt to Punka, 3500 ft, January 1910, *W.A. Robertson* 88 (K). **Tanintharyi Region**, Dawei district, Tovey, s.w. headquarters of the Heinyc Chang 700 15.02.1919, *A.T. Gage* 139 (CAL); Mishmi Hills, Sadiya plain, 600 ft, 10.03.1949, *F. Kingdon Ward* 18390 (NYBG [02652102 digital image]); Moulmein, *s.d., C.S.P. Parish* *s.n.* (K [K000096757]). THAILAND, **Kanchanaburi**, Sangklaburi, Toong Yal Naresuan Wildlife Reserve, 200 m, 16.01.1994, *J.F. Maxwell* 94-77 (L [L.2821707 digital image]).

Conservation status: *Aeschynanthus gracilis* is distributed across seven countries, with an EOO of 14,81,364.549 km^2. Based on current data, the AOO is estimated at 148 km^2. This species exhibits significant growth in its natural habitat, both as an epiphyte and lithophyte, and no severe threats were found. According to the IUCN Criteria, it is provisionally assessed as Least Concern (LC).

Notes: Wang (1975) proposed *Aeschynanthus novogracilis* W.T.Wang as a new name (*nom. nov*.) to replace *A. gracilis* Parish ex C.B.Clarke, 1874, since he considered the latter as a later homonym of *A. gracilis* Hort. ex Hanst.,1864. However, *A. gracilis* Hort. ex Hanst. is not a valid name, making *A. gracilis* Parish ex C.B.Clarke the legitimate name.

Wang (1984) placed *A. novogracilis* (= *A. gracilis*) under the section *Haplotrichium* based on its distinct corolla characteristics (oblique mouth, conspicuous and unequal lobes), and further subdivided the section into two series: ser. *Bracteatus* and ser. *Novograciles*. However, Mendum *et al.* (2001) found that the seed characteristics of ser. *Novograciles* align more closely with those of section *Xanthonthos*, while ser. *Bracteatus* became conspecific with section *Haplotrichium*, rendering both series invalid.

Kränzlin (1928) described *A. setosus* based on Lobb's collection from Eastern India, comparing it to *A. leptocladus* C.B.Clarke. A detailed examination of the protologue and the type specimen reveals that the slender stems, superposed, hairy, elliptic to elliptic-lanceolate leaves, and oblique corolla are similar to *A. gracilis*. Therefore, *A. setosus* is considered a synonym of *A. gracilis*. Morphologically, *A. gracilis* is closely allied to *A. chiritoides* in the vegetative phase, sharing slender, hanging stems with superposed, elliptic to elliptic-lanceolate leaves and similar hairiness. However, the two species differ significantly in flower morphology: *A. chiritoides* has a white corolla, resembling the corolla of *Chirita* (=*Henckelia*), with all stamens coherent by their anther tips. In contrast, *A. gracilis* has a reddish tubular corolla typical of *Aeschynanthus* species, with an oblique mouth and stamens that are coherent in pairs by their anther tips.

The specific epithet ‘gracilis’ (from Latin, meaning slender) refers to the slender habit of the plant.

7. Aeschynanthus hookeri C.B.Clarke in A.DC. & C.DC., Monogr. Phan. 5: 21. 1883, in Hook.f., Fl. Brit. India 4: 338. 1884; Kanjilal *et al.,* Fl. Assam 3: 388. 1939; H.Hara, Fl. Eastern Himalaya 1: 297. 1966, Fl. Eastern Himalaya 2: 121. 1971, Enum. Fl. Pl. Nepal 3: 132. 1982; W.T.Wang *et al.*, Fl. China 18: 384. 1998; Hilliard in Grierson & D.G.Long., Fl. Bhutan 3: 1302. 2002; Kress *et al.*, Checkl. Myanmar 261. 2003; Z.Y.Li & Y.Z.Wang, Gesneriaceae China. 378. 2004; A.Mukh. *et al.*, Pleione 2 (2): 153. 2008; G.D.Pal, Fl. Lower Subansiri District, Arunachal Pradesh 2: 165. 2013; U.C.Bhattach. & Goel, Phytotaxonomy 14: 17. 2015; B.K.Sinha & Su.Datta, Nelumbo 58: 11. 2016; Su.Datta *et al.,* J. Jap. Bot. 91: 233. 2016; A.A.Mao & Gogoi, Fl. Dziiko/Dzukou Valley 181. 2016; A.A.Mao *et al.*, Check List Fl. Nagaland 96. 2017; Gogoi *et al.,* Fl. Sikkim. Pict. Guide. 220. 2021; Bh.Adhikari & Mich.Möller in M.F.Watson, Fl. Nepal (Web ed.). 2023. *Trichosporum hookeri* Kuntze, Revis. Gen. Pl. 2: 477. 1891. *Lectotype* (designated by Datta *et al*., 2016): INDIA, **Sikkim**, 4–5000 ft, *s.d., J.D. Hooker s.n.* (K [K000831874!] isolecto A [00444310]); *residual syntypes*: INDIA, **Sikkim**, Rungbee, 5000 ft, 21.07.1870, *C.B. Clarke* 12191 (K [K000096742!]); **Sikkim**, *s.d., J.D. Hooker s.n.* (K [K000096743!]).

Aeschynanthus parasiticus auct. non Wall.: C.B.Clarke, Commelyn. Cyrtandr. Bengal. t. 49. 1874.

Figs. 30–31

Epiphytic perennial under shrubs. Stems branched, arching to pendulous, green to dark green when young, straw-coloured at maturity, glabrous, rooting at nodes. Nodes slightly swollen; internodes 2–5.5 cm long. Leaves opposite; petioles 0.8–1 cm long, terete, canaliculated above, dark green to dark purple, glabrous; lamina 6–8 × 1.5–2.3 cm, lanceolate to lance-ovate, fleshy, dark to light-green above, pale green beneath, apex acuminate, curved, base cuneate, margins entire to sub-entire, glabrous; midvein sunken adaxially, prominent abaxially; lateral veins obscure. Inflorescences pseudoterminal, 4–10 (–20)-flowered; peduncles absent. Bracts 0.3–0.5 × 0.07–0.1 cm, lanceolate, green, apex acute, margins entire, glabrous, nerves obscure, deciduous; pedicels 1–1.5 cm long, terete, green to reddish green, glabrous. Calyx lobed from above middle; tube 1–1.4 cm long, yellowish green at base, red to reddish brown higher up, glabrous; lobes 0.5–0.7 × 0.2–0.3 cm, oblong, red to reddish brown; apex obtuse to round, margins entire, straight,

Fig. 30. Lectotype of *Aeschynanthus hookeri* C.B.Clarke (K [K000831874]). © The Board of Trustees for the Royal Botanic Gardens, Kew. Reproduced with permission.

glabrous. Corolla 2.8–3 cm long; tube 2.4–2.8 cm long, 0.2–0.3 cm wide at base up to middle, gradually inflated towards the throat with 0.6–0.7 cm, curved, outside pale orange at base, orange-red to scarlet higher up, dark stripes running down from the lobes, puberulent, inside yellowish to orange red, glabrous; mouth slightly oblique; lobes outside orange with dark brown stripes at centre, pubescent, inside pale orange arched with deep orange band followed by dark brown band, dark brown stripes running downward from the centre of each lobe, glabrous, ciliate; upper lobes 0.4–0.5 × 0.2–0.3 cm, oblong, apex rounded, slightly reflexed; sinuses 0.2–0.3 cm deep; lateral lobes, 0.4–0.5 × 0.2–0.3 cm, oblong, ovate or deltoid, apex obtuse to rounded, reflexed; lower lobes 0.3–0.4 × 0.2–0.4 cm, elliptic-oblong, apex rounded, reflexed. Stamens fused in two pairs, long exserted; anterior filaments 2.5–2.8 cm long, inserted at 1.6–1.8 cm from corolla base; posterior filaments 2.4–2.6 cm long, inserted at 1.4–1.6 cm from corolla base; filaments white at base, red or purple higher up, glandular hairy; anthers *c.* 0.2 × 0.07 cm, narrowly elliptic, purple; pollen yellow. Staminode *c.* 0.1 cm long, clavate, inserted 2–2.2 cm from corolla base. Disk *c.* 0.1 cm high, 5-crenate or annular, greenish yellow. Pistils 2.5–3 cm long; stipes 0.4–0.5 cm long, greenish white, glabrous; ovary 1.8–2 cm long, linear, white to greenish white, glabrous; styles 0.5–1 cm long, linear, white to purple, glandular pubescent; stigmas *c.* 0.2 cm across, capitate, purple. Capsules 10–15 × 0.5–0.6 cm, green to purple. Seeds 0.8–1.3 × 0.2–0.4 mm, testa cells warty; apical appendage 2–3.5 cm long; hilar appendages 2, 1.5–3.5 cm long, appendages papillose.

Fig. 31. *Aeschynanthus hookeri* C.B.Clarke: **a.** Habit; **b.** Inflorescence; **c.** Leaf - adaxial view; **d.** Leaf - abaxial view; **e.** Calyx; **f–i.** Flower bud development stages; **j–l.** Corolla - split open: **j.** Showing stamens; **k.** Showing corolla - lobes; **l.** Showing corolla - base; **m.** Pistil.

Vernacular name: Hooker's blushwort.

Flowering & fruiting: Flowering from May to July and fruiting from July to October.

Habitat: Epiphytic undershrubs growing on large trees at the margin of forests.

Distribution: Bhutan, China, India, Myanmar and Nepal (GRC, 2024) (Fig. 32).

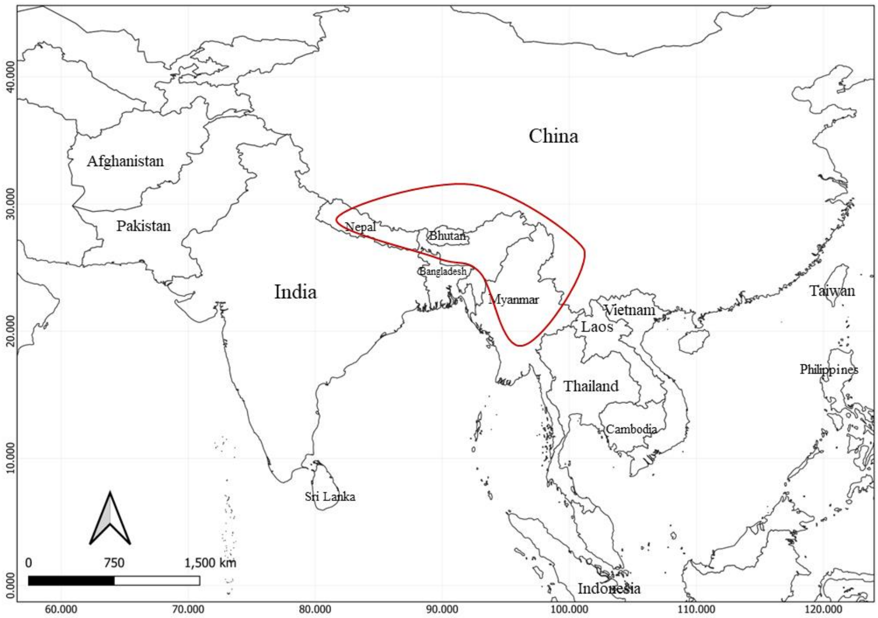


Fig. 32. Distribution of *Aeschynanthus hookeri* C.B.Clarke

Specimens examined: BHUTAN, Eastern Bhutan, Nyoth, 22.10.1965, *N.P. Balakrishnan* 44249 (ASSAM). CHINA, **Yunnan**, Longling Xian, Longjiang Xiang, N 24°55'27", E 98°45'31", 2410 m, 05.09.2003, *Li Heng*, *Dao Zhiling*, *Li Rong & Jiang* 18823 (E [E00222941]). INDIA, **Arunachal Pradesh**, Tirap, Khonsa to Khela, 22.08.1958, *G. Panigrahi* 14525 (ASSAM). **Manipur**, Senapati district, Liyai Village, 2460 m, 02.06.2005, *A.A. Mao* 109015 (ASSAM); Ukhrul district, Sirhoi, 23.07.1948, *F. Kingdon Ward* 17856 (NYBG [02652101 digital image]). **Meghalaya**, East Garo Hills district, Nokrek Biosphere Reserve, Nengmandalgre along Simsang, 30.03.2008, *Vivek N. Singh & Bikarma Singh* 116892 (ASSAM); East Khasi Hills district, Wakhen, 10.08.2016, *Aabid Hussain Mir* 230 (ASSAM). **Mizoram**, Pualreng Wildlife Sanctuary, 05.12.2010, *Singh S.K. & H.A. Barshya* 120832 (ASSAM). **Sikkim**, *s.loc.*, *s.d.*, *J.D. Hooker s.n.* (K [K000096743]); *s.loc.*, 4–5,000 ft, *s.d.*, *J.D. Hooker s.n.* (K [K000831874]); *s.loc.*, 5000 ft, May 1885, *Legit Panthing* 46627 (K); *s.loc.*, 4–5000 ft, 14 April, *J.D. Hooker* 1859 (P [P00606319 digital image]); Sidon Cher towards Kibek, 11.06.1955, *R.S. Rao* 1087 (ASSAM); West Sikkim, 20.05.2002, 1700 m, *D. Maity & N. Pradhan* 23495 (BSHC acc. no. 33511); *Ibid.*, *s.d.*, *B.S. Rao* 1087 (CAL). **West**

Bengal, Darjeeling district, Darjeeling, 7000 ft, July 1874, *Gamble* 3494A (CAL); *Ibid*., July 1874, *Gamble* 3495A (K); Ridge above Maurein, 7000 ft, 20.05.1902, *J.H. Lace* 2231 (E [E00630412, E00630413]); Lepchajagat, 7000 ft, 05.07.1902 *J.H. Lace* 2309 (CAL, E [E00630414); Jopgow, 3000–5000 ft, 04.03.1934, *K. Biswas* 2052 (CAL); Kalimpong li, Icha village, near Hanuman tok, N 27°08'11", E 88°34'09", 1560 m, 01.06.2022, *M.K. Akhil & T.P. Krishnaraj* 160623 (CALI); *Ibid*., N 27°08'09.8", E 88°34'08", 1500 m, 01.06.2022, *M.K. Akhil & T.P. Krishnaraj* 160624 (CALI); Mahaderam, 7000 ft, 30.05.1884, *C.B. Clarke* 34950 (K [K000096782]); Senchal, 29.05.2007, *A.K. Ghosh* 41672 (CAL); *Ibid*., 7–8000 ft, *s.d*., *S. Kurz s.n* (CAL); *Ibid*., 8000 ft, 1862, *T. Anderson* MD970 (CAL); Senchal WLS, Lake compound, 27.05.2007, *A.K. Ghosh* 41647 (CAL); Senchal Hill, N 26°59', E 88°16', 2350 m, 05.07.1992, *D.G. Long, R.J.D. McBeath, H.J. Noltie & M.F. Watson* 67 (E [E00630411]); Singalila N.P., Gorkhey- Ramam, 01.06.2006, *Manas R. Debta* 40850 (CAL); Sapgow, 3000–5000 ft, 04.03.1934, *K. Biswas* 2052 (CAL); Tiger Hills, 24.07.2019, *Nikhil Krishna* DG007 (CALI); Ubayuri-dani 2200 m, 25.07.1972, *H. Ohashi, H. Hara & K. Iwatsuki* 72725 (BM [BM000883864]). MYANMAR, Chawngmaw?, 6000–7000 ft, 10.08.1919, *F. Kingdon Ward* 3498 (E [E00096770]). **Chin**, along new road towards Maha Myaing village, Mindat Township, Natma Taung National Park, N 21°23'49.28", E 93°44'55.68", 2303 m, 27.02.2014, *Prachaya Srisanga, Monthon Norsaengsri, Robert Unwin, Tin Tin Mu, Ling Shein Man & Law Shine* 097352 (E [E00758291]). NEPAL, Arun Valley, Machang Khola, E. of Num, 9000 ft, 03.05.1956, *J.D.A. Stainton* 202 (BM [BM000883863]); Bagmati zone, Rasuwa district, Lingju, N 28°12', E 85°07', 2185 m, 13.08.1994, *F. Miyamoto, K.R. Rajbhandari, S. Akiyama, M. Amano, H. Ikeda & H. Tsukaya* 9400089 (BM, [BM000832782], E [E00107635]); Basantapur, 2300 m, 06.06.1972, *H. Kanai, H. Ohashi, K. Iwatsuki, H. Ohba & P.R. Shakya* 720214 (BM [BM000832780]); Chitre, 872271, 2400 m, 06.06.1972, *H. Kanai, H. Ohashi, K. Iwatsuki, H. Ohba & P.R. Shakya* 720206 (BM [BM000832783]; Dor, 2600 m, 07.07.1972, *H. Kanai, H. Ohashi, K. Iwatsuki, H. Ohba, Z. Iwatsuki & P.R. Shakya* 721155 (E [E00630409, E00630410]); *Ibid*., *H. Kanai, H. Ohashi, K. Iwatsuki, H. Ohba & P.R. Shakya* 720214 (BM [BM000832781]); East of Meklajam, N 26°51'; E 87°34', 5500 ft, 27.05.1969, *L.H.J. Williams* 209 (BM [BM000883862]); E Koshi zone, Sankhuwa Sabha district, Around Tashi Gaun (Tashigaon) 2160–2340 m, 13.07.1988, *M. Suzuki, et al.* 8820409 (BM [BM000832786]); between Gupa and Taplejung, 8500 ft, 26.06.1971, *L.W. Beer* 8222 (BM [BM000832784]); Salpa Bhamjayang, 7000 ft, 05.05.1974, *J.D.A. Stainton* 6990 (BM [BM000832779]); Sagarmatha zone, Solukhumbu district, Fera, 2940 m, 26.07.1995, *F. Miyamoto et al*. 95 (BM [BM000883868]). **Kathmandu**, N. of Mulkharka, 1500 m, 30.06.1973, *Grey-Wilson & Philips* 242 (K).

Conservation status: *Aeschynanthus hookeri* is distributed across five countries, with an EOO of 10,34,090.520 km^2. Based on current data, the AOO is estimated at 204 km^2. It generally grows in the forest margins of high-altitude areas, with minimal habitat destructions observed. This species is provisionally assessed here as Least Concern (LC).

Notes: In the vegetative phase, *A. hookeri* resembles the widely distributed *A. parasiticus* and *A. parviflorus*, particularly in its lanceolate to lance-ovate laminae. However, it can be easily distinguished during the flowering stage by its unique calyx characteristics. The calyx is reddish or purple, long and tubular (1–1.4 cm long), with short, oblong lobes that have obtuse to round apices. While the mature flowers of *A. hookeri* resemble those of species in the *Aeschynanthus* sect. *Aeschynanthus* in having a ‘water calyx’, the calyx in *A. hookeri* does not function as a miniature water bath. Instead, the development of the calyx and corolla occurs almost synchronously in *A. hookeri*, with a more pronounced lobation in the calyx (0.5–0.7 cm long compared to 0.1–0.2 cm in other species).

8. Aeschynanthus linearifolius C.E.C.Fisch., Bull. Misc. Inform. Kew 1935 (5): 321. 1935; Kanjilal *et al.*, Fl. Assam 3: 393. 1939; W.T.Wang *et al.*, Fl. China 18: 379. 1998; Kress *et al.*, Checkl. Myanmar 261. 2003; Z.Y.Li & Y.Z.Wang, Gesneriaceae China 369. 2004; U.C.Bhattach. & Goel, Phytotaxonomy 14: 10. 2015; B.K.Sinha & Su.Datta, Nelumbo 58: 7. 2016. *Type*: INDIA, **Arunachal Pradesh**, Delei Valley, N 28°2', E 96°37', 2400 m, *s.d.*, *F. Kingdom Ward* 8470 (holo K [K000096760!]).

Aeschynanthus peelii Hook.f. & Thomson var. *oblanceolatus* J.Anthony, Notes Roy. Bot. Gard. Edinburgh 18: 190. 1934. *A. oblanceolatus* (J.Anthony) C.E.C.Fisch., Bull. Misc. Inform. Kew 1940: 40. 1940. *Lectotype* (designated by Akhil & Nampy, 2019): MYANMAR (BURMA), **N.E. Upper Burma**, Western flank of the Chimile N’Maikha, N 26°23', E 98°48', 7–8000 ft, September 1924, *G. Forrest* 24933 (E [E00023687!];

isolecto BM [BM000883879!], K [K000831880!]; *residual syntypes*: MYANMAR (BURMA), **Upper Burma**, N. Maikha-Salwin divide, 7–8000 ft, 15.07.1925, *G. Forrest* 27080 (A [A00423925 digital image!], E [E00096779!], NY [NY02218966 digital image!], P [P00606315 digital image!]), US [US00444737 digital image!]; CHINA, **Xizang** (Tibet), Tsarong, September 1921, *G. Forrest* 20124 (P [P00606314], US [US00623796]); Salwin-Kui Chiang divide, N 28°24', E 98°24', August 1921, *G. Forrest* 20099 (A [A00353709 digital image!], E [E00135111!]); *Ibid.*, September 1921, *G. Forrest* 20124 (E [E00135112!], P [P00606314 digital image!]); **Yunnan**, 1924, *G. Forrest* 24980 (E [E00135113!]).

Figs. 33–34

Epiphytic or lithophytic perennial under shrubs. Stems laterally branched, pendulous, green when young, grey to brown at maturity, glabrous, rooting at nodes. Nodes slightly swollen; internodes 1.5–4 cm long. Leaves opposite, superposed; petioles 0.5–0.8 cm long, canaliculated above, dark green to dark purple, glabrous; lamina 4.5–7.5 × 0.8–2 cm, linear to oblanceolate, slightly thick, pale green to green, apex acuminate to caudate, base cuneate to attenuate, margins entire to slightly revolute, glabrous; midvein sunken adaxially, prominent abaxially; lateral veins obscure. Inflorescences pseudoterminal or axillary, 1–4-flowered; peduncles 1–3, 1–4.5 cm long, terete, greenish brown, glabrous. Bracts 0.2–0.3 × *c.* 0.1 cm, lanceolate, green, apex acute, margins

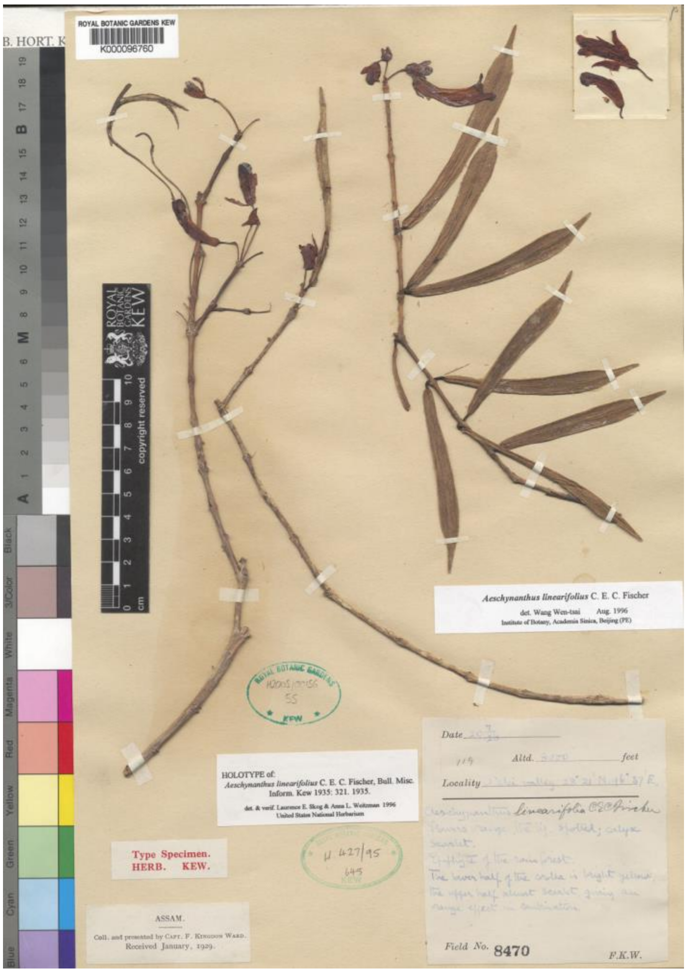


Fig. 33. Holotype of *Aeschynanthus linearifolius* C.E.C.Fisch. (K [K000096760]). © The Board of Trustees for the Royal Botanic Gardens, Kew. Reproduced with permission.

entire, nerves obscure, glabrous, ciliate, persistent; bracteoles 1.3–1.5 × 0.8–1 cm, ovate-lanceolate, red to reddish green, apex cuspidate, margins entire, midvein visible, lateral nerves obscure, glabrous; pedicels 0.5–2 cm long, terete, reddish brown, glabrous. Calyx slightly fused at base; tube 0.2–0.3 cm long, yellowish red, glabrous; lobes 1.2–2.2 × 0.3–0.7 cm, oblong, apex obtuse to rounded, margins entire, glabrous. Corolla 2.5–3.5 cm long; tube 2.2–3.2 cm long, 0.3–0.5 cm wide at base, gradually inflated towards the throat with 0.6–0.8 cm, curved from the middle, outside crimson red, sparsely pubescent; inside pale orange, glabrous; mouth not oblique; lobes red with dark striations, glabrous, sparsely ciliate, apex rounded, not reflexed; upper lobes 0.3–0.4 × 0.2–0.3 cm, oblong, apex rounded, not reflexed; sinus 0.2–0.4 cm deep; lateral lobes, 0.3–0.4 × 0.2–0.3 cm, oblong, apex rounded, not reflexed; lower lobe 0.4–0.6 × 0.2–0.35 cm, oblong, apex rounded, not reflexed. Stamens fused in two pairs, included; filaments glandular pubescent; anterior 1.3–1.5 cm long, inserted at 1.3–1.5 cm from corolla base; posterior 1.4–1.6 cm long, inserted at 1.4–1.6 cm from corolla base; anthers *c.* 0.2 cm long, oblong, cream coloured. Staminode *c.* 0.1 cm long, clavate, inserted *c.* 1.5 cm from corolla base. Disk *c.* 0.1 cm high, annular. Pistils 1–4 cm long; stipe 0.5–1.5 cm long, glabrous; ovary 0.5–1.5 cm long, linear, greenish, glandular hairy or gland dotted; styles 0.5–1 cm long, green, sparsely pubescent; stigmas *c.* 0.2 cm across, notched or funnel-shaped. Capsules 9–10 × 0.5–0.6 cm, green. Seeds 1.3–1.6 × 0.2–0.3 mm; testa cells strongly papillose, slight to moderate clockwise orientation; apical appendage 1.5–1.7 mm long; hilar appendage a solitary hair, 1.3–1.5 mm long, appendages not papillose.

Flowering & fruiting: Flowering from July to August and fruiting from September to October.

Habitat: An epiphyte on large tree trunks or as lithophyte in forest margins.

Distribution: China, India and Myanmar (GRC, 2024) (Fig. 35).

Specimens examined: CHINA, *s.loc*., 09.07.1938, *T. Yu* 22061 (E [E00067601]); **Xizang** (Tibet), Dulong Jiang valley, Qiqi to Bapo in the N 27°43'52", E 98°24'16", 17.07.2000, *Li Heng* 12918 (E [E00132451]); Gongshan, Cikai, Eastern side of Gaoligong Shan, West of Gongshan, in the vicinity of Qiqi above the Pula He, N 27°42'47", E 98°31'34", 12.07.2000, *Li Heng* 12474 (E [E00132435]); Xiaoxue Cao along the Danzhu He on the road from the Nu Jiang at Danzhu to the Myanmar border, N 27°37'45", E 98°37'45", 02.07.2000, *Li Heng* 12306 (E [E00132446]); Zizhixian, East side of Gaoligong Shan, West of Gongshan, near bridge no. 12, W of Qiqi on the trail from Gongshan to the Dulong Jiang valley, N 27°42'52", E 98°30'54", 19.07.2000, *Li*

Fig. 34. *Aeschynanthus linearifolius* C.E.C.Fisch.: **a.** Habit; **b–c.** Inflorescence; **d.** Single flower; **e.** bracts; **f.** Calyx; **g.** Corolla - split open - showing stamens; **h.** Pistil. (Images f–h. from Walter N. Koelz 25735 (E [E00665630]) © Royal Botanic Gardens, Edinburgh. Reproduced with permission).

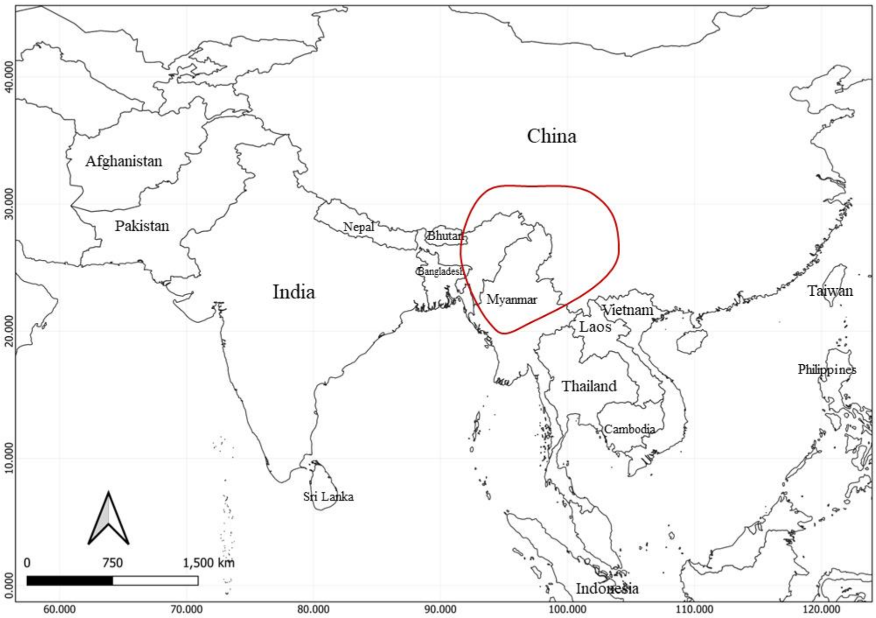


Fig. 35. Distribution of *Aeschynanthus linearifolius* C.E.C.Fisch.

from Gongshan to the Dulong Jiang valley, N 27°42'52", E 98°30'54", 19.07.2000, *Li Heng* 12957 (E [E00132452]); *Ibid.*, N 27°42'26", E 98°32'41", 10.07.2000, *Li Heng* 12226 (E [E00132453]); Mt Kenichunpo, eastern and western slopes, Salwin and Irrawady divide, 1932, *J. Rock* 22082 (E [E00087187]). INDIA, **Arunachal Pradesh**, Lower Dibang Valley district, On the way to Anini, 11.06.2019, *M.K. Akhil, P. Javad* & *Santhosh Nampy* 169316 (CALI). **Nagaland**, Naga Hills, Takubama, 7000 ft, 12.08.1950, *Walter N. Koelz* 25735 (E [E00665630]); Kohima district, way to Japfu Peak, N 25°36'07", E 94°07'44", 2000 m, 01.11.2021, *M.K. Akhil & Santhosh Nampy* 186444 (CALI); Puliebadze, 7000 ft, 04.08.1935, *N.L. Bor* 6345 (K). MYANMAR, **Kachin**, Putao, Nam Tamai Valley; N 27°50', E 97°55', 8000 ft, 17.08.1937, *F. Kingdon Ward* 12948 (BM [BM000883878]); Valley of the Nam Tamai, 4000–5000 ft, 11.09.1926, *F. Kingdon Ward* 7400 (K). **Upper Burma**, Chawng Hka, 11.08.1919, *F. Kingdon Ward* 3494 (E [E00096783]); Laktang, 03.08.1919, *F. Kingdon Ward* 3342 (E [E00096776]).

Conservation status: *Aeschynanthus linearifolius* is distributed across three countries, with an EOO of 3,56,965.977 km^2. Based on current knowledge, the AOO is calculated at 144 km^2. This species generally grows along forest margins as well as inside the forest, with minimal habitat destructions observed. The species is provisionally assessed as Least Concern (LC).

Notes: Anthony (1934) described *A. peelii* var. *oblanceolata* based on specimens collected by G. Forrest and F.K. Ward from the upper Burma (Myanmar)-Tibetan border during 1921 and 1925. He noted the peculiar oblanceolate leaves and established the variety, citing additional supporting characters such as the size of the peduncles, calyx and corolla. Fischer (1940) elevated this variety to species status as *A. oblanceolatus*, stating that Anthony's (*l.c.*) characters were sufficient to recognize it as a new species, rather than a variety. Fischer also highlighted the non-exserted stamens as a significant character to delimit the species, which Anthony had overlooked. Fischer (1935) described *A. linearifolius* from the Delei Valley of Arunachal Pradesh. Later, in 1990, Wang reduced *A. oblanceolatus* as a variety of *A. linearifolius*.

The red inflorescence and the seeds of *A. linearifolius* resemble those of *A. bracteatus*, but can be distinguished by its linear to oblanceolate leaves (*vs*. elliptic or ovate), oblong calyx lobes (*vs*. narrowly ovate or narrowly elliptic) and included stamens (*vs*. exserted).

I collected specimens of this species from Arunachal Pradesh, but they contained only rudimentary flowers and dehisced fruits.

9. Aeschynanthus mannii Kurz ex C.B.Clarke in A.DC & C.DC., Monogr. Phan. 5: 29. 1883, in Hook f., Fl. Brit. India 4: 341. 1884; Kanjilal *et al.*, Fl. Assam 3: 390. 1939; Hilliard in Grierson & D.G.Long., Fl. Bhutan 3: 1303. 2002; G.P.Sinha, Fl. Mizoram 2: 198. 2012; G.D.Pal, Fl. Lower Subansiri District Arunachal Pradesh 2: 165. 2013; U.C.Bhattach. & Goel, Phytotaxonomy 14: 10. 2015; B.K.Sinha & Su.Datta, Nelumbo 58: 8. 2016. *Lectotype* (designated by Dutta *et al.*, 2016): INDIA, Naga, Patkoye, *s.d.*, *Griffith* 3816 (K [K000096771!]); *residual syntype*: INDIA, Naga Hills, Patkoye, *s.d.*, *s.coll. s.n.* (K [K000096772!]).

Figs. 36–37

Epiphytic perennial herbs or undershrubs. Stems dichotomously branched, sub-woody at base, erect, slightly arching when very long, pale green to olive green when young, straw coloured at maturity, glabrescent, rooting at nodes. Nodes swollen; internodes 0.3–2.5 cm long. Leaves opposite or ternate, densely approximate towards apex, sessile or with 0.1–0.2 cm long petioles, terete, canaliculated above, green, glabrous; lamina 2–4 × 1–2.2 cm, elliptic to broadly lanceolate or oblanceolate, fleshy, green above, pale green beneath, apex acute to obtuse, base cuneate, margins entire, deflexed when drying, glabrous; midvein sunken adaxially and abaxially; lateral veins 4 or 5, weakly visible or obscure. Inflorescences axillary; flowers solitary; peduncle absent. Bracts 0.2–0.3 × 0.08–0.1 cm, linear, green, apex acute, margins entire, nerves obscure, glabrous, deciduous; pedicels 0.3–1 cm long, slender, terete, green, glandular pubescent. Calyx free or slightly fused at base; tube *c.* 0.1 cm long, green, pubescent; lobes 0.5–0.8 × 0.2–0.3 cm, triangular, pale green, apex acuminate, margins entire, spreading, glandular pubescent out, glabrous in. Corolla 2–2.5 cm long; tube 1.8–2.3 cm long, 0.1–0.2 cm wide at base to middle, gradually inflated towards the throat with 0.4–0.5 cm, curved, outside pinkish red, sparsely glandular pubescent, inside pale pink, glabrous; mouth not oblique; lobes outside pink to red with greenish yellow, sparsely glandular pubescent, inside pale pink arched with dark blotches, glabrous, ciliate; upper lobes 0.2–0.3 × 0.15–0.2 cm, ovate, apex rounded, not reflexed; sinus 0.05–0.1 cm deep; lateral lobes 0.2–0.3 × 0.2–0.25 cm, ovate, apex rounded, not reflexed; lower lobe 0.3–0.4 × 0.2–0.3 cm, elliptic, apex rounded, slightly reflexed. Stamens fused in two pairs, long exserted; anterior filaments 2.3–2.6 cm long, inserted at 1–1.3 cm from corolla base; posterior filaments 2.5–3 cm long, inserted at 1.2–1.4 cm from corolla base; filaments white at base, red or purple higher up, glandular hairy; anthers *c.* 0.2 × 0.1 cm, elliptic, off white. Staminode *c.* 0.1 cm long, clavate, inserted 1–1.5 cm from corolla base. Disk *c.* 0.1 cm high, annular. Pistils 2.5–4 cm long; stipes 0.4–0.5 cm long, green, glabrous; ovary 0.9–1.8 cm long, linear, greenish, sparsely pubescent; styles 1–1.8 cm long, green, sparsely glandular pubescent; stigmas *c.* 0.2 cm across, sub-capitate, purple. Capsules 3–8 × 0.2–0.3 cm, green. Seeds 0.8–1.2 × 0.2–0.4 mm, testa cells warty; apical appendage 1.5–1.8 cm long; hilar appendage a solitary hair, 1.5–2 cm long, appendages papillose.

Fig. 36. Lectotype of *Aeschynanthus mannii* Kurz ex C.B.Clarke (K [K000096771]). © The Board of Trustees for the Royal Botanic Gardens, Kew. Reproduced with permission.

Fig. 37. *Aeschynanthus mannii* Kurz ex C.B.Clarke: **a–c.** Habit with flowers; **d.** Habit with fruit; **e.** Single flower; **f.** Calyx (Images a–c. by Swamaliana, e & f. from S. Kurz *s.n.* (CAL) © BSI. Reproduced with permission).

Flowering & fruiting: Flowering from February to April and fruiting from May to October.

Habitat: An epiphyte in primary or degraded evergreen or scrub forests.

Distribution: India and Myanmar (GRC, 2024) (Fig. 38).

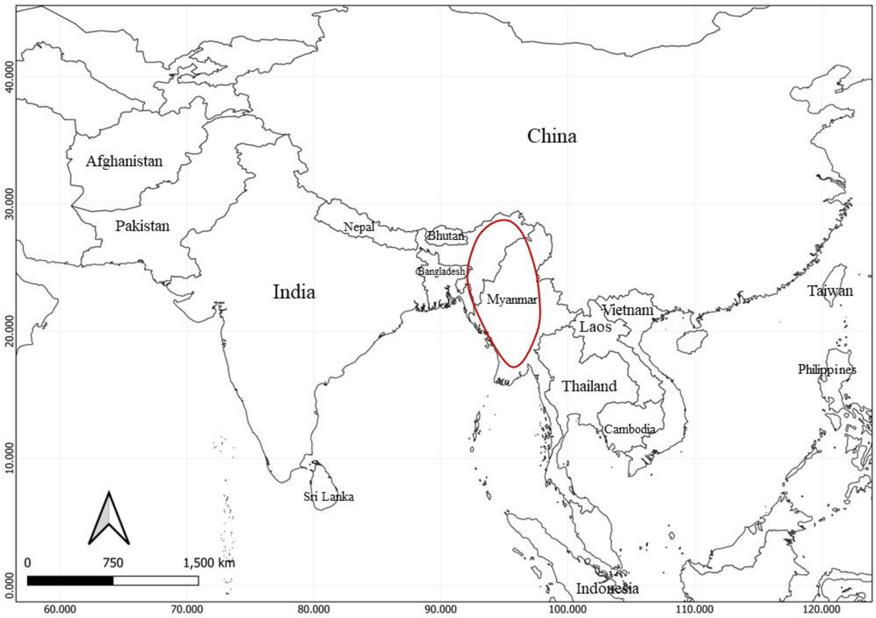


Fig. 38. Distribution of *Aeschynanthus mannii* Kurz ex C.B.Clarke

Specimens examined: INDIA, **Arunachal Pradesh**, Lohit district, Mishmi Hills, Glow, Kamlang Valley, 4000 ft, 24.03.1949, *F. Kingdon Ward* 18448 (NYBG [02652104 digital image]); *Ibid.*, 09.04.1949, *F. Kingdon Ward* 18500 (NYBG [02652103 digital image]). **Assam**, Dima Hasao district, North Cachar Hills, 4200 ft, February 1972, *Tessier-Yandell* 142 (K). **Meghalaya**, Garo Hills, April 1976, *s.coll.* 99 (ASSAM); Khasia, October 1880, *King* 99 (K [K000096770]); Khasi Hills and Brahmaputra Plains, *S. Kurz s.n.* (CAL). **Mizoram**, Aizawl district, Lushai Hills, Sialsuk, 4700 ft, 15.01.1963, *D.B. Deb* 30776 (ASSAM); *Ibid.*, 17.02.1953 *G.K. Deka* 23359 (ASSAM); Puspui, 6000 ft, February 1927, *Parry Ni s.n.* (K); Lawngtlai district, Farkawn, Lurh Tlang, N 23°02'37", E 93°17'17", 1,891 m, 12.06.2022, *M.K. Akhil, E.P. Rajeesh & A. Amrutha* 160629 (CALI); *Ibid.*, N 23°03'07", E 93°18'19", 1,800 m, 12.06.2022, *M.K. Akhil, E.P. Rajeesh & A. Amrutha* 160630 (CALI). MYANMAR (Burma), **Changwang**, 6000 ft, 13.04.1920, *F. Kingdon Ward* 1504 (E [E00096771]); **Chin**, Joung Gyi, 24.07.1930, *Bala* 11789 (CAL), road from Matupi to Palatwa, Natma Taung National Park, 1821 m, 10.03.2014, *P. Srisanga, M. Norsaengesri, R. Unwin, M. Rodda, E. Schuettpels, T.T. Mu & L.S. Man* 097798 (E [E00758290]); Mindat, Victoria, 5700 ft, 01.04.1956, *F. Kingdon Ward* 21904 (BM [BM000883869]), Naga Hills, Patkai, *s.d.*, *Wight s.n.* (K [K000096772]).

Conservation status: *Aeschynanthus mannii* is distributed in Northeast India and Northern Myanmar, with very few populations. The AOO is estimated at 40 km^2. In recent years, Mizoram has faced a high risk of habitat destruction due to the conversion of forest land into agricultural fields. Although the seeds are wind dispersed, deforestation creates gaps in the forest continuum, and the cultivated land serve as a barrier, preventing the seeds from reaching suitable host surfaces (such as tree branches with mosses and other plants). This disruption ultimately will reduce the population size. The species is provisionally assessed as Endangered (EN) B2b(iii)c(iii).

Notes: Kurz (1883) described *A. mannii* and *A. masoniae* Kurz ex C.B.Clarke from Khasia and Burma, respectively. The key distinguishing feature between these two species lies in the shape of the leaves: *A. masoniae* has ovate-elliptic leaves with a round base, while *A. mannii* has elliptic to broadly lanceolate or oblanceolate leaves with a cuneate base. Some herbarium specimens (*D.B. Deb* 30776) in India were initially identified as *A. masoniae*, but none match the round-based ovate-elliptic leaves characteristic of *A. masoniae*. Therefore, it is confirmed that these materials belong to *A. mannii*, not *A. masoniae*.

The erect stems, densely approximated leaves towards the apex, and ternate phyllotaxy distinguish *A. mannii* from other Indian species of *Aeschynanthus*, but show similarity to the *A. andersonii* group, distributed in the Myanmar-Thailand region.

10. Aeschynanthus maoi Debta & A.Shenoy, Brittonia 76: 161–167. 2024. *Type*: INDIA, **Arunachal Pradesh,** Lower Dibang Valley district, near Hunli, N 28°20'09", E 95°56'48", 1190 m, 18.10.2022, *M.R. Debta & Akshath Shenoy* 44200 (holo ARUN; iso ARUN, CAL, CALI!).

Figs. 39, 41 & 42

Epiphytic perennial under shrubs. Stems branched, arching to pendulous, green when young, grey or grey-brown at maturity, glabrous, rooting at nodes. Nodes slightly swollen; internodes 5.2–11.5 cm long. Leaves, decussate; petioles 1.3–1.8 cm long, canaliculated above, green, glabrous; lamina 4.7–11 × 1.8–4.9 cm, elliptic or ovate, coriaceous, green above, pale green beneath, apex acute to acuminate, base cuneate to rounded, margins entire, glabrous; midvein sunken adaxially, prominent abaxially; lateral veins 6–11, weakly visible. Inflorescence axillary or pseudoterminal, 1–8-flowered, peduncles absent or 0.2–0.8 cm long, terete, green, glabrous. Bracts 0.3–0.5 × *c.* 0.2 cm, lanceolate, green, apex acuminate, margins entire, incurved, boat-like, deciduous; pedicels 1–1.8 cm long, angular, pale green, glabrous. Calyx free to base; lobes 0.6–1.3 cm long, narrowly ovate or narrowly triangular, pale green, apex acuminate, margins entire, glabrous. Corolla 3.2–4.2 cm long; tube 3–3.8 cm long, 0.2–0.3 cm wide at base, gradually inflated towards the throat with 0.6–0.9 cm, slightly curved from middle, outside greenish white at base, claret higher up, glabrous, inside greenish white at base, crimson tinged with pink or white higher up, glabrous; mouth oblique; lobes outside claret, dark red stripes running down towards the middle of the tube from lateral lobes, glabrous; inside red to claret with pale markings, glandular pubescent near base, otherwise sparsely puberulent; upper lobes 0.45–0.6 × 0.38–0.4 cm, oblong, apex rounded, not reflexed; sinuses 0.2–0.3 cm deep; lateral lobes, 0.55–0.65 × 0.38–0.46 cm, ovate-elliptic, apex rounded, reflexed; lower lobe 0.52–0.7 × 0.4–0.55 cm, ovate-elliptic, apex rounded, reflexed. Stamens fused in two pairs, long exserted; anterior filaments 2.4–2.6 cm long, inserted at 1.4–1.8 cm from corolla base; posterior filaments 1.8–2.1 cm long, inserted at 1.6–2.1 cm from corolla base; filaments red at base, cream and dark red to maroon higher up, glandular pubescent; anthers 0.18–0.2 × *c.* 0.1 cm, elliptic, purple, pollen grey. Staminode *c.* 0.2

Fig. 39. Holotype of *Aeschynanthus maoi* Debta & A.Shenoy (ARUN [ARUN000030895]). © The Director, Botanical Survey of India. Reproduced with permission.

cm long, turbinate, inserted 1.8–2 cm from corolla base. Disk *c.* 0.2 cm high, annular, brown, glabrous. Pistils 3.8–5.1 cm long; stipe *c.* 2 cm long, pale green, pubescent; ovary 1.5–2.3 cm long, pale green, glandular pubescent; styles 0.6–1 cm long, pale green, densely pubescent; stigmas *c.* 2 mm across, capitate, white. Capsules 9.5–10.5 × 0.2–0.3 cm, green. Seeds 0.6–0.8 × 0.1–0.2 mm; testa cells strongly papillose, papillae formed towards the end of the cell, slight to moderate clockwise orientation; apical appendage 1.5–2.5 mm long; hilar appendage a solitary hair, 1.8–3.5 mm long, appendages slightly papillose.

Flowering & fruiting: Flowering from August to October and fruiting from September to November.

Habitat: An epiphyte on large trees or a pendulous lithophyte near streams.

Distribution: India (GRC, 2024) (Fig. 40).

Conservation status: *Aeschynanthus maoi* is currently known only from the type locality, where a single population consisting of two mature individuals has been found. The AOO is less than 4 km^2. Further exploration of similar habitats in Northeast India and neighbouring countries is needed to ascertain its conservation status. Road widening and deforestation pose significant threats to the existing populations. The species is provisionally assessed as Critically Endangered (CR) B2a,b(iii), D.

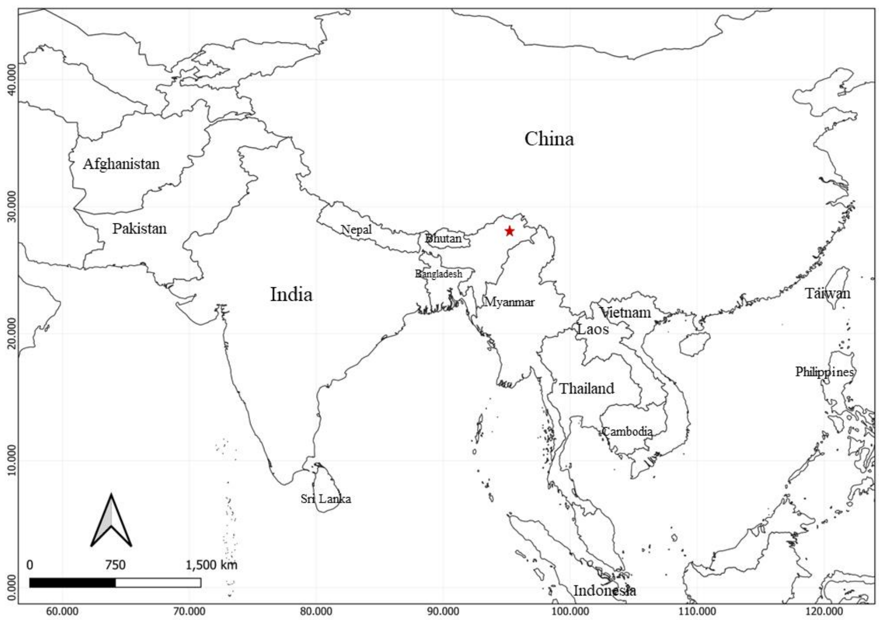


Fig. 40. Distribution of *Aeschynanthus maoi* Debta & A.Shenoy

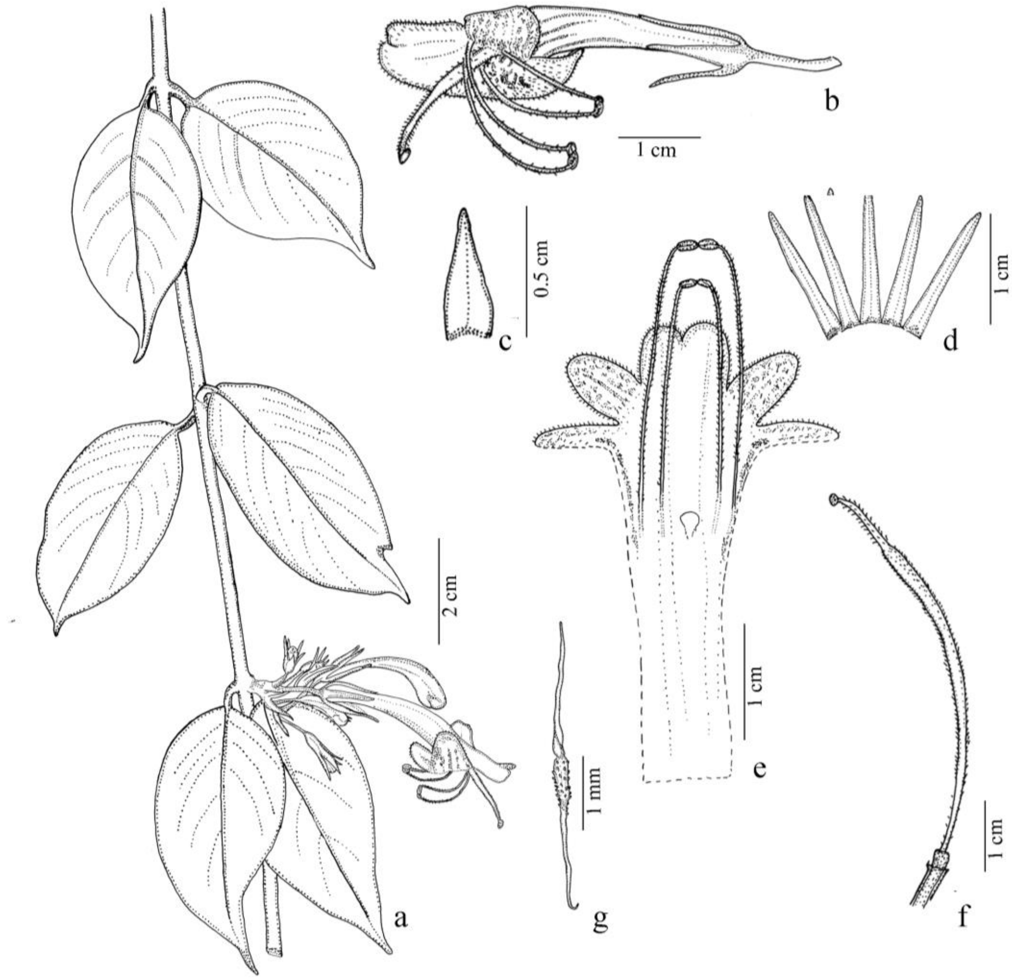


Fig. 41. *Aeschynanthus maoi* Debta & Akshath: **a.** Habit; **b.** Single flower; **c.** Bract; **d.** Calyx; **e.** Corolla - split open; **f.** Pistil; **g.** Seed.

Notes: *Aeschynanthus maoi* is morphologically allied to *A. wardii* Merr. and *A. bracteatus* in terms of leaf shape and texture, reflexed lateral corolla lobes, corolla striations, and seed type. However, it differs from *A. wardii* by its 1–8-flowered inflorescence (*vs.* 1–4-flowered), 3–5 mm long boat-like bracts (*vs.* 6–13 mm long protrusive), narrowly ovate or triangular calyx (*vs*. linear -lanceolate), turbinate staminode (*vs*. clavate) and from *A. bracteatus* by its caducous green bracts (*vs.* persistent red), 0.2–0.8 cm long peduncles (*vs*. 0.8–11 cm long) and narrowly ovate or triangular green calyx (*vs.* linear to narrowly ovate or elliptic red).

In mature plants, the phyllotaxy of *A. maoi* appears decussate, a characteristic not seen in any other Indian species. In all other species, leaves that are initially decussate eventually become distichous due to the twisting of the branches.

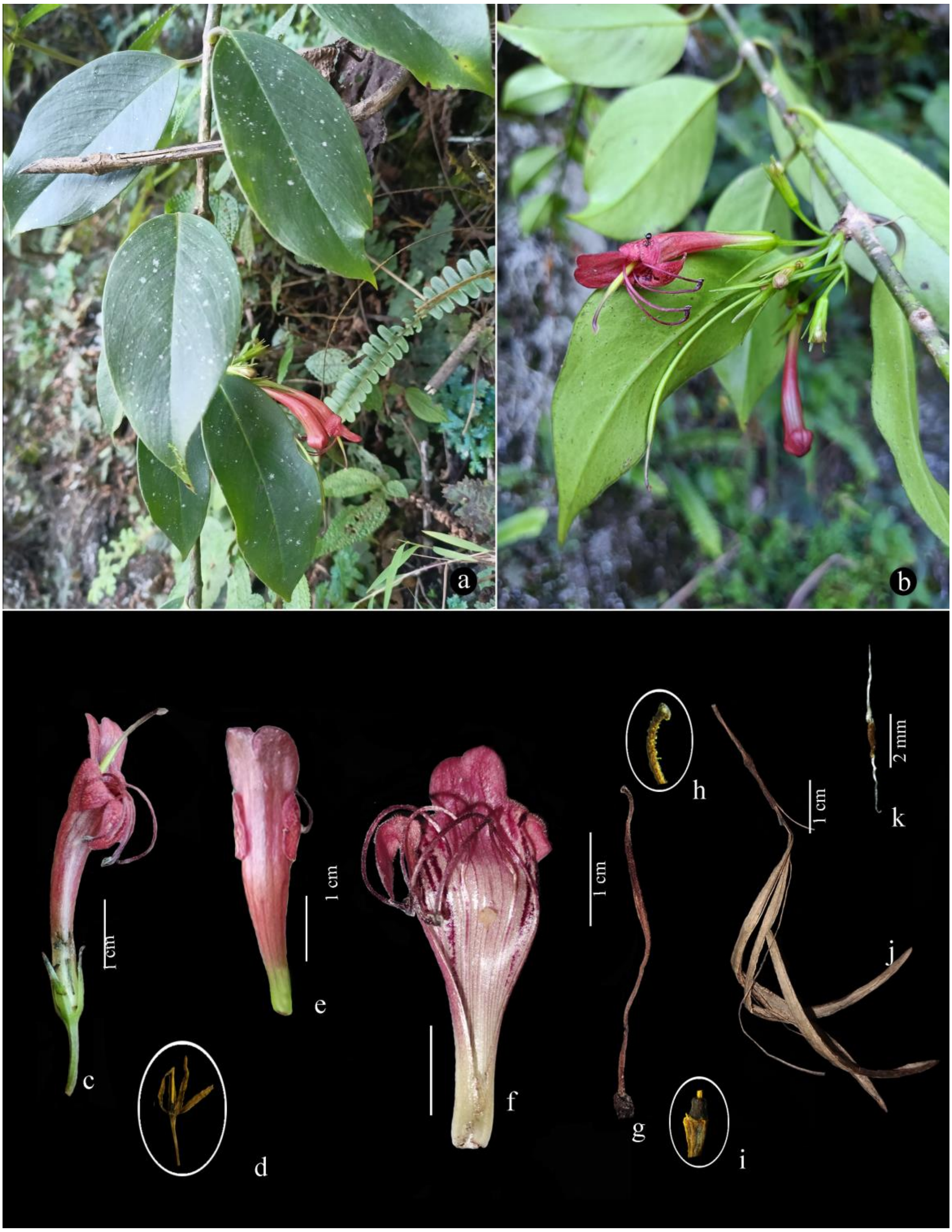


Fig. 42. *Aeschynanthus maoi* Debta & Akshath: **a.** Habit; **b.** Inflorescence; **c.** Single flower; **d.** Calyx; **e.** Corolla - back view; **f.** Corolla - split open; **g.** Pistil; **h.** Style and stigma; **i.** Disk; **j.** Capsule; **k.** Seed.

11. Aeschynanthus micranthus C.B.Clarke in A.DC. & C.DC., Monogr. Phan. 5: 27. 1883, in Hook.f., Fl. Brit. Ind. 4: 340. 1884; Kanjilal *et al.*, Fl. Assam 3: 390. 1939; Hilliard, Fl. Bhutan 2(3): 1300. 2001; Hilliard in Grierson & D.G.Long. Fl. Bhutan 3: 1300. 2002; G.D.Pal, Fl. Lower Subansiri District, Arunachal Pradesh 2: 166. 2013; U.C.Bhattach. Phytotaxonomy 14: 11. 2014; B.K.Sinha & Su.Datta, Nelumbo 58: 9. 2016; S.S.Dash & P.Singh, Fl. Kurung Kumey District 2: 352. 2017; Souvann. *et al.*, Gard. Bull. Singapore 73(2): 448. 2021; Gogoi *et al.*, Fl. Sikkim. Pict. Guide 220. 2021. *Trichosporum micranthum* (C.B.Clarke) Kuntze, Revis. Gen. Pl. 478. 1891. *Aeschynanthus parviflorus auct. non* D.Don: C.B.Clarke, Commelyn. Cyrtandr. Bengal t. 47. 1874. *Lectotype* (designated by Middleton, 2009): INDIA, **Meghalaya**, East Khasi Hills district, Cherrapunji, *J.D. Hooker* 879 (K [K000190170!]); *residual syntypes*: INDIA, **Assam**, *s. loc., s.d., W. Griffith* 3812 (K [K000190168!]); *Ibid., s.d., N. Wallich* 4 (K [K000190171!]); Tinsukia district, Suddiya (Sadiya), 07.01.1836, *W. Griffith* 3812 (K [K000190169!]); **Sikkim**, *s. loc., s. d., J.D. Hooker s.n.* (K [K000096755!]); **West Bengal**, Darjeeling, Ruman, 2000 ft, 15.10.1870, *C.B. Clarke* 13213 (BM [BM000883908!]).

Aeschynanthus austroyunnanensis W.T.Wang, Acta Phytotax. Sin. 13(2): 63. 1975, Fl. Reipubl. Popularis Sin. 69: 512. 1990; W.T.Wang *et al.*, Fl. China 18: 381. 1998; Z.Y.Li & Y.Z.Wang, Gesneriaceae China 368. 2004; Y.G.Wei, Gesneriaceae S. China 692. 2010. *Type*: CHINA, **Yunnan**, Che-li Hsien, Nan-hsien-ho, October 1936, *C.W. Wang* 79443 (holo PE *n.v.*; photo E!).

Aeschynanthus guangxiensis Chun ex W.T.Wang & K.Y.Pan, Bull. Bot. Res., Harbin 2(2): 146. 1982. *Aeschynanthus austroyunnanensis* var. *guangxiensis* (Chun ex W.T.Wang & K.Y.Pan) W.T.Wang, Fl. Reipubl. Popularis Sin. 69: 513. 1990; W.T.Wang *et al.*, Fl. China 18: 381. 1998. *Type*: CHINA, Guangxi, Dar Wan, 27.07.1928, *R.C. Ching* 6557 (holo IBSC *n.v.*; iso A; photo of holo E!).

Figs. 43, 45 & 46

Epiphytic or lithophytic perennial under shrubs. Stems laterally branched, creeping or hanging, green when young, grey-brown at maturity, glabrous, rooting at nodes. Nodes slightly swollen; internodes 1.5–3.5 cm long. Leaves opposite; petioles 0.1–0.8 cm long, terete, canaliculated above, olive green to green, glabrous; lamina 2.5–5.2 × 1–2 cm, ovate to elliptic-oblong, coriaceous or slightly fleshy, green above, pale green beneath, apex acute to acuminate, base cuneate to rounded, margins entire, revolute when drying, glabrous; midvein weakly visible adaxially, sunken abaxially; lateral veins 4–6 pairs, weakly visible or obscure. Inflorescences axillary, 1–4-flowered; peduncles absent. Bracts 0.4–0.6 cm long, linear, apex acuminate, margins entire, green, nerves obscure, deciduous; pedicels 0.7–1 cm long, terete or angular, green, glabrous. Calyx free to base; lobes 0.4–0.8 × 0.2–0.3 cm, narrowly triangular to narrowly

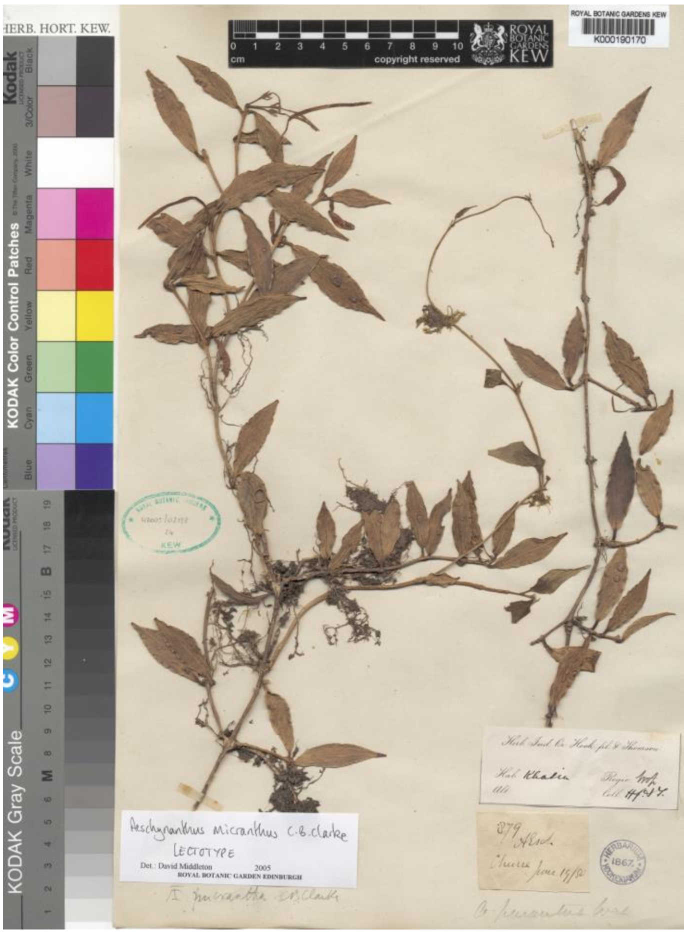


Fig. 43. Lectotype of *Aeschynanthus micranthus* C.B.Clarke (K [K000190170]). © The Board of Trustees for the Royal Botanic Gardens, Kew. Reproduced with permission.

elliptic, green, apex acute, margins entire, glabrous or sparsely ciliate at apex. Corolla 2.5–3.5 cm long; tube 2.3–3.2 cm long, 0.2–0.3 cm wide at base, gradually inflated towards throat with 0.5–0.6 cm, curved from middle with shallow ridge on lower surface, outside red to dark red, glabrous, inside pale orange to white, glabrous or sparsely glandular hairy; mouth not oblique; lobes outside dark red, glabrous; inside pale yellow or cream arched with red, glabrous, ciliate; upper lobes 0.2–0.3 × 0.3–0.4 cm, ovate to elliptic, apex rounded, not reflexed; sinus 0.2–0.3 cm deep; lateral lobes 0.2–0.3 × 0.2–0.3 cm, oblong to ovate, apex obtuse or rounded, not reflexed; lower lobe 0.3–0.5 × 0.2–0.4 cm, elliptic to oblong, apex rounded, not reflexed. Stamens fused in two pairs, slightly to long exserted; anterior filaments 2–2.5 cm long, inserted at 1–1.6 cm from corolla base; posterior filaments 1.5–2.3 cm long, inserted at 1–1.6 cm from corolla base; filaments white at base, red or purple higher up, glandular hairy towards tip; anthers *c.* 0.2 × 0.1 cm, elliptic, purple or grey; pollen yellow. Staminode *c.* 0.1 cm long, clavate, inserted 1.8–2 cm from corolla base. Disk *c.* 0.1 cm high, 5-crenate or annular, brown or cream coloured. Pistils 2–3.5 cm long; stipes 0.5–0.8 cm long, white to greenish yellow, glabrous; ovary 1.5–2.2 cm long, linear, white to greenish yellow, glabrous or gland dotted; styles 0.5–1 cm long, linear, white to greenish yellow, glandular pubescent; stigmas *c.* 0.1 cm across, capitate, purple or white. Capsules 9–15 × 0.2–0.3 cm, green. Seeds 1–1.3 × 0.15–0.3 mm, testa cells warty, straight orientation; apical appendage 1.5–2.2 cm long; hilar appendage a solitary hair, 1.4–2 cm long, appendages papillose.

Flowering & fruiting: Flowering from May to November and fruiting from September to December.

Habitat: A creeping or hanging epiphyte or lithophyte found at altitudes between 150–2500 m.

Distribution: Bangladesh, China, India, Myanmar and Vietnam (GRC, 2024) (Fig. 44).

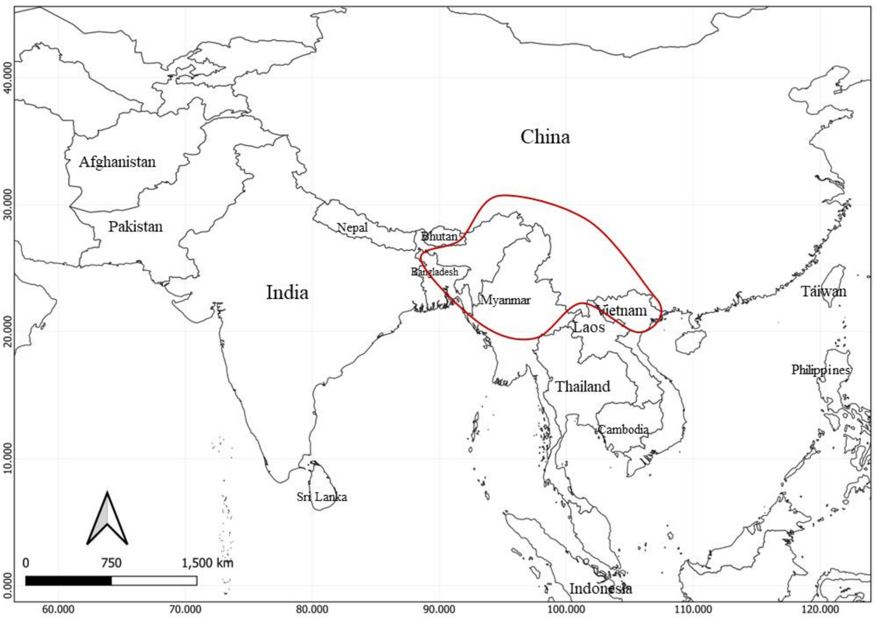


Fig. 44. Distribution of *Aeschynanthus micranthus* C.B.Clarke

Specimens examined: BANGLADESH, Sylhet, *s.d.*, *M.R. Smith* Wallich 796 (K [K001111912]). CHINA, **Guangdong**, Guangzhou (Kweichow), 1936, *S.W. Teng* 91033 (L 0443528). **Yunnan**, Syemao furata, 4000 ft, *A. Henry* 12868 (K). INDIA, **Arunachal Pradesh**, Anjaw district, district border N 27°59′59″, E 96°22′10″, 852 m, 16.06.2019, *M.K. Akhil & Santhosh Nampy* 169344 (CALI); Changlang, N 27°17'46", E 95°33'47", 1180 m, 17.11.2021, *M.K. Akhil & Santhosh Nampy* 186468; *Ibid*., N

Fig. 44. *Aeschynanthus micranthus* C.B.Clarke: **a.** Habit; **b.** Habit with Inflorescence; **c.** Single flower; **d.** Corolla - lateral view; **e.** Calyx; **f.** Corolla - split open inner view; **g.** Corolla - split open back view; **h.** Stamens; **i.** Pistil.

Fig. 45. *Aeschynanthus micranthus* C.B.Clarke in its natural habitats.

27°08'26", E 95°44'56", 1200 m, 17.11.2021, *M.K. Akhil & Santhosh Nampy* 186469; *Ibid*., N 27°06'32", E 95°40'12", 1205 m, 17.11.2021, *M.K. Akhil & Santhosh Nampy* 186470; Hayuliang, N 28°04′45″, E 96°33′17″, 912 m, 16.06.2019, *M.K. Akhil & Santhosh Nampy* 169340; *Ibid*., N 28°04′47″, E 96°33′26″, 914 m, 16.06.2019, *M.K. Akhil & Santhosh Nampy* 169341 (CALI); East Siang district, Pasighat, Boying, N 28°02'55", E 95°17'09", 328 m, 19.06.2019, *M.K. Akhil & Santhosh Nampy* 169351; way to Pasighat from Roing, N 28°09'31", E 95°47'45", 950 m, 18.06.2019, *M.K. Akhil & Santhosh Nampy* 169350 (CALI); Siang River bank, 280 m, 15.11.2013, *M. Bhaumik* 29770 (ARUN); Lower Dibang Valley district, Roing, near Saley Lake, N 28°10'04", E 95°50'21", 514 m, 11.06.2019, *M.K. Akhil & Santhosh Nampy* 169305; *Ibid*., N 28°14'18", E 95°51'27", 500 m, 11.06.2019, *M.K. Akhil & Santhosh Nampy* 169308; 40 km away from Roing on Anini route, 1990 m, 11.06.2019, *M.K. Akhil & Santhosh Nampy* 169310 (CALI); Papum Pare district, Itanagar, Ganga Lake, N 27°04'37", E 93°34'03", 357 m, 16.11.2021, *M.K. Akhil & Santhosh Nampy* 186496; *Ibid*., N 27°04'27", E 93°34'58", 357 m, 16.11.2021, *M.K. Akhil & Santhosh Nampy* 186497 (CALI); Naharlagun Dam site, 06.11.1978 *G.D. Pal* 70141 (ARUN); Senki View, BSI, 550 m, 15.11.2021 N 27°05'58", E 93°36'22", 309 m, *M.K. Akhil, T,P. Krishnaraj & K.H. Harishma* 186493 (CALI); Tirap district, Khonsa, N 26°57'19", E 95°22'14", 1200 m, 9.11.2021, *M.K. Akhil, T.P. Krishnaraj & K.H. Harishma* 186476 (CALI). **Assam**, *s.loc.*, *s.d.*, *G.A. Watt* 457 (E [E00630475]); *Ibid*., *s.d.*, *Wallich* 4 (K [K000190171]); *Ibid*., *s.d.*, *W. Griffith s.n.* (K [K000190168]); *Ibid*., October 1898, *Dr. Prain's collector* 165; *Ibid*., October 1898, *Dr. Prain's collector* 172 (CAL); *Ibid*., 17.02.1957, *G. Panigrahi* 5539 (ASSAM); Dima Hasao district, N. Cachar, Haflong, 2500 ft, 22.08.1908, *W.G. Craib* 372 (K, CAL); Lakhimpur district, Kadam Reserve, 14.05.1966, *D.M. Verma* 46307; Kakoi R.F, 11.02.2011, *N. Odiyuo & D.K. Roy* 121245; *Ibid*., 24.05.2012, *N. Odiyuo & R. Daimary* 126829 (ASSAM); Nagaon district, Janakmukh, 16.12.1911, *I.H. Burkill* 37184 (CAL); Tinsukia district, Digboi, N 27°23'21", E 95°37'59", 534 m, 14.11.2021, *M.K. Akhil, T.P. Krishnaraj & K.H. Harishma* 186487; *Ibid*., N 27°34'20", E 95°35'53", 523 m, 14.11.2021, *M.K. Akhil, T.P. Krishnaraj & K.H. Harishma* 86490 (CALI); Sadiya, 20.07.1935, *G.K. Deka* 13150 (ASSAM). **Meghalaya**, East Khasi Hills district, Nongpoh, 23.07.1966, *J. Joseph* 45601 (ASSAM); Khasia, 3–4000 ft, *J.D. Hooker & T. Thomson s.n.* (K). **Nagaland**, Dikhu River, N 26°32'11", E 94°42'25", 486 m, 04.11.2021, *M.K. Akhil & Santhosh Nampy* 186456; *Ibid*., N 26°31'15", E 94°42'45", 493 m, 04.11.2021, *M.K. Akhil & Santhosh*

Nampy 186458 (CALI). **Sikkim**, *s.loc*., 2000 ft, 08.06.1874, *G. King* 808 (CAL); *Ibid*., *s.d*., *S. Kurz s.n.* (CAL); Teesta, 1000 m, 10.06.1916, *s.coll. s.n* (CAL). **West Bengal**, Jalpaiguri district, Gorumara National Park, 28.09.2010, *V. Ranjan & Anant Kumar* 49999; *Ibid*., Khunia Tower, 23.09.2008, *V. Ranjan & Anant Kumar* 44630; Jaldapara National Park, Kodalbasthi, 05.06.2013, *K. Karthigeyan* 59342; *Ibid*., Jaldapara east, 22.09.2012, *K. Karthigeyan* 58935; Ryang, 250 ft, 08.06.1877, *G. King* 4889 (CAL). MYANMAR, **Kachin**, Myitkyina, Laukhaung-Ritsaw Road, 4000 ft, 28.03.1938, *C.W.D. Kermode* 16672; 10 miles from Mogaung on Myitkyina road, *c*. 150 m, 12.01.1958, *H.S. Mekee* 6037; Valley of the Nogmung, N 27°30', E 97°50', 1000–2000 ft, 08.09.1926, F. *Kingdon Ward* 7378 (K). VIETNAM**, Ha Giang**, Quan Ba district, Can Ty community limestone mountain, 12.07.2002, *H. Van der Werff, Nguyen Kim Dao, Bruce Gray & Do Tien Doan* 17333 (E [E00435181]).

Conservation status: *Aeschynanthus micranthus* is distributed across five countries, with an EOO of 8,87,081.021 km^2. Based on current knowledge, the AOO is estimated at 200 km^2. This species is widespread, generally growing along forest margins and near streams or riversides. Minimal habitat destruction has been observed, and the species is provisionally assessed as Least Concern (LC).

Notes: The Wall. Cat. No. 796 for *A. parasiticus* includes specimen of *A. micranthus* (K001111912). Several specimens at CAL, ASSAM, and ARUN were also misidentified as *A. parasiticus* due to the superficial similarity in leaf shape. However, *A. micranthus* can be easily distinguished by its creeping habit, 5-lobed calyx from the base, and a corolla without an oblique mouth.

Most frequently, *A. micranthus* produces solitary flowers in the axils, though occasionally 2–4 flowers may appear per axil. This widespread species shows some variation in leaf shape (ranging from ovate to elliptic-oblong), corolla colour (from red to dark red), the width and curvature of corolla tube, and the hairiness of floral parts.

Wang (1975) and Wang *et al*. (1982) described *A. austroyunnanensis* W.T.Wang and *A. guangxiensis* Chun ex W.T.Wang & K.Y.Pan respectively from China. Wang *et al*. (1990), later, reduced *A. guangxiensis* as a variety of *A. austroyunnanensis*, while Middleton (2009) synonymised both names under *A. micranthus*.

Bhattacharyya and Goel (2015) reported *A. austroyunnanensis* var. *guangxiensis* from India, but did not cite any relevant specimens. Upon scrutiny of specimens in various herbaria, it was found that one specimen at CAL, collected by Dr. Prain's collector (172) from Assam in 1898, had been identified by Bhattacharyya as *A. austroyunnanensis* var. *guangxiensis*. However, upon closer examination, it became clear that the glabrous nature of the calyx and corolla represents merely a variation, while the toothed leaf margins are likely a result of the wrinkling of the leaves upon drying.

The yellow flowers reported for *A. micranthus* by Taram (2023) from Arunachal Pradesh represent only an unusual variation.

12. Aeschynanthus monetaria Dunn, Bull. Misc. Inform. Kew 1920: 135. 1920; U.C.Bhattach. & Goel, Phytotaxonomy 14: 17. 2015; B.K.Sinha & Su.Datta, Nelumbo 58: 11. 2016; Hu *et al.*, Phytotaxa 450: 109. 2020; Chowlu *et al.*, Curr. Sci. 122: 884. 2022. *Lectotype* (designated by Datta *et al.*, 2016): INDIA, **Arunachal Pradesh**, East Siang district, Rottung (Rotung), 1300 ft, 17.01.1912, *Maubir* 36088 (K [K000096761!]); *residual syntype*: INDIA, **Arunachal Pradesh**, Janakmukh, Abor Hills, 16.12.1911, *Burkill* 37186 (CAL [CAL0000025816!]).

Figs. 47–48

Epiphytic perennial herbs. Stems branched, repent or creeping, pale brown to straw coloured, glabrescent, rooting at nodes. Nodes slightly swollen; internodes 1.5–3 cm long. Leaves opposite; petioles 0.1–0.2 cm long, terete, green, glabrous; lamina 1.1–1.2 × 0.9–1.2 cm, orbicular, discoid or elliptic, thick, fleshy, deep green above, green to purplish green beneath, apex rounded, base rounded, margins entire, glabrous; midvein obscure adaxially, weakly visible abaxially; lateral veins obscure. Flowers axillary, solitary. Bracts 0.1–0.2 × *c.* 0.1 cm, ligulate, green, deciduous; pedicels 1–2 cm long, terete to angular, green, glandular pubescent. Calyx free or slightly fused at base; tube 0.1–0.15 cm long, green, glabrous; lobes 0.4–0.6 × 0.1–0.2 cm long, lanceolate, green to purplish-green, apex acute, margins entire, glandular pubescent out, glabrous in, slightly ciliate. Corolla 3–4 cm long; tube 2.8–3.6 cm long, 0.3–0.5 cm wide at base, gradually inflated towards the throat with 0.8–1 cm, curved from middle, shallow ridge formed longitudinally on lateral sides, outside scarlet, pubescent, inside yellowish-orange, glabrous; mouth not oblique; lobes outside scarlet, sparsely pubescent, inside yellowish-orange arched with dark red and random blotches, glabrous, ciliate; upper lobes 0.3–0.4 × 0.5–0.6 cm, elliptic, apex rounded, slightly reflexed; sinuses 0.2–0.4 cm deep; lateral lobes 0.4–0.5 × 0.2–0.3 cm, oblong, apex truncate, reflexed; lower lobes 0.3–0.4 × 0.2–0.3 cm, oblong, apex obtuse to truncate, spreading or reflexed;. Stamens fused in two pairs, long exserted; anterior filaments 2–2.5 cm long, inserted at 1–1.6 cm from corolla base; posterior filaments 1.5–2.5 cm long, inserted at 1.6–2.2 cm from corolla base; filaments white at base, purple higher up, glabrous at base, gradually pubescent above; anthers *c.* 0.2 × 0.1 cm, elliptic, purple; pollen grey. Staminode 0.1–0.2 cm long, clavate, inserted 1.8–2.2 cm from corolla base. Disk *c.* 0.1 cm high, 5-crenate or annular, green. Pistils 3.5–4 cm long; stipes *c.* 0.6 cm long, green, glabrous; ovary 2–2.5 cm long, linear, white to greenish white, sparsely pubescent; styles 0.5–1 cm long, linear, white to purple, sparsely to densely glandular pubescent; stigmas *c.* 0.2 cm across, capitate, pink or purple. Capsules not seen.

Fig. 47. Lectotype of *Aeschynanthus monetaria* Dunn (K [K000096761]). © The Board of Trustees for the Royal Botanic Gardens, Kew. Reproduced with permission.

Flowering & fruiting: Flowering from October to January; fruiting not seen.

Habitat: A repent epiphyte on large tree trunks and branches in open areas, near riversides, forest margins or roadsides, often growing along with mosses and *Hoya nummularia* Decne. ex Hook.f.

Distribution: China, India and Myanmar (GRC, 2024) (Fig. 49).

Fig. 48. *Aeschynanthus monetaria* Dunn: **a, c.** Habit; **b.** Habit with flower; **d.** Leaf - adaxial view; **e.** Leaf - abaxial view; **f.** Calyx; **g.** Single flower; **h.** Corolla - lateral view; **i.** Corolla - split open; **j.** Stamens; **k.** Pistil.

Specimens examined: INDIA, **Arunachal Pradesh**, Anjaw district, Changwinti, N 28°07′32.7″, E 97°00′45.2″, 1134 m, December 2021, *K. Chowlu* 41886 (CAL, ARUN); Hayuliang, Near transit camp, N 28°04′49″, E 96°32′02″, 590 m, 11.11.2021, *M.K. Akhil & Santhosh Nampy* 186484; *Ibid.*, N 28°04′53″, E 96°31′35″, 585 m, 11.11.2021, *M.K. Akhil & Santhosh Nampy* 186485 (CALI); 5 km above Hyuliang, N 27°56′25″, E 96°21′54.8″, 543 m, December 2021, *K. Chowlu* 41872 (CAL, ARUN); East Siang district, Janakmukh, Abor Hills, 16.12.1911, *Burkill* 37186 (CAL [CAL0000025816]); Rottung, 1300 ft, 17.01.1912, *Moubir* 36088 (K [K000096761]). **Assam**, Dehing Valley, 2–3000 ft, 10.02.1928, *F. Kingdon Ward* 7825. MYANMAR, **Kachin**, Forest Northwest of Kanang, 5–7000 ft, *Keenan J., Tun Aung U.& U. Tha Hla* 3026 (E [E00630421]); between Ning W'Krok and Kanang, 4–5000 ft, 20.01.1962, *J. Keenan, U. Tun Aung & U. Tha Hla* 3343 (E [E00630422], K).

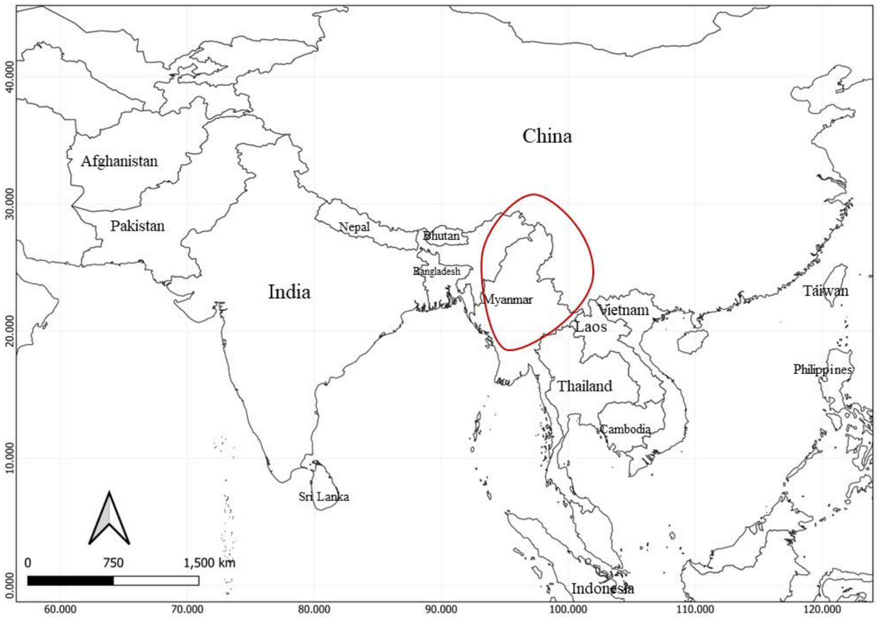


Fig. 49. Distribution of *Aeschynanthus monetaria* Dunn

Conservation status: *Aeschynanthus monetaria* is distributed in southern China, Northeast India, and northern Myanmar with an EOO of 13,687.889 km^2. The AOO is calculated at 20 km^2. The species is generally found on the branches of large trees in open lands, near riversides, forest margins or roadsides. It is susceptible to habitat destruction due to landslides, road widening and other construction activities. The species is provisionally assessed as Endangered (EN), B2b(iii)c(iii).

Notes: Dunn (1920) described *A. monetaria* based on two specimens collected by Burkill (Isaac Henry Burkill, 1870–1965), from the Rengging and Rottung parts of Abor Hills, with collection numbers 36088 (K000096761) and 37186 (CAL0000025816). These syntypes were housed at K and CAL, respectively. Datta *et al.* (2016) designated the K specimen (K000096761!) as the lectotype, though the herbarium label lists 'Maubir', as the collector, which contradicts Burkill as stated in the protologue. Hu *et al.* (2020) resolved this discrepancy by giving detailed nomenclatural notes and history related to the herbarium labels. They also corrected the misapplication of the name *A. monetarius* by Datta *et al.* (2016) and others, stating that Dunn used the specific epithet '*monetaria*' as a noun in apposition, which, according to the Art. 23.5 (Turland *et al.*, 2018) should be retained as such, regardless of the gender of the generic name.

Although the type locality is currently within the Indian political boundary (East Siang district of Arunachal Pradesh), Hu *et al.* (2020) considered it part of China (Motuo County, Southeast Tibet). In the Indian context, the recent discovery of *A. monetaria* along the Yarlung Zangbo (Yalu Tsangpo) River in Motuo (Mêdog) County (*Hujun* HJ05104) should be regarded as a new addition for China, rather than a rediscovery. Apart from the ongoing boundary disputes, this confirms the extended distribution of the species into China. After nearly a century, *A. monetaria* was rediscovered in India by Chowlu *et al.* (2022) in the Hayuliang area of Anjaw district, Arunachal Pradesh. During my own expeditions, I collected additional specimens from different locations in Hayuliang. Further, while consulting different herbaria, two additional materials from the Kachin state of Myanmar (E00630421!, E00630422!) were found, confirming the extended distribution of the species to Myanmar.

All Indian materials examined had orbicular leaves, whereas the Chinese and Myanmar specimens had orbicular to elliptic leaves. This variation in leaf shape may lead to misidentify with *A. chiritoides*, in the vegetative phase. However, the white or yellowish corolla and the four cohering stamens of *A. chiritoides* are distinct and cannot be confused with the scarlet corolla and pairwise cohering stamens of *A. monetaria*.

13. Aeschynanthus parasiticus (Roxb.) Wall., Num. List 796. 1829; R.Br., Cyrtandreae 115. 1835; B.L.Burtt & Davidson, Notes Roy. Bot. Gard. Edinburgh 21: 231. 1955; Deb, Fl. Tripura 2: 301. 1983; N.P.Balakr., Fl. Jowai 2: 344. 1983. Harid. & R.R.Rao, Forest Fl. Meghalaya 2: 651. 1987; Hilliard in Grierson & D.G.Long, Fl. Bhutan 3: 1302. 2002; Kress *et al.*, Checkl. Myanmar 261. 2003; G.P.Sinha, Fl. Mizoram 2: 199. 2012;

Ambrish, Fl. Upper Subansiri District 338. 2013; U.C.Bhattach. & Goel, Phytotaxonomy 14: 10. 2014; B.K.Sinha & Su.Datta, Nelumbo 58: 14. 2016; S.S.Dash & P.Singh, Fl. Kurung Kumey District. 2: 353. 2017; A.A.Mao *et al.*, Check List Fl. Nagaland 96. 2017; Gogoi *et al.*, Fl. Sikkim. Pict. Guide 220. 2021; Bh.Adhikari & Mich.Möller in M.F.Watson, Fl. Nepal (Web ed.). 2023. *Incarvillea parasitica* Roxb., Pl. Corom. 3: 88. 1820. *Aeschynanthus grandiflorus* var. *parasiticus* (Roxb.) C.B.Clarke in A.DC. & C.DC., Monogr. Phan. 5: 22. 1883. *Trichosporum parasiticum* (Roxb.) Kuntze, Revis. Gen. Pl. 477. 1891. *Lectotype* (designated by Middleton, 2009): Roxb., Pl. Corom. 3: plate 291. 1820.

Trichosporum grandiflorum D.Don, Edinburgh Philos. J. 7: 85. 1822, in Buch.-Ham., Prodr. Fl. Nepal. 125. 1822 *nom. superfl*., *Aeschynanthus grandiflorus* Spreng., Syst. Veg. 4(2): 238. 1827, *nom. superfl*.; G.Don, Gen. Hist. 4: 656. 1838; Steud., Nomencl. Bot. ed. 2, 1: 32. 1840; D.Dietr., Syn. PI. 3: 581. 1843; A.DC., Prodr. 9: 261. 1845; Miq., Fl. Ned. Ind. 2: 718 1858; C.B.Clarke in A.DC. & C.DC., Monogr. Phan. 5: 22. 1883, in Hook.f., Fl. Brit. Ind. 4: 338. 1884; Kanjilal *et al.*, Fl. Assam 3: 389. 1939. *Lectotype* (designated by Middleton, 2009): BANGLADESH, Sylhet, *s.d.*, *M.R. Smith* Wallich 796 (K [K000096744!]; isolecto K [K000096745!, K000096746!, K000096747!, K001111913!, K001111964!]; PH [PH00000044 digital image]).

Aeschynanthus deleiensis C.E.C.Fisch., Bull. Misc. Info. Kew 1935: 320. 1935; U.C.Bhattach. & Goel, Phytotaxonomy 14: 10. 2014. *Type*: INDIA, **Arunachal Pradesh**, Anjaw district, Delei Valley, 14.07.1928, *F. Kingdon Ward* 8447 (holo K [K000096759!]).

Aeschynanthus mimetes B.L.Burtt, Bot. Mag. 162: t. 9595. 1940; Wang, Phytologia 45: 310. 1980; Li, Acta Bot. Yunnan. 5: 35. 1983; Wang, Fl. Reipubl. Popularis Sin. 69: 522. 1990; Wang *et al.*, Fl. China 18: 384. 1998; Kress *et al.*, Checkl. Myanmar 261. 2003. *Neotype* (designated by Middleton, 2009): INDIA, **Nagaland**, Vekhahomi, *s.d.*, *Bor* 5060 (K).

Aeschynanthus andamanensis Goel, Vasudeva Rao & Mehrotra, Bull. Bot. Surv. India 31: 154. 1989. *Type*: INDIA, **Andaman Islands**, South Andamans, Alexandria Island, 26.10.1986, *A.K. Goel* 16636 (holo CDRI; iso CAL [CAL0000033233!], CDRI).

Figs. 50, 52 & 53

Fig. 50. Lectotype of *Aeschynanthus parasiticus* (Roxb.) Wall. (Roxb., Pl. Corom. 3: plate 291)

Epiphytic or lithophytic perennial under shrubs. Stems laterally branched, arching or pendulous; green with dark purple blotches when young, straw coloured at maturity, glabrous, rooting at nodes. Nodes swollen; internodes 3–5 cm long. Leaves opposite; petioles 0.5–1 cm long, terete, canaliculated above, green, glabrous; lamina 10–13 × 1.8–3.5 cm, linear lanceolate or elliptic to ovate, fleshy, green above, pale green beneath, apex acuminate, straight or curved like a sickle, base cuneate to rounded, margins sub-entire to undulate, glabrous; midvein sunken adaxially, prominent abaxially; lateral veins generally 4–6 pairs, weakly visible or obscure. Inflorescences axillary or pseudo-terminal, 2–12-flowered; peduncle absent. Bracts 0.8–1.2 × 0.6–0.8 cm, elliptic to lanceolate, green, apex acute, margins entire, inflexed, faintly 1–3 nerved, glabrous, deciduous; pedicels 1–1.2 cm long, terete to angular, yellowish green to green, glabrous. Calyx foliaceous, lobed from middle or above; tube 0.4–0.7 (–1.5) cm long, yellowish green to green or brownish to reddish green, glabrous; lobes 0.6–0.8 (–1.5) × 0.2–0.4 cm, elliptic to triangular, occasionally foliaceous, yellowish green-green or brownish-reddish green, apex acute to obtuse, margins entire, straight, glabrous. Corolla 3.5–4.5 (–6) cm long; tube 3–4 (–5.5) cm long, 0.3–0.5 (–0.8) cm wide at base, strikingly inflated towards the throat with 1.2–1.6 cm, curved almost semi-circular by the upper surface, outside yellowish orange or orange to bright red, dark stripes running down from the lobes, glandular puberulent, inside yellowish to pale orange, glabrous with a band of multicellular hairs just above the base; mouth slightly oblique; lobes outside red to orange-red with dark brown stripes running down from the centre, pubescent; inside pale orange arched with deep orange band followed by dark brown or purple markings, dark brown stripes running downward from the centre of each lobe, glabrous, ciliate; upper lobes 0.3–0.6 × 0.4–0.5 cm, orbicular or oblong, apex rounded, not reflexed; sinus 0.2–0.4 cm deep; lateral lobes 0.3–0.6 × 0.45–0.8 cm, oblong to ovate, apex obtuse to rounded, not reflexed; lower lobe 0.5–0.8 × 0.3–0.5 cm, elliptic to oblong, apex rounded, reflexed or not. Stamens fused in two pairs, long exserted; anterior filaments 2–2.5 (–4) cm long, inserted at 2.5–2.8 cm from corolla base; posterior filaments 1.8–2.2 (–3.8) cm long, inserted at 1.8–2.1 cm from corolla base; filaments white at base, red or purple higher up, glandular hairy; anthers 0.7–0.8 × 0.08–0.09 cm, elliptic, purple or grey; pollen yellow or grey. Staminode 0.1–0.2 cm long, clavate, inserted *c.* 1.8 cm from corolla base. Disk *c.* 0.1 cm high, 5-crenate or annular, cream or brownish red. Pistils 3.5–4 (–0.5) cm long; stipes 0.4–0.6 (–1) cm long, greenish white, glabrous; ovary 2–2.2 (–4.5) cm long, linear, white to greenish white, glabrous; styles 0.7–0.9 (–1.5) cm long, linear, white to purple, glandular pubescent; stigmas 0.1–0.2 cm across, capitate, pink or purple. Capsules 15–25 × 0.2–0.4 cm, green, yellow green or purple. Seeds 0.8–1.3 × 0.2–0.3 mm, testa cells warty, straight orientation; apical appendage 1.8–3.5 cm long; hilar appendages 2, 1.3–3 cm long, appendages papillose.

Vernacular name: Large-flower blushwort.
Flowering & fruiting: Flowering from May to July and fruiting from July to October.
Habitat: An epiphyte on large tree trunks or branches in forest margins, near streams, road sides or even on Areca palms in cultivated land or as lithophytes in mossy-rich rocks mainly on roadsides.
Distribution: Bangladesh, China, India, Myanmar, Nepal and Vietnam (GRC, 2024) (Fig. 51), however, I was unable to locate any specimens from Vietnam, from the herbaria I consulted.

Specimens examined: BANGLADESH, **Sylhet**, Jaintapur, 02.10.1983, *Hug, Rahman & Mia* 6295 (E); *Ibid*., 02.10.1983, *Huq Rahman & Mia H.* 5139 (K). CHINA, **Yunnan**, Syemar N., 500 ft, *s.d., A. Henry* 12995 (E [E00067581, E00067582]); Lava leed west of Zeng Juch, July 1919 *G. Forrest* 18418 (E [E00067583]); Shunning, Hila, 1980 m, 28.06.1938, *T.T. Yu* 16549 (E [E00067584]). INDIA, **Arunachal Pradesh**, East Siang district, Simang River bank, 280 m, 15.11.2013, *Dr. M. Bhaumik* 29770 (ARUN); Lower Subansiri district, A.F.S. Garden, 19.09.1990, *A.A. Mao* 5767 (ARUN); West Siang district, Along-Tato, 1200 m, 22.08.2011, *M. Bhaumik* 25833 (ARUN); Kaying to Tumbin, N 28°29'08", E 94°39'52", 1467 m, 25.08.2023, *Krishnapriya M.P & M. Sreya*

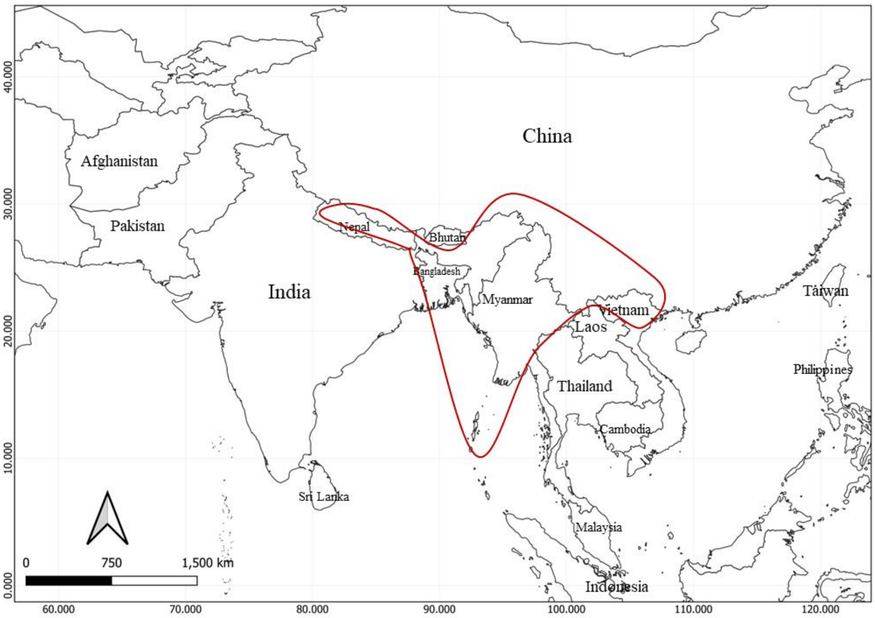


Fig. 51. Distribution of *Aeschynanthus parasiticus* (Roxb.) Wall.

160643 (CALI). **Assam**, Dima Hasao district, Haflong, near Cachar Hills, 2500 ft, 14.08.1808, *W.G. Craib s.n.* (K). **Meghalaya**, Khasi Hills, 1200 m, 1861, *J.D. Hooker & T. Thomson s.n.* (GDC digital image); Khasia, 4000 ft, *s.d.*, *J.D. Hooker & T. Thomson* (BR [BR0000008495389 digital image], G [G00492381 digital image], L [L.2821563, L.2821564 digital images]); *Ibid.*, 26.05.1909, *s.coll. s.n.* (L [L 0414495 digital image]); East Khasi Hills district, Cherrapunji, 4000 ft, 14.07.1952, *Walter N. Koelz* 26206 (L [L.2821559 digital image]); *Ibid*., shola near to Seven Sister waterfalls, N 25°14'34", E 91°43'95", 1430 m, 16.09.2021, *M.K. Akhil & Santhosh* Nampy 186402; *Ibid*., N 25°13'37", E 91°45'95", 1400 m, 16.09.2021, M.P. *Krishnapriya* , *K.H. Harishma & M.K. Akhil* 186403; way to Cherrapunji, 5700 ft, 09.10.2017, *Vishnu Mohan & Santhosh Nampy* 156850; way to Dawki, N 25°11'38", E 91°77'02", 1400 m, 25.09.2021, *M.K. Akhil & Santhosh Nampy* 186425; Lapalang, way to Byrdaw waterfalls, N 25°12'88", E 91°57'02", 1430 m, 25.09.2021, *M.K. Akhil & Santhosh Nampy* 186421; Mawlynnong, 2029 ft, 11.10.2017, *Santhosh Nampy & Vishnu Mohan* 156856; *Ibid*., 4125 ft, 11.10.2017, *Santhosh Nampy & Vishnu Mohan* 156858; way to Mawlynnong, 4294 ft, 11.10.2017, *Santhosh Nampy & Vishnu Mohan* 156856; near Mawsmai Cave, N 25°14'46", E 91°43'30", 1247 m, 16.09.2021, *Kanthraj* 186404; Mawsynram 3766 ft, 08.10.2017, *Vishnu Mohan & Santhosh Nampy* 156839; way to Mawsynram 3760 ft, 08.10.2017, *Santhosh Nampy & Vishnu Mohan* 156824; Nongriat,

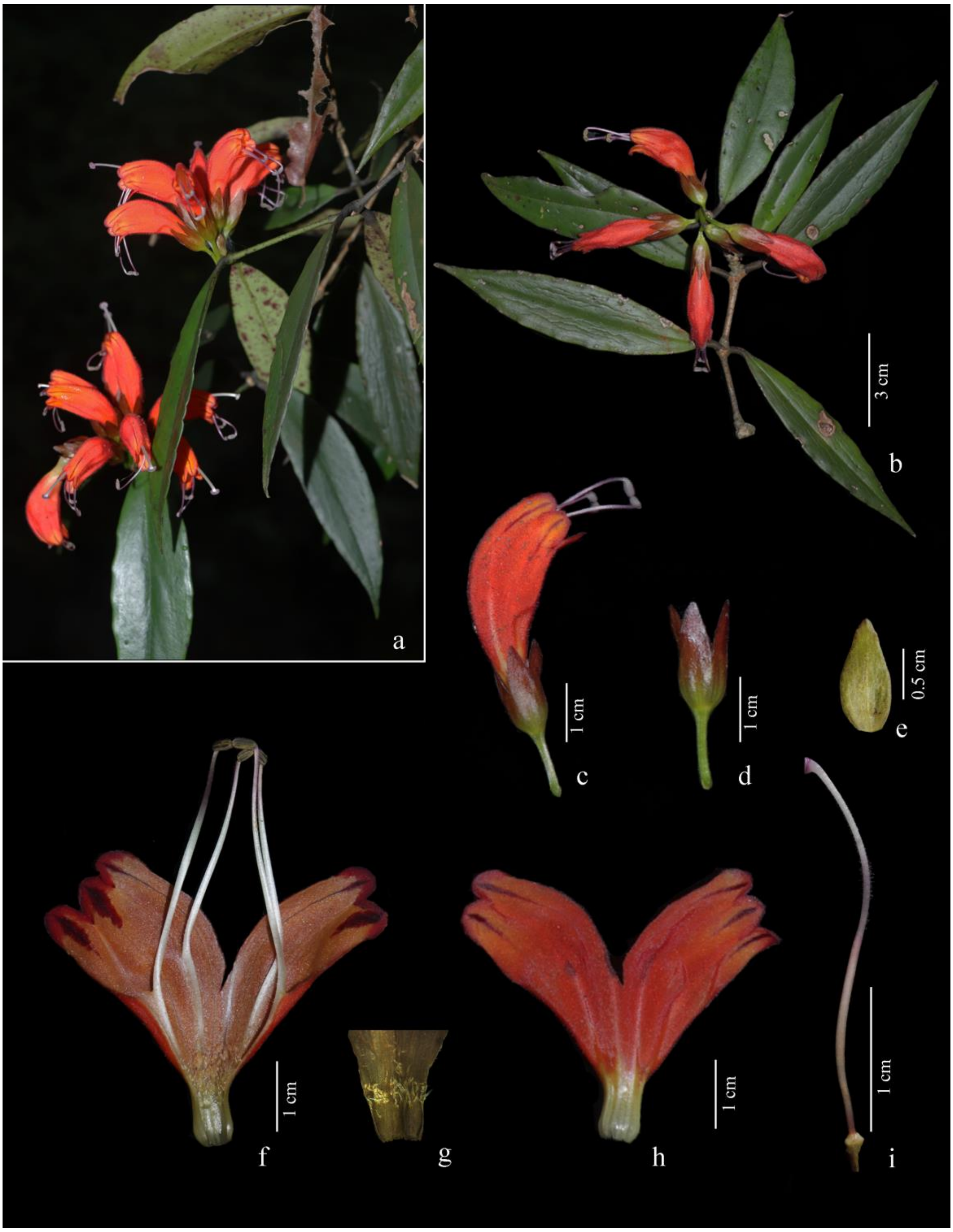


Fig. 52. *Aeschynanthus parasiticus* (Roxb.) Wall.: **a & b.** Habit; **c.** Single flower; **d.** Calyx; **e.** bract; **f.** Corolla - split open - showing stamens; **g.** Inner corolla hairs; **h.** Corolla - split open - back view; **i.** Pistil.

Fig. 53. *Aeschynanthus parasiticus* (Roxb.) Wall. in its natural habitats.

Akhil & Santhosh Nampy 186426; *Ibid*., N 25°14'84", E 91°40'30", 1350 m, 26.09.2021, *M.K. Akhil & Santhosh Nampy* 186430; *Ibid*., N 25°15'06", E 91°40'15", 825 m, 02.10.2021, *M.K. Akhil & Santhosh Nampy* 186439; Pynursla, N 25°19'35", E 91°53'58", 1300 m, 20.09.2021, *M.K. Akhil & Santhosh Nampy* 186408; way to Pynursla, N 25°17'31", E 91°50'28", 1340 m, 20.09.2021, *M.K. Akhil & Santhosh Nampy* 186406 (CALI); Sylhet, 1829, *Wallich* 796 (K); *Ibid.*, 1830, *Wallich* 796 (K); *Ibid.*, 1832, *Wallich* 796 (K); *Ibid.*, 1832, *M.R. Smith* 796 (G00133091, G00133080 digital images); Umium, Barapani, N 25°41'31", E 91°56'10", 995 m, 16.09.2021, *M.K. Akhil & Santhosh Nampy* 186401 (CALI); Jaintia Hills district, 11 km Jarain to Dawki road, 15.11.1962, *N.P. Balakrishnan* 49827 (ASSAM); Tura Mountain, Garo Hills, 4000 ft, 16.03.1950, *Thakur Rup Chand* 2833 (K); West Jaintia Hills district, Jowai, 26.05.1956, *R.S. Rao* 2551 (ASSAM); *Ibid*., N 25°25'89", E 92°10'92", 1300 m, 23.09.2021, *M.K. Akhil & Santhosh Nampy* 186417; way to Jowai, N 25°34'30", E 92°10'71", 1380 m, 22.09.2021, *M.K. Akhil & Santhosh Nampy* 186412 (CALI); West Garo Hills district, Sasagre, on the way to Nokrek Peak, 06.09.1975, *M.K.V. Rao* 61583 (ASSAM). **Mizoram**, Champhai district**,** Murlen National Park, Chamdur core, 01.03.2014, *Ramesh Kumar & Party* 128768; *Ibid.*, Rabung, 19.09.2012, *Ramesh Kumar & Party* 127069; Dampa Tiger Reserve, Saithal, 600 m, 24.09.2006, *B.K. Sinha & N. Odyuo* 112934 (ASSAM); Lushai Hills, Sangao [Sangau], 4000 ft, 20.02.1953, *Thakur Rup Chand* 6875 (L [L.2821561 digital image]); *Ibid.*, 08.03.1953, *Thakur Rup Chand* 6890 (L [L.2821562 digital image]). **Nagaland**, Kohima district, Naga Hills, Takubama, 7000 ft, 27.08.1950, *T.R. Chand* 3479 (L [L.2821565 digital image]); *Ibid.*, *c*. 5000 ft, 20.09.1950, *Walter N. Koelz* 26206 (L [L 0414469, L.2821560 digital image]); Vekhaham, 3000 ft, 04.08.1935 *N.C. Jon* 5060 (K). **Odisha**, Banguru district, *s.loc.*, 04.07.1957, *G. Panigrahi* 8637S (CAL); Kapsi river 1500 ft, 03.10.1939, *H.F. Mooney* 1160 (K); Keonjhar, 1600 ft, 03.08.1935, *H.F. Mooney* 1160 (CAL). **Sikkim**, *s.loc*., 4000 ft, *J.D. Hooker s.n*.; Chakung, November 1849, *J.D. Hooker s.n.*; Gor, May 12, *J.D. Hooker s.n*. (K); Mangan district, Chungthang, 14.05.1845, *J.D. Hooker s.n.* (K). **Tripura**, North Tripura district, Phuldungsei, 602 m, 30.10.2007, *B.K. Sinha* 117256 (ASSAM). **West Bengal**, Darjeeling, 5000 ft, August 1883, *Gamble* 9684 (CAL). MYANMAR, **Bassien**, Kyathung chaung, Mezali Reserve, 03.12.1927, *C.W.D. Kermode* 7312 (K); Ngawchang Valley, 3000 ft, 05.07.1919, *R. Farrer* 1079 (E [E00096773]). **Rakhine**, Road between Padein and Ann, W of Minbu, 52 miles from Schwesettaw, 12 miles from Ann, N 19°52'07", E 94°23'07", 1350 m, 27.06.1999, *W.J. Kress, M. Bordelon, K. Williams & Thet Htun* 99-6467 (US [US 00732951 digital image]). **Shan**, Kung Teng, 2500 ft, 1909, *R.W. MacGregor* 792 (E [E00096772]);

descent from Sansi gorge to Sadon, 8000 ft, September 1912, *G. Forrest* 9102 (E [E00087184, E00096775]). NEPAL, Sanguri Danda, 3500 ft, 03.08.1975, *L.W. Beer* 25302 (E [E00630428]).

Conservation status: *Aeschynanthus parasiticus* is distributed across six countries, with an EOO of 31,39,598.698 km^2. Based on current knowledge, the AOO is calculated at 204 km^2. It is widespread in Northeast India. While road widening and associated construction works have impacted its population in several areas, the species is provisionally assessed as Least Concern (LC) considering its broader distribution.

Notes: Roxburgh (1820) described *Incarvillea parasitica* (under Bignoniaceae), based on live specimens collected from the Garo Hills and subsequently cultivated at the Calcutta Botanic Gardens. However, Roxburgh's (*l.c.*) treatment was incorrect, and Wallich (1829) later corrected it by transferring the species to *Aeschynanthus* as *A. parasitica* (=*A. parasiticus*). Due to the lack of original material collected by Roxburgh, Middleton (2009) designated the illustration in the protologue as the lectotype. Meanwhile, *Trichosporum grandiflorum* D.Don became a superfluous name, as Don (1822) treated *I. parasitica* as a synonym.

Middleton (2009) synonymised several names under *A. parasiticus*, including *A. macranthus* (Merr.) Pellegr., *A. deleiensis* C.E.C.Fisch., *A. mimetes* B.L.Burtt, *A. dolicanthus* W.T.Wang, *A. pachytrichus* W.T.Wang, and *A. andamanensis* Goel, Vasudeva Rao & Mehrotra. Upon examining the type sheets of *A. deleiensis, A. mimetes*, and *A. andamanensis* described from India, I also agree with Middleton (*l.c*.) treatment.

Fischer (1935) described *A. deleinensis* and mentioned a single hilar appendage. However, upon scrutiny of the type material, it is found that the specimens possess two hilar appendages, indicating an error in the protologue. For *A. mimetes*, the longer, narrow calyx tube with shallow lobes is distinct from the much broader foliaceous calyx typical of *A. parasiticus*. However, this can be considered an extreme variation of the species.

Goel *et al.* (1992) described *A. andamanensis* from the Andaman and Nicobar Islands. Middleton (2009) synonymised it under *A. parasiticus*, stating that its calyx characteristics fall within the variation of the species. Bhattacharyya and Goel (2015) resurrected *A. andamanensis*, but the characters they used to demarcate it, except for the absence of stripes or markings on the corolla mouth and lobes, are not sufficient to keep it as a distinct species.

Bhattacharyya and Goel (2015) reported *A. griffithii* from Andaman Islands without citing any specimens. Upon consulting materials at CAL, I found that some specimens from Andaman had been mistakenly identified as *A. griffithi* (*N.G. Nair* 4857, 501, *N.P. Balakrishnan & N. Bhargava* 3607, *Dr. King's collector s.n.*). After careful study, it has been confirmed that all these specimens actually belong to *A. parasiticus*, as *A. griffithii* is an entirely different species, characterized by marbled leaves, a greenish corolla, and a tuft of hilar appendages.

In India, *A. parasiticus* shows considerable variation in leaf shape and calyx characters (Figs. 54–55). The typical foliaceous calyx is not always present in all specimens. Some specimens collected from the West Siang district of Arunachal Pradesh have unusually large flowers, reaching up to 6 cm in length, representing an extreme variation. *Aeschynanthus parasiticus* can be separated from the widespread and allied *A. parviflorus,* by its relatively broader corolla tube and the presence of robust multicellular hairs at the base of the corolla.

Fig. 54. *Aeschynanthus parasiticus* (Roxb.) Wall.: Variations in **a.** Leaves; **b.** Calyx.

Fig. 55. *Aeschynanthus parasiticus* (Roxb.) Wall.: Floral diversity.

14. Aeschynanthus parviflorus (D.Don) Spreng., Syst. Veg. 4(2): 238. 1827; G.Don, Gen. Hist. 4: 656. 1838; Steud., Nomencl. Bot. ed. 2, 1: 32. 1840; D.Dietr., Syn. PI. 3: 580. 1843 (*A. parviflorus* (D.Don) G.Don); A.DC., Prodr. 9: 261. 1845; Miq., Fl. Ned. Ind. 2: 718. 1858 (*A. parviflorus* (D.Don) G.Don); Hilliard in Grierson & D.G.Long. Fl. Bhutan 3: 1303. 2002; G.P.Sinha, Fl. Mizoram 2: 200. 2012; S.S.Dash & P.Singh, Fl. Kurung Kumey District 2: 352. 2017; Gogoi *et al.*, Fl. Sikkim. Pict. Guide 223. 2021; Bh.Adhikari & Mich.Möller in M.F.Watson, Fl. Nepal (Web ed.). 2023. *Trichosporum parviflorum* D.Don, Edinburgh Philos. J. 7: 85. 1822; in Buch.-Ham., Prodr. Fl. Nepal. 125. 1822. *Aeschynanthus ramosissimus* Wall., Pl. Asiat. Rar. 1: 55. 1830; G.Don, Gen. Hist. 4: 657. 1838; R.Br., Cyrtandreae 115. 1839; Steud., Nomencl. Bot. ed. 2, 1: 32. 1840; Brown in Bennett, Pl. Jav. Rar. 115. 1840; D.Dietr., Syn. PI. 3: 580. 1843; A.DC., Prodr. 9: 260. 1845; C.B.Clarke, Commelyn. Cyrtandr. Bengal. t. 50. 1874, in A.DC. & C.DC., Monogr. Phan. 5(1): 23. 1883, in Hook.f., Fl. Brit. Ind. 4: 339. 1884. *Lectotype* (designated by Middleton, 2007): NEPAL, *s.loc.*, *s.d.*, *N. Wallich* 799 (K [K000190172!]; isolecto K [K001111919!], P [P00606325 digital image!]).

Aeschynanthus maculatus Lindl., Bot. Reg. 27: t. 28. 1841; D.Dietr., Syn. PI. 3: 581. 1843; A.DC., Prodr. 9: 261. 1845; Miq., Fl. Ned. Ind. 2: 718. 1858; C.B.Clarke in A.DC. & C.DC., Monogr. Phan. 5: 24. 1883, in Hook.f., Fl. Brit. Ind. 4: 339. 1884; Li, Acta Bot. Yunnan. 5(1): 35. 1983; Wang, Fl. Reipubl. Popularis Sin. 69: 525. 1990; B.L.Burtt, Edinburgh J. Bot. 55: 487. 1998; W.T.Wang *et al.*, Fl. China 18: 384. 1998; Hilliard, Fl. Bhutan 2(3): 1303. 2001. *Trichosporum maculatum* (Lindl.) Kuntze, Revis. Gen. Pl. 478. 1891. *Type*: *s.loc.*, *s.d.*, *s.coll. s.n.* (holo CGE).

Aeschynanthus maculatus var. *stenophyllus* C.B.Clarke in A.DC. & C.DC., Monogr. Phan. 5: 24. 1883. *Lectotype* (designated by Middleton, 2007): INDIA, **Meghalaya**, Khasia, Mamloo, 27.08.1850, *J.D. Hooker & T. Thomson s.n.* (K [K000196663!]; *residual syntypes*: BANGLADESH, Chattogram (Chittagong), 1000 ft, *s.d.*, *J.D. Hooker & T. Thomson s.n.* (K [K000196665!]); INDIA, **Meghalaya**, Khasia, *s.d.*, *J.D. Hooker & T. Thomson s.n.* (K [K000196664!]); *Ibid.*, 3–6000 ft, 1861, *J.D. Hooker & T. Thomson s.n.* (BM [BM000883887!, BM000883888!], GDC [G00492417 digital image!], NYBG [NY01287872 digital image!], MEL, S, US, W).

Aeschynanthus maculatus var. *sikkimensis* C.B.Clarke in A.DC. & C.DC., Monogr. Phan. 5(1): 24. 1883. *Aeschynanthus sikkimensis* (C.B.Clarke) Stapf, Bot. Mag. 148: t. 8938. 1922; Kanjilal *et al.*, Fl. Assam 3: 392. 1939; N.P.Balakr., Fl. Jowai 2: 345. 1983; Harid. & R.R.Rao, Forest Fl. Meghalaya 2: 651. 1987; Hilliard in Grierson & D.G.Long. Fl. Bhutan 3: 1303. 2002; G.P.Sinha, Fl. Mizoram 2: 200. 2012; Gogoi *et al.*, Fl. Sikkim. Pict. Guide 223. 2021. *Lectotype* (designated by Middleton, 2007): INDIA, **Sikkim**, Balasun, 5000 ft, *s.d.*, *J.D. Hooker s.n.* (K [K000096763!]; isolecto K [K000096764!]); residual syntypes: INDIA, Khasia, *s.d.*, *J.D. Hooker & T. Thomson s.n.* (E [E00062776!], K [K000831875!]). **Sikkim**, 3–6000 ft, 1861, *J.D. Hooker s.n.* (GDC [G00492438 digital image!], W [W 2006-0016677 digital image!]); *Ibid*., 3–5000 ft, *s.d.*, *J.D. Hooker s.n.* (W [W 2006-0016677 digital image!]).

Aeschynanthus consobrinus Kraenzl., Repert. Spec. Nov. Regni Veg. 24: 215. 1928. *Type*: *s.loc.*, *s.d.*, *s.coll. s.n.* (holo W [W 1889-0111086 digital image!]).

Figs. 56–58

Epiphytic or lithophytic perennial under shrubs. Stems dichotomously branched, arching to pendulous, green to dark green with dark purple blotches when young, straw coloured at maturity, glabrous to sparsely pubescent, rooting at nodes. Nodes slightly swollen; internodes 3–8(–18) cm long. Leaves opposite; petioles 0.6–1.5 (–2) cm long, terete, canaliculated above, green to dark green, glabrous; lamina (2–) 5–16 (–24) × 1.2—5 cm, linear lanceolate to elliptic lanceolate, thick or coriaceous to fleshy, green to dark green above, pale green beneath, at times purple blotches on entire surface, apex acuminate, straight or curved, base cuneate, margins entire to sub-entire or undulate, recurved

Fig. 56. Lectotype of *Aeschynanthus parviflorus* (D.Don) Spreng (K [K000190172]). © The Board of Trustees for the Royal Botanic Gardens, Kew. Reproduced with permission.

back, glabrous or sparsely hairy at apex; midvein sunken adaxially; lateral veins generally 4–5 (–9) pairs, weakly visible or obscure. Inflorescences axillary or pseudoterminal, 1–20-flowered; peduncles absent. Bracts 0.5–0.8 × 0.2–0.3 cm, linear, green, apex acuminate, margins entire, nerves obscure, glabrous, ciliate, deciduous; pedicels 0.5–0.9 cm long, terete to angular, yellowish green to dark purple, glabrous to sparsely puberulent. Calyx lobed from middle or below middle; tube 0.2–0.8 cm long, green, yellow-green or red to reddish purple, sparsely papillose to glandular pubescent out, glabrous in; lobes 0.3–0.7 × 0.2–0.3 cm, linear to narrowly triangular, green, yellow-green or red to reddish purple, apex acuminate, margins entire, straight, sparsely papillose to glandular pubescent out, glabrous in, ciliate. Corolla 3–3.5 cm long; tube 2.6–3.2 cm long, 0.3–0.5 cm wide at base, gradually inflated towards the throat with 0.8–1 cm, curved from middle, shallow ridge formed as continuation of lateral lobes up to the throat, appear to be shrunken mouth laterally, outside yellowish orange to bright red, sometimes paler on ventral surface, dark stripes running down from the lobes, sparsely to densely glandular puberulent except at base, inside yellowish to orange red, glabrous or sparsely glandular hairy or densely gland dotted just below the lobes; mouth not oblique; lobes outside red to orange-red with darker stripes running down from the middle, pubescent; inside pale orange arched with deep orange band, dark brown stripes running downward from the centre of each lobe, glabrous, ciliate; upper lobes 0.2–0.4 × 0.2–0.4 cm, orbicular or ovate, apex rounded, not reflexed; sinuses 0.2–0.4 cm deep; lateral lobes 0.3–0.4 × 0.3–0.4 cm, oblong to ovate, apex obtuse or rounded, not reflexed; lower lobe 0.4–0.6 × 0.4–0.6 cm, elliptic to oblong, apex rounded, not reflexed. Stamens fused in two pairs, long exserted; anterior filaments 2–2.5 cm long, inserted at 1–1.6 cm from corolla base; posterior filaments 1.5–2.5 cm long, inserted at 1.6–2.2 cm from corolla base; filaments white at base, red or purple higher up, glabrous or glandular hairy; anthers 0.18–0.2 × 0.08–0.1 cm, elliptic, purple; pollen pale yellow or grey. Staminode 0.1–0.2 cm long, clavate, inserted 1.8–2.2 cm from corolla base. Disk *c.* 0.1 cm high, 5-crenate or annular, yellowish green or reddish brown. Pistils 3.5–4 cm long; stipes 0.4–0.6 cm long, greenish white, glabrous; ovary 2.5–2.7 cm long, linear, white to greenish white, glabrous to sparsely pubescent; styles 0.5–1 cm long, linear, white to purple, sparsely to densely glandular pubescent; stigmas *c.* 0.2 cm across, capitate, pink or purple. Capsules 15–25 × 0.2–0.3 cm, green to purple. Seeds 0.9–1.3 × 0.2–0.3 mm, testa cells warty, straight orientation; apical appendage 1.2–3.5 cm long; hilar appendages 2, 1.2–2.8 cm long, appendages papillose.

Fig. 57. *Aeschynanthus parviflorus* (D.Don) Spreng.: **a & b.** Habit; **c.** Single flower; **d.** Inflorescence showing bracts; **e.** Calyx; **f.** Corolla - split open; **f.** Corolla - split open - dorsal view; **h & i.** Stamens**;** **j.** Pistil.

Fig. 58. *Aeschynanthus parviflorus* (D.Don) Spreng. in its natural habitats.

Vernacular name: Sikkim blushwort.

Flowering & fruiting: Flowering from June to September and fruiting from August to October.

Habitat: An epiphyte on large trees in forest margins or as lithophytes.

Distribution: Bangladesh, Bhutan, China, India, Myanmar, Nepal, Thailand and Vietnam (GRC, 2024) (Fig. 59), but I was unable to locate any specimens from Bangladesh, from the herbaria I consulted.

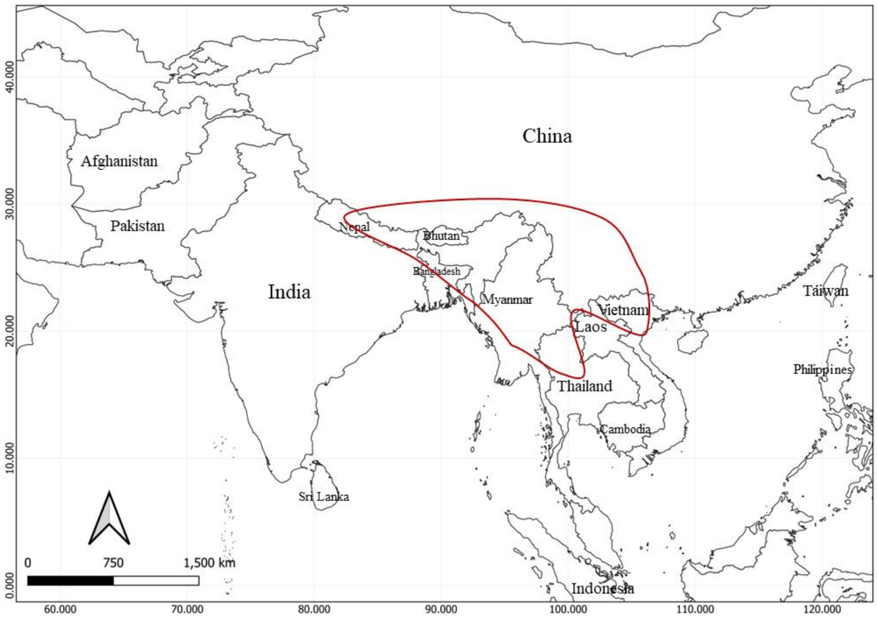


Fig. 59. Distribution of *Aeschynanthus parviflorus* (D.Don) Spreng

Specimens examined: BHUTAN, Mongar, Khoma, Lhuntse, 1400 m, 21.07.2000, *Bowes Lyon, S.* 13019 (E [E00148524]); Yongkola, Southern edge of Thrumshing La National Park, 1800 m, 31.05.2000, *Y. Dorji, N. Pearce & P. Cribb* 87 (E [E00280168]). CHINA, **Longling Xian**, Lujiang Xiang, Nankang Village, 1908 m, 25.08.2003, *Li Heng, Dao Zhiling, Li Rong & Jiang* 17838 (E [E00222954]). INDIA, *s.d.*, *Wallich* 796 (L [L.2821571 digital image]); East Bengal, *s.d.*, *Griffith* 3811 (U [U.1600054 digital image]). **Arunachal Pradesh**, Dibang Valley district, 40 km away from Roing on Anini route, 1990 m, 11.06.2019, *M.K. Akhil & Santhosh Nampy* 169311 (CALI); *Ibid*., 50 km away from Roing on Anini route, 2350 m, 11.06.2019, *M.K. Akhil & Santhosh Nampy* 169312 (CALI); way to Anini, 2260m, 11.06.2019, *M.K. Akhil & Santhosh Nampy* 169318 (CALI); *Ibid*., 2250 m, 11.06.2019, *M.K. Akhil & Santhosh Nampy* 169319 (CALI); *Ibid*., 2360 m, 12.06.2019, *M.K. Akhil & Santhosh Nampy* 169326 (CALI); Anini, 1968 m, 13.06.2019, *M.K. Akhil & Santhosh Nampy* 169330 (CALI); Seppa to Bomdilla, 29.06.2019, *M.K. Akhil* 169376 (CALI). **Meghalaya**, Khasia, 3–6000 ft, *s.d.*, *J.D. Hooker & T. Thomson s.n.* (GDC [G00492417 digital image]; U [U.1600055 digital image]); *Ibid., s.d., J.D. Hooker & T. Thomson s.n.* (K [K000196664]; L [L 0414498, L.2821566 digital image]); Coromandel, Mamloo, 27.08.1850, *J.D. Hooker & T. Thomson s.n*. (K [K000196663]); East Khasi Hills district, way to Mawsynram, 4806 ft, 08.10.2017, *Vishnu Mohan, M.K. Akhil & Santhosh Nampy* (CALI); *Ibid*., Shillong, 6400 ft, 10.08.1885, *C.B. Clarke* 38691A (K); West Jaintia Hills district, Jowai, 27.01.1957, *G.K. Deka* 5224 (L [L.2821575 digital image]); *Ibid*., N 25°25'89", E 92°12'90", 1310 m, 23.09.2021, *M.K. Akhil & Santhosh Nampy* 186418 (CALI); way to Jowai, N 25°27'54", E 92°11'07", 1300 m, 23.09.2021, *M.K. Akhil & Santhosh Nampy* 186413 (CALI); *Ibid*., N 25°18'30", E 92°07'23", 2800 ft, 24.09.2021, *M.K. Akhil & Santhosh Nampy* 186420 (CALI); Nongriat, way to Double decker root bridge, N 25°14'84", E 91°41'58", 1300 m, 26.09.2021, *M.K. Akhil & Santhosh Nampy* 186426 (CALI). **Mizoram**, Lawngtlai district, Farkawn, Lurh Tlang, N 23°12'35", E 93°16'50", 1,800 m, 12.06.2022, *M.K. Akhil, E.P. Rajeesh & A. Amrutha* 160631 (CALI). **Nagaland**, district, Kohima, way to Japfu peak, N 25°36'07", E 94°07'44", 2000 m, 01.11.2021, *M.K. Akhil & Santhosh Nampy* 186443 (CALI); Naga Hills, Kilomi, 28.06.1935, *N.L. Bor* 5053 (K). **Sikkim**, *s.d.*, *T. Thomson* 14 (L [L.2821572 digital image]); *Ibid., s.d., T. Thomson* 11 (L [L.2821574 digital image]); *Ibid.*, 3–6000 ft, *s.d.*, *J.D. Hooker s.n.* (GDC [G00492438 digital image]; L [L.2821570 digital image]); *Ibid.*, 2–5000 ft, 1861, *J.D. Hooker s.n.* (GDC [G00492385 digital image], L [L.2821573 digital image]); Pakyong, N 27°14'25", E 88°36'07", 1331 m, 02.06.2022, *M.K. Akhil & T.P. Krishnaraj* 160626 (CALI); Yuksom, N 27°22', E 88°13', 1700 m, 13.04.2015, *Frieda Billiet* 8829 (BR [BR0000036398942 digital image]). **Uttarakhand**, 4000 ft, *R. Strachey & J.E. Winterbottom s.n.* (K); Kumaon, Mohargari, *s.d.*, *R. Strachey & J.E. Winterbottom s.n.* (BR [BR0000008495372 digital image]). **West Bengal**, Darjeeling, 1909, *J.R. Drummond* 20955 (K); Rishap, 4000 ft, 21.08.1869, *C.B. Clarke* 8755 (L [L.2821567 digital image]). MYANMAR, **Kachin**, Nam Tamai, 4000 ft, 08.05.1926, *F. Kingdon Ward* 6697 (K); North Triangle (HRiulum), 4000–5000 ft, 29.04.1953, *F. Kingdon Ward* 20740 (BM [BM000883944]); Chin, Mindat, Kanpetlet, 6000 ft, 01.07.1956, *F. Kingdon Ward* 22498 (BM [BM000883906]); Khaiyang, 6000–7000 ft, 10.05.1948, *F. Kingdon Ward* 17434 (NYBG [NYBG 02652107 digital image]). NEPAL, 1819, *s.coll. s.n.* (GDC [G00133146 digital image]); *Ibid.*, 1821, *Wallich s.n.* (GDC [G00133089]); *Ibid.*, 1830, *Wallich* 799 (K [K000190172]); Chittre, 2200 m, 16.08.1972, *J.F. Dobremez* 1477 (E [E00622150]); Dhawalagiri zone, Myagdi district, around Jugepani, 1460 m, 12.09.1996, *M. Mikage, A. Takahashi & K. Yonekura* 9682423 (E [E00839418]); Gandaki zone, Gorkha district, Soti Khola to Machha Khola, South of Liding, 740 m, 25.07.2008, *H. Ikeda et al.* 20817020 (E [E00647027]); *Ibid*., 810 m, 25.07.2008, *H. Ikeda et al.* 20815017 (E [E00779561]); Kathmandu district, Sundarijal, 1550 m, N 27°45', E 25°24', 21.09.1974, *de Haas J.H.* 2862 (L [L.2107627 digital image]); Koshi zone, Sankhuwa Sabha district, 8 Bhotebas, 1800 m, 08.07.1988, *M. Suzuki et al.* 8840092 (E [E00223260]); Gadhi Danda, 1050 m, 28.08.1998, *N. Noshiro et al.* 9840202 (E [E00223259]); Num, 1335 m, 13.08.1998, *N. Noshiro et al.* 9830006 (E [E00238455]); *Ibid*., 19.08.1997, *N. Noshiro et al.* 9770187 (E [E00238466]); Mechi zone, Ilam district, Dobate to Hangetham, 2656 m, 05.09.2007, *R.M. Kunwar et al.* LKSRC 187 (E [E00667563]); Sanguri Lekh, N of Dharan, N 26°31'12", E 87°12'0", 4000 ft, 03.09.1967, *Williams & Stainton* 8354 (K). THAILAND, *s.d.*, *V. Beusekom* 1660 (L [L.2821580 digital image]). Kamphaeng Phet, Mae Wong National Park. Chong Yen, 1240 m, 12.07.1999, *Chatchai Ngamriabsakul* CN44 (E [E00267309]). **Nakhom Ratchasima province**, Khao Yai National Park, 700 m, N 14°45', E 102°, 17.10.1969, *C.F. van Beusekom & C. Charoenpol* 1660 (L [L.2821579 digital image]); *Ibid.*, 700–1200 m, 02.12.1983, *N. Fukuoka & M. Ito* T-34608 (L [L.2821568 digital image]). **Chiang Mai**, Jawm Tong, Doi Intanon National Park, 2100 m, 24.05.1990, *J.F. Maxwell* 90-555 (L [L.2821577 digital image]). **Nakhon Nayok Province**, Khao Yai National Park, Near top of Kow Keyo, *c.* 1300 m, 11.08.1974, *J.F. Maxwell* 74-781 (L [L.2821569 digital image]); *Ibid.*, 650 m, 08.08.1979, *Tatemi Shimizu, Hideo Toyokuni, Hiroshige Koyama, Tetsukazu Yahara & Thawatchai Santisuk* 19550 (L [L.2821578 digital image]); Khao Khieo, Khao Yai, 1300 m, 29.08.1963, *D. Smitinand & H. sleumer* 8382 (L [L.2821576 digital image]). VIETNAM, **Lam Dong**, Lac Duong district, Bi Doup Peak area, 20.09.2001, *N.D.T. Luu & N.V. Chi* 226 (E [E00144836]); *Ibid*., 20.09.2001, *N.D.T. Luu & N.V. Chi* 228 (E [E00144837]); Langbiang Mountains, Cong Troi, 6.09.2001, *M.F. Gardner, P. Thomas, N.D.T. Luu & N.V. Chi* 123 (E [E00144847]). *s.loc.*, *s.d.*, *s.coll. s.n.* (BR [BR0000036398973]); *s.loc.*, *s.d.*, *J.B.B. s.n.* (BR [BR0000036398966]).

Additional specimens examined (*Aeschynanthus lineatus* Craib): CHINA, **Yunnan**, west of Tengyeuh, 5000 ft, July 1912, *George Forrest* 9138 (E [E00067596, E00087188]); MYANMAR, **Kachin**, Myitkyina, Laktang, 5000 ft, 09.08.1919, *F. Kingdon Ward* 3472 (E [E00067608]); Putao, Hkinlum, 4250 ft, 13.07.1953, *F. Kingdon Ward* 21146 (BM [BM000883936]); Nam Tamai Valley, N 27°42", E 97°54' 4000 ft, 02.09.1938 *R. Kaulback* 107 (BM [BM000883938]); Valley of the Mali Hka, Mile 120, 2000–3000 ft, 08.08.1937, *F. Kingdon Ward* 12793 (BM [BM000883935]); THAILAND, **Chiang Mai**

Province, Doi Chiang Dao, 1300–1900 m, 26.09.1971, *Gen Murata, Kunio Iwatsuki & Chamlong Pengklai* 15083 (L [L 0414335, L.2821675 digital image]);

Conservation status: *Aeschynanthus parviflorus* is distributed across eight countries, with an EOO of 50,19,519.687 km^2. Based on current data, the AOO is calculated ats 288 km^2. It is widespread and shows a wide range of morphological variation depending on the habitat. In many areas, road widening has destroyed the lithophytic habitats of *A. parviflorus* in Northeast India, while the epiphytic habitats are less prone to such destruction. Hence, given its broader range, the species is provisionally assessed as Least Concern (LC).

Notes: Don (1822) originally described *Trichosporum parviflorum*, based on specimen collected by Wallich from the lower mountain ranges of Nepal. Later, Sprengel (1827) transferred this species to *Aeschynanthus* as *Aeschynanthus parviflorus*. Unaware of this treatment, G. Don (1838) independently made the same combination, a stance followed by Dietrich (1843) and Miquel (1858).

Wallich (1829) described *A. ramosissimus* from Nepal, and both *A. ramosissimus* Wall. and *A. parviflorus* (D.Don) Spreng were treated as separate species by many authors (Don, 1838; Steudel, 1840; Dietrich, 1843; de Candolle, 1845), until Clarke (1883) synonymized *A. parviflorus* under *A. ramosissimus*. According to the rule of priority, *A. parviflorus* takes precedence, with *A. ramosissimus* now considered a synonym.

Lindley (1841) described *A. maculatus*, comparing it to both *A. ramosissimus* (= *A. parviflorus*) and *A. parasiticus*. Lindley used characters such as branching of stem, and size of calyx and corolla to delineate the new species. However, these characters are not reliable, particularly for distinguishing this highly variable species. Despite using a beautiful illustration by Mrs. Lawrence in the protologue, Lindley's depiction failed to represent the important features of the species, such as the hairiness of calyx and corolla. As the characters falls within the range of variation, Clarke (1874) synomymized *A. maculatus* under *A. ramosissimus*.

Middleton (2007) cited a specimen at the CGE herbarium without any collection details as the holotype of *A. maculatus,* leaving the selection of this specimen unclear. I was unable to locate this specimen at CGE. The Wall. Cat. No. 796, which is associated with *A. parasiticus*, also includes some specimens of closely allied *A. parviflorus* (E00665627, E00665628, K000831986).

De Candolle (1845) indicated in his work a variant of *A. maculatus* having leaves devoid of any spots, inflorescence arising from the terminal as well as in the axillary position, and less protruding stamens. Clarke (1883) later described it as a new variety, *A. maculatus* var. *sikkimensis*, based on specimens from Sikkim and Khasia. He also described another variety *A. maculatus* var. *stenophylla*, from Khasia and Bangladesh, distinguished by its linear leaves and deeply divided hairy calyx. In *Flora of British India*, Clarke (1884) accepted only *A. maculatus* var. *stenophylla*. He further noted that despite the smaller calyx size, it was very difficult to distinguish *A. maculatus* from *A. ramosissimus*. Stapf (1922) elevated *A. maculatus* var. *sikkimensis* to the species status as *A. sikkimensis*, and synonymized *A. maculatus* var. *stenophylla* under *A. maculatus*. Middleton (2007) synonymised *A. sikkimensis* under *A. parviflorus*. After field observations and a thorough examination of the types of each name (*A. parviflorus*, *A. maculatus*, *A. maculatus* var. *stenophyllus*, and *A. sikkimensis*), it is found that while these taxa exhibit varying leaf characters, they all share key features, such as calyx lobed from below the middle with an acuminate apex, and a corolla with a narrow tubular base and glabrous inner surface. Therefore, I also consider all the above names to be conspecific with *A.parviflorus*.

Kränzlin (1928) described *A. consobrinus* based on characters such as acuminate leaves, larger flowers, and smaller, and less deeply divided calyces and differentiated it from *A. ramosissimus* (= *A. parviflorus*). However, after examining numerous specimens of *A. parviflorus*, it is clear that the above characters differentiating *A. consobrinus* fall within the range of variation of *A. parviflorus*. The sole available material at W (W18890111086) is an incomplete representative of the species and lacks collection data, making it difficult to reach a definitive conclusion about *A. consobrinus*.

Taram and Borah (2021) misidentified some populations of *A. parviflorus* from Northeast India as *A. lineatus* Craib, by pointing out that the calyx lobes free from just above the base was not a character for *A. parviflorus*. However, upon examining specimens at BM, E, K and the digital images from L, along with the scrutiny of protologue and relevant literature revealed that *A. lineatus* has completely free, glabrous calyx lobes and are obtuse to rounded at apex as against the observation of Taram and Borah (2021). We could collect *A. parviflorus* with many variations in the calyx (Fig. 61) character and this one should be one of the specimens with extreme variation.

Aeschynanthus parviflorus is one of the widespread species in Northeast India, showing considerable variation in shape and size of leaves and calyx structure (Figs. 61–62). It can be easily distinguished from the closely allied *A. parasiticus* by its non-foliaceous calyx lobes with acuminate apex, narrower corolla tube, and absence of multicellular coarse hairs in the basal portion of the corolla tube.

Fig. 60. *Aeschynanthus parviflorus* (D.Don) Spreng.: Variations in **a.** Leaves; **b.** Calyx

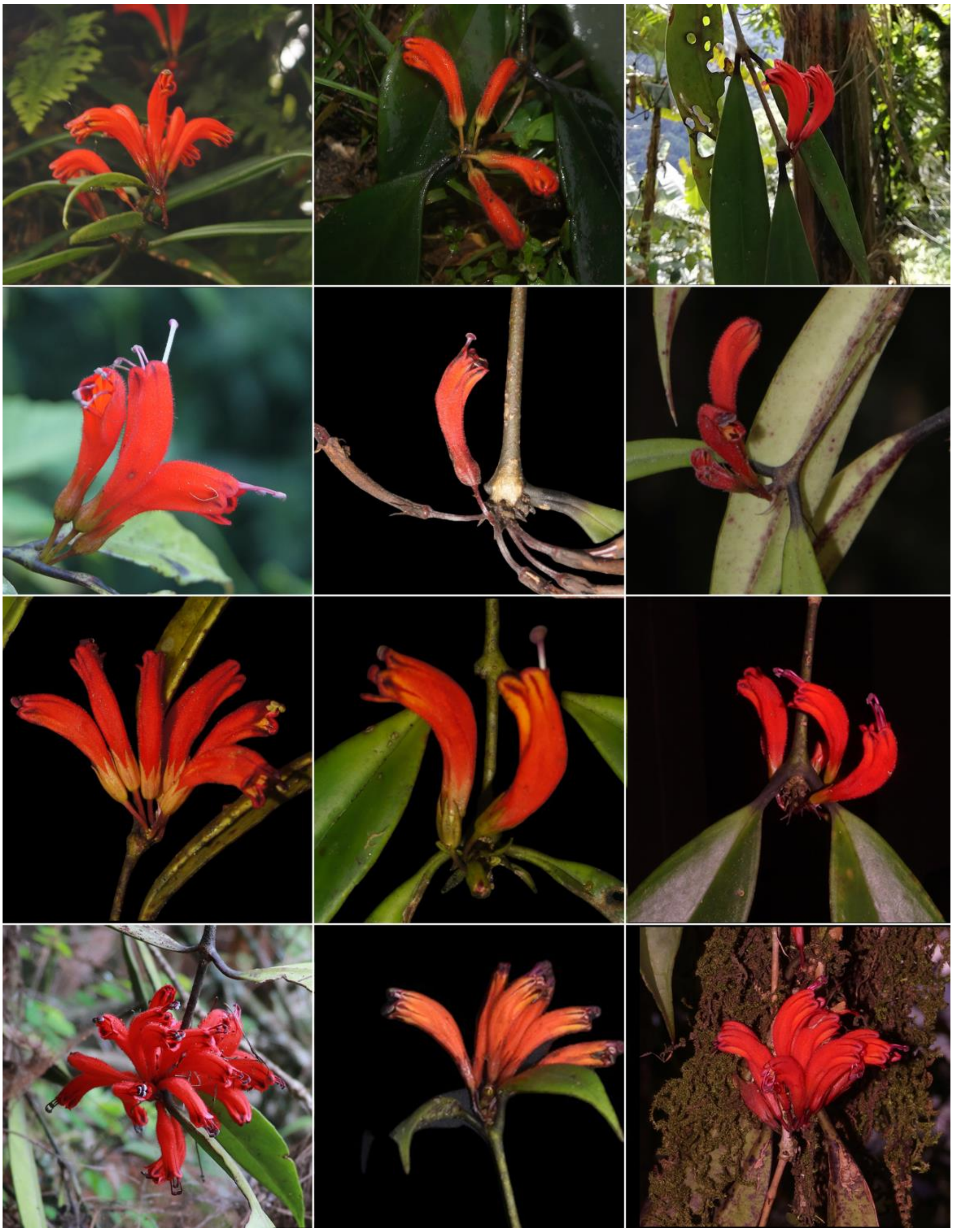


Fig. 61. *Aeschynanthus parviflorus* (D.Don) Spreng.: Floral diversity.

15. Aeschynanthus perrottetii A.DC., Prodr. 9. 261. 1845, Monogr. Phan. 5(1): 25. 1883; Woodrow, J. Bombay Nat. Hist. Soc. 12: 176. 1898; Gamble, Fl. Madras 2: 984. 1924; Santapau, J. Bombay Nat. Hist. Soc. 48: 489. 1952; Subram. & A.N.Henry, Bull. Bot. Surv. India 12: 1. 1970; Ramamoorthy in C.J.Saldanha & Nicolson, Fl. Hassan Dist. 528. 1976; Vajr., Fl. Palghat Dist. 332. 1981; Yogan. *et al.*, Fl. Chikmagalur Dist. 243. 1981; B.D.Sharma *et al.*, Fl. Karnataka analysis 196. 1984; K.K.N.Nair & M.P.Nayar, Fl. Courtallum 2: 279. 1987; Gopalan in A.N.Henry *et al.*, Fl. Tamil Nadu Ind., Ser I: Analysis 131. 1987; M.Ahmedullah & M.P.Nayar, Endemic Pl.Indian Region 1: 142. 1987; Manilal, Fl. Silent Valley 199. 1988; M.Mohanan & A.N.Henry, Fl. Thiruvanathapuram Dist. 337. 1994; Sasidh. & Sivar., Fl. Pl. Thrissur Forest 329. 1996; Sivar. & P.Mathew, Fl. Nilambur 482. 1997; N.Mohanan & Sivad., Fl. Agasthyamala 494. 2002; Sasidh., Biodivers. Doc. Kerala, Part 6: Fl. Pl. 331. 2004; N.Anilkumar *et al.*, Fl. Pathanamthitta Dist. 369. 2005; T.S.Nayar *et al.*, Fl. Pl. Kerala 342. 2006; K.N.Ganeshaiah *et al.*, Pl. Western Ghats 43. 2012; N.Krishnak. *et al.*, Fl. Pl. Shola and Grasslands Nilgiris 214. 2013; T.S.Nayar *et al.*, Fl. Pl. Western Ghats 526. 2014; U.C.Bhattach. & Goel, Phytotaxonomy 14: 15. 2014. *Trichosporum perrottetii* Kuntze, Revis. Gen. Pl. 2: 478. 1891. *Lectotype* (designated by Janeesha & Nampy, 2017): INDIA, **Tamil Nadu**, The Nilgiris district, *s.d.*, *Perrottet* 770 (K [K000190159!]; isolecto G [G00370692 digital image!], P [P03851790 digital image!]).

Aeschynanthus grandiflorus J.Graham, Cat. Pl. Bombay: 146. 1839, *nom. illeg. superfl.*

Aeschynanthus perrottetii A.DC. var. *planiculmis* C.B.Clarke in A.DC. & C.DC., Monogr. Phan. 5(1): 25. 1883, in Hook.f., Fl. Brit. India 4: 340. 1885 (as *platyculmis*); Santapau, J. Bombay Nat. Hist. Soc. 48: 489. 1952. *Aeschynanthus planiculmis* (C.B.Clarke) Gamble, Fl. Madras 2: 985. 1924. *Aeschynanthus ceylanicus* Wight, Icon Pl. Ind. Orient. 4: t. 1347. 1850. *Lectotype* (designated by Janeesha & Nampy, 2017): INDIA, **Tamil Nadu**, Tenkasi district, Courtallum, September 1835, *Wight* 651 (K [K000190161!]; isolecto E [E00062775]); *residual syntypes*: INDIA, **Maharashtra**, Mumbai (Bombay), *s.d.*, *Stocks s.n.* (K [K000190160!]).

Aeschynanthus perrottetii A.DC. var. *malabaricus* C.B.Clarke in A.DC. & C.DC., Monogr. Phan. 5(1): 25. 1883. *Lectotype* (designated by Janeesha & Nampy, 2017): INDIA, Malabar, Ram Ghat?, February 1853, *Ritchie* 1861 (K [K000190163!]); *residual syntypes*: INDIA, **Maharashtra**, Mumbai (Bombay), *s.d.*, *Dalzell s.n.* (K

[K000190164!]); Parva Ghat (Parwar Ghat), *s.d.*, *Stocks s.n.* (K [K000190165!]); **Tamil Nadu**, Tenkasi district, Courtallum, February 1836, *Wight* 656 (E [E00062774!], K [K000096749]); *Ibid.*, February 1836, *Wight* 2347 (K [K000096750!]).

Aeschynanthus ceylanicus Gardner, Calcutta J. Nat. Hist. 6: 474. 1846, ***syn. nov.***; Wight, Icon Pl. Ind. Orient. t. 1347. 1848; Walpers, Ann. Bot. Syst. 3: 95. 1852; Thwaites, Enum. Pl. Zeyl. 206. 1864; C.B.Clarke in A.DC. & C.DC., Monogr. Phan. 5(1): 26. 1883; Trimen, Handb. Fl. Ceylon 3: 272. 1895. *Trichosporum ceylanicum* (Gardner) Kuntze, Revis. Gen. Pl. 2: 478. 1891. *Lectotype* (designated by Ranasinghe *et al.*, 2019): SRI LANKA [Ceylon], *s.d.*, *Gardner* 599 (K [K000190166!]).

Aeschynanthus ceylanicus Gardner var. *pinguis* C.B.Clarke in A.DC. & C.DC., Monogr. Phan. 5(1): 25. 1883; U.C.Bhattach. & Goel, Phytotaxonomy 14: 7. 2014. *Type*: INDIA, **Tamil Nadu**, The Nilgiris district, *s.d.*, *Wight s.n.* (K [K000190167!]).

Figs. 62–64

Epiphytic or lithophytic perennial under shrubs. Stems branched, climbing, hanging or pendulous, pale green to green when young, straw-coloured at maturity, glabrous, rooting at nodes. Nodes slightly swollen; internodes (1–1.5–) 2.8–9.5 cm long. Leaves opposite; petioles 0.2–1 cm long, terete, canaliculated above, green to dark green or with brown tinch, glabrous; lamina 2.5–10.5 × (0.8–) 1–2.5 (–3.8) cm, narrow elliptic to elliptic-lanceolate or ovate-elliptic, slightly fleshy, leathery, dark to mid green above, pale green, numerous purple blotches above and beneath, apex acute to acuminate, base attenuate to obtuse or rounded, margins entire to

Fig. 62. Lectotype of *Aeschynanthus perrottetii* A.DC. (K [K000190159]). © The Board of Trustees for the Royal Botanic Gardens, Kew. Reproduced with permission.

sub-entire, glabrous; midvein sunken adaxially, prominent abaxially; lateral veins generally 4–5 pairs, weakly visible or obscure. Inflorescences axillary, solitary or 2–5-flowered; peduncles absent. Bracts 0.05–0.2 cm long, linear to oblanceolate, green to brownish, apex acute, margins entire, nerves obscure, glabrous, slightly ciliate, deciduous; pedicels 0.5–1.7 cm long, terete to angular, brownish green or purplish, glabrous. Calyx free or slightly fused at base; tube *c.* 0.1 cm long, green, glabrous; lobes (0.2–) 0.4–0.8 × 0.2–0.3 cm, sub-equal or one sepal slightly smaller than the others; linear lanceolate to narrowly triangular, green, greenish red or green with red or purple spots, apex acute to acuminate, margins entire, glabrous, sparsely ciliate. Corolla (2–) 3.5–4.5 (–6.2) cm long; tube 1.8–5.8 cm long, 0.1–0.2 (–0.4) cm wide at base up to middle, gradually inflated towards the throat with 0.4–0.5 (–0.8) cm, curved from below the mouth, outside pinkish red to crimson red or rarely white, glabrous to sparsely glandular pubescent, inside pale pink or cream coloured, glabrous; mouth not oblique; lobes outside pinkish to red or with greenish shade, sparsely glandular pubescent, inside pale pink or cream arched with red or dark brown band, followed by three red or dark brown stripes or random blotches running downward to throat from lower lips, glabrous, ciliate; upper lobes 0.3–0.6 × 0.2–0.5 cm, oblong, apex rounded, not reflexed; sinus 0.2–0.4 cm deep; lateral lobes, 0.4–0.6 × 0.3–0.5 cm, oblong or ovate, apex obtuse to rounded, reflexed or not; lower lobe 0.5–0.8 × 0.4–0.5 cm, elliptic-oblong, apex rounded, reflexed. Stamens fused in two pairs, long exserted; anterior filaments 1.8–3 cm long, inserted at 1.6–2 cm from corolla base; posterior filaments 1.2–2.4 cm long, inserted at 1.8–2.3 cm from corolla base; filaments white at base, red or purple higher up, glandular hairy; anthers 0.1–0.2 × *c.* 0.1 cm, elliptic to oblong, pink to purple; pollen yellow. Staminode 0.05–0.2 cm long, clavate, inserted 1.8–2.2 cm from corolla base. Disk 0.1–0.2 cm high, 5-crenate or annular, green or cream. Pistils (1.5–) 2.5–5.6 cm long; stipes 0.4–0.8 cm long, white to greenish white, glabrous; ovary 1.8–3 cm long, linear, white to greenish white, glabrous; styles 0.5–1.5 cm long, linear, white to purple, glandular puberulent; stigmas *c.* 0.2 cm across, capitate, purple. Capsules (7.5–) 10–21 × 0.3–0.5 cm, green to yellow green. Seeds 0.4–1 × 0.2–0.35 mm, testa cells warty, straight orientation; apical appendage 1.5–1.8 cm long; hilar appendage a solitary hair, 1.4–1.6 cm long, appendages papillose.

Vernacular name: Nilghiri blushwort.

Flowering & fruiting: Flowering from August to April and fruiting from February to May.

Fig. 63. *Aeschynanthus perrottetii* A.DC.: **a & b.** Habit; **c.** Branch apex showing bracts; **d.** Single flower; **e.** Calyx; **f.** Corolla - split open; **g.** Corolla - front view; **h.** Corolla - split open showing stamens; **i.** Pistil.

Fig. 64. *Aeschynanthus perrottetii* A.DC. in its natural habitats.

Habitat: It is an epiphytic undershrub found on medium-sized to large trees in evergreen forests with proper sunlight, on the margins of shola forests, or on trees in open lands or as lithophytes, in high altitude areas with proper mulchy conditions for rooting.

Distribution: India and Sri Lanka (GRC, 2024) (Fig. 65).

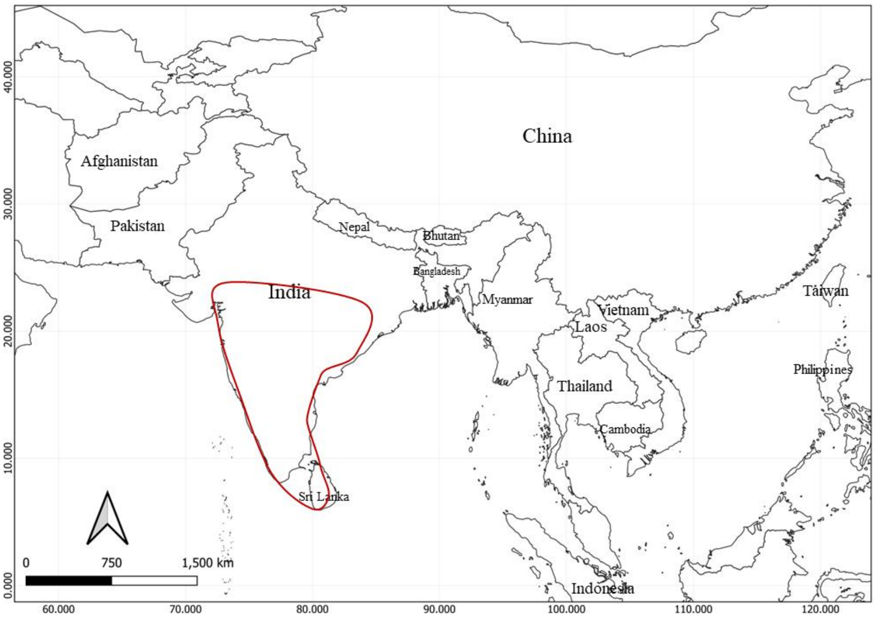


Fig. 65. Distribution of *Aeschynanthus perrottetii* A.DC.

Specimens examined: INDIA, **Karnataka**, Chamarajanagar district, Biligirrangan Hills, September 1938, *Edward Batneo* 411 (K); Chikkamagaluru district, Bababudangiri, 10.1908, *A. Meebold* 9555 (CAL); Sringeri-Gobbagodu, 21.09.2014, *A.P. Janeesha* 134298 (CALI); Dakshina Kannada district, Nikund ghat, *s.n.*, *s.coll.* 6972 (BSI); Shiradi ghat-Yethinahiulla bridge, 19.09.1979, *C.J Saldhana & K.P. Sreenath* 9140 (CAL); Sulga-ghat, 29.01.1978, *R. Raghavan* 152070 (BSI); Hassan district, Banuhalla, 04.09.1969, *C. Saldanha* 14797 (E [E00833866], K); Kodagu district, Abbey falls, 26.01.1976, *B.C. Banerjee* 11358 (CAL); *Ibid*., N 12°26'58", E 75°43'30", 1201 m, 20.01.2023, *M.K. Akhil*, *T.P. Krishnaraj & Alan Thomas* 160636 (CALI); Bhagmandala, 16.05.1959, *R.K. Arora* 55222 (BSI); *Ibid*., 27.10.1963, *A.S. Rao* 95265 (CAL); *Ibid*., 30.10.1976, *B.C. Banerjee* 11674; Mercara, 30.01.1976, *B.C. Banerjee* 11425 (CAL); Madikeri (Coorg), September 1904, *Bourne* 4757 (K); *Ibid*., 1150 m, 14.12.2020, *Namitha & M.K. Akhil* 169451 ; *Ibid*., N 12°26'13", E 75°43'20", 1166 m, 20.01.2023, *M.K. Akhil* , *T.P. Krishnaraj & Alan Thomas* 160634 (CALI); Mercara-Karalabadaga Village, 21.08.1961, *A.S. Rao* 74474; Napoklu, 03.09.1961, *A.S. Rao* 74878 (BSI); Talakavery Wildlife Sanctuary, 1276 m, 15.12.2020, *Namitha & M.K. Akhil* 169452 (CALI); Mysore district, Mudigene-Todkala, *R.S. Raghavan* 126072 (BSI); Shimoga district, Agumbe, 07.02.1961, *R.S. Raghavan* 69459 (CAL); *Ibid*., 28.11.1983, *K. Shanthi* 1028; *Ibid*., 28.11.1983, *T.P. Radhakrishnan* 1263 (CALI); Agumbe-near P.W.D. Rest house, 27.10.1960, *R.S. Raghavan* 67814 (BSI, CAL); Shirur forest, 01.09.1963, *R. Raghavan* 90370; Hosuru near Yedur, 05.10.1962, *R. Raghavan* 82990 (BSI); Kavaledurga, 02.10.1962, *R.S. Raghavan* 82898; Yedur, 04.10.1962, *R.S. Raghavan* 82939 (BSI, CAL); *s.loc., s.d., N. Narayanaswami* 1548 (CAL); Udupi district, Manmanhara forest, 17.10.2007, *P.G. Diwakar & R. Kr. Singh* 193236; Mavinakkatte forest, 14.10.2008, *P.G. Diwakar & R. Kr. Singh* 184459 (BSI). Uttara Kannada district, *s.loc*., 10.1919, *s.coll.* 7179 (CAL). **Kerala**, Malabar Concan, *s.loc*., *s.d*., *J.E. Stocks & Law s.n.* (P [P03851792]); Idukki district, way to Anamudi base camp, 2400 m, 10.12.2019, *D.K. Venugopal & Santhosh Nampy* 170038 (CALI); Chapathu, 30.09.1981, *C.N. Mohanan & B. Ramanujam* 72092 (CAL); old Devikulam, 1625 m, 25.01.1964, *K.M. Sebastine* 18471 (E [E01053381]); Edamalakkudi, 1100–1700 m, 17.03.2019, *D.K. Venugopal & Santhosh Nampy* 168987 (CALI); Kuruchikella, 13.02.1957, *G.S. Puri* 15705 (BSI); Kuttikanam-Peermade, 100 m, 21.01.1965, *K. Vivekananthan* 22933 (E [E01053382]); Mankulam, Nallathanni Kallar, 671 m, 15.09.2018, *D.K. Venugopal & Santhosh Nampy* 161915; Mankulam to Kanketty, 671 m, *D.K. Venugopal & Santhosh Nampy* 164816 (CALI); Mappara Estate, 07.02.1981, *N.C. Nair* 70121 (CAL); Pallivasal, 19.02.1957, *G.S. Puri* 155323 (BSI); Peerumedu, 12.1909, *A. Meebold* 13375 (CAL); Mathikettan Shola National Park, 1200–1984 m, 04.01.2017, *D.K. Venugopal & Santhosh Nampy* 151501; Munnar-Rajamal roadside, 1600 m, 18.11.2020, *D.K. Venugopal & Santhosh Nampy* 173333; Painavu, 3900 ft, 04.04.2018, *D.K. Venugopal & Santhosh Nampy* 158428; Periyar-Mangaladevi, 10.10.1993, *Jomy Augustine* 12540 (CALI); Silent Valley R.F., Valara R.F., 24.11.1982, *K. Ramamurthy* 74988 (CAL); Umayamala–Devikulam, 1975 m, 22.11.1965, *B.V. Shetty* 26615 (E [E00833867]); Vagamon, 03.10.2015, *C. Pramod & A.P. Janeesha* 137653; Kozhikode district, lower side of Kakkayam dam, 19.09.2013, *A.P. Janeesha, S. Syam Radh & Habeeb Rahman* 134218; *Ibid*., N 11°35'45", E 75°53'34", 710 m, 06.10.2022, *M.P. Krishnapriya & K.H. Harishma* 160632 (CALI); Malappuram district, Nilambur-Nadukani, 28.03.1982, *Philip Mathew* 33149; Palakkad district, Karimala-near rest para, 26.09.2013, *A.P. Janeesha, K. Thoiba & K. Smitha* 134226; Nelliyampathy, 15.08.2015, *S. Resmi & A.P. Janeesha* 137631;*Ibid.*, 900 m, 29.11.2007, *K.P. Amitha Bachan,* 98952; Nelliyampathi-Karappara, 29.11.2007, *K.P. Amitha Bachan,* 98899; N 10°32'40", E 76°42'33", 1000 m, 24.11.2022, *M.K. Akhil, M.P. Krishnapriya, K.H. Harishma & Ashna Toms* 160633 (CALI); Panthanthode, 21.09.1977, *J. Joseph* 51437 (CAL); Silent Valley, way to Anakaithodki, N 11°04'35", E 76°25'43", 960 m, 03.02.2022, *M.K. Akhil & Santhosh Nampy* 160606 (CALI); hanging bridge, 05.10.1979, *N.C. Nair* 64267 (CAL); *Ibid*., N 11°05'48", E 76°26'47", 942 m, 02.02.2022, *M.K. Akhil & Santhosh Nampy* 160604; Camp Shed, 04.12.1981, *C. Sathish Kumar* 10101; way to Parathode, N 11°05'07", E 76°25'12", 941 m, 04.02.2022, *M.K. Akhil & Santhosh Nampy* 160607; Parathode, N 11°06'08", E 76°25'36", 980 m, 04.02.2022, *M.K. Akhil & Santhosh Nampy* 160608 (CALI); Poochippara slopes, 10.02.1980, *N.C. Nair* 69199 (CAL); Poochippara to Valakkad, N 11°04'37", E 76°22'38", 309 m, 05.02.2022, *M.K. Akhil & Santhosh Nampy* 160609; *Ibid*., 05.02.2022, *M.K. Akhil & Santhosh Nampy* 160610; way to Punnamala, N 11°06'48", E 76°28'67", 1089 m, 03.02.2022, *M.K. Akhil & Santhosh Nampy* 160605; Valakkad, N 11°11'17", E 76°25'13", 1619 m, 05.02.2022, *M.K. Akhil & Santhosh Nampy* 160611 (CALI); Thuthampara R.F., 16.02.1979, *E. Vajravelu* 60505 (CAL); Pathanamthitta district, Anathode, 10.11.1975, *K. Vivekananthan* 46609 (CAL); Thiruvananthapuram district, Agasthyamalai, 06.07.2015, *P.G. Arunkumar & A.P. Janeesha* 134149 (CALI); *Ibid*., 2016, *K. Shinoj & A.P. Janeesha* 137654; N 8°37'11", E 77°13'25", 990 m, 23.02.2023, *P.M. Vineesha, Vaishnavi & M.K. Akhil* 160637; way to Agasthyamala, N 8°37'35", E 77°14'84", 1356 m, 02.03.2021, *M.K. Akhil, T.P. Krishnaraj & K.H. Harishma* 169464; *Ibid*., N 8°37'37", E 77°14'86", 1350 m, 02.03.2021, M.K. *Akhil, T.P. Krishnaraj & K.H. Harishma* 169465; *Ibid*., N 8°37'47", E 77°14'88", 1355 m, 02.03.2021, *M.K. Akhil, T.P. Krishnaraj & K.H. Harishma* 169466; Athirumala, 06.02.1988, *N. Mohanan* 9417, 7437; *Ibid*., 12.10.1988, *N. Mohanan* 4204; *Ibid*., 14.10.1988, *N. Mohanan* 4245; *Ibid*., N 8°37'00", E 77°14'22", 1000 m, 03.03.2021, *M.K. Akhil, T.P. Krishnaraj & K.H. Harishma* 169471; way to Nadukanippara, N 8°37'23", E 77°13'31", 1079 m, 23.02.2023, *P.M. Vineesha, Vaishnavi & M.K. Akhil* 160638; *Ibid*., N 8°37'28", E 77°13'51", 1083 m, 23.02.2023, *P.M. Vineesha , Vaishnavi & M.K. Akhil* 160639; Pongalappara, 06.06.2014, *K.M. Manudev, P.G. Arunkumar & A.P. Janeesha* 138921; *Ibid*., N 8°37'48", E 77°14'50", 1305 m, 02.03.2021, *M.K. Akhil & Santhosh Nampy* 169462; *Ibid*., N 8°37'50", E 77°14'57", 1305 m, 02.03.2021, *M.K. Akhil & Santhosh Nampy* 169463; Chemunji, N 8°40'57", E 77°11'25", 900 m, 23.12.2020, *M.K. Akhil & Santhosh Nampy* 169437; *Ibid*., N 8°41'23", E 77°11'07", 1200 m, 23.12.2020, *M.K. Akhil & Santhosh Nampy* 169438; *Ibid*., N 8°40'56", E 77°11'30", 1200 m, 23.12.2020, *M.K. Akhil & Santhosh Nampy* 169439; *Ibid*., N 8°40'58", E 77°11'32", 1200 m, 23.12.2020, *M.K. Akhil & Santhosh Nampy* 169440; *Ibid*., N 8°40'48", E 77°11'28", 1200 m, 23.12.2020, *M.K. Akhil & Santhosh Nampy* 169441; *Ibid*., 1180 m, 15.11.2020, *Namitha & M.K. Akhil* 169450; Ponmudi, 900 m, 17.01. 1989, *N. Sasidharan* 5274; way to Ponmudi, N 8°45'30", E 75°07'15", 900 m, 21.12.2020, *M.K. Akhil & Santhosh Nampy* 169415 (CALI); Ponmudi-Lower sanatorium, 16.11.1977, *M. Mohanan* 52536 (CAL); Poonkulam, way to Agasthyarkudam, 1800 m, 05.03.1980, *N. Mohanan* 66031 (CAL); Thrissur district, Malakkappara, 13.12.2013, *A.P. Janeesha & S. Syam Radh* 134243; Sholayar, N 10°21'15", E 76°33'47", 680 m, 10.07.2019, *S. Resmi, M.K. Akhil & Santhosh Nampy* 160615 (CALI); Wayanad district, Chandanathode, 12.02.1978, *V.S. Ramachandran* 57576; *Ibid*., *s.d., V.S. Ramachandran* 53966 (CAL); Kurichiermala, 28.10.2013, *A.P. Janeesha & P.G. Arunkumar* 134236; Near Vattappoyil, 31.08.2013, *A.P. Janeesha, S. Syam Radh & P.G. Arunkumar* 134212; Neerchal-periya, 08.11.2012, *A.P. Janeesha & Santhosh Nampy* 134252; Periya, 25.08.1984 (CALI); *Ibid*., 12.11.1897, *Borne* 575 (K); Periya-Chandanathode road, N 11°50′21″, E 75°49′53″, 800 m, 21.06.2021, *M.K. Akhil& Santhosh Nampy* 169454; *Ibid*., N 11°50′41″, E 75°49′33″, 810 m, 21.06.2021, *M.K. Akhil& Santhosh Nampy* 169455; *Ibid*., N 11°50′44″, E 75°49′53″, 750 m, 21.06.2021, *M.K. Akhil& Santhosh Nampy* 169456 (CALI). **Tamil Nadu**, Coimbatore district, Waverly estate, 22.10.1961, *J. Joseph* 13090; *s.loc*., 24.08.1905, *C.E.C. Fischer* 324 (CAL); Sholayar submergible area, 1040 m, 29.12.1963, *K. Ramamurthy* 18193 (E [E00833869]); Dindigul district, Kodaikanal, Shembaganur, Tigar shola, 1600 m, 24.05.1987, *M. Charles* 49756 (K); Kanyakumari district, Muthukuzhivayal, 27.08.1976, *A.N. Henry* 47575 (CAL); Madurai district, near Kumili, 100 m, 18.10.1959, *K. Subramanyam* 9439 (E [E01053383]); Nilgiris district, Avalanche, 24.01.1973, *C. Townsend & T.P. Ramamoorthy* 107; Gudalur, 24.06.1897, *Bourne* 333 (K); Naduvattam, 30.03.1870, *C.B. Clarke* 11388 (CAL); Nilgiri, 11.1883, *J.S. Gamble* 13477; *Ibid*., 10.1884, *J.S. Gamble* 14891; Sethur hills, Deviar estate to Naduvattam, 07.03.1981, *S.R. Srinivasan* 68020; Pulney district, *s.loc*., 12.11.1897, *A.G. Bourne* 575 (CAL); Perumal, January, *Rev. Van Malderen* 1360. *s.loc*., 06.12.1907, *C.E.C. Fischer* 253; Tenkasi district, Courtallum, February 1835, *Wight* 651 (E [E00062775]); *Ibid*., September 1835, *s.coll. s.n.* (K); *Ibid*., February 1836, *Wight* 656 (E [E00062774, E00833870], K [K000096750]); Vaithamalai, N 8°56'04", E 77°15'54", 800 m, 17.02.2019, *M.K. Akhil & Santhosh Nampy* 160601; *Ibid*., N 8°55'12", E 77°16'43", 850 m, 17.02.2019, *M.K. Akhil & Santhosh Nampy* 160602 (CALI); Theni district, Meghamalai, N 9°40'04", E 77°24'20", 1500 m, 08.12.2021, *K.M. Manudev & K.K. Jeomol* 160617 (CALI); Tirunelveli district, Agasthyamalai, 22.05.1901, *C.A. Barber* 2887 (K); Upper Kodayar, 1350 m, 23.09.1975, *K.M. Mathew* 14944 (E [E00833810]); *Ibid*., N 8°29'49", E 77°24'11", 1500 m, *M.K. Akhil. & Santhosh Nampy* 160603; *Ibid*., N 10°21'06" E 76°55'25", 1500 m, 02.10. 2021, *K.M. Manudev & K.K. Jeomol* 160616 (CALI); way to Upper Kodayar, 1200 m, 02.09.1963, *A.N. Henry* 17429 (E [E01053380]); Muthukuzhivayal, N 8°29'12", E 77°22'33", 1450 m, 09.12.2021, *K.K. Manudev & K.K. Jeomol* 160618 (CALI). SRI LANKA, *s.d.*, *G.W. Walker* 135 (E [E00833871]); Sispara pass, 14.01.1887 *s.coll. s.n.* (E [E00833873]); Nuwara Eliya district, Hakgala Nature Reserve, 05.10.1973, *S. Waas* 94 (E [E00833874], K); Hakgala Mountain, 1870 m, 24.10.1974, *G. Davidse* 7974 (K); roadside above St. Clair Falls, near Talawakele, 07.02.1973, *B.L. Burtt & C.C. Townsend* 85 (E [E00833875]).

Conservation status: *Aeschynanthus perrottetii* is distributed in southern India and Sri Lanka, with an EOO of 8,53,740.126 km^2. Based on current data, the AOO is calculated at 380 km^2. This species is widespread in high-altitude areas (above 800 m) of South India and exhibits considerable morphological variation. It is found in forests, open lands, and along roadsides. Although the plant is vulnerable to habitat threats in forest margins and roadsides, the majority of the populations are located in protected areas. Hence the species is provisionally assessed as Least Concern (LC).

Notes: Graham (1839) in his *Catalogue of plants growing in Bombay and its vicinity* described *A. grandiflorus* from the Konkan region of South India. Since the name *A. grandiflora* was already occupied (Don, 1827), the name proposed by Graham (1839) became an illegitimate later homonym.

De Candolle (1845) formally established *A. perrottetii*, based on specimens collected by Perrottet from the Nilgiris. In the following year, Gardner (1846) described *A. ceylanicus* from Sri Lanka (Ceylon) and provided a detailed morphological comparison with *A. perrottetii*. The two species were distinguished by several characters: *A. ceylanicus* has broader leaves with acute base (*vs*. narrow leaves with obtuse base in *A. perrottetii*), two flowered umbels (*vs*. 3–5 flowered umbels), a glandular-pubescent corolla (*vs*. a glabrous corolla) and a longer capsule (20 cm *vs*. 8 cm).

Wight (1848) published an illustration of *A. ceylanicus* based on materials from India (Courtallum) and Sri Lanka. Clarke (1883) recognised two varieties under *A. perrottetii* (*A. perrottetii* var. *malabaricus* and *A. perrottetii* var. *planiculmis*) and one under *A. ceylanicus* (*A. ceylanicus* var. *pinguis*). *A. perrottetii* var. *malabaricus* was established based on the collections of Ritchie from Ram Ghat, Stocks from Parva Ghat (Panoar Ghaut) and Wight from Courtallum and has attenuate leaf bases and small calyces (03–06 cm). *Aeschynanthus perrottetii* var. *planiculmis* has compressed branches, densely approximated broadly lanceolate or elliptic leaves and 2–4-flowered umbels with longer corolla (3.5–4 cm long), and was based on collections of Wight from Courtallum, Thomson from Nilgiris and Stocks from Bombay. Clarke (1883) also treated Wight's illustration of *A. ceylanicus* under this name, and established the narrow-leaved plants with pubescent corolla as *A. ceylanicus* var. *pinguis,* based on the collections of Walker and Wight from Sri Lanka, Wight from Pycarah Hills of Nilgiris and Beddome from Anamalai. Later, Clarke (1884) in *Flora of British India*, used the varietal name *A. perrottetii* var. *platyculmis* instead of *A. perrottetii* var. *planiculmis*, and included Gardner's specimens of *A. perrottetii* (Gardner, 1846) as *A. ceylanicus* var. *pinguis*.

Trimen (1895) in *Flora of Ceylon* rejected the occurrence of *A. ceylanicus* var. *pinguis* in Sri Lanka or India, suggesting that the Sri Lankan materials were typical *A. ceylanicus*, and the Indian materials were likely typical *A. perrottetii*. He called for more studies of South Indian specimens for confirmation. Cooke (1908) dismissed Clarke's varieties, recognizing *A. ceylanicus* as conspecific with *A. perrottetii* by his observations on the variations of leaf size, base, and calyx length on the same plant and stated that the flattened branches are a common condition in epiphytic plants depending on the force with which the young stem has been pressed against the supporting tree, as well as the climatic conditions.

Later, Gamble (1924) raised the varietal status of *A. perrottetii* var. *planiculmis* to the rank of a species, by providing the distinguishing features as flattened stems and broadly ovate leaves and considered the var. *pinguis* as a smaller form of *A. perrottetii* and *A. ceylanicus* as a smaller flowering subspecies of this taxon. Santapau (1948), studied the *A. perrottetii - A. ceylanicus* specimens at Kew and observed the occurrence of broad and narrow leaves on the same specimen as well as the continuous set of intermediate stages between the two extremities of leaves. From this, he opinioned that, there is very little ground for erecting the broad-leaved plants into a variety, much less so for erecting them into a species. Bhattacharyya and Goel (2015) reported the occurrence of *A. ceylanicus* var. *pinguis* in South India based on the collection of Gamble which contradicts the treatment of Gamble (1924).

Based on detailed analysis of live materials as well as herbarium specimens including type sheets deposited at ARUN, ASSAM, BM, CAL, CALI, E, and K, it is clear that *A. perrottetii* is an extremely variable species (Figs. 66–67). There are no strong characters to separate the *A. ceylanicus* from *A. perrottetii* and the existing varieties. Therefore, *A. ceylanicus* is here synonymised under *A. perrottetii*.

Fig. 66. *Aeschynanthus perrottetii* A.DC.: Variations in **a & b.** Corolla; **c.** Calyx; **d.** Leaves.

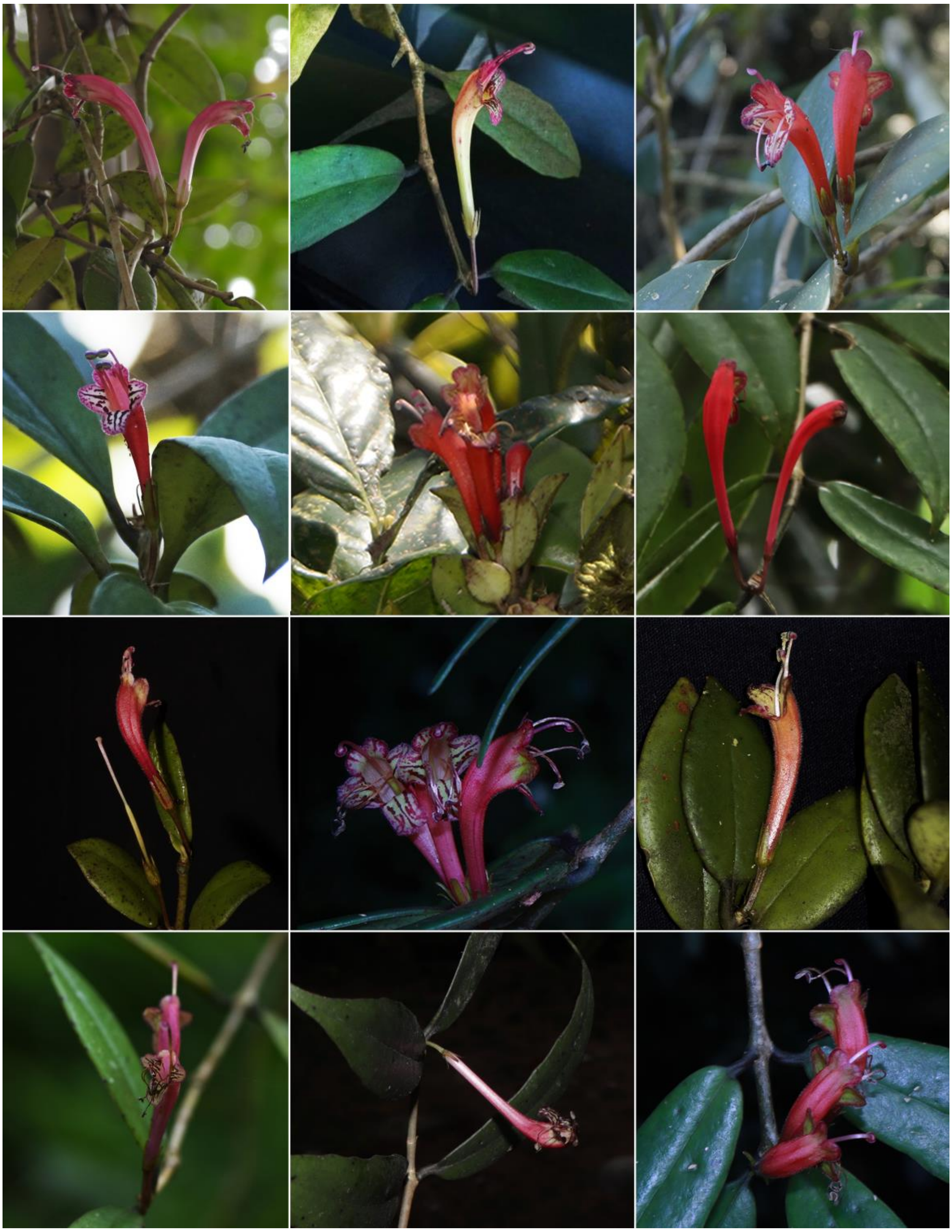


Fig. 67. *Aeschynanthus perrottetii* A.DC.: Floral diversity

16. Aeschynanthus reiekensis Lalhlupuii, S.D.Khomdram & S.D.Yumkham, Taiwania 68(1): 2. 2023. *Type*: INDIA, **Mizoram**, Mamit District, Reiek Tlang, 23°40′58.2″ N 92°36′22.0″ E, 1391.70 m, 17.07.2018, *Margaret Lalhlupuii* 128821 (holo MZUH; iso 0000512, ASSAM; 000999, MUMP).

Figs. 68 & 70

Epiphytic perennial under shrubs. Stems dichotomously branched, pendulous, green with purple tinge when young, straw coloured at maturity, glabrous, rooting at nodes. Nodes swollen; internodes 2–4 cm long. Leaves opposite; petioles 0.4–0.8 cm long, terete, canaliculated above, dark green with purple dots, glabrous; lamina 8–13 × 0.3–0.6 cm, linear to narrowly lanceolate, coriaceous, fleshy, green above, pale beneath with vinaceous blotches, apex acuminate, base cuneate, margins entire to sub-entire, recurved back and revolute when drying, glabrous; midvein sunken adaxially, prominent abaxially; lateral veins obscure. Flowers 1–3, axillary or pseudoterminal; peduncles absent. Bracts *c.* 0.2 × 0.1 cm, triangular, maroon, apex acuminate, margins entire, nerves obscure, glabrous. Pedicels 0.8–1.6 cm long, terete, green at base, maroon higher up, glabrous. Calyx free or slightly fused at base; tubes 0.15–0.25 cm long, green, glabrous; lobes 0.3–0.7 × 0.1–0.13 cm, narrowly triangular to linear, green or greenish maroon, apex acute to acuminate, margins entire, glabrous. Corolla 2–2.9 cm long; 1.7–2.5 cm long, tube 0.1–0.2 cm wide at base, gradually inflated towards the throat with 0.5–0.6 cm, curved from below middle, outside whitish yellow at base, orange to red higher up, glabrous at base, sparsely to densely glandular puberulent above, inside yellow to pale red with a tuft of multicellular hairs just above the base; mouth not

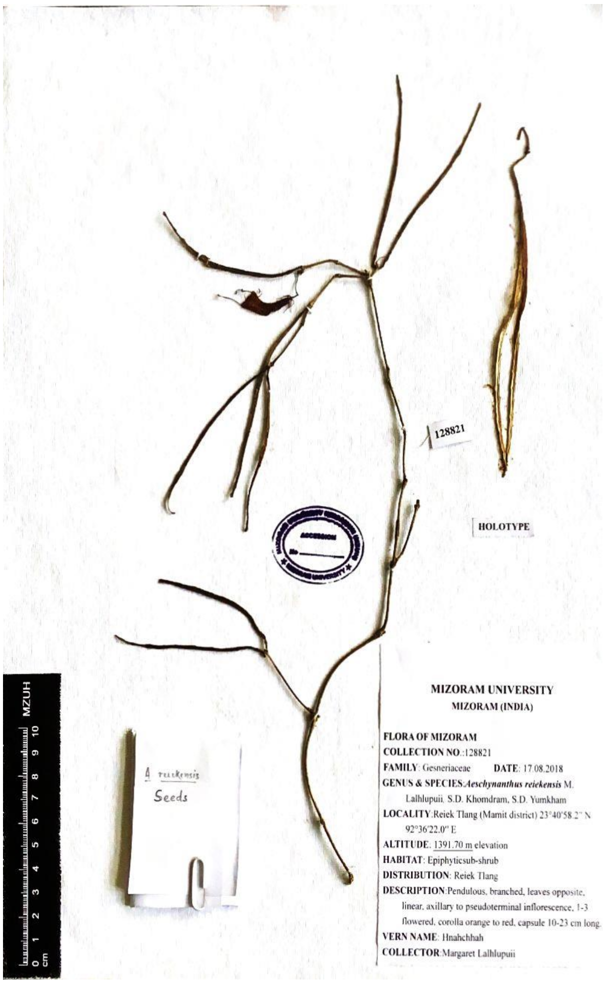


Fig. 68. Holotype of *Aeschynanthus reiekensis Lalhlupuii, S.D.Khomdram & S.D.Yumkham* (MZUH 128821). © Mizoram University Herbarium, Mizoram. Reproduced with permission.

oblique; lobes outside yellowish orange to orange, arched with red, glabrous, inside pale orange arched with red on upper lobes, additionally claret streak running down on from lower lobes, glabrous, ciliate; upper lobes 0.3–0.4 × 0.4–0.5 cm, oblong or elliptic, apex rounded, not reflexed; sinus 0.1–0.2 cm deep; lateral lobes, 0.3–0.4 × 0.4–0.5 cm, elliptic or deltoid, apex rounded, not reflexed; lower lobe 0.4–0.5 × 0.3–0.4 cm, elliptic-oblong, apex rounded, reflexed or spreading. Stamens fused in two pairs, long exserted; anterior filaments 3–3.3 cm long, inserted at 0.5–0.7 cm from corolla base; posterior filaments 2.5–2.8 cm long, inserted at 0.6–0.8 cm from corolla base; filaments white at the base and light purple higher up, glandular hairy; anthers 0.15–0.3 × 0.1 cm, elliptic, purple or grey; pollen grey. Staminode *c*. 0.1 cm long, clavate, inserted 0.8–1 cm from corolla base. Disk 0.1–0.2 cm high, 5-crenate, greenish white. Pistils 2–4.1 cm long; stipes 0.1–0.2 cm long, greenish white, glabrous; ovary 0.5–1.5 cm long, linear, white to greenish white, gland dotted or sparsely pubescent; styles 0.5–1 cm long, linear, white, sparsely to densely glandular pubescent; stigmas *c*. 0.2 cm across, capitate, white or purple. Capsules 7–15 × 0.2–0.3 cm, greenish yellow. Seeds 1–1.2 × 0.2–0.3 mm, testa cells warty, straight orientation; apical appendage 1.5–2 cm long, hilar appendages 2–4, 1.5–2.5 cm long; appendages slightly papillose.

Flowering & fruiting: Flowering from October to July and fruiting from January to August.

Habitat: An epiphyte on large trees.

Distribution: India (GRC, 2024) (Fig. 69).

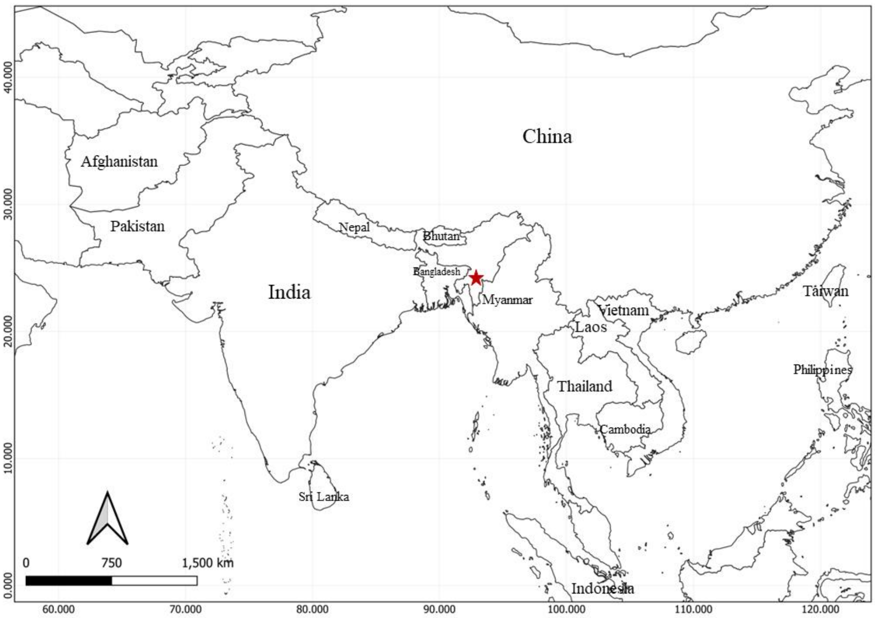


Fig. 69. Distribution of *Aeschynanthus reiekensis* Lalhlupuii, S.D.Khomdram & S.D.Yumkham

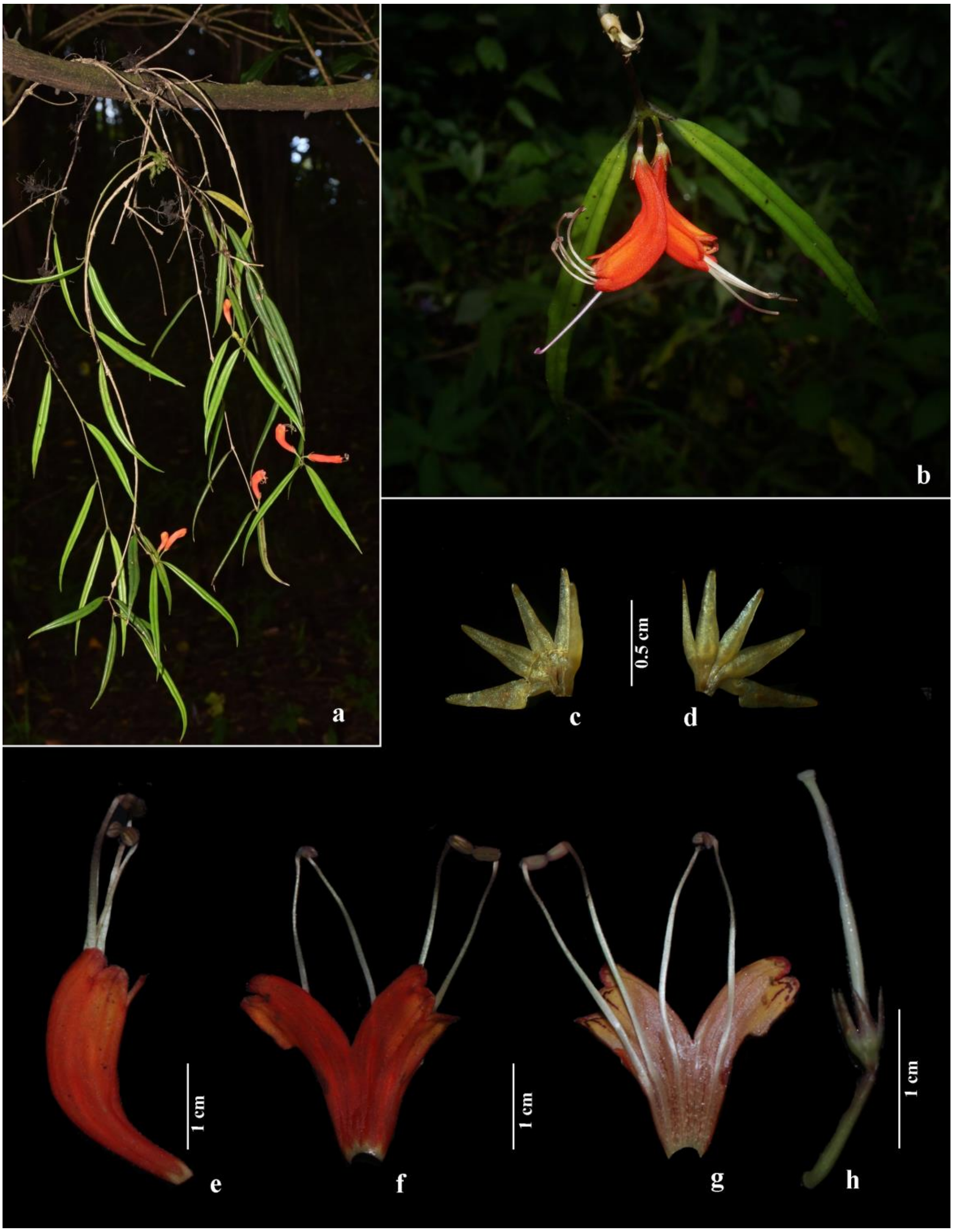


Fig. 70. *Aeschynanthus reiekensis* Lalhlupuii, S.D.Khomdram & S.D.Yumkham: **a.** Habit; **b.** Inflorescence; **c.** Calyx - inner view; **d.** Calyx - outer view; **e.** Corolla - lateral view; **f.** Corolla - split open - back view; **g.** Corolla - split open - inner view; **h.** Pistil with calyx.

Specimen examined: INDIA, **Mizoram**, Mamit district, Reiek Tlang, N 23°41′04.2″, E 92°36′23.5″, 1288 m, 02.10.2021, *M.K. Akhil, M.P. Krishnapriya, K.H. Harishma & Santhosh Nampy* 186431 (CALI).

Conservation status: *Aeschynanthus reiekensis* is currently known only from its type locality, Reiek Tlang, a community reserve in Mizoram, where it exists in just two populations (AOO = 8 km^2). Further data from similar habitats in Northeast India and neighbouring countries are needed to ascertain its conservation status. Nevertheless, threats to the existing populations are anticipated in the near future due to construction activities associated with tourism development. Based on the IUCN Red List Categories and Criteria (2012, 2022), the species is provisionally assessed as Critically Endangered (CR) B2a,b(iii),D.

Notes: *Aeschynanthus reiekensis* can be easily distinguished from the morphologically most similar *A. tengchungensis,* by having fewer flowers per inflorescence (1–3), 5-lobed calyx which is free or sometimes fused at base, tufts of hairs inside near the base of corolla tube, smaller capsules (23 cm long) and 2–4 hilar appendages. In *Aeschynanthus*, the number of hilar appendages is 1 or 2, or more than 5. The presence of 2–4 appendages at the hilar end is unique to *A. reiekensis*.

The specimens of *A. reiekensis* were first collected in flowering and fruiting by researchers from Mizoram University in mid-July 2018 (*Margaret Lalhlupuii* 128821). Three years later, as part of the present study, I also collected similar plants in flowering from the same locality, in early October (*M.K. Akhil, M.P. Krishnapriya, K.H. Harishma & Santhosh Nampy* 186431). The calyx lobes were completely free to the base in the latter, while it shows some fusion at the base in the latter. It is likely that the fusion of sepals could be a variation of the species.

17. Aeschynanthus stenosepalus J.Anthony, Notes. Roy. Bot. Gard. Edinburgh 18: 191. 1934; W.T.Wang *et al.*, Fl. China 18: 378. 1998; Kress *et al.*, Checkl. Myanmar 261. 2003; Z.Y.Li & Y.Z.Wang, Gesneriaceae China 367. 2004; U.C.Bhattach. & Goel, Phytotaxonomy 14: 16. 2015. *Lectotype* (designated by Akhil & Nampy, 2020): UPPER BURMA, **Htawgaw**, July 1924, *G. Forrest* 24773 (E [E00096780!]).

Figs. 71, 73 & 74

Epiphytic or lithophytic slender under shrubs. Stems laterally branched, pendulous, yellowish green when young, straw coloured at maturity, glabrous, rooting at nodes. Nodes slightly swollen; internodes 2.2–5.2 cm long. Leaves opposite; petioles 0.4–0.8 cm long, terete, canaliculated above, green, glabrous; lamina 5–7 × 2–3 cm, ovate-elliptic, fleshy, dark to mid green above, pale green beneath, apex acuminate, base rounded, margins entire, glabrous; midvein sunken adaxially, prominent abaxially; lateral veins generally 3–5 pairs, weakly visible or obscure. Flowers 1–2, axillary or pseudoterminal; peduncles 1–2, 4–7 cm long, filiform, terete, green, glabrous. Bracts 0.35–4 cm long, linear, green, apex acute, margins entire, midrib visible, lateral nerves obscure, glabrous, persistent; pedicels 0.8–1.2 cm long, terete, green to greenish maroon, glabrous. Calyx free to base; lobes 0.8–1 × 0.1–0.2 cm, lanceolate, maroon or greenish maroon, apex acuminate, margins entire, glabrous. Corolla 2.8–3.2 cm long; tube 2.4–2.8 cm long, globose-dilated at base, 0.5–0.6 cm wide, narrowing above with 0.2–0.3 cm wide, gradually inflated towards the throat with 0.6–0.7 cm, curved from above the gibbous, outside crimson red, glabrous, inside yellowish to orange red, glabrous; mouth not oblique; lobes outside crimson red with dark red stripes running down to the tube, glabrous; inside crimson red with dark red stripes, glabrous, ciliate; upper lobes 0.5–0.6 × 0.3–0.4 cm, obtuse, apex rounded, not reflexed; sinus 0.1–0.2 cm deep; laterals lobes 0.4–0.5 × 0.2–0.3 cm, oblong, apex rounded, not reflexed; lower lobe 0.4–0.5 × 0.3–0.4 cm, elliptic-oblong,

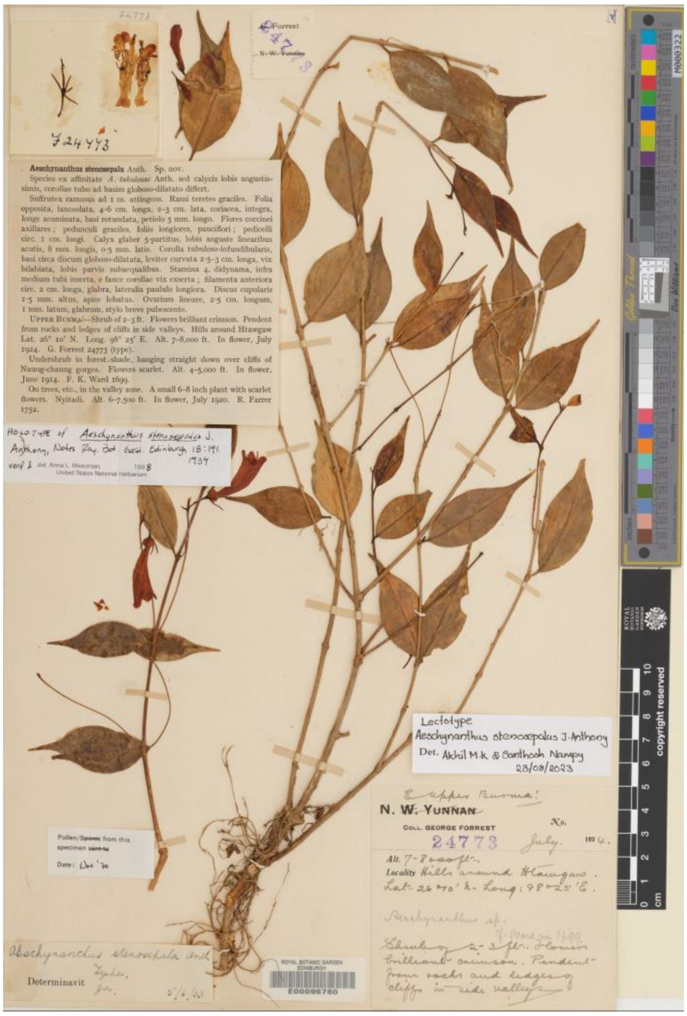


Fig. 71. Lectotype of *Aeschynanthus stenosepalus* J.Anthony (E [E00096780]). © The Board of Trustees for the Royal Botanic Gardens, Edinburgh. Reproduced with permission.

apex rounded, slightly reflexed or spreading. Stamens fused in two pairs, exserted just above the mouth at the level of upper lip; anterior filaments 1.5–1.8 cm long, inserted at 1.2–1.3 cm from corolla base; posterior filaments 1.5–1.7 cm long, inserted at 1.4–1.5 cm from corolla base; filaments pale orange or yellow, glandular pubescent; anthers *c.* 0.1 × 0.07 cm, narrowly elliptic, yellow; pollen yellow. Staminode *c.* 0.1 cm long, clavate, inserted 1.8–2 cm from corolla base. Disk 0.1–0.2 cm high, 5-crenate or annular, greenish yellow. Pistils 2.5–3.2 cm long; stipes 0.2–0.3 cm long, greenish yellow, glabrous; ovary 2–2.5 cm long, linear, greenish yellow, glabrous; styles 0.5–0.8 cm long, linear, green, glandular pubescent; stigmas *c.* 0.2 cm across, capitate, yellowish green or red. Capsules 8–10 × 0.5–0.6 cm, green. Seeds 0.85–1.5 × 0.2–0.26 mm, testa cells strongly papillose, papillae formed from the centre of the cell, slight clockwise orientation; apical appendage 2.5–3.5 mm long; hilar appendage a solitary hair, 2.5–3.8 mm long, appendages not papillose.

Vernacular name: Narrow sepal blushwort.

Flowering & fruiting: Flowering from July to September and fruiting from September to October.

Habitat: An epiphytic shrub on large trees or a lithophyte on rocky patches in the forest margins.

Distribution: China, India and Myanmar (GRC, 2024) (Fig. 72).

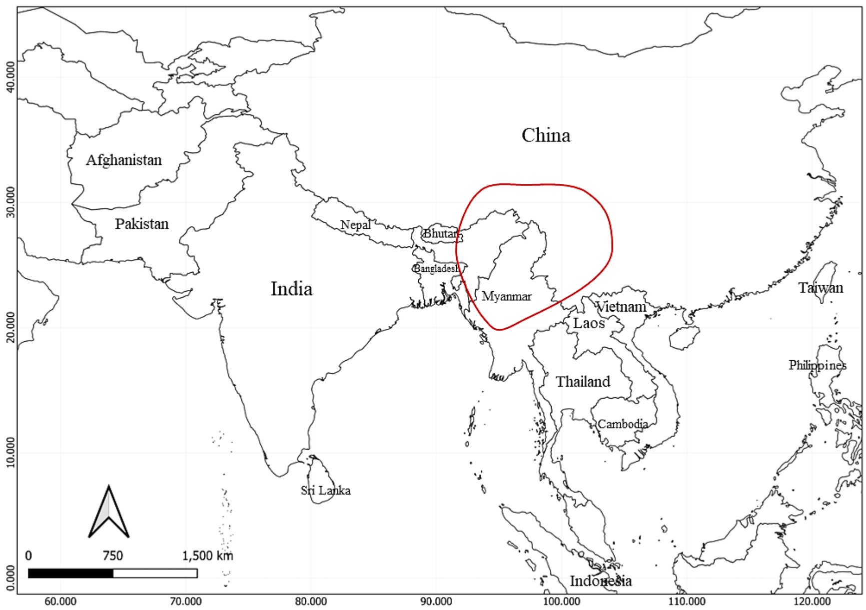


Fig. 72. Distribution of *Aeschynanthus stenosepalus* J.Anthony

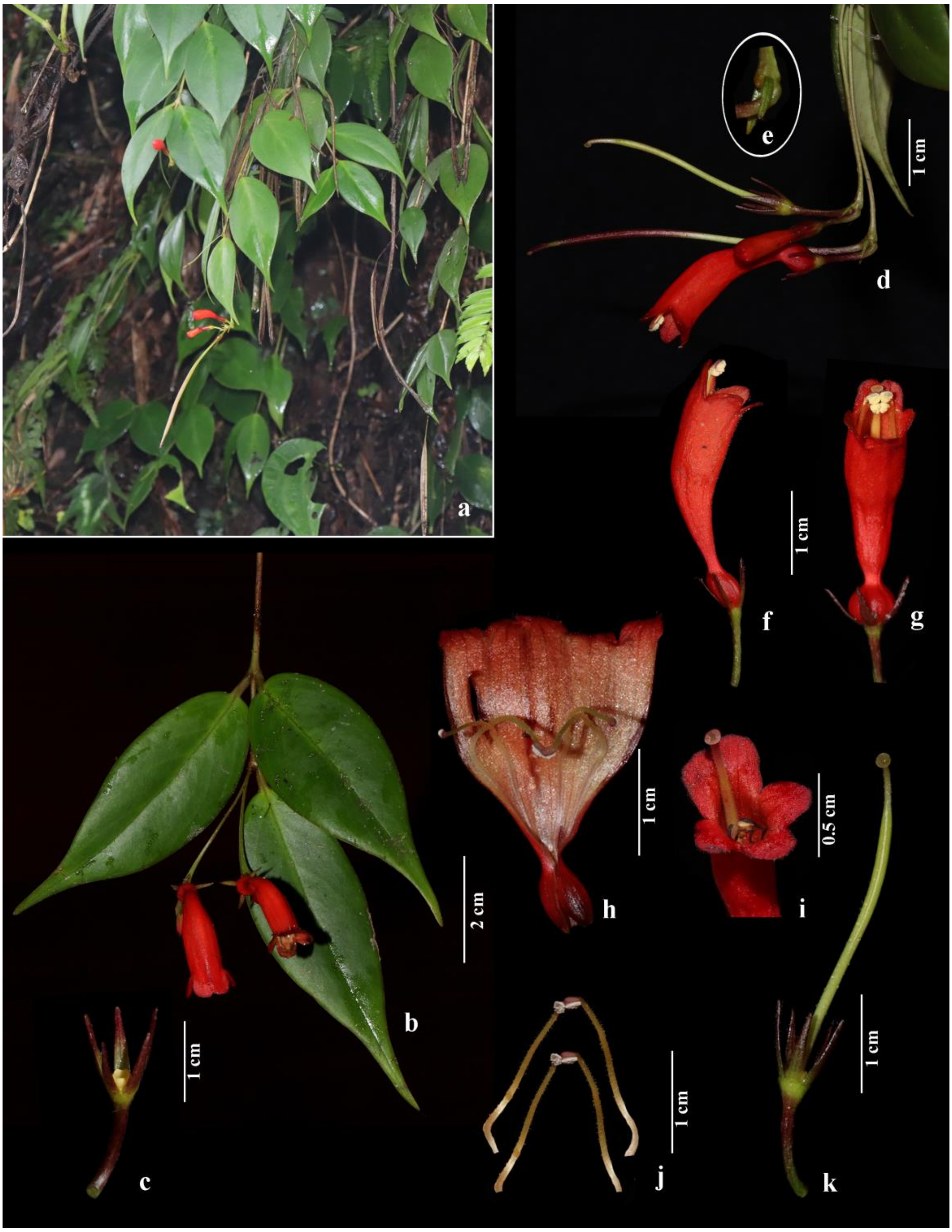


Fig. 73. *Aeschynanthus stenosepalus* J.Anthony: **a & b.** Habit; **c.** Calyx; **d.** Inflorescence; **e.** Bract; **f.** Single flower - lateral view; **g.** Single flower - front view; **h.** Corolla - split open; **i.** Corolla - mouth - front view; **j.** stamens; **k.** Pistil with calyx.

Fig. 74. *Aeschynanthus stenosepalus* J.Anthony in its natural habitats.

Specimens examined: CHINA, **Yunnan**, Gongshan Xian, Cikai Zheng, Dangdan park, E side of Gaoligong Shan, 1600 m, 29.06.2000, *Li Heng* 11784 (E [E00132450]); Kiukiang Valley, Taron, Chiengen, 1800 m, 26.07.1938, *T.T. Yu* 19422 (E [E00067578]); Salwin Valley, Bahnlo, 1600 m, 21.10.1938, *T.T. Yu* 22914 (E [E00067579]). INDIA, **Arunachal Pradesh**, Lower Subansiri district, Jaca, 17.09.1982, *G.D. Pal* 586 (ARUN); Ziro, 2300 m, 19.07.2019, *Momang Taram* 700(b) (CAL); *Ibid.*, west of old Ziro, 18.09.1983, *G.D. Pal* 1208 (ARUN); Shi Yomi district, near Tato, N 28°31'41", E 94°21'1", 1454 m, 25.08.2023, *M.P. Krishnapriya & M. Sreya* 160640; way to Mechuka N 28°34'45", E 94°05'45", 2200 m, 25.08.2023, *M.K. Akhil, M.P. Krishnapriya & M. Sreya* 160641; *Ibid.*, N 28°32'11", E 94°14'56", 1885 m, 25.08.2023, *M.P. Krishnapriya & M. Sreya* 160642 (CALI). **Meghalaya**, Rahu to Vokamoska, 26.08.1958, *G. Panigrahi* 16835 (ASSAM, CAL); Rahu to Wahka, 02.07.1961, *D.B. Deb* 26424 (CAL). MYANMAR, **Kachin**, Naung Chaung gorge, 4–5000 ft, 23.06.1914, *F. Kingdon Ward* 1699 (E [E00096781]); North Triangle (HRiulum), 4250 ft, 13.07.1953, *F. Kingdon Ward* 21147 (BM [BM000883946]); Nyitadi, 6–7500 ft, 25.07.1920, *R. Farrer* 1752 (E [E00096782]); Putao, Gorge of the Tara Wang, Nam Tamai, N 27°45', E 97°50', 5000 ft, 15.08.1937, *F. Kingdon Ward* 12936 (BM [BM000883945]); Valley of the Senghku, 11.08.1926. *F. Kingdon Ward* 7266 (K). **Myitkyina**, 5 miles from Kangfang, 17.07.1938, *Naw Mu Pa* 17438. **Upper Burma**, 4–5000 ft, 23.06.1914, *F. Kingdon Ward* 1699; 7–8000 ft, July 1924, *G. Forrest* 24773 (K [K000831882]).

Conservation status: *Aeschynanthus stenosepalus* is distributed in southern China, Northeast India, and northern Myanmar, with an EOO of 1,50,383.119 km^2. Based on current data, the AOO is calculated at 104 km^2. This species is usually found on forest margins as a lithophyte. While no severe threats to its habitat have been identified at present, future threats are anticipated due to road widening. The species is provisionally assessed as Least Concern (LC).

Notes: Anthony (1934) described *A. stenosepalus* from Myanmar (Upper Burma) based on collections by F. Forrest, F.K. Ward and R. Farrer. The specific epithet refers to the narrow sepals of the flower. However, the main distinguishing feature of this species is its globose-dilated corolla base, which is not found in any other Indian species.

The occurrence of this species in India was first reported by Bhattacharyya and Goel (2015) based on specimens by D.B. Deb (Coll. No: 26424) and G. Panigrahi (Coll.

No: 16835) from the ASSAM and CAL herbaria, respectively. Due to the similarity in the habit and ovate-elliptic leaves, these specimens were earlier misidentified as *A. philippinensis* C.B.Clarke. But *A. stenosepalous* can be easily distinguished from *A. philippinensis* by its long peduncle (4–7 cm) and larger corolla tube (2.8–3.2 cm) with a gibbous base. The specimens collected by G.D. Pal from Arunachal Pradesh in 1982 and 1983 (ARUN, collection numbers 586, 1208) also belong to this species, but were misidentified as *A. micranthus*.

18. Aeschynanthus superbus C.B.Clarke, Commelyn. Cyrtandr. Bengal. 73. t. 46. 1874, in A.DC. & C.DC., Monogr. Phan. 5(1): 32. 1883, in Hook.f., Fl. Brit. Ind. 4: 342. 1884; Kanjilal *et al.,* Fl. Assam 3: 391. 1939; W.T.Wang, Phytologia 45: 310. 1980; Harid. & R.R.Rao, Forest Fl. Meghalaya 2: 652. 1987; Li, Acta Bot. Yunnan. 5(1): 28. 1983; N.P.Balakr., Fl. Jowai 2: 345. 1983; W.T.Wang, Fl. Reipubl. Popularis Sin. 69: 507. 1990; W.T.Wang *et al.*, Fl. China 18: 379. 1998; Hilliard, Fl. Bhutan 2(3): 1301. 2001; B.L.Burtt, Thai Forest Bull. (Bot.) 29: 84. 2001; Hilliard in Grierson & D.G.Long. Fl. Bhutan 3: 1301. 2002; Kress *et al.*, Checkl. Myanmar 262. 2003; Z.Y.Li & Y.Z.Wang, Gesneriaceae China. 368. 2004; D.J.Middleton, Edinburgh J. Bot. 66(3): 440. 2009; G.P.Sinha, Fl. Mizoram 2: 201. 2012; Ambrish, Fl. Upper Subansiri district 339. 2013; G.D.Pal, Fl. Lower Subansiri district, Arunachal Pradesh 2: 166. 2013; U.C.Bhattach. Phytotaxonomy 14: 17. 2015; B.K.Sinha & Su.Datta, Nelumbo 58: 11. 2016; S.S.Dash & P.Singh, Fl. Kurung Kumey Dt. 2: 353. 2017; A.A.Mao *et al.*, Check List Fl. Nagaland 97. 2017. *Trichosporum superbum* (C.B.Clarke) Kuntze, Revis. Gen. Pl. 478. 1891. *Lectotype* (designated by Middleton, 2009: INDIA, Pundua, *Wallich* 795 (BM [BM000883951!]); isolecto: (K-W [K000831877!], M [M0090743 digital image!], P [P00606326 digital image!], S [S08-11113 digital image!]).

Figs. 75, 77 & 78

Epiphytic or lithophytic perennial suffruticose undershrubs. Stems branched, sub-woody, arching and pendulous, green when young, grey-white at maturity with peeling bark, glabrous, rooting at nodes. Nodes swollen; internodes 8–15 cm long. Leaves opposite; petioles 0.6–1.5 cm long, terete, canaliculated above, glabrous; lamina 8–22 × 1.5–10 cm, elliptic to widely ovate, fleshy or coriaceous, green above, pale green to greenish white beneath, apex acuminate, base cuneate to obtuse, margins entire, glabrous; midvein sunken adaxially, prominent abaxially; lateral veins generally 4–12 pairs, clearly visible to obscure. Inflorescences sub-umbellate, 2–15-flowered, pseudoterminal or axillary; peduncles 1.2–2.5 cm long, terete, stout, green, glabrous. Bracts 3.5–6 × 1–4 cm, ovate or elliptic, spathaceous, boat-like, rose-red or red with greenish tinch at base, apex obtuse, margins entire, faintly 5–7-nerved, glabrous, deciduous; pedicels 0.7–1.3 cm long, terete to angular, rose-red with white at base, glabrous. Calyx free to base; lobes 5, 1.4–3.9 × 0.5–1.3 cm, elliptic to obovate, rose-red to red, apex obtuse to rounded, margins entire, straight, glabrous, deciduous. Corolla 6–8.5 cm long; tube 5–7 cm long, 0.4–0.6 cm wide at base up to middle, gradually inflated towards the throat with 1–1.2 cm, curved from base, forming many weak longitudinal ridges, outside pink or pinkish-red at base, gradually fade towards the top with pink or rose-red streaks along length, glabrous, inside pale pink or white at base, red or rose-red streaks along length starts from near the middle and spreads on lobes, densely glandular hairy at throat in; mouth not oblique; lobes outside pale pink, glabrous; inside pink with dark red blotches running down towards the tube, glabrous, ciliate; upper lobes 1–2 × 0.8–1.2 cm, orbicular, oblong or ovate, apex rounded, reflexed or spreading; sinus 0.5–0.6 cm deep; lateral lobes 1–2 × 1–1.4 cm, elliptic, orbicular or ovate, apex rounded, reflexed; lower lobe 1–1.6 × 1–1.2 cm, ovate or orbicular, apex rounded, spreading. Stamens fused in two pairs, long exserted; anterior filaments 3.5–4 cm long, inserted at 3–3.8 cm from corolla base; posterior filaments 2.5–3.2 cm long, inserted at 3.7–4.5 cm from corolla base; filaments white at

Fig. 75. Lectotype of *Aeschynanthus superbus* C.B.Clarke (BM [BM000883951]). © The Board of Trustees for the Natural History Museum, London. Reproduced with permission.

base, red or purple higher up, glandular hairy; anthers 0.3–0.4 × 0.1–0.2 cm, elliptic to oblong, reddish purple; pollen cream coloured. Staminode 0.1–0.4 cm long, clavate, inserted at 3.6–4 cm from base. Disk 0.2–0.3 cm high, 5-crenate or annular, red. Pistils 6–7.5 cm long, white; stipe 1.8–3.4 cm long, whitish green, glabrous to glandular puberulent; ovary 1.5–4.4 cm long, linear, whitish green, glandular pubescent or with sessile glands; styles 0.8–1.8 cm long, linear, whitish green, glandular pubescent; stigmas *c.* 0.2 cm across, capitate, pink or purple. Capsules 25–40 × 0.15–0.3 cm, green to yellowish green. Seeds 0.8–1.2 × 0.2–0.25 mm, testa cells strongly papillose, papillae formed towards the end of the cell, slight to moderate clockwise orientation; apical appendage 4.5–7.5 mm long; hilar appendage a solitary hair, 4.5–6.4 mm long, appendages not papillose.

Vernacular name: Superb blushwort.

Flowering & fruiting: Flowering from August to October and fruiting from October to December.

Habitat: Evergreen forest margins, with 1000–1500 m altitude.

Distribution: Bangladesh, Bhutan, China, India, Laos, Myanmar, Thailand and Vietnam (GRC, 2024) (Fig. 76).

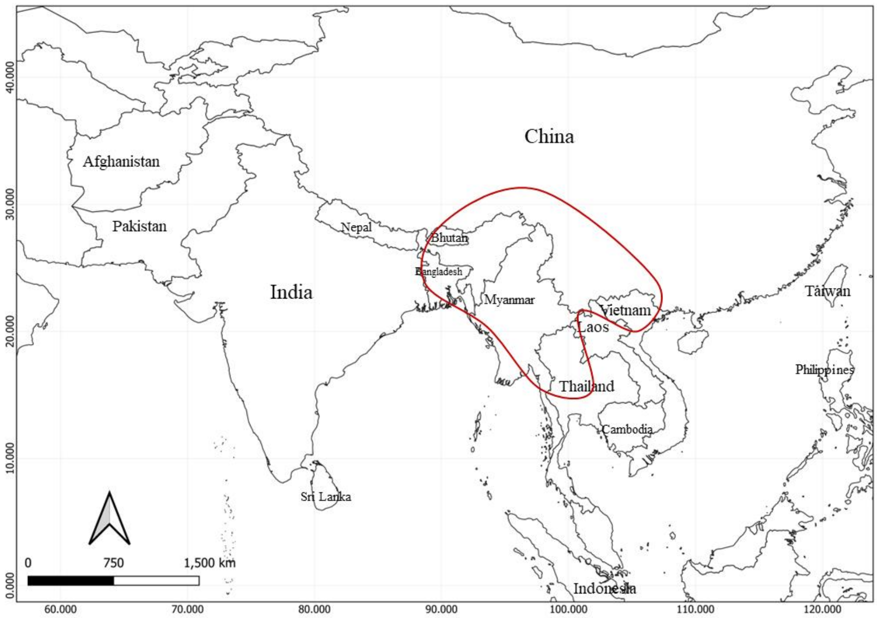


Fig. 76. Distribution of *Aeschynanthus superbus* C.B.Clarke

Fig. 77. *Aeschynanthus superbus* C.B.Clarke: **a & c.** Habit; **b.** Inflorescence; **d.** Bracts; **e.** Calyx; **f.** Single flower; **g.** Corolla - split open; **h.** Corolla - mouth - front view; **i & k.** stamens; **j.** Staminode; **l.** Pistil with calyx; **m.** Pistil.

Fig. 78. *Aeschynanthus superbus* C.B.Clarke in its natural habitats

Specimens examined: BANGLADESH (EAST BENGAL), *s.loc*., *s.d.*, *Griffith* 3808 (U [U.1600053 digital image]). BHUTAN, Mongar district (Shongar), 4000 ft, 28.08.1915, *R.E. Cooper & A.K. Bulley* 4705 (BM [BM011025831]; E [E00394335]). CHINA, **Yunnan**, Kiukiang Valley, Monting, 1400 m, 24.09.1938, *T.T. Yu* 20405 (E [E00067573]); Shweli Salwin divide, 7000 ft, September 1913, *G. Forrest* 11743 (E [E00067575, E00096763]); Zhenganzheng, Xiaoshui He, on the W side of Gaoligong Shan near the divide between the Irrawaddy and Salween watersheds, N 24°50'16", E 98°45'53", 2170 m, 22.10.1998, *Li Heng, Bruce Bartholomew & Dao Zhilin* 10791 (E [E00237931]). INDIA, **Arunachal Pradesh**, Chanlang district, Pyoum-Ngachang, 900 m, 11.09.2011, *M. Bhaumik* 27386 (ARUN); Changlang to Khela, 1066 m, 18.10.1959, *R.S.Rao* 20270 (ASSAM, CAL); East Kameng district, Sessa, 1050 m, 12.09.1964, *J. Joseph* 39845 (ASSAM); Kurung Kumey district, on way to Parlo, *s.d.*, *S.S. Dash* 31703 (ARUN); Tirap district, Laju to Raho, 26.08.1958, *G. Panigrahi* 14772 (ASSAM, CAL); Wakka, 29.08.1958, *G. Panigrahi* 14991 (ASSAM, E [E00630466]); West Siang district, Kamba surrounding forest, 950 m, 27.11.2010, *M. Bhaumik* 25514 (ARUN); Kaying to Tumbin, N 28°29'08", E 94°39'52", 1467 m, 25.08.2023, *M.P. Krishnapriya & M. Sreya* 160643 (CALI). **Assam**, *s.loc.*, *s.d.*, *s.coll.* 421 (ASSAM); *Ibid.*, *s.d.*, *Wallich s.n.* (L [L.2820966 digital image]); *Ibid.*, *s.d.*, *Dr. King's collector* 189 (US [US 00444755 digital image]); Karbi Anglong district, Koilamati, 15.06.1994, *A.K. Baishya* 95453; Myrdou, 28.01.1938, *S.R. Sharma* 16387; Thu Ran, 31.10.1917, *U. Kanjilal* 7285 (ASSAM); Shi Yomi district, way to Mechuka, N 28°31'38.88", E 94°31'58.018", 1120 m, 25.08.2023, *M.P. Krishnapriya & M. Sreya* 160644 (CALI). **Manipur**, *s.loc*., Noongar, 1600 m, 28.11.1885, *C.B. Clarke* 42222A (K). **Meghalaya**, East Jaintia Hills district, Jarain, 1893, *Dr. King's collector s.n.* (K); *Ibid*., 5000 ft, 1898, *G. Mann s.n.* (CAL); East Khasi Hills district, Khasia, *s.loc.*, *s.d.*, *G. Mann s.n.* (CAL); *Ibid.*, *s.d.*, *Griffith s.n.* (L [L.2820969 digital image]; K [K000096765]); *Ibid.*, *s.d.*, *J.D. Hooker & T. Thomson s.n.* (K [K000096766]); *Ibid.*, 2–4000 ft, *s.d.*, *J.D. Hooker & T. Thomson s.n.* (BM [BM011025830]; BR [BR0000008495396 digital image]; E [E00630467]; GDC [G00492482 digital image], L [L.2820971, L.2820970 digital images]); Cherrapunji, 4500 ft, 18.09.1913, *U. Kanjilal* 2616 (ASSAM, CAL); *Ibid.*, 4000 ft, 24.07.1952, *T.R. Chand* 6229 (MICH digital image); *Ibid.*, 14.08.1952, *Walter N. Koelz* 31114 A (MICH [MICH 1002446 A, MICH 1002446 B digital images]); Mahadeo, 09.10.1886, *C.B. Clarke* 44910 (BM [BM011025828], K, US [US 00444756 digital image]); Maufew, 09.11.1871, *C.B. Clarke* 15261 (L [L.2820967 digital image]); Mawmluh, 09.11.1930, *P.C. Kanjilal* 8879 (ASSAM); Mawryngkneng, 4000 ft, 19.10.1951, *T.R. Chand* 4762 (E [E00630465]; MICH [MICH 1197558 digital image]);

Mawsmai, 13.09.1931, *S.R. Sharma* 1422; *Ibid.*, 13.09.1931, *S.R. Sharma* 9422; Mawsmai road, 13.09.1931, *S.R. Sharma* 9422; Pongtung, 11.11.1936, *S.K. Daka* 15011; *Ibid.*, 12.10.2016, *Aabid Hussain Mir* 231 (ASSAM); Pynursla, 4000 ft, 25.08.1949, *Walter N. Koelz* 23592 (E [E00630468], MICH [MICH 1197555 digital image]); way to Pynursla, N 25°19'35", E 91°53'58", 1340 m, 20.09.2021, *M.K. Akhil. & Santhosh Nampy* 186407 (CALI); Umwai, 3000, 12.10.1886, *C.B. Clarke* 45854; Um Dola Paha, 3500 ft, 22.12.1913, *U. Kanjilal* 2829 (CAL). Near Laskein village N.E of Raliang, 1350 m, 24.11.1969, *N.P. Balakrishnan* 50184 (ASSAM); Sohra, 550 m, 18.08.1968, *N.P. Balakrishnan* 46734 (ASSAM); West Garo Hills district, Nokrek Biosphere Reserve, along Simsang, ±750 m, 11.04.2009, *B. Singh, V.N. Singh & B.K. Sinha* 118537 (ASSAM); near Nokrek, 4000 ft, 06.03.1950, *T.R. Chand* 2725 (L [L.2820964 digital image]); *Ibid.*, 10.03.1950, *T.R. Chand* 2805 (L [L.2820965 digital image]); Rongsingiri, *B. Singh* 115851 (ASSAM); West Jaintia Hills district, Jowai River bank, 26.01.1957, *G. Panigrahi* 5231 (ASSAM); *Ibid.*, December 1893, *Dr. King's collector s.n.*; *Ibid*, 5000 ft, 29.01.1893, *Dr. King's collector, s.n.* (CAL); way to Dawki from Pynursla, 16.09.1970, *A.S. Rao* 38678 (ASSAM); way to Krang Shuri waterfalls, N 25°17'30", E 92°07'25", 1200 m, 24.09.2021, *M.K. Akhil & Santhosh Nampy* 186419 (CALI); oWest Khasi Hills district, Mairang, Nongkhlaw, 07.03.1932, *Sri Ram* 9928a; *Ibid.*, 07.03.1932, *S.R. Sarma* 9918; Rangthali, 13.09.2016, *Aabid Hussain Mir* 229 (ASSAM). **Mizoram**, Lunglei district, Tuisenchhuah (Tuisenhan), 4000 ft, 22.10.1927 *Mrs. N.E. Parry* 323 (K); Zobauk, 4500 ft, September 1928, *W.J.L. Wenger* 227 (K). **Nagaland**, Tseminyu district, Tseminyu-Zumpha road, 05.10.1977, *C.L. Malhotra* 75057; Naga Hills, June 1936, *N.L. Bor* 20879 (ASSAM); Road to Therama, September 1886, *Dr. D. Prain s.n.* (CAL); Tesaugbi, 5000 ft, 04.09.1935, *N.L. Bor s.n.* (K). MYANMAR (BURMA), **Kachin**, Cachin Hills, 1897, *s.loc*., *Shaik Mokim s.n.* (CAL); Myitkyina district, Hukawng Valley (HKawng Oaw), N 25°58', E 98°00', 2500 ft, 12.09.1939, *R. Kaulback* 403 (BM [BM011025825]; E [E00096784]); Putao district, Nam Tamai Valley, 3000–4000 ft, 09.11.1922, *F. Kingdon Ward* 5519 (E [E00096786]); *Ibid.*, N 27°42', E 97°54', 3000 ft, 28.08.1939, *R. Kaulback* 97 (BM [BM011025826], E [E00096787]); North Triangle (Hkinlum), 4000 ft, 03.08.1953, *F. Kingdon Ward* 21231 (BM [BM000883952]). **Shan**, Kengtung, 4000 ft, September 1909, *R.W. MacGregor,* I.M.S. 1054 (E [E00096785]); Ngawchang Valley, 3000–4000 ft, 12.09.1919, *F. Kingdon Ward* 3634 (E00067574). **Upper Burma**, Nam Tesanq, 2500 m, February 1912, *Capt. S.M. Toppin R.A.* 6324 (CAL). *s.loc.*, ±5500 ft, 17.04.1910, *Capt. R.W. MacGregor J.M.S* 1054 (CAL). LAOS, **Phong Sali**, Between Phinh Ha and Lao Phutai, on the track from Phong Sali to Lai Chau, 1000 m, 27.04.1936, *E. Poilane*

25913 (P [P02088797 digital image]). THAILAND, **Chiang Mai Province**, Fang district, Doi Ang Khang, *c*. 1560 m, 14.09.1927, *H.B.G. Garrett* 450 (L [L.2820975 digital image]) *Ibid*., *c*. 1540 m, 18.06.1934, *H.B.G. Garrett* 865 (L [L.2820974 digital image]); Northern Chiang Mai, Doi Inthanon, 900–1800 m, 02.10.1971, *Gen Murata, Kunio Iwatsuki, Chamlong Pengklai & Charal Charamphoi* 15760 (L [L.2820972 digital image]). **Nan Province**, Doi Phu Kha National Park, Pua, N 19°13', E 101°05', 1250 m, 16.09.1999, *P. Srisanga & C. Puff* 1077 (E [E00111086, E00111087]); *Ibid*., 23.09.2000, *P. Srisanga* 1610 (E [E00500077]); Doi Wao, 1400–1700 m, 10.09.1995, *Kai Larsen, Supee S. Larsen, Christian Tange & Duangchai Sookchaloem* 46295 (E [E00319273], L [L.2820976 digital image]). VIETNAM, **Lam Dong**, Durc Trong district, Nui Voi, Elephant Mountain, N 11°51'02", E 108°26'29", 1500 m, 17.09.2001, *P. Thomas, N.D.T. Luu & N.V. Chi* 202 (E [E00144835]). **Thanh Hoa**, Ba Thuoc district, Thanh Son, middle part of Pu Luong range, N 20°28'14", E 105°05'34", 1450–1550 m, 09.10.2003, *L. Averyanov, P.K. Loc, D.T. Doan & N.T. Vinh* 4206 (E [E00435179]).

Conservation status: *Aeschynanthus superbus* is distributed across eight countries, with an EOO of 34,10,073.778 km^2. Based on current data, the AOO is calculated at 120 km^2. This species grows gregariously, and no significant threats were found. The species, therefore, is provisionally assessed here as Least Concern (LC).

Notes: The Wallichian name *A. longiflora* was based on specimens collected by De Silva from Pundua (probably part of Bangladesh) in 1824 with collection number 795 (BM000883951, K000831877, M0090743, P00606326, S08-11113). Meanwhile, Blume (1826) described *Lysionotus longiflorus* from Java (L0627500, L0627501, L0627507), and de Candolle (1845) transferred it to *Aeschynanthus* as *A. longiflorus* (Blume) A.DC. The Wallichian name remains undescribed until Clarke (1874). Since the epithet was preoccupied, Clarke assigned a new epithet to Wallich's *A. longiflorus* as *A. superbus*. In the protologue, Clarke mentioned the Wallichian collection as "the most beautiful among many fair ones (inter multas pulchras pulcherrima)" and used the epithet '*superba'* to describe this species.

The gregarious growth, suffruticose habit, comparatively larger leaves, and floral parts signify its name. The large (3.5–6 × 1–4 cm), fleshy, rose-red, concave bracts give a spathe-like appearance and protect 5–15 young flower buds in their juvenile phase and dehisce upon maturity. The petaloid, rose-red calyx, which is completely free at the the base, and the white corolla striped pink, differ from the much common scarlet or crimson flowers found in *Aeschynanthus*. The umbel inflorescences arise from the nodal regions on a solitary, short peduncle (1.2–4 cm long) of matured leafless stem parts, giving the plant a cauliflorous appearance.

19. Aeschynanthus tirapensis U.C.Bhattach., Bull. But. Surv. India 35: 131. 1993; U.C.Bhattach. & Goel, Phytotaxonomy 14: 17. 2015; B.K.Sinha & Su.Datta, Nelumbo 58: 11. 2016. *Type*: INDIA, **Arunachal Pradesh**, Tirap/Changlang District, Tirap Frontier Division, *s.loc.*, 08.09.1958, *G. Panigrahi* 17015A (holo CAL [CAL000025104!]); *residual syntypes*: INDIA, **Arunachal Pradesh**, Tirap /Changlang district, Tirap Frontier Division, *s.loc.*, 09.09.1958, *G. Panigrahi* 17015B (CAL [CAL000025105!, CAL000025106!]).

Figs. 79

Lithophytic perennial herbs. Stems branched, creeping, sub-sulcate, sparsely pubescent on younger parts, rooting at nodes. Nodes slightly swollen; internodes 2–4 cm long. Leaves opposite; petioles 0.2–0.4 cm long, green, terete, glabrescent, canaliculated above; lamina 1–3 × 0.6–1 cm, ovate to elliptic, green, fleshy, apex acute to obtuse, base cuneate to rounded, margins entire, midvein sunken adaxially, prominent abaxially; lateral veins obscure, glabrescent above, strigose hairy beneath. Flower solitary axillary; peduncles absent. Bracts deciduous; pedicels 1.2–1.4 cm long, terete to angular, sparsely pilose. Calyx free to base; lobes 0.6–0.8 × 0.1–0.3 cm, linear-lanceolate, green, apex acute to obtuse, margins entire, pubescent out, straight, glabrous in, ciliate. Corolla 3–3.2 cm long; tube 2.8–3 cm long, 0.2–0.3 cm wide at base, gradually inflated towards the throat with 0.5–0.6 cm, curved from above middle, outside red, dark red stripes running down from the centre of lobes, glandular pubescent, inside pale red, glabrous; mouth not oblique; lobes outside with dark streak at centre running down to the throat, sparsely pubescent, inside pale red arched with dark red, glabrous, ciliate; upper lobes 0.2–0.25 × 0.25–0.3 cm, ovate, apex rounded, not reflexed; sinus *c.* 0.2 cm deep; lateral lobes 0.15–0.2 × 0.2–0.25 cm, ovate, apex rounded, not reflexed; lower lobe 0.3–0.35 × 0.2–0.25 cm, oblong, apex rounded, slightly reflexed. Stamens fused in two pairs, long exserted; anterior filaments 1.8–2.2 cm long, inserted at *c.*1.3 cm from corolla base; posterior filaments 1.7–2 cm long, inserted at *c.* 1.5 cm from corolla base; filaments glandular hairy; anthers *c.* 0.2 × 0.07 cm, narrowly elliptic, grey. Staminode *c.* 0.1 cm long, clavate, inserted *c.* 1.5 cm from corolla base. Disk *c.* 0.1 cm high, 5-crenate. Pistils 2–2.3 cm long; ovary 1.3–1.6 cm long, linear, glabrous; styles 0.5–0.7 cm long, linear, glandular pubescent; stigmas *c.* 0.2 cm across, capitate. Capsules not seen.

Fig. 79. *Aeschynanthus tirapensis* U.C.Bhattach.: **a.** Holotype; **b.** Leaf - abaxial view; **c.** Leaf - adaxial view; **d.** Single flower with pedicel; **e.** Single flower showing stamens & pistil (Images from *G. Panigrahi* 17015A (CAL [CAL000025104]) © BSI. Reproduced with permission).

Flowering & fruiting: Flowering from September to November and fruiting not recorded.

Habitat: A lithophytic herb in cool forest areas.

Distribution: India (GRC, 2024) (Fig. 81).

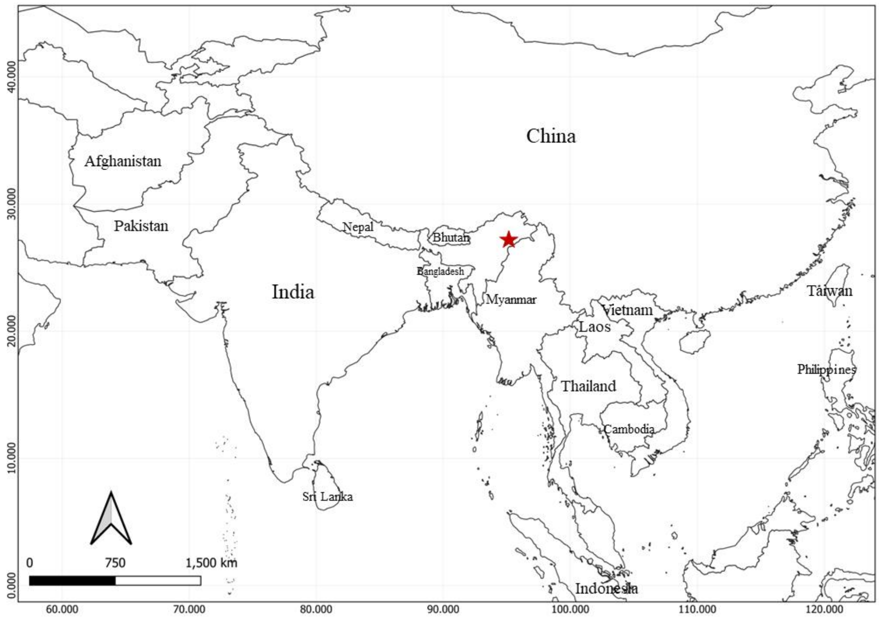


Fig. 80. Distribution of *Aeschynanthus tirapensis* U.C.Bhattach.

Specimen examined: INDIA, **Arunachal Pradesh**, Changlang district, Nampong, 316–1233 m, 12.10.1959, *R.S. Rao* 20157 (CAL [CAL000025107]).

Conservation status: *Aeschynanthus tirapensis* is currently known only from two locations in Arunachal Pradesh. There has been no further data available for the species in nearly 60 years, and no additional collections have been recorded since its type collection. Therefore, the species is provisionally assessed as Data Deficient (DD).

Notes: Until Bhattacharyya (1993) described *A. tirapensis* from the collection of G. Panigrahi, it had been misidentified as *A. masoniae* Kurz ex C.B.Clarke for more than three decades. Apart from the apparent resemblance in leaf shape, *A. tirapensis* has no other similarities with *A. masoniae*.

Aeschynanthus tirapensis was often compared with the widely distributed *A. micranthus* because of its superficial similarity in the climbing or creeping habit. However, it can be differentiated by the size and hairiness of leaves and flowers (Bhattacharyya, 1993).

After the collection of G. Panigrahi in 1958, and R.S. Rao in 1959, no further collections of this species were made. Consequently, the description was based on data from the type sheets and the protologue. Taram (2023) synonymised this species under *A. lineatus*, arguing that the two species differ only in the number of flowers, with no other delimiting characters. However, upon detailed analysis, it was found that *A. tirapensis* possesses leaves with strigose hairs on the abaxial surface (*vs*. glabrous), smaller pedicels (1.2–1.4 cm *vs*. 1.5 – 2.4 cm long), smaller sepals (0.6–0.8 cm *vs*. 1–1.6 cm long), and deciduous bracts (*vs*. persistent). Hence, this species is reinstated here.

20. Aeschynanthus volubilis Jack, Trans. Linn. Soc. London 14: 42. 1823; G.Don, Gen. Hist. 4: 656. 1838; R.Br., Cyrtandreae 115. 1839; Steud., Nomencl. Bot. ed. 2, 1: 32. 1840, *nom. nud*.; R.Br. in Bennett, Pl. Jav. Rar. 115. 1840; D.Dietr., Syn. PI. 3: 581. 1843; A.DC., Prod. 9: 262. 1845; Miq., Fl. Ned. Ind. 2: 719. 1858; C.B.Clarke in A.DC. & C.DC., Monogr. Phan. 5(1): 46. 1883; Merrill, J. Arnold Arb. 33: 214. 1952; Backer & Bakhuizen van den Brink, Fl. Java 2: 524. 1965; B.K.Sinha, Fl. Gt. Nicobar Isl. 329. 1999. *Trichosporum volubile* (Jack) Nees, Flora 8: 144. 1825. *Type*: Jack, Trans. Linn. Soc. London Bot. 14: Pl.2, f. 3. 1823; *Epitype* (designated by Middleton, 2016): **Sumatra**, East Coast (Sumatera Utara), Asahan, Silo Maradja, June 1927, *Bartlett* 8695 (NYBG [NY02218965 digital image!]); isoepi: MICH).

Aeschynanthus obovatus C.B.Clarke in A.DC. & C.DC., Monogr. Phan. 5(1): 47. 1883. *Trichosporum obovatum* (C.B.Clarke) Kuntze, Revis. Gen. Pl. 478. 1891. *Type*: INDONESIA, **Borneo**, Kalimantan, Kalimantan Selatan, Banjarmasin, *s.d.*, *Motley J.* 1158 (K [K001096536!]).

Aeschynanthus hoseanus Kraenzl., J. Linn. Soc. Bot. 37: 284. 1906. *Trichosporum hoseanum* (Kraenzl.) Merr., J. Straits Branch Roy. Asiat. Soc. Spec. No. 530. 1921. *Type*: MALAYSIA, **Borneo**, East Malaysia, Sarawak, Saribas, 24.11.1893, *Haviland G.D. & C. Hose* 3528 (holo K [K001089576!]; iso BM [BM000797673!]).

Figs. 81 & 82

Epiphytic perennial herbs. Stems branched, climbing, straw coloured, glabrous, rooting at nodes. Nodes swollen; internodes 1.5–4.5 cm long. Leaves opposite; petioles 0.5–1 cm long, terete, canaliculated above, glabrous or sparsely puberulent; lamina 2–5.5 × 1–2.5 cm, elliptic or ovate, coriaceous, green above, pale green beneath, apex acute to obtuse, base cuneate to rounded, margins entire, glabrous; midvein sunken adaxially, prominent abaxially; lateral veins 3–5, weakly visible or obscure. Inflorescences pseudoterminal or axillary, 3–4-flowered; peduncles 0.3–0.7 cm long, terete, glabrous. Bracts 0.4–0.5 × 0.2–0.3 cm, widely lanceolate to ovate, apex obtuse, margins entire, to glabrous to sparsely pubescent, nerves obscure, persistent; pedicels 0.5–1 cm long, terete

Fig. 81. *Aeschynanthus volubilis* Jack: **a.** Holotype (Jack, Trans. Linn. Soc. London, Bot. vol. 14, Plate II, fig. 3); **b.** Epitype (NYBG [NY02218965 digital image!]). © The Board of Trustees for the Newyork Botanical Garden. Reproduced with permission.

angular, puberulent. Calyx lobed from above middle; tube 1–1.6 cm long, green; lobes 0.4–0.6 × 0.2–0.3 cm, triangular or elliptic, apex obtuse to rounded, margins entire. glabrous to puberulent. Corolla 2–3 cm long; tube 1.7–2.7 cm long, 0.15–0.2 cm wide at base, gradually widens towards the throat with 0.3–0.35 cm, inflated at middle of upper surface, curved, outside crimson red, puberulent, inside glabrous or sparsely glandular hairy; mouth slightly oblique; lobes red, glandular pubescent, ciliate; upper lobes 0.35–0.4 × 0.2–0.25 cm, oblong, apex obtuse, not reflexed; sinus 0.15–0.2 cm deep; lateral lobes 0.3–0.5 × 0.35–0.4 cm, deltoid, apex obtuse to rounded, reflexed; lower lobes 0.4–0.55 × 0.3–0.4 cm, oblong, apex rounded, reflexed. Stamens fused in two pairs, long exserted; anterior filaments 1.6–1.8 cm long, inserted at 1.4–1.6 cm from corolla base; posterior filaments 1.2–1.3 cm long, inserted at 1.6–1.9 cm from corolla base; filaments glandular hairy; anthers 0.2–0.25 × 0.07–0.1 cm, narrowly elliptic, grey. Staminode *c.* 0.1 cm long, clavate, inserted 1.5–1.8 cm. Disk *c.* 0.1 cm high, 5-crenate. Pistils 2–3 cm long; stipe 0.8–1.2 cm long, glabrous; ovary 1–1.6 cm long, linear, glabrous; styles 0.4–0.8 cm long, linear, glandular puberulent; stigmas *c.* 0.2 cm across, sub-capitate. Capsules 10–28 × 0.2–0.3 cm. Seeds 0.5–0.6 × 0.1–0.2 mm, testa cells papillose, anti-clockwise orientation; apical appendage 0.4–0.8 cm long; hilar appendage a solitary hair, 0.7–0.9 cm long, bubble cells present at base of hilar end, appendages papillose.

Fig. 82. *Aeschynanthus volubilis* Jack: **a.** Habit; **b.** Single flower; **c.** Peduncle & bract; **d.** Corolla - split open - outer view **e.** Corolla - split open - inner view; **f.** Stamen; **g.** Pistil; **h.** Seed (images from *G.C. Matthew s.n.* (K) © Royal Botanic Gardens, Kew. Reproduced with permission).

Flowering & fruiting: Flowering from May to August and fruiting from September to October.

Habitat: An epiphytic herb on large trees.

Distribution: India, Indonesia and Malaysia (GRC, 2024) (Fig. 83).

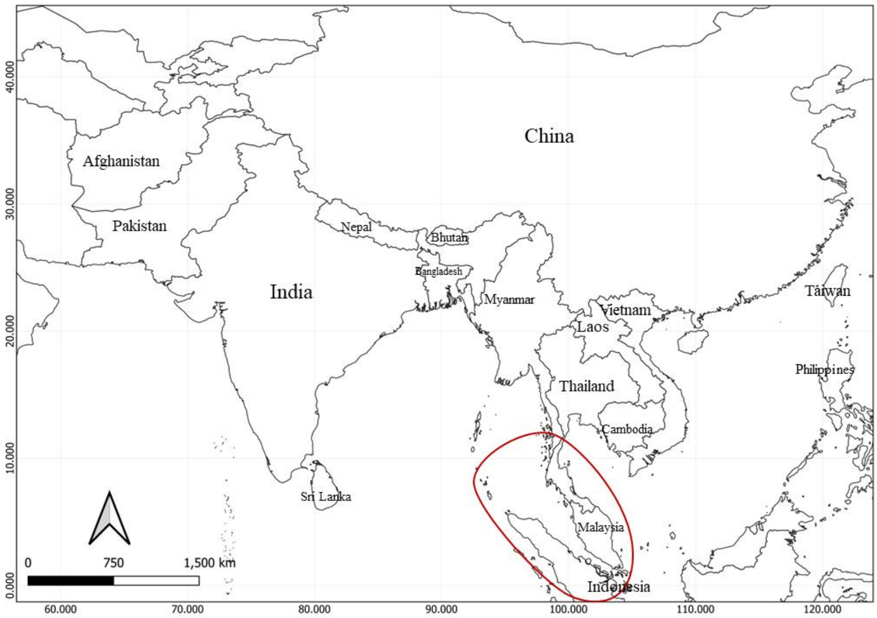


Fig. 83. Distribution of *Aeschynanthus volubilis* Jack

Specimens examined: INDIA, **Andaman and Nicobar Islands**, Great Nicobar Islands, Laful, ±20 m, 08.06.1981, *D.K. Hara* 8759 (CAL, E [E00630469], PBL [PBL0000029941 digital image]); South Nicobars, Mt. Thullier, 30.05.2002, *J. Jayanthi* 19349 (PBL [PBL0000014808 digital image]). INDONESIA, **Sumatra**, *s.loc*., September 1914, *C.G. Matthew s.n.* (K); Tapianoeli, Padang Si Dimpoean, Padang Lawas, 3–14.07.1933, *Rahmat Si Toroes* 4867 (E [E00396178]); Aer Kandis, near Rantau Parapat, Bila, 28.05.1932, *Rahmat Si Toroes* 2597 (E [E00396180]). MALAYSIA, **Penang**, Balik, Pulau, 02.01.1926, *F. Flippance s.n.* (E [E00062943]).

Conservation status: *Aeschynanthus volubilis* is distributed in Nicobar Islands, Indonesia and Malaysia, with an EOO of 11,25,518.280 km^2. Based on current data, the AOO is calculated at 24 km^2. Further explorations of similar habitats in Northeastern India and neighbouring countries are needed to better assess its conservation status. The species is provisionally assessed here as Data Deficient (DD).

Notes: The presence of bubble cells (clusters of inflated cells) at the base of the hilar appendage of the seeds, along with the shallowly lobed calyx, confirms the placement of *A. volubilis* under section *Aeschynanthus*, and it is the only species from this section found in India.

The consultation of herbarium specimens at BM, E, and K, confirmed that *A. obovatus* C.B.Clarke and *A. hoseanus* Kraenzl. Both have sparsely pubescent, elliptic or ovate leaves, and a long calyx tube (1–1.6 cm) with an obtuse apex, similar to *A. volubilis*. Therefore, these names are considered conspecific with *A. volubilis*, which reaffirms the conclusion of Middleton (2016).

CHAPTER- 6

COMPARITIVE MORPHOLOGY

COMPARATIVE MORPHOLOGY

The morphological data of Indian *Aeschynanthus* are consolidated through extensive field explorations and studying specimens at major herbaria in India and abroad (ARUN, ASSAM, BM, BSHC, CAL, CALI, E, & K), as well as consulting digital images from virtual herbaria around the world. Twenty species are documented during the study, viz. *A. acuminatus* Wall. ex A.DC., *A. angustioblongus* W.T.Wang, *A. bracteatus* Wall. ex A.DC., *A. chiritoides* C.B.Clarke, *A. fulgens* Wall. ex R.Br., *A. gracilis* C.S.P.Parish ex C.B.Clarke, *A. hookeri* C.B.Clarke, *A. linearifolius* C.E.C.Fisch., *A. mannii* Kurz ex C.B.Clarke, *A. maoi* Debta & A.Shenoy, *A. micranthus* C.B.Clarke, *A. monetaria* Dunn, *A. parasiticus* (Roxb.) Wall., *A. parviflorus* (D.Don) Spreng., *A. perrottetii* A.DC., *A. reiekensis* Lalhlupuii, S.D.Khomdram & S.D.Yumkham, *A. stenosepalus* J.Anthony, *A. superbus* C.B.Clarke, *A. tirapensis* U.C.Bhattach., *A. volubilis* Jack. and the findings are discussed here.

Habit

All species are primarily epiphytic, found rooted in the moist, mulchy branch clefts or moss-dominated tree trunks and branches, or in association with epiphytic fern roots on medium to large-sized trees. Under suitable conditions become, some species can also grow as lithophytes (Burtt & Woods, 1975). Eight species are strictly epiphytic (*A. angustioblongus*, *A. fulgens*, *A. hookeri*, *A. mannii*, *A. monetarius*, *A. reiekensis*, *A. tirapensis*, and *A. volubilis*), while the remaining species display both epiphytic as well as lithophytic habits.

Generally, the branches exhibit a pronounced arching or pendulous growth habit, as seen in *A. acuminatus*, *A. bracteatus*, *A. fulgens*, *A. hookeri*, *A. linearifolius*, *A. maoi*, *A. parasiticus*, *A. parviflorus*, *A. perrottetii*, *A. reiekensis*, and *A. stenosepalus*. *Aeschynanthus superbus* displays a suffruticose habit with gregarious branch growth. Species with relatively weaker stems, such as *A. chiritoides*, *A. fulgens*, *A. gracilis*, *A. hookeri*, *A. micranthus*, *A. monetarius*, *A. tirapensis*, and *A. volubilis* tend to exhibit a strict hanging or creeping habit. These species produce prominent adventitious roots that allow them to creep or climb along tree trunks or branches effectively.

Aeschynanthus mannii is the only Indian species with erect habit, however, as the branch length increases, it may assume an arching habit. In contrast, species of the *A. andersonii* group (comprising *A. andersonii*, *A. persimilis* and *A. humilis*), found in South China, Myanmar and North Thailand region, also display erect habit. In this group, the roots penetrate deep into the bark of the host tree, functioning as a hemi-parasite (Middleton, 2007). However, in *A. mannii*, the roots only superficially expand along the branches, providing support but not acting as a hemi-parasite.

Leaves

The leaves are generally opposite, although they can occasionally be ternate, as in *A. chiritoides* and *A. mannii*. A verticillate or whorled phyllotaxy is exhibited by species such as *A. speciosus* from Thailand, *A. angustifolius* from Malaysia, and the *A. andersonii* group, but has not been reported in any Indian species.

In most cases, the opposite leaves arise in a decussate manner, but as branches mature and twist, the leaf arrangement changes to a distichous condition. This decussate arrangement remains visible even at later stages in *A. maoii*. In *A. mannii*, the leaves are densely crowded near the branch apex, resulting in an obscure leaf arrangement, similar to that of the *A. andersonii* group.

The leaves are simple and typically equal in size in opposite pairs. Sessile leaves are rare in Indian species, occurring only in *A. gracilis* and *A. mannii*. The laminae are generally thick, fleshy, and coriaceous, although in *A. bracteatus* and *A. mannii*, the leaves are not as fleshy, being somewhat thin and dry. In *A. parasiticus*, *A. parviflorus*, and *A. perrottetii*, several purple blotches are present on the leaves, likely due to the presence of phenolic compounds.

The size and shape of the lamina vary both between species and within taxa (Fig. 84). In India, *A. monetarius* has very small, orbicular or discoid leaves, about 1.2 cm diameter, while *A. superbus* has much larger leaves, measuring up to 22 × 10 cm, and are elliptic to widely ovate in shape. *A. reiekensis* has very narrow leaves (0.3–0.6 cm wide), with a linear or narrowly elliptic shape. For the widely distributed *A. parviflorus*, the leaf shape varies from linear lanceolate to elliptic lanceolate, and for *A. parasiticus* from linear lanceolate or elliptic to ovate. *A. perrottetii* also shows considerable variation, with leaf shape ranging from narrow elliptic to elliptic-lanceolate or ovate-elliptic.

In contrast, some Malaysian and Thai species, such as *A. cambodiensis*, *A. longicaulis*, *A. mendumiae*, *A. poilanei*, and *A. fecundus* have marbled leaves, which can be considered as a distinguishing feature (Middleton, 2007). However, marbled leaves were not found in any species occurring in India.

The leaf apex varies considerably, ranging from round (*A. monetarius*) to acuminate (*A. acuminatus, A. bracteatus, A. fulgens, A. hookeri, A. linearifolius, A. micranthus, A. parasiticus, A. parviflorus, A. perrottetii, A. reiekensis*, and *A. superbus*) or caudate (*A. bracteatus, A. linearifolius*). The leaf base can be attenuate to rounded. Most Indian species exhibit entire leaf margins, though some may be sub-entire or undulate (*A. gracilis, A. parasiticus, A. parviflorus, A. perrottetii*, and *A. reiekensis*) or weakly dentate as in *A. chiritoides*. The mid vein is prominent on the abaxial surface of all Indian species except for *A. monetarius*. Due to the fleshy nature of the leaves, lateral nerves are weakly visible or are obscure.

Leaf hairiness is a key characteristic for species delineation. While most Indian species have glabrous leaves, notable hairiness is found in herbaceous, hanging or creeping species like *A. chiritoides* and *A. gracilis*. *Aeschynanthus chiritoides* leaves are pilose on both surfaces, whereas *A. gracilis* has almost glabrous adaxial surface. *Aeschynanthus tirapensis* is strigose hairy on the abaxial surface, a key feature that separate it from *A. micranthus*.

Inflorescences

Of the 20 Indian species studied, *A. angustioblongus, A. gracilis, A. mannii, A. monetarius*, and *A. tirapensis* have strictly solitary, non-pedunculate flowers, born in the axillary position (Fig. 85). *Aeschynanthus chiritoides, A. micranthus, A. perrottetii*, and *A. reiekensis* typically have single flowers in either axillary or terminal positions, though occasionally these may form a cyme with more than one flower. In *A. fulgens*, *A. hookeri*, *A. parasiticus* and *A. parviflorus* flowers are usually born in pseudoterminal or axillary clusters, with a single or pair of flowers occasionally present. *Aeschynanthus acuminatus*, *A. bracteatus*, *A. linearifolius*, *A. stenosepalus*, *A. superbus*, and *A. volubilis* are characterised by distinct pedunculate inflorescences, while in *A. maoi*, the peduncle may be absent or very short (0.2–0.8 cm long).

Bracts are prominent in some species of *Aeschynanthus* in India (Fig. 86), including *A. acuminatus* (ovate to widely ovate), *A. bracteatus* (elliptic or ovate), *A. maoi* (boat-shaped), *A. parasiticus* (elliptic to lanceolate), *A. superbus* (ovate or elliptic), and *A. volubilis* (widely lanceolate to ovate). Among these, *A. bracteatus* and *A. superbus* are notable for their brightly coloured bracts, ranging from pink to red. In *A. linearifolius*, instead of bracts, bracteoles are prominent, with an ovate lanceolate shape and a reddish green colour.

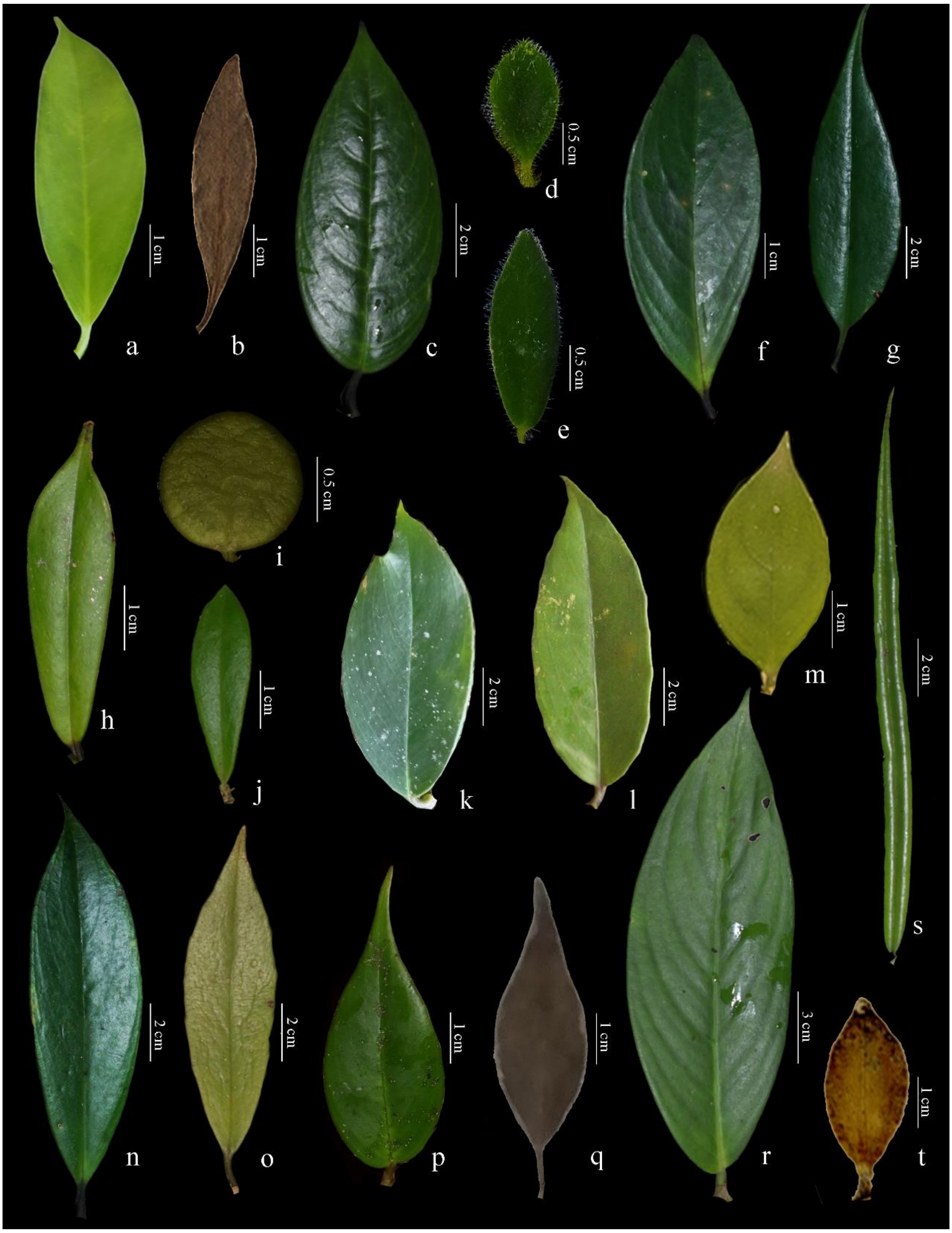


Fig. 84. Leaves of *Aeschynanthus* Jack: **a.** *A. acuminatus*; **b.** *A. angustioblongus*; **c.** *A. bracteatus*; **d.** *A. chiritoides*; **e.** *A. gracilis*; **f.** *A. fulgens*; **g.** *A. hookeri*; **h.** *A. linearifolius*; **i.** *A. monetaria*; **j.** *A. mannii*; **k.** *A. maoi*; **l.** *A. parasiticus*; **m.** *A. micranthus*; **n.** *A. parviflorus*; **o.** *A. perrottetii*; **p.** *A. stenosepalus*; **q.** *A. tirapensis*; **r.** *A. superbus*; **s.** *A. reiekensis*; **t.** *A. volubilis*. (Scale bar = 1 cm)

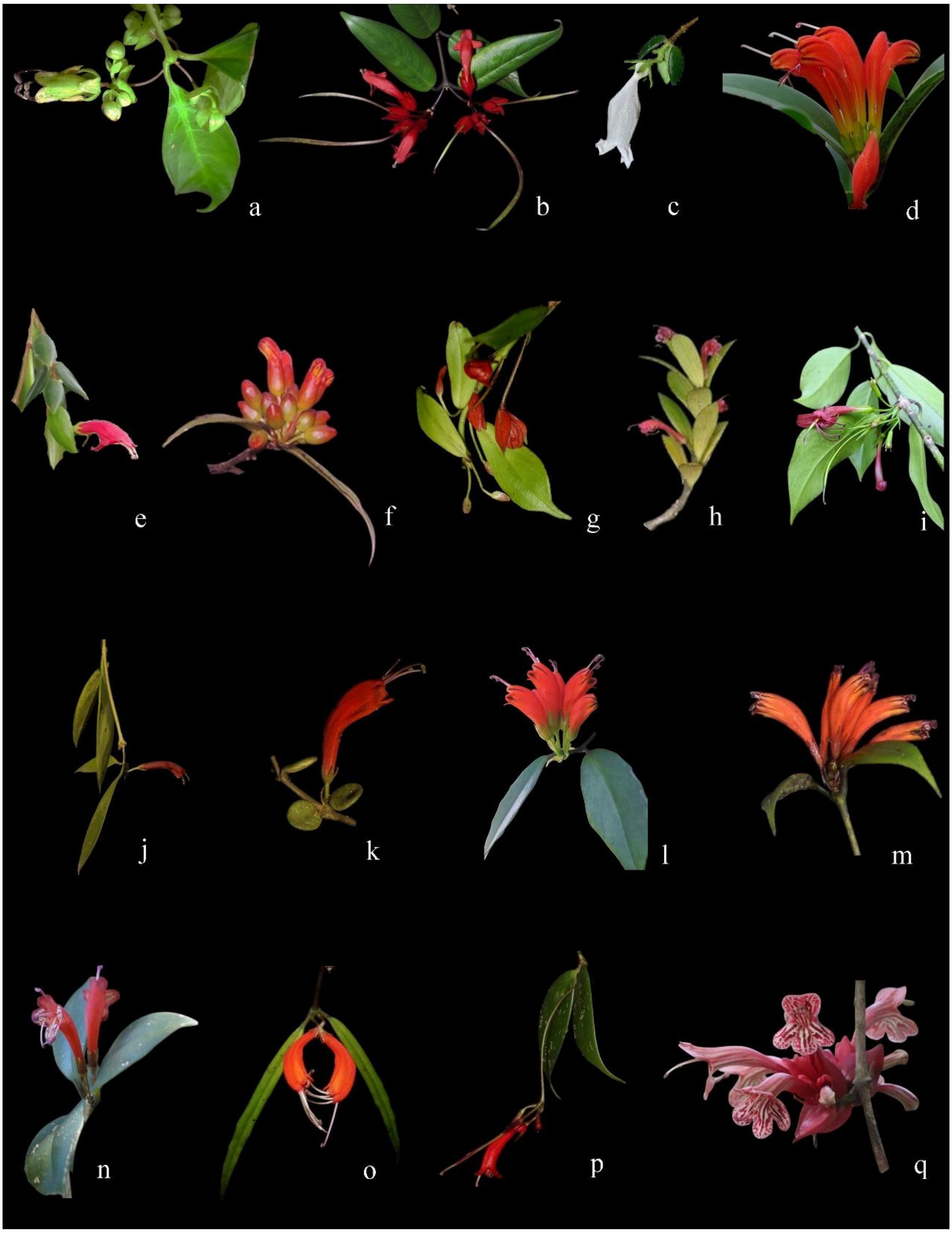


Fig. 85. Inflorescence of *Aeschynanthus* Jack: **a.** *A. acuminatus*; **b.** *A. bracteatus*; **c.** *A. chiritoides*; **d.** *A. fulgens*; **e.** *A.gracilis*; **f.** *A. hookeri*; **g.** *A. linearifolius*; **h.** *A. mannii*; **i.** *A. maoi*; **j.** *A. micranthus*; **k.** *A. monetaria*; **l.** *A. parasiticus*; **m.** *A. parviflorus*; **n.** *A. perrottetii*; **o.** *A. reiekensis*; **p.** *A. stenosepalus*; **q.** *A. superbus*.

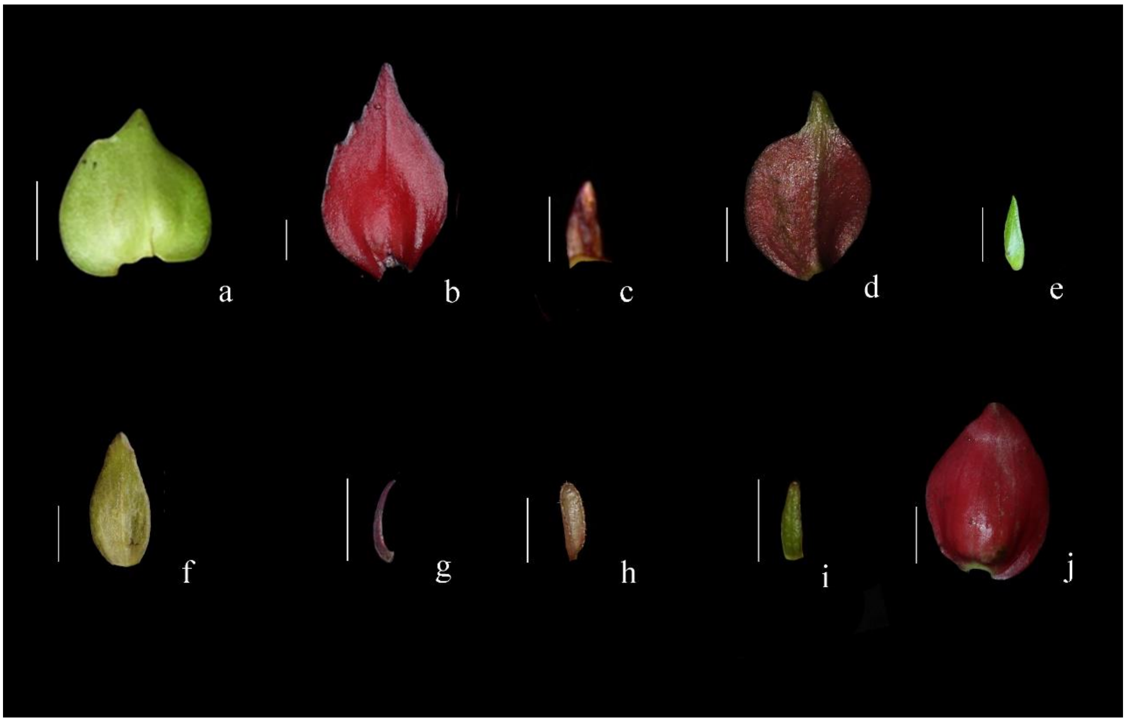


Fig. 86. Bracts of *Aeschynanthus* Jack: **a.** *A. acuminatus*; **b.** *A. bracteatus*; **c.** *A. hookeri*; **d.** *A. linearifolius*; **e.** *A.maoi*; **f.** *A. parasiticus*; **g.** *A. parviflorus*; **h.** *A. perrottetii*; **i.** *A. stenosepalus*; **j.** *A. superbus*. (Scale bar = 0.5 cm)

Flowers

All flowers are bisexual, zygomorphic, pedicellate and protandrous. The length of the pedicel varies from 0.3 cm (as in *A. chiritoides* and *A. mannii*) to 2.5 cm (as in *A. gracilis*). Pedicels are typically angular, though they can be terete in species such as *A. chiritoides, A. gracilis*, and *A. linearifolius*. Most species have glabrous pedicels, while others such as *A. chiritoides, A. fulgens*, *A. gracilis*, *A. mannii*, *A. monetarius, A. parviflorus, A. tirapensis,* and *A. volubilis* show varying degrees of hairiness. The twisting of pedicels is a common feature observed in nearly all species, helping to position the flowers within the inflorescence, facilitating pollinator access.

Calyx

The five sepals of the calyx may be either free or fused to varying levels, serving as an important species delineation character (Fig. 87). About 70% of Indian species have free sepals, with four species (*A. linearifolius*, *A. mannii*, *A. perrottetii*, and *A. reiekensis*) occasionally showing slight fusion at the base. In *A. fulgens*, *A. hookeri*, and *A. volubilis*, the calyx lobes are fused for 75–90% of their length, forming a distinct tubular structure. In *A. bracteatus*, fusion occurs in less than 25% of the calyx length, though the aestivation of calyx gives the appearance of about 50% fusion.

The closely related species *A. parviflorus* and *A. parasiticus* can often be distinguished by the extent of fusion of calyx lobes, though this can sometimes be difficult. In *A. parasiticus*, the calyx lobes typically start to separate from the middle or above middle, while in *A. parviflorus*, the lobation begins at 15–20% of the calyx length or may extend to the middle or beyond. In these cases, the hairiness of the calyx can help differentiate the species: in *A. parasiticus*, the calyx lobes are always glabrous, while in *A. parviflorus*, the calyx may show varying degrees of pubescence or occasionally be glabrous.

Other species with pubescent calyces include *A. chiritoides, A. gracilis, A. monetarius,* and *A. volubilis*. In contrast, *A. micranthus* and *A. perrottetii* show a slightly ciliate condition at the tips of the sepals, with very few eglandular hairs. *Aeschynanthus angustioblongus* has hairy sepals on the inner side, while in all other species, the ventral side of the calyx is glabrous.

The shape of the sepals varies from linear to triangular, lanceolate to elliptic, or oblong, with apices generally acute to acuminate, though sometimes obtuse to rounded, as in *A. acuminatus*, *A. hookeri*, *A. linearifolius*, *A. superbus*, and *A. volubilis*. The colour is usually pale green to green, but can vary widely across species, ranging from green to various shades of yellow, red, maroon, brown, or purple, as seen in *A. acuminatus*, *A. fulgens*, *A. monetarius*, *A. parasiticus*, *A. parviflorus*, *A. perrottetii*, *A. reiekensis*, and *A. stenosepalus*. In species such as *A. bracteatus*, *A. linearifolius,* and *A. superbus*, the sepals are petaloid, displaying bright red or pink hues. *Aeschynanthus hookeri* also has a red or purple calyx, which can help distinguish it from *A. parasiticus*.

The size of the calyx is not a consistent character, even within a single species. Field observations, for example, have shown that *A. perrottetii* can have calyces of varying length on different branches of the same plant, one with sepals 0.2 cm long and another with 0.8 cm long sepals.

A unique feature of *A. acuminatus* is its reflexed calyx lobes, which have not been observed in any other Indian species. In *A. volubilis*, the calyx develops prior to the corolla and serve as a "water calyx" providing a miniature water bath to help the developing buds survive desiccation during drought (Burtt & Woods, 1975) or to prevent herbivory (Carlson & Harms, 2007). Most species in the section *Aeschynanthus*, such as *A. javanicus, A. obconicus, A. pulcher, A. radicans, A. tricolor*, etc. exhibit this type of calyx. In species like *A. wallichii* (Malaya - Sumatra) and *A. rejieae* (Philippine), the calyx lobes are fused and form a wide-open cup, while in *A. chrysanthus* (Sumatra), yellow calyx lobes surpass the length of the corolla, which are not found in Indian species.

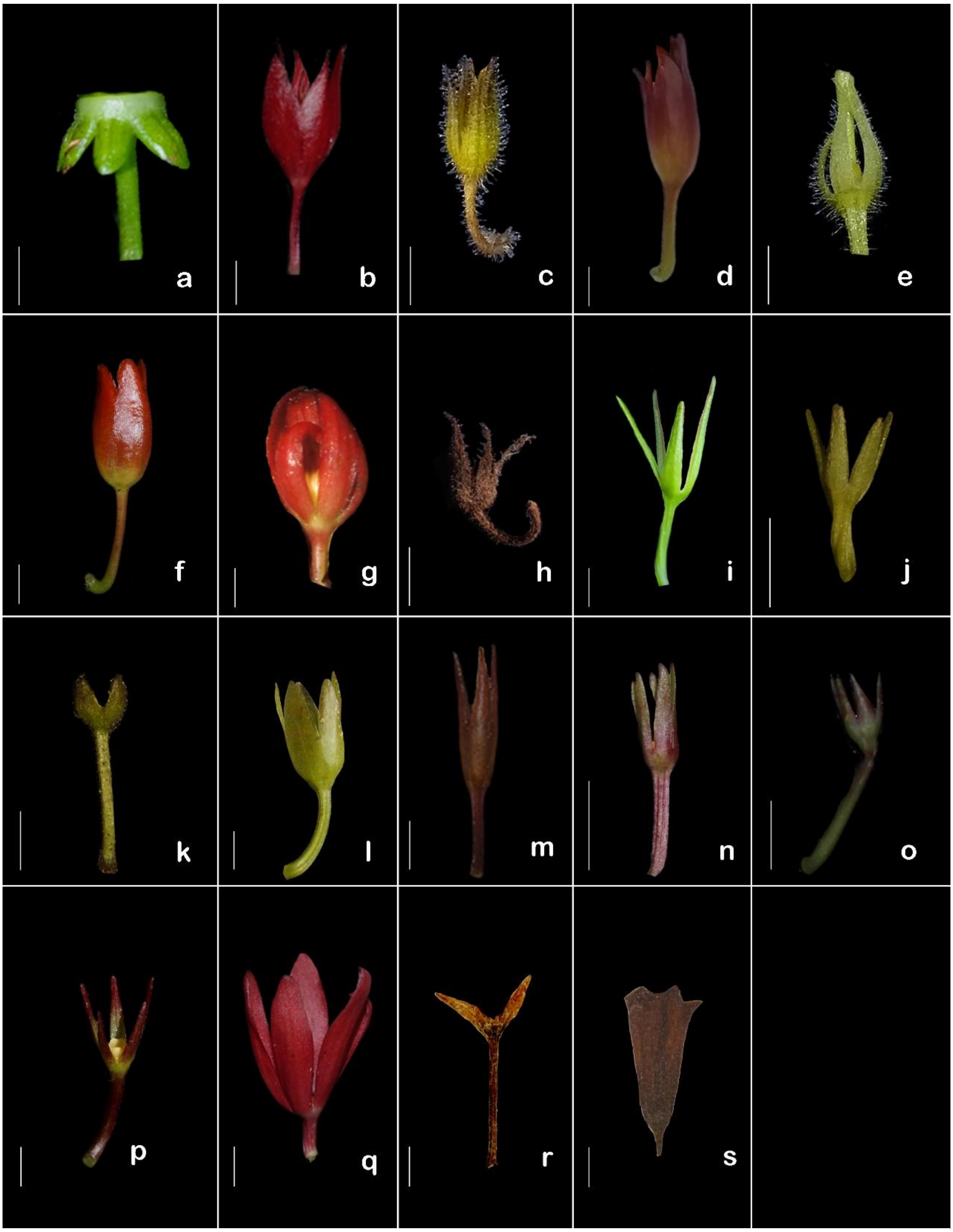


Fig. 87. Calyx of *Aeschynanthus* Jack: **a.** *A. acuminatus*; **b.** *A. bracteatus*; **c.** *A. chiritoides*; **d.** *A. fulgens*; **e.** *A.gracilis*; **f.** *A. hookeri*; **g.** *A. linearifolius*; **h.** *A. mannii*; **i.** *A. maoi*; **j.** *A. micranthus*; **k.** *A. monetaria*; **l.** *A. parasiticus*; **m.** *A. parviflorus*; **n.** *A. perrottetii*; **o.** *A. reiekensis*; **p.** *A. stenosepalus*; **q.** *A. superbus*; **r.** *A. tirapensis*; **s.** *A. volubilis*. (Scale bar = 0.5 cm)

Corolla

As a general feature of gamopetalous flowers, in *Aeschynanthus*, the five petals are united at the base, forming a long, narrow tube with free, bi-lipped lobes in a 2+3 arrangement (Figs. 88 & 89). An exception is *A. chiritoides,* which has a somewhat bulged corolla tube, resembling that of the genus *Chirita* (= *Henckelia*). The base of the corolla tube is usually narrow but can be broad, as seen in *A. acuminatus* and *A. gracilis*, or gibbous at the base and then tapering into the tube, as in *A. stenosepalus*. The size of the corolla can vary significantly within a species. For instance, in *A. parasiticus,* the corolla ranges from 3.5 to 6 cm long, while in *A. perrottetii,* it ranges from 2 to 6.2 cm long. *Aeschynanthus acuminatus* (1.4–2.5 cm long) and *A. mannii* (2–2.5 cm long) have smaller corolla, while *A. superbus* has the largest, measuring 6 to 8.5 cm long.

For species such as *A. acuminatus*, *A. gracilis*, and *A. maoi*, the corolla mouth is oblique, with highly reflexed lateral and lower lobes. Corolla colour is a useful characteristic for species differentiation, although it can be difficult to describe accurately due to the wide range of shades (Middleton, 2007). Generally, *Aeschynanthus* species have brightly coloured corolla in shades of orange or red, which attract bird pollinators. However, in species like *A. acuminatus*, the corolla may be green, and in *A. chiritoides,* it can be white or light yellow. Bright yellow corolla is seen in the Sumatran species *A. chrysanthus* and the Malaysian species *A. angustifolius* and *A. dischidioides*. *Aeschynanthus albidus* and *A. longicaulis* from Malaysiaalso has green corolla similar to those of *A. acuminatus* in India.

The corolla lobes in many species are marked with dark striations or markings, both inside and outside, though this feature is not consistent across all species. All Indian species have hairiness on the outer surface of the corolla, particularly around the rims of the lobes, while the inner corolla is almost always glabrous. A distinctive feature of *A. parasiticus* is the presence of multicellular coarse hairs on the inside of the corolla basally, which is a key characteristic for distinguishing it from the closely allied *A. parviflorus*. Similarly, the newly described *A. reikensis*, also has these multicellular hairs, making it distinguishable from its Chinese counterpart *A. tengchungensis*.

Fig. 88. Corolla of *Aeschynanthus* Jack: **a.** *A. acuminatus*; **b.** *A. angustioblongus*; **c.** *A. bracteatus*; **d.** *A. chiritoides*; **e.** *A. fulgens*; **f.** *A.gracilis*; **g.** *A. hookeri*; **h.** *A. linearifolius*; **i.** *A. mannii*; **j.** *A. maoi*; **k.** *A. micranthus*; **l.** *A. monetaria*; **m.** *A. parasiticus*; **n.** *A. parviflorus*; **o.** *A. perrottetii*; **p.** *A. reiekensis*; **q.** *A. stenosepalus*; **r.** *A. superbus*; **s.** *A. tirapensis*; **t.** *A. volubilis*. (Scale bar = 1 cm)

Fig. 89. Corolla split-open of *Aeschynanthus* Jack: **a.** *A. acuminatus*; **b.** *A. bracteatus*; **c.** *A. chiritoides*; **d.** *A. fulgens*; **e.** *A.gracilis*; **f.** *A. hookeri*; **g.** *A. maoi*; **h.** *A. micranthus*; **i.** *A. monetaria*; **j.** *A. parasiticus*; **k.** *A. parviflorus*; **l.** *A. perrottetii*; **m.** *A. reiekensis*; **n.** *A. stenosepalus*; **o.** *A superbus*. (Scale bar = 1 cm)

Stamens

The four stamens are generally fused in pairs by their anther apices (Fig. 90). However, in *A. chiritoides* and the recently described Chinese species *A. smaragdinus*, all four stamens are coherent. The stamens typically display a slight didynamous condition, with two stamens positioned just above the other. As a protandrous flower, the stamens mature before the pistil, which is well exserted and straight positioning. In contrast, *A. chiritoides* and *A. linearifolius* consistently have included stamens, and in *A. stenosepalous*, the stamens are positioned at or just above the mouth of the corolla.

Among the species, *A. chiritoides* has the smallest filament, while *A. superbus* has the largest filament. The fifth stamen is abortive, represented by a staminode that is usually very small (0.1–0.4 cm long) and usually with a clavate shape. In *A. maoi*, the staminode is turbinate, which is one of its major distinguishing characters. The anthers in most species are elliptic or oblong, with a yellow or grey colour.

Pollen

Pollen grains are generally yellow, cream or grey in colour. There are no distinct features for species delineation based solely pollen, except for slight variations in size. The pollen is generally spheroidal, tricolpate or tricolporoidate, with long apertures and perforate sculpturing (see chapter 09).

Pistils

After the stamens wither, the pistils enlarge, and the at maturation, well exserted from the corolla tube, though it is difficult to determine whether they have fully matured, making pistil size unreliable for species identification (Fig. 91).

A prominent disk is a characteristic feature of the genus, which is annular or 5-crenate, with a height of 0.1–0.3 cm. In *A. gracilis*, the disc is crenate but irregular in shape. The ovary extends to the base with a sterile stipe, and its size varies with flower development. Generally, the ovary is green, greenish-yellow, or white, and is glabrous or covered with many sessile glands. Glandular hairs are present in *A. bracteatus*, *A. chiritoides*, *A. gracilis*, *A. linearifolius*, *A. mannii*, *A. monetarius*, and *A. parviflorus*.

The styles are usually glandular pubescent, except in *A. acuminatus*, where they are glabrous. The stigma is generally capitate or sub-capitate, though in *A. linearifolius*, it is notched or funnel shaped.

Capsules

The size of the capsules varies significantly, ranging from 6 cm in *A. chiritoides* to 40 cm in *A. fulgens* and *A. superbus*. The basal portion of the capsule features a stipe, which is exceptionally long in some species, such as *A. micranthus* and *A. perrottetii* (Fig. 92)

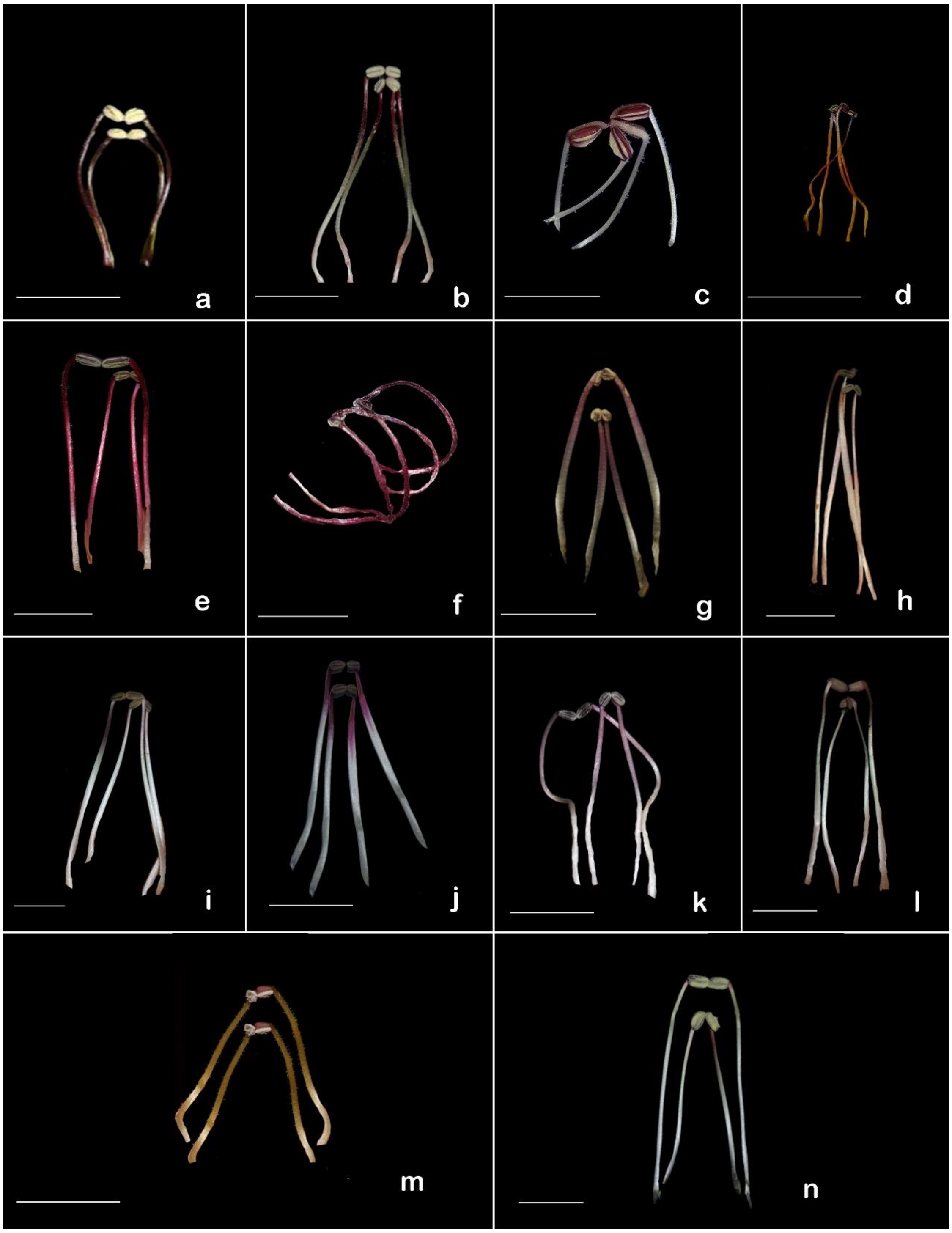


Fig. 90. Stamen of *Aeschynanthus* Jack: **a.** *A. acuminatus*; **b.** *A. bracteatus*; **c.** *A. chiritoides*; **d.** *A. gracilis*; **e.** *A. hookeri*; **f.** *A. maoi*; **g.** *A. micranthus*; **h.** *A. monetaria*; **i.** *A. parasiticus*; **j.** *A. parviflorus*; **k.** *A. perrottetii*; **l.** *A. reiekensis*; **m.** *A. stenosepalus*; **n.** *A superbus*. (Scale bar = 1 cm)

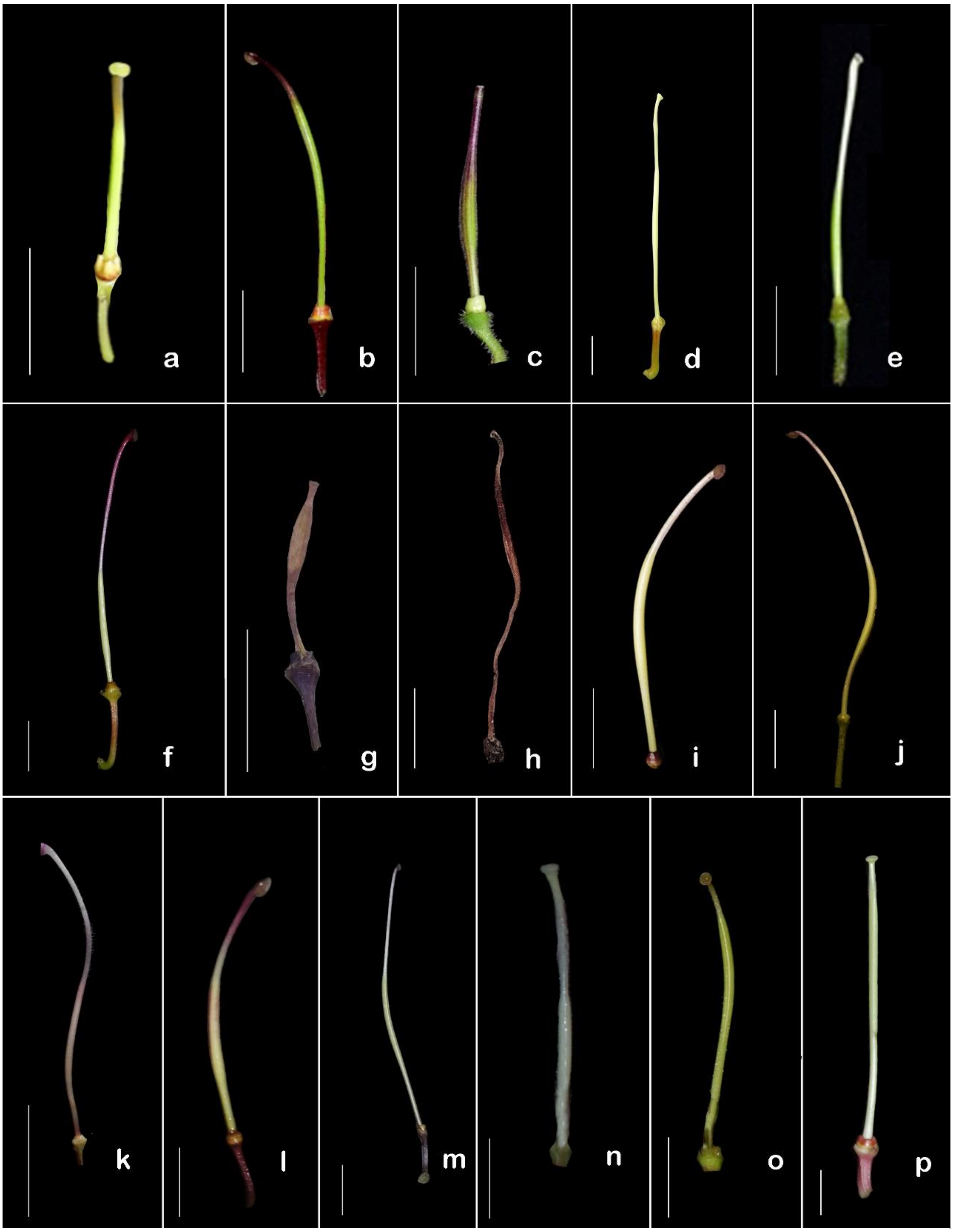


Fig. 91. Pistil of *Aeschynanthus* Jack: **a.** *A. acuminatus*; **b.** *A. bracteatus*; **c.** *A. chiritoides*; **d.** *A. fulgens*; **e.** *A.gracilis*; **f.** *A. hookeri*; **g.** *A. linearifolius*; **h.** *A. maoi*; **i.** *A. micranthus*; **j.** *A. monetaria*; **k.** *A. parasiticus*; **l.** *A. parviflorus*; **m.** *A. perrottetii*; **n.** *A. reiekensis*; **o.** *A. stenosepalus*; **p.** *A superbus*. (Scale bar = 1 cm)

Fig. 92. Capsules of *Aeschynanthus* Jack: **a.** *A. acuminatus*; **b.** *A. bracteatus*; **c.** *A. chiritoides*; **d.** *A. gracilis*; **e.** *A. hookeri*; **f.** *A. linearifolius*; **g.** *A. mannii*; **h.** *A. micranthus*; **i.** *A. parasiticus*; **j.** *A. parviflorus*; **k.** *A. perrottetii*; **l.** *A. stenosepalus*; **m.** *A. superbus* (Scale bar = 1 cm)

Seeds

The seeds are characterised by a central cylindrical seed grain with appendages at both the apical and hilar ends. In all species, generally there is a single apical appendage, while the number of hilar appendages can range from 1 to 2 or 2 to 4. In the 17 species studied for the seed morphology, 13 species (*A. acuminatus*, *A. bracteatus*, *A. charities*, *A. fulgens*, *A. gracilis*, *A. linearifolius*, *A. mannii*, *A. maoi*, *A. micranthus*, *A. perrottetii*, *A. stenosepalus*, *A. superbus*, and *A. volubilis*) have a single hilar appendage, while three species (*A. hookeri*, *A. parasiticus*, and *A. parviflorus*) have two hilar appendages, and *A. reiekensis* has 2–4 hilar appendages. So far, no Indian species have been reported with more than five hilar appendages.

Among the species studied, *A. reiekensis* has the smallest seed grain (0.25–0.65 × 0.05–0.18 mm), while *A. manni* has the largest seed grain (1.5–2 × 0.2–0.4 mm). *Aeschynanthus linearifolius* has the shortest apical (0.15–0.17 cm) and hilar (0.13–0.15) appendages. In contrast, *A. mannii*, *A. parasiticus*, *A. parviflorus*, and *A. reiekensis* have the longest apical appendages, reaching up to 3.5 cm, and *A. manni* has the longest hilar appendages, measuring up to 3.8 cm (see chapter 09).

CHAPTER- 7
SEED MICROMORPHOLOGY

SEED MICROMORPHOLOGY

Seed refers to the fertilized ovule and its associated structures (Harper *et al.*, 1970), which enhance the chances of successful establishment, followed by diversification and local adaptation by spreading farther and lasting longer, exposing them to a wider range of environmental conditions (Donohue *et al.*, 2010). *Aeschynanthus* seeds exhibit an exceptionally broad range of secondary cell modifications (Beaufort-Murphy, 1983), consisting of a central small seed body with a papillose or warty surface, a single apical appendage pointing towards the base of the capsule, and one or more hilar appendages pointing toward the apex. Both the appendages are generally long, filiform hairs (or short and stout in some species) and are likely aiding wind dispersal, while also helping to anchor the seed on wet branches in the tree canopy. The number and type of hilar appendages, the structure of the papillae, the orientation of the testa cells, and the nature of the papillae on the testa are significant characteristics for infrageneric classification.

Mendum *et al*. (2001), based on SEM data, classified the seeds into two categories: 'Type A', where papillae are formed by the raised portion of a single cell (papillose), with the testa cells oriented spirally (either clockwise or anticlockwise) and short smooth appendages; and 'Type B' where papillae result from the fusion of the raised ends of two adjacent cells (warty), with the testa cell oriented straight and long slender papillose appendages. Each type was further subdivided into subtypes and groups to aid in the classification of species. A brief summary of the sectional assignment of species based on seed type is given in Fig. 93.

Materials and methods

Seeds were collected from mature capsules of both live and herbarium samples. The number of hailar appendages was confirmed by examining a large number of seeds from mature capsules of different accessions of each taxon, using needles, forceps, and hand lenses. To obtain precise morphological data and measure the length of the appendages, at least ten seeds were randomly selected from different capsules and observed by both light and scanning electron microscope. Full-size images were captured with an EOS 77D DSLR camera (Canon, Tokyo, Japan) or using ZEN 2.3 lite software equipped with Stemi 508 stereo microscope (Zeiss, Jena, Germany) affixed with an Axiocam 105 colour camera (Zeiss, Jena, Germany) (for small appendaged seeds)

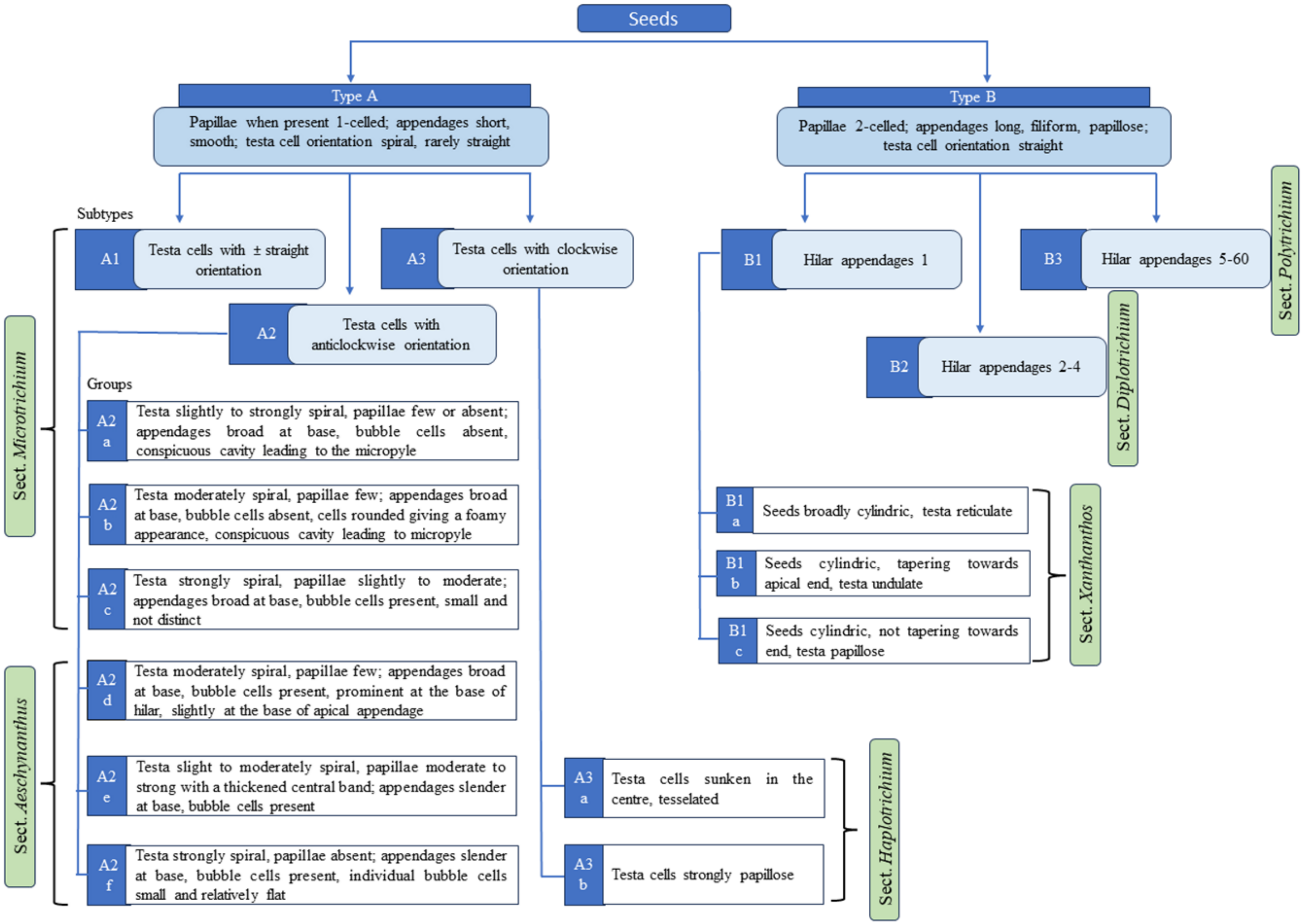


Fig. 93. Schematic representation of the sectional assignment of the species based on the seed type

Samples of 15 species were analysed through scanning electron microscope. Ripe seeds were wrap up in butter paper and dehydrated at 45^0C overnight in a hot air oven. After dehydration, the samples were mounted onto aluminium stubs using carbon tape, then sputter coated with gold and palladium using SC7620 Sputter Coater (Quorum, East Sussex, UK). For each sample, images of the testa cells, apical appendages, and hilar appendage(s) were captured using a Gemini 300 FESEM (Zeiss, Wetzlar, Germany) at 2 kV voltage and an 8.2 mm working distance, at the Central Sophisticated Instrument Facility (CSIF), University of Calicut. The terminology followed Beaufort-Murphy (1983) and Mendum *et al.* (2001).

Results

In the present study, the seed characteristics of 17 species were analysed, of which, data for two species (*A. chiritoides* and *A. fulgens*) were procured from Mendum *et al*. (2001). Since data for *A. angustioblongus*, *A. monetaria* and *A. tirapensis* were not available, these species were excluded from the analysis.

1. Sect. Aeschynanthus

Aeschynanthus volubilis **Fig. 94**

Seeds 0.5–0.6 × 0.1–0.2 mm; testa cells papillose, towards the end, central band thick, oriented slightly anti-clockwise; apical appendage 0.4–0.8 cm long; hilar appendage a solitary hair, 0.7–0.9 cm long, bubble cells present at base; appendages slender, papillose.

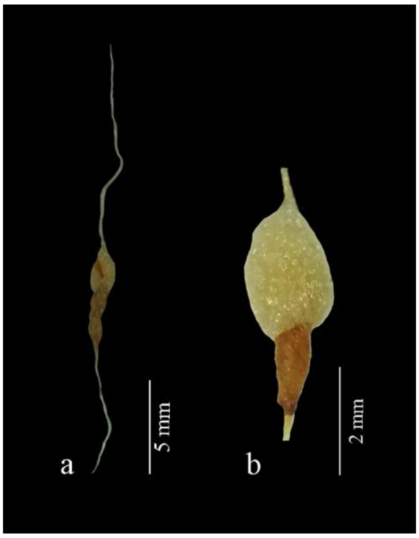


Fig. 94. *Aeschynanthus volubilis* Jack: **a.** Seed **b.** Bubble cells.

2. Sect. Haplotrichium

Aeschynanthus acuminatus **Fig. 95**

Seeds 0.7–1.4 × 0.2 mm; testa cells sunken at the centre, tessellated, edges slightly raised, not papillose, oriented slightly to moderately clockwise; apical appendage 2.9–3.7 mm long; hilar appendage a solitary hair, 3–3.2 mm long; appendages not papillose.

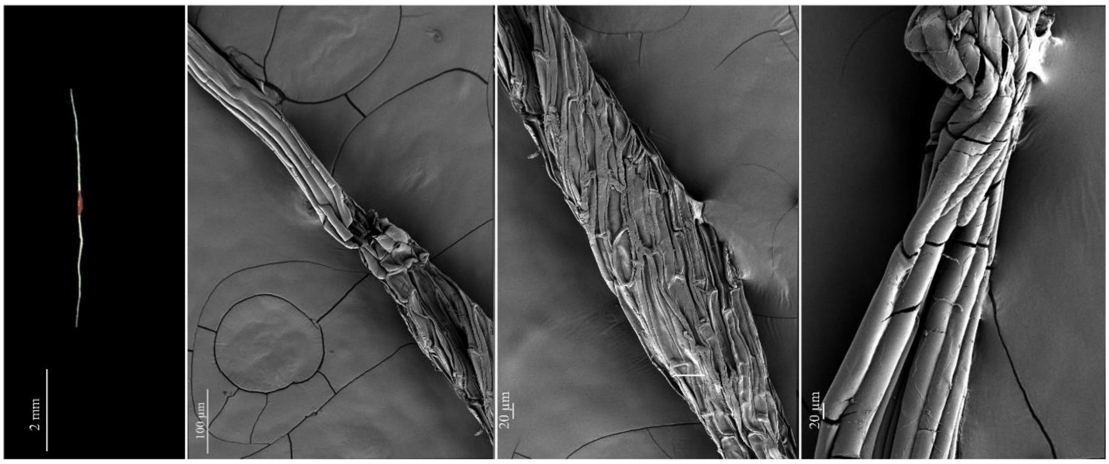


Fig. 95. *Aeschynanthus acuminatus* Wall. ex A.DC.: From left to right, Seed-full image; Hilar appendage; Seed grain showing testa cells; Apical appendage.

Aeschynanthus superbus **Fig. 96**

Seeds 0.8–1.2 × 0.2–0.25 mm; testa cells papillose, towards the end, oriented slightly to moderately clockwise; apical appendage 4.5–7.5 mm long; hilar appendage a solitary hair, 4.5–6.4 mm long; appendages not papillose.

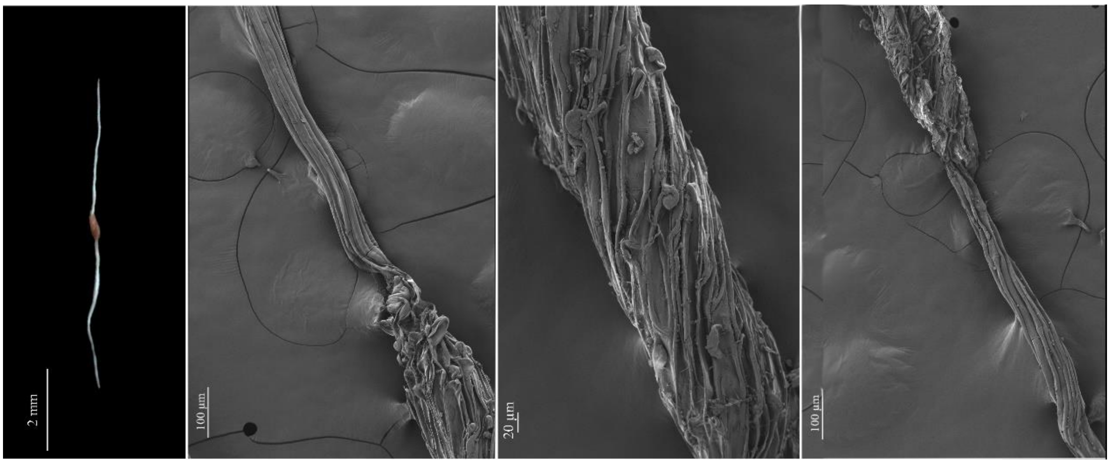


Fig. 96. *Aeschynanthus superbus* C.B.Clarke: From left to right, Seed-full image; Hilar appendage; Seed grain showing testa cells; Apical appendage.

Aeschynanthus bracteatus **Fig. 97**

Seeds 0.8–1.5 × 0.2–0.25 mm; testa cells strongly papillose towards the end of the cell, oriented slightly to moderately clockwise; apical appendage 2.5–3.5 mm long; hilar appendage a solitary hair, 2.5–3.8 mm long; appendages slightly papillose; papillae originate from single cell.

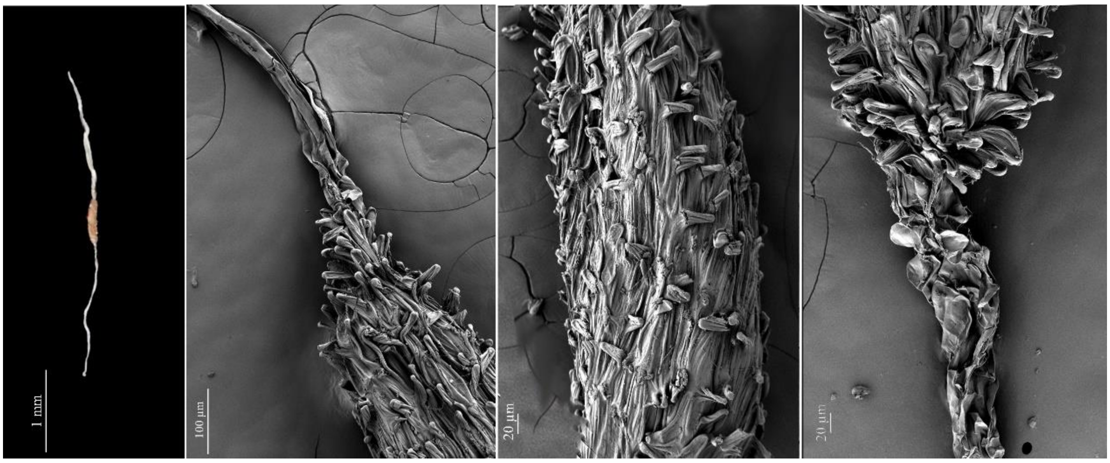


Fig. 97. *Aeschynanthus bracteatus* Wall. ex A.DC.: From left to right, Seed-full image; Hilar appendage; Seed grain showing testa cells; Apical appendage.

Aeschynanthus linearifolius **Fig. 98**

Seeds 1.3–1.6 × 0.2–0.3 mm; testa cells strongly papillose, towards the end of the cell, oriented slightly to moderately clockwise; apical appendage 1.5–1.7 mm long; hilar appendage a solitary hair, 1.3–1.5 mm long; appendages not papillose.

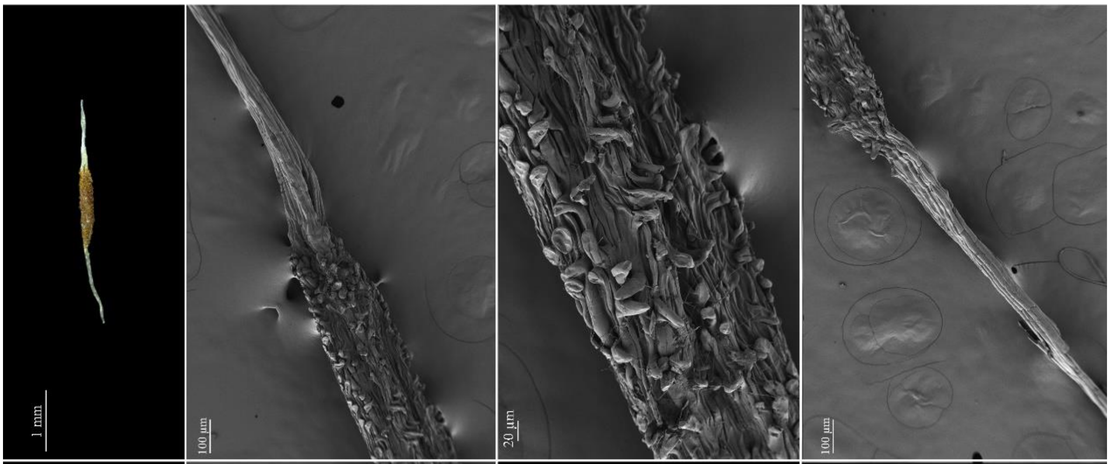


Fig. 98. *Aeschynanthus linearifolius* C.E.C.Fisch.: From left to right, Seed-full image; Hilar appendage; Seed grain showing testa cells; Apical appendage.

Aeschynanthus maoi **Fig. 99**

Seeds 0.6–0.8 × 0.1–0.2 mm; testa cells strongly papillose, towards the end of the cell, oriented slightly to moderately clockwise; apical appendage 1.5–2.5 mm long; hilar appendage a solitary hair, 1.8–3.5 mm long; appendages slightly papillose.

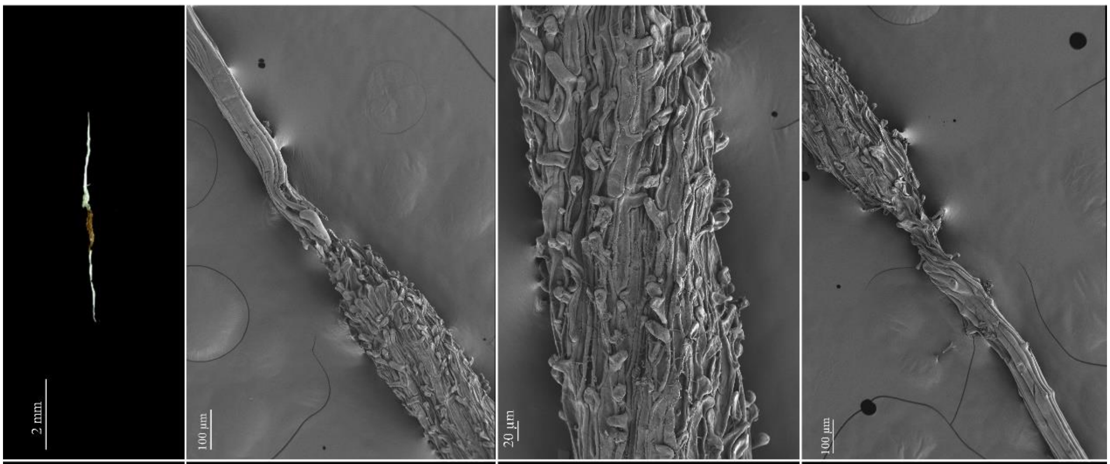


Fig. 99. *Aeschynanthus maoi* Debta & A.Shenoy: From left to right, Seed-full image; Hilar appendage; Seed grain showing testa cells; Apical appendage.

Aeschynanthus stenosepalus **Fig. 100**

Seeds 0.85–1.5 × 0.2–0.26 mm; testa cells strongly papillose, at the centre of the cell, oriented slightly clockwise; apical appendage 2.5–3.5 mm long; hilar appendage a solitary hair, 2.5–3.8 mm long; appendages not papillose.

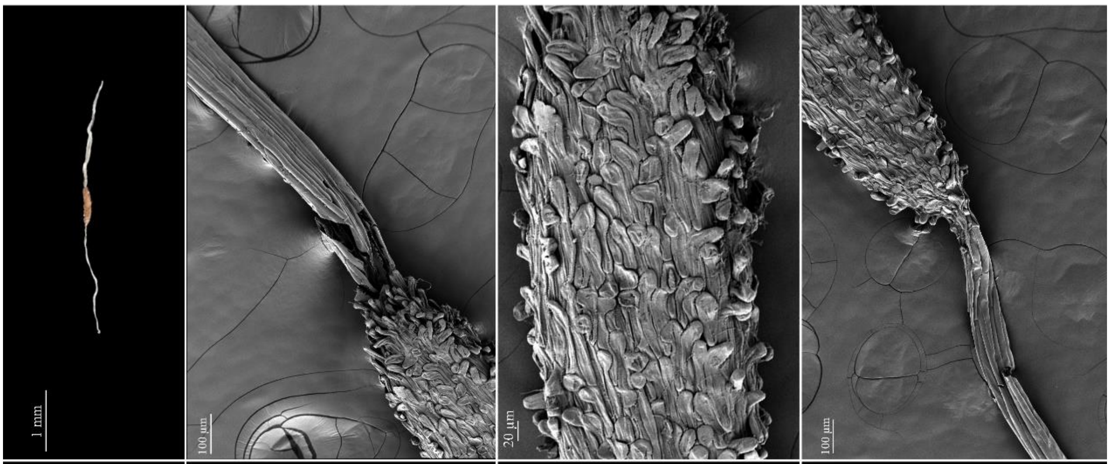


Fig. 100. *Aeschynanthus stenosepalus* J.Anthony: From left to right, Seed-full image; Hilar appendage; Seed grain showing testa cells; Apical appendage.

3. Sect. Xanthanthos

Aeschynanthus chiritoides

Seeds *c*. 0.1 × 0.03 cm, warty; apical appendage, 1.6–2 cm long; hilar appendage a solitary filiform hair, 1.2–1.7 cm long; appendages papillose.

Aeschynanthus mannii **Fig. 101**

Seeds 0.8–1.2 × 0.2–0.4 mm; testa cells warty; apical appendage 1.5–1.8 cm long; hilar appendage a solitary hair, 1.5–2 cm long; appendages papillose.

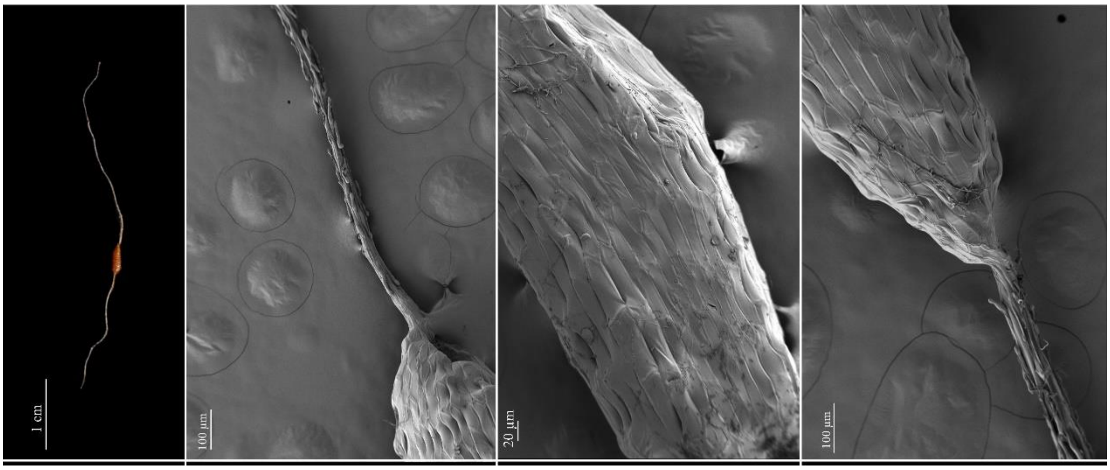


Fig. 101. *Aeschynanthus mannii* Kurz ex C.B.Clarke: From left to right, Seed-full image; Hilar appendage; Seed grain showing testa cells; Apical appendage.

Aeschynanthus fulgens

Seeds 0.8–2 × *c*. 0.3 mm; testa cells warty; apical appendage 1.5–3 cm long; hilar appendage a solitary hair, 1.3–3.5 cm long; appendages papillose.

Aeschynanthus gracilis **Fig. 102**

Seeds 0.65–0.9 × 0.12–0.3 cm; testa cells warty, oriented straight; apical appendage 1.5–1.8 cm long; hilar appendage a solitary hair, 1.8–2 cm long; appendages papillose.

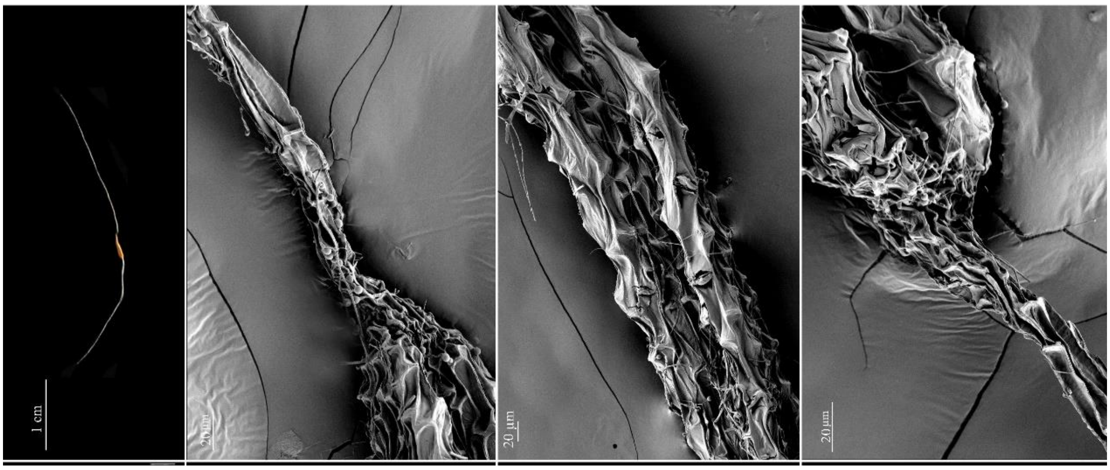


Fig. 102. *Aeschynanthus gracilis* C.S.P.Parish ex C.B.Clarke: From left to right, Seed-full image; Hilar appendage; Seed grain showing testa cells; Apical appendage.

Aeschynanthus micranthus **Fig. 103**

Seeds 1–1.3 × 0.15–0.3 mm; testa cells warty, oriented straight; apical appendage 1.5–2.2 cm long; hilar appendage a solitary hair, 1.4–2 cm long; appendages papillose.

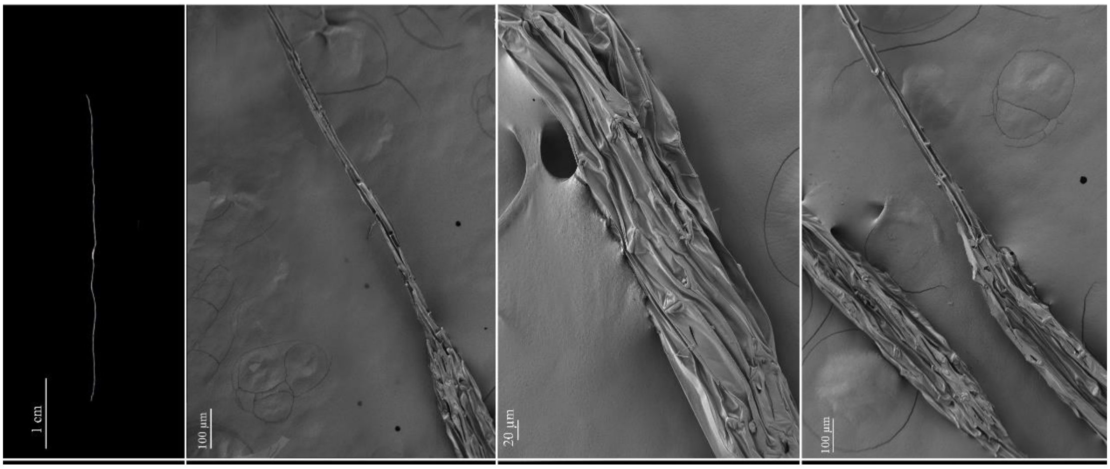


Fig. 103. *Aeschynanthus micranthus* C.B.Clarke: From left to right, Seed-full image; Hilar appendage; Seed grain showing testa cells; Apical appendage.

Aeschynanthus perrottetii **Fig. 104**

Seeds 0.4–1 × 0.2–0.35 mm; testa cells warty, oriented straight; apical appendage 1.5–1.8 cm long; hilar appendage a solitary hair, 1.4–1.6 cm long; appendages papillose.

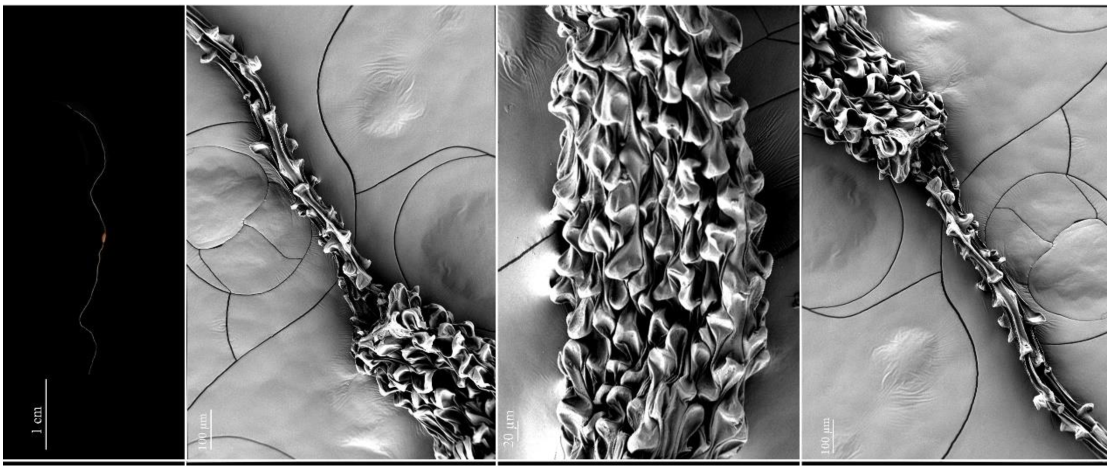


Fig. 104. *Aeschynanthus perrottetii* A.DC.: From left to right, Seed-full image; Hilar appendage; Seed grain showing testa cells; Apical appendage.

4. Sect. Diplotrichium

Aeschynanthus hookeri **Fig. 105**

Seeds 0.8–1.3 × 0.2–0.4 mm; testa cells warty; apical appendage 2–3.5 cm long; hilar appendages 2, 1.5–3.5 cm long; appendages papillose.

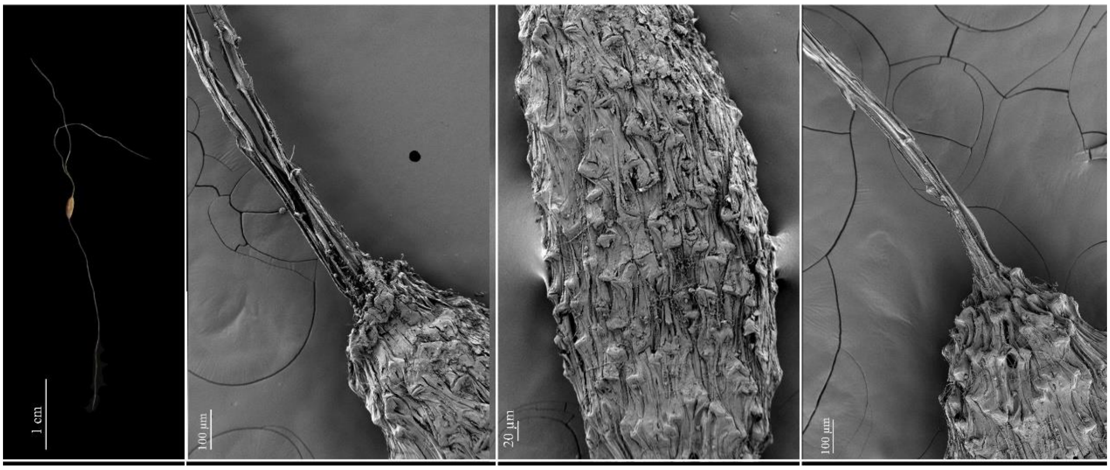


Fig. 105. *Aeschynanthus hookeri* C.B.Clarke: From left to right, Seed-full image; Hilar appendages; Seed grain showing testa cells; Apical appendage.

Aeschynanthus parasiticus **Fig. 106**

Seeds 0.8–1.3 × 0.2–0.3 mm; testa cells warty, oriented straight; apical appendage 1.8–3.5 cm long; hilar appendages 2, 1.3–3 cm long; appendages papillose.

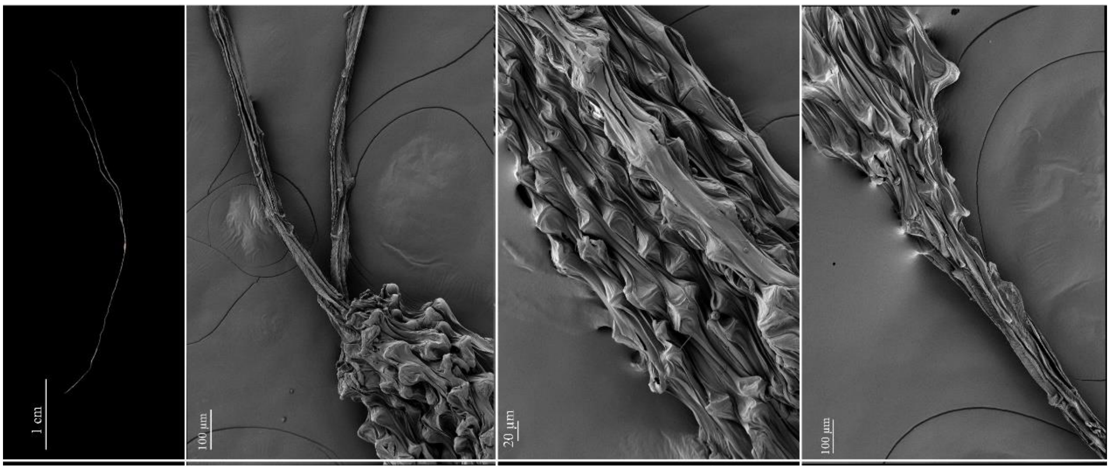


Fig. 106. *Aeschynanthus parasiticus* (Roxb.) Wall.: From left to right, Seed-full image; Hilar appendages; Seed grain showing testa cells; Apical appendage.

Aeschynanthus parviflorus **Fig. 107**

Seeds 0.9–1.3 × 0.2–0.3 mm; testa cells warty, oriented straight; apical appendage 1.2–3.5 cm long; hilar appendages 2, 1.2–2.8 cm long; appendages papillose.

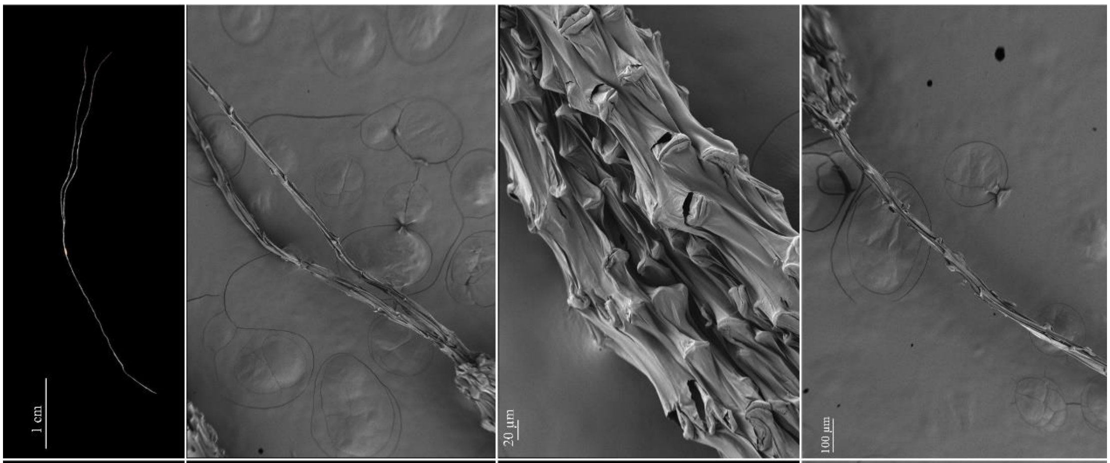


Fig. 107. *Aeschynanthus parviflorus* (D.Don) Spreng.: From left to right, Seed-full image; Hilar appendage; Seed grain showing testa cells; Apical appendage.

Aeschynanthus reiekensis **Fig. 108**

Seeds 1–1.2 × 0.2–0.3 mm; testa cells warty, oriented straight; apical appendage 1.5–2 cm long; hilar appendages 2–4, 1.5–2.5 cm long; appendages slightly papillose.

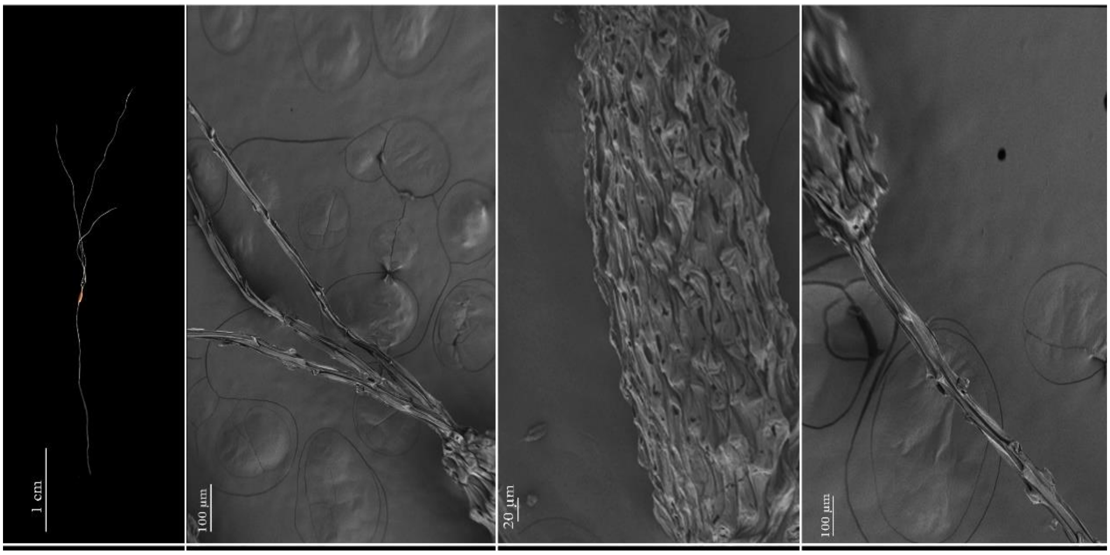


Fig. 108. *Aeschynanthus reiekensis* Lalhlupuii, S.D.Khomdram & S.D.Yumkham.: From left to right, Seed-full image; Hilar appendages; Seed grain showing testa cells; Apical appendage.

Inferences

The result indicates that the features of the seed appendages are significant in the sectional classification. A detailed comparison of the seed characteristics are provided in Table 03.

Discussion

Species with seed types A1 and A2 (subtypes A2a–A2c), which represent sect. *Microtrichium*, are characterized by broad-based appendages and deeply divided or spathaceous calyces. None of the Indian species fall into this section.

The remaining subtypes of A2 (A2d–A2f), represent the sect. *Aeschynanthus*, are characterized by smooth anti-clockwise oriented testa cells and basally slender, long appendages (0.4–0.9 cm long) with bubble cells at the hilar end. *Aeschynanthus volubilis*, from the Great Nicobar Islands, exhibits these seed features and belongs to group A2e. Additionally, it possesses tubular calyces with obtuse to rounded lobe apices, which align with the general morphological appearance of sect. *Aeschynanthus*.

Subtype A3 represents sect. *Haplotrichium*, distinguished by clockwise oriented testa cells, long pedunculate inflorescences, and usually large, persistent bracts. It is further divided into two groups: A3a and A3b.Group A3a has a tessellated seed appearance, with slightly raised edges and centrally sunken testa cells, and smooth appendages. *Aeschynanthus acuminatus* and *A. superbus* exhibit this kind of seed morphology. Group A3b is characterized by strongly papillose testa cells, with smooth or slightly papillose appendages. Species in this group include *A. bracteatus*, *A. linearifolius*, *A. maoi*, and *A. stenosepalus*. The sect. *Haplotrichium* is represented by six species in India.

The majority of the studied Indian species (10/17) fall into Type B, with six species under subtype B1 and four species under subtype B2. The subtype B3, with a comma (5–60) of hilar appendages, is not represented in India.

In this analysis, subtype B1 represents sect. *Xanthanthos*, which is further divided into three groups: B1a, B1b and B1c. Group B1a is characterised by broadly cylindrical seed grains and a testa with smooth and reticulate articulation. *Aeschynanthus chiritoides* and *A. mannii* show this seed pattern. Group B1b features seeds that are cylindrical and taper at the apical end, with papillae masked by the thick testa walls. *Aeschynanthus fulgens* is the only Indian species in this group. Group B1c includes many morphologically distinct species, such as *A. gracilis*, *A. micranthus* and *A. perrottetii*, all of which have cylindrical seeds that do not taper at the ends and possess a warty testa. The absence of a peduncle is the only key macro-morphological character that is common within this subtype, in addition to the seed characteristics.

Subtype B2 can be easily distinguished by the presence of two hilar appendages and is found in sect. *Diplotrichium*. *Aeschynanthus hookeri*, *A. parasiticus* and *A. parviflorus* consistently have two hilar appendages, *A. reiekensis* have 2 to 4 apendages. Phylogenetic studies (see chapter. 10) show that *A. reiekensis* nested with other species in sect. *Diplotrichium*, prompting a slight revision in the sectional classification.

Mendum *et al*. (2001) reported a third hilar appendage in a collection of *A. parasiticus* and a second hilar appendage in *A. gracilis* and *A. micranthus*, suggesting that the number of hilar hairs is not always fixed, and more detailed investigations are needed to establish the variation in other species. The occurrence of more than two hilar appendages in *A. reiekensis* may represent a similar form of variation.

Table 03. Comparison of seed characters

Sl No.	Seed Type	Species	No. of hilar appendages	Size of seed grain (mm)	Testa cells		Appendages				Section
					Articulation	Orientation	Size of apical (cm)	Size of hilar (cm)	Papilla	Bubble cells	
1	A2e	***A. volubilis***	1	0.5–0.6 × 0.1– 0.2	Papillose	Anti clockwise	0.4–0.8	0.7–0.9	Papillose	Present	***Aeschynanthus***
2	A3a	***A. acuminatus***	1	0.7–1.4 × 0.1–0.2	Sunken in the centre, edges slightly raised	Slight to moderate clockwise	0.29–0.37	0.3–0.32	Not papillose	Absent	***Haplotrichium***
3	A3a	***A. superbus***	1	0.8–1.2 × 0.2–0.25	Strongly papillose, papillae formed towards the end of the cell	Slight to moderate clockwise	0.45–0.75	0.45–0.64	Not papillose	Absent	***Haplotrichium***
4	A3b	***A. bracteatus***	1	0.8–1.5 × 0.2–0.25	Strongly papillose, papillae formed towards the end of the cell	Slight to moderate clockwise	0.25–0.35	0.25–0.38	Slightly papillose	Absent	***Haplotrichium***
5	A3b	***A. linearifolius***	1	1.3–1.6 × 0.2–0.3	Strongly papillose	Slight to moderate clockwise	0.15–0.17	0.13–0.15	Not papillose	Absent	***Haplotrichium***
6	A3b	***A. maoi***	1	0.6–0.8 × 0.1–0.2	Strongly papillose, papillae formed towards the end of the cell	Slight to moderate clockwise	0.15–0.25	0.18–0.35	Slightly papillose	Absent	***Haplotrichium***
7	A3b	***A. stenosepalus***	1	0.85–1.5 × 0.2–0.26	Strongly papillose, papillae formed from the centre of the cell	Slight clockwise	0.25–0.35	0.25–0.38	Not papillose	Absent	***Haplotrichium***

8	B1a	***A. chiritoides***	1	*c.* 1 × 0.3	warty	Straight	1.6–2	1.2–1.7	Papillose	Absent	***Xanthanthose***
9	B1a	***A. mannii***	1	0.8–1.2 × 0.2–0.4	Warty	Straight	1.5–1.8	1.5–2	Papillose	Absent	***Xanthanthose***
10	B1b	***A. fulgens***	1	0.8–2 × *c.* 0.3	Warty	Straight	1.5–3	1.3–3.5	Papillose	Absent	***Xanthanthose***
11	B1c	***A. gracilis***	1	0.65–0.9 × 0.12–0.3	Warty	Straight	1.5–1.8	1.8–2	Papillose	Absent	***Xanthanthose***
12	B1c	***A. micranthus***	1	1–1.3 × 0.15–0.3	Warty	Straight	1.5–2.2	1.4–2	Papillose	Absent	***Xanthanthose***
13	B1c	***A. perrottetii***	1	0.4–1 × 0.2–0.35	Warty	Straight	1.5–1.8	1.4–1.6	Papillose	Absent	***Xanthanthose***
14	B2	***A. hookeri***	2	0.8–1.3 × 0.2–0.4	Warty	Straight	2–3.5	1.5–3.5	Papillose	Absent	***Diplotrichium***
15	B2	***A. parasiticus***	2	0.8–1.3 × 0.2–0.3	Warty	Straight	1.8–3.5	1.3–3	Papillose	Absent	***Diplotrichium***
16	B2	***A. parviflorus***	2	0.9–1.3 ×. 0.2–0.3	Warty	Straight	1.2–3.5	1.2–2.8	Papillose	Absent	***Diplotrichium***
17	B2	***A. reiekensis***	2–4	1–1.2 × 0.2–0.3	Warty	Straight	1.5–2	1.5–2.5	Slightly papillose	Absent	***Diplotrichium***

Conclusion

Being an epiphytic plant, *Aeschynanthus* seeds are specially adapted for wind dispersal and anchoring to suitable substrates, with hair-like appendages and secondary cell character elaborations. Based on the orientation of the testa cells, the nature of the papillae, and the number of hilar appendages, seeds can be classified into two types, and further into several subtypes and groups. Thus, the seed characteristics are significant for an infrageneric classification of the genus.

CHAPTER- 8

INFRA GENERIC CLASSIFICATION

INFRAGENERIC CLASSIFICATION

Infrageneric classification plays a crucial role in organizing the diversity of species within a genus, providing a framework for understanding their relationships. In *Aeschynanthus* seed morphology, especially the number of hilar appendages, and the lobation of calyx play an important role in the infrageneric grouping of the genus over other prominent morphological characters.As a result, correlating the additional morphological characters for sectional assignments has been a chaalenging task for taxonomists.

Bentham (1876) took a pioneering contribution to the sectional classification of the genus, recognizing four sections: *Polytrichium* (seed with many hairs at the hilar end), *Diplotrichium* (seed with two hairs at the hilar end), *Haplotrichium* (seed with a single hair at the hilar end and a deeply divided calyx), and *Holocalyx* (*i.e. Aeschynanthus* seed with a single hair at the hilar end and a shallowly lobed calyx). Clarke (1883) further refined this classification, identifying bubble-like cells at the base of the hilar appendage as a distinctive feature of the sect. *Holocalyx*. He also introduced a new section, *Microtrichium*, to accommodate *A. microtrichus* C.B.Clarke, described from New Guinea, which has relatively short and flat seed appendages at each end.

Based on the unequal division of the calyx, Schlechter (1923) established a sixth section, *Anisocalyx* for, *A. pachyanthus* Schltr. also described from New Guine. However, Burtt and Woods (1975) later synonymized this section with *Microtrichium*. The incorporation of corolla characters (such as colour and shape) into sectional delimitation led to the establishment of a new section, *Xanthanthose*, for the Chinese species, *A. denticuliger* W.T.Wang (Wang, 1984). Wang also sub divided sect. *Haplotrichium* into two series: ser. *Bracteati* and ser. *Novogracilis*. Later, Mendum *et al.* (2000) recognized that the seed characters of ser. *Novograciles* actually fall within sect. *Xanthonthos*, making ser. *Bracteati* redundant with sect. *Haplotrichium*.

When seeds are unavailable, assigning a species to a particular section based on other taxonomic characters often amounts to little more than a guess, and it is frequently an incorrect one. For instance, the placement of *A. arfakensis* C.B.Clarke, *A. leptocladus* C.B.Clarke and *A. philippinensis* C.B.Clarke within the sect. *Haplotrichium* by Clarke (1883) was erroneous.

Mendum *et al.* (2000) informally sub-divided the genus into two types, Type A and Type B, based on the morphology of seed testa and appendages. Type A includes species with spirally oriented testa cells and Type B possesses straightly oriented testa cells. They also attempted to include other morphological features, enabling the sectional placement of many species even without seed material. This study reveals that sect. *Haplotrichium* contains both Type A and Type B seeds, prompting a revised classification. The revised system places all species with Type A seeds into sect. *Haplotrichium* sensu stricto, while species with Type B seeds are placed in a new section *X*.

Thus, Type A contains the sections *Aeschynanthus*, *Haplotrichium* s.s. and *Microtrichium,* while Type B includes *Polytrichium*, *Diplotrichium*, *Xanthonthos,* and *X*. Despite superficial similarities between the seed characters of sect. *Xanthanthos* and sect. *X*, further studies are required to properly circumscribe sect. *X*. These studies also suggest a relationship between the seed type and geographical distribution: Type A seeds are primarily Malesian (with the exception of sect. *Haplotrchium* s.s.), while Type B are found in South and southeast Asia, except for the widely distributed sect. *Polytrichium*. This classification is supported by seed ontogeny studies (Christie & Mendum, 2001) and molecular findings by Denduangboripant *et al.* (2001).

The sectional classification is inherently natural, with seed characters strongly distinguishing the sections from one another. By analysing seed characteristics (e.g., number of hilar appendages and testa cell orientation, see chapter 07) along with morphological features such as inflorescence pattern, calyx lobation, and corolla colour (see chapter 05), and molecular data (see chapter 10) we propose an update to the current sectional classification. This revision expands the circumscriptions of sections *Xanthanthos* and *Diplotrichium*.

In addition to seed type, the epedunculate inflorescence is the only consistent morphological feature distinguishing sect. *X* from sect. *Haplotrichium*. Sect. *Xanthanthos* species, which have a single hilar appendage, straightly oriented testa cells,and lack a peduncle. Given these morphological similarities, I propose merging sect. *Xanthanthos* with sect. *X*, rather than treating the former as a separate entity based solely on corolla colour and fusion of anthers. Furthermore, *A. chiritoides* (sect. *Xanthanthos*) closely resembles *A. gracilis* (sect. *X*) in vegetative characters and form a sister clade in molecular phylogenetic analysis (see chapter 10).

In addition to this, the circumscription of sect. *Diplotrichium* is broadened to accommodate the new species, *A. reiekensis* from Northeast India. This species possesses 2–4 hilar appendages, an unusual feature compared to the strictly two appendages found in the sect. *Diplotrichium*. Detailed morphological studies revealed that *A. reiekensis* is more closely related to *A. parviflorus* and *A. tengchungensis*, in molecular studies which is nested with *A. parasiticus* as sister clade (see chapter 10), of which belong to sect. *Diplotrichium*,. Therefore, placing this species in a different section or creating a new section would be inappropriate

The updated sectional classification of Mendum *et al*. (2001) along with its distribution range is given below.

Key to the sections

la. Seeds with a single appendage at hilar end, testa cell orientation straight ……..... 2

lb. Seeds with more than 1 appendage at hilar end, testa cell orientation spiral 5

2a. Appendages 0.07–0.45 cm long, smooth 3

2b. Appendages 1–4.5 cm long, slender, papillose ……................... sect. *Xanthanthos*
(Sri Lanka, India, S China, mainland SE Asia, W Malesia)

3a. Testa cell orientation anticlockwise, rarely straight; inflorescences rarely pedunculate; bracts small (0.1–0.7 cm long), caducous 4

3b. Testa cell orientation clockwise, inflorescences pedunculate, bracts large (1–6 cm long), usually persistent .... sect. *Haplotrichium*
(NE India, SW China, Burma, Thailand)

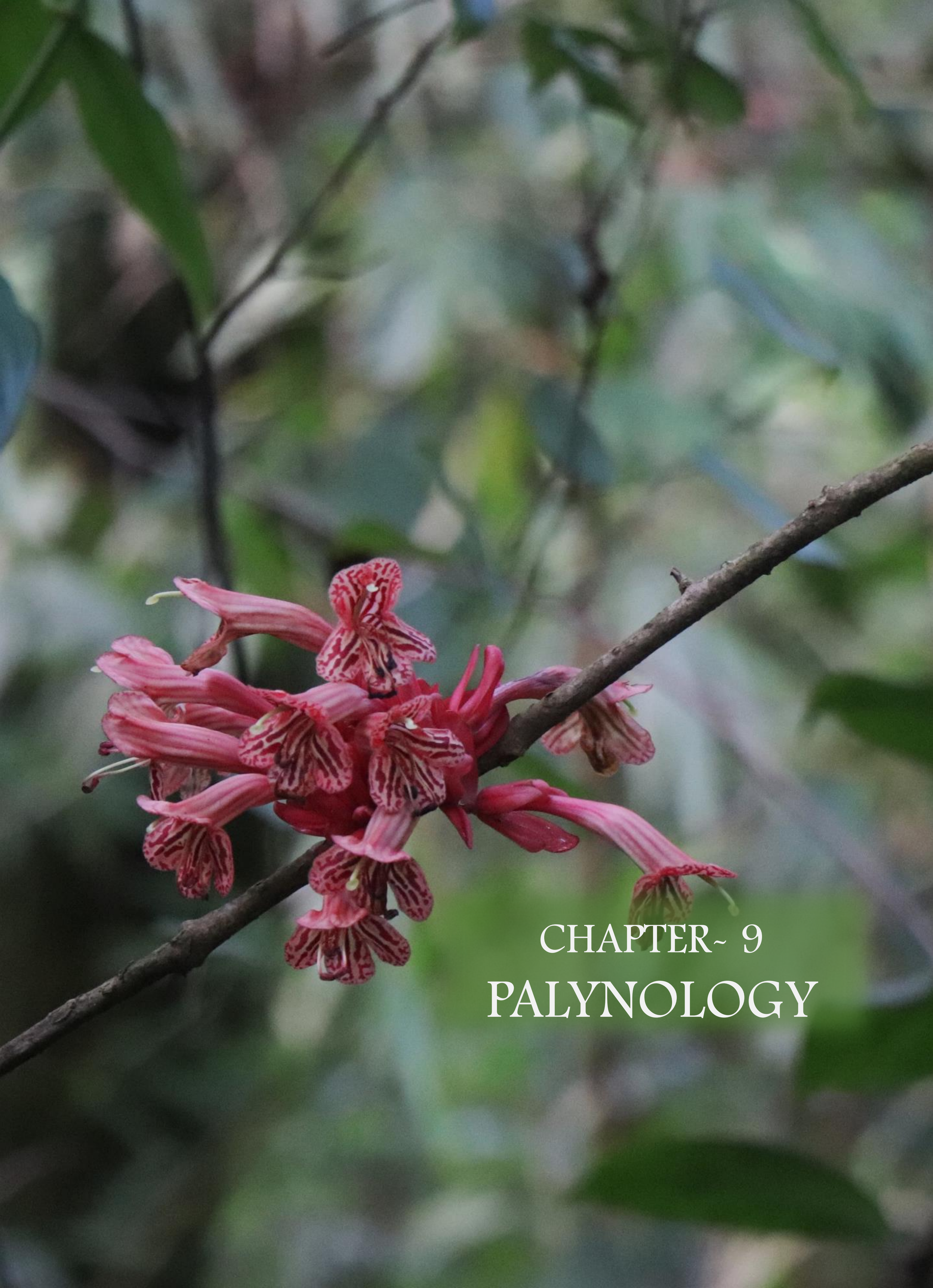
4a. Appendages broad at base; bubble cells absent; calyx without abscission layer at base, usually deeply divided, rarely tubular or spathaceous, lobes acute to acuminate ………………………………..…………………………………….. sect. *Microtrichium*
(Malesia)

4b. Appendages slender at base, bubble cells often present; calyx with abscission ayer at base, tubular or cup-shaped, lobes rounded, rarely acuminate .. sect. *Aeschynanthus*
(India (Nicobar Island), S Thailand to New Guinea)

5a. Leaves not marbled; seeds with 2–4 appendages at hilar end ... sect. *Diplotrichium*
(NE India, SW China, Burma, Thailand)

5b. Leaves marbled; seeds with 5–60 appendages at hilar end …… sect. *Polytrichium*
(S China and Burma to New Guinea)

Out of six sections of *Aeschynanthus*, India has representativesfrom four sections *viz*., sections *Aeschynanthus, Haplotrichium, Diplotrichium* and *Xanthanthos*. Sect. *Aeschynanthus* is represented by a single species *A. volubilis*, which is found in the Great Nicobar Islands; sect. *Haplotrichium* includes six species, *viz*. *A. acuminatus*, *A. bracteatus*, *A. linearifolius*, *A. maoi*, *A. stenosepalus*, and *A. superbus*, all of which are confined to Northeast India; sect. *Diplotrichium* consists of four species, *viz*. *A. hookeri*, *A. parasiticus*, *A. parviflorus*, and *A. reiekensis*, also confined only to Northeast India; sect. *Xanthanthos* constitutes six species, *viz*. *A. chiritoides*, *A. fulgens*, *A. gracilis*, *A. mannii*, *A. micranthus*, and *A. perrottetii*, which are distributed both in Northeast India and South India. Due to the lack of seed data, it is difficult to assign the species, *A. angustioblongus*, *A. monetaria* and *A. tirapensis* to the specific sections. Based on their morphological similarities, *A. angustioblongus* is likely to belong sect. *Diplotrichium*, while *A. monetaria* and *A. tirapensis* may be placed in sect. *Xanthanthos*.



CHAPTER- 9

PALYNOLOGY

PALYNOLOGY

Angiosperm systematics has greatly benefitted from palynological data at all levels, particularly in the delimitation of taxa (Stuessy, 2009; Ulrich *et al.*, 2012). However, only about 10% of flowering plants have been studied with regard to pollen grain morphology, and even fewer have been analysed at the ultrastructure level (Halbritter *et al.*, 2018). In the Gesneriaceae family, palynological studies have revealed that the exine structure and sculpture are highly significant, offering valuable insights at the generic, subgeneric, and even at the specific levels (Erdtman 1952; Luegmayr 1993; Palee *et al.*, 2003). Even though the subfamily Cyrtandroideae is generally eurypalynous, some genera, including *Aeschynanthus* are strictly stenopalynous and are unique at the generic level (Luegmayr, 1993). Zhi-jian *et al*. (1997) and Palee *et al.* (2003) stated that pollen morphology shows some difference at the infrageneric level too.

Apart from the pollen, orbicules, sometimes produced by the inner anther walls can provide valuable taxonomic information due to their diverse size and structures, though, many palynological studies overlooked them (Vinckier & Smets, 2003; Verstraete *et al.*, 2014). Puglisi *et al.* (2011) utilized nature of orbicules to delineate species in *Oreocharis*, while Janeesha *et al*. (2023) found orbicules to be less significant for *Rhynchoglossum*.

The present study aims to: (i) analyse the detailed structure of pollen grains; (ii) assess significance of pollen morphology at the species or sectional level, and (iii) examine the structure of orbicules to elucidate their relevance within the genus.

Materials and methods

Anthers from living collections were preserved in 70% alcohol. For scanning electron microscopic (SEM) analysis, pollen samples were fixed in glutaraldehyde, followed by dehydration in an alcohol / acetone series (Erdtman, 1960). After critical point drying with a K850 Critical Point Dryer (Emitech Quorum, PA, USA), the samples were mounted onto aluminium stubs using carbon tape and sputter-coated with gold and palladium using a SC7620 mini sputter coater (Emitech Quorum, PA, USA). For each sample, polar, equatorial and magnified surface views were captured using a Gemini 300 FESEM (Zeiss, Wetzlar, Germany) at a 2 kV voltage and 9.6 mm working distance at the Central Sophisticated Instrument Facility (CSIF), University of Calicut. Pollen terminology followed Erdtman (1972) and Punt *et al*. (1994), while exine classification followed Palee *et al.* (2003). Orbicule terminology was based on Huysmans *et al*. (1997) and Vinckier *et al*. (2000).

Results

Eight species from India under three sections, viz*. Aeschynanthus* sect. *Haplotrichium* (*A. bracteatus* and *A. superbus*); sect. *Xanthanthos* (*A. gracilis*, *A. monetaria*, *A. micranthus* and *A. perrottetii*) and the sect. *Diplotrichium* (*A. hookeri*, *A. parasiticus*, and *A. parviflorus*) were analysed. Detailed observations of the study are as follows:

1. **Sect. Haplotrichium**

Aeschynanthus bracteatus **Fig. 109a**

Grains 13–16 µm in diam., spheroidal in equatorial view, circular to angular in polar view; tricolpate; colpi long, elliptic with acuminate ends, borders wide and smooth, ectexinous granular elements present, supratectate sculptural elements absent; exine microreticulate at mesocolpium, microreticulate to perforate at apocolpium. Orbicules 0.03–0.05 µm in diam., rounded to oblate.

Aeschynanthus superbus **Fig. 109b**

Grains 8–12 µm in diam., spheroidal in equatorial view, circular in polar view; tricolpate; colpi medium, elliptic with acute ends, borders wide and smooth, ectexinous granular elements present, supratectate sculptural elements absent; exine microreticulate at mesocolpium, microreticulate to perforate at apocolpium. Orbicules 0.03–0.05 µm in diam., rounded oblate.

2. **Sect. Xanthanthos**

Aeschynanthus micranthus **Fig. 109c**

Grains 13–15 µm in diam., spheroidal in equatorial view, circular to angular in polar view; tricolpate; colpi long, elliptic with acuminate ends, borders wide and smooth, ectexinous granular elements present, supratectate sculptural elements absent; exine microreticulate at mesocolpium, microreticulate to perforate at apocolpium. Orbicules 0.03–0.05 µm in diam., rounded oblate.

Aeschynanthus monetaria **109d**

Grains 15–17 µm in diam., spheroidal in equatorial view, circular to angular in polar view; tricolpate; colpi long, elliptic with acuminate ends, borders wide and smooth, ectexinous granular elements present, supratectate sculptural elements absent; exine microreticulate at mesocolpium, microreticulate to perforate at apocolpium. Orbicules 0.03–0.05 µm in diam., rounded oblate.

Aeschynanthus perrottetii **110a**

Grains 15–17 µm in diam., spheroidal in equatorial view, circular to angular in polar view; tricolpate; colpi medium to long, elliptic with acuminate ends, borders wide and smooth, ectexinous granular elements present, supratectate sculptural elements absent; exine microreticulate at mesocolpium, microreticulate to perforate at apocolpium. Orbicules 0.03–0.05 µm in diam., rounded oblate.

3. Sect. Diplotrichium

Aeschynanthus hookeri **110ba**

Grains 14–18 µm in diam., spheroidal in equatorial view, circular in polar view; tricolpate; colpi long, elliptic with acuminate ends, borders wide and smooth, ectexinous granular elements present, supratectate sculptural elements absent; exine microreticulate at mesocolpium, microreticulate to perforate at apocolpium. Orbicules 0.03–0.05 µm in diam., rounded oblate.

Aeschynanthus parasiticus **110c**

Grains 14–16 µm in diam., spheroidal in equatorial view, circular to angular in polar view; tricolpate, colpi long, elliptic with acuminate ends, borders wide and smooth, ectexinous granular elements present, supratectate sculptural elements absent; exine microreticulate at mesocolpium and apocolpium. Orbicules 0.03–0.05 µm in diam., rounded oblate.

Aeschynanthus parviflorus **110d**

Grains 15–17 µm in diam., spheroidal in equatorial view, circular to angular in polar view; tricolpate; colpi long, elliptic with acuminate ends, borders wide and smooth, ectexinous granular elements present, supratectate sculptural elements absent; exine microreticulate at mesocolpium, microreticulate to perforate at apocolpium. Orbicules 0.03–0.05 µm in diam., rounded oblate.

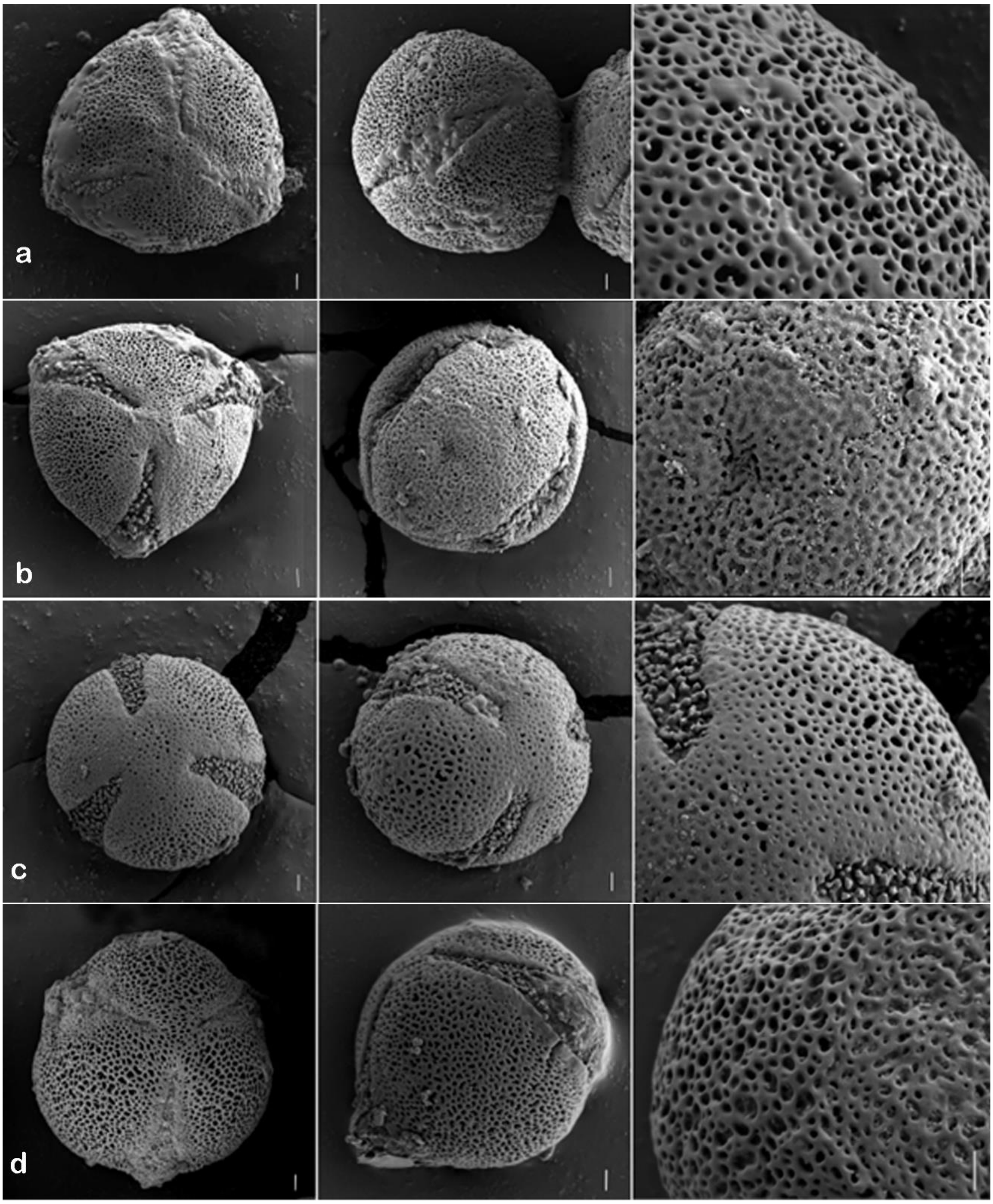


Fig. 109. Pollen: **a.** *A. bracteatus*; **b.** *A. superbus*; **c.** *A. micranthus*; **d.** *A. monetaria* (from left to right- Polar view, equatorial view; surface structure; Scale bar = 1 μm).

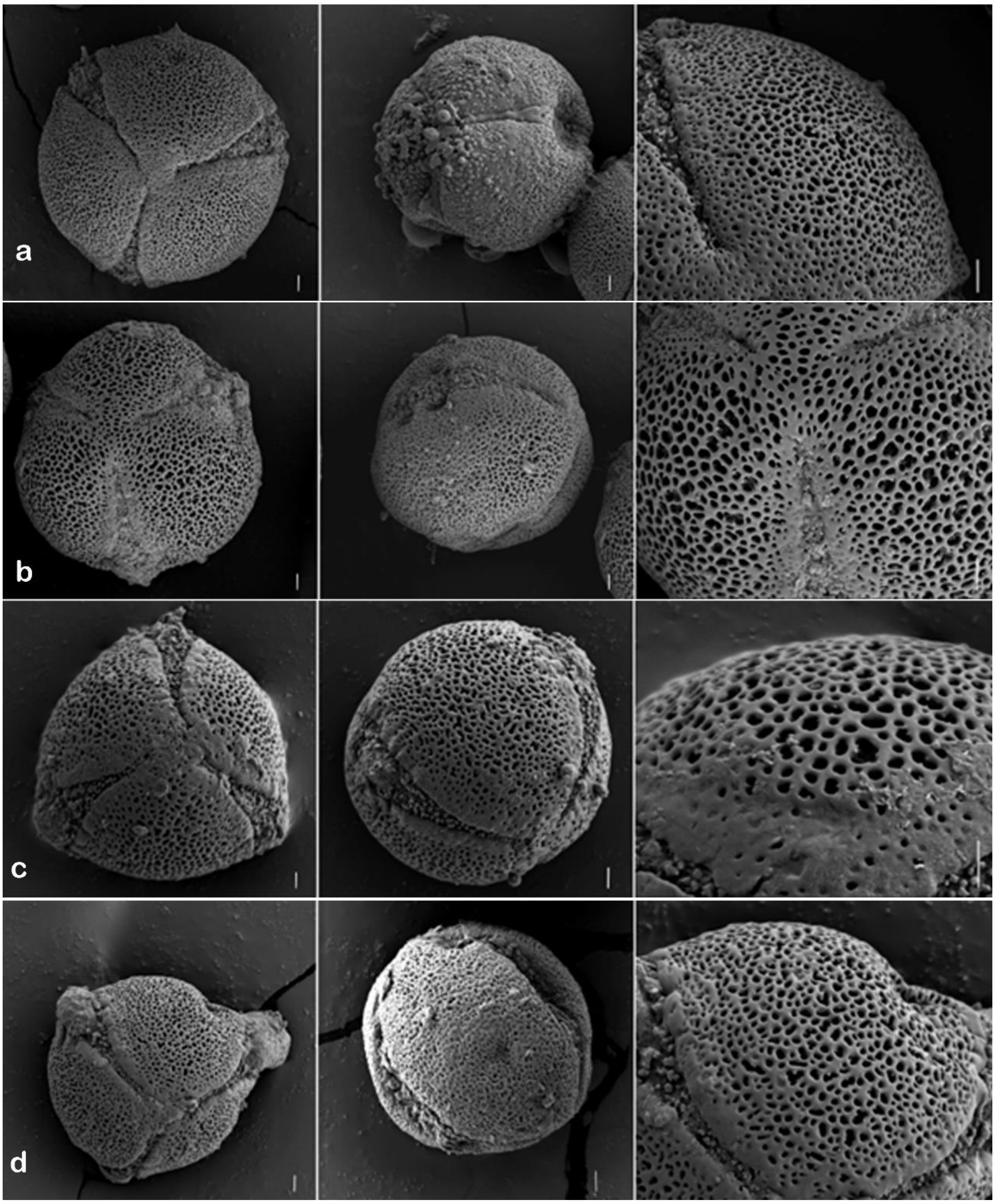


Fig. 110. Pollen: **a.** *A. perrottetii*; **b.** *A. hookeri*; **c.** *A. parasiticus*; **d.** *A. parviflorus* (from left to right- Polar view, equatorial view; surface structure; Scale bar = 1 μm).

Discussion

The results of the present study, along with data from previous works (Zhi-jian *et al*., 1997; Palee *et al.*, 2003), are tabulated in Table 04.

The study showed that the pollen grains were shed as monads, exhibiting a relatively consistent structure with some variation in size. The grains were radially symmetrical and isopolar, with diameters ranging from 8–18 µm. They were spheroidal in the equatorial view, and circular to angular in polar view. Most of the surface of the pollen grains was covered by a broad microreticulate mesocolpium and microreticulate to perforate apocolpium. The pollen grains were tricolpate, with colpi extending nearly to the poles. They were elliptic with acute or acuminate ends, and the borders were wide and smooth. Several ectexinous granular elements were distributed across the colpi. The lumen was thin, with deep luminal floors, and the shape of the lumen varied, from circular, sub-circular, elliptical or irregular. In the equatorial zone, the colpi were large, while at the poles, they were comparatively small.

Luegmayr (1993) examined the pollen characters of 108 species (including 13 *Aeschynanthus* species) from 18 genera (representing all tribes) of the subfamily Cyrtandroideae, and recognized ten exine types. According to Luegmayr (*l.c.*), *Aeschynanthus* is stenopalynous with a Type-2 exine pattern (mesocolpia reticulate proceeding to perforate apocolpia; lumina at the mesocolpia conspicuously irregular, supratectate sculptural elements absent; occasionally rod-like luminal processes present). Palee *et al.* (2003) elaborated on the exine patterns with an addition of five new types to resolve contradictions in the pollen terminology by Punt *et al.* (1994). They defined five out of six *Aeschynanthus* species with a Type-11 exine pattern characterized by a microreticulate tectum at both apo- and mesocolpia, with regular lumina of almost equal width at both regions, and the absence of supratectate sculptural elements and luminal processes. The remaining species was classified with a Type-15 exine pattern, where the pollen is perforate-scabrate and lacks supratectate sculptural elements.

From the current study, it is evident that exine exhibits microreticulate sculpturing at the mesocolpous region and microreticulate to perforate sculpturing at the apocolpus region (except for *A. parasiticus*). The lumina were not regular always. Therefore, the exine pattern almost closely align with Luegmayr (1993) treatment, apart from the usage of' 'reticulate' instead of 'microreticulate' in the description.

While studying the tribe Trichosporeae in China, Zhi-jian *et al*. (1997) correlated pollen characteristics with the different sections, suggesting that the pollen size is relatively smaller in the sections *Haplotrichium* and *Diplotrichium* compared to the sections *Microtrichium*, *Xanthanthos,* and *Aeschynanthus*. However, from the data presented in table. 04, no significant differences in size were observed between any species or sections.

Palee *et al.* (2003) propound that the pollen morphology could be useful for delineating species within this genus, by elucidating the three distinct exine sculpturing patterns in different accessions of *A. hildebrandii*. However, Middleton (2007) opined that the authors were likely studying different accessions of *A. persimilis*, rather than *A. hildebrandii* (= *A. andersonii*) and that all the accessions in question belonged to the same taxon. Therefore, the variation in exine sculpturing pattern would be considered infraspecific variation rather than a species delimiting character.

Li *et al.* (2020) studied the pollen morphology of *A. fulgens* in China, along with the related species *A. hookeri*, and revealed that, unlike the spheroid pollen usually found in the genus, *A. fulgens* has prolate pollen. Similarly, Lalhlupuii *et al*. (2023) reported prolate pollen in *A. reiekensis*. The occurrence of such unique pollen morphology in only two distantly related species from different sections within the genus is quite interesting. However, studying in detail with the relevant literature (Katifori *et al*., 2010; Halbritter *et al*., 2018) it was clear that the prolate shape were attained by the spheroid pollen grains by folding the pollen wall to prevent desiccation during dry condition as an adaptive measure (harmomegathy) and originally those will be spheroid, as like the other members of the genus. We observed some pollen of *A. perrottetii* also showing this harmomegathy (Fig. 111).

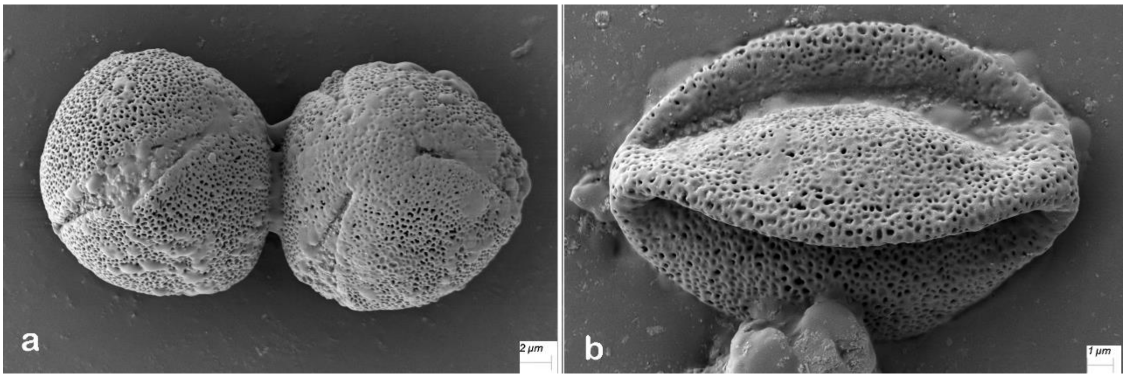


Fig. 111. Harmomegathy in pollen grains of *A. perrottetii*: **a.** Normal pollen grains; **b.** Desiccated pollen grains.

In this study, orbicules (Fig. 112) are reported for the first time in *Aeschynanthus*. In Lamiales, most of the families either lack orbicules or insufficiently studied in this regard (Verstraete *et al.*, 2014). However, orbicules have been reported in a few genera within the Gesneriaceae, such as *Oreocharis* and *Rhynchoglossum* (Puglisi *et al*., 2011; Janeesha *et al*., 2023). All the species studied here have Type-IIIb orbicules, which are characterized by small size (<0.5 µm diam.), a rounded to oblate shape, and smooth surfaces.

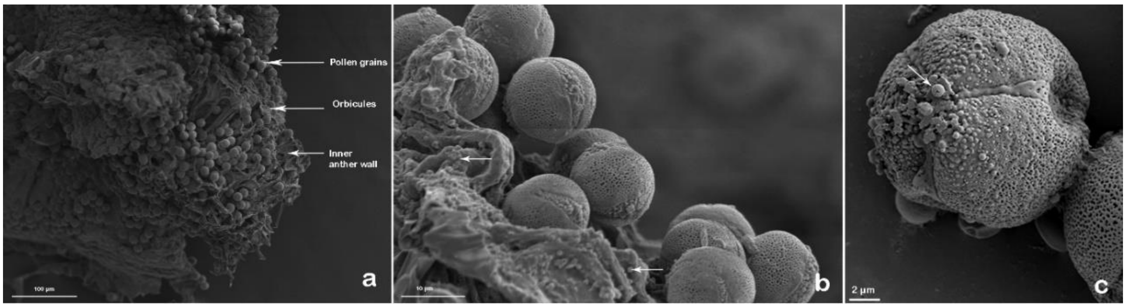


Fig. 112. Orbicules: **a.** orbicules attached to the inner anther walls; **b – c.** Orbicules indicated by the arrow

Conclusion

Aeschynanthus pollen grains are stenopalynous, which has little relevance for infrageneric delimitation. In general, the grains are small (8–25 µm in diam.), spheroidal, and tricolpate, with long colpi containing several ectexinous granular elements. The exine pattern is microreticulate to perforate. To prevent desiccation, some pollen grains also show harmomegathy. Additionally, all species studied possess orbicules, which are similar in size, ranging from 0.03–0.05 µm in diam.

Table 04. Comparison of pollen characters

Species	**Section**	**Size (µm)**	**Exine pattern**	**Aperture**	**Aperture**	**Elements on colpi**	**Source of data**
A. garretii	*Microtrichium*	17–18	Micro reticulate -psilate	Tricolpate	Extending near the pole	Dense granular	Palee *et al.* (2003)
A. buxifolius	*Microtrichium*	12.2–16.8	Microreticulate	Tricolpate	Extending near the pole	Dense tubercular	Zhi-jian *et al*. (1997)
A. acuminatus	*Haplotrichium*	11.2–14.7	Microreticulate	Tricolpate	Extending near the pole	Dense granular	Zhi-jian *et al*. (1997)
A. acuminatissimus	*Haplotrichium*	10.7–14.5	Microreticulate	Tricolpate	Extending near the pole	Dense granular	Zhi-jian *et al*. (1997)
A. bracteatus	*Haplotrichium*	13–16	Microreticulate	Tricolpate	Extending near the pole	Dense granular	Present study
A. superbus	*Haplotrichium*	8–12	Microreticulate	Tricolpate	Extending half way to the pole	Dense granular	Present study
A. denticuliger	*Xanthanthos*	18.4–23	Microreticulate	Tricolpate	Extending near the pole	Sparse granular	Zhi-jian *et al*. (1997)
A. gracils	*Xanthanthos*	14–15	Microreticulate - psilate	Tricolpate	Extending near the pole	Dense granular	Palee *et al.* (2003)
A. macranthus	*Xanthanthos*	16–20	Microreticulate - psilate	Tricolpate	Extending near the pole	Dense granular	Palee *et al.* (2003)

A. micranthus	*Xanthanthos*	13–15	Microreticulate - perforate	Tricolpate	Extending near the pole	Dense granular	Present study
A. monetaria	*Xanthanthos*	15–17	Microreticulate - perforate	Tricolpate	Extending near the pole	Dense granular	Present study
A. perrottetii	*Xanthanthos*	15–17	Microreticulate - perforate	Tricolpate	Extending half way to near the pole	Dense granular	Present study
A. persimilis	*Xanthanthos*	17–19	Microreticulate or perforate-scabrate	Tricolporoida te	Extending near the pole	Dense granular	Palee *et al.* (2003)

CHAPTER- 10
MOLECULAR PHYLOGENY

MOLECULAR PHYLOGENY

Molecular biology and bioinformatics have made remarkable advancements over nearly three decades, facilitating the development of molecular-based system of plant taxonomy. This approach serves as an effective tool for addressing long-standing issues in classical taxonomy by constructing phylogenetic analysis and enhancing our understanding of the evolutionary history and relationships among plant groups. This progressive growth of molecular systematics has been remarked by the development of the Sanger sequencing method (Sanger *et al.*, 1977). Even though a fraction (hundreds to thousands of nucleotides of the millions to billions of base pairs) of the genome was generally analysed through this method, it has proven to have a wide range of applications (Hollingsworth *et al.*, 1999). Recently, the molecular data acquisition has shifted from kilobase-scale to a gigabase-scale by the increased accessibility of next-generation sequencing (NGS) approaches (Straub *et al*., 2012).

In their evolutionary investigation of the genus *Aeschynanthus*, Denduangboripant and Cronk (2000) made significant progress by including around 50 species, although their analysis was limited to the nuclear ITS region. However, the representation of Indian taxa was limited, which was insufficient to resolve existing inconsistencies in species delineation (Clarke, 1884; Bhattacharyya & Goel, 2015; Sinha & Datta, 2016) of the genus in India. The present study aims to unravel the phylogenetic relationships of *Aeschynanthus* species occurring in India using Sanger sequencing and a newly developed Amplicon sequencing pipeline.

Amplicon sequencing

As an alternative to direct Sanger sequencing, Nishii *et al.*, (2024) developed a new amplicon sequencing pipeline, which I had the opportunity to test with several samples of *Aeschynanthus* species, during my visit to the Royal Botanic Garden Edinburgh (RBGE), UK from August–October 2023. This new pipeline resolved the problems related to the intra-individual length variants in the *Aeschynanthus* ITS sequences (Denduangboripant & Cronk, 2000, 2001), enabling smooth transition from Sanger sequencing to small-scale NGS sequencing without the need for outsourcing and at a reduced cost. The pipeline is based on a multi-marker ONT (Oxford Nanopore Technologies) amplicon-seq protocol that uses a commercially available ONT [

https://nanoporetech.com, continuous long read (CLR) method of PacBio: https://www.pacb.com] barcoding kit. The bioinformatics pipeline covers steps from basecalling to consensus sequence generation, using snakemake (Mölder *et al.*, 2021). This pipeline was developed to generate a relatively small number of markers compared to genome skimming or hybrid-bait sequencing. The test was carried out using 50 samples of *Aeschynanthus*, including 13 samples from India.

Materials and Methods

01. Taxon samplings

For the long-term preservation of plant tissue for molecular studies, young leaf tips from each collected sample were placed in an empty tea bag or wrapped in tissue paper and dried in silica gel. Each sample was labelled with its collection number for future reference.

Silica-dried materials of nine accessions of *A. perrottetii* [including the taxa, *A. ceylanicus* var. *pinguis* (1 sample), *A. perrottetii* var. *malabaricus* (1) and *A. perrottetii* var. *planiculmis* (3)], two accessions of *A. hookeri*, and single accession each of *A. parviflorus*, and *A. gracilis* from India were brought to the RBGE, UK with permission from the National Biodiversity Authority (NBA), Government of India. After completing the registration procedure for using the RBGE molecular lab, all sample data were submitted to the EDNA portal (DNA database of RBGE). Along with these 13 samples, 37 samples of *Aeschynanthus* from the RBGE collection were selected as the ingroup taxa for the analysis. A single sample each from three species of *Cyrtandra* J.R.Forst. & G.Forst (*C. mooreaensis* G.W.Gillett, *C. oblongifolia* (Blume) Benth. & Hook.f. ex C.B.Clarke and *C. picta* Zoll.), two species of *Agalmyla* Blume (*A. biflora* (Elmer) Hilliard & B.L.Burtt and *A. chalmersii* (F.Muell.) B.L.Burtt), single species each of *Billolivia* D.J.Middleton (*B. violacea* D.J.Middleton & H.J.Atkins), *Didymocarpus* Wall. (*D. antirrhinoides* A.Weber), and *Loxostigma* C.B.Clarke (*L. griffithii* (Wight) C.B.Clarke) were selected as the outgroup taxa, and some of their data were downloaded from GenBank.

02. DNA Extraction, PCR and Sequencing

Twenty mg of silica gel-dried leaf material were ground using a Tissuelyser II Mill Grinder (Qiagen, Hombrechtikon, Switzerland). The resulting fine powder was then processed using a modified CTAB (cetyl trimethylammonium bromide) method (Doyle

& Doyle, 1990). The composition of the 2% CTAB buffer and the various stock solutions used in the study are given in the Appendix 01.

DNA isolation using a modified CTAB method (Doyle & Doyle, 1990)

- Preheat 1 ml 2% CTAB buffer with 2µl β-mercaptoethanol (per sample) in a plastic falcon tube at 65° C. Add 1 ml of the CTAB/ β-mercaptoethanol buffer and a pinch of poly vinyl pyrrolidine (PVP) to each ground sample, then mixed thoroughly.
- Incubate the mixture for 30 minutes at 65°C in a Thermomixer set to 800 rpm.
- Remove the tube from the heated block and allow it to cool to an ambient temperature for 1–2 minutes.
- Add 500 µl of chloroform-iso-amyl alcohol (24:1) to each tube. Mix gently by shaking to obtain a momentary single phase. Then transfer the tubes to an orbital shaker set to a minimum speed for 10–20 minutes.
- Centrifuge the samples for 10 minutes at 13,000 rpm at 4°C on a cool centrifuge (Prism R, Labnet International).
- Transfer the supernatant to a clean 1.5 ml Eppendorf tube and repeat the chloroform extraction process.
- The supernatant was collected in a clean 1.5 ml Eppendorf tube. DNA was precipitated by adding 600 µl of ice-cold isopropanol and shaking gently until the oily appearance disappeared. The sample was then left in the freezer overnight (or longer at this stage).
- DNA precipitate was pelleted by centrifuging for 10 minutes at 13,000 rpm.
- The supernatant was removed, and 500 µl of 70% alcohol was added to the pellet. The mixture wass agitated vigorously to release the pellet from the bottom of the tube and left for 30 minutes at room temperature.
- Centrifuge for 5 minutes at 13,000 rpm. The supernatant was removed, and the tubes were inverted to allow any remaining wash buffer to drain. The pellet was then dried in a vacuum centrifuge for 5 minutes or longer until completely dry.
- Dissolve the pellet in 50 to 100 µl of 1X TE buffer based the pellet quantity and mixed well.
- The DNA samples were stored at -20° C.

03. Quantification of DNA by Agarose gel electrophoresis

DNA quality and concentration were checked using 1% agarose gel. To prepare the gel, 0.75 g of agarose was dissolved in 75 ml of 1X TBE (Tris Borate EDTA) buffer and heated until fully dissolved. Afterward, 4 µl of SYBR Safe DNA gel stain was added to the solution, gently swirled, and then poured into a gel casting tray with a pre-positioned comb. The gel was left to solidify for 30 minutes. Once solidified, the clamp and comb were gently removed. The gel was then placed in an electrophoresis tank containing 1X TBE buffer.

3.5 µl of Invitrogen 1Kb+ ladder was loaded into the first well,followed by 5 µl each sample (3 µl DNA + 2 µl loading dye) into the subsequent wells. The gel was run at 80 V and 120 A for 40 minutes. After electrophoresis, the gel was visualised with a gel documentation system (Syngene G:Box F3). DNA samples with clear, strong bands were chosen for further analysis.

04. Amplicon sequencing in MinION

This protocol was developed to use traditional PCR based molecular markers using Oxford Nanopore Technologies (ONT) MinION. The ONT's Native Barcoding Kit 24 V14 (SQK-NBD114.24) was used for this analysis due to its wide application possibilities. The major steps of this protocol are outlined below:

i. PCR amplification
ii. Electrophoresis and relative quantification using gel images
iii. Normalisation of PCR products and pooling
iv. Cleaning of the pooled samples using AmpureXP beads and quantification by Qubit
v. Library preparation
vi. Barcode ligation
vii. Adaptor ligation and clean up
viii. MinION sequencing

04.i. **PCR amplification**

The extracted DNA of 39 *Aeschynanthus* samples (including 13 Indian samples) were used for this study. A total of two nuclear (ITS and ETS) and eight chloroplast markers (*trn*L-F, *ndh*F, *mat*K, *rps*16, *psb*A-*trn*H, *rpl*32-*trn*L, *rpl*20-*rps*12, and *ndh*F-*rpl*32) were chosen for the amplification in 12 PCR reactions. The details of these primers are given below in the Table 00.

The PCR protocols were adjusted for 10 µl PCR reactions, with a total of 12 PCR reactions (since *ndh*F and *mat*K require two separate PCR reactions, each targeting approximately 1000 bp). Biotaq DNA polymerase was used, following the PCR recipe given in Table 05. Amplification reactions were performed in thermo cycler (Applied Biosystem, Veriti, Foster City, USA).

Voucher data along with marker used for the study provided in appendix 02.

Table 05. Primers and sequences used, and their references

Locus	Primer	F/R	Sequence (5'-3')	References
ITS	ITS 5P	Forward	GGA AGG AGA AGT CG T AAC AAG	Möller & Cronk, 1997
	ITS 8P	Reverse	CAC GCT TCT CCA GAC TAC A	Möller & Cronk, 1997
ETS	Ast-1	Forward	CGT AAA GGT GCA TGA GTG GTG T	Baldwin & Marcos, 1998
	18S-ETS	Reverse	ACT TAC ACA TGC ATG GCT TAA TCT	Beardsley & Olmstead, 2002
*trn*L-F	*trn*L-Fc	Forward	CGA AAT CGG TAG ACG CTA CG	Taberlet *et al*., 1991
	*trn*L-Ff	Reverse	ATT TGA ACT GGT GAC ACG AG	Taberlet *et al*., 1991
*ndh*F1	11F	Forward	CCT ATC AAT ATG CAT GGA TCA TAC C	Luna *et al.*, 2019
	989R	Reverse	CCC ATT CCT AGA GCG AAC ATC A	Luna *et al.*, 2019
*ndh*F2	916F	Forward	GCT ACT TTA GCT CTT GCT CAA AAA	Luna *et al.*, 2019
	1813R	Reverse	AAG CTA GAC TGA CTG AAA AGA TTG C	Luna *et al.*, 2019
*mat*K1	206 F	Forward	CCG GGT TAT GAC AAT AAA TCC AGT	Luna *et al.*, 2019
	946 R	Reverse	ATA AAT CCT TCT TGG ATG AAA CCA C	Luna *et al.*, 2019
*mat*K2	917 F	Forward	GTA ACT TTT TGG CAA TGG CAT TTT T	Luna *et al.*, 2019
	1734R	Reverse	CCG TGC TTG CAT TTT TCA TTG C	Luna *et al.*, 2019
*rps*16	27F	Forward	GGT AGA AAG CAA CGT GCG AC	Luna *et al.*, 2019
	1030R	Reverse	CGA TAG ACG GCT CAT TGG GA	Luna *et al.*, 2019
*psb*A-*trn*H	*psb*A3	Forward	GTT ATG CAT GAA CGT AAT GCT C	Sang *et al.*, 1997
	*trn*H05	Reverse	CGC GCA TGG TGG ATT CAC AAA TC	Sang *et al.*, 1997
*rpl*32-*trn*L	*rpl*32-F	Forward	CAG TTC CAA AAA AAC GTA CTT C	Shaw *et al.*, 2007
	*trn*L$^{(UAG)}$	Reverse	CTG CTT CCT AAG AGC AGC GT	Shaw *et al.* 2007
*rpl*20-*rps*12	*rpl*20	Forward	TTT GTT CTA CGT CTC CGA GC	Hamilton, 1999
	*rps*12	Reverse	GTC GAG GAA CAT GTA CTA GG	Hamilton, 1999
*ndh*F-*rpl*32	CO57.F	Forward	CCA ATA TCC CTT YYT TTT CCA A	Shaw *et al.*, 2007
	CO57.R	Reverse	GAA AGG TAT KAT CCA YGM ATA TT	Shaw *et al.*, 2007

Table 06. PCR recipe for 10 µl reactions

Chemicals	**Volume (µl)**
10 x buffer	1.00
dNTP	1.00
MgCl2	0.30
Forward primer (10 nM)	0.50
Reverse primer (10 nM)	0.50
CES	2.00
DNA	1~2.00
Biotaq	0.20
dH2O	X
Total	**10.00**

PCR conditions for each primer pair are given below:

i. **ITS**

The ITS region (ITS) is located between the 18S and 26S ribosomal gene regions and contains two spacers: ITS1 (between 18S and 5.8S), and ITS2 (between 5.8S and 26S) along with the intervening ribosomal gene, 5.8S rRNA. Both ITS 1 and ITS 2 are highly variable in length and nucleotide sequences, whereas the 5.8S gene is more conserved in nucleotide composition and has a consistent length of 164 bp (Yokota *et al.*, 1989). Forward primer: ITS-5P; Reverse primer: ITS-8P

Table 07. PCR conditions for ITS

	Temperature	**Time**
1	94 °C	4 min
2	94 °C	1 min
3	55 °C	1 min
4	72 °C	1 min 30 Sec
5	To step 2, in total 30 cycles	
6	72 °C	10 min
7	15 °C	∞

ii. **ETS**

The external transcribed spacer (ETS) region is located at the 5'-end of the 18S of nuclear ribosomal DNA. The 5'-end of the ETS is bordered by a highly variable non-transcribed spacer (NTS), while the 3'-end is nested within the conserved 18S gene.

Forward primer: Ast-1

Reverse primer: 18S-ETS

Table 08. PCR conditions for ETS

	Temperature	**Time**
1	94 °C	4 min
2	94 °C	1 min
3	50 °C	1 min
4	72 °C	1 min
5	To step 2, in total 35 cycles	
6	72 °C	10 min
7	15 °C	∞

iii. ***trn*L-F**

The *trn*L-F region consists of the plastid tRNA transferase gene *trn*L, with an approximately 550 bp long intron, followed by the tRNA transferase gene *trn*F, which is separated from *trn*L by an approximately 500 bp long spacer.

Forward primer: *trn*L-cg, or *trn*Lc; Reverse primer: *trn*L-f

Internal primers: *trn*L-d (reverse), *trn*L-e (forward)

Table 09. PCR conditions for *trn*L-F

	Temperature	**Time**
1	94 °C	4 min
2	94 °C	30 sec
3	57 °C (or 55 °C)	30 sec
4	72 °C	1 min 30 sec
5	To step 2, in total 35 cycles	
6	72 °C	10 min
7	15 °C	∞

iv. ***ndh*F**

The *ndh*F region consists of a plastid NADH dehydrogenase (*ndh*F) gene.

***ndh*F1:** Forward primer: *ndh*F-11F; Reverse primer: *ndh*F-989R

***ndh*F2:** Forward primer: *ndh*F-916F; Reverse primer: *ndh*F-1813R

v. ***mat*K**

The *mat*K gene is a chloroplast genome encoded maturase protein located within the intron of the chloroplast gene *trn*K.

***mat*K1:** Forward primer: *mat*K-206F; Reverse primer: *mat*K-946R

***mat*K2:** Forward primer: *mat*K-917F; Reverse primer: *mat*K-1734R

vi. ***rps*16**

The *rps*16 region consists of a plastid ribosomal protein S16 (*rps*16) gene, and an intron region.

Forward primer: *rps*16-27F; Reverse primer: *rps*16-1030R

Table 10. PCR conditions for *ndh*F, *mat*K, and *rps*16

	Temperature	Time
1	94 °C	4 min
2	94 °C	1 min
3	55 °C	1 min
4	72 °C	1 min 30 sec
5	To step 2, in total 35 cycles	
6	72 °C	10 min
7	15 C	∞

vii. ***psb*A-*trn*H**

The *psb*A-*trn*H region consists of a plastid photosystem II protein D1 gene *psb*A and tRNA-His gene *trn*H separated by an intergenic spacer.

Forward primer: CO63.F (*psb*A-f); Reverse primer: CO63.R2 (Note: NOT CO63.R)

viii. ***rpl*32-*trn*L**

The *rpl*32-*trn*L region consists of partial sequences for the plastid ribosomal protein L32 (*rpl*32) gene and *trn*L gene separated by an intergenic spacer.

Forward primer: CO54.F; Reverse primer: CO54.R

Table 11. PCR conditions for *psb*A-*trn*H and *rpl*32-*trn*L

	Temperature	**Time**
1	94 °C	4 min
2	94 °C	1 min
3	52 °C	1 min
4	72 °C	1 min 30 sec
5	To step 2, in total 35 cycles	
6	72 °C	10 min
7	15 °C	∞

ix. ***rpl*20-*rps*12**

The *rpl*20-*rps*12 region consists of partical sequences of the plastid ribosomal protein L20 (*rpl*20) gene, and *rps*12 gene separated by an intergenic spacer.

Forward primer: CO71-F; Reverse primer: CO71-R

x. ***ndh*F-*rpl*32**

The *ndh*F-*rpl*32 region consists of partial sequences for the plastid NADH dehydrogenase (*ndh*F) gene, and *rpl*32-like gene separated by an intergenic spacer.

Forward primer: CO57.F; Reverse primer: CO57.R

Table 12. PCR conditions for *rpl*20-*rps*12 and *ndh*F- *rpl*32

	Temperature	**Time**
1	95 °C	5 min
2	95 °C	30 Sec
3	53 °C	45 Sec
4	72 °C	45 Sec
5	To step 2, in total 35 cycles	
6	72 °C	10 min
7	15 C	∞

04.ii. **Electrophoresis and amplicon quantification**

A 1% agarose-TBE gel containing SYBR Safe (4 µl in 100 ml) was prepared, and 3µl PCR product mixed with 2 µl dye was loaded into the wells along with 5 µl and 2 µl 1kb+ ladder in the next wells. After running electrophoresis for 40 minutes at 80 V, gel images were captured using Syngene G:Box F3 gel documentation system. The *mat*K and *ndh*F-*rpl*32 amplifications produced poor results, and these markers were excluded from further steps.

A gel imaging system was used to quantify the relative PCR product concentration to reduce the cost, compared to Qubit. The gel image was imported into ImageJ (U.S. National Institutes of Health, Bethesda, Maryland, USA) and each band was analysed relative to the 5 µl ladder lane (first lane). After generating a histogram for each selected lane, a baseline was drawn to remove the background noise and then selected the peaks above the baseline with wand tool. The areas of the selected peaks were displayed in a window and exported as a CSV file, then values for normalisation were calculated using 1 as standard.

04.iii. **Normalisation of PCR products and pooling**

According to the calculated normalisation values, the adequate quantity of Sigma water was added to the PCR products. Then, an equal amount of each PCR product (e.g., 6 µl) was pooled into one tube per sample (specimen). The mixture was thoroughly mixed by pipetting and the solution were spun down.

The following is the formula for rough estimation of relative concentrations against the ladder peak:

	gene: trnLF													
	length:	950	bp											
			raw value	ladder_unit1	norm_ladder	length	length_adjustment	unit_lad_len	vol	total unit	final unit conc	total vol	adding water	adding water final
example	1	KN308	10473.15	688.4161	15.21339492	864	1.157407407	17.60809597	7	123.2567	10	12.32567	5.325667182	5
	1	KN308	14559.49	732.01	19.88974058	950	1.052631579	20.93656903	7	146.556	10	14.6556	7.65559832	8

The standard length was taken as 1000 bp, and length adjustments e.g. for *trn*L-F is 1000/950 = 1.053

Table 13. Explaining the abbreviations used for normalisation value calculation

Header	**Explained**
raw_value	Area of the PCR peak
ladder_unit1	Area of the ladder peak
norm_ladder	raw_value/ladder_unit1
length	length of PCR product
length_adjustment	1000 / length of PCR product
unit_lad_len	Norm_ladder * length adjustment
vol	PCR sample volume in the tube (µl)
total_unit	unit_lad_len * vol
final_unit_conc	Desired final relative concentration
total_vol	Total_unit / final_unit_conc
adding_water	total_vol - vol
adding_water_final	Minus value made to 0

04.iv. **Cleaning of the pooled sample using AmpureXP beads and quantification by Qubit**

Thirty µl of pooled PCR products were added to new strips and 39 µl (1.3 vol) AmpureXP beads added and vortexed them separately. The samples and beads were thoroughly mixed by pipetting and left for more than 8 minutes. They were then placed into a magnetic rack until the beads created a pellet (~ 1 minute). 65 µl of the supernatant was then transferred into a new tube and 200 µl freshly prepared 80% Et-OH was added. Left for 30 seconds on the magnetic plate and removed the alcohol content completely. Repeated the washing with 80% Et-OH again two times and left the tube for air drying after completely removing the alcohol content. Then 25 µl re-suspension buffer (0.1x TE buffer) and 22 µl cleaned PCR product (amplicons) to PCR strips for library preparation and the remaining 3 µl amplicons were used to check cleaned DNA concentration using Qubit HS.

Normalisation II

From the Qubit HS value, normalised the sample to 11 ng/µl.

For the full reaction 11.5 µl, half reaction 5.75 µl to the new strops

NOTE: We use half reaction for End prep and Barcode ligation steps in the protocol.

04.v. **Library preparation – End preparation**

200 fmol (~ 130 ng for 1000 bp amplicons) was the input for Native Barcoding Kit 24 V14, for full reaction. We calculated the volume of the full reaction as an 11.5 µl NEB calculator (https://nebiocalculator.neb.com/#!/dsdnaamt). We used half-reaction (5.75 µl) for End preparation and Barcode ligation steps.

Diluted the DNA Control Sample (DCS) by adding 105 µl Elution buffer and mixed gently by pipetting and spinning down. The following chemical preparation were then carried out on ice. Mixed the Ultra II End-prep Reaction buffer and Enzyme mix to make the master mix and added to the samples

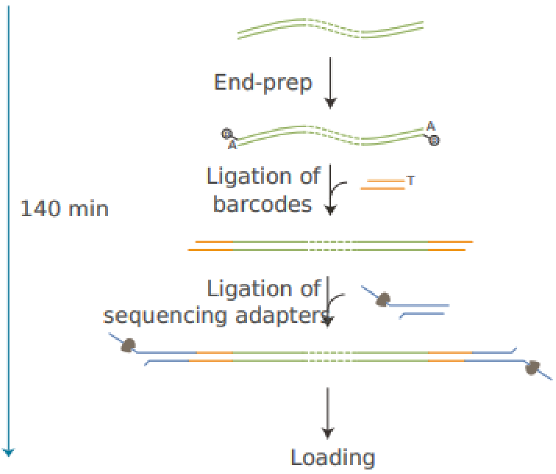


Fig. 113. Schematic representation of Library preparation

Table 14. Chemical profile for End preparation

Reagent	Volume	Volume 1/2
200 fmol amplicon	11.5 µl	5.75 µl
Diluted DNA Control Sample	1 µl	0.5 µl
Ultra II End-prep Reaction Buffer	1.75 µl	0.875 µl
Ultra II End-prep Enzyme Mix	0.75 µl	0.375 µl
Total volume	15 µl	7.5 µl

Incubated the sample at 20 ºC for 15 minutes and 65 ºC for 15 minutes in a thermal cycler with lid set to ≥ 75 ºC.

04.vi. **Barcode ligation**

We used NEBNext Ultra II Ligation Module

Table. 15. Reaction set up for Barcode ligation

Reagent	Volume	Volume 1/2
End-prepped DNA	15 µl	7.5 µl
Native Barcode (NB01-24)	2.5 µl	1.25 µl
UltraII Ligation Master Mix	8.4 µl	4.2 µl
Ligation Enhancer	0.28 µl	0.14 µl
Total	26.18 µl	13.09 µl

The master mix of ligase and enhancer was prepared by spinning down the components separately and mixing them thoroughly. A barcode was added to each individual PCR strip tube, which was then mixed well with the master mix on ice. The mix was incubated at 20°C for 20 minutes with the heated lid turned off. After incubation, 1 µl EDTA was added and mixed thoroughly by pipetting and spinning down. AmpureXP bead cleaning was carried out as described above by adding 17 µl AmpureXP beads (1.3 vol AmpureXP beads for 1 kb amplicons). The samples were then eluted in 5 µl nuclease free water and the Qubit HS was carried out. The barcode ligated and AmpureXP beads cleaned library was normalised and pooled into a single tube.

04.vii. **Adaptor ligation and clean up**

The following chemicals were mixed in a single PCR tube on ice, with 10–20 pipette mixes between each addition.

Table. 16. Reaction set up for Adaptor ligation

Reagent	Volume
Pooled barcoded sample	30 µl
Native Adapter (NA)	5 µl
NEBNext Quick Ligation Reaction Buffer (5X)	10 µl
Quick T4 DNA Ligase	5 µl
Total	50 µl

The reaction mix was incubated in a thermal cycler at 20°C for 20 minutes and the AmpureXP beads cleanup was then performed at room temperature. The reaction mixture was transferred to a 1.5 ml LoBind tube, and 80 µl (1.3 vol) of resuspended AmpureXP beads was added. The mixture was thoroughly mixed by pipetting and left for 10 minutes at room temperature.

The amples were spun down and placed on a magnetic rack to allow pellet formation. Afterward, 125 µl Short Fragment Buffer (SFB) was added to the supernatant, and the beads were gently flicked to resuspend before spinning down. The tube was again placed on the magnetic rack until the beads formed a pellet, and the SFB was removed. The SFB wash was repeated, and all residual supernatant was carefully pipetted off.

The beads were then resuspended in 15 µl Elution Buffer (EB) and incubated at 37°C for 10 minutes. The beads were pelleted on the magnet, and the library was moved to a clean 1.5 ml LoBind tube. The library concentration was checked with Qubit HS assay and adjusted to 12 µl at 10–20 fmol (for 1000 bp amplicons, 12 µl at 15 fmol is about 10 ng/µl concentration). The library was now ready for loading onto the MinION.

04.viii. **MinION sequencing**

Sequencing output was in POD5 file format. Uploaded the POD5 data to the server works with GPU-Dorado (pydorado v 2.5.3) for base calling, it generates .bam file (https://github.com/nanoporetech/dorado). Samtools (v1.1.1) working on CPU sorting the bam file and generate sorted.bam file as output (https://github.com/samtools/samtools). The sorted bam file is provided as input to demultiplexing under guppy (v3.1.0) working on CPU and generate fastq file (https://timkahlke.github.io/LongRead_tutorials/BS_G.html). For the trimming of adaptor/barcode, Porechop (v0.2.4) was used (https://github.com/rrwick/Porechop) which takes about 15 minutes and only retains the primer sequences as such. Chopper (v0.6.0) works for quality and length trimming by removing poor reads and short reads within few seconds. Minimum read length (300) to remove noise; to be set for each region/pooled sample and maximum read length (1250) to remove chimeras not detected by porechop; to be set for each pooled sample (https://github.com/wdecoster/chopper)

Ampliconsorter (v2023-03-24) under CPU, created the read files by locus/amplicon and building consensus sequences. The first run with default settings and then without and created the .tmp file and was used in further analyses. The maximum read length was set to 150000 to enforce reading all reads and default for minimum length was 300bp (https://github.com/avierstr/amplicon_sorter).

All sequences were separately aligned online with MAFFT v.7 (https://maft.cbrc.jp/alignment/server/) and matrices for each locus were prepared.

Sanger sequencing

05.i. DNA extraction and PCR

Sanger sequencing was carried out for the ITS and *rps*16 markers. DNA isolation and amplification were carried out in the molecular laboratory of the Department of Botany, University of Calicut. PCR product purification and sequencing were outsourced to GeneSpec Pvt. Ltd., Kochi, Kerala, India.

Genomic DNA was isolated and amplified as described above, but the PCR reaction mixture was prepared for 25 µl volumes, including the template DNA. Successful PCR products were then purified using ExoSAP-IT (GE Healthcare, Massachusetts, USA). For this, 5 µl PCR product was mixed with 0.5 µl ExoSAP-IT and incubated at 37^0C for 15 minutes. At this stage, the remaining primers and unincorporated dNTPs from the PCR product were degraded and heating to 85°C for 5 minutes inactivated the enzyme.

05.ii. Sequencing and matrix alignment

The purified PCR products were subjected to cycle sequencing carried out in a PCR thermal cycler (GeneAmp PCR System 9700, Applied Biosystems) using the BigDye Terminator v3.1 Cycle sequencing Kit (Applied Biosystems, Texas, USA). For 10 µl reactions mixture, 6.6 µl of distilled water, 1.5 µl of 5× sequencing buffer, 0.3 µl of each forward and reverse primer, 0.3 µl sequencing mix, and 1 µl of ExoSAP-treated PCR product were used. The sequencing profile used was 96°C for 2 minutes, and 30 cycles of 96°C for 30 seconds, 50°C for 40 seconds, 60°C for 4 minutes, and terminated at 4°C.

The amplified product was cleaned up by preparing a 50 µl mixture of 1 µl 3M sodium acetate (pH of 4.6), 0.1 µl of 125mM EDTA, 5 µl of distilled water, and 44 µl ethanol (100%) per sample. The 50 µl mixture was added to each well in the sequencing plate containing the PCR product. Vortexed the sample for thorough mixing and incubated at room temperature for 30 minutes. After the incubation, centrifuged at 3700 rpm for 30 minutes and the supernatant was decanted. Each well was washed with 50 µl of 70% ethanol and repeated centrifugation at 3700 rpm for 20 minutes and followed the further steps. After decanting the supernatant, the pellet was air-dried and subjected to sequencing on ABI3500 DNA Analyzer (Applied Biosystems, Foster City, California, USA). The final output was in an ABA file format along with electrophorograms and was further used for the analysis.

To get the consensus sequence, the newly generated forward and reverse sequences were combined with Sequencher v.4.14 (https://sequencher.software.informer.com/4.1/) and the obtained DNA sequences were subjected to the Basic Local Alignment Search Tool (BLAST) to test for contamination and to confirm the targeted marker. The sequences were aligned online with MAFFT v.7 (https://maft.cbrc.jp/alignment/server/). With Mesquite v.3.7 (Maddison and Maddison, 2019) all the obtained alignments were manually adjusted.

06. Phylogenetic analyses

To infer evolutionary relationships among species, Maximum Parsimony (MP) analysis was carried out. This method estimates the evolutionary history of organisms by identifying the least number of evolutionary changes or mutations. To assess the likelihood of phylogenetic trees, Bayesian inference (BI) analysis was used, which incorporates prior information and provides a probabilistic framework based on Markov Chain Monte Carlo (MCMC) algorithms.

The analysis was conducted using a combined amplicon sequence data matrix (**Amp58**), which includes sequences from two nuclear (ETS and ITS) and six chloroplasts (*trn*LF, *ndh*F, *rps*16, *psb*A-*trn*H, *rpl*32-*trn*L, and *rpl*20-*rps*12) markers representing 50 *Aeschynanthus* samples. Additionally, Sanger sequence data for ITS (**nr94**) from 87 *Aeschynanthus* samples and *rps*16 (**cp56**) from 50 *Aeschynanthus* samples were included. The Amp58 matrix includes 13 Indian samples, whereas nr94 comprises 55 Indian samples and cp56 includes 26 Indian samples.

07. Partition homogeneity test (ILD test)

The combinability of the matrices was determined by the incongruence length difference (ILD) test of Farris *et al.* (1995) implemented in PAUP v.4.0b (Swofford, 2003) as a Partition homogeneity test using a heuristic search, on 100 replicates of repartitioning with TBR (Tree Branching Reconnection) as branch swapping algorithm and MulTrees off. The ILD tests were carried out to test the combinability of ITS and ETS matrices, both of which are linked nuclear markers, in order to test for data coherences (i.e., absence of recombinations or sample/lab mix-ups), and for the chloroplast matrices *trn*LF, *ndh*F, *rps*16, *psb*A-*trn*H, *rpl*32-*trn*L, and *rpl*20-*rps*12. Finally, to test for possible effects of incomplete lineage sorting or hybridisation, the congruence between the combined nuclear and chloroplast matrices was also tested.

08. Parsimony analysis

The matrices Amp58, nr94, and cp56 were analysed by maximum parsimony (MP), implemented in PAUP* beta Version 4.0a146 (Swofford, 2002). All characters were used unordered with equal weighting, and gaps (indels) were treated as missing data. A heuristic search was performed by generating 10,000 trees via stepwise random addition, no branch swapping, 'MulTrees' and 'Steepest Descent' options activated. The most parsimonious tree was then optimised using 'TBR branch swapping', with the 'MulTrees' and 'Steepest Descent' options on. The resulting trees were filtered to retain only the shortest trees, addressing a glitch in PAUP.

The amount of parsimony signal was assessed using the number of parsimony informative sites, consistency index (CI) (Kluge and Farris, 1969), retention index (RI), and rescaled consistency index (RC) (Farris, 1989). For assessing bootstrap branch support, bootstrap analysis was carried out by generating 10,000 trees via stepwise random addition (=1), with TBR branch swapping and 'MulTrees' option deactivated.

09. Bayesian Inference

The matrices Amp58, nr94, and cp56 were also analysed by Bayesian Inference (BI). Best-fitting models of nucleotide substitution were selected for all data partitions of the Amp58 (ITS, ETS, *trn*L-F, *ndh*F, *rps*16, *psb*A-*trn*H, *rpl*32-*trn*L, and *rpl*20-*rps*12), ITS (nr94) and *rps*16 (cp56) using MrModeltest v.2.4 (Nylander, 2004), according to the Akaike Information Criterion (AIC - Akaike, 1974). The selected models for each partition of Amp58 are provided in Table. 17. For ITS (nr94), and *rps*16 (cp56), the best-fitting model was GTR+I+G.

Table 17. MrModeltest values for individual matrices

	Matrix	Selected Model	No samples
Nuclear	ITS	GTR+I+G	58
	ETS	HKY+G	41
	*trn*L-F	GTR+G	50
	*ndh*F	GTR+G	47
	*rps*16	GTR+I+G	48
	*psb*A-*trn*H	F81+G	52
	*rpl*32-*trn*L	GTR+G	49
	*rpl*20-*rps*12	GTR+G	43

Two independent runs, each with four MCMC chains, were carried out for 1 million generations, sampling every 1000th generation. A burn-in of 20% was set to the sampled trees. Convergence of the two independent runs was tested using the Average Standard Deviation of Split Frequencies (ASDSF), which should be below 0.01, and the Potential Scale Reduction Factor (PSRF) (Gelman and Rubin 1992), which should converge to 1. Additionally, the Effective Sample Size (ESS) for each parameter was verified to be above 200 using Tracer v.1.7.1 (Rambaut *et al.*, 2018).

The majority rule consensus tree was generated using the command 'sumt'. Branch support values, represented as posterior probabilities, were retrieved from the consensus tree in FigTree v.1.4.4 (Rambaut, 2006–2018). The tree was manually edited in iTOL v7.

Fig. 114. Amplicon sequencing carried out from the RBGE molecular laborotary

Results

Molecular phylogenetic analyses

The Partition Homogeneity Test PHT for the Amplicon sequence matrix resulted in a value of 0.8 for the comparison of the nuclear matrices (ETS, ITS), 0.47 for the comparison of the chloroplast matrices (*trn*L-F, *ndh*F, *rps*16, *psb*A-*trn*H, *rpl*32-*trn*L, and *rpl*20-*rps*12), and 0.06 for the comparison of the combined nuclear and chloroplast matrices, suggesting that the data were congruent and combinable for further analysis.

The Amp58 matrix was 8102 characters long. 856 characters, representing the ambiguous regions at the 5' and 3' ends, were excluded using the eliminate command. Missing data were represented with '?' and gaps were marked by '-'. Of the remaining 7246 characters, 6024 were constant (83.1%), 530 were variable but parsimony-uninformative (7.3%) and 692 were parsimony-informative (9.6%). The MP analysis resulted in two most parsimonious trees, each of 2007 steps, with a CI of 0.7275, a RI of 0.8388, and an RC of 0.6102. Bootstrap values ranged between 56% –100%.

In the BI analysis of the Amp58 matrix, the models used for the individual markers are as in Table 17. The ASDFS was 0.005989 after 1 million generations, indicating satisfactory converge between the two MCMC runs. The trees topologies obtained from both the MP and BI analyses of the Amp58 matrix were identical, with both analyses supporting the monophyly of the genus with high branch support (BS:100; PP:1). The genus was resolved into two major clades: clade I, and clade II.

The ITS matrix included 94 samples and was 782 characters long, of which 386 characters were constant (49.4%), 145 were variable but parsimony-uninformative (18.5%) and 251 were parsimony-informative (32.1%). The MP analysis resulted in two most parsimonious trees, each of 886 steps, with a CI of 0.6230, a RI of 0.8152, and a RC of 0.5079. Bootstrap values ranged from 56% –100%.

For the BI analysis of the ITS matrix, the best-fit model was GTR+I+G according to the Akaike Information Criterion. After 1 million generations, the ASDFS was 0.09, indicating satisfactory convergence of the two MCMC runs. The consensus trees from both the MP and BI analyses were identical in topology.

The cp56 matrix was 883 characters long. Of these, 736 characters were constant (83.4%), 63 were variable but parsimony-uninformative (7.1%), and 84 were parsimony-informative (9.5%). The MP analysis resulted in two most parsimonious trees, each of 204 steps, with a high CI of 0.7843, a RI of 0.8728, and a RC= 0.6846. Bootstrap values ranged from 56% –97%.

The best-fit model for the BI analysis of the cp56 matrix was GTR+I+G according to the Akaike Information Criterion. After 1 million generations, the ASDFS was 0.009, indicating that satisfactory convergence of the two MCMC runs. The consensus MP and BI trees showed some topological incongruences.

All phylogenetic trees produced in this study indicated the monophyly of the genus, with high branch support (BS:100; PP:1). The genus was resolved into two major clades: clade I, and clade II, both with high bootstrap support (100% clade I; 100% clade II). Notably, all the Indian taxa were nested within clade I (Figs. 115–120)

The ILD test resulted in a value of 0.01, indicating incongruence between the ITS and *rps* 16 matrices. *rps*16 phylogram does not have not many strongly supporting branches (Fig. 119). Hence it is not discussing in detail.

Discussion

In the present study, two main clades (clade I and clade II) were recognized through phylogenetic analyses of *Aeschynanthus*, both with high bootstrap support and posterior probability (BS:100%, PP:1) for both the clades. As discussed by Denduangboripant *et al*. (2001), Southeast Asian taxa were nested in clade I, while the Malaysian taxa mainly nested in clade II (*A. guttatus, A. magnificus, A. nummularius, A. pachyanthus, A. roseoflorus, A. solomonensis, A. tricolor and A. vinaceous*).

Clade I is further bifurcated into clade Ia (BS:100, PP:1) and clade Ib (BS:100, PP:1). Clade Ia was represented by a single species, *A. buxifolius* Hemsl., which is morphologically distinct from the other taxa in clade I by its flaky, wrinkled appearance attained by the dense, minute papery ridges on the stems, as well as its very short seed appendages (0.5–1.1 mm long).

In the phylogenetic tree derived from Amp58 matrix, clade Ib was further diverged into two, of which clade Ibi (BS:100, PP:1) includes the Indian taxa, *A. gracilis*, *A. hookeri*, *A. parviflorus*, and several Chinese, Malayan and New Guinean species. clade Ibii (BS:100, PP:1) consists of the South Indian and Sri Lankan taxa (*A. ceylanicus*, *A. ceylanicus* var. *pinguis*, *A. perrottetii*, *A. perrottetii* var. *malabaricus*, *A. perrottetii* var. *planiculmis*). The subclade I (BS:100, PP:1) of clade Ibi the species *A. albidus*, *A. angustifolius*, *A. arfakensis*, *A. hartleyi*, and *A. longicaulis*, which are characterized by marbled leaves and numerous hilar appendaged (*c*. 60) seeds.

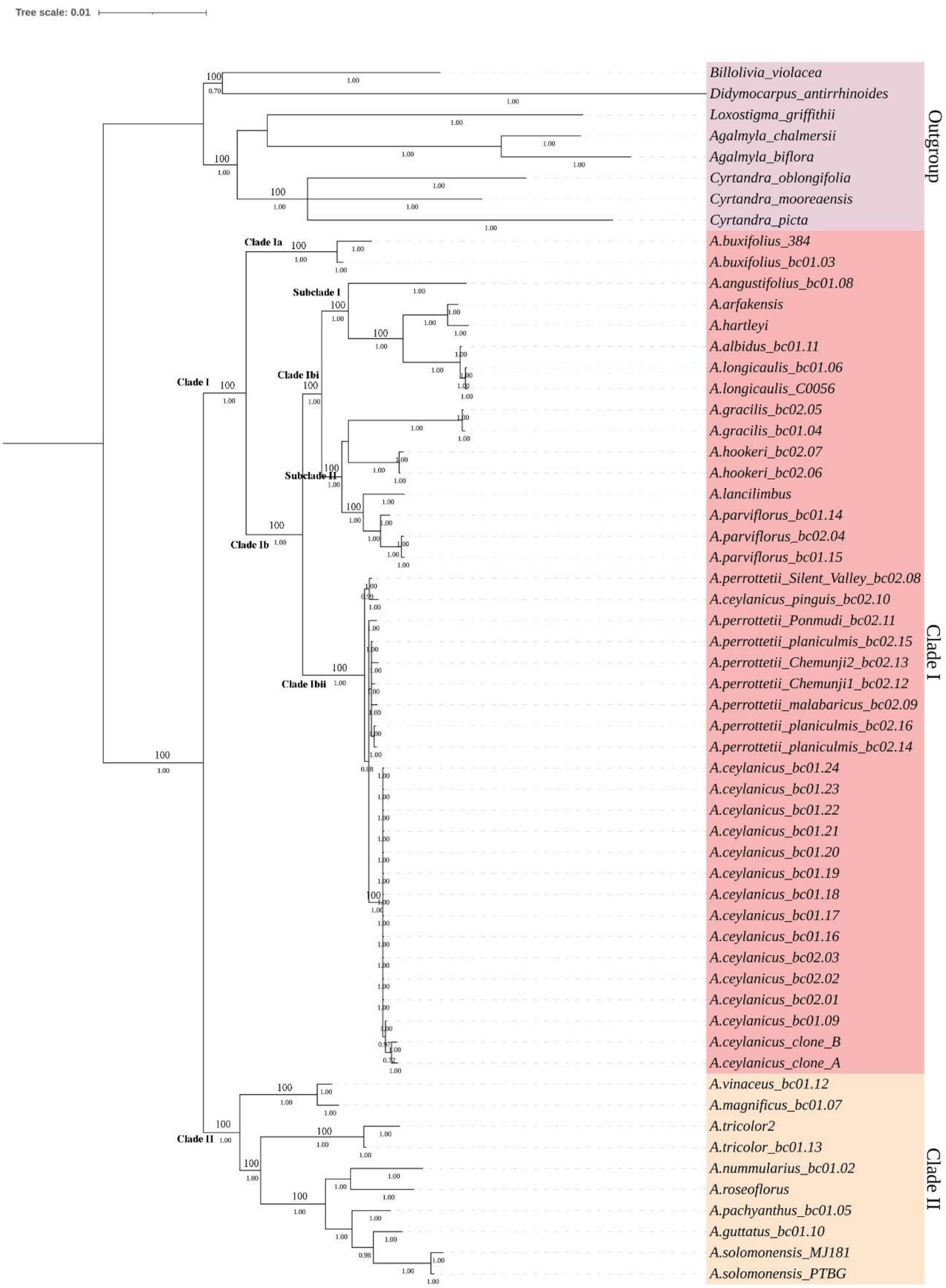


Fig. 115. Strict consensus tree of *Aeschynanthus* inferred from Amp50 combined matrix. Numbers above branches are MP bootstrap support (BS) followed by Bayesian posterior probabilities (PP) below the branches.

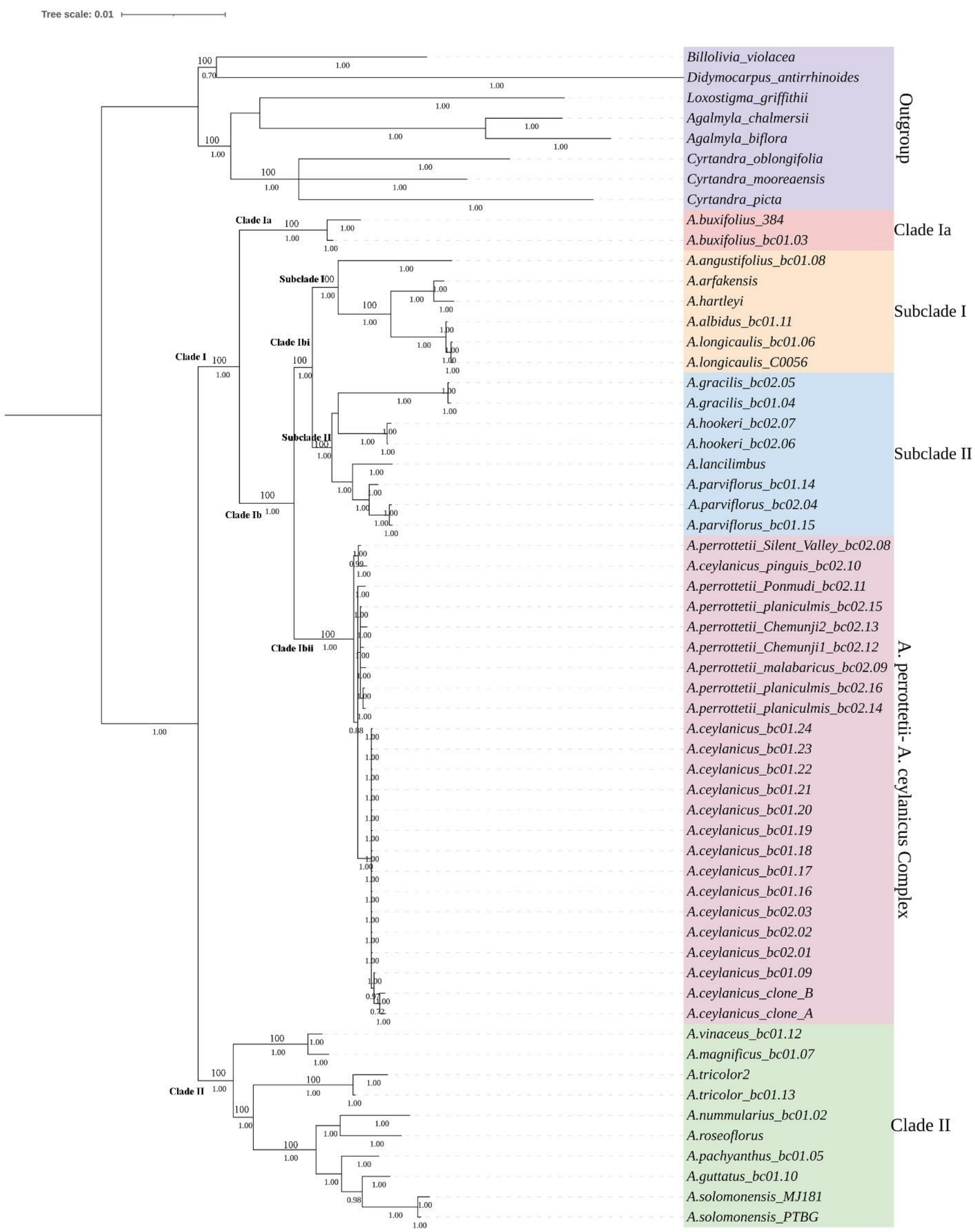


Fig. 116. Strict consensus tree of *Aeschynanthus* inferred from Amp50 combined matrix. Numbers above branches are MP bootstrap support (BS) followed by Bayesian posterior probabilities (PP) below the branches.

Fig. 117. Phylogram obtained from MP analysis of ITS (nr94) matrix.

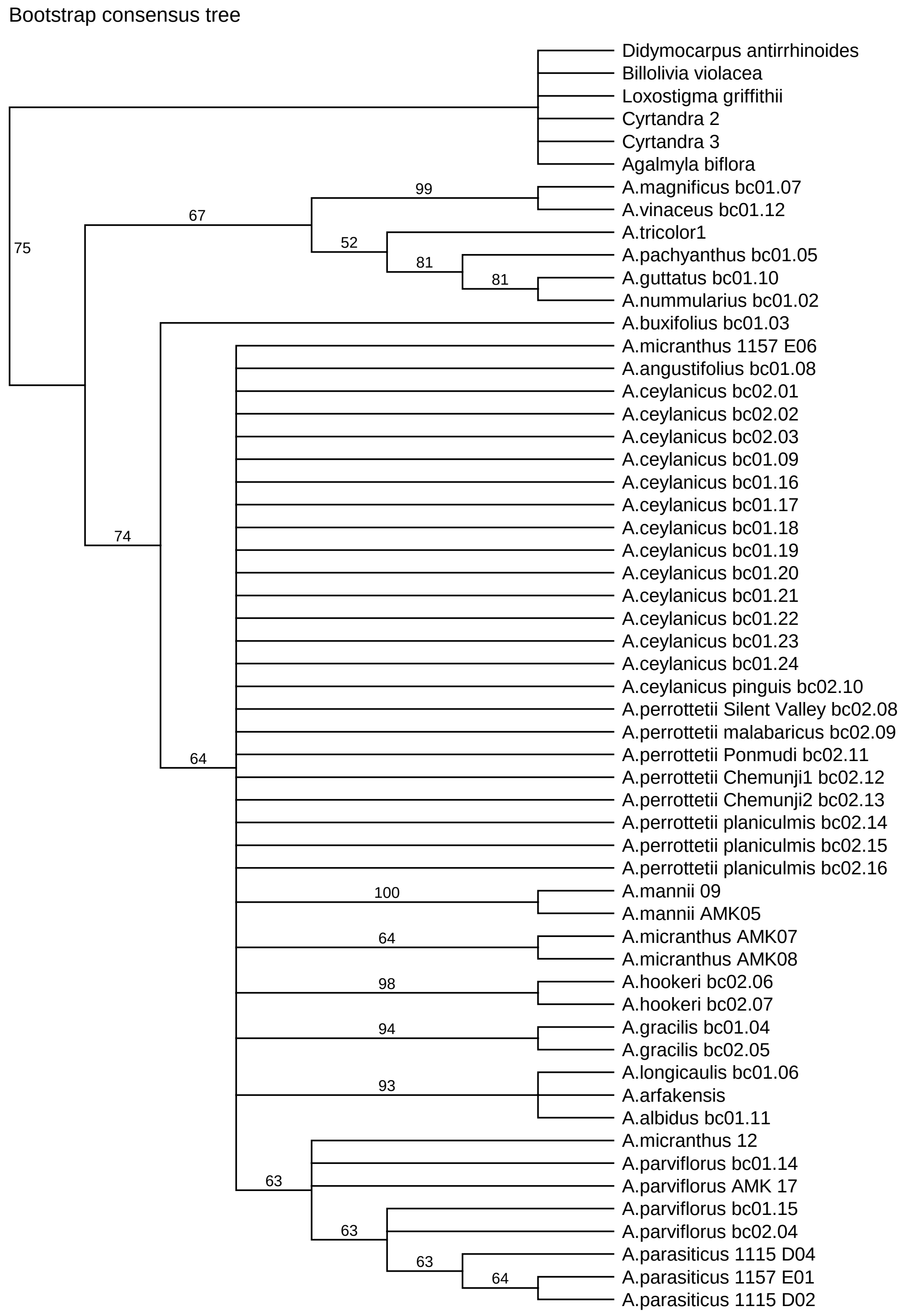


Fig. 118. Bootstrap consensus tree obtained from MP analysis of ITS (nr94) matrix.

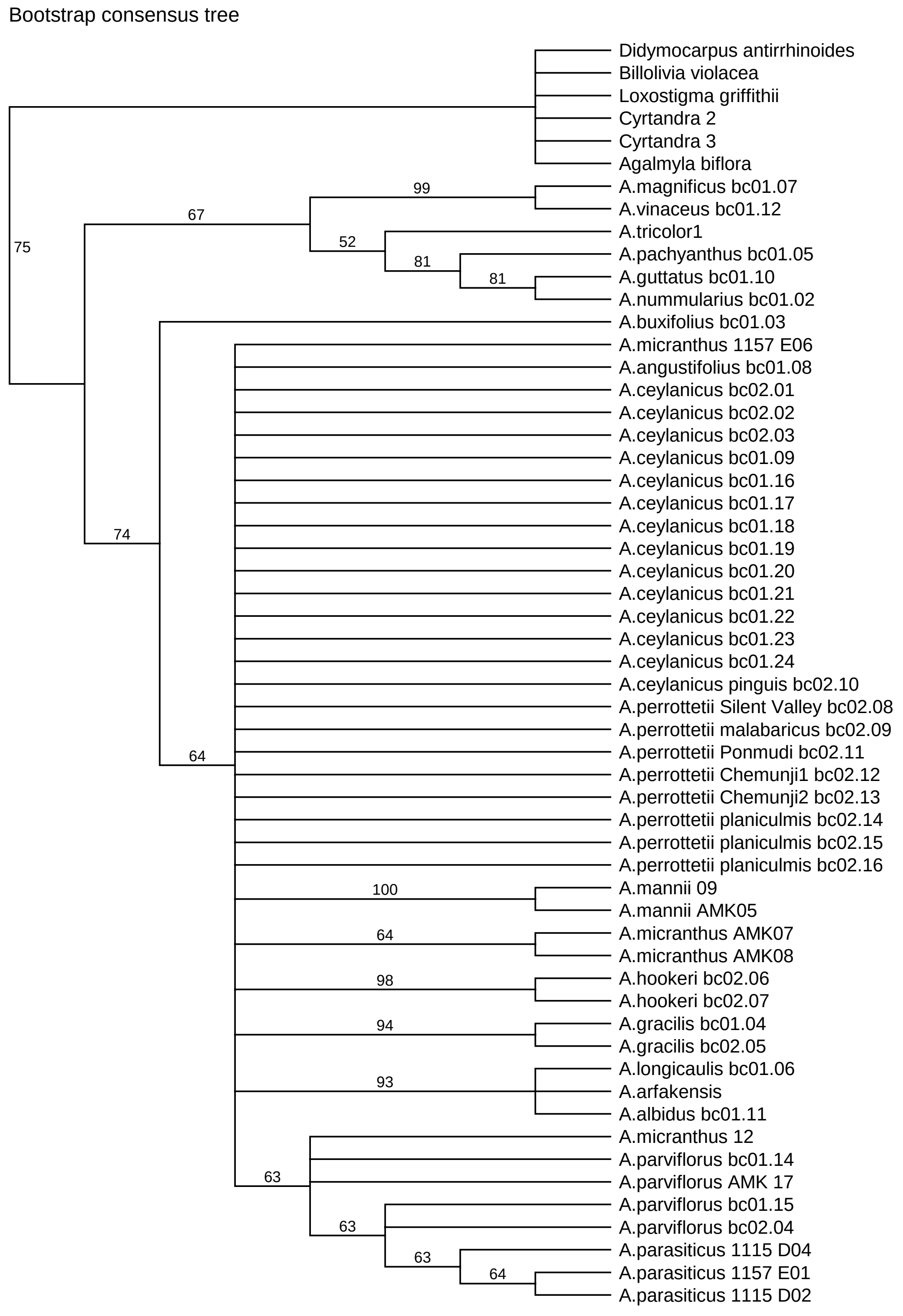


Fig. 119. Bootstrap consensus tree obtained from MP analysis of *rps*16 (cp56) matrix.

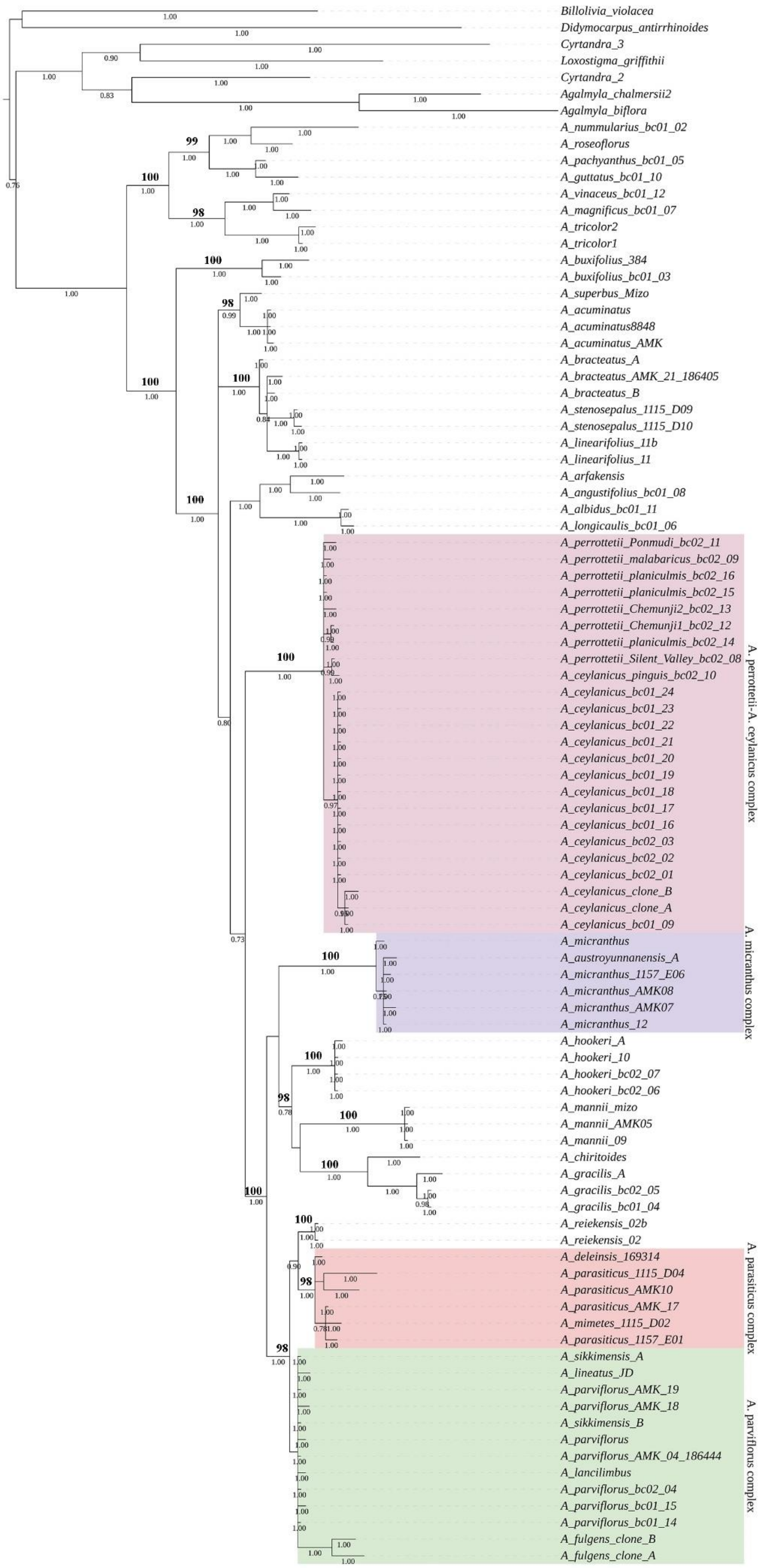


Fig. 120. Strict consensus tree of *Aeschynanthus* inferred from ITS (nr94) matrix. Numbers above branches are MP bootstrap support (BS) followed by Bayesian posterior probabilities (PP) below the branches.

In the nr94 tree (Figs. 117, 118 & 120), more taxa from both India and other regions are included. As discussed previously, the tree is mainly divided into two clades, with clade I further subdivided into clade Ia and clade Ib, exhibiting the same bootstrap support and posterior probability as mentioned above. Within clade Ib, there is further divergence into clade Ibi and clade Ibii (BS:100, PP:1). Clade Ibii includes species distributed in Northeast India, specifically *A. bracteatus, A. linearifolius* and *A. stenosepalus*. *Aeschynanthus linearifolius* forms a highly supported clade in MP analysis (BS:100, PP:1), while *A. bracteatus* and *A. stenosepalus* form a polytomous clade. However, in the BI analysis, all these three species were placed in a polytomy, suggesting a lack of resolution among them.

The clade Iai is further divided into two subclades, of which subclade II contains *A. superbus* and *A. acuminatus*, which are separated by high branch support (BS: 98, PP:0.99). Subclade I is consisted of two additional subclades, subcladeIa includes the South Indian and Sri Lankan taxa (BS:100, PP: 1), while subclade Ib further diverges into two distinct subclades. Subclade Ibi (BS:100, PP:0.996) consists of all remaining Indian taxa, including *A. acuminatus, A. fulgens, A. gracilis, A. hookeri, A. mannii, A. micranthus, A. parasiticus, A. parviflorus, A. reiekensis,* and *A. sikkimensis*. This suclade also includes the Chinses species *A. austroyunnanensis* and *A. lineatus* (found both in China and Thailand). Subclade Ibii (BS:100, PP:1) contains the Malaysian and New Guinean species, such as *A. albidus, A. angustifolius, A. arfakensis* and *A. longicaulis*.

Status of *Aeschynanthus perrottetii – ceylanicus* complex

Various morphological studies have been conducted to explore the existence of different species and varieties of *Aeschynanthus* in India and Sri Lanka (De Candolle, 1845; Gardner, 1846; Clarke, 1883; Hooker, 1884; Trimen, 1895; Cooke, 1908; Gamble, 1921; Santapau, 1948; Bhattacharyya & Goel, 2014). However, the phylogenetic studies undertaken in the genus (Denduangboripant *et al.*, 2001; Ranasinghe, 2017) have not included South Indian accessions, which are essential for resolving the taxonomic uncertainties. Recently, Ranasinghe (2017) suggested that further studies are needed in the *A. perrottetii - ceylanicus* complex to understand whether distinct taxonomic boundaries exist between these taxa and their varieties, particularly by incorporating samples from South India.

For the present study, nine accessions from South India (*A. perrottetii*) and 15 accessions from Sri Lanka (*A. ceylanicus*) were used. Among the South Indian samples, four were identified as *A. perrottetii,* three as *A. perrottetii* var. *planiculmis,* one each as *A. perrottetii* var. *malabaricus* and *A. ceylanicus* var. *pinguis.* All samples were collected from different geographical areas, which also reflect distinct morphological patterns. The selection of varieties was based solely on the protologues.

The phylogenetic tree derived from Amp50 matrix (Figs. 115 & 116) shows the divergence of a clade consisting of South Indian and Sri Lankan accessions with high phylogenetic support (BS:100, PP:1). However, this clade further resolves into a polytomous clade, with South Indian accessions nested as sister to the Sri Lankan accessions, which also form a polytomous group. Additionally, *A. ceylanicus* var. *pinguis* and one accession of *A. perrottetii* are sister to the rest of the Indian & Sri Lankan samples; this would make *A. perrottetii* paraphyletic with Sri Lankan *A. ceylanicus* nesting within it. Even though these two taxa, (*A. ceylanicus* and *A. parviflorus*) geographically divided, their morphological variations are strikingly overlapping with each other.

Interestingly, the small form of *A. ceylanicus,* i.e., *A. ceylanicus* var. *pinguis,* is nested within the *A. perrottetii* samples and there is no clade divergence observed to separate the varieties each other, suggesting a lack of distinct phylogenetic differentiation between these two species. Altogether, the tree implies that there is little distinction between *A. perrottetii* and *A. ceylanicus*.

The amplicon tree clearly indicates the initial diversification of the taxa in South India, followed by a split between South India and Sri Lanka, suggesting that South India represents the ancestral area for this clade. Therefore, it is concluded that, *A. ceylanicus* is conspecific to *A. perrottetii*.

Aeschynanthus micranthus complex

Wang (1975) described *A. austroyunnanensis* from China, and in 1990 he reduced the status of a later described species *A. guangxiensis*, to a variety of *A. austroyunnanensis*. Later, Middleton (2009) synonymised these names under *A. micranthus*.

In the present study, two accessions of *A. austroyunnanensis* from China were included and were nested in the same clade as *A. micranthus* in the nr94 (ITS) tree (Fig.

120), and formed sister clade to *A. hookeri* with strong phylogenetic support (BS:100, PP:1). The morphological characteristics of these two entities were discussed in chapter 05. Based on the molecular data, this study validates the synonymisation done by Middleton (2009).

***Aeschynanthus parviflorus* complex**

The name *A. parviflorus* was accepted over *A. ramosissimus* based on the rule of priority (see chapter 05). Later, Lindley (1841) described *A. maculatus*, and Clarke (1883) recognized two varieties: *A. maculatus* var. *sikkimensis* and *A. maculatus* var. *stenophylla*. Subsequently Stapf (1922) elevated *A. sikkimensis* to a species, and treated *A. maculatus* var. *stenophylla* as conspecific with *A. maculatus*. Middleton (2007), synonymised all these names under *A. parviflorus*.

The present study involves nine accessions of *A. parviflorus,* of which two each were identified as *A. sikkimensis* and *A. maculatus* based on the protologue. The ITS tree (Fig. 120) revealed that, all these accessions were nested in the same clade, sister to the *A. parasiticus* - *A. reiekensis* clade (BS: 98, PP:1) validating the synonymisation of Middleton (2007). Additionally, *A. lineatus* and *A. fulgens* formed a polytomous clade in the MP ITS tree, located on a near-basal lineage, but this relationship was likely not highly supported, suggesting that these species are likely not part of the *parviflorus* complex.

***Aeschynanthus parasiticus* complex**

Based on the morphological characters, Middleton (2009) synonymised *A. deleiensis*, *A. mimetes*, and *A. andamanensis* under *A. parasiticus*. The present study includes six accessions of *A. parasiticus*, including one accession each of *A. deleiensis* from the Delay valley and *A. mimetes* with a longer, narrow calyx tube and shallow lobes from Meghalaya. The ITS tree revealed that all these accessions were nested within the same clade, sister to the newly described *A. reiekensis* clade, with high boot strap support (BS: 98, PP:1). These two clades share a similar distinct morphological in having strigose hairs inside the base of corolla tube. These results validate the synonymisation proposed by Middleton (2009).

The *A. reiekensis* clade has high statistical support (BS: 100, PP:1) denoting its distinct identity with the sister clade (*A. parasiticus* complex). The clade altogether has the similarity in their strigose hairs on the inner corolla base.

Furthermore, *A. chiritoides* (sect. *Xanthanthos*) nested as sister clade to *A. gracilis* (sect. *X*) showing their phylogenetic relation. Hence the treatment of these two species together in a section is feasible (see chapter 7 & 8).

While the seed characters optimised onto a tree set obtained from Maximum Parsimony analysis of ITS (nr94) matrix, based on parsimony method in Mesquite (Fig. 121) indicates that, Sections are paraphyletic and hence can't be considered as natural.

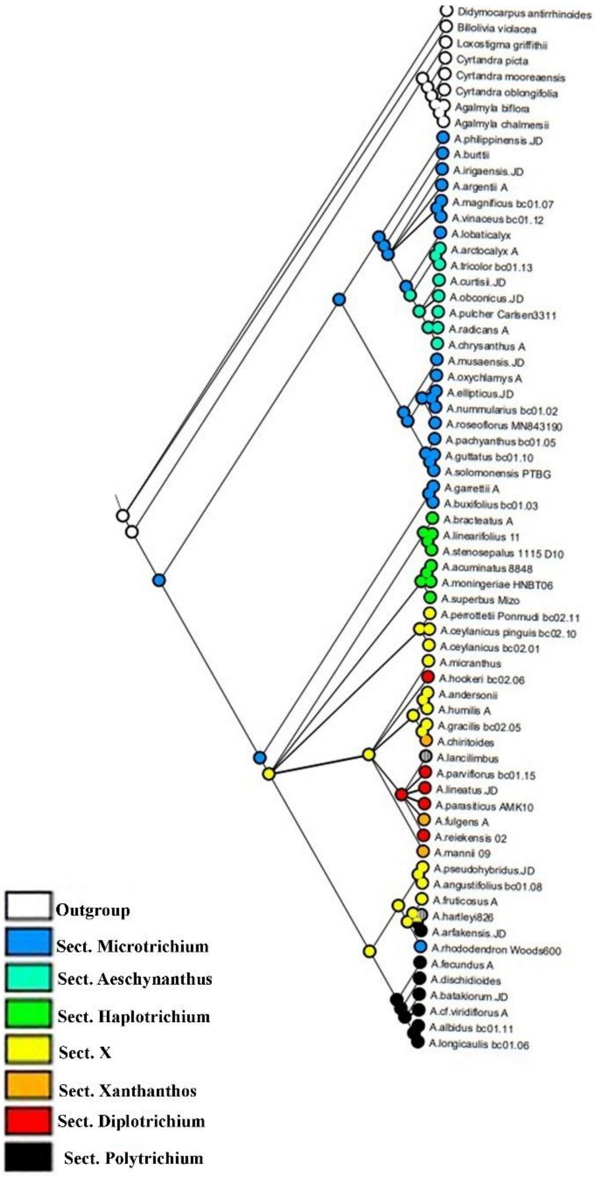


Fig. 121. Fig. 56. Evolutionary pattern of the seed characters in *Aeschynanthus*.

CHAPTER- 11
ECOLOGY

ECOLOGICAL ADAPTATIONS

The wet tropical vegetation is mainly characterized by the abundance of epiphytic flora. In general, true epiphytes are plant species that germinate on the trunks or branches of living plants and complete their entire life cycle without establishing root connections to the ground. In certain instances, some plants may form connections with the ground during specific stages of their life cycle (Madison, 1977). Most *Aeschynanthus* species prefer epiphytic habitats, only becoming lithophytes when attaining proper growth conditions. To establish, survive, and reproduce, epiphytes have developed various adaptive strategies. This chapter discusses the ecological adaptations of *Aeschynanthus* species in general.

i. Seed dispersal

The method of seed dispersal in epiphytic plants is specifically designed to reach highly specialized habitats conducive to germination. The long, slender capsules of *Aeschynanthus* contain numerous anatropous ovules, with the apical end having a single appendage pointing towards the base, while the hilar end may have one, two, or many appendages pointing towards the apex of the capsule (Fig. 122). Upon maturation, the capsules open loculicidally, releasing tiny (0.25–2 mm without appendages), appendaged seeds that are dispersed by the wind. This method is advantageous for epiphytes, living high in the tree canopy, as the wind helps carry them further through the upper reaches of the forest.

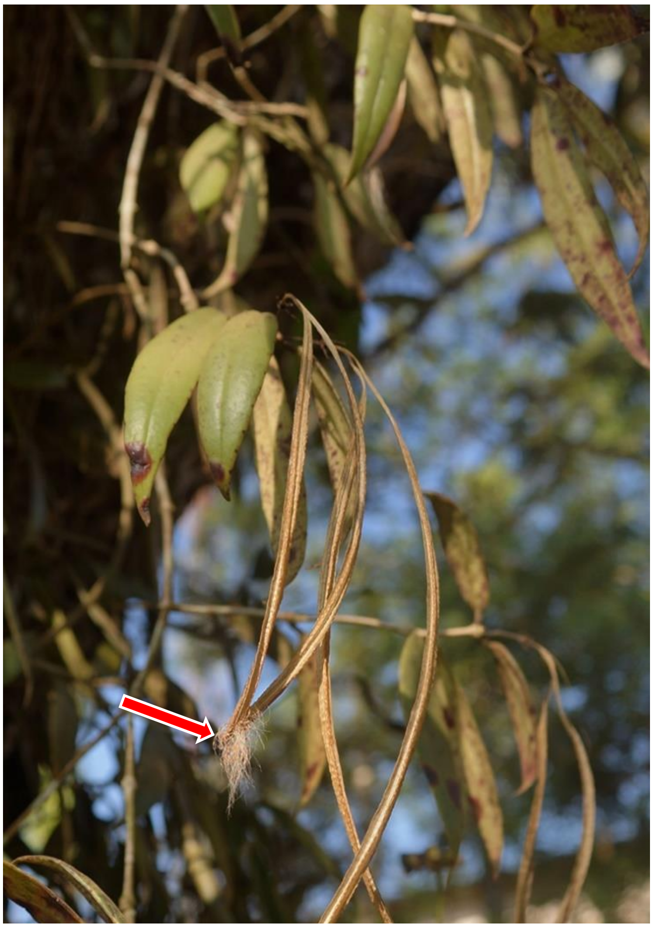


Fig. 122. Capsule dehiscence, see the appendaged seeds

In addition to the hairs on the seeds, some species (sect. *Aeschynanthus*) possess a cluster of bubble-like cells at the base of the hilar appendage (Fig. 123). These cells are filled with air, increase the seed's buoyancy, aiding long distance dispersal by air currents. Geographically, the length and number of appendages are directly related to dispersal efficiency. This is evidenecd by the wider distribution of the sect. *Polytrichium*, which has a tuft of hilar appendages, compared to the more restricted distribution of the single appendaged (Malesian) sect. *Aeschynanthus* or *Micritrichium* (Mendum *et al.*, 2000).

Fig. 123. Seed with bubble cell

The appendages also assist in anchoring the seeds to suitable substrates, such as branches, when they become wet. Additionally, the papillae on the testa cells of the seeds increase their surface area, enhancing water absorption and enabling germination without a dormancy period (Madison, 1977).

ii. Establishment

Aeschynanthus species produce adventitious roots primarily from their nodes (Fig. 124), allowing them to securely attach to the host tree trunk or branches. This adaptation also facilitates vegetative reproduction through fragmentation. Species with creeping stems can successfully establish themselves in this manner (Madison, 1977).

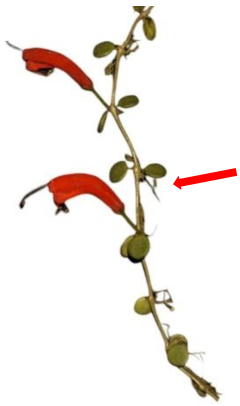


Fig. 124. Adventitious roots

Vivipary: In some cases, when the seeds are delayed in dispersal, they may begin to germinate while still inside the capsule. I observed this rare occurrence in *A. parasiticus* in the field in Sikkim (Fig. 125a). This observation is further supported by evidences from the herbarium specimens of *A. bracteatus* from Myanmar at BM (BM000883934), and *A. fecundus* P.Woods from Thailand at E (E00428728), both of which contain capsules with tiny seedlings emerging from them (Fig. 125b-d).

Fig. 125. Vivipary shown by different *Aeschynanthus* species: **a.** *A. parasiticus***; b.** *A. fecundus* **c & d.** *A. bracteatus*.

iii. Water relation

In epiphytic habitats, water availability fluctuates dramatically. Most epiphytes have evolved mechanisms to cope with these situations by storing and trapping water during dry periods, while minimizing water loss (Madison, 1977). The roots of *Aeschynanthus* are generally found within a thick mantle of moss or humus that accumulates in tree crotches or among fern roots, which function as a good water reservoir, helping to prevent desiccation. Additionally, the plants exhibit several xeromorphic adaptations, such as fleshy and leathery leaves, the presence of thin-walled, large water-storing cells in the hypodermis (with varying numbers of cell layers) (Weber, 2004), and waxy cuticles that reduce transpiration.

Water calyx

In some species of sect. *Aeschynanthus*, the calyx matures well before the corolla and serves as a water reservoir. It fills with a slimy secretion from the sepals, possibly mixed with rainwater, creating a miniature "water bath" in which the flower buds develop (Fig. 126). This adaptation helps to protect the developing buds from extreme desiccation (Burtt & Woods, 1975), and may also offer some defence against herbivory (Carlson & Harms, 2007).

Fig. 126. Water calyx

Harmomegathy

To maintain the viability of pollen grains over extended periods, the pollen walls fold onto themselves during dry conditions, reducing the surface area, and then unfold when favourable conditions return, a process known as harmomegathy (Katifori *et al.*, 2010; Halbritter *et al.*, 2018). In *Aeschynanthus*, the spheroid pollen grains adopt a prolate shape, by means of three longitudinal folds. This phenomenon was observed in *A. perrottetii* and *A. reiekensis* during the present study (Fig. 111).

iv. Pollination

Aeschynanthus is mainly adapted for ornithophily, or bird pollination, characterized by bright (often red) colour, arcuate corolla tube, strong protandry, downwardly shedding pollen grains from the exserted stamens, and the production of copious nectar with a low-sucrose content (Porsch, 1924; Burtt & Woods, 1975). The gynophores, often associated with the slender, streamlined ovary, helps protect the ovules from damage caused by the bird's beak (Grant, 1950).

v. Herbivory

To deter herbivory, *Aechynanthus* species employ several strategies. One such strategy is the formation of "water calyx" (already discussed above). The other deterrent measures include:

a. Trichomes

Fig. 127. Leaf trichomes

Trichomes are external outgrowths of epidermal cells, that serve a variety of functions, including acting as a protective barrier against herbivory, pathogen attacks, and excessive transpiration (Uphof, 1962). Hairy vegetative parts are a characteristic feature of juvenile stages in *Aeschynanthus*. As the plant mature, they become glabrous. However, many species in sect. *Aeschynanthus* and some species in sect. *Xanthanthos* (e.g., *A. chiritoides*, *A. gracilis*, Fig. 127), and sect. *Microtrichium* (e.g., *A. nummularius*) retain these juvenile, hairy features (Burtt & Woods, 1958, 1975). Additionally, glandular trichomes are present on the reproductive parts of some *Aeschynanthus* taxa (such as *A. chiritoides*, *A. gracilis*), often varying with altitude. These trichomes may secrete bioactive compounds, contributing to the plant's defence against herbivory (Uphof, 1962).

b. Batesian mimicry- first-ever report for *Aechynanthus*

It is very interesting to note that many *Hoya* species (Apocynaceae) are often misidentified as *Aeschynanthus* during field explorations in the Asian tropics, especially in their vegetative or fruiting stages (Middleton, 2007). For example, when describing *Hoya membranifolia* Costantin based on a fruiting specimen, the author did not initially consider placing it under the genus *Aeschynanthus*, until Middleton (2007) made the new combination by pointing out the similarity of its capsule and seeds to those of *Aeschynanthus*. Similarly, Costantin (1912) initially treated *A. fulgens* from Laos as *Hoya pseudolanceolata* Costantin, but this was later synonymized by Middleton (2016).

On several occasions, I mistakenly collected *Hoya* species with similar morphology to *Aeschynanthus*, only realizing the misidentification upon noticing the exudation of latex (mostly milky). Initially, I assumed this morphological similarity was a result of adaptation to comparable habitat preferences in these two extremely dissimilar plant groups. However, upon further examination, revealed that *Aeschynanthus* species had likely evolved to mimic *Hoya* species in several ways, particularly as a strategy to discourage herbivory. The mimicry of an unpalatable species by a palatable one is termed Batesian mimicry (Stilling, 2012), and is common and widely discussed in animals, but it is extremely rare in plants (Gianoli & Carrasco-Urra, 2014; Yager *et al.*, 2016; Lev-Yadun, 2019). This represents the first-ever report of the Batesian mimicry in an epiphytic plant, specifically within the genus *Aeschynanthus*.

Many insect herbivores show a preference for specific leaf shapes or structures, both for feeding and oviposition. This preference often serves as a visual indication for the plant's palatability (Mackay & Jones, 1989; Rivero-Lynch *et al.*, 1996; Campitelli *et al.*, 2008). By mimicking *Hoya*, *Aeschynanthus* has adapted to deter herbivores through the production of latex, from *Hoya*. Latex typically contains several bioactive chemical compounds, including alkaloids, cardiac glycosides, terpenes, digestive proteins, and sugar-mimicking substances (Agrawal & Konno, 2009; Konno, 2011; Mithöfer & Boland, 2012). These compounds help protect plants not only from insects but also from fungi, bacteria, and even vertebrate herbivores (Fahn, 1979; Konno, 2011). The sticky nature of the latex causes insect herbivores to become stuck, leading to slow death, or it deters them by gluing their mouth parts, thus preventing or discouraging feeding. Many *Hoya* species produce milky latex, which, due to its white colour, increases its visibility within the plant canopy, serving as a visual aposematic (warning) signal to potential herbivores (Lev-Yadun, 2014).

While collecting young leaf samples of *A. monetaria* from the field for molecular analysis, I unexpectedly noticed milky latex oozing out from the cut ends of some petioles. Upon further examination, I discovered that the latex actually originated from *Hoya nummularia* Decne ex Hook.f., an epiphytic plant species that shares identical vegetative characteristics such as narrow creeping stems, short petioles, and opposite, fleshy, discoid leaves, and similar niche specificities (Fig. 128a,b). Due to these superficial similarities, distinguishing between the two plant groups at a first glance can be challenging. Although I had often noticed the coexistence of various *Hoya* species alongside different *Aeschynanthus* species in the field, this was the first time I encountered an indistinguishable pair. This observation led to the realization of Batesian mimicry in *Aeschynanthus* as an adaptive strategy to prevent herbivory.

During a field expedition in the Lurh Tlang hills of Mizoram, I spotted several populations of *Hoya burmanica* Rolfe, initially mistaking them for *A. mannii*. It has an epiphytic habitat, with relatively short stems and opposite, fleshy leaves that converge towards the apex, resembling those of *A. mannii*. Eventually, I found *A. mannii* in a mixed population with *H. burmanica*. While there are some differences in leaf shape, overall, the two species appeared quite similar (Fig. 128c,d).

Similarly, I found *Hoya lanceolata* growing in areas that overlap with the habitat of *A. gracilis* in several places across Meghalaya and Arunachal Pradesh. This species has a drooping habit with opposite, fleshy, and small elliptic leaves similar to those of *A. gracilis* (Fig. 128e,f).

During the early stages of my research, I collected samples of large-leaved, gregariously growing *Hoya* with long, narrow capsules initially assuming it to be *A. superbus*. However, upon noticing the mass of short hairs on only one side of the seeds, I realized my mistake. Without flowers or seeds, distinguishing between *Hoya* from *Aeschynanthus* in their dried state is extremely challenging. Many specimens in various herbaria have been misidentified, with *Hoya* species often incorrectly as *Aeschynanthus*.

In South India, during several field trips, I mistakenly collected *Hoya wightii* Hook.f. as as *A. perrottetii*. Alhough these two species usually grow separately; they can coexist within the same location. Upon closer examination, I found that both species exhibit similar morphological variation in their vegetative characters, and the altitudinal gradient seems to enhance the scope for mimicry. More specifically, *Hoya wightii* has two subspecies: *H. wightii* subsp. *wightii* and *H. wightii* subsp. *palniensis* K.T.Matthew (Fig. 129a,b). The former subspecies has fleshy, elliptic to lanceolate leaves that exactly resemble those of *A. perrottetii* growing in low altitudes, while the latter subspecies has small ovate leaves matching the leaves of *A. perrottetii* at these elevations.

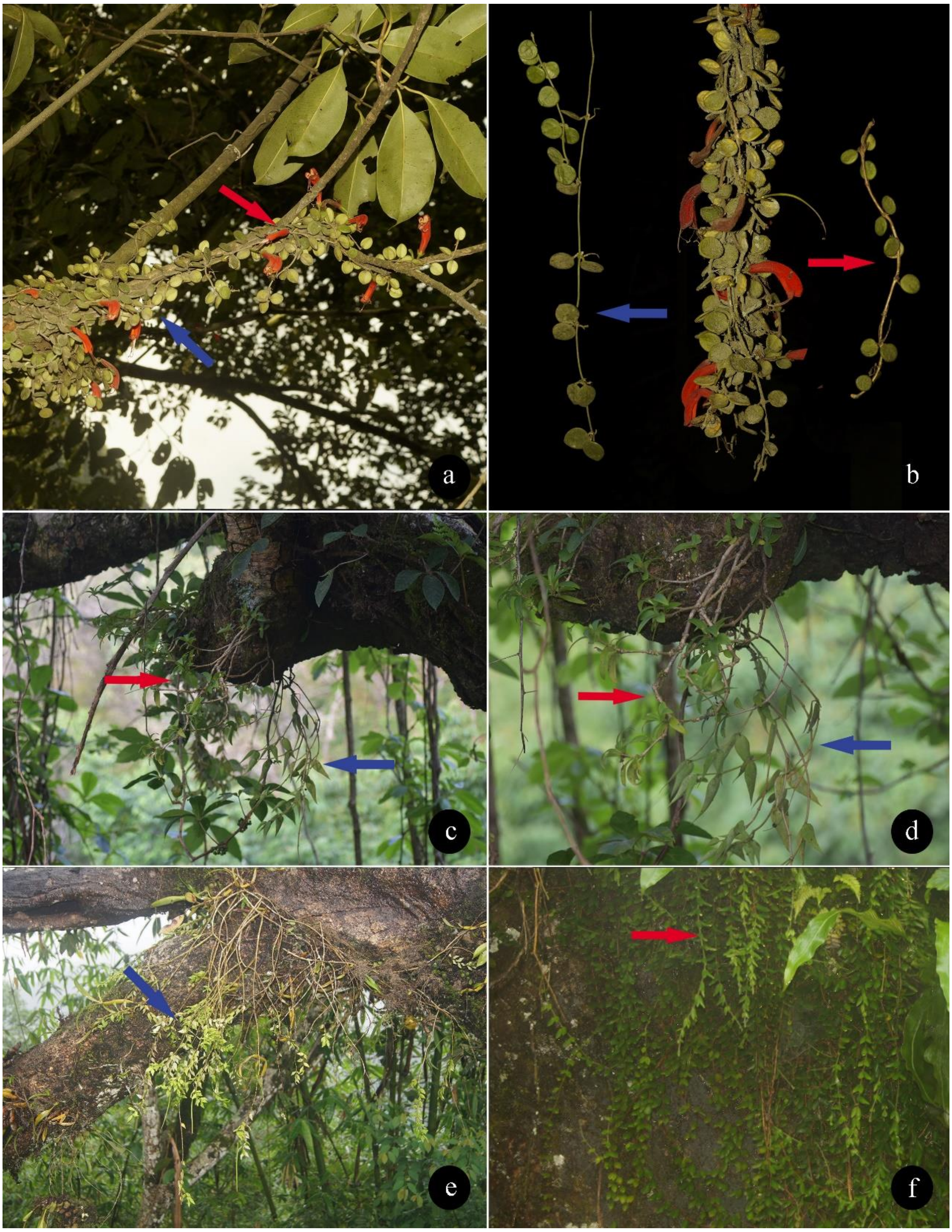


Fig. 128. Batesian mimicry is shown by different *Aeschynanthus* species: **a & b.** *A. monetaria* (red arrow) and *Hoya nummularia* (blue arrow); **c & d.** *A. mannii* (red arrow) and *H. burmanica* (blue arrow); **e.** *H. lanceolata*; **d.** *A. gracilis*.

Fig. 129. a & b. Batesian mimicry: **a.** *Hoya wightii*; **b.** *Aeschynanthus perrottetii*; **c–g.** Stem gall of *A. perrottetii*

From these interesting observations, I hypothesize that:

i. The undefended *Aeschynanthus* species mimics the leaf shape of the unpalatable *Hoya* species, providing a clear example of Batasian mimicry in plants.
ii. The variations in foliar morphology among the two subspecies of *H. wightii* across an altitudinal gradient paralle the variations observed in *A. perrottetii*.
iii. The morphological similarity between these two plant groups is pronounced when they grow in close proximity to one another than when they are found in separate locations.

c. Stem galls

Gall formation is a dynamic process that represents a balance between the offensive stimulus delivered by the inducing insects (including mites) and the defensive response of the host plant (Rosenthal & Janzen, 1978). This process involves the developmental alterations in the plant that occur at specific critical points during its differentiation, leading to the partial or complete enclosure of the inducing insect and its offspring within the gall. The gall, in turn, provides both nutrition and shelter for the developing insects until they reach maturity or complete their reproduction (Raman, 2003).

During field explorations at Nelliampathi hills, Palakkad district, Kerala I noticed some populations of *A. perrottetii* exhibiting an unusual growth in their stems (Fig. 129c-g). Upon closer morphological and anatomical examination, I confirmed these structures as stem galls, a rare occurrence in the genus. I was unable to find similar formations in any other species or other locations of *A. perrottetii*. With assistance from experts at the Department of Zoology, University of Calicut, I identified the gall makers as the host-specific Dipteran insect, *Prolasioptera aeschynanthus perottetii* Mani. This insect penetrates the delicate stems and creates cavities in the cortex, where it feeds on the surrounding tissue. The gall formation is induced by cecidogenetic stimulation, which triggers the proliferation of cortical tissue outside the larval chamber while having minimal effect on the stele, which finally results in a solid, fleshy, globose or cylindrical, brown, rugose, and often agglomerated swelling on the branches (Mani, 1965; Jayaraman, 1989).

Gall formation is generally considered a defensive mechanism, and it is typically detrimental to the host plant (Price *et al*., 1987). However, the gall may also act as a nutrient sequester, making the host plant less susceptible to further herbivory or pathogen attacks (Price *et al.*, 1987; Wool, 2004). The production of phenolic compounds and other secondary metabolites plays a crucial role in regulating plant defense responses to phloem-feeding insects (Thompson & Goggin, 2006; Howe & Jander, 2008; Giron *et al*., 2016).

Despite the gall formation, *A. perrottetii* exhibits massive growth in the affected areas, suggesting that the plant may derive some advantages from this unusual structure. This may represent an ecological adaptation for the species, warranting further investigations to draw definitive conclusions.

CHAPTER~ 12

ORNAMENTAL LIPSTICK PLANTS

ORNAMENTAL LIPSTICK PLANTS

The striking appearance and adaptability of *Aeschynanthus* have made it one of the most popular choices among gardeners and indoor plant enthusiasts. Its bright orange or red tubular flowers, resembling lipstick tubes, create a dramatic contrast against the dark green foliage. With its hanging growth habit, it enhances the aesthetic appeal, and are popularly known as lipstick vines, lipstick plants, or basket vines. The trailing growth is creatively used in a variety of ornamental arrangements and is also valued for its ability to bloom intermittently throughout the year. Apart from the floral beauty, some *Aeschynanthus* are also grown for their architecturally pleasing foliage (as in *A. longicaulis*), and are commonly called 'tiger lipstick' among gardeners for their marbled leaves.

Most of the ornamental *Aeschynanthus* are native to the humid tropical forests of Malaysia, Indonesia, and the Philippines, and they naturally grow as epiphytes, thriving on other plants or trees in the warm, moist understory of the forest canopy. In cultivation, these plants typically reach a height of about one meter, but under ideal conditions, they can reach up to two meters tall.

Generally, lipstick vines prefer bright, indirect sunlight and well-draining, rich organic potting mix with an ambient temperature between 18°C and 24°C for good growth. They are usually adapted to thrive best in humid environments and can be achieved by placing regular misting or with a room humidifier. Pruning in regular time intervals promotes vigorous growth and flowering. Propagation can be easily achieved through stem cuttings (https://gesneriads.info/gesneriad-genera/aeschynanthus/).

Some commonly cultivating lipstick plants in Indian gardens are:

1. Aeschynanthus radicans Jack

These are widely called red-lipstick plants and are native to Malaysia and Indonesia. It is prized for its tubular dark-coloured calyx and emerging reddish corolla. The trailing growth habit with glossy, dark green leaves makes them a good choice for hanging baskets.

2. Aeschynanthus longicaulis Wall ex. R.Br.

Also known as the zebra lipstick or tiger lipstick plant, it is native to Peninsular Malaysia. The plant is characterized by its striking foliage, featuring marbled leaves with silvery or brownish veins resembling zebra's or tiger's stripes. The flowers are usually green and not very captivating.

3. Aeschynanthus speciosus Hook.

This species is a native of Malaysia and is known for its robust growth habit and larger flowers. The leaves are glossy and the tubular flowers appear in various colours ranging from orange to red.

4. Aeschynanthus pulcher (Blume) G.Don

This species is native to the rainforests of Borneo and is featured for its dark green leaves and vibrant orange-red flowers.

Hybrid varieties

Apart from the natural species, several hybrid varieties of lipstick plants are cultivated through controlled breeding to combine desirable traits from different species of the genus. These hybrids often exhibit unique characteristics in terms of foliage and flower shape, size, and colouration. Here are some notes on major hybrid varieties of lipstick plants:

1. Aeschynanthus × splendidus (Splendid Lipstick Plant)

This hybrid variety is known for its large, showy flowers and glossy foliage. It typically produces clusters of tubular flowers in shades of red, orange, or pink. It is prized for its vigorous growth and profuse flowering, making it a popular choice for indoor gardens and hanging baskets.

2. Aeschynanthus 'Black Pagoda' (Black Pagoda Lipstick Plant)

This hybrid is named for its striking dark purple to black foliage, which contrasts beautifully with its bright red flowers. 'Black Pagoda' is a compact variety, making it suitable for small spaces or as a focal point in a mixed container garden.

3. Aeschynanthus 'Rasta' (Rasta Lipstick Plant)

This hybrid variety is prized for its unique foliage, which features bright green leaves with red edges, resembling the colours of the Rastafarian flag. It produces clusters of tubular flowers in shades of red, orange, or yellow, adding to its ornamental appeal. *Aeschynanthus* 'Rasta' is relatively easy to care for and thrives in warm, humid conditions with bright, indirect light.

4. Aeschynanthus 'Twister' (Twister Lipstick Plant)

This hybrid variety is named for its twisted or contorted foliage, which adds an interesting texture to indoor gardens. It typically produces clusters of tubular flowers in shades of red, orange, or pink, contrasting beautifully with its variegated leaves. This one is a low-maintenance plant that thrives in bright, indirect light and prefers consistently moist soil.

5. Aeschynanthus 'Mona Lisa' (Mona Lisa Lipstick Plant)

This hybrid variety is known for its compact growth habit and prolific flowering. It produces clusters of tubular flowers in shades of red, orange, or pink, with a long bloom period. *Aeschynanthus* 'Mona Lisa' is a versatile plant that can be grown indoors or outdoors in containers, provided it receives adequate light and moisture.

6. Aeschynanthus "Thai Pink"

This cultivar is popularised by their quite unusual pinkish corolla. This is a vigorous, large growing species with vines often reaching up to two meters. The fused (tubular) calyx may also pink or light green and the plant may refer to *A. chinanthus*, or *A. chinanthus*.

Conservation of wild Aeschynanthus at CUBG

During the present study, attempt has been made to collect the wild germplasm of *Aeschynanthus* from various regions of India, and conserve them at the Calicut

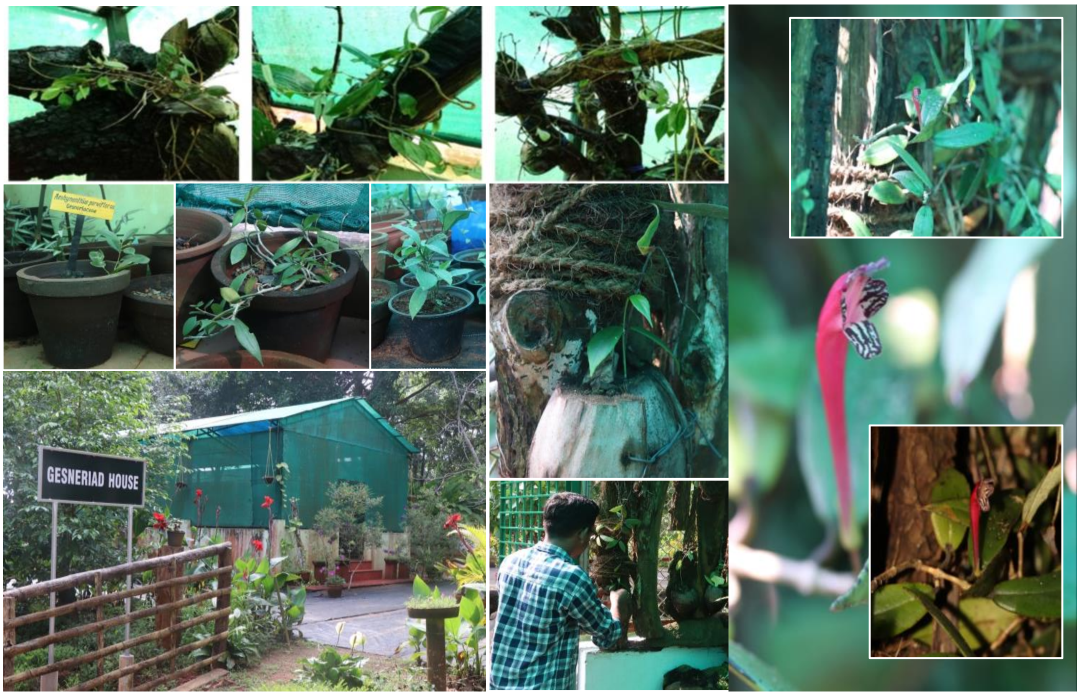


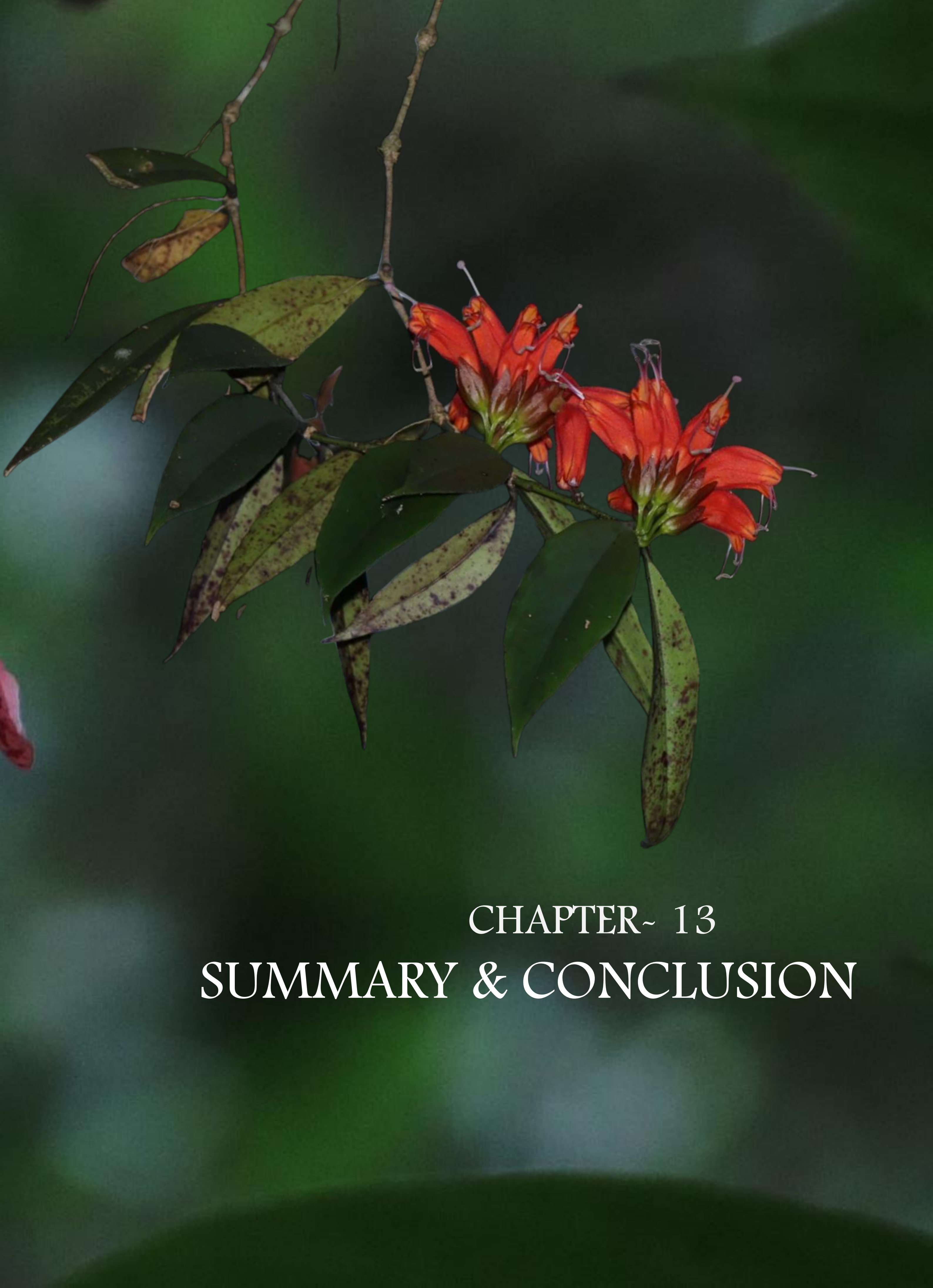
Fig. 130. Conservation at the Gesneriad House of CUBG

University Botanical Garden (CUBG). It was found that all the *Aeschynanthus* species found in India prefer specific climatic conditions, making it challenging to establish them in regions with differing environments. However, at CUBG, accessions of *A. perrottetii* from various parts of South India have shown successful establishment and growth. Among the Northeastern accessions, only *A. parviflorus* exhibits relatively considerable establishment.

During my visit to the Royal Botanic Garden Edinburgh (RBGE), I had the opportunity to observe many species of *Aeschynanthus* from various countries growing in excellent condition (Figs.131 & 132). This provided a unique opportunity to study the genus on the global scale, with live samples, enhancing my understanding of its diversity and morphology.

Fig. 131. Living collections of *Aeschynanthus* at RBGE: **a.** *A. batakiorum*; **b.** *A. chrysanthus*; **c.** *A. curvicalyx*; **d.** *A. ellipticus*; **e.** *A. humilis*; **f.** *A. vinaceous*; **g.** *A. lineatus*; **h.** *A. longicaulis*; **i.** *A. siphonanthus*; **j.** *A. magnificus*; **k.** *A. mendumiae*; **l.** *A. musaensis*.

Fig. 132. Living collections of *Aeschynanthus* at RBGE: **a.** *A. philippinensis*; **b.** *A. pseudohybridus*; **c.** *A. radicans*; **d.** *A. macrocalyx*; **e.** *A. spp.*; **f.** *A. siphonanthus*; **g.** *A. ternifolius*; **h.** *A. guttatus*; **i.** *A. spp*; **j.** *A. irigaensis.*; **k.** *A. tricolor*; **l.** *A. rhododendron.*



CHAPTER- 13

SUMMARY & CONCLUSION

SUMMARY AND CONCLUSION

The present study is the first attempt to make a comprehensive taxonomic account of the genus *Aeschynanthus* Jack (Gesneriaceae) in India based on morphology, seed micromorphology, palynology, and molecular phylogeny. Extensive field explorations were carried out in India, particularly in South India and Northeast India during 2019–2023, to collect live specimens from the field and to study its habitat and ecology. About 25 collection trips were carried out and spent above 200 days in the field. Ten states, (Arunachal Pradesh, Assam, Karnataka, Kerala, Meghalaya, Mizoram, Nagaland, Sikkim, West Bengal, and Tamil Nadu) were covered, and collected live samples of 17 species were, including two new species. Multiple accessions of each species were collected as possible, for studying the variation and molecular analysis. From the collected specimens, 200+ herbarium sheets were prepared and deposited at the Calicut University Herbarium (CALI) and were digitized. Attempts have been taken to conserve the germplasm at the Gesneriad house of Calicut University Botanical Garden (CUB) which is reflected in the good growth of South Indian species *A. perrottetii* and Northeast Indian *species A. parviflorus*.

To obtain in-depth morphological knowledge, several National (ARUN, ASSAM, BSHC, CAL, and CALI) and International (BM, E, and K) herbaria were consulted, and attached determinative slips for 100+ specimens at K, 15 specimens at E, 3 specimens at BM and about 80 specimens at various Indian herbaria.

The present study documents 20 species of *Aeschynanthus* from India, including two new species. The majority (90 %) of species were distributed in the Northeastern region and the remaining in South India and Andaman and Nicobar Islands. The list of Indian *Aeschynanthus* species is given below:-

1. *Aeschynanthus acuminatus* Wall. ex A.DC.
2. *Aeschynanthus angustioblongus* W.T.Wang
3. *Aeschynanthus bracteatus* Wall. ex A.DC.
4. *Aeschynanthus chiritoides* C.B.Clarke
5. *Aeschynanthus fulgens* Wall. ex R.Br.
6. *Aeschynanthus gracilis* C.S.P.Parish ex C.B.Clarke
7. *Aeschynanthus hookeri* C.B.Clarke

8. *Aeschynanthus linearifolius* C.E.C.Fisch.
9. *Aeschynanthus mannii* Kurz ex C.B.Clarke
10. *Aeschynanthus maoi* Debta & A.Shenoy
11. *Aeschynanthus micranthus* C.B.Clarke
12. *Aeschynanthus monetaria* Dunn
13. *Aeschynanthus parasiticus* (Roxb.) Wall.
14. *Aeschynanthus parviflorus* (D.Don) Spreng.
15. *Aeschynanthus perrottetii* A.DC.
16. *Aeschynanthus reiekensis* Lalhlupuii, S.D.Khomdram & S.D.Yumkham
17. *Aeschynanthus stenosepalus* J.Anthony
18. *Aeschynanthus superbus* C.B.Clarke
19. *Aeschynanthus tirapensis* U.C.Bhattach.
20. *Aeschynanthus volubilis* Jack

In consultation with protologues and types of all the names placed under Indian Aeschynanthus, the nomenclature of all the Indian taxa was updated according to ICN. A detailed taxonomic description, photo plates, distribution map, and key to the species of *Aeschynanthus* occurring in India were provided for easy identification. **Lectotypes** were selected for the following three names: *Aeschynanthus oblanceolatus* (J.Anthony) C.E.C.Fisch., *A. philippinensis* C.B.Clarke and *A. stenosepalus* J.Anthony (Akhil & Nampy, 2020) and two **new taxa**: *Aeschynanthus reiekensis* and *Aeschynanthus maoi*, respectively from Mizoram and Arunachal Pradesh were published (Lalhlupuii *et al*., 2023; Debta *et al*., 2024).

The present study revealed that *A. maoi*, *A. reiekensis* and *A. tirapensis* are **endemic** to the country (Northeast India) and *A. perrottetii* is endemic to the Western Ghat and Sri Lankan biodiversity hotspot. The world-level conservation assessment based on IUCN categories and criteria revealed that, out of 20 species two species each come under Critically Endangered (CR) and Endangered (EN) categories, thirteen under Least Concern (LC), and three under Data Deficient (DD) category.

Seed micromorphological studies carried out for 17 Indian species imply that hair-like seed appendages and secondary testa cell character elaborations were particularly moulded for wind dispersal and establishing an epiphytic habit. Based upon the testa cell orientation and the nature of papillae, seeds were mainly classified into two types and further into several subtypes and groups. Of the 17 studied species, 13 have a single hilar appendage (one species under A2 type, 6 species each under A3 type, and B1 type), three have two hilar appendages and one has 2–4 hilar appendages (all comes under B2 type). Based upon the morphological and molecular data, the present study combined the sect. *X* with the sect. *Xanthanthose* and re-circumscribed the sect. *Diplotrichium* to include the species with 2–4 hilar appendages. The A2 seed type represents the sect. *Aeschynanthus* (*A. volubilis*) which possesses bubble cells in the base of the hilar appendage, A3 seed type represents the sect. *Haplotrichium* with comparatively small, single hilar appendages (0.15–0.64 cm long), B1 seed type represents the sect. *xanthanthose* with long, single hilar appendages (1.5–3.5 cm long), and the B2 seed type represents the sect. *Diplotrichium* with 2 (–4) hilar appendages. The existing sectional classification was primarily laid on the seed characters and has no phylogenetic support, hence it is not followed for the systematic treatment.

The **palynological** studies were carried out by analysing pollen characters of eight species belonging to three sections (as per the existing classification) and observed that the pollen grains are generally stenopalynous and have spheroidal, tricolpate structures with long colpi and several ectexinous granular elements. Through the critical analysis of already published data, it is clear that pollen grain has no relevance in the infrageneric delimitations. A detailed observation documented the presence of orbicules (ubisch bodies) along with the pollen grains and is the first report in this genus.

For the **phylogenetic analysis**, a total of 382 sequences were generated for the ingroup taxa, 78 for the ITS locus, 56 for *rps*16, 46 for *psb*A-*trn*H, 43 each for *rpl* 32 and *trn* LF, 40 for *ndh*F and 39 each for *rps*12-*rpl*20 and ETS. 20 additional sequences were retrieved from NCBI for ITS. For the outgroup, 47 sequences were generated. The present study analysed the combined amplicon sequence data (nuclear + chloroplast) for 50 sampled matrices, after checking the congruence of matrices with ILD test. For a greater number of samples generated through Sanger sequencing, ITS and *rps*16 matrices were separately built and was non-congruent for compilation and analysed separately.

All the trees support the monophyly of the genus with strong statistical support. The combined tree generated using Parsimony and Bayesian methods yielded similar topologies and exhibited two major clades of *Aeschynanthus* (Clade I & II). Clade I includes all the Indian species, nested along with species from Indochina and South China. Clade II includes species from New Guinea, Sulawesi, Philippines, and Seram as discussed by Denduangboripant *et al.* (2001). Clade I is further divided into two, of which Clade Ia consists of a species distributed in China and Vietnam, and Clade Ib is further divided into two sub-clades of which one (sub-clade I) consists of all the Indian species confined to Northeast India along with the species from China and Vietnam, and the other (sub-clade II) consists of a polytomous clade of South Indian-Sri Lankan species.

Based on the morphological and molecular studies, **Synonymised** the Sri Lankan taxa *A. ceylanicus* under the South Indian *A. perrottetii* and also the treatment considered all the existing varieties (*A. perrottetii* var. *malabaricus*, var. *planiculmis*, *A. ceylanicus* var. *pinguis*) conspecific to *A. perrottetii*. Apart from this, the study supporting the synonymisation of *A. sikkimensis* under *A. parviflorus*, *A. austroyunnanensis* under *A. micranthus*, and *A. deleiensis* and *A. mimetes* under *A. parasiticus*.

Being an epiphyte, several **ecological adaptations** were undertaken by the genus in nature for the establishment, survival, and reproduction, which include tolerance to desiccation, prevention of herbivory, bird pollination syndromes, wind dispersal of seeds, etc. The present study observed the mimicry of several *Aeschynanthus* species to the *Hoya* species to deter herbivory and this Batesian mimicry is the first report for the genus. Additionally, the vivipary also reporting for the first time here.

The striking appearance and adaptability of *Aeschynanthus* have made it one of the most popular choices among gardeners and indoor plant enthusiasts. The bright orange or red tubular flowers resemble lipstick tubes and stand out against the dark green foliage with hanging habits enhancing its aesthetic appeal. Apart from the floral beauty, many *Aeschynanthus* species were grown for their molted leaves also.

CHAPTER- 14

RECOMMENDATIONS

RECOMMENDATIONS AND FUTURE OUTLOOKS

The present work provides an integrated approach to the taxonomy of the genus *Aeschynanthus* in India, based on morphology, seed micromorphology, palynology, and molecular phylogeny. The recommendations put forward herein are based on comprehensive field-based studies on this genus in India.

Aeschynanthus flowers exhibit characteristic features associated with bird pollination, such as arcuate corolla tube, strong protandry, exserted anthers with downwardly shedding, often brightly coloured pollen, and a considerable quantity of nectar productions (Porsch, 1924; Burtt & Woods, 1975; Grant 1950). However, there has been limited research on the pollination biology of the genus globally. Rahman (2011) reported bumble bees (*Bombus rucifes*) as the pollinators for a Malaysian species, offering new insights into the pollination ecology of the genus. Despite high pollination success in the wild, bird visits to these plants are uncommon in the field. During my own field work, I observed bird visit to *A. superbus* on only one occasion, whereas spotted ants and small insects were frequent visitors . Given these observations, I strongly recommend conducting a detailed pollination study for the genus to understand its pollination strategies.

The present study reports the occurrence of orbicules in the inner anther walls, which are of similar shape (rounded oblate) and size (0.03–0.05 µm in diam.) across the studied samples. Further research is required to investigate these structures, as orbicules have been shown to have much evolutionary significance in many genera, (Verstraete *et al.*, 2014).

For molecular analysis, complete plastome sequencing would provide a more comprehensive and clearer image of the evolutionary trends within the genus. Currently, molecular data for the genus is sparse, with only about one-third of the species studied at the global level, and most of the existing data is based on nuclear ribosomal ITS sequences. A focused approach to expand molecular analyses using herbarium specimens could greatly enhance the available data, especially from regions, where field collection is challenging. This approach could contribute to biogeographical studies and provide insights into infraspecific variation studies across different populations.

In terms of growth, development, and reproduction, the genus exhibits a wide range of ecological adaptations, of which Batesian mimicry and vivipary are new findings in this genus, adding to its ecological complexity. I recommend conducting a thorough field survey to further explore these adaptations and better understand their ecological and evolutionary significance.

Many *Aeschynanthus* species also hold ethnobotanical value, as they are used by indigenous communities in various parts of the world to treat ailments such as worm infestations in children, headaches, fever, body pain, tonsilitis, tuberculosis, and infertility (Lemmens & Bunyapraphatsara, 2003; Aththorick & Berutu, 2018; Gesneriad reference web). However, scientific phytochemical studies to validate these traditional uses have been limited. Given the potential medicinal value of this genus, I strongly recommend conducting phytochemical investigations to support or refute these traditional applications and to explore their possible therapeutic benefits.

In India, many species of *Aeschynanthus* have been introduced as ornamental plants from regions such as Malaysia, Thailand, and other parts of Southeast Asia. However, a commercial propagation of native Indian species has yet to be explored. The majority of the indigenous species are found in the Northeastern states, where they are adapted to specific geographic and climatic conditions. I strongly recommend studies focussed on the commercial propagation of the native species, as it could provide a valuable avenue for both ornamental use and germplasm conservation.

Furthermore, the development of hybrid varieties using native species could be an intriguing and fruitful endeavour. Hybridization may lead to a unique combination of desirable characteristics, enhancing the diversity and appeal of the species. Such efforts have already been successfully carried out in various countries, including the UK (at the Royal Botanic Gardens Edinburgh), but in India, this area remains unexplored. Developing hybrid varieties from native species could potentially contribute to the horticultural industry and may also open new avenues for research into the genetics and ecological adaptation of the genus.

Outlook for the future

1. **Phylogenetic approach**: Future research should focus on an extensive phylogenetic approach using Next Generation Sequencing (NGS) technologies, specifically plastome sequencing, incorporating multiple accessions from diverse geographic regions, including samples from herbarium specimens. This

would provide a clearer and more comprehensive understanding of the evolutionary relationship within the genus.

2. **Biogeographic and molecular dating studies**: To infer the origin and evolutionary trends of the genus, biogeographic studies combined with molecular dating should be undertaken. These studies can help elucidate the historical distribution patterns and its evolutionary time line.
3. **Ecological adaptations**: An in-depth field study is needed to explore the ecological adaptations of the genus, especially in relation to Batesian mimicry and vivipary. Such studies will contribute to our understanding of how these adaptations support survival and reproduction in varying environments.
4. **Survey in Andaman & Nicobar Islands**: The Andaman and Nicobar Islands, geographically close to the peninsular Malaysia, may harbour more *Aeschyanthus* species, especially in the great Nicobar Islands. An extensive survey of these islands is needed to explore the potential diversity and discover new species or populations.
5. **Ecological niche modelling**: Ecological niche modelling should be applied to assess the distribution of threatened *Aeschynanthus* species, helping to predict their habitat preferences and identify areas that require conservation efforts. This can guide the protection of critical habitats and inform conservation strategies.
6. **Pollination biology**: A detailed investigation into the pollination biology of the genus is essential. Understanding the pollination mechanisms, including potential pollinators and pollination strategies, will provide valuable insights into the reproductive ecology of the genus.
7. **Phytochemical analysis**: Phytochemical studies are necessary to identify and characterize bioactive compounds present in *Aeschynanthus* species that have been traditionally used in ethnobotanical treatments. This can validate the medicinal uses of the genus and may lead to the discovery of novel therapeutic compounds.

Addressing these research priorities will undoubtedly enhance our understanding of the evolution, ecology, phytochemistry, pollination biology, and the conservation of *Aeschynanthus*. It will also shed light on the critical role this genus plays in tropical forest ecosystems and its potential applications in medicine and horticulture.

CHAPTER- 15
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APPENDIX 1

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 2

Sl No.	Taxon Name	Voucher data (Coll. No./EDNA No./Genbank acc. No.)	Country	Markers
1	*Aeschynanthus acuminatus* Wall ex A.DC.	160628 (CALI)	INDIA	ITS
2	*Aeschynanthus acuminatus* Wall ex A.DC.	160635 (CALI)	INDIA	ITS
3	*Aeschynanthus acuminatus* Wall ex A.DC.	8848 (RBGE)	CHINA	ITS
4	*Aeschynanthus bracteatus* Wall. ex A.DC.	186405 (CALI)	INDIA	ITS
5	*Aeschynanthus bracteatus* Wall. ex A.DC.	19970165_Clone A (RBGE)	VIETNAM	ITS
6	*Aeschynanthus bracteatus* Wall. ex A.DC.	19970165_Clone B (RBGE)	VIETNAM	ITS
7	*Aeschynanthus chiritoides* C.B.Clarke	EDNA0000049 (RBGE)	CHINA	ITS
8	*Aeschynanthus fulgens* Wall. ex R.Br.	19900384_Clone A (RBGE)		ITS
9	*Aeschynanthus fulgens* Wall. ex R.Br.	19900384_Clone B (RBGE)		ITS
10	*Aeschynanthus gracilis* Parish ex C.B.Clarke	160625 (CALI)		ITS, ETS, *trn*LF, *ndh*F, *rps*16, *psb*A-*trn*H, *rpl*32-*trn*L, and *rpl*20-*rps*12
11	*Aeschynanthus gracilis* Parish ex C.B.Clarke	(RBGE)	CHINA	ITS, ETS, *trn*LF, *ndh*F, *rps*16, *psb*A-*trn*H, *rpl*32-*trn*L, and *rpl*20-*rps*13
12	*Aeschynanthus gracilis* Parish ex C.B.Clarke	19802575 (RBGE)	BHUTAN	ITS
13	*Aeschynanthus hookeri* C.B.Clarke	74854 (CALI)	INDIA	ITS
14	*Aeschynanthus hookeri* C.B.Clarke	160623 (CALI)	INDIA	ITS, ETS, *trn*LF, *ndh*F, *rps*16, *psb*A-*trn*H, *rpl*32-*trn*L, and *rpl*20-*rps*13
15	*Aeschynanthus hookeri* C.B.Clarke	160624 (CALI)	INDIA	ITS, ETS, *trn*LF, *ndh*F, *rps*16, *psb*A-*trn*H, *rpl*32-*trn*L, and *rpl*20-*rps*14
16	*Aeschynanthus hookeri* C.B.Clarke	19892128 (RBGE)	NEPAL	ITS
17	*Aeschynanthus linearifolius* C.E.C.Fisch	169316 (CALI)	INDIA	ITS
18	*Aeschynanthus linearifolius* C.E.C.Fisch	186444 (CALI)	INDIA	ITS
19	*Aeschynanthus mannii* Kurz ex C.B.Clarke	160629 (CALI)	INDIA	ITS, rps16
20	*Aeschynanthus mannii* Kurz ex C.B.Clarke	160630 (CALI)	INDIA	ITS, *rps*16
21	*Aeschynanthus mannii Kurz ex C.B.Clarke*	OR759952 (MIZORAM)	INDIA	ITS

22	*Aeschynanthus micranthus* C.B.Clarke	169305 (CALI)	INDIA	ITS
23	*Aeschynanthus micranthus* C.B.Clarke	169308 (CALI)	INDIA	ITS, *rps*16
24	*Aeschynanthus micranthus* C.B.Clarke	169316 (CALI)	INDIA	ITS, *rps*16
25	*Aeschynanthus micranthus* C.B.Clarke	169340 (CALI)	INDIA	ITS, *rps*16
26	*Aeschynanthus micranthus* C.B.Clarke	169344 (CALI)	INDIA	ITS, *rps*16
27	Aeschynanthus austroyunnanensis W.T.Wang	AF349218 & AF349299	CHINA	ITS
28	*Aeschynanthus parasiticus* (Roxb.) C.B.Clarke	160621 (CALI)	INDIA	ITS, *rps*16
29	*Aeschynanthus parasiticus* (Roxb.) C.B.Clarke	169439 (CALI)	INDIA	ITS, *rps*16
30	*Aeschynanthus parasiticus* (Roxb.) C.B.Clarke	186425 (CALI)	INDIA	ITS, *rps*16
31	*Aeschynanthus deleiensis* C.C.C.Fisch.	169314 (CALI)	INDIA	ITS
32	*Aeschynanthus parasiticus* (Roxb.) C.B.Clarke	169399 (CALI)	INDIA	ITS
33	*Aeschynanthus mimetes* B.L.Burtt	186402 (CALI)	INDIA	ITS
34	*Aeschynanthus parviflorus* (D.Don) Spreng	169314 (CALI)	INDIA	ITS
35	*Aeschynanthus parviflorus* (D.Don) Spreng	169317 (CALI)	INDIA	ITS, *rps*16
36	*Aeschynanthus parviflorus* (D.Don) Spreng	169397 (CALI)	INDIA	ITS
37	*Aeschynanthus parviflorus* (D.Don) Spreng	186444 (CALI)	INDIA	ITS
38	*Aeschynanthus parviflorus* (D.Don) Spreng	186443 (CALI)	INDIA	ITS, ETS, *trn*LF, *ndh*F, *rps*16, *psb*A-*trn*H, *rpl*32-*trn*L, and *rpl*20-*rps*12
39	*Aeschynanthus parviflorus* (D.Don) Spreng	RBGE	CHINA	ITS, ETS, *trn*LF, *ndh*F, *rps*16, *psb*A-*trn*H, *rpl*32-*trn*L, and *rpl*20-*rps*13
40	*Aeschynanthus parviflorus* (D.Don) Spreng	RBGE	CHINA	ITS, ETS, *trn*LF, *ndh*F, *rps*16, *psb*A-*trn*H, *rpl*32-*trn*L, and *rpl*20-*rps*14
41	Aeschynanthus sikkimensis C.B.Clarke	19611984_Clone A(RBGE)	NEPAL	ITS
42	Aeschynanthus sikkimensis C.B.Clarke	19611984_Clone B(RBGE)	NEPAL	ITS
43	*Aeschynanthus perrottetii* A.DC.	160604 (CALI)	INDIA	ITS, ETS, *trn*LF, *ndh*F, *rps*16, *psb*A-*trn*H, *rpl*32-*trn*L, and *rpl*20-*rps*12
44	*Aeschynanthus perrottetii* var. *malabaricus* C.B.Clarke	160607 (CALI)	INDIA	ITS, ETS, *trn*LF, *ndh*F, *rps*16, *psb*A-*trn*H, *rpl*32-*trn*L, and *rpl*20-*rps*13

45	*Aeschynanthus ceylanicus* var. *pinguis* C.B.Clarke	160609 (CALI)	INDIA	ITS, ETS, *trn*LF, *ndh*F, *rps*16, *psb*A-*trn*H, *rpl*32-*trn*L, and *rpl*20-*rps*14
46	*Aeschynanthus perrottetii* A.DC.	169415 (CALI)	INDIA	ITS, ETS, *trn*LF, *ndh*F, *rps*16, *psb*A-*trn*H, *rpl*32-*trn*L, and *rpl*20-*rps*15
47	*Aeschynanthus perrottetii* A.DC.	169438 (CALI)	INDIA	ITS, ETS, *trn*LF, *ndh*F, *rps*16, *psb*A-*trn*H, *rpl*32-*trn*L, and *rpl*20-*rps*16
48	*Aeschynanthus perrottetii* A.DC.	169441 (CALI)	INDIA	ITS, *trn*LF, *ndh*F, *rps*16, *psb*A-*trn*H, *rpl*32-*trn*L, and *rpl*20-*rps*17
49	*Aeschynanthus perrottetii* var. *planiculmis* C.B.Clarke	169462 (CALI)	INDIA	ITS, ETS, *trn*LF, *ndh*F, *rps*16, *psb*A-*trn*H, *rpl*32-*trn*L, and *rpl*20-*rps*18
50	*Aeschynanthus perrottetii* var. *planiculmis* C.B.Clarke	169463 (CALI)	INDIA	ITS, ETS, *trn*LF, *ndh*F, *rps*16, *psb*A-*trn*H, *rpl*32-*trn*L, and *rpl*20-*rps*19
51	*Aeschynanthus perrottetii* var. *planiculmis* C.B.Clarke	169466 (CALI)	INDIA	ITS, ETS, *trn*LF, *ndh*F, *rps*16, *psb*A-*trn*H, *rpl*32-*trn*L, and *rpl*20-*rps*20
52	*Aeschynanthus reiekensis* Lalhlupuii, S.D.Khomdram & S.D.Yumkham	186431 (CALI)	INDIA	ITS
53	*Aeschynanthus reiekensis* Lalhlupuii, S.D.Khomdram & S.D.Yumkham	186432 (CALI)	INDIA	ITS
54	*Aeschynanthus stenosepalus* J.Anthony	160640 (CALI)	INDIA	ITS
55	*Aeschynanthus stenosepalus* J.Anthony	160641 (CALI)	INDIA	ITS
56	*Aeschynanthus superbus* C.B.Clarke	OR759953 (MIZORAM)	INDIA	ITS
57	*Aeschynanthus ceylanicus* Gardner	10976 (RBGE)	SRI LANKA	ITS, ETS, *trn*LF, *ndh*F, *rps*16, *psb*A-*trn*H, *rpl*32-*trn*L, *rpl*20-*rps*12
58	*Aeschynanthus ceylanicus* Gardner	15301 (RBGE)	SRI LANKA	ITS, ETS, *trn*LF, *ndh*F, *rps*16, *psb*A-*trn*H, *rpl*32-*trn*L, rpl20-rps12
59	*Aeschynanthus ceylanicus* Gardner	6515 (RBGE)	SRI LANKA	ITS, ETS, *trn*LF, *ndh*F, *rps*16, *psb*A-*trn*H, *rpl*32-*trn*L, rpl20-rps12
60	*Aeschynanthus ceylanicus* Gardner	3049 (RBGE)	SRI LANKA	ITS, ETS, *trn*LF, *ndh*F, *rps*16, *psb*A-*trn*H, *rpl*32-*trn*L, rpl20-rps12
61	*Aeschynanthus ceylanicus* Gardner	2527 (RBGE)	SRI LANKA	ITS, ETS, *trn*LF, *ndh*F, *rps*16, *psb*A-*trn*H, *rpl*32-*trn*L, rpl20-rps12

62	*Aeschynanthus ceylanicus* Gardner	2878 (RBGE)	SRI LANKA	ITS, ETS, *trn*LF, *ndh*F, *rps*16, *psb*A-*trn*H, *rpl*32-*trn*L, rpl20-rps12
63	*Aeschynanthus ceylanicus* Gardner	1764 (RBGE)	SRI LANKA	ITS, ETS, *trn*LF, *ndh*F, *rps*16, *psb*A-*trn*H, *rpl*32-*trn*L, rpl20-rps12
64	*Aeschynanthus ceylanicus* Gardner	2014 (RBGE)	SRI LANKA	ITS, ETS, *trn*LF, *ndh*F, *rps*16, *psb*A-*trn*H, *rpl*32-*trn*L, rpl20-rps12
65	*Aeschynanthus ceylanicus* Gardner	1634 (RBGE)	SRI LANKA	ITS, ETS, *trn*LF, *ndh*F, *rps*16, *psb*A-*trn*H, *rpl*32-*trn*L, rpl20-rps12
66	*Aeschynanthus ceylanicus* Gardner	1464 (RBGE)	SRI LANKA	ITS, ETS, *trn*LF, *ndh*F, *rps*16, *psb*A-*trn*H, *rpl*32-*trn*L, rpl20-rps12
67	*Aeschynanthus ceylanicus* Gardner	2411 (RBGE)	SRI LANKA	ITS, ETS, *trn*LF, *ndh*F, *rps*16, *psb*A-*trn*H, *rpl*32-*trn*L,*rpl20-rps12*
68	*Aeschynanthus ceylanicus* Gardner	2338 (RBGE)	SRI LANKA	ITS, ETS, *trn*LF, *ndh*F, *rps*16, *psb*A-*trn*H, *rpl*32-*trn*L, rpl20-rps12
69	*Aeschynanthus ceylanicus* Gardner	2127 (RBGE)	SRI LANKA	ITS, ETS, *trn*LF, *ndh*F, *rps*16, *psb*A-*trn*H, *rpl*32-*trn*L, rpl20-rps12
70	*Aeschynanthus ceylanicus* Gardner	19850904 (RBGE)	SRI LANKA	ITS
71	*Aeschynanthus ceylanicus* Gardner	19850904 (RBGE)	SRI LANKA	ITS
73	*Aeschynanthus albidus* (Blume) Steud	2688 (RBGE)	RBGE	ITS, ETS, *trn*LF, *ndh*F, *rps*16, *psb*A-*trn*H, *rpl*32-*trn*L, *rpl*20-*rps*12
74	*Aeschynanthus andersonii* C.B.Clarke	AY047040 (RBGE)	CHINA	ITS
75	*Aeschynanthus angustifolius* (Blume) Steud	3637 (RBGE)	Sumatra	ITS, ETS, *trn*LF, *ndh*F, *rps*16, *psb*A-*trn*H, *rpl*32-*trn*L, *rpl*20-*rps*12
76	*Aeschynanthus arctocalyx* Mendum & Madulid	19922776 (RBGE)	Philippines	ITS
77	*Aeschynanthus arfakensis* C.B.Clarke	19972046 (RBGE)	Indonesia	ITS, *trn*LF, *ndh*F, *rps*16
78	*Aeschynanthus argentii* Mendum	19801419 (RBGE)	Borneo	ITS
79	*Aeschynanthus batakiorum* Mendum & Madulid		Philippines	ITS
80	*Aeschynanthus burttii* Mendum	sp.00293	Sulawesi	ITS
81	*Aeschynanthus buxifolius* Hemsl.	RBGE		ITS, ETS, *trn*LF, *ndh*F, *rps*16, *psb*A-*trn*H, *rpl*32-*trn*L, and *rpl*20-*rps*12
82	*Aeschynanthus buxifolius* Hemsl.	2026 (384)	Vietnam	ITS, *trn*LF, *psb*A-*trn*H, *rpl*32-*trn*L

83	*Aeschynanthus cf.viridiflorus* Teijsm. & Binn.	228	Sulawesi	ITS
84	*Aeschynanthus chrysanthus* P.Woods		Indonesia	ITS
85	*Aeschynanthus curtisii* C.B.Clarke		Borneo	ITS
86	*Aeschynanthus dischidioides* (Ridl.) D.J.Middleton		Malaysia	ITS
87	*Aeschynanthus ellipticus* K.Schum. & Lauterb.	AF349163 & AF349244	Papua New Guinea	ITS
88	*Aeschynanthus fecundus* P.Woods	AF349154 & AF349235	Thailand	ITS
89	*Aeschynanthus fruticosus* Ridl.	AF349159 & AF349240	Indonesia	ITS
90	*Aeschynanthus garrettii* Craib	AF349158 & AF349239	Thailand	ITS
91	*Aeschynanthus guttatus* P.Woods	MN843190	Papua New Guinea	ITS, ETS, *trn*LF, *ndh*F, *rps*16, *psb*A-*trn*H, *rpl*32-*trn*L, *rpl*20-*rps*12
92	*Aeschynanthus hartleyi* P.Woods	KF148657		ITS, ETS, *psb*A-*trn*H
93	*Aeschynanthus humilis* Hemsl.	AF349169 & AF349250	Thailand	ITS
94	*Aeschynanthus irigaensis* (Merr.) B.L.Burtt & P.Woods	AF349162 & AF349243	Philippines	ITS
95	*Aeschynanthus lancilimbus* W.T.Wang	AF349180 & F349261		ITS, *trn*LF, *ndh*F, *rps*16
96	*Aeschynanthus lobaticalyx* Mendum	AF349165 & AF349246	Sulawesi	ITS
97	*Aeschynanthus longicaulis* Wall. ex R.Br	AF349172 & AF349253	Thailand	ITS, ETS, *psb*A-*trn*H, *rpl*32-*trn*L
98	*Aeschynanthus magnificus* Stapf	AF349153.2 & AF349234	Borneo	ITS, *trn*LF, *ndh*F, *rps*16, *psb*A-*trn*H, *rpl*32-*trn*L, *rpl*20-*rps*12
99	*Aeschynanthus moningerae* (Merr.) Chun	AF349164 & AF349245	CH	ITS
100	*Aeschynanthus musaensis* P.Woods	MO,OL536342	Papua New Guinea	ITS
101	*Aeschynanthus nummularius* K.Schum.	AF349178 & F349259	Papua New Guinea	ITS, ETS, *trn*LF, *ndh*F, *rps*16, *psb*A-*trn*H, *rpl*32-*trn*L, *rpl*20-*rps*12
102	*Aeschynanthus obconicus* C.B.Clarke	AF349174 & F349255	Borneo	ITS
103	*Aeschynanthus oxychlamys* Mendum	AF349224 & AF349305	Indonesia	ITS
104	*Aeschynanthus pachyanthus* Schltr.	RBGE	Papua New Guinea	ITS, ETS, *trn*LF, *ndh*F, *rps*16, *psb*A-*trn*H, *rpl*32-*trn*L, *rpl*20-*rps*12
105	*Aeschynanthus philippinensis* C.B.Clarke	AF349204 & AF349285	Philippines	ITS
106	*Aeschynanthus pseudohybridus* Mendum	AF349222 & AF349303	Borneo	ITS

107	*Aeschynanthus pulcher* (Blume)G.Don	FJ501333		ITS
108	*Aeschynanthus radicans* Jack	AF349196 & AF349277	Malaysia	ITS
109	*Aeschynanthus rhododendron* Ridl.	KF148661	Malaysia	ITS
110	*Aeschynanthus roseoflorus* Mendum	AF349192 & AF349273	Seram	ITS, *trn*LF, *psb*A-*trn*H, *rpl*32-*trn*L
111	*Aeschynanthus solomonensis* P.Woods	RBGE		ITS, ETS, *psb*A-*trn*H, *rpl*32-*trn*L
112	*Aeschynanthus solomonensis* P.Woods	AF349227 & AF349 PTBG		ITS, ETS, *psb*A-*trn*H
113	*Aeschynanthus tricolor* Hook.	RBGE	Borneo	ITS, *trn*LF, *ndh*F, *rps*16, *psb*A-*trn*H, *rpl*32-*trn*L, *rpl*20-*rps*12
114	*Aeschynanthus tricolor* Hook.	RBGE	Borneo	ITS, ETS, *rps*16, *psb*A-*trn*H
115	*Aeschynanthus vinaceus* P.Woods	AF349229	Borneo	ITS, *trn*LF, *ndh*F, *rps*16, *psb*A-*trn*H, *rpl*32-*trn*L, *rpl*20-*rps*12
116	*Aeschynanthus lineatus* Craib	19970163 (RBGE)	CHINA	ITS
117	**OUT GROUP TAXA**			
118	*Didymocarpus antirrhinoides* A.Weber	DQ912671		ITS, *trn*LF, *ndh*F, *rps*16, *psb*A-*trn*H, *rpl*32-*trn*L, *rpl*20-*rps*12
119	*Billolivia violacea* D.J.Middleton & H.J.Atkins	KU985115		ITS, *trn*LF, *ndh*F, *rps*16, *psb*A-*trn*H, *rpl*32-*trn*L
120	*Loxostigma griffithii* (Wight) C.B.Clarke	MN843194		ITS, ETS, *trn*LF, *ndh*F, *rps*16, *psb*A-*trn*H, *rpl*32-*trn*L, *rpl*20-*rps*12
121	*Cyrtandra picta* Blume	EU919978		ITS, ETS
122	*Cyrtandra mooreaensis* G.W.Gillett	MN843261		ITS, *trn*LF, *ndh*F, *rps*16, *psb*A-*trn*H, *rpl*32-*trn*L
123	*Cyrtandra oblongifolia* (Blume) Benth. & Hook.f. ex C.B.Clarke	MN843223		ITS, *trn*LF, *ndh*F, *rps*16, *psb*A-*trn*H, *rpl*32-*trn*L, *rpl*20-*rps*12
124	*Agalmyla biflora* (Elmer) Hilliard & B.L.Burtt	FJ501361		ITS, *trn*LF, *ndh*F, *rps*16
125	*Agalmyla chalmersii* (F.Muell.) B.L.Burtt	MN843192		ITS, *trn*LF, *ndh*F, *rps*16, *psb*A-*trn*H, *rpl*32-*trn*L, *rpl*20-*rps*12

APPENDIX 3

PAPERS PUBLISHED IN INTERNATIONAL JOURNALS

- Debta M.R., Akshath S., **Akhil M.K.** & S. Nampy. 2024. *Aeschynanthus maoi*, a new species of Gesneriaceae from Arunachal Pradesh, India. *Brittonia* 76: 161–167. https://doi.org/10.1007/s12228-024-09790-2
- Lalhlupuii M, Khomdram S.D., Yumkham S.D., **Akhil M.K.** & S. Nampy 2023. *Aeschynanthus reiekensis*, a new species of Gesneriaceae from Mizoram, Northeast India. *Taiwania* 68(1): 1–7. DOI: 10.6165/tai.2023.68.1
- Krishnapriya M.P., **Akhil M.K.**, Harishma K.H., Alan T.S., Krishnaraj T.P. & Santhosh 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
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PAPERS PRESENTED

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- **Akhil M.K.** & Santhosh Nampy. 2022. '**The genus *Aeschynanthus* Jack (Gesneriaceae) in Northeast India**'. XXXII Annual conference of Indian Association for Angiosperm Taxonomy and National symposium on "The Contribution of Angiosperm diversity to human wellbeing and the risks associated with its decline" held at Karnatak University's Karnatak Science College, Dharward, Karnataka. 11–13 November 2022.
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AWARDS/FELLOWSHIPS/SCHOLORSHIPS RECEIVED

- ELVIN MCDONALD Research Endowment Fund Gesneriad Society, USA 2022
- IAPT Research Grant International Association for Plant Taxonomy 2021
- Best paper presentation award 2024 International Seminar on Plant Systematics held at Department of Botany, University of Calicut, Kerala during 15–17 February 2024.

OVERSEAS VISITS / TRAINING PROGRAMMES

- Six-week training course in the preparation and analysis of next-generation sequencing data obtained from Oxford Nanopore Technologies (ONT) MinION system and character evolution analysis in *Aeschynanthus* Jack (Gesneriaceae) at Royal Botanic Garden, Edinburgh, UK. 21.08.2023 – 06.10.2023.
- GIAN Workshop on Molecular Phylogeny, held at the Department of Botany, University of Calicut during 23–27 July 2019.

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ORIGINAL RESEARCH

Aeschynanthus maoi, a new species of Gesneriaceae from Arunachal Pradesh, India

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Abstract
Aeschynanthus maoi, a new species of Gesneriaceae from Lower Dibang Valley of Arunachal Pradesh, India, is described and illustrated. It is morphologically similar to *A. wardii* and *A. bracteatus*, but differs from the former by its small (3–5 mm long) boat-like bracts, narrowly ovate or triangular calyx lobes, 1–8 flowered inflorescences, and turbinate staminodes. It differs from the latter by caducous green bracts, short peduncles (0.2–0.8 cm long), and narrowly ovate or triangular green calyx lobes. A detailed description of the new species with color photographs and a comparison to similar species are provided. The new species is evaluated for risk of extinction and provisionally assessed as Critically Endangered (CR) according to IUCN Red List Categories and Criteria.

Keywords *Aeschynanthus wardii* · lipstick plant · Lower Dibang Valley · northeast India · sect. *Haplotrichium*

Introduction

Aeschynanthus Jack (Gesneriaceae, subfamily Didymocarpoideae) is an important component of Southeast Asian tropical forests. The genus is characterized mainly by an epiphytic or lithophytic habit, with pendulous, creeping, arching, or erect branches that root from the nodes. The leaves are opposite (rarely whorled), and thick and leathery. The flowers of *Aeschynanthus* are either solitary or borne in few-flowered axillary clusters or in pseudoterminal clusters. The calyx lobes may be either fused or free, and the corollas are tubular and brightly colored (generally red, occasionally green, yellow, or white), a presumed adaptation for ornithophily. Stamens in *Aeschynanthus* are definitively protandrous and are generally coherent in pairs. The fruits are capsules, which are long and narrow, containing seeds with one or more appendages at the hilar end, and one at the apical end (Burtt & Woods, 1975; Weber, 2004; Middleton, 2007). The genus comprises approximately 181 species (GRC, 2024), distributed from Sri Lanka and India through southern China and Northeast India to New Guinea and the Solomon Islands (Weber, 2004; Middleton, 2016; Möller et al., 2017). It is the third largest genus of Gesneriaceae in India, with about 24 species. Within India, Northeast India has the greatest species richness (80%), while the Western Ghats has about 10% of species, and the Andaman and Nicobar Islands have 15% (Bhattacharyya & Goel, 2015; Krishna et al., 2020; Taram & Borah, 2021; Lalhlupuii et al., 2023).

While conducting floristic expeditions in various parts of Northeast India, two of the authors (MRD and AS) came across a population of *Aeschynanthus* from the areas surrounding Hunli village in the Lower Dibang Valley district of Arunachal Pradesh. The unidentified collection resembles *A. wardii* Merr. and *A. bracteatus*

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Wall. ex A.DC. in its habit, stems, leaves, and corolla striations, but shows remarkable differences in number of flowers per inflorescence, bracts, calyx lobes, corolla color, staminodes, and disk (Table 1). After consulting relevant literature (Clarke, 1884; Wang et al., 1998; Li & Wang, 2004; Middleton, 2007, 2009, 2016; Mukherjee et al., 2008; Bhattacharyya & Goel, 2014; Datta et al., 2016; Sinha & Datta, 2016; Möller et al., 2017) and comparing the collection to herbarium specimens and live images of *A. wardii* and *A. bracteatus*, the population from Hunli village was considered too morphologically distinct to be included in either of those two species, and is therefore described and illustrated here as a new species, *Aeschynanthus maoi.*

Materials & Methods

The specimens were collected from Northeast India (Hunli village, on the road from Anini to Roing, in the Lower Dibang Valley district of Arunachal Pradesh) during the month of October 2022 (Fig. 1). The fresh collections were dissected in the field and then processed to make herbarium specimens. The distinctiveness of the species was confirmed by consulting types and other specimens of *Aeschynanthus* deposited at the following herbaria: ARUN, ASSAM, BM, CAL, CALI, E, K, MA (acronyms follow Thiers, 2024 & continuously updated), as well as relevant protologues and other literature (Clarke, 1884; Merrill, 1941; Middleton, 2007, 2009, 2016; Mukherjee et al., 2008; Bhattacharyya & Goel, 2014; Datta et al., 2016; Sinha & Datta, 2016; Möller et al., 2017). Photographs were taken using a SMZ 745T trinocular stereo microscope outfitted with a multi-output digital camera (Nikon, Japan), and a photographic plate was prepared (Fig. 4). Seed micromorphology was examined using a scanning electron microscope (Zeiss, Germany). The samples were dehydrated, critical-point dried, and then mounted onto stubs and coated with gold and palladium. Type specimens of the new taxon were deposited in ARUN, CAL, and CALI. A provisional conservation assessment was carried out following the IUCN (2012, 2022) guidelines, and a distribution map was created using *QGIS* ver. 3.22.1 (QGIS, 2023).

Taxonomic Treatment

Aeschynanthus maoi Debta & A.Shenoy, **sp. nov.** TYPE: India: Arunachal Pradesh, Lower Dibang Valley district, near Hunli, 28°20'09.4"N, 95°56'48.4"E, ca. 1,190 m, 18 Oct 2022 (fl.), *M.R. Debta & A. Shenoy 44200* (holotype: ARUN, barcode ARUN000030895 [!]; isotypes: ARUN, barcode ARUN000030893 [!];CAL [!];CALI [!]). Figs. 2 and 3.

Diagnosis. *Aeschynanthus maoi* resembles *A. wardii* and *A. bracteatus* in sharing coriaceous and elliptic or ovate leaves, reflexed lateral corolla lobes, corolla striations, and seeds with single hilar appendage and moderately spiral testa cell orientation, but it differs from *A. wardii* by its 1–8 flowered inflorescences (vs. inflorescences with 1–4 flowers), small (3–5 mm long) boat-like bracts (vs. bracts that are 6–13 mm long and protrusive), narrowly ovate or triangular calyx lobes (vs. linear lanceolate), turbinate

Table 1. Comparison of *Aeschynanthus maoi* to two similar species.

	A. maoi	***A. wardii***	***A. bracteatus***
Flowers per inflorescence	1–8	1–4	2–6
Bracts	3–5 mm long, oblong-lanceolate, margins incurved, boat-like structure, lateral veins obscure, green, deciduous	6–13 mm long, lanceolate or narrowly ovate, margins recurved, lateral veins distinct, persistent or deciduous	1.5–4.1 cm long, elliptic or ovate, red, margins serrate, incurved, boat-like structure, lateral veins obscure, persistent
Pedicel length	1–1.8 cm	0.7–1 cm	0.8–1.7 cm
Calyx	0.6–1.3 cm long, lobes narrowly ovate or narrowly triangular, green	0.6–0.7 cm long, lobes linear-lanceolate, green	1.5–2.6 cm long, lobes linear to narrowly ovate or elliptic, red or deep maroon
Corolla	Claret on the upper part and greenish-white towards the base out; crimson tinged with pink or white above the middle and greenish white towards the base in	Red to orange out and in	Crimson red out; reddish white above middle and white towards the base
Staminodes	Ca. 2 mm long, turbinate	Ca. 0.6 mm long, clavate	Ca. 2 mm long clavate
Disk	Ca. 2 mm high	Ca. 1.5 mm high	Ca. 2 mm high
Distribution	NE India (Arunachal Pradesh)	China, Myanmar	Bhutan, China, NE India, Myanmar

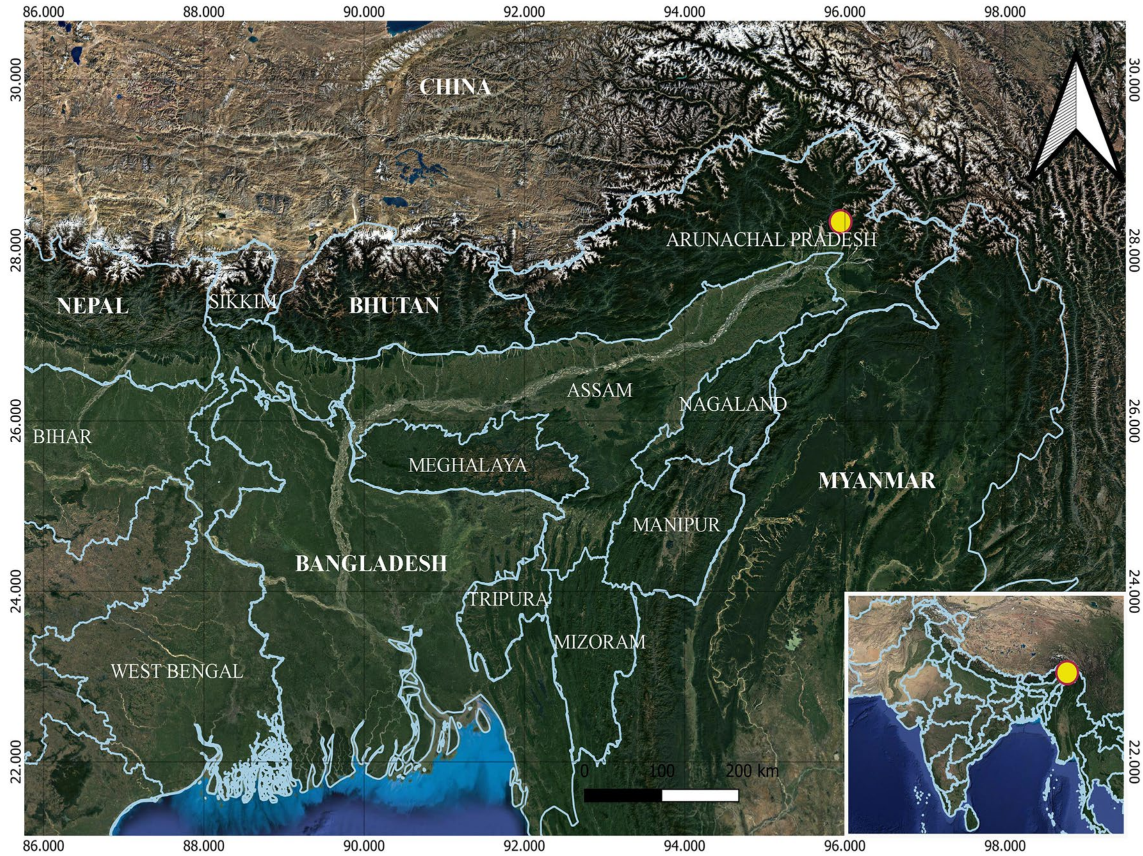

Fig. 1. Map showing the collection locality of *Aeschynanthus maoi*: Hunli, Lower Dibang Valley District in Arunachal Pradesh, India.

staminodes (vs. clavate). The new species differs from *A. bracteatus* in having caducous, green bracts (vs. persistent and red bracts), short (0.2–0.8 cm long) peduncles (vs. 0.8–11 cm long) and narrowly ovate or triangular, green calyx lobes (vs. linear to narrowly ovate or elliptic calyx lobes that are red).

Description. Epiphytic perennial undershrubs with arching to pendulous stems. Stems robust, terete, green, grey or grey-brown, glabrous, 0.5–0.8 cm diam.; nodes slightly swollen; internodes 5.2–11.5 cm long. Leaves opposite; petioles 1.3–1.8 cm long, terete, glabrous; leaf blade 4.7–11 × 1.8–4.9 cm, elliptic or ovate, coriaceous, cuneate to rounded at the base, the margin entire, acute or acuminate at the apex, midvein prominent, lateral veins 6–11, obscure, green above, pale green below, few punctate, glabrous on both surfaces. Inflorescences axillary or pseudoterminal, 1–8 flowered, peduncles absent or short, 0.2–0.8 cm long, ca. 2 mm in diam.; bracts 3–5 mm long, oblong-lanceolate, boat shaped, acuminate at apex, margins incurved, lateral veins obscure, caducous, green; pedicels 1–1.8 cm long, pale green, glabrous. Calyx lobes nearly free to the base, 0.6–1.3 cm long, narrowly ovate or narrowly triangular, acuminate at the apex, margins entire, pale green, glabrous. Corolla tubular, 3.2–4.2 cm long, not inflated at the middle, gradually expanding towards the mouth, 2 mm wide at the base, 6–9 mm wide at the mouth, claret on the upper part and greenish white towards the outside of the base, crimson tinged with pink or white above the middle and greenish white towards the inside of the base, striped with dark red from the middle of the tube transitioning towards the lateral lobes, glabrous outside, sparsely puberulent inside, mouth oblique, densely glandular pubescent only at the mouth and lobes, the limbs indistinctly 2-lipped; upper lobes erect, 4.5–6.1 × 3.8–4.5 mm, round at apex; lateral lobes reflexed, 5.5–6.6 × 3.8–4.6 mm, ovate-elliptic; lower lobes spreading, 5.2–7 × 4–5.5 mm, ovate-elliptic. Stamens 4, coherent in 2 pairs by their anther tips; filaments exserted, upper half dark red to maroon, pubescent, lower half cream tinged, red at base, sparsely pubescent; anterior filaments 2.4–2.6 cm long, inserted at 1.4–1.8 cm from corolla base; posterior filaments 1.8–2.1 cm long, inserted at 1.6–2.1 cm from corolla base; anthers 1.8–2.1 mm long, grey to brown; staminode 1, ca. 2 mm long, turbinate, light yellow. Carpels 2, disk ca. 2 × 1 mm, cylindrical, shallowly crenate, brown, glabrous;

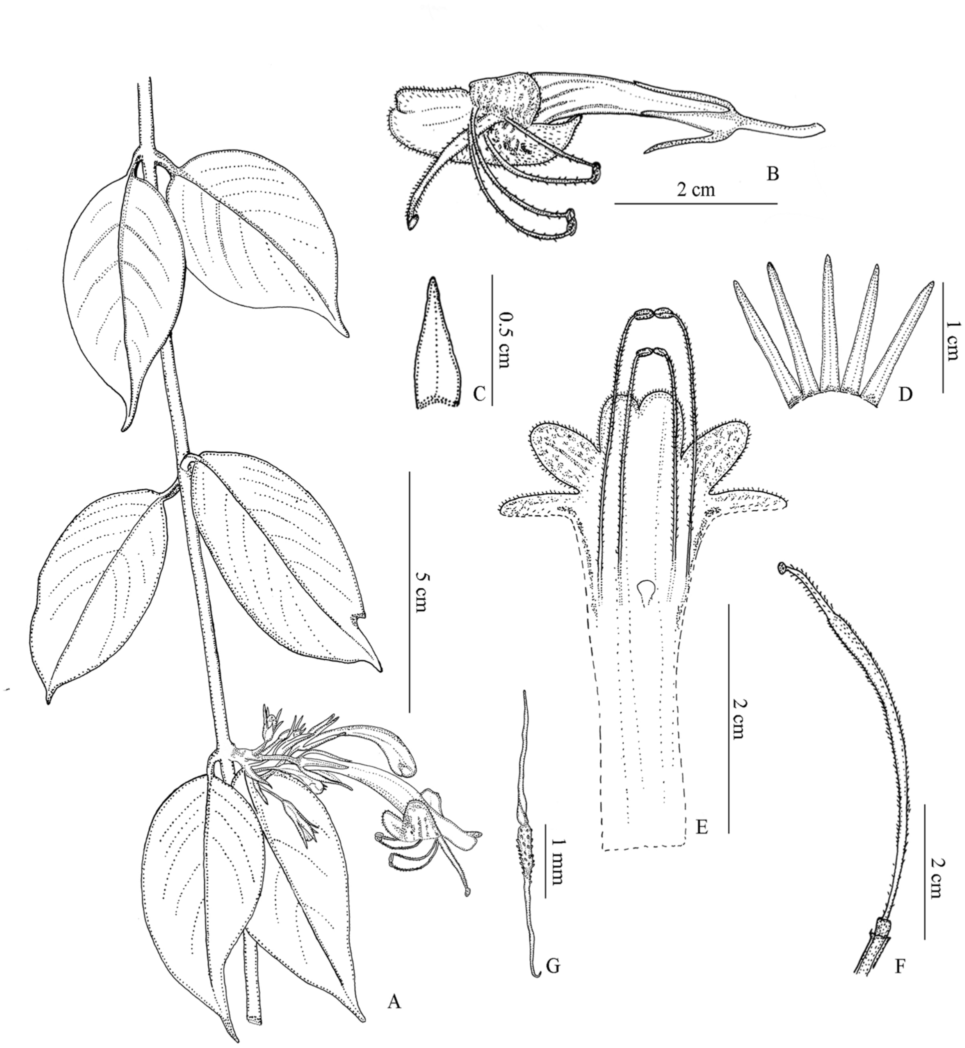

Fig. 2. *Aeschynanthus maoi*: **A.** Habit. **B.** Flower. **C.** Bract. **D.** Calyx. **E.** Corolla opened. **F.** Pistil. **G.** Seed. [Drawn from holotype *M.R. Debta & A. Shenoy 44200*, ARUN, by M.K. Akhil].

pistil 3.8–5.1 cm long; stipe ca. 2 cm long, finely pubescent; ovary superior, 1.5–2.3 cm long, pale green, with glandular hairs; style 0.6–1 cm long, densely pubescent; stigma capitate, ca. 2 mm across, white. Fruits capsular, 9.5–10.5 cm long, pale green turning straw color when mature, slightly curved; seeds 0.6–0.8 × 0.1–0.2 mm, elongated; testa cells strongly papillose, papillae formed towards the end of the cell in a slightly to moderately clockwise orientation; apical appendage a filiform hair, 1.8–3.5 mm long; hilar appendage a solitary filiform hair, 1.5–2 mm long, appendages slightly papillose.

Distribution. The new species is only known from the type locality, at an elevation of 1,190 m.

Phenology. Flowering from August to October and fruiting from September to November.

Etymology. The new species is named in honor of Dr. Ashiho Asosii Mao, Director of the Botanical Survey of India (BSI), Kolkata, for his immense and valuable contributions to the field of botanical research in Northeast India.

Preliminary conservation status. Only a single subpopulation of *Aeschynanthus maoi* is currently known, representing the type locality. In order to explore the species' occurrence at other locations, adjacent areas were also surveyed, but no additional subpopulations were discovered. The area of occupancy (AOO) for the new species is 4 km^2 and only two mature individuals were found. The

Fig. 3. *Aeschynanthus maoi*: **A–B.** Habit. **C.** Flower. **D.** Calyx. **E.** Back side of the flower showing recurved lateral petal lobes. **F.** Corolla split open. **G.** Pistil. **H.** Stigma. **I.** Disk. **J.** Dehisced capsule. **K.** Seed. [From the holotype, *M.R. Debta & A. Shenoy 44200*, ARUN, photographed by MRD & AS; plate prepared by M.K. Akhil].

individuals are adjacent to a road and the existing population faces ongoing threats from road-widening projects and other anthropogenic activities, such as habitat degradation due to the collection of firewood by local people. Based on the available data, *A. maoi* is provisionally assessed here as Critically Endangered (CR) according to criteria B2ab(ii,iii) of the IUCN Red List Categories and Criteria (IUCN, 2012; IUCN Standards and Petitions Committee, 2022). While making vouchers for the type collections, only a few branch cuttings with flowers were removed to

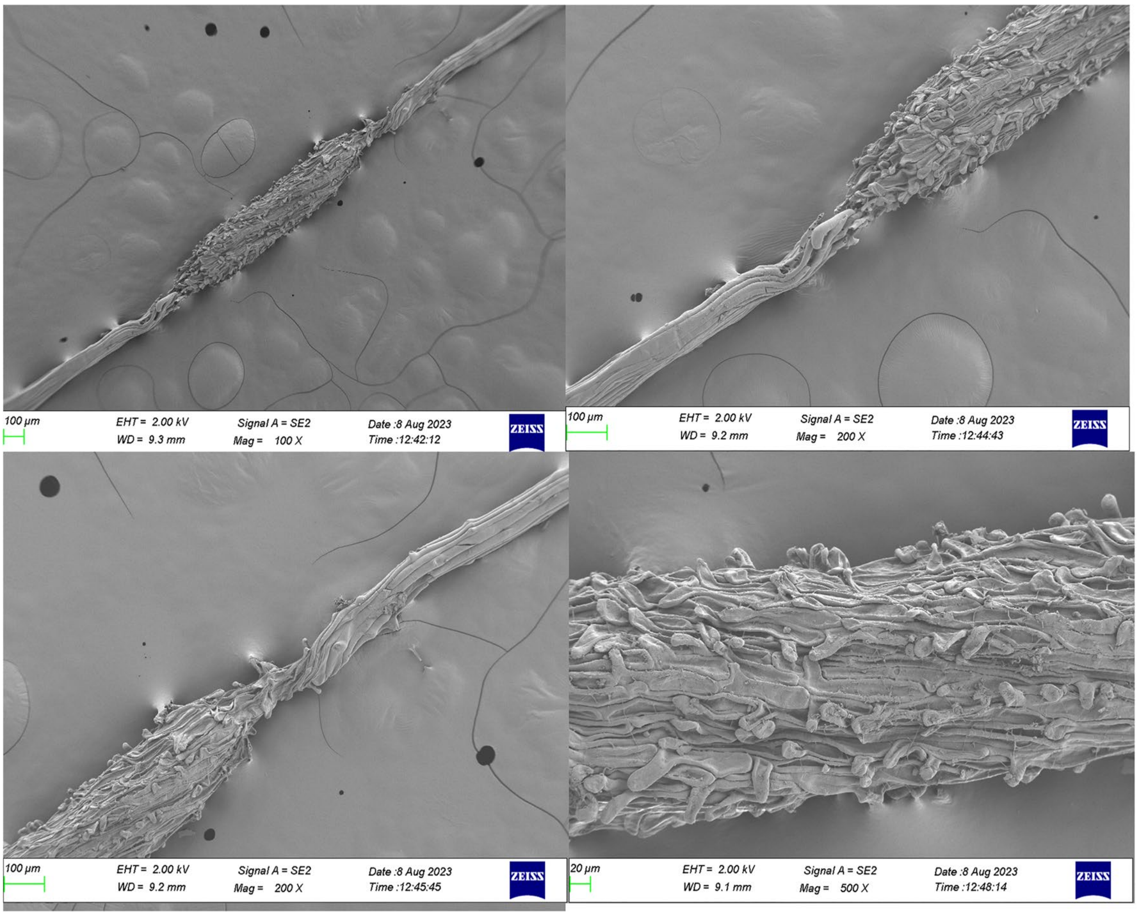

Fig. 4. A–D. Seed micromorphology of *Aeschynanthus maoi*. [From the holotype, *M.R. Debta & A. Shenoy 44200*, ARUN.].

make herbarium specimens, in order to minimize damage to these plants.

Notes. The seeds of *Aeschynanthus maoi* have a smooth filiform appendage at each end, without bubble cells; the testa cell orientation is moderately spiralled and the papillae form from single cells (towards the apex) (Fig. 4). These characters suggest that the new taxon belongs to the section *Haplotrichium* (Mendum et al., 2001).

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Declarations

Competing interests

The authors have no competing interests to declare that are relevant to the content of this article.

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Aeschynanthus reiekensis, a new species of Gesneriaceae from Mizoram, Northeast India

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ABSTRACT: A new species of Gesneriaceae, *Aeschynanthus reiekensis* is described and illustrated from the Mizoram state of Northeast India. It closely resembles *A. tengchungensis* W.T.Wang in having leathery, linear leaves and axillary to pseudoterminal inflorescences, but differs by its calyx characters, number of flowers per inflorescence, size of pistil and capsule and in the number of seed hilar appendages. It is also compared with two other closely allied species, *A. angustissimus* (W.T. Wang) W.T. Wang and *A. hookeri* C. B. Clarke which differs in having smaller size bracts, strongly oblique corolla mouth and tuft of hair being present inside the corolla. The pollen grains of the newly described species are monads, isopolar, small in size, prolate, circular to subangular amb and tricolporate with the exine microreticulate ornamentation. Based on the present data, the new species is provisionally assessed here as Critically Endangered (CR), according to IUCN Red List Categories and Criteria.

KEY WORDS: *Aeschynanthus angustissimus, Aeschynanthus hookeri*, *Aeschynanthus tengchungensis,* Indo-Burma Hotspot.

INTRODUCTION

Aeschynanthus Jack, commonly known as lipstick plant is a genus coming under the Gesneriaceae (subfamily Didymocarpoideae, tribe Trichosporeae, subtribe Didymocarpinae; Weber *et al*., 2013) with approximately 174 species. The genus includes mainly tropical or subtropical evergreen epiphytic herbs and shrubs, and rarely as lithophytes (Weber, 2004; GRC, 2022). *Aeschynanthus* is mainly distributed in India, southern and southwestern China, New Guinea, Solomon Islands and other Southeast Asian regions (Weber *et al*., 2013; Middleton, 2016).

In India, *Aeschynanthus* is mainly confined to eastern Himalayan region, with a few species reported from southern India and the Andaman Islands (Bhattacharyya and Goel, 2014).The first comprehensive treatment of the genus in India was given by Clarke (1884) in the *The Flora of British India* and reported 23 species. Although, Bhattacharyya and Goel (2014) reported 26 species from India, many species were subsequently treated as synonyms by Middleton (2007, 2009). Sinha and Datta (2016) reported 16 species from the Northeast India including two new additions, *A. angustioblongus* W.T.Wang (Wang, 1975) and *A. philippinensis* C.B. Clarke (Clarke, 1883). Möller *et al*. (2017) mentioned a total report of 18 species of *Aeschynanthus* from the Northeast India and even indicated the requirement of additional work in this genus from India. Taram and Borah (2021) recorded *A. lineatus* Craib (Craib, 1913) from Arunachal Pradesh, as a new addition to the Indian flora.

Being a part of Northeast India and the Indo-Burma hotspot, the Mizoram state has a rich biodiversity. In "Flora of Mizoram", Sinha (2012) reported nine species of *Aeschynanthus* from the state viz., *A. acuminatus* Wall. ex A.DC. (Candolle, 1845), *A. gracilis* Parish ex C.B.Clarke (Clarke, 1874), *A. maculatus* Lindl. (Lindley, 1841), *A. mannii* Kurz ex C.B.Clarke (Clarke, 1883), *A. masoniae* Kurz ex C.B.Clarke (Clarke, 1883), *A. parasiticus* (Roxb.) Wall. (Wallich, 1829), *A. parviflorus* (D.Don) Spreng. (Sprengel, 1827), *A. sikkimensis* (C.B.Clarke) Stapf. (Stapf, 1922) and *A. superbus* C.B.Clarke (Clarke, 1874). As a part of the ongoing revisionary study on the family Gesneriaceae of Mizoram state, authors from the Mizoram University (ML, SDK & SDY) across an interesting specimen of *Aeschynanthus* from Reiek Tlang in Mamit district of Mizoram. Concomitantly, the authors from the University of Calicut, Kerala (AMK & SN) visited the same locality as a part of the ongoing revision of Indian *Aeschynanthus*, and met with similar materials. Even though these specimens look very similar to *A. tengchungensis* W.T.Wang (Wang, 1984) and *A. angustissimus* (W.T.Wang) W.T.Wang (Wang, 1981), critical analysis of morphological characters and scrutiny of relevant literature and herbarium specimens in 10 herbaria including the digital ones revealed that they represent a hither to undescribed species, which is described and illustrated here as *A. reiekensis*.

MATERIALS AND METHODS

Specimens of *Aeschynanthus* were collected during extensive field surveys in different locations in Mizoram, including Reiek Tlang from 2018 to 2021 (Fig. 1). Relevant literature (Wang *et al*., 1998; Mendum, 1998, 1999, 2001; Mendum *et al*., 2001, 2006; Christie and

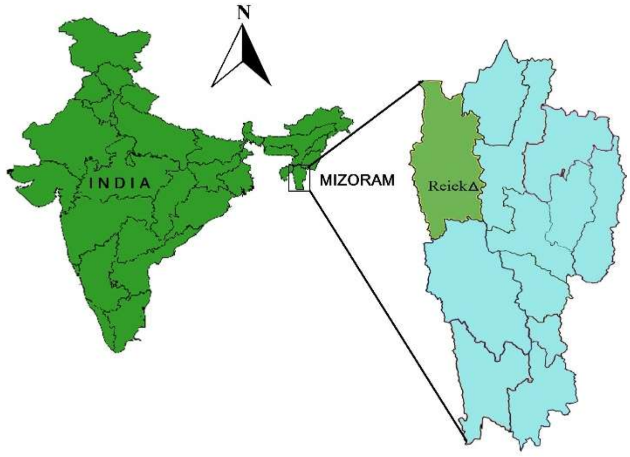

Fig. 1. Map of India showing the state of Mizoram and Mamit District with location of collection site of ***Aeschynanthus reiekensis*** M.Lalhlupuii, S.D.Khomdram & S.D.Yumkham

Mendum, 2002; Middleton, 2007, 2009, 2016; Sinha *et al*., 2012; Bhattacharyya and Goel, 2015; Sinha and Datta, 2016; Olimpos and Mansibang, 2021) including types and protologue of morphologically most similar species available in various herbaria (ARUN, ASSAM, BSHC, CAL, CALI, NEHU, E, K, NY, PE) were consulted to assess the existing recorded species, and for confirming the novelty of the species. Voucher specimens were deposited at ASSAM (Botanical Survey of India, Shillong), MZUH (Mizoram University Herbarium), MUMP (Manipur University Museum of Plants) and CALI (Calicut University Herbarium). The conservation status was assessed as per IUCN Red List Categories and Criteria (2022).

Microphotographs were taken by using LED–USB digital microscope (Cooling Tech, Jiangsu, China), DSC–W610 digital camera (Sony, Tokyo, Japan) and D5300DSLR camera (Nikon, Tokyo, Japan). Palynological studies were done from fresh pollens (Schlag-Edler and Kiehn, 2001). The sizes of pollen grains were expressed as Polar axis (P) × Equatorial axis (E) in micrometre (μm). Terminology given by Punt *et al*. (2007) and Halbritter *et al*. (2018) are used to describe the characters of pollens. For the micromorphological studies, seeds and pollen grains were dehydrated, critical point dried and mounted onto stubs coated with gold. The images were taken using field emission scanning electron microscope (JEOL, Freising, Germany).

TAXONOMIC TREATMENT

Aeschynanthus reiekensis M.Lalhlupuii, S.D.Khomdram & S.D.Yumkham ***sp. nov.***

Figs. 2–4

Type: INDIA. Mizoram, Mamit District, Reiek Tlang,23°40′58.2″ N 92°36′22.0″ E,1391.70 m elevation, 17 July 2018, *Margaret Lalhlupuii 128821* (holotype, ASSAM!; isotype, 0000512, MZUH!; isotype,000999, MUMP!).

Diagnosis: *Aeschynanthus reiekensis* can be easily distinguished from the morphologically most similar *A. tengchungensis,* in having fewer number of flowers per inflorescence (1–3), five-lobed calyx which are free or sometimes fused at base, tufts of hairs inside near the base of corolla tube, smaller capsules (23 cm long) and 2–4 seed hilar appendages. *A. reiekensis* also differs from the other two allied species, *A. angustissimus* and *A. hookeri* in having smaller bracts (c. 2 × 1 cm), strongly oblique corolla, and presence of tuft of glandular multicellular hairs inside the corolla.

Description: Epiphytic sub-shrubs, pendulous and branched. Stems 11 to 50 cm long, glabrous, smooth, rounded, green with a purple tinge when young, become straw coloured when old; nodes 3 to 8 in each branchlets, swollen; leaf scars prominent; internodes 2–4 cm long. Leaves opposite; petiole 4–8 mm long, glabrous; leaf blade 8–13 × 0.3–0.6 cm, linear, coriaceous, green above, pale beneath with vinaceous dots, glabrous, acuminate at apex, cuneate at base, entire to sub-entire at margins, sometimes recurved back and revolute when drying; midrib slightly sunken, lateral veins obscure. Cymes axillary, pseudo-terminal, 1–3 flowered; peduncle absent. Bracts 2, 2 × 1 mm, triangular, maroon, glabrous. Pedicels 0.8–1.6 cm long, green at base, maroon towards apex, glabrous. Calyx lobes 3–7 × 1–13 mm, lobes free or sometimes slightly fused of calyx tube (1.5–2.5 mm) at base, narrowly triangular to linear, glabrous, green flushed with maroon, acute-acuminate at apex, entire at margins. Corolla 2–2.9 cm long, tubular, strongly oblique mouth, inflated at middle; tube *c.* 1 mm broad at base, gradually widened towards the throat with 5–6 mm, orange to red, whitish yellow at base, sparsely to densely glandular puberulent except at base, yellow to pale red with a tuft of multicellular glandular hairs just above the base internally; lobes yellowish-orange to orange, arched with red on the rim internally, with a claret streak running down on the lower lobes, upper lobes unstreaked, each lobe *c.* 3 × 4 mm, not spreading or reflexed. Stamens 4, exserted at anthesis; anthers fused in 2 pairs, 1.5–3 × *c.*1 mm, purple or grey; pollen grey; anterior filament 3–3.3 cm long, inserted at 5–7 mm from corolla base; posterior filaments 2.5–2.8 cm long, inserted at 6–8 mm from corolla base; white at base and light purple higher up, glandular hairy. Staminode 1, *c.* 1 mm long. Disk 1–2 mm high, 5-crenate. Pistil 2–4.1 cm long; stipe 1–2 mm long, glabrous; ovary 0.5–1.5 cm long, linear, white to greenish white, glabrous, with sessile glands or minutely papillose; style 0.8–2 cm long, white, sparsely to densely glandular pubescent; stigma capitate, pink or purple, *c.* 2 mm across. Capsules 10–23 cm. Seeds 25–30 × 0.5–0.6 mm, apical appendage 1, 3.2–3.5 cm long, hilar appendages 2–4, 2.7–2.9 cm long; testa cells with straight orientation, strongly papillose; papilla 25–30 μm high.

Pollen grains: Monad; isopolar; small 17–19 μm × 10–12 μm; circular to subangular amb; prolate (P/E ratio

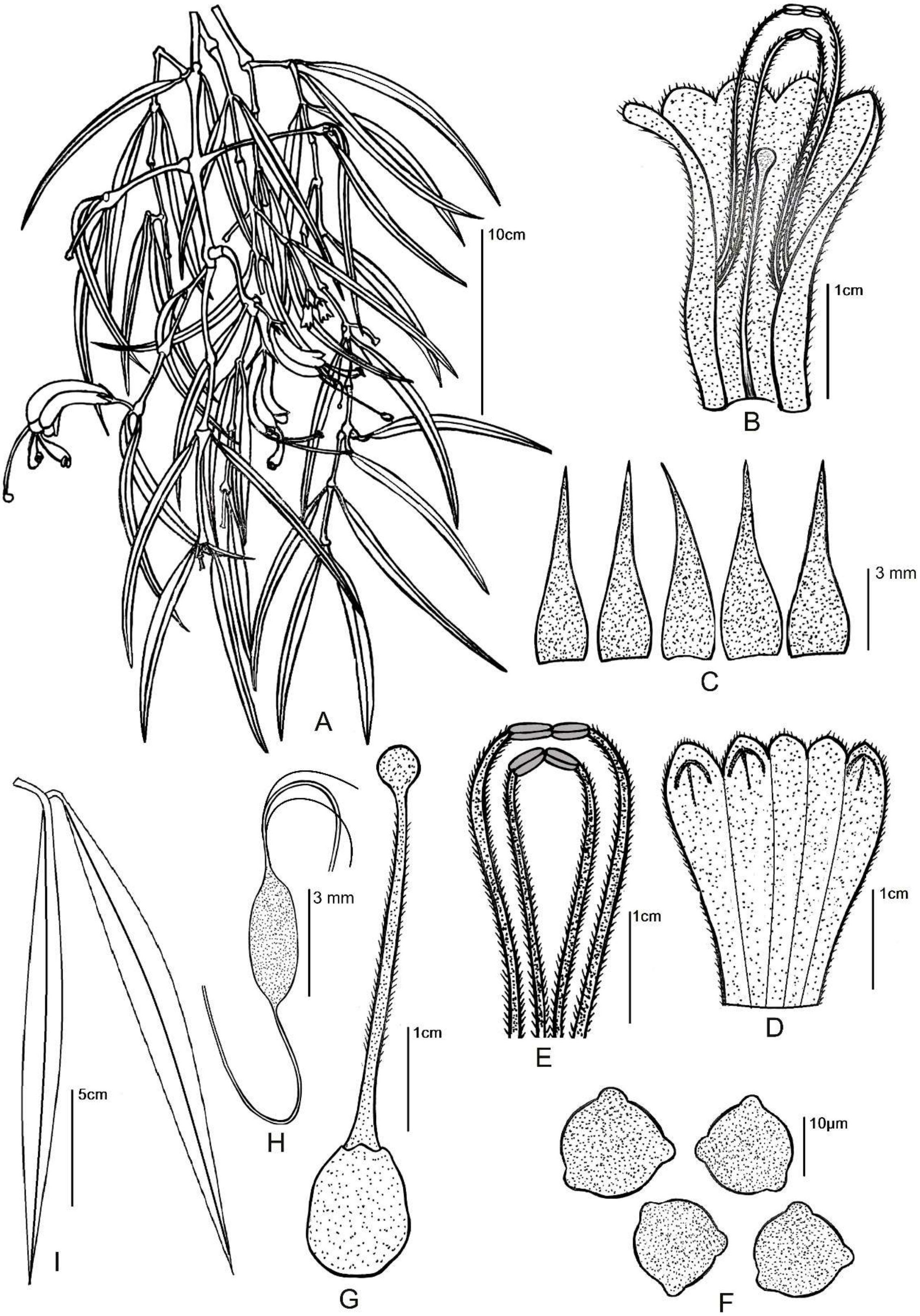

Fig. 2. ***Aeschynanthus reiekensis*** M.Lalhlupuii, S.D.Khomdram & S.D.Yumkham **A.** Flowering twig; **B.** Flower opened; **C.** Calyx; **D.** Opened corolla showing streaks; **E.** Stamens showing hairs with fused anthers; **F.** Pollen (polar view); **G.** Gynoecium with hairy style; **H.** Seeds showing apical and hilar appendages; **I.** Opened capsule.

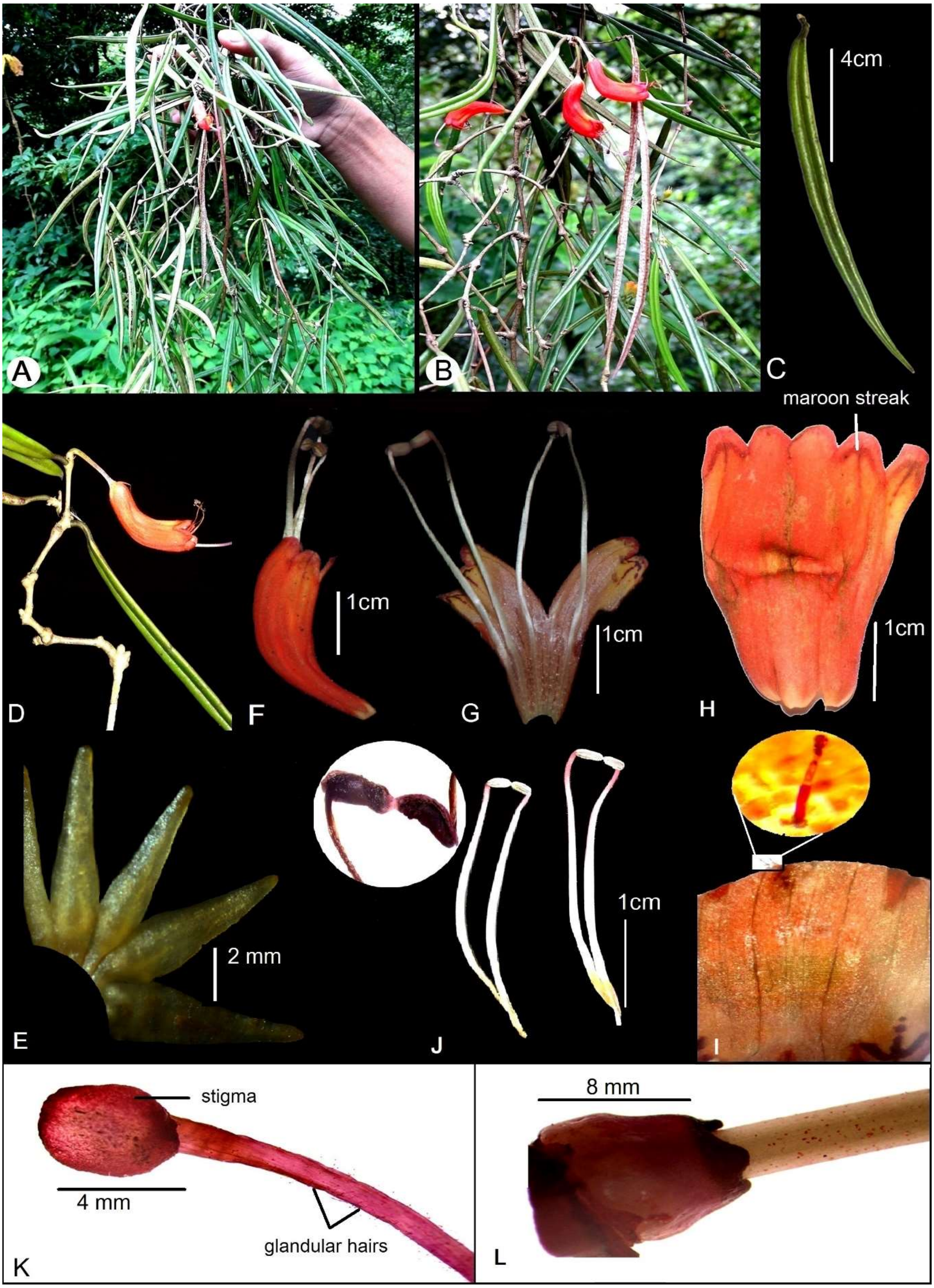

Fig. 3. ***Aeschynanthus reiekensis*** M.Lalhlupuii, S.D.Khomdram & S.D.Yumkham **A-B.** Habit; **C.** Leaf; **D.** Flowering twig; **E.** Calyx; **F.** Mature Flower **G.** Fully opened flower; **H.** Opened corolla showing maroon streaks; **I.** Inner corolla base showing glandular hairs; **J.** Stamen pairs showing fused anthers; **K.** Part of pistil showing glandular hairs on style; **L.** Ovary.

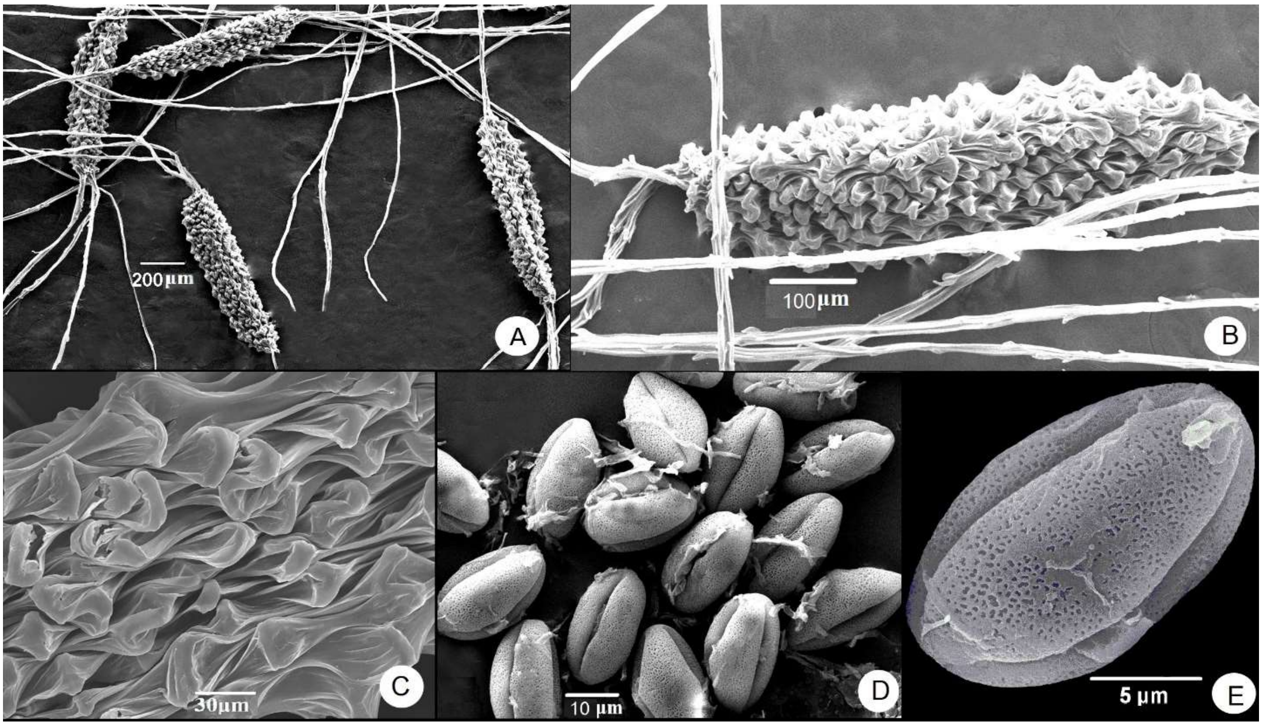

Fig. 4. SEM photograph of ***Aeschynanthus reiekensis*** M.Lalhlupuii, S.D.Khomdram & S.D.Yumkham, sp. nov.; **A.** Seeds with apical and hilar appendages; **B.** Enlarged seed; **C.** Seed testa; **D.** Pollen grains (equatorial view); **E.** Enlarged pollen grain (equatorial view).

between 1.4–1.9); tricolporate; ectoaperture long and tapering; exine microreticulate.

Distribution: So far collected only from the type locality, Reiek Tlang.

Habitat and ecology: Reiek Tlang is a part of community protected forest and a tourist spot located in the Northwest of Mizoram state in Mamit district. It covers an area of 25 km^2 and is situated about 29 km from Aizawl. The area is part of tropical wet semi-evergreen forest, with an average altitude of 900 m above sea level. The rainfall averages between 200–250 cm annually and the temperature varies between 20°C to 28°C. In Mizoram, epiphytes represent about 10.56% of the total recorded plants (Lalzarzovi and Lalnuntluanga, 2017). A small population of *A. reiekensis* was growing at altitudes between 1288–1391.70 m above sea level, as an epiphyte on *Castanopsis tribuloides* (Sm.) A.DC. (Fagaceae) which is locally known as *Thingsia*.

Phenology: Flowering from July to November and fruiting from September to December.

Vernacular name: In Mizo language, *Aeschynanthus* are commonly known as '*Hnahchhah'* which means 'thick leaf'.

Etymology: The species is named after the type locality '*Reiek'* which is a famous mountainous tourist spot located in Mizoram state (Northeast India).

Conservation status: The species is collected from the type locality at Reiek Tlang (Mamit district) located at Reiek forest, a part of community protected forest zone in Mizoram. The area was surveyed for more than three years and we found a population of few plants growing as epiphytes on the host tree, *Castanopsis tribuloides* (Sm.) A.DC. The area of occupancy is assumed to be less than 10 km^2. The collection site is one of the most important tourist destinations in the state, very near to Aizawl city (*c.* 29 km) and hence several developmental activities are expected in this area in the future. Further surveys in other likely areas are required to estimate the extended occurrence of the new species. Based on the available data, it is provisionally assessed here as Critically Endangered (CR) according to the criteria B2ab (ii, iii) c (ii, iii); D of IUCN Red List Categories and Criteria (IUCN 2022).

Additional specimens examined: ***Aeschynanthus reiekensis*** M.Lalhlupuii, S.D.Khomdram & S.D.Yumkham**:** INDIA, **Mizoram**, Mamit district, Reiek Tlang, 23°41′04.2″ N, 92°36′23.5″E, 1288 m, 02 October 2021, *M.K. Akhil*, *Krishnapriya M.P.*, *Harishma K.H.*, *Santhosh Nampy 186431* (CALI!). ***Aeschynanthus angustissimus*** (W.T. Wang) W.T.Wang: **CHINA**. **Medog Xian**, 3 Aug 1974, *Qinghai Xizang Expedition 3948* (E00062760, E00062761 digital image!). ***Aeschynanthus hookeri*** C.B.Clarke: **INDIA**. **Arunachal Pradesh**, Nongpoh, 13 March 1932, *R. Sharma 9934* (ASSAM). **Manipur**, Senapati, above Liye village, 2460m, 2 June 2005, *A. A. Mao 109095* (ASSAM). **Meghalaya**, Khasia–Jaintia hills, 31 May 1965, *N. P. Balakrishnan* 42257 (ASSAM). **Nagaland**, Banraw forest, 342 m, 7 February 1999, *A.A. Mao 101982* (ASSAM). ***Aeschynanthus tengchungensis*** W.T.Wang: **CHINA**. **N.W. Yunnan**, 2134 m June 1924, *George Forrest 24499* (E00087190 digital image!).

Notes: The presence of tufts of multicellular glandular hairs inside the lower half of the corolla tube is a key character to distinguish one of the widespread species *Aeschynanthus parasiticus* (Roxb.) Wall. Middleton (2009)

Table 1. Comparison of diagnostic characters of ***Aeschynanthus reiekensis***, ***A. tengchungensis***, ***A. hookeri*** and ***A. angustissimus***.

Characters	*A. reiekensis*	*A. tengchungensis*	*A. hookeri*	*A. angustissimus*
Stem	Nodal knots prominent, grows in zig-zag manner	Nodal knots not prominent, grows slightly in zig-zag manner	Nodal knots and zig-zag growth absent	Nodal knots not prominent and zig-zag growth absent
Leaves	8–13 × 0.4–0.6cm; leaf blade linear	17–23 × 0.8–3cm; leaf blade linear to narrowly oblanceolate or narrowly elliptic	7–9 × 2.3–4 cm; leaf blade narrowly elliptic to oblong	6.5–12.2 × 0.4–0.7 cm; leaf blade linear to narrowly oblanceolate
Petiole	4–8 mm	5–10 mm	6–10 mm	2–3 mm
No. of flowers per cyme	1–3	1–14	4–10	1–4
Bract	Maroon, 2 × 1 mm	Green tinged purple, 5 × 2 mm	Green, 5–9 × 1.5–3 mm	Red, 16–18 × 5–8mm
Peduncle	Absent	Absent	Absent	5.2–10 cm
Pedicel	8–16 mm, glabrous	3–6 mm, puberulent	10–15 mm, glabrous	8–18 mm, glabrous
Calyx	0.4–0.7 cm, green flushed with maroon, both surfaces glabrous, 5-lobed throughout the length	0.5 cm, green tinged purple, outside sparsely puberulent, 5-lobed from above to middle	1–1.3 cm, red or purple, outside glabrous, 5-lobed from above to middle	1.2–1.8 cm, red, outside glabrous, 5-lobed from base
Corolla	Orange to red, 2–2.9 cm long, inside with tuft of hairs	Red, 2.4–3.4 cm long, inside without tuft of hairs	Scarlet to orange-scarlet, 2.5–3 cm, inside without tuft of hairs	Red, upto 3.2 cm long, inside without tuft of hairs
Corolla mouth	Strongly oblique	Not oblique	Slightly oblique	Not oblique
Stamen	Filament 2.5–2.8 cm long, anther (1.5–3) mm	Filament 1.5–2 cm long, anther (1–1.5) mm	Filament 2.6–3 cm long, (2.5–3) mm	Filament 1.2–1.5 cm long, anther c. 2 mm
Capsule	Upto 10–23 cm long	Upto 20–30 cm long	Upto 27–30 cm long	Upto 4.8–7 cm long
Seed hilar appendages	2–4	2	2	Not available

synonymized *A. andamanensis* Goel, Vasudeva Rao and Mehrotra, *A. deleiensis* C.E.C.Fisch, *A. dolicanthus* W.T.Wang and *A. pachytrichus* W.T.Wang under *A. parasiticus* based on the above character. The new species also has this type of hair inside the corolla tube, but the linear narrow leaves, small triangular bracts, free or slightly fused calyx, corolla lobes without any external marks distinguishes it from *A. parasiticus.* The newly described species is morphologically allied to *Aeschynanthus tengchungensis* W.T.Wang, *A. angustissimus* (W.T. Wang) W.T. Wang and *A. hookeri* C. B. Clarke with their comparison given in Table 1.

Pollen characters like shape, size, pattern of exine sculpturing and apertures in *Aeschynanthus* are important in species delineation (Yan *et al*., 1997). According to Palee *et al*. (2003), pollens in *Aeschynanthus* are spheroidal, tricolpate or tricolporate/tricolporoidate (strongly developed colpus with weak porate) with long apertures. However, in *A. reiekensis*, the P/E ratio ranges between 1.4–1.9 showing prolate shape, tricolporate with long-tapering ectoapertures and exine with microreticulate tectum which is found to be similar with *A. fulgens* Wall. ex R.Br. as reported by Li *et al*. (2020).

The seeds of *A. reiekensis* have straight testa cell orientation and the papillae are formed from the raised ends of two adjacent cells. According to Mendum *et al*. (2001), based on the nature of seeds, it can be placed under the Type B category. Mendum *et al*. (2001) further recognized three sub types based on the nature of hilar appendages, namely, B1 (seeds with single hilar appendage), B2 (seeds with two hilar appendages) and B3 (seeds with a coma of 5–60 hilar appendages). Our species is quite distinct in having 2–4 hilar appendages and does not fit into any of the existing sections of *Aeschynanthus*.

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Lectotypification of three names in *Aeschynanthus* (Gesneriaceae)

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Abstract: Lectotypes are designated here for three names in *Aeschynanthus* Jack (Gesneriaceae), *viz.*, *A. oblanceolatus* (J.Anthony) C.E.C.Fisch., *A. philippinensis* C.B.Clarke and *A. stenosepalus* J.Anthony along with notes on their typification.

Keywords: *Aeschynanthus oblanceolatus*, *A. philippinensis*, *A. stenosepalus,* India, Nomenclature.

Introduction

The genus *Aeschynanthus* Jack (Gesneriaceae) consists of approximately 177 species (POWO, 2020), distributed from Sri Lanka and India through southern China and Northeast India to New Guinea and the Solomon Islands (Weber, 2004; Middleton, 2016; Möller *et al*., 2017). In India, the genus is distributed in the eastern Himalayan regions (particularly in Sikkim, Arunachal Pradesh, Meghalaya and Assam), Andaman and Nicobar Islands and the Western Ghats (Bhattacharyya & Goel, 2015). Clarke (1883) in Hooker's *Flora of British India* reported 15 species of *Aeschynanthus* under 4 sections from the present political boundary of India while Bhattacharyya and Goel (2015) reported 26 species and considered *A. kingii* C.B.Clarke a doubtful species. Sinha and Datta (2016) recognized 16 species from Northeast India.

As part of the ongoing revisionary study on *Aeschynanthus* in India, the authors found that types were not designated for three names, *viz*., *A. oblanceolatus* (J.Anthony) C.E.C.Fisch., *A. philippinensis* C.B.Clarke and *A. stenosepalus* J.Anthony. After consulting the protologues, types and other relevant specimens at A, B, BM, CAL, E, FI, G, GH, K, L, MEL, MO, TR, US and W (acronyms as per Thiers, 2020 continuously updated), lectotypes are designated here for these three names according to Art. 7.3, 7.11 and 9.3 (Turland *et al*., 2018).

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Typifications

Aeschynanthus oblanceolatus (J.Anthony) C.E.C.Fisch., Bull. Misc. Inform. Kew 1940: 40. 1940. *A. peelii* Hook.f. & Thomson var. *oblanceolatus* J.Anthony, Notes Roy. Bot. Gard. Edinburgh 18: 190. 1934. (= **Aeschynanthus linearifolius** C.E.C.Fisch.).

Lectotype (designated here): BURMA, **N.E. Upper Burma**, Western flank of the Chimile N'Maikha, N 26°23', E 98°48', 7–8000 ft, September 1924, *G. Forrest* 24933 (E [E00023687 digital image!]).

Fig. 1

Notes: Anthony (1934) in the protologue of *A. peelii* Hook.f. & Thomson var. *oblanceolatus* J.Anthony cited "UPPER BURMA.– G. Forrest 24933, 24980, 27080; F.K. Ward 1893, 3476. TIBET.– G. Forrest 20099, 20124" without assigning any of them as type. We traced the following relevant collections at different herbaria: *G. Forrest* 24933 at BM (BM000883879 digital image!), E (E00023687 digital image!), K (K000831880 digital image!); *G. Forrest* 27080 at E (E00096779 digital image!), A (A00423925 digital image!), NY (NY02218966 digital image!), US (US00444737 digital image!),

Fig. 1. Lectotype of *Aeschynanthus oblanceolatus* (E00023687 http://data.rbge.org.uk/herb/E00023687). © The Board of Trustees for the Royal Botanic Gardens, Edinburgh. Reproduced with permission.

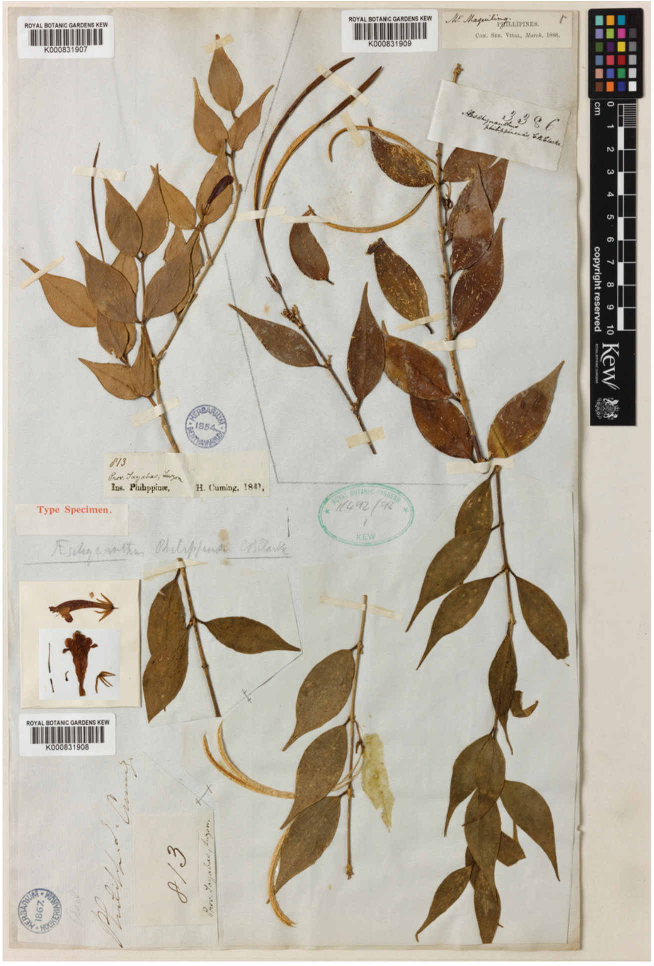

Fig. 2. Lectotype of *Aeschynanthus philippinensis* (K000831908). © The Board of Trustees for the Royal Botanic Gardens, Kew. Reproduced with permission.

P (P00606315 digital image!); *G. Forrest* 20099 at A (A00353709 digital image!), *G. Forrest* 20124 at P (P00606314 digital image!) and US (US00623796 digital image!), but could not locate *G. Forrest* 24980 and *F. Kingdon-Ward* 1893, 3476 in any possible herbaria. While all specimens possess field labels, some lack flowers (specimens from A, NY, P and US). The sheet E00023687 with a flowering twig and dehisced capsules best represents this taxon and is designated here as the lectotype.

Aeschynanthus philippinensis C.B.Clarke in A.DC. & C.DC., Monogr. Phan. 5: 9. 1883. *Lectotype* (designated here): PHILIPPINES, **Luzon**, 1841, *H. Cuming* 813 (K [K000831908 digital image!]). **Fig. 2**

Notes: *Aeschynanthus philippinensis* was originally described by Clarke (1883) and cited "Ins. Philippinae (Cuming, n. 813, in hh. Kew, Mus. Brit., Paris, Boissier, Wien)", without indicating the holotype. A thorough search in the above herbaria revealed one specimen at P (P00606332 digital image!), two each at K (K000831907, K000831908 digital images!) and W (W1889-0119557, W2006-0016684 digital images!), but none at BM or G as mentioned in the protologue. Besides these, we found a few specimens of Cuming at FI (FI009834 digital image!), L (L0281672 digital image!) and MEL (MEL2088158 digital image!).

Sinha and Datta (2016) mentioned a sheet at K as the type (the collection number 318 given by the authors might be an error) without indicating the barcode or including the phrase "designated here" (hic designatus). According to Art. 7.11 (Turland *et al.*, 2018) this cannot be accepted as an inadvertent lectotypification.

The lone sheet at K has three collections with individual barcodes, of which two belong to Cuming's collections (K000831907, K000831908) and the remaining one (K000831909) belongs to Vidal's collection. Clarke (*l.c.*) in the protologue mentioned "saepius 2-floris". The sheets K000831908 and P00606332 alone satisfy this condition while all others lack flowers or bear only a single flower. Among them, K000831908 with flowers and mature fruits and annotation by the author, is selected here as the lectotype of the name.

Aeschynanthus stenosepalus J.Anthony, Notes Roy. Bot. Gard. Edinburgh 18: 191. 1934. *Lectotype* (designated here): UPPER BURMA, **Htawgaw**, July 1924, *G. Forrest* 24773 (E [E00096780 digital image!]). **Fig. 3**

Notes: Anthony (1934) in the protologue of *A. stenosepalus* cited for the type "UPPER BURMA.—Shrub of 2–3 ft. Flowers brilliant crimson. Pendent from rocks and ledges of cliffs in side valleys. Hills around Htawgaw Lat. 26°10' N. Long. 98°25' E. Alt. 7-8,000 ft. In flower, July 1924. G. Forrest 24773 (type)". According to Stafleu and Cowan T1976) Anthony's herbarium and types are housed at A, B, BM, CAL, E, GH, K, MO, TR and US, and our search resulted in locating two relevant sheets, one each at E (E00096780 digital image!) and K (K000831882 digital image!). The sheet with barcode K000831882 bears three leaves and two flower buds mounted separately. Whereas the sheet with barcode E00096780 bears two specimens: the one on the left is a complete specimen with flowers and fruit while the right one without flowers or fruits. An annotation by A.L. Weitzman on the sheet as 'holotype' in 1998 is not correct, because Anthony in the protologue didn't assign specifically the specimen at K or E as the holotype. The specimen at E (E00096780) best represent the protologue and is chosen here as the lectotype according to Art. 9.3 (Turland *et al.*, 2018).

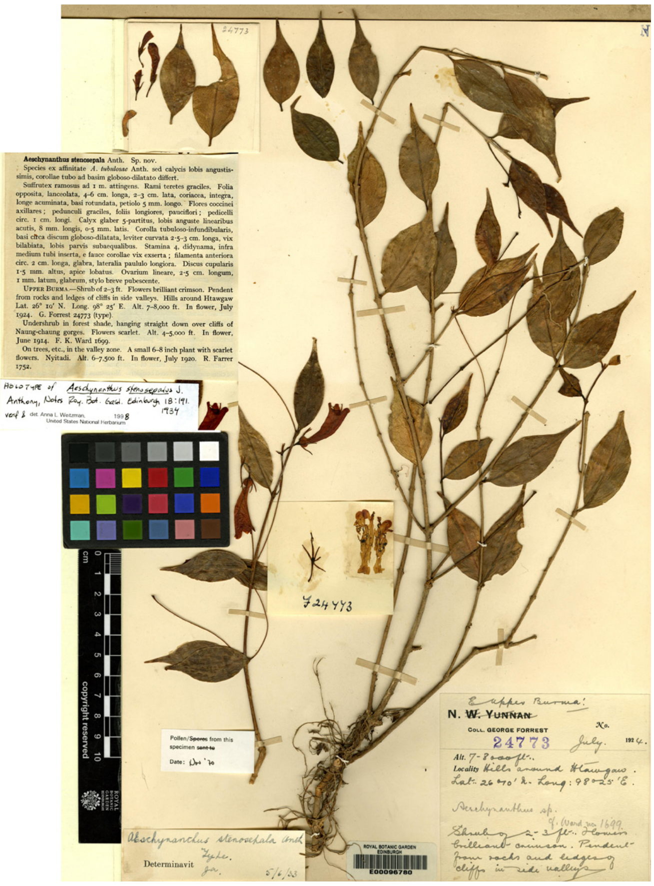

Fig. 3. Lectotype of *Aeschynanthus stenosepalus* (E00096780 http://data.rbge.org.uk/herb/E00096780). © The Board of Trustees for the Royal Botanic Gardens, Edinburgh. Reproduced with permission.

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Akhil M.K.
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Bratislava, June 8, 2021

Dear Akhil,

I am pleased to let you know that, based on your application, the IAPT Grants Committee decided to award you the IAPT Research Grant in the amount of **2,000 US $** towards your project:

Towards an integrative revision of the genus Aeschynanthus (Gesneriaceae) in India based on morphological, palynological and molecular approaches

At the same time we are pleased to offer you a free IAPT membership for 2021 with on-line access to Taxon.

We award you this grant on the following conditions:

After completing the project, but not later than on **31 December 2022**, we expect to receive a brief financial report describing how the full amount of money was spent, signed by you and by your supervisor or head of your department, as well as a short report describing the results of your study, achieved with the support of the IAPT Research Grant. Your report should also include some photos that will be displayed on the IAPT web page.

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The Gesneriad Society established the Elvin McDonald Research grants in 1986 and the Nellie D. Sleeth Scholarships in 2005 in order to assist researchers and students in their work with gesneriads.

Research grants and scholarships are awarded based on the submission of proposals from gesneriad researchers and students from around the world. Guidelines for submitting an application for an Elvin McDonald Research Grant can be found **here**; guidelines for submitting an application for a Nellie D. Sleeth Scholarship can be found **here**.

The Gesneriad Society is proud to have supported these researchers and students in their work in expanding our knowledge of the Gesneriaceae. Recent recipients of these grants and scholarships are:

2022 NDSSEF: Zulfadli from Indonesia (Exploration of *Aeschynanthus* in Sulawesi, Indonesia)
2022 EMREF: S.B. Rhuthuparna from India (Understanding the role of phylogeny and ecology in driving floral diversity in Indian Gesneriaceae
M.K. Akhil from India (An integrative approach based on taxonomic and molecular analysis of the genus *Aeschynanthus* (*Gesneriaceae*) in India)
Dr. A.P. Janeesha from India (Gesneriaceae of South India — a pictorial guide)
2021 EMREF: Roland Putra Pribadi Ahmad from Indonesia (Exploration for Gesneriaceae in Central Sulawesi, Indonesia)

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Tuesday 10 October 2023

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CERTIFICATE

For participating in a six-week training course in the preparation and analysis of next-generation sequencing data obtained from Oxford Nanopore Technologies (ONT) MinION system and character evolution analysis in *Aeschynanthus* Jack (Gesneriaceae)

Period of 21 August to 6 October 2023

This is to certify that Mr. Akhil M.K. has successfully participated in training in CTAB extraction of DNA, setting up and performing PCR reactions, agarose gel electrophoresis and ImageJ analysis, beads-cleaning and adapter and barcode-labelling, and sequencing using ONT MinION, phylogenetic analyses (BI: MrBayes; ML: IQTree; MP: PAUP) and character mapping for morphological character evolution (Mesquite), and the elucidation of the biogeographic history (BEAST and BioGeoBears) of samples of *Aeschynanthus*, at the Royal Botanic Garden Edinburgh under the supervision of Dr Michael Moeller (Tropical Diversity) and Dr Kanae Nishii (Scientific and Technical Services).

Mr Akhil has also been working in the RBGE Herbarium (E) and the living collection of *Aeschynanthus* collections towards a revision of the genus in India for his PhD degree.

We wish him every success in all his future scientific endeavours.

Yours sincerely

Michael Möller — Kanae Nishii

Dr Michael Moeller — Dr Kanae Nishii

DEPARTMENT OF BOTANY
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CERTIFICATE

This certificate is presented to Prof./Dr./Mr./Ms. Akhil M. K.

Department of Botany, University of Calicut.

for winning the **best oral presentation award** in the

Revisions & Monographs.

section for the paper titled

The genus Aeschynanthus (Gesneriaceae) in India.

during the **International Seminar on Plant Systematics: Present Status and Future Prospects** held from 15 to 17 February 2024 at the Department of Botany, University of Calicut, Kerala, India.

Prof. Santhosh Nampy
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Prof. C.C. Harilal
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Calicut University
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CERTIFICATE

This is to Certify that **Mr. Akhil M K** of **UNIVERSITY OF CALICUT, KERALA** presented a paper (ORAL) entitled "*Diversity, distribution and endemism of the genus Aeschynanthus Jack (Gesneriaceae) in India*" in National Seminar on Plant Taxonomy and Traditional Knowledge in the Himalayas and Northeast India & Annual Conference of East Himalayan Society for Spermatophyte Taxonomy (EHSST), scheduled on February 21-22, 2022.

(Dr. Tonlong Wangpan)	**(Prof. Sumpam Tangjang)**	**(Prof. Saket Kushwaha)**
Organizing Secy.	**Organizing Chairman**	**Vice-Chancellor, RGU**