Taxonomic Studies on Family Gesneriaceae Rich. & Juss. in South India Supplemented with Molecular Data

Thesis Submitted to
the University of Calicut in partial fulfillment of
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DOCTOR OF PHILOSOPHY

By

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CERTIFICATE

This is to certify that the thesis entitled **"Taxonomic Studies on Family Gesneriaceae Rich. & Juss. in South India Supplemented with Molecular Data"** submitted to the University of Calicut by **Ms. Janeesha A.P.** in partial fulfillment for the award of the degree of Doctor of Philosophy in Botany is the bonafide record of research work done under my guidance and supervision. No part of this work has been presented elsewhere for any degree or diploma previously.

Calicut University,

Santhosh Nampy
(Supervising Teacher)

DECLARATION

I hereby declare that the thesis entitled **"Taxonomic Studies on Family Gesneriaceae Rich. & Juss. in South India Supplemented with Molecular Data"**, submitted by me in partial fulfillment for the award of degree of Doctor of Philosophy of the University of Calicut, incorporates the results of the original work done by me in the Department of Botany, University of Calicut, Malappuram 673 635. No part of the work has formed the basis for the award of any other degree or diploma previously.

Calicut University,

Janeesha A.P.

to

My Parents, Teachers & Husband

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Janeesha A. P.

CONTENTS

Introduction

Diversity has inspired collectors to collect, painters to paint, travellers to travel the world, and researchers to do research. The biodiversity of the world covers all the organisms including the microbes. The flowering plants (Angiospermae), with about 2,60,000 living species, are the diverse, dominant group of vascular plants classified under 453 families (Soltis *et al*., 2004; Simpson, 2006). They arose in the early Cretaceous period (*c*. 120 million years ago) and inhabited in all habitats. India is one of the floristically rich countries in the world, with about 17,500 species of flowering plants, which account for more than seven percent of the total plant species of the world (Karthikeyan, 2000). It lies within the Indo-Malaya ecozone and completely houses two of the 34 biodiversity hotspot in the world (Moghe, 2011). Western Ghats is one of the important biodiversity hotspot in India, comprises nearly 7,402 flowering plants (Nayar *et al*., 2014), which encompass about two third of species diversity of South India.

Gesneriaceae Rich. & Juss. is a medium-sized plant family with *c.* 3400 species of the order Lamiales (APG III, 2009 & APG IV, 2016), where they belong to the more basal families (Schaferhoff *et al*., 2010). The family has an equal distribution in the Neotropics and Paleotropics, with some outliers in temperate South America and Europe (Weber, 2004a). In Asia-Malesia and in America there are around 60 genera, in Africa 9 genera (*c*. 160 sp.) and in Europe 3 genera (6 sp.). Nine genera (20 sp.) have a distinctly southern hemisphere distribution. But *Rhynchoglossum* is represented both in Asia and (with a single species) in the neotropics. The second genus with transcontinental distribution is *Epithema* (one species in West Africa and the

other (*c*. 20) in Mainland Asia and Malesia, Weber & Skog, 2007). The plants are generally small, perennial herbs with conspicuous showy flowers. The family is easily distinguished by opposite deccusate (sometimes anisophyllous or alternate) leaves, pair-flowered cymes, pentamerous bisexual flowers with zygomorphic corolla, usually four or two stamens, presence of an annular or a one-sided disk and 1-locular ovary with parietal placentation. Gesneriaceae are closely related to Calceolariaceae, but distinguished by the unilocular ovary with parietal placentation. Many species of Gesneriaceae are grown as ornamentals while a few are of ethnobotanical interest.

As per the recent classification of Gesneriaceae by Weber *et al*. (2013), Indian Gesneriaceae belongs to the subfamily Didymocarpoideae and its two tribes, *Epithemateae* C.B.Clarke and *Trichosporeae* Nees. Clarke (1884) reported 20 genera and 114 species from India. Gamble (1924) recorded 7 genera and 19 species for South India. Skog and Boggan (2007) in the World Checklist for Gesneriaceae of the Smithsonian Institution listed 110 species and 9 varieties under 24 genera from India. Since 2007, and essentially based on molecular data, many genera have been redefined, several new genera were established and a considerable number of genera were sunk into synonymy and a number of additional taxa has been described or recorded by various authors (Punekar & Lakshminarasimhan, 2009; Rajakumar *et al*., 2009; Manudev *et al*., 2012; Singh *et al*., 2012; Datta *et al*., 2014; Janeesha & Nampy, 2015; Joe *et al*., 2016). At present, the family is represented by 22 genera and 109 species in India (Moeller *et al*. 2017, in press) and 7 genera and 24 species and one variety in South India.

Study Area

South India, the area of present study, includes the states of Andhra Pradesh, Karnataka, Kerala, Tamil Nadu, Telangana and union territories of Lakshadweep and Puducherry (**Plate 01**). Geographically the area falls between 8^{o} 4'–15^{o} 6'N latitudes on the west coast and 19^{o} N on the east coast and 74^{o}–85^{o} E longitudes. It covers an area of 4, 67, 186 sq. km and lies entirely in the tropical zone. It is bound on the west by the Arabian Sea, east by the Bay of Bengal, south by the Indian Ocean and on the north by the Vindhya and Satpura ranges.

South India consists of two major floristic regions - the Deccan and the Malabar. The Deccan is the largest plateau in India, stretching from the mountain ranges of central India *viz.,* Aravallis, the Malva, the Vindhyas, the Satpura and the Chota Nagpur hills in the north and almost right down to Kanyakumari in the south. The Deccan consists of three distinctive physiographic subdivisions a) North Deccan plateau b) South Deccan plateau and c) East Deccan plateau. The second and third physiographic subdivisions fall within the present study area. The south Deccan plateau consists of Karnataka plateau, Rayalaseema uplands, Tamil Nadu uplands, and Telangana plateau. The east Deccan plateau is a very sparsely populated rugged terrain. It is the rain shadow region of Western Ghats and is characterized by the tropical deciduous forests and in the open plains it is replaced with drought resistant species and thorny bushes. The eastern coastal plains of Deccan plateau is a broad strip running parallel to the coast of Bay of Bengal and gradually rising from it. It consists of fertile coastal plains mainly formed by the deltas of Cauvery in Tamil Nadu, Godavari and Krishna in Andhra Pradesh and a number of small rivulets and streams.

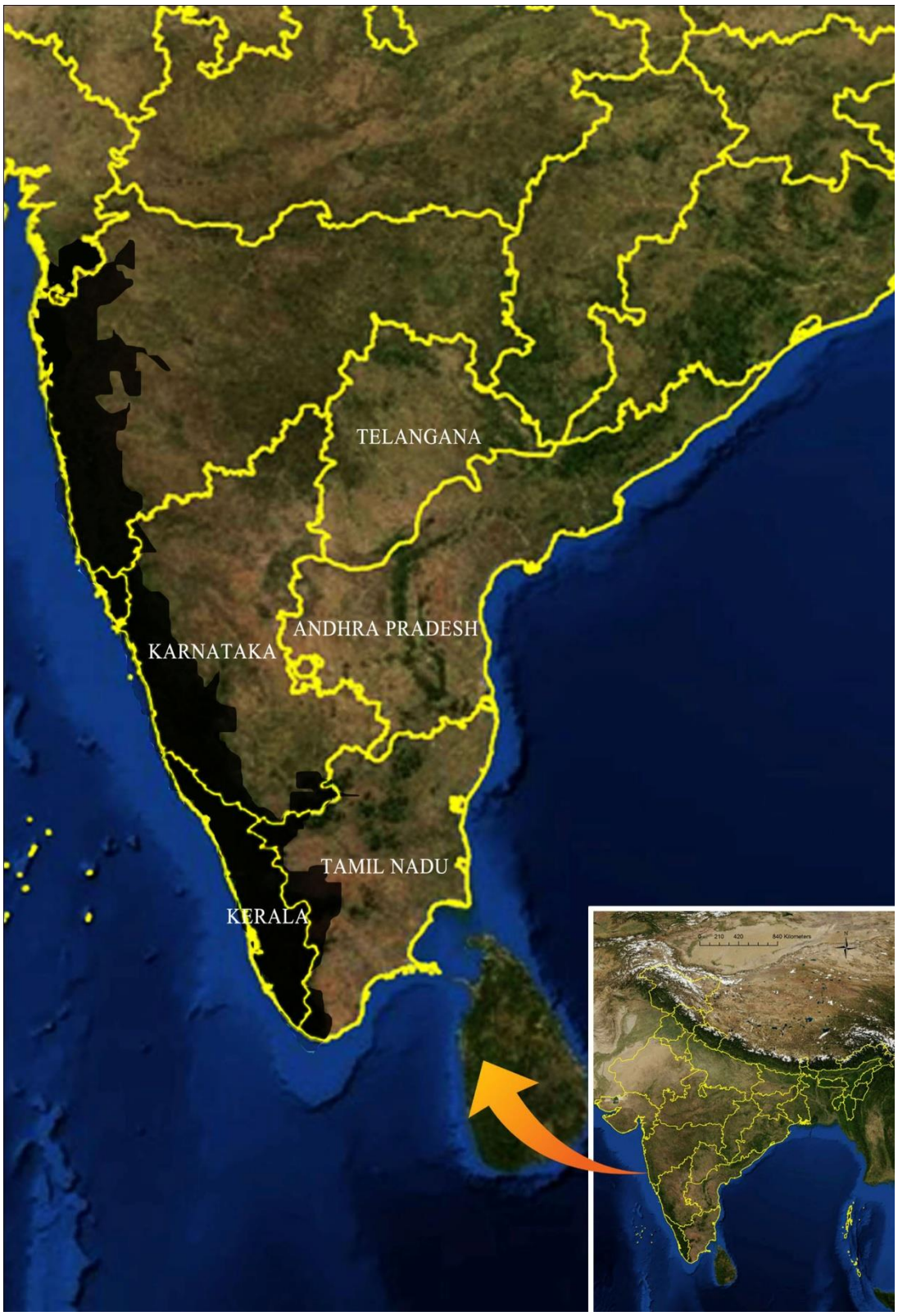


PLATE 01: Area of study

The Malabar Coast is a long, narrow strip of land running parallel to the coast of Arabian Sea, west of the Western Ghats and south of Konkan. This region is floristically very rich and includes coastal plains and a series of hill ranges of the Western Ghats. The Malabar and the Deccan regions together provide a wide range of climatic and edaphic zones with mountain ranges, hillocks, valleys, swamps, marshy lowlands, sandy sea-coasts, fresh water streams and back waters on the sea-front and harbours diverse type of vegetation.

South India encompasses two mountain ranges, the Western and the Eastern Ghats. The Western Ghats (Sahyadri) is a chain of mountains along the western border of the Deccan, overlooking the Arabian Sea on the West and run parallel to the coast of peninsular India. It comprises an area of approximately 1.6 lakh sq. km. and stretch as a narrow belt over a distance of 1600 km from Tapti valley in Gujarat where it touches the western edge of the Vindyas, down to the tip of the peninsula, the Kanyakumari in Tamil Nadu. These mountain ranges run north-south along the west coast traversing the states of Gujarat, Maharashtra, Goa, Karnataka, Kerala and Tamil Nadu and give birth to all the important rivers of South India. These hill ranges are more prominent and more continuous than the Eastern Ghats. The Western Ghats mountain ranges have an average altitude of 1550 m but rises to 2000–2500 m peaks here and there. By virtue of its geographic location, topography and rainfall from both south-west and north-east monsoon, it supports the luxurious growth of tropical wet evergreen, semi-evergreen and moist deciduous forest.

The Eastern Ghats run along the eastern border of the Deccan plateau, extends over a length of 1750 km in Indian peninsula with an average width

of 200 km in the north and 100 km in the south. The Mahanadi basin marks the northern boundary of the Eastern Ghats while the southern boundary is the Nilgiri hills. Unlike the Western Ghats, the Eastern Ghats does not form a continuous range since the great rivers Godavari and Krishna cut across it.

On account of the comparatively low temperature prevailing in south Indian hills, the climate and vegetation of these areas are often spoken of as temperate type. However, Meher-Homji (1967) described the climate of this region as tropical montane type.

Phytogeographic divisions

Hajra *et al.* (1995) recognised eleven phytogeographic zones in India. They are, 1). North-West Himalayas, 2). Indo Gangetic Plains, 3). Eastern Himalayas: Sikkim & Arunachal Pradesh, 4). North eastern India and North Bengal, 5). Central India, 6). Arid Zone, 7). Northern Western Ghats and Northern West Coast, 8). Southern Western Ghats, West Coast and Lakshadweep, 9). Deccan, 10). Eastern Ghats-Coromandel Coast and 11). Andaman and Nicobar Islands.

Out of these, South India falls under the following five zones: Central India, Northern Western Ghats and Northern West Coast, Southern Western Ghats, West Coast and Lakshadweep, Eastern Ghats-Coromandel Coast and Andaman and Nicobar Islands.

Rain

South India is fed by two rain bearing winds, the south-west monsoon and the north-east monsoon. Of these, the south-west monsoon is the dominant, especially in the states of Kerala and Karnataka. The north-

east monsoon comes in the wake of south-west monsoon and is comparatively weaker. Before the south-west monsoon open in full force in June, there are intermittent pre-monsoon showers in April-May. Western Ghats plays an important role in the distribution of rain in South India.

The south-west monsoon starts on the west coast of South India at about the beginning of June. The rain fall is erratic, ill distributed and it varies from place to place and year to year. The west coast of South India (parts of Karnataka and Kerala) receives the heaviest rainfall with more than 220 cm annually, where as Andhra Pradesh, Tamil Nadu and Telangana receives only 100–200 cm rain fall, and the southern parts of Andhra Pradesh gets only 50 cm annually.

Forests

The forests in South India include tropical, wet and semi evergreen types of the Western Ghats; tropical, moist deciduous forests in the southern Karnataka and Kerala; tropical thorn forests, found in much of the drier Deccan plateau; and montane and wet temperate forests in the higher parts of Tamil Nadu and Kerala. The southern tropical wet evergreen forests were subdivided into two groups according to the exposure to wind, soil and climatic conditions: the west coast tropical evergreen forests and the southern hilltop tropical evergreen forests.

Soil

Soil is the part of earth crust in which humus is present. Soil is made up of five components which include mineral particles, dead organic matter, soil atmosphere, soil water and biological system or soil microorganism. The major types of soil met in South India are,

a) Red soil: Red soil mainly occurs in Andhra Pradesh, Karnataka and Telangana. Red soil of valleys and plains are dark and fertile. These are composed of silica and aluminium with free quarts or sand. They are low in bases and characterized by the absence of lime nodules. Humus and nutrients are also low. It is light, friable, porous and has low humus and water holding capacity.

b) Black soil: It is mainly seen in Tamil Nadu (Ramnad and Tirunelvely district), parts of Karnataka and Andhra Pradesh. Black colour of this soil is due to the presence of a double hydrated Ferrous and Aluminium silicate. The soil is clayey or loamy, argillaceous, fine grained and contains a high proportion of Calcium and Magnesium carbonates. They are very tenacious to moisture and exceedingly sticky when wet. This soil is poor in Phosphorus and rich in organic matter and nitrogen.

c) Lateritic soil: These are generally reddish or yellowish-red and turn black on exposure to sun. This type of soil occurs in parts of Tamil Nadu, and in the Eastern and Western Ghats. These soils are formed in regions of alternate wet and dry seasons. This soil is majorly composed of hydrated oxides of aluminium and iron with minor quantities of manganese and titanium oxides. Laterites are well developed on hilltops and are characterized by rich humus content. It is fertile and contains 10–20% organic matter. In Kerala, lateritic soils at low elevations show poor nutrient status, while at higher altitude it supports plantation crops. The lateritic soil of Karnataka is comparable to Tamil Nadu and is good in organic matter.

d) Aluvial soil: It is the most productive type of soil in India, also present in the fringes of Peninsula India. It has a high proportion of clay, and are more sticky, and its texture may vary from sandy loam to clay and colour vary from grey to reddish brown. It is rich in potassium and deficient in nitrogen and organic matter. In Kerala, the coastal alluviums are sandy having a low water holding capacity and nutrient status.

Climate

The climate in South India is general and uniformly mega-thermal (Subramanyam *et al*., 1965; Rao & Verma, 1972). Chowdhury and Sarwade (1982), on the basis of the ratio of the rainfall to evapotranspiration, classified the homoclimatic region of India into five categories *viz*., arid region, semi-arid region, sub-humid region, humid regime and super-humid regime. Among them, South India falls under four homoclimatic types. The coastal districts of Andhra Pradesh, Telangana, interior areas of Karnataka and some districts in Tamil Nadu come under semi-arid climate. Northern coastal Telangana, southern districts of Karnataka and north Tamil Nadu experience dry sub-humid, climate while coastal Karnataka and norhtern parts of Kerala have moist sub-humid climate. The humid regime predominates in southern districts of Kerala and high altitude locations around Conoor and Ooty (Tamil Nadu); whereas super-humid, climatic regime occupies the smallest area, Kodaikanal in Tamil Nadu.

Relevance of the study

Gesneriaceae represent a significant floristic component of forests and open habitats in the tropics and subtropics of the Old and the New World.

While the gesneriad flora of the neotropics is fairly well known (due to the strong American scientific engagement in Central and South America), the exploration of paleotropical Gesneriaceae lags behind. This hold especially true for India, for which no modern floristic treatment is available. This is regrettable as Indian Gesneriaceae are particularly interesting as they include a number of biogeographically and geohistorically interesting genera and as there is a high degree of endemism. Most of the species present here are endemic (80%) to southern Western Ghats. Among them some are rare, vulnerable and some are Critically Endangered (Ahmedullah & Nayar, 1987; Nayar & Sastry, 1990; Walter & Giillet, 1997; Gopalan & Henry, 2000; Sasidaran, 2004). List of endemic taxa of Gesneriads are given in **Table 01** including the newly identified taxa during the present study). Currently the taxonomy of Gesneriaceae is in a fluctuating state, and none has been so far attempted to deal with it holistically after Clarke's (1884) treatment in Flora of British India.

The great diversity, the high degree of endemism, the incomplete taxonomic understanding and the rarity of some taxa necessitated a study of the family Gesneriaceae in South India.

Table 01: List of endemic taxa of Gesneriaceae in South India

Sl. No.	Species
1	*Aeschynanthus perrottetii* A.DC.
2	*Henckelia bracteata* Janeesha & Nampy
3	*H. fischeri* (Gamble) A.Weber & B.L.Burtt var. *fischeri*
4	*H. fischeri* (Gamble) A.Weber & B.L.Burtt var. *x*
5	*H. gambleana* (C.E.C.Fisch.) A.Weber & B.L.Burtt
6	*H. incana* (Vahl) Spreng.
7	*H. innominata* (B.L.Burtt) A.Weber & B.L.Burtt
8	*H. lyrata* (Wight) A.Weber & B.L.Burtt
9	*H. macrostachya* (E.Barnes) A.Weber & B.L.Burtt
10	*H. meeboldii* (W.W.Sm. & Ramaswami) A.Weber & B.L.Burtt
11	*H. missionis* (R.Br.) A.Weber & B.L.Burtt
12	*H. ovalifolia* (Wight) A.Weber & B.L.Burtt
13	*H. pradeepiana* Nampy, Manudev & A.Weber
14	*H. repens* (Bedd.) A.Weber & B.L.Burtt
15	*H. wightii* (C.B.Clarke) A.Weber & B.L.Burtt
16	*H. x*
17	*Jerdonia indica* Wight
18	*Microchirita sahyadriensis* (Punekar & Lakshmin.) A.Weber & D.J.Middleton
19	*Rhynchoglossum notonianum* (Wall.) B.L.Burtt
20	*R. scabrum* Dalzell

Objectives of the study

1. Field exploration and assessment of present distributional status of all the genera, species, subspecies and varieties of the family Gesneriaceae in South India.

2. Maintenance of live specimens in the botanical gardens for further study.

3. Preparation of herbarium specimens for future references.

4. Establishment of database on the family in South India.

5. Identification of each taxon in consultation with types or other authentic collections and relevant literature.

6. Molecular characterization of members of Gesneriaceae in South India and construction of phylogenetic tree.

7. Preparation of an illustrated taxonomic account on the family in South India.

Review of Literature

Taxonomy

French botanists Richard and Jussieu (1804) were the first to consider Gesneriaceae as a family. They found *Gesneria* L., *Besleria* L., *Columnea* L., *Achimenes* Pers., *Gloxinia* L'Her. and *Eriphia* P. Brown as distinct and can be included under a new family based on the unilocular fruit, fleshy disk at the base of the ovary and the insertion of stamen on the corolla. But, neither Jussieu nor Richard mentioned a name for the new family. The family was formally established by Alphonse De Candolle (1816) as Gesnerieae 12 years later and this comprises only the Neotropical plants. De Candolle did not give a description for this, but it was validated by giving reference to Jussieu's paper.

Don (1822) and Jack (1823) established two old world families *viz*., Didymocarpaceae (as Didymocarpeae) and Cyrtandraceae (as Cyrtandreae) to accommodate plants from Asia and Pacific respectively. Don worked with the plants collected by Wallich and collaborators in Nepal, and named his family with *Didymocarpus* Wall. as the type genus (Hamilton in 1819). Subsequently Don (1825) described two new genera: *Lysionotus* D.Don (2 sp.), *Trichosporum* D.Don (2 sp.) in addition to *Didymocarpus* Wall. (4 sp.). Jack (*l.c.*) established Cyrtandreae based on the the plants collected from Penang and Sumatra and recognised four genera under it *viz*., *Cyrtandra* Jack & G.Frost (11 sp.), *Didymocarpus* Wall. (7 sp.), *Loxonia* Jack and *Aeschynanthus* Jack (2 sp.). Later, De Candolle (1845) merged Didymocarpaceae under

Cyrtandaceae though former had priority over the latter. However he kept the old world plants distinct from American Gesneriacece.

Martius (1829) was the first compare New World Gesneriaceae and Old World Cyrtandraceae who discuss the relationship among them. However, he decided to keep them distinct though they were closely related. Subsequently George Don (1838) and Robert Brown (1839) concluded that the differences between these two are not enough to warrant familial separation and formally united these two into a single one under Gesneriaceae.

The united concept of Gesneriaceae by Brown and Don was followed by Bentham (1876), who was the first to publish an overall account of Gesneriaceae in a wide sense. Later Clarke (1883) revised the paleotropical Cyrtandraceae. Fritsch (1893-1894) revised the family as a whole and provided a detailed intrafamilial classification. He divided the family into two sub-families - Cyrtandroideae and Gesnerioideae based on the position of the ovary, and recognised several tribes under them. Burtt (1963) reverted essentially to the original geographical separation and recognized that Paleotropical Gesneriaceae shared a conspicuous and uncommon feature- the anisocotylous seedlings. Burtt defined this group as a sub-family Cyrtandroideae with 5 tribes under it. Ivania (1965, 1967) and Wang *et al*. (1990, 1998) added additional tribes to the family Gesneriaceae. Weber (1975, 1976a, 1976b, 1978a, 1978b) united the two tribes *Klugiae* and *Loxonieae* and presently figure out as tribe *Epithemateae* (Burtt, 1997). Some Australian and South Pacific genera were not included in the Paleotropical sub-family Cyrtandroideae. These genera were placed in tribe *Coronanthereae* with the temperate South American tribes. Wiehler (1983) united *Coronanthereae* and

Mitrarieae and raised them to a sub-family of its own- Coronantheroideae, based on the nature of the nectary. Thus according to Burtt and Wiehler (1995) the family Gesneriaceae comprises three sub-families. Weber *et al*. (2013) in a recent formal classification recognised three subfamilies, 7 tribes and 24 sub-tribes.

The first account of this family in India was by Clarke (1884) who reported 130 species under 25 genera in his treatment of Gesneriaceae in Flora of British India. Gamble (1924) reported 19 species in Flora of the Presidency of Madras. Sinha & Datta (2016) gave an account of this family for North East India. There is no revisionary work available for this family in South India apart from the treatement in various state/ regional floras (Cooke, 1906; Rama Rao, 1914; Fyson, 1915; Ramaswamy & Razi, 1973; Saldhana & Nicolson, 1976; Matthew, 1981; Yoganarasimhan *et al*., 1981; Manilal & Sivarajan, 1982; Matthew, 1982; Sharma *et al*., 1984; Nair & Nayar, 1986; Rao & Hara, 1986; Henry *et al*., 1987; Chandrabose & Nair, 1988; Manilal, 1988; Ramachandran & Nair, 1988; Singh, 1988; Keshavamurthy *et al*., 1990; Vajravelu, 1990; Mohanan & Henry, 1994; Matthew, 1995, 1996; Sasidharan & Sivarajan, 1996; Sivarajan & Mathew, 1997; Pullaiah & Ali Moulali, 1997; Pallithanam, 2001; Mohanan & Sivadasan, 2002; Kumari *et al*., 2002; Bhat, 2003; Sasidharan, 2004; Anilkumar *et al*., 2005; Nayar *et al*., 2006; Sunil & Sivadasan, 2009; Punekar & Lakshminarasimhan, 2011; Pullaiah *et al*., 2011; Ganeshaiah *et al*., 2012; Krishnakumar *et al*., 2013; Nayar *et al*., 2014) and few scattered papers (Punekar & Lakshminarasimhan, 2009; Rajakumar *et al*., 2009; Manudev *et al*., 2012; Janeesha & Nampy, 2014, 2015 *etc*.). At present, the family is represented by 22 genera and 109 species in India (Moeller *et al*. 2017, in press).

Anatomy

The application of anatomical characters in plant classification dates back to Bureau (1864), who for the first time used them for the delimitation of taxa of various levels within the family of Begoniaceae (Sivarajan & Robson, 1991). It provides evidences concerning the inter relationship of large groups or in helping to establish the affinities of genera of certain taxonomic status. The anatomical methods are of great value in identifying the herbarium specimens, which do not bear flowers or fruits (Sivarajan, 1984). There are several works in discussion of leaf and stem anatomy, indumentum, stomata, trichomes *etc.* of family Gesneriaceae: Rechinger (1899) and Pongracic (1931) on the trichomes; Sachs (1915) on the leaf anatomy; Rosser and Burtt (1969) on the stem and leaf anatomy of Trichosporea; Bokhari and Burtt (1970), Burtt and Bokhari (1973) on the sclereids in *Cyrtandra*; Sahasrabudhe and Stace (1974) studied the anatomical and developmental aspects of stomata and trichomes; Herat and Theobald (1979) on the anatomy of Sri Lankan taxa; Wiehler (1983) on the anatomy of Neotropical Gesneriaceae and Carlquist and Hoekman (1986) on the wood anatomy.

Rechinger (*l.c.*) observed that the trichome structure of Gesneriaceae are usually simple and uniseriate (raely multiseriate, as in *Rhynchoglossum*), eglandular or glandular. He also found that simple trichomes are common in Gesneriaceae where as branched eglandular hairs are occasional. According to Weber (1976c, 1977b) the hairs usually end in a single terminal cell but sometimes it will bend to form a small hook as in *Epithema, Stauranthera.* Several workers mentioned about the anatomical features of Gesneriaceae. The rod like hairs are found in *Henckelia* sect. *Glossadenia*. In

Didymocarpus and *Streptocarpous*, pigmented glands of yellow brown to blackish red are present due to the biosynthesis of naphthaquinone (Price & Robinson, 1938, 1940; Stokig *et al*., 1973, Inoue *et al*., 1984). Wollenweber *et al*. (1981) reported that gland exudates in *Didymocarpus* sp. have the presence of aurentiacin, benzoquinnoid *etc*. Weber & Burtt (1983) illustrated some variations in the pigmented glands and the type and composition of indumentum is often used for species identification. Burtt (1984) separated *Boea* and *Paraboea* essentially based on the type of indumentums.

In Gesneriaceae, the stomata are anisocytic, surrounded by 3–4 unequal subsidiary cells. Skog (1976) observed stomatal turrets (domes) with group of stomata in *Cyrtandra*, *Nepeanthus* and in the *Gesneria* alliance. Wiehler (1983) observed domes with individual stomata in the tribe *Gloxinieae*. He also noticed that aniso-mesogenous type of stomata are found in Gesnerioid Gesneriaceae and anomo-mesoperigenous type in Coronantheroid Gesneriaceae.

Stem anatomy of *Aeschynanthus* and *Agalmyla* was studied by Rosser (in Rosser & Burtt, 1969). Generally the stele of Gesneriaceae is a hollow cylinder of continuous phloem and xylem of which the latter may contain fibres and/or libriform tracheids. Medullary bundles were noticed by Hollstein (1878) and Wonisch (1909) in the pith of *Rhynchoglossum* and *Monophyllaea*. They also found the presence of schizogenous secretory ducts in some Epithematoid Gesneriaceae (formed next to the xylem and run through the stem, leaves, *etc*.) and in the medullary bundles of *Rhynchoglossum* and *Monophyllaea.*

Wiehler (1983) studied the nodal anatomy of Neotropical Gesneriaceae and provided useful character for defining tribes. The

differences of nodal anatomy of *Columnea ambigua* in the natural and cultivated condition have been reported by Howard (1970). The wood anatomy of Gesneriaceae have been studied by Carlquist & Hokeman (1986). Patel (1990) studied the wood anatomy of some New Zealand Gesneriaceae. Jong *et al*. (2012) made a survey on the unusual morphological and anatomical features of two woody Madagascan S*treptocarpus*. The anatomical studies revealed that the Gesneriaceae posses cell inclusions, commonly in the form of calcium oxalates. Cystoliths are found in *Rhynchoglossum* (Fritsch, 1908). Reichart (1913) observed the prescence of starch in Gesneriaceae.

The floral anatomy of Gesnericeae was studied by Wilson (1974a, 1974b) who mainly focused on the vasculature of the nectaries on Cyrtandroideae and Gesnerioideae. The members of Gesnericeae are commonly provided with nectarines located at the base of the ovary. The nectary is termed as disk which is found in two forms (i) a ring or cup shaped body, called annular disk and (ii) the segmented disk, composed of one to five glands. According to Wilson (*l.c.*) vascularised annular disk is presented in *Cyrtandreae*, *Trichosporeae* and *Klugieae*, and in *Didymocarpeae*, two groups, one with vascularised annular disk and other group without disk can be found. He also found that in *Jerdonia*, non-vascularised necteriferous disk is present. In all the groups except *Klugieae,* the vascularised disk nourishes the floral organs.

Similar to vegetative organs, epidermal trichomes are also present in the floral region. This may be glandular, eglandular or sessile trichomes. Some examples are Chalk-secreting glands on the inner side of the sepal of *Whytockia* and *Monophyllae* (Weber, 1976a, 1976b), dense yellow glands on

the stylar region (make it an anther dummy) of *Henckelia geitleri* (Weber, 1989a) and patches of densly packed glands on the lower lip of *Emarhendia* (Kiew *et al*., 1998). Ocassionally, distinct rings or patches of hairs are found inside the corolla tube of some genera such as *Hemiboea*, *Agalmyla* sect. *Agalmyla* (Hilliard & Burtt, 2002). These hairs may have significant role in pollination. Boggan (1996) observed that the flowers of *Sinningia* and *Gloxinia* have trichomes of various type inside the corolla tube, which is strongly correlated with insect pollination. He also noted that bird pollinated flowers are nearly glabrous inside.

Cytology

Karyological studies are critical in plants since they allow the detection of particular changes in chromosome number such as aneuploidy or diploidy processes (Briggs & Walters, 1997). It has been accepted that the absolute size of chromosomes in karyotype is fairly constant, species specific character (Davis & Heywood, 1963). The earliest reporte of chromosome count in Gesneriaceae was made by Oehlkers (1923) in *Monophyllaea horsfieldii* R.Br. Investigations on the cytology of New World Gesneriaceae were done by a team of scientists from New York (Lee, 1962a, 1962b, 1964, 1966a, 1966b, 1967; Lee & Grear, 1963; Lee in Moore, 1955, 1963) and scientists from Royal Botanical Garden, Edinburgh worked on the Old World Gesneriaceae (Ratter, 1963, 1975; Ratter & Milne, 1970; Ratter & Prentice, 1964, 1967; Milne, 1975).

The other major contributors includes Roger (1954), Roger in Lee (1962a), Eberle (1956, 1957a, 1957b), Fussell (1958), Morley (1967, 1972), Morley in Stearn (1969), Davidse (1970, 1971, 1981), Wiehler (1972, 1975a, 1975b, 1975c, 1975d, 1976), Oliver & Skog (1985) for New World taxa. Ratter

(1975) reported that the smallest chromosomes are found in *Aeschynanthus* and *Cyrtandra* (less than 1 μm in length) whereas the largest in *Agalmyla* (over 3 μm in length). Skog (1984) discovered that the most frequent count in the family is n=9 and two other peaks occurs at n=13 and n=16. And also the lowest count known is n=4 in *Chirita pumila* D. Don.

Kiehn & Weber (1998) and Keihn *et al.* (1997) added around 120 counts for the Old World Gesneriaceae mainly in the subfamily Cyrtandroideae from Malaysia. Jong & Moller (2000) and Rashid *et al.* (2001) reported the chromosome count of *Streptocarpus* from Madgascar and *Aeschynanthus* respectively. In the synopsis of cytological studies in Gesneriaceae, Moller & Kiehn (2003) mentioned around 1000 chromosome count has been published for the family Gesneriaceae till now. Zhou *et al.* (2004) carried out the cytological work of the subfamily Cyrtandroideae from China and Vietnam and also they reported the chromosome number of 12 species under 10 genera. Christie *et al*. (2012) determined the chromosome number s of species hitherto regarded as *Chirita* and found that *Chirita* is heterogenous in chromosome numbers including seven different somatic numbers.

Embryology

Embryological characters are less prone to adaptive stress and relatively stable and have acquired great significance in taxonomy (Kapil & Bhatnagar, 1980). The potential role of embryology in the taxonomy of flowering plants has been discussed by various authors like Maheswari, Johri, Coccuci *etc*. There are few papers on the embryology of Gesneriaceae. Brown (1839) reported that the prescence or absence of endosperm in seeds is an old distinction between the Neotropical and Paleotropical

Gesneriaceae. The embryo development is Onagrad type, whereas embryo of *Rhytidophyllum crenulatum* lack cotyledons and tissue differentiation (Cook, 1907). An overview of endosperm development was studied by Schnarf (1931) and Johri *et al*. (1992). Huber (1953) and Weber (1976a) studied the anther anatomy of Gesneriaceae and found to be dicotyledonous type, with 4 layers *viz*., epidermis, endothecium, middle layer and tapetum. The nucellus is single layered and the embryosac development is Polygonum type in Gesneriaceae (Anders, 1966). Adatia *et al*. (1971) discovered that the three antipodals degenerate so that the mature embryosac comprises four cells. Luegmayer (1994) studied the function of tapetal cells, male sporogenesis development in *Monophyllaea horsfieldii*. He found that the development follows the regular pattern of angiosperms and the mature pollen grains are 2-celled. The ovules of Gesneriaceae are anatropus, unitegmic and tenuinucellate. The other papers in this field are by Balicka-Iwanowska (1899), Schnarf (1921), Laurent (1923), Oehlkers (1923), Glisic (1928, 1934), Thathachar (1942), Crete (1942, 1949, 1955a, 1955b), Arekal (1961), Padmanabhan (1961), Swamy and Padmanabhan (1961), Holmqvist (1964), Padmanabhan (1966), Viemont and Astie (1974), Viemont (1976), Alimova and Yakovlev (1982), Svoma and Kiehn (1993) and Luegmayer (1994).

Molecular Phylogeny

Molecular phylogenetics applies a combination of molecular and statistical techniques to infer evolutionary relationship (Dowell, 2008) and it is the most powerful approach in systematics available at present (Bremer & Struwe, 1992). Molecular studies have clarified the phylogenetic relationships of many genera and tribes, providing evidence that supports

(1) the monophyly of Gesneriaceae as one of three families sister to core Lamiales (Oxelman *et al.,* 1999, 2005; Backlund *et al.,* 2000; Olmstead *et al.,* 2001; Bremer *et al.,* 2002; APG III, 2009; APG IV, 2016); (2) the monophyly of the New World subfamily Gesnerioideae and the presence within it of at least six or seven tribes (Smith *et al.,* 1997; Zimmer *et al.,* 2002; Roalson *et al.,* 2005a); (3) the presence of a distinct tribe, *Epithemateae*, sister to the rest of the tribes within sub-family Cyrtandroideae (Mayer *et al.,* 2003); (4) the incongruence between traditional classification and tribal relationships suggested by molecular data within sub-family Cyrtandroideae excluding *Epithemateae* (Moller *et al.,* 2009); and (5) the internal relationships and monophyly of several tribes (*Episcieae*: Smith & Carrolle, 1997; Smith, 2000b; Clark *et al.,* 2006; *Gloxinieae*: Smith & Atkinson, 1998; Roalson *et al.,* 2005a, 2005b, 2008; *Beslerieae* and *Napeantheae*: Smith, 2000a; *Sinningieae*: Perret *et al.,* 2003; *Gloxinieae* and *Gesnerieae*: Smith *et al.,* 2004a, 2004b) and genera (*Columnea*: Smith & Sytsma, 1994a, 1994b; *Saintpaulia*: Moller & Cronk, 1997; Smith *et al.,* 1998; *Streptocarpus*: Moller & Cronk, 2001; *Aeschynanthus*: Denduangboripant & Cronk, 2001; *Achimenes*: Roalson *et al.,* 2003; *Alloplectus*: Clark & Zimmer, 2003; *Cyrtandra*: Samuel *et al.,* 1997; Bramley *et al.,* 2004; Cronk *et al.,* 2005).

Smith (1996) studied the tribal relationship with in Gesneriaceae with the aid of a cladistic analysis of morphological data. His study resulted that Klugieae as sister to the reminder of the family which consist of a paraphyletic Cyrtandroideae and monophyletic Gesnerioideae. The other major molecular works carried in this family includes the studies conducted by Moller and Cronk (1997, 2001), Cronk (1999), Denduangboripant and Cronk (2000, 2001), Smith (2000a, 2000b), Denduangboripant *et al*. (2001),

Zimmer *et al*. (2002), Mayer *et al*. (2003), Moller at al. (2003), Perret *et al.* (2003), Bramley *et al*. (2004), Wang *et al.* (2004), Ni *et al*. (2006), Palee *et al*. (2006), Li & Wang (2007); Moller *et al*. (2008, 2009, 2011), Wang *et al*. (2010), Wie *et al*. (2010), Wang *et al.* (2011), Weber *et al*. (2011), Zhang *et al*. (2011), Woo *et al.* (2011), Moller & Clark (2013), Perret *et al*. (2013), Pillon *et al*. (2013), Smith & Clarke (2013), Wang *et al*. (2013); Weber *et al*. (2013); Martin (2015) and Roalson and Roberts (2016).

Moller and Cronk (1997) modified the primers published by White *et al*. (1990) and Yokota *et al*. (1989) for Gesneriaceae as ITS5P and ITS8P along with the universal primers ITS4. They also used ITS3P (White *et al*., 1990) and ITS2G (Moller & Cronk, 1997) as the internal primers. Denduangboripant and Cronk (2000, 2001) studied the genus *Aeschynanthus* at the molecular level and found that there is an insertion or deletion hot spot in the ITS2 sequence in *Aeschynanthus* that is difficult to align. They noted that this phenomenon is widespread in the family. The hot spot located in the terminal part of the arm 1, which is highly variable and can be delete, which implies that it is functionally superfluous. Denduangboripant *et al*. (2001) studied the evolution in the genus *Aeschynanthus* inferred from ITS sequence and showed that the genus is polymorphic and can be divided in to two clades, Clade I primarily occurring in mainland SE Asia and Clade II in Malesia. Clade I members are characterised with a seed-testa having straight or clockwise spiral orientation and Clade II members are characterised with a seed-testa having an anticlockwise orientation. They also proposed a tentative model of geographic pattern of evolution in *Aeschynanthus*, suggesting a combination of ancient vicariance, recent dispersal and coalescence events in the region.

The study on phylogenetic relationship in Gesnerioideae carried out by Zimmer *et al*. (2002) strongly supported the monophyly of Beslerieae/Napeantheae clade, Episcieae clade, Gesnerieae clade and Gloxinieae clade. Phylogenetic studies by Mayer *et al*. (2003) confirmed the monophyly of Epithemateae and suggested that it appears as sister to the rest of the Paleotropical Gesneriaceae, and within *Epithemateae*, *Rhynchoglossum* is sister to the remaining members.

Burtt (1998b) proposed that Gesneriaceae is a family of Gondwanan origin that arose in Australasia and invaded South America and Asia. He saw the current Coronantheroid Gesneriaceae as a relic group that had a continuous presence in the area for 80 million years and gave rise to the Asian Cyrtandroideae and the American Gesnerioideae. However, Woo *et al.* (2011) did not support the Gondwanan vicariance; rather, they suggest that multiple long-distance dispersal events in the Miocene explain the tribe's current distribution in South America and the southwest Pacific regions.

The studies by Moller *et al*. (2009) showed that the available classification in Old World Gesneriaceae are artificial and do not reflect any natural relationship and also found that *Rhynchotechum* was in a more basal position relative to most asiatic Gesneriaceae and was distant from *Cyrtandra*. A similar phylogeny was generated by Wei *et al.* (2010) based on trnL-F and ITS, and it supported *Boeica* as the closest genus to *Rhynchotechum*. Later Weber *et al*. (2013) proposed a new formal classification for the family Gesneriaceae based on molecular phylogenetic studies. They recognised three sub-families; Sanangoideae, Gesnerioideae and Didymocarpoideae. These are further divided in to tribes and sub-tribes. Weber *et al*. (2011) remodelled the polyphyletic genus *Chirita* and

associated genera based on molecular phylogeny. *Chirita* sect. *Chirita* and *Hemiboeosis* are amalgamated with *Henckelia* sect. *Henckelia*, some species of *Chirita* are included in *Damrongia*, *Chirita* sect. *Leibgia* is upgraded in to genus *Leibgia* and *Chirita* sect. *Microchirita* in to *Microchirita* and *Chirita* sect. *Gibbosacus*, *Chiritopsis* and *Wentsaiboea* in to the genus *Primulina*. Perret *et al*. (2013) suggested the origin of ancestors of Gesneriaceae in South America during the late cretaceous. The distribution of Gesneriaceae in the paleotropic and Australia was inferred as resulting from two independent long-distant dispersal during Eocene and Oligocene.

Roalson and Robert (2016) studied the diversification in different clades of Gesneriaceae using the sequences available in Gen Bank. Their study suggested that there are both Old World and New World clades are occur in Gesneriaceae with elevated diversification rate. Ornithophily is an important feature for the increased diversification rate in New World taxa than in Old World.

Phytochemistry

Phytochemical characters started to attract the attention of plant taxonomists early in 1960's. Gesneriaceae is one of the taxa which seem to have little recognition with reference to its biochemical and biological evaluation. Many persons worked on the chemical characters of Gesneriaceae. Harborne (1966, 1967) and Lowry (1972) reported anthocyanins-a flavanoid found throughout the family. According to Lowry (1973) the most primitive anthocyanins–Cyanidin and Pelargonidin-3-glucoside was found in Coronantheroid Gesneriad from New Zealand. Harborne (*l.c.*) also detected the presence of other flavanoids such as chalcones and aurones in Gesneriaceae. The gland exudates of *Didymocarpus*

species have the presence of benzoquinoid chalcoes (Wollenweber *et al*., 1981).

Liu *et al.* (1989) discovered a new anthraquinone from *Rhynchotechum vestitum* which they called rhynchotechol. Iridoids are the compounds found in Scrophulariaceae and related families, but are absent in Gesneriaceae. Instead cornosids - a vicarious to iridoids are found in several genera (Jensen, 1992). Hegnauer (1966) found the presence of caffeic acids in the leaves of *Aeschynanthus*, *Cyrtndra*, *Gloxinia etc*. and verbascoside in *Nauticalyx* and he also found the volatile oils from *Didymocarpus pedicellatus*. Kvist and Pederson (1986) reported the complete absence of verbascoids in *Epithemateae*, *Napeantheae*, *Agalmyla* and *Saintpaulia*. They also distinguished the Old World Gesneriaceae from the New World ones by the absence of 3-desoxyanthocyanin and the presence of chalcones and aurones. The other contributions to the phytochemistry of the Gesneriaceae include the works by Price and Robinson (1938, 1940), Kvist (1984), Inoue *et al*. (1984), Molgard and Ravan (1988), Bianchi *et al*. (1991), Guha and Bhattacharya (1992), Damtoft and Jenson (1994), Jensen (1996), Liu *et al*. (1996, 1998), Griesbach (1998), Lu *et al*. (1998a, 1998b), Albini *et al*. (1999), Segawa *et al*. (1999), Cong-Ying *et al*. (2001), Smith *et al*. (2004a), Singh (2007), Li *et al*. (2008, 2011), Verdan *et al*. (2009, 2013), Ebrahimi *et al.* (2011), Jothi and Rajakumar (2012) and Wen *et al*. (2013).

A few physiological studies were also carried out in this family, that includes the work of Sumanasiri *et al.* (2013) who studied the effect of gibberelic acid on *Henckelia humboldtiana*; Deng *et al.* (2003), Nishii *et al*. (2012) and Sarvestani *et al.* (2012) who studied the effect of some biotic and abiotic factors on the growth and development of Gesneriaceaen members.

Floral Biology

The pollen characters are extensively used in the taxonomic and evolutionary studies (Blackmore, 1982) and the bearing of palynology on angiosperm phylogeny was discussed at length by Walker and Doyle (1975) and its taxonomic implications by Erdtman (1952) and Rudenko (1959). A detailed study of pollens of Gesneriaceae by means of SEM and TEM was done by Anna and Mauro (1973), Williams (1978), Fritze and Williams (1988), Luegmayer (1993a, 1993b, 1993c). Luegmayer (1993c) studied the development of generative cell in *Cyrtandra pendulosa*.

Many of the authors carried out field studies on pollination of Gesneriaceae. Vogel (1966) reported perfume flowers in *Gloxinia perrenis* and many species of *Gloxinia* sect. *Gloxinia*. *Monophylla* also shows the presence of perfumed flowers (Wiehler, 1983). Vogel (1978) stated that Gesneriaceae exhibit a general character syndrome of oligandric pollen flowers. Generally the corolla with distinct tube has nectars but some have the general habit of nectar flower but the nectar if present at all, is non functional (Burtt, 1958a; Weber, 1979). Gesneriaceaen members shows simulation of copious pollen grains by (a) Yellow anther wall-Yellow anther wall attractive for much longer time than the pollen availability (Vogel, 1978); (b) Yellow blotch on corolla above the anthers; (c) Yellow filament knees (Weber & Kiew, 1983; Vogel, 1993); (d) Yellow blotch on the corolla near the insertion (Weber, 1989a); (e) A patch of yellow monoliform hairs at the palate or (f) An exerted yellow style (Weber, 1989a).

Whitton *et al.* (1990) studied the flowering of *Aeschynanthus* 'Koral' at fluctuating and constant temperature. The other major works in this field include studies by Jone and Rich (1972), Jong and Burtt (1975), Roelofs

(1979), Snow (1980), Weber (1982, 1988, 1995), Steiner (1985), Freeman *et al.* (1991), Kato *et al*. (1993), Boggan (1996), Sazima *et al.* (1996), Wang *et al.* (1997), Perret *et al.* (2001), Canela and Sazima (2003), Perret *et al*. (2003, 2006, 2007), Sanmartin-Gajardo and Sazima (2004, 2005) and Guo *et al.* (2013).

Carpological studies for the whole family was carried out by Ivania (1965, 1967) and that to the Neotropical members were provided by Wiehler (1983). Generally Gesneriacean fruits are capsules or berries. The fruits may be dehiscent or indehiscent. Dry capsular fruits are found in Paleotropical Gesneriaceae, which is treated as the primitive forms. The dehiscence is mostly by longitudinal slits, loculicidally or both. Regarding the seed dispersal, the simple capsular fruits are unspecialised; the seeds are shaken out by the wind, rain or passing animals and simply fall on the ground. In several genera, the fruits are twisted, the two valves being helically wound. Twisting takes place from a special mode of growth starting after anthesis. In follicular fruits, the dehiscence takes place in the upper carpel only. These types of fruits held ± horizontally making an angle with the pedicel. This kind of fruit is found in plants of ever wet rain forest and represents a special form of rain wash or rain splash capsule (when the fruit opens dorsally, the seeds lie exposed and are washed away by the rain). *Henckelia* is an example for this kind of fruit. Short, ovoid or globose capsules opens by upper carpelor by a circumsessile line (eg: *Epithema*-a perfect rain splash cup is embedded in a funnel shaped calyx (Weber, 1976c) or the upper part of the fruit wall breaks irregularly in to pieces as in the case of *Loxonia burttiana* (Weber, 1977a).

In Neotropical Gesneriaceae, different forms of fleshy capsules are seen especially in Episcieae. In this case the seed dispersal is by birds and

also by mammels such as monkeys and bats (Wiehler, 1983). Two types of capsules can be seen in Neotropicl Gesneriaceae (a) fleshy or semi fleshy capsules in which the opening convex valves forms a cup which presents the seeds with prominent funicle. Eg:- *Episcia*, *Chrysothemis etc*. (b) fleshy capsules in which the valve curve back and become separated from the placenta, the latter form a central cone covered by the funicles and seeds. Eg:- *Drymonia*, *Nematanthus etc*. (Weber, 2004a). Indehiscent fruits are common in Gesnerioid and Coronatheroid Gesneriaceae. Whereas in Paleotropical Gesneriacea, the indehiscent fruits are found only in *Cyrtandra*, *Sepikea* and *Rhynchotechum*. In neotrpical *Chrysothemis* sp., the large fleshy funicle is rich in lipids and serve as a kind of elaiosomes in ant dispersal (Lu & Mesler, 1981) and Kleinfeldt (1978) observed the seed transportation by ants in *Codonanthus* sp.

In Gesneriaceae, the ovules and seeds are generally produced in large numbers. The seeds are small and less than 1 mm long. The smallest seeds are found in Gloxinieae, Gesnerieae and Beslerieae and larger one in Sinningieae (Wiehler, 1983). The seed anatomy is fairly uniform. Hartl (1959) stated that in Gesneriaceae, the seeds look slightly furrowed from outside and designated as Aulacospermous, as found in many scrophulariaceae. Beaufort-Murphy (1983) discussed the taxonomic significance of seed surface characters in various systematic groups. Sontag and Weber (1997) and Muhlabauer (in Weber & Burtt, 1997) demonstrated the potential of seed characters for a better delimitation of many genera. Mendum *et al*. (2001) discussed the testa and seed appendage morphology in *Aeschynanthus* and and its phytogeographical and taxonomic implications. Thathachar (1943) studied the seed ontogeny of *Rhynchoglossum obliquum*. Christie and

Mendum (2002) studied the ontogeny of *Aeschynanthus* and found that there is no significant difference in the pre-pollination pattern but there are two patterns are evident in post-pollination.

Weber (2013) studied the pair flowered cymes (PFC) in Lamiales, their structure, distribution and origin. The PFC have originated from the paniculate system, with the front flowers representing the remnant flowers. He concluded that PFC exhibit considerable morphological and developmental diversity in taxa of Lamiales, and it is omnipresent in Calceolaraceae and almost so in the Gesneriaceae.

Economic botany

The ethnobotanical use of this family was mainly known from Central and South America (Weihler, 1995). The Indian tribes in coastal region of Ecuador use the plant species of *Columnea*, *Drymonia* and *Chrysothemis* for snake bite treatments (Kvist, 1984; Kvist & Holm-Nielsen, 1987), and the Indian tribes in Panama use *Chrysothemis* for the same (Duke, 1970). *Drymonia serrulata*, *Columnia rubriacuta* and *C. parviflora* are used to cure eczema and *Columnea* sp. is applied for the burns (Kvist, 1989). A decoction of *Napeanthus robustus* is used as a pain killer by Indian tribes in Ecuador, and the shamans use gesneriads as magical plants in their rite (Kvist, 1985). Amazon Indians use *Codonanthopsis didimulata* and *Drymonia coriacea* for toothache (Vicker & Plowman, 1984). Much less is known about the ethnobotany of the paleotropical gesneriads. A few *Rhynchotechum* species are used by indigenous peoples for food, medicine, smoking and fibre. In Bangladesh, the flowers and leaves of *Rhynchotechum ellipticum* (Wall. ex D.Dietr.) A.DC. are used as food and medicine (Uddin, 2009). According to Lu *et al*. (1998a, 1998b), *R. vestitum* is used in Yunnan, China as a folk

medicine treatment for hepatitis A and B. Li *et al.* (2008) studied the chemical constitution of *Aeschynanthus bracteatus* and stated that they have a weak anti-inflammatory activities. The leaves of *Didymocarpus pedicellatus* have lithnotriptic properties and used as a medicine for kidney stone and urinary problems (Chitme *et al*., 2010).

Gesneriaceae are widely used as ornamentals. Hubert and Hubert (1991) reported there are more than 40000 named cultivars of *Saintpaulia* available now. There are several books on ornamental Gesneriaceae available in market by various authors (Moore, 1957; Fogg, 1968; Elbert & Elbert, 1984; Arthurs, 1988; Clement, 1988; Robey, 1988; Wall, 1990 and Erhardt & Erhardt, 1993). Apart from that, there are so many societies of Gesneriad lovers and growers all over the world.

Some species of Gesneriaceace are used as food and fodder, eg: in Northeast India, *Rhynchotechum ellipticum* and *R. vestitum* leaves are eaten as a vegetable (Jain & Borthakur, 1980; Neogi *et al.,* 1989; Kayang, 2007), *R. ellipticum* is used for fodder (Hilliard, 2001) and *R. obovatum* (Griff.) B.L.Burtt leaves are smoked as a substitute for tobacco and the plant may be used to supply fibre for cording (Anderson & Middleton, 2013).

Classification of Gesneriaceae

The classification of the family was started with G. Don (1838). He classified the 'order Gesneriaceae' into two tribes *Gesnerieae* and *Cyrtandriae* (*Cyrtandraceae* in publication). The tribe *Gesnerieae* was further divided into three sub-tribes such as *Gloxinieae*, *Conradieae* and *Beslerieae* with all genera occurring in the New World, and the tribe *Cyrtandriae* into four sub-tribes, *Trichosporeae*, *Didymocarpeae*, *Cyrtandreae* and *Loxotieae* with all the genera from Old World. Endlicher (1839) proposed a similar, but less detailed classification. He divided the order *Gesneraceae* into sub-orders I. *Cyrtandreae*, with tribes *Didymocarpeae* and *Eucyrtandreae*, and II. *Gesnereae* with tribes *Beslerieae*, *Episcieae*, and *Eugesnereae*. Later Brown (1839) sub-divided the family into three tribes 1) *Beslerieae*, 2) *Gesneriae* and 3) *Cyrtandreae*, he mainly included the genera from Old World for this classification. During the same time A.P. De Candolle (1839) classified the Gesneriaceae into two tribes, such as *Gesneriae* and *Besleriae*. Six years later A.P. De Candolle (1845) divided Cyrtandraceae also into two tribes, *Didymocarpae* and *Cyrtandreae*. A more comprehensive treatment of the family was presented by Bentham (1876). He gave importance for the morphological characters over phytogeographical relation. He divided the family into two tribes, 1) *Gesnereae*, with fully or partly inferior ovary and 2) *Cyrtandreae*, with superior ovary. He recognises four sub-tribes, *Bellonieae*, *Gloxinieae*, *Eugesnereae* and *Pentaraphieae* under *Gesnereae* and divided *Cyrtandreae* into five sub-tribes, *Columeae*, *Eucyrtandreae*, *Aeschynantheae*, *Beslerieae* and *Didymocarpeae*.

The next comprehensive treatment after Bentham was done by Clarke (1883). But his classification is only for '*Cyrtandreae*', which is divided into three sub-tribes, *Trichosporeae*, *Didymocarpeae* and *Eucyrtandreae*. While revising the family for Engler and Prantels's '*Die Naturlichen Pflanzenfamilien*', Fritsch (1893–1894) classified the family in to two sub-families and recognised 18 tribes under them (12 tribes under Cyrtandroideae and 6 under Gesnerioideae). Burtt in 1954 harshly commented on Fritsch's classification as retrogression with little original work in it and negative in quality. Though Fritsch made some errors by mixing Old World and New World genera together, still his classification had some positive points too. Fritsch was the first to correctly recognise and delineate the Coronanthereae, and he placed *Rhynchotechum* Blume (genus with berry fruits) correctly in the capsular fruited alliances of *Leptoboea* Benth. and *Boeica* C.B.Clarke (Weber *et al*., 2013).

Burtt (1963) classified the Old world Gesneriaceae into two sub-families based on the geography, as Cyrtandroideae and Gesnerioideae and he clearly stated that the Old World Gesneriaceae share the uncommon feature of an anisocotylous seedling. He reduced the 12 Old world tribes of Fritsch into the following five tribes, *Cyrtandreae*, *Trichosporeae*, *Klugieae*, *Loxonieae* and *Didymocarpeae* under Cyrtandroideae. Gesnerioideae is sub-divided into two tribes, *Coronanthereae* which includes four genera from South Pacific and *Mitrarieae* to accommodate four monotypic genera from temperate South America. Four years later, Ivanina (1967) classified the entire family and her work was published as a book in Russian, '*The family Gesneriaceae – a carpological review*'. Based on fruit and seed character and she regrouped the entire family in to three sub-families, Cyrtandroideae, Episcioideae – a new sub-family and Gesnerioideae. Each sub-families furthur classified in to tribes and sub-tribes. Wiehler (1983) classified the

New World and Southern Hemisphere Gesneriaceae into two sub-families, such as Gesnerioideae and Coronantheroideae. Gesnerioideae was divided in to five tribes, *Gloxinieae*, *Episcieae*, *Beslerieae*, *Nepeantheae* and *Gesnerieae* and included a single tribe *Coronanthera* under Coronantheroideae.

Recently Burtt and Wiehler (1995) published a classification of Gesneriaceae, mostly based on morphology and data from chromosome numbers and breeding experiments were included additionally for the neotropical members. In contrast to the preceding classifications the following three sub-families were recognized: 1) Gesnerioideae, 2) Coronantheroideae, and 3) Cyrtandroideae. The Coronantheroideae was actually established by Wiehler (1983) based on the sub-tropical distribution in southern hemisphere and the adnate nectary. They merged *Loxonieae* into *Klugieae* mainly based on the investigations of Weber (1975 to 1982) and treated as one of the tribe under Cyrtanadroideae. In total five tribes have been included under this sub-family *viz*., *Klugieae*, *Didymocarpeae*, *Trichosporeae*, *Cyrtandreae* and *Titanotricheae* (a monospecific tribe described by Wang *et al*., 1990).

A preliminary classification was proposed by Weber (2004a) based on molecular systematic studies. However Weber's treatment was therefore presented as a mixture of formal and informal groups. The following four informal groups were recognized: 1) Coronantheroid Gesneriaceae, 2) Gesnerioid Gesneriaceae, 3) Epithematoid Gesneriaceae, and 4) Didymocarpoid Gesneriaceae. No sub-divisions were suggested for Coronantheroid and Epithematoid Gesneriaceae. The Gesnerioid Gesneriaceae were sub-divided into the following established traditional tribes: *Beslerieae*, *Napeantheae*, *Gloxinieae*, *Gesnerieae*, and *Episcieae*. The Didymocarpoid Gesneriaceae were sub-divided into the following informal

groups: 1) The Basal Asiatic genera, 2) The European genera, 3) The African and Madagascan genera and 4) The Advanced Asiatic and Malesian genera.

In the present study, a new formal classification of Gesaneriaceae by Weber *et al.* (2013) was used. They divided the whole family in to three sub-families, Sanangoideae A.Weber *et al.*, Gesnerioideae Burnett and Didymocarpoideae Arn. The sub-family Sanangoideae is established to include only the genus *Sanango*. The sub-family Gesnerioideae is divided in to five tribes, 1. *Titanitricheae* Yamz. *ex* W.T.Wang; 2. *Napeantheae* Wiehler; 3. *Beslerieae* Bartl. (two sub-tribes); 4. *Coronantherae* Fritsch (three sub-tribes) and 5. *Gesnerieae* (four sub-tribes). Similarly the sub-family Didymocarpoideae divided in to two tribes *viz.*, *Epithemateae* and *Trichosporeae*, which is furthur divided in to four and ten sub-tribes respectively. The Classification of Gesneriaceae in South India according to Weber *et al.* (2013) is presented in **Plate 02**.

Materials and Methods

1. Taxonomic study:

1.1) **Literature survey**: The details regarding the taxa under investigation were collected from different sources such as libraries of institutions, Universities, and information retrieval systems. The literature retrieval systems of New York Botanical garden (http://www.biodiversity heritagelibrary.org), Missouri Botanical Garden Libraries (http://www.botanicus.org and http://www.tropicos.org), online libraries like JSTOR (https://www.jstor.org),BnF digital library – Gallica (http://www.bnf.fr/en/collections_and_services/digital_libraries_gallica .html), Index Nominum Genericorum (ING) of Smithsonian National Museum of Natural History (http://botany.si.edu/ing), Gesneriaceae Cytology database by Moller *et al.* (2002) (http://elmer.rbge.org.uk/webcyte), and Wallich catalogue details (http://Wallich.rbge.info) of Royal Botanic Garden, Edinburgh *etc*. were also utilized.

1.2) **Specimen collection**: Materials for the present study were collected through extensive field work in different parts of South India during 2012-2016. About 200 days were spent in the field in 65 collection trips. Live samples of twenty two out of twenty four species were collected live. The specimens were introduced in the Botanical Garden (CUBG) but after two-three years of growth, they started retarding. Several populations of most of the species were observed in the field.

1.3) **Herbarium consultation:** Specimens from the following herbaria were examined: BLAT, BSI, BSID, CAL, CALI, DEV, E, JCB, KFRI, MH, RHT, SKU, TBGT, and herbarium of S.N. College, Kollam and Goa University. The digital images of type specimens were obtained from BM, C, CAL, E, K, L and MH. A list of herbaria consulted was given in Appendix II, acronyms of herbaria was according to Thiers (2011).

1.4) **Herbarium preparation:** Plant materials of proper size with relevant parts were collected from the field and sealed in polyethylene bags. Herbaria were prepared following wet method (De Vogel, 1987; Forman & Bridson, 1989). The dried specimens were mounted on standard handmade sheets (28 × 42 cm) and labeled properly with standard labels (14.5 × 11 cm), after including all the relevant information. All the specimens collected were fumigated and deposited in Calicut University Herbarium (CALI).

1.5) **Description, photoplates and illustrations:** A data sheet was prepared for each population studied. The data sheet included informations on habit, habitat, ecology, nature of inflorescence, colour of petals, structure, position and orientation of stamens and other features like nectariferous glands were recorded in the field itself (a sample data sheet is given in Appendix III). Detailed morphological studies were made using all the available materials and variations were recorded. Descriptions of each taxa were prepared after proper determination and examining wide range of specimens. Photographs were taken using Leica EZ 4HD stereo microscope. Illustrations were made with the help of camera lucida. For description of taxa, the terminology followed Simpson (2006). The distribution maps were prepared based

on specimens examined during the present investigation. Metric system was followed in all kinds of measurements. Data on phenology was mostly from field studies and rarely from the literature and herbarium sheets.

1.6) **Identification, nomenclature and citation:** Identification of taxa was done in consultation with types and protologues. The illustrations provided by various authors were also used for the identification. The citations of all taxa followed the database of the International Plant Name Index (http://www.ipni.org), Brummitt and Powell (1992) and world checklist of Gesneriaceae, a database of Smithsonian National Museum of Natural History (http://botany.si.edu/gesneriaceae/checklist). The Plant List, a working list of all known plant species by Royal Botanic Gardens, Kew and Missouri Botanical Garden (www.theplantlist.org) were also utilized. The nomenclature of each species was updated as per the Melbourne Code (McNeill *et al*., 2012).

1.7) **Presentation of Data:** The systematic part begins with a treatment of the family. This includes the citation, type, detailed description, flowering, fruiting, distribution, chromosome numbers, etymology and relevant notes. This is followed by key to the genera and species. The genera and species are presented in alphabetic sequence. Details on etymology, vernacular names, distribution, ecology, flowering and fruiting period, nomenclatural notes, relationships, and variations were also provided for each taxon. All specimens studied were cited under specimens examined. The details of specimens cited are given in the following sequence: state, district: collection locality, date of collection,

collector/collector's name, collection number, and acronym of the depository is given in parenthesis.

2. Molecular phylogenetic analysis:

For molecular analysis, the following steps were involved: 1). Isolation of DNA from the sample, 2). Screening of the isolated sample for the presence of genomic DNA using agarose gel electrophoresis, 3). Amplification of selected genes using specific primers employing PCR techniques, 4). Screening of PCR product for amplified DNA using agarose gel electrophoresis techniques, 5). Amplified PCR product purification, 6). Sequencing of the amplified gene, 7). Quality check of the newly generated sequence and 8). Computational molecular phylogenetic analysis using suitable softwares.

Molecular analysis of the samples used in this study were carried out in the molecular laboratory of Royal Botanic Garden, Edinburgh, UK and Department of Botany, University of Calicut. The composition of various solutions used for the molecular study is given in Appendix V.

2.1) **Isolation of Genomic DNA:** The genomic DNA was isolated from fresh or silica dried leaves, using a modified CTAB method (Doyle & Doyle, 1990). Voucher information for plant material used in this study is given in the Appendix VI. The modified CTAB method for the extraction of Gesnericace is given below.

- 100 mg of fresh leaf tissue / 30 mg of silica dried tissue was homogenated using mortar and pestle in a medium containing 1 ml of preheated extraction buffer (1 ml 2% CTAB + 2µl ß-mercaptoethanol) and pinch of Poly Vinyl Pyrrolidine (PVP).

- The homogenate was taken in a 1.5 ml eppendorf tube and incubated for 30 minutes at 65^0 C with occasional stirring in a water bath (KEMI). The tube was removed from the heated block and allowed to cool to an ambient temperature for 1-2 minutes.
- 500 µl of chloroform-iso-amyl Alcohol (24 : 1) was added to each tube. Mixed gently by shaking to obtain a single phase using a rotar (REMI CM101 Plus) for 10-20 minutes.
- Centrifuged for 10 minutes at 13000 rpm at 4°C on a cool centrifuge (Prism R, Labnet International).
- The supernatant was collected and transferred to a clean 1.5 ml eppendorf tube and the chloroform extraction was repeated.
- The supernatant was collected to a clean 1.5 ml eppendorf tube. DNA was precipitated by adding 600 µl of ice cold isopropanol and shaken gently (DNA should be left in the freezer over night 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 pellete. It is then vigorously agitated to release the pellet from the bottom of the tube and leaved for at least 30 minutes at room temperature.
- Centrifuged for 5 minutes at 13,000 rpm. The supernatant was removed and the tubes were inverted to allow the remaining wash buffer to drain away.
- The pellet was then dissolved in 50 to 100 µl of 1X TE buffer, mixed well.
- DNA samples were stored at -20 ^{0} C.

DNA extraction kit (DNeasy® Plant Mini Kit, QIAGEN) as per manufacturer's guidelines were also used for those samples that didn't respond to modified CTAB method.

2.2) **Agarose gel electrophoresis:** The isolated samples were subjected to electrophoresis. For this 0.75 g agarose was dissolved in 75 ml 1X Tris Acetate EDTA (TAE) buffer (1% of agarose solution) and melted until the agarose dissolves completely. 3 µl of ethidium bromide was added to this solution and swirled to mix. The agarose solution was poured to the gel casting tray in which a comb of suitable size was placed. The gel was kept undisturbed for 45 minutes to 1 hr. After the solidification time, the comb was removed carefully and the gel was placed in the electrophoresis tank containing 1X TAE buffer. The gel should be totally immersed in buffer.

The isolated genomic DNA (5 µl) was mixed with 3 µl gel loading dye (6X gel loading buffer, ML015, Himedia). The first well of the gel is filled with 3 µl of DNA ladder (Tracklt™ 100bp DNA ladder, Invitrogen) to quantify the size of the isolated DNA. Then the samples were loaded in to the subsequent wells. The electrophoretic unit was then run for 40 minutes at 80 V (constant) and 120 A. After the completion of the electrophoresis, the gel was softly transferred and placed on UV trans–illuminator system (ENDURO™ GDS1302, Labnet International) for visualizing the resultant DNA bands (**Plate 03**). The DNA samples showing good bands were selected for further analysis.

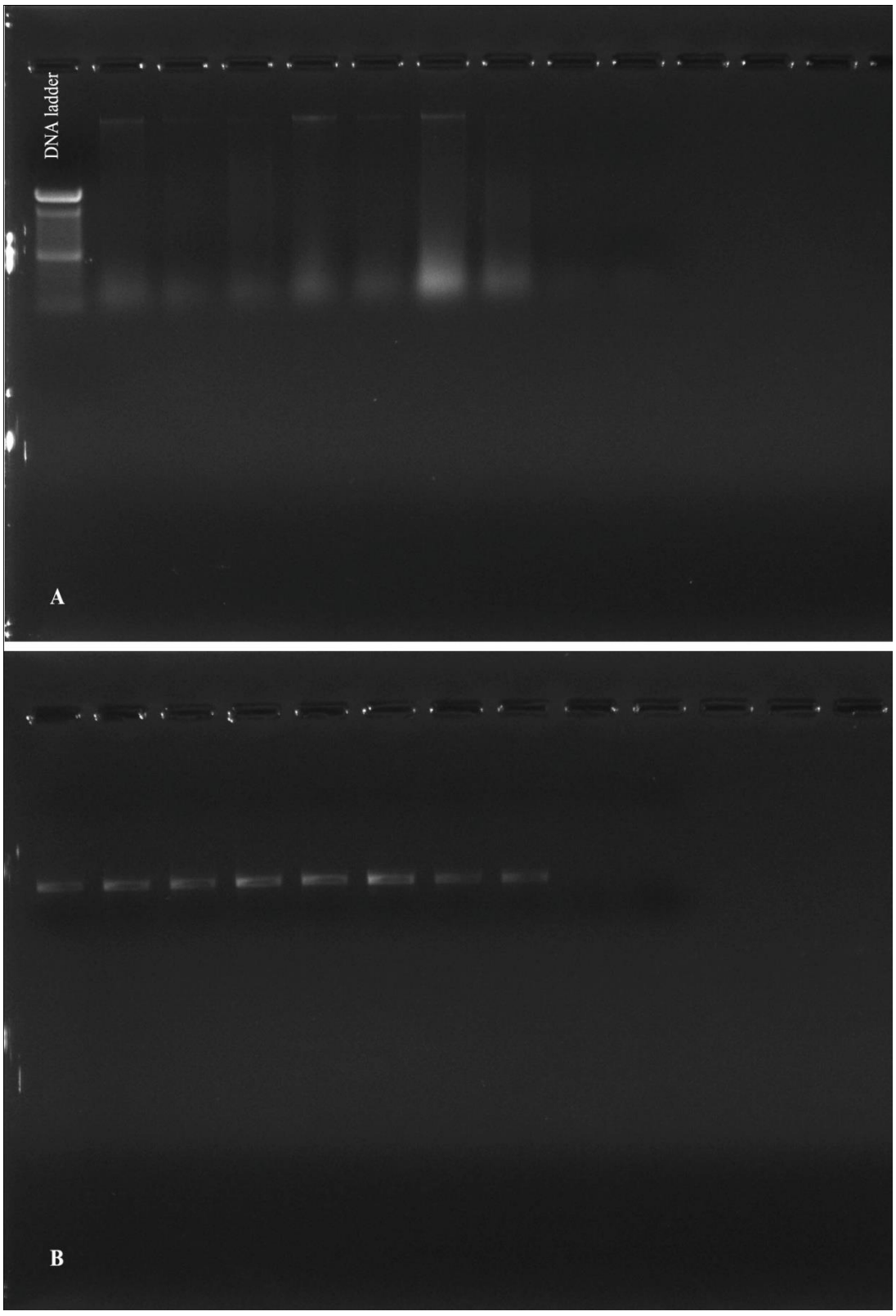


PLATE 03: Agarose Gel Electrophoresis images **A.** After DNA extraction; **B.** After PCR amplification.

2.3) **PCR amplification:** The nuclear ribosomal DNA sequence of the Internal transcribed spacer (ITS1, 5.8S and ITS2) and chloroplast DNA sequence (trnL-F intron spacer region) were used for the phylogentic analysis. PCR reactions were performed using primers 5P (-GGA AGG AGA AGT CGT AAC AAGG-) and 8P (-CAC GCT TCT CCA GAC TAC A-) for ITS (Moller & Cronk, 1997) and Primers 'cg' (-GTG AAG ACT TTC AAA TTC AGA GAA AC-) and 'f' (-ATT TGA ACT GGT GAC ACG AG-) for trnL-F (Taberlet *et al.,* 1991). The amplification reactions were performed in thermo cycler (Applied Biosystem, Veriti). The components of the amplification reaction mixture and the PCR profile are given in **Table 02 & 03**.

Table 02: Mastermix reagents for 1 µl DNA Sample

Reagents	ITS	trn
H_2O	16.65 µl	16.65 µl
$MgCl_2$	1.5 µl	1.5 µl
10X buffer	2.5 µl	2.5 µl
d NTP	0.4 µl	0.4 µl
Primer A (Forward)	0.75 µl	0.75 µl
Primer B (Reverse)	0.75 µl	0.75 µl
DMSO	1.25 µl	1.25 µl
Taq	0.2 µl	0.2 µl

Total volume of the mastermix per sample =24 µl

After the PCR amplification, the amplified product was subjected to electrophoresis. For that 2 μl of the amplified product was mixed with the 3 μl gel loading dye and the remaining procedure is same as mentioned above.

2.4) **Purification of PCR product:** To purify the amplified genomic DNA, the samples were subjected to exosap and Big Dye reactions. 2 μl of Exosap IT (GE Healthcare) solution and 5 μl of PCR product were mixed together and incubated at 37^0C for 15 minutes and at 80^0C for another 15 minutes.

Half of the samples were purified at a commercial facility (Scigenome, Cochin). The amplified PCR product were purified using column purification (Genejet TM PCR purification kit, Thermo fisher Scientific, Mumbai, India) as per manufacturer's guideline.

2.5) **Sequencing:** The sequencing was performed at two centers, 1) University of Edinburgh, UK and 2) Scigenome, Cochin (on commercial basis). After the exosap purification, the mixture was subjected to Big Dye reaction. Two kinds, forward and reverse Big Dye master mixture using forward and reverse primers were prepared separately by following the reagent volumes given in the **Table 04** and were subjected to another thermocycling and the profile is given in **Table 05**.

This sample was then sequenced.

The purified amplified DNA samples were subjected to automated DNA sequencing on an AB13730X1 DNA Analyser (Applied Biosystems, Foster City, California, USA) using the same primers used for sequencing.

2.6) **Determination of sequence quality:** The generated raw sequence were trimmed to remove indecipherable sequences at both ends manually using Sequencher v. 5.3 (Gene Codes Corporation, MI, U.S.A.) and BioEdit sequence alignment editor v.7.2.5 (Hall, 1999). The newly generated sequences were searched on BLAST (Basic Local Alignment Search Tool) to know the similarity indices.

2.7) **Phylogenetic analysis:** The newly generated 80 sequences along with those retrieved from genbank (Appendix VI) were aligned using ClustalW in BioEdit version 7.1.11 (Hall, 1999) and the alignments manually adjusted in Mesquite version 2.75 (Maddison & Maddison, 2011). Maximum likelyhood analysis was implemented in MEGA v.6 (Tamura *et al*., 2013) and Bayesian analysis was performed in Mr.Bayes version 3.1.2 (Ronquist & Huelsenbeck, 2003; Huelsenbeck & Ronquist, 2007). For the Bayesian Analysis, parameters prior setting were obtained independently for the ITS and trnL-F spacers using Mr.Modeltest v.2.3 (Nylander, 2004), and were SYM+G and GTR+G respectively, as suggested by the Akaike Information Criteria (AIC: Akaike, 1974). To test the combinability of the two primers, Incongruence Length Difference (ILD) test was implemented in PAUP* v.4.0.b10 (Swofford, 2002). The phylogenetic trees generated after the analysis were displayed with FigTree v.1.4.2 (Rambaut, 2014).

Systematic Treatment

Gesneriaceae Rich. & Juss., in A.DC., Essai Propr. Med. Pl., ed. 2: 192. 1816 *nom. cons.*; A.Weber, in Kubitzki Fam. Gen. Vasc. Pl. 7: 63. 2004; B.K.Sinha & S.Dutta, Nelumbo 58: 2. 2016. **Type:** *Gesneria* L.

Belloniaceae Martinov, Tekno-Bot. Slovar 67. 1820. Type: *Bellonia* L.

Didymocarpaceae D.Don, Edinburgh Phil. J. 7: 83. 1822. Type: *Didymocarpus* Wall.

Cyrtandraceae Jack, Trans. Linn. Soc. 14(1): 24. 1823. Type: *Cyrtandra* J.R. & G.Forst.

Besleriaceae Raf., Sylva Tellur. 70. 1838. Type: *Besleria* Plum. *ex* L.

Ramondaceae Godr., in Grenier & Godron, Fl. France 2: 506. 1850. Type: *Ramonda* Rich.

Perennial (very rarely annual) herbs, subshrubs, shrubs or small trees; perennial herbs with fibrous roots or with rooting above- or underground stems, rootstocks, rhizomes, scaly rhizomes, or tubers; terrestrial, epiphytic or climbing. ***Stems*** erect, ascending, decumbent, creeping, pendulous, or ± absent. ***Leaves*** opposite, sometimes in whorls of three or four, or in near-distichous or spiral-alternate arrangement; usually petiolate; stipules absent; lamina usually undivided, very rarely lobed or pinnately dissected. Number of leaf pairs sometimes reduced to the cotyledonary pair, with one of the two cotyledons growing up to a large, foliar organ. Indumentum of stem and leaves of glandular and eglandular hairs, rarely absent. ***Inflorescence***

usually cymes, rarely racemes, axillary, often near the apex and appearing terminal, cymes sometimes reduced to solitary flowers. ***Flowers*** perfect, 5- (very rarely 4-) merous. ***Calyx*** usually 5-divided, Sepals free or connate to a variable extent, equal or unequal. ***Corolla*** zygomorphic with bilabiate limb; shape variable, long-tubular, infundibuliform, funnel-shaped, campanulate; white, blue, violet, red, orange or various colours combined, with or without markings. ***Fertile stamens*** 2 or 4, then often didynamous, rarely 5, epipetalous, dorsifixed; anthers free or coherent, thecae 2, parallel, divergent, or divaricate; staminodes 1–3 or absent. ***Disk*** ringlike, rarely absent, either adnate to ovary base or free. ***Ovary*** syncarpous, composed of two median carpels; mostly unilocular with lateral, T-shaped placentae; rarely bilocular with axile placentae, rarely one carpel sterile; ovary superior, semi-inferior or inferior; style usually well developed; stigma capitate, bilabiate or variously bifid; ovules numerous, anatropous, unitegmic, tenuinucellate. ***Fruit*** dehiscent (a dry or fleshy capsule) or indehiscent (a sclerocarpous or fleshy berry); capsules elongate, ovoid or globose, opening septicidally or loculicidally; fleshy berries sometimes vividly coloured. ***Seeds*** numerous, ellipsoid or ovoid, minute, sometimes with appendages at 1 or both ends, with or without endosperm; testa frequently reticulate; embryo straight, cotyledons equal or unequal (anisocotyly in paleotropical Gesneriaceae).

The family is represented by around 3400 species, between 150 and 160 genera and has roughly a third of its distribution in the Neotropics and two thirds in the Paleotropics, with some outliers in Europe (Weber *et al*., 2013; Moller *et al*., 2017 in press). Main centers of distributions are the tropics and subtropics of the Old and the New World, with transgressions to the

north (Europe: Pyrenees, Balkan Peninsula; Asia: Himalayas, China incl. North China) and the south (SE Australia, New Zealand, South Chile). Both in Asia-Malesia and in America there are around 60 genera; in Africa there are 9 genera, in Europe 3 genera. Nine genera have a distinctly southern hemisphere distribution. Only one genus, *Rhynchoglossum*, is represented both in Asia and (with a single species) in the neotropics. The second genus with transcontinental distribution is *Epithema* (one species in West Africa, the other (*c*. 20) species in Mainland Asia and Malesia) (Weber & Skog, 2007).

The current genus count in India is 23, with 87–98 species (Moller *et al*., 2017 in press). In South India the family is represented by 7 genera with 24 species and one variety.

Key to the genera of Gesneriaceae in South India

1a. Sub-shrubs; fruit indehiscent .....**Rhynchotechum**

1b. Herbs; fruit dehiscent.....**2**

2a. Seeds appendaged; plants epiphytic.....**Aeschynanthus**

2b. Seeds not appendaged; plants not as above **3**

3a. Annual herbs; stem present; leaves alternate or opposite. **4**

3b. Perennial herbs; stem reduced or absent, leaves in basal rosette.....**6**

4a. Flowers in terminal racemes; leaves alternate..... **Rhynchoglossum**

4b. Flowers in axillary cymes; leaves opposite (lower cotyledonous leaf solitary) ….....**5**

5a. Peduncle fused with petiole; bracts absent ..... **Microchirita**

5b. Peduncle free from petiole; bracts cucullate…..... **Epithema**

6a. Stamens four; filaments spurred; capsules ovoid, dehiscing loculicidally ..... **Jerdonia**

6b. .....Stamens two, filaments not spurred; capsules linear (rarely globose), dehiscing along the upper suture only ..... **Henckelia**

Aeschynanthus Jack

Aeschynanthus, the third largest genus of Gesneriaceace in India, is represented by around 166 species in the world. They are epiphytic plants with showy tubular corolla and loculicidally dehiscing, long narrow capsules with numerous appendaged seeds. The genus is distributed from Sri Lanka and India through southern China and South East Asia to New Guinea and the Solomon Islands (Weber, 2004a; Middleton, 2016). 18–25 species occur in India (Skog & Boggan, 2007; Bhattacharyya & Goel, 2014), distributed in the western Himalayan regions particularly in Sikkim, Arunachal Pradesh, Meghalaya, Assam, Andaman & Nicobar Islands and Western Ghats. In South India, the genus is represented by one species, *Aeschynanthus perrottetii* A.DC.

Aeschynanthus was originally described by Jack in 1823 with two species, *A. volubilis* Jack and *A. radicans* Jack, both from Sumatra. Another genus *Trichosporum* had been described a year earlier by Don (1822) with two species, *T. grandiflorum* and *T. parviflorum*, both from Nepal. Several taxa were then described in both genera by later botanists although more often in

Aeschynanthus than in *Trichosporum*. Following the proposal by Sprague (1929: 59, 91), the name *Aeschynanthus* had been conserved against *Trichosporum* in the interests of stability. Sprague (*l.c.*) typified *Aeschynanthus* with *A. volubilis* Jack, but did not cite a type specimen for the species. The most significant single contribution to the taxonomy of this genus to date is that of Clarke (1884) who listed and recognized 64 species, many of them newly described in that work.

As part of the studies in Gesneriaceae of the Old world, Burtt and Woods revised the genus in 1975. The other works includes descriptions of new species/ new combinations in *Aeschynanthus* by Raymond (1962), Mendum (1999), Mendum et al. (2006), Middleton (2007a), Singh *et al*. (2012) and Datta *et al.* (2014, 2015). Revisions of this genus have been published for the neighbouring countries by various authors (China: Wang *et al.*, 1998; Thailand: Middleton, 2007b; Cambodia, Laos and Vietnam: Middleton, 2009; Singapore and Peninsular Malesia: Middleton, 2016). Checklists have been published for Singapore (Turner, 1993; Chong *et al*., 2009), Peninsular Malesia (Turner, 1997), Myanmar (Kress *et al.*, 2003), Sulawesi (Mendum & Atkins, 2003) Sumatra (Tjitrosoedirdjo *et al*., 2009) and Vietnam (Phuong, 2004).

The capsules in *Aeschynanthus* are long, slender containing many anatropous ovules, with the hilar end pointing towards the apex and the apical end towards the base of the capsule. The number and type of hilar appendage has been used to sub-divide the genus into sections. Bentham (1876) recognized four sections, *viz.* sect. *Polytrichium*-with many appendages at the hilar end, sect. *Diplotrichium*-with two appendages at the hilar end, sect. *Haplotrichium*-with a single appendage at the hilar end

combined with a deeply divided calyx and sect. *Holocalyx* (now sect. *Aeschynanthus)*-with a single appendage at the hilar end and a shallowly lobed calyx. Clarke (1883) added a fifth section, *Microtrichium* with a short flat triangular appendage at each end; he also noted the 'bubble cells' at the base of the hilar appendage in members of sect. *Aeschynanthus.* Schlechter's 1923 section *Anisocalyx* was reduced to sect. *Microtrichium* by Burtt and Woods (1975). An additional section, *Xanthanthos,* mainly based on corolla colour and shape, was established by Wang (1984). Thus there are 6 sections recognised in *Aeschynanthus*. Mendum *et al*. (2001) studied the testa and seed appendage morphology to clarify the sections, and the sectional position particularly of those species with seeds having intermediate characters. Their study resulted that *Aeschynanthus* species may be split into two groups: those with spiral cell orientation and one-cell papillae (Type A), and those with straight cell orientation and two-cell papillae (Type B) and these types are further divided in to many sub-types. They suggested another section *X* to include Type B members of the current sect. *Haplotrichium,* thus a total of seven sections in *Aeschynanthus*. They also stated that the hair coma in *Aeschynanthus* helps for the wind dispersal and by means of this *Aeschynanthus* sect. *Polytrichium* has a wide distribution in Asia and Malesia.

Christie and Mendum (2002) studied the ontogeny of *Aeschynanthus* seeds. Zhi-Jian *et al*. (1997) studied the pollen morphology of tribe *Trichosporeae* in China. Molecular and evolutionary relationship of the genus was studied by Denduangboripant *et al*. (2001) and Jaidee (2004). Some cytotaxonomic work was done by Ratter and Prentice (1964) and Rashid *et al*. (2001). Whitton *et al.* (1990) studied the flowering of *Aeschynanthus* in the fluctuating temperature.

The first accounts *Aeschynanthus* in India was published by C.B. Clarke's (1884) in his treatment of Gesneriaceae in Flora of British India who reported 23 species. As per the world check list of Gesneriacaeae, the genus is represented by 18 species in India. In a systematic account of the genus, Bhattacharyya and Goel (2014) reported 25 species.

As per the new classification of Gesneriaceae by Weber *et al.* (2013), this genus comes under subfamily Didymocarpoideae Arn., tribe *Trichosporeae* Nees and sub-tribe *Didymocarpinae* G.Don.

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; C.B.Clarke in A.DC. & C.DC., Monogr. Phan. 5(1): 18. 1883; in Hook.f., Fl. Brit. India 4: 337. 1884; Gamble, Fl. Madras 2: 984. 1924; W.L.Theob. & Grupe in Dassan. & Fosberg, Rev. Handb. Fl. Ceylon 2: 81. 1981; A.Weber in Kubitzki, Fam. Gen. Vasc. Pl. 7: 145. 2004; U.C. Bhattach. & Goel, *Phytotaxonomy* 14: 2. 2014. **Type**: *Aeschynanthus volubilis* Jack.

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

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

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

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

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

Epiphytic herbs or subshrubs with erect, arching or pendulous stems, rooting at the nodes along their lengths when in contact with a suitable substrate. ***Leaves*** opposite, petiolate; laminae coriaceous to distinctly fleshy, simple, margins entire to weakly dentate, venation pinnate but more often than not obscure. ***Inflorescence*** an axillary few-flowered cyme, or flowers solitary in the axils of leaves, or a pseudoterminal cluster. ***Flowers*** strongly protandrous. ***Calyx*** of 5 sepals, free or variously fused into a tube for part or most of length, when fused the whole tubular or cup-shaped. ***Corolla*** zygomorphic, tubular, widening towards lobes, curved to various degrees, sometimes distinctly inflated at the base, glabrous to variously pubescent outside and inside; with 5 lobes, these consisting of a 2-lobed upper lip, 2 lateral lobes and a lower lobe; very variable in colour but most frequently red or orange with other darker or lighter patterning. ***Stamens*** 4, in 2 pairs, attached to the inside of the corolla tube and occupying the space in the upper curve of the flowers, included or exserted from corolla tube when mature; vestigial staminode present; anthers of each pair attached by their apices. ***Disk*** present, annular. ***Pistil*** developing as filaments wither and reflex downwards and also occupying the space in the upper curve of the corolla tube, consisting of a sterile stipe at the base, the fertile ovary section, the style and the peltate stigma; ovules many, anatropous. ***Fruit*** a long

narrow capsule which opens loculicidally by two valves. ***Seeds*** many, tiny, with short to long appendages at both ends.

Distribution: From Sri Lanka and India through southern China and South East Asia to new Guinea and the Solomon Islands (Weber, 2004a; Middleton, 2016).

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 in 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 Plants of 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 Grass lands 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. **Type**: South India, Nilgiris, *s.d., Perrottet s.n*. (K000190159, lectotype designated here). **Plates 04, 05; Fig. 01**

PLATE 04: *Aeschynanthus perrottetii* A.DC. **A.** Habit; **B.** Single flower; **C.** Corolla split opened; **D.** Calyx; **E.** Corolla lobes-note the mosaic pattern; **F.** Stamens; **G.** Gynoecium with calyx; **H.** Fruit; **I.** Seed (**A-H** from *A.P. Janeesha, S. Syam Radh* & *P.G. Arunkumar 134212* & **I** from *A.P. Janeesha* & *S. Syam Radh 134243*).

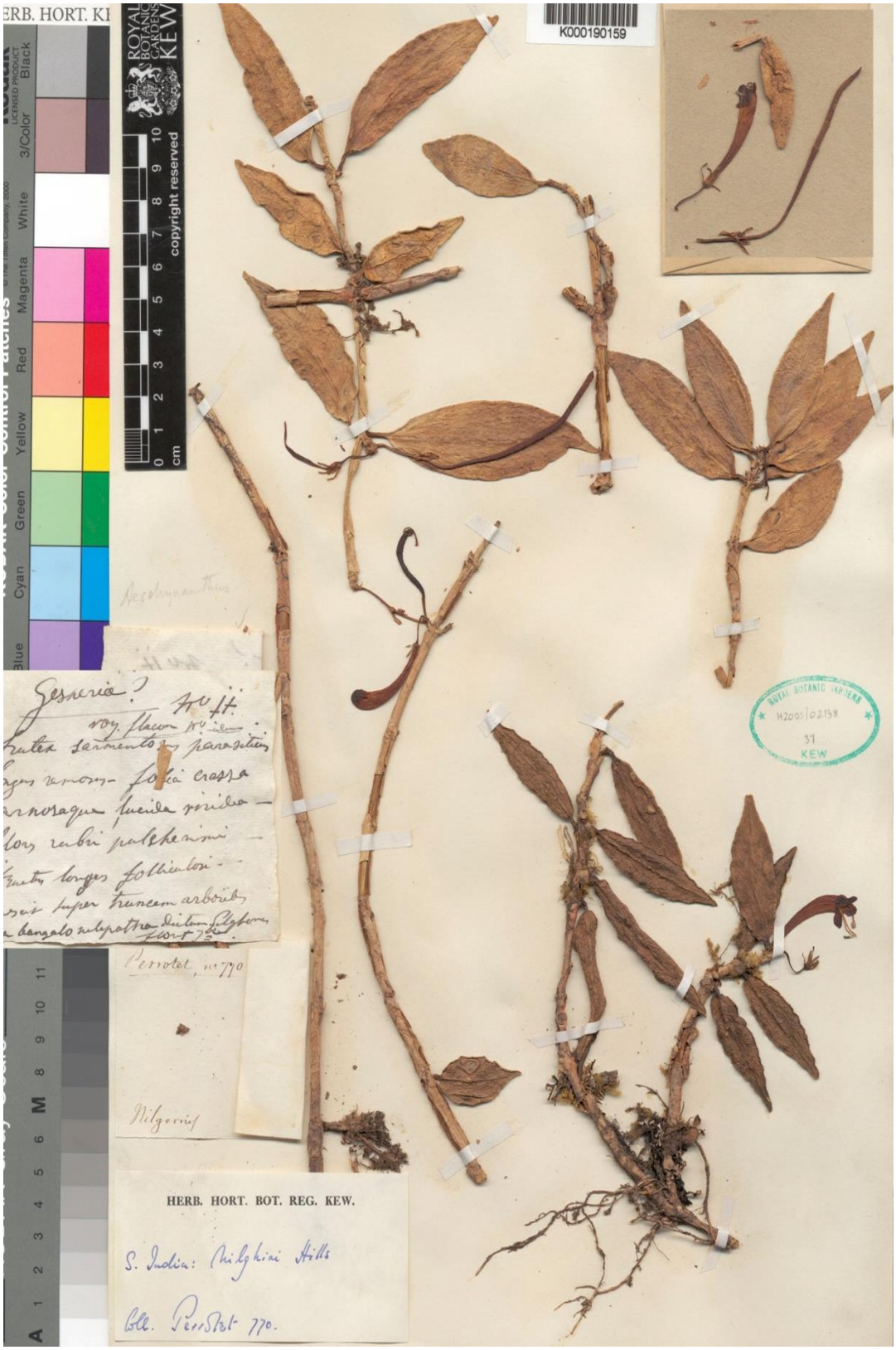


PLATE 05: Lectotype of *Aeschynanthus perrottetii* A.DC.

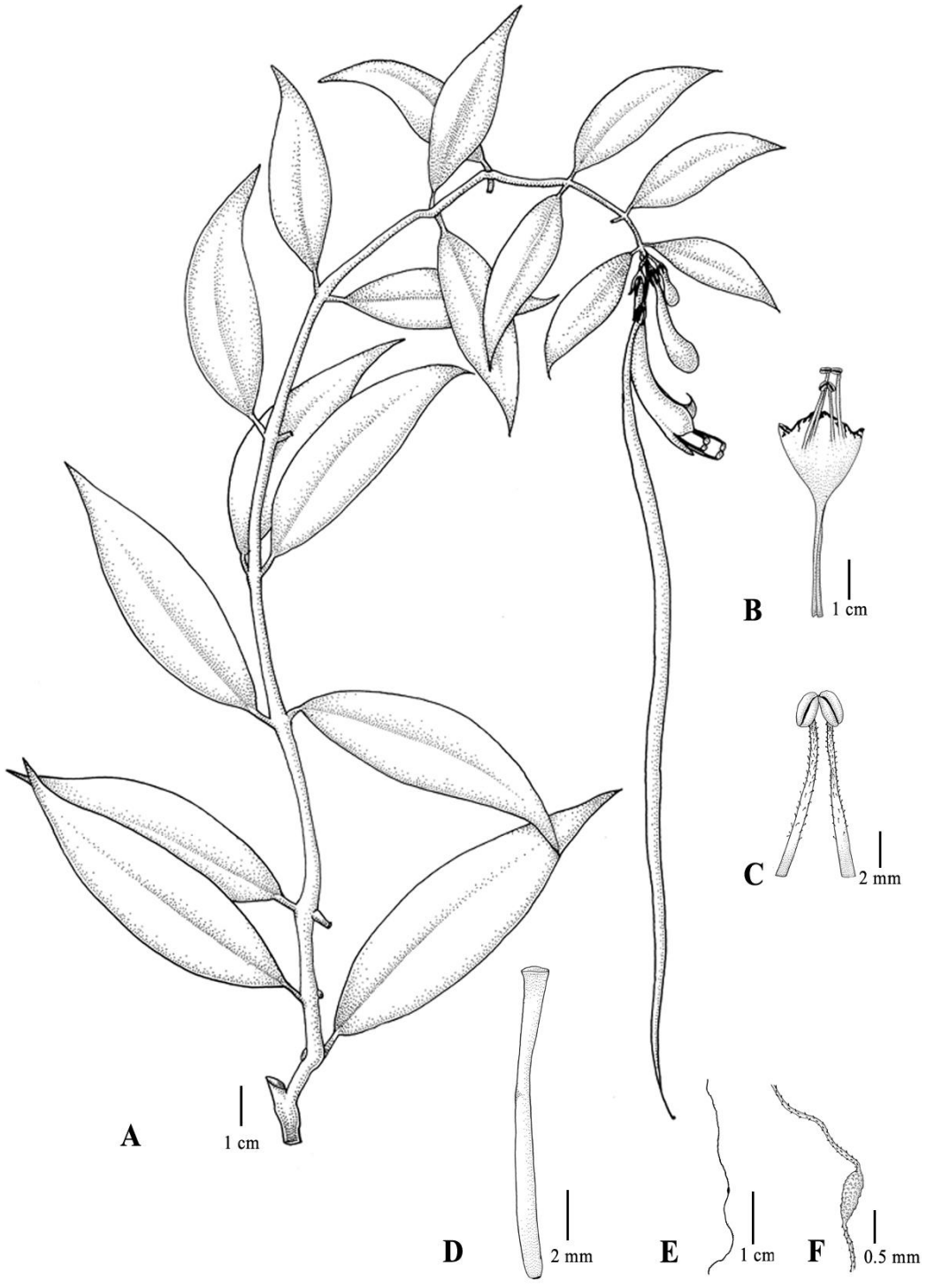


FIGURE 01: *Aeschynanthus perrottetii* A.DC. **A.** Flowering twig; **B.** Corolla split opened; **C.** Stamens; **D.** Gynoecium; **E.** Seed; **F.** Portion of seed enlarged showing testa and appendage (**A-F** from *A.P. Janeesha* & *Santhosh Nampy 134252*).

Aeschynanthus perrottetii A.DC. var. *planyculmis* 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. *A. planiculmis* (C.B.Clarke) Gamble, Fl. Madras 2: 985. 1924. *A. ceylanicus* Wight, not Gardner, Icon Pl. Ind. Orient. 4: t. 1347. 1850. Type: Courtallum, September 1835, *Wight s.n.* (K000190161, lectotype designated here)

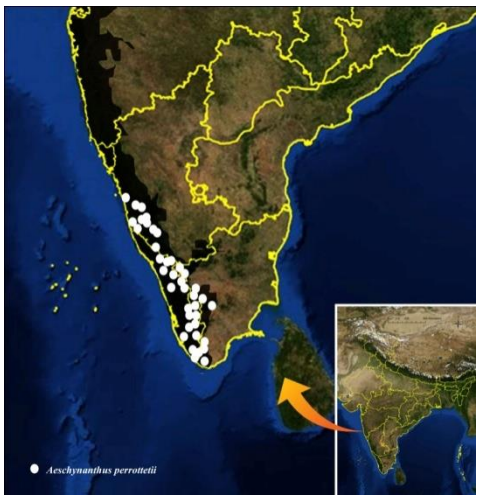
Aeschynanthus perrottetii A.DC. var. *malabaricus* C.B.Clarke in A.DC. & C.DC., Monogr. Phan. 5(1): 25. 1883. Type: *Hoya parviflora* by *D. Ritchie* (K000190163, lectotype designated here)

Aeschynanthus ceylanicus Gardner, Calcutta J. Nat. Hist. 6: 474. 1846 *syn. nov.*; C.B.Clarke in A.DC. & C.DC., Monogr. Phan. 5(1): 26. 1883; W.L.Theob. & Grupe in Dassan. & Fosberg, Rev. Handb. Fl. Ceylon 3: 81. 1981. Type: Rambadde, Ceylon (Holotype-K000190166!).

Aeschynanthus ceylanicus Gardner var. *pinguis* C.B.Clarke in A.DC. & C.DC., Monogr. Phan. 5(1): 25. 1883 *syn. nov.*; U.C.Bhattach. & Goel, Phytotaxonomy 14: 7. 2014. Type: Nilgiris, *s.d., Wight s.n.* (Holotype-K000190167!)

Climbing epiphyte or sometimes lithophytic; stems glabrous, profusely branched, swollen at nodes. ***Leaves*** opposite; petiole 2–10 mm long, glabrous; lamina 2.5–10.5 × 1–2.5 cm, lanceolate, slightly fleshy, leathery, dark to mid green above, pale green beneath, apex acuminate, base obtuse, glabrous above and beneath, margin entire with many brown spots. ***Inflorescences*** axillary, solitary or in a group of 2–5-flowered; bracts linear, 1–1.5 mm long, brownish; pedicels 9–14 mm long, brownish green or purplish, glabrous. ***Calyx*** of 5 sepals, connate at the base, one sepal usually slightly smaller than the others; lobes linear, 5–7 mm long, green to

brownish green, persistent. ***Corolla*** 3.8–6.2 cm long; tube 3–5 cm long, narrow at base, curved below the mouth, glabrous to glandular hairy out, glandular hairy in, tube dark red externally, cream internally; lobes unequal, upper three lobed and lower lobe two lobed, widely ovate, rounded at the tip, ciliate, lobes bright red or dark red out, creamy white inside with purple lines and dots. ***Stamens*** 4, fused in 2 pairs, didynamous; shorter filaments 1.5–2 cm long, larger ones 2.5–3 cm long, alternipetalous, bearded with small glandular hairs, basally hyaline and distal pink in colour; anthers 2 mm long, dehiscing by slits, 5th stamen abortive; staminode minute. ***Disk*** annular, 2 mm high, slightly 5-crenate. ***Pistil*** 1.5 cm long, pale greenish; glabrous to sparsely minutely papillose; ovary 1 cm long, glabrous; style 1 cm long; stigma capitates; ovules 5–7 per locule. ***Capsule*** 11–20 cm long, linear, slightly curved. ***Seeds*** 0.4–0.6 × 0.2–0.35 mm, brown, warty; appendaged at both ends; appendage a filiform hair, 14–18 mm long, papillose.



Chromosome number: Not reported.

Etymology: The speciesis named after G.S. Perrottet who collected the material for the first time from Nilgiris.

Flowering & fruiting: August-February.

Habitat & ecology: Grows as an epiphyte in primary and secondary forests, sometimes seen as lithophyte.

Distribution: India and Sri Lanka

Specimens examined: Karnataka, Chamarajanagar district, Biligiriranga hills, 01.02.1971, *R. Ragavendra Rao 1266* (JCB). Chikkamagaluru district, Bababudangiri, 10.1908, *A. Meebold 9555* (CAL); Kemmangundi-Shankar falls, 16.10.1978, *C.J. Saldanha* & *K.R. Keshavamurthy 3348* (JCB); Sringeri-Gobbagodu, 21.09.2014, *A.P. Janeesha 134298* (CALI). Dakshina Kannada district, Charmadi ghat, 28.10.1960, *C.J. Saldanha CS6298* (JCB); Charmadi ghat top, 25.09.1979, *C.J. Saldanha 9424* (JCB); Nikund ghat, *s.n., s.coll., 6972* (BSI); Sampagi Ghat, 13.11.1900, *C.A. Barber 2321* (MH); Shiradi ghat, 12.10.1976, *Rahul Warrior 4* (JCB); *Ibid*., 14.08.1981, *C.J. Saldanha 13479* (JCB); Shiradi ghat-Yethinahiulla bridge, 19.09.1979, *C.J Saldhana* & *K.P. Sreenath 9140* (CAL); Sulga-ghat, 29.01.1978, *R. Raghavan 152070* (BSI); Way to shiradi ghat, 19.09.1979, *C.J. Saldanha* & *K.P. Sreenath 9140* (JCB). Hassan district, Byagadhalli to Hettur, 30.09.1967, *C.J. Saldanha 11107* (JCB); Devalkare, 05.09.1970, *F.M. Jerret, C.J. Saldanha* & *T.P. Ramamoorthy 684* (JCB); Hettur to Byagadhalli, 01.10.1967, *C.J. Saldanha 11153* (JCB); Hettur road, 11.11.1967, *C.J. Saldanha 11517* (JCB); Hanbal, 07.10.1965, *C.J. Saldanha CS10145, CS10146, CS10147* (JCB); Road to Hanbal, 21.11.1969, *C.J. Saldanha 15680* (JCB); Sakleshpur, 01.10.1967, *C.J. Saldanha 11153* (JCB). Kodagu district, Abbey falls, 26.01.1976, *B.C. Banerjee 11358* (CAL); *Ibid*., 28.12.1978, *C.J. Saldanha, P. Prakash* & *S.B. Manohar 5564* (JCB); 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* (CAL); *Ibid*., 22.08.1978, *S.R. Ramesh 2315* (JCB); Mercara-Siddapur, 11.10.1978, *S.R. Ramesh* & *P. Prakash 3276* (JCB); Somwarpet, 14.08.1978, *S.R. Ramesh 2369* (JCB); Mercara, 30.01.1976, *B.C. Banerjee 11425* (CAL); Mercara-Karalabadaga village, 21.08.1961, *A.S. Rao 74474* (BSI); Napoklu, 03.09.1961, *A.S. Rao 74878* (BSI). Koduru district, On the way to

makut, 10.10.1978, *S.R. Ramesh* & *P. Prakash 3162* (JCB). Mysore district, Mudigene-Todkala, *R.S. Raghavan 126072* (BSI). Shimoga district, Agumbe, 17.10.1960, *C.J. Saldanha CS6064, CS6065* (JCB); *Ibid*., 07.02.1961, *R.S. Raghavan 69459* (CAL); *Ibid*., 28.11.1983, *K. Shanthi 1028* (CALI); *Ibid*., 28.11.1983, *T.P. Radhakrishnan 1263* (CALI); Agumbe-near P.W.D. loadge, 27.10.1960, *R.S. Raghavan 67814* (BSI, CAL); Shirur forest, 01.09.1963, *R. Raghavan 90370* (BSI); Hosuru near Yedur, 05.10.1962, *R. Raghavan 82990* (BSI); Kavaledurga, 02.10.1962, *R.S. Raghavan 82898* (BSI, CAL); Malnadu forest, 14.10.1977, *M. Pathumalai 3* (JCB); *s.loc*., 04.09.1696, *C.J. Saldanha 14797* (JCB); 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* (BSI); 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**, Idukki district, Bank of Dhana Valley-Way to Muduvankudi, 13.01.1989, *P. Bhargavan 9092* (MH); Chapathu, 30.09.1981, *C.N. Mohanan* & *B. Ramanujam 72092*(CAL, MH); Devikulam, 22.11.1965, *B.V. Shetty 26615* (MH); *Ibid*., 31.03.1978, *V.P.K. Nambiar* 1066 (KFRI); *Ibid*., 14.07.1993, *A. Nazarudeen 17821* (TBGT); Guderale, 18.03.1993, *A.E. Shanavas Khan 13066* (TBGT); Idukki, 28.09.1981, *C. N. Mohanan 72410* (MH); *Ibid*., 08.11.1981, *C.N. Mohanan 72410* (MH); Kattappana Cardamom plantation, 28.09.1981, *C.N. Mohanan* & *B. Ramanujam 72152* (MH); Kuruchikella, 13.02.1957, *G.S. Puri 15705* (BSI); Lakshmi Estate, 12.09.1968, *D.B. Deb 30757* (MH); Mannavan Shola-Munnar, 27.11.1979, *V.P.K. Nambiar 1064* (KFRI); Mappara Estate, 07.02.1981, *N.C. Nair 70121* (CAL, MH); Munnar, 16.10.1963, *K.M. Sebastine 1759*1 (MH); Old Devicolam, 25.01.1964, *K.M. sebastine 18471* (MH); Pallivasal, 19.02.1957, *G.S.*

Puri 155323 (BSI); Peerumedu, 12.1909, *A. Meebold 13375* (CAL); Peermade, 14.11.1928, *N. Narayanaswamy 1548* (MH); *Ibid*., *s.d*., *Narayana Iyer 1873* (TBGT); Peerumedu-kuttikanam**,** 25.09.1964, *K. Vivekananthan 21391* (MH); Periyar-Mangaladevi, 10.10.1993, *Jomy Augustine 12540* (CALI); Silent Valley R.F., 22.12.1969, *E. Vajravelu 33267* (MH); Valara R.F., 24.11.1982, *K. Ramamurthy 74988* (CAL, MH); Umaiamalai, Kuttikanam-Peerumedu, 21.01.1965, K. *Vivekananthan 22933* (MH); Vallakkadavu R.F., 08.10.1972, *B.D. Sharma 42439* (MH). Kollam district, Chokkanpatty hills, 21.02.1982, *C.N. Mohanan, 73425* (MH). Kottayam district, Nagarampara reserve forest, 25.11.1987, *N. Venkatasubramanian* & *K.R. Sasidharan 13486* (FRC); Wagamon, 03.10.2015, *C. Pramod* & *A.P. Janeesha 137653* (CALI). Kozhikode district, lower side of Kakkayam dam, 19.09.2013, *A.P. Janeesha, S. Syam Radh* & *Habeeb Rahman 134218* (CALI). Malappuram district, Nilambur-Nadukani, 28.03.1982, *Philip Mathew 33149* (CALI). Palakkad district, Karimala-near rest para, 26.09.2013, *A.P. Janeesha, K. Thoiba* & *K. Smitha 134226* (CALI); Nelliyampathy, 15.08.2015, *S. Resmi* & *A.P. Janeesha 137631* (CALI); Nemmara–Pulayampara Grassland, 15.11.1984, *K.N. Subramanian 10717* (FRC); Panthanthode, 21.09.1977, *J. Joseph 51437* (CAL); Parathode, 10.11.1994, *Stephen Sequiera 9688* (KFRI); *Ibid*., 10.11.1994, *Stephen Sequiera 9683* (KFRI); *Ibid*., 16.04.1994, *C.C. Joy* & *Stephen Sequiera 9689* (KFRI); Silent Valley, 10.12.1980, *N.G. Nair* & *N. Sasidharan 1961* (KFRI); *Ibid*., 14.01.1993, *A. Nazarudeen 15894* (TBGT); *Ibid*., 14.01.1993, *E.S. Santhosh Kumar 15918* (TBGT). S.V.R.F-Poochippara slopes, 10.02.1980, *N.C. Nair 69199* (CAL); Silent valley hanging bridge, 05.10.1979, *N.C. Nair 64267* (CAL); Silent valley Camp Shed, 04.12.1981, *C. Sathish Kumar 10101* (CALI); Thuthampara R.F., 16.02.1979, *E. Vajravelu 60505* (CAL); Way to Pothumala, Nelliampathy,

20.01.1994, *C.C. Joy* & *Stephen Sequiera 9679* (KFRI). Pathanamthitta district, Anathode, 10.11.1975, *K. Vivekananthan* 46609 (CAL, MH); Anathode–Kaki Forest, 23.01.1992, *R. Chandrasekaran 96614* (MH); Pamba to Anathode, 16.12.1974, *K. Vivekananthan 45303* (MH); Parumalai, 21.05.1911, *C.E.C. Fischer 2781* (FRC). Thiruvananthapuram district, Agasthyamalai, 19.10.1993, *S. Willim Decruse* & *A. Gangaprasad 18422* (TBGT); *Ibid*., 06.07.2015, *P.G. Arunkumar* & *A.P. Janeesha 134149* (CALI); *Ibid*., 2016, *K. Shinoj* & *A.P. Janeesha 137654* (CALI); Athirumala, 06.02.1988, *N. Mohanan 9417, 7437* (CALI, TBGT); *Ibid*., 12.10.1988, *N. Mohanan 4204* (CALI); *Ibid*., 14.10.1988, *N. Mohanan 4245* (CALI); Kallar River Bank, 22.01.1983, *K.N. Subramanian 9041* (FRC); Pongalappara, 06.06.2014, *K.M. Manudev*, P.*G. Arunkumar* & *A.P. Janeesha 138921* (CALI); Ponganpara, 23.01.1987, *N. Mohanan 9804* (TBGT); Ponmudi-Lower sanatorium, 16.11.1977, *M. Mohanan 52536* (CAL, MH); Ponmudi, 16.10.1959, *K.M. Mathew 1341* (RHT); *Ibid*., 19.09.1968, *s.coll. 9176* (RHT); *Ibid*., 17.01.1989, *N. Sasidharan 5199* (KFRI); Poonkulam, Way to Agasthyarkudam, 05.03.1980, *N. Mohanan 66031* (CAL, MH); Vazhukkumpara, 29.09.2000, *K. Radhakrishnan 43404* (TBGT); Western Slopes of Agasthyamala, 06.10.1973, *J. Joseph 44574* (MH). Thrissur district, Malakkappara, 13.12.2013, *A.P. Janeesha* & *S. Syam Radh 134243* (CALI); Mudiyankunnu-starting point, 12.12.2013, *A.P. Janeesha* & *Santhosh Nampy 134245* (CALI); Sholayar, 20.01.1989, *N. Sasidharan 5197* (KFRI). Wayanad district, Chandanathode, 12.02.1978, *V.S. Ramachandran 57576* (MH, CAL); *Ibid*., 14.08.1979, *V.S. Ramachandran 63944* (MH); *Ibid*., 25.09.1984, *K.R. Sasidharan 10497* (FRC); *Ibid*., 18.10.1994, *Stephen Sequiera 9682* (KFRI); *Ibid*., *s.d*., *V.S. Ramachandran 53966* (CAL, MH); Kurichiermala, 28.10.2013, *A.P. Janeesha* & *P.G. Arunkumar 134236* (CALI); Kuthuparamba Road, 11.02.1982,

K.N. Subramanian 7848 (FRC); Makkamala, 22.11.1983, *K.N. Subramanian 9883* (FRC); Near vattappoyil, 31.08.2013, *A.P. Janeesha, S. Syam Radh* & *P.G. Arunkumar 134212* (CALI); Neerchal-periya, 08.11.2012, *A.P. Janeesha* & *Santhosh Nampy 134252* (CALI); Pakshipathalam, 30.10.2007, *Kulloli* & *R. Subbu 61514, 61615* (TBGT); Periya, 25.08.1984, *R.T. Balakrishnan 40497* (CALI); *Ibid*., 25.11.1986, *R.T. Balakrishnan 42734* (CALI); Thirunelly reserve forest, 23.11.1983, *K.N. Subramanian 9754* (FRC); *Ibid*., 20.09.1996, *Stephen Sequiera* & *Michael 9686* (KFRI); Vythiri, 05.12.1994, *A.E. Shanavas Khan 23304* (TBGT); Way to Kannoth-Chandanathode, 08.12.1967, *J.L. Ellis 29527* (MH); Way to Periya-Chandanthode, 31.10.1965, *J.L.Ellis 25778* (MH). **Tamil Nadu**, Chennai district, Near Kumili, 18.10.1959, *K. Subramanyam 9439* (MH). Coimbatore district, Attakatti-alaprai, Anamalai, 14.12.1960, *N.P. Balakrishnan* & *J.L. Ellis 11719* (MH); Doddasampage, 08.07.1930, *V. Narayanaswami 3743* (MH); Grass Hills, Iyerpadi, Anamalai, 09.11.1901, *C.A. Barber 4016* (MH); Iyerpadi, Anamalai, 21.04.1903, *C.A. Barber 5432* (MH); Shola between Attikar, 24.08.1905, *C.E.C.Fischer 324* (FRC); Sholayar Submergable area, 29.12.1963, *K. Ramamurthy 18193* (MH); Waverly estate, 22.10.1961, *J. Joseph 13090* (CAL, MH); Upper Nirar Dam Site, 06.05.1980, *K.N. Subramanian 7530* (FRC); *s.loc*., 24.08.1905, *C.E.C. Fischer 324* (CAL); Valparai-Iyerpadi, 03.10.1984, *K.M. Mathew 18358* (RHT); Way to Godaiyar, 02.09.1963, *A.N. Henry 7429* (MH). Dindigul district, Kodaikanal, 21.05.1989, *K.M. Mathew 10287* (RHT); Ibid., 03.03.1990, *K.M. Mathew 54149* (RHT); Kodaikanal-muthukuzhivayal, 21.01.1986, *K.M. Mathew 18750* (RHT); Kukkal shola, 04.02.1986, *K.M. Mathew* & *N. Rajendran 43988* (RHT); *Ibid*., 19.05.1986, *K.M. Mathew 45283, 45285* (RHT); Palani hills-Kukkal shola, 23.08.1986, *K.M. Mathew, M. Charles* & *N. Rajendran 46524* (RHT). Kamarajar

district, Way to Chinnapachiyar estate, 22.10.1988, *S.R. Srinivasan 89460* (MH). Kanyakumari district, Grassey slopes-Way to Mahendragiri, 05.12.1969, *B.V. Shetty 33051* (MH); Muthukuzhivayal, 27.08.1976, *A.N. Henry 47575* (CAL, MH). Madurai district, Anna-Parappar stream, 03.03.1986, *K.M. Mathew* & *N. Rajendran 44456* (RHT); *Ibid*., 24.05.1987, *M. Charles 49756* (RHT); Anna-Pambar falls top, 18.06.1988, *K.M. Mathew 53168* (RHT); Gundan valley shoal stream, 09.06.1899, *s.coll. 2843* (MH); High way mts, 08.09.1925, *K.C. Jacob 17602* (MH); Highway route, 05.1917, *E. Blatter* & *Hallbeerg 22568, 22569, 772* (BLAT); Upper manalar, 18.04.1981, *K.M. Mathew 17595* (RHT). Nilgiris district, Avalanche, 17.10.1972, *K. Vivekananthan 42989* (MH); Devala R.F., 19.11.1972, *E. Vajravelu 42832* (MH); Mullimund, 31.03.1972, *K. Vivekananthan 40662* (MH); Naduvattam, 30.03.1870, C.B. Clarke 11388 (CAL); *Ibid*., 29.08.1970, *B.D. Sharma* 3590 (MH); *Ibid*., 22.10.1972, *J.L. Ellis 43313* (MH); Nilgiri, 11.1883, *J.S. Gamble 13477* (CAL); *Ibid*., 10.1884, *J.S. Gamble 14891* (CAL); *Ibid*., *s.d*., *M.A. Lawsow s.n*. (MH); Ooty to Gudalore Road, 14.05.1963, *K.N. Subramanian 666* (FRC); Ouchterlong Valley, 29.01.1971, *J.L. Ellis 37747*; (MH); Sethur hills, Deviar estate to Naduvattam, 07.03.1981, *S.R. Srinivasan 68020* (CAL). Pulney district, *s.loc*., 12.11.1897, *A.G. Bourne 575* (CAL). Ramanathapuram district, *s.loc*., 07.03.1981, *S.R. Srinivasan 68020* (MH). Tirunelveli district, Agasthyamalai, 25.05.1901, *C.A. Barber 2887* (MH); Kalivayapil, 01.06.1901, *C.A. Barber 3041* (MH); Vannikotty R.F., 12.02.1989, *R. Gopalan 90142*; (MH). Tirunelveli district, Above Kannikketti, 11.04.1985, *V.S. Manickam 18408* (RHT); Upper Kodayar-near dam, 23.09.1975, K.*M. Mathew 14944* (RHT); Sengaltheri-Kakkachi path, 25.01.1979, K.*M. Mathew 16328* (RHT). Peninsular india orientalis, Herb. Wight Proper *2347, 651* (CAL). Highway

mountain 4000–5500 feet, 05.1971, *Blatter* & *Hallberg 772* (CAL). Perumal, January, *Rev. Van Malderen 1360* (CAL). *s.loc*., 06.12.1907, *C.E.C. Fischer 253* (CAL).

Notes: This species was described by De Candolle in 1845 based on the material from Nilgiris. Gardner (1846), one year later, described another species from Ceylon as *A. ceylanicus*. The latter taxa was distinguished by its broader leaf with an acute base; two flowered umbels, glandular corolla and *c.* 20 cm long capsule as opposed to narrow leaves with obtuse base, 3–5 flowered umbels, glabrous corolla and shorter capsule (*c.* 8 cm long).

Clarke (1883) in *Monographiae Phanerogamarum* recognized a new variety, var. *pinguis* C.B. Clarke under *A. ceylanicus* which is characterised by minute succulent leaves, sub-glabrous corolla and 7–14 cm long capsules. It is assumed that *A. perrottettii* occurs only in South India and *A. ceylanicus* in Ceylon. Bhattacharyya and Goel (2014) reported the occurrence of *A. ceylanicus* var. *pinguis* in South India.

From the live collections, it is observed that the characters used for distinguishing these three taxa were overlapping. Leaf shape and size varies considerably in plants collected from southern India. The hairiness is also proved to be varying in younger and older flowers of same plant-young ones had glandular hairs and older ones doesn't. Number of flowers in umbel and capsule length also varies in plants collected from South India. Hence *A. ceylanicus* and its variety *A. celanicus* var. *pinguis* is synonymised under *A. perrottetii*.

Epithema Blume

Epithema, a genus of lithophytic herbs was originally established by Blume (1826) to include a single species, *E. saxatile* Blume. Thereafter Robert Brown (in Wallich, 1832) published another genus *Aikinia* for a different species *A. brunonis*. Later it was synonymised under *Epithema* by Decaisne in 1834. Several species were then described in both genera by later botanists. Further combinations or new taxa were added to *Epithema* by Bentham (1835) and Spanoghe (1841), but Don (1838) continued the use of *Aikinia*, treating *Epithema* in synonymy. Later authors, however, preferred the name *Epithema* and correctly published treatments under it.

A.P. De Candolle (1845) and Clarke (1883) made significant contributions in this genus. Candolle (*l.c.*) included five species while Clarke (*l.c.*) included six species, but recognized eight new varieties and one new varietal combination. Since then, there were regional accounts/ descriptions of new taxa by different authors (Henriques, 1892; Chevalier, 1912; Ohwi, 1943; Burtt, 1958b; Kiew, 1985; Ying, 1992; Hilliard & Burtt, 1997; Wang *et al*., 1998). The genus was recently revised by Bransgrove and Middleton (2015) and corrected the feminine endings of varietal names described by Clarke (*l.c.)* to neuter ending.

Smith *et al.* (1997) in their molecular study of the family using *ndhF* cpDNA sequences found that the two members of tribe *Epithemateae* included in their analysis are sister to all other. Smith (2000b) using *ndhF*, and *rbcL* found that *Epithemateae* are sister to the remainder of Cyrtandroideae. Mayer *et al.* (2003) studied *Epithemateae* based on combined *atpB* and *trnL-F* data and they also confirm the observations of Smith (*l.c.*)

that tribe *Epithemateae* form a sister clade to the other paleotropical Gesneriaceae, with good branch support.

Earlier workers like G. Don (1838), De Candolle (1845), Clarke (1883) and Fritsch (1893) placed *Epithema* under Cyrtandraceae. Burtt and Wiehler (1995) placed the genus in the tribe *Epithemateae* and in sub-tribe *Klugieae*. As per the recent classification of Weber *et al.* (2013) it comes under the sub-family Didymocarpoideae, tribe *Epithemateae* and in sub-tribe *Epitheminae*.

In *Epithema*, splash cup dispersal is the major means of seed dispersal. The splash cups are formed from the persistent calyx and seeds are dispersed directly from the capsule, usually by raindrops. But, this kind of dispersal is only effective over short distances (Bransgrove & Middleton, 2015). The genus is distributed in central tropical Africa (Cameroon, Central African Republic, Democratic Republic of Congo, Equatorial Guinea, Guinea, Ivory Coast, Liberia, Sierra Leone and Uganda), South Asia (Nepal, India, Sri Lanka), Southeast Asia (southern China, Myanmar, Thailand, Vietnam, Cambodia, Laos, Taiwan), Malesia (Philippines, Malesia, Indonesia) and the Solomon Islands. Bransgrove and Middleton (2015) recognized twenty species with two new combinations. Three species occur in India of which only one is distributed in South India.

Epithema Blume, Bijdr. Fl. Ned. Ind. 14: 737. 1826; C.B.Clarke in A.DC. & C.DC., Monogr. Phan. 5(1): 176. 1883, in Hook.f., Fl. Brit. India 4: 369. 1884; King & Gamble, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 74(2): 783. 1909; Gamble, Fl. Madras 2: 991. 1924; W.L.Theob. & Grupe in Dassan. & Fosberg, Revis. Handb. Fl. Ceylon 3: 102. 1981; A.Weber in Kubitzki, Fam. Gen. Vasc. Pl. 7: 129. 2004; Bransgr. & D.J.Middleton, Gard. Bull. Singapore 67(1): 159. 2015. **Type:** *Epithema saxatile* Blume.

Aikinia R.Br. in Wall., Pl. Asiat. Rar. 3: 65. 1832. Type: *Aikinia brunonis* Wall. (= *Epithema brunonis* (Wall.) Decne.).

Carpocalymna Zipp., Alg. Konst- Lett.-Bode 1: 297. 1829 *nom. nud.*

Herbs caulescent, succulent. ***Leaves*** petiolate, lowest leaf solitary, upper leaves opposite; laminae membranous, ovate to cordate, rarely elliptic to orbicular, apex rounded to acute, base mostly cordate or sub-auriculate to obtuse, inserted evenly or unevenly on petiole, margin entire to crenate, serrate or (bi-)dentate, venation pinnate, sometimes variegated. ***Inflorescences*** 1–6 per plant; peduncles usually originating from the leaf axils; bract single, subtending each inflorescence, cucullate and enclosing the entire inflorescence or partially, margin entire to dentate. ***Calyx*** cylindrical to campanulate, consisting of a tube and 5 lobes, with an embedded gland towards the apex of each lobe. ***Corolla*** tube usually white, lobes pale pink to blue or purple, commonly with darker markings on either lip; tube cylindrical to narrowly fluted, occasionally slightly constricted at the apex; lobes entire to fimbriate. ***Stamens*** 2, fertile; anthers coherent at thecae tips or along entire thecae; staminodes 2. ***Disk*** annular. ***Ovary*** cylindrical to spherical, glabrous to densely pubescent, unilocular, placentation parietal; style short; stigma bi-lobed, papillate, glabrous. ***Capsule*** cylindrical to spherical; operculum circumscissile or irregularly dehiscing at maturity, indumentum glabrous to densely pubescent; surrounded by persistent calyx. ***Seeds*** usually narrowly to broadly ovoid, ends acute and/or constricted, light to dark brown with darker ends, pattern straight to spiralled.

Distribution: Twenty species from central tropical Africa, India, Sri Lanka, Nepal, southern China and through Southeast Asia and Malesia to the Solomon Islands (Bransgrove & Middleton, 2015).

Epithema ceylanicum Gardner, Calcutta J. Nat. Hist 6: 492. 1846; Wight, Icon. Pl. Ind. Orient. 4: 11. t. 1354. 1848; Bransgr. & D.J.Middleton, Gard. Bull. Singapore 67(1): 159. 2015. *Epithema carnosum* Benth. var. *ceylanicum* (Gardner) C.B.Clarke in A.DC. & C.DC. Monogr. Phan. 5(1): 178. 1883. **Type:** Sri Lanka, *Gardner, G. 606* (K000435690, lectotype designated by Bransgrove & Middleton, 2015). **Plates 06, 07; Fig. 02**

Epithema carnosum Benth. var. *hispidum* C.B.Clarke in A.DC. & C.DC., Monogr. Phan. 5(1): 178. 1883; Santapau, J. Bombay Nat. Hist. Soc. 48: 491. 1952; Ramamoorthy in C.J.Saldanha & Nicolson, Fl. Hassan Dist. 530. 1976; Vajr., Fl. Palghat Dist. 333. 1981; Yogan. *et al*., Fl. Chikmagalur Dist. 242. 1981; B.D.Sharma *et al*., Fl. Karnataka: analysis 197. 1984; R.S.Rao, Fl. Goa, Diu, Daman, Dadra & Nagarhaveli 2: 209. 1985; R.S.Rao & S.Hara, Fl. Srikakulam Dist. 348. 1986; Gopalan in A.N.Henry *et al*., Fl. Tamil Nadu Ind., Ser I: Analysis 133. 1987; M.Ahmedullah & M.P.Nayar, Endemic Plants of Indian region 1: 143. 1987; K.K.N.Nair & M.P.Nayar, Fl. Courtallum 2: 281. 1987; Sasidh. & Sivar., Fl. Pl. Thrissur Forest 330. 1996; Pull. & Ali Moulali, Fl. Andhra Pradesh 2: 680. 1997; Subba Rao & Kumari, Fl. Vishakapattanam Dist. (Andhra Pradesh) 603. 2002; Sasidh., Biodivers. Doc. Kerala, Part 6: Fl. Pl. 332. 2004; T.S.Nayar *et al*., Fl. Pl. Kerala 344. 2006; Sunil & Sivad., Fl. Alappuzha Dist. 522. 2009; Punekar & Lakshmin., Fl. Anshi Nat. Park 338. 2011; N.Krishnak. *et al*., Fl. Pl. Shola and Grass lands Nilgiri 216. 2013; T.S.Nayar *et al*., Fl. Pl. Western Ghats 1: Dicots 527. 2014. *Epithema dentatum* (C.B.Clarke) Hilliard & B.L.Burtt subsp. *hispidum* (C.B.Clarke) Hilliard & B.L.Burtt, Edinburgh J. Bot. 54(1): 111. 1997. **Type:** India, Tamil Nadu, Western Ghats, Courtallum, August 1835, *Wight 2350* (K001089590, first step designated by Bransgr. & Middleton, 2015; second step designated here).

PLATE 06: *Epithema ceylanicum* Gardner **A.** Habit; **B.** Inflorescence; **C.** Single flower; **D.** Calyx; **E.** Corolla; **F.** Corolla split opened; **G.** Stamens; **H.** Gynoecium; **I.** Fruit; **J.** Fruit upper view; **K.** Seeds (**A** from *A.P. Janeesha* & *Santhosh Nampy 134285*; **B** from *A.P. Janeesha, S. Resmi* & *K. Shinoj 137683* & **C-K** from *A.P. Janeesha* & *Santhosh Nampy 137624*).

PLATE 07: Lectotype of *Epithema ceylanicum* Gardner

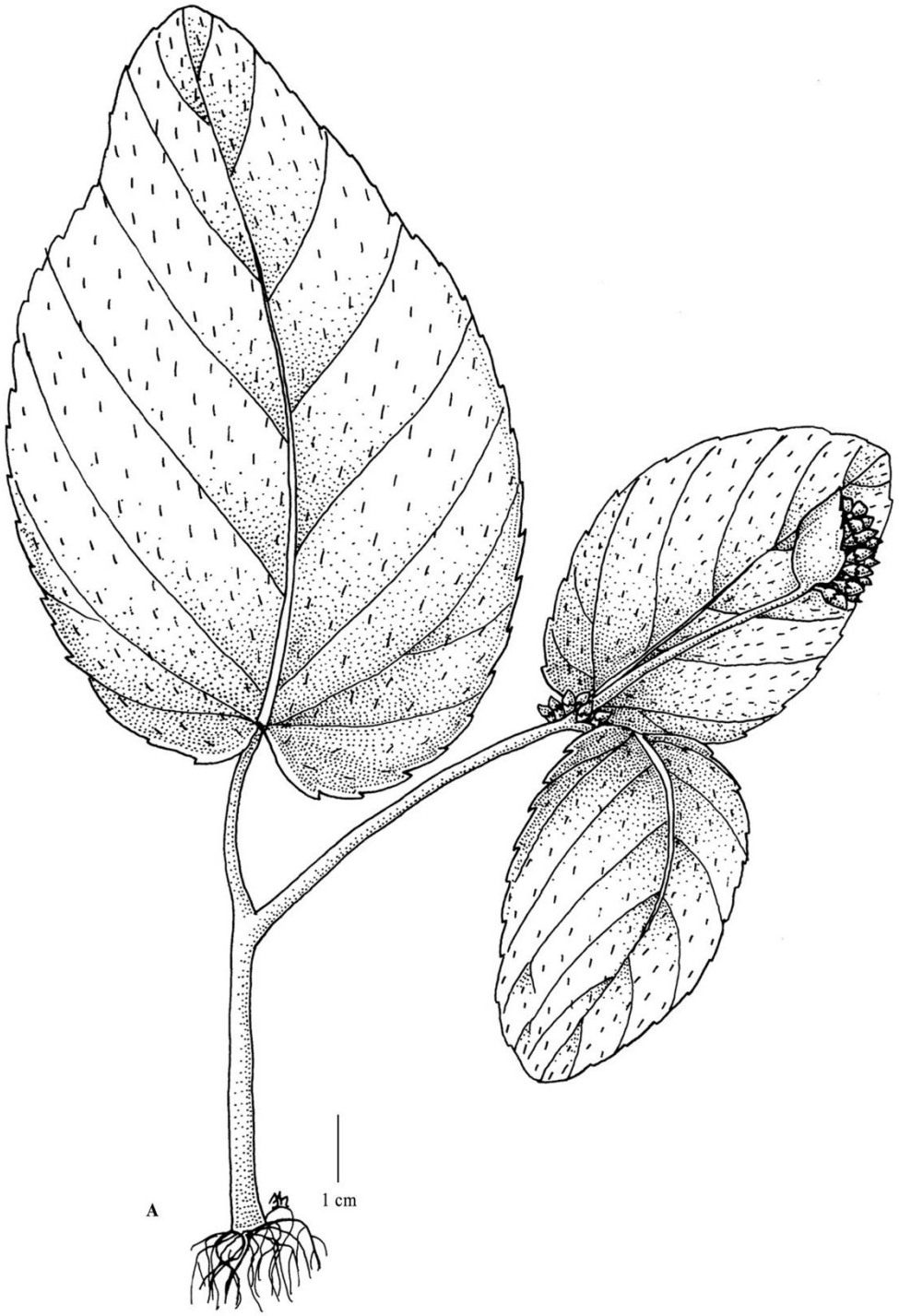


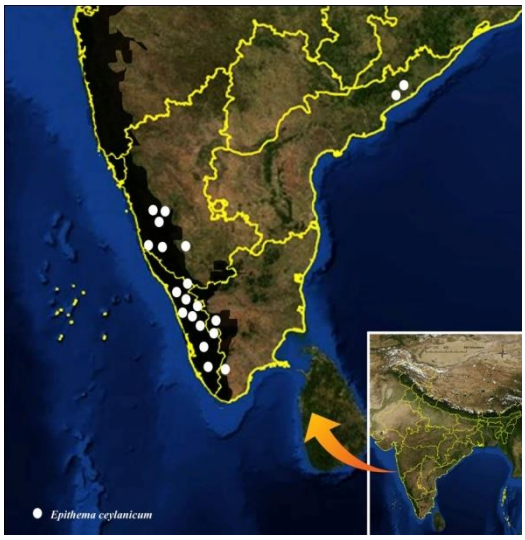
FIGURE 02: *Epithema ceylanicum* Gardner (From *A.P. Janeesha, S. Resmi & K. Shinoj 137683*).

Epithema carnosum Benth. var. *dentatum* C.B.Clarke in A.DC. & C.DC., Monogr. Phan. 5(1): 177. 1883. *Epithema dentatum* (C.B.Clarke) Hilliard & B.L.Burtt, Edinburgh J. Bot. 54: 111. 1997. Type: Burma, Moulmein, Farm Cave Rocks, *s.d., Parish, C.S.P. 63* (K001089587, lectotype designated by Hilliard & Burtt, 1997).

Epithema brunonis Decne. var. *fasciculatum* C.B.Clarke in A.DC. & C.DC., Monogr. Phan. 5(1): 180. 1883. *Epithema taiwanense* S.S.Ying var. *fasciculatum* (C.B.Clarke) Z.Yu Li & M.T.Kao, Fl. Taiwan, ed. 2, 4: 697. 1998. Type: Philippines, Tayabas, 1841, *H. Cuming, 823* (K000438698, lectotype designated by Bransgrove & Middleton, 2015).

Succulent, caulescent herbs, 4–28 cm high. ***Stems*** 0.5–15 cm × 4–10 mm, sub-glabrous, sparsely strigose or sparsely pubescent. ***Leaves*** opposite**,** one of those of lowest pair abortive and appeared as solitary, membranous, lowest leaf always petiolate, upper leaves slightly sessile to petiolate, sometimes with a solitary leaf per plant; petiole of lowest leaf 0.8–3.9 cm long, sub-glabrous to densely pubescent, petioles of upper leaves 0.1–2 cm long, sub-glabrous, minutely pubescent; blades of lowest leaves 4.7–11 × 3–8.5 cm, upper leaves 1.8–7 × 1.2–5.5 cm, lower leaves cordate to ovate, upper leaves cordate, ovate or elliptic, apex acute to rounded, base of lower leaf cordate to truncate, base of upper leaves obtuse, rounded or truncate, occasionally sub-cordate, margin subentire to dentate, bidentate or serrate; upper surface pale-green or rarely purplish green, sometimes variegated with sparse straight and/or hooked hairs and sparsely to densely strigose; lower surface paler green or purplish in colour, sub-glabrous to strigose, hairs sparse to medium density. ***Inflorescences*** 1–6 per plant; peduncles arising from the leaf axils, usually from the upper leaves, fasciculate; ***bracts*** (sub-)cucullate, enclosing the inflorescence (not completely), 3–18 × 2–11 mm, margin entire to dentate, glabrous to strigose; pedicels 0.5–4.5 mm long, densely pubescent

with fine minute hairs and more sparsely with larger strigose hairs. ***Calyx*** 1.9–5.56 mm long; tube 0.9–2.61 × 0.8–2.35 mm; lobes 0.9–2.71 × 0.7–1.1 mm, lanceolate to triangular, sparsely to densely pubescent outside with fine, minute straight and hooked hairs, glabrous or subglabrous inside. ***Corolla*** whitish or blue, blue-violet; tube white, 4–8.32 mm long; tube 3.2–4.9 × 0.8–1.9 mm; lobes 2–3.05 × 1.52–1.9 mm long, glabrous to sparsely pubescent outside on lobes, dense band of villous hair inside, at the middle portion of the tube. ***Stamens*** 1.4–2.04 mm long; filaments 1.3–2 mm long; anthers 0.4–0.7 × 0.31–0.5 mm long; staminodes 1–1.25 mm long. ***Disk*** annular, lobed, 0.8–1 × 1.43–1.62, whitish. ***Ovary*** sub-spherical to cylindrical, 1–1.42 × 0.9–1.59 mm pubescent on the uppermost part of the ovary, hairs hooked or primarily hooked; style 2.35–3.8 mm long, glabrous or sparsely pubescent in lower region near to the ovary, hairs hooked; stigma to 0.7–0.98 × 0.4–0.6 mm wide, pappillate. ***Fruits*** cylindrical to spherical, 2.2–5.1 × 1.1–2.4 mm; operculum 0.4–0.8 mm long, densely pubescent as on ovary. ***Seeds*** ovoid, 0.42–0.6 × 0.12–0.19 mm, spirally grooved, brownish.



Chromosome number: Not reported.

Flowering & fruiting: August-February.

Habitat & ecology: It requires shaded conditions with high humidity and is frequently found near or in cave entrances, on rocks on the forest floor, on fallen trees or tree trunks, or on rocks beside, or in, shallow streams and rivers.

Distribution: India, Sri Lanka, Taiwan, Myanmar, Thailand, Cambodia, Vietnam.

Specimens examined: Andhra Pradesh, Visakhapatnam district, Araku Valley, 17.09.1961, *N.P. Balakrishnan 653* (CAL); Chintapalli, 31.08.1966, *G.V. Subba Rao 28210* (MH); Forest near Araku, 24.08.1960, *N.P. Balakrishnan 10815* (MH); on the way to Agraharam from Guden, 29.10.1972, *G.V. Subba Rao 42798* (MH). **Karnataka**, Hassan district, Bisle Ghat, 14.08.1967, *C.J. Saldanha 10921* (JCB); *Ibid*., 14.0831971, *T.P. Ramamoorthy 2007* (JCB); Bisle Ghat-Attahalla, 18.09.1969, *C.J. Saldanha 15078* (JCB); Kenchankumari reserve forest, 15.08.1971, *T.P. Ramamoorthy 2035* (JCB). Dakshina Kannada district, Charmadi ghat, 13.08.1981, *C.J. Sldanha 13455* (JCB); Shiradi Ghat-Kempuhole, 07.08.1969, *C.J. Saldanha 14444* (JCB); Shiradi Ghat, 15.08.1967, *C.J. Saldanha 10958* (JCB); *Ibid*., 22.08.1980, *C.J. Saldanha 12079* (JCB); *Ibid*., 15.08.1967, *C.J. Saldanha 10958* (JCB); Shiradi Ghat-Maranahalli, 22.08.1969, *C.J. Saldanha 14622* (JCB). *s.loc*., Gangegiri, 15.08.1980, *C.J. Saldanha 11951* (JCB). Shimoga district, Agumbe-after 9th hairpin turn, 17.09.2014, *A.P. Janeesha 134291* (CALI); Jog falls, 26.09.1965, *John Cheriyan 106715* (BSI); *Ibid*., 19.09.2014, *A.P. Janeesha 134296* (CALI); Hulikal ghat, 24.08.1963, *R.S. Raghavan 90185* (CAL); *Ibid*., 18.09.2014, *A.P. Janeesha 134294* (CALI); Narasimhaparvatha, 21.09.2014, *A.P. Janeesha* & *Santhosh Nampy 134297* (CALI). Udupi district, Meghan valley, 27.08.2007, *P.G. Diwakar* & *R. Kr. Singh 191876* (BSI). *s.loc.*, 09.09.2015, *K. Thoiba, V. Drishya* & *A.P. Janeesha 137634* (CALI). **Kerala**, Idukki district, Panamkutty, 07.10.1983, *A.G. Pandurangan 79276* (MH); Sabarimalai slope, 26.09.1972, *B.D. Sharma 42032* (MH); Thannikkudy, 28.8.1993, *Jomy Augustine 12373* (CALI); *Ibid*., 22.09.1996, *Jomy Augustine 16827* (CALI). Kasargod district, Konnakkad, 30.09.1982, *A. Ansari 74391* (CAL, MH). Kollam district, Near Palaruvi waterfalls, 18.08.2016, *A.P. Janeesha, S. Resmi* & *K. Shinoj 137683* (CALI). Kottayam district, Wagamon, 03.10.2015, *C. Pramod* & *A.P. Janeesha 137648*

(CALI). Kozhikode district, Kabini tributary falls, 17.08.1964, *J.L. Ellis 20452* (MH); Muthappanpuzha, 19.08.2010, *Santhosh Nampy* & *Manudev 3107* (DEV); *Ibid*., 12.08.2014, *A.P. Janeesha* & *Santhosh Nampy 134285, 134286* (CALI); Muthappanpuzha-Kundanthode, 15.06.2015, *A.P. Janeesha* & *Santhosh Nampy 137624* (CALI); Tusharagiri-1st waterfall, 10.06.2015, *S. Resmi* & *A.P. Janeesha 137622* (CALI); Way to Olichuchattam, 12.08.2014, *A.P. Janeesha, S. Resmi* & *S. Syam Radh 134281* (CALI). Malappuram district, Nilambur ghat, 11.09.2015, *S. Resmi, V. Veena* & *A.P. Janeesha 137636, 137638* (CALI). Palakkad district, Nelliampathy, 26.07.1990, *N. Sasidharan 6522* (KFRI); Silent valley, 21.08.1966, *E. Vajravelu 27558* (MH). Thrissur district, Athirappalli Upstream, 14.09.1996, *A.G. Pandurangan 30790* (TBGT); Karadippara-Peechi, 06.10.1987, *N. Sasidharan 4558* (KFRI); Sholayar, 11.08.1982, *N.G. Nair* & *N. Sasidharan 2392* (KFRI); *Ibid*., 18.08.1989, *N. Sasidharan 5610* (KFRI); Thottappuzha, 11.12.2013, *A.P. Janeesha, S. Syam Radh* & *Santhosh Nampy 134256* (CALI); Vellanippacha forest, 22.09.2015, *A.P. Janeesha* & *S. Resmi 137641* (CALI). Wayanad district, Brahmagiri, 18.08.1980, *V.S. Ramachandran 68236* (CAL, MH); Lakkidi, 18.11.1985, *M.P. Anitha 5053* (CALI); Nedumpoil, 24.12.1979, *V.S. Ramachandran 65399* (CAL, MH); Poolakkutti-Palchuram, 01.07.2014, *A.P. Janeesha* & *A.P. Janid Khan 134267* (CALI); Tirunelly, 16.10.2015, *S. Resmi* & *A.P. Janeesha 137650* (CALI). Travancore state, Kulkundal, 12.0909, *A. Meebold 13087*; *s.d.*, *C.C. Calder* & *M. Ramaswami 426* (CAL). **Tamil Nadu**, Dindigul district, Kodaikanal-Ratter waterfalls, 25.02.2014, *A. Kabeer* & *A.P. Janeesha 134259* (CALI). Madurai district, Thekkadi, 20.09.1925, *K.C. Jacob 17748* (MH); way to Kumily, 14.10.1959, *K. Subramanyam 8975* (CAL). Tinnevelly district, Courtallum, 25.10.1919, *K.C. Jacob 16238* (MH); Tinnevelly hills, 1864, *Beddome s.n.* (MH).

Notes: Bransgrove and Middleton (2015) placed *Epithema taiwanense* under the synonymy of *E. ceylanicum*. The detailed study of the protologue and type specimen revealed that *E. taiwanense* has glabrous ovary where as *E. ceylanicum* has hooked hairs on the upper part of the ovary. Since this is an important feature in species delineation, *E. taiwanense* cannot be placed under *E. ceylanicum* and is excluded from the synonymy of the latter.

Brangrove and Middleton (*l.c.*) in their revision typified majority of the names including the synonyms. *Epithema carnosum* var. *hispidum* C.B.Clarke was typified by selecting the material *Wight 2350* in K. While searching for the type specimens, three sheets were found in K (K001089589, K001089590 and K001089591), thus warranting a second step lectotypification to narrow down the choice of type. Among the three sheets, K001089590 and K001089591 have the annotation Courtallum, August 1835 while the third one (K001089589) doesn't have any annotation. So the probable lectotype should be among the first two. Both sheets have more than one specimens mounted on it. The sheet K001089590 which show clearly the nature of leaves, inflorescence *etc*., is selected here as the lectotype (second step) of *Epithema carnosum* var. *hispidum* C.B.Clarke.

***Henckelia* Spreng**.

The genus was first described as *Rottlera* by Vahl in 1804. Since this name was pre-occupied for a different genus, Sprengel (1817) renamed it as *Henckelia.* Meanwhile Wallich (1819, 1829), described another genus *Didymocarpus* and transferred all epithets under *Henckelia* to *Didymocarpus*. This treatment was followed by the subsequent taxonomists for over 200 years. Weber and Burtt (1997) resurrected *Henckelia* from the synonymy of *Didymocarpus*. Subsequently, Weber *et al.* (2011) remodelled the genus to

include the species of *Henckelia* sect. *Henckelia*, *Chirita* sect. *Chirita* (excluding the species under *Damrongia* Kerr *ex* Craib), the monotypic genus *Hemiboeopsis* W.T.Wang and excluded the species of *Henckelia* sect. *Loxocarpus*, *Didymanthus*, *Heteroboea* and *Glossadenia*. They recognized 56 species, distributed in Sri Lanka, Southern and Northeastern India, Nepal, Bhutan, Southern China, Northern Vietnam, Northern Laos, Northern Thailand. A few more species were described subsequently from different areas such as *H. pradeepiana* Nampy *et al*. (Manudev *et al*., 2012), *H. bracteata* Janeesha & Nampy (Janeesha & Nampy, 2015) from Kerala, *H. sivagiriensis* (Rajakumar, Selvak., S.Murug. & Chellap.) E.S.S.Kumar from Tamil Nadu (Kumar, 2014) and *H. wijesundarae* Ranasinghe & Mich.Moller from Sri Lanka (Ranasinghe *et al*., 2016), making the total number of species in to 60. The other major works on this genus are done by Burtt (1998a), Weber *et al.* (2000) and Middleton *et al.* (2013).

The general characters of the genus include perennial herbaceous habit, sometimes with a woody base, caulescent or rosette form (rarely creeping); leaves opposite, alternate or whorled, entire to pinnately lobed; bracts free or connate at base; calyx with free or fused lobes; corolla infundibuliform to (more rarely) tubular; filaments geniculate or straight; ovary unilocular or bilocular; stigma chiritoid to (rarely) truncate; capsules splitting into 2 valves, or only along the dorsal side (Weber *et al*., 2011).

Thirty three species and one variety are found in India of which fifteen species and one variety occur in South India. In the present investigation, one new species and one new variety are described and *H. sivagiriensis* (Rajakumar, Selvak., S.Murug. & Chellap.) E.S.S.Kumar is reduced to the synonymy.

As per the recent classification of Gesneriaceae by Weber *et al.* (2013), the genus comes under the sub-family Didymocarpoideae Arn., tribe *Trichosporeae* Nees and sub-tribe *Didymocarpinae* G.Don.

Systematic treatment

Henckelia Spreng., Anleit., ed. 2. 2(1): 402. 1817. *Henckelia* sect. *Henckelia* A.Weber & B.L.Burtt, Beitr. Biol. Pflanzen 70: 334. 1997. *Didymocarpus* sect. *Orthoboea* Benth. in Benthem & Hooker, Gen. Pl. 2(2): 1022. 1876. **Type:** *Henckelia incana* (Vahl) Spreng.

Chirita Buch.-Ham. *ex* D.Don, Edinburgh Philos. J. 7: 83. 1822. *Chirita* sect. *Euchirita* C.B.Clarke in A.DC. & C.DC., Monogr. Phan. 5(1): 111. 1883. *Didymocarpus* sect. *Euchirita* (C.B.Clarke) Chun, Sunyatsenia 6: 294. 1946. *Roettlera* sect. *Euchirita* (C.B.Clarke) Fritsch in Engler & Prantl, Nat. Pflanzenfam. IV/3b: 148. 1895. Type: *Chirita urticifolia* Buch.-Ham. *ex* D.Don (=*Henckelia urticifolia* (Buch.-Ham. *ex* D.Don.) A. Dietr.) (lectotype designated by Burtt, 1954).

Calosacme Wall., Numer. List: 800–806. 1829 *nom. nud*.

Babactes A.DC. *ex* Meisn., Pl. Vasc. Gen. 1: tab. diag. 302, Comm. 211. 1840. Type: *Babactes oblongifolia* (Roxb.) A.DC. (=*Henckelia oblongifolia* (Roxb.) D.J.Middleton & Mich.Moller).

Gonatostemon Regel, Gartenflora 15: 353. 1866. Type: *Gonatostemon boucheanum* Regel (=*Henckelia urticifolia* (Buch.-Ham. *ex* D.Don.) A.Dietr.).

Ceratoscyphus Chun, Sunyatsenia 6: 276. 1946. Type: *Ceratoscyphus caerulea* Chun (=*Henckelia ceratoscyphus* (B.L.Burtt) D.J.Middleton & Mich.Moller).

Hemiboeopsis W.T.Wang, Acta Bot. Yunnan. 6: 397. 1984. Type: *Hemiboeopsis longisepala* (H.W.Li) W.T.Wang (=*Henckelia longisepala* (H.W.Li) D.J.Middleton & Mich.Moller).

Herbs perennial or annual, sometimes woody at base, caulescent or acaulescent, rarely creeping. ***Leaves*** opposite, alternate or whorled, or reduced to just one or two leaves, petiolate; laminae variable. ***Inflorescences*** axillary (or sometimes appearing terminal by reduction of vegetative shoot), cymose; bracts paired, ovate to linear, narrowly ovate or narrowly triangular, sometimes early caducous. ***Calyx*** of 5 sepals, free or fused into a tube for part of length, lobes linear, lanceolate, ovate or triangular to narrowly triangular. ***Corolla*** companulate to infundibuliform, more rarely tubular, tube often slightly pouched, sometimes rather constricted in throat; bilabiate with 2-lobed upper lip and 3-lobed lower lip; colouration variable, often with yellow markings in throat. ***Stamens*** 2; filaments slightly bented; anthers fused face to face, glabrous or pubescent. ***Disk*** a simple annular ring or 5-lobed, often very small. ***Ovary*** shortly stipitate or not; stigma chiritoid, often weakly so and rarely almost truncate, lower lobe bifid or not. ***Capsule*** linear, rarely globose, splitting into 2 valves or opening only along the dorsal side, stipitate or sessile. ***Seeds*** minute, ellipsoid.

Distribution: Sri Lanka, Southern and Northeastern India, Nepal, Bhutan, Southern China, Northern Vietnam, Northern Laos, Northern Thailand (Weber *et al*., 2011).

There are two basic groups of *Henckelia* in India (1) plants predominantly caulescent with internodes and leaves in whorls of 2 or 3 and orthocarpic capsules dehiscing along both upper and lower suture and (2)

plants predominantly acaulescent with leaves in basal rosette and plagiocarpic capsules opening along the upper suture only.

South Indian species of *Henckelia* falls in the second group.

Henckelia pradeepiana Nampy, Manudev & A.Weber, Rheedea 22(2): 119. 2012; T.S.Nayar *et al*., Fl. Pl. Western Ghats 1: Dicots 529. 2014. **Type:** Kerala, Kozhikode district, Muthappanpuzha, 11°26.699′ N & 076°05.288 E, 470 m, 19.08.2010, *S. Nampy* & *K.M. Manudev 3102* (Holotype-CALI!).

Acaulescent, tuberous herbs. ***Tubers*** 1–2.5 cm diameter, discoid. ***Leaves*** usually 1, rarely upto 3; petioles 1.8–5.6 cm long, sparsely glandular hairy, not winged; laminae broadly ovate or elliptic, oblong-ovate, 9–16 × 5.5–9 cm, acute at apex, slightly oblique or cordate at base, glabrous above, glandular hairy below, membranaceous, margins entire to serrulate, glandular hairy on the margins, surfaces smooth; veins 7 on each side, much branched and conspicuous beneath. ***Cymes*** axillary; scapes 1–3 per plant, 1–6 times divided, 2–19 flowered, glandular hairy; peduncles 5–20 cm long, terete, green, glandular hairy; bracts two at each branching, lanceolate to triangular, 4.8–6.1 × 1.2–1.7 mm, acute at apex, margin entire, slightly hairy;

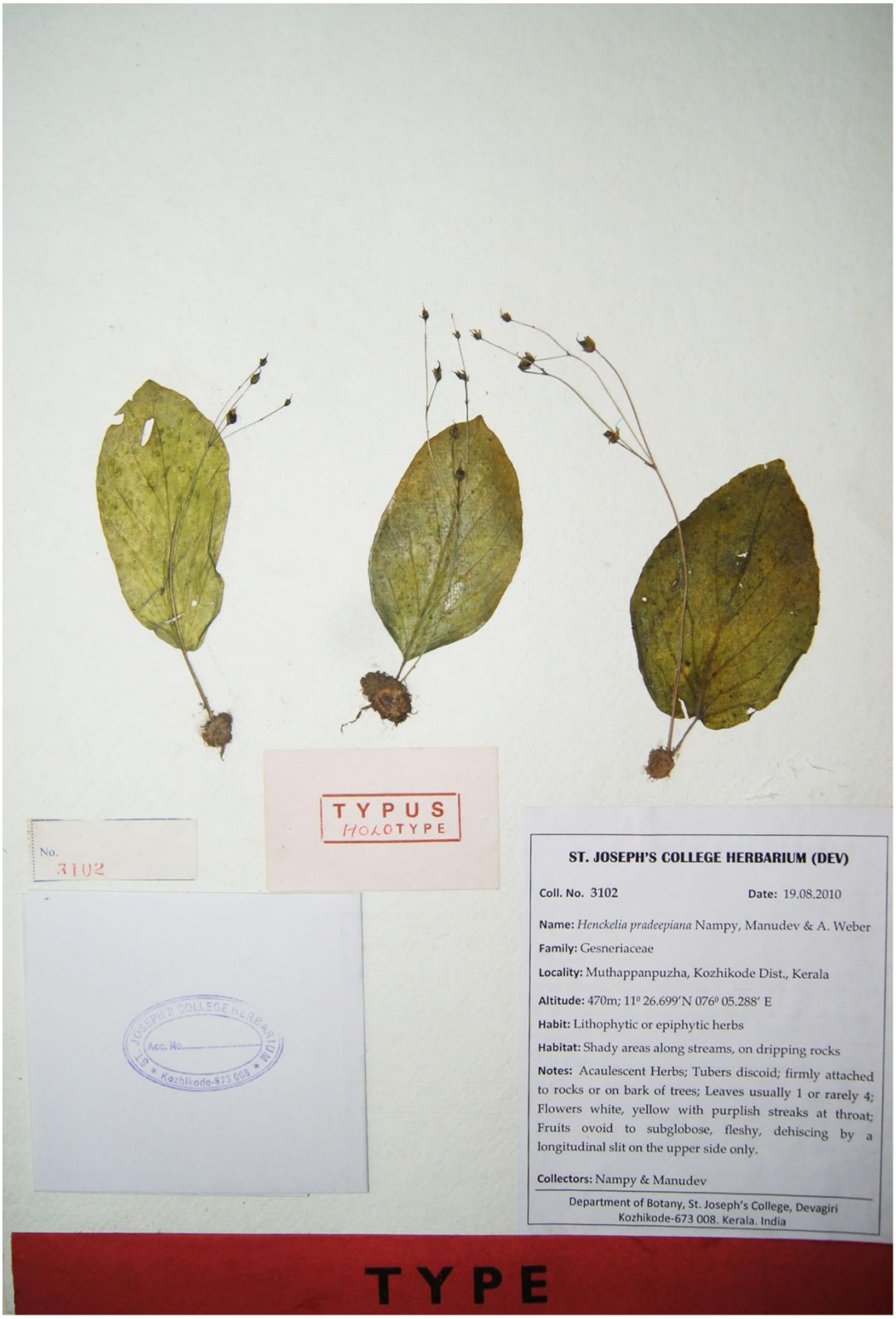


PLATE 09: Holotype of *Henckelia pradeepiana* Nampy, Manudev & A.Weber

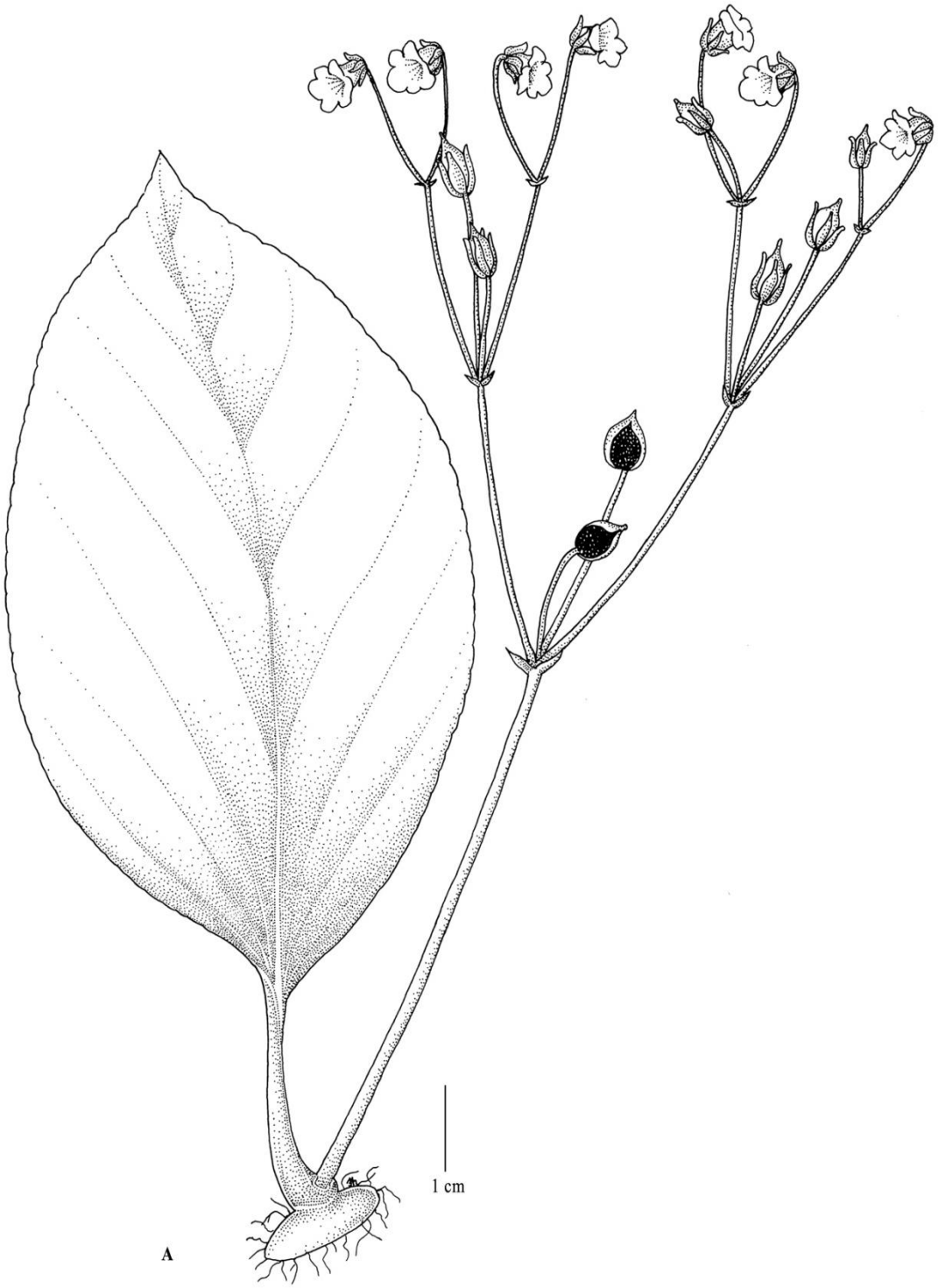


FIGURE 03: *Henckelia pradeepiana* Nampy, Manudev & A.Weber (From *A.P. Janeesha & Santhosh Nampy 134287*).

pedicels 1–3.8 mm long, terete, narrow, glandular hairy. ***Flowers*** 10 × 7 mm, zygomorphic. *Calyx* 5 partite, basally connate; lobes equal, ovate-lanceolate, 6.3–7 × 1.3–2.1 mm, keeled, green, blunt at apex, margins entire, glabrous. ***Corolla*** companulate, glabrous within and out (but with a few hairs at corolla mouth), 5-lobed; tube 4–5.4 × 5.2–5.6 mm, lilac to pale lilac with a yellow patch at the throat, with 7–10 purplish streaks; lobes unequal, 3–3.8 × 3.6–4.3 mm, ovate to rounded at apex. ***Stamens*** 2, adnate to the base of corolla, included; filaments 2.4–3.3 mm long, glabrous, greenish yellow; anthers bithecous, reniform, coherent by the adaxial surface, 1.3–1.5 × 0.53–0.73 mm, milky white, glabrous. ***Staminodes*** 2; filaments 1–1.2 mm long, hyaline, glabrous; antherodes ovate to oblate, 0.31 × 0.3 mm. ***Ovary*** ovoid, 2–2.4 × 1.35–1.75 mm, green, glabrous, unilocular, placentation parietal; style terete, 4–5.22 mm long, green, glabrous; stigma 1.7–2.1 × 0.5–0.87 mm, papillate. ***Capsules*** ovoid to subglobose, 5.6–6.3 × 5–6 mm, greenish brown, with persistent calyx and a prominent beak. ***Seeds*** numerous, elliptic, 0.4–0.52 × 0.15–0.2 mm, acute at both ends; testa dark brown, pitted.

Chromosome number: Not reported.

Flowering & fruiting: July-September.

Habitat & ecology: In moist rocks and mountain slopes. Grow in association with some moss species and ferns.

Distribution: Endemic to southern Western Ghats (Kerala).

Specimens examined: Kerala, Kozhikode district, Muthappanpuzha, 11°26.699' N & 076°05.288' E, 470 m, 18.07.2010, *K.M. Manudev 3022* (DEV); *Ibid*., 19.08.2010, *A.K. Pradeep 90089* (CALI); *Ibid*., 19.08.2010, *K.M. Manudev* & *Santhosh Nampy 3105* (DEV); *Ibid*., 17.09.2011, *Santhosh Nampy* & *K.M. Manudev 4547* (DEV); *Ibid*., 12.08.2014, *A.P. Janeesha* & *Santhosh Nampy 134287, 134288* (CALI); *Ibid*., 15.06.2015, *A.P. Janeesha* & *S. Resmi 137624* (CALI); Muthappanpuzha-Kundanthode, 15.06.2015, *A.P. Janeesha* & *S. Resmi 137623* (CALI); way to Vellarimala-Olichuchattam, 11°25.784 N & 076°05.173' E, 1160 m, 19.09.1997, *A.K. Pradeep 56009* (CALI).

Notes: Discoid, perennating tubers are found only in this species among *Henckelia*. The leaves are usually one (sometimes upt to 3) and capsules are globose in contrast to the linear to cylindrical ones in other South Indian Henckelias. But they are plagiocarpic and dehisce along the ventral suture in both cases.

Henckelia* sect. *Henckelia

Weber and Burtt (1997) recognized five sections in *Henckelia*, *viz*., sect. *Henckelia*, *Loxocarpus*, *Didymanthus*, *Heteroboea* and *Glossadenia*. Weber *et al*. (2011), while remodelling the genus *Chirita* and associated genera, concluded that there is no sharp boundary between *Henckelia* sect. *Henckelia* and the genus *Chirita* and considered *Henckelia* as an "amalgamation of the type sections of *Henckelia* and *Chirita* (excluding the species placed in *Damrongia*), but excludes all other infrageneric taxa referred to *Henckelia* by Weber & Burtt (1997, *ie*, sect. *Loxocarpus*, *Didymanthus*, *Heteroboea* and *Glossadenia*". The type section is characterized by plants predominantly acaulescent with leaves in basal rosette and plagiocarpic capsules dehiscing along the ventral suture. This section is distributed only in South India and

Sri Lanka. Altogether sixteen species are there in this section including the new species described in this work, of which fourteen occur in South India.

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

1a. Leaves with simple petiole **3**

1b. Leaves with winged petiole **5**

2a. Inflorescence scaly hairy; filaments glabrous..... **H. missionis**

2b. Inflorescence not as above; filaments bearded..... **4**

3a. Creeping herbs; laminae broadly ovate to sub-orbicular; filaments hairy at middle .....**H. repens**

3b. Rosette herbs; laminae ovate; filaments hairy towards apex……..... ....**H. ovalifolia**

4a. Laminae spathulate-obovate; without petiole……..... **6**

4b. Laminae not as above, but of variable shapes; with definite petiole…… ..... …….**7**

5a. Peduncles 30–54 cm long, covered with golden brown hairs…… …… ..... **H. macrostachya**

5b. Peduncles 10–18 cm long, covered with glandular hairs .....**H. wightii**

6a. Leaf margin doubly crenate to serrate, first crenation or serration deep and irregular ..... ……**8**

6b. Leaf margin crenate, not deep and irregular…… **11**

7a. Petioles lacerate; leaf base lyrate; bracts linear, pilose hairy ..... .**H. lyrata**

7b. Petioles not lacerate; leaf base attenuate; bracts not as above…..... .**9**

8a. Leaves in whorls of three; calyx lobes hispid hairy on both side ....**H. innominata**

8b. Leaves in whorls of four; calyx lobes tomentose out, glabrous in **10**

9a. Laminae ovate-widely ovate; bracts lanceolate; ovary white hairy .... **H. fischeri**

9b. Laminae narrowly elliptic to widely elliptic; bracts ovate; ovary purple hairy…..... **H. x**

10a. Leaves in whorls of three..... **12**

10b. Leaves opposite-deccusate **13**

11a.Capsules 13–15 mm long, tomentose hairy; calyx deciduous…..... ... .**H. gambleana**

11b. Capsules 21–28 mm long, hispid hairy; calyx persistent .....**H. incana**

12a. Bracts 10–12 mm long, elliptic; anthers bearded..... .**H. bracteata**

12b. Bracts 3–5 mm long, linear; anthers glabrous..... **14**

13a. Calyx lobes linear; corolla villous without; ovary 8–9 mm long ....**H. humboldtiana**

13b. Calyx lobes lanceolate; corolla glandular hairy without; ovary 4–6.5 mm long ..... **H. meeboldii**

1. Henckelia bracteata Janeesha & Nampy**,** Willdenowia 45(1): 53. 2014. **Type**: Kerala, Kottayam district, Kurisumala, near to 10th Cross, 1100 m, 07.08.2014, *A.P. Janeesha* & *Santhosh Nampy 134270* (Holotype-CALI!).

Plates 10, 11; Fig. 04

Perennial scapigerous, stem-less hairy herbs with rootstocks. ***Roots*** adventitious, thin. ***Leaves*** 8–14, basal, opposite deccusate; petioles 2–9 cm long, pubescent, winged; wings 2–3 mm broad; laminae elliptic-ovate, 5.5–12.5 × 3–9 cm, acute or obtuse to rounded at apex, narrowly cuneate to attenuate at base, tomentulose on both surfaces, but more on the younger leaves and on lower veins, becoming less so with age, margins shallowly crenate, surfaces usually rugose; veins 5 on each side, much branched and conspicuous beneath. ***Cymes*** axillary, dense; scapes 1–11 per plant, 3–5 (–6) times divided, 14–38 flowered, pubescent; peduncles 14–32 cm long, terete, reddish brown, pubescent; bracts two at each branching, elliptic to obovate, 10–21 × 5–8 mm, obtuse to rounded at apex, margin crenate, tomentose; pedicels 2–10 mm long, terete, narrow, pubescent. ***Flowers*** 10–20 × 4–9 mm, zygomorphic. ***Calyx*** 5 or 6 partite, very deeply divided or basally connate; lobes unequal, ovate, 3–4 × 1–2 mm, reddish brown, slightly acute at apex, margins entire, white tomentose hairy. ***Corolla*** companulate, villous without, glabrous within, 5-lobed; tube 7–9 × 5.5–7.5 mm, lilac to pale lilac with a yellow patch at the throat; lobes unequal, 5.2–7 × 7.4–8.3 mm, ovate to rounded at apex. ***Stamens*** 2, adnate to the base of corolla, included; filaments 4–6 mm long, glabrous or sparsely pubescent towards the region of the connective, green on the top and colourless towards base; anthers bithecous, reniform, coherent by the adaxial surface, 1.5–1.8 × 0.8–0.9 mm, milky white, bearded at the junction of the anther lobe and filament. ***Staminodes*** 3 (sometimes 2); filaments 2.5–3 mm long, hyaline, glabrous;

PLATE 10: *Henckelia bracteata* Janeesha & Nampy **A.** Habit; **B.** Inflorescence; **C.** Single flower; **D.** Calyx; **E.** Calyx with gynoecium; **F.** Bract; **G.** Stamens; **H.** Gynoecium; **I.** Staminode; **J.** Fruit; **K.** Seeds (**A-K** from *A.P. Janeesha* & *Santhosh Nampy 137209*).

PLATE 11: Holotype of *Henckelia bracteata* Janeesha & Nampy

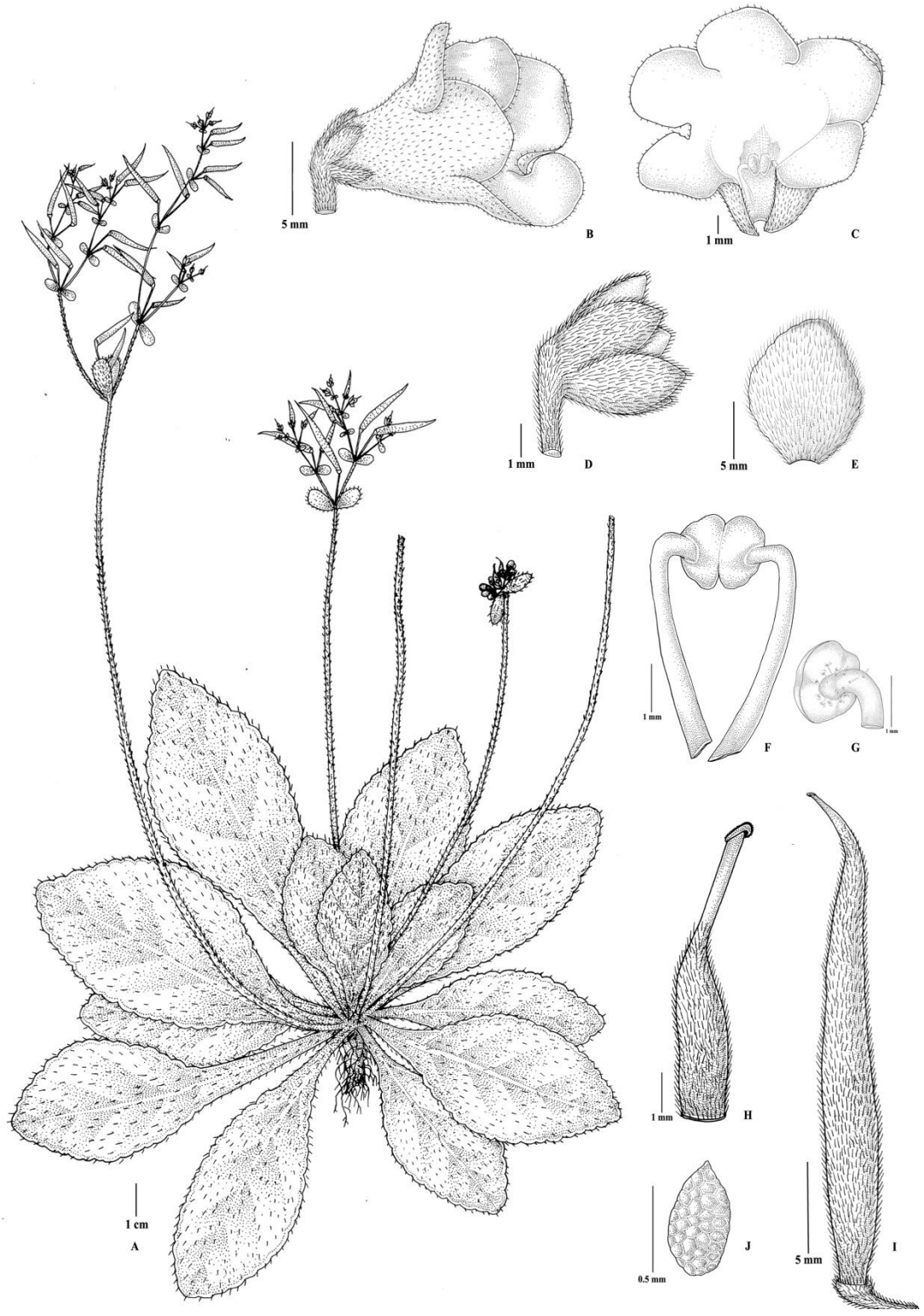


FIGURE 04: *Henckelia bracteata* Janeesha & Nampy **A.** Habit; **B.** Single flower; **C.** Corolla split opened; **D.** Calyx; **E.** Bract; **F.** Stamens; **G.** Anther lobe showing hairs; **H.** Gynoeciuum; **I.** Fruit; **J.** Seed (**A-K** from *A.P. Janeesha* & *Santhosh Nampy 137209*).

antherodes not seen. ***Ovary*** ovoid to oblong, 5–7 × 1.25–1.5 mm, green, pubescent, unilocular, placentation parietal; style terete, 2–2.5 mm long, green, glabrous; stigma 0.8–1.1 × 0.5–0.82 mm, papillate. ***Capsules*** cylindrical, straight or slightly curved, 18–30 × 1.6–2 mm, reddish brown, tomentulose with rudimentary stigma. ***Seeds*** numerous, elliptic, 0.4–0.6 × 0.2–0.25 mm, slightly acute at apex, truncate at base; testa dark brown to black, pitted.

Chromosome number: Not reported.

Flowering & fruiting: July-October.

Habitat & ecology: This species grows on wet humus on granite rocks crevices at altitudes of about 1,100 m above sea level. It is found in association with *Mitracarpus* species (Rubiaceae), *Porella* and several moss species (Bryophytes), *Selaginella* species (Pteridophytes) and grass species.

Distribution: Hitherto known only from type locality. Endemic to southern Western Ghats.

Specimens examined: Kerala, Kottayam district, Kurisumala, 17.08.2013, *K.M. Manudev* & *A.P. Janeesha 134206, 134209* (CALI); near to 6th cross, 07.08.2014, *A.P. Janeesha* & *A.P. Roshan 134269* (CALI); near 7th cross, 26.06.2016, *P.S. Sreeja* & *A.P. Janeesha 137659* (CALI); near 10th cross, 26.06.2016, *P.S. Sreeja* & *A.P. Janeesha 137660* (CALI); On the way to Elaveezhapoonchira, 28.06.2016, *A.P. Janeesha* & *Santhosh Nampy 137665*

(CALI); Way to 6th cross, 07.08.2014, *A.P. Janeesha* & *A.P. Roshan 134268* (CALI).

Notes: This recently described species is close to *H. humboldtiana* in the shape of leaves, presence of bracts and scapes which are much longer than the leaves. However, it is distinguished by having thick lamina with narrowly cuneate to attenuate base, much large, elliptic to obovate bracts, ovate calyx lobes not reaching the full length of the ovary and hairs at the junction of anther lobes and filaments. The plant is robust and dull green throughout while the peduncle, pedicel, calyx and capsules are generally reddish brown. Though the margins of the lamina are crenate, the crenation is shallow when compared to the allied *H. humboldtiana*. The colour of corolla changes from pale lilac to dark lilac or violet when in cultivation at low altitudes.

2. Henckelia fischeri (Gamble) A.Weber & B.L.Burtt, Beitr. Biol. Pflanzen 70: 344. 1997; T.S.Nayar *et al*., Fl. Pl. Western Ghats 1: Dicots 527. 2014. *Didymocarpus fischeri* Gamble, Kew Bull. 117. 1923; Gamble, Fl. Madras 2: 988. 1924; A.N.Henry *et al*., Fl. Tamil Nadu Ind., Ser I: Analysis 2: 132. 1987; M.Ahmedullah & M.P.Nayar, Endemic Plants of Indian region 1: 142. 1987; M.Mohanan & A.N.Henry, Fl. Thiruvananthapuram 337. 1994; Sasidh., & Sivar., Fl. Pl. Thrissur Forest 329. 1996; Sasidh., Biodivers. Doc. Kerala part 6: 331. 2004; T.S.Nayar *et al*., Fl. Pl. Kerala 342. 2006. **Type**: Anamalai Hills, Coimbatore district, 500–600 m alt., August 1915, *C.E.C. Fischer s.n*. (Holotype-K000450837!).

Perennial scapigerous, stem-less hairy herbs with rootstocks. ***Roots*** adventitious, thin. ***Leaves*** 12–20, basal, whorl of four; petioles 0.7–5 cm long (sometimes up to 7.5 cm), pubescent, winged; wings 4–12 mm broad;

laminae ovate-widely ovate, 8–23 × 6–12 cm, obtuse to slightly acute at apex, attenuate at base, tomentose on both surfaces, white small patches on the upper surface, golden brown on the younger leaves and on lower veins, becoming less so with age, margins doubly crenate, lobes irregular, surfaces usually rugose; veins 6–8 on each side, much branched and conspicuous beneath. ***Cymes*** axillary; scapes 3–7 per plant, 4–7 times divided, 16–37 flowered; peduncles 17–38 cm long, terete, green-pale reddish brown, glandular hairy; bracts two at each branching, lanceolate, 2–4 × 1 mm, acute at apex, margin entire, tomentose, with a tuft of hairs at the apex, green to purple; pedicels 6–24 mm long, terete, narrow, glandular hairy. ***Flowers*** 11–17 × 9–22 mm, large, zygomorphic, held horizontal to the earth surface. ***Calyx*** 5 partite, very deeply divided or basally connate; lobes unequal, linear to broadly lanceolate-ovate, 2.5–6 × 0.8–1.9 mm, reddish brown, slightly acute or obtuse to rounded at apex, margins entire, hairy. ***Corolla*** companulate, glandular hairy without, glabrous within, 5-lobed; tube 6.8–12 × 5.7–7.9 mm, dark to pale lilac with a yellow blotch at the throat, swollen towards the mouth; lobes almost equal, very widely ovate with undulate margin, 6.6–7.8 × 8.6–10.12 mm, rounded at apex. ***Stamens*** 2, adnate to the base of corolla, included; filaments 4–5.3 mm long, glabrous, yellow; anthers bithecous, reniform, coherent by the adaxial surface, 1.5–2.75 × 0.75–1.16 mm, milky white to cream. ***Staminodes*** 2, sometimes 3; filaments 2.4–4 mm long, hyaline, glabrous; antherodes sometimes present. ***Ovary*** ovoid to oblong, 3.7–6 × 1–1.27 mm, green, glandular hairy, unilocular, placentation parietal; style terete, 1–4.5 mm long, green, glabrous towards the apex, basally glandular hairy; stigma 0.65–0.87 × 0.9–1.1 mm, slightly papillate, broad. ***Capsules*** cylindrical, straight or slightly curved, 14–37 × 1.8–2.4 mm, reddish brown, glandular hairy with rudimentary stigma and persistent

calyx. ***Seeds*** numerous, elliptic, 0.57–0.69 × 0.22–0.29 mm, slightly acute at apex, truncate at base; testa dark brown, pitted.

Henckelia fischeri (Gamble) A.Weber & B.L.Burtt var. **fischeri**

Plates 12, 13; Fig. 05

Leaves in whorls of four; petioles winged; wings 4–12 mm broad; laminae ovate-widely ovate, margins doubly crenate, lobes irregular, first crenation very deep. ***Calyx*** lobes unequal, broadly lanceolate to ovate, slightly acute at apex, margins entire, glandular hairy basally, tomentose towards the apex. ***Staminodes*** 2, sometimes 3; antherodes 0.4–0.58 × 0.5–0.65 mm.

Chromosome number: Not reported.

Flowering & fruiting: May-December.

Habitat & ecology: In moist slopes and in rock crevices, usually at an altitude above 850 m. Grow in association with some pteridophytes like *Adiantum lunulatum* Burm., *A. concinnum* Willd. (Adiantaceae),

PLATE 13: Holotype of *Henckelia fischeri* (Gamble) A.Weber & B.L.Burtt var. *fischeri*

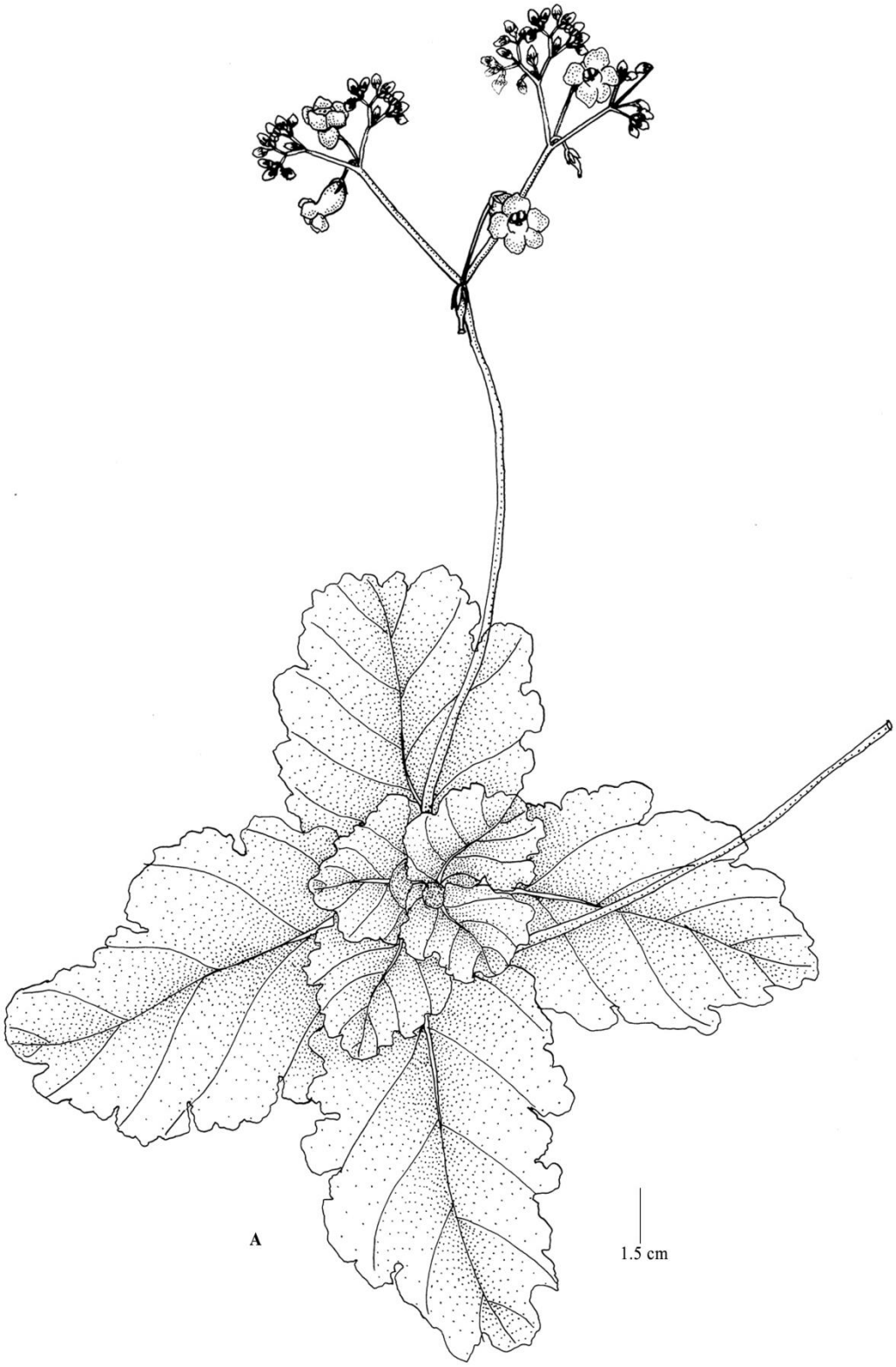


FIGURE 05: *Henckelia fischeri* (Gamble) A.Weber & B.L.Burtt var. *fischeri* (From *A.P. Janeesha & Santhosh Nampy 137222*).

Hemionitis arifolia (Burm.) T.Moore (Hemionitidaceae), *Spermacoce exilis* (L.O.Williams) C.D.Adams *ex* W.C.Burger & C.M.Taylor, *Mitracarpus hirsutus* (L.) A.DC., *Oldenlandia* sp. (Rubiaceae), *Leucas aspera* (Willd.) Link (Lamiaceae) and some species of grass.

Distribution: Endemic to southern Western Ghats (Kerala and Tamil Nadu).

Specimens examined: **Kerala,** Idukki district, Kottamala, 16.05.1995, *Jomy Augustine 15309* (CALI); near Idukki dam, 24.08.1981, *V.S. Raju 71173* (MH); Shanthanpara, 2016, *P. Soumya* & *A.P. Janeesha 137678* (CALI). Palakkad district, Karimala-grass land, 26.09.2013, *A.P. Janeesha* & *Santhosh Nampy 134227* (CALI); Nelliampathy, 29.06.1994, *A.E. Shanavas Khan* & *E.S. Santhosh Kumar 20100* (TBGT); *Ibid., s.d., V.P.K. Nambiar 1067* (KFRI); Parambikulam-way to Thunakadavu dam view point, 24.09.2013, *A.P. Janeesha* & *Santhosh Nampy 134222* (CALI); Seetharkund-near the water fall, 17.09.2013, *A.P. Janeesha, Habeeb Rahman* & *A. Kabeer 134216* (CALI); Vengoli hills-on the way, 25.09.2013, *A.P. Janeesha, K. Smitha* & *K. Thoiba 134223B* (CALI); Vengoli hill top, 25.09.2013, *A.P. Janeesha* & *Santhosh Nampy 134224* (CALI). Pathanamthitta district, Achan Kovil, *s.d.*, *A.G. Pandurangan 14432* (TBGT). **Tamil Nadu**, Coimbatore district, Anamalai, 1857, *s.coll. s.n*. (MH). Madurai district, Meghamalai, 25.08.1985, *K. Ravikumar 2380* (MH). Nilgiri district, Kodanad, 12.11.1970, *E. Vajravelu 36854* (MH). Tirunelveli district, Courtallum, *s.d.*, *K. Narayana Iyer 01874* (TBGT); Kularatti estate, 21.12.1980, *E. Vajravelu 76416* (MH).

Notes: This is fairly a large plant with deeply crenated leaves and many flowered, longer scapes. The flowers are deeply pouched and horizontally oriented. Their scapes are pale claret-greenish red in natural conditions, but when grown in green house become handsome green.

Notes: This taxon was originally collected from Vengoli hills in Parambikulam and subsequently planted in the University green house. They retained their characters in cultivation many years. It can be differentiated from the type variety by its less crenated leaves with 3–5 mm wide wings (v/s deeply crenated leaves with 7–9 mm wide wings), linear calyx lobes with glandular hairs (v/s lanceolate calyx lobes with glandular hairs at the base and tuft of hairs at the apex) and without a prominent antherodes (v/s prominent antherodes).

3. Henckelia gambleana (C.E.C.Fisch.) A.Weber & B.L.Burtt**,** Beitr. Biol. Pflanzen 70: 345. 1997; T.S.Nayar *et al*., Fl. Pl. Western Ghats 1: Dicots 528. 2014. *Didymocarpus gambleanus* C.E.C.Fisch., (as *gambleana*) Bull. Misc. Inform. Kew 1938: 36. 1938; A.N.Henry *et al*., Fl. Tamil Nadu, Ser I: Analysis 2: 132. 1987; M.Ahmedullah & M.P.Nayar, Endemic Plants of Indian region 1: 143. 1987. *Didymocarpus rottlerianus* var. *lanuginosus* C.B.Clarke in A.DC. & C.DC., Monogr. Phan. 5 (1): 102. 1883. *Didymocarpus tomentosus* var. *lanuginosus* (C.B.Clarke) C.B.Clarke in Hook.f., Fl. Brit. India 4: 353. 1884. *Didymocarpus lanuginosus* Wight *ex* Gamble, Fl. Madras 988. 1924. non *Didymocarpus lanuginosus* Wall. *ex* R.Br., non *Didymocarpus lanuginosus* Wall. *ex* A.DC., non *Didymocarpus lanuginosus* Wall. *sensu* Maxim. *Didymocarpus lanuginosus* Wight *ex* C.B.Clarke in A.DC., ("*lanuginosa*") *nom. nud. pro syn*. **Type:** *s.loc*., *s.d*., *Wight 561* (K000858182, lectotype designated here).

Plates 15, 16; Fig. 06

Perennial scapigerous, stem-less hairy herbs with rootstocks. ***Roots*** adventitious, thin. ***Leaves*** 6–12, basal, in whorl of three; petioles 0.7–1.8 cm long, pubescent, winged, younger leaves subsessile; wings 5–8 mm broad; laminae widely ovate, 4–7.7 × 3.2–6 cm, acute to obtuse at apex, narrowly

PLATE 16: Lectotype of *Henckelia gambleana* (C.E.C.Fisch.) A.Weber & B.L.Burtt

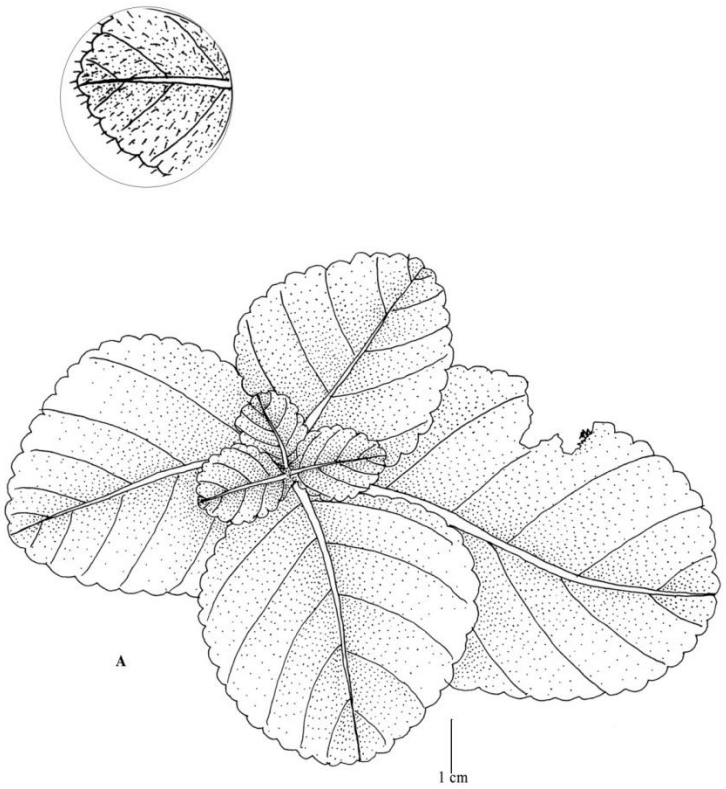


FIGURE 06: *Henckelia gambleana* (C.E.C.Fisch.) A.Weber & B.L.Burtt (From *A.P. Janeesha* & *Santhosh Nampy 137677*).

cuneate to attenuate at base, hispid hairy on the upper surface, golden brown hairy on lower surface, but more on younger leaves and lower veins, becoming less with age, margins regularly crenate, surfaces usually rugose; veins 4 on each side, much branched and conspicuous beneath. ***Cymes*** axillary, dense; scapes 2–4 per plant (rarely up to 11), 3–5 times divided, 12–36 flowered, golden brown hairy; peduncles 8–19 cm long, terete, green to reddish brown, golden brown hairy; bracts two at each branching, lanceolate to triangular, 3–3.5 × 0.36–0.4 mm, obtuse to slightly acute at apex, margin entire, white tomentose; pedicels 4–14 mm long, terete, narrow, pubescent. ***Flowers*** 8–11 × 5–6.5 mm, zygomorphic. ***Calyx*** 5 partite, very deeply divided or basally connate; lobes unequal, lanceolate to narrowly oblong, 2.7–3.2 × 0.42–0.68 mm, reddish brown, obtuse at apex, margins entire, white hairy. ***Corolla*** companulate, villous without, glabrous within, 5-lobed; tube 7–8 ×

5.8–6.4 mm, lilac to pale lilac with a yellow patch at the throat; lobes widely ovate, 3.8–5.1 × 3.7–5 mm, rounded to truncate at apex. ***Stamens*** 2, adnate to the base of corolla, included; filaments 2.2–2.7 mm long, glabrous, green on the top and colourless towards base; anthers bithecous, reniform, coherent by the adaxial surface, 1.3–1.5 × 0.6–0.7 mm, milky white, glabrous. ***Staminodes*** 2; filaments 1.6–1.8 mm long, hyaline, glabrous; antherodes not seen. ***Ovary*** narrowly ovoid to oblong, 4–4.7 × 0.9–1 mm, green, pubescent, unilocular, placentation parietal; style terete, 2.6–2.9 mm long, green, glabrous; stigma 0.21 × 0.5 mm, papillate. ***Capsules*** cylindrical, straight, 13–15 mm long, reddish brown, tomentulose with rudimentary stigma. ***Seeds*** numerous, elliptic, pitted.

Chromosome number: Not reported.

Flowering & fruiting: July-November (sometimes up to March).

Habitat & ecology: In moist hill slopes. Grow in association with *Adiantum raddianum* Presl. (Adiantaceae) and some moss (Bryophyte) species.

Distribution: Endemic to southern Western Ghats (Tamil Nadu).

Specimens examined: Tamil Nadu, Coimbatore district, Bolampattivalley, 24.02.1917, *C.E.C. Fischer 4059* (FRC). Kanyakumari district, Muthukuzhivayal grass land, 15.03.1979, *A.N. Henry 60703* (MH). Tirunelveli district, Agasthyamalai peak, 01.07.1964, *A.N. Henry* & *M. Chandrabose 19215* (MH); *Ibid.,* 24.08.1963, *A.N. Henry 17317* (MH); Courtallum-Thekkumalai, 11.11.1984, *Jolly Jacob 4072* (CALI); *Ibid*., 11.11.1984, *A.R. Sheela 3677* (CALI); *Ibid*., 11.11.1984, *K. Leela 4344* (CALI); *Ibid.,* 11.11.1984, *A.M. Rema 4878*

(CALI); Kannikathi, 13.06.1899, *C.A. Barber 506* (MH); Neelikkattu, 11.10.1992, *R. Gopalan 99487* (MH); on way to Kakkachi-near Manjolai estate board, 21.07.2016, *A.P. Janeesha* & *Santhosh Nampy 137677* (CALI); Sevgaltai, 24.09.1915, *s.coll. 12477* (MH); Upper Kodayar, 02.09.1981, *K.M. Matthew 17831* (RHT); way to Kannikkatti, 05.07.1964, *A.N. Henry* & *M. Chandrabose 19292* (MH). *s.loc., s.d., T. Surendran 5105* (CALI).

4. Henckelia humboldtiana (Gardner) A.Weber & B.L.Burtt, Beitr. Biol. Pflanzen 70: 346. 1997; T.S.Nayar *et al*., Fl. Pl. Western Ghats 1: Dicots 528. 2014. *Didymocarpus humboldtianus* Gardner, Calcutta J. Nat. Hist. 6: 477. 1846; Gamble, Fl. Madras 988. 1924; W.L.Theob. & Grupe in Dassan. & Fosberg, Rev. Handb. Fl. Ceylon 3: 84. 1981; A.N.Henry *et al*., Fl. Tamil Nadu Ind., Ser I: Analysis 2: 132. 1987; Manil., Fl. Silent Valley 200. 1988; Sasidh., Biodivers. Doc. Kerala Part 6: Fl. Pl. 332. 2004; N.Anilkumar *et al*., Fl. Pathanamthitta Dist. 370. 2005; T.S. Nayar *et al*., Fl. Pl. Kerala 342. 2006. *Roettlera humboldtiana* (Gardner) Kuntze, Revis. Gen. Pl. 2: 476. 1891. **Type**: Sri Lanka (Ceylon), Rambodde, *Gardner 600* (K000858189, lectotype designated by Janeesha & Nampy, 2015). **Plates 17, 18; Fig. 07**

PLATE 18: Lectotype of *Henckelia humboldtiana* (Gardner) A.Weber & B.L.Burtt

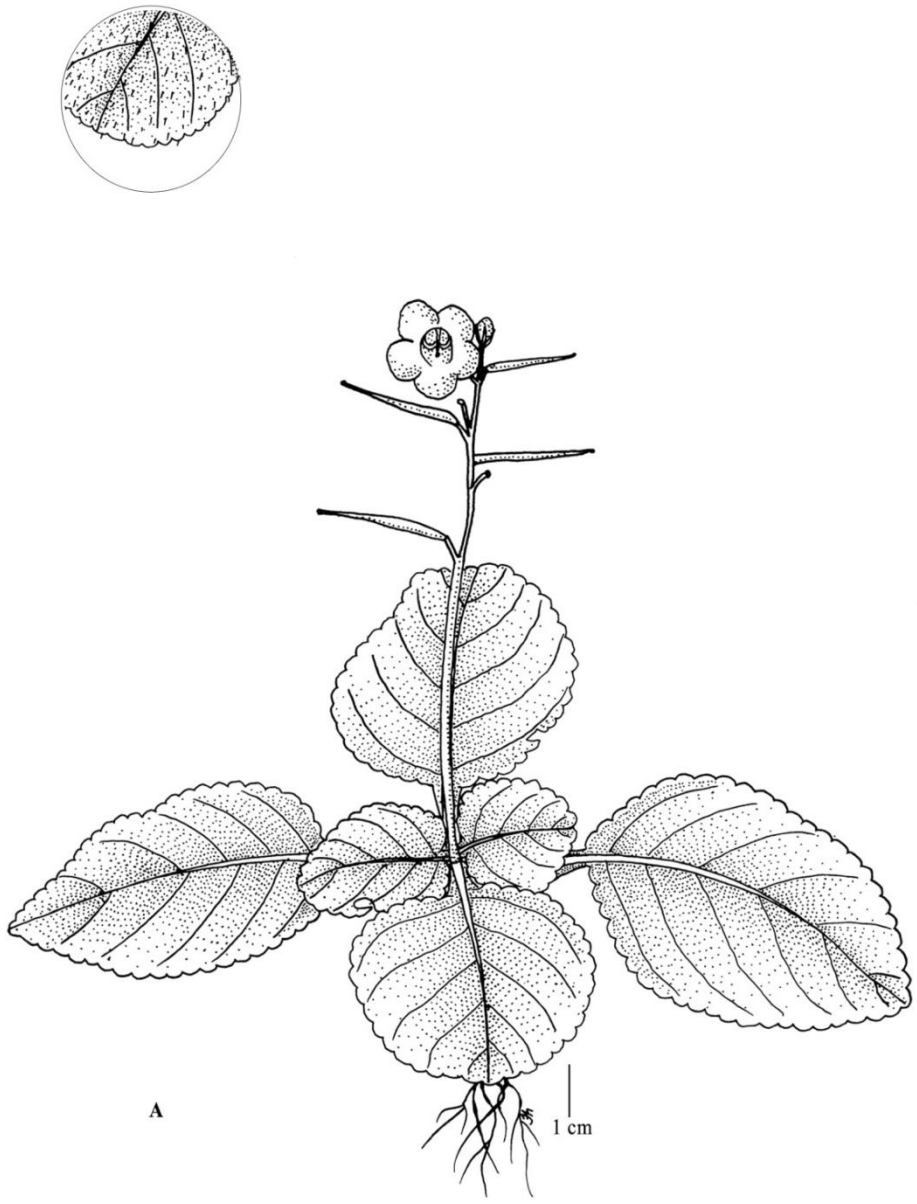


FIGURE 07: *Henckelia humboldtiana* (Gardner) A.Weber & B.L.Burtt (From *A.P. Janeesha, S. Resmi & K. Haseem 137687*)

Didymocarpus primulifolius Gardner, Calcutta J. Nat. Hist. 6: 478. 1846. Type: Hantane range, Near Candy, Ceylon, *s.d.*, *Gardner 601* (K000858191, lectotype designated here).

Perennial scapigerous, stem-less hairy herbs with rootstocks. ***Roots*** adventitious, thin. ***Leaves*** 4–12, basal, opposite deccusate, rarely whorl of three; petioles 2-6 cm, pubescent, older leaves have longer petiole, minutely winged; wings 0.5–2 mm broad; lamina elliptic-ovate, 5–8 × 2.1–5.9 cm, slightly acute at apex, attenuate at base, tomentulose on both surfaces, but more on the younger leaves and on lower veins, becoming less so with age, margins crenate, slightly undulate, surfaces rugose; veins 5–6 pairs on each side, much branched and conspicuous beneath. ***Cymes*** axillary, lax; scapes 1–4 per plant, 2–3 times divided, 6–10 flowered, pubescent; peduncles 8–12 cm long, terete, pale green, pubescent; bracts two at each branching, linear to oblong, 4.2–5.1 mm long, obtuse at apex, tomentose; pedicels 5–10 mm long, terete, narrow, pubescent. ***Flowers*** 10–12 × 6–7.5 mm, zygomorphic. ***Calyx*** 5 partite, free or very deeply divided; lobes unequal, linear, 4.8–6 × 0.6–0.9 mm, pale green with a pich of reddish brown at the base, slightly acute at apex, margins entire, tomentose hairy. ***Corolla*** companulate, ventricose, villous without, glabrous within, 5-lobed; tube 5–9 × 4.2–5.5 mm, pale lilac to white with a yellow patch at the throat; lobes unequal, rounded, 3.2–4.1 × 3.4–5 mm, rounded at apex. ***Stamens*** 2, adnate to the base of the corolla, included; filaments 5 mm long, slightly bearded, pale green at the top, base hyaline; anthers bithecous, reniform, coherent by the adaxial surface, 1.3 × 0.8 mm, milky white, glabrous. ***Staminodes*** 2. ***Ovary*** ovoid to oblong, 8–9 × 1–1.1 mm, green, pubescent, unilocular, placentation parietal; style terete, 3.5–4 mm long, green, base slightly hairy; stigma 0.65–0.8 × 0.34–0.42 mm, papillate. ***Capsules*** linear, straight or slightly curved, 12–21 × 1.1–1.6 mm, pale green, tomentulose with rudimentary stigma. ***Seeds*** numerous, elliptic, 0.32–0.5 × 0.1–0.19 mm, slightly acute at apex, truncate at base; testa dark brown to black, pitted.

Chromosome number: Not reported.

Flowering & fruiting: May-November.

Habitat & ecology: In moist slopes or on rocks, in medium to high elevations. It grows in association with *Selaginella* sp. (Selaginellaceae), *Pteris* sp. (Pteridaceae), *Impatiens gardneriana* Wight, *I. acaulis* Arn. (Balsaminaceae) and some grass species.

Distribution: In South India (Kerala and Tamil Nadu) and Sri Lanka.

Uses: This species has antioxidant activity and can prevent oxidative stress and other diseases (Kindo *et al.*, 2014). Sumanasiri *et al.* (2013) studied the effect of gibberelic acid (GA_3) on growth and flowering and concluded that GA_3 improve the flowering behaviour.

Specimens examined: Kerala, Ernakulam district, Neriyamangalam, 20.08.1965, *K.M. Sebastine 25087* (MH). Idukki district, Munnar, 08.11.1985, *P.C. Binoy 05047* (TBGT). Kollam district, Thenmala, 01.10.1960, *K.J. Joseph Joseph 2, Joseph 3* (BSI). Kottayam district, Pambanar, 24.05.1964, *K. Vivekananthan 23998* (MH); Pulluparai, 24.09.1964, *K. Vivekananthan 21314* (MH); Wagamon, 03.10.2015, *C. Pramod* & *A.P. Janeesha 137644, 137647* (CALI). Kozhikode district, Kakkayam, 20.07.2013, *A.P. Janeesha* & *A.J. Robi 134201* (CALI); *Ibid*., 26.05.2015, *S. Resmi* & *A.P. Janeesha 137618* (CALI); *Ibid*., 26.05.2015, *A.P. Janeesha, P.K. Dilna* & *Santhosh Nampy 137620* (CALI); Kakkayam-Ghat road side, 03.10.2016, *A.P. Janeesha* & *K. Haseem 137687*

(CALI); way to Kakkayam forest office, after 12th turning, 19.09.2013, *A.P. Janeesah*, *Habeeb Rahman* & *S. Syam Radh 134221* (CALI). Palakkad district, Koomankundu, 18.09.1982, *K. Prasannan 10991* (CALI); Pulippara, 18.09.1982, *T. Sabu 10999* (CALI). Wayanad district, Boys town-Kannur Mananthavadi route, *Shimi Cheriyan, P.K. Dilna* & *A.P. Janeesha 137687* (CALI). Travancore, *s.d.*, *C.C. Calder* & *M.S. Ramaswami 1312* (CAL). **Tamil Nadu,** Coimbatore district, Aliyar Dam, 24.08.1963, *K.N. Subramanian 782* (FRC); Anamalai, 04.11.1897, *s.col. s.n.* (MH); Bolamapatty hills, *s.d., s.coll. 14019* (MH). Dindigul district, Kodaikanal hills, 14.10.1919, *K.C. Jacob 16114* (MH); Kodaikanal-Pulney, 20.10.1898, *A.G. Bourne 193* (CAL); Perumal malai, 24.10.1977, *M. Chandrabose 51666* (CAL, MH); Poombarai, 18.10.1977, *M. Chandrabose 51365* (CAL, MH); way to Pannaikadu, 15.1968, *s.colll. 30849* (MH). Kanyakumari district, Kurathividuthi estate, 11.11.1989, *S.R. Srinivasan 86969* (MH). Kamarajar district, Mysore medu, 22.10.1988, *S.R. Srinivasan 89452*; *s.loc*., 11.11.1989, *S.R. Srinivasan 86972* (MH). Nilgiri district, Conoor, 27.07.1957, *K.M. Sebastine 4060* (MH). Madurai district, Anna-Manalur, 06.08.1985, *K.M. Matthew 41821* (RHT); Dolphins nose, 07.07.1959, *K.M. Matthew 433* (RHT); *Ibid*., 31.10.1985, *K.M. Matthew 42477* (RHT). Ramanthapuram district, Deviar estate, 11.06.1979, *S.R. Srinivasan 63518* (CAL, MH). *s.loc*., 20.05.1913, *s.coll. 691* (CAL). *s.loc*., 23.08, *s.coll. 229* (CAL). *s.loc., s.d., s.coll. 1784* (CAL).

Notes: This species is close to *H. bracteata* and *H. meeboldii* in its leaf shape but can be easily identified by the nature of bracts (linear to oblong in *H. humboldtiana* and elliptic to obovate in *H. bracteata*), nature of calyx lobes (linear in *H. humboldtiana*, ovate in *H. bracteata* and ovate to lanceolate in *H.*

meeboldii) and presence or absence of hairs on connectives (hairy in *H. bracteata* whereas glabrous in *H. meeboldii*).

Didymocarpus primulifolius was described by Gardner based on materials from Ceylon (*Gardner 601*). There are two specimens collected by Gardner from Sri Lanka, one each in K (K000858191) and BM (BM000997738). Of these, the specimen at K (K000858191) matching with the protologue is designated here as the lectotype.

5. Henckelia incana (Vahl) Spreng., Syst. Veg. 1: 38. 1824; Pallith., Fl. Sirumalai Hills 180. 2001; Noltie, Bot. Robert Wight 276. 2005; T.S.Nayar *et al*., Fl. Pl. Western Ghats 1: Dicots 528. 2014. *Roettlera incana* Vahl, Enum. Pl. 1: 88. 1804. *Gratiola montana* Rottler in letter. **Type:** Madurai, *s.d., Rottler* (Holotype C; Photograph at E- E00155176!). **Plates 19, 20; Fig. 08**

Didymocarpus tomentosus Wight, Icon. Pl. Ind. Orient. 4: t. 1349. 1848; Rama Rao, Fl. Pl. Travancore 295. 1914; Gamble, Fl. Madras 989. 1924; S.V.Ramaswamy & Razi, Fl. Bangalore Dist. 545. 1973; Vajr., Fl. Palghat Dist. 332. 1981; K.M.Matthew, Material Fl. Tamil Nadu 287. 1981; A.N.Henry *et al*., Fl. Tamil Nadu Ind., Ser I: Analysis 2: 133. 1987; K.M.Matthew, An excursion Fl. Central Tamil Nadu 359; M.Mohanan & A.N. Henry, Fl. Thiruvananthapuram Dist. 338. 1994; Pull. & Ali Moulali, Fl. Andhra Pradesh 2: 680. 1997; Sasidh., Biodivers. Doc. Kerala Part 6: Fl. Pl. 332. 2004; T.S.Nayar *et al*., Fl. Pl. Kerala 343. 2006; Pull. *et al.,* Fl. Eastern Ghats 4: 636. 2011. *Didymocarpus rottlerianus* var. *tomentosus* (Wight) C.B.Clarke, Monogr. Phan. 5: 101. 1883. Type: Kaitie falls, Nielgherries, February, *Wight s.n.* (Icon. Pl. Ind. Orient. 4: t. 1349. 1848, lectotype designated here).

Vernacular name: Elichuzhien (Malayalam).

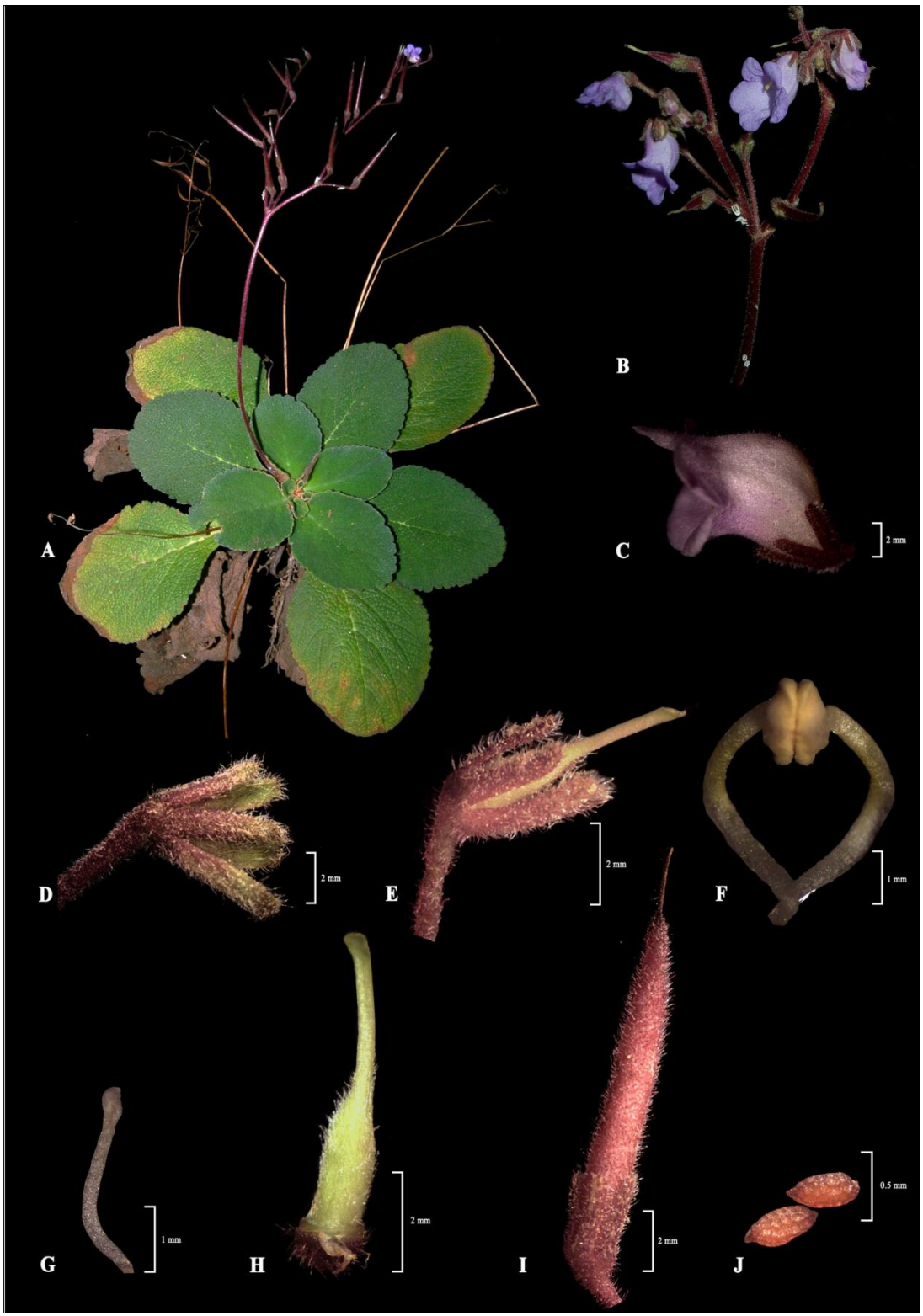


PLATE 19: *Henckelia incana* (Vahl) Spreng. **A.** Habit; **B.** Inflorescence; **C.** Single flower; **D.** Calyx; **E.** Calyx with gynoecium; **F.** Stamens; **G.** Staminode; **H.** Gynoecium; **I.** Fruit; **J.** Seeds (**A-J** from *A.P. Janeesha, P.M. Shahina* & *K.M. Manudev 134255*).

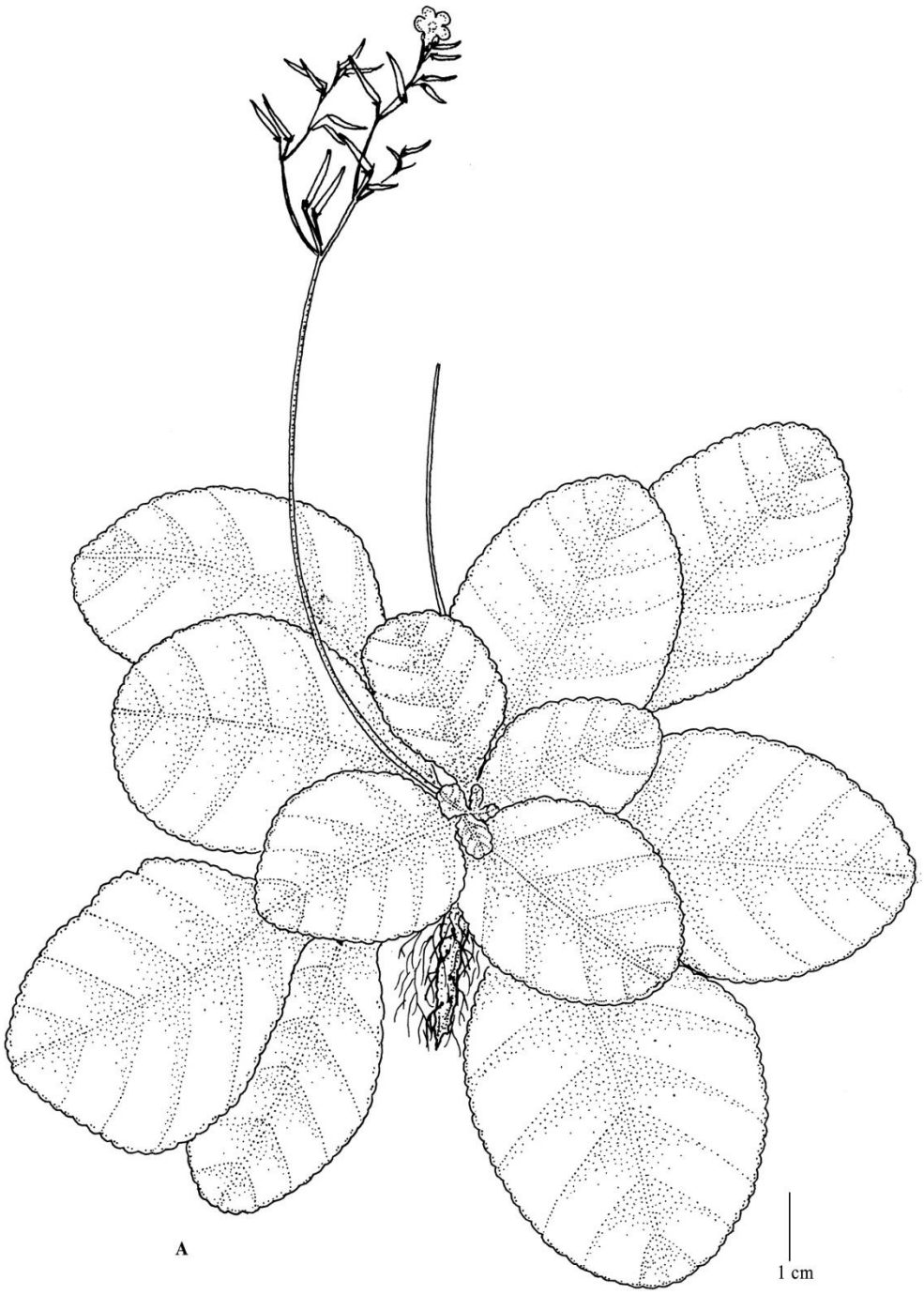


FIGURE 08: *Henckelia incana* (Vahl) Spreng. (From *A.P. Janeesha,P.M. Shahina* & *K.M. Manudev 134255*).

Perennial scapigerous, stem-less hairy herbs with rootstocks. ***Roots*** adventitious, thin. ***Leaves*** 6–18, basal, whorl of three; petioles 0.8–3 cm long, pubescent, winged; wings 2.3–3.4 mm broad; laminae elliptic-widely ovate, 5.5–11 × 3–9 cm, acute to obtuse at apex, attenuate at base, pilose hairy on the upper surface, tomentose on lower surfaces, but more on the younger leaves and on lower veins, becoming less so with age, margins shallowly crenate, surfaces usually rugose; veins 5 on each side, much branched and conspicuous beneath. ***Cymes*** axillary, dense; scapes 2–6 per plant, 2–4 times divided, 8–17 flowered, pubescent; peduncles 6–23 cm long, terete, reddish brown, pubescent; bracts two at each branching, ovate to lanceolate 2.2–2.8 × 0.5–0.6 mm, obtuse to narrowly acute at apex, margin crenate, hispid hairy along the margin; pedicels 7–15 mm long, terete, narrow, glandular hairy. ***Flowers*** 10–15 × 6–10 mm, zygomorphic. ***Calyx*** 5, very deeply divided; lobes unequal, lanceolate, 3.4–5.2 × 1–1.3 mm, reddish brown, slightly acute to obtuse at apex, margins entire, hispid hairy. ***Corolla*** companulate, glandular hairy without, glabrous within, 5-lobed; tube 6.7–7.3 × 5.4–7.1 mm, lilac to pale lilac with a yellow patch at the throat; lobes unequal, oblate to widely ovate, 3.6–4.8 × 4.7–5.2 mm, rounded to slightly acute at apex. ***Stamens*** 2, adnate to the base of the corolla, included; filaments 4–5.4 mm long, glabrous, rarely few (3–5) hairs towards the top, green on the top and colourless towards base; anthers bithecous, reniform, coherent by the adaxial surface, 1.6–1.8 × 0.7–0.9 mm, milky white, glabrous. ***Staminodes*** 2; filaments 2.4–3.1 mm long, hyaline, glabrous; antherodes globose or not prominent, glabrous, if globose rarely 1 or 2 hairs. ***Ovary*** ovoid to oblong, 3.8–4.3 × 1.16–1.46 mm, green, glandular hairy, unilocular, placentation parietal; style terete, 3.23–3.86 mm long, green, glabrous; stigma 0.4–0.6 × 0.74–1 mm, papillate. ***Capsules*** cylindrical, straight or slightly curved, 21–28

× 2–2.4 mm, reddish brown, hispid hairy, with rudimentary stigma and persistent calyx. ***Seeds*** numerous, elliptic, 0.5–0.56 × 0.22–0.26 mm, slightly acute at apex, truncate at base; testa dark brown to black, pitted.

Chromosome number: n=27 (Thathachar, 1942), n=±45 (Ratter & Prentice, 1967); 2n= ±90 (Ratter & Prentice, 1967).

Flowering & fruiting: May-December.

Habitat & ecology: In moist slopes and rock crevices, in association with *Begonia floccifera* Bedd. (Begoniaceae), *Justicia japonica* Thunb. (Acanthaceae), moss species and some grass species.

Distribution: Endemic to southern Westyern Ghats (Karnataka, Kerala and Tamil Nadu).

Uses: The leaves are used for treating fever and skin allergy (Kottaimuthu, 2008; Kholkute, 2009; Jothi & Rajakumar, 2012).

Specimens examined: Karnataka, Bangalore district, Savandurga Hilltop, 14.08.1979, *K.P. Sreenath 8954* (CAL). **Kerala**, Idukki district, Alampetty, Marayur, 30.07.1982, *V.P.K. Nambiar* & *N. Sasidharan 2168* (KFRI); Calvary mount, 13.11.1981, *V.S. Raju 71239* (CAL); Devikulum, 14.07.1993, *A. Nazarudeen 17834* (TBGT); Idukki dam, 24.08.1981, *V.S. Raju 71172* (MH); Kanthallur-Munnar, *A.K. Pradeep* & *A.P. Janeesha 137665* (CALI); Kattappana, 23.08.1977, *K. Vivekananthan 50486* (MH); *Ibid*., 23.08.1981, *V.S. Raju 71162* (MH); *Ibid*., 27.09.1981, *C.N. Mohanan 72013* (MH); Kulamavu, 12.10.1982, *C.N. Mohanan 74583* (CAL, MH); Marakkanam, 23.08.1977, *K. Vivekananthan*

50486 (CAL); Munnar F.D.- Suryanelli, 19.10.1986, *B. Gurudev Singh* & *K.R. Sasidharan 12427* (FRC); On the hill between Cheruthoni and Idukki dam, 24.08.1981, *V.S. Raju 71172* (CAL); Rajamalai, 16.09.1998, *S.D. Biju 35857* (TBGT); *Ibid*., 27.10.1998, *S.D. Biju 38393* (TBGT); Way to Calvary mount, 13.11.1981, *V.S. Raju s.n*. (MH). Palakkad district, Nelliyampathy, 16.09.1998, *K. Radhakrishnan 29060* (TBGT); *Ibid*., 2016, *P. Soumya* & *A.P. Janeesha 137691* (CALI); Parambikulam, 20.04.1976, *Rugmini Devi 12129* (CALI); *Ibid*., 28.04.1976, *M.P. Ramani s.n*. (CALI); *Ibid*., 26.05.2014, *A. Kabeer* & *A.P. Janeesha 134262* (CALI); Walayar forest, 10.07.1963, *J. Joseph 17049* (MH). Kollam district, Aryankavu, 08.06.1977, *E. Sarada Amma 21894* (CALI); Kazhuthuruthy-Thenmala, 20.12.1978, *C.N. Mohanan 59572* (MH); Ottakkal Hills near Arnarkkad, 23.121969, *M.V. Viswanathan MVV307* (MH); Thenmala, 13.07.2010, *Geetha Kumari 69602* (TBGT). Kottayam district, Kumarakam, 25.12.1980, *A.S. Suletha 92205* (DEV). Thiruvananthapuaram district, Arivikarai, 10.10.1928, *V. Narayanaswami 934* (MH); Ponmudi, 19.09.1968, *K.M. Matthew 9190* (RHT); *Ibid*., 12.09.1970, *K.M. Matthew 12411* (RHT); *Ibid*., 16.08.1980, *M. Mohanan 69225* (MH); *Ibid*., 17.11.1977, *M. Mohanan 52549* (MH); *Ibid*., 25.05.1979, *M. Mohanan 63280* (MH); *Ibid*., *s.d*., *M. Abdul Jabbar 13777* (TBGT); *Ibid*., 29.10.1983, *Satheesh Kumar 5921* (TBGT); *Ibid*., 28.11.2012, *A.P. Janeesha, P.M. Shahina* & *K.M. Manudev 134255* (CALI); *Ibid*., 31.07.2014, *Santhosh Nampy* & *A.P. Janeesha 134146, 134148* (CALI); *Ibid*., 31.07.2014, *S. Syam Radh, Santhosh Nampy* & *A.P. Janeesha 134152, 134165, 134168* (CALI); Ponmudi-way to upper sanatorium, 25.05.1979, *M. Mohanan 63280* (CAL); *Ibid*., 16.08.1980, *M. Mohanan 69225* (CAL). Wayanad district, Edakkal cave-inside, 08.07.2016, *A.P. Janeesha* & *P.G. Arunkumar 137674* (CALI). **Tamil Nadu**, Coimbatore district, Aliyar submergible area, 28.07.1962, *K.M. Sebastine 14686* (CAL, MH); Anamalai, 08.10.1901, *C.A. Barber 3629* (MH); *Ibid*., 10.10.1901, *C.A. Barber 3659* (MH); *Ibid*., 26.06.1973,

R.N. Kajal & *G.N. Tribedi 567* (CAL); Andiparaishola R.F., 26.06.1973, *E. Vajravelu 44302* (MH); Around Attakatti, *s.d., J. Joseph 12685* (CAL, MH); Bolampetty valley, 24.02.1917, *C.E.C. Fischer 4059* (CAL); Hassanur, 25.08.1914, *s.coll. 10634* (MH); Kurudimalai, 27.09.1956, *K. Subramanyam 865* (MH); *Ibid*., 17.11.1968, *J.L. Ellis* & *S. Karthikeyan 31325* (MH); *Ibid*., 20.01.1970, *M.V. Viswanathan MVV375* (MH); Kuridimalai-northern slopes, 27.09.1956, *K. Subramanyam 865* (CAL); Marudamalai, 24.06.1930, *V. Narayanaswami 3072* (MH); *Ibid*., 09.08.2014, *K. Thoiba* & *A.P. Janeesha 134280* (CALI); Pykara falls, 08.1884, *J.S. Gamble 15292* (CAL); Valparai-Shivamalai, 13.12.2013, *A.P. Janeesha* & *Santhosh Nampy 134244* (CALI); Velliangiri hills-way to temple, 29.05.2014, *S. Syam Radh, R. Rajeevan* & *A.P. Janeesha 138187, 138189, 138191* (CALI); *Ibid*., 30.09.2016, *Nikhil Krishna* & *A.P. Janeesha 137689* (CALI). Dindigul district, Kodaikanal, 20.11.2012, *K.M. Manudev, A.P. Janeesha* & *Santhosh Nampy 134254* (CALI); Perumparai, 22.10.1977, *M. Chandrabose 51612* (CAL); Ratter water fall, 25.02.2014, *A. Kabeer, K. Shinoj* & *A.P. Janeesha 134258* (CALI); Sirumalai, 16.05.1958, *J.M. Pallithanam 3356* (BLAT). Kanyakumari district, Kooladai, 08.09.1969, *B.V. Shetty 32293* (MH); Maranthuvalmalai, 18.10.1985, *R. Gopalan 83374* (MH); Sevgaltai, 24.09.1915, *s.coll*. *12447* (MH); Thekkumalai, 19.11.1956, *K.M Sebastine 1368* (CAL, MH). Madurai district, Amaravathi sagaram-Lower camp, 22.06.1968, *D.B. Deb 30121* (MH); Cumbum valley, 20.06.1959, *K. Subramanyam 8048* (MH); High way hut, 05.1917, *E. Blatter* & *Hallberg 355* (BLAT, CAL); Sirumalai, 23.08.1913, *C.A. Barber 9058* (MH); Vengayapparai, 21.11.1985, *K.M. Matthew, A. Usha* & *N. Rajendran 42987* (RHT); way to Perumparai, 22.10.1977, *M. Chandrabose 51612* (MH). Mysore district, Devagiri betta-Beduguli, 08.09.1961, *Seshagiri Rao Rolla 73794* (CAL); *Ibid*., 17.04.1962, *A.S. Rao 80020* (CAL). Namakkal district, Kolli hills, 01.08.1978, *N. Venugopal 15984* (CAL). Nilgiris district, Bimaka shoal, 26.08.1970, *G.V. Subba Rao 36346* (MH); Kil

Kotagiri-on the way, 25.10.1956, *K. Subramanyan 1171* (CAL); Kodanad view point, 24.07.1970, *E. Vajravelu 35084* (MH); Mudumalai, 03.06.1994, *S.K. Mandal 7214* (CAL); Naduvattam, 28.06.1970, *B.V. Shetty 34457* (MH); *Ibid*., 30.08.1970, *B.D. Sharma 35926* (MH); Way to Anakkatai from Ebanad, 27.07.1972, G.V. *Subba Rao 41563* (MH); Way to Kilkotagiri, 25.10.1972, *K. Subramanyam 1171* (MH); Way to Naduvattam from Devar shoal, 21.07.1960, *K. Subramanyam 10517* (CAL, MH). Pudukkottai district, Ponnamaravathi, 22.07.1984, *C. Arulappan s.n.* (MH). Ramnad district, Kendiparai-Ayyanar koil, 23.09.1971, *E. Vajravelu 38704* (MH); Mudaliarattu, 21.09.1917, *P.S. Jivanna Rao 15096* (MH). Selam district, Kollihills, 10.09.1992, *A.A. Ansari 97066* (MH); Retreat area-Yercaud, 24.07.1965, *S. Karthikeyan 26853* (MH). Thiruchirapalli district, Trichy, 18.10.1985, *P.C. Jose Kutty 1146* (DEV). Tirunelveli district, Chunkankada hills, near Sree Ayyappa College, 20.07.2016, *A.P. Janeesha, S. Resmi* & *P.G. Arunkumar 137676* (CALI); Courtallum, 04.07.1974, *T.N. Reetha Bai 30815* (CALI); Karayar Dam, 30.07.1989, *Shanavas Khan 5853* (TBGT); Kohimalai, 02.11.1914, *s.coll. 11396* (MH); Kulurathumottai Grassland, 16.10.1992, *R. Gopalan 9997* (MH); Mahendragiri, 17.09.1916, *s.coll. 13139* (MH); Near Kodayar power house, 19.07.2016, *A.P. Janeesha, S. Resmi* & *P.G. Arunkumar 137675* (CALI); Neelikkathu R.F., 03.05.1989, *R. Gopalan 90532* (MH); Papanasam project, 07.1101959, *K.M. Sebastian 9560* (CAL); Thulukkam parai, 28.11.1969, *B.V. Shetty 32947* (MH); Vasudevanallur R.F., 03.10.1971, *E. Vajravelu 38847* (MH). Vellore district, slopes of Konamalai, 18.07.1961, *C. P. Sreemadhavan CPS741* (MH). *s.loc*., 27.09.1986, *S.R. Raja* & *Nagavath s.n* (MH). State unknown, *s.loc*., 06.1883, *J.S. Gamble 11780* (CAL). Peninsular India, *s.d., R. Wight 2352* (CAL).

6. Henckelia innominata (B.L.Burtt) A.Weber & B.L.Burtt, Beitr. Biol. Pflanzen 70: 347. 1997; T.S.Nayar *et al*., Fl. Pl. Western Ghats 1: Dicots 528.

2014. *Didymocarpus innominatus* B.L.Burtt, Notes Roy. Bot. Gard. Edinburgh 21: 201. 1954; B.D.Sharma *et al*., Fl. Karnataka: Analysis 195. 1984; A.N.Henry *et al*., Fl. Tamil Nadu Ind. Ser I: Analysis 2: 132. 1987; M.Ahmedullah & M.P.Nayar, Endemic Plants of Indian region 1: 143. 1987; N.P.Singh, Fl. Eastern Karnataka 2: 475. 1988; Pull. & N.Yesoda, Fl. Anantapur Dist. 182. 1989; Sasidh. & Sivar., Fl. Pl. Thrissure Forest 329. 1996; Pull. & Ali Moulali, Fl. Andhra Pradesh 2: 679. 1997; Sasidh., Biodivers. Doc. Kerala Part 6: Fl. Pl. 332. 2004; T.S.Nayar *et al*., Fl. Pl. Kerala 342. 2006; Pull. *et al*., Fl. Eastern Ghats 4: 361. 2011. *Didymocarpus rottlerianus* Wall., Numer. List 778. 1829; Gamble, Fl. Madras 989. 1924. **Type**: *s.loc., s.d., Wallich 778* (K001111885 (778B), lectotype designated here). **Plates 21, 22; Fig. 09**

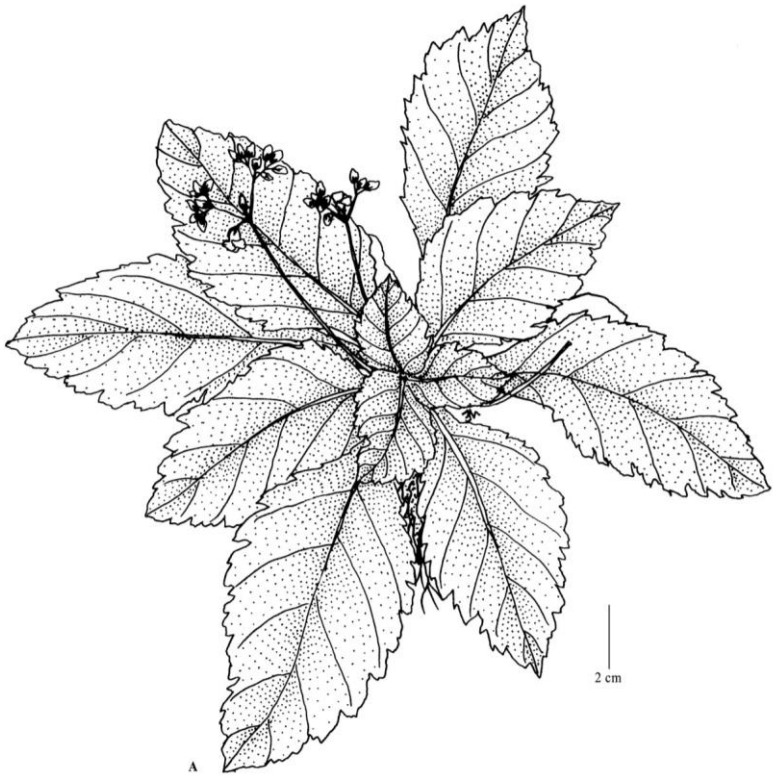


FIGURE 09: *Henckelia innominata* (B.L.Burtt) A.Weber & B.L.Burtt (From *A.P. Janeesha* & *Santhosh Nampy 137681*).

Perennial scapigerous, stem-less hairy herbs with rootstocks. ***Roots*** adventitious, thin. ***Leaves*** 6–15, basal, whorl of three; petioles 2.5–9 cm long, pubescent, winged; wings 1–3 mm broad; laminae elliptic, 8.5–12 × 4.7–6.7 cm, acute at apex, narrowly cuneate to attenuate at base, hispid on both surfaces, but more on the younger leaves and on lower veins, becoming less so with age, margins doubly serrate, first serration deep and irregular, surfaces usually rugose; veins 5 on each side, much branched and conspicuous beneath. ***Cymes*** axillary, dense; scapes 2–7 per plant, 3–5 times divided, 12–22 flowered, pubescent; peduncles 18–24 cm long, terete, green, pubescent; bracts two at each branching, linear, 3–5 × 1.3–2.4 mm, obtuse at apex, margin entire, hispid hairy; pedicels 4–14 mm long, terete, narrow, pubescent. ***Flowers*** 10–20 × 4–9 mm, zygomorphic. ***Calyx*** 5, very deeply divided or basally connate; lobes equal, elliptic to oblong, 2–2.5 × 0.68–1 mm, reddish brown towards the base and green towards the apex, obtuse at apex, margins entire, hispid hairy on both side. ***Corolla*** companulate, glandular hairy without, glabrous within, 5-lobed; tube 6.8–7.9 × 5.3–6.2 mm, pale lilac with a yellow patch at the throat; lobes unequal, 4.5–5.6 × 5.3–6.2 mm, widely ovate to orbicular, rounded at apex, slightly undulate. ***Stamens*** 2, adnate to the base of the corolla, included; filaments 3.3–3.8 mm long, glabrous, green on the top and colourless towards base; anthers bithecous, reniform, coherent by the adaxial surface, 1.45–1.6 × 0.62–0.7 mm, milky white, glabrous. ***Staminodes*** 2; filaments 1.8–2 mm long, hyaline, glabrous; antherodes not prominent. ***Ovary*** ovoid to oblong, 3.1–3.5 × 1.15–1.3 mm, green, glandular hairuy, unilocular, placentation parietal; style terete, 2.4–2.6 mm long, green, glabrous; stigma 0.53–0.58 × 0.3 mm, papillate. ***Capsules*** cylidrical, straight, 12–19 × 1.4–1.6 mm, reddish brown, tomentulose with

rudimentary stigma and persistent calyx. ***Seeds*** numerous, elliptic, 0.43–0.56 × 0.2 mm, slightly acute at both ends; testa dark brown to black, pitted.

Chromosome number: n=16, 2n=32 (Ratter & Prentice, 1967).

Flowering & fruiting: May-December.

Habitat & ecology: In moist slopes and rock crevices. Grow in association with *Selaginella* sp. (Selaginellaceae), *Spermacoce alata* Aubl. (Rubiaceae) and some grass species.

Distribution: Endemic to southern Western Ghats (Andhra Pradesh, Kerala and Tamil Nadu).

Specimens examined: Andhra Pradesh, Nellore district, Mulleccukonda hills, 26.07.1914, *M.S. Ramaswami 1267* (CAL). **Kerala,** Idukki district, Chinnar, 19.01.1986, *B. Gurudev Singh* & *K.R. Sasidharan 12428* (FRC); *Ibid*., 07.10.1994, *E.S. Santhosh Kumar 17595* (TBGT). Palakkad district, Dhoni reserve forest, 20.07.1963, *J. Joseph 17220* (MH). Pathanamthitta district, Achankovil to Mekkarai, 05.09.1913, *M. Rama Rao 1652* (CAL). Kollam district, Achencoil, 22.05.1979, *C.N. Mohanan 63025* (MH); Moonnamra-Thenmala, 17.08.2016, *A.P. Janeesha* & *Santhosh Nampy 137681* (CALI); Moonnamra-near constructing railway track, 17.08.2016, *A.P. Janeesha, S. Resmi, Dani Francis* & *Arathi 137682* (CALI). **Tamil Nadu,** Coimbatore district, Attakatti, 04.07.1961, *J. Joseph 12685* (MH); *Ibid*., 21.11.1980, *M. Chandrabose* & *V. Chandrasekaran 69044* (MH, CAL); Parappalar dam, 11.11.1986, *K.M. Matthew 47293* (RHT). Coorge district,

s.loc., s.d., s.coll. s.n. (CAL). Dharmapuri district, Chitteri hills, 12.08.1978, *K.M. Matthew 16362* (RHT); *Ibid*., 09.01.1980, *K.M. Matthew 25618* (RHT). Kanyakumari district, *s.loc*., 29.10.2015, *K. Thoiba* & *A.P. Janeesha 137651, 137652* (CALI). Madras district, Siruvani, 14.08.1960, *A.N. Henry 351* (MH); Siruvani-near Bungalow, 14.08.1960, *A.N. Henry 350* (BLAT). Nilgiri district, *s.loc., s.d., G. Thomson 1351* (CAL). Ramnad district, Ayyanarkoil, 23.09.1971, *E. Vajravelu 38715* (MH); Cumbummedu, 14.03.1970, *E. Vajravelu 33767* (MH); Yanaimutti rocks, 13.12.1972, *E. Vajravelu 39412* (MH). Salem district, Krishnagiri, 24.09.1917, *s.coll. 14935* (MH).; Yercaud, 28.06.1980, *V. Sainaba 28364* (CALI). Tirunelveli district, Around Shembagadevi, 27.09.1975, *K.K.N. Nair 1167* (CAL); Courtallum, 18.07.1901, *C.A. Barber 3374* (MH); *Ibid*., 16.07.1907, *C.A. Barber 8378* (MH)*; Ibid*., 23.07.1957, *K. Subramanyam 3745* (MH)*; Ibid*., 29.06.1980, *K. Indira Devi 5760* (CALI); *Ibid*., 30.06.1980, *K.S. Hema 8143* (CALI); *Ibid*., 30.06.1980, *T. Usha 30144* (CALI); *Ibid*., 30.06.1980, *M.S. Baby Usha Kiran 3783* (CALI); forest near Papanasam project, 07.11.1959, *K.M. Sebastine 9560* (MH)*;* Kannakattii, 13.06.1899, *C.A. Barber 505* (MH)*;* Mekkarai-on rock, 06.09.1913, *C.C. Calder* & *M.S. Ramaswami 620* (CAL); Naterikal, 21.09.1914, *s.coll. 10952* (MH); Sengalten, 16.02.1913, *D. Hooper* & *M.S. Ramaswami 39219* (CAL); Vasudevanallur, 13.11.1925, *S.R. Raju 17801* (MH)*; Ibid*., 03.10.1971, *E. Vajravelu 38845* (MH);. *s.loc*., 01.09.1913, *C.C. Calder* & *M.S. Ramaswami 507* (CAL). *s.loc*., 01.06.1905, *C.E.C. Fischer 22* (CAL). *s.loc., s.d., M.S. Ramaswami 607* (CAL). *s.loc., s.d., s.coll. 67* (CAL); *s.loc., s.d., s.coll. 2678* (CAL); *s.loc., s.d., s.coll. 778* (CAL).

Plates 23, 24; Fig. 10

Didymocarpus lyratus Wight var. *protractus* C.B.Clarke in A.DC. & C.DC., Monogr. Phan. 5: 102. 1883; A.N.Henry *et al*., Fl. Tamil Nadu Ind. Ser I: Analysis 2: 132. 1987. Type: Pulney Hills, *Beddome 8505* (Holotype-BM).

Perennial scapigerous, stem-less hairy herbs with rootstocks. ***Roots*** adventitious, thin. ***Leaves*** 6–9, basal, whorl of three; petioles 4.5–14 cm long, pubescent, lacerate; laminae widely elliptic-orbicular, 4.5–7.5 × 4.5–6.3 cm, rounded to obtuse at apex, lyrate at base, pilose hairy on both surfaces, but more on the younger leaves and on lower veins, becoming less so with age, margins doubly crenate, sometime first crenation is very deep and irregular, surfaces usually rugose; veins 5 on each side, much branched and conspicuous beneath. ***Cymes*** axillary; scapes 3–9 per plant, 3–5 times divided, 12–21 flowered, pubescent; peduncles 13–29 cm long, terete, green,

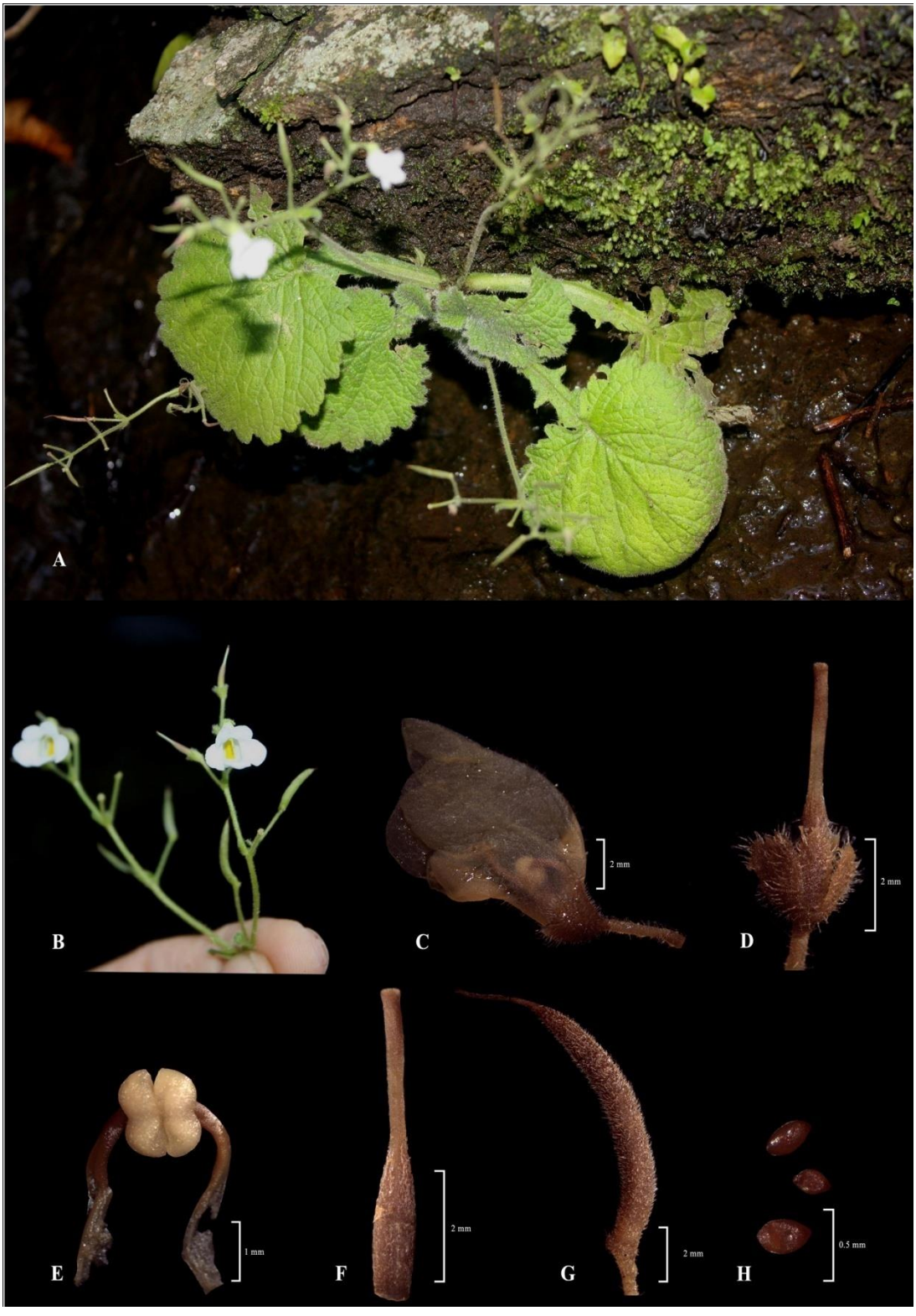


PLATE 23: *Henckelia lyrata* (Wight) A.Weber & B.L.Burtt **A.** Habit; **B.** Inflorescence; **C.** Single flower; **D.** Calyx with gynoecium; **E.** Stamens; **F.** Gynoecium; **G.** Fruit; **H.** Seeds (**A-H** from *K.M. Prabhukumar* & *A.P. Janeesha 7559*).

PLATE 24: Lectotype of *Henckelia lyrata* (Wight) A.Weber & B.L.Burtt

FIGURE 10: *Henckelia lyrata* (Wight) A.Weber & B.L.Burtt (From *E. Vajravelu 39412*)

pubescent; bracts two at each branching, linear, 3–5 × 1 mm, obtuse to rounded at apex, margin entire, white pilose hairy; pedicels 4–25 mm long, terete, narrow, pubescent. ***Flowers*** 10–14 × 5–7 mm, zygomorphic. ***Calyx*** 5 partite, very deeply divided; lobes equal, broadly lanceolate, 2–11 × 0.7–3 mm, green, obtuse at apex, margins entire, white pilose hairy. ***Corolla*** companulate, minutely villous without, glabrous within, 5-lobed; tube 8–10 × 5–6.7 mm, white to pale lilac with a yellow patch at the throat; lobes unequal, widely ovate, 3.7–5 × 4–5.3 mm, ovate to rounded at apex. ***Stamens*** 2, adnate to the base of the corolla, included; filaments 3.5–4.2 mm long,

glabrous; anthers bithecous, reniform, coherent by the adaxial surface, 1.5–1.6 × 0.62 mm, milky white. ***Staminodes*** 2; filaments 3.1–3.5 mm long, glabrous; antherodes not seen. ***Ovary*** ovoid to oblong, 2.6–3 × 0.78–0.86 mm, pubescent, unilocular, placentation parietal; style terete, 3–3.8 mm long, glabrous; stigma *c.* 0.34 mm diameter, papillate. ***Capsules*** cylindrical, straight or slightly curved, 12–36 mm long, green, glandular hairy with rudimentary stigma and persistent calyx. ***Seeds*** numerous, oblong-ovoid to elliptic, 0.4–0.51 × 0.17–0.21 mm, slightly acute at apex; testa dark brown to black, pitted.

Chromosome number: Not reported.

Flowering & fruiting: May-December.

Habitat & ecology: On moist rocks. Grow in association with *Porella* sp. (Pteridophyte).

Distribution: Endemic to southern Western Ghats (Kerala and Tamil Nadu).

Specimens examined: Kerala, Idukki district, Neymakkad gap, 10° 08′ 46.3″ N, 77° 05′ 16.9″ E, 1784 m, 22.10.2004, *M.P. Geethakumary* & *A.G. Pandurangan 55339* (TBGT). Kollam district, Aryankavu, 02.12.1961, *K.N. Subramanian 77355* (BSI). Palakkad district, Dhoni forest-Korakkallu region, 27.09.2013, *K.M. Prabhukumar* & *A.P. Janeesha 7559* (CALI). **Tamil Nadu**, Ramnad district, Kendiparai slopes-Ayyanarkoil, 23.09.19711, *E. Vajravelu 38715* (MH); Kumbumedu, 14.03.1970, *E. Vajravelu 33767* (MH); Yanimutti

Rock-Mudaliaruthu, 13.12.1972, *E. Vajravelu 39412* (MH). Virudhunagar district, Srivilliputhur Wildlife sanctuary, 24.10.2013, *Kabeer* & *G. Gnanashekaran 130400* (MH).

Notes: Wight (1848) described this species from Courtallum. Subsequently it has been collected from a few localities in adjoining districts (see above) but wrongly identified as *Didymocarpus rottlerianus* (MH specimens *33767*, *38715* & *39412*). Geethakumari *et al*. (2016), without knowing this, reported their collection as a rediscovery after 169 years. This interesting species can be readily identified by its lyrate leaves.

8. Henckelia macrostachya (E.Barnes) A.Weber & B.L.Burtt, Beitr. Biol. Pflanzen 70: 349. 1997; Shaju *et al*., Taprobanica 5(2): 138. 2013; T.S.Nayar *et al*., Fl. Pl. Western Ghats 1: Dicots 528. 2014. *Didymocarpus macrostachya* E.Barnes, Bull. Misc. Inform. Kew 1938. 37. 1938; M.Ahmedullah & M.P.Nayar, Endemic Plants of Indian region 1: 143. 1987; Sasidh., Biodivers. Doc. Kerala Part 6: Fl. Pl. 332. 2004; T.S.Nayar *et al*., Fl. Pl. Kerala 342. 2006. **Type**: Travancore, High range on Ottapparai ridge, 5500 ft., September, *E. Barnes 1263, 1264, 1265, 1266* (K000858197, lectotype designated here).

Plates 25, 26; Fig. 11

Perennial scapigerous, stem-less hairy herbs with rootstocks. ***Roots*** adventitious, thin. ***Leaves*** 9–12, basal, whorl of three; leaves narrowly end in to a petiole, having a sessile to sub-sessile appearence; laminae obovate-widely spathulate, 16–27 × 6–10 cm, rounded to slightly acute at apex, attenuate to narrowed at base, white bullate hairy on the upper surface, golden brown tomentose hairy on the younger leaves and on lower veins, becoming less so with age, margins crenate, surfaces usually rugose; veins 7–8 on each side, much branched and conspicuous beneath. ***Cymes*** axillary; scapes 1–2 per plant, 3–6 times divided, 16–28 flowered; peduncles 30–54 cm

PLATE 26: Lectotype of *Henckelia macrostachya* (E.Barnes) A.Weber & B.L.Burtt

FIGURE 11: *Henckelia macrostachya* (E.Barnes) A.Weber & B.L.Burtt (from *A.P. Janeesha A.P. & Santhosh Nampy 137616*)

long, terete, stout, tufted with golden brown tomentose hairy, golden brown; bracts two at each branching, broadly linear to elliptic, with rounded apex, 1.5–4 × 1–1.9 mm, basally hairy, green; pedicels 3–11 mm long, terete,

narrow, hairy. ***Flowers*** 10–20 × 13–18 mm, zygomorphic. ***Calyx*** 5 partite, very deeply divided or basally connate; lobes unequal, ovate to elliptic, 2.5–4.9 × 0.8–1.92 mm, reddish brown, slightly acute to obtuse at apex, margins entire, glandular hairy on the base, golden brown tomentose hairy towards the apex. ***Corolla*** companulate, white tomentose hairy without, glabrous within, 5-lobed; tube 8–12 × 4.3–5.5 mm, pale lilac to white with a yellow blotch at the throat; lobes almost equal, very widely obovate with undulate margin, 5.5–6.2 × 7–7.8 mm, rounded at apex. ***Stamens*** 2, adnate to the base of the corolla, included; filaments 4.5–5 mm long, glabrous, yellow; anthers bithecous, reniform, coherent by the adaxial surface, 1.5–2.75 × 0.75–1.16 mm, milky white to cream, bearded at the region of connective. ***Staminodes*** 2; filaments 2.4–3.3 mm long, hyaline, glabrous; antherodes dome shaped, 0.4–0.62 × 0.5–0.7 mm, bearded at the region of connective. ***Ovary*** ovoid, 4–6 × 2.1–2.64 mm, pale green, with glandular and white tomentose hairs all over, unilocular, placentation parietal; style terete, 1.8–3 mm long, green, glabrous; stigma 0.65–0.7 × 0.8–0.86 mm, slightly papillate. ***Capsules*** cylindrical, short and stout, 13–28 × 2.2–2.7 mm, reddish brown, glandular hairy with rudimentary stigma and persistant calyx. ***Seeds*** numerous, elliptic, 0.57–0.69 × 0.22–0.29 mm, slightly acute at apex, truncate at base; testa dark brown, pitted.

Chromosome number: Not reported.

Flowering & fruiting: July-October.

Habitat & ecology: In moist slopes and rock crevices. Grown in association with *Cyanotis obtusa* Trim. (Commelinaceae), *Christella* sp. (Pteridophyte) and some grass species.

Distribution: Endemic to southern Western Ghats (Kerala).

Specimens examined: Kerala, Idukki district, Devikulam, Pallivasal, 01.07.1944, *N.R. Yull 236* (CAL); Eravikulam National Park, 22.08.2014, *A.P. Janeesha* & *Santhosh Nampy 137612*; *Ibid*., 22.08.2014, *S. Syam Radh, Prashob* & *A.P. Janeesha 134192* (CALI); *Ibid*., 19.05.2015, *A.P. Janeesha, S. Resmi* & *V. Veena 137615* (CALI); Eravikulam NP-after view point, 19.05.2015, *A.P. Janeesha* & *Santhosh Nampy 137616* (CALI); near Idukki dam, 24.08.1981, *V.S. Raju 71173* (MH); Pettimudi, 30.10.2012, *Shaju* & *Shareef, 74028* (TBGT).

9. Henckelia meeboldii (W.W.Sm. & Ramaswami) A.Weber & B.L.Burtt, Beitr. Biol. Pflanzen 70: 349. 1997; T.S.Nayar *et al*., Fl Pl. Western Ghats 1: Dicots 528. 2014; Janeesha & Nampy, Phytotaxa 268(1): 80. 2016. *Didymocarpus meeboldii* W.W.Sm. & Ramaswami, Rec. Bot. Surv. India 6: 43. 1914; Gamble, Fl. Madras 2: 989. 1924; A.N. Henry *et al*., Fl. Tamil Nadu Ind. Ser I: Analysis 2: 132. 1987; M.Ahmedullah & M.P.Nayar, Endemic Plants of Indian region 1: 143. 1987; Sasidh., Biodivers. Doc. Kerala Part 6: Fl. Pl. 332. 2004; T.S.Nayar *et al*., Fl. Pl. Kerala 342. 2006. **Type**: India, Kerala, Peermade Ghat, *s.d., Meebold 12851* (CAL0000019179, lectotype designated by Janeesha & Nampy, 2016). **Plates 27, 28; Fig. 12**

Perennial scapigerous, stem-less hairy herbs with rootstocks. ***Roots*** adventitious, thin. ***Leaves*** 8–13, basal, opposite deccusate; petioles 4–12 cm long, pubescent, winged; wings 2–3 mm broad; laminae widely elliptic-

ovate, 6–16 × 5–11.5 cm, obtuse to acute at apex, attenuate at base, pubescent on both surfaces, but more on the younger leaves and on lower veins, becoming less so with age, margins crenate, sometimes slightly doubly crenate, surfaces usually rugose; veins 5–7 on each side, much branched and conspicuous beneath. ***Cymes*** axillary; scapes 1–5 per plant, 6–9 times divided, 10–18 flowered; peduncles 10–26 cm long, terete, reddish brown, glandular hairy; bracts two at each branching, linear, 3–4 × 0.8–1 mm, acute at apex, margin entire, pilose; pedicels 4–25 mm long, terete, narrow, glandular hairy. ***Flowers*** 13–15 × 11–13 mm, zygomorphic, drooping. ***Calyx*** 5 partite, very deeply divided or basally connate; lobes unequal, ovate to lanceolate, 2.5–5 × 0.8–1.8 mm, reddish brown, slightly acute at apex, margins entire, glandular hairy. ***Corolla*** companulate, glandular hairy without, glabrous within, 5-lobed; tube 9–11 × 3.7–4.2 mm, dark lilac with a

PLATE 28: Lectotype of *Henckelia meeboldii* (W.W.Sm. & Ramaswami) A.Weber & B.L.Burtt

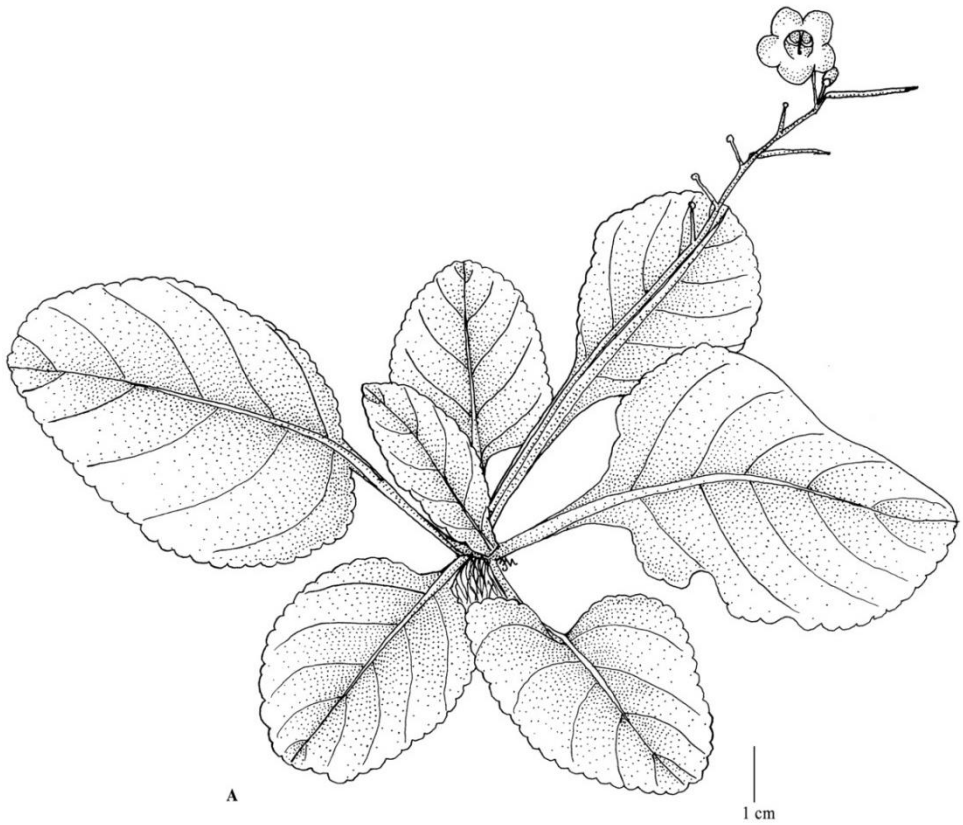
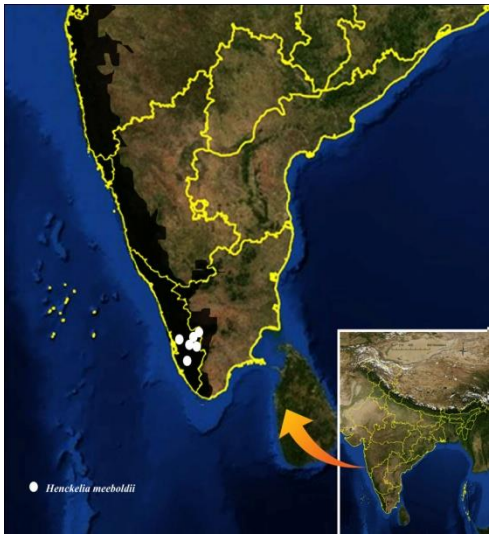


FIGURE 12: *Henckelia meeboldii* (W.W.Sm. & Ramaswami) A.Weber & B.L.Burtt from *A.P. Janeesha & K.M. Manudev 134202*)

yellow patch at the throat; lobes unequal, posterior three long 6–7 × 5–6 mm, anterior two 4 × 5, ovate to slightly elliptic, rounded at apex, aestivation quincuncial. ***Stamens*** 2, adnate to the base of corolla, included; filaments 4–6 mm long, hairy, green on the top and colourless towards base; anthers bithecous, reniform, coherent by the adaxial surface, 1.5–1.7 × 0.9–0.95 mm, milky white, glabrous. ***Staminodes*** 2; filaments 2.2–2.5 mm long, hyaline, glabrous; antherodes not seen. ***Ovary*** ovoid to oblong, 4.8–6.5 × 0.9–1.2 mm, green, glandular hairy, sometimes slightly curved, unilocular, placentation parietal; style terete, 4–5.5 mm long, green, glabrous; stigma 0.3–0.35 × 0.2–0.25 mm, papillate. ***Capsules*** cylindrical, straight or slightly curved, 14–35 ×

1.3–1.5 mm, reddish brown, tomentulose with rudimentary stigma. ***Seeds*** numerous, elliptic, 0.38–0.45 × 0.2–0.22 mm, obtuse to slightly acute at apex, truncate at base; testa dark brown, pitted.



Chromosome number: Not reported.

Flowering & fruiting: July-November.

Habitat & ecology: In moist slopes. Gow in association with *Adiantum lunulatum* Burm. (Adiantaceae), *Christella* sp., *Selaginella* sp. (Pteridophyte) and *Cyanotis villosa* (Spreng.) Schult.f. (Commelinaceae).

Distribution: Endemic to southern Western Ghats (Kerala & Tamil Nadu).

Specimens examined: Kerala, Ernakulam district, Shoolamudi, *A.P. Janeesha, Manu Philip* & *K. Shinoj 137692* (CALI). Idukki district, Mannavan shola, 24.05.2015, *K.M. Manudev, S. Syam Radh* & *A.P. Janeesha 137617* (CALI); Munnar, 10.09.2013, *A.P. Janeesha* & *Santhosh Nampy 134214* (CALI); near Kuttikanam-Kumali road, 30.06.2016, *A.P. Janeesha* & *P.S. Sreeja 137662* (CALI); Neryamangalam to Adimali route, 25.07.2013, *A.P. Janeesha* & *K.M. Manudev 134202* (CALI); Onnamthode-Mathikettanshola National Park, 08.05.2015, *S. Syam Radh* & *A.P. Janeesha 137613* (CALI); Peerumedu, 31.08.1992, *A. Nazarudeen 14386* (TBGT); *Ibid*., 12.09.2009, *Geethakumary 58596* (TBGT); Pothumade-Munnar, 25.07.2013, *A.P. Janeesha* & *K.M. Manudev 134203* (CALI); Pynavu, 29.06.2016, *P.S. Sreeja* & *A.P. Janeesha 137667* (CALI). Upputhora, 30.09.1981, *C.N. Mohanan 72086* (MH). Kottayam district, near

Ottayitti, 26.06.2016, *P.S. Sreeja* & *A.P. Janeesha 137661* (CALI); Vagamon churam turning, 07.08.2014, *A.P. Janeesha* & *A.P. Roshan 134273, 134274, 134275,* (CALI); *Ibid*., 03.10.2015, *C. Pramod* & *A.P. Janeesha 137645* (CALI); Vagamon churam-200 mtr after view point, 07.08.2014, *A.P. Janeesah, A.P. Roshan* & *Santhosh Nampy 134276* (CALI). **Tamil Nadu**, Madura district, Palani-Kodaikanal ghat road, 27.11.1985, *K.M. Matthew* & *N. Rajendran 43308* (RHT); Tiger shola-acroos to Korappar, 01.08.1986, *K.M. Matthew* & *M. Charles 46094* (RHT).

Notes: Ramaswami (1914) described the corolla tube and filaments as glabrous. Butthe corolla tube is glandular hairy out and the filaments are bearded. The species is close to *H. humboldtiana*, but can be distinguished by its broadly elliptic to ovate leaves, glandular hairy pedicel, calyx lobes, corolla tube and ovary. It is a showy plant with lilac to dark lilac flowers.

10. Henckelia missionis (Wall. *ex* R.Br.) A.Weber & B.L.Burtt, Beitr. Biol. Pflanzen 70: 350. 1997; T.S.Nayar *et al*., Fl. Pl. Western Ghats 1: Dicots 528. 2014. *Didymocarpus missionis* Wall. *ex* R.Br., Pl. Jav. Rar. 119. 1839; Rama Rao, Fl. Pl. Travancore 295. 1914; Gamble, Fl. Madras 2: 988. 1924; A.N.Henry & Swamin., J. Bombay Nat. Hist. Soc. 76: 373. 1977; A.N.Henry *et al*., Fl. Tamil Nadu Ind. Ser I: Analysis 2: 132. 1987; M.Ahmedullah & M.P.Nayar, Endemic Plants of Indian region 1: 143. 1987; M.P.Nayar & Sastry, Red Data Book of Indian Plants 3: 157. 1990; K.S.Walter & H.J.Gillet, IUCN Red list of Threatened plants 291. 1997; Gopalan & A.N.Henry, Endemic Plants of India 114. 2000; T.S.Nayar *et al*., Fl. Pl. Kerala 342. 2006. *Roettlera missionis* (Wall. *ex* R.Br.) Kuntze, Revis. Gen. Pl. 2: 476. 1891. **Type:** *s.loc., s.d., Wallich 6396* (Holotype-BM000617800!). **Plate 29; Fig. 13**

Didymocarpus membranaceus Bedd. Icon. Pl. Ind. Or. 1: 39. 1874. Type: Pachemallay hills, South Travancore, *Beddome s.n.*

Perennial scapigerous, stem-less hairy herbs with rootstocks. ***Roots*** adventitious, thin. *Leaves* basal; petioles 11–16 cm long, pubescent, not winged; laminae ovate to elliptic, 7.9–12.1 × 5.2–7.3 cm, membranaceous, acute to acuminate at apex, obliquely cordate at base, strigose hairy on the upper surface, margins entire, with white pellucid hairs, surfaces rough; veins 5 on each side, much branched and conspicuous beneath. ***Cymes*** axillary; scapes 1–5 per plant, 3–5 times divided, with scaly hairs towards apex; peduncles 20–29 cm long, terete; pedicels 6–9 mm long, terete, narrow, pubescent. ***Flowers*** 20–25 mm long, zygomorphic. ***Calyx*** 5, very deeply divided; lobes linear, acute at apex, hairy. ***Corolla*** sub-infundibuliform, glabrous, 5-lobed. ***Stamens*** 2, adnate to the base of corolla, included, glabrous; anthers bithecous, reniform, coherent by the adaxial surface, bearded. ***Staminodes*** 2; antherodes present. ***Ovary*** ovoid, unilocular, placentation parietal; style terete, glabrous; stigma capitate. ***Capsules*** cylindrical, 27–33 mm, with rudimentary stigma. ***Seeds*** not seen.

Chromosome number: Not reported.

Flowering & fruiting: May-December.

Habitat & ecology: In moist slopes and rock crevices.

Distribution: Endemic to southern Western Ghats (Tamil Nadu).

Specimens examined: Tamil Nadu,

Kanyakumari district, Kilaviyarumalai-Balamore, 28.07.1977, *A.N. Henry 49421* (MH).

Notes: It is evident from herbarium data that this species has been collected only twice (Madras Herbarium: *Henry 48151* & *Henry 49421*, Henry & Swaminathan, 1977) after type collection, and are both from Kanyakumari district. I could not able to collect this species. From the available data, it is assessed as critically endangered.

11. Henckelia ovalifolia (Wight) A.Weber & B.L.Burtt, Beitr. Biol. Pflanzen 70: 351. 1997; T.S.Nayar *et al*., Fl. Pl. Western Ghats 1: Dicots 529. 2014; Janeesha & Nampy, Phytotaxa 268(1): 84. 2016. *Didymocarpus ovalifolia* Wight, Icon. Pl. Ind. Orient. 4: 24. t. 1351. 1848, Ill. Ind. Bot. 2: 131. t. 142, fig. 6. 1850; Hook.f., Fl. Brit. India 4: 354. 1885; Rama Rao, Fl. Pl. Travancore 295. 1914; Gamble, Fl. Madras 2: 988. 1924; M. Ahmedullah & M.P.Nayar, Endemic Plants of Indian region 1: 143. 1987; A.N. Henry *et al*., Fl. Tamil Nadu Ind. Ser I: Analysis 2: 132. 1987; Manilal, Fl. Silent Valley 200. 1988; M.Mohanan & A.N.Henry, Fl. Thiruvananthapuram Dist. 338. 1994; Gopalan & A.N.Henry, Endemic Plants of India 117. 2000; M.Mohanan & Sivad., Fl. Agasthyamala 495. 2002; Sasidh., Biodivers. Doc. Kerala part 6: Fl. Pl. 332. 2004; Noltie, Bot. Robert Wight 7: 276. 2005; T.S. Nayar *et al*., Fl. Pl. Kerala 342. 2006. *Rottlera ovalifolia* (Wight) Kuntze, Revis. Gen. Pl. 2: 476. 1891. **Type:** India, Tamil Nadu, Courtallum, August 1835. 558, *Wight 2673* (E00155178, lectotype designated by Janeesha & Nampy, 2016).

Plates 30, 31; Fig. 14

Perennial scapigerous, stemless herbs with rootstock. ***Roots*** adventaceous. ***Stem*** reduced or absent. ***Leaves*** 8–18, long petiolate, opposite deccusate; petioles 4–14 cm long, hairy throughout, not winged; laminae usually ovate-broadly ovate, rarely orbicular, 3.3–12.8 × 2.5–7.7 cm, slightly acute to obtuse at apex, unequal at base, white strigose or tomentose above and on the lower veins, margins crenate to serrate; veins 7–10 on each side, much branched and conspicuous beneath. ***Cymes*** axillary; scapes 2–5 per plant, scapes 2–3 times divided, 6–8 flowered; bracts two, oblanceolate, 6.38 × 1.34 mm, white tomentose hairy out; peduncles 9–22.5 cm long, terete, green-pale reddish brown, hairy throughout; pedicels 5–10 mm long, terete, narrow, hairy. ***Flowers*** 12–20 × 8–15 mm, large, zygomorphic. ***Calyx*** 5 partite, very deeply

PLATE 30: *Henckelia ovalifolia* (Wight) A.Weber & B.L.Burtt **A.** Plant in natural habitat; **B.** Habit; **C.** Inflorescence; **D.** Single flower; **E.** Calyx; **F.** Calyx with gynoecium; **G.** Bract; **H.** Stamens; **I.** Staminode; **J.** Gynoecium; **K.** Fruit**; L.** Seeds (**A** from *K.P Vimal, M.G. Prasad* & *A.P. Janeesha 137602*; **B-L** from *K.M. Manudev* & *A.P. Janeesha 138919*).

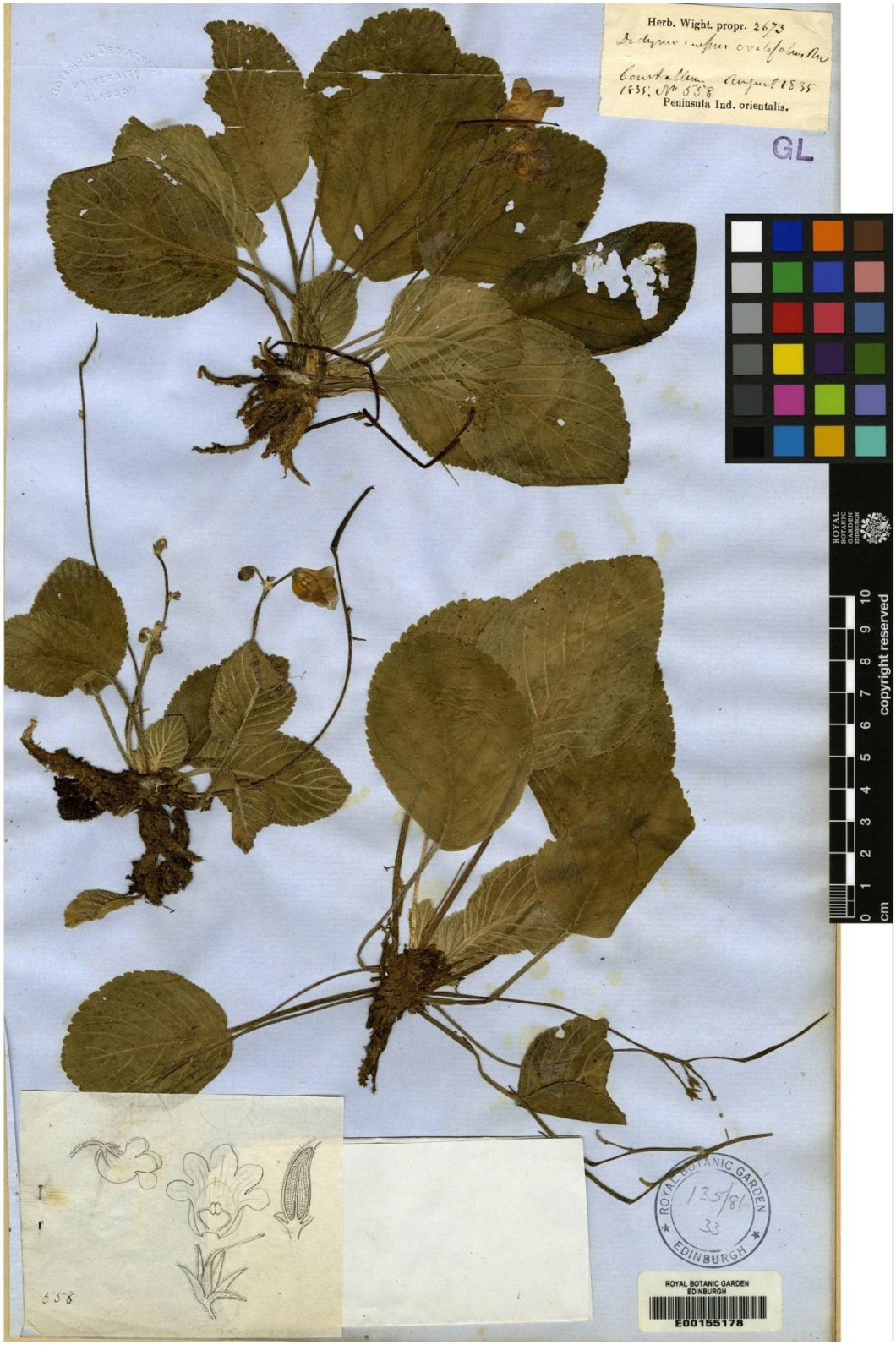


PLATE 31: Lectotype of *Henckelia ovalifolia* (Wight) A.Weber & B.L.Burtt

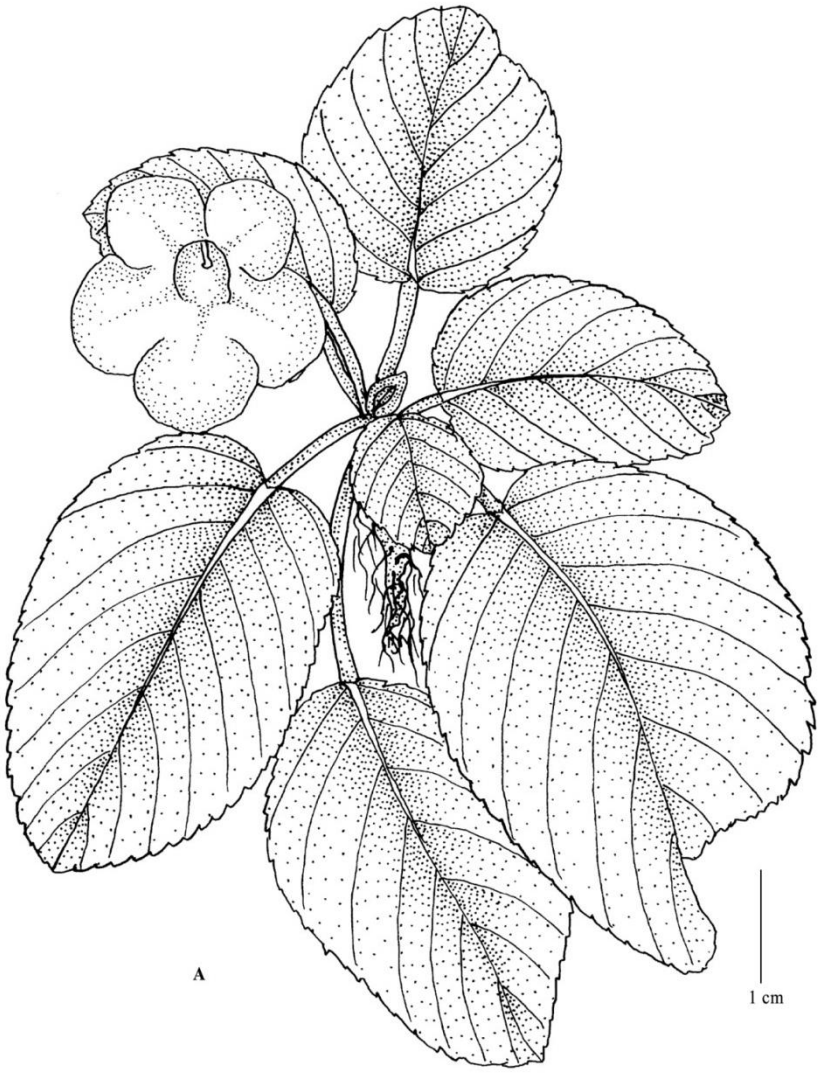


FIGURE 14: *Henckelia ovalifolia* (Wight) A.Weber & B.L.Burtt (From *K.M. Manudev & A.P. Janeesha 138925*).

divided or basally connate; lobes unequal, linear to lanceolate, 5.8–6.8 × 1.1–1.2 mm, reddish brown, slightly acute at apex, margins entire, white tomentose without. ***Corolla*** companulate, white hirsute out, glabrous within, 5-lobed; tube 7.2–11.3 × 5–5.8 mm, very pale violet to brilliant purple colour, deep purple at the throat and a yellow blotch at the base of the tube;

lobes almost equal, very widely ovate, 8.2–8.4 × 7.1–7.25 slightly acute to obtuse at apex, aestivation quincuncial. ***Stamens*** 2, adnate to the base of the corolla, included; filaments 5.3–5.7 mm long, hairy towards the apex, light yellowish green towards the top and milky white towards the base; anthers bithecous, reniform, coherent by the adaxial surface, 1.7–1.9 × 0.65–0.8 mm, yellowish brown colour, glabrous. ***Staminodes*** 2; filaments 3.5–3.7 mm long, hyaline, glabrous; antherodes not prominent. ***Ovary*** narrowly ovoid to cylindrical, tapering to a style, 4.9–5 × 1.1–1.21 mm, green towards the base and reddish brown towards the apex, hairy, unilocular, placentation parietal; style terete, 4–4.1 × 0.35–0.40 mm long, hyaline, hairy throughout up to the middle; stigma capitate, 0.68 × 0.38 mm, papillate like. ***Capsules*** linear, straight, 36–44 × 2–2.2 mm, reddish brown, hairy with rudimentary stigma and persistent calyx. ***Seeds*** numerous, elliptic, 0.49–0.59 × 0.21–0.24 mm, acute at apex, truncate at base;
testa dark brown, pitted.

Chromosome number: Not reported.

Flowering & fruiting: June-October (up to February).

Habitat & ecology: In moist shady areas of dense evergreen forest, also occurs on mossy tree trunks. Grow in association with *Impatiens travancorica* Bedd. (Balsaminaceae), *Christella* sp. (Pteridophyte), *Osbeckia* sp. (Melastomataceae) and some grass species.

Distribution: Endemic to southern Western Ghats (Kerala and Tamil Nadu).

Specimens examined: Kerala, Idukki district, Kallar Reserve Forest, 16.07.1989, *s.col. 90687* (MH); Periyar–Koruthode, 25.09.1996, *Jomy Augustine 16811* (CALI). Kollam district, Thenmala, 15.06.1984, *N. Mohanan 165* (TBGT). Palakkad district, Nillikkal South, 08.06.1982, *Prasannan 10392* (CALI). Thiruvananthapuram district, Agasthyamala, 24.06.1993, *N. Mohanan 11454* (CALI, TBGT); *Ibid*., 19.10.1993, *G. Gangaprasad* & *S. William Decruse 18419* (TBGT); *Ibid*., 06.06.2014, *K.M. Manudev* & *A.P. Janeesha 138919, 138925* (CALI); *Ibid*., 2016, *K. Shinoj* & *A.P. Janeesha 137658* (CALI); Pongalapara, 25.08.1990, *N. Mohanan 10044* (TBGT); Ponmudi, N 8.76°4133, E 77.114°058, 10.10.2014, *K.P. Vimal, M.G. Prasad* & *A.P. Janeesha 137602* (CALI); Western slopes of Agasthyamalai, 06.10.1973, *J. Joseph 44608* (MH). Wayanad district, Gurukula botanical sanctuary (cultivated), 25.11.2014, *A.P. Janeesha* & *S. Resmi 137609* (CALI); Periya, 25.08.1984, *R.T. Balakrishnan 40450*; Thalapaya, 10.02.1986, *R.T. Balakrishnan 41944* (CALI). **Tamil Nadu,** Kanyakumari district, Muthukuzhivayal, 06.08.1977, *A.N. Henry 49610* (MH); *Ibid*., 01.09.1981, *K.M. Matthew 17788* (RHT). Tirunelveli district, Agasthyamalai, 22.06.1901, *C.A. Barber 2918* (MH)*; s.loc.*, 1807, *Major R.H. Beddome 164* (MH).

Notes: This species has the largest flower (around 2 cm long) and fruit (3.5–4 cm long) among South Indian *Henckelia*.

12. Henckelia repens (Bedd.) A.Weber & B.L.Burtt, Beitr. Biol. Pflanzen 70: 354. 1997; T.S.Nayar *et al*., Fl. Pl. Western Ghats 1: Dicots 529. 2014. *Didymocarpus repens* Bedd., Icon. Pl. Ind. Or. 1: 24. t. 120. 1874; Hook.f., Fl. Brit. India 4: 354. 1885; Rama Rao, Fl. Pl. Travancore 295. 1914; Gamble, Fl. Madras 2: 987. 1924; M.Ahmedullah & M.P.Nayar, Endemic Plants of Indian region 1: 143. 1987; A.N.Henry *et al*., Fl. Tamil Nadu Ind. Ser I: Analysis 2:

133. 1987; M.Mohanan & A.N.Henry, Fl. Thiruvananthapuram Dist. 338. 1994; Gopalan & A.N.Henry, Endemic Plants of India 121. 2000; M.Mohanan & Sivad., Fl. Agasthyamala 496. 2002; Sasidh., Biodivers. Doc. Kerala Part 6: Fl. Pl. 332. 2004; T.S. Nayar *et al*., Fl. Pl. Kerala 342. 2006. *Rottlera repens* (Bedd.) Kuntze, Revis. Gen. Pl. 2: 477. 1891 **Type:** Tinnevelly and Travancore forest, 1000–3000 feet elevation, s.d., Beddome s.n. (K000858200, lectotype designated by Vitek *et al*., 2000).

Plates 32, 33; Fig. 15

Creeping herbs, rooting at nodes, hairy throughout. ***Roots*** adventaceous. ***Stem*** slender, terete, hairy; internodes 6–12 cm long. ***Leaves*** usually one or 1–3 per node, long petiolate, not winged; petioles 3.5–18 cm long; laminae broadly ovate to sub-orbicular, 5.2–10 × 5–8.3 cm, acute at apex, cordate at base, hairy, margins doubly crenate; veins 5–6 on each side, much branched and conspicuous beneath. ***Cymes*** few flowered, usually one from each node; scapes 1–3 times divided, 2–4 flowered; peduncles 4–14.5 cm long, terete, green-pale reddish brown, hairy throughout; pedicels 5–10 mm long, terete, narrow, glandular hairy. ***Flowers*** 12–20 × 8–15 mm, large, zygomorphic. ***Calyx*** 5 partite, very deeply divided or basally connate; lobes unequal, broadly lanceolate, 3.4–4.2 × 0.83–1 mm, reddish brown, slightly acute at apex, margins entire, hairy. ***Corolla*** companulate, glandular hairy without, glabrous within, 5-lobed; tube 12–13 × 4.5–5.4 mm, dark to pale lilac with a yellow blotch at the throat; lobes almost equal, elliptic to oblong, 4.9–6.65 × 3.05–5.47 mm, rounded at apex, aestivation quincuncial. ***Stamens*** 2, adnate to the base of the corolla, included; filaments 7.5–8 mm long, broad and hairy at the middle, yellow at the middle, other parts milky white; anthers bithecous, reniform, coherent by the adaxial surface, 2–2.1 × 0.5–0.7 mm, grape colour except the cohering region of the lobes and also the region surrounding the connective. ***Staminodes*** 2; filaments 3.6–4.1 mm long,

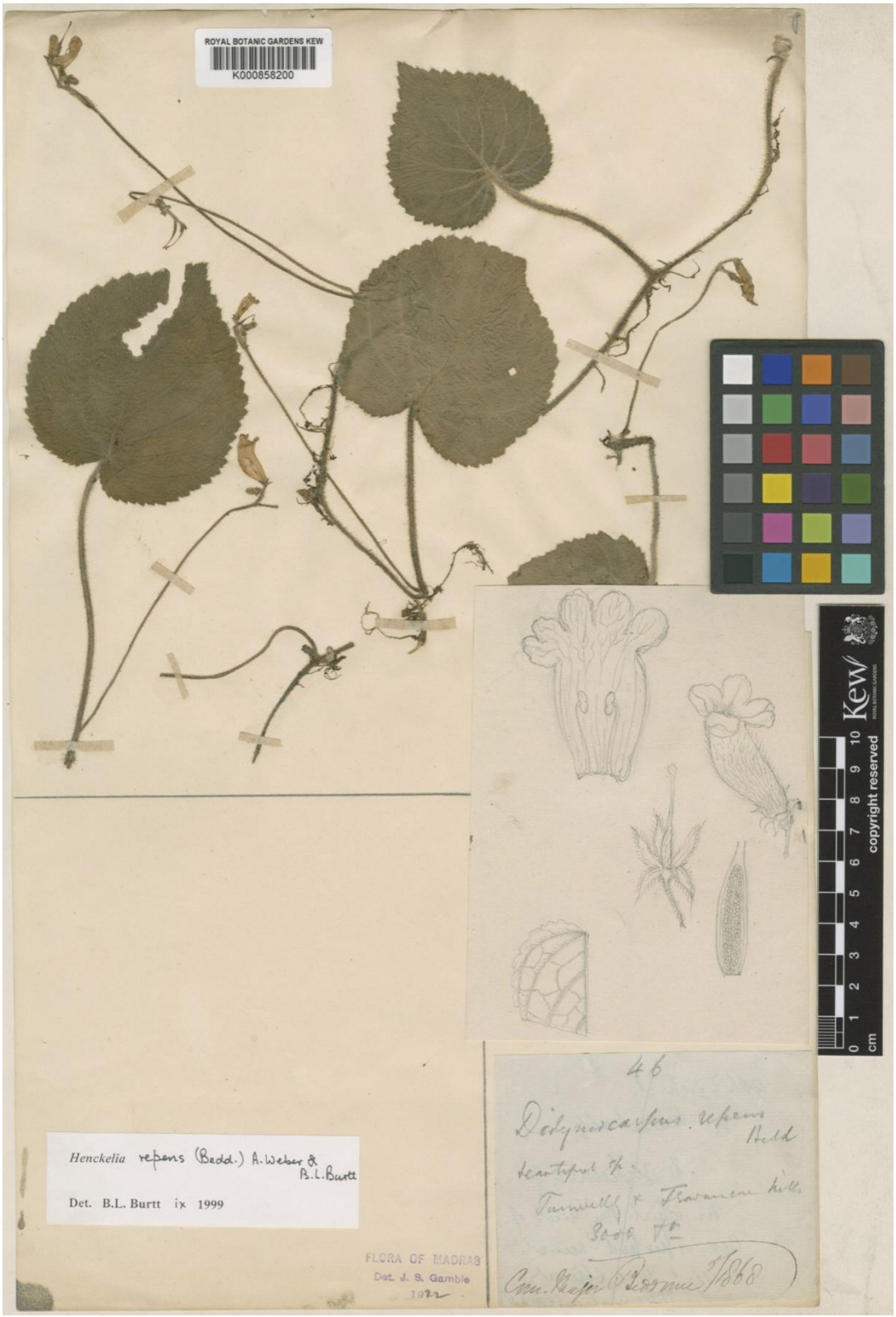


PLATE 33: Lectotype of *Henckelia repens* (Bedd.) A.Weber & B.L.Burtt

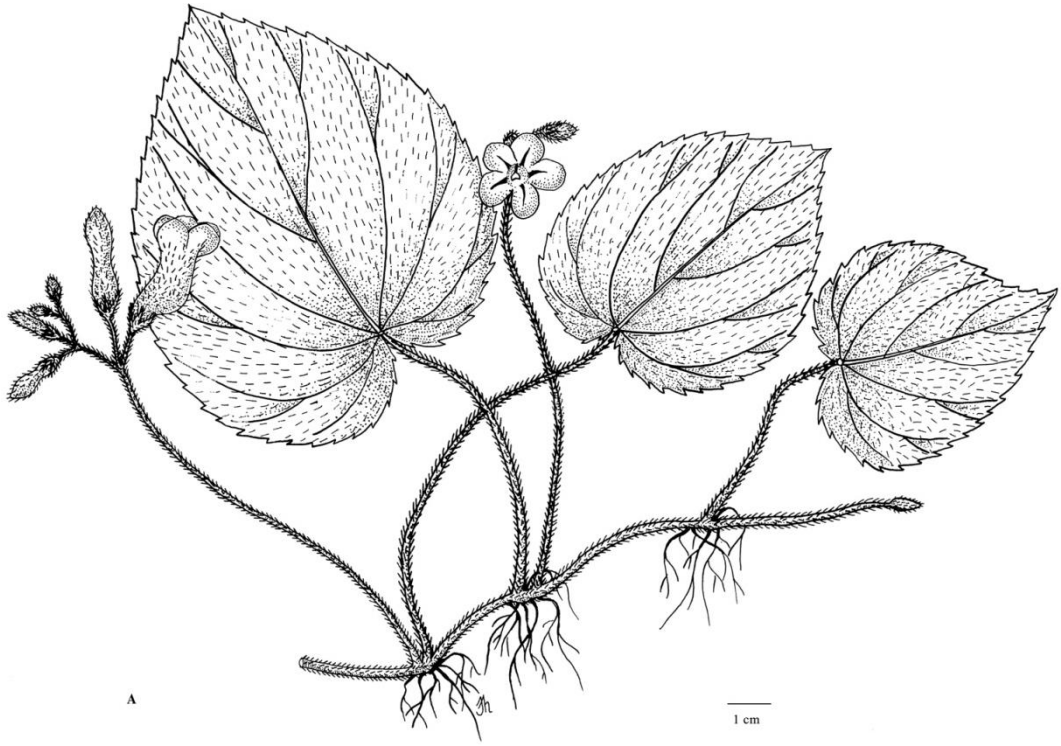


FIGURE 15: *Henckelia repens* (Bedd.) A.Weber & B.L.Burtt (From *K.M. Manudev* & *A.P. Janeesha 138940*).

hyaline, hairy towards the middle; antherodes trilobed, 0.42–0.44 × 0.36–0.37 mm, prominent. ***Ovary*** narrowly ovoid, tapering to a style, 7.2 × 1.21 mm, green towards the base and reddish green towards the apex, hairy, unilocular, placentation parietal; style terete, 4–4.4 × 0.5 mm long, hyaline, hairy throughout; stigma chiritoid like, large, 1.7 × 1.23 mm, glabrous. ***Capsules*** linear, straight, 20–22 × 2–2.2 mm, reddish brown, hairy, with rudimentary stigma. ***Seeds*** numerous, elliptic, 0.49–0.59 × 0.21–0.24 mm, slightly acute at apex, truncate at base; testa dark brown, pitted.

Chromosome number: Not reported.

Flowering & fruiting: May-December.

Habitat & ecology: In moist shady areas of dense evergreen and deciduous forests. Grow in association with *Elatostema* sp., *Pouzolzia* sp. (Urticaceae), *Adiantum lunulatum* Burm. (Adiantaceae), *Christella* sp., *Selaginella* sp. (Pteridophyte) and some grass species.

Distribution: Endemic to southern Western Ghats (Kerala, Tamil Nadu).

Specimens examined: **Kerala,** Kollam district, Colatoor, *s.coll. 1293* (MH). Thiruvananthapuram district, Agasthyamala-Mutthathatti, 06.06.2014, *K.M. Manudev, A.P. Janeesha* & *Santhosh Nampy, 138940* (CALI); Athirumala, 12.08.1988, *N. Mohanan 4227* (TBGT, CALI); *Ibid*., 07.06.2014, *K.M. Manudev, P.G. Arun Kumar* & *A.P. Janeesha 138936* (CALI); Attayar, 13.05.1988, *N. Mohanan 9614*; Bonaccorde, 27.04.1993, *A. Nazarudeen 17128* (CALI); *Ibid*., 21.12.1987, *N. Mohanan 9066* (TBGT, CALI); Ezhumadak-Muttuthath, 07.06.2014, *K.M. Manudev* & *A.P. Janeesha 138940* (CALI); Forest near Bonaccord, 21.08.1975, *J. Joseph 46470* (MH); *Ibid*., 02.10.1973, *J. Joseph 44493* (MH); Chemungi, *s.d*., *Rajkumar 11775*; *Ibid*., 18.08.1992, *E.S. Santhosh Kumar* & *M. Abdul Jabbar 14447* (TBGT); *Ibid*., 11.08.2011, *P.M. Sheeba 66275* (TBGT); Pandimottai, 19.05.1979, *M. Mohanan 61853* (MH); Pidichathamparamal, 31.05.2001, *NWFPS Team 46274* (TBGT); Pinarummodu, 25.09.2008, *C.G. Vishnu 64727* (TBGT); Ponmudi, 28.11.2012, *A.P. Janeesha, P.M. Shahina* & *K.M. Manudev 134240* (CALI); *Ibid*., 10.10.2014, *Vimal, M.G. Prasad* & *A.P. Janeesha 137603* (CALI); *s.loc*., 21.12.1987, *N. Mohanan 9066* (CALI). **Tamil Nadu**, Tirunelveli district, Ambasamudram to

Kannikkatti, 31.12.1977, *K.M. Matthew 15627* (RHT); *Ibid*., 01.01.1978, *K.M. Matthew 15796* (RHT); Chittar river-way to Agasthyamalai, 22.08.1963, *A.N. Henry 16971* (MH); Kannikkatti, 12.06.1899, *C.A. Barber 396* (MH); Kannikkatti to Kalivayalpil, 31.05.1901, *C.A. Barber 3002* (MH); Valayar forest, 11.07.1976, *P. Bhargavan 47445* (MH); way to Ainthuthalai, 14.10.1989, *R. Gopalan 90662* (MH); Way to Pothgai malai, 16.10.1989, *R. Gopalan 91605* (MH); way to Kalivarapil, 23.01.1991, *R. Gopalan 94658* (MH); Tirunelveli district, *s.loc*.,1877, *R.H. Beddome s.n.* (MH); Papanasam hills 1867, *R.H. Beddom s.n.* (MH).

13. Henckelia wightii (C.B.Clarke) A.Weber & B.L.Burtt, Beitr. Biol. Pflanzen 70: 359. 1997. *Didymocarpus rottleriana* Wall., Wight, Icon. Pl. Ind. Orient. 4: 24. t. 1348. 1848. *Didymocarpus rottlerianus* Wall. *ex* R.Br. var. *wightii* C.B.Clarke in A.DC. & C.DC., Monogr. Phan. 5: 101. 1883. *Didymocarpus wightii* (C.B.Clarke) Gamble, Fl. Madras 2: 989. 1924; Gopalan in A.N.Henry et al., Fl. Tamil Nadu Ind. Ser I: Analysis 2: 133. 1987; M.Ahmedullah & M.P.Nayar, Endemic Plants of Indian Region 1: Peninsular India 143. 1987; Sasidh., Biodivers. Doc. Kerala Part 6: Fl. Pl. 332. 2004; T.S.Nayar *et al*., Fl. Pl. Kerala 343. 2006; T.S.Nayar *et al*., Fl. Pl. Western Ghats 1: Dicots 529. 2014. **Type:** Shevghery, Courtallum, Wight 2323 (K000858201, lectotype designated here). **Plates 34, 35; Fig. 16**

Henckelia sivagiriensis (Rajakumar *et al.*) E.S.S. Kumar *syn. nov*., Polish Bot. J. 59(1): 149. 2014. *Didymocarpus sivagiriensis* Rajakumar *et al*., Indian J. Forest. 32(3): 481. 2009; T.S.Nayar *et al*., Fl. Pl. Western Ghats 1: Dicots 527. 2014. Type: Tirunelveli, Thalayani reserve forest, Rajakumar, Selvakumari, Murugesan & Chellapperumal 829 (Holotype-JCH!).

Perennial scapigerous, stem-less hairy herbs with rootstocks. ***Roots*** adventitious, thin. ***Leaves*** 12–20, basal, whorl of four, sometimes whorl of

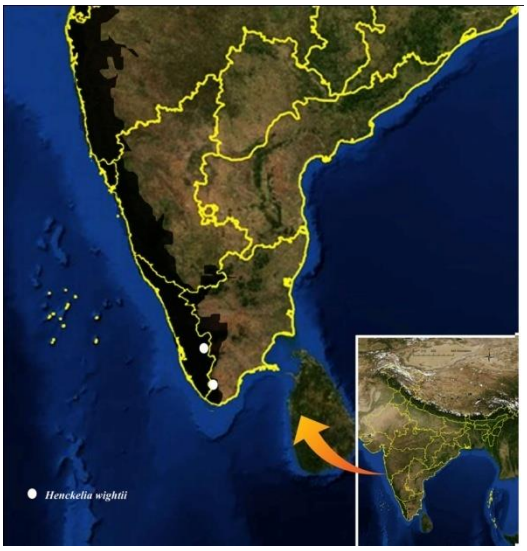
five or seven; leaves narrowly end in to a petiole, having a sessile to sub-sessile appearance; laminae spathulate-obovate to elliptic, 3.8–10.7 × 1.6–3.6 cm, obtuse to rounded at apex, attenuate at base, with white wooly hairs on both surfaces, but more on the younger leaves and on lower veins, becoming less so with age, margins slightly crenate and undulate, surfaces smooth, velvety; veins 4–6 on each side, much branched and conspicuous beneath. ***Cymes*** axillary, dense; scapes 2–6 per plant, 3–4 times divided, 5–13 flowered, glandular hairy; peduncles 10–18 cm long, terete, greenish, glandular hairy; bracts two at each branching, minute, completely wooly, c. 2 mm; pedicels 9–18 mm long, terete, narrow, glandular hairy. ***Flowers***, zygomorphic. ***Calyx*** 5 partite, very deeply divided; lobes oblong-lanceolate, 2–3 mm, slightly acute at apex, margins entire, with white wooly hairs on

FIGURE 16: *Henckelia wightii* (C.B.Clarke) A.Weber & B.L.Burtt (Cultivated in Gurukula Botanical Sanctuary, Periya)

the upper side. ***Corolla*** companulate, glandular hairy without, glabrous within, 5-lobed, pouched; tube lilac to pale lilac with a yellow patch at the throat; lobes unequal, orbicular, ovate to rounded at apex. ***Stamens*** 2, adnate to the base of corolla, included; filaments c. 2 mm long, glabrous; anthers bithecous, reniform, coherent by the adaxial surface, glabrous. ***Staminodes*** 3 (sometimes 2); filaments c. 1.2 mm long, glabrous; antherodes not seen. ***Ovary*** ovoid to cylindrical, c. 2.5 mm, white tomentose hairs, unilocular, placentation parietal, completely enclosed within calyx; style terete, c. 1.3

mm long, glabrous; stigma glabrous, sub-capitate. ***Capsules*** linear-cylindric, straight, 11–17 mm long, green, tomentulose with rudimentary stigmaand persistent calyx. ***Seeds*** numerous.

Chromosome number: Not reported.



Flowering & fruiting: July.

Habitat & ecology: On moist rocks.

Distribution: Endemic to southern Western Ghats (Kerala, Tamil Nadu).

Specimens examined: Kerala, Idukki district, Karadippara-Munnar, 25.07.2013, *A.P. Janeesha* & *K.M. Manudev 134203* (CALI). **Tamil Nadu,** Erode district, Attamalai Hills, 24.07.1988, *N. Venkatasubramanian 1424* (FRC). Ramnad district, Kendiparai to Cumbumedu-Ayyanar Koil, 23.09.1971, *E. Vajravelu 38720* (MH); Mudaliarattu, 11.12.1971, *E. Vajravelu* 39339 (MH). Tirunelveli district, New Courtallum, 16.07.2015, *A.P. Janeesha, S. Resmi* & *P.G. Arunkumar 137628* (CALI).

Jerdonia Wight

Jerdonia was originally described by Robert Wight (1848) in his *Icones Plantarum Indiae Orientalis*, commemorating Major T.C. Jerdon, an eminent ornithologist and surgeon of the Indian Army. The genus is monotypic and includes the local endemic *J. indica* Wight, distributed in southern Western Ghats. Features like four separate parietal placentae, flattened, spurred filaments and isocotylous seedlings makes *Jerdonia* unusual within

Gesneriaceae. Wight (1848, 1850), Bentham (1876), Clarke (1883) and Fritsch (1893–1894) treated it under Gesneriaceae while Burtt (1977) placed it under Scrophulariaceae. According to Weber (1989b), the inflorescences are composed of pair-flowered cymes and thus match an important gesneriacean character. Weber (1989a) also reported that their seeds are prominently aulacospermous and endosperm is star like in cross section. Due to its anomalous features Weber & Skog (2007) doubted the inclusion of this genus in Gesneriaceae. Based on molecular data, Moller *et al.* (2009) placed it under Gesneriaceae, falling in the ''Basal Asiatic genera'' as sister to all of the remaining Didymocarpoid Gesneriaceae which does not equate to primitive. In the most recent classification of Gesneriaceae, Weber *et al*. (2013) included this genus under the sub-family Didymocarpoideae Arn., tribe *Trichosporea* Neesand sub-tribe *Jerdoniinae* A.Weber & B.L.Burtt.

Jerdonia Wight, Icon. Pl. Ind. Orient. 4: t. 1352. 1848, Ill. Ind. Bot. 2: t. 159b. 1850; Hook.f., Curtis's Bot. Mag. 96: t. 5814. 1870; C.B.Clarke in Hook.f., Fl. Brit. India 4: 339. 1885; Gamble, Fl. Madras 2: 991. 1924; B.D.Sharma *et al*., Fl. Karnataka: analysis 1: 197. 1984; A.Weber in Kubitzki, Fam. Gen. Vasc. Pl. 7: 150. 2004. **Type**: *Jerdonia indica* Wight

Perennial herbs. ***Stems*** reduced, with prominent leaf scars. ***Leaves*** simple, petiolate; laminae ovate-elliptic, pubescent. ***Inflorescences*** axillary, erect, hairy throughout, longer than the leaves. ***Flowers*** horizontal, pedicellate, pale lilac to white; bracts linear, pilose. ***Calyx*** of 5 sepals; lobes lanceolate, free. ***Corolla*** infundibuliformis, bilabiate, zygomorphic, inner hairy on the swollen portion of the tube and the throat; tube funnel shaped, swollen towards the anterior, upper lip with two small lobes, lower with three large lobes, lobes rounded. ***Stamens*** 4, all fertile, cohering over the stigma by their

lobes, anterior filament hairy at the top, posterior filament with a descending spur; anthers bithecous, hairy on one side. ***Disk*** annular. ***Ovary*** ovoid, locule 1, glabrous; placentae 4, parietal; style linear, glabrous; stigma peltate. ***Capsules*** ovoid to globose, hairy, reddish brown. ***Seeds*** ellipsoid, hooked at the apex; testa pitted, dark brown.

Distibution: The genus is monotypic, represented by *J. Indica*, endemic to southern Western Ghats (Janeesha & Nampy, 2014).

Jerdonia indica Wight, Icon. Pl. Ind. Orient. 4: t.1352. 1848, Ill. Ind. Bot. 2: t. 159b. 1850; Hook.f., Curtis's Bot. Mag. 96: t. 5814. 1870; C.B.Clarke in Hook.f., Fl. Brit. India 4: 339. 1885; Gamble, Fl. Madras, 2: 991. 1924; B.D.Sharma *et al*., Fl. Karnataka: analysis 1: 197. 1984; M.Ahamedullah & M.P.Nayar, Endemic Plants of Indian region 1: 143. 1987; Noltie, Bot. Robert Wight, Chapter 7: 276. 2005; T.S.Nayar *et al*., Fl. Pl. Kerala 344. 2006; Janeesha & Nampy, Envis Newsletter 19(2): 8. 2014. **Type**: Western slopes of the Nilgiri, March/ April. *Wight s.n.* (Icon. Pl. Ind. Orient. 4: t. 1352, lectotype designated here).

Plates 37, 38; Fig. 17

Perennial herbs with root stock, 16–28 cm long; root stock 2–10 cm long, with persistent leaf scars. ***Stems*** reduced. ***Leaves*** simple, opposite-deccusate in juvenile stage, later became alternate; laminae ovate-elliptic, 3–9.2 × 2–7 cm long, acute to acuminate at apex, cordate to sagittate at base, younger leaves pubescent, margin and veins of older leaves covered with purple or reddish hairs; petioles 2.5–13 cm long, purplish green, hairy. ***Inflorescences*** axillary, 2–6 per plant, erect, few flowered, 10–21 cm long, purple, hairy throughout, longer than the leaves. ***Flowers*** 1.2–2.5 cm long, horizontal, pouched; pedicels 8–15 mm long, purple, terete, hairy; bracts 3–5 mm long, linear, pilose. ***Calyx*** of 5 sepals; lobes lanceolate, 3.7–8 × 0.85–1.05 mm, free,

purplish green, hairy. ***Corolla*** infundibuliform, bilabiate, zygomorphic, pale lilac or milky white with a pinch of orange colour, streaked with dark lilac, inner hairy on the swollen portion of the tube and throat; tube funnel shaped, swollen towards the anterior, upper lip with two small lobes, lower with three large lobes, lobes rounded. ***Stamens*** 4, all fertile, cohering over the stigma by their lobes; anterior filament 6.3–7.1 mm long, hairy at the top,

PLATE 37: *Jerdonia indica* Wight **A.** Habit; **B.** Flowering twig; **C.**Throat of corolla; **D.** Calyx; **E.** Posterior stamen; **F.** Anterior stamen; **G.** Gynoecium with disk; **H.** Fruit; **I.** Fruit at the time of dehiscence; **J.** Seeds (**A** from *A.P. Janeesha* & *A.P. Janid Khan 134265*; **B-J** from *A.P. Janeesha, S. Syam Radh* & *P.G. Arunkumar 134211*).

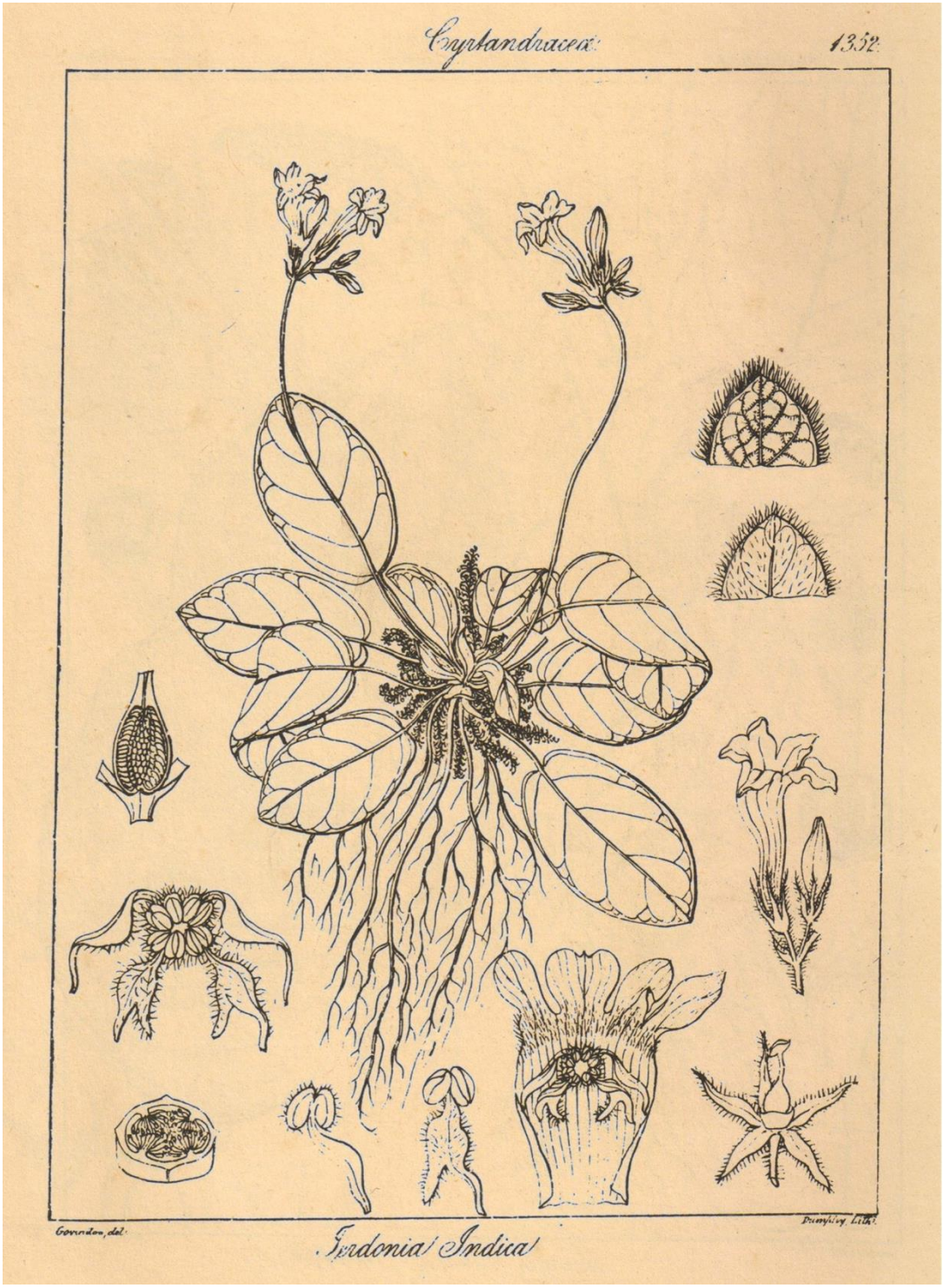


PLATE 38: Lectotype of *Jerdonia indica* Wight

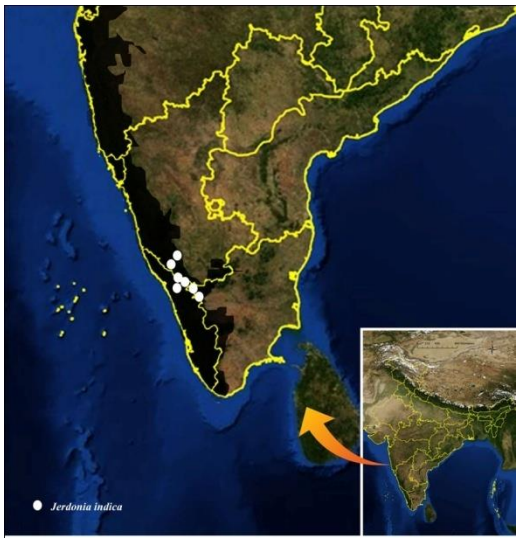
FIGURE 17: *Jerdonia indica* Wight (From *A.P. Janeesha, S. Syam Radh* & *P.G. Arunkumar 134211*)

posterior filament 7–7.5 mm long, with a descending spur; spur yellow, hairy on one side; anthers 0.7–1.08 mm long, bithecous, hairy on one side. ***Disk*** annular, bright orange, 0.5 mm long. ***Ovary*** ovoid, 2.2–2.8 mm long, locule 1, glabrous, narrowed in to a short style, situated in a disk; style linear, 0.6 mm long, glabrous; stigma peltate, 1.27 × 1.10 mm; placentae 4, parietal, bearing numerous ovule. ***Capsules*** ovoid to globose, 5–8.1 × 5.1–7.2 mm, hairy, reddish brown. ***Seeds*** ellipsoid, hooked at the apex, 0.7–0.75 × 0.37–0.45 mm; testa pitted, dark brown.

Chromosome number: Not reported.

Flowering & fruiting: March-April and August-September.

Habitat & ecology: In moist, shady slopes, in way sides and river banks, usually at an elevation of 400–960 m above sea level. Grown in association with *Elatostema lineolatum* Wight (Urticaceae), *Christella* sp. (Pteridophyte) and some moss species.



Distribution: Endemic to southern Western Ghats, (Kerala, Tamil Nadu and Karnataka).

Specimens examined: Karnataka, Gadag district, Mulgund, 02.03.1889, *W.A. Talbot 1869* (BSI, CAL). Hassan district, Bisle Ghat, 16.07.1967, *C.J. saldanha 10739* (JCB); *Ibid*., 15.05.1968, *C.J. Saldanha 11694* (JCB); *Ibid*., 24.10.1970, *F.M. Jareett* & *T.P. Ramamoorthy 984* (E, JCB); *Ibid*., 04.05.1971, *C.J. Saldanha* & *T.P. Ramamoorthy 1670* (E, JCB); *Ibid*., 14.08.1971, *T.P. Ramamoorthy 1990* (E); *Ibid*., 23.09.1971, *C.J. Saldanha* & *K.N. Gandhi 2157* (E, JCB); *Ibid*., 22.01.1972, *D.H. Nicolson, T.P. Ramamoorthy* & *K.N. Gandhi 2864* (JCB). Kodagu district, Coorg, 12.09.1934, *s.coll. 933* (MH); Mercara-on the way to Abis falls, 24.09.1961, *A.S. Rao 74619* (BSI, E); *Ibid*., 20.10.1963, *A.S. Rao 94981* (CAL); *Ibid*., 14.11.1965, *P.J. Cherian 107114* (E). South Canara district, Subramanya, *s.d., R.S. Raghavan 152053* (BSI). *s.loc*., 04.12.1983, *W.A. Talbot 789* (BSI, CAL). **Kerala**, Idukki district, Anamallai, 06.1882, *Beddome s.n.* (MH). Kottayam district, forest road side between Watekolly and Kakkathodu, 03.05.1970, *K.N. Subramanian 4024* (FRC). Kozhikode district, Muthappanpuzha, way to Kundanthode, 15.06.2015, *A.P. Janeesha* & *S. Resmi 137625* (CALI);

Pakramthalam churam, 20.07.2010, *Manudev K.M. 3028* (DEV). Palakkad district, *s.d., s.coll. 83* (CAL). Pathanamthitta district, Elamannoor, 20.09.1985, *Anil Kumar C. 05049* (TBGT). Wayanad district, Boys town, Kannur-Manathavadi route, *P.K. Dilna*, *Shimi Cheriyan* & *A.P. Janeesha 137680* (CALI); Carcoor ghat, 1864, *Beddome s.n.*, (MH); Chandanathode, 11.12.1920, *C.E.C. Fischer 4564* (CAL); *Ibid*., 25.06.1965, *J.L. Ellis 25172* (MH); *Ibid*., 13.07.1978, *V.S. Ramachandran 57594* (MH), *Ibid.,* 22.02.1979, *V.S. Ramachandran 61309* (CAL, MH); *Ibid*., 15.10.1981, *V.P.K. Nambiar 5823* (KFRI); *Ibid*., 04.02.2010, *Santhosh Nampy* & *Manudev K.M. 2686* (DEV); Kanthanpara, 26.12.1997, *E.J. Jose Kutty 60020* (CALI); Nedumpoyil-Palchuram, 25.11.2014, *A.P. Janeesha, Santhosh Nampy* & *S. Resmi 137606* (CALI); Palchuram-4th mile, 31.08.2013, *A.P. Janeesha, S. Syam Radh* & *P.G. Arunkumar 134211* (CALI); *Ibid*., 01.07.2014, *A.P. Janeesha* & *A.P. Janid Khan 134265* (CALI); Periya, 06.12.1994, E*.S. Santhosh Kumar 23224* (TBGT); *Ibid*., 28.12.2007, *K.P. Deepthy 60537* (TBGT); Periya Ghat-4th hairpin turn, 22.08.2015, *P.K. Dilna, A.K. Pradeep* & *A.P. Janeesha 137632* (CALI). *s.loc.,* 1869, *Beddome s.n.* (MH); South Malabar, 11.12.1920, *C.E.C. Fischer 4564* (FRC). **Tamil Nadu,** Coimbatore district, Siruvani, 03.01.1978, *N.C. Nair 41497* (CAL, MH). Nilgiri district, Naduvattam, 08.1883, *M.A. Lawson s.n.* (MH).

Microchirita (C.B.Clarke) Yin Z. Wang

Microchirita is a small genus with about 28 species, distributed in Western Ghats of India, the foothills of the Himalayas, through continental Southeast Asia to Borneo, Sumatra and Java (Weber *et al*., 2011). The genus is unique with its crested epiphyllous inflorescences. The other features of the genus are fleshy stems, presence of a connective tissue holding the two fertile anthers together, and a dense indumentum on the dorsal side of anthers. As per the recent classification of Gesneriaceae by Weber *et al.*

(2013), the genus comes under Subfamily Didymocarpoideae Arn., tribe *Trichosporeae* Nees and sub-tribe Didymocarpinae G.Don.

The genus was established by Wang *et al*. (2011) by elevating *Chirita* sect. *Microchirita* to a distinct genus based on phylogenetic analysis of *Chirita* and its allies combined with morphological data using nrDNA internal transcribed spacer and cpDNA *trnL-F*. They considered *Chirita* as an artificial, polyphyletic genus and concluded that *Chirita* sect. *Microchirita* is an independent clade located at the basal node of the phylogenetic tree. Five new combinations were made by Wang *et al*. (*l.c.*). Weber *et al.* (2011) also carried out a similar kind of study and remodelled *Chirita* and associated genera. They corroborated the views of Wang *et al.* (*l.c.*) in keeping *Microchirita* as a distinct genus and made several new combinations.

Since then several new species were described from different places like Thailand, Malesia *etc*. (Rafidah & Haron, 2013; Middleton & Tiboun, 2013; Puglisi *et al*., 2016) making the total number of species in this genus to 28 (Moller *et al*., 2017 in press). Punekar and Lakshminarasimhan (2009) published a new species of *Chirita* from Western Ghats. This species too belongs to the *Chirita* sect. *Microchirita* and later combined under *Microchirita* as *M. sahyadriensis* (Punekar & Lakshmin.) A.Weber & D.J.Middleton (Weber *et al*., 2011).

The genus has two species in India and both occur in South India. *M. hamosa* (R.Br.) Yin Z.Wang is the common species distributed in Northern and North eastern India, rarely in South India (Karnataka) where as *M. sahyadriensis* is endemic to Western Ghats.

Microchirita (C.B.Clarke) Yin Z.Wang, J. Syst. Evol. 49(1): 59. 2011; Weber *et al*., Taxon 60(3): 778. 2011. *Chirita* sect. *Microchirita* C.B. Clarke in A.DC. & C.DC., Monogr. Phan. 5: 127. 1883. *Roettlera* sect. *Microchirita* (C.B.Clarke) Fritsch in Engler & Prantl, Nat. Pflanzenfam. 4(3b): 148. 1895. *Didymocarpus* sect. *Microchirita* (C.B.Clarke) Chun, Sunyatsenia 6: 290. 1946. **Type**: *Microchirita hamosa* (R.Br.) Yin Z.Wang (lectotype designated by Burtt, 1954).

Annual, caulescent herbs. ***Stems*** often fleshy or juicy. ***Leaves*** in distant pairs, except lower most leaf solitary (macrocotyledon). ***Inflorescences*** usually two or several in a leaf axil, often displaced onto the petiole, often consisting of a short-stalked serial flower pair only, but this repeated several times (serial arrangement, "inflorescence crest"), peduncle usually fused with the petiole. ***Calyx*** of 5 sepals; lobes free to base, narrowly triangular to narrowly ovate, appressed to fruit. ***Corolla*** usually infundibuliform, rarely tubular or funnel-shaped; limb bilabiate; upper lip 2-lobed, lower lip 3-lobed, lobes rounded; colour white, bluish, blue. ***Stamens*** 2, anthers usually joined by the projections on the connectives. ***Ovary*** not stipitate; stigma chiritoid. ***Fruit*** an elongate, straight or curved capsule, usually splitting into 2 valves. ***Seeds*** minute, ellipsoid with conspicuous knobs on the testa cells.

Distribution: Western Ghats of India, the foothills of the Himalayas, through continental Southeast Asia to Borneo, Sumatra and Java.

Key to the species

1a. Calyx lobes 5–11 mm long, hairy throughout; corolla hairy out; anthers bearded.....**M. hamosa**

1b. Calyx lobes up to 3 mm long, hairy at the apex and base, glabrous in middle; corolla glabrous out; anthers not bearded.....**M. sahyadriensis**

1. Microchirita hamosa (R.Br.) Yin Z.Wang, J. Syst. Evol. 49(1): 60. 2011; Weber *et al*., Taxon 60(3): 778. 2011. *Chirita hamosa* R.Br., in Benn., Pl. Jav. Rar. 117. 1840; Subba Rao & Kumari, Bull. Bot. Surv. India 9: 187. 1967; Pull. & Ali Moulali, Fl. Andhra Pradesh 2: 679. 1997; Pull. *et al*., Fl. Pl. eastern Ghats 4: 361. 2011; T.S.Nayar *et al*., Fl. Pl. Western Ghats 1: Dicots 529. 2014. *Didymocarpus hamosus* Wall., Numer. List, no. 788. 1829. nom. nud. *Roettlera hamosa* Kuntze, Revis. Gen. Pl. 2: 475. 1891. **Type**: Trogla in Martabania, *Wallich 788* (K000999524, lectotype designated here).

Plates 40, 41; Fig. 18

Didymocarpus cristatus Dalzell, Hooker's J. Bot. Kew Gard. Misc. 3: 225. 1851. *Chirita cristata* (Dalzell) B.L.Burtt, Notes Roy. Bot. Gard. Edinburgh 23: 96. 1960. Type: Pariwar Ghats, on rocks, Flowering September & October, *Dalzell s.n.* (K000735780, lectotype designated here).

Chirita hamosa R.Br. var. *finlaysonia* C.B.Clarke in A.DC. & C.DC., Monogr. Phan. 5(1) 128. 1883. Type: China, *Finlayson 468*.

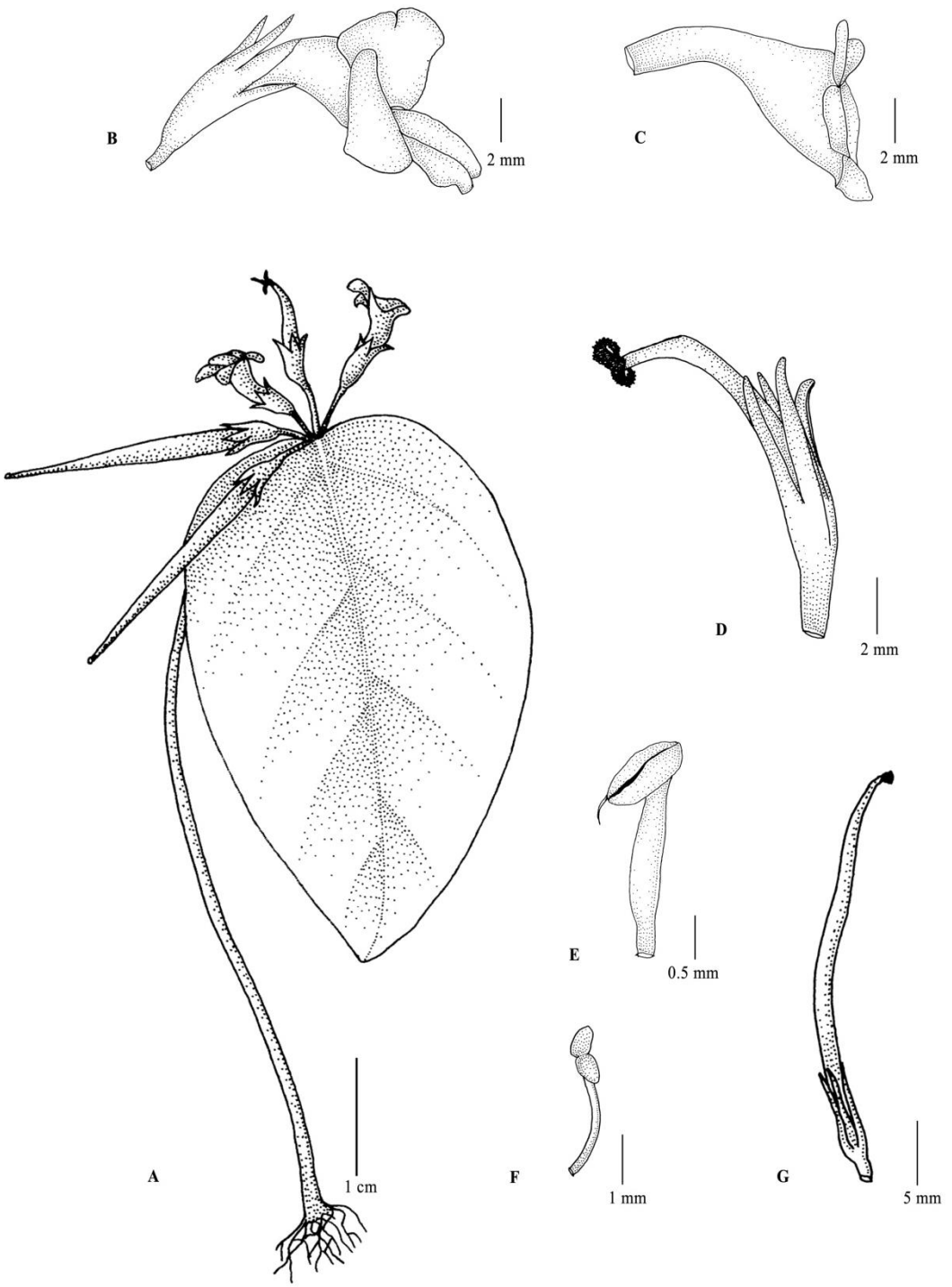


FIGURE 18: *Microchirita hamosa* (R.Br.) Yin Z.Wang **A.** Habit; **B.** Single flower; **C.** Corolla; **D.** Calyx enclosing gynoecium; **E.** Stamen; **F.** Staminode; **G.** Fruit (**A-G** from *Karan Rana* & *A.P. Janeesha 134300*).

Chirita hamosa R.Br. var. *unifolia* C.B.Clarke in A.DC. & C.DC., Monogr. Phan. 5(1): 129. 1883. Type: India, Meghalaya, Khasia, alt. 150 mtr.

Didymocarpus pygmaeus C.B.Clarke in A.DC. & C.DC., Monogr. Phan. 5(1): 82. 1883; Gamble, Fl. Madras 2: 988. 1924; R.S.Rao & S.Hara, Fl. Srikakulam Dist. 348. 1986; Pull. & Ali Moulali, Fl. Andhra Pradesh 2: 679. 1997; Subba Rao & Kumari, Fl. Vishakhapattanam Distr. (Andhra Pradesh) 602. 2002; Pull. *et al*., Fl. Eastern Ghats 4: 362. 2011. *Roettlera pygmaea* Kuntze, Revis. Gen. Pl. 2: 476. 1891. Type: Chota Nagpur, *s.d., C.B.Clarke 25070* (BM000997735, lectotype designated here).

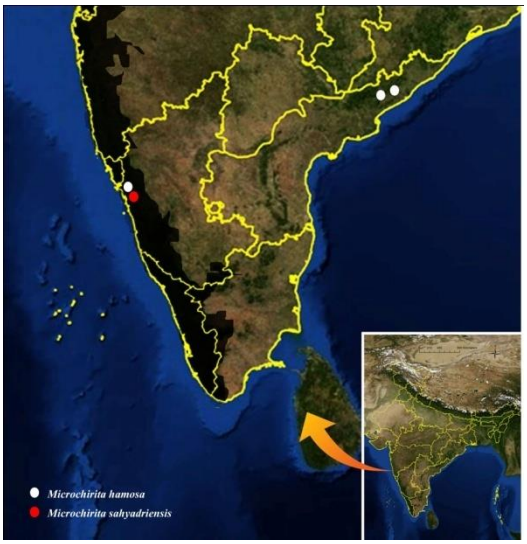
Annual succulent herbs. ***Stems*** 5–12 cm long, erect**,** sparsely puberulent to glabrous. ***Leaves*** 1–4, lowermost one solitary, upper leaves opposite; lamina 2– 6 × 1.7–4 cm, ovate, base rounded to cordate, margin entire, apex acute to obtuse; upper surface puberulent, lower surface sparsely puberulent to glabrescent, lateral veins 6–16 on each side of midrib, conspicuous. Petiole 1–3 mm long, glabrescent. ***Inflorescence*** 2– 5 flowered. Peduncle inconspicuous. Bracts absent. Pedicel 3–14 mm long, spreading pubescent. ***Calyx*** of 5 sepals, fused to form a small tube; tube 1–2.18 × 1.4–2.2 mm long; outside puberulent, inside glabrous; lobes linear-lanceolate to triangular, unequal, 5.1–7.85 × 0.5–0.79 mm, apex acute, margin entire, hairy out, glabrous inside. ***Corolla*** white, throat yellow, 1–1.8 cm long, outside sparsely puberulent, inside glabrous; tube 8–12 × 2–3.2 mm; upper lip of 2 lobes, lobes widely depressed ovate to orbicular, 2–3 × 1.4–1.9 mm long, apex runded, lower lip of 3 lobes, widely ovate, 3–5 × 2–3.1 mm long apex slightly acute to obtuse. ***Stamens*** 2; filaments 2.6–3.8 mm long, glabrous; anthers 1–1.3 × 0.5–0.59 mm, bearded; staminodes 2, 0.8–1.3 mm long. ***Ovary*** cylindrical, 6–8.2 × 1.3–1.67 mm, puberulent; style 2.8–5 mm long,

puberulent; stigma bifid, pappillate, each lobe 1.2–1.4 × 0.55–0.65 mm. ***Capsules*** erect, linear to slightly curved, 2.8–4.1 × 0.11–0.14 cm, pubescent, with persistent calyx and rudimentary stigma, calyx reaches 1/4th of the fruit length.

Chromosome number: n=17 (Milne, 1975).

Flowering & fruiting: September–December.

Habitat & ecology: Grows on shaded rocks in the forest, cliffs or streamside valleys. Sometimes occur in the walls of fort.



Distribution: Southern, Northern and northeastern India, China (Guangxi, Yunnan), Burma, Thailand, Laos, northern Vietnam.

Specimens examined: Andhra Pradesh, Vishakapattanam district, Punyagirir, 09.1961, *P.N. Rao s.n*. (E00627763); Srungavarapukota, 21.10.1964, *G.V. Subbarao 21819* (E, MH) *21814* (E); *Ibid*., 21.10.1964, *G.V. Subbarao 21814* (MH). East Godavari district, Bison hills, 03.12.1902, *C.A. Barber 5063* (MH). **Gujarat,** Narmada district**,** Shoolpaneswar Wildlife Sanctuary, 24.09.2015, *Karan Rana & A.P. Janeesha 134300* (CALI). **Karnataka**, Uttara Kannada district, Magod-Surge tank, 30.09.1981, *S.R. Ramesh* & *S. Udaya Kumar 13704* (JCB). **Kerala**, Wayanad district, Gurukula botanical sanctuary, in cultivation, 15.09.2016, *A.P. Janeesha* & *K. Haseem 137693* (CALI).

2. Microchirita sahyadriensis (Punekar & Lakshmin.) A.Weber & D.J.Middleton, Taxon 60(3): 779. 2011. *Chirita sahyadriensis* Punekar & Lakshmin., Folia Malaysiana 10: 18. 2009; Punekar & Lakshmin. Fl. Anshi Nat. Park 338. 2011; T.S.Nayar *et al*., Fl. Pl. Western Ghats 1: Dicots 530. 2014. **Type**: Ulvi to Akalgavi road, Anshi National Park, Uttara Kannada, Karnataka, 22.10.2001, *Punekar* & *Laksminarasimhan 178331* (Holotype-CAL0000019224!). **Plate 42; Fig. 19**

Annual lithophytic succulent herbs. ***Stems*** 12 cm high, erect, sparsely hairy. ***Leaves*** lower one solitary, upper one opposite, petiolate to sub-sessile; laminae ovate elliptic to lanceolate, lower leaf 10 × 6.5 cm, upper leaf 4 × 2.8 cm, acute atapex, cordate at base, margin entire with marginal hairs. ***Inflorescences*** as a crest, 2–4 flowered**.** ***Calyx*** of sepals 5, 3 mm long; tube not clear; lobes hairy at the apex and base, glabrous in between. ***Corolla*** white, bilabiate, glabrous outside; tube slender; upper lip 2-lobed, lower lip 3-lobed. ***Stamens*** 2, epipetalous, included. ***Ovary*** 5 mm long, hairy; style 6 mm long; stigma bifid. ***Capsules*** c. 2 cm long, linear, glabrous, many seeded. ***Seeds*** not seen.

Chromosome number: Not reported.

Flowering & fruiting: August-December.

Habitat & ecology: Rare, grows on the limestone rocky cliff.

Distribution: Endemic to southern Western Ghats; hitherto reported only from the type locality.

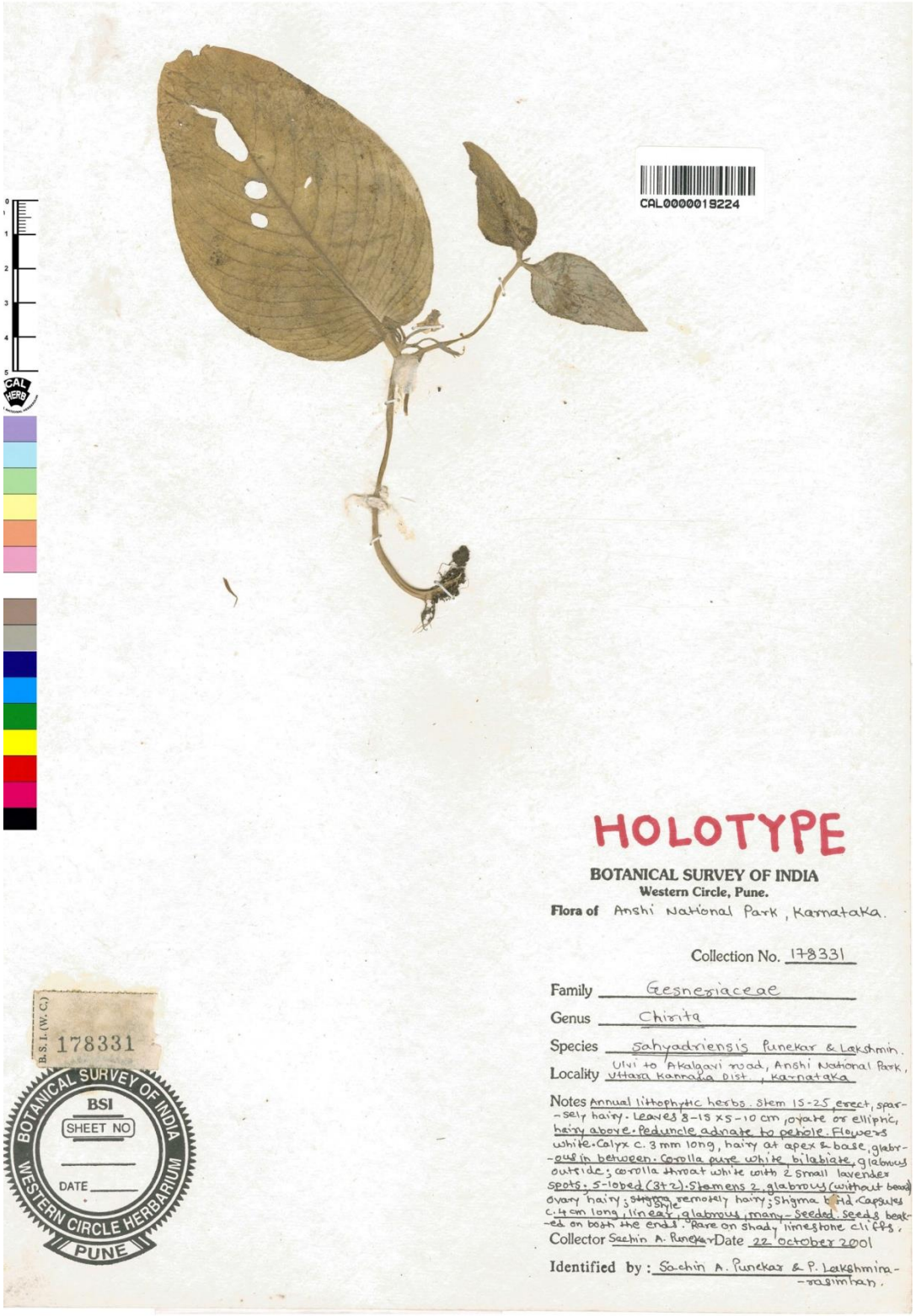


PLATE 42: Holotype of *Microchirita sahyadriensis* (Punekar & Lakshmin.) Yin Z.Wang

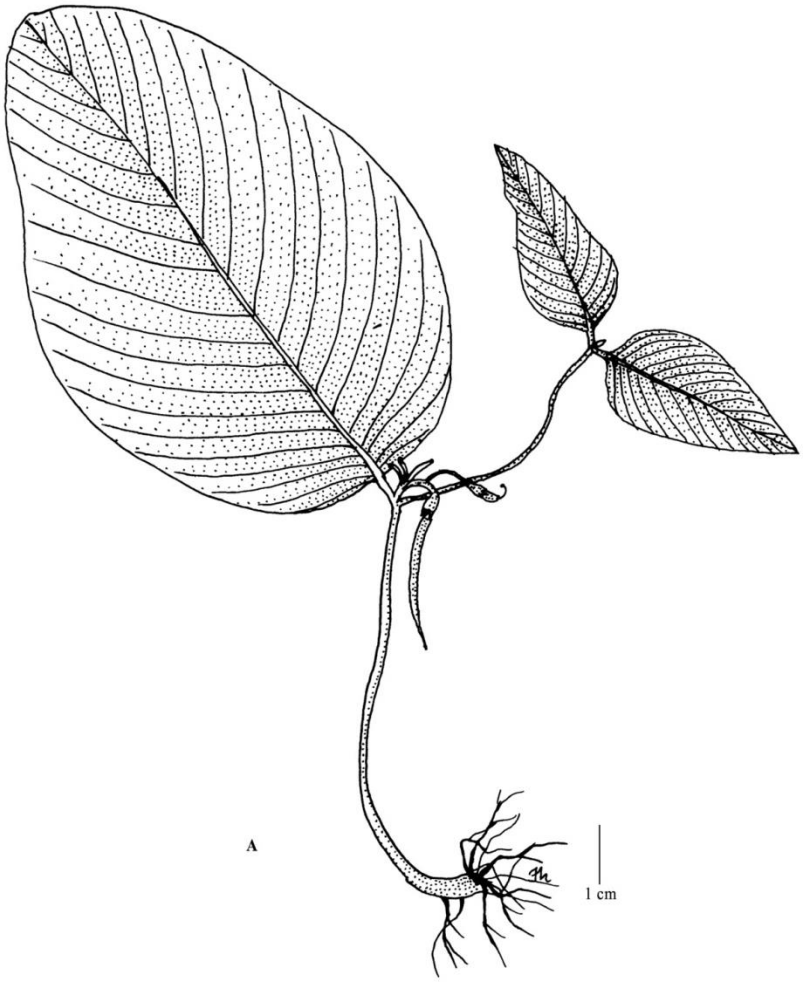


FIGURE 19: *Microchirita sahyadriensis* (Punekar & Lakshmin.) Yin Z.Wang (From *S.A. Punekar* & *P. Laksminarasimhan 178331*)

Specimen examined: **Karnataka**, Uttara Kannada district, Ulvi to Akalgavi road, Anshi National Park, 22.10.2001, *Punekar* & *Laksminarasimhan 178331* (CAL).

Notes: This species is morphologically much close to *M. hamosa*, but can be easily differentiated by its shorter calyx lobes (v/s longer calyx lobes 5–11 mm long), hairy at the apex and base, glabrous in middle (v/s calyx hairy throughout), corolla pure white (v/s corolla pale lavender with yellow throat) and anthers without beard (v/s bearded anthers).

Rhynchoglossum Blume

Rhynchoglossum was originally described by Blume (1826) to include a single species, *R. obliquum* Blume. It is a small genus of 16 species worldwide, mainly distributed in India, Sri Lanka, Nepal, S. China, Formosa, Indochina, Thailand and Malesia with one species found in southern America (Mayer *et al*., 2003, Weber, 2004a). The main features of the genus include fleshy herbaceous habit, decussate or alternate anisophyllous leaves, asymmetrical laminae and unilateral inflorescences. The genus has little economic value but several Botanic Gardens and private gardens grow this plant as an ornamental (Skog, 1985).

Burtt (1962) merged *Klugia* (with four stamens) under *Rhynchoglossum* (with two stamens) and assigned 13 species all over the world comprising 10 species from Asia and 3 from America. The genus was recently revised for Malesia by Kartonegore (2013) and Thailand by Patharahirantricin (2014). Four species were reported from India, *viz*., *Rhynchoglossum ampliatum* (C.B. Clarke) B.L. Burtt , *R. lazulinum* Rao & Joseph, *R. notonianum* (Wall.) B.L. Burtt and *R. obliquum* Blume, of which the latter two occur in South India. In the present work *R. scabrum* Dalzell is resurrected from the synonymy of *R. notonianum*, making a total of three species in South India, and five in India.

The disjunct distributions of this genus within Australasia to America make *Rhynchoglossum* very unique and have an interesting distribution history. Mayer *et al*. (2003) indicated that American species (*R. azureum* (Schltdl.) B.L. Burtt) is a recent introduction to the neotropics and that it does not represent an ancient relic. Weber (2004a; 2004b) assumed that the genus spreads from Asia to America recently, probably via transpacific trips or migrations of early Polynesian.

According to Weber (1978a) *Rhynchoglossum* is closer to *Epithema, Loxonia* and *Saturanthera* rather than to *Whytockia* and *Monophyllae* and the closest relative could be *Loxonia*. The molecular data of Mayer *et al*. (2003) suggested that *Rhynchoglossum* is sister to the remaining genera of Epithematoid Gesneriaceae. Hence Weber (2004a) placed *Rhynchoglossum* under Epithematoid Gesneriaceae in his informal classification of Gesneriaceae. As per the new classification of Gesneriaceae by Weber *et al.* (2013), the genus comes under sub-family Didymocarpoideae Arn., tribe *Epithemateae* C.B.Clarke and sub-tribe *Loxotidinae* G.Don.

Blume (1826) used the spelling '*Rhinchoglossum* but later in *Flora Javae* (1828) he corrected it as '*Rhynchoglossum*. The name is derived from two Greek words, *rhynchos* (=beak) and *glossa* (=tongue). The second part of the name indicates to the broad, tongue like lower lip of the corolla (Weber, 2004a).

Rhynchoglossum Blume, Bijdr. Fl. Ned. Ind. 741. 1826; C.B.Clarke in A.DC. & C.DC. Monogr. Phan. 5: 161. 1883, in Hook.f., Fl. Brit. India 4: 367. 1884; Cooke, Fl. Bombay 2: 324. 1905; Gamble, Fl. Madras 2: 990. 1924; A.Weber in Kubitzki, Fam. Gen. Vasc. Pl. 7: 128. 2004. **Type**: *Rhynchoglossum obliquum* Blume.

Antonia R.Br. in Wall., Pl. Asiat. Rar. 3: 65. 1832. (auct. non Pohl.). Type: *Antonia obliqua* (Wall.) R.Br. (= *Rhynchoglossum obliquum* Blume).

Klugia Schltdl., Linnaea 8: 248. 1833; A.DC., Prodr. 9: 275. 1845; Benth. in Benth. & Hook.f., Gen. Pl. 2: 1019. 1876; C.B.Clarke, in A.DC & C.DC., Monogr. Phan. 5: 158. 1883; C.B.Clarke in Hook.f., Fl. Brit. Ind. 4: 366. 1885. Type: *Klugia azurea* Schltdl. (=*Rhynchoglossum azureum* (Schltdl.) B.L. Burtt).

Loxotis R.Br. *ex* Benth., Scroph. Ind. 57. 1835; R.Br. in Benn., Pl. Jav. Rar. 102. 1838; Miq., Fl. Ned. Ind. 2: 731. 1856. Type: *Loxotis obliqua* (Wall.) R.Br. *ex* Benth. [=*Rhynchoglossum obliquum* Blume].

Glossanthus J.G.Klein *ex* Benth., Scroph. Ind. 57. 1835. Type: *Glossanthus malabaricus* J.G.Klein *ex* Benth.

Annual or perennial, terrestrial, erect to creeping fleshy–succulent herbs. ***Stems*** terete, branched or simple, glabrous or with sparse indumentums from often branched, many–celled, to glandular hairs, puberulous to pubescent. ***Leaves*** alternate, nearly distichous, exstipulate, petiolate; laminae obliquely ovate–cordate; base asymmetrical, one half cordate, the other sinuate–attenuate; texture thin, delicate and sub-coriaceous, apex acute to acuminate, surface puberulent to glabrous; margin entire to serrate; venation penninerved. ***Inflorescences*** racemose, terminal, few–to many–flowered, in 2–rows; bract single if present, opposite each flower; bracteole single, linear, from base or middle of the pedicel. ***Flowers*** bisexual, zygomorphic, complete. ***Calyx*** of 5 sepals, connate in the lower half, with or without wings at the lines of fusion, lobes narrow triangular–acute, actinomorphic. ***Corolla*** strongly zygomorphic; tube cylindrical, tubular, inside glabrous or sparsly puberulent or medussoid pilose hairy near the mouth; white, bluish to dark purple or azure, slightly longer than limb, limb strongly bilabiate, adaxial lip 2–lobed, shorter and smaller; abaxial lip 3–lobed, seldom undivided, lobed equal or sub-equal, apex rounded or elongate to obtuse, larger than adaxial. ***Stamens*** 2 or 4, if stamens 2, they adnate to corolla tube near middle of abaxial limb and if stamens 4, then adnate to corolla tube near middle of adaxial limb; filament flat or terete; anthers basifixed, coherent in pairs, thecae nearly parallel or divaricate,

dehiscing longitudinally. ***Ovary*** globose–ovoid, 1–loculed, placentas 2, parietal; style terete glabrous, stigma 1, terminal, sub-globose, undivided. ***Capsules*** ovoid to elongate, full or half enclosed by calyx, dehiscing loculicidally to base; 2–valved, straight, not twisted. ***Seeds*** minute, cuneate, unappendaged.

Distribution: Distributed in India, Sri Lanka, South China, Taiwan, Indochina to Malay Archipelago and one species in Southern America (Mexico to Peru).

Key to the species

1a. Calyx lobes winged; stamens 4 ..... **R. notonianum**

1b. Calyx lobes not winged; stamens 2 ..... **R. obliquum**

1. Rhynchoglossum notonianum (Wall.) B.L.Burtt, Notes Roy. Bot. Gard. Edinburgh 24(2): 170. 1962; Santapau, J. Bombay Nat. Hist. Soc. 48: 490. 1952, Fl. Khandala 190. 1967; Ramamoorthy in C.J.Saldanha & Nicolson, Fl. Hasssan Dist. 531. 1976; Vajr., Fl. Palghat Dist. 333. 1981; W.T.Theob. & Grupe in Dassan. & Fosberg, Rev. Handb. Fl. Ceylon 3: 99. 1981. B.D.Sharma *et al*., Fl. Karnataka: analysis 1: 197. 1984; R.S.Rao, Fl. Goa, Diu, Daman, Dadra & Nagarhaveli 2: 310. 1986; K.K.N.Nair & M.P.Nayar, Fl. Courtallum 2: 283. 1987; Gopalan in A.N.Henry *et al*., Fl. Tamil Nadu Ind., Ser I: Analysis 133. 1987; Manilal, Fl. Silent Valley 200. 1988; Kesh.Murthy *et al*., Fl. Coorg 319. 1990; Sasidh. & Sivar., Fl. Pl. Thrissur Forest 330. 1996; Sivar. & P.Mathew, Fl. Nilambur 482. 1997; N.Mohanan & Sivad., Fl. Agasthyamala 496. 2002; Sasidh., Biodivers. Doc. Kerala, Part 6: Fl. Pl. 331. 2004; T.S.Nayar *et al*., Fl. Pl. Kerala 342. 2006; Punekar & Lakshmin., Fl. Anshi Nat. Park 339. 2011; K.N.Ganeshaiah *et al*., Pl. Western Ghats 43. 2012; T.S.Nayar *et al*., Fl.

Pl. Western Ghats 1: 530. 2014. *Wulfenia notoniana* Wall.**,** Num. List 409. 1822*;* Wall., Tent. Fl. Napal 46. 1826; *Glossanthus notonianus* (Wall.) R.Br., in Benn. Pl. Jav. Rar. 121. 1840. *Klugia notoniana* (Wall.) A.DC., Prodr. 9: 276. 1845; C.B.Clarke in Hook.f., Fl. Brit. Ind. 4: 367. 1884; Cooke, Fl. Bombay 2: 324. 1905; Rama Rao, Fl. Pl. Travancore 295. 1914; Gamble, Fl. Madras 2: 990. 1924; Fyson, Fl. Nilgiri & Pulney 308. **Type**: Swamp near Nilgherry, *s.d., Noton B. 409* (Holotype-K001109983!). **Plates 43, 44; Fig. 20**

Glossanthus malabaricus J.G.Klein *ex* Benth., Scroph. Ind. 57. 1835; Wall., Numer. List 6394. 1829. Type: Montibus Nilgherry Peninsula, *s.d., Wallich 6394* (K001123774, lectotype designated here).

Klugia glabra Gardner, Calcutta J. Nat. Hist. 6: 489. 1846. *Klugia notoniana* (Wall.) A.DC. var. *glabra* (Gardner) C.B.Clarke, Fl. Brit. India 4: 366. 1885. Type: in moist shady places near Rambodde, *Gardner*.

Erect annual fleshy herbs, 7–106 cm tall; stem, bract and petiole green to dark purple in colour. ***Stems*** branched, terete, 1.5–3 cm diameter, one side hairy or a line of hairs on one side. ***Leaves*** simple, alternate, estipulate, nodes swollen; petiole 0.8–6 cm, terete, one side hairy; lamina ovate, 6–32 × 3–15 cm, upper surface pubescent with gland dots, lower glabrous, acuminate at apex, oblique at base, one side rounded to cordate, other side attenuate to cuneate; margins entire or nearly serrate; venation

PLATE 43: *Rhynchoglossum notonianum* (Wall.) B.L.Burtt **A.** Habit; **B.** Single flower; **C.** Calyx; **D.** Calyx with gynoecium; **E.** Stamens; **F.** Gynoecium; **G.** Fruit; **H.** Seeds (**A-H** from *A.P. Janeesha* & *K. M. Manudev 134205*).

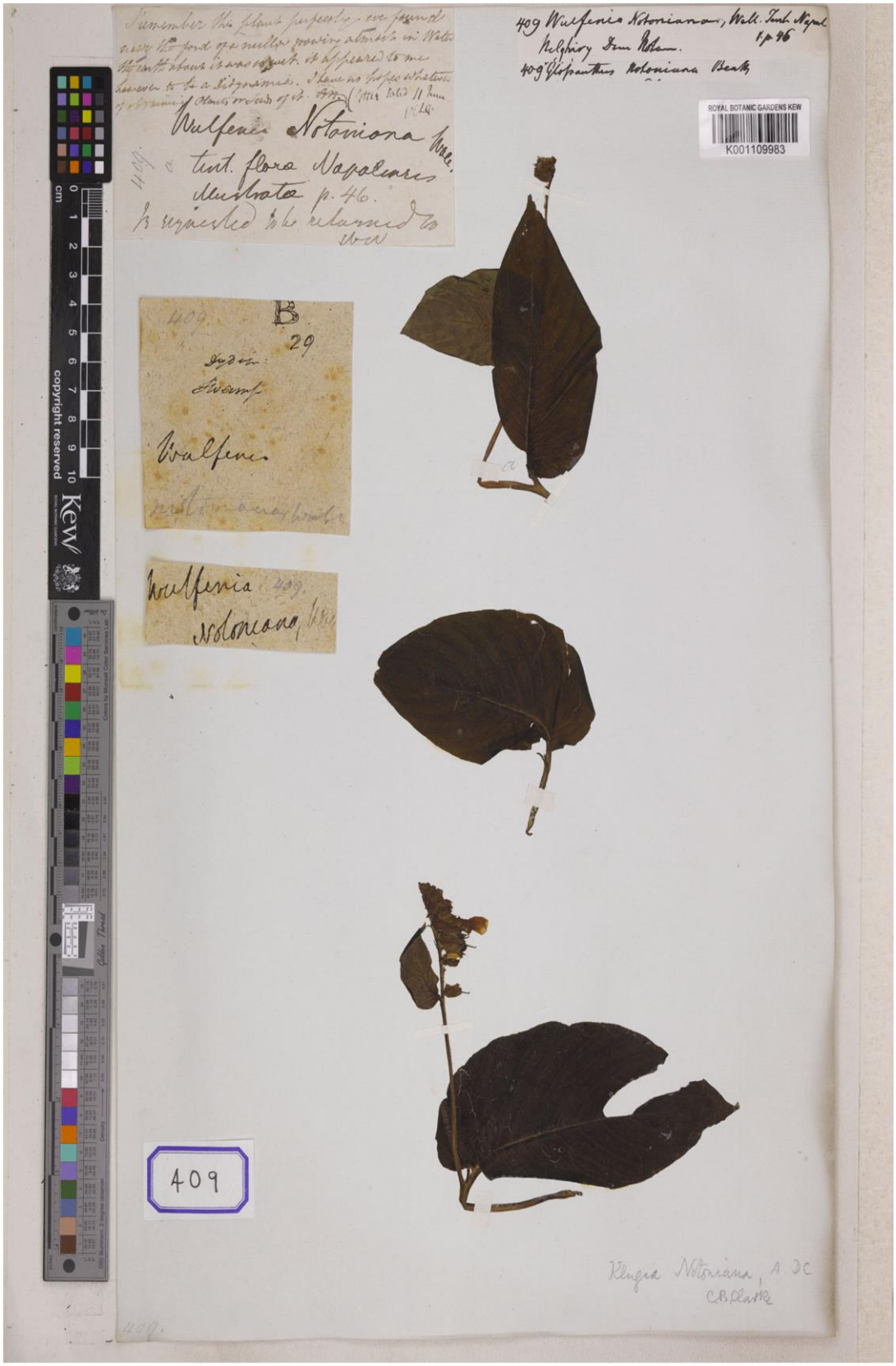


PLATE 44: Holotype of *Rhynchoglossum notonianum* (Wall.) B.L.Burtt

FIGURE 20: *Rhynchoglossum notonianum* (Wall.) B.L.Burtt (From *A.P. Janeesha* & *Santhosh Nampy 134219*)

penninerved, reticulate, midrib puberulous. ***Racemes*** terminal, 2–20 cm long, sometimes pendulous; peduncle terete, green, pubescent throughout, 10–18 flowerd; bract linear, subtending the inflorescences, puberulous, 1.5–5 mm long; bracteoles linear, 2–3 mm long; pedicels 2–6 mm long, terete, one side hairy. ***Flowers*** 2–3 × 0.9–2.5 cm, bright blue colour. ***Calyx*** of sepals 5. green, sometimes hairy; tube 6–8 mm long, glabrous to glabrescent, pale green to white; lobes 5, triangular or lanceolate to obovate, 0.7–1.02 cm long, winged, one wing large, apex acuminate, margin entire or serrate. ***Corolla*** 2-lipped, bright blue colour; tube 6–10 mm long, white to pale green, glabrous; lobes ovate to elliptic, upper lip small, bifid 2.2–4.4 × 2.4–5 mm, lower lip large, trifid or undivided bearing a tongue like lobe, 0.8–3 × 0.5–2.5 cm, with two pockets or cavities at the base of the lower lip just at the region of the corolla throat, yellow blotch at the throat near the cavities. ***Stamens*** 4, epipetalous, cohering in pairs; filaments terete, 4.8–8.5 mm long, glabrous, hyaline to pale green; anthers bithecous, 0.8–1 × 0.6–0.7 mm long, milky white, basifixed. ***Disk*** present, annular, 1.2 mm. ***Ovary*** ovoid to oblong and gradual to style, 2.4–3.2× 1.5–2 mm, green, glabrous, surrounded by a disc, 1-loculed, green; style 12–13 × 0.3–0.5 mm, terete, glabrous, green; stigma papillate, 0.4–0.5 mm in diameter ***Capsules*** ovoid, 0.52–1 × 0.32–0.56 cm, glabrous, enclosed fully with calyx remnant, opening loculicidally to base; calyx remnant 4–7 mm long; stalk 1–5 mm long, glabrous to puberulous; style remnant about 6–10 mm long. ***Seeds*** ellipsoid, 0.43–0.63 × 0.18–0.23 mm, pale brown, reticulate, unappendaged.

Chromosome number: n=10, 2n=20 (Eberle, 1956; Eberle, 1957a; Ratter, 1975).

Flowering & fruiting: July-November.

Habitat & ecology: This species grows in areas with moisture and shade, near streams and waterfalls and prefers elevations above 1200 m. Grow in association with *Selaginella* sp. (Pteridophyte) and *Sonerila* sp. (Melastomataceae).

Distribution: India (Kerala, Tamil Nadu, Karnataka) and Sri Lanka.

Specimens examined: Karnataka, Dakshina Kannada district, Charmadi Ghat, 03.09.1981, *C.J. Saldanha 13503* (JCB); Shiradi Ghat-Kempuhole, 22.08.1969, *C.J. Saldanha 14640* (JCB); Shiradi Ghat, 26.10.1967, *C.J. Saldanha 11288* (JCB); *Ibid*., 03.09.1969, *C.J. Saldanha 14792* (JCB); *Ibid*., 20.08.1970, *C.J. Saldanha* & *T.P. Ramamoorthy 541* (JCB); *Ibid*., 18.10.1975, *K.P. Mary 51* (JCB); *Ibid*., 07.09.1980, *C.J. Saldanha 12246* (JCB). Lower Shiradi Ghat, 09.10.1979, *C.J. Saldanha 9746* (JCB). Hassan district, Bisle Ghat, 01.10.1967, *C.J. Saldanha 11201* (JCB); Bisle Ghat- Bottom section, 18.09.1969, *C.J. Saldanha 15079* (JCB); Devangudi, 12.09.1970, N. *Satyananda 32* (JCB); Donigal to Yadukumari, 12.12.2013, *K.M. Manudev* & *A.P. Janeesha 134242* (CALI); Hassan, 11.09.1970, *K. Vijayalakshmi 44* (JCB); Sakleshpur, 28.04.1973, *R.P. Nirmala s.n.* (JCB); *Ibid*., 12.12.2013, *K.M. Manudev, A.P. Janeesha* & *Santhosh Nampy 134246* (CALI). Kodagu district, Bhagmandala, 22.08.1978, *S.R. Ramesh 2324* (JCB); Mercara-Virajpet road, 09.11.1979, *K.P. Sreenath* & *B. Gurudev Sigh 10324* (JCB). Koduru district, on the way to Makut, 10.10.1978, *S.R. Ramesh* & *P. Prakash 3183* (JCB). Shimoga district, Agumbe Ghat, 13.10.1962, *R.S. Raghavan 83185* (BSI); *Ibid*, 30.08.1963, *R.S. Raghavan 90295* (BSI); Agumbe-after 9th hairpin loop,

17.09.2014, *A.P. Janeesha 134293* (CALI); Hulical Ghat, 09.10.1962, *R.S. Raghavan 83087* (BSI); *Ibid*, 24.08.1963, *R.S. Raghavan 90172* (BSI); Jog falls, 15.10.1964, *R.S. Raghavan 103610* (BSI); *Ibid*, 26.09.1965, *John Cheriyan 106717* (BSI); *Ibid*., 27.09.1978, *K.P. Keshavamurthy* & *K.P. Sreenath 2960* (JCB); *Ibid*., 19.09.2014, *A.P. Janeesha 134295* (CALI); Near Nagara, 27.09.1980, *B.R. Ramesh 12349* (JCB); Yedur, 22.08.1903, *R.S. Raghavan 90135* (BSI); *Ibid*, 04.10.1962, *R.S. Raghavan 82970* (BSI); *Ibid*, 05.10.1962, *R.S. Raghavan 82984* (BSI). Uttar Kannada district, Castle rock, 10.1908, *A. Meebold 6822* (CAL); *Ibid*., 22.12.1953, *H. Santapu 17854* (BLAT); *Ibid*., 09, *s.coll, 4357* (CAL); Honavar, 17.10.1962, C*.J. Saldanha CS8443* (JCB); Kumta, 17.10.1962, *C.J. Saldanha CS8444, CS8445* (JCB); Surge tank, 30.0931981, *B.R. Ramesh* & *S. Udaya Kumar 13706* (JCB). *s.loc*., 27.11.1883, *W.A. Talbot 807* (CAL). *s.loc*., 14.10.1968, *M.R. Almeida s.n*. (BLAT). District unknow, Arabail Ghat, 02.10.1981, *S.R. Ramesh* & *S. Udayakumar 13769* (JCB); Gauremore estate, 30.10.1981, *C.J. Saldanha, Shivaprakash* & *B. Gurudev Singh 13968* (JCB). **Kerala**, Ernakulam district, Kavalay Cochin, 11.1910, *A. Meebold 12330, 12146* (CAL); *s.loc.*, 1884, *J.S. Gamble 14699* (CAL). Idukki district, Adimali, 13.07.1993, *A. Nazarudeen 17814* (TBGT); Devikulam-Kumali Road, 30.05.1964, *K.N. Subramanian 1458* (FRC); Kallar, 25.07.2013, *A.P. Janeesha* & *K.M. Manudev 134205* (CALI); Karimalai Stream Bed, 25.01.1910, *C.E.C. Fischer s.n.* (FRC); Kulamavu, 04.10.1983, *C.N. Mohanan 79992* (MH); Munnar, 08.10.1985, *P.C Binoy 05050* (TBGT); *Ibid*., 10.09.2013, *A.P. Janeesha* & *Santhosh Nampy 134215* (CALI); Vattavada-Munnar, 28.07.1982, *V.P.K. Nambiar* & *N. Sasidharan 2164* (KFRI). Kannur district, Chandanakampara, 15.05.1982, *V.J. Nair 7389* (CAL); Payyannur, 05.10.1979, *R. Ansari 64751* (CAL); Thiruvangad, 30.08.1970, *V.V. Sivarajan 438* (CALI). Kollam district, Muthalathode achenkoil section, 05.12.1961, *K.N. Subramanian 77460* (BSI);

Near Palaruvi waterfall, 18.08.2016, *A.P. Janeesha* & *S. Resmi 137684* (CALI); Palaruvi, 28.11.1961, *K.N. Subramanian 77191, 77193* (BSI); Thenmala-Talapara RF, 13.05.1961, *K.N. Subramanian 71091, 71092* (BSI); Thenmala-Nagamala road, 23.11.1961, *K.N. Subramanian 77076* (BSI). Kottayam district, Koruthode, Ranni R.F., 14.09.1982, *K.N. Subramania, C.K.J., N.V.* & *K.R.S. 8583* (FRC); Mookkenpetty, 10.08.1992, *E.S. Satheeesh Kumar 14442* (TBGT)**;** Vagamon, 17.08.2013, *K.M. Manudev* & *A.P. Janeesha 134207* (CALI); *Ibid*., 03.10.2015, *A.P. Janeesha* & *C. Pramod 137646* (CALI), Way to Vagamon-Kurishumala, 07.08.2014, *A.P. Janeesha* & *A.P. Roshan 134271* (CALI). Kozhikode district, Kakkayam, 21.10.2014, *Manjula* & *A.P. Janeesha 137605* (CALI); Thamarassery churam, 31.08.2013, *A.P. Janeesha* & *S. Syam Radh 134210* (CALI); Way to Kakkayam forest office, 19.09.2013, *A.P. Janeesha* & *Santhosh Nampy 134219* (CALI); Way to Muthappanpuzha river, 12.08.2014, *A.P. Janeesh* & *Santhosh Nampy 134284* (CALI). Palakkad district, Aruvampara, 21.08.1982, *T. Sabu 10667* (CALI); Cherunelli, 14.11.1984, *N. Venkatasubramanian* & *K.R. Sasidharan 10660* (FRC); Dhoni hills, 18.09.1980, *V.P.K. Nambiar1070* (KFRI); Karimpuzha, 01.10.1981, *s.coll. 28773* (CALI); Karivara-river side, 10.11.1976, *E. Vajravelu 48910* (CAL); Karuvara, 20.09.1977, *K.N. Subramanian 7018* (FRC); Manthampotti, 06.12.1979, *s.coll. 1072* (KFRI); Mukkali forest, 11.10.1979, *N.C. Nair 64518* (CAL); Near Pothundy dam, 07.11.2013, *K. Thoiba* & *A.P. Janeesha 134237* (CALI); Nelliyampathi road side, 12.01.1983, *K.N. Subramanian 8862* (FRC); Panthanthode, 21.09.1977, *J. Joseph 51444* (CAL); Silent Valley campsite, 04.12.1981, *C. Sathish Kumar 10134* (CALI); Thanipallam, 09.10.1960, *A.N. Henry, ANH 670* (BLAT). Pathanamthitta district, Kaki forest, 10.08.1988, *R. Chandrasekaran 88524* (MH); Moozhiyar-Konni R.F., 19.10.1983, *K.N. Subramanian 9655* (FRC). Thiruvananthapuram district, Athirumala,

24.08.1990, *N. Mohanan 10008* (TBGT); Attayar, 22.12.1987, *N. Mohanan 9165* (TBGT); Karamanayar, 17.08.1995, *M. Navas* & *Sunil 23471* (TBGT); Thundathil Range, 23.09.1987, *K.N. Subramanian 13273* (FRC); *s.loc*., 15.10.1988, *N. Mohanan 4484* (TBGT). Thrissur district, Ambalapara dam, 30.09.1984, *K.M. Mathew 18280* (RHT); Peechi, 17.07.1982, *N. Sasidharan 2166* (KFRI); Pindimedu, 10-9-1985, *K.K.N. Nair 8033* (KFRI); Sholayar-34th thodu, 11.12.2013, *A.P. Janeesha* & *S. Syam Radh 134247* (CALI); Thottappuzha-Malakkappara, 11.12.2013, A.*P. Janeesha* & *Santhosh Nampy 134251* (CALI); Vazhachal to Sholayar, 23.09.1982, *K. Ramamurthy 74737* (CAL); Vazhachal, 19.12.1984, *K.N. Subramanian 10867* (FRC); *Ibid*., 02.09.1987, *N.P. Surayya Beegum 13613* (CALI); *Ibid*., 05.11.1987, *V.T. Valsamma 11214* (CALI); Vellanimala, 21.10.1997, *T. Shaju* & *R. Rajesh 36011* (TBGT); way to pipe house-Sholayar, 11.12.2013, *A.P. Janeesha, K. Thoiba* & *K. Smitha 134248* (CALI). Wayanad district, Palchuram, 08.11.2012, *Santhosh Nampy* & *A.P. Janeesha 134253* (CALI); South Wayanad, 22.08.1979, *R. Ashok Kumar 44* (CALI); *s.loc*., 21.09.1990, *P. Sheeja 4826* (CALI). Travancore, High Range, 18.02, *J.H. Bardillon 34* (CAL). Travancore, *s.loc.,* 29.08.1913, *C.C. Calder* & *M.S. Ramaswammi 177* (CAL). Malabar, *s.loc., s.d., Stock Law s.n.* (CAL). Highway mountain, 05.1971, *Blatter* & *Hallberg 356* (CAL). **Tamil Nadu,** Coimbatore district, Anankanthy shola, 28.09.1984, *K.M. Matthew 18224* (RHT); Anamalai, 15.02.1949, *J. Sakhharam rao s.n.* (MH); Anamalai-Sholayar Valaparai dam, 29.09.1984, *K.M. Matthew 18245* (RHT); Italiar forest, 06.09.1983, *K. Ramamurthy 78422* (MH); Lower Nirar, 06.09.1983, *K. Ramamurthy 78422* (CAL); Mount Stouert, 29.01.1962, *J. Joseph 13804* (MH); Near damsite, 27.07.1978, *M. Chandrabose 57298* (MH); Sholayar submergible area, 25.07.1963, *K.M. Sebastine 16651* (MH); Waverly estate, 22.10.1961, *J. Joseph 13099* (CAL, MH). Dindigul district, Kodaikanal, 29.07.1913, *Rev. Aug.*

Sauliers 821 (CAL); *Ibid*., *s.d., R. Ananthkrishnan s.n.* (RHT); *Ibid*., 15.07.1979, *Nalini 32130* (CALI); *Ibid*., 15.07.1979, *O. Gouri 31552* (CALI); *Ibid*., 30.10.2012, *K.M. Manudev* & *A.P. Janeesha 134239* (CALI); *Ibid*., 09.1949, *s.coll. s.n.* (RHT); Kodaikanal-Levinge, 1956, *K.M. Matthew 436* (RHT); *Ibid*., 13.09.1959, *K.M. Matthew 1206* (RHT); Kodaikanal-Perumal malai, 12.05.1979, *K.M. Matthew 16715* (RHT); Kodaikanal-Shembagannur path, 07.02.1986, *K.M. Matthew 44085* (RHT); Kodaikanal–Tiger shola, 14.10.1919, *K.C. Jacob 16113* (MH); *Ibid*., 24.04.1965, K. *Ramamurthy 23386* (MH); *Ibid*., 14.02.1974, *B.K. Nayar* & *K. Unnikrishnan 2629* (CALI); *Ibid*., 24.10.1977, *M. Chandrabose 51646* (MH); *Ibid*., 05.03.1978, *D.K. Hore 608* (CAL); Palani, 1897, *A.G. Bourne s.n.* (CAL); Palani hills-Talayar top, 16.08.1986, *K.M. Matthew 46279* (RHT); Silver cascade, 26.09.1979, *K.M. Matthew 16950* (RHT); *Ibid*., 30.11.1982, *Viji 37241* (CALI); Valakkappara, 21.05.1969, *K.M. Matthew 10268* (RHT); Vilpatty-Palani path, 22.03.1987, *K.M. Matthew 48664* (RHT); way to Kodaikanal, 09.03.1958, *K. Subramanyam 5534* (MH). Kamarajar district, Nagariyar estate, 29.04.1991, *S.R. Srinivasan 96752* (MH). Kanchipuram district, Gudallore road, 14.08.1981, *Philip Mathew 28565* (CALI). Madura district, Anna-Ittippallam, 03.03.1980, *K.M. Matthew 17328* (RHT); Anna-Laws Ghats road-Machur, 26.07.1986, *K.M. Matthew* & *M. Charles 45853* (RHT); Anna-Palamalai, 20.02.1986, *K.M. Matthew 44199* (RHT); Anna-Palamalai Machur path, 10.05.1986, *K.M. Matthew* & *N. Rajendran 44916* (RHT); Anna-Palani hills, 20.11.1985, *K.M. Matthew* & *N. Rajendran 43378* (RHT); *Ibid*., 29.11.1985, *K.M. Matthew* & *N. Rajendran 43468* (RHT); Anna-Pambar shola, 31.05.1984, *K.M. Matthew 40161* (RHT); Anna-Shembagannur, 07.05.1985, *K.M. Matthew 41335* (RHT); *Ibid*., 03.09.1985, *J. Britto 42149* (RHT); Anna-Sinnappar Kurisadi, 04.12.1985, *K.M. Matthew 43696* (RHT); Bodi-mettu, 30.12.1984, *K. Ravikumar 2007* (MH); High way hut, 05.1917, *E. Blatter* & *Hallbeerg 356* (BLAT); High

way-Madura, 07.09.1925, *K.C. Jacob 17550* (MH); Highway route, 07.09.1925, *K.C. Jacob 77031* (CAL); near Kumily, 20.10.1959, *K. Subramanyam 9472* (CAL, MH); Pambar forest, 16.09.1968, *D.B. Deb 30921* (MH). Nilgiri district, Conoor Ghat, 16.03.1870, *C.B. Clarke 10908* (CAL); *Ibid*., 31.07.1878, *G. King s.n.* (CAL); *Ibid*., 01.1899, *Dr. Pravin s.n.* (CAL); *Ibid*., 08.01.1910, *C.E.C. Fischer 1587* (FRC, CAL); *Ibid*., 10.1910, *A. Meebold 12024* (CAL); *Ibid.,* 06.09.1970, *B.D. Sharma 36065* (MH)*; Ibid*., 29.04.1971, *N.C. Radhakrishnan 38115* (MH)*;* Idukorai, 16.05.1971, *E. Vajravelu 38411* (MH); Kolikari, 04.02.1972, *E. Vajravelu 39759* (MH); Koorg, *s.d., G. Thomson s.n.* (MH)*;* Lower tiger shola, 23.03.1957, *K.M. Sebastine 2590* (MH); *s.loc.,* 1877, *G. Bidie Rog s.n.* (MH); Mattada water falls, 22.03.1972, *G.V. Subbarao 40406* (MH); Nilghiri hills, 02.1848, *R. Wight s.n.* (CAL); way to Anaikalti, 25.03.1972, *G.V. subbarao 40474*; (MH); *s.loc*., 04.1883, *J.S. Gamble 11390* (CAL); *s.loc*., 18.08.1878, *G. King s.n.* (CAL); *s.loc., s.d., G. Thomson 43* (CAL). Ramanathapuram district, Periyagavu estate, 11.03.1980, *S.R. Srinivasan 63683* (MH); way to Deviyar estate, 09.06.1979, *S.R. Srinivasan 61492* (MH). Siruvani district, Thannipallam, 09.10.1960, *A.N. Henry 671* (MH)*; Ibid.,* 09.10.1960, *A.N. Henry 669* (MH). Theni district, Bodi Mettu, 30.12.1984, *K. Ravikumar 2007* (CAL). Tirunelveli district, Courtallum, 13.10.1959, *K.M. Matthew 1307* (RHT); *Ibid*., 05.07.1979, *K.K. Harindran 32478* (CALI); *Ibid., s.d., R. Annathkrishnan s.n.* (RHT); New Courtallum, 16.04.2015, *A.P. Janeesha, S. Resmi* & *P.G. Arunkumar 137629* (CALI); Shembakadevi, 15.12.1957, *K. Subramanyam 4928* (MH). Penninsular India Orientalis, *s.d., Wight 2349* (CAL). *s.loc, s.die*, *Rev. Aug. Sauliers 978* (CAL). *s.loc*., 06.1916, *P.F. Fyson, 32953* (BLAT).

Notes: The name *Glossanthus malabaricus* was first published by Klein and was listed by Wallich (1829) in his catalogue, later the name is validated by

Bentham (1835). There are two sheets available in K under Wallich Cat. No. 6394 (K001123774 and K001123775). Among them, sheet K001123774, matching with the protologue, is selected here as the lectotype.

2. Rhynchoglossum obliquum Blume, Bijdr. Fl. Ned. Ind. 741. 1826; C.B.Clarke in A.DC. & C.DC., Monogr. Phan. 5:161. 1883, Hook.f., Fl. Brit. India 4: 367. 1884; Cooke, Fl. Bombay 2: 324. 1905; Gamble, Fl. Madras 2: 990. 1924; Santapau, J. Bombay Nat. Hist. Soc. 48: 491. 1952; Santapau, Fl. Khandala 190. 1967; C.J.Saldanha & Nicolson, Fl. Hasssan Dist. 531. 1976; B.D.Sharma *et al*., Fl. Karnataka: analysis 1: 197. 1984; R.S.Rao, Fl. Goa, Diu, Daman, Dadra & Nagarhaveli 2: 310. 1986; Gopalan in A.N.Henry *et al*., Fl. Tamil Nadu Ind. Ser I: Analysis 133. 1987; Kesh.Murthy *et al*., Fl. Coorg 319. 1990; Pull. & Ali Moulali, Fl. Andhra Pradesh 2: 681. 1997; Pull. *et al*., Fl. Eastern Ghats 4: 364. 2011; Subba Rao & Kumari, Fl. Vishakapattanam Distr. (Andhra Pradesh) 603. 2002; Sasidh., Biodiversity Doc. Kerala, Part 6: Fl. Pl. 331. 2004; T.S.Nayar *et al*., Fl. Pl. Kerala 342. 2006; Punekar & Lakshmin., Fl. Anshi Nat. Park 339. 2011; T.S.Nayar *et al*., Fl. Pl. Western Ghats 1: 530. 2014. *Rhynchoglossum blumei* A. DC., Prodr., 9: 274. 1845. **Type**: Java, *Blume 52* (L0836219, lectotype designated by Kartonegoro, 2011). **Plates 45, 46; Fig. 21**

Wulfenia obliqua Wall., Tent. Fl. Napal 45. 1826. *Antonia obliqua* (Blume) R.Br., Pl. Asiat. Rar. 3: 65. 1832. *Loxotis obliqua* (Wall.) Benth., Scroph. Ind 57. 1835; R.Br. in Benn., Pl. Jav. Rar. 102. 1838. *Rhynchoglossum obliquum* (Wall.) A.DC. *auct. non.* Blume, Prodr. 9: 275. 1845. *Rhynchoglossum obliquum* Blume var. *parviflorum* C.B.Clarke in A.DC. & C.DC., Monogr. Phan. 5: 162. 1883. Type: Nepal, *s.d., Wallich 407* (Holo, BM).

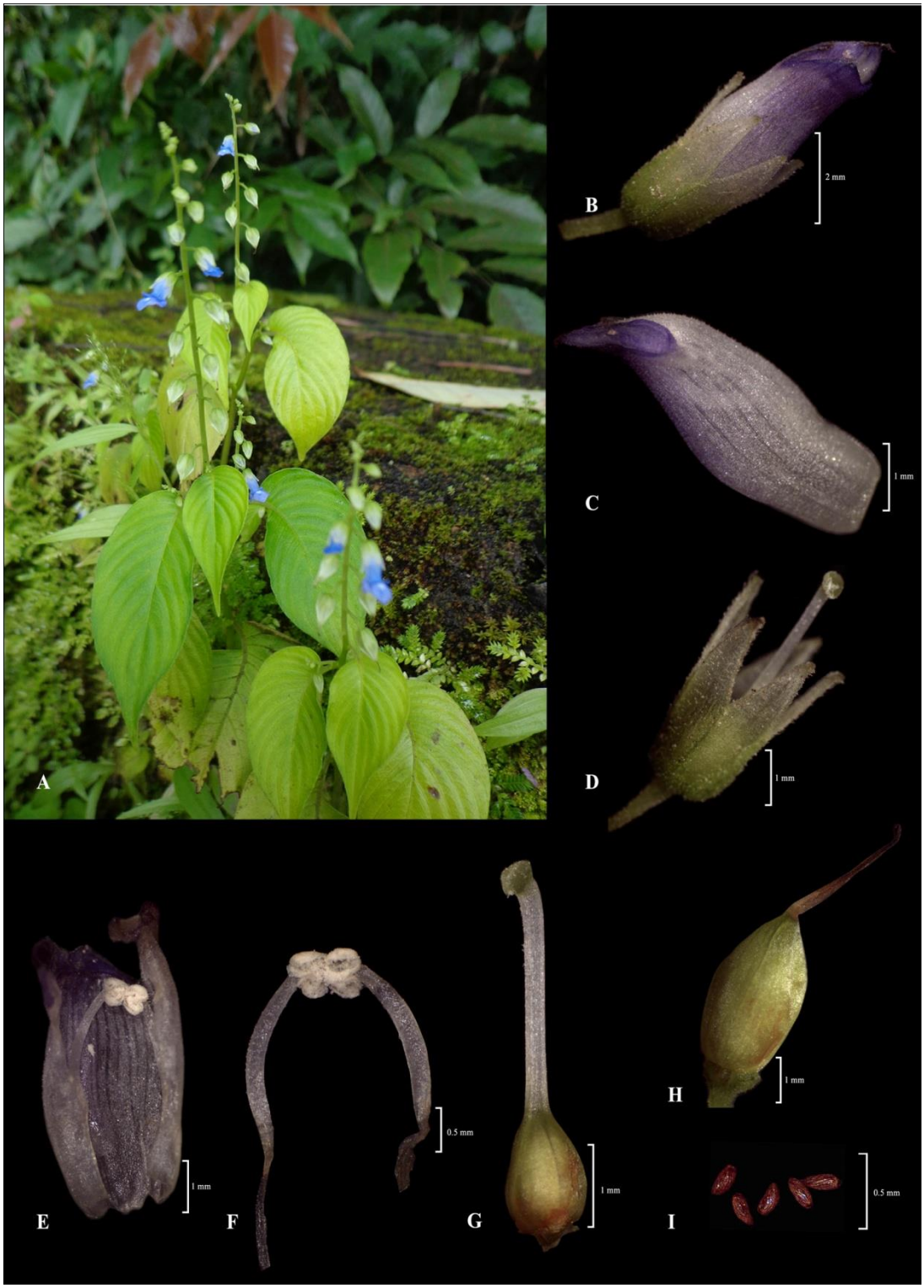


PLATE 45: *Rhynchoglossum* obliquum Blume **A.** Habit; **B.** Single flower; **C.** Corolla; **D.** Calyx; **E.** Corolla split opened; **F.** Stamens; **G.** Gynoecium; **H.** Fruit; **I.** Seeds (**A** from *K.M. Manudev, P.G. Arunkumar* & *A.P. Janeesha 134235*; **B-I** from *A.P. Janeesha* & *P.M. Shahina 134238*).

PLATE 46: Lectotype of *Rhynchoglossum obliquum* Blume

FIGURE 21: *Rhynchoglossum obliquum* Blume (From *K.M. Manudev* & *A.P. Janeesha 134241*).

Loxotis intermedia (Wall.) Benth., Scroph. Ind. 57. 1835. *Rhynchoglossum obliquum* Blume var. *intermedium* (Benth.) A.DC. & C.DC., Prodr. 9: 275. 1845. Type: Nepal, *s.d., Wallich 408* (Holo, BM).

Rhynchoglossum rheedi A.DC. & C.DC., Prodr. 9: 274. 1845. Type: *Rheede*, Hort. Mal., 9: t. 80.

Rhynchoglossum zeylanicum Hook., Bot. Mag. 71: t. 4198. 1845. Type: Ceylon, *s.d., Gardner s.n.* (Holo, BM).

Rhynchoglossum hologlossum Hayata, Icons Pl. Formosan. 5: 131. t. 11. 1915. *Rhynchoglossum obliquum* Blume var. *hologlossum* (Hayata) W.T.Wang, Bull. Bot. Res.Harbin 4(1): 31. 1984. Type: Formosa, Rinkiho. 8. 1911, *s.coll., s.n.* (Holo, TI).

Rhynchoglossum papuae Schltr., Bot. Jahrb. Syst. 58(3): 299. 1923. Type: New Guinea, 150 m., 8.4.1904, *s.coll., s.n.* (Lecto, BO).

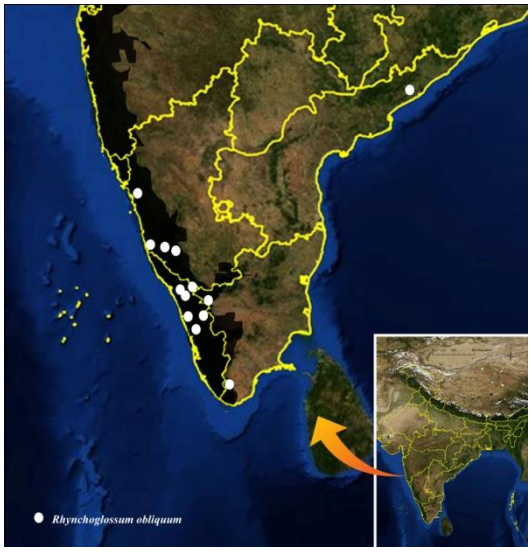
Vernacular name: Kalu-tali

Erect fleshy herbs, annuals, about 9–40 cm high. ***Stems*** branched, terete, glabrous-puberulent, branching nodes swollen. ***Leaves*** alternate, exstipulate; laminae ovate-oblong, 2.5–11 × 1.4–5 cm, at acuminate apex, oblique at base, margins entire, upper surface pubescent, lower glabrous; petioles 0.3–0.5 cm long, terete, sparsely pubescent, green; venation reticulate with many parallel veins. ***Racemes*** terminal, 2–21 cm long, many flowered; peduncles 2–21 cm long, terete, green, pubescent throughout; bracts linear, 1.5–4 mm long; bracteoles linear, 1–3 mm long. ***Flowers*** 0.6–1.5 × 1.5–4 mm, pale violet; pedicels 2–6 mm long, terete, densely pubescent. ***Calyx*** 3–5 × 0.8–1.2 mm long, green to pale green, outer hairy, ½–¾ of calyx portion fused; tube 1.8–3.1 mm long; lobes triangular, 1.3–2.1 mm long, acute or acuminate at apex, margin entire or serrate, puberulous, not winged. ***Corolla*** bilipped, zygomorphic, hairy out, pale violet to violet, more than ¾ of corolla is fused forming a tube; tube 4–6 mm long; lobes 1.9–2.3 mm long, 2-lipped, upper lip bifid, lower lip trifid. ***Stamens*** 2, epipetalous, cohering in pairs; filaments terete, 2–3.2 mm long, glabrous; anthers bithecous, 0.4–0.8 mm long, milky white, basifixed. ***Disk*** present, incomplete. ***Ovary*** ovoid, superior, glabrous, 1- loculed, 1.6–2.5 ×

1–1.5 mm, green,; style 2.8-3.5 mm long, terete, glabrous, green to white; stigma capitate, 0.5–0.6 mm in diameter, green. ***Capsules*** enclosed in calyx, rudimentary stigma present, 4–6 × 1.8–2.7 mm long, glabrous. ***Seeds*** ellipsoid, c. 0.5 mm, cuneate, unappendaged.

Chromosome Number: n=18 (Vasudevan, 1976), n=21 (Ratter & Prantice, 1967; Ratter, 1975).

Flowering & fruiting: September-November.



Habitat & ecology: In moist slopes and open, watery areas near streams

Distribution: India, Nepal, South China, Formosa, Indochina, Thailand, Malay archipelago to New guinea.

Specimens examined: Andhra Pradesh, Kurnool district, Pachagundala, 16.01.2008, *B. Raviprasad Rao* & *B. Sadasivaiah 30561* (SKU). Visakhapatnam district, Adativalara, 12.10.1964, *G.V. Subba Rao 21626* (MH). **Karnataka,** Bellari district, Swamimalai-Sanduru, 16.11.1979, *S.R. Ramesh* & *B.R. Ramesh 10481* (JCB). Dakshina Kannada district, Charmadi Ghat, 27.10.1960, *C.J. Saldanha CS6216* (JCB); Charmadi, 23.11.1927, *S.R. Raju 18163* (MH); Jolpal, 13.11.1900, *C.A. Barber 2330* (MH); *Ibid*., 14.11.1900, *C.A. Barber 2350* (MH); Mangalore Ghat, 09.10.1970, *R.S. Raghavan 126216* (BSI); Shiradi Ghat, 11.11.1978, *C.J. Saldanha* & *P. Prakash 4015* (JCB). Hassan district, Belur, 07.10.1970, *R.S. Raghavan 126108* (BSI); Bisle Ghat, 11.11.1967, *C.J. Saldanha 11401* (JCB); *Ibid*., 30.10.1969, *C.J. Saldanha 15513* (JCB); *Ibid*., 06.10.1970, *F.M. Jarret, C.J. Saldanha* & *T.P. Ramamoorthy 853* (JCB); Sakleshpur, 07.11.2013, *A.P. Janeesha*

& *P.M. Shahina 134238* (CALI). Uttar Kannada district, Castle rock, 22.12.1953, *H. Santapu 17854* (BLAT); *s.loc*., 14.10.1968, *M.R. Almeida s.n*. (BLAT). **Kerala,** Cannanore disrtrict, Ambayathode, 05.11.1978, *s.coll. 58232* (MH); Palchuram via Kannur, road side, 30.10.2012, *K.M. Manudev* & *A.P. Janeesha 134241* (CALI); Taliparamba, 17.07.1981, *R. Ansari 70090* (MH). Ernakulam district, *s.loc*., 09.1884, *J.S. Gamble 14699* (CAL). Kottayam district, Nagarampara Reserve Forest, 25.11.1987, *N. Venkatasubramanian* & *K.R. Sasidharan 13455* (FRC). Kozhikode district, way to Kakkayam forest office, after XIIth turning, *A.P. Janeesha, K. Thoiba* & *S. Syam Radh 134220* (CALI); Kakkayam, 21.10.2014, *A.P. Janeesha* & *Manjula 137604* (CALI); *Ibid*., 03.10.2016, *A.P. Janeesha* & *K. Haseem 137688* (CALI). Trichur district, Kozhikkunnu, 13.12.1983, *K.N. Subramanian 9981* (FRC); Parambikulum sub-mergible area, 26.07.1962, *K.M. Sebastine 14609* (MH). Wayanad district, Begur Range, Hilldale R.F., 23.11.1983, *K.N. Subramanian 9797* (FRC). Malabar, *s.loc*., *s.d*., *Stock Law s.n.* (CAL). **Tamil Nadu,** Dindigul district, Kodaikanal, 13.11.1984, *K.K. Jayaprabha 5223* (CALI). Nilgiri district, *s.loc*., 1884, *M.A. Lawson, s.n.* (MH). Tirunelveli district, Courtallum–Thekkumalai, 11.11.1984, *K.M. Jayaram 4828* (CALI).

Notes: The flowers are violet to pale violet usually, but pale towards the base of corolla tube. The filaments are attached to the middle of corolla tube

Rhynchotechum Blume

The genus *Rhynchotechum* consists a group of understorey sub-shrubs with sixteen species in India and Sri Lanka, east through Bangladesh and Burma into China and Taiwan, south through Vietnam, Laos, Cambodia and Thailand into Sumatra, east through Java, Borneo and Sulawesi to New Guinea, and north through the Philippines to Japan (Anderson & Middleton, 2013). Nine species are found in India, mainly in East and North East areas,

but represented by one species (*R. permolle*) in South India. The genus is easily recognised by relatively small flowers, four stamens, anthers having confluent pollen sacs that dehisce by a valve on the inner face and often white, fleshy, globose indehiscent fruits.

The genus was established by Blume (1826) and included under Cyrtandreae. However, it is distinguished from *Cyrtandra* by its four fertile stamens with unilocular anthers and globose fruits. Bentham (1876) placed it in tribe *Cyrtandreae* close to *Isanthera* Nees. Burtt (1962) united *Isanthera* and *Rhynchotechum* on the basis of valve-like dehiscence in both the genera. The genus was placed in Cyrtandreae by Burtt (1963) and Burtt and Wiehler (1995) near to *Cyrtandra*, which also has indehiscent fruits, but the classification of *Rhynchotechum* along with *Leptoboea* and *Boeica* was already established by Fritsch (1893–1894). As per the new classification of Gesneriaceae by Weber *et al.* (2013), *Rhynchotyechum* comes under the sub-family Diymocarpoideae Arn., tribe *Trichosporeae* Nees and sub-tribe *Leptoboeinae* C.B.Clarke along with *Beccarinda* Kuntze, *Boeica* C.B.Clarke, *Championia* Gardner (to be confirmed), *Leptoboea* Benth. and *Platystemma* Wall.

A few cytological works were carried out in this genus by various authors: Ratter (1963) reported 2n=20 for *R. discolor* (Maxim.) B.L.Burtt, Kiehn & Weber (1998) reported 2n=18–20 for *R. parviflorum* Blume, Wang & Wang (2000) reported 2n=20 for *R. discolour*, *R. brevipedunculatum* J.C.Wang and *R. formosanum* Hatus. Moller *et al*. (2009) using *trnL-F*, *atpB-rbcL* and *ITS* sequences constructed a phylogeny of some Old World Gesneriaceae and found that *Rhynchotechum* occupies a more basal position relative to most asiatic Gesneriaceae and is distant from *Cyrtandra*. In that analysis, *Rhynchotechum* grouped monophyletically with *Boeica* T.Anderson ex

C.B.Clarke, *Platystemma* Wall. and *Leptoboea* Benth. all of which have dehiscent fruits. Wei *et al*. (2010) generated a similar phylogeny based on *trnL-F* and *ITS*, and it supported *Boeica* as the closest genus to *Rhynchotechum*. Some scattered papers on the phytochemical-ethnobotanical values and the economic importance of this genus was published (Uddin, 2009- *R. ellipticum* (Wall. *ex* D.Dietr.) A.DC. as food and medicine in Bangladesh; Jain & Borthakur, 1980, Neogi *et al*., 1989, Kayang, 2007- *R. ellipticum* and *R. vestitum* as vegetable in Northeast India; Hilliard, 2001- *R. ellipticum* as fodder; Lu *et al*., 1998a, 1998b- *R. vestitum* as folk medicine against Hepatitis A and B in Yunnan, China). Liu *et al.* (1989) discovered a new anthraquinone from *R. vestitum* called "Rhynchotechol". Wang & Wang (2000) looked at seed coat ornamentation in three species in Taiwan. The small flowers of *Rhynchotechum* may indicate insect pollination, while the white berries could be bird dispersed. Moeller *et al*. (2009) indicated that the fleshy fruits are bird dispersed, likening them to the fruits of *Cyrtandra* which Cronk *et al.* (2005) suggested may well be bird dispersed. In a recent revision, Anderson and Middleton (2013) reported 16 species, three of which are newly described (*R. burmanicum* B.M.Anderson from Burma, *R. gracile* B.M.Anderson from Northeast India, and *R. vietnamense* B.M.Anderson from Vietnam).

Rhynchotechum Blume, Bijdr. Fl. Ned. Ind. 775. 1826; G.Don, Gen. Hist. 663. 1838; Endl., Gen. Pl. 719. 1839; R.Br. in Benn., Pl. Jav. Rar. 122. 1840; A.DC., Prodr. 9: 285. 1845; Miq., Fl. Ned. Ind. 2: 749. 1858; Benth. in Benth. & Hook.f., Gen. Pl. 2: 1016. 1876; C.B.Clarke in A.DC. & C.DC., Monogr. Phan. 5(1): 194. 1883, C.B.Clarke in Hook.f., Fl. Brit. India 4: 372. 1884; Fritsch in Engl. & Prantl, Nat. Pflanzenfam. 4(3b): 159. 1894; B.L.Burtt, Notes Roy. Bot. Gard. Edinburgh 24: 36. 1962; A.Weber in Kubitzki, Fam. Gen. Vasc. Pl. 7: 131. 2004. **Type**: *Rhynchotechum parviflorum* Blume.

Isanthera Nees, Trans. Linn. Soc. London 17(1): 82. 1834; C.B.Clarke in Hook.f., Fl. Brit. India 4: 372. 1884. Type: *Isanthera permollis* Nees.

Corysanthera Wall. ex Endl., Gen. Pl. 719. 1839. Type: *Corysanthera elliptica* Wall. ex D.Dietr.

Chiliandra Griff., Not. Pl. Asiat. 4: 150. 1854; Benth. in Benth. & Hook.f., Gen. Pl. 2: 1025. 1876. Type: *Chiliandra obovata* Griff.

Sub-shrubs, erect or decumbent, typically unbranched. ***Leaves*** alternate, opposite or whorled, petiolate; young leaves and stem apices often densely hairy, the hairs become less dense with age. ***Inflorescences*** compound cymes, pedunculate, sometimes peduncle reduced and the inflorescence branches appearing fascicled; bracts linear to triangular at branch points. ***Flowers*** perfect, sub-regular, white to pink-purple or maroon. ***Calyx*** of 5 sepals, divided nearly to the base, persistent. ***Corolla*** short tubular and two-lipped, the upper lip of two lobes, the lower of three. ***Stamens*** four, fertile, attached near the base of the corolla tube; filaments twisted; the anthers globose with pollen sacs confluent and opening by a longitudinal slit with a valve-like dehiscence. ***Disk*** small, surrounding the ovary at the base. ***Ovary*** of two carpels, unilocular; placentation parietal; style single, persistent in fruit. ***Fruit*** fleshy and indehiscent, white at maturity, rarely brown. ***Seeds*** numerous, very small, irregular ellipsoid, dimpled or grooved.

Distribution: India and Sri Lanka, east through Bangladesh and Burma into China and Taiwan, south through Vietnam, Laos, Cambodia and Thailand into Sumatra, east through Java, Borneo and Sulawesi to New Guinea, and north through the Philippines to Japan (Anderson & Middleton, 2013).

Rhynchotechum permolle (Nees) B.L.Burtt, Notes Roy. Bot. Gard. Edinburgh 24: 39. 1962; Ramamoorthy in C.J.Saldanha & Nicolson, Fl. Hassan Dist. 531. 1976; W.L.Theob. & Grupe in Dassan. & Fosberg, Revis. Handb. Fl. Ceylon 3: 105, fig. 8. 1981; B.D.Sharma *et al*., Fl. Karnataka: analysis 195. 1984; A.N. Henry *et al*., Fl. Tamil Nadu Ind., Ser I: analysis 2: 133. 1987; K.K.N.Nair & M.P.Nayar, Fl. Courtallum 2: 283. 1987; Manilal, Fl. Silent Valley 201. 1988; Vajr., Fl. Palghat Dist. 333. 1990; M. Mohanan & A.N. Henry, Fl. Thiruvananthapuram Dist. 338. 1994; Sasidh. & Sivar., Fl. Pl. Thrissur Forest 331. 1996; N.Mohanan & Sivad., Fl. Agasthyamala 497. 2002; Sasidh., Biodivers. Doc. Kerala, Part 6: Fl. Pl. 333. 2004; T.S.Nayar *et al*., Fl. Pl. Kerala 344. 2006, Fl. Pl. Western Ghats, India 1: 530. 2014. *Isanthera permollis* Nees, Trans. Linn. Soc. London 17(1): 82. 1834; A.DC., Prodr. 9: 280. 1845; Wight, Icon. Pl. Ind. Orient. 4: 11. t. 1355. 1848, Ill. Ind. Bot. 2: 182. t. 159b(5); C.B.Clarke in A.DC. & C.DC., Monogr. Phan. 5(1): 192. 1883, in Hook.f., Fl. Brit. India 4: 372. 1884; Rama Rao, Fl. Pl. Travancore 295. 1914; Gamble, Fl. Madras 2: 987. 1924; Santapu, J. Bombay Nat. Hist. Soc. 48: 492. 1952. **Type**: *Heyne s.n*. in Wallich *9073* (K000858004, lectotype designated by Anderson & Middleton, 2013). **Plates 49, 50; Fig. 22**

Isanthera floribunda Gardner, Calcutta J. Nat. Hist. 6: 483. 1846. Type: Ceylon, Gardner 605 (K000831996, lectotype designated by Anderson & Middleton, 2013).

Isanthera permollis Nees var. *paucinervia* C.B.Clarke in A.DC. & C.DC., Monogr. Phan. 5(1): 192. 1883. Type: Lower Burma, Mergui, *Griffith s.n*. (Holotype- K!).

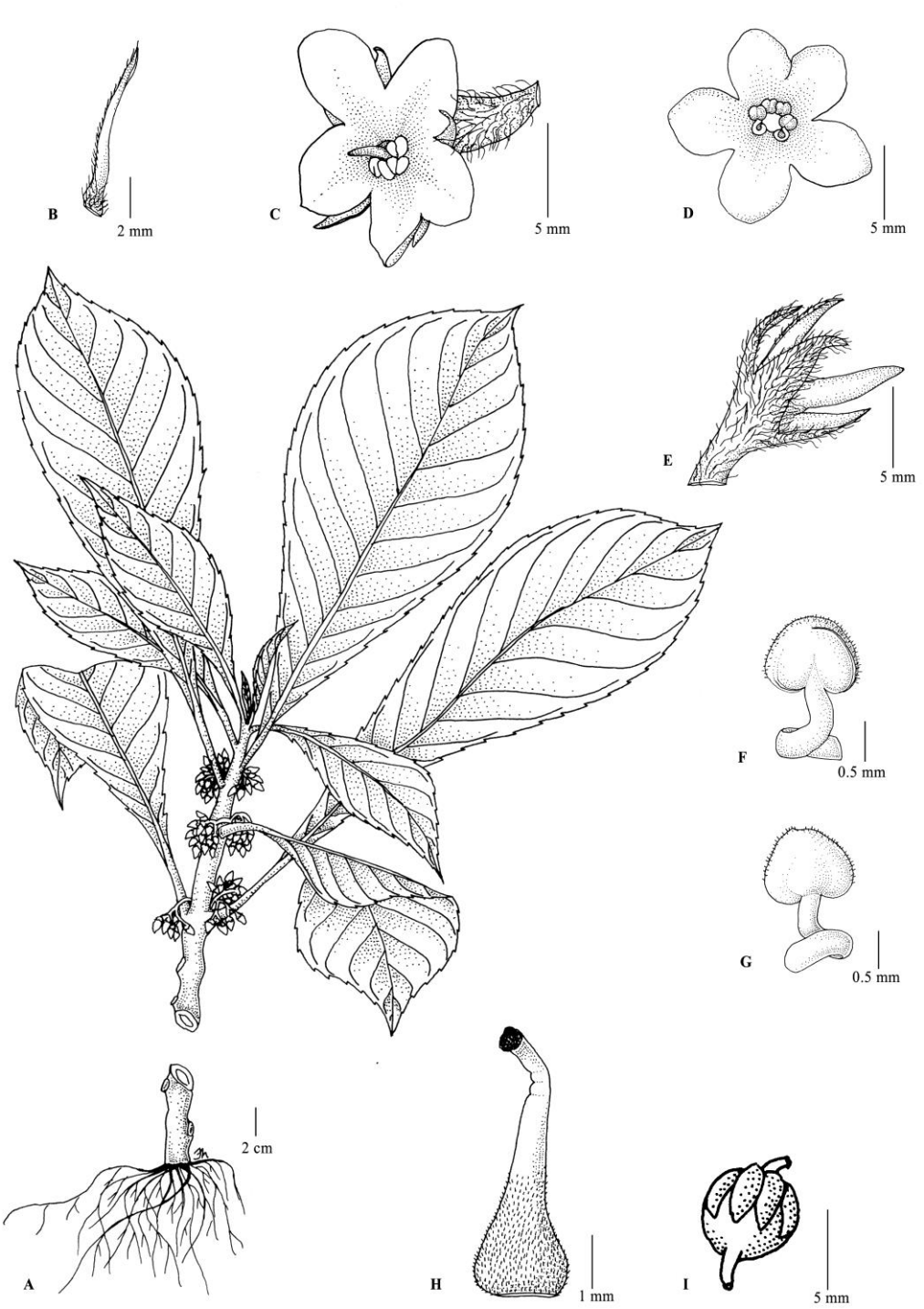


FIGURE 22: *Rhynchotechum permolle* (Nees) B.L.Burtt **A.** Habit; **B.** Bract; **C.** Single flower; **D.** Corolla; **E.** Calyx; **F & G.** Stamens anterior and posterior view; **H.** gynoecium; **I.** Fruit (**A-H** from *A.P. Janeesha* & *A.P. Janid Khan 134264*).

Stems 18–65 cm tall, rooting at nodes. ***Leaves*** alternate; petiole 0.7–2.8 cm long; laminae obovate to narrowly obovate, 9–24 × 4–10 cm, apex acute to acuminate, base narrowly cuneate to attenuate; margin serrate to denticulate, veins 12–20 pairs; adaxially dark green to green, glabrous to white pubescent, denser on the midvein; abaxially pale green, yellow-rusty woolly to rarely sub-glabrous, denser on the rusty-brown veins. ***Inflorescences*** 1.5–5.5 cm long, 2–4 times branched; peduncle 0.8–2.4 cm long, golden yellow villous; bracts linear to slightly lanceolate, 7–11 × 0.5–0.65 mm. ***Pedicels*** 2.2–6.1 mm long, golden yellow villous. ***Calyx*** lobes triangular to lanceolate, apices slightly acute to caudate, 5.17–6 × 0.88–1.20 mm, densely yellow to golden brown tomentose. ***Corolla*** white, glabrous; upper two lipped; lobes 5.2–5.46 × 3.6–3.75 mm, apices rounded to obtuse; lower three lipped, lobes 5.8–6.6 × 4.3–4.5 mm, apices rounded to obtuse; tube ca. 1 mm long. **Stamens** inserted at 0.3–0.6 mm above the base of the corolla tube; filaments 1.2–1.7 mm long, glabrous; anthers yellow, 0.6–0.825 × 0.8–1.2 mm, slightly puberulent on the upper side; staminode not seen. ***Disk*** present, minute. ***Ovary*** 1.3–1.58 × 1–1.2 mm, puberulent; style 1.8–2.4 mm long; stigma apex truncate. ***Capsules*** ovoid, 3–7 × 2.6–4.9 mm, puberulent.

Chromosome number: Not reported.

Flowering & fruiting: May–December.

Habitat & ecology: In shady and moist conditions in primary and secondary forests, often on steep slopes, between 250–1200 m.

Distribution: India, Sri Lanka and possibly Burma (Anderson & Middleton, 2013).

Specimens examined: **Karnataka**, Chikamagalur distict, Gangamula, 08.10.1979, *C.J. Saldanha 9711* (JCB). Hassan district, Galligudda, 13.05.1962, *R. Raghavan 80515* (BSI); Kenchankumari reserve forest, 18.07.1969, *C.J. Saldanha 14211* (JCB); *Ibid*., 05.0831970, *C.J. Saldanha* & *T.P. Ramamoorthy 406* (JCB); *Ibid*., 15.08.1971, *T.P. Ramamoorthy 2022* (JCB). Kodagu district, Mercara, 21.07.1979, *S.R. Ramesh* & *S.B. Manohar 824* (JCB); Makut range, 30.10.1963, *A.S. Rao 95340* (CAL). Shimoga district, Agumbe, 17.10.1960, *C.J. Saldanha CS6033, CS6034* (JCB); Agumbe-Cattleshed road, 15.05.1960, *R.S. Raghavan 62497* (CAL); Agumbe-Galin Gudda, 13.05.1962, *R.S. Raghavan 80515* (CAL); Agumbe-after 9th hairpin turning, 17.09.2014, *A.P. Janeesha* & *Santhosh Nampy 134292* (CALI); Barkana, 31.08.1963, *R. Raghavan 90346* (BSI); Cattleshed road, 15.05.1960, *R. Raghavan 62497* (BSI); Galin Gudda, 28.10.1960, *R. Raghavan 67876* (BSI); Hulikal Ghat, 24.08.1963, *R. Raghavan 90180* (BSI); Onake Abbi, 16.05.1962, *R. Raghavan 62556* (BSI); Varahi falls, 26.08.1963, *R. Raghavan 90242* (BSI); *Ibid*., 08.10.1962, *R. Raghavan 83048*, *83054* (BSI); *s.loc*., 08.10.1962, *R. Raghavan 83054* (CAL). Uttara Kannada district, Gersoppa ghut, 10.1919, *Hallberg* & *Mc Cann 34760, 34758, 34762, 35050, 35053* (BLAT); Kattekan, 08.05.1969, *M.R. Almeida 1218* (BLAT). **Kerala**: Alappuzha district, Muthukulam, 24.03.1976, *K.N. Subramanian 5838* (FRC). Ernakulam district, Pooyamkutty, 06.07.1988, *P. Bharghavan 87396* (CAL, MH). Idukki district, Adimali reserve forest,

29.03.1980, *K. Ramamurthy 66569* (CAL, MH); *Ibid*., 09.10.1982, *C.N. Mohanan 74506* (CAL); Kulamavu, 26.05.1982, *C.N. Mohanan 74033* (MH); *Ibid*., 09.10.1982, *C.N. Mohanan 74506* (MH); *Ibid*., 24.02.1984, *A.G. Pandurangan 78074* (CAL, MH); Kulamavu-Ayyappankoil, 26.05.1982, *C.N. Mohanan 74033* (CAL); Kuruchikella, 16.02.1957, *G.S. Puri 15094* (BSI); Periyar–Mlappara, 16.11.1997, *Jomy Augustine 17958* (CALI). Kollam district, *s.loc*., 01.10.1976, *K. Vivekananthan 48364* (CAL). Palakkad district, Kunthipuzha dam site, 06.11.1976, *E. Vajravelu 48871* (CAL, MH); Mukkali, 21.09.1977, *K.N. Subramanian 7048* (FRC); Muthkulam dam, 26.04.1979, *E. Vajravelu 62907* (MH); New Dam Site, 17.05.1982, *T. Sabu 10500* (CALI); Silent Valley, 11.12.1980, *N.G. Nair* & *N. Sasidharan 1962* (KFRI); Valiyaparathode, 05.12.1980, *N.C. Nair 69126* (CAL); Silent valley, 10.10.1965, *E. Vajravelu 26093* (MH); *Ibid*., 15.07.1969, *E. Vajravelu 32135* (MH); *Ibid*., 21.12.1969, *E. Vajravelu 33204* (MH); Silent valley-way to hanging bridge, 05.10.1979, *N.C. Nair 64298* (MH); Silent valley-hanging bridge, 05.10.1979, *N.C. Nair 64298* (CAL). Kollam district, Rose Mala, 16.12.2005, *J.S. Suja 57333* (TBGT); *s.loc*., 01.10.1976, *K. Vivekananthan 48364* (MH); Palaruvi-Shenduruni on the way, 18.08.2016, *A.P. Janeesha, S. Resmi* & *Santhosh Nampy 137685* (CALI); Thenmala, 22.03.1969, *K.N. Subramanian 3687* (FRC). Kottayam district, Vagamon-Kurishumala, 17.08.2013, *K.M. Manudev* & *A.P. Janeesha 134208* (CALI); Vagamon-near first turning, 07.08.2014, *A.P. Janeesha* & *A.P. Roshan 134272* (CALI). Kozhikode district, Kakkayam, 26.05.2015, *A.P. Janeesha, S. Resmi* & *P.K. Dilna 137619* (CALI); Near urakkuzhi waterfall-Kakkayam, *A.P. Janeesha, Habeeb Rahman* & *S. Syam Radh 134217* (CALI); Tusharagiri-near Thumbitullum waterfall, 10.06.2015, *S. Resmi, V. Veena* & *A.P. Janeesha 137621* (CALI); Way to Olichuchattam, 12.08.2014, *A.P. Janeesha, S. Resmi* & *S. Syam Radh 134282* (CALI). Malappuram district, Nilambur, 11.09.2015, *S.*

Resmi, V. Veena & *A.P. Janeesha 137639* (CALI). Pathanamthitta district, Pamba, 27.06.1968, *D.B. Deb 30444* (MH); Sabarimalai slope, 29.09.1972, *B.D. Sharma 42017* (MH). Thiruvananthapuram district, Agasthyamala, 14.05.1992, *N. Mohanan 9673* (TBGT); Athirumala, 14.05.1988, *N. Mohanan 9673* (CALI); *Ibid*., 15.10.1988, *N. Mohanan 4441* (TBGT); Bonaccard estate, 02.10.1973, *J. Joseph 44503* (MH); Chinichola, 26.09.2008, *C.G. Vishnu 64744* (TBGT); Kallar, 08.06.1992, *M. Abdul Jabbar 13771* (TBGT); Meenmutty waterfalls-Ponmudi, 19.08.2016, *A.P. Janeesha, Santhosh Nampy* & *K. Shinoj 137686* (CALI); Ponmudi, 08.06.1976, *C.E. Ridsdale s.n.* (MH); *Ibid*., 18.09.1985, *N. Mohanan s.n.* (TBGT). Thrissur district, Sholayar, 04.08.1977, *V.P.K. Nambiar 1068* (KFRI); *Ibid*., 18.08.1989, *N. Sasidharan 5612* (KFRI); *Ibid*., 18.04.1990, *N. Sasidharan 6257* (KFRI); Thrissur, 01.08.1996, *A.G. Pandurangan 30753* (TBGT); Vellanippacha forest, 22.09.2015, *A.P. Janeesha, S. Resmi* & *Manu Philip 137640* (CALI); Way to Malakkappara, 14.12.2013, *A.P. Janeesha* & *S. Syam Radh 134249* (CALI). Wayanad district, Chandanathode, 29.06.1965, *J.L. Ellis 25242* (MH); *Ibid*., 31.10.1965, *J.L. Ellis 26324* (MH); Fourth mile-Palchuram, 01.07.2014, *A.P. Janeesha* & *A.P. Janid Khan 134266* (CALI); Kulathupuzha, *s.d., K. Swarrupanandhan 984* (CALI); Kulirkad estate, 12.05.1961, *K.N. Subramanian 71039* (BSI); Makkicheravattam, 05.12.1967, *J.L. Ellis 29497* (MH); Nedumpoyil, 25.11.2014, *A.P. Janeesha, Santhosh Nampy* & *S. Resmi 137607* (CALI); Teppakulam, 15.05.1961, *K.N. Subramanian 71172* (BSI); Vattappoyil, 31.08.2013, *A.P. Janeesha, S. Syam Radh* & *P.G. Arunkumar 134213* (CALI); *Ibid*., 01.07.2014, *A.P. Janeesha* & *A.P. Janid Khan 134264* (CALI). **Tamil Nadu**: Coimbatore district, Bolampatty, 11.1852, *R. Wight 2357* (CAL). Kodagu district, Koinad, 23.07.1978, *S.R. Ramesh 1924* (CAL). Nilgiris district, Devala Ghat, 11.0184, *J.S. Gamble 15633* (CAL, MH); Nedungani, 18.10.1972, *J.L. Ellis 43237* (MH); Santhi estate, 30.07.1970, *J.L.*

Ellis 35314 (MH). Ramanathapuram district, Deviar estate-Sethur hills, 24.07.1980, *S.R. Srinivasan 65999* (MH). Tirunelveli district, Courtallum, 09.1835, *R. Wight 2035* (CAL); *Ibid*., 08.1835, *R. Wight 384* (CAL); Kalivayalpil, 03.06.1901, *C.A. Barber 3094* (MH); Sivagiri hill, 08.1836, *R. Wight 3511* (CAL); Kannikatte, 03.06.1901, *C.A. Barber 3094* (CAL).

Notes: This taxon is similar to the Chinese species *R. discolour* and Sumatran species *R. eximium*, but differs from the former by its broader leaves and shorter calyx lobes and from the latter by shorter and more contracted inflorescences and longer fruits. Anderson and Middleton (2013) reported staminodes in *R. permolle* but are lacking in South Indian materials studied.

Phylogenetic Analysis

For this study 37 trnL-F sequences and 70 ITS sequences were newly generated and an additional of 50 ITS and 38 trnL-F sequences were obtained from Gen Bank (Appendix VI). Both the sequences was aligned automatically and then adjusted by eye. For the phylogenetic analysis, two analysis – Maximum Likelihood (ML) implemented in MEGA v.6.0 (Tamura *et al.,* 2013) and Bayesian inference (BI) in Mr.Bayes version 3.1.2 (Ronquist & Huelsenbeck, 2003; Huelsenbeck & Ronquist, 2007) was carried out. The trnL-F and ITS sequences were analysed together after their combinability was checked by the Incongruence Length Difference (ILD) test implemented in PAUP* v.4.0.b10 (Swofford, 2002). The ILD test indicated a high level of congruence between the two data set (P=0.010), and the data was deemed combinable.

For the ML analysis, the adopted method was Tamura-Nei Model and the bootstrap consensus tree inferred from 1000 replicates. The branches corresponding to partition reproduced in less than 50% bootstrap replicates are collapsed. Initial tree for the heuristic search were obtained by applying the Neighbour-Joining method to the matrix of pairwise distance using the maximum composite likelihood (MCL) approach. For the BI analysis, model and parameters prior settings were obtained independently for the trnL-F and ITS spacers using Mr.Modeltest v.2.3 (Nylander, 2004), suggested by the Akaike Information Criteria (AIC: Akaike, 1974) and were GTR+G and SYM+G respectively. In all cases, species of Scrophulariacea was selected as the out group taxa to root the tree.

Phylogeny using trnL-F

For the analysis a discrete gamma distribution was used to model evolutionary rate difference among cites (+G, parameter=1.0293). The analysis involved 75 nucletotide sequences. All positions with less than 95% site coverage were eliminated. There were a total of 669 positions in the final dataset. For the BI analysis four lakh generations were run with four Markov Chain Monte Carlo (MCMC) chain. One tree was sampled at every 100 generation and the first 25% generations discarded as burn in. A total of seven clades was revealed by the ML tree (**Figure 23**) and the BI (**Figure 24**). Both the trees were almost identical in topology with slight difference in the branching totpology among poorly supported nodes (BS<50). The difference is found in the genus *Jerdonia* (sub-tribe: *Jerdoniinae*; tribe *Trichosporeae*) which fall in clade formed by the genera *Rhynchoglossum* and *Epithema* (tribe *Epithemateae*) which is conflict with the recent classification of Gesneriaceae proposed by Weber *et al*. (2013). Whereas it forms a separate clade between the tribe *Epithemateae* and tribe *Trichosporeae* in BI and attain a basal position as suggested by Moller *et al*. (2009).

In ML analysis, the South Indian taxa fall in five different clades where as in BI they fall in six clades (the formation of *Jerdonia* clade with the tribe *Epithemateae* makes the number one less in ML analysis). From both the trees, t the South India genera are monophyletic in origin and are supported by high bootstrap (BS) value and posterior probability (PP). The clade formed by the species of *Epithema* are supported (BS=99, PP=1) and is sister to the clade of *Rhynchoglossum* (BS=99, PP=1). Both these genera together forms the clade 1 (BS=71, PP=1). There is a controversy is seen in the case of *Epithema carnosum*, the sequence retrieved from Gen Bank which is nested in

the clade formed by *Primulina*. The clade formed by the genus *Jerdonia* (BS=99, PP=1) is sister to clade 1 in ML analysis, where as it is sister to the clade formed by all other members of the tribe *Trichosporeae* in BI. The other genera *Rhynchotechum*, *Microchirita*, *Aeschynanthus* and *Henckelia* together comprise the tribe *Trichosporeae*. The clade formed by *Rhynchotechum* (BS= 98, PP=1) is closest to *Boeica* species (clearly seen in BI) and the entire clade is sister to the rest of the genera in the tribe Trichosporeae. The genus *Microchirita* is supported by BS=99 and PP=1. The clade of the epiphytic genus *Aeschynanthus* (BS=99, PP=0.94) is sister to the clade of *Agalmyla* and this clade is sister to the clade formed by the species of *Henckelia*

Phylogeny using ITS

For the analysis a discrete gamma distribution was used to model evolutionary rate difference among cites (+G, parameter=2.5796). The analysis involved 121 nucletotide sequences. All positions with less than 95% site coverage were eliminated. There were a total of 437 positions in the final dataset. For the BI analysis four lakh generations were run with four Markov Chain Monte Carlo (MCMC) chain. One tree was sampled at every 100 generation and the first 25% generations discarded as burn in.

The ML tree obtained (**Figure 25**) have five different clades. Of which the first clade is formed by genus *Epithema*, *Rhynchoglossum* along with *Jerdonia* and each forms three sub-clades (*Rhynchoglossum* (BS=58), *Jerdonia* (BS=85) and *Epithema* (BS=98). But the nesting of *Jerdonia* between *Epithema* and *Rhynchoglossum* is not supported by BS value. Within the clade of *Rhynchoglossum*, the reinstated species, *R. scabrum* forms a separate position which is sister to *R. notonianum*. Clade two is formed by the species of *Rhynchotechum*. Clade three is formed by species of *Microchirita*, *Codnoboea*,

Didymocarpus and *Primulina*. Where it forms two sub-clades, with in the second sub-clade, the group of *Microchirita* (BS=64) is sister to the group of *Codnoboea* (BS=82). Species of *Aeschynathus* forms the fourth clade.

Phylogeny using combined data of trnL-F and ITS

For the analysis a discrete gamma distribution was used to model evolutionary rate difference among cites (+G, parameter=0.6907). The analysis involved 67 nucletotide sequences. All positions with less than 95% site coverage were eliminated. There were a total of 1074 positions in the final dataset. For the BI analysis three lakh generations were run with four Markov Chain Monte Carlo (MCMC) chain. One tree was sampled at every 100 generation and the first 25% generations discarded as burn in.

The tree obtained from the BI (**Figure 27**) is exactly similar with the tree obtained using trnL-F. All the genera in South India are monophyletic in origin. The tree revealed seven clades. Clade one formed by *Rhynchoglossum* and *Epithema* with PP=1. Clade two formed by *Jerdonia* (PP=1), which is sister to the remaining members of tribe *Trichosporeae*. Clade three formed by *Rhynchotechum* and its allied genus *Boeica* (PP=1). The clade four is formed by the species of *Microchirita* with a posterior probability of 1. Clade five formed by the species of *Codnoboea*, which was earlier treated as species of *Henckelia*. Clade six is formed by *Aeschynanthus* and *Agalmyla* and the *Primulina* species (PP=0.6), where the sub-clade of *Aeschynanthus* is supported with PP=1. Here also the retrieved sequence of *E. carnosum* nested in clade six. The seventh clade is formed by the species of *Henckelia* (PP=1), which further forms three sub-clades.

Discussion

A taxonomic revision of the family Gesneriaceae in South India is completed using morphological and molecular data. The result obtained during the present study is discussed below under different heads.

I. Comparative morphology

a) **Habit (Plate 51)**:

Species of Gesneriaceae are mostly perennial herbs or sub-shrubs; terrestrial, epiphytic or lithophytic, with fibrous roots or rootstock or tubers. *Aeschynanthus* species are epiphytic but when their branches come in contact with a suitable substratum in ground, it grows as lithophyte. Whereas species of *Epithema* are lithophytic (rarely found on tree trunks), seen on areas with high humidity and shade. Species of *Henckelia*, are perennial herbs, majority are rosette forming, very rarely tuberous (*H. pradeepiana*) or creeping (*H. repens*). They grow on hill slopes or in rock crevices or on rocks, but never on limestones. The monotypic genus *Jerdonia* is a perennial herb occurring in shady, moist soils. *Microchirita* are caulescent annual herbs found on limestones while species of *Rhynchoglossum* are fleshy succulent annual herbs found from low to high altitudes. They need high water content for their growth. *Rhynchotechum* are sub-shrubby plants with woody stems and grows on primary and secondary forests.

PLATE 51: Different habits of Gesneriacean members **A.** *Aeschynanthus perrottetii* A. DC.; **B & C.** *Epithema ceylanicum* Gardner; **D.** *Henckelia bracteata* Janeesha & Nampy; **E.** *Jerdonia indica* Wight; **F.** *Microchirita hamosa* (R.Br.) Yin Z.Wang; **G.** *Rhynchoglossum scabrum* Dalzell; **H.** *Rhynchotechum permolle* (Nees) B.L.Burtt

b) **Inflorescence** (**Plate 52**):

The inflorescences of Gesneriaceae are "Pair flowered cymes (PFC)". These are special type of cymes where the terminal flower (T) of each cyme unit is associated with an additional flower in the frontal position (F). Thus each cyme unit seems to end in a flower pair. Genus to genus, they exhibit wide variation. In *Aeschynanthus*, the inflorescences appear as axillary few-flowered cymes or the flowers are solitary in the axils of leaves, or they are in a pseudoterminal cluster. Where as in *Epithema*, the inflorescence is reduced to a single bract/ inflorescence unit (Weber 2004a). The flowers are arranged in two to three rows and are collectively subtended by a cucullate bract. *Henckelia*, *Jerdonia* and *Rhynchotechum*, exhibit typical pair flowered cymes, where the number of cyme unit may vary. In *Microchirita*, due to the serial repetation of cymes, the inflorescence is appeared as crested in the leaf axis. Where as in *Rhynchoglossum*, the cymes are reduced to single flower, and the thyrse switches to a unilateral raceme.

c) **Flowers** (**Plate 53**):

The flowers are usually showy, tetracyclic, gamopetalous and zygomorphic. Among Gesneriaceaen members, *Aeschynanthus* has the largest flower and *Epithema*, the smallest. The calyx consist of five sepals which are either free or fused to variable extend (**Plate 54**). In *Epithema* and *Rhynchoglossum*, the calyx is fused at the basal half where as in other genera, it is free. In *Rhynchoglossum notonianum* and *R. scabrum*, the calyx lobes are winged and one wing is prominently winged than the others. The calyx is usually green, but vividly coloured. The calyx is hairy except in *Rhynchoglossum* and *Aeschynanthus* . The shape of calyx lobe and hair pattern are useful for species delineation in South Indian *Henckelia*. The longest calyx

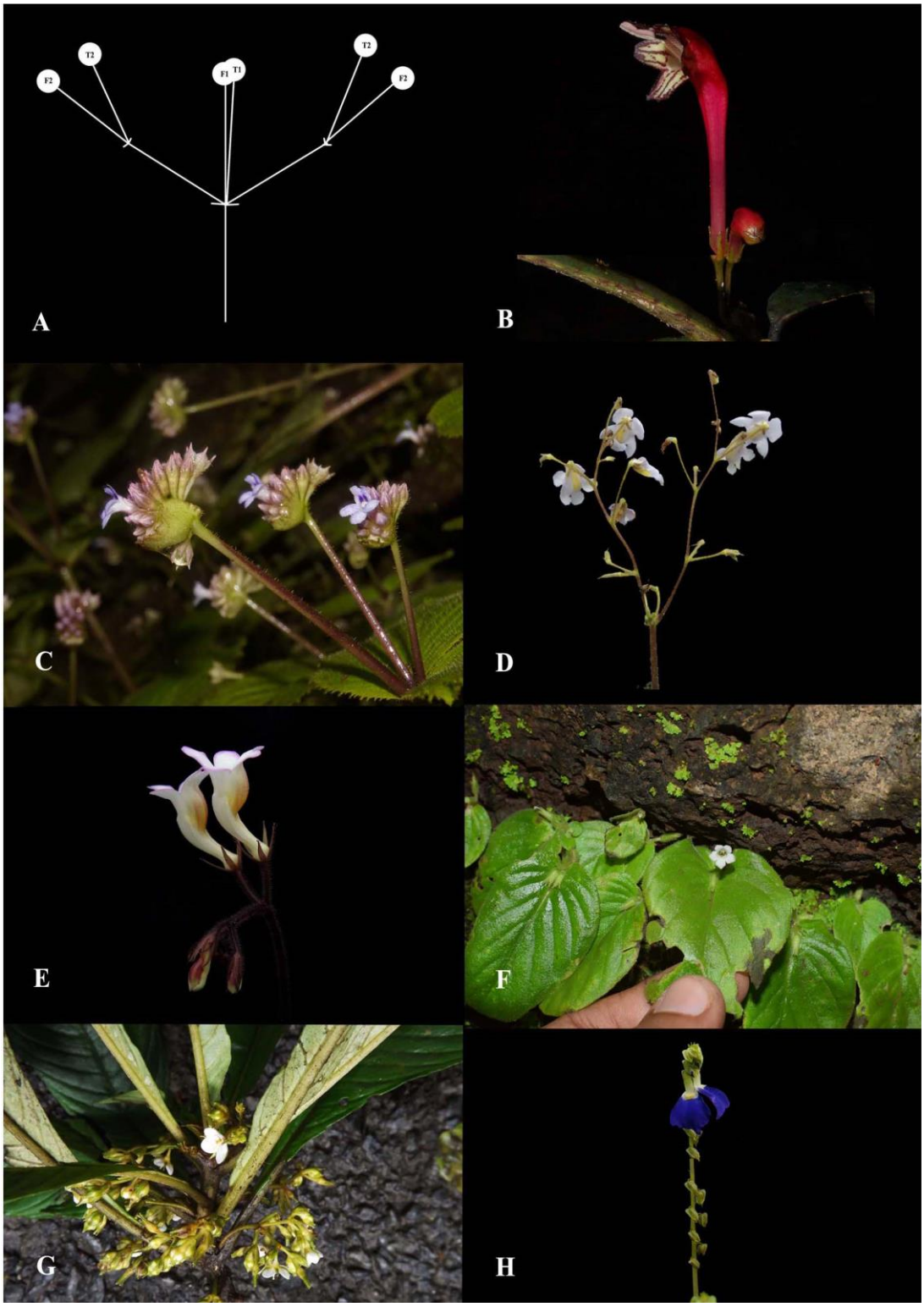


PLATE 52: Inflorescence in Gesneriaceae **A.** Typical pattern of Pair Flowered Cymes (PFC); **B.** *Aeschynanthus*; **C.** *Epithema*; **D.** *Henckelia*; **E.** *Jerdonia*; **F.** *Microchirita*; **G.** *Rhynchotechum*; **H.** *Rhynchoglossum*.

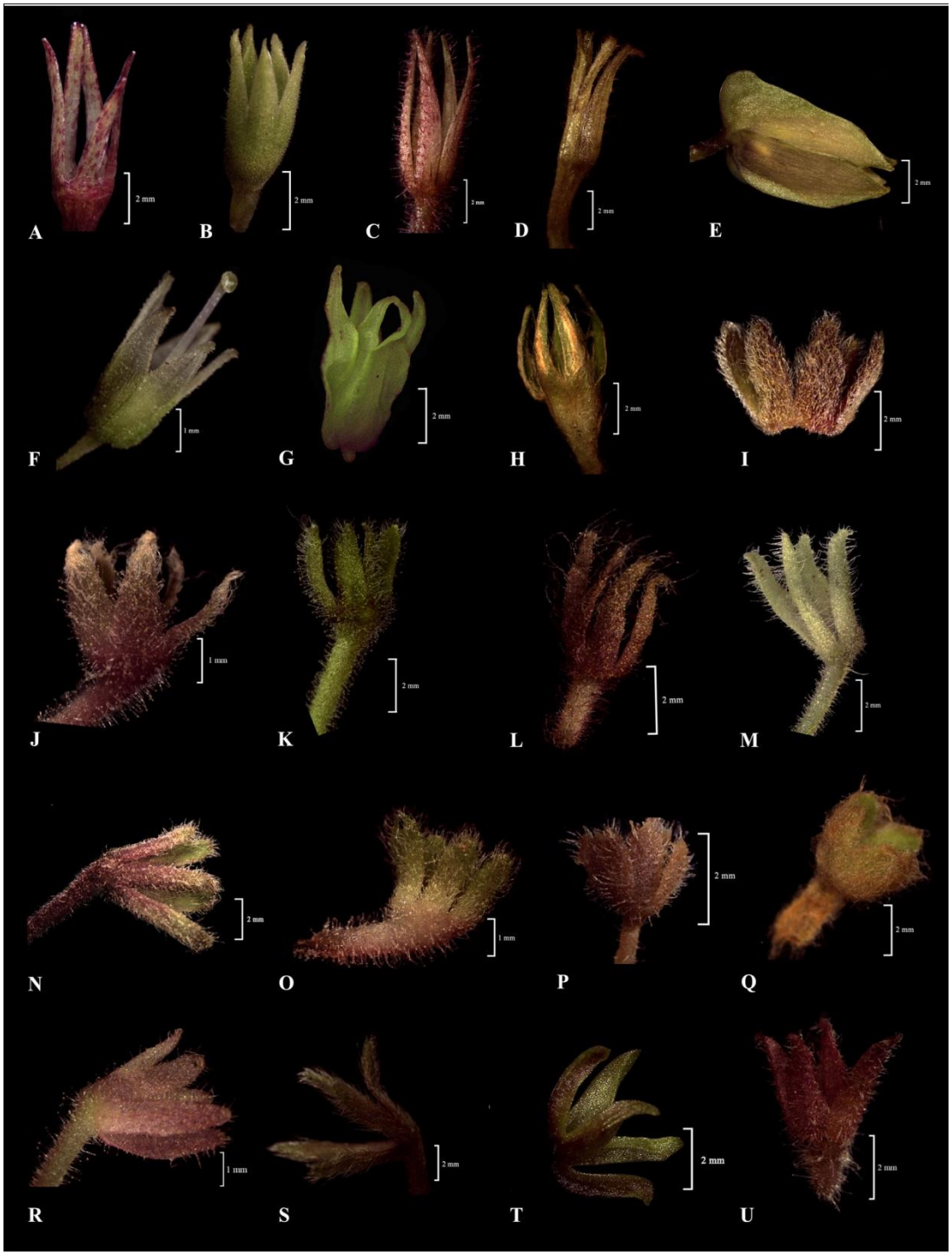


PLATE 54: Calyx of Gesneriaceae **A.** *Aeschynanthus perrottetii*; **B.** *Epithema ceylanicum*; **C.** *Jerdonia indica*; **D.** *Microchirita hamosa*; **E.** *Rhynchoglossum notonianum*; **F.** *R. obliquum*; **G.** *R. scabrum*; **H.** *Rhynchotechum permolle*; **I.** *Henckelia bracteata*; **J.** *H. fischeri*; **K.** *H. fischeri* var. *x*; **L.** *H. gambleana*; **M.** *H. humboldtiana*; **N.** *H. incana*; **O.** *H. innominata*; **P.** *H. lyrata*; **Q.** *H. macrostachya*; **R.** *H. meeboldii*; **S.** *H. ovalifolia*; **T.** *H. pradeepiana*; **U.** *H. repens*.

is seen in *H. ovalifolia* (5.8–6.8 mm) while the smallest in *H. macrostachya* (2.5–4.9 mm). The calyx lobes are keeled but glabrous in *H. pradeepiana*. In *M. hamosa*, the calyx is hairy throughout where as in *M. sahyadriensis* hairs are confined to the apex and base of the calyx.

Corolla is gamopetalous and pentamerous but shows wide range of variation. The corolla tube may be narrow and long in *Aeschynanthus*, gently or abruptly widening, pouched on ventral side in *Jerdonia* and *Henckelia* but very short in *Rhynchotechum permolle*. Among species of *Henckelia*, the tube is very long in *H. repens*. The corolla lobe is primarily bilabiate, with two upper and three lower lobes. The bilabiate nature is much prominent in flowers of *Epithema* and *Rhynchoglossum*, where the flowers resemble the flowers of Lamiaceae. The corolla lobes are rounded to orbicular generally, except in *Rhynchoglossum*,. In all genera except *Rhynchoglossum* and *Microchirita sahyadriensis*, the corolla is hairy out while in *Epithema, Jerdonia* and *Microchirita hamosa*, the corolla is hairy inside too. The colouration of corolla is extremely varied, ranging from white (*Jerdonia, Microchirita, Rhynchotechum*), red (*Aeschynanthus*), lilac (*Henckelia, Epithema*) to Blue (*Rhynchoglossum*) with or without some striations. The corolla is streaked with red in *Jerdonia* and in *Henckelia* species, but have a yellow blotch near the region of stamen insertion. In *H. pradeepiana*, the yellow blotch is streaked with dark lilac.

The androecium composed of 4 (5) or 2 fertile stamens, and the others being reduced to staminodes (**Plates 55 & 56**). In *Aeschynanthus*, the four fertile stamens are arranged in 2 pairs, didynamous, and the filaments are glandular hairy. The fifth one is reduced as staminode. In *Henckelia* and *Epithema*, all species have two stamens and two staminodes. The stamens of

PLATE 56: Staminodes of Gesneriaceae **A.** *Microchirita hamosa*; **B.** *Henckelia bracteata*; **C.** *H. fischeri*; **D.** *H. fischeri* var. *x*; **E.** *H. gambleana*; **F.** *H. humboldtiana*; **G.** *H. incana*; **H.** *H. innominata*; **I.** *H. macrostachya*; **J.** *H. meeboldii*; **K.** *H. ovalifolia*; **L.** *H. pradeepiana*; **M.** *H. repens*.

H. bracteata have a few hispid hairs on the region of connective. The filaments of *H. meeboldii*, *H. ovalifolia* and *H. repens* are hairy, while others have glabrous filaments. In *H. ovalifolia*, the filaments are hairy distally whereas in *H. repens*, the filaments are broad and hairy at the middle region. *Jerdonia* has four fertile stamens and shows anterior and posterior pair differentiation. Anterior filaments have hairs at the top and the posterior filaments have a descending yellow spur bearing hairs on one side.

Microchirita has two fertile stamens and two staminodes. The anthers are bearded in *M. hamosa* but not bearded in M. *sahyadriensis*. In *Rhynchoglossum, R. notonianum* and *R. scabrum* have four fertile stamens where as *R. obliquum* has only two, but in all of them, the anthers cohere together. *Rhynchotechum* has four fertile stamens attached near the base of the corolla tube. The filaments are twisted and anthers are hairy and open by a longitudinal slit with a valve-like dehiscence.

The filaments of the staminodes are short, with or without an antherode. *Henckelia macrostachya* has a hairy, dome shaped antherode and in *H. repens*, the filaments are hairy throughout its length. In *H. pradeepiana*, the filament is broad ending in an ovate antherode.

The gynoecium is composed of ovary, style and stigma (**Plate 57**). A disc is present between stamen and ovary. It shows great variety of forms sometimes may be a complete cylindrical ring or cup with shallow lobes at the ring. The shape of ovary varies from globose, ovoid, elongated to cylindrical. In *Aeschynanthus* the ovary is linear, glabrous where as in *Epithema* the ovary is sub-spherical to cylindrical and hooked hairy distally. The hairiness on ovary is used to identify species in this genus. In *Henckelia*, the ovary is ovoid to cylindrical and glandular hairy, except in *H. pradeepiana* which has a glabrous ovary. In *Jerdonia*, the ovary is ovoid and glabrous situated on a bright orange annular disk. In *Microchirita*, the ovary is cylindrical and hairy, globose to ovoid and glabrous in *Rhynchoglossum* and slightly globose and hairy in *Rhynchotechum* . The style may be straight or gently curved. The style is hairy in the basal half but in *H. repens* is hairy along its entire length. The stigma is inconspicuous, distinctly capitate or bilobed. In *H. pradeepiana*, typical chiritoid stigma is seen but in *H. repens*, the

stigma is spathulate. The proportion of calyx to gynoecium (**Plate 58**) is important in species delineation, especially in South Indian *Henkelias*.

d) **Fruits** (**Plate 59**):

The fruits may be dehiscent capsules or indehiscent berries. *Aeschynanthus* species has the longest capsules among Gesneriaceae, up to 20 cm long, dehisces along both the sutures. In *Epithema* it is cylindrical to spherical with an operculum and helps in splash cup dispersal. The capsules are linear, with or without persistent calyx and rudimentary stigma in all *Henckelia* except *H. pradeepiana* where it is ovoid to sub-globose. They dehisce only along the upper suture (plagiocarpic). *Jerdonia* has an ovoid capsule with four parietal placenta and dehisces along its entire length by both sutures. *Microchirita* also has linear capsule, with persistent calyx. In *Rhynchoglossum*, the capsule is ovoid, glabrous and enclosed with in calyx whereas in *Rhynchotechum*, it is an indehiscent fleshy, glabrous berry.

e) **Seeds** (**Plate 60**):

The seeds are small and produced in large numbers in Gesneriaceae. They are with or without appendages. In *Aeschynanthus perrottetii*, the seeds bear long filiform hair at the hilar end and at the apical end (sect. *Haplotrichum*), and the testa is warty. This appendage helps in wind dispersal of the seeds. All other genera in South India have unappendaged seeds. In *Epithema*, the seeds are ovoid and spiralled while in *Henckelia*, the seeds are elliptic and pitted. The seeds are aulacospermous and pitted in *Jerdonia* while ellipsoid with conspicuous knobs on the testa cells in *Microchirita*. The seeds of *Rhynchoglossum* are ellipsoid with reticulate ornamentation.

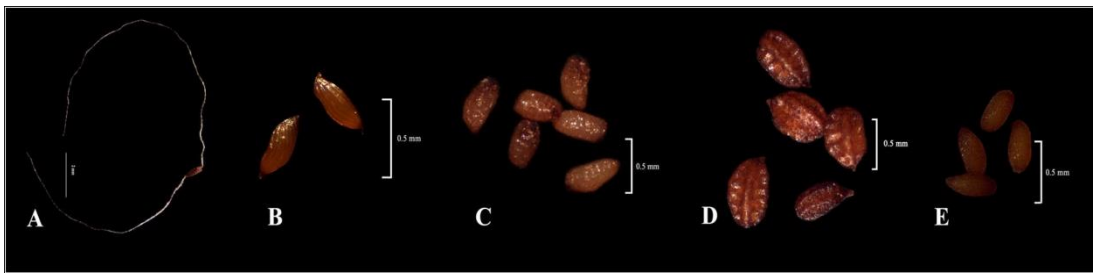


PLATE 60: Seeds of Gesneriaceae **A.** *Aeschynanthus*; **B.** *Epithema*; **C.** *Henckelia*; **D.** *Jerdonia*; **E.** *Rhynchoglossum*.

II. Phylogenetic analysis

The internal transcribed spacer (ITS) of the nuclear ribosomal DNA are frequently used for phylogenetic analysis at species level (Baldwin *et al.,* 1995). But the ITS region contains many ambiguous sites that are not easily aligned while constructing the data-matrix. Whereas the trnL-F intron region is less variable due to its catalytic property and it could be more useful for evolutionary studies at higher taxonomic level (Taberlet *et al.,* 1991). The ITS sequence of *Aeschynanthus* shows sequence polymorphism (Denduangboripant & Cronk, 2000) which is also observed in our data too, that makes the sequence difficult to interpret.

The trnL-F and the combined analysis agree with the recent classification of Gesneriaceae by Weber *et al.* (2013). The analysis supported the monophyletic origin of South Indian Genera. The members of the tribe *Epithemateae* and *Trichosporeae* form separate clades. Within the tribe *Epithemateae*, *Rhynchoglossum* stands apart which is closely allied to *Stauranthera* and *Epithema* as given by Mayer *et al.* (2003). This indicate that *Rhynchoglossum* split off very early from other taxa then existing and that there was long period of time available for the evolution of elaborated morphological pattern.

Sub-tribe *Jerdoniinae*, represented by the monotypic genus *Jerdonia*, forms a separate clade in all analysis. This is very evident in the combined matrix and corroborates Moller *et al.* (2009) that *Jerdonia* is sister to the rest of the 'Didymocarpoid Gesneriaceae' (now called tribe *Trichosporeae*).

Summary

The family Gesneriaceae in South India is revised based on extensive field studies and consulting specimens in major Indian herbaria. The molecular phylogeny is also done using sequences from chloroplast (trnL-F) and nuclear genome (ITS).

The classification by Weber *et al*. (2013) is followed in the present work. They recognised three sub-families in Gesneriaceae, *viz*., Sanangoideae A.Weber, J.L.Clarke & Mich.Moller, Gesnerioideae Burnett and Didymocarpoideae Arn. Among them, sub-family Didymocarpoideae Arn. alone is represented in South India. The sub-family Didymocarpoideae is divided into two tribes, tribe *Epithemateae* and tribe *Trichosporeae*. Tribe *Epithemateae* is divided in to four sub-tribes, of which only two, sub-tribe *Loxitidinae* G.Don (*Rhynchoglossum* Blume) and *Epithematinae* DC. ex Meisn. (*Epithema* Blume) are represented here. Tribe *Trichosporeae* is divided in to ten sub-tribes, of which three sub-tribes, *viz., Jerdoniinae* A.Weber & Mich.Moller (*Jerdonia* Wight), *Leptoboeinae* C.B.Clarke (*Rhynchotechum* Blume) and *Didymocarpinae* G.Don (*Aeschynanthus* Jack, *Henckelia* Spreng. and *Microchirita* (C.B.Clarke) Yin Z.Wang) occur in South India. All genera except *Henckelia* are represented by one to few species in South India, where as *Henckelia* has 14 species and 1 variety including the newly described taxa.

Sixty five field trips were conducted in different parts of South India during 2012-2016 and about 200 days were spent in the field (a few images of the collection localities were given in **Plate 61**). Major herbaria in India were consulted for accounting the diversity of each species. Freshly collected

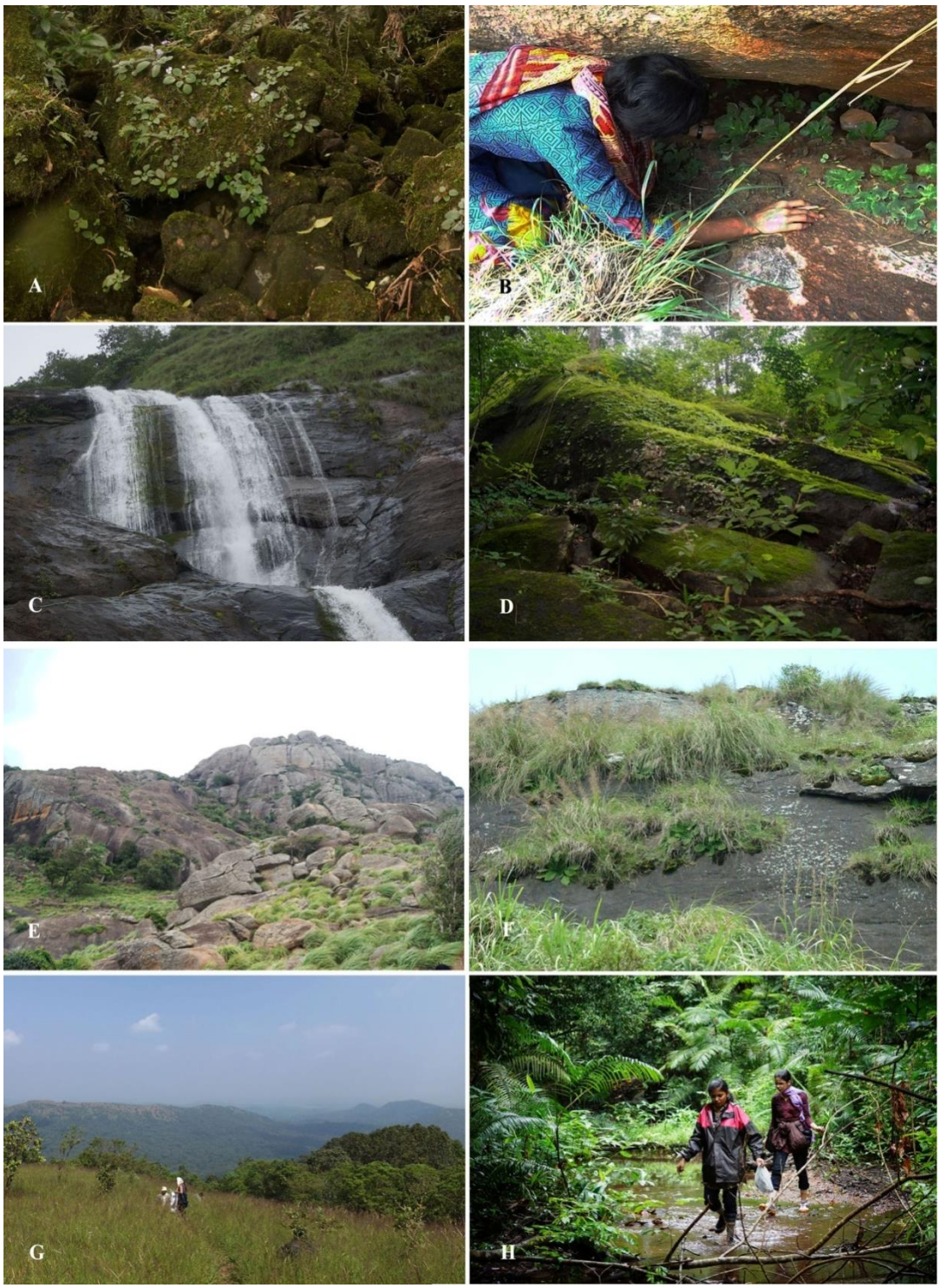


PLATE 61: Few areas visited for specimen collection **A.** Agasthyamala, Thiruvanathapuram, Kerala; **B.** Penukonda hills, Andhra Pradesh; **C.** Palaruvi waterfall, Kollam, Kerala; **D.** Moonnamra, Thenmala, Kerala; **E.** Chunkankada hills, Tamil Nadu; **F.** Karimala, Parambikulam, Kerala; **G.** Kodajadri, Karnataka; **H.** Neyyar, Thiruvananthapuram, Kerala.

material was introduced in Calicut University Botanical Garden (CUBG) as a part of the germplasm collection (**Plate 62**). Herbarium specimens were prepared using conventional methods. More than 310 specimens were prepared and deposited in Calicut University Herbarium (CALI).

As part of the present revision, 24 species and 1 variety are recognised from South India. Two species and one variety are newly described (one species and one variety awaiting publication)

Nomenclature of all taxa were updated as per latest Botanical Code. Four new synonyms are recognized, 17 names (including synonyms) are lectotypified.

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