Taxonomic Studies on the genera *Pogostemon* Desf., *Anisochilus* Wall. ex Benth., and *Scutellaria* L. (Lamiaceae) of the Western Ghats of India

Submitted to the
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SHINOJ, K.

DEPARTMENT OF BOTANY
UNIVERSITY OF CALICUT
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DECLARATION

This thesis entitled **Taxonomic Studies on the genera *Pogostemon* Desf., *Anisochilus* Wall. ex Benth., and *Scutellaria* L. (Lamiaceae) of the Western Ghats of India** submitted by me in partial fulfilment of the requirements for the award of the degree of **Doctor of Philosophy** in **Botany** of the **University of Calicut** and it has not been submitted earlier either in part or in full for any other degree or diploma of any University.

Calicut University **Shinoj, K.**

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CONTENTS

CHAPTER 1
INTRODUCTION

Taxonomy the mother of all biological sciences has its major role in naming and classifying organisms in our surroundings. It has probably been taken place when humans started to communicate to know the names of plants and animals useful to them. The illustrations of medicinal plants in Egyptian wall paintings from ca. 1500 B.C., portrayed before us the uses of plants in medicines and revealed that a basic taxonomy was in place in those days. Aristotle, the father of biology was the first to classify organisms and he divided all living organisms into two groups: plants and animals. Theophrastus (Greece, 370–285 BC), the father of botany, carried on this tradition, mentioning some 500 plants and their uses in his *Historia Plantarum.*

The development of sophisticated optical lenses allowed the micromorphology of organisms to be studied in detail and categorizing organisms became more prevalent and scientific studies started replacing the ancient texts. Classical taxonomic studies over the last centuries classified plants through different approaches but the major focus was on similarity and differences on important characters.

Taxonomic studies using scientific principles and procedures become an interesting subject when we found some unique characters in a taxon helping to sort out it from the rest. At the same time many biologists considered taxonomy as an herculean task because in many taxa the variations play a crucial role and forms a riddle in identification. Lamiaceae is one such family whose circumscription and boundary at all levels were a confusing topic among botanists.

1.1. Significance of the study

After Bentham's monograph of the family (1832), the Indian Lamiaceae were dealt in detail by Hooker (1885), and later, a revision was done by Mukerjee (1940). All these publication were based mainly on herbarium materials. Many local floras have been published recently, adding further accessions to the list, but there has been no complete revision of the family based on microcharacters as preserved in fresh specimens. Due to these taxonomic studies of the family Lamiaceae in India lack precision, particularly on certain genera like *Pogostemon, Anisochilus* and *Scutellaria*. It is in this context, a study based on field observation and fresh specimens is attempted to revise these genera (*Pogostemon, Anisochilus* and *Scutellaria)* in a biodiversity rich area like Western Ghats. This is, in fact, is a prelude to revise the entire family in India.

Objectives

1. Taxonomic revision of the genera *Pogostemon, Anisochilus* and *Scutellaria* of Western Ghats based on comparative morphology.
2. Extensive survey, and assessment of species diversity based on field exploration and collection in Western Ghats.
3. Collection of literature and type specimens from different herbaria to review the same for adding precision in identification.
4. Microscopic and macroscopic observation of the morphology to yield taxonomic characters.
5. Preparation of a detailed taxonomic account of the three genera with descriptions, illustrations of some rare species, photographs, ecology, phenology, distribution and a key for identification.

6. Resolving nomenclatural problems of all taxa and typification wherever necessary.

7. Conservation of live germplasm in the Calicut University Botanical Garden for further studies.

8. Preparation of distribution map of these genera in Western Ghats.

CHAPTER 2
OVERVIEW OF LAMIACEAE

Lamiales are one of the largest orders of flowering plants comprises more than 20,000 species in at least 25 families as per the recent APG system of classification (Olmstead et al. 1993, 2000, Soltis et al. 2000, Bremer et al. 2002, Schäferhoff et al. 2010) and are distributed all over the world. From the pre-cladistic classification systems (Dahlgren 1987, Takhtajan 1997) the order Lamiales has undergone drastic conceptual changes during the recent past. The earlier order Lamiales was expanded by including former orders Scrophulariales and Oleales according to APG III (2009). The phylogenetic system of classification unravel before us the monophyly of the order Lamiales (Olmstead et al. 1993, Oxelman et al. 1999, Backlund et al. 2000, Albach et al. 2001, Bremer et al. 2002, Hilu et al. 2003) and many of the families coming under this order are well established (Scotland et al. 1995, Smith et al. 1997, Wagstaff and Olmstead 1997, McDade and Moody 1999, Spangler and Olmstead 1999, Wallander and Albert 2000, Muller et al. 2004, Rahmanzadeh et al. 2005). In the recent works of Schäferhoff et al. (2010) and Refulio-Rodriguez and Olmstead (2014) the inter-relationships among major lineages of Lamiales were clarified.

Lamiaceae the sixth largest family of angiosperms with 236 genera and around 7173 species is presently circumscribed as the largest family level clade within the order Lamiales (Harley et al. 2004, Olmstead, 2012, Chase et al., 2016). This mint family or the dead nettle family is considered to be highly evolved with gamopetalous flowers and epipetalous stamens. The origin of this family date back to the early cretaceous period of the Mesozoic era (Harley et al. 2004). The family name Lamiaceae is based on the type genus *Lamium* L., a temperate taxon distributed chiefly in Eurasia, Macaronesia to Ethiopia. Earlier this family was known by the name Labiatae ('Labium' meaning lip) due to the presence of bilipped floral parts especially corolla, a term introduced by the great French botanist and most forceful early promoter of the "natural system", Antoine Laurent de Jussieu (1789). Since the period of Linnaeus, the classification of Lamiaceae was a matter of debate. Bentham's classification (1832, 1848), was based mainly on the floral features and is valid till today. Later Bentham's classification was revived by Briquet (1897) with various modifications.

Lamiaceae is related to the sister family Verbenacae in many aspects and some of the species coming under both the families show stricking similarities. The APG system of classification also portrayed before us the same picture leading to the expantion of the family boundary by including some genera from Verbenacea like *Callicarpa, Symphorema, Tectona* etc. Recent phylogenetic studies of Lamiales, considered both Lamiaceae and Verbenaceae within a single large clade called "core Lamiales". Lamiaceae are sister to a well-supported clade comprising of several small families (Mazaceae, Paulowniaceae, Phrymaceae, Rehmanniaceae and the parasitic family Orobanchaceae), whereas the family Verbenaceae are coming sister to the small African family Thomandersiaceae (Soltis et al. 2011; Refulio-Rodriguez and Olmstead, 2014; Schäferhoff et al., 2010). The unique characters namely the presences of gynobasic style in the members of the family Lamiaceae make them stand apart. The attachment of ovules to the ovary wall relative to the false septa that leads to the division of each carpel into two single-seeded chambers is a fundamental distinction. The ovules in Lamiaceae attach to the sides of an inrolled carpel wall, whereas in Verbenaceae the ovules attach directly to the margins of the false carpel septa. In addition, the inflorescence nature of Lamiaceae also shows distinction, which is fundamentally cymose versus racemose in Verbenaceae, though a recemoid inflorescence has independently evolved in several subgroups of Lamiaceae (Li et al., 2016).

Several herbaceous members of the family with zygomorphic flowers have attracted mankind due to its importance in perfumes, flavourings, foods and medicinal drugs. Presence of essential oils with varied properties is the main reason behind its economic value. Economically important products like teak wood (*Tectona*), oil of peppermint (*Mentha*) and patchouli (*Pogostemon*) are the major highlight of this family. Other commonly known plants of economic value includes culinary herbs like Basil (*Ocimum*), Oregano (*Origanum*), Rosemary (*Rosmarinus*), Thyme (*Thymus*), Sage (*Salvia*), and both spearmint and peppermint (*Mentha*).

Harley et al. (2004) divided the family into seven subfamilies namely Ajugoideae, Lamioideae, Nepetoideae, Prostantheroideae, Scutellarioideae, Symphorematoideae and Viticoideae. They also included a separate group of ten genera under *incertae sedis* which could not be treated under any of these seven subfamilies. Nepetoideae with clearly defined synapomorphic chararacters is the largest among all mint subfamilies. Phylogenetic studies also supported the monophyly of five subfamilies Ajugoideaea, Lamioideae, Nepetoideae, Prostantheroideae and Scutellarioideae. Three new sub families namely Cymarioideae, perenematoideae, and Premnoideae were included in the large scale phylogenetic reconstruction of Lamiaceae using chloroplast sequences by Li et al. (2016).

2.1. Pogostemon Desf.

Pogostemon Desf. belongs to tribe *Pogostemoneae*, subfamily Lamioideae of the family Lamiacae (Bendiksby et al. 2011). It is distributed mainly in tropical and subtropical regions of Asia, and with five species endemic to Africa (Bhatti & Ingrouille 1997, Scheen et al. 2010). The genus

Pogostemon Desf. is globally represented by 96 species (Mabberley 2005). In the *Plant List* the genus *Pogostemon* is represented by 130 scientific names, (Plantlist.org) of these 92 are accepted species names. *Pogostemon* is represented in South and Southeast Asia by 79 taxa (Bhatti & Ingrouille, 1997). India has the highest number of *Pogostemon* species in the world, represented by 56 taxa (53 species and 3 varieties), Harley et al. (2004). *Pogostemon* can be distinguished from other Lamiaceae by the presence of exerted stamens bearing moniliform hairs (Hasskarl 1842, Kuntze 1891, Press 1982, Bhatti & Ingrouille 1997). The relationship between *Pogostemon* (in a narrow sense) and the genus *Dysophylla* Blume (1826) has been debated in the past. *Pogostemon s.s.* was usually considered to include terrestrial herbs or subshrubs with opposite, broad and petiolate leaves as well as solid stems, whereas *Dysophylla* was a group from aquatic and marshland habitats, with opposite or verticillate, linear to filiform and sessile leaves on hollow stems (ElGazzar & Watson 1967, Wu et al. 1975, Bhatti & Ingrouille 1997). However, some species in *Dysophylla* including its type, *D. auricularia* (L.) Blume (1826), exhibit opposite leaves and seem to be intermediate between these two genera (Li 1975, Bhatti & Ingrouille 1997). Some authors (Bentham 1848, Hooker 1885, Briquet 1897, Airy Shaw 1967, Keng 1969, Li 1975, and Press 1982) suggested that those species with opposite leaves in *Dysophylla* should be transferred to *Pogostemon s.s.*, and *Dysophylla* then includes only those species with verticillate leaves. Recent molecular phylogenetic studies implied that *Pogostemon s.l.* is strongly supported to be monophyletic and all species sampled included in *Dysophylla* are nested within *Pogostemon* (Bendiksby et al. 2011). In *Flora of China*, Li & Hedge (1994) mostly accepted the treatment by Wu & Huang (1977) except for treating two varieties as synonyms of *Dysophylla stellata* (Lour.) Benth. (1830). When Bhatti & Ingrouille (1997) published revision of the genus, they did not treat most of the species published by Chinese taxonomists probably because of non availability of material.

Infrageneric classification of the Genus *Pogostemon* by Bhatti and Ingroille (1997) consist of three subgenera namely subgenus *Pogostemon* sensu Bhatti & Ingr., subgenus *Allopogostemon* Bhatti & Ingr. and subgenus *Dysophyllus* (Blume) Bhatti & Ingr. subgenus *Allopogostemon* with two sections viz. section *Racemosus* (Benth.) Bhatti and Ingr. (with two subsections *Racemosus* and *Glabriusculus* (Briq.) Bhatti) and section *Zygocalyx* Bhatti & Ingr. They also divided the subgenus *Dysophyllus* into two sections *Dysophyllus* and *Verticillatus* (Benth.) Bhatti & Ingr.

2.2. Anisochilus Wall. ex. Benth.

The genus *Anisochilus,* is an Asian genus of herbs and shrubs, first described by Bentham (1830). The genus belongs to the tribe Ocimeae of sub family Nepetoideae (Harley et al. 2004). The striking features of this genus is the congested spike-like head, flowers sessile or subsessile, calyx with unequal lips, fruiting calyx with posterior lobes decurved or deflexed and concealing the throat after anthesis, corolla tube decurved with declinate stamens and confluent anthers. Based on calyx characters, Bentham (1848) divided the genus into 2 sections, A*nisochilus* Benth. and S*tiptanthus* Benth. At present, the genus comprises around 20 species and is chiefly distributed in India, Sri Lanka, Himalaya, Burma, south China, Thailand and Indo-China (Suddee & Paton 2009). Trang Province of Peninsular Thailand is the southern most distribution known so far. At present, the genus contains seventeen species in India including the two recently reported species (Sunil et al. 2015, Shinoj & Sunoj Kumar 2018) from southern region. Of these eight are endemic to the Deccan Peninsula. The genus *Leocus* A. Chev. recognised by Harley et al. (2004) is superficially similar to the genus *Anisochilus* but it differs in having fused stamens and differences in calyx structures. The former is also restricted to Africa, whereas *Anisochilus* is an Asian genus. As a part of the perparatory work done for the *Flora of East Tropical Africa*, the type of *Leocus,* (*L. lyratus* A. Chev.), is recognised as a synonym of *Plectranthus betonicifolius* Baker and that the genus *Leocus* is better subsumed into *Plectranthus*.

Anisochilus is closely related to the genus *Plectrathus* in vegetative and floral characters other than calyx. It can be distinguished from *Plectranthus* by the nature of spike-like head and a deflexed posterior lip on the fruiting calyx (Harley et al. 2004). A phylogeny of *Plectranthus* and related genera is presented in Paton et al. (2004). This work shows that *Anisochilus* nests within the '*Coleus*' clade but the authors opined that better resolution and support are required before making any changes to the generic circumscription in this complex.

Bentham (1848) divided *Anisochilus* into two sections based on calyx characters. Section *Anisochilus* has posterior lip of calyx ovate and deflexed and truncate anterior lip. Section *Stiptanthus* is characterised by 5-toothed calyx with incurved and oblique teeth and incumbent and elongate nature of the uppermost tooth.

2.3. Scutellaria L.

The genus *Scutellaria*, commonly known as skullcaps belongs to the subfamily Scutellarioideae. It is one of the largest genera with 466 species having subcosmopolitan distribution (Govaerts et al. 2011). Majority of the species are found on the temperate mountains in the tropics and southern hemisphere. The genus is so far not reported from the Arctic regions of southern hemisphere, the Amazon basin, desert regions of North Africa, and the Australian continent except for Victoria and New South Wales. The Irano Turanian phytogeographic region of Asia shows the highest diversity of this genus. East Mediterranean and Andes are considered as secondary centers (Paton, 1990; Cicek & Yaprak 2013). According to Borror (1971) the name *Scutellaria* is derived from the Latin word “*scutella*” meaning a dish which describes the lower half of the calyx after mericarp dissemination but Lane (1976) differently opined that the Latin word “*scutellum*” meaning a little shield, probably referring to a small, rigid, erect, sail like or hooded structure protruding from the outer surface of the posterior lip of calyx.

Scutellaria has been separated into two subgenera: *Scutellaria* Paton with five sections: *Scutellaria* Paton, *Perilomia* (Kunth) Epling emend. Paton. *Salzaria* (Torrey), *Salvifoliae* (Boiss.) Edmondson and *Anaspis* (Rech.f.) Paton. and sub genera *Apeltanthus* (Nevski ex Juz.) Juz emend. Paton. with two sections: *Apeltanthus* Nevski ex Juz. and *Lupulunaria* A. Hamilton. Section *Lupulunaria* is further broken into two subsections. Among the two sections, the section *Lupulunaria* (A. Ham.) Paton and *Cystaspis* (Juz.) Paton. *Lupulinaria* is the largest subsection distributed throughout North Africa and Eurasia with approximately 120 species (Paton, 1990).

CHAPTER 3
REVIEW OF LITERATURE

3.1. Taxonomy

3.1. 1.Lamiaceae

The name Labiatae was first used by de Jussieu in 1789. Bentham (1832–1836) published the first overall classification of Lamiaceae at generic and infrageneric level. Eleven tribes were recognized by him, which was later reduced to eight in de Candolle's *Prodromus* (1848).

Hooker (1885) gave a brief description and keys to different genera of the family Lamiaceae. He recognised 55 spp. of Lamiaceae under 7 tribes which incude 13 spp. and 3 varities of *Anisochilus,* 25 spp. of *Pogostemon*, 17 spp. of *Dysophylla* and 14 spp. and 4 varities of the genus *Scutellaria.* Based on Bentham, Briquet (1895–1897) prepared a comprehensive classification of Labiatae in his *Die Naturlichen Pflanzenfamilien* which is widely followed nowadays.

Gamble (1921) described 26 genera of Lamiaceae with a brief description, key to the different genera and species under it. He included 12 species of *Anisochilus,* 15 species of *Pogostemon*, 7 species of *Dysophylla* and 5 species of *Scutellaria* from Madras Presidency.

A revision of the Labiatae of Indian empire was first completed by Mukerjee (1940), in which he recognised 14 species of *Anisochilus,* 45 species of *Pogostemon* and 22 species of *Scutellaria.*

Ever since, the early classification of Labiatae by Junell (1934) and Erdtman (1945), the relationship of this family to other families need a seriouis re-evaluation. An alternative classification of Labiatae was proposed by Erdtman (1945), on the basis of palynological features. He suggested that the Labiatae consist of two natural subfamilies Lamioideae and Nepetoideae, that differ in their pollen features. The sub family Lamioideae have tricolpate or occasionally tetracolpate grains that are shed at a two-celled stage, whereas the Nepetoideae possess hexacolpate grains or rarely 8-, 10- or 12-colpate, that are three-celled when shed.

An updated synopsis of the supra-generic taxa was given by Melchior (1964) which largely followed Bentham (1848) and Briquet (1897). The extensive pollen survey by Wunderlich (1967) lent strong support to Erdtman's groupings through the addition of many new genera to the palynological data base. She noted several embryological characters and whose variation patterns are more or less parallel to those of the two pollen characters. A number of chemical characters have been found to correlate as well in later studies (El-Gazzar & Watson 1970a; Kooiman 1972; Litvinenko *et al.* 1975; Novit skaya and Krishtopa 1971; Zoz and Litvinenko 1979). The classification of Lamiaceae into six subfamilies by Wunderlich (1967) can be correlated well with Briquet (1897) classification. These six sub families are: Ajugoideae, Catepherioideae, Lamioideae, Nepetoideae, Prostantheroideae and Scutellarioideae. These were later corrected by Sanders and Cantino (1984), as per ICBN rules. A highly congruent classification with Bentham's tribal classification was followed by Cantino and Sanders (1986).

El-Gazzar and Watson (1970b) conducted a cluster analysis involving 116 genera of Labiatae, 17 of Verbenaceae, 3 of Dicrastylidaceae, and 2 of Stilbaceae resulted in two primary clusters. One of the yielded cluster corresponded to Erdtman's Nepetoideae, and the other one to Erdtman's Lamioideae plus the genera from the other three families. Their analysis was based on 46 characters, including two pollen characters used by Erdtman in categorising the subfamilies.

In spite of the convincing evidence that Erdtman's subfamilies are the primary phenetic subgroups of the Labiatae and the strong statements of support that the classification has received in the non-American literature (Wunderlich 1967; El-Gazzar & Watson 1967, 1970a, 1970b; Zoz and Litvinenko 1979), his subfamilial classification remains poorly known in North America. In this context, Cantino and Sanders (1986) revised the sub familial classification of Lamiaceae with the objectives to include the number of pollen cells and colpi in 108 genera, including 93 not previously investigated ones. Their view was to follow the subfamilial classification according to Erdtman's system and to summarize and discuss the character data that support Erdtman's subfamilies. They considered Erdtman's groupings from a phylogenetic perspective and provided a comprehensive list of genera in each subfamily. This enabled to evaluate Bentham's and Briquet's treatments of the family in the light of the support for Erdtman's subfamilies. Cantino and Sanders (1986) concluded that Erdtman's subfamilies appear to be the primary phenetic groupings of the Labiatae except subfam. Nepetoideae which was found to be monophyletic on the basis of synapomorphies. Briquet's (1895–1897) widely used classification was highly incongruent with Erdtman's, and it was recommended that the former be abandoned.

A preliminary cladistic analysis by Cantino (1992), suggests that the Labiatae are polyphyletic and the gynobasic styled Labiatae which make up about 90% of the family emerge as a clade, nested within a larger group which is characterized by supra-reticulate pollen and a fruit composed of nutlets. According to the results obtained, he found that the bulk of Labiatae plus the verbenaceous genera *Garrettia* and *Holmskioldia* and its closest relatives are in tribe Viticeae (Verbenaceae). Six genera including *Teucrium* of Ajugeae (Labiatae) belong to a large clade characterized by pollen with branched to granular columellae. Most members of which are currently assigned to tribes Clerodendreae and Caryopterideae (Verbenaceae). Another group Prostanthereae which was traditionally placed in the Labiatae, tribe appears to be most closely related to subfamily Chloanthoideae (Verbenaceae). The hypothesis relating to the evolution of gynobasic-styled Labiatae in southern China or Indomalaysia (Wu & Li 1982) was supported by this analysis. An Australian origin for the cosmopolitan genus *Teucrium* based on the distributions of its closest relatives was also hypothesized by him.

3.1. 2. Pogostemon

The first written document pertaining to the genus *Pogostemon* was given by Van Rheede (1678–1693) in his monumental work, '*Hortus Malabaricus'*. He depicted the medicinal value of *Pogostemon heyneanus* as 'Kottum' in Malayalam, (10: 153, t.77, 1690) used to cure swellings and pustules of mouth. He also described *Pogostemon paniculatus* as 'Manam-podam' in Malayalam (10: 129, t.65. 1690). Hermann (1717)mgave the polynomial *Veronica hirsute latifolia zeylanica aquatica* to a species of *Pogostemon* collected from Ceylon.

The genus *Pogostemon* was first recognised as a distinct genus by Desfontaines (1815). The word *Pogostemon* came from the Greek word '*pogon'* meaning beared and *'pogonostemon'* meaning beared stamen (Stearn, 1992). *Pogostemon plectranthoides* Desf., the type species of this genus, described by Desfontaines and he placed it near *Hyssopus* L.

Aleucuro-veronica a genus listed by Linnaeus (1747) was later treated as a synonym of *Mentha auricularia* by the same author in 1767. A species *Majana foetida* described by Rumphius (1750) was treated as another synonym *Majorona foetida*, which has a close affinity to other species of *Mentha*.

Blume (1826), recognised *Dysophylla* as a distinct genus based on the type species *Dysophylla auricularia* (L.) Blume (= *Mentha auricularia*) and cited Rumphius' illustration. He placed *Dysophylla* next to *Mentha* though he found it different from *Mentha* by having closed fruiting calyx, fleshy swelling of the disc and beared stamens.

The species described as *Mentha* by Loureiro (1790) and Roxburgh (1814, 1832) was also included under the genus *Dysophylla* by Bentham (1829, 1830, 1832-1836). Based on the phyllotaxy Bentham (1830) divided *Dysophylla* into two groups, one with opposite leaves and other with verticillate leaves. These groups were formally recognised as section *Oppositifoliae* and section *Verticillatae* by Bentham (1832) in *Labiatarum genera et species*. Section *Oppositifoliae* included three species namely *Dysophylla auricularia* (L.) Blume, *D. myosuroides* Benth. and *D. styrigosa* Benth. which agreed with Blume's original description *Dysophylla*. On the basis of inflorescence, Bentham (1832-1836) divided the genus *Pogostemon* into two sections, the *Paniculatae* and the *Racemosae*.

Rafinesque-Schmaltz (1837) and Briquet (1897) followed Bentham's splitting of *Dysophylla* and *Pogostemon*. Rafinesque-Schmaltz (1847) considered *Dysophylla* section *Verticillatae* to a generic rank. He published a new genus *Eusteralis* Raf. which included *Mentha Pumila* Graham and *Mentha verticellata* Roxb. Briquet (1897) sub divided *Dysophylla* into two sections *Rhabdocalicinae* Briq. & *Goniocalicinae* Briq. and the genus *Pogostemon* into two sections *Racemosa* Benth. and *Paniculata* Benth.

In 1929, Kudo treated *Dysophylla* and *Pogostemon* under subtribe *Pogostemon*inae as distinct genera. He divided *Dysophylla* into two sections *Eudysophylla* and *Chotekia.*

El-Gazzar & Watson (1967) studied 37 species of *Pogostemon* Desf. and *Dysophylla* Blume and divided them into two distinct groups comprising of 26 species under *Pogostemon* and 11 species under *Dysophylla*. According to them the differences in leaf characters go in hand with the microscopic characters and hence Group I consist of plants growing on dry grounds characterised by Conglomerates (Calcium Oxalate crystals) on their calyx whereas Group II including plants with marshy habitats characterized by aerenchymatous cortical tissue in their stems. They found that 4 species of Bentham's section Oppositifoliae (1848) were out of place and must be removed to the genus *Pogostemon.* All these species have minute flowers and the classical distinction between the genera was marginal. They amended the generic diagnoses and shifted four species of *Dysophylla* Blume including the type species, *D. auricularia* (L.) Blume to *Pogostemon* Desf., and eleven species of group 2 were kept apart to represent the genus *Dysophylla sensu auct., non* Blume.

One of the four species transferred by El-Gazzar and Watson to *Pogostemon*, namely *Dysophylla auricularia* (L.) Bl., was the type species of the genus *Dysophylla* Blume and hence the latter becomes a generic synonym of *Pogostemon* Desf., whilst the bulk of the species included in *Dysophylla* were left without a generic name. To obviate a large number of name-changes, it seems reasonable to retain the name *Dysophylla* for these species, by establishing and conserving the new genus *Dysophylla* El-Gazzar & L. Watson, with a corresponding new type. Airy Shaw (1967) proposed conservation of *Dysophylla* El-Gazzar & L. Watson ex Airy Shaw with *D. quadrifolia* (Benth.) El-Gazzar & L. Watson ex Airy Shaw as the type species.

Different authors added novelties to the genera in these years. Ridley (1967), added 3 species from Malay Peninsula, Backer & Brink (1965) recorded 7 species from Java and Merrill (1968) and one species from Philippines.

Murata (1971) reported 9 species of *Dysophylla* and 8 species of *Pogostemon* from Thailand. McVaugh (1974) reported 60 species of genus *Pogostemon* Desf.

Airy Shaw (1973) extended the generic boundary of *Eusteralis* Raf. with *E. pumila* (Graham) Raf. as the type and sole species by transferring *Dysophylla* El-Gazzar & L. Watson ex Airy Shaw to the genus *Eusteralis* Raf. and kept the later *Dysophylla* El-Gazzar & L. Watson ex Airy Shaw congeneric and synonymous to *Eusteralis* Raf.

In 1976, Panigrahi proposed sixteen new combinations in *Eusteralis* Raf. and one new combinations in *Pogostemon* Desf., from Indian region. According to Keng (1978) there are about 50 species of *Pogostemon* Desf. distributed throughout Southeast Asia to China and Japan, southwards to Australia.

Bhatti & Ingrouille (1997) and Press (1982) published seventy-nine species of *Pogostemon*. Doan (1936) collected *Pogostemon globulosus* (Doan) W. Chuakul for the first time from South Vietnam in 1868. But this was described and illustrated by him as *Dysophylla globulosa* Doan in 1936. Brummit (1992) and Cantino et al. (1992) considered both *Dysophylla* Blume and *Eusteralis* Raf. Congeneric with *Pogostemon* Desf. In 2002, Chaukul reported *Pogostemon globulosus* (Doan) W. Chuakul *comb. nov.* for the first time from Thailand and gave a full description.

Based on field observation and extensive herbarium studies, a comprehensive taxonomic revision of the genus *Pogostemon* in China was carried out by Yao et al. (2015). They recognised twenty-seven species and two varieties of *Pogostemon*. Among this eleven species and one variety are endemic to China. A new species, *P. henanensis*, was also described and illustrated. Two new combinations were proposed namely *P. glaber* var. *tsingpingensis* and *P. latifolius*. Eleven names were lectotypified and a name was neotypified and six names were reduced to synonymy.

3.1. 3. Anisochilus

Rheede (1678–1693) in his monumental work, '*Hortus Malabaricus'*, depicted the medicinal value of *Anisochilus carnosus* ("Kaattukoorkka" in Malayalam) as herbs used to check poison in snakebites. This was the first appearance of *Anisochilus* in a published literature. The genus name *Anisochilus* was first validly published by Bentham (1830) based on the description by Wallich in Edward's Botanical register (1830). Later in *Labiatarum genera et species*, Bentham (1832–1836) considered 9 species under two sections *Anisochilus* and *Stiptanthus*. Division of the genus into 2 sections was based on calyx characters: section *Anisochilus* Bentham (1848) with 4/5-toothed calyx, posterior calyx lip ovate and decurved, anterior lip truncate, and section *Stiptanthus* Bentham (1848) with 5-toothed calyx, teeth incurved and oblique, uppermost tooth elongate and incumbent. Bentham and Hooker in *Genera Plantarum* (1876) included 16 species of *Anisochilus.*

Wight (1850), illustrated four species of *Anisochilus: Anisochilus albidum, A. dysophylloides, A. purpureum* and *A. suffruticosus* from India. Hooker (1885) given a brief description of 13 species and 3 varities of *Anisochilus* from India. Prain (1890), described two species *Anisochilus carnosus*, and *A. polystachyus* based on the collections from Chota Nagpur (Bihar) and North Bengal respectively.

Trimen (1895) described 3 species of *Anisochilus* namely *Anisochilus carnosus*, *A. paniculatus* and *A. velutinus* from Ceylon. Cooke (1906) described 2 species *Anisochilus carnosus*, and *A. verticillatus* from Bombay presidency. Later Gamble (1921) included 12 species of *Anisochilus* from Madras Presidency.

Fyson (1932), described two species of *Aniosochilus: A. dysophylloides* & *A. suffruticosus* from the hill stations of South India. Mukerjee (1940), described 14 species of *Anisochilus* from Indian empire. Later Cramer (1981) described 3 species of *Anisochilus* in Ceylon.

Naithani (1985) collected and described only single species *Aniosochilus carnosus* from Chamoli, Howrah. Harley et al. (2004), mentioned the presence of 15–20 species of *Anisochilus* distributed mainly in rocky areas in India and Indo-China.

In 2004, Suddee et al. as part of a revision of the tribe Ocimeae in continental South East Asia revised the subtribe Plectranthinae and a detailed account of descriptions, full synonyms relevant to South East Asian Floras, maps, line drawings, information about ethnobotany, distributions, habitats, ecology, endemism and conservation, selected specimen citations and an index to accepted names and synonyms were provided for the different genera.

Subsequently, Suddee and Paton (2009) in their revision of the genus *Anisochilus* (Lamiaceae) considered sixteen species of *Anisochilus*. Information about types, distributions, and a key to species and full synonymy were also given. The type of *A. adenanthus* Dalzell has been found and the widely used name *A. verticillatus* was treated as synonym. *A. sericeus* and *A. dysophylloides* var. *purpureus* were turned to be synonyms of *A. dysophylloides*. A recently published name *A. henryi*, also converted to synonym of *A. robustus*. Nine names were lectotypified. The description of the genus were confined to species from South Asia, from the Eastern

Himalaya, North Thailand, and South China in the North to Sri Lanka and Peninsular Thailand in the South.

Sunil et al. (2015) described a new species *Anisochilus shoolamudianus* from the Western Ghats of Ernakulam District of Kerala in India. The species resembles *Anisochilus adenanthus* Dalzell., but differs from it in possessing some unique characters such as antrosely pubescent terete stem with yellow glands covered and short strigose simple leaves, short bract, calyx and corolla.

Shinoj and Sunojkumar (2018), described another species from Kanyakumari District of Tamil Nadu. It was seen similar to *A. carnosus* in vegetative characters and nature of inflorescence whereas in floral characters it was close to *A. paniculatus*, but differs from both by its decumbent habit, leaf size and shape, short petiole, nature of inflorescence, size and shape of spike head, corolla size and shape and densely villous calyx. Detailed description, photographs, illustrations, distribution map, notes on biogeography and other relevant notes were also provided.

3.1. 4. Scutellaria

Cortuso (1591), an Italian botanist first used the term *Scutellaria,* a Latin word (meaning dish) due to the presence of dish like scutellum on the posterior lip of the calyx. He used the term for an alternative name for *Lamium perigrinum.* But the generic status of *Scutellaria* was first suggested by a Scottish botanist and taxonomist, Robert Morison (1669). Brown (1810) described two species of *Scutellaria* namely *S. humulis* and *S. mollis.* Wight (1850) illustrated two species *Scutellaria rivularis* and *S. violacea.*

Bentham (1832–1836) described 63 species of *Scutellaria* and placed it along with *Prunella* L. and *Cleonia* L. in the tribe Scutellarineae on account of the superficial resemblances of calyx. Bentham (1848) described 86 species under four sections. Visiani (1847) sensibly separated *Cleonia* and *Prunella* from Scutellarineae. Bentham (1848 and 1876) didn't agree the above view and kept these genera together and merged them into a larger tribe Stachydeae. In *Genera Plantarum* (1876) he described 90 species of *Scutellaria* under three sections *Lipulinaria*, *Heteranthasia* and *Vulgares.*

Caruel (1886), based on curved or bent nature of embryo, placed *Scutellaria, Perilomia* and *Salazaria* in a new family the Scutellariaceae. But such a classification obscured the vegetative and floral similarities of *Scutellaria* to the rest of the Labiatae. *Scutellaria* with an incumbent radicle and *Perilomia* with a curved embryo do not form a natural group as suggested by Gray (1872). Similarly Briquet (1896), using this and the transverse position of the seed in fruit in *Scutellaria* and erect in *Perilomia* placed *Scutellaria* and *Salazaria* in Subfamily Scutellarioideae and Pe*rilomia* in Subfamily Stachyoideae. The differences between the incumbent radicle of some species like *S. galericulata* L and the short-radicled right angled embryo of *Salazaria* and the slightly curved embryo of *Perilomia ocymoides* Kunth do not support subfamilial delimitation on the basis of similarities in inflorescence, calyx, nutlet and pollen characters. According to Briquet (1896) the meaning of 'seed upright' and 'seed transverse' is uncertain. Penland (1924) discussed the importance of position of the seed in *Scutellaria* classification, but still its infallibility is questionable when it separates such closely related forms. Briquet's (1896) and Melchior's (1964) classification are similar thus obscures the resemblances between these taxa. But it is Briquet's subfamilial system which is most commonly used today in a few major works like *Flora USSR* (Juzepczuk 1954) and *Flora Reipublicae Popularis Sinicae* (Wu & Li 1977).

A new division of the Labiatae was proposed by Erdtman (1945) based on pollen morphology and placed *Scutellaria* and *Perilomia* with tricolpate pollen in Subfamily Lamioideae. The characters listed by Cantino & Sanders (1986) well supported this classification system. A few species of *Scutellaria* studied were similar to the rest of the Lamioideae in having iridoid glycosides according to Kooiman (1972), but poor in volatile terpinoides as stated by El Gazzar & Watson (1970a), rosmarinic acid by Zoz & Litvinenko (1979) and linolenic acid by Hagemann et al. (1967).

Wunderlich's (1967) classification, based on pollen, seed and embryo characters was in terms with Erdtman's classification and none of her subfamilies were having both tri- and hexa-colpate pollen. Her classification accurately reflects the position of *Scutellaria* and allied genera, because she placed *Scutellaria*, *Salazaria* and *Perilomia* in the same subfamily, Scutellarioideae. These genera are morphologically similar and different from the rest of the Labiatae. Juzepczuk (1954), in *Flora URSS*, dealt with 148 species emphasising the character of upper lip of the calyx and divided the genus into 4 subgenera: *Euscutellaria* Briq. with a small scutellum; *Cystaspis* (Juz.) Juz. with single large membranous-inflated scutellum; *Anaspis* (Rech.f.) Juz. with a testudinate calyx; and *Apeltanthus* (Nevski ex Juz.) Juz. with a much smaller testudinate calyx. Subgenera *Euscutellaria* is divided into the 3 sections of Hamilton (1832) plus Section *Nevskinthe* Juz. which is similar to Section *Lupulinaria*.

Later Rechinger (1982) follows Juzepczuk's classification but mentioned that section *Nevskinthe* was absent in Iran. Wu & Li (1977) maintained Briquet's subgenera but followed Bentham (1834) in dividing Subgenera *Euscutellaria* into 5 sections on the basis of inflorescence characters. In *Flora of Turkey*, Edmondson (1982) abandoned Briquet's subgenera in dividing the genus in congruent to Hamilton and Bentham on the basis of inflorescence characters. The only revision of New World *Scutellaria* after Briquet (1896) was by Epling (1942). He divided the genus into 18 sections based on floral, inflorescence and rhizome characters which demonstrated that the modern infrageneric classifications of *Scutellaria* are mostly not comparable with one another, as these authors have not considered the global variation of the genus. Some of the infrageneric taxa were in generic rank in the past, e.g. *Anaspis* by Rechinger (1941) and *Apeltanthus* as a generic *nomen nudum* by Nevski in 1935. Grossheim (1945) opined that Section *Heteranthesia* should be given generic rank.

Paton (1990) did a global taxonomic investigation of *Scutellaria* (Labiatae). He presented a revision of allied genera *Scutellaria* L., *Perilomia* Kunth, *Harlanlewisia* Epling and *Salazaria* Torrey. Morphological and geographical variation aspects based on the study of a representative selection of species from throughout the world were focussed. All taxa studied were included in one genus, *Scutellaria*. Two subgenera namely Subgen. *Scutellaria* and Subgen. *Apeltanthus* (Nevski ex Juz.) Juz. *emend*. Paton. Five sections were recognised within the type subgenus, they include Sects. *Scutellaria, Anaspis* (Rech.f) Paton, *Salviifoliae* (Boiss.) Edmondson, *Salazaria* (Torrey) Paton, and *Perilomia* (Kunth) Epling *emend.* Paton. Subgenus *Apeltanthus* was divided into two sections namely Section *Apeltanthus* Nevski ex Juz. and Section *Lupulinaria* A. Hamilton. Section *Lupulinaria* further divided into Subsections *Lupulinaria* (A. Hamilton) Paton and *Cystaspis* (Juz.) Paton. The infrageneric taxa are described, keyed out, typified and phylogenetic conclusions were also presented. The classification was also compared finally using a numerical phenetic (UPGMA) study.

Gallegos and García (2013) identified two new species *Scutellaria cuevasiana* and *Scutellaria sublitoralis*, from Jalisco and Nayarit, Mexico. *Scutellaria cuevasiana* is morphologically close to *S. blepharophylla* Epling, *S. rosei* Fernald and *S. seleriana* Loes and fits best within section Uliginosae Epling. It differs from them by possessing some unique characters like magenta corollas, small and sessile floral bracts, longer petioles and bigger leaves. *Scutellaria sublitoralis* is morphologically similar to *S. pallidiflora* Epling. and does not show any clear morphological affinity with the species of the section enumerated by Epling. It was found closely related to species in the section *Pallidiflorae* Epling or *Uliginosae*, particularly with *Scutellaria ovate* or *S. caerulea* species group defined by Paton.

3.1.5. Recent Indian floristic works coming under India

The major local floras published in India which included the number of species of the three genera *Pogostemon, Anisochilus* and *Scutellaria* is enumerated in **Table 3.1.5.1.**

Name of the State/ District	**Authors of the flora**	**Year of publication**	**No. of species**		
			Anisochilus	***Pogostemon***	***Scutellaria***
		Andhra Pradesh			
West Godavari	Rao R.S. et al.	1986	1	2	-
Anantapur	Pullaiah, T. & Yesoda, N.	1989	1	-	-
Nallamalais	Ellis, J.L.	1990	1	-	-
Nellore	Suryanarayana, B. & Srinivasa Rao, A.	2002	1	-	-
Visakhapatanam	Subba Rao, G.V. & Kumari, G.R.	2008	1	2	2
		Bihar			
West Champaran	Battacharya, P.K. & Sarkar, K.	1998	-	2	1
Bihar (analysis)	Singh, N.P. et al.	2001	2	10	2
Hazaribagh	Paria, N.D. & Chattopadhyay, S.P.	2005	2	1	-
		Chattisgarh			
Raipur, Durg,	Verma, D.M.	1985	1	2	-

Rajnandgaon	et al.				
Bilaspur	Murthi, S.K. & Panigrahi, G.	1999	1	2	-
Indravathi Tiger Reserve	Kumar, A.	2003	1	1	-
Goa					
BhagavanMahavir (Molem) National Park & Adjoining	Mandar Nilkanth Datar & Lakshminarasimhan, P.	2013	-	2	1
Gujarat					
Saurashtra	Bole, P.V. & Pathak, J.M.	1988	1	-	-
Himachal Pradesh					
Himalayas	Atkinson, E.T.	1980	1	3	3
Himachal Pradesh	Chowdhery, H.J. & Madhwa, B.M.	1984	1	2	6
Jharkhand					
Chota Nagpur	Haines, H.H.	1910			
Palamau	Sarma, T.K. & Sarkar. A.K.	2002	1	1	-
Karnataka					
Hassan	Saldanha, C.J. & Nicolson, D.H.	1976	2	-	-
Karnataka analysis	Sharma, B.D. *et al.*	1984	5	15	6
Coorg	Keshava Murthy, K.R. & Yoganarasimhan, S.N.	1990	1	5	2
Uduppi	Bhat, K.G.	2003	1	3	-
Anshi National Park	Punekar S.A. & Lakshminarasimhan, P.	2011	1	2	1
Rajiv Gandhi N.P.	Manikandan, R. & Lakshminarasimhan, P.	2013	1	2	1
Kerala					
Calicut	Manilal, K.S.	1982	1	3	1

	& Sivarajan, V.V.				
Tropical Botanical Garden Palode	Nayar, T.S. et al.	1986	-	1	-
Cannanore	Ramachandran, V.S. & Nair, V.J.	1988	1	8	1
Silent Valley	Manilal, K.S.	1988	-	5	2
Palghat	Subramanian, K.N. et. al.	1987	1	-	-
Palghat	Vajravelu, E.	1990	2	6	
Thiruvananthapuram	Mohanan, M. & Henry, A.N.	1994	1	8	1
Nilambur	Sivarajan, V.V. & Mathew, P.	1996	1	3	1
Thrissur	Sasidharan, N &Sivarajan, V.V.	1996	1	4	1
Agasthyamala	Mohanan, N. & Sivadasan, M.	2002	1	5	1
Alappuzha	Sunil, C.N. & Sivadasan, M.	2009	1	2	-
Madhya Pradesh					
Pachmarhi&Bori Reserves	Mukherjee, A.K.	1984	2	4	-
Bilaspur	Murti, S. K. & Panigrahi, G.	1999	1	2	-
Maharashtra					
Bombay	Theodore Cooke	1906	2	10	1
Khandala	Santapau, H.	1967	2	-	-
Akola	Kamble, S. Y. & Pradhan, S. G.	1988	1	1	-
Sindhudurg	Kulkarni, B.G.	1988	1	3	1
Savantwadi	Almeida, S. M.	1990	-	5	1
Nassik	Lakshminarasimhan, P. & Sharma, B.D.	1991	2	2	-
Raigad	Kothari, M.J. &Moorthy, S.	1993	-	5	-
Mahabaleshwar&Adjoinings	Deshpandey, S.D. et al.	1995	2	7	1
Kolhapur	Yadav, S. R & Sardesai, M.M.	2002	1	4	1

Maharashtra (Endemic and threatened flowering plants of Maharashtra)	Dipak Kumar Misra & Singh, N. P.	2002	-	1	-
Sanjay Gandhi National Park	Pradan, S.G. & Sharma, B.D.	2005	-	2	-
Meghalaya					
Jowai	Blakrishnan, N.P.	1983	-	6	1
Mizoram					
Mizoram	Sinha, G.P.et al.	2012	2	13	5
Rajasthan					
Banswara	Singh, V.	1983	1	-	-
Rajasthan	Shetty, B.V. & Singh, V.	1991	2	3	-
Tamil Nadu					
Nilgiri	Sharma, B.D.	1975	1	13	3
Tamil Nadu	Henry, A.N. et al.	1987	11	20	4
Courtallum	Nair, K.K.M. & Nayar, M.P.	1987	1	1	1
Central Tamil Nadu	Matthew, K.M.	1991	2	5	1
Pulnihills	Matthew, K.M.	1999	4	6	3
Uttarakhand					
Chamoli	Neithani, B.D.	1985	1	1	4
Corbett National Park	Pant, P.C.	1986	-	1	1
Gangotri National Park	Pusalkar, P. K. & Singh, D.K.	2012	-	-	1
Union Territories					
Goa, Diu, Daman, Dadra & Nagar Haveli	Rao, R.S.	1986	1	4	1

3.2. Anatomy / Micromorphology

Among various taxonomic characters studied, the micromorphology has proven particularly interesting in the family Lamiaceae and has been used regularly for the past 150 years (Bentham 1832; Briquet 1897). According to Schermann (1967) morphology, shape, colour and size of the nutlets were used as diagnostic characters in classification. The structure and development of the unusual epidermal mucilage cells in the epidermis of *Coleus blumei* nutlet which produce pentagonal and hexagonal plates and the possible function of these cell type was also discussed by Witztum (1978).

In the evolution and classification of angiosperms, micromorphological and ultrastructural data play an important role and have contributed invaluable information (Cole & Behnke 1975; Dahlgren 1980). The knowledge of plant surfaces became more vivid with the help of the invention and use of many sophisticated instruments like scanning electron microscopes during the last decade (Barthlott 1981).

Leaf anatomy of the subtribe Hyptidinae (Labiatae) by Rudall (1980) revealed variable nature of characters of leaf lamina such as frequency and forms of trichomes, cuticular markings, thickness of leaf, presence of adaxial stomata, occurrence of sclerified tissues, mesophyll structures and venation pattern. These variations were related to xeromorphy and were taxonomically useful within the frame work of classification. Two median and two lateral traces in the petiole, which is the most common condition in Hyptidinae was also observed by him.

Lane (1983) investigated mericarp micromorphology of Great Plains *Scutellaria* and emphasized that Scanning electron and light microscopic studies of mericarps of the Great Plains species of *Scutellaria* have proven taxonomically very useful. Mericarps with a unique suite of morphological characters like fruit color, size and shape; conformation of papillae; and epidermal cell type and pattern were produced by each species. The reduction of *S. wrightii* to synonomy with *S. resinosa*, and the treatment of *S. parvula* as having three varieties, rather than as three separate species were strongly supported by these informations.

The leaf anatomy in six genera of subtribe Melittidinae (*Physostegia*, *Brazoria*, *Macbridea*, *Synandra*, *Chelonopsis*, *Melittis*) and related taxa like *Galeobdolon*, *Lamium*, *Leonurus*, *Marrubium*, *Stachys*, *Ajuga*, *Pogostemon*, *Prostanthera*, *Scutellaria*, *Teucrium*, *Trichostema*, *Blephilia*, *Monarda* were studied in detail by Abu-Asab and Cantino (1987) to evaluate their systematic significance. No evidence to prove the subtribe as monophyletic was obtained from the results on leaf anatomy provided. But the anatomical characters of leaf provided a strong support for *Physostegia*-*Brazoria* clade and a weaker support for *Physostegia*-*Brazoria*-*Macbridea* clade.

Micromorphological study of some representative Old World species using scanning electron micrographs of nutlet surface show a wide range of variation, not only among genera, but also at lower levels of classification in the tribe Saturejeae conducted by Husain et al. (1990). The seed morphology and taxonomy of the North African species of *Sideritis* L. was performed by Rejdali (1990) and found that seed sculpturing was found to be of great value for separating taxa at all levels of the hierarchy.

Ryding (1993, 1994a, 1994b, 1994c,, 1995) studied in detail the nutlet characters especially the pericarp structure of some genera of the family Lamiaceae using scanning electron microscopy. Characters like seed ultrastructure, surface morphology and shape were used in cladistic analysis to draw conclusions regarding relationship within the family Lamiaceae by Cantino (1992a) and Ryding (1998).

Marin et al.. (1994) studied the nutlet sculpturing of 23 *Teucrium* species and discussed the significance of nutlet microcharacters as additional taxonomical markers in the infrageneric classification of the genus *Teucrium*.

The nutlet sculpturing of 22 taxa of *Scutellaria* sect. *Resinosa* and the monotypic genus *Salazaria* were studied by Turner and Delprete (1996) using scanning electron microscopy and they discussed the significance of nutlet microcharacters within sect. *Resinosa*. They opined that *Salazaria* had nutlet sculpturing unique from all the other taxa belonging to sect. *Resinosa*.

Budantsev and Lobova (1997) examined the nutlet morphology of 156 species of tribe *Nepeteae* of the family Lamiaceae using SEM and recognized two main types of mericarp surfaces, smooth and sculptured. They also discussed the taxonomic significance of these characters.

Özdemir and Şenel (1999) discussed the taxonomic usefulness of detailed description of morphology, anatomy and karyology of *Salvia sclarea* L.

Variations in the morphological anatomical, ecological and phonological characters of *Origanum onites* L. with respect to altitudinal variations were studied by Gönüz and Özörgücü (1999). They also tested the differences in etheric oil content and observed significant variations in anatomical structures and volatile oil content in parallel with an increase in altitude.

The pericarp structure of 37 species representing 13 genera of four tribes of Nepetoideae was analysed by Duletiae-Lauseviae and Marin (1999) and found that pericarp characters studied are of taxonomical significance and mainly correlated with the generic or infrageneric classification of some genera in Nepetoideae.

A detailed study on the nutlet micromorphology of 31 taxa of *Stachys* distributed in Iran by light and scanning electron microscopy was studied by Salmaki et al. (2008) and concluded that the type of sculpturing is more useful for separating species within the sections, rather than correlating the related ones to each other. They also added that in contrary to other genera of Lamiaceae, nutlet characters are of low phylogenetic value in *Stachys* especially due to high variation among species.

The calyx anatomy of 181 genera of Lamiaceae with particular emphasis on the amount of fibres and xylem cells was carried out by Ryding (2007). Their results showed that Lamioideae and Scutellarioideae are closely related to each other and remotely related to Nepetoideae. This data also contributed to the knowledge about the phylogeny within Lamioideae. The amount of fibres and similar xylem cells shown positive correlation with the calyx size and width, and the ballistic dispersal mechanism in the genus *Scutellaria*.

Moon et al. (2006) documented the nutlet morphology (SEM) of the tribe Mentheae and the presence or absence of myxocarpy in 65 genera to assess the systematic value of nutlet characters and to evaluate the existing molecular phylogenies of this group. Their result showed significant variation in nutlet shape, morphology of the abscission scar, distribution of trichomes, and surface sculpture.

The mericarp morphology of 12 *Salvia* species from Turkey using scanning electron microscopy was examined by Ozkan et al. (2009). They found out that the mericarps exhibited variation in size, shape, colour, and surface sculpturing.

The pericarp and seed structure in 16 species of the *Caryopteris s.l.* and in a few species of the related *Rubiteucris, Amethystea, Trichostema* and *Ajuga* was carried out by Ryding (2009). He found that pericarp structure was found to be very variable, and the variation largely parallels the most recent classification.

The morphology, anatomy, palynology and nutlet micromorphology of the rediscovered Turkish endemic *Salvia ballsiana* (Lamiaceae) and their taxonomic implications were studied in detail by Kahraman et al. (2010).

Moon et al. (2010) analyzed the distribution of selected morphological characteristics such as nutlet shape and existence of abscission scar and its form to reconstruct the evolutionary history of tribe Mentheae.

Salmaki et al. (2011) conducted a detailed comparative anatomical studies of the petioles and leaf lamina of 34 *Stachys* L. taxa representing 12 sections of the genus in Iran to evaluate interspecific relationships and anatomical features that may prove useful in species identification and subgeneric classification. Leaf anatomy provides valuable characters that are useful in subgeneric classification as well as species delimitation in *Stachys*. The shape of transverse sections of leaf, length of ventral and dorsiventral axis, number of median bundles in the petiole, number of cell layers of palisade and spongy parenchyma, type and thickness of collenchyma, and trichome type were found to be the characters of taxonomic interest.

Kahramen et al. (2011) examined the mericarp morphology of 15 taxa of *Salvia* section *Hymenosphac*e Benth. in Turkey, using light microscopy (LM) and scanning electron microscopy (SEM) to evaluate the utility of mericarp characters in systematic studies. Their results concluded that the nature of surface sculpturing, mericarp shape and size, exocarp cell shape, nature of transverse sections and abscission scar diameter were found as useful diagnostic characters. This work proved that variations observed on these characters was sufficient to distinguish taxa at species level, including morphologically similar species and the data provided here are also relevant to phylogenetic questions at higher levels within *Salvia*.

Andréia et al. (2013), studied the anatomy of vegetative organs of *Scutellaria agrestis*, a medicinal plant cultivated by riverine populations of the Brazilian Amazon. They aimed to characterize the anatomy and to make histochemical analysis on vegetative organs of *Scutellaria agrestis.* Leaf, stem and root samples were collected, fixed and prepared following standard techniques for scanning electron microscopy and for light microscopy. To detect the main classes of compounds present in the secretion, histochemical tests were carried out on sections. Both leaf and stem of *S. agrestis* was characterised by numerous glandular trichomes. The leaves with amphihypostomatic and dorsiventral mesophyll was seen in them. In the tip of the marginal teeth hydathodes were present. Anthocyanin pigments were seen to occur in the epidermal cells of the stem, petiole, and abaxial leaf surface. They concluded that data like concave-convex shaped collateral vascular bundles in petiole; square-shaped, evident endoderm, collateral vascular bundles and parenchymatous pith in stem; typical protostelic structure, idioblasts containing mucilage and phenolic compounds occurring in the cortex of root are important and can be useful to identify this species.

Evolution of trichomes in *Salvia* was investigated by Eiji and Salmaki (2016) in order to clarify the relationships at different taxonomic ranks and their results on trichome micromorphology provided reliable data in the delimitation of species, but have low phylogenetic value because of high variation observed among closely related species.

Genc et al. (2015) studied the leaf indumentum and nutlet surface micromorphology of 13 taxa belonging to the *Teucrium* sect. *Teucrium* with the aid of scanning electron microscope.

Hassan and Al-Thobaiti (2015) for the first time studied the macro and micro morphology of nutlets of 23 taxa belonging to 12 genera of Lamiaceae from Al-Taif, Saudi Arabia using both light and scanning electron microscope. Their observations revealed that nutlet color, shape, size and presence of areole are of limited taxonomic value. They also pointed out that the pericarp sculpturing are the most important diagnostic characters for differentiating the species through a constructed key.

Krawczyk and Glowacka (2015) examined fruit surface in the genus *Lamium* L. They aimed to define new features that differentiate subspecies taxa which are difficult to identify on the basis of macromorphological characters. Cuticle striation proved to be the most useful character in distinguishing the taxa examined. Their results also demonstrated that *L. flexuosum* and *L. orvala* differed to a large extend from other species coming under the genus *Lamium* but shows high similarity with *L. galeobdolon*. The study also provided an argument for the inclusion of *L. galeobdolon* to the genus *Lamium*.

The morphological characters of the nutlets of *Cyclotrichium* in Turkey using scanning electron microscopy (SEM) was investigated by Kaya et al. (2015). They found that the nutlet morphology of examined specimens exhibits some variation in size, shape and sculpture and the micromorphological characters were very much useful in solving taxonomic problems of *Cyclotrichium*.

Based on morphological, palynological, and micromorphological characters of trichomes, Abdel-Khalik (2016) conducted a systematic revision of the genus *Plectranthus* in Saudi Arabia. The morphology and ultrastructure characters of seeds, pollen grains and trichomes were investigated by the author in order to evaluate their systematic value of these characters in specific and intraspecific separation of the Saudi Arabian *Plectranthus* species.

Çali (2017), investigated anatomy and glandular trichome micromorphology of *scutellaria orientalis*. Subsp. *Pinnatifida* Edmondtson to comprehend the important characteristics for systematic purposes. Anatomical characters such as 1, 2 or 3 rowed pith rays in roots, the quadrangular stem and 5–6 layered collenchyma cells groups on the corners of stem, cruciferae type stoma and bifacial leaf, one small subsidiary bundle in the wings and one big vascular bundle in the center of petiole were some of the characters found in *S. orientalis* subsp. *pinnatifida*. These characters proved to be taxonomically significant. Stems, vegetative and reproductive organs of the plant were characterised by four different glandular trichome types. The glandular trichome types such as peltate (type I), type II A, type II B and type II C capitate glandular were seen. Type II A capitate glandular trichomes were observed on all organs of *S. orientalis* L. subsp. *pinnatifida*, but peltate, type II B and type II C capitate glandular trichomes were seen only on vegetative organs of *S. orientalis* subsp. *pinnatifida.*

The nutlet and leaf micromorphology of 27 *Teucrium* taxa using SEM was studied by Genc et al. (2017) and found that significant variation was noticed on the nutlet surface ornamentation and indumentum and this was mainly useful at the sectional level.

3.3. Palynology

The use of both Scanning Electron microscopy (SEM) and Transmission Electron microscopy (TEM) to investigate the surface structure and exine ultra-structure of pollen was used for the first time by Nabli (1976), to study the pollen of *Teucrium* and various other selected genera of the family. A subfamilial level classification of Lamiaceae based only on pollen features was proposed by Erdtman (1945).

The pollen morphology of *Salvia* and some related genera were studied by Henderson et al. (1968) as an additional useful taxonomic tool in assessing relationships and delimiting taxa both in *Salvia* and its putative allies.

Rudall (1980) studied the pollen morphology of subtribe Hyptidinae of family Lamiaceae and found that the pollen grains are 6-colpate, with reticulate surface sculpturing, ranges from a type with large lumina surrounding numerous small puncta to a type with smaller lumina surrounding fewer larger puncta. He also concluded that the range of surface characters appears to represent an evolutionary series though taxonomic applications are limited.

In 1968, Cantino and Sanders attempted a subfamilial classification of family Lamiaceae and reported the number of pollen cells and colpi for 108 genera of the family. They discussed the character data that support Erdtman's subfamilial classification, summarised and evaluated Bentham's and Briquet's treatments of the family in the light of support from Erdtman's subfamilies.

The pollen of 20 species of *Ocimum* and four closely allied genera was studied by Harley et al. (1992) with the aid of light, scanning electron and transmission electron microscopy. They described four pollen types, of which three were subdivided. They also provided keys to the types and subtypes. Trudel and Morton (1992), using SEM examined pollen morphology of 118 species of Lamiaceae native to North America. They identified that pollen in this family is subspheroidal and either tricolpate in Lamioideae or hexacolpate in Nepetoideae.

Abu-Asab and Cantino (1992), did palynological survey of subfamily Lamioideae and the data revealed that majority of the genera studied have tricolpate, inoperculate pollen with a tectate-perforate to microreticulate exine, suprareticulate sculpturing and simple columellae. Wagstaff (1992) undertook similar study on the pollen morphology in tribe Mentheae. His study found that all pollen had simple columellae with a tectate-perforate to semitectate exine structure.

The pollen morphological studies in subtribe Ociminae was done by Harley (1992) and evaluated the potential value of pollen characters both in taxonomic revisions and in the understanding of relationships and evolution within the family Lamiaceae.

Abu-Asab et al. (1993) conducted pollen morphology of 15 species of *Caryopteris* (Lamiaceae). They found that *Caryopteris* comprises three primary phenetic groups based on pollen morphology and correlated variation in floral and fruit morphology. Abu-Asab and Cantino (1993) also conducted a palynological survey of tribe Ajugeae. In their study five pollen types were distinguished based on differences in colpal structure (operculate vs. inoperculate), supratectal sculpturing, and the structure of the columellate stratum.

Pollen morphology and it's importance in taxonomy including the characters like aperture number, size, shape and tectum ornamentation were studied in different members of the family Lamiaceae by Abu-Asab and Cantino (1994).

An SEM study of pollen morphology in *Mosla* and the representative species of the allied genera, *Collinsonia, Elsholtzia, Keiskea, Perilla*, and *Perillula* by Zhou et al. (1997) revealed that the pollen surface sculpture of *Mosla* (except *M. cavaleriei*) and *Perilla* has discontinuous ridges, while that of the other genera have suprareticulate ornamentation. The taxonomic value of pollen morphology of 8 species of *Nepeta* L. native to Iran based on SEM studies was compared by Azizian et al. (2001).

Moon and Hong (2003) documented details of pollen morphology of 15 species of *Lycopus* (Lamiaceae, Mentheae) using light microscopy (LM), scanning electron (SEM), and transmission electron microscopy (TEM). The result showed that pollen is mostly medium or sometimes small in size, with a circular amb, oblate prolate in shape, hexacolpate with granular membranes; the exine is bireticulate, columellae unbranched and endexine continuous, lamellated. Their result also indicated that the value of pollen characters for taxonomic applications was limited in *Lycopus*.

Hong (2007) studied the pollen morphology of six species of *Keiskea* and three representative taxa of *Collinsonia* in detail using LM, SEM, and TEM. The author suggested that in both genera, pollen grains are monad, hexacolpate, mostly medium in size. He also demonstrated that the pollen morphology easily support the separation of *Keiskea* from *Collinsonia*.

A detailed study of the pollen morphology of forty taxa of the genus *Nepeta* L. was conducted by Celenk et al. (2008) using light microscopy (LM) and scanning electron (SEM) microscopy and concluded that the pollen grains are hexacolpate (very rarely tetracolpate) with granular membranes. He also undertook a palynological study of the genus *Mentha* L. (Lamiaceae) in the same year, in which he investigated the pollen morphology and exine structure of 10 *Mentha* species using light microscopy and scanning electron microscopy. He found that the pollen grains of all the species were hexazonocolpate with granular membranes and a circular amb, varying in shape from prolate-spheroidal to suboblate.

The pollen morphology and ultrastructure of the subtribe Salviinae was investigated by Moon et al. (2008) with light, scanning electron, and transmission electron microscopy. Their result found that *Salviinae* pollen was small to large, oblate to prolate in shape, with a circular to slightly elliptic amb, and mostly hexacolpate. Their combined phylogenetic analyses also showed that the addition of palynological characters contributed to improved resolution and also increases bootstrap support values in comparison with molecular phylogenetic analyses.

Pollen morphology of 13 taxa (34 specimens) of the genera *Glechoma* L., and *Marmoritis* Benth. using light, scanning electron, and transmission electron microscopy was studied by Jang & Hong (2010) and found that pollen grains of all studied taxa are prolate-spheroidal to prolate in shape and mostly hexacolpate with granular membranes.

Jang et al. (2010) studied the pollen morphology of 18 species representing all three currently recognized sections of the genus *Elsholtzia* in detail using light, scanning electron and transmission electron microscopy. The study revealed that the pollen grains are mostly prolate-spheroidal to prolate, and rarely oblate-spheroidal to subprolate in shape, hexacolpate with granular aperture membranes and sexine ornamentations observed are perforate, rugulose-bireticulate, and bireticulate.

Ozler et al. (2011) investigated on the pollen morphology of 30 taxa of the genus *Salvia* from Turkey by light (LM) and scanning electron microscopy (SEM). They concluded that the basic shape of the pollen grains in most taxa is suboblate, subprolate, oblate-spheroidal or prolate-spheroidal and the grains are hexacolpate in all taxa, but in *S. recognita* octacolpate pollen was also found. Different exine sculpturing types like reticulate-perforate, reticulate-granulate and bireticulate are the present in this genus. They also compared the pollen morphological characteristics and discussed their taxonomic importance, especially in delimiting species.

Pollen morphology of 21 taxa belonging to 16 genera of the subfamilies: Ajugoideae, Scutellarioideae, Nepetoideae and Lamioideae from Mongolia was examined by Bazarragchaa et al. (2012) using scanning electron microscope (SEM) and based on their results, they suggested that pollen characters form a useful tool to differentiate various genera in the family Lamiaceae. The preliminary results obtained from the studies on the pollen micromorphology of plants from four populations of the Tyrrhenian insular endemic *Stachys salisii* using light and scanning electron microscopy by Boi et al. (2013) showed some differences between the populations analyzed as regard to pollen surface micromorphology and dimensions.

Jamzad & Hasani-Nejad (2014), conducted a similar study on the pollen morphology of 29 species of *Scutellaria* from both the Old and the

New World to evaluate their taxonomic importance for infrageneric classification of the genus. Their results showed that all examined pollen grains are isopolar, tricolpate, suboblate, oblate spheroidal, prolate spheroidal to subprolate. The exine was found to be mainly bireticulate perforate. The study also confirmed the importance of exine ornamentation as a diagnostic character useful for the infrageneric classification of *Scutellaria*.

The investigations on the pollen morphological characters of 6 species belonging to 4 genera of the subfamily Stachyoideae (Lamiaceae) growing naturally in Saudi Arabia was done by Al-Watban et al. (2015) with the aid of light microscope (LM) and scanning electron microscope (SEM).

Doaigey et al. (2018) studied the pollen morphology of 20 species belonging to 16 genera of the Lamiaceae using Light Microscopy (LM) and Scanning Electron Microscopy (SEM) and found that the pollen grains were characterized by 3-zonocolpate or 6-zonocolpate and size of the pollen is variable between the genera but not among the species of the same genus. Different types of exine surface pattern like fine reticulate, rough reticulate, mega-reticulate, reticulate-perforate, bireticulate-perforate or granulate, leading to 6 types of pollen grains. These variations revealed the significant value of pollen morphology in solving problems in the classification of Lamiaceae members. A key to the species based on the morphological features of pollen grains were also provided by them.

3.4. Cytology

The number and morphology of chromosomes characters are not influenced by minor environmental changes and hence karyomorphological studies are of great importance and can therefore be used as a tool for identifying species. Disparity index, variation coefficient, karyotype asymmetry etc. are used nowadays which can be used in the phylogenetic point of view. For enumerating the chromosomes and studying their morphological aspects mitotic squash preparations are widely used.

The chromosome count in *Eusteralis stellata* was reported as 2n = 72 by Borgmann (1964). But according to Bir and Saggoo (1985), further cytological studies are needed to reveal cytological evolution of this species since that was a polyploid number.

Gill (1971) and Vij & Kashyap (1976) revealed x = 8 as the basic number of the genus *Pogostemon.* In contrast Saggoo and Bir (1985) who reported that x = 16 and 17 as its basic numbers.

In *P. purpurascens*, the sporophytic chromosome number was disclosed as 2n = 32 (Krishnappa and Basavaraj, 1982) and 2n = 34 (Cherian and Kuriachan, 1984; 1993). The gametophytic chromosome number was found to be n = 16 (Bir and Saggoo, 1981; Saggoo, 1983) and n = 17 (Cherian & Kuriachan, 1993).

Cherian and Kuriachan (1981, 1993) reported the haploid chromosome number of *P. paniculatus* to be n = 16. The cytological studies by various authors like Vembu, 1982, 1983; Krishnappa and Basavaraj, 1982; Basavaraj and Krishnappa, 1983; Cherian and Kuriachan, 1993; Vembu and Sampathkumar, 1999) revealed that the diploid chromosome number of *P. paniculatus* to be 2n = 32.

The sporophytic chromosome count of *P. cablin* was reported by two authors in two different ways. Lavania (1984), it was observed as 2n = 32, whereas Tyagi and Bahl (1990) reported a 2n = 64 condition.

Tyagi and Bahl, (1990) reported the chromosome number of *P. cablin* as 2n = 64 (Lavania, 1984) and 2n = 64. Several authors studied the chromosome constitution of *P. paniculatus*. Studies by Vembu (1982), Krishnappa and Basavaraj (1982), Basavaraj and Krishnappa (1983), Vembu (1983), Cherian and Kuriachan (1993), and Vembu and Sampathkumar, (1999) revealed the sporophytic chromosome number to be 2n = 32 in this species.

Several authors worked out the chromosome number of *P. heyneanus* but a gametophytic chromosome number of n = 16 was suggested by Krishnappa and Basavaraj (1982) and Basavaraj and Krishnappa (1983). Cherian and Kuriachan (1993), reported the gametophytic chromosome number to be n = 32.

The chromosome number of *P. pubescens* was elucidated by several authors like Saggoo and Bir (1982), Saggoo (1983), Bir and Saggoo (1985) and reported the gametophytic number to be n = 16. The sporophytic number *of P. speciosus* was reported by Krishnappa and Basavaraj (1982) & Basavaraj and Krishnappa (1983) as 2n = 34. The chromosome complement of *P. vestitus* was analysed by Thoppil (1993) and reported a somatic number of 2n = 32 and a variant number, 2n = 34.

The karyotype of *Eusteralis quadrifolius* as elucidated by Thoppil and Jose (1995) revealed the chromosome number of *E. quadrifolius* to be 2n = 30.

3.5. Phytochemistry/Pharmacology

Plants serve an important role in medicine as a source material for the isolation and synthesis of drug compounds due to the presence of many biologically active molecules. Lamiaceaen plants are economically important due to the presence of volatile essential oils and is well known for their flavour and fragrance.

The essential oils isolated from Lamiaceaen plants have been chemically analysed by various authors worldwide. Terhune et al., (1973) isolated a new sesquiterpene compound cycloseychellene from *P. cablin* by $AgNO_3/A1_2O_3$ column chromatography and used NMR spectroscopy to determine the structure of the compound. The steam distilled oil of *P. formosanus* yielded large amount of colourless crystals which were found to be germacrone, a ten-membered ring sesquiterpenoid (Yeh 1975). The structure of these crystals were portrayed by NMR spectroscopy

Authors like Banerji et al., (1980); Hussaini et al., (1993) reported the chemical characterisation of the essential oils of *Pogostemon* species and many other oil rich genera of Lamiaceae. The isolation of 2-hydroxy-4, 6-dimethoxycrotonophenone, an open chain form of chromanone was reported from *Dysophylla stellata* by Banerji et al. (1980). UV and NMR spectral studies by Patwardhan and Gupta, (1981) proved successful in revealing the structure of a new octamethoxyflavone, purpurascenin (3, 5, 6, 7, 8, 2, 4, 5'-octamethoxytlavone) compound isolated from the acetone extract of the whole plant of *P. purpurascens.*

GC-MS analysis of the essential oil of *P. cablin* by Akhila and Nigam, (1984) identified the major constituents like α-bulnesene, β-bulnesene, α-caryophyllene, cycloseychellene, α-guaiene, β-guaiene, δ-guaiene, norpatchoulenol, patchouli alcohol, α-patchoulene, β-patchoulene, γ-patchoulene, δ-patchoulene, pogostol and seychellene.

The isolation of friedelin, friedelan-3-ol, phytol and sitosterol and epoxyparvinolide from the acetone extract of *P. parviflorus* was reported by Nanda et al. (1985). Prakash et al., (1987) carried out high resolution two dimensional NMR studies to elucidate the structure of auricularic acid which was isolated from *P. auricularis*.

Hussaini et al. (1988) isolated three diterpenoid acids from the hexane extracts of *P. auricularis* which were identified as cleistanth- 13, 15-dien- 18-oic acid (auricularic acid), 7-hydroxy-cleistanth-13, 15-dien-18-oic acid and 7-acetoxy cleistanth-13, 15-dien-18-oic acid. In 1993 they isolated another new diterpene acid isolated from *P. auricularis* that has been characterized as (4R, 5S, 8R, 9S, 10S, 14R)-cleistanth-12, 15dien-19-oic acid by spectral and X-ray crystallographic analyses.

Hasegawa et al., (1992) found out that among the species of *Pogostemon*, the essential oil found in *P. cablin* is widely used in perfume industries and hence much of the research in this genus is concentrated on this species. The other important species are *P. heyneanus* and *P. benghalensis* which also contains some amount of patchouli alcohol.

Dung *et al.* (1990) isolated and studied the essential oil from *P. cablin* plants grown in Vietnam by capillary GC-MS. They found that Patchouli alcohol constituted 32-38% of the oil, followed by α-bulnesene and α-guaiene. 7, 4'-di-O-methyleriodictyol, 7, 3, 4'-tri-O- methyleriodictyol and 3, 7, 4'-tri-O-methylkaempferol. These were isolated from the dichloromethane fraction of *P. cablin* by column chromatography. These compounds were found to be responsible for the antimutagenic action of the extract.

Zhou *et al.* (1996) analysed the flavonoids and phenylethanoids from hairy root cultures of S*cutellaria baicalensis* and successfully established hairy root cultures of *Scutellaria baicalensis* by direct inoculation on sterile seedlings with *Agrobacterium rhizogenes* pRi15834 harbouring pBI121. Direct detection of the inserted T-DNA transformation was proved by the polymerase chain reaction. Effects of five basal media were investigated to determine the optimal medium for growth of hairy roots. It was seen that the growth was best in B5 liquid medium. From the hairy root cultures of *S. baicalensis* a new flavones glucoside, 5,7,2',6'-tetrahydroxyflavone 2'-O-β-Dglucopyranoside, 15 known flavonoids and five known phenylethanoids were isolated for the first time. By using various spectroscopic methods their structures were also elucidated.

Antioxidant activity of trihydroxyflavones from *Scutellaria baicalensis* in Lecithin Liposomes on oxidation induced by ultraviolet light, was studied with phosphatidylcholine liposome membrane by Gabrielska et al. (1997). They also investigated as standards, the antioxidative activity of baicalin, wogonin, baicalein and butylated hydroxytoluene (BHT). ESR measurement results obtained confirm that *Scutellaria baicalensis* extract and the BHT compound significantly depressed the effect of liposome oxidation. A very satisfactory concentration-dependent protection of the liposome membrane against UV-induced oxidation was ensured by the new trihydroxyflavones of *Scutellaria baicalensis*. The extract of the *Scutellaria baicalensis* have ability to scavenge free radicals and protect the effect of lipid peroxidation caused by sunlight irradiation and hence can be mediated in certain diseases especially for skin diseases.

Bowel et al. (2002) discussed role of patchouli oil in aromatherapy to calm nerves, relieve depression and stress.

Yu et al. (2004) carried out studies on Chemical compostion and antimicrobial activity of the essential oil of *Scutellaria barbata* by hydrodistillation with 0.3% (V/W) yield and analysed by GC and GCMS. Hexahydrofarsenylacetone 3,7,11,15-tetramethyl-2-hexadecen-1-ol, methanol and 1-octen-3-ol were the main compounds found in the oil. Using disc diffusion and broth microdilution methods, the antimicrobial activity of the oil was evaluated against 17 microorganisms. It was seen that the gram +ve bacteria, including methicillin resistant *Staphylococcus aureus,* were more sensitive to oil than that of Gram –ve and Yeasts.

Patchouli oil was analysed qualitatively and quantitatively using GC (FID) and GC/MS by Bure and Sellier (2004). Twenty eight compounds were identified using different ionization techniques in mass spectrometry. The presence of four new compounds γ-gurjunene (2.2%), germacrene D (0.2%), aciphyllene (3.4%) and 7-epi-α- selinene (0.2%) were reported by them.

Nayar et al. (2006) unravelled the use of another commonly occurring species *P. paniculatus*. He reported that the plant has been used as antidepressant, anti-inflammatory, antiseptic, aphrodisiac, astringent, carminative, diuretic, febrifuge, fungicide, insecticide, sedative and tonic.

A chemical fingerprint of *P. cablin* was developed by Hu et al. (2006) which revealed β-patchoulene, caryophyllene, α-guaiene, seychellene, β-guaiene, δ-guaiene, spathulenol, patchouli alcohol and pogostone as important constituents. The collected *P. cablin* samples were divided into three chemotypes patchouliol-type, pogostone-type and an interim-type.

Arpana et al. (2008) found that the fresh leaves of patchouli are used as a decoction to treat nausea, diarrhoea, cold and headache.

The flowers of *P. deccanensis* are used as febrifuge and leaves as mosquito repellent (Franco & Narasimhan, 2009).

Ivan et al., (2009) studied various bioactivities exhibited by *Pogostemon* plant extracts like antioxidant, antimicrobial, antitumour, antidiabetic, anti-inflammatory etc. which can be attributed to the presence of different phytochemical substances in them. The active compounds in a fraction can be identified and isolated by various techniques like chromatography. Most popular method for the determination of essential oil composition is by Gas Chromatography-Mass Spectrometry (GC−MS).

Sundaresan et al. (2009) compared the essential oil composition of an endemic plant of Western Ghats namely P. *travancoricus* with that of the cultivated *P. cablin* by GC-MS analysis. In *P. travancoricus* thirteen compounds were reported whereas eleven compounds were found in *P. cablin.*

The flowers of *P. deccanensis* were used in traditional medicines to purify blood and also to treat worm infestations (Biswas et al., 2010).

For quantification of chromones in *D. stellata,* Gautam et al. (2010a) developed an HPLC method, which was simple, accurate and selective for the separation and quantification of chromones. In the same year from the n-hexane extract of *P. stellatus*, *Gautam* et al. (2010b) identified 5-hydroxy-6, 7-dimethoxy-2-methylchromone(stellatin),1-(2-hydroxy-4,6-dimethoxyphenyl) but-2en-1-one, 5-hydroxy-7-methoxy-2-methylchromone and 5, 7-dimethoxy-2-methylbezopyran-4-one.

Bhuiyan et al. (2011) revealed the uses of aerial parts of *P. cablin* for the treatment of the common cold, headache, fever, vomiting, indigestion and diarrhoea and the leaves of *P. benghalensis* to clean wounds.

The results of the insilico, invitro studies on anticancer and antimicrobial efficacy of *Anisochilus carnosus* extract by Muthuraman et al. (2012) suggested the ethanol extract of selected plant *Anisochilus carnosus* possess potent anticancer activity against Ehrlich ascites carcinoma. They also discussed the scope of further in depth phytochemical studies in the identification of a new anticancer compound leading to the development of a novel safe and efficacious anti cancer drug from this natural source.

The essential oil composition of the leaves of *P. speciosus* by GC-MS and GC-FID was analysed by Murugan and Mallavarapu (2013) and found to be rich in sesquiterpenes and oxygenated sesquiterpenes. α-bisabolol, (E)-

caryophyllene, cubebol, germacrene B and δ-cadinene were the major constituents of the sixty three components present. The essential oil from *P. speciosus* may be considered as an alternative source of α-bisabolol.

A study was carried out to evaluate the nature and localisation of different phytoconstituents in leaf, stem and their respective calli of *A. carnosus* an ethnomedicinal herb by Nissar et al. (2015). Their results revealed the presence of alkaloids, flavonoids, saponins, glucosides, tannins, lignin, pectin, starch, cellulose and carbohydrates in in vivo and in vitro plant material. The study also paved a way for the production and isolation of biologically active secondary metabolites from callus culture and can be used as alternatives for in vivo plant material.

Liu et al. (2015) isolated four patchoulene sesquiterpenoids from the essential oil of leaves and stems of *P. cablin* and the structures of these compounds were isolated by NMR spectroscopy. Kim et al. (2015) isolated three new compounds from the aerial parts of *Pogostemon cablin*. Their result included a new octaketide, named cytosporone V and two phenylethanoid glycosides, verbascoside and pedicularioside. Using NMR and High Resolution Mass Spectrometry (HR-MS) the structures of these compounds were also elucidated.

The presence of many phenolic and flavonoid compounds by HPLC analysis of ethyl acetate, methanol and acetone extracts were shown by George et al. (2016). The active compound in the ethyl acetate extract was naringenin a flavonoid compound. The main components in acetone extract were found to be chlorogenic acid, caffeic acid, trans-cinnamic acid, catechin, quercetin and naringenin.

3.6. Molecular Phylogeny

El- Gazzar and Watson (1970) conducted a numerical phenetic study, which provided support for Erdtman's subfamilial classification. Affinities of Lamiales were evaluated by Cantino (1982) based on cladistic principles. Olmstead (1989) carried out independent analyses of phylogenetic relationships in the *Scutellaria angustifolia* complex using both molecular and morphological data. The phylogenetic relationships among ten taxa of this *Scutellaria angustifolia* complex was derived from a synthesis of the molecular and morphological analyses.

Stevens (1984), considered Lamiaceae, a "natural" group and one of the largest and most distinctive angiosperm families. The gynoecial morphological studies (Junnel 1934), palynological (Abu-Asab and Cantino 1992), and phylogenetic analyses of non-DNA data (Cantino 1992) and molecular DNA data (Wagstaff & Olmstead 1997; Wagstaff et al. 1998) uneavelled before us the polyphyly of Lamiaceae and based on these studies, the traditionally circumscribed family Verbenaceae was thought to be paraphyletic.

Harley et al. (2004) recognized 236 genera (comprising more than 7000 species), in Lamiaceae, 226 of which were assigned to seven subfamilies: Ajugoideae, Lamioideae, Nepetoideae, Prostantheroideae, Scutellarioideae, Symphorematoideae and Viticoideae. Ten genera that could not be placed in a subfamily were listed as separate group and named incertae sedis.

Ryding (1992) investigated pericarp structure of 205 species of Lamiaceae subfamily Nepetoideae tribe Ocimeae and the result showed that in its basic structure, the pericarp of the tribe Ocimeae corresponds to that of other Nepetoideae and the exocarp has usually both mucilaginous and nonmucilaginous cells.

Cantino (1992a) conducted a preliminary cladistic analysis which revealed the polyphyletic origin of Lamiaceae and the analysis supported the hypothesis of origin of gynobasic-styled Labiatae in southern China or Indomalaysia (Wu & Li 1982). Cantino (1992b) carried out a cladistic analysis at the sametime to evaluate the major classifications of Lamiaceae in Bentham's (1876), Briquet (1895–1897), Erdtman (1945) and Wunderlich's (1967) systems.

A parsimony analysis of Labiatae and Verbenaceae using *rbcL* sequences by Wagstaff and Olmstead (1997) supported the monophyly of Labiatae *s.l.* To resolve phylogenetic relationships in Labiatae *s.l*. Wagstaff et al. (1998) analysed cpDNA sequences (*rbcL* and *ndhF*) independently and in combination and all the three analyses supported the monophyly of Labiatae *s.l.*

Jamzad et al. (2003) based on ITS sequence data studied the phylogenetic relationships in *Nepeta* L. (Lamiaceae) and related genera. In their study 43 species of *Nepeta* and representatives of closely related genera and outgroups were sequenced. The result obtained by parsimony analysis indicated that *Nepeta* is monophyletic and composed of five major monophyletic groups.

Studies of Steane et al. (2004) on the phylogenetic relationships between *Clerodendrum* (Lamiaceae) and other Ajugoid genera inferred from nuclear and chloroplast DNA sequence data revealed that the Australian monotypic genus *Huxleya* evolved from within *Clerodendrum.* They also sunk *Huxleya* into *Clerodendrum* and make a new combination, Based on sequences of the *trnL* intron, *trnL–trnF* intergene spacer and *rps16* intron of the plastid genome, Paton et al. (2004) presented a phylogeny of basils and allies (Lamiaceae, tribe Ocimeae) using maximum parsimony with equally and successively weighted characters, bootstrap resampling, and Bayesian inference to reconstruct phylogenies and to assess statistical support for clades. Their result concluded that the genus *Plectranthus* is paraphyletic and recognized two clades: *Coleu*s and *Plectranthus* within subtribe Plectranthinae. They also opined that previously used morphological characters cannot diagnose clades within the sub-tribe and emphasised the need of further sampling to support monophyly within the group. Asiatic origin for Ocimeae and several secondary occurrences in Asia arising from the African Ociminae and Plectranthinae clades were also supported by this study.

Phylogenetic studies of Nepetoideae and two genera of subfamily Ajugoideae to test the monophyly of the genus and to elucidate its phylogenetic placement within subtribe Menthinae were carried out by Brauchler et al. (2005). They performed a parsimony analysis of *trnK* intron sequence data of 51 accessions representing 15 genera of Nepetoideae and two genera of subfamily Ajugoideae. A well supported "core group" indicating four distinct lineages and the polyphyletic nature of the genus were revealed by tree topology.

A phylogenetic study of the genus *Sideritis* (Lamiaceae) from sequences of the nuclear ribosomal DNA internal transcribed spacers (ITS) and two plastid regions (*trnL* intron, *trnT-trnL* intergenic spacer) were done by Barber et al. (2007), in order to reconstruct relationships among all extant island taxa using both nuclear and chloroplast data. The individual phylogenies reconstructed from the nuclear and chloroplast sequence data were seen to be incongruent, and differing placements of taxa were well supported in each of the two datasets.

Schäferhoff et al. (2010) & Li et al. (2016), discussed the relationship between the closely related families Lamiaceae and Verbenaceae based on recent phylogenetic studies. Both these works concluded that many genera classified in Verbenaceae should be transferred to Lamiaceae.

Yuan et al. (2010) undertook a phylogenetic study using four chloroplast DNA regions, *trnT-L*, *trnL-F*, *trnD-T,* and *trnS-fM*, to clarify the generic boundaries of *Clerodendrum.*

Scheen *et al.* (2010) did a phylogenetic analysis of Lamiaceae subfam. Lamioideae based on chloroplast sequences: *trnL* intron, *trnL-trnF* intergenic spacer, and *rps16.* In this they included all major lamioid and pogostemonoid genera. The monophyly of Lamioideae *s.l.* (i.e., including *Pogostemonoideae*) was strongly supported in this study.

Lamiaceae and Verbenaceae were placed within a large clade called "core Lamiales" by recent phylogenetic studies of angiosperms (Soltis et al. 2011), and especially Lamiales (Refulio-Rodriguez & Olmstead 2014; Schäferhoff et al., 2010), where Lamiaceae are sister to a well-supported clade comprising Orobanchaceae and several small families (Mazaceae, Paulowniaceae, Phrymaceae, etc.), and Verbenaceae are sister to the small African family Thomandersiaceae.

Bendiksby et al. (2011) used a total of 402 DNA sequences generated from 71 new DNA extracts from silica dried leaves and based on earlier published data presented a taxonomic update of the subfamily lamioideae. They used four chloroplast regions (matK, rps16, trnL intron and trnL-F spacer) and the results identified phylogenetic positions of 10 out of 13 previously unplaced small or monotypic Asian lamioid genera and 37 additional lamioid species and the classification was updated accordingly.

A Phylogenetic and biogeographic study of the lamioid genus *Phlomis* (Lamiaceae) by Mathiesan et al. (2011) based on three cpDNA regions (*trnL* intron, the *trnL – F* intergenic spacer, and the *rps16* intron) supported a split of the genus into two separate groups that are recognised here as the genera *Phlomoides* and *Phlomis* in order to decrease taxonomic complexity. Curto et al. (2012) studied the development of phylogenetic markers from single-copy nuclear genes for multi locus, species level analyses in the mint family (Lamiaceae) and presented the strategy and results of marker development for phylogenetic analysis in *Micromeria*, using publicly available DNA sequences and ESTs from related genera from Lamiaceae, subfamily Nepetoideae.

Salmaki et al. (2013) conducted molecular phylogenetical studies of the tribe Stachydeae (Lamiaceae subfamily Lamioideae). From a taxonomically and geographically broad sampling of the tribe they carried out parsimony and Bayesian phylogenetic analyses of nuclear (ribosomal ITS) and plastid (*trnL* intron*, trnL– trnF* spacer, *rps16* intron) DNA sequence data to identify major evolutionary lineages and to test taxonomic hypotheses within this largest of all lamioid tribes. They concluded that both nuclear and plastid data corroborate monophyly of the tribe, with *Melittis* as sister to all remaining Stachydeae.

Recent molecular studies of Lamiales (Refulio-Rodriguez & Olmstead 2014; Schäferhoff et al., 2010) have shown that Verbenaceae as traditionally circumscribed were polyphyletic, with genera such as *Vitex* L., *Clerodendrum* L., and *Callicarpa* L. Also these studies reveal that these genera are more closely related to the traditional Lamiaceae than they are to Verbenaceae *s. str*.

Molecular studies of Roy and Lindqvist (2015) confirmed the monophyly of five of the seven subfamilies (Ajugoideae, Lamioideae, Nepetoideae, Prostantheroideae, and Scutellarioideae).

A phylogenetic analyses of the genus *Pogostemon s.l.* (Lamiaceae) by Yao et al. (2016) using the ITS and five plastid regions (*matK*, *rbcL*, *rps16*, *trnH-psbA*, *trnL-F*) confirmed the monophyly of *Pogostemon* and its sister relationship with the genus *Anisomeles.* Molecular dating and biogeographic diversification analyses revealed the early strengthening of Asia monsoon system that was triggered by the uplifting of the Qinghai–Tibetan Plateau in the early Miocene as the root cause for the *Pogostemon* split from its sister genus in southern and Southeast Asia and resulted in the subsequent diversification of the genus. Their result also unravelled the transoceanic long distance dispersal of *Pogostemon* from Asia to Africa occurred at least twice, once in the late Miocene and again during the late-Miocene/early-Pliocene.

A large-scale phylogenetic reconstruction of Lamiaceae using chloroplast sequences by Li et al. (2016) representing approximately 78% of the genera produced twelve strongly supported primary clades which form the phylogenetic backbone of Lamiaceae. The introduction of three new subfamilies namely Cymarioideae, Peronematoideae, and Premnoideae and the updated compositions of other subfamilies based on new findings from the last decade also forms the major contribution of their work. Will and Claben-Bockhoff (2017) in an intention to fill the gap of under-representation of Old World *Salvia* species, reconstructed the phylogeny of *Salvia* (Lamiaceae) with a wide sampling of taxa. They aimed to check the polyphyletic nature of the genus and the identification of well-supported clades that provided the basis for evolutionary and taxonomic conclusions.

Recently a phylogenetic analysis of tribe Elsholtzieae (Nepetoideae, Lamiaceae) using two nuclear (ETS, ITS) and five chloroplast (*rbcL*, *matK*, *trnL-F*, *ycf1*, *ycf1-rps15*) genes was carried out by Li et al. (2017) to reconstruct the phylogeny, biogeographic history, and patterns of diversification. Based on the results obtained they concluded that tribe Elsholtzieae is monophyletic and divided into five clades. Five major clades were established during the Eocene period and the ancestral area reconstructions revealed that the tribe originated in East Asia, and then dispersed to Southeast Asia and North America as supported by molecular dating. The upliftment of the Qinghai-Tibetan Plateau (QTP) and climate changes from Middle Miocene in promoting species diversification of Elsholtzieae was also highlighted in their study.

CHAPTER 4
REVIEW OF CLASSIFICATION

Lamiaceae is one of the largest family included in the order Lamiales, having a pantropical distribution except in Antartica. The earliest full monographic account of this family was that of Bentham (1832–1836), which was later modified by him in De Candolle's *Prodromus* (1848) and in the *Genera Plantarum* (1876). Modifications to this system in the arrangement of taxa at infra family level were made by many authors like Komarov (1954), Calpham et al. (1962), Gleason & Cronquist (1963) and Melchior (1964).

The summary of Bentham's arrangement in terms of tribes and sub tribes are as follows.

Tribe1. Ocimoideae

Tribe 2. Satureieae

Subtribe: Elshotzieae

Subtribe: Mentoideae

Subtribe: Thymeae

Subtribe: Melisseae

Tribe 3. Monardeae

Tribe 4. Nepeteae

Tribe 5. Stachydeae

Subtribe: Scutellarieae

Subtribe: Melliteae

Subtribe: Marrubiea

Subtribe: Lamieae

Tribe 6. Prasieae

Tribe 7. Prostanthereae

Tribe 8. Ajugoideae

Research in the recent decades on the family level relationships employing developments in allied fields like morphology, chemotaxonomy and molecular phylogeny have generated enormous amounts of data. Employing these data in classification has over turned relationship of this family at higher level and within it. Many genera, which was traditionally placed under Verbenaceae were added to Lamiaceae (Harley *et al.* 2004). As a result, the family at present contains about 236 genera and more than 7173 species.

4.1. Classification of Lamiaceae by Harley et al. (2004)

I. Subfamily: Symphorematoideae Briq. in Engler & Prantl (1895)

II. Subfamily: Viticoideaea Briq. in Engler & Prantl (1895)

III. Subfamily: Ajugoideae Kostel. (1834)

IV. Subfamily: Prostantheroideae Luerss. (1882)

1. Tribe: Chloantheae Benth. & Hook.f. (1876)
2. Tribe: Westringieae Bartl. (1830)

V. Subfamily: Scutellarioideae (Dumort.) Caruel (1884)

VI. Subfamily: Lamioideae Harley (2004)

VII. Subfamily: Nepetoideae (Dumort.) Luerss. (1882)

1. Tribe: Elsholtzieae (Burnett) Sanders & Cantino (1984)

2. Tribe: Mentheae Dumort. (1827)

    a. Subtribe: Salvinae (Dumort.) Endl. (1838)

    b. Subtribe: Menthinae (Dumort.) Endl. (1838)

    c. Subtribe: Nepetinae (Dumort.) Coss. & Germ. (1845)

    d. Mentheae: *Incertae sedis* (*Melissa* L., *Heterolamium* C.Y. Wu.)

3. Tribe: Ocimeae Dumort.(1829)

    a. Subtribe: Lavandulinae Endl. (1838)

    b. Subtribe: Hanceolinae (C.Y. Wu.) A.J. Paton, Ryding & Harley(2002)

    c. Subtribe: Hyptidinae Endl. (1838)

    d. Subtribe: Ociminae (Dumort.) Schmidt in Mart. (1858)

    e. Subtribe: Plectranthinae Endl. (1838)

VIII. Labiatae: *Incertae sedis*: *Tectona* L.f., *Callicarpa* L., Hymenopyramis Wall ex. Grtiff., *Petraeovitex* Oliv., *Peronema* Jack, .*Garretia* H.R. Fletcher, *Cymaria* Benth., *Acrymia* Prain, *Holochelia* (Kudo) S. Chow, *Ombrocharis* Hand. Maz.

4.2. Key to the subfamilies in which the genus under study belongs

1a. Style always gynobasic 2

1b. Style terminal or subterminal. If rarely gynobasic, then calyx 2-lipped with lips entire, rounded .... **Scutellarioideae (Scutellaria)**

2a. Pollen usually hexacolpate, 3- celled, plants often strongly aromatic with volatile terpenoids, rosmarinic acid, embryo-investing.......................... .... **Nepetoideae (Anisochilus)**

2b. Pollen usually tricolpate, 2-celled, plants rarely aromatic, terpenoids and rosmarinic acid usually very poorly represented, embryo spatulate .... **Lamioideae (Pogostemon)**

Subfamily Lamioideae Harley

Lamioideae the second largest subfamily under the family Lamiaceae, (including Pogostemonoideae), was considered to consist of 63 genera and about 1260 species. Since Harley et al. (2004), many works added different genera to this subfamily like; *Rydingia* which was established by Scheen & Albert (2007); *Betonica* which was resurrected from synonymy under *Stachys* by Scheen et al. (2010); *Phlomoides* which was resurrected from *Lamiophlomis* Kudô; Notochaete Benth. and *Pseuderemostachys* Popov. which were subsumed into Phlomoides by Mathiesen et al. (2011). Thus, 63 genera are at present included in subfamily Lamioideae. Recently, Scheen et al. (2010) produced a first, general phylogenetic framework for Lamioideae based on chloroplast DNA sequence data, which elucidated evolutionary relationships of many genera and clades and permitted a preliminary tribal classification system. It confirmed that Lamioideae were non-monophyletic following earlier work by Cantino et al. (1992), but monophyletic as circumscribed by Harley et al. (2004), i.e., including former subfamily

Pogostemonoideae. However, a better sampling in the family still needs to be corroborated with the aim to identify the exact circumscription of the subfamily within Lamiaceae.

In the morphological phylogeny of Lamiaceae by Cantino (1992a, b), the subfamily Nepetoideae was nested within Lamioideae, and this group most closely related to *Ajuga* (in Ajugoideae) and the incertae sedis genera *Cymaria, Acrymia, Holocheila* and *Garrettia*. However, data obtained from more recent molecular data, suggests that the two subfamilies Lamioideae and Nepetoideae are only remotely related, and Lamioideae are more closely related to Scutellarioideae than to Ajugoideae (Wink & Kaufmann 1996; Wagstaff & Olmstead 1997; Wagstaff et. al. 1998). Scheen et. al. (2010) strongly supported the monophyly of Lamioideae *s.l.* (i.e., including Pogostemonoideae) with *Cymaria* Benth. as its sister group, and Pogostemonoideae, is subsumed in the sub family Lamioideae. On the basis of the phylogenetic hypothesis, Lamioideae is divided into nine tribes by adding three new tribes namely Gomphostemmateae Scheen & Lindqvist, Phlomideae Mathiesen, and Leucadeae Scheen & Ryding. The other six tribes Pogostemoneae Briq., Synandreae Raf., Stachydeae Dumort., Leonureae Dumort., Lamieae Coss. & Germ., and Marrubieae Vis.The genus *Betonica* L. is also reestablished. Bendiksby et al. (2011) by using a total of 402 chloroplast DNA sequences (matK, rps16, trnL intron and trnL-F spacer) generated from specimens held at the different herbaria and in a few cases, from silica dried leaves presented a taxonomic update of the subfamily Lamioideae. They identified phylogenetic positions of 10 out of 13 previously unplaced small or monotypic Asian lamioid genera and 37 additional lamioid species and the classification was updated accordingly.

4.3 Infrageneric classification of the Genus *Pogostemon* by Bhatti and Ingroille (1997)

Genus: *Pogostemon* Desf.

I. Subgenus *Pogostemon* sensu Bhatti & Ingr.

II. Subgenus: *Allopogostemon* Bhatti & Ingr.

a. Section: *Racemosus* (Benth.) Bhatti and Ingr.

i. Subsection: *Racemosus*

ii. Subsection: *Glabriusculus* (Briq.) Bhatti & Ingr.

b. Section: *Zygocalyx* Bhatti & Ingr.

III. Subgenus: *Dysophyllus* (Blume) Bhatti & Ingr.

a. Section *Dysophyllus*

b. Section: *Verticillatus* (Benth.) Bhatti & Ingr.

4.3.1. Key to subgenera of *Pogostemon*

1a. Calyx broadly conical, diameter greater than length, length < 4 mm, five veins only, thin and translucent; calyx teeth normally ≤ 1mm; leaves normally sessile or subsessile (petiole < 5 mm).. subgenus ***Dysophyllus***

1b. Calyx tubular, diameter narrower than length, length ≥ 4mm, five main veins but with intercostals veins, thick or papery; calyx teeth normally > 1mm; leaves normally petiolate **2**

2a. Calyx with 5 main rib-veins and multiple parallel intercostal secondary veins meeting at the sinuses; calyx tube often with scattered hairs within; bracts and bracteoles large, equalling or exceeding calyx, frequently broadly lanceolate or bifid and toothed or lobed, less frequently narrow lanceolate; lateral verticillasters 2 or more, or rarely an unbranched verticillaster but then filament bases normally glabrous or with long hairs...subgenus ***Pogostemon***

2b. Calyx with 5 main rib-veins and isolated, more or less branched intercostal veins from sinuses of teeth; bract and bracteoles linear to linear lanceolate, large or small; inflorescence an unbranched verticillaster, or if branched then filament bases glabrous or densely villous) ....subgenus ***Allopogostemon***

Key to sections of subgenus *Allopogostemon*

1a. Calyx more or less 2-lipped; at least 2 calyx awl- shaped, the margins fringed by stiff bristle-like hairs .... section ***Zygocalyx***

1b. Calyx symmetrical; calyx teeth triangular with a fringe of line hairs .... section ***Racemosus***

Key to sub sections of section *Racemosus*

1a. Monoliform staminal hairs present .... subsection ***Racemosus***

1b. Monliform stamina hairs absent .... subsection ***Glabriusculus***

Key to sections of subgenus *Dysophyllus*

1a. Leaves linear or linear lanceolate, sessile, base truncate, rounded or cuneate, verticillate, > 2 per node (rarely two opposite leaves at each node) .... section ***Verticillatus***

1b. Leaves lanceolate, elliptic, ovate or clavate, petiolate, base usually cuneate rarely rounded, 2 opposite leaves at each node (rarely some nodes with 4) ....section ***Dysophyllus***

Subfamily Nepetoideae (Dumort.) Luerss.

Nepetoideae is the largest among the mint subfamilies, with clearly defined diagnostic morphological characters like hexacolpate and three-nucleate pollen, an investing embryo, presence of rosmarinic acid. It contains about half of the genera (~105/236) and about half of the species (~3,600/7,173) in Lamiacae. Various molecular analyses proved Nepetoideae as monophyletic and divided into three tribes namely Elsholtzieae, Mentheae, and Ocimeae. Tribe Mentheae is the largest including the well known genera such as *Mentha, Nepeta, Origanum, Rosmarinus, Salvia* and *Thymus*. Tribe Ocimae take the middle position in number of genus and contains some economically important genera such as Ornamental *Coleus, Lavandula* and *Ocimum*. Elsholtzieae tribe is the smallest which includes only about 71 species (Kaufmann & Wink 1994).

Classification of Sub family Nepetoideae by Harley et al. 2004

1. Tribe Elzholtzieae (Burnett) Sanders & Cantino (1984) include 5 species

2. Tribe Mentheae Dumort. (1827)

   Subtribe: Salviinae (Dumort.) Endl. (1838) include 8 species

   Subtribe: Menthinae (Dumort.) Endl. (1838) include 43 species

   Subtribe: Nepetinae (Dumort.) Cross. & Germ. (1845) include 12 species

   Subtribe: Mentheae : *Incertae sedis* include 2 species

3. Tribe Ocimeae Dumort. (1829)

   Subtribe: Lavandulinae Endl. (1838) includes 1 species

   Subtribe: Hanceolinae (C.Y. Wu) A.J. Paton, Ryding & Harley (2002) include 3 species

Subtribe: Hyptidinae Endl. (1838) include 8 species

Subtribe: Ociminae (Dumort.) Schmidt in Mart. (1858) include 12 species

Subtribe: Plectranthinae Endl. (1838) include 11 species

4.4. Infrageneric classification of the Genus *Anisochilus*

Calyx characters are of great taxonomic importance in the genus *Anisochilus.* Bentham (1848) divided *Anisochilus* into 2 sections based on calyx characters. Section *Anisochilus* has posterior lip of calyx ovate and deflexed and truncate anterior lip. Section *Stiptanthus* is characterised by 5-toothed calyx with incurved and oblique teeth and incumbent and elongate nature of the uppermost tooth. This classification is not followed by Suddee & Paton (2009) in his recent revisionary work as it does not reflect the homology of calyx lobes, placing species both the 1/4 arrangement and 2/3 arrangement in section *Anisochilus.*

4.4.1. Key to subgenera / sections by Bentham (1848)

1a. Calyx teeth of posterior lip ovate and deflexed; anterior lip truncate .... section ***Anisochilus***

1b. Calyx teeth of posterior lip elongate and incumbent; anterior lip incurved and oblique .... section ***Stiptanthus***

Subfamily Scutellarioideae (Dumort.) Caruel (1884)

The subfamily Scutellarioideae consist of five genera and around 380 species. *Holmskioldia* Retz., *Renschia* Vatke, *Scutellaria* L., *Tinnea* Kotschy ex Hook. f., and *Wenchengia* C.Y. Wu & S. Chow are these genera (Harley et al. 2004; Li et al. 2012; Li et al. 2016). Of these *Scutellaria* is one of the largest genera with 360 species, distributed chiefly in China (Harley et al.

2004). It differs from the other genera of this subfamily by possessing some unique characters like aborted single theca in anterior stamens, nutlet attachment scar minute and presence of scutellum on the upper lip of calyx.

4.5. Infrageneric classification of the Genus *Scutellaria*

Various authors like Hamilton (1832), Bentham (1834, 1876), Briquet (1896), Epling (1942), Juzepczuk (1954), Wu & Li (1977), Rechinger (1982), Edmonson (1982), Paton (1990) made infrageneric treatement of the genus *Scutellaria.*

Recent classification of the genus *Scutellaria* by Paton (1990) is more similar to that of Bentham (1836). Both of these system considered variation of *Scutellaria* at global level.

A comparison of classification of the genus *Scutellaria* by various authors are tabulated below in Table 4.5.1.

4.5.1. Key to subgenera of *Scutellaria*

1a. Inflorescence one sided or rarely spiral; flowers opposite or not, subtended by leaves or leaf-like bracts ....subgenera ***Scutellaria***

1b. Inflorescence 4- sided, with flowers opposite and decussate, subtended by cucullate bracts ....subgenera ***Apeltanthus***

4.5.1. Key to the sections of subgenera *Scutellaria* by Paton (1990)

1a. Corolla lips ± equal in size and shape, spreading, upper lip not galeate...Section ***Perilomia***

1b. Corolla lips unequal, lateral lips more closely joined to upper lip than lower; upper lip galeate **2**

2a. Intricately branched shrub upto 1m; calyx forming a membraneous bladder longer than 1 cm in fruit ....Section ***Salzaria***

2b. Herbaceous or suffruticose upto 60 cm; calyx not membraneous in fruit, less than 1 cm long, upper lip testudinate or with scutellum.. **3**

3a. Chasmophytes; upperlip of calyx testudinate in fruit, nutlets grey-black with hairs longer than 0.5 mm... section ***Anapsis***

3b. Not Chasmophytes; upperlip of calyx with a sail-like scutellum; nutlets grey- black or not, with hairs less than 0.5 cm or glabrous **4**

4a. Suffruticose mat- or cushion- forming herbs; nutlets sub-papillate, grey-black with hairs completely covering the nutlet surface .... section ***Salvifoliae***

4b. Erect or prostrate herbs, suffrutricose or not; nutlets usually papillate and rarely subpapillate, smooth or ridged; yellow, orange, brown, black or grey- black; glabrous or with hairs only partially covering the nutlet surface .... section ***Scutellaria***

CHAPTER 5
AREA OF STUDY

5.1. Topography

The present study area, **Western Ghats** are mountain ranges that runs almost parallel to the western coast of the Indian peninsula. It is one of the eight "hottest hotspots" of biological diversity in the world and is a UNESCO World Heritage Site. It is sometimes known as the Great Escarpment of India. This mountain range runs north to south along the western edge of the Deccan Plateau, and separates the plateau from a narrow coastal plain, called Konkan, along the Arabian Sea. The Western Ghats covers 6 states Goa, Gujarat, Karnataka, Kerala, Maharashtra and Tamil Nadu. **(Plate 1–6)**

These mountains stretch, 1,600 km long, is interrupted only by the 30 km Palghat Gap at around 11°N. It cover an area of around 1,40,000 km². The Doddabetta of Nilgiri Biosphere Reserve which attains the height of 2,637 m is the highest peak and average height of this plateau is 1,950 m. The mountain chain of the Western Ghats are older than the Himalaya mountains and represents geomorphic features of immense importance in unique biophysical and ecological processes. The forests of Western Ghats are home to at least 325 globally threatened flora, and it include some of the best representatives of non-equatorial tropical evergreen forests. About 229 plant species, 31 mammal species, 15 bird species, 43 amphibian species, 5 reptile species and 1 fish species represents the globally threatened flora and fauna in the Western Ghats.

The Western Ghats can be geographically divided into northern and southern Western Ghats. The northern Western Ghats is a narrow strip of mountains situated between Goa and Tapti river mouth. This mountain ranges about 750 km lie between 15^0 21' N and 73^0 50' to 75^0 50' E with an altitude range between 300–1500 m above m.s.l. They are popularly known as Sahyadris and are characterised by isolated conical and flat topped hills with steep sides and distinct striations. The only exceptions are the ghats south of Amboli ghat and Goa were steep slopes are striations are absent.

The Queen of Hills, Nilgiris is one of the important biodiversity hotspots coming under Western Ghats. This Blue Mountain is located mainly in Tamil Nadu between the longitudinal range of $11^0$10' to $11^0$45' N and longitudinal dimension of $76^0$14'E to $77^0$2'E covering about an area of 2453 sq. km. The Nilgiris stretches an elevation of 900 to 2636 metres above mean sea level. Doddabetta, which lies at a height of 2,595 metres from the mean sea level is the place of highest elevation in Nilgiris. Nilgiris which harbours rich plant diversity, both exotic and native shares the northern boundary with Karnataka states, on the western side by Coimbatore and Erode districts, southern side by Kerala state and Coimbatore district and on the eastern side by Kerala state. It houses a forest area of 1,42,577 hectares and comprises six taluks namely, Coonoor, Gudalur, Kotagiri, Kundah, Pandalur and the major hill station Udhagamandalam or Ooty.

5.1. Soil

Soils are formed from the withering of rocks due to different catastrophic events occurred on the crust of earth. It is a mixture of minerals and organic matter. Geographically Indian soils are categorized into three major groups

(i) Mature soils of Peninsular India (Red, Black and Lateritic soils)

(ii) Alluvial soils of Indo-Gangetic Plains

(iii) Scanty soils of Himalayas

For a comprehensive description that occur in the country, presently soils are grouped into eight categories such as

1. Laterite or Lateritic soils
2. Black cotton soils
3. Red soils
4. Alluvial soils
5. Alkali soils and saline soils
6. Peaty and other organic soils
7. Desert soils
8. Scanty soils of mountains

Among these lateritic soil, red soil and black soil are mainly found in Western Ghats. Lateritic soil is found mainly in Tamil Nadu and other parts of Western Ghats especially in regions having alternate wet and dry seasons. Lateritic soils are characterised by low levels of lime and are well developed on hill tops. In Karnataka, western parts of districts such as Chikmagalur, Hassan, Mysore and Shimogha are characterised by lateritic soils. Regur or black cotton soils are found predominantly in Gujarat and some parts of Tamil nadu like Tirunelveli, parts of Karnataka and Maharashtra. Red soil including red loam, and yellow earth with low humus and other organic nutrients are distributed mainly in Peninsular India. In Western Ghats this can be mainly seen in Karnataka and Maharashtra. Alkali and saline soils can be seen at a very low quantity in some parts of Tamil Nadu and Maharashtra.

Soils of northern Western Ghats are originally derived from Deccan traps and the major types observed are lateritic, red loam, red gravelly soils, medium black soils and mixed red and black soils. Medium black soils are common on flat hill tops whereas deep, red, gravelly soils can be met with valleys with rich humus content. Soils of southern Western Ghats have different origins mostly these are volcanic in areas from Dangs to Goa, Mullayanagiri and mountain ranges from Malaprapha and Kali rivers in Karntaka, down to Pulneys.

5.2. Climate and Rain fall

The vegetation of Western Ghats is mainly influenced by the heavy rainfall from South West monsoon which starts from early June and continue upto late September. Places like Mahabaleswar and Amboli, the top regions in northern Western Ghats and the windward side of the Sahyadris get rainfall ranges from 6200 mm and 7477 mm. The mean annual rainfall varies from 2359 mm to 7450 mm, the humidity between 70% to 90% during monsoon months and 10 to 30% during dry periods and mean annual temperature from 20^0 C to 24^0 C is observed in northern Western Ghat regions. In Sahyadris the absolute minimum temperature reaches between 6^0 C to 14.8^0 C in the coldest months December and January. Apart from South West monsoon, southern Western Ghats receive North West monsoon during the months from October to January. The annual rain fall of southern Western Ghats varies from 2350 mm in north to 7450 mm in south. The maximum rainfall is received by the western slopes which are exposed to frontal attack of South West monsoon. The annual rainfall exceeds 5000 mm, in certain peaks like Agumbe, Kundah range of Nilgiris and Anamudi of the states Karnataka, Tamil Nadu and Kerala respectively. A special micro climate developed in areas like Silent Valley which are shielded all around. The mean annual temperature of around 24^0 C is observed in northern parts of southern Western Ghats, where as coming to the south it get reduced to 20^0 C.

5.3. Vegetation types

The different types of vegetation seen in Sahyadris are:

1. Scrub Forest
2. Dry deciduous Forest
3. Moist deciduous Forest
4. Montane subtropical ever green forest
5. Grasslands

According to Champion and Seth (1968), four main types with subdivisions and edaphic or seral variations of forests can be recognised in southern Western Ghats.

1. Moist Tropical Forests

a. Tropical Wet Evergreen Forests
b. Tropical Semievergreen Forests
c. Tropical Moist Deciduous Forests
d. Littoral and Swamp forests

2. Dry tropical Forests

1. Tropical Dry Deciduous Forests
2. Tropical Thorn Forests

3. Montane Tropical Forests

1. Sub tropical Broad leaved hill forests

4. Montane Temperate Forests

1. Montane Wet Temperate Forests

CHAPTER 6
MATERIALS AND METHODS

6.1. Literature survey

The literature survey pertaining with the present study was carried out in the first two years of the work. The classical literature was accessed from online resources like www.biodiversitylibrary.org, www.botanicus.org, and www.archives.com. Important institution libraries like BSI Calcutta, BSI, Southern Circle Coimbatore, Shivaji University Kolhapur, BSI Pune, TBGRI Trivandrum, KFRI Trissur, IFGTB Coimbatore and FRLHT Bangalore were referred while conducting the Herbarium visits. Electronic information was retrieved using internet, INFLIBNET, INFONET etc.

6.2. Herbaria reference

Field work for the present investigation was planned after thorough references of Herbarium data from different institutions. Major herbaria in the country were visited and references were carried out in the off seasons of the first three years. Herbaria like BLAT, BSI, CAL, CALI, FRC, KFRI, MH, FRLH, TBGT, XCH etc. were visited and references were made. Lamiacean specimens including type materials of three genera *Pogostemon*, *Anisochilus* and *Scutellaria* were also accessed from online Herbaria like BM, E, K, L, LINN, M, P, etc.

6.3. Specimen collection

Extensive field trips were conducted in different seasons and the specimens were collected from Western Ghat areas of Maharashtra, Goa, Gujarat, Karnataka, Kerala and Tamil Nadu states. Areas having high diversity of lamiacean plants like Nilgiris and Anamallay hills, were given priority in the first two years of research. Collections in the northern and southern parts of Western Ghats were conducted in rest of the years. Flowering season of majority of species under the genus *Anisochilus* starts after July and that of the genus *Pogostemon* starts after November. The genus *Scutellaria* was common in the wet areas of forests and hence the flowering season varies according to the availability of moisture though it starts from July and ends in April. Field collections of the genus *Anisochilus* were carried out in the third year since many of the species were confined to the drier parts i.e. in the eastern slopes of the Western Ghats. During field trips 3–4 accessions of each specimen were collected. Variations within the species and between them were studied by analysing accessions of the same and different species from different localities. Collected specimens were given accession numbers and preserved in Formalin-Acetic-Alcohol (FAA) mixture for further laboratory studies and for preparing illustrations. From the collected samples, 3–4 twigs were dried and preserved as herbarium vouchers for future references. A complete data on the collection details of each specimen such as locality, altitude, vegetative characters, stem and leaf nature, flower colour, odour, nature of fruit, etc were noted in the field book from the field itself. Important characters were microscopically observed using Leica M80 Stereo Microscope fitted with a digital camera and the field photographs were taken using Sony α 55, DSLR Camera. Micro-morphological studies of mericarps of new and similar species were done using Jeol JSM—6390LV/ JED—2300 scanning electron microscope with 20 kV voltage at STIC, Cochin University, Kerala.

6.4. Herbarium preparation

Flowering twigs of approximately 1–1.5 feet size were collected from the field and processed for making herbarium. These include plant parts or the whole plant according to the nature of plants. Parts of some species having robust size and leaves eg; *Anisochilus robustus, Pogostemon plectrantoides,* etc. were mounted on more than one sheet. Majority of species coming under the genus *Scutellaria* are comparatively small and hence the whole plant was mounted on a single sheet. Specimens were mounted on the sheets of the size 28 × 42 cm and labelled properly following the conventional methods of herbarium preparation. All relevant information pertaining the species was furnished with label and the herbarium sheets were deposited in Calicut University Herbarium (CALI).

6.5. Plant identification

A thorough literature survey and herbarium reference helped us to plan the field trips properly and to identify the plants from the field tentatively. Taxonomic keys provided in standard revisionary works, Floras, monographs and other relevant literatures were highly helpful in species identifications. Ultimately the species identities were confirmed by critically comparing with type materials deposited in various herbaria and with the protologue information of each taxa. Tracing the history of each species and etymology were highly helpful in critically comparing similar species and identification. Expert opinions from taxonomy workers and researchers were also helpful in plant collection and identification.

6.6. Description

Descriptions of species and recognized varities were made by combining the datas collected in two stages. In the first phase all the field observed characters of the plant from the field especially habit, stem, leaf inflorescence characters etc. were collected from the field book. Since colour and odour were the two characters which will be lost during preservation, it was given priority. In the second phase, detailed observations of the floral parts and trichome characters and measurements prepared using microscopic observations through Labomed CMS2, Willd Herrbrug and Leica M80 Stereo Microscope were collected from the laboratory worksheet. Botanical Latin (Stearn 1998) was used for standard botanical terms to prepare full description.

6.7. Illustration and photographs

Drawings of important parts of 3 rare plants were made on standard gateway paper with the help of 0.1 mm and 0.2 mm micro tip pen (Rotring Isograph) by direct observation and with the help of Camera Lucida attached on to a Leica M80 Stereo Microscope. Microscopic photographs of some vegetative and the floral parts were taken with the help of camera attached to a Leica M80 Stereo Microscope.

6.8. Nomenclature and citations

Nomenclatural clarifications were made according to the Shenzhen International Code of Nomenclature for algae, fungi, and plants (ICN; Turland et al. 2018). Citations for plant names were obtained from International Plant Name Index (IPNI- http://www.ipni.org/) and The World checklist of selected Plant Families (http://wcsp.science.kew.org/). Author names were written based on the guidelines provided by Brummitt and Powell (1992) and herbarium acronyms were used based on Index Herbariorum.

6.9. Presentation of data

Systematic part of the thesis begins with the family treatment; its citations, type details, description, phenology, distribution, habitat notes and other relevant notes. This is followed by key to the species of the three genera coming under Western Ghats. The species are presented in alphabetic order. Details such as phenology, habitat and ecology, distribution, conservation status and nomenclatural notes are included for each taxon. All specimens studied were cited under specimen examined section. Taxa wise morphological characters of the three genera were analysed and comparative tables were given after the systematic section of the thesis. The genus *Pogostemon* was given more priority and described first as these forms the major part of the study followed by the genera *Anisochilus* and *Scutellaria.*

6.10. Conservation

The fresh specimens with roots, seeds and soil samples collected from the field during this study were used for planting in Calicut University Botanical Garden (CUBG) for variation studies, further analysis and also for conservational purpose. Pots of various sizes were filled with standard potting mixture and used for growing plants.

6.11. Herbarium acronyms used

BM	The Natural History Museum, London, England, UK
BLAT	Blatter Herbarium, St. Xavier's College, Mumbai, Maharashtra, India
BSI	Botanical Survey of India, Western Circle, Pune, Maharashtra, India
C	Museum Botanicum Hauniense, University of Copenhagen, Denmark
CAL	Central National Herbarium, Botanical Survey of India, Howrah, West Bengal, India
CALI	Herbarium of University of Calicut, Malappuram, Kerala, India.
DEV	St. Josephs College, Devagiri, Calicut, Kerala, India
E	Royal Botanical Garden, Edinburgh, Scotland, UK

FRC	Herbarium of Institute of Forest Genetics and Tree Breeding, Coimbatore, Tamil Nadu, India
FRLH	Herbarium of Foundation for Revitalisation of Local Health Traditions (FRLHT), Bangalore, Karnataka, India
JCB	Indian Institute of Science (IISc), Bangalore, India
K	Royal Botanical Gardens, Kew, England, UK
KFRI	Kerala Forest Research Institute, Trissur, Kerala, India
KUBH	University of Kerala, Thiruvanathapuram, Kerala, India
L	Naturalis, Leiden, Netherlands
LINN	Linnaean Society of London, England, UK
MH	Madras Herbarium, Coimbatore, Tamil Nadu, India
M	Botanische Staatssammlung München, Bavaria, Germany
NMNH	National Museum of National History, Smithsonian, US
P	Museum of National d'Historie naturelle, Paris, France
PDA	National Herbarium, Royal Botanical Gardens, Peradeniya, Sri Lanka
RHT	Rapinat Herbarium, St. Joseph's College, Tiruchirapalli, Tamil Nadu, India
SUK	Sivaji University, Kolhapur, Maharashtra, India
TBGT	Tropical Botanical Garden and Research Institute (TBGRI), Kerala, India.
XCH	St. Xaviers College, Palayamkottai, Tirunelveli, Tamil Nadu, India

CHAPTER 7
SYSTEMATIC TREATEMENTS

1. POGOSTEMON Desf.

POGOSTEMON Desf. in Mém., Mus. Hist. Nat. Paris 2: 154. 1815; Benth. in Wall., Pl. Asiat. Rar. 1: 30. 1830; Wild. Sp. Pl. 3:59. 1800; Benth., Labiat. Gen. Spec. 152. 1833; Benth. in DC., Prodr. 12: 151. 1848; Hook. f., Fl. Brit. India 4: 631. 1885; H. Trimen, A Hanb. Fl. Ceylon 3: 378. 1895; T. Cooke, Fl. Bombay 535. 1906; Rama Rao, Fl. Pl. Travancore 323. 1914; Gamble, Fl. Madras 2: 1132. 1924; Fyson, Fl. S. Ind. Hill Sta. 2: 471. 1932; Mukerjee, Rec. Bot. Surv. India 14: 56. 1940; B.V. Shetty & Vivek., Bull. Bot. Surv. India 15:155. 1973; B.D. Sharma, Fl. Nilgiri Dist. 232. 1975; C.J. Saldanha, Fl. Hassan Dist. 507. 1978; Prain, Bengal Pl. 2: 849. 1981; Manilal & Sivar., Fl. Calicut 240. 1982; B.D. Sharma et al., Fl. Karnataka 225. 1984; Henry et al., Fl. Tamil Nadu 2: 184. 1984; B.D. Naithani, Fl. Chamoli 2: 517. 1985; V. Abraham, Fl. Trombay 28. 1985; R.S. Rao et al., Fl. Goa Diu Daman Dadra & Nagar haveli 2: 350. 1986; B.G. Kulkarni, Fl. Sindhudurg 360. 1988; Kamble & S.G. Pradan, Fl. Akola Dist. 186. 1988; Manilal, Fl. Silent Valley 222. 1988; V.S. Ramach. & V.J. Nair, Fl. Cannanore 371. 1988; P.C. Pant, Fl. Corbet N.P. 130. 1989; Kesh. Murthy & S.N. Yogan. Fl. Coorg 353. 1990; S.M. Almeida, Fl. Sawantwadi 1: 343. 1990; Vajr. Fl. Palghat Dist. 382. 1990; Nicolson et al., Fl. Dominica 2: 125. 1991; M. Mohanan & A.N. Henry, Fl. Thiruvanthapuram 372. 1994; S. Deshpande et al., Fl. Mahabaleshwar 483. 1995; Bhatti & Ingr., Bull. Nat. Hist. Mus. 27(2): 77–147. 1997; K.M. Mathew, Fl. Palni Hills 1008. 1999; D.K. Mishra & N.P. Singh, Endem. Threat. Fl. Pl. Maharashtra 194. 2001; N.P. Singh et al., Fl. Maharashtra, Dicot. 2: 751. 2001; S.R. Yadav & M.M. Sardesai, Fl. Kolhapur Dist. 384. 2002; T.K. Sharma & A.K. Sarkar, Fl. Palmau Dist. 3: 508. 2002; B.K.

Manjun., et al., Fl. Devanagare 392. 2004; S.G. Pradhan et al., Fl. Sanjay Gandhi National Park 3: 515. 2005; Sunil, Fl. Alappuzha Dist. 576. 2009; Mandar & Lakshmin., Fl. Bhagwan Mahavir 197. 2013; K.N Subramanian & B.K. Nayar, Fl. Thenmalai 49. 2014.

Heterotypic Synonyms

Dysophylla Blume, Bijdr. Fl. Ned. Ind. 826. 1826.

Chotekia Opiz & Corda, Flora 13: t. 33. 1830.

Eusteralis Raf., Fl. Tellur. 2: 95. 1837.

Dysophylla El Gazzar & L.Watson ex Airy Shaw, Taxon 16: 190. 1967. *nom. illeg.*

Anuragia Raizada, Suppl. Duthie's Fl. Upper Gangetic Plain. 219. 1976. *nom. illeg.*

Annual or perennial erect, scandent, procumbent herbs or suffruticose shrubs. Stem herbaceous or woody glabrous to tomentose. Leaves sessile to petiolate; linear to orbicular. Bracts and bracteoles persistent; linear to semi-orbicular; non membraneous, mostly ciliate. Inflorescence a single terminal or with two or more lateral verticillasters, rarely cymose. Calyx tubular to companulate, teeth 5, mostly triangulat to linear equal or sub equal; glabrous to hairy inside; densely or sparsely hairy outside. Corolla white, yellow, blue or purple coloured; 4 lobed, bilipped; upper lip consist of three lobes with identical two lateral lobes and variable middle lobe; lips densely to sparsely hairy outside; glabrous inside. Stamens 4, didynamous; filaments long, exerted with monoliform hairs in the middle or glabrous; anterior two pairs villos towards the base. Style exerted, long; stigma bifid, lobes equal or unequal. Disc symmetrical or assymetrical, glabrous to rarely hairy and gland dotted. Nutlets 4, equal.

Key to species of the genus *Pogostemon* in Western Ghats

1a. Herbs or suffruticose perennial shrubs, with opposite leaves. Calyx tubular; teeth ≥1 mm, five main veins and intercostals veins present...... **2**

1b. Herbaceous annuals with sessile or subsessile whorled leaves. Calyx broadly conical, broader than the length; teeth equal ≤ 1 mm, five veins only **16**

2a. Inflorescence with two or more lateral spikes giving a panicle appearance. Multiple parallel intercoastal secondary veins meeting at the sinuses in calyx, bracts and bracteoles large and broad **3**

2b. Inflorescence without lateral spikes. Isolated branched intercoastal veins from sinuses of calyx teeth, bracts and bracteoles linear to linear lanceolate **8**

3a. Plants suffruticose shrub **4**

3b. Plants herbs or undershrub **6**

4a. Leaf margin serrate to inciso-crenate with 6–7 major teeth, inflorescence with less than five lateral verticilla ………....... .**6**. ***Pogostemon gardneri***

4b. Leaf margin serrate, double serrate or poly serrate with 15–25 major teeth … **5**

5a. Bract < 8 mm long, corolla tube < 4 mm, anthers < 0.5 mm, style < 1 mm long.... .... **3. *P. benghalensis***

5b. Bract > 8 mm long, corolla tube > 4 mm, anthers > 0.5 mm, style >1 mm long .... **15. *P. plectrantoides***

6a. Inflorescence lax.... .... **7**

6b. Inflorescence dense .... 1**6. *P. purpurascens***

7a. Inflorescence sub secund, bracts broadly ovate concealing the calyx. .... **13. *P. paniculatus***

7b. Inflorescence non secund, bracts narrow and smaller than calyx ....**7. *P. heyneanus***

8a. Calyx more or less 2 lipped; the margins of calyx teeth fringed by stiff bristle like hairs .... **21. *P. wightii***

8a. Calyx symmetrical; the margins of calyx teeth fringed by fine hairs..........**9**

9a. Monoliform staminal hairs present **10**

9b. Monoliform staminal hairs absent **12**

10a. Plants with petiole > 3 cm, inflorescence very lax verticillaster .... **12. *P. paludosus***

10b. Plants with petiole < 3 cm, inflorescence congested verticillaster **11**

11a. Calyx ovate, corolla < 5.5 mm, ovary disc < 0.3 mm ....**9. *P. mollis***

11b. Calyx tubular, corolla > 5.5 mm, ovary disc > 0.3 mm . ...**11. *P. nilagiricus***

12a. Inflorescence terminal verticillaster / racemes **13**

12b. Inflorescence axillary cymose .... **14. *P. peethapushpam***

13a. Calyx dark purple glabrous ....**20. *P. travancoricus***

13b. Calyx green, sometimes with a purple tintch, pubescent to hirsute **14**

14a. Bracts leafy to ovate, corolla yellow . ...**8. *P. hedgei***

14b. Bracts linear to lanceolate **15**

15a. Corolla purple with dark purple corolla tube, staminal filament and style > 10 mm .... **1. *P.atropurpureus***

15b. Corolla white or pale pink with dark pink corolla tube, staminal filament and style < 10 mm ....**19. *P.speciosus***

16a. Leaves lanceolate, elliptic, ovate or clavate, petiolate, base usually cuneate rarely rounded, 2 opposite leaves at each node (rarely some nodes with 4) **17**

16b. Leaves linear or linear-lanceolate, sessile, base truncate, rounded or cuneate, verticillate, > 2 per node (rarely 2 opposite leaves at each node..... ....**20**

17a. Plants with terrestrial / upland habitats.. **18**

17b. Plants with marshy habitat **19**

18a. Bracteoles ovate, corolla < 2 mm long, nutlets ovate...................... .... **10. *P. myosuroides***

18b. Bracteoles oblong, corolla > 2 mm long, nutlets orbicular....................... ....**17. *P.quadrifolius***

19b. Plants with solid stem and opposite ovate leaves ....**2. *P. auricularius***

19b. Plants with hollow stem and whorled linear to lanceolate leaves ………………... **18. *P. salicifolius***

20a. Erect or procumbent herb upto 20 cm high, leaves less than 2 cm, nutlets orbicular .... **5. *P. deccanensis***

20b. Erect herb > 20 cm high, leaves > 2 cm, nutlets oblong … **4. *P. cruciatus***

1. Pogostemon atropurpureus Benth., D.C. Prodr. 12: 154. 1848; Hook.f., Fl. Brit. Ind. 4: 637. 1884; Gamble, Fl. Madras 2: 1134. 1923; B.D. Sharma, Fl. Nilgiri Dist. 232. 1975; A.N. Henry , Fl. Tamil Nadu 2: 184. 1987; Bhatti & Ingr., Bull. Nat. Hist. Mus. 27(2): 104. 1997. **Type:**—INDIA. Nilgiri, Ootacamund, *Perrotet 308* (holotype: P, P00737543, digital image!).

(Plate 7, 8, & 52 D)

=*Pogostemon imberbis* Wight ex Hook.f., Fl. Brit. India 4: 637. 1885.

Perennial, erect herb, 80–120 cm high; stem base 1–3 cm in diameter, profusely branching, branches 70–100 cm long, quadrangular, pilose with 2–4 mm long white hairs; internodes 3–7 cm long. Leaves opposite deccusate, ovate, 8–12 × 5–8 cm, thin, base cordate, apex acute, margin crenate to double crenate with 15–25 teeth, reticulately nerved, secondary veins 4–6, veins prominent beneath, lower surface slightly pubescent, more on veins; petiole 5–7 cm long, glabrescent to pubescent. Inflorescence terminal racemes, 6–15 cm long, dense above lax below, 2–3 cm across, many flowered; pedicels short, 0.5–2 cm long. Bracts caduous; bracteoles linear ca. 1.6 × 0.25 mm, ciliate, shorter than calyx, acute to obtuse tip, pubescent outside, hairs white, margin ciliate. Flowers numerous, around 150–200 in an inflorescence, sessile. Calyx companulate, 5–6 mm long both in flower and in fruit, narrowed towards base and mouth, gradually broadened towards middle, glabrous inside; teeth 5 in number, linear to lanceolate, 1.2–1.6 mm long, lower two little longer than upper three, tips bent upwards, ciliate. Corolla 7–7.5 mm long, tube 3–3.5 mm long, straight and fully included in calyx, dark purple; lobes pubescent to hispid outside, glabrous inside; lower lip, 3–3.5 mm long, trilobed, pale violet with dark purple margins; middle lobe ca. 1.2 mm broad, ovate, lateral lobes slightly broader ca. 1.4 mm broad with white hairs outside. Stamens 4, exerted, didynamous; long, 12.5–13.5 mm, double the size of corolla, anterior two basally villous, posterior two glabrous, pale violet; anthers pale yellow or straw coloured ca. 0.5 mm across. Disc 0.6 mm long. Style 14–15 mm long, slender; stigma lobes equal, ca. 0.57 mm long. Nutlets 4, ca. 0.318 × 0.233 mm.

Phenology:—Flowering and fruiting occurs during November to February.

Distribution:—Endemic to Southern Western Ghats, in Nilgiris.

Habitat and Ecology:—It prefers to grow in lateritic wall cuttings in humid regions in montane evergreen or semi evergreen forests and forest openings at an altitude above 1500 m above msl.

Specimen examined:—**Tamil Nadu.** Nilgiris district: Coonoor, 6500 ft, November 1886, *Gamble 1815* (MH!); *ibid,* 1966 m, 19 January 1957, *K.M. Sebastine 2057* (MH!); Vandisholai, 2000 m, 7 April 2007, *R. Murugan 26* (FRLH!); Ooty, Mynila, 2200 m, 14 February 2007, *R. Murugan 30* (FRLH!); Thummanatti, 2200 m 17 January 2009, *R. Murugan 39* (FRLH!); Doddabetta, (after Doddabetta junction, before 2nd hairpin curve), 19 December 2013, *Shinoj & Vimal 135918* (CALI!); Coonoor, on the way to Dolphin nose, 1791 m, 11^0 21'44.3" N & $76^0$50'11.0" E, 22 January 2016, *Shinoj 145435* (CALI!).

Conservation status:—During our exploration in Western Ghats we were able to collect a few specimens from Coonoor, Nilgiri District in Tamil Nadu. But it was seen only as small patches less than 50 mature individuals in Nilgiris. Moreover it is mainly distributed in road side tourist places. Hence we treat this species under NT category.

Note:—This taxon is very close to *Pogostemon speciosus* Benth. but differs from it in possessing dark purple corolla, completely opened corolla lobes, corolla tube completely included in the calyx congested inflorescence and absence of glands on nutlets.

2. Pogostemon auricularius (L.) Hassk., Tijdschr. Natuurl. Gesch. Physiol., 10: 127. 1843; Hook.f., Fl. Brit. Ind. 4: 637. 1884; B.D. Sharma, Fl. Nilgiri Dist. 232. 1975; B.D. Sharma et al., Fl. Karnataka 224. 1984; T.S. Nayar et al. Fl. TBG 73. 1986; A.N. Henry, Fl. Tamil Nadu 2: 184. 1987; V.S. Ramach. & V.J. Nair, Fl. Cannanore Dist. 371. 1988; K.N. Kesh. Murthy, Fl. Coorg 361. 1990; N. Mohanan & A.N. Henry, Fl. Thiruvananthapuram 371. 1994; S. Deshpande et al., Fl. Mahabaleshwar 482. 1995; Bhatti & Ingr., Bull. Nat. Hist. Mus. 27(2): 106. 1997; K.M. Mathew, Fl. Palni Hills 1008. 1999; K.N Subramanian & B.K. Nayar, Fl. Thenmalai 49. 2014. **(Plate 9, 10 & 50D)**

≡ *Mentha auricularia* L., Mantissa Plantarum 81. 1767.

≡*Dysophylla auricularius* (L.) Blume, Bijdr. Fl. Ned. Ind. 3: 825. 1826; Benth. in D.C., Prodr. 12:156. 1848; *Dysophylla auricularia* Prain, Bengal Pl. 2: 849. 1981; H. Trimen, A Hanb. Fl. Ceylon 3: 380. 1895; Rama Roa, Fl. Travancore 324. 1914; Gamble, Fl. Madras 2: 1134. 1923.

≡ *Eusteralis auricularia* (L.) M.R. Almeida, Fl. Maharashtra 4A: 146. 2003.

Type:—SRI LANKA. *Paul Hermann s.n.* (lectotype: BM, BM 000628193, digital image!).

Annual procumbent herb, stem ascending, 30–50 cm high, rooting at nodes; stem base 0.5–1 cm in diameter, branches 20–40 cm long, quadrangular, rigid, pilose, internodes 5–15 cm long. Leaves opposite deccusate, ovate, 4–8 × 2–4 cm, base rounded or truncate, apex obtuse, margin serrate to double serrate with 12–20 teeth, reticulately nerved, secondary veins 6–8, veins prominent beneath, lower surface pilose; petiole 2–3 mm long, pilose. Inflorescence a terminal congested spike, 5–12 cm long, 1.5–2 cm across, dense flowered; pedicels long, 5–10 cm long. Bracts leafy, 1.5–3 × 1–1.5 cm; bracteoles spatulate to narrowly elliptic, 1.8–2.4 × 1–1.2 mm, villous, almost equaling the size of calyx, tip obtuse, margin ciliate. Flowers numerous, around 60–

120 in an inflorescence, 7–9 mm long, sessile. Calyx companulate, 1–1.4 × 0.8–1 mm long both in flower and in fruit, glabrous inside; teeth 5; equal 0.3–0.5 × 0.3–0.5 mm. Corolla 2.5–3.5 mm long; tube 1.5–2.5 mm long, straight, fully included in calyx, pale violet; pubescent to villous outside, glabrous inside; upper lip three lobed, apex round or ovate 0.7–0.8 × 0.7– 0.8 mm, equal, villous; lower lip single lobed, triangular, 0.8–1× 0.7–0.8 mm hairs 5–6 celled, scattered outside. Stamens 4, exerted, didynamous; posterior pair filaments 4.2–4.5 mm long, anterior pair 4–4.2 mm long, numerous violet monoliform hairs at middle, 1.5 mm long; anthers purple to brown 0.3–0.4 mm across. Disc 0.23–0.25 mm long. Style 5–5.2 mm long, slender; stigma lobes equal, 0.3–0.32 mm. Nutlets 4, ca. 0.35 × 0.15 mm, ellipsoid, brown.

Phenology:—Flowering and fruiting occurs during July to February

Distribution:—Tropical Asia to South China.

Habitat and Ecology:—It is mostly found in marshy areas near to grasslands and sholas at an altitude about 1000 m above msl.

Specimen examined:—**Kerala.** Idukki District: Devicolom, 15 October 1963, 1550 m, *K.M. Sebastian 17574* (MH!); Vallakkadavu R. F., 800 m, 23 September 1972, *B.D. Sharma 40840* (MH!); Kannur District: Kuthuparamba, 20 September 1913, *s.coll. 9289* (MH!); Nedumpoil Chandanathode, 930 m, 26 June 1965, *J.L. Ellis 29179* (MH!); Kannoth R. F., ±150 m, 10 July 1978, V. *S. Ramachandran 57539* (MH!); Mannantoddy, ±700 m, 12 July 1978, *V. S. Ramachandran 53885* (MH!); on the way to Brahmagiri, ±750 m, 4 March 1979,*V. S. Ramachandran 62108* (MH!); *s.l.,*16 December 1915, *s.coll. 9635* (MH!); Kollam District: Kulathupuzha, ±250 m, 16 May 1978, *M. Mohanan 54839* (MH!), Kulathupuzha, 300 m, 17 August 1978, *C.N. Mohanan 55571* (MH!); Kozhikode District: Kuttyadi, 190 m, 23 June 1965, *B.D. Naithani 24175* (MH!); Wayanad District: South Wayanad, Neddikarna to Nedimballi, 14 January 1903, *s.coll. 5616* (MH!); Manantoddy, 29 May 1922, *S.N. Chandrabose & J.R. Naganathan 84055* (MH!); Wayanad, Sulthan Bathery, 950 m, 8 February 1964, *J.L. Ellis 18621* (MH!); Chembra (near Love lake), 1360 m, 21 August 2013, *Shinoj & Smitha 135524* (CALI!); Chembra (near Love lake), 16 January 2014, *Shinoj & Vimal 139584* (CALI!); *ibid.* 15 October 2015, *Shinoj & Manjula 138391* (CALI!); Kurichermala (near a marshy area beside a pond), 28 October 2013, *Shinoj & Smitha 135580* (CALI!); *ibid.* 31 December 2015, *Shinoj145415* (CALI!); Tirunelly, on the way to Tirunelly forest, before 54, (open marshy area inside forest), 7 July 2015, *Shinoj & Manu Philip 138363* (CALI!); Idukki District: Munnar, Devikulam (road side marshy land), 2 January 2014, *Shinoj, Prasad & Vimal 135935* (CALI!). **Tamil Nadu.** Nilgiris District: Konavakorai, Kotagiri, 1833 m, 4 January 1957, *K. Subrahmanya 1906* (MH!); Kunnakombai R. F., 2000 m, 11 December 1957, *K.M. Sebastian 4907* (MH!); Benne forest, 1000 m, 18 July 1960, *K. Subrahmanya 10446* (MH!); Ebanadu to Sirur, 1700 m, 30 August 1970, *G.V. Subbarao 36439* (MH!); Ebanadu to Sirur, 1550 m, 28 July 1972, *G.V. Subbarao 41567* (MH!); Nilgiris District: Kinnakorai, 5000”, 13 February 1990, *Fischer 1722* (FRC!); Pulney District: Pulney, 27 December 1898, *Bourne 1328* (MH!); Salem District: Kollamalzi, Tiruchirapali, 27 June 1916, *s.coll. 12980* (MH!); Balmdeis estate, Yercaud, 1666 m, 19 December 1958, *K. Subramanyan 7547* (MH!); all the way to Kiliyur waterfalls, Yercaud, ±1380 m, 27 July 1966, *S. Karthekeyan 28298* (MH!); Kaveri peak, Yercaud, ±1400 m, 4 November 1968, *D.B. Deb 31305* (MH!); Theni District, Cumbam R. F. West, Madurai, 26 September 1925, *K.C. Jacob 17779* (MH!).

Conservation status:—This is a wide spread species distributed from Tropical Asia to South China. During our field exploration also we met with many accessions with high population density in Kerala and Tamil Nadu. Hence we treat it under Least concern (LC) category of IUCN.

Notes:—This taxon shows much variation in leaf, hair nature and inflorescence characters. But it is strictly found in marshy habitats.

3. Pogostemon benghalensis (Burm. f.) Kuntze, Revis. Gen. Pl. 2: 529. 1891; B.D. Sharma, Fl. Karnataka 2: 224. 1984; B.D. Naithani, Fl. Chamoli 2: 517. 1985; R.S. Rao et al., Fl. West Godavari Dist. 335. 1986; R.S. Rao et al., Fl. Goa, Diu, Daman, Dadra & Nagar haveli 2: 350. 1986; B.G. Kulkarni, Fl. Sindhudurg 362. 1988; V.S. Ramach. & V.J. Nair, Fl. Cannanore Dist. 371. 1988; P.C. Pant, Fl. Corbet N.P. 130. 1989; Kesh. Murthy & S.N. Yogan. Fl. Coorg 361. 1990; E.Vajravelu, Fl. of Palghat Dist. 38. 1990; S.M. Almeida, Fl. Sawantwadi 1: 349. 1990; Sasidh. & Sivar., Fl. Pl. Trissur 364. 1995; S. Deshpande et al., Fl. Mahabaleshwar 482. 1995; Bhatti & Ingr., Bull. Nat. Hist. Mus. 27(2): 89. 1997; K.M. Mathew, Fl. Palni Hills 1009. 1999; N. Mohanan, Fl. Agasthyamala 537. 2002; S.R. Yadav & M.M. Sardesai, Fl. Kolhapur Dist. 384. 2002; T.K. Sharma & A.K. Sarkar, Fl. Palmau Dist. 3: 508. 2002; S.G. Pradhan et al., Fl. Sanjay Gandhi National Park 3: 515. 2005; K.N Subramanian, Fl. Thenmalai, 49. 2014; Anilkumar et al., Fl. Pathanamthitta 402. 2005. **(Plate 11, 12 & 49A)**

≡ *Origanum benghalense* Burm.f., Fl. India 128, t.38, f.3. 1768. **Type**:—Illustration in Burm.f., Fl. Ind. 126, t.38, f.3 (holotype: Illustration!)

Pogostemon parviflorus sensu T. Cooke, Fl. Bombay 536. 1906; Prain, Bengal Pl. 2: 850. 1981; B.G. Kulkarni, Fl. Sindhudurg 362. 1988; Kamble & S.G. Pradan, Fl. Akola Dist. 186. 1988; S.M. Almeida, Fl. Sawantwadi 1: 349. 1990; *non* Benth. Pl. Asiat. Rar. 2: 31. 1830.

Pogostemon purpurescens sensu Mandar & Lakshmin., Fl. Bhagwan Mahavir 197. 2013; *non* Dalzell, Hooker's J. Bot. Kew Gard. Misc. 2: 337. 1850.

= *Pogostemon pubescens* Benth. in DC., Prodr. 12: 152. 1848; Kesh. Murthy & S.N. Yogan. Fl. Coorg 362. 1990; B.D. Sharma et al., Fl. Karnataka 225.

1984; Manilal, Fl. Silent Valley 222. 1988; M. Mohanan & A.N. Henry, Fl. Thiruvanthapuram 372. 1994; K.M. Mathew, Fl. Palni Hills 1010. 1999. **Type**:—INDIA, Bombay, *Lawson M.A. s.n.* (holotype: K, K000480000, digital image!) ***syn. nov.***

= *Origanum indicum* Roth, Nov. Pl. Sp. 265. 1821.

= *Mentha integra* Buch. Ham. ex Benth. in Wall., Pl. Asiat. Rar. 1: 31. 1830.

= *Pogostemon frutescens* J. Graham, Cat. Pl. Bombay149. 1839.

= *Pogostemon purpuricaulis* Dalzell, Hooker's J. Bot. Kew Gard. Misc. 2: 336.1850.

= *Pogostemon indicus* (Roth) Kuntze, Um die Erde 500. 1881.

Suffruticose, erect herb or undershrub, 80–200 cm high; stem base 1–3 cm in diameter, profusely branching, branches 70–150 cm long, quadrangular, with older stem woody, glabrous, younger stem purple, pubescent to glabrescent; internodes 5–15 cm long. Leaves opposite deccusate, ovate, 8–22 × 6–18 cm, thin, cuneate at the base, acute to acuminate at apex, margin serrate to double serrate with 15–25 teeth, rarely entire, reticulately nerved, secondary veins 3–6, veins prominent beneath, lower surface slightly pubescent or glabrescent; petiole 3–6 cm long, glabrescent to pubescent. Inflorescence terminal and axillary many flowered congested spike, 6–15 cm long, dense above, lax below, 3–4 cm across; peduncle short, 0.5–2 cm long. Bracts prominent, ca. 6 × 3.5 cm, 3–4 numbers below a small bunch of 3–5 flowers; bracteoles linear thin and papery 1.6 × 0.25 mm, slightly pubescent, almost equaling calyx, acute to obtuse tip, outside glabrescent to pubescent, hairs white, margin non ciliate. Flowers numerous, 100–200, sessile. Calyx tubular, 5–6 mm long, narrow towards base and teeth, gradually broadened towards middle, glabrous inside; teeth 5, equal, linear to lanceolate, 3–4 mm long.

Corolla 7–8 mm long, tube 3–3.2 mm long, pale purple, straight, fully included in calyx; lips pubescent to glabrescent outside, glabrous inside; lower lip, ca. 2 mm long, trilobed, pale violet with dark purple shade inside, middle lobe project out from the lateral lobes at a length ca. 1.4 mm, 0.6 mm broad, ovate, lateral lobes slightly broader ca. 1.4 mm broad. Stamens 4, exerted, didynamous; filaments long, ca. 7 mm, middle with numerous monoliform hairs, violet coloured, hairs ca. 2.5 mm long; anterior pair basally villous on the filament, posterior pair glabrous; anthers white to pale violet ca. 0.4 mm across. Disc ca. 0.6 mm long. Style ca. 7 mm long, slender; stigma lobes equal, 1 mm. Nutlets 4, ca. 0.533 × 0.366 mm, oblong.

Phenology:—Flowering and fruiting occur during November to April.

Distribution:—Pakistan to Indo-China

Habitat and Ecology:—Prefers to grow in open forest floors and forest roadsides.

Specimen examined:—**Goa.** South Goa District: Dharbandore, 4 km before Kajumal, Molem, Panjim Belgaum road, 60 m, 18 August 2014, *Shinoj, Manudev & Vimal 138322* (CALI!); Anmod Checkpost, Goa Karnataka border, 18 August 2014, *Shinoj, Manudev & Vimal 138323* (CALI!). **Gujarat.** Dang District: Near Nandi tura river, 134 m, 17 September 2017, *Shinoj, Sharad & Manju 151062* (CALI!). **Karnataka.** Chamarajanagar District: Bandipur, Gopalaswamy hills, 29 Januaray 1965, *B.D. Naithani 23231* (MH!); Chikmagalur District: Bababudangiri (on the way to Mullayangiri), 16 February 2013, *Shinoj & Prasad M. G. 290180* (CALI!); Shimogha District: Kodachadri hill top near Sarvajnapeedam (shola-grassland borders), 20 January 2014, *Shinoj, Prasad & Vimal 135965* (CALI!); Sringeri, Kigga, Sirumane falls, (near forest road) 23 January 2015, *Shinoj, Shravan & Srinivas 138362* (CALI!). **Kerala.** Ernakulam District:

Edamalayar, Varium to Shoolamudi hill, 15 December 2016, *Shinoj, Manu Philip & Nikhil 151025* (CALI!); Idukki District: Munnar, Eravikulam near information centre, 22 February 1917, *S.D. Biju 34516* (TBGT!); Devikulam, 1550 m, 15 October 1963, *K.M. Sebastine 17575* (MH!); Devikulam, Lock heart gap, 1675 m, 23 January 1964, *K.M. Sebastine 18403* (MH!); Lower Vaguvarai, 1700 m, 26 April 1966, *B.V. Shetty 27389* (MH!); Sabarimala, Poongavanam, 650 m, 15 February 1981, *N.C. Nair 70216* (MH!); Thannikudi, Kumarikulam Sholai, 9 December 1981, *N.C. Nair 70165* (MH!); Rajamala, 2000 m, 26 December 1983, *A.G. Pandurangan 66497* (MH!); *ibid., Deepthi & Asha 72751* (TBGT!); Kannimalai Hills, 22 January 1990, *Fischer 1655* (FRC!); Mathikettanshola N.P., Vellapara, 19 December 2016, *Shinoj & Syam 151029* (CALI!); Devikulam (road side), 2 January 2014, *Shinoj & Vimal 135932* (CALI!); Kottayam District: Peermede, 1000 m, 24 January 1965, *K. Vivekanandan 22984* (MH!); Palakkad District: Attapadi hills, 4600', 29 January 1911 *Fischer 2509* (CAL!); Karasuryamalai, 1150 m, 5 March 1945, *E. Vajravelu 46193* (MH!); Siruvani, Muthukuzhi, 6 May 1961, *A.N. Henry 1394* (BLAT!); Valiyaparathode, 850 m, 15 January 1980, *N.C. Nair 65469* (MH!); Nelliampathy, 4 February 1996, *K. Radhakrishnan 28105* (TBGT!); Silent Valley N.P. Walakkad (near forest Campshed), 6 February 2014, *Shinoj & Vimal 135605* (CALI!); Nelliampathy, Minampara, 11 December 2016, *Shinoj 151019* (CALI!); Pathanamthitta District: Kakki dam area, 100 m, 22 March 1978, *C.N. Mohanan 54353* (MH!); Trivandrum District: Agasthyamala, on the way to Athirumala, 8 October 2014, *Shinoj, Prasad M.G. & Vimal 138327* (CALI!); Agasthyarkoodam way, 950 m, 3 March 1980, *M. Mohanan 66005* (MH!); Ponmudi, 950 m, 9 March 1980, *M. Mohanan 66627* (MH!); Meenmutty, 600 m, 14 February 1982, *C.N. Mohanan* (MH!); Attayar, 700 m, 4 February 1988, *N. Mohanan 8912* (TBGT!); Athirumala, 1000 m, 30 March 1989, *N. Mohanan 7900* (TBGT!); Bonacaud, 2 March 1996, *Dhavan T. 27990* (TBGT!); Chemunji, 500 m, 15

February 1996, *N. Mohanan 10314* (TBGT!); Ponmudi Hill top, near guest house junction, 6 October 2014, *Shinoj, Prasad M.G. & Vimal 138326* (CALI!); Wayanad District: Sulthan bathery, 950 m, 8 February 1964, *J.L. Ellis 18604* (MH!); Chandanathode, 1000 m, 17 April 1966, *J.L. Ellis 27096* (MH!); Periya, 750 m, 13^{th} February 1978, *V.S. Ramachandran 53937* (MH!); Muthanga forest, Aimangalam (grassland forest border), 8 July 2015, *Shinoj & Manu Philip 138364* (CALI!); Periya 36, on the way to Gurukula Sanctuary (road side), 14 September 2015, *Shinoj, Smitha & Soumya 138380* (CALI!); Chembra, shola near Love lake, 1360 m, 15 October 2015, *Shinoj & Manjula 138393* (CALI!); in shola near love lake, 1394 m, 30 December 2015, *Shinoj & Soumya 145411* (CALI!); Kurichermala, 31 December 2015, *Shinoj & Drisya 145413* (CALI!); Vythiri, Mandhanmala, near Navodaya School, 15 January 2017, *Shinoj & Jeomol 151042* (CALI!). **Maharashtra.** Kolhapur District: Panhala, 8 November 2016, *Shinoj 151091*(CALI!); Nashik District: Brahmagiri, 1005 m, 16 September 2017, *Shinoj, Sharad & Manju 151048* (CALI!); Burgav hill, 1015 m, 17 September 2017, *Shinoj, Sharad & Manju 151063* (CALI!); Palghar District: Thungareswar, 11 January 1962, *N.Y. Das 5524* (BLAT!); Pune District: Khandala, 17 April 1904, *H. Santapau 24043* (BLAT!); *ibid.,* 19 May 1917, *H. Santapau 23530* (BLAT!); Purandhar, Vazirgadh fort, 24 December 1945, *H. Santapau 8228* (BLAT!); 2 km before Lavasa, 972 m, 21 September 2017, *Shinoj, Sharad & Manju 151066* (CALI!); Raigad District: Matheran, Jummapatti, near railway line, 20 December 1958, *N.A. Irani 2784* (BLAT!); Satara district: Pratapgad fort, 23 December 1962, *G.L. Shah 10622* (BLAT!); Mahabaleswar, near Krishna and Lakshmi temple, 1275 m, 10 November 2016, *Shinoj 150911* (CALI!); on the way to Mahabaleswar, 11 November 2016, *Shinoj 150918* (CALI!); Satara, 11 November 2016, *Shinoj 150912* (CALI!); Sindhudurg District: Phonda ghat to Dhajipur, 22 June 1965, *R.D. Pataskar 105313* (BSI!); Chafeli, Pulas jungle, 12 February 1970, *B.G. Kulkarni 120036*

(BSI!); Amboli Ghat 12 November 2016, 554 m, *Shinoj 150908* (CALI!); Thane District: Murbad range, Kunda Reserve forest, 7 June 1967, *R. Sundhari Raghavan 110809* (BSI!). **Tamil Nadu.** Coimbatore District: Poonachi, Anamalais, 13 April 1908, *S.R. Raju 20237* (MH!); Kollegal, Poonachi betta, 8 February 1930, *V. Narayanaswami 19641* (MH!); Ainigiri betta, Geddesal, 15 March 1931, *K. Cherian Jacob 361* (MH!); Velliyangiri hills, 22 February 1932, *S.R. Raju & Ratnavelu 243* (MH!); Valparai, 2 March 1942, *S.R. Raju 20327* (MH!); Siruvani, 1033 m, 18 December 1956, *K. Subramanyam 1783* (MH!); way to Valparai, 933 m, 15 March 1960, *K. Subramanyam 10209* (MH!); Akkamalai, 1575 m, 23 January 1962, *J. Joseph 13753* (MH!); Andipara shola, 1333 m, 24 March 1969, *R. Maruthan 31766* (MH!); Kanyakumari district: Mahendragiri, on the way to peak, 1275 m, 8 February 1972, *B.D. Sharma 40047* (MH!); Muthukkuzhivayal, 16 February 1983, *R. Gopalan 77025* (CAL!); Mahendragiri, 28 February 1989, *N. Mohanan 7900* (TBGT!); Madurai District: Aruna estate, 1500 m, 28 April 1960, *B.V. Shetty 10337* (MH!); Kodaikanal ghat, 1600 m, 21 February 1978, *M. Chandrabose 54224* (MH!); Bodimettu, 1400 m, 30 December 1984, *K. Ravikumar 2017* (MH!); Nilgiri District: Kotagiri Aravenu, 2000 m, 4 January 1957, *K. Subramanyam 1892* (MH!); Runnymede forest 1666 m, 22 March 1957, *K.M. Sebastine 2550* (MH!); Runneymede, 1350 m, 30 April 1971, *N.C. Rathakrishnan 38146* (MH!); Naduvattam, 1825 m, 28 November 1971, *N.C. Rathakrishnan 39046* (MH!); Devala Nadugani forest, 875 m, 22 February 1973, E. *Vajravelu 43664* (MH!); Tirunelveli District: Naterikal to Sengelteri, 7 March 1917, *s.coll. 145438* (MH!).

Conservation status:—Least concern. This is a wide spread species. In Western Ghats we were able to collect specimens from many localities. Wherever we met this species, it was showing dense vegetation with more than 200 populations.

Notes:—This is a highly variable species particularly on its leaf and inflorescence characters. We have worked out the morphology of more than 20 accessions. Even though they exhibit difference in leaf and inflorescence nature, the floral characters remains the same. We could not come across any population of the similar plants with corolla size ca. 5 mm to consider it as *P. pubescens* during the long span of our research. Many collections examined in different herbaria and the specimens annotated as *P. pubescens* in many floristic works in the recent years is nothing but *P. benghalensis* with minor variations. This plant is allied to *P. plectrantoides*, but differs from it in possessing less congested spike, smaller bract, flower, calyx, narrow corolla tube and narrow median teeth of the upper corolla lip.

4. *Pogostemon cruciatus* Kuntze., Revis. Gen. Pl. 2: 530. 1891.

= *Dysophylla cruciata* Benth. in Wall., Pl. Asiat. Rar. 1: 30. 1830; Prain, Bengal Pl. 2: 849, 1981; Bhatti & Ingr., Bull. Nat. Hist. Mus. 27(2): 113. 1997. **(Plate 13, 14 & 51A)**

≡ *Anuragia cruciata* (Benth.) Raizada, Suppl. Duthie's Fl. Upper Gangetic Plain: 218. 1976.

≡ *Eusteralis cruciata* (Benth.) Panigrahi, Phytologia 32: 478. 1976; B.D. Sharma et al., Fl. Karnataka 219. 1984.

Type:—Nepal, *Wallich 1541* (lectotype: K, K000848012, digital image!).

Annual erect herb, stem 30–60 cm high, fleshy, stem base 0.5–0.8 cm in diameter, branches 20–30 cm long, terete, rigid; internodes 3–8 cm long. Leaves whorled, normally 4–5 at each node, linear to lanceolate, 4–8 × 0.5–1 cm, base cuneate or truncate, apex acute to acuminate, margin entire, revolute, mid vein prominent beneath, hirsute above, pubescent below; petiole absent. Inflorescence terminal, congested spike, 5–10 cm long, dense towards apex, lax below, 1–1.5 cm across, many flowered; peduncle short 3–5 cm long.

Bracteoles ovate to spatulate, 2–2.5 × 0.5–0.6 mm, base cuneate, apex acute to acuminate, margin ciliate, villous. Flowers numerous, 80–120 per inflorescence, 5–7 mm long, sessile. Calyx companulate, 1–1.2 × 0.8–1 mm in flower and fruit, glabrous inside, teeth 5; equal 0.25–0.4 × 0.2–0.4 mm, villous. Corolla 2.5–3 mm long, tube 2–2.2 mm long, straight and half included in calyx, pale violet, pilose outside; upper lip three lobed, apex acute, lateral lobes 0.4–0.5 × 0.4–0.5 mm, median lobe 0.5–0.6 × 0.5–0.7 mm; lower lip single lobed, triangular, 0.5–0.7 × 0.6–0.8 mm. Stamens 4, exerted, filaments exerted at equal length, 4.5–4.7 mm long, numerous hairs at middle; anthers 0.41–0.44 mm across. Disc ca. 0.2 mm long. Style 5–6 mm long, slender; stigma lobes equal, 1–1.3 mm long. Nutlets 4, ca. 0.6 mm × 0.4 mm, oblong, brown, smooth.

Phenology:—Flowering and fruiting occurs during November to March.

Distribution:—India to Nepal

Habitat and Ecology:—It is mostly found in marshy damp areas inside evergreen or semi evergreen forests.

Specimen examined:—**Kerala.** Wayanad District: Sultan Bathery, Valluvady forest, 21 January 2016, *Shinoj* & *Sunoj 145429* (CALI!).

Conservation status:—As per the literature survey and herbarium reference this species can be considered as rare in South India. In Western Ghats the plant was collected only from a single locality, the Valluvady forest, near Sultan Bathery of Wayanad district of Kerala in India.

Notes:—This taxon shows similarity to *Pogostemon stellatus* which is a submerged species, with fleshy habit and shorter congested inflorescence. It resembles a robust form of *P. deccanensis* but with fewer leaves.

5. Pogostemon deccanensis (Panigrahi) Press., Bull. Br. Mus. Nat. Hist. (Bot.) 10: 73. 1982; *Eusteralis malabarica* B.G. Kulkarni, Fl. Sindhudurg 354. 1988; S. Deshpande et al., Fl. Mahabaleshwar 483. 1995; Bhatti & Ingr., Bull. Nat. Hist. Mus. 27(2): 118. 1997; S.R. Yadav & M.M. Sardesai, Fl. Kolhapur Dist. 384. 2002. **(Plate 15, 16 & 51 B)**

= *Eusteralis deccanensis* Panigrahi, Phytologia 32: 465. 1976; Manilal & Sivar., Fl. Calicut 240. 1982; Sunil, Fl. Alappuzha Dist. 576. 2009; N.P. Singh et al., Fl. Maharashtra Dicot 2: 752. 2001.

≡ *Dysophylla tomentosa* Dalzell, Hooker's J. Bot. 2: 337. 1850; Hook. f., Fl. Brit. India 4: 641. 1885; B.D. Sharma et al., Fl. Karnataka 220. 1984; S.M. Almeida, Fl. Sawantwadi 1: 343. 1990.

≡ *Eusteralis tomentosa* (Dalzell) Panigrahi , Phytologia 32: 477. 1976; S.C. Majumdar, J. Bombay Nat. Hist. Soc. 74: 385. 1978; B.G. Kulkarni, Fl. Sindhudurg 355. 1988; Kesh. Murthy & S.N. Yogan., Fl. Coorg 353. 1990.

≡ *Dysophylla stellata* Benth. in Wall., Pl. Asiat. Rar. 1: 30. 1830 *pro parte,* include descript., exclude type and synonym; T. Cooke, Fl. Bombay 540. 1906; B.D. Sharma, Fl. Nilgiri Dist. 227. 1975; S. Deshpande et al., Fl. Mahabaleshwar 485. 1995; Bhatti & Ingr., Bull. Nat. Hist. Mus. 27(2): 117. 1997; N.P. Singh et al., Fl. Maharashtra Dicot 2: 754. 2001.**Type**:—INDIA, Kerala, Malabar, *Wallich 1542-1* (labelled *Mentha malabarica* Herb. Heyne) (holotype: K, barcode no, digital image!)

≡ *Pogostemon erectus* (Dalzell) Kuntze, Revis. Gen. Pl. 2: 530. 1891; ***syn. nov.***

≡ *Eusteralis gracilis* (Dalzell) Panigrahi, Phytologia 32: 476. 1976; B.G. Kulkarni, Fl. Sindhudurg 350. 1988. **Type**:—INDIA, Bombay, *Dalzell s.n.* (holotype: K, K001113399, digital image!).

Annual erect or procumbent herb, stem 8–20 cm high, thin, fleshy, stem base 0.2–0.3 cm in diameter, branches 5–10 cm long, terete; internodes 0.4–0.6 cm long. Leaves whorled, normally 6–12 at each node; lamina linear to lanceolate, 8–12 × 1.1–1.4 mm, base cuneate, apex acute to acuminate, margin entire, revolute, mid vein prominent beneath, hisute above, pubescent beneath; petiole absent. Inflorescence terminal congested spikes, 2–6 cm long, dense flowered, 0.8–1.2 cm across; peduncle short 0.4–0.6 cm long. Bracteoles ovate to spatulate, 2–2.5 × 0.3–0.4 mm, base cuneate, apex acute to acuminate, margin ciliate, villous. Flowers numerous, 40–80 in an inflorescence, 4–5 mm long, sessile. Calyx companulate, 1.4–1.8 × 1–1.5 mm in flower and fruit, glabrous inside; teeth 5; equal, 0.4–0.6 × 0.4–0.5 mm, villous. Corolla 1.5–1.8 mm long; tube 1–1.2 mm long, straight, half included in calyx, pale violet, pilose outside; upper lip three lobed, apex acute, lateral lobes 0.4–0.5 × 0.4– 0.5 mm, median lobe 0.5–0.6 × 0.5– 0.6 mm; lower lip single lobed, triangular, 0.5–0.7 × 0.6–0.8 mm. Stamens 4, exerted, filaments exerted, equal, 2.5–2.9 mm long, with numerous hairs at middle; anthers 0.20–0.25 mm across. Disc ca. 0.2 mm long. Style 3.5–4 mm long, slender; stigma lobes equal, 0.6–0.7 mm long. Nutlets 4, ca. 0.5 × 0.45 mm, orbicular, brown, smooth to reticulate.

Phenology:—Flowering and fruiting occurs during November to March.

Distribution:— Endemic to Peninsular India, mainly in Western ghats.

Habitat and Ecology:—It is mostly found in marshy damp areas.

Specimen examined:—**Maharashtra.** Kolhapur District: Chaukul, Amboli to Misapur road, near temple, 730 m, 14 September 2017, *Shinoj, Soumya & Manju 151047* (CALI!); Azhur amboli road, 13 km before Amboli, 11 November 2016, *Shinoj 150907* (CALI!); Amboli Ghat, starting of ghat, 12 November 2016, 38 m, *Shinoj 150909* (CALI!); Nashik District: Brahmagiri, 1005 m, 16 September 2017, *Shinoj, Sharad & Manju 151049* (CALI!); Mulshi, Shindevadi paud road, on the way to Mulshi, 21 September 2017, *Shinoj, Sharad & Manju 151067* (CALI!). **Karnataka**. Kodagu District: Coorg, Kumarahelle village, Somwarpete range, 17 February 1984, *E. Vajravela 77787* (MH!); Uttara Kannada District, Sullia, October 1900, *s.coll. 2167* (MH!); Pilicode, 11 November 1917, *s.coll. 15347* (MH!); Naravi, ~300 m, 19 November 1927, *S.R. Raju & Naganatha 18107* (MH!); Uttara Kannada District: Beltangadi, 25 November 1900, *s.coll. 2528* (MH!); Karkal, 17 March 1915, *s.coll. 11982* (MH!). **Kerala.** Kannur District: Kannoth, 28 October 1945, *T. Gopal Rao 88261* (MH!); Cannanore, Arunapparai, ±775 m, 9 February 1978, *V.S. Ramachandra 53821* (MH!); Brahmagiri, ±900 m, 6 March 1979, *V.S. Ramachandra 62087* (MH!); Pilathara, 100 m, 8 October 1979, Muzhapplangadi, ±50 m, 13 December 1979, *V. S. Ramachandra 64081* (MH!); *R. Ansari 64805* (MH!); Thaliparamba farm, Malabar, 15 February 1993, *s.coll. 8743* (MH!); Kasargod District: Kasaragod, 13 December 1931, *Narayana 6348* (MH!); Palakkad District: Kanjikode, September 1984, *s.coll. s.n* (MH!); Thaliparamb (in paddy fields near Sir Syed College), 12 January 2013, *Shinoj & Manish 290175* (CALI!); Urathur (in marshy areas), 28 November 2013, *Shinoj & Manudev 135591* (CALI!); Moyyam, near Sir Zyed College, 27 December 2015, *Shinoj 145408* (CALI!).

Conservation status:—Widespread in Western Ghats with plenty of populations, hence we treat it under Least Concern (LC) category of IUCN.

Notes:—This is a highly variable species. Both vegetative and reproduction stages show variation in most characters. But the variations noticed were continous and cannot be considered as valid for species circumscription.

6. Pogostemon gardneri Hook.f., Fl. Brit. India 4: 632, 1885; Rama Rao, Fl. Pl. Travancore 323. 1914; Gamble, Fl. Madras 2: 1133. 1924; B.D. Sharma, Fl. Nilgiri Dist. 232. 1975; Henry et al., Fl. Tamil Nadu 2: 184. 1984;

Manilal, Fl. Silent Valley 222. 1988; Bhatti & Ingr., Bull. Nat. Hist. Mus. 27(2): 91. 1997. **Type (designated here)**:— INDIA, Nilgiris, Sisspara, *Wight 2122* (lectotype: K, K000479999, digital image!) **(Plate 17, 18 & 49 B)**

Annual erect undershrub or shrub, 100–150 cm high; stem base 1–2.5 cm in diameter, profusely branching, branches 80–120 cm long, reddish brown, zig zag due to sympodial growth, terete to quadrangular, hispid, hairs upwardly directed, present more towards younger part; hairs 3–4 celled; internodes 6–13 cm long. Leaves opposite deccusate, with one larger leaves on the alternate sides, the latter one of each pair slightly smaller; lamina ovate, 5–10 × 4–8 cm, cartaceous, base acute to slightly cuneate, apex acute to acuminate, margin serrate to inciso-crenate with 6–7 major teeth, reticulately nerved, secondary veins 4–5, veins prominent beneath, lower surface hispid to pannose; petiole 3–5 cm long, pubescent to hispid. Inflorescence a terminal congested spike with two lateral spikes, rarely axillary towards branch tip, 7–12 cm long, dense flowered above, lax below, 2–3 cm across; peduncles short, 1.5–2.5 cm long. Bracts leafy, ca. 1.5 × 1 cm, bracteoles ovate, 3.5–4 × 1.7–2 mm, slightly villous, almost equaling the calyx, base obtuse to round, margin ciliate, tip acute. Flowers numerous per inflorescence, 8–9 mm long, sessile. Calyx tubular to companulate, 4.8–5.2 mm long in flower and fruit, narrow towards base, slightly inflated towards teeth, greenish purple, villous outside more towards teeth, glabrous inside; teeth 5, triangular, 1.7–2 × 0.8–1 mm, equal, villous outside, margin ciliate. Corolla 6–7 mm long, tube 4.8–5.2 mm long, straight and fully included in calyx, pale purple; lobes pubescent to hispid outside, glabrous inside; upper lip ca. 1.2 mm long, trilobed, pale violet; middle equals the length of lateral lobes ca. 0.6 mm long, 0.6 mm broad, dome shaped, lateral lobes slightly broader ca. 0.6 × 1.2 mm; lower teeth with single lobe, 1.2 × 1 mm. Stamens 4, exerted; filaments ca. 6 mm long, monoliform hairs at middle, violet, numerous, ca. 2mm long, glabrous towards base; anthers white to pale violet ca. 0.5 mm across. Disc 1.4 × 1 mm. Style ca. 6 mm long, slender; stigma lobes equal, ca. 1.2 mm long. Nutlets 4, ca. 0.67 × 0.86 mm, disc shaped.

Phenology:—Flowering and fruiting occurs during November to February.

Distribution:—Endemic to Western Ghats.

Habitat and Ecology:—It prefers to grow in open forest floors of evergreen forests.

Specimen examined:—**Karnataka.** Shimogha District: Agumbe ghat (near 15th hairpin curve), 610 m, 17 October 2014*, Shinoj, Satheesh & Prasad M.G. 138336* (CALI!). **Kerala.** Trivandrum District: Bonacaud, Agasthyamala, on the way to Pongalapara, 7 October 2014, *Shinoj, Prasad M.G. & Vimal 138331* (CALI!); Bonacaud, Agasthyamala, on the way to Athirumala, 8 October 2014, *Shinoj, Prasad M.G. & Vimal 138328* (CALI!); Wayanad District: 900 Acre forest, 1 August 2013*, Shinoj & Prasad M.G. 135505* (CALI!); Kurichermala, 31 December 2015, *Shinoj & Drisya 145412* (CALI!). **Tamil Nadu.** Coimbatore District: Anamali Hills, Valpara, Iyarpadi shola, 1500 m, 26 January 2007, *R. Murugan 20* (FRLH!); Tirunelveli District: Kallivayilpil, 900 m, 7 July 1964, *A.N. Henry 19810* (MH!).

Conservation status:—This species is distributed mainly in Kerala and Karnataka. We were able to met more than 100 population during our field trips in Agasthyamala and Shimogha. Both these are protected areas and abundant growth of many population were noticed. Hence we treat it as Least concern.

Note:—This taxon is very close to *Pogostemon purpurascens* Dalzell, but differs from it in possessing stout shrubby habit, broader calyx and calyx teeth, hispid body parts, pale purple corolla, incompletely opened corolla lobes, bracteole structure and lax subsecund inflorescence.

7. Pogostemon heyneanus Benth. in Wall., Pl. Asiat. Rar. 1: 31. 1830; H. Trimen, A Hanb. Fl. Ceylon 3: 378. 1895; B.D. Sharma et al., Fl. Karnataka 224. 1984; S.M. Almeida, Fl. Sawantwadi 1: 349. 1990; Dan H. Nicolson et al., Fl. Dominica 2: 125. 1991; M. Mohanan & A.N. Henry, Fl. Thiruvanthapuram 371. 1994; Sivar. & P. Mathew, Fl. Nilambur 552. 1996; Bhatti & Ingr., Bull. Nat. Hist. Mus. 27(2): 94. 1997; K.G. Bhat, Fl. Udupi 519. 2003; K.N Subramanian, Fl. Thenmalai 49. 2014. **Type (designated here):—** INDIA, *Heyne 1532* (lectotype: K, K000509678, digital image!)

(Plate 19, 20 & 49 C)

Annual erect herb 60–100 cm high; stem base 0.5–1.5 cm in diameter, profusely branching, branches 40–80 cm long, brownish, quadrangular, with glabrous to glabrescent stem, internodes 6–12 cm long. Leaves opposite deccusate; ovate to elliptic, 6–10 × 4–10 cm, thin, base cuneate to rarely truncate, apex acute, margin serrate to double serrate or crenate with 10–15 major teeth, reticulately nerved, secondary veins 3–4, veins prominent beneath, lower surface glabrous to glabrescent; petiole 5–8 cm long, glabrescent. Inflorescence terminal branched raceme with two or more branches, 7–12 cm long, lax, 1–2.5 cm across, many flowered; pedicels short, 1.5–3 cm long. Bracts leafy, ca. 7–8 × 4–5 mm, bracteoles ovate, 2.8–3 × 1.4–1.8 mm, glabrascent, slightly smaller than calyx, tip acute, margin ciliate. Flowers numerous, 40–80 in an inflorescence, 5.5–6.2 mm long, sessile. Calyx tubular, 4–4.2 mm long both in flower and fruit, narrow, glabrous inside; teeth 5, triangular, ca. 1 × 0.6 mm long, equal, pubescent with scattered long hairs towards the tip, intermingled with white transparent sessile glands scattered over outer surface. Corolla 4.5–5.5 mm long, tube 2.5–3.2 mm long, straight and fully included in calyx, pale purple to white; teeth pubescent to slightly villous outside, glabrous inside; upper lip, 2–2.3 mm long, trilobed, pale violet with light purple to wheatish shade inside;

middle lobe 1–1.3 mm long, 0.7–0.9 mm broad, lateral lobes 0.8–1 mm long, 0.8–1 mm broad; lower lip with single lobe, 0.8–1 mm long, 1–1.2 mm broad. Stamens 4, exerted, didynamous; upper pair ca. 4 mm long, lower ca. 4.5 mm, filaments with numerous white to pale violet monoliform hairs at middle, ca. 1.2 mm long; anthers white to pale violet ca. 0.4 mm across. Disc ca. 6mm long. Style ca. 5 mm long, stigma lobes equal, ca. 0.5 mm long. Nutlets 4, ca. 0.5 × 0.4 mm, orbicular.

Phenology:—Flowering and fruiting occur during November to April.

Distribution:—Wide spread in South Asia, mainly in India, Srilanka, Indonesia etc.

Habitat and Ecology:—It is mainly found near open areas in evergreen forest in moist places.

Specimen examined:—Karnataka. Dakshina Kannada District: Sampagi, 7 November 1900, *C.A. Barber 2218* (MH!); Naravi, 300 m, 21 November 1927, *S.R. Raju 18149* (MH!); Subramanyam, 500’, 3 December 1927, *S.R. Raju 18263* (MH!); Shimogha District: Agumbe (near forest checkpost), 620 m, 17 October 2014, *Shinoj, Satheesh & Prasad M.G. 138338* (CALI!); Hulikkal ghat (5–10 km before Chandikamba temple), 18 October 2014, *Shinoj, Satheesh & Prasad M.G. 138344* (CALI!); Jog falls (road side near view point) 472 m, 22 January 2015, *Shinoj, Shravan & Srinivas 138354* (CALI!); Uttara Kannada District: Mastani, 25 November 1950, *J. Fernandez 1886* (BLAT!). **Kerala.** Kannur District: Chandanathode, 800 m, 31 October 1965, *J.L. Ellis 25791* (MH!); Chandanathode, Theethundamalai, 740 m, 4 December 1967, *J.L. Ellis 25791* (MH!); Kottiyur, 550 m, 22 January 1979, *V.J. Nair & R. Ansari 59786* (MH!); Ambayathode, 525 m, 22 January 1979, *V.S. Ramachandran 59097* (MH!); Kollam District: Plapalli, Chalakayam, 375 m, 26 November 1976, *M. Chandrabose 49200* (MH!); Kollam, *Deepthy*

& *Geetha 52954* (TBGT!); Palakkad District: Mukkali forest, 575 m, 26 November 1973, *E. Vajravelu 44832* (MH!); Thiruvananthapuram District: Attayar, 700 m, 9 February 1988, *N. Mohanan 9587* (TBGT!); Adiparamb, 9 January 1992, *A. Nazarudeen 13622* (TBGT!); *ibid.,* 30 November 1992, *E.S. Santhoshkumar & Abdul Jabbar 14781* (TBGT!); Kurusumalai, 725 m, 23 August 1975, *J. Joseph 46499* (MH!); Pattampara, 575 m, 17 March 1978, *M. Mohanan 54695* (MH!); Wayanad District: Vallapoil to Chandanathode, 600 m, 14 November 1981, *S. R. Srinivasan 72369* (MH!); Periya, Gurukula Sanctuary, 7 December 2016, *Shinoj & Manu Philip 151011* (CALI!). **Maharashtra.** Satara District: Mahabaleswar, 18 June 1958, *P.V. Bole 1590* (BLAT!). **Tamil Nadu.** Salem District: Palakkode, near Krishnagiri, 29 November 1940, *K.C. Jacob 20106* (MH!); Tirunelveli District: Upper Kodayar, way to Manjolai, 1066 m, 17 October 1957, *K.M. Sebastine 4517* (MH!); Courtallam, Therkumalai, 667 m, 19 December 1957, *K. Subramanyam 5013* (MH!).

Conservation status:—During our exploration in Western Ghats we were able to collect specimens from Hulihhal Ghat region and near Jog fall waterfalls of Karnataka state, were we found a dense vegetation. Literature review and herbarium reference indicates that it is a wide spread species in South Asia. So we treat it as Least concern (LC) under IUCN category.

Note:—This taxon is a very distinct species which can be easily identified from the rest of the species found in Western Ghats. It shows similarity to *Pogostemon paludosus* Benth., but differs from it in possessing larger, branched habit, larger leaves, calyx and corolla nature etc. Similarity between the two species lies mainly in inflorescence and leaf nature.

8. *Pogostemon hedgei* V.S. Kumar & B.D. Sharma, Nord. J. Bot. 15: 163–166. 1995. **Type**:—INDIA, Tamil Nadu, Kanniyakumari District, Muthukuzhivayal way, 1 February 1978, *A.N. Henry 53351A* (holotype: MH, MH00000919, digital image!). **(Plate 21, 22 & 52 E)**

=*Pogostemon raghavendranii* R. Murugan & Livingst., Rheedea 20: 21. 2010. **Type**:—INDIA, Tamil Nadu, Coimbatore District, Valparai, Akkamalai shola, 27 January 2007, *R. Murugan 22* (holotype: CAL, digital image!; isotype MH, digital image!).) ***syn. nov.***

Scandent shrub, 80–130 cm high; stem base 1–3 cm in diameter, profusely branching, branches 60–90 cm long, obtusely quadrangular, rigid, hirsute with 0.8–1.5 mm long white hairs, internodes 4–8 cm long. Leaves opposite decussate; ovate to sub orbicular, 4–8 × 3–6 cm, sub membraneous to chartaceous, base cordate, apex acute, margin double or multicrenate to double serrate with 12–20 teeth, reticulately nerved, secondary veins 4–6, veins prominent beneath, lower surface slightly pubescent, hirsute on veins; petiole 4–7 cm long, pubescent. Inflorescence terminal racemes, 5–15 cm long, dense above lax below, 2.5–3.5 cm across, many flowered; peduncle short, 1–3 cm long. Bracts leafy 1–1.2 cm long, ovate, bracteoles linear 2.2–2.4 × 0.3–0.4 mm, shorter than calyx, obtuse tip, hirsute with white hairs outside, margin ciliate. Flowers numerous, 100–150 in an inflorescence, pedicelate. Calyx companulate, 6.2–6.6 × 2.3–2.5 mm long in flower and fruit, narrow towards both ends, gradually broadened towards middle, glabrous to hirsute throat; teeth 5, linear to lanceolate, 2.2–2.6 mm long, lower two teeths little longer than the upper teeth and the tips remain bent upwards, ciliate. Corolla 8–9 mm long, tube 3.8–4.2 mm long, straight and fully included in calyx, yellow to green; teeth pubescent to hirsute outside, glabrous inside; lower lip, 2.4–2.6 mm long, single lobed, yellow to greenish yellow; upper lip trilobed; middle lobe of upperlip 0.4–0.6 × 1.8–2 mm semicircular, lateral lobes slightly broader 2.5–2.7 mm broad with white hairs outside. Stamens 4, exerted, didynamous, filaments long, 10–12 mm, anterior two basally villous, posterior two glabrous, pale yellow to white; anthers pale yellow or straw coloured ca. 0.75 × 0.84 mm. Disc 0.92–0.95 × 0.98–1 mm long. Style 10–13 mm long, slender; stigma lobes equal, 1.2–1.4 mm long. Nutlets 4, ca. 0.34 × 0.37 mm, suborbicular, rounded at the apex, glands and hairs present at apex.

Phenology:—Flowering and fruiting occurs during December to February.

Distribution:—Endemic to southern Western Ghats, so far reported only from Kerala and Tamil Nadu.

Habitat and Ecology:—It prefers to grow in shola grassland borders above 1200 m.

Specimen examined:—**Kerala.** Iduki District: Umayamala, Devicolam, 2175 m, 19 April 1966, *B.V. Shetty* 27329 (MH!); Anamudi slopes, Rajamala side, 2200 m, 6 February 1970, *B.V. Shetty* 33425 (MH!); Mathikettan shola N.P., Periya 36, 1 January 2015, *Shinoj & Syam 138349* (CALI!); Wayanad District: Periya 36, Gurukula Sanctuary, 14 September 2015, *Shinoj, Smitha & Soumya 138379* (CALI!). **Tamil Nadu.** Coimbatore District: Akkamalai, 1675 m, 18 February 1980, *M. Chandrabose 65849* (MH!); Valparai, 2000 m 27 January 2007, *Ravikumar & Livingstone 22* (FRLH!).

Conservation status:—During our exploration in Western Ghats we were able to collect few specimens from Mathikettan Shola National Park in Idukki district of Kerala, where a very few population of less than 20 mature plants were found. The type locality of this species is in Tamil Nadu and in the holotype the collector A.N. Henry (1978) described it as common in Muthukuzhivayal above 1200 m. The distance between two places is more than 200 km, which indicates that the area of occupancy is more than 20,000 km^2. A thorough reference in major herbaria of South India and from relevant literature it is identified that only a few specimens are collected so far. Hence we treat this species under NT category under IUCN status.

Note:—This plant shows similarities to *Pogostemon travancoricus* and *P. peethapushpum* but differs from both in calyx characters and in the nature of inflorescence from the latter.

9. Pogostemon mollis Benth., Labiat. Gen. Spec. 155. 1833; Benth. in DC., Prodr. 12: 154. 1848; Hook. f., Fl. Brit. India 4: 635. 1885; Rama Rao, Fl. Pl. Travancore 324. 1914; Gamble, Fl. Pres. Madras 2: 1134. 1924; Fyson, Fl. S. Ind. Hill Sta. 2: 471. 1932; B.D. Sharma, Fl. Nilgiri Dist. 233. 1975; C.J. Saldanha, Fl. Hassan Dist. 507. 1978; B.D. Sharma et al., Fl. Karnataka 224. 1984; Henry et al., Fl. Tamil Nadu 2: 184. 1984; Manilal, Fl. Silent Valley 222. 1988; Vajr. Fl. Palghat Dist., 382. 1990; M. Mohanan & A.N. Henry, Fl. Thiruvanthapuram 371. 1994; Bhatti & Ingr., Bull. Nat. Hist. Mus. 27(2): 99. 1997; K.M. Mathew, Fl. Palni Hills 1010. 1999; N.P. Singh et al., Fl. Maharashtra 2: 755. 2001. **Type (designated here)**:—INDIA, *Wight 2124* (lectotype: K, K000509676, digital image!). **(Plate 23, 24 & 52 A)**

= *Pogostemon rajendranii* R. Sasi & R. Sivalingam, Asian J. Pl. Sci. Res. 2(4): 515. 2012. **Type**:—INDIA, Tamil Nadu, Nilgiri District, Talaikundha, 2600 m, December 2011, *R. Sasi & R. Sivalingam 006159* (holotype: MH, digital image!; isotype: BUH, digital image!) ***syn. nov.***

Annual erect herb or undershrub, 30–50 cm high; stem base 0.5–1 cm in diameter, profusely branching, branches 20–40 cm long, quadrangular to terete when mature, rigid, pubescent; internodes 3–8 cm long. Leaves opposite deccusate, ovate, 3–5 × 2–3 cm, thick, coriaceous, base obtuse or rounded, apex obtuse, margin serrate to double serrate with 9–12 teeth, reticulately nerved, secondary veins 3–5, veins prominent beneath, lower surface hoary tomentose; petiole 1–1.8 cm long, pubescent. Inflorescence terminal congested spike, 3–9 cm long, dense above lax below, 1.5–2 cm across, many flowered; pedicels short, 0.5–1 cm long. Bracts leafy; bracteoles, 4–4.2 × 1–1.2 mm, slightly villous, almost equaling the size of calyx, acute tip, margin ciliate. Flowers numerous, 60–120 in an inflorescence, 7–9 mm long, sessile. Calyx ovate, 2.5–4 × 1.4– 1.6 mm long in flower and fruit, glabrous inside; teeth 5, equal, 0.8–1 × 0.5–0.6 mm Corolla 5–5.5 mm long, tube 2–2.5 mm long, straight and fully included in calyx, white; lobes pubescent to villous outside, glabrous inside; upper lip three lobed, apex round or ovate, 1.3–1.5 × 0.7– 8 mm, lobes equal, villous outside; lower lip single lobed, triangular, 1.8–2 × 1.5–1.8 mm, hairs 5–6 celled, scattered outside. Stamens 4, exerted, didynamous; upper pair 4.5–4.7 mm long, lower pair ca. 4.2–4.4 mm long, with numerous white coloured monoliform hairs at middle, hairs 1.5 mm long; upper two basally villous, lower two basally glabrous; anthers white to pale violet 0.3–0.4 mm across. Disc 0.25–0.26 mm long. Style 5.5–6 mm long, slender; stigma lobes equal, ca. 1.3 mm long. Nutlets 4, 0.25 × 0.20 mm, obovate to orbicular.

Phenology:—Flowering and fruiting were observed during September to March.

Distribution:—Endemic to South India. Mainly distributed in Kerala and Tamil Nadu above 1000 m.

Habitat and Ecology:—It grows on rock surfaces and lateritic wall cuttings. Mostly found intermingled with grasses of hill tops.

Specimens examined:—Karnataka. Chikmagalur District: Bababudangiri (on the way to Mullayangiri), 16 February 2013, *Shinoj & Prasad M.G. 290179* (CALI!); Kodaku District: Coorg, Talacauveri, 27 October 2016, *Shinoj & Geethika 151004* (CALI!). **Kerala.** Idukki district: Mathikettan

Shola N.P., Choondal, near campshed, 4 November 2015, *Shinoj, Smitha & Syam 145402* (CALI!); Eravikulam to Marayur road 5 mile, 5 November 2015, *Shinoj & Smitha 14505* (CALI!); Palakkad District: Dhoni forest, on the way to Palamala from Korakkallu, 27 September 2013*, Shinoj & Vimal 135552* (CALI!); Nelliampathy, on the way to minampara, 24 June 2014, *Shinoj, Prasad M.G. & Vimal 138318* (CALI!); Minampara, 11 December 2016, *Shinoj 151017* (CALI!); Trivandrum District: Ponmudi Hill top, 6 October 2014, *Shinoj, Prasad M.G. & Vimal 138325* (CALI!); Wayanad District: Kurichermala, 28 October 2013, *Shinoj & Smitha 135578* (CALI!); 31 December 2015, *Shinoj 145414* (CALI!); Wayanad District: Chembra peak, 1360 m, 16 January 2014, *Shinoj & Vimal 135956* (CALI!); *ibid.,* 15 October 2015, *Shinoj & Manjula 138392* (CALI!), *ibid.,* 30 December 2015, *Shinoj & Soumya 145410* (CALI!), Mananthavady, Periya 36, Gurukula Sanctuary, 14 September 2015, *Shinoj, Smitha & Soumya 138376* (CALI!). **Tamil Nadu.** Coimbatore District: Velliyangiri, 30 September 2016, *Shinoj, Nikhil & Pradeep 151001* (CALI!); Velliyangiri, 30 September 2016, *Shinoj & Nikhil 151001* (CALI!); Yercaud, Pagoda point, 12 December 2017, *Shinoj, Jeomol & Manudev 150943* (CALI!); Nilgiri District: Kothagiri, Aravenu, 2083 m, 22 October 1956, Adikaratti, Kunnakombai reserve forest, 2000 m, 11 December 1957, *K.M. Sebastine 4902* (MH!); way to Pykara falls, above 6000', 18 September 1928, *G.V. Nararyanan & S.R. Raju 18461* (MH!); Ooty, Naduvattam, 1800 m, 26 January 1978, *S.R. Srinivasan 50580* (MH!); Ooty, Kothagiri, 18 December 2013, *Shinoj & Vimal 135916* (CALI!).

Conservation status:—It is a widely distributed species in South India. We were able to see more than 200 mature individuals in all the localities accessed. Hence we treat it under the IUCN category Least Concern (LC).

Notes:—This is a highly variable species. The branching pattern, texture and hair nature of leaves and stem, inflorescence length, etc. shows much variation according to the ecological condition of the localities. It shows close relation to the species *Pogostemon nilagiricus* Gamble but differs from it in possessing pubescent nature of hair pattern, long petiole, short inflorescence, shorter floral parts like calyx, corolla , style, etc.

Here we treat *Pogostemon rajendranii* R. Sasi & R. Sivalingam as synonym of *P. mollis* as the differentiating characters mentioned by the authors is not stable and is merely due to ecological variations.

10. *Pogostemon myosuroides* (Roth) Kuntze, Revis. Gen. Pl. 2: 530. 1891; T. Cooke, Fl. Bombay 538. 1906; S. Deshpande et al., Fl. Mahabaleshwar 485. 1995; Bhatti & Ingr., Bull. Nat. Hist. Mus. Lond. (Bot.) 27: 110. 997; N.P. Singh et al., Fl. Maharashtra 2: 755. 2001; El Gazzar & L. Watson, Taxon 16: 187. 1967. **(Plate 25, 26 & 50 E)**

=*Mentha myosuroides* Roth, Nov. Pl. Sp. 257. 1821.

≡ *Dysophylla myosuroides* (Roth) Benth. ex Wall., Numer. List. 1547. 1829; Hook.f., Fl. Brit. India 4: 638. 1885; T. Cooke, Fl. Bombay 538. 1906; Mukerjee, Rec. Bot. Surv. India 14: 78. 1940.

= *Eusteralis myosuroides* (Roth) M.R. Almeida, Fl. Maharashtra 4A: 147. 2003. **Type**:—INDIA, *Wallich 1547.* (isotype: K, K000509700, digital image!).

Annual erect herb or undershrub, stem, 40–80 cm high, stem base 0.3–1 cm in diameter, branches 20–50 cm long, terete, rigid, greyish, pubescent; internodes 2–10 cm long. Leaves whorled, normally 4 at each node rarely 2–3, linear to lanceolate, 2.5–8 × 0.4–1 cm, base rounded to cuneate, apex obtuse, margin serrate to serulate with 7–15 teeth, reticulately nerved, secondary veins 5–7, veins prominent beneath, lower surface pubescent; petiole 2–3 mm long, pubescent. Inflorescence terminal, congested spikes with two or more lateral spikes on branch tips, 4–18 cm long, dense and many flowered, 0.5–1 cm broad; pedicels short or absent, 0.1–0.2 mm long. Bracteoles ovate, ca. 1–1.2 × 0.5–0.7 mm, base obtuse, apex acute, margin ciliate, villous. Flowers numerous, 150–300 per inflorescence, 5–6 mm long, sessile. Calyx companulate, 1–1.2 × 0.8–1 mm in flower and fruit, glabrous inside; teeth 5; equal 0.2–0.4 × 0.2–0.3 mm, villous. Corolla 1–1.2 mm long, tube, 0.5–0.6 mm long, straight and half included in calyx, pale violet; glabrescent to pubescent outside, glabrous inside; upper lip three lobed with round or ovate apex 0.5–0.6 × 0.4–0.6 mm; lower lip single lobed, triangular, 0.6–7 × 0.5–0.6 mm. Stamens 4, exerted, filaments 0.5–0.6 mm long, with numerous lavender coloured monoliform hairs at middle, hairs 0.3–0.4 mm; anthers straw coloured 0.05–0.06 mm across. Disc 0.12–0.14 mm long. Style 1–1.2 mm long; stigma lobes equal, 0.4–0.5 mm long. Nutlets 4, ca. 0.1 mm × 0.08 mm, ovate, brown, spinulose.

Phenology:—Flowering and fruiting occurs during July to February.

Distribution:—Mainly in eastern part of South India, rarely in Western Ghats.

Habitat and Ecology:—It is mostly found in dry areas mainly on rocky surfaces amidst grasses.

Specimen examined:—**Andra Pradesh.** Sreekalahasthi, near temple, 10 December 2017, *Shinoj, Geethika & Sunoj 150940* (CALI!). **Tamil Nadu.** Gudian, near Poondi, 80 m, 5 January 2008, *R. Murugan* & *Narasimhan 34* (FRLH!); Chengalpattu District: Tiruvalluvar taluk, way to Mannotchiyamma Konai, near Gudiyool, ±700 m, 10 December 1984, *D. Narasimhan 737* (MH!); *ibid.,* 16 November 1987, *Raman Drug 41092* (MH!).

Conservation status:—Distribution is more confined to south east India. In Western Ghats this species is found rare. But more information based on collection in south east India is needed to categorise it under any category of IUCN.

Notes:—This taxon shows much similarity with *Pogostemon quadrifolius* but differs from it in having herbaceous plant body, delicate stem, smaller leaves, inflorescence and floral features.

11. Pogostemon nilagiricus Gamble, Fl. Madras 1134. 1924; Fyson, Fl. S. Ind. Hill Sta. 2: 471. 1932; Henry et al., Fl. Tamil Nadu 2: 184. 1984; Bhatti & Ingr., Bull.Nat. Hist. Mus. 27(2): 97. 1997; *Pogostemon rotundatus* Wight, Icon. Pl. Ind. Orient: t. 1441. 1849, *nom. illeg*. **Type**:—INDIA*, s.l., Wight Icon 1441.* **(Plate 27, 28 & 52 B)**

= *Pogostemon rotundatus* Benth. in Wall., Pl. Asiat. Rar. 1: 31. 1830; Benth., Labiat. Gen. Sp. 155. 1833; Benth., in DC., Prodr. 12: 155. 1848; Hook.f., Fl. Brit. India 4: 635. 1885; Gamble, Fl. Pres. Madras 2: 1134. 1924. **Type**:—India, *Heyne 1535* (holotype: K, digital image!) ***syn. nov.***

= *Pogostemon vestitus* Benth. in Wall., Pl. Asiat. Rar. 1: 31.1830; Hook.f., Fl. Brit. India 4: 635. 1885; Gamble, Fl. Pres. Madras 2: 1134. 1924; Manilal, Fl. Silent Valley 222. 1988. **Type**:—INDIA, *s.l., Heyne 1534* (holotype: K, barcode, digital image!) ***syn. nov.***

Annual ascending herb or undershrub, 20–40 cm high; stem base 0.5–1 cm in diameter, profusely branching, branches 10–20 cm long, quadrangular, terete when mature, rigid, hirsute, hairs 0.2–0.5 mm long, white; internodes 1.5–3 cm long. Leaves opposite deccusate; ovate, 2–3 × 1.5–2.5 cm, thick, coriaceous, base obtuse or rounded, apex obtuse, margin serrate to crenate with 9–12 teeth, reticulately nerved, secondary veins 3–5, veins prominent beneath, lower surface hoary tomentose, veins hirsute; petiole 0.4–0.6 cm long, hirsute to hirsutulous. Inflorescence a terminal congested spike, 4–20 cm long, dense above lax below, 1.5–2 cm across, many flowered; pedicels short, 0.5–1 cm long. Bracts ovate or lanceolate 7–8 × 1.8–2.2 mm; bracteoles, linear 4–5 × 0.8–1 mm, slightly villous, more than the size of calyx, acute tip, margin ciliate. Flowers numerous, 80–200 in an inflorescence, 7–8 mm long, sessile. Calyx tubular, 4.5–5 × 1.4– 2 mm long in flower and fruit, glabrous inside; teeth 5; equal, 2–2.5 × 0.5–0.8 mm, hirsute outside; hairs 5–6 celled, 0.6–0.9 mm long. Corolla 6–7 × 2–2.5 mm long; tube 2–2.5 mm long, straight and fully included in calyx, white; teeth pubescent to villous outside, glabrous inside; upper lip three lobed, apex round or ovate; middle lobe 1.8–2 × 0.8–1 mm, lateral lobes 0.8–1 × 0.8– 1 mm, villous; lower lip single lobed, triangular, 0.8–1 × 0.8–1 mm hairs 4–5 celled, scattered outside. Stamens 4, exerted, subequal, 4–4.2 mm long, filaments basally villous, numerous white monoliform hairs at middle, 1.5 mm long; anthers white 0.5–0.6mm across. Disc 0.5–0.6 × 0.7–0.8 mm, ovary 4 partite, 0.8–0.9 mm long; style 8–9 mm long, slender; stigma lobes equal, 0.8–1 mm long. Nutlets 4, obovate to orbicular, 0.28–3 × 0.18–0.25 mm.

Phenology:—Flowering and fruiting during September to December.

Distribution:—Endemic to Karnataka and Tamil Nadu.

Habitat and Ecology:—Mainly distributed in hill tops, on rock surfaces and crevices.

Specimens examined:—Karnataka. Chikmagalur District: Kemmanagudi (grassland near childrens park), 17 February 2013, *Shinoj & Prasad M. G. 290185* (CALI!). **Tamil Nadu**: Coimbatore district, Anamalai, ibex hill, 5000”, 15 January 1912, *Fischer 3288* (FRC!); *s.l.,* 4600 ft., 18 August 1917, *Fischer 4056* (FRC!); Nilgiris district, Kinnakorai, 5300”, 19 January 1913, *Fischer 3526* (FRC!); Bikkapattimund, 6800”, 15 January 1921, *Fischer 4603* (FRC!).

Conservation status:—This species is not wide spread. It is confined only to a few areas in South India. We collected the plant only from Kemmanagudi of Chikmagalur District in Karnataka were a fragmented distribution of less than 50 mature individuals were seen. Herbarium references shows that it is also distributed in Nilgiris and Coimbatore areas, but rare. As per the available data this species can be assessed under the category endangered (EN) according to the criteria B1b of IUCN (2012, 2017).

Notes:—This species shows close similarities to *Pogostemon mollis* Benth. but differs from it in possessing some unique characters. Long petiole, nature of hairiness, inflorescence length (upto 20 cm), larger calyx, corolla, style etc., are some of the characters which separate these species from each other.

12. *Pogostemon paludosus* Benth. in DC., Prodr. 12: 154. 1848; Hook.f., Fl. Brit. India 4: 635. 1885; Gamble, Fl. Madras 2: 1134. 1921; Sharma & Kumar in Nair & Sastry (eds), Red Data Book 3. 169. 1990; Bhatti & Ingr., Bull. Nat. Hist. Mus. 27(2): 102. 1997. **Type (designated here)**:— INDIA, Nilgiris, *Ex. Herb. Wight Prop*. *s.n.* (neotype: K, K000848025, digital image!)

(Plate 29, 30 & 52 C)

Annual erect or straggling herb 40–60 cm high; stem base 0.4–0.8 cm in diameter, profusely branching, branches 20–40 cm long, quadrangular, rigid, pubescent, hairs 5–6 celled, 0.4–0.6mm long, internodes 3–10 cm long. Leaves opposite deccusate; ovate, 4–8 × 3–7 cm, thin, membraneous, base rounded or somewhat truncate, apex acute, margin crenate to double crenate teeth 7–10, reticulately nerved, secondary veins 3–4, veins prominent beneath, glabrous to glabrescent; upper surface glabrous; petiole 4–8 cm long, glabrous. Inflorescence a single terminal lax spike, 7–15 cm long, 1–1.5 cm across, few flowered; pedicels short, 1.5–3 cm long. Bracts leafy, bracteoles linear, 2–2.2 × 0.3–0.5 mm, villous, margin ciliate. Flowers less congested, around 8–12 in an cymose cluster, 8–10 mm long, sessile. Calyx ovate to tubular, 4.5–5 × 2–2.4 mm in flower and fruit, glabrous inside; throat densely tomentose within, villous outside, teeth 5, equal, 0.8–1 × 0.8–1 mm. Corolla 5–6.5 mm long; tube 3.5–4 mm long, straight and fully included in calyx, white, teeth pubescent to villous outside, glabrous inside; upper lip consist of three lobes with round or ovate apex; middle lobe 1.5–1.8 × 0.8– 1 mm, lateral lobes 0.8–1 × 1.6–2 mm, villous outside; lower lip consist of single lobe, triangular, 2–2.2 × 2.2–2.5 mm, hairs 4–5 celled, scattered over outer surface. Stamens 4, exerted, didynamous; upper pair 7.5–8 mm long, base slightly bent, villous, lower two 6.5–7 mm long, base glabrous or slightly villous, filaments with numerous white monoliform hairs at middle, hairs ca.1.5 mm long, mature anthers white to brownish, 0.4–0.5 mm across. Disc, 0.8–1× 1–1.2 mm, white, glabrous. Style 7–9 mm long, slender; stigma lobes equal, 1.3–1.5 mm long. Nutlets 4, obovate to orbicular, 0.25 × 0.20 mm.

Phenology:—Flowering and fruiting during October to March.

Distribution:— The plant is an endemic, found in the Nilgiris and Silent Valley areas in Nilgiri Biosphere Reserve. Apart from the buffer zone, we were able to locate few specimens in the core area of Silent Valley, on the way to Sispara, during the month of February 2014. This gives a vivid idea that this plant is still surviving in few pockets in the Silent Valley National Park.

Habitat and Ecology:— It is found growing in evergreen forest openings, usually in shady places at higher elevation above 6000 ft.

Specimens examined:— Kerala. Palakkad District: Silent Valley National Park (Forest near Mullanpara), 31 October 2013*, Shinoj & Vimal 135602* (CALI!); on the way to Sisspara from Walakkad, 6 February 2014*, Shinoj & Vimal 135973* (CALI!).

Conservation status:—This species is very rarely seen in south India. We collected the plant only from Silent Valley National Park where a fragmented population of less than 25 mature individuals were seen. Herbarium references shows that it is endemic to Nilgiris. As per the available data this species can be assessed under the category endangered (EN) according to the criteria B1b of IUCN (2012, 2017).

Notes:—This species was first described by Bentham (1854) on the basis of Perrottet's collection from Ootacamund. Robert Wight also reported a specimen from the same hills. In 1883 and 1885, M.A Lawson reported it from Sispara, Nilgiri Hills. No mention of this plant was found in the recently published the *Flora of Silent Valley*. There is no recent collection of this taxon since 1885. Hence the present collections form a rediscovery of this species from the type locality after a gap of 134 years.

13. Pogostemon paniculatus (Willd.) Benth. in Wall., Pl. Asiat. Rar. 1: 30. 1830; Wild., Sp. Pl. 3: 59. 1800; Benth. in DC., Prodr. 12: 151. 1848; Hook.f., Fl. Brit. India 4: 631. 1885; T. Cooke, Fl. Bombay 535. 1906; Rama Rao, Fl. Pl. Travancore 323. 1914; Gamble, Fl. Madras 2: 1132. 1924; Manilal & Sivar., Fl. Calicut 240. 1982; B.D. Sharma et al., Fl. Karnataka 225. 1984; Manilal, Fl. Silent Valley 22. 1988; V.S. Ramach. & V.J. Nair, Fl. Cannanore 371. 1988; Kesh. Murthy & S.N. Yogan., Fl. Coorg 362. 1990; Vajr. Fl. Palghat Dist. 382. 1990; M. Mohanan & A.N. Henry, Fl. Thiruvanthapuram 372. 1994; Bhatti & Ingr., Bull. Nat. Hist. Mus. 27(2): 92. 1997; S.R. Yadav & M.M. Sardesai, Fl. Kolhapur Dist. 384. 2002; K.G. Bhat, Fl. Udupi 519. 2003; B.K. Manjun. et al., Fl. Devanagare 392. 2004; Mandar & Lakshmin., Fl. Bhagwan Mahavir 196. 2013; K.N Subramanian, Fl. Thenmalai 49. 2014.

(Plate 31, 32 & 49 D)

≡*Elsholtzia paniculata* Willd., Sp. Pl. 3: 59. 1800. **Type**:—MYANMAR, September 1826, *Wallich 1561* (holotype: K, K000509695, digital image!)

= *Hyssopus cristatus* Lam., Encycl. 3: 187. 1789.

Annual erect herb or undershrub with solid stem, 60–100 cm high. Stem solid, base 0.5–1 cm in diameter, profusely branching, branches 50–80 cm long, purplish, branches zig zag appearance due to sympodial growth can be met with branches, quadrangular, sericeous, hairs 3–4 celled, 0.6–0.7 mm long. internodes 6–12 cm long. Leaves opposite deccusate, larger and smaller leaves alternate on each node, ovate, larger 5–8 × 4–6 cm, smaller 1.5–3 × 2–3.5 cm, cartaceous, base cuneate and unequal, apex acute to acuminate slightly bent, margin serrate to inciso-crenate with 4–5 major teeth, reticulately nerved, secondary veins 3–5, veins prominent beneath, lower surface pubescent to hispid, more towards veins; petiole 3–5 cm long, pubescent to hispid. Inflorescence panicle, axillary, towards branch tips, a terminal lax spike with lateral spikes, 8–10 flowered clusters, subsecund, unilateral, dense above lax below, 7–20 cm long, 1.5–2 cm across; peduncles 1.5–3.5 cm long, villous. Bracts leafy, ca. 0.5 × 0.25 cm across, bracteoles broadly ovate to orbicular, 8–10 clusters on peduncles, 1.5–2 cm apart, ca. 3.2 × 3 mm, slightly villous, almost equaling to calyx, base obtuse to round with a very short stalk ca. 0.5 mm, margin ciliate, tip acute. Flowers sessile. Calyx tubular, ca. 4 mm long both in flower and in fruit, narrow towards base and mouth, villous outside, glabrous inside; teeth 5, triangular, ca. 1 × 0.8 mm, equal, villous, hairy outside, margin ciliate. Corolla pale purple to white, 6–7 mm long, tube 3.8–4.2 mm long, straight and fully included in calyx, lobes pubescent to hispid outside, glabrous inside; upper lip, ca. 1.8 mm long, trilobed, pale violet; middle lobe ca. 1.8 × 0.6 mm and ca. 0.5 mm longer than the lateral lobes, lateral teeth ca. 1.3 × 0.9 mm, dome shaped; lower lip with single lobe, 1 × 1.2 mm. Stamens 4, exerted, didynamous condition not prominent; filaments ca. 4.8 mm long, numerous violet monoliform hairs at middle, hairs 2 mm long; glabrous towards the base; anthers white to pale violet ca. 0.5 mm across. Disc ca. 0.2 × 0.4 mm. Style ca. 6.2 mm long, slender; stigma lobes equal, ca. 0.8 mm long. Nutlets 4, ca. 0.24 × 0.16 mm, ovate.

Phenology:—Flowering and fruiting occurs during October to March.

Distribution:—India to West Indo-China.

Habitat and Ecology:—Wide spread, usually found along road sides, open areas, waste places and in forest margins. This species prefers shades and humid rich areas.

Specimen examined: Karnataka. Chikmagalur District: Madikere, 11 February 1990, *R.S. Raghavan 120675* (BSI!); Sringeri, Kigga, Sirumane falls (near forest road), 23 January 2015, *Shinoj, Shravan & Srinivas 138359* (CALI!); Dakshina Kannada District: Sullia, 25 October 1900, *s.coll. 2098* (MH!); Shiradi, 15 December 1918, *s.coll. 15618* (MH!): Kombar, 16 December 1918, *s.coll. 15675* (MH!); Charmadi, 500 m, 24 November 1927, *S.R. Raju 18203* (MH!); Kodaku District: Makut, Kerati reserve forest, 4 November 1981, *S.R. Srinivasan 72308* (MH!); Shimogha District: Hulikkal ghat (near Chandikamba temple) 18 October 2014, *Shinoj, Satheesh & Prasad M.G. 138345* (CALI!); Dabbe falls (near forest road) 22 January 2015, *Shinoj, Shravan & Srinivas 138352* (CALI!); Uduppi District: Hebri 250”, 25 November 1920, *Fischer 4555* (FRC!); Uttara Kannada District: Mastani, 25 November 1950, *J. Fernandez 1887* (BLAT!); Kattekan, 8 May 1969, *M.R. Almeida 1228* (BLAT!). **Kerala.** Ernakulam District: Pooymkutty forest road side, 15 December 2016, *Shinoj, Manu Philip & Nikhil 151022* (CALI!); Neriamangalam, Karimanal, 18 December 2016, *Shinoj 151033* (CALI!); Idukki District: Thekkady, 850 m, 15 March 1973, *B.D. Sharma 43878*

(MH!); Uppuparai, 1000 m, 17 December 1974, *K. Vivekananthan 45330* (MH!); Thekkady, 825 m, 22 December 1974, *K. Vivekananthan 45389* (MH!); Kannur District: Thaliparamb, 11 March 1915, *s.coll. 11914* (MH!); Chandanathode, Theethundamalai, 740 m, 4 December 1967, *J.L. Ellis 29447* (MH!); Chandanathode, 825 m, 13 July 1978, *V.S. Ramachandran 57680* (MH!); Kannoth reserve forest, 400 m, 20 January 1979, *V.S. Ramachandran 59048* (MH!); Valara reserve forest, 100 m, 7 December 1984, *K. Ramamurthy 80413* (MH!); Moyyam, near Sir Zyed College, 50 m, 27 December 2015, *Shinoj 145409* (CALI!); Kasaragod District: Kasaragod, 125 m, 26 January 1979, *V.J. Nair 59926* (MH!); Kollam District: Ariankavu, near rest house, 200 m, 30 November 1961, *K.N. Subramani 77265* (BSI!); Plapally, Ranni forest, 208 m, 29 October 2017, *Shinoj et al. 151044* (CALI!); Kottayam District: Changanacherry, Perunna, 19 January 1964, *N.C. Nair 29744* (MH!); Pulluparai, 525 m, 22 January 1965, *K. Vivekananthan 22950* (MH!); Changanacherry, Nalukodi, 25 m, 27 December 1983, *V. T. Antony 3* (MH!); Kozhikode District: Vadakara, 27 October 1900, *s.coll. 164* (MH!); Kannoth, 11 December 1913, *s.coll. 9756* (MH!); Kozhikode, 11 December 1931, *E.V. Narayanan 6277* (MH!); Peruvannamuzhi (near dam site), 24 August 2015*, Shinoj, Manu & Resmi 138373* (CALI!); Malappuram District: Perinthalmanna, 18 m, 23 December 1990, *Yusuf* 2338 (TBGT!); Nadukani Churam, 14 September 2015*, Shinoj 138385* (CALI!); Palakkad District: Dhoni, 550”, 19 January 1910, *Fischer 1595* (FRC!); Dhoni forest 27 January 1957, *Govindan C.G. s.n*. (TBGT!); Pothundy, Kanikkatty, 3 February 1996, *K. Radhakrishnan 26585* (TBGT!); Mannarkad (near Kunthipuzha), 29 December 2012*, Shinoj & Lamiya 290164* (CALI!); Dhoni forest, on the way to Palamala, 26 september 2013*, Shinoj & Vimal 135549* (CALI!); Mukkali (near Silent Valley N.P.), 30 October 2013*, Shinoj & Vimal 135612* (CALI!); Ottappalam, Ananganadi (road side), 6 December 2013*, Shinoj & Vimal 135600* (CALI!); Silent Valley N.P., Pandra (on the way to Walakkad), 7

February 2014*, Shinoj & Vimal 135980* (CALI!); Nelliampathy, on the way to Minampara, 24 June 2014, *Shinoj, Prasad M.G. & Vimal 138320* (CALI!); Minampara, 11 December 2016, *Shinoj 151018* (CALI!); Pathanamthitta District: Adoor, Chandanakavu, 19 February 1979, 150 m, *C.N. Mohanan 6144* (MH!); Aiekad, 125 m, 14 November 1979, *C.N. Mohanan 68301* (MH!); Nellimukal, 100 m, 30 November 1984, *Anilkumar N. 130* (MH!); Konni, near new forest office, 50 m, 19 December 1987, *Anilkumar N. 249* (MH!); upper Moozhiyar, 550 m, 25 November 1988, *Anilkumar N. 1192* (MH!); Thiruvananthapuram District: Jawahar colony, 4 November 1915, *Deepthi Das 26279* (TBGT!); Ponmudi, 15 October 1976, *Pradeep Kumar s.n.* (TBGT!); Kallar, 225 m, 24 March 1978, *M. Mohanan 54749* (MH!); Bonacaud, 21 December 1983, *N. Mohanan 9083* (TBGT!); Wayanad District: Sulthan Bathery, Kuppadi, 6 February 1964, *J.L. Ellis 18546* (MH!); Kurichermala, 31 December 2015, *Shinoj 145416* (CALI!); Tirunelly, Brahmagiri, (on the way to Pakshipathalam) 1300 m, 26 November 1995, *K. Radhakrishnan 26533* (TBGT!); *Ibid.,* 16 October 2015, *Shinoj & Manjula 138398* (CALI!), Periya, Gurukula Sanctuary, 7 December 2016, *Shinoj & Manu Philip 151013* (CALI!); Vythiri, Mandhanmala, near Navodaya School, 15 January 2017, *Shinoj & Jeomol 151043* (CALI!); **Tamil Nadu.** Coimbatore District: Anamalai, kariyan shola, 2500', 25 February 1942, *S.R. Raju 20293* (MH!); Coimbatore, 22 February 1951, *G.S. Puri 15790* (BSI!); near Siruvani foot, 633 m, 26 February 1957, *K. Subramanyam 2467* (MH!); Coimbatore, 14 February 1960, *N.P. Balakrishnan & J.L. Ellis 11728* (MH!); Yanikudi shola, 750 m, 29 January 1962, *J. Joseph 13815* (MH!); Valparai, Nallamudi, Sankaram Kudi, 100 m, 29 March 1990, *V.B. Hosagounar 93803* (MH!); Kanyakumari District: Malaikode, 31 December 1919, *s.coll. 16361* (MH!); Nilgiris District: Ooty, Lovedale, October 1910, *Fyson 1446* (FRC!); Karian shola Devala road, 1250 m, 23 January 1961, *B.V. Shetty 12015* (MH!); Kuzhivayal reserve forest, 850 m, 26 February 1973, *E. Vajravelu*

43732 (MH!); Naduvattam, near Royal Valley tea estate, 1843 m, 11^0 28’38.1”N, 76^0 32’36.3”E, 8 February 2016, *Shinoj 145446* (CALI!).

Conservation status:—During our exploration in Western Ghats we met dense vegetation and were able to collect specimens from various parts of Karnataka, Kerala and Tamil Nadu.. Literature reference and herbarium consultation indicates that it is a wide spread species. So we treat it as Least concern.

Note:—This taxon is very close to *Pogostemon gardneri* and *P. purpurescens*, but differs from both by possessing long lax inflorescence, longer corolla and wider bracts.

14. Pogostemon peethapushpum Pradeep, Candollea 53: 419. 1998; Shinoj et al., SIJBS 2(1); 49. 2016. **Type**:—INDIA. Kerala, Calicut, Vellarimala. *Pradeep 5489.* (holotype: K, digital image!; isotype: CALI!).

(Plate 33, 34 & 52 F)

Scandent shrub, 80–150 cm high. Stem solid, base 1–3 cm in diameter, profusely branching, branches 60–120 cm long, obtusely quadrangular, rigid, wedged, pubescent, hairs white, 0.2–0.4 mm long; internodes 7–12 cm long. Leaves opposite decussate, ovate to sub orbicular, 3.5–7 × 2.5–5 cm, chartaceous, base cordate, apex acute, margin double or multicrenate to double serrate, teeth 10–18, reticulately nerved, secondary veins 4–6, veins prominent beneath, lower surface slightly hispid, hirsute on veins, upper surface hispid; petiole 4–7 cm long, pubescent. Inflorescence axillary cymes, 3–6 cm long, congested near tip, 1.5–2 cm across; peduncle short, 0.6–1 cm long. Bracts 0.6–0.8 cm long, linaer to spathulate, bracteoles linear 2.2–2.4 × 0.1–0.2 mm, shorter than calyx, obtuse tip, hirsute with white hairs outside, margin ciliate. Flowers limited, around 9–15 in an inflorescence, pedicellate. Calyx companulate, 6.2–7 × 2.3–2.5 mm long in flower and fruit, narrowed towards base and mouth, gradually broadened towards middle, hirsute inside throat and teeth; teeth 5, linear to lanceolate, 2.2–2.6 mm long, lower two little longer than the upper, tips remain bent upwards, ciliate. Corolla 7–9 mm long, tube 3.8–4.2 mm long, straight and fully included in calyx, dark yellow; lobes pubescent to hirsute outside, glabrous inside; lower lip, 2.4–2.6 mm long, single lobed, yellow; upper lip trilobed; middle lobe of upperlip 0.4–0.6 × 1.8–2 mm semicircular, lateral lobes slightly broader 2.5–2.7 mm broad with white hairs outside. Stamens 4, exerted, didynamous, filaments long, 10–12 mm, anterior two basally villous, posterior two glabrous, pale yellow to white; anthers pale yellow or straw coloured ca. 0.8 × 1 mm. Disc 0.92–0.95 × 0.98–1 mm long. Style 12–15 mm long, slender; stigma lobes equal, 1–1.2 mm. Nutlets 4, ca. 0.42 × 0.47 mm, suborbicular, rounded at the apex, glands and hairs present at apex.

Phenology:—Flowering and fruiting occurs during November to March.

Distribution:—Endemic to southern Western Ghats.

Habitat and Ecology:—Grasslands at the borders of shola forests above 1300 m; intermingled with other hedge plants.

Specimen examined:—**Karnataka.** Chikmagalur District: Baba Budan Giri (near a broken building), 16 February 2013, *Shinoj & Prasad M. G. 290176* (CALI!). **Kerala.** Calicut District: Vellarimala. *Pradeep 5489* (CALI!).

Conservation status:—During our exploration in Western Ghats we were able to collect few specimens from Baba Budan hills of Chikmagaluru district in Karnataka. A few population with less than 50 mature individuals were met during our last field trip in this tourist and pilgrim area. We had visited this area thrice during the research period and the population density was seen to be decreasing. In the type locality Vellarimala, in Calicut district of Kerala the population of mature individuals was less than 100. Therefore, we suggest that *Pogostemon peethapushpam* should be classified as endangered (EN) according to the criteria B1b of IUCN (2012, 2017).

Note:—This taxon is very close to *Pogostemon hedgei* V.S. Kumar & B.D. Sharma, but differs from it in possessing axillary cymose inflorescence with less clustered flowers. In *P. hedgei*, terminal thyrse inflorescence was met with leafy bracts.

15. **Pogostemon plectrantoides** Desf., Mém. Mus. Hist. Nat. 2: t.6, 155. 1815; T. Cooke, Fl. Bombay 536. 1906; Prain, Bengal Pl. 2: 849.1981; Bhatti & Ingr., Bull. Nat. Hist. Mus. 27(2): 91. 1997. **Type**:— Mém. Mus. Hist. Nat. 2: 155, t. 6 (holotype: Illustration!). **(Plate 35, 36 & 49 E)**

= *Ocimum bengalense* Poir. in J.B.A. M.de Lam., Encycl. 4: 608. 1798.

= *Mentha secunda* Roxb., Hort. Bengal.: 44. 1814. *nom. nud.*

= *Wensea pyramidata* J.C.Wendl., Coll. Pl. 3: 26. 1819.

= *Mentha fruticosa* Roxb. ex D.Don, Prodr. Fl. Nepal.: 115. 1825.

Suffruticose, erect herb or undershrub, 80–180 cm high; stem base 1–3 cm in diameter, profusely branching, branches woody, 70–150 cm long, quadrangular, with glabrous, younger stem slightly pubescent to glabrescent; internodes 6–15 cm long. Leaves opposite deccusate, lamina ovate, 7–25 × 6–18 cm, thin, base cuneate, apex acute to acuminate, margin serrate to double or polyserrate, teeth 15–25, sharply pointed, reticulately nerved, secondary veins 3–5, veins prominent beneath, lower glabrescent; petiole 5–7 cm long, glabrescent to pubescent. Inflorescence terminal and axillary congested spike, 6–13 cm long, dense above lax below, 3–5 cm across, many flowered; pedicels absent. Bracts prominent, ca.10 × 6 mm, villous, larger than calyx; bracteoles 3–4 numbers associated with bunch of 3–5 flowers, linear, thin, papery ca. 6 × 2 mm, slightly pubescent, acute to obtuse tip, glabrescent to pubescent outside, hairs white. Flowers numerous, around 100–200 in an inflorescence, sessile. Calyx tubular, ca. 5 mm long both in flower and in fruit, narrowed towards the base and mouth, gradually broadened towards the middle, glabrous inside; teeth 5, ovate, tip acute, 1 × 0.8 mm long, equal. Corolla pale purple, 8 mm long, tube 6 mm long, straight and fully included in calyx; lobes pubescent to glabrescent outside, glabrous inside; lower lip, ca. 2 mm long, trilobed, pale violet with pale purple shade inside; middle lobe project out from the lateral lobes at a length ca. 1 mm, 0.8mm broad, ovate, lateral lobes slightly broader ca. 1.4mm broad. Stamens 4, exerted, didynamous, filaments long, ca. 8 mm, numerous violet monoliform hairs at middle, ca. 2.5 mm long; anterior pair basally villous, posterior two glabrous; anthers white to pale violet ca. 0.7mm across. Disc 0.5 mm long, larger than nutlets. Style ca. 1.3 mm long, slender; stigma lobes equal, 1mm. Nutlets 4, ca. 0.856 × 0.524 mm, oblong.

Phenology:—Flowering and fruiting occurs during November to April.

Distribution:—India to Bengladesh.

Habitat and Ecology:—It prefers to grow near margins between forest and grasslands at an altitude ca.1500 m msl.

Specimen examined:—Goa. North Goa District: Talaulim, 21 April 1906, *John Cherian 109017* (BSI!). **Kerala.** Wayanad District: Attapara, 4600”, 29 January 1911, *Fischer 2509* (FRC!); Pakshipathalam 23 March 1996, K. Radhakrishnan 28183 (TBGT!); Tirunelly, Brahmagiri, (on the way to Pakshipathalam) 1300 m, 16 October 2015, *Shinoj & Manjula 138396* (CALI!). **Maharashtra.** Mumbai City District: Madh, Salsette island, February 1941, *H. Santapau 143* (BLAT!); Madh Island, 3 March 1957, *G.L. Shah 8675* (BLAT!); Marve Madh road, 7 December 1957, *G.L. Shah 9598* (BLAT!); Nashik district: Ozhar, near Swarghinasi river, 14 June 1958, *P.S.*

Toor 39165 (BSI!); Palghar District: Thungareswar, Usgaon, 28 February 1961, *N.Y. Das 3151* (BLAT!); Pune District: Khandala, 17 March 1917, *H. Santapau 23538* (BLAT!); Khandala, 11 February 1961, *C. Saldhana 6520* (BLAT!); Raigad District: Matheran, 20 December 1958, *N.A. Irani 2635* (BLAT!); Karanja, Uran, 1 March 1960, *P. Divakar 545* (BLAT!); Satara district: Mahabaleswar, 27 December 1964, *J.A. Lewis 536* (BLAT!); Tiger path 28 December 1964, *M.R. Almeida 168* (BLAT!); Sindhudurg District: Ansur, 16 June 1958 *P.S. Toor 39186* (BSI!); Solapur District: Mahol, 10 June 1968, *S.K. Jain 38481* (BLAT!); Thane District: Mumbra, 9 February 1954, *K.V. Shenoy 2140* (BLAT!). **Tamil Nadu.** Coimbatore District: Marudamalai, 21 February 1956, *S.K. Wagh 1682* (BLAT!); Tirunelveli district Kanikkatty hills, 650 m, 7 August 1997, *V.S. Manickam 12946* (XCH!).

Conservation status:—During our exploration in Western Ghats we were able to collect specimens from Wayanad district of Kerala, were we found a dense vegetation. Herbarium consultation indicates that it is a wide spread species in Northern India. So we treat it under Least concern (LC) category.

Note:—This taxon is very close to *Pogostemon benghalensis*, but differs from it in possessing larger bracts, shorter median teeth of upper corolla lobe, pale purple corolla without dark purle shade inside, calyx size and more congested inflorescence.

16. Pogostemon purpurascens Dalzell, Hooker's J. Bot. Kew Gard. Misc. 2: 337. 1850; Hook.f., Fl. Brit. India 4: 632. 1885; T. Cooke, Fl. Bombay 537. 1906; Rama Rao, Fl. Travancore 324. 1914; Gamble, Fl. Madras 2: 1134. 1924; B.D. Sharma et al., Fl. Karnataka 224. 1984; R.S. Rao et al., Fl. Goa, Diu, Daman, Dadra & Nagar haveli 2: 350. 1986; B.G. Kulkarni, Fl. Sindhudurg 362. 1988; V.S. Ramach. & V.J. Nair, Fl. Cannanore 372. 1988; S.M. Almeida, Fl. Sawantwadi 1: 349, 1990; Vajr. Fl. Palghat Dist. 382.

1990; M. Mohanan & A.N. Henry, Fl. Thiruvanthapuram 372. 1994; S. Deshpande et al., Fl. Mahabaleshwar 487. 1995; Sivar. & P. Mathew, Fl. Nilambur 554. 1996; Bhatti & Ingr. Bull. Nat. Hist. Mus. 27(2): 92. 1997; S.R. Yadav & M.M. Sardesai, Fl. Kolhapur Dist. 384. 2002; K.G. Bhat, Fl. Udupi 521. 2003; Fl. Sanjay Gandhi National Park 3: 515. 2005; K.N Subramanian, Fl. Thenmalai 49. 2014. **Type**:—INDIA, the Concan, *s.d., Dalzell s.n.* (lectotype: K, K000848043, digital image!).

(Plate 37, 38 & 49 F)

Annual erect herb or undershrub, 80–120 cm high. Stem solid, base 1–2 cm in diameter, profusely branching, branches 60–100 cm long, zig-zag appearance due to sympodial growth, bright green, terete to quadrangular, tomentose, hairs 7–8 celled, more towards the base; internodes 6–14 cm long. Leaves opposite deccusate; one large and small leaf alternate at nodes; ovate, larger 5–12 × 4–10 cm, smaller 2–4 × 1.8–3.5 cm, thin, base cuneate, apex acute to acuminate, margin serrate to inciso-crenate, major teeth 6–8, reticulately nerved, secondary veins 4–6, veins prominent beneath, lower hoary tomentose; petiole 3–5 cm long, pubescent to tomentose. Inflorescence terminal congested spike with two lateral spikes, rarely axillary towards the branch tip, 7–13 cm long, dense above, lax below, 2–3 cm across, many flowered; pedicels short, 2–3 cm long. Bracts leafy, ca. 2 × 2.5 cm , bracteoles ovate, 5–6 × 3.5–4 mm, slightly villous, almost equaling the calyx, acute to obtuse tip, margin ciliate. Flowers numerous, around 60–120 per inflorescence, 7–8 mm long, sessile. Calyx tubular, 5.2–5.5 mm long in flower and fruit, narrow, glabrous inside; teeth 5, linear to lanceolate, 2–2.5 × 0.7 mm long, equal, villous, hairs 5–6 celled, intermingled with sessile glands outside. Corolla pale purple, 5–6 mm long; tube 2.8–3.2 mm long, straight and fully included in calyx; lobes pubescent to glabrescent outside, glabrous inside; upper lip, 2–2.5 mm long, trilobed, pale violet with dark purple shade inside; middle lobe project out from the lateral lobes at a length ca. 1.2 mm, 0.7 mm broad, ovate, lateral lobes slightly broader ca. 0.8 × 1.2 mm broad; lower lip with single lobe, 0.8 × 1.2 mm. Stamens 4, exerted, didynamous; upper pair ca. 5mm long, lower two ca. 7 mm, numerous violet monoliform hairs at the middle, hairs 2.4 mm; upper two basally villous on the filament, lower two glabrous; anthers white to pale violet ca. 0.4 mm across. Disc, 0.4 × 0.55 mm long. Style ca. 7 mm long, slender; stigma lobes equal, ca. 1.3 mm long. Nutlets 4, ca. 0.65 × 0.56 mm, ovate to orbicular.

Phenology:—Flowering and fruiting occurs during November to February.

Distribution:—South India, Himalayas to Assam.

Habitat and Ecology:—It prefers to grow in lateritic wall cuttings and open areas inside forest at a height of 1000 ft above msl.

Specimen examined:—Gujrat. Dang District: Dang, Kasaibari forest, 21 December 1963, *G.L. Shah 10700* (BLAT!); Sapatura ghat, 449 m, 17 September 2017, *Shinoj, Sharad & Manju 151061* (CALI!). **Karnataka.** Belgaum District: Yadur forest road, 22 September 1962, *R. Sundara Rao 80871* (BSI!); Dakshina Kannada District: Naravi, 300 m, 19 November 1927, *S.R. Raju 18121* (MH!); Charmady, 320 m, 6 February 1997, *K. Ravikumar 9838* (FRLH!); Shimogha District: near Jog falls, October 1919, *Hallberg & Mc. Cann 34384* (BLAT!); Kodachadri grassland (on lateritic wall cuttings), Someshwara, 14 February 1940, *S.R. Raju 6390* (MH!); 4 January 2013, *Shinoj & Prasad E. R. 290167* (CALI!); Hulikkal ghat (2–3 km before Chandikamba temple), 18 October 2014, *Shinoj, Satheesh & Prasad M.G. 138341* (CALI!); Sringeri, Kigga, Narasimhaparvatha (on the way to hill), 23 January 2015, *Shinoj, Shravan & Srinivas 138355* (CALI!); Jog falls to Sringeri (23 km from Jog falls), 29 December 2016 *Shinoj & Soumya 151036* (CALI!); Uttara Kannada District: Castle rock, March 1918, *s.coll.*

27792 (BLAT!); Karwar, October 1919, *Hallberg & Mc. Cann 34273* (BLAT!); Sirsi Kumta road, 19th mile, 9 May 1956, *G.S. Puri s.n.* (BSI!); Bedti, 21 May 1957, *G.S. Puri 18141* (BSI!). Uduppi District: Hosanagadi, 300 m, 1 January 1939, *S.R. Raju 6344* (MH!); **Kerala.** Palakkad District: Silent Valley N.P., on the way to Sisspara from Walakkad (Forest floor), 6 February 2014, *Shinoj & Vimal 135976* (CALI!); Kasaragod District: Kumbala, Chillangaya, 3 January 2017, *Shinoj & Nikhil 151040* (CALI!). **Maharashtra.** Palgarh District: Chahad Khind, 15 January 1968, *K.V. Billore 113592* (BSI!); Pune District: Lonavala, November 1918, *E. Blatter 28261* (BLAT!); Khandala, Behrams Plateau, 27 December 1943, *H. Santapau 3449* (BLAT!); Echo point, Ravine, 11 December 1943, *H. Santapau 3219* (BLAT!); Khed Taluka, Sahib Cha Amba (near Vandra), 30 November 1961, *K.P. Janardhanan 76028* (BSI!); Ambavne, Kate Pani forest, 2 February 1964, *B. Venkata Reddi 959540* (BSI!); Lonavala, Kate Pani forest, Ambavne, 6 May 1964, *B.V. Reddi 97672* (BSI!); Koyna, Naiya, 29 November 1978, *R.K. Kochar 157963* (BSI!); Raigad District: Bombay, Matheran, 28 January 1957, *G.S. Puri 9885* (BSI!); Matheran, Neral to water pipe, 17 November 1958, *N.A. Irani 2400* (BLAT!); Amba MPCA, 9 January 1999, *C.R. Jawahar 15463* (FRLH!); Matheran, 11 November 2006, *S.C. Majumdar & S.K. Das 192484* (BSI!); Ratnagiri District: Usgaon, 28 February 1961, *N.Y. Das, s.n.* (BLAT!); Jungli Jaigad, 11 February 1979, *R.K. Kochar 158333* (BSI!); Thane District: Borwili, Salsette, Kanery caves, November 1918, *E. Blatter 36169* (BLAT!); Mumbra, 30 March 1954, *K.V. Snenoy 2529* (BLAT!); Tungareswar, Mandvi, 10 December 1960, *N.Y. Das 9891* (BLAT!); Tungareswar, Chandip, 18 February 1961, *N.Y. Das 3101* (BLAT!); Ghodbunder, 2 December 1961, *G.L. Shah 104607* (BLAT!); Tokavada range, Bairav baba, Naneghat, 15 June 1967, *K.V. Billore 10979* (BSI!); Murbad range, Sidgad foot hill, 12 April 1968, *K.V. Billore s.n.* (BSI!); Sidgad Sadhya ghat slope, 17 April 1968, *K.V. Billore s.n.* (BSI!); Washala range, Devighat, 31 May 1968, *K.V. Billore 116088* (BSI!). **Tamil Nadu.** Coimbatore District: Valparai, near Nooradi settlement area 1050 m, 23 March 1990, *V.B. Hosagonson 92465* (MH!).

Conservation status:—During our exploration in Western Ghats we were able to collect specimens from Gujrat, Goa, Karnataka & Kerala. This species is found to be very common in forest areas of Karnataka, especially in Kodachadri and Shimogha areas. The condition of plants is very dreadful in Kodachadri areas as it is a pilgrim place. The plants are mainly distributed near forest road sides and hence its population is seen to be highly disturbed. But it is distributed nearby areas also. We were also able to met many population in Goa and Kerala. So presently we treat it as Least concern.

Notes:—This taxon is very close to *Pogostemon gardneri* Hook.f., but differs from it in possessing herbaceous habit, narrow calyx, longer calyx teeth, villous body parts, dark purple shade inside corolla, completely opened corolla lobes, bracteole structure and more congested inflorescence with whorled arrangement of flowers towards tip of inflorescence.

17. *Pogostemon quadrifolius* (Roxb. ex D. Don) F. Muell., Fragm. 5: 200. 1866; B.G. Kulkarni, Fl. Sindhudurg 355. 1988; R.S. Rao et al., Fl. West Godavari Dist. 331. 1986; Bhatti & Ingr., Bull. Nat. Hist. Mus. 27(2): 110. 1997; K.N. Subramanian, Fl. Thenmalai 49. 2014. **(Plate 39, 40 & 50 F)**

=*Mentha quadrifolia* Roxb. ex D. Don, Prodr. Fl. Nepal 113. 1825.

≡ *Dysophylla quadrifolia* (Roxb. ex D. Don) Benth. in Wall., Numer. List 85. 1829; T. Cooke, Fl. Bombay 535. 1906; Prain, Bengal Pl. 2: 849. 1981.

≡ *Anuragia quadrifolia* (Roxb. ex D.Don) Raizada, Suppl. Fl. Upper Gangetic Plain 7: 218. 1976.

≡ *Eusteralis quadrifolia* (Roxb. ex D.Don) Panigrahi, Phytologia 32: 478. 1976. **Type**:—INDIA, Pandua, *Wallich 1540* (isotype: M, M0009942, digital image!)

Annual erect herb or undershrub, 80–120 cm high. Stem solid, base 0.5–1.5 cm in diameter, branches 20–60 cm long, round to elliptic in cross section, rigid, hoary; internodes 5–12 cm long. Leaves whorled, normally 4 at each node rarely 2–3; linear to lanceolate, 3–10 × 0.5–1 cm, base rounded to cuneate, apex acute to slightly acuminate, margin serrate to serulate, teeth 12–20, reticulately nerved, secondary veins 5–7, veins prominent beneath, lower hoary; petiole 2–3 mm long, pubescent. Inflorescence terminal congested spikes on branch tips, dense flowered, 5–20 cm long, 1–1.5 cm across; pedicels short or absent, 0.1–0.2 cm long. Bracts oblanceolate , 2.4–2.7 × 0.5–0.6 mm, base cuneate, apex acute , margin ciliate, villous; bracteoles oblong , 1.2–1.4 × 0.2–0.3 mm, base and apex obtuse, margin ciliate. Flowers numerous, 150–500 per inflorescence, 5–6 mm long, sessile. Calyx companulate, 1.8–2.2 × 0.8–1 mm in flower and fruit, glabrous inside; teeth 5; equal 0.4–0.5 × 0.4–0.5 mm, villous. Corolla pale violet, 2–2.5 mm long, tube 1.4–1.6 mm long, straight and half included in calyx; lobes glabrescent to pubescent outside, pilose inside, hairs more near stamens; upper lip three lobed, equal, 0.5–0.6 × 0.4– 0.5 mm, apex round or ovate; lower lip single lobed, triangular, 0.6–7 × 0.5–0.6 mm. Stamens 4, exerted, filaments almost equal length; filaments 4.2–4.5 mm long, numerous lavender monoliform hairs at middle, 0.4–0.6 mm long; anthers purple 0.2–0.25 mm across. Disc 0.28–0.3 mm long, 4 lobed, lobes ca. 1mm long. Style 4.2–4.5 mm long, slender; stigma lobes unequal, 0.8–1 mm long. Nutlets 4, ca. 0.2 × 0.15 mm, orbicular, brown, spinulose.

Phenology:—Flowering and fruiting occurs during October to March.

Distribution:—South West India, Assam to China.

Habitat and Ecology:—It is mostly found in dry lateritic hillsides and disturbed places with an altitude ca. 100 ft above sea level.

Specimen examined:—**Kerala.** Kannur District: Thaliparamb, 20 September 1904, *J. S. Gamble 6474* (MH!); Thaliparambu, October 1905, *J. S. Gamble 7115* (MH!); Thaliparambu, 14 February 1913, *s.coll. 8694* (MH!); Thaliparambu, 150 m, 17 December 1931, *G. V. Narayana 39* (MH!); Madayipara, 20 August 2013*, Shinoj & Pramod 135509* (CALI!); Kasaragod District: Kumbala, 75 m, 25 January 1979, *V. J. Nair 59869* (MH!); Kumbala, 100 m, 14 October 1979, R. *Ansari 64914* (MH!); Cheruvathur, 150 m, 22 July 1981, R. *Ansari 70990* (MH!); Kozhikode District: Chelannur, 10 July 2014, *Shinoj, Syam & Arun 138321* (CALI!); Malappuram District: Calicut University Campus, Chenakkal (near lifelong learning Department), 20 January 2015*, Shinoj 138351* (CALI!); near beauty spot (road side), 2 September 2015*, Shinoj & Manu Philip 138374* (CALI!); 27 October 2016, near ladies hostel, *Shinoj & Geethika 151005* (CALI!); Vazhayur, Safi College compound, 10 November 2017, *Shinoj 150939* (CALI!).

Conservation status:—This is a common species in Western Ghats, Assam and China. Particularly seen in hilly areas with lateritic soils. Hence this species can be treated under Least concern (LC) category of IUCN.

Notes:—This taxon shows similarity to *Pogostemon myosuroides* but distinct by its large, shruby habit compared to the latter. Also the nature of inflorescence and floral characters shows much variation on close observation.

18. Pogostemon salicifolius (Dalzell ex Hook.f.) El Gazzar & L.Watson, Taxon 16: 187. 1967**;** S. Deshpande et al., Fl. Mahabaleshwar 487. 1995; Bhatti & Ingr., Bull. Nat. Hist. Mus. 27(2): 110, 1997; D.K. Mishra & N.P. Singh, Endem. Threat. Fl. Pl. Maharashtra 194. 2001. **(Plate 41, 42 & 51 C)**

= *Dysophylla salicifolia* Dalzell ex Hook.f., Fl. Brit. India 4: 638. 1885; T. Cooke, Fl. Bombay 539. 1906

≡ *Eusteralis salicifolia* (Dalzell ex Hook.f.) M.R. Almeida, Fl. Maharashtra 4A: 148. 2003.

Type (designated here):— INDIA, *Dalzell, s.n.* (lectotype: E, E00301420, digital image!)

Annual erect herb, stem 40–60 cm high. Stem hollow, base 0.3–0.5 cm in diameter, branches 20–30 cm long, round to elliptic in cross section; internodes 3–8 cm long. Leaves whorled, 4 at each node rarely 2–3; linear to lanceolate, 4–8 × 0.5–1 cm, base cuneate, apex acuminate, margin serulate to entire, mid vein prominent beneath, lateral veins not much vivid, lower surface pubescent; petiole 3–5 mm long, pubescent. Inflorescence terminal congested spikes on branch tips, 5–8 cm long, dense and many flowered, 1–1.5 cm across; peduncle short 3–5 cm long. Bracteoles ovate, 1–1.2 × 0.5–0.6 mm, base cuneate, apex acute to acuminate, margin ciliate, villous. Flowers numerous, 80–120 per inflorescence, 2–2.2 mm long, sessile. Calyx companulate, 1–1.2 × 0.8–1 mm in flower and fruit, glabrous inside; teeth 5; equal, 0.3–0.5 × 0.3–0.4 mm, villous. Corolla pale violet, 2–2.3 mm long; tube 1.8–2 mm long, straight, half included in calyx; lobes glabrescent to pubescent outside; upper lip three lobed, equal, 0.5–0.6 × 0.4– 0.5 mm, apex round or ovate; lower lip single lobed, triangular, 0.6–0.8 × 0.6–0.8 mm. Stamens 4, exerted, filaments exerted at equal length; 1–1.3 mm long, sparse hairs at middle; anthers 0.12–0.14 mm across. Disc ca. 0.1 mm long, slightly 4 lobed, lobes alternate with nutlets. Style 4.5–5 mm long, slender; stigma lobes unequal, 0.2–0.3 mm long. Nutlets 4, ca. 0.52 mm × 0.37 mm, oblong, brown, smooth.

Phenology:—Flowering and fruiting occurs during December to March.

Distribution:— Endemic to Western Ghats.

Habitat and Ecology:—It is mostly found in marshy damp areas.

Specimen examined:—**Maharashtra.** Mumbai city District: Mumbai, *Dalzell s.n.* (K!); Mumbai, 1878, *Dalzell 18* (CNH!); Pune District: Pune, 1 December 1888, *Woodrow 1721* (CNH!); Satara District: Mahabaleswar, near Lingmala falls, 4500 ft, 23 February 1956, *S.D. Mahajan 13620* (BSI!); *ibid. L.J. Sedgwick & T.R.D. Bell 4645* (CNH!); *ibid.*, *T. Cooke 69922* (MH!); November 1918, Koyna, On the way to Jangli Jaigad, 11 February 1979, *R.K. Kochar 154359* (BSI!).

Conservation status:—This is a rare species endemic to Western Ghats, especially in Karnataka and Maharashtra. More studies are required to assess it's conservation status. Hence it is treated as Data deficient (DD) as per IUCN guidelines.

Notes:—Though we visited in Mahabaleshwar and Belgaum areas for collecting this plant, we were not able to collect the fresh specimens. The characters mentioned above are based on dried herbarium specimens.

This taxon shows similarity to *Pogostemon stellatus* which is a submerged species, with fleshy habit and shorter congested inflorescence.

19. Pogostemon speciosus Benth. in Wall., Pl. Asiat. Rar. 1: 31. 1830; Benth., Lab. Gen. Spec. 156. 1833; Benth. in DC., Prodr. 12: 155. 1848; Hook. f. Fl. Brit. India 4: 637. 1885; B.D. Sharma, Fl. Nilgiri Dist. 233. 1975; B.D. Sharma et al., Fl. Karnataka 225. 1984; Rama Rao, Fl. Pl. Travancore 324. 1914; Gamble, Fl. Madras 2: 1134. 1924; Fyson, Fl. S. Ind. Hill Sta. 2: 471. 1932; Bhatti & Ingr., Bull. Nat. Hist. Mus. 27(2): 102, 1997. **Type (designated here):**—INDIA. Peninsular India, 13 November 1869, *Wight 2128* (lectotype: P, P00737563, digital image!). **(Plate 43, 44 & 50 A)**

=*Pogostemon speciosus* var. *filiformis* V.S. Kumar & B.D. Sharma, Nordic J. Bot. 15: 166. 1995. **Type**:—INDIA. Tamil Nadu, Nilgiris district, 1 February 1913, *Fischer 3540* (isotype: MH!). ***syn. nov.***

Perennial, erect herb, 100–150 cm high. Stem solid, base 2–4 cm in diameter, profusely branching, branches 80–120 cm long, quadrangular, pubescent, hairs white, 1–2 mm long; internodes 4–8 cm long. Leaves opposite deccusate, ovate, 8–12 × 5–8 cm, thin, base cordate, apex acute, margin crenate to double crenate, teeth 15–25, reticulately nerved, secondary veins 4–6, veins prominent beneath, lower slightly pubescent, especially on veins; petiole 5–7 cm long, glabrescent to pubescent. Inflorescence terminal racemes, 8–20 cm long, dense above lax below, 2–3 cm across, many flowered; pedicels short, 0.5–2 cm long. Bracts caducous, bracteoles linear 1.5 × 0.25 mm, ciliate, shorter than calyx, tip acute to obtuse, pubescent outside, hairs white, margin ciliate. Flowers numerous, 200–250 per inflorescence, sessile. Calyx companulate, ca. 5.8–6.2 mm long in flower and fruit, narrowed towards the base and mouth, gradually broadened towards the middle; tube straight, 2.8–3 mm long, glabrous inside; teeth 5, linear to lanceolate, ca. 3 mm long, median teeth of the upper lobe remain little smaller compared to the other four, pubescent with ciliate margins. Corolla ca. 6 mm long, tube ca. 2.5 mm long, straight and fully included in calyx, pale yellow or white with reddish or pink tintch inside; teeth pubescent to hispid outside, glabrous inside; lower lip, ca. 2 mm long, single lobed, white; upperlip trilobed, middle lobe longer, ca. 1 mm long and lateral lobes ca. 0.8 mm long; ovate, lateral lobes slightly broader ca. 1.8 mm broad with white hairs outside. Stamens 4, exerted, didynamous; filaments white, posterior pair ca. 9 mm long, base villous, anterior pair ca. 8 mm long, base glabrous; double the size of corolla, white; anthers pale yellow or straw coloured ca. 0.7 mm across. Disc ca. 0.5 mm long. Style ca. 8 mm long, slender; stigma lobes equal, ca. 1 mm. Nutlets 4, oblong ca. 0.672 × 0.567 mm, gland dotted, glands cup-like.

Phenology:—Flowering and fruiting occurs during November to February.

Distribution:—Endemic to southern Western Ghats.

Habitat and Ecology:—It prefers to grow in lateritic wall cuttings in humid regions of evergreen or semi-evergreen forests above 4000 ft from msl.

Specimen examined:—**Tamil Nadu.** Nilgiris District: Ooty, January 1913 *Fyson 2227* (FRC!); Lovedale, April 1920, *C. Mc. Cann 50355* (MH!); road to Kil Kotagiri, 1666 m, 5 January 1957, *K. Subramanyan 1946* (MH!); Kotagiri Ooty road side, 200 m, 8 March 1969, *D.B. Deb 31541* (MH!); Nilgiris, 2000 m, 5 January 1971, *B.V. Shetty 37715* (paratype of *Pogostemon speciosus* var. *filiformis* V.S. Kumar & B.D. Sharma (MH!); on the way to Naduvattam from balmadies estate, 1750 m, 2 February 1971, *J.L. Ellis 31841* (MH!); Pykara, 2100 m, 22 February 1972, *B.D. Sharma 39883* (MH!); Coonoor, Snowdown Reserve forest, 2400 m, 28 February 1972, *B.D. Sharma 40335* (MH!); on the way to Hiduhatti from Bikkapattimund, 1950 m, 26 March 1972, *G.V. Subbarao 40482* (MH!); Doddabetta, 22 January 1973, *Townsend & Ramamurthy 47* (K!); 8 mile towards Naduvattam, 2 February 1980, *K. Rajappan 1914* (KUBH!); Naduvattam, near Royal valley tea estate, 1843 m, 11^0 28’38.1”N, 76^0 32’36.3” E, 8 February 2016, *Shinoj 145444* (CALI!).

Conservation status:—During our exploration in Western Ghats we were able to collect few specimens from Naduvattam, in Tamil Nadu. But it was seen only as small patches with less than 50 mature individuals in Nilgiris. Moreover it is mainly distributed in road side places in tourist spots and near tea plantations and their existence in these places are under threat. Hence our opinion is to treat this species under Near Threatened (NT) category.

Note:—This taxon is very close to *Pogostemon atropurpureus* Benth. but differs from it in possessing white corolla, partially closed corolla lobes, corolla tube longer lax inflorescence and presence of glands on seeds. *Pogostemon speciosus* var. *filiformis* V.S.Kumar & B.D.Sharma does not shows much variation with this species. The author in the protologue mentioned a slight differences in hair pattern and length of calyx teeth as distinguishing characters. Since these are variable characters we treat this as a new synonym.

20. Pogostemon travancoricus Bedd., Icon. Pl. Ind. Or.: 34. 1869; M. Mohanan & A.N. Henry, Fl. Thiruvanthapuram 373. 1994; Bhatti & Ingr., Bull. Nat. Hist. Mus. 27(2): 104. 1997. **Type**:—INDIA. Travancore, Athirumalay, *Beddome 109* (holotype: BM, BM000950345, digital image!)

= *Pogostemon travancoricus* var. *devicolamensis* B.V.Shetty & Vivek., Bull. Bot. Surv. India 15: 155. 1973. **Type**:—INDIA. Kerala, Idukki district, Munnar, Devicolam, lower Vaguvarai, 1800 m, 5 February 1970, *B.V. Shetty & Vivek 33420A* (holotype: CAL!; isotypes: MH!, *33420* I, K).

(Plate 45, 46 & 50 B)

Perennial, erect herb, 100–150 cm high. Stem solid, base 2–4 cm in diameter, profusely branching, branches 80–120 cm long, quadrangular, pubescent, hairs white, 1–2 mm long; internodes 4–8 cm long. Leaves opposite deccusate, ovate, 8–12 × 5–8 cm, thin, base cordate, apex acute, margin crenate to double crenate with 15–25 teeth, reticulately nerved, secondary veins 4–6, veins prominent beneath, lower slightly pubescent, more on veins; petiole 5–7 cm long, glabrescent to pubescent. Inflorescence terminal racemes, 8–20 cm long, dense above lax below, 2–3 cm across, many flowered; pedicels short, 0.5–2 cm long. Bracts caducous, bracteoles linear 1.5 × 0.25 mm, ciliate, shorter than calyx, tip acute to obtuse, pubescent outside, hairs white, margin ciliate. Flowers numerous, 200–250 per inflorescence, sessile. Calyx companulate, 5.8–6 mm long in flower and fruit, narrowed towards base, gradually broadened towards middle; calyx tube straight, ca. 3 mm long, glabrous inside; teeth 5, triangular, ca. 3 mm long, base ca. 0.5mm broad, pubescent with ciliate margins. Corolla ca. 6 mm long, tube ca. 2.5 mm long, straight and fully included in calyx, pale yellow or white with reddish or pink tinge inside, glabrous inside; lower lip, ca. 2 mm long, single lobed, white; upperlip trilobed, middle teeth longer, ca. 1 mm long, lateral lobes ca. 0.8 mm long; ovate, lateral lobes slightly broader ca. 1.8mm broad, pubescent outside, hairs white. Stamens 4, exerted, double the size of corolla, white, didynamous; posterior pair ca. 9 mm long, base villous, anterior pair ca. 8 mm long, base glabrous; anthers pale yellow or straw coloured ca. 0.7 mm across. Disc 0.5 mm long. Style ca. 8 mm long, slender; stigma lobes equal, ca. 1 mm. Nutlets 4, oblong ca. 0.672 × 0.567 mm, gland dotted, glands cup-like.

Phenology:—Flowering and fruiting occurs during October to March.

Distribution:—Endemic to southern Western Ghats.

Habitat and Ecology:—Moist areas in grassland shola borders above 1500 m among with grasses.

Specimen examined:—**Kerala.** Idukki District: Munnar, Mankulam, 2500 ft, 10 May 1915, *Vasudeva Rao 3223* (KUBH!); Devicolam, lower vaguvarai, 1800m, 25 April 1966, *B.V.Shetty & Vivekanandan 27370B* (paratype MH!); Kollam District: Chokkampatti hills, 1700 m, 22 February 1882, *C.N. Mohanan 73446* (MH!); Trivandrum District: Agasthyamala, Pongalapara, 9 January 1996, *E.S. Santhoshkumar 25572* (FRLH!); Bonacaud, Agasthyamala, on the way to Pongalapara, 7 October 2014, *Shinoj, Prasad M.G. & Vimal 138330* (CALI!). **Tamil Nadu.** Tirunelveli District: Agasthyamali, Poonkulam, 1600 m, 5 March 1980, *M. Mohanan 66032* (MH!); Sangamuthirai, Panithrai, 1450 m, 23 February 1990, *R. Gopalan*

91644 (MH!); Poonkulam, 1400 m, 11 March 2007, *R. Murugan 23* (FRLH!); Ambasamudram, Agasthiyar hills, near Poonkulam, 1500 m, 24 April 1999 *V.S. Manickam 15334* (XCH!).

Conservation status:—During exploration in Western Ghats we were able to collect this plant from Pongalappara of Agasthyarkoodam in Trivandrum district of Kerala. Though this place is coming under protected forest area there are frequent pilgrim visitors in the month of December to January during which the plant attains the peak time of its flowering. Moreover it is distributed mainly along the path to Pongalapara. We have seen only small patches between 50 to 100 mature individuals there. There is not many herbarium sheets available for sthis plant. From the literature survey and herbarium consultation it is inferred that the plant is distributed only in Trivandrum and Idukki districts of Kerala and Tirunelveli district of Tamil Nadu. Hence our opinion is to treat this species under Near Threatened (NT) category.

Note:—This taxon is very close to *Pogostemon hedgei* V. S. Kumar & B. D. Sharma, but differs from it in possessing dark purple glabrous to pubescent calyx (vs green hirsute calyx), purplish glabrous stem, absence of leafy bract and tichomes on nutlets.

21. Pogostemon wightii Benth., Labiat. Gen. Spec. 156. 1833; B.D. Sharma et al., Fl. Karnataka 225. 1984; M. Mohanan & A.N. Henry, Fl. Thiruvanthapuram 373. 1994; Bhatti & Ingr., Bull. Nat. Hist. Mus. 27(2): 106. 1997; K.M. Mathew, Fl. Palni Hills 1011. 1999; *Pogostemon hirsutus* Wight, Icon. Pl. Ind. Orient. t. 1442. 1849, *nom. illeg*. **Type**:—INDIA, Peninsular India, *Wight 2131* (holotype P, P00737571, digital image!). **(Plate 47, 48 & 50 C)**

Annual erect herb or undershrub, 30–50 cm high. Stem solid, base 0.5–1 cm in diameter, profusely branching, branches 20–40 cm long, quadrangular to terete when mature, rigid, pubescent to distantly villous, hairs 8–9 celled, 1.7–2 mm long; internodes 3–8 cm long. Leaves opposite deccusate, ovate, 5–9 × 3–7 cm, thin, membraneous, base rounded or somewhat truncate, apex acute to acuminate, margin serrate to double serrate, major teeth 8–12, reticulately nerved, secondary veins 3–4, veins prominent beneath, glabrous to glabrescent; upper glabrous to slightly pubescent towards margin; petiole 4–8 cm long equaling the size of leaf lamina, glabrous. Inflorescence terminal spike, 4–12 cm long, 1.5–2 cm across, many flowered; pedicels short, 0.5–1 cm long. Bracts leafy; bracteoles, 4–4.2 × 1–1.2 mm, slightly villous, tip acute, margin ciliate. Flowers numerous, 60–120 per inflorescence, 5.5–6 mm long, sessile. Calyx ovate, 3.5–4 × 1.4– 1.6 mm long in flower and fruit, teeth 5; equal, 0.8–1 × 0.5–0.6 mm, villous outside, glabrous inside, throat with an annulus of hairs inside. Corolla white with a slight violet shade, 4.2–4.7 mm long; tube 2–2.5 mm long, straight and fully included in calyx; teeth pubescent to villous outside, glabrous inside; upper lip three lobed, apex round or ovate; middle lobe 0.4–0.7 mm across, more villous outside; lateral lobes broader 0.4–0.7 × 0.8–1 mm distantly villous; lower lip single lobed, triangular, 1–1.2 mm across; hairs 9–10 celled, scattered outside. Stamens 4, exerted, didynamous; upper pair 4.2–4.5 mm long, lower two 4–4.2 mm long, numerous white to violet monoliform hairs at middle, 1.2–1.5 mm long; upper two basally villous, lower two glabrous; apex purple coloured; anthers purple to dark brown when mature, 0.2–0.3 mm across. Disc 0.25–0.27 mm long. Style 5.5–6 mm long, slender; stigma lobes equal, 0.23–0.25 mm long. Nutlets 4, ca. 0.25 × 0.20 mm, obovate to orbicular.

Phenology:—Flowering and fruiting were observed during August to February.

Distribution:—South India, mainly in Karnataka, Kerala and Tamil Nadu.

Habitat and Ecology:—Usually grows in shades in moist evergreen forest floors above 1000m.

Specimens examined:—Kerala. Idukki District: Anamudi Shola N.P. (Forest road side), 13 December 2012*, Shinoj, Prasad & Vimal 290140* (CALI!); Palakkad District: Silent Valley N.P., on the way to Sisspara from Walakkad (forest floor), 6 February 2014*, Shinoj & Vimal 135974* (CALI!). **Tamil Nadu.** Nilgiris District: Ooty, Naduvattam, near Royal valley tea estate, 1843 m, 11^{0} 28'37.3"N, 76^{0} 32'36.4"E, 8 February 2016, *Shinoj 145445* (CALI!); Pulney District: Kodaikanal, on the way to Pillar rock, 1940 m, 25 February 2014, *Shinoj, Sreejith & Kabeer 135993* (CALI!).

Conservation status:—This is a wide spread species in evergreen forest of Karnataka, Kerala and Tamil Nadu. We met denser population in Nilgiris and Anamalais during our field trips. Hence it is categorised under Least Concern (LC) category according to IUCN.

Notes:—This is the only South Indian species coming under the section *Zygocalyx*. Hence it was easy to identify from the rest. This plant shows slight similarities to *Pogostemon mollis* and *P. nilagiricus* but differs from both by the zygomorphic nature of its calyx.

ANISOCHILUS Wall. ex Benth.

Anisochilus Wall. ex Benth., Edwards's Bot. Reg. 15: sub t. 1300. 1830; Benth. in Wall., P1. Asiat. Rar. 2: 18. 1830; Labiat. Gen. Spec. 59. 1832; Benth. in DC., Prodr. 12: 80. 1848; Benth. in Benth. & Hook. f., Gen. P1. 2: 1177. 1876; Hook. f., Fl. Brit. India 4: 627. 1885; H. Trimen, A Hanb. Fl. Ceylon 3: 376. 1895; Briq. in Engler & Prantl, Nat. Pflanzenfam. 4 (3A): 350. 1897; T. Cooke, Fl. Bombay 2: 531. 1905; Gamble, Fl. Madras 2: 1127. 1921; Fyson, Fl. S. Ind. Hill Sta. 2: 469. 1932; Doan in Lecomte, Fl. Indo-Chine 4: 941. 1936; Mukerjee, Rec. Bot. Surv. India 14: 56. 1940; B.D. Sharma, Fl. Nilgiri Dist. 225. 1975; Hsuan in Wu & Li, Fl. Reipubl. Popularis Sin. 66: 411. 1977; Prain, Bengal Pl. 2: 847, 1981; L.H. Cramer in Dassan. & Fosberg, Rev. Hanb. Fl. Ceylon 3: 151. 1981; B.D. Sharma et al., Fl. Karnataka 218. 1984; B.D. Neithani, Fl. Chamoli 2: 502. 1985; Ahmadullah & Nayar, Endem. Pl. Indian reg. 1: 133. 1986; R.S. Rao et al., Fl. West Godavari Dist. 331. 1986; R.S. Rao et al., Fl. Goa, Diu, Daman, Dadra & Nagar haveli 2: 343. 1986; Kamble & S.G. Pradan, Fl. Akola Dist. 179. 1988; B.G. Kulkarni, Fl. Sindhudurg 350. 1988; T. Pullaiah & N. Yesoda, Fl. Anantapur Dist. 198. 1989; J.L. Ellis, Fl. Nallamalais 2: 328. 1990; Kesh. Murthy & S.N. Yogan., Fl. Coorg 352. 1990; Vajr. Fl. Palghat Dist. 372. 1990; Li & Hedge in Wu & Raven, Fl. China 17: 268. 1994; M. Mohanan & A.N. Henry, Fl. Thiruvanthapuram 364. 1994; S. Deshpande et al., Fl. Mahabaleshwar 467. 1995; Sivar. & P. Mathew, Fl. Nilambur 542. 1996; K.M. Mathew, Fl. Palni Hills 983. 1999; Kulkarni & Das in Singh et al., Fl. Maharashtra St. Dicot 2: 713. 2001; S.R. Yadav & M.M. Sardesai, Fl. Kolhapur Dist. 377. 2002; T.K. Sharma & A.K. Sarkar, Fl. Palmau Dist. 3: 495. 2002; K.G. Bhat, Fl. Udupi 510. 2003; R.M. Harley et al., in K. Kubitzki (ed.). Fam. & Gen. Vasc. Pl. 7: 226. 2004; H.J. Noltie, The Botany of Robert Wight. Regnum Veg., 145: 298–299. 2005; S. Sudee & A. Paton, Kew. Bull. 64(2): 235–237. 2009.

≡ *Lavandula carnosa* L.f., Suppl. Pl. 273. 1782; Amoen. Acad. 10: 56. t.3. 1790.

Type:—*Anisochilus carnosus* (L. f.) Wall. ex Benth.

Erect, ascending, decumbent or prostrate herbs or undershrubs. Stems quadrangular or round-quadrangular or terete, often fleshy, pubescent to tomentose or villous with red or yellow sessile glands, branched or not. Leaves sessile, subsessile or petiolate, opposite or whorled, membranous to chartaceous, usually fleshy, entire, crenate, serrate or dentate. Inflorescence terminal, simple, or opposite and decussately branched and paniculate; adjacent verticils arranged close together forming a dense tetragonal or cylindrical spike-like inflorescence; cymes sessile, unbranched, few to many-flowered; bracts caducous, sessile, often forming a coma on the top of the inflorescence. Calyx ovoid or tubular in flower, oblique-tubular in fruit, suberect, clearly bilabiate or obliquely 5-toothed; posterior lip 1 or 3-lobed, recurved, or deflexed and concealing throat after anthesis; anterior lip 2 or 4-lobed, short, sometimes appearing truncate, minutely toothed, or absent; tube oblique, usually constricted at throat and ventrally saccate around the middle, with 10–12 longitudinal veins, prominent inside, without spur at anterior base; throat glabrous. Corolla much exerted from calyx tube; posterior lip shortly 3–4-lobed, equal or the median lobes larger; anterior lip entire, elongate, concave, longer than posterior; tube gradually dilated towards throat and decurved above around midpoint, or abruptly expanded around midpoint with narrow slender base, villous, pubescent or glabrous. Stamens 4, didynamous, declinate, slightly exserted, not exceeding the anterior corolla lip, glabrous, inappendiculate, anterior pair slightly longer; posterior and anterior pairs attached on corolla throat at the base of anterior corolla lobe; filaments free; anther reniform, synthecous, back usually with sessile glands, often confluent. Ovary glabrous; style declinate, stigma shortly bifid with subequal branches.

Disc lobed, anterior side well developed, exceeding the ovary. Nutlets orbicular, ovoid, ellipsoid, or oblong, smooth, shining, basal scar small, mature nutlets usually producing mucilage when wetted.

Notes:—The genus *Anisochilus* shows close similarity to *Plectranthus* in the nature of corolla. Both the genera have boat shaped corolla with tube gradually dilated towards throat and decurved above around midpoint, or abruptly expanded around midpoint with narrow slender base. Some species like *Plectranthus montanus, P. barbatus, P. caninus*, etc. shows close similarities in corolla, inflorescence and vegetative characters with the species coming under the section *Anisochilus.* But they differ in the nature of calyx. The calyx in the section *Anisochilus* show four short sometimes truncate posterior teeth whereas in the genus *Plectranthus* the posterior teeth of the calyx are long and prominent.

Key to species of genus *Anisochilus* in Western Ghats

1a. Calyx teeth of posterior lip ovate and deflexed; anterior lip truncate **2**

1b. Calyx teeth of posterior lip elongate and incumbent; anterior lip incurved and oblique.. **8**

2a. Congested spike Inflorescence > 10 in number **3**

2b. Congested spike Inflorescence < 10 in number **4**

3a. Secondary peduncles > 3 cm, spike head > 3 cm .... **5. *A. eriocephalus***

3b. Secondary peduncles < 3 cm, spike head < 3 cm .... **7. *A. paniculatus***

4a. Spike-like head long and narrow cylindric, more than 3 times as long as broad **5**

4b. Spike-like head ovoid to ovoid-cylindric, less than 3 times as long as broad **6**

5a. Leaves orbicular with purple margins, inflorescence dark purple or black when dry .... **13.** ***A. wightii***

5b. Leaves ovate without purple margins, inflorescence white, brown when dry ... . **14.** ***A.*** **sp.1**

6a. Leaves ovate, inflorescence simple or 2–3 branched............ **10.** ***A. scaber***

6b. Leaves orbicular or cordate, inflorescence usually 3–5 branched 7

7a. Habit erect, leaf base cordate, secondary peduncles > 4 cm..**3.** ***A. carnosus***

7b. Habit decumbent, leaf base rounded secondary peduncles < 4 cm............ .... **6.** ***A. kanyakumariensis***

8a. Robust shrubs, upto 3 m high .... **9.** ***A. robustus***

8b. Herbs or under shrubs, < 2 m high **9**

9a. Leaves linear, > 5 cm, viens prominent on both surfaces ...**1.** ***A. adenanthus***

9b. Leaves oblong, ovate or lanceolate, < 5 cm, veins prominent only on lower surface **10**

10a. Phyllotaxy whorled **11**

10b. Phyllotaxy opposite decussate **12**

11a. Habit erect, leaves upto 8 cm long, base attenuate, inflorescence upto 7 cm long ....**11.** ***A. shoolamudianus***

11b. Habit procumbent, leaves upto 5 cm long, base cuneate, inflorescence upto 18 cm long .... **2.** ***A. argenteus***

12a. Numerous inflorescences arising from terminal region of each branch, peduncles > 5 cm long ....**12.** ***A. suffruticosus***

12b. Single inflorescence arises from the terminal region of each branch, peduncles < 5 cm long **13**

13a. Inflorescence terminal only, leaves narrow oblong ......**8. *A. plantagineus***

13b. Inflorescence terminal and axillary, leaves broad oblong .... **4. *A. dysophylloides***

1. Anisochilus adenanthus Dalzell & A. Gibson, Bombay Fl. 206. 1861; S. Sudee & A. Paton, Kew. Bull. 64(2): 235. 2009. **Type**:—INDIA, Concan, near Dharwar, Bababoodan hills, April 1878, *Dalzell s.n.* (holotype: K, K000674763, digital image!). **(Plate 53, 54 & 81 A)**

= *Anisochilus verticillatus* Hook. f., Fl. Brit. India 4: 629. 1885; T. Cooke, Fl. Pres. Bombay 2: 451. 1906; Gamble, Fl. Madras 2: 1125. 1921; Mukerjee, Rec. Bot. Surv. India 14 (1): 59. 1940; B.D. Sharma et al., Fl. Karnataka 189. 1984; Ahmadullah & M.P. Nayar, Endem. Pl. Indian reg, 1: 135. 1986; B.G. Kulkarni, Fl. Sindhudurg 352. 1988; P. Lakshmin & B.D. Sharma, Fl. Nashik Dist. 468. 1991; N. Sasid., Fl. Periyar Tiger Reserve 316. 1998; Anilkumar et al., Fl. Pathanamthitta 398. 2005. **Type**:—INDIA, The Concan, Cheetah hills, *Dalzell s.n.* (lectotype: K, K000674763, digital image!).

Erect annual brittle herb or short lived perennial under shrub, 1–2 m high; perennial from woody basal stem. Stem 2–3 cm across at base, profusely branching up, branches 50–120 cm long, quadrangular, grooved, silky villous ridges, furrows glabrescent; internodes 6–15 cm long. Leaves 3–4, whorled, subsessile to sessile, linear-lanceolate or oblong, 7–10 × 2–3 cm, base attenuate, apex acute, margin entire or serrulate, lateral veins 6–7, prominent beneath; silky villous or slightly tomentose beneath, pubescent above; petiole 1–2 mm long. Inflorescence terminal, mostly a single spike on branch tips, apex narrowed, 15–30 cm long. Bracts caducous, sessile, ca. 8–10 × 2.5 mm, ovate with acuminate tip, densely pubescent to villous. Calyx ovoid, ca. 1.8–2 × 1–1.2 mm at anthesis, densely villous, obliquely 5-toothed; posterior lip 3-lobed, recurved, or deflexed and concealing throat after anthesis; anterior lip 2-lobed, short, sometimes appearing truncate, teeth 5, minute, oblique, usually constricted at throat and ventrally saccate around the middle, glabrous inside, tomentose outside; fruiting calyx ca. 4mm long; hairs 4–5 celled. Corolla 4.8–5.2 long, 2.8–3 mm broad, white to bluish white; posterior lip shortly 4-lobed, subequal with larger median lobes 0.7–0.8 mm long, lateral lobes shorter ca. 0.2 mm; anterior lip ca. 2 mm long, entire, elongate, concave, longer than posterior; tube 2–2.2 mm, fully included in the calyx, gradually dilated towards throat, decurved above around midpoint, pubescent. Stamens 4, didynamous, declinate, slightly exserted, not exceeding the anterior corolla lip, glabrous, inappendiculate, anterior pair slightly longer; posterior and anterior pairs attached on corolla throat at the base of anterior corolla lobe, included in anterior corolla lip; filaments free, posterior pair ca. 1.3 mm long, anterior pair ca. 1.8 mm long; anther reniform, synthecous, back usually with sessile glands, often confluent; anthers bilobed, dorsifixed, ca. 0.2 mm long, dehisces longitudinally. Disc lobed, anterior side well-developed, exceeding the ovary. Ovary glabrous. Style ca. 10 mm long, declinate; stigma shortly bifid with subequal branches, longer one ca. 0.15 mm long. Nutlets ca. 0.2 mm across brown ovoid to orbicular, smooth, shining, basal scar small, mature nutlets usually producing mucilage when wetted.

Phenology:—Flowering and fruiting were observed during September to December.

Distribution:—Endemic to Peninsular India. In Western Ghats this species is reported from Cheetah Hills of Purwar Ghat, Sindhudurg and Phonda of

Maharashtra, Belgaum, Chikmagalur and Mysore of Karnataka and Periyar Tiger Reserve of Kerala and Coimbatore of Tamil Nadu.

Habitat and Ecology:—Usually seen in moist deciduous forests and disturbed rocky plateaus intermingled with grasses.

Specimens examined:—Karnataka. Mysore District: Mysore, near Hanumat koil, 900 m, 26 Janury 1916 *B.D. Naithani 23165* (MH!). **Kerala.** Idukki District: Moolamattam, 1000 m, 12 October 1998, *Sunil 2173* (CALI); Thiruvananthapuram District: Kaldurity rock, 11 September 1913, *Cladder & Ramaswami 820* (CALI!); Kottur R.F., 300 m, 27 September 1973, *J. Joseph 44435* (MH!). **Maharashtra.** Kolhapur District: Navikurli, Phonda, 59 m, 9 September 2017, *Shinoj, Soumya & Resmi 151054* (CALI!). **Tamil Nadu.** Coimbatore District: Hassanur, 3700", 1 January 1906, *Fischer 1378* (CALI!); Kollegal, Gargathihola, 2900', 25 November 1937, *K. Cherian Jacob 485* (MH!).

Conservation status:—This species is found fairly widespread in the Deccan Peninsula as per the herbarium assessment and literature survey, including the recent revisionary work of Suddee and Paton (2005) conducted in this study. We collected this species only from Phonda of Maharashtra, where dense population was observed. This species is also reported from Parambikulam Wildlife Sanctuary. As per the available data this species can be assessed under the category Least Concerned (LC) following IUCN rules.

Notes:—*Anisochilus adenanthus* was first described by Dalzell and Gibson (1861) in *Bombay flora*. But Hooker (1885) did not come across this name and introduced a new name *Anisochilus verticillatus* for the plant he described in *Flora of British India*. This lead to a cascade of wrong identification and many botanists like Cooke, Gamble, Mukerjee followed this name. However in their recent revisionary work, Sudee and Paton (2004) noticed this fact and retinstated the name *Anisochilus adenanthus* and synonymised the name *A. verticillatus* under it.

2. Anisochilus argenteus Gamble, Fl. Madras, 2: 1127. 1921; Mukerjee, Rec. Bot. Surv. India, 14: 61. 1940; Ahmedullah & Nayar, Endem. Pl. Indian reg., 1: 133. 1986; S. Sudee & A. Paton, Kew. Bull 64(2): 250–251. 2009. **Type**:—INDIA, Madras, Pulney Hills, Kodaikanal Ghat new road, 29 Dec. 1898, *Bourne 1441* (lectotype: K, K000674753, digital image!)

(Plate 55, 56 & 81 B)

Ascending or decumbent annual or perennial succulent herb or stout under shrub upto 80 cm high, base 1–2 cm in diameter; profusely branching; branches 40–60 cm long, almost terete, grooved when dry, silvery tawny tomentose; internodes 0.5–1 cm long. Leaves whorled, 3–4 per node, alternate with the adjacent whorl at the other node giving a rosette or whorled appearance, sessile, obovate to oblanceolate, 2–4.5 × 1–1.5 cm, thick, chartaceous, base cuneate, apex obtuse, margin entire or serrulate, densely silvery or tawny tomentose hairs on both surface, veination invisible; petiole absent. Inflorescence terminal, congested spike, subtended by a pair of leaves, 4–7.5 × 1–2 cm, linearly elliptic, dense, many flowered. Bracts caducous, sessile, ovate to lanceolate with acuminate tip ca. 1.5 × 1 mm long, densely villous. Calyx ovoid 1.8–2.2 × 1.4–1.7 mm, teeth 5; posterior lip 3-lobed, recurved, or deflexed and concealing throat after anthesis; anterior lip 2-lobed, tube glabrous inside, densely tomentose outside. Corolla ca. 3.5 × 3 mm, pale yellow or off white, exerted from calyx, posterior lip shortly 4-lobed, lobes curved outside, 0.2–0.4 mm long; anterior lip entire, elongate, 1.8–2 mm, concave at younger stage and convex at older stage, longer than posterior; tube ca. 2 mm long, gradually dilated towards throat, pubescent to distantly villous with orange colour glands. Stamens exserted, exceeding the anterior corolla lip, inappendiculate, attached on corolla throat at the base of anterior corolla lobe included in anterior corolla lip, anterior pair slightly longer; filaments free, glabrous, posterior pair 2–2.2 mm long, anterior pair 1.6–1.8 mm long, anther purple coloured at maturity, reniform, synthecous, usually with sessile glands on back side, often confluent, anthers bilobed, dorsifixed, ca. 0.6 mm long, dehisces longitudinally. Disc lobe not much prominent, creamy yellow with orange sessile glands. Ovary glabrous. Style ca. 5 mm long; stigma shortly bifid with equal lobes, ca. 0.23 mm long. Nutlets brown ovoid, 1–1.2 × 0.6–1 mm, smooth, mature nutlets usually producing mucilage when wetted.

Phenology:—Flowering and fruiting were observed during July to March.

Distribution:—Endemic to southern India. In Western Ghats so far reported only from Pulney Hills of Tamil Nadu and Idukki district of Kerala.

Habitat and Ecology:—Rare on open rock surface above 1500 m.

Specimens examined:—Kerala. Idukki District: Mathikettan shola N.P., Vellapara, 19 December 2016, *Shinoj & Syam 151028* (CALI!); Choondal, 5 January 2017, *Shinoj, Dani & Syam 151041* (CALI!). **Tamil Nadu.** Madras, Pulney Hills, Kodaikanal Ghat new road, 11 Nov. 1897, *Bourne 885* (K!); Madras, Pulney Hills, Kodaikanal, Lidcot Valley, 2 July 1898, *Bourne 1036* (K!); Madras, Pulney Hills, Kodaikanal Ghat new road, 26 December 1898, *Bourne 1441A* (K!); 28 Decemner 1898, *Bourne 1441B* (K!); *s.l.,* 29 December 1898, *Bourne 1441C* (K!); *s.l., s.d., Saldanha CS 5190* (K!); Madura District: Pulneys Hills, March 1923, *Herb. Mrs M. A. Evershed s.n.* (BM); Kodaikanal, on rocky slopes of the side of bear shola, 20 March 1960, *D. Daulsunday & S. Subbaranrao 93861* (MH!); Pulney Hills, July 1984, *s.coll.* 40900 (MH!); Dindigul, Kodaikanal, Tiger Shola, rock halfway across to Korappur, 1800 m, 1 August 1986, *Matthew RHT 46120* (K); Madras, Dindigul, Kodaikanal, Perumal peak, northern slopes, 2150 m, 12 Decmber

1986, *Matthew RHT 47921* (K); *s.l., s.d., s. coll.* 16579 (MH!); Madurai District: Pachakumatchi Hills, Varayattumottai, 1600 m, *V. Lakshmanan 91191* (MH!).

Conservation status: — Matthew (1999) described it as common species in Pulney Hills although Henry et al. (1987) recorded this species as rare and endangered. We were able to collect the specimen from Choondal Hills of Mathikettan shola National Park of Idukki District in Kerala were it was seen only as few population less than 100 mature individuals, but the distance between Mathikettan National Park and Pulney Hills is around 200 km, which indicates that the area of occupancy is more than 20000 km^2. After analysing herbarium data we could confirm that majority areas of distribution are coming outside protected areas and many of these are tourist places. Hence our we treat this species under Near Threatened (NT) category.

Notes:—*Anisochilus argenteus* is an elegant herb with succulent rosette leaves which can be utilised for ornamental purpose. This species shows similarities to *A. shoolamudianus* but differ from it in having stouter plant body, short internodes, leaves and long slender inflorescence.

3. Anisochilus carnosus (L.f.) Wall. ex Benth., Pl. Asiat. Rar. 2: 1300. 1830; DC. Prodr. 81. 1848; Hook.f., Fl. Brit. India 4: 627. 1885; H. Trimen, A Hanb. Fl. Ceylon 3: 376. 1895; T. Cooke, Fl. Pres. Bombay 450. 1906; Gamble, Fl. Pres. Madras 2: 1127. 1921; Mukerjee, Rec. Bot. Surv. India 14 (1): 58. 1940; B.D. Sharma, Fl. Nilgiri Dist. 225. 1975; L.H. Cramer in Dassan. & Fosberg, Rev. Hanb. Fl. Ceylon 3: 151. 1981; Prain, Bengal Pl. 2: 847. 1981; B.D. Sharma et al., Fl. Karnataka 2: 225. 1984; Manilal & Sivar., Fl. Calicut 235. 1982; Mohanan, Fl. Quilon Dist. 319. 1984; B.D. Naithani, Fl. Chamoli 502. 1985; S.Y. Kamble & S.G. Pradan, Fl. Akola Dist. 179. 1988; V.S. Ramach. & V.J. Nair, Fl. Cannanore Dist. 318. 1988; J.L. Ellis, Fl. Nallamalais 2: 328. 1990; Kesh. Murthy & S.N. Yogan., Fl. Coorg. 352.

1990; Vajravelu, Fl. Palghat Dist. 372. 1990; P. Lakshmin. & B.D. Sharma, Fl. Nashik Dist. 468. 1991. M. Mohanan & A.N. Henry, Fl. Thiruvanthapuram 364. 1994; S. Deshpande et al., Fl. Mahabaleshwar & adj. Maharashtra 467. 1995; Sivarajan & P. Mathew, Fl. Nilambur 543. 1996; K.M. Mathew, Fl. Palni Hills 983. 1999; Kulkarni & Das in Singh et al., Fl. Maharashtra 2: 713. 2001; S.R. Yadav & M.M. Sardesai, Fl. Kolhapur Dist. 377. 2002; T.K. Sharma & A.K. Sarkar, Fl. Palmau Dist. 495. 2002; K.G. Bhat, Fl. Udupi 510. 2003; S. Sudee & A. Paton, Kew. Bull. 64(2): 235–237. 2009.

≡ *Lavandula carnosa* L. f, Suppl. Pl. 273. 1782; Amoen. Acad. 10: 56. t.3. 1790, **Type**:— *Koenig s.n.,* [holotype: C, C10012982. digital image!].

(Plate 57, 58, 59 & 81 C)

= *Plectranthus dubius* Spreng., Syst. Veg. 691. 1825. *nom illeg.*

= *Plectranthus strobiliferus* Roxb., Hort. Beng. 45. 1814; Hook.f., Fl. Indica 23: 1832.. **Type**:—'Katu-Kurka', Illustration in Rheede, Hort. Malab. 10: 179, t. 90. 1690, (holotype: illustration!).

= *Anisochilus carnosus* (L.f.) Wall. ex Benth. var. *purpurascens* Benth., Pl. Asiat. Rar. 2: 1300. 1830; Labiat. Gen. Spec. 60. 1832; DC. Prodr. 81. 1848; Hook.f., Fl. Brit. India 4: 627. 1885, **Type**:—MYANMAR, in monte Taong Dong Ava, 24 Nov. 1826, *Wall. Cat. 2753A* (lectotype: K, digital image!).

= *Anisochilus glaber* Schrad. Index seminum Hort. 1833: 1; Ausz. aus den Saam. Botan. Gärt. für das Jahr 1836: 69. Year; *Anisochilus carnosus* (L.f.) Wall, ex Benth. var. *glabras* (Schrad.) Benth., Labiat. Gen. Spec. Suppl. 711. 1835, as 'glabrum.; *Anisochilus carnosus* (L.f.) Wall, ex Benth. var. *glabrior* (Schrad.) Benth. in DC., Prodr. 81. 1848; Hook.f., Fl. Brit. India 4: 627.

1885, **Type**:—INDIA, W. Himalaya, to 2400 m, *Edgworth 14* (neotype: K, digital image!)

= *Anisochilus carnosus* (L.f.) Wall. ex Benth. var. v*illosior* Benth. in DC., Prodr. 81. 1848; Hook.f., Fl. Brit. India 4: 627. 1885, **Type**:—INDIA, Deccan Peninsula. *s.d.*, *Herb. Wight 2516* (lectotype: K, digital image!).

= *Anisochilus carnosus* (L.f.) Wall., ex Benth. var. *viridis* Benth. in DC. Prodr. 81. 1848; Hook.f., Fl. Brit. India 4: 627. 1885. **Type**:—DECCAN PENINSULA, *s.d., Herb. Wight 2521,* [holotype: K, digital image! (Herb. Benthamianum, with *A. rupestris* Wight MSS)].

= *Anisochilus crassus* Benth. in DC. Prodr. 81. 1848. **Type**: DECCAN PENINSULA, *Wight. 2517* (lectotype: K, digital image!).

= *Anisochilus petraeus* J. Mathew & Yohannan, Taiwania 62: 144. 2017. **Type**:—INDIA: Kerala, Kollam District: 1.5 km from Achankovil town, Achankovil, 9°06′51.03″N, 77°12′ 08.2″E, 95 m, 24 August 2013, *J. Mathew 4527* (holotype: TBGT!, isotype: MSSRF!).

Erect annual succulent herbs, upto 100 cm high, unbranched or branched; branches 40–60 cm long, quadrangular, grooved when dry, pubescent; internodes 3–5 cm long. Leaves opposite decussate, petiole 3–5 cm, pubescent; lamina broadly ovate 4–8 × 4–6 cm, carnose, base cordate, apex acute, margin crenate with 15–20 teeth, secondary veins 6–8, veins prominent on both surface, tomentose beneath, pubescent above, minute sessile glands present on both the surfaces. Inflorescence mostly terminal branched; both main and secondary branches end in a congested spike, 3–7 in an inflorescence, arranged opposite decussate with a single terminal spike and 2–6 lateral spikes; individual spike heads long tetragonal in young and cylindrical in fruit, 30–60 mm long. Bracts ovate 4–4.2 × 2.8–3 mm, pubescent with sessile glands on both surfaces; bracteole ovate 1.3–1.5 × 1–1.2 mm, distantly villous outside, glabrous inside. Calyx ovoid to cylindrical 2.8–3 × 1–1.2 mm when posterior lip opened, 1.8–2 × 0.8–1 mm when closed, pubescent with bright red sessile glands; fruiting calyx 2.8–3.2 mm long; posterior lip single lobed, dome shaped, tip acute to acuminate, ciliate to villous; hairs 4–5 celled; anterior lip obscure, teeth 4. Corolla 8.5–10 × 4–4.2 mm long, with lavender corolla tube and dark blue corolla lips; posterior lip shortly 4-lobed, 0.7–0.9 mm long; anterior lip entire, elongate, concave at younger stage and convex at older stage, longer than posterior; 1.6–2 × 1–1.4 mm, obtuse to rounded at apex; base of the corolla tube narrow and glabrous or distantly villous. Stamens 4, free, attached at the mouth of the corolla tube, didynamous, posterior pair attached just below anterior but not united, filament of posterior 1.8–2.2 mm long, anterior pair 2.8–3 mm long, appendages absent, included in anterior corolla lip; anthers bilobed, dorsifixed, 0.46–0.48 mm long, violet (when mature), dehisces longitudinally. Disc cup shaped unequally 4 lobed with anterior lobe enlarged 4–4.2 mm, lateral lobes 2–2.2 mm long; style 8–10 mm long; stigma 0.18–2 mm long, bifid. Nutlets 0.6–0.7 × 0.4–0.5 mm brown round to ellipsoid.

Phenology:—Flowering from September to December, fruiting from October to January.

Distribution:—*Anisochilus carnosus* is distributed mainly in Nepal, India, Assam, Sri Lanka, Burma and South China. In India it is mainly distributed in Western Gats, Malabar coast, Assam and Sikkim. A recent study by Ali et al.. (2017) added its presence in Swabi area of Pakisthan.

Habitat and ecology:—The plant usually grows on humus rich rocks and even on building roof amidst mosses.

Specimens examined:— **Karnataka.** Bagalkot District: Badami, hills behind cave temple, 578 m, 15^0 55'24.678"N $75^0$41'38.168" E, 2 December 2017, *K. Shinoj & Jagdish Dalavi 150936* (CALI!); Bijapur District: Badami, 17 October 1892, *W.A. Talbot 2815* (BSI!); Chikmagalur District: Sukkalhalli, Kaliadi, 25 November 1970, *R.S. Raghavan 126630* (BSI!); South Canara District: Pilarkhan R.F., 150 m, 8 November 1981, *S.R. Srinivasan 72344* (CAL!). **Kerala.** Ernakulam District: Neriamangalam, Karimanal, 18 December 2016, *Shinoj 151034* (CALI!); Idukki District: Chinnar WLS (Forest rock surface near dormitory), 3 January 2014*, Shinoj, Prasad & Vimal 135946* (CALI!); Kannur District: Tholpetty Coffee plantation, 825 m, 22 November 1977, *V.S. Ramachandran 52288* (CAL!); Kollam District: Kumaramapuram, Konni R.F., 150 m, *M. Chandrabose 49008* (CAL!); Achankovil, near new Forest Inspection Bangalow, 06 December 2017, *Shinoj 150938* (CALI!); Kozhikode District: Kappad shore, 9 November 1972, *T. A. Rao 9840* (CAL!); Balussery, Vayalada, 2 January 2017*, Shinoj 151038* (CALI!); Malappuram District: Thenjipalam, 25 October 1983, *A. Babu 36366* (CAL!); Calicut University Campus (on roofs of pareeksha bhavan), 1 November 2013*, Shinoj 135583* (CALI!); Nilambur, Adyanpara, 149 m, 11 February 2016, *Shinoj 145452* (CALI!); Ponnani, near harbour, 20 September 2016, *Shinoj 145498* (CALI!); Palakkad District: Kanjikode, 4 May 1958, *G.S. Puri 36317* (BSI Nelliampathy, Manpara, 20 August 2013, *K. Shinoj & P. Sunojkumar 135539* (CALI!); Nelliampathy (Manpara), 20 September 2013*, Shinoj & Vinod 135539* (CALI!), Ottappalam, Anangamala, 6 December 2013*, Shinoj & Soumya 135901* (CALI!); Trissur District: Vettllipara to Athirapally, elev. 350 m, 27 November 1982, *K. Ramamurthy*

75566 (CAL!); Trivandrum District: Aruvikkara, 150 m, 15 November 1979, *M. Mohanan 63859* (CAL!); Trivandrum, *C.C. Clader & M.S. Ramaswami 471* (CAL!); Wayanad District: Manikkunnumala, near MSSRF, 28 November 2013, *Shinoj & Vimal 135587* (CALI!). **Maharashtra.** Kolhapur district: Solankur, Radhanagri road, open roof of shops, 514 m, 9 September 2017, *Shinoj, Sharad & Resmi 151060* (CALI!); Nashik district: Brahmagiri, on rocky walls of temple, 950 m, 16 September 2017, *Shinoj, Sharad & Manju 1510548* (CALI!). **Tamil Nadu.** Coimbatore District: Ethuruboli, 4400', 2 December 1905, *C.E.C. Fisher 704* (CAL!); Kuridimalai, 766 m, 21 December 1951, *K. Subramanyam 1832* (CAL!); Maruthamalai, 653 m, 29 December 1956, *K.M. Sebastine 1861* (CAL!); Palani District: Anamalai Hills, Mount Stuart, 11 January 1916, *C.E.C. Fischer 3860* (CAL!); Madras, Devanakonda, 3000', 7 October 1920, *V. Narayanaswami 471* (CAL!); Ramanathapuram District: Periathusuragam, Khansapuram, 16 February 1979, *N.C. Nair 60890* (CAL!); Chinnakokkal, Yelagiri Hills, 980 m, 13 December 1984, *M.B. Viswanathan 676* (CAL!); Tirunelveli District: Courtallum, Nellai Kattabomman, 9 March 1994, *S.P. Subramani 003900* (FRLH!); Puthukottai, Kathakkurichy, 100 m, *N. Ganapathy 51880* (FRLH!); Nilgiri District: Ooty, Burliar road, 18 December 2012, *K. Shinoj & K.P. Vimal 135911* (CALI!).

Conservation status:—It is a wide spread species showing dense vegetation, hence this is treated under the category Least concern (LC).

Notes:—*Anisochilus carnosus* shows similarity to *A. eriocephalus* and *A. kanyakumariensis*. Cooke treated *A. eriocephalus* as one of the synonyms of *A. carnosus* with more slender peduncles. Prain (1981) and Suddee and Paton (2009) also considered *A. carnosus* and *A. eriocephalus* as conspecific due to their striking similarities during vegetative phase and herborized specimens. But our critical observation proved that *A. eriocephalus* can be no more considered as synonym under *A. carnosus. Anisochilus kanyakumariensis* is also similar to *A. carnosus* but differs from it by its decumbent habit, orbicular leaf, short petiole, cylindrical inflorescence, densely villous calyx and corolla.

Anisochilus petraeus J. Mathew & Yohannan (Matthew et al. 2017) a recently published species is a local variant, seemingly due to physiological reasons. It doesn't even show any variation in morphological characters. *A. carnosus* usually grows on humus rich rocks and even on building roof amidst mosses with abundant sunlight. The authors collected the plant from a shady place in Achankovil near forest Inspection Bungalow, where a very few population was growing among grasses on rocky surfaces and the area was shaded by growth of trees. We contacted the authors and were able to locate the exact place and found that these plants were growing among grasses and for sunlight requirement plants exhibited elongated internodes. The inflorescence was deformed due to improper growth and not due to any other reason. We did a thorough survey of the neighbouring areas and found that the plants in sunlight were showing typical characters of *A. carnosus*. We collected the plant and a detailed observation of the floral parts were carried out and its identity was confirmed to be *A. carnosus* and the name *Anisochilus petraeus* J. Mathew & Yohannan is treated here as a new synonym.

Table used by J. Mathew and Yohannan as Diagnostic morphological characters of *Anisochilus patraeus* and *A. carnosus* and our remarks.

Characters		*Anisochilus patraeus*	*Anisochilus carnosus*	remarks
habit		herbs, 25 cm tall	subshrubs, 20–100 cm tall	According to the habitat and climate *Anisochilus carnosus* varies from small delicate plants to undershrub nature
leaf	colour	dark green above	pale green above	Leaves are highly variable in *Anisochilus carnosus*
	base	Unequal and obtuse	equal and cordate but varaible	
	serrations	distally	serrate throughout	
	size	upto 25 × 22 mm	upto 20–105 × 20–60 mm	Under stress smaller leaves are seen in *Anisochilus carnosus*
Peduncle (size)		short, upto 3 cm	2–12 cm in size	Size varies according to availability of light
Inflorescence		simple spike, cylindrical, 2.5– 3.5 cm long	Simple or basally branched spike, tetragonal or cylindrical, single spike 3–8 cm long	individual spike heads long tetragonal in young and cylindrical in fruit
flowers		arranged in circular manner	arranged in circular or pyramidal manner	varies after maturation of inflorescence
seeds		ovoid	ovoid to orbicular	Shape of seeds varies according to maturation

4. Anisochilus dysophylloides Benth. in Wall., Pl. Asiat. Rar. 2: 19. 1830; B.D. Sharma et al., Fl. Karnataka 225. 1984; Gamble, Fl. Madras 2: 1128. 1921; Fyson, Fl. S. Ind. Hill. Sta. 469. 1932; Mukerjee, Rec. Bot. Surv. India 14 (1): 60. 1940; B.D. Sharma, Fl. Nilgiri Dist. 226. 1975; Ahmedullah & Nayar, Endem. Pl. Indian reg. 1: 134. 1986; S. Sudee & A. Paton, Kew. Bull 64(2): 249. 2009. **Type**:—INDIA. Madras, Nilgiri Hills, *Herb. Wight in Wall. Cat. 2756* (lectotype: K, K000674673, digital image!).

= A*nisochilus purpureus* Wight, Icon. Pl. Ind. Orient. 4: t. 1435. 1849; *Anisochilus dysophylloides* var. *purpureus* (Wight) Gamble, Fl. Madras 2: 1128. 1924; B.D. Sharma, Fl. Nilgiri Dist. 226. 1975; Ahmedullah & Nayar, Endem. Pl. Indian reg; 1: 134. 1986. **Type**: INDIA. Madras, Nilgiri Hills, Coonoor, Ex Herb. Wight Propr., *Wight* Ic. t. *1435* (holotype:K, bar, digital image!).

= *Anisochilus sericeus* Benth. in DC., Prodr. 12: 82. 1848. Ahmedullah & Nayar, Endem. Pl. Indian reg; 1: 135. 1986. **Type**:—INDIA, Deccan Peninsula, Courtallum, *Herb. Wight 2515* (holotype: K, bar, digital image!).

(Plate 60, 61 & 81 D)

Erect or ascending, annual brittle herb or under shrub, upto 100 cm high, perennial from woody basal stem and root stock, stem base 1.5–2 cm in diameter, branched, branches 40–70 cm long, terete, hollow with prominent leaf scars, tomentose; internodes 2–5 cm long. Leaves opposite decussate, petiolate; lamina obovate 3–5 × 2–3 cm, base cuneate, apex obtuse, margin entire or serrulate, secondary veins 6–7, veins prominent on lower surface, lower tomentose, upper pubescent petiole 0.3–0.5 mm long, tomentose. Inflorescence terminal and axillary, congested spike, 3–5 cm long. Bracts caducous, sessile, ovate with acuminate tip 1.8–2 × 1–1.2 mm, villous with ciliate margin. Calyx ovoid 1.9–2.1 × 1.3–1.5 mm, teeth 5; posterior lip 3-

lobed, recurved, or deflexed and concealing throat after anthesis; anterior lip 2-lobed, tube glabrous inside, pubescent outside forming villous towards the base, fruiting calyx 2.5–2.7 mm long. Corolla white, pale pink or purple, exserted from calyx tube 3.5–3.7 × 3–3.2 mm; posterior lip shortly 4-lobed, subequal, 0.8–1.2 mm; anterior lip entire, elongate, 1.6–1.8 mm incurved at younger stage and concave at older stage, longer than posterior; tube gradually dilated towards throat and slightly decurved above midpoint, pubescent with orange glands. Stamens declinate, exserted, exceeding the anterior corolla lip, glabrous, inappendiculate, anterior pair slightly longer; posterior and anterior pairs attached on corolla throat at the base of anterior corolla lobe, included in anterior corolla lip; filaments free, posterior pair 2–2.3 mm long, anterior pair 1.5–1.8 mm long, anther reniform, synthecous, back usually with sessile glands, often confluent; anthers bilobed, dorsifixed, 0.4–0.6 mm long, dehise longitudinally. Ovary glabrous; style 2.5–2.7 mm long; stigma shortly bifid with equal lobes, 0.24–0.28 mm long. Disc lobed, bright orange colour, anterior side well-developed, exceeding the ovary. Nutlets brown, ovoid, smooth, shining, 0.24–0.28 × 0.22–0.25 mm.

Phenology:—Flowering and fruiting were observed during November to February.

Distribution:—Endemic to South India, rare, in Western Ghats it is reported from Nilgiris and Pulney Hills coming under Nilgiri biosphere reserve.

Habitat and Ecology:—Rare among grasses on open hill slopes in shola grassland ecotone areas.

Specimens examined:—Karnataka. Mysore, Nandi Hills, 14 September 2015, *Shinoj & Purvi 138381* (CALI!). **Tamil Nadu.** Coimbatore District: Top slopes of Konnamalai, 15 January 1963 *C.P. Sreemadhavan CPS385* (MH!); Dindigul District: Madras, Anamallays, *Beddome 33* (BM, K!);

Madras, Pulneys, Machur Path, 5 November 1897, Bourne 1320 (K!), *s.l.,* 27 December. 1898, *Bourne 1715* (CAL!); Kodaikanal, 300 m, 24 June 1913, *Sanlieres 718* (CAL!); Nilgiri District: Nilgiri, 17 March 1870, *Clarke 10966* (BM!); Ooty, 7500 ft, May 1886, *J.S. Gamble 17298* (MH!); Nilgiris, 2250 m, May 1881, *Clarke 17298* (BM!), *s.l.,* January. 1883, *Gamble 11898* (K!); *s.l., s.d., Hohenacker 1407* (BM!); Madras, Nilghiri, *s.d., Schmidt s.n.* (K!); Madras, Nilgiri Hills, *Herb. Wight 2108* (K!), *s.l.,* January 1848, *Herb. Wight 2110* (K!); *s.l., s.d., Herb. Wight 2112* (NY!); Nilgiri District: Kinnacoorie, 5300', 19 January 1913, *Fischer 2626* (FRC!); Bikkapattimund, 6600', 12 January 1921, *Fischer 4581* (FRC!); Ooty, Kettitown, on rock surface near Hanuman temple, 25 January 2014, *Shinoj & Manu Philip 151089* (CALI!); *ibid.* 8 February 2016, *Shinoj 145447* (CALI!); on the way to Kotagiri, 25 January 2014, *Shinoj & Manu Philip 151095* (CALI!); Ooty, Hulathi, 14 December 2017, *Shinoj & Resmi 150947* (CALI!).

Conservation status:—Singh (1988) and Rao & Razi (1981) mentioned this species as "very rare" and "not common" respectively. This species is endemic to Pulney Hills and Nilgiri Hills. The distance between Anamudi Hills and Pulney Hills is around 270 km, which indicates that the area of occupancy is more than 20000 km^2. But it was seen only as small patches with less than 50 mature individuals in Nilgiris. Moreover it is mainly distributed in road sides in tourist places. Hence our opinion is to treat this species under Near Threatened (NT) category.

Notes:—*Anisochilus dysophylloides* is a species which shows variation from thick stout stem with broad leaves and terminal inflorescence to comparatively thinner stem with long obovate leaves and axillary inflorescence. The flower colour also shows variation from pale violet to dark purple. Due to this reason many authors introduced different species names and variety names for these variations as *Anisochilus purpureus, A. sericeus, A. albidus, A. dysophylloides* var. *purpureus,*etc.

5. *Anisochilus eriocephalus* Benth., DC. Prodr. XII: 81. 1848; Hook.f. Fl. Brit. India 4: 627. 1885; Gamble, Fl. Pres. Madras 2: 1127. 1921; B.D. Sharma et al., Fl. Karnataka 2: 225. 1984; Mukerjee, Rec. Bot. Surv. India 14(1): 58. 1940; P. Lakshmin. & B.D. Sharma, Fl. Nashik Dist. 1991, *Anisochilus carnosus* (L.f.) Wall. ex Benth. var. *eriocephalus* (Benth.) T. Cooke, Fl. Bombay 2: 531. 1905; **Type**:—INDIA, Deccan Peninsula, Bellary, *Herb. Wight 2518* [lectotype: K, K000674678, digital image!).

(Plate 62, 63, 64 & 81 E)

= *Anisochilus decussatus* Dalzell in Dalzell & Gibson, The Bombay Fl. 206. 1861. **Type**:—INDIA, Concan, on the Highest Ghats opposite Bombay, *Dalzell s.n.* (holotype: K, digital image!).

Erect or ascending annual or short lived perennial succulent herbs 40–120 cm high, branches deliquescent, internodes 2–4 cm long. Stem round, glabrescent to pubescent. Leaves petiolate, opposite decussate, orbicular to ovate 3–6 × 3–4 cm, sarcous, apex rounded or obtuse, base rounded or obtuse, margin sinuate, glabrescent to pubescent on both surfaces, minute sessile glands present on both surfaces, lateral veins 3–4, veins not much prominent on both surface; petiole short, 1–2 cm, glabrescent to pubescent. Inflorescence numerous, terminal and axillary, branched, both main and secondary branches end in a congested spike, 3–5 in an inflorescence, arranged opposite decussate with a single terminal head and 2–4 lateral heads; individual spike heads globose or cylindical both in bud and in fruit, 10–40 mm long. Bracts ovate ca. 1.5 × 0.8 mm sarcous, pubescent with sessile glands on both surfaces; bracteole deltoid ca. 0.8 × 0.8 mm, villous outside, glabrous inside. Calyx ovoid to globose ca. 3.5 × 2.5 mm with posterior lip opened and ca. 2.5 × 2.5

mm with posterior lip closed, woolly; fruiting calyx ca. 5 mm long; posterior lip 1-lobed acute to acuminate, ciliate to villous; hairs 4–5 celled; anterior lip obscure, teeth 4, densely villous outside. Corolla ca. 10 × 4 mm long, with pale violet corolla tube and dark violet corolla lips; posterior lip shortly 4-lobed, subequal, 0.5–0.7 mm; anterior lip entire, elongate, 3.2–3.5 mm concave at younger stage and convex at older stage , longer than posterior, base of the corolla tube narrow and densely villous outside. Stamens 4, free, attached at the mouth of the corolla tube, didynamous, posterior pair attached just below anterior but not united, filament of posterior ca. 2.2 mm long, anterior pair ca. 2.7 mm long, appendages absent, included in anterior corolla lip; anthers bilobed, dorsifixed, ca. 0.35 mm long, violet (when mature), dehisces longitudinally. Ovary glabrous; style 9.5–10 mm long; stigma shortly bifid with equal lobes, ca. 0.2 mm long. Disc cup shaped subequal, 4 lobed, lobes 2–2.2 mm long.Nutlets brown ovoid or ellipsoid.

Phenology:—Flowering from October to December, fruiting from November to January.

Distribution:—*Anisochilus eriocephalus* is known only from drier parts of Maharashtra and Karnataka states in India. In Maharashtra it is very common and many botanists treat this as *A. carnosus.* In Western Ghats it is confined mostly towards northern region.

Habitat and ecology:—The plant grows on shallow depressions and crevices of lateritic rocks in scrub jungle or rocky grasslands.

Specimens examined:—**Karnataka.** Bagalkot District: Badami, 17 October 1892, *W.A. Talbot 2815(a)* (BSI!); Bagalkot District: Badami, hills behind cave temple, 577 m, 15^0 55’4.730”N $75^0$41’39.303” E, 2 December 2017, *K. Shinoj & Jagdish Dalavi 150935* (CALI!); Belgaum District: Belgaum town, *s.d., s.coll. 28623* (BSI!); Belgaum, Sutagatti, *s.d., s.coll. 29788* (BSI!);

Londha, 3 November 1902, *G.A. Gammie 15862* (BSI!); Shimoga District: Karodi, 28 September 1962, *R.S. Raghavam 32754* (BSI!). **Maharashtra.** Amravati District: Tarubanda, 22 August 1976, *M.Y. Ansari, 144064* (BSI!); Ghatang Ghat, 7 November 1977, *M.Y. Ansari, 159623* (BSI!); Buldhana District: Sonala Range, 7 October 1982, *P.G. Diwakar 164623* (BSI!); Satara, Yavateswar, 18 July 1983, *S.D. Deshpande 165882* (BSI!); Pune District: Shivaneri, 24 June 1956, *G.S. Puri 2635* (BSI!).

Conservation status:—This is a wide spread species in Maharashtra. Moreover many specimens annotated as *Anisochilus carnosus* in many herbaria (CAL, MH, BLAT, BSI, etc.) belong to this species. So this can be treated under the category least concern.

Notes:—Bentham in 1848 first described *Anisochilus eriocephalus* based on Wight's specimen (*catalogue no. 2518*) from Peninsular India. Though he couldn't see the corolla, he described it as a distinct taxa having ascending branches, with numerous ovoid or globose spike and woolly calyx. Bentham's treatment was followed by Hooker (1885) and described it as glabrous or puberulous herb with many ovoid or cylindric spikes having villous or woolly calyx. Whereas Cooke (1903) treated it as a variety having more slender plant body with numerous heads of the wide spread species *Anisochilus carnosus*. Gamble (1924) followed Hooker (1885) and treated it as a distinct species possessing smaller heads and numerous peduncles similar to *Anisochilus carnosus*. *A. eriocephalus* was treated as a synonym of *A. carnosus* by Prain (1981) and in a recently published revisionary work of *Anisochilus,* by Suddee and Paton (2009).

It is pertinent to mention here that though in vegetative stage, both the plants look same and also it is difficult to differentiate both from herbarium specimens, the numerous inflorescences arising from a single plant and the woolly nature of inflorescence of *Anisochilus eriocephalus* were observed to be a very distinct character from *Anisochilus carnosus*. Hence we raised the status of *Anisochilus eriocephalus* to a distinct species.

6. Anisochilus kanyakumariensis Shinoj & Sunojk., *Phytotaxa,* 333(1). 100. 2018. **Type:**—INDIA. Tamil Nadu, Kanyakumari District, Maruthwamala, 8º07'53.90"N, 77º30'24.48"E, 70–90 m, 30 October 2015, *K. Shinoj & P. Sunojkumar* (holotype: CALI!, *CU138400 a*), (isotypes: CALI!, *CU138400 b-c*), (isotype: MH!, *CU138400 d*). **(Plate 65, 66, 67 & 81 F)**

Decumbent annual or short lived perennial herbs, branches succulent, 50–70 cm long. Stem terete, glabrescent to pubescent. Leaves petiolate, orbicular, 4–5 × 3–4 cm, apex rounded or obtuse, margin crenulate, adaxial surface rusty tomentose, abaxial surface tomentose, lateral veins 5–6 and 2–3 basal veins on each side of the midrib, secondary and tertiary reticulate venation prominent beneath; petiole short, 1–2 cm long, pubescent. Inflorescence terminal, main axis 15–20 cm long; secondary branches 5–7, arranged opposite decussate, each 5–10 mm long, both main and secondary branches end in a congested spike which are ovoid to cylindrical ≥20 mm long. Bract dome-shape, 1.5 × 1.6 mm, early caducous; bracteoles dome-shaped 0.75 mm × 0.76 mm, ciliate, caducous. Calyx ovoid, 2–3 mm long when posterior lip opened and 1.5–2 mm long when posterior lip closed, densely villous; posterior lip 1-lobed, acute to acuminate, ciliate to villous, hairs 4–5 celled; anterior lip obscure, teeth 4, glabrascent to pubescent; fruiting calyx ca. 3–3.5 mm long. Corolla 4–5 mm long from base to top of lower lip, white with a pink tinge at inner surface of posterior teeth, corolla base tube funnel shaped and densely villous outside; posterior lip shortly 4-lobed, sub-equal, 0.15–0.2 mm; anterior lip entire, elongate, 1.4–1.7 mm concave at younger stage and convex at older stage. Stamens 4, free, attached at mouth of the corolla tube; didynamous, posterior pair attached just below anterior but not united, filament of the posterior 1.5–2 mm long, of the anterior pair 2–2.5 mm long, included in anterior corolla lip; anthers bilobed, dorsifixed, ca. 0.3 mm long, orange to brown (when mature), dehisces longitudinally. Mericarps circular or widely elliptic, 818–824 × 745–750 µm brownish, surface undulate, reticulate, cells faintly polygonal.

Etymology:—The species is named after Kanyakumari District of Tamil Nadu from where the specimens were originally collected (It was collected from the rock crevices of Maruthwamala and Chunkankadai Hill of Kanyakumari District).

Distribution:—*Anisochilus kanyakumariensis* is only known from Maruthwamala and nearby hills of Kanyakumari District in Tamil Nadu, India.

Habitat and ecology:—The plant grows on rock crevices. It is usually found growing in association with herbaceous *Jusicia diffusa* Sm ex. T. Anderson*, Leucas nepetifolia* Benth.*,* and grasses like *Apluda mutica* L. and *Sehima nervosum* (Rottler) Stapf.

Phenology:—Flowering from June to January, fruiting from July to March.

Specimens examined (paratypes):—**Tamil Nadu.** Kanyakumari District: Chunkankadai Hill, 120 m, 8º12'11.28"N, 77º23'12.78"E, 21 July 2016, *K. Shinoj & P. Sunojkumar 145485* (CALI!); Kanyakumari District: Maruthwamala, 70 m, 8º07'54.54"N, 77º30'20.69"E, 20 November 2016, *K. Shinoj & P. Sunojkumar 151006* (CALI!); Kanyakumari District: Maruthwamala, 22 June 1984, *T.K. Abraham, P. Mohan Kumar & P.J. Mathew 283* (TBGT!).

Conservational status:—*Anisochilus kanyakumariensis* grows on rock crevices, with an area of occupancy smaller than 20 km^2. Based on field observations, it is estimated that the total number of individuals of this endemic species does not exceed 200 in two different localities. Moreover a fragmented distribution with a very few population was met in Chunkankadai Hills. Therefore, we suggest that *Anisochilus kanyakumariensis* should be categorised as endangered (EN) according to the criteria B1b of IUCN (2012, 2017).

Notes:—*Anisochilus kanyakumariensis* is similar to *A. carnosus* and *A. paniculatus*, but differs from both species by its decumbent habit (vs. erect in *A. carnosus* and erect or ascending in *A. paniculatus*); orbicular leaf, 4–5 × 3–4 cm (vs. broadly ovate, 5–7 × 3–5 cm in *A. carnosus* and ovate or elliptic, 4–6 × 2–3 cm in *A. paniculatus*); petiole 0.5–1 cm long (vs. 4–5 cm in *A. carnosus* and 2–3 cm in *A. paniculatus*); inflorescence narrow cylindrical, 2–3 cm long (vs. tetragonal, 3–6 cm in *A. carnosus*, and small ovoid, 1.5–2 cm in *A. paniculatus*); bracteoles ovate as in *A. paniculatus* (vs. lanceolate in *A. carnosus*); densely villous calyx (vs. pubescent calyx in *A. carnosus* and *A. paniculatus*); densely villous corolla, 4–6 mm long (vs. slightly pubescent corolla, 8–9 mm long in *A. carnosus,* and pubescent corolla ca. 7 mm long in *A. paniculatus*).

7. **Anisochilus paniculatus** Benth. in DC., Prodr. 12: 82. 1848; Hook.f., Fl. Brit. India 4: 628. 1885; Gamble, Fl. Madras 2: 1127. 1921; Mukerjee, Rec. Bot. Surv. India 14 (1): 59. 1940; L.H. Cramer in Dassan. & Fosberg, Rev. Hanb. Fl. Ceylon 3: 153. 1981; S. Sudee & A. Paton, Kew. Bull 64(2): 243–244. 2009. **Type**:—SRI LANKA, *s.l., s.d., Walker 52* (holotype: K, K000674751, digital image!). **(Plate 68, 69 & 82 A)**

Erect or ascending annual succulent herbs, upto 100 cm high. Stem, pale green pubescent, round or obscurely quadrangular without intra petiolar hairs; internodes 2–6 cm long. Leaves short petiolate, opposite decussate; lamina ovate, elliptic or obovate, 3–7 × 2–6 cm, base rounded or shortly cuneate, apex obtuse or rounded, margin crenate, pubescent above tomentose beneath, minute sessile glands present on both the surfaces, lateral veins 5–6 of which 2–3 basal veins arise from either side of the midrib, veins prominent on lower surface; petiole 1–2 cm, pubescent. Inflorescence terminal, profusely branched giving a panicle appearance, individual spike heads short $\leq$ 20 mm long and ca. 80 mm wide. Bract ovate, 1.5–1.6 × 1.3–1.4 mm, early caducous; bracteoles dome-shaped 0.74–0.75 mm × 0.74–0.76 mm, ciliate, caducous. Calyx ovoid to cylindrical, 1.5–2.3 × 1–1.2 mm when posterior lip opened and 1.2 –1.4 × 1–1.2 mm when posterior lip closed, pubescent with red sessile glands; fruiting calyx ca. 3 mm long; posterior lip 1-lobed acute to acuminate, ciliate. Corolla 7.8–8.1 × 3.9–4.2 mm, white with a pale purple colour, base of the corolla tube narrows forming a near funnel shaped. Outside pubescent with red sessile glands; Stamens 4, free, attached at the mouth of the corolla tube, didynamous, posterior pair attached just below anterior but not united, filament of posterior ca. 4.6 mm long, anterior pair ca. 3.4 mm long, appendages absent, included in anterior corolla lip; anthers bilobed, dorsifixed, ca. 0.75 mm long, dehisces longitudinally. Style ca. 10 mm long, stigma bifid ca. 0.2 mm long. Nutlets brown round to ellipsoid 0.3–0.32 × 0.17–0.2 mm.

Phenology:—Flowering and fruiting from September to February.

Distribution:—South India and Sri Lanka.

Habitat and Ecology:—On exposed rocks above 400 m.

Specimens examined:—Kerala. Wayanad District: Mananthavady, Periya 36, Gurukula Sanctuary, 12 December 2014, *Shinoj & Sunojkumar138346* (CALI!); *ibid.*, 14 September 2015, *Shinoj, Smitha & Soumya 138382* (CALI!); *ibid.*, 15 January 2016, *Shinoj & Smitha 145426* (CALI!); *ibid.*, 7 December 2016, *Shinoj & Manu Philip 151010* (CALI!). **Tamil Nadu.** Namakkal District: Kolli Hills, Solakkadu, Kottamottu, Paruthai, 1200 m, 19

October 1978, *Mathew RHT 18522* (K!); Pulney District: Kodaikanal Ghat, 13 December 1898 *Bourne 1296* (MH!); Ramnad District: Mudaliaruttu, Srivilliputtur, 19 September 1917, *s.col. 15036* (MH!); Tirunelveli District: way to Kannikatti, 400 m, 26 February 1960, *Sebastine 9955* (CAL!).

Conservational status:—*Anisochilus paniculatus* was known from less than 5 localities and hence considered as "rare" by Cramer in 1981. We were not able to collect this specimen from the wild and the description given above is solely based on specimens collected during flowering season from Gurukula Botanical Sanctuary, Wayanad and comparing the same with the protologue and type. Further field work and data gathering is necessary to establish the extent of distribution and habitat reduction. Therefore an assessment of its threatened status is not made.

Notes:—*Anisochilus paniculatus* and *A. kanyakumariensis* are allied species but differs from the later in having erect or ascending habit, elliptic leaf, small ovoid spike, etc. The corolla colour and shape of both the species looks similar but the corolla is more villous and short in *A. kanyakumariensis*. The major differences between them lie in the nature of inflorescence and congested spike. There are numerous spike in *A. paniculatus* and the inflorenscence axis have secondary and tertiary branching giving a panicled appearance whereas in *A. kanyakumariensis* secondary branching may present in rare case but no tertiary branching. Also the congested spike head is less than 2 cm in *A. paniculatus* where as above 3 in *A. kanyakumariensis.*

8.Anisochilus plantagineus Hook.f., Fl. Brit. India 4: 628. 1885; Ahmedullah & Nayar, Endem. Pl. Indian reg. 1: 135. 1986; Gamble, Fl. Madras 2: 1127. 1921; Mukerjee, Rec. Bot. Surv. India 14(1): 61. 1940; S. Sudee & A. Paton, Kew. Bull 64(2): 247. 2009. **Type**:—INDIA, Deccan Peninsula, Mysore, Bababoodan Hills, *s.d., Dalzell s.n*. (lectotype: K, K000674770, digital image!). **(Plate 70, 71 & 82 B)**

Erect or ascending dwarf undershrub, up to 50 cm high. Stems woody like, branched upwards, terete, pubescent to slightly tomentose with prominent circular leaf scars. Leaves opposite decussate, congested at branch tips, sessile or subsessile, lamina bright green with slight reddish colour on adaxial surface near tip and margin, oblong, obovate or ovate, 3–4 × 2–3 cm, base cuneate, apex obtuse to round, margin entire or obscurely crenate, thick, pubescent to tomentose above, lateral veins 5–7, prominently raised beneath; petiole 3–4 mm long, tomentose. Inflorescence terminal, simple, congested spike narrow cylindric, up to 90 mm long and 2.5–3 mm wide; peduncles short and stout, 3–4 mm long, reddish, pubescent; bracts ovate, minute, early caducous. Calyx ovoid, 1–1.2 mm long at anthesis, densely tomentose; posterior lip shortly oblong, truncate, rounded or obscurely 3-toothed at apex, slightly deflexed after anthesis but not concealing throat, tomentose; anterior lip truncate or obscurely 2-lobed, membranous and adpressed on tube; tube ventrally saccate around the middle, slightly constricted at throat, pubescent. fruiting calyx 1.5–2 mm long; Corolla white to pale yellow, 8–9 mm long, pubescent; tube tubular, deflexed from above the base. Stamens 4, free, attached at the mouth of the corolla tube, didynamous, posterior pair attached just below anterior but not united, filament of posterior ca. 1.5 mm long, anterior pair ca. 1 mm long, appendages absent, included in anterior corolla lip; anthers bilobed, dorsifixed, ca. 0.5 mm long, dehisces longitudinally. Disc lobed, anterior side well-developed, exceeding the ovary 0.8–1 mm long. Style 8–9 mm long, stigma bifid ca. 0.4 mm long. Nutlets dark brown, ovoid or ellipsoid, ca. 0.4 × 0.3 mm.

Phenology:—Flowering and fruiting observed during December to February.

Distribution:—Endemic to northern Western Ghats of India. So far reported only from Bababudan hills (Chikmagalur) of Karnataka.

Habitat and Ecology:—On exposed rocks and walls of rocky cliffs. Seen in open places amidsts deciduous forests at an elevation about 700 m.

Specimens examined:—India. *s.l., s.d., Stocks s.n.* (K!, digital image); *s.l., s.d., Dalzell s.n.* (K!, digital image). **Karnataka.** Chikmagalur District: Bababudan Hills, *Lawson s.n.* (K!, digital image); Mullayanagiri hill top, 23 January 2017, *Shinoj & Manu Philip 151081* (CALI!).

Conservation status:—*Anisochilus plantagineus* is reported only from Bababudan Hills. We visited Bababudangiri three times during the research period and we were able to find a few mature individuals less than 200 individuals from rocky slopes of Mullayangiri. We had conducted a thorough survey in nearby areas and concluded that this species was restricted to only less than 100km^2. As Mullayanagiri is a tourist place and many of these plants are in vicinity to the way to hill top we conclude that this species must come under CR catergory based on criteria B1a, B1b (III) of IUCN.

Notes:—*Anisochilus plantagineus* shows similarities to *A. suffruticosus* in possessing woody stem with prominent leaf scars but differs from it in having small plant body with a single terminal inflorescence.

9. Anisochilus robustus Hook.f., Fl. Brit. India 4: 629. 1885; Ahmedullah & Nayar, Endem. Pl. Indian reg. 1: 135. 1986; Hook.f., Fl. Brit. India 4: 629. 1885; Gamble, Fl. Madras 2: 1128. 1921; Mukerjee, Rec. Bot. Surv. India 14 (1): 61. 1940; S. Sudee & A. Paton, Kew. Bull. 64(2): 246. 2009. **Type**:— INDIA. Deccan Peninsula, Courtallum, Herb. *Wight 625* (holotype: K, K000674766, digital image!). **(Plate 72, 73 & 82 C)**

=*Anisochilus henryi* K. Ravi. & V. Lakshm. Rheedea 9: 72.1999. **Type**:— INDIA. Tamil Nadu, Theni District, near Varaiyaatumottai peak, Venniar Estate, Pachakumatchi hills, 1800 m, 28 May 1989, *Lakshmanan & Ravikumar 91708* (holotype: CAL!; isotype: MH!).

Erect robust shrub, reaching a height of 3 m. Stem round to quadrangular, ridged with prominent groove on each face, pubescent to slightly tomentose, prominent leaf scars amidst hairs, sessile glands present on stem surface. Leaves petiolate, opposite deccusate, broadly ovate, large, 7–20 × 5–15 cm, base obtuse or rounded, apex acute or obtuse, margin crenate, fleshy, pubescent to tomentose above, red sessile gland found scattered on the lower surface, venation prominent beneath, lateral veins 9–12; petiole up to 3.5 mm long, pubescent to tomentose. Inflorescence mostly terminal, 15–40 cm long, 2–2.5 cm wide; branched slender lax spike, rarely congested; bracts lanceolate, base orbicular, tip acute, margin ciliate, pubescent, caduceus, remain congested near the tip of inflorescence. Calyx ovoid, 1–1.5 mm at anthesis, densely pubescent, fruiting calyx 2.5–3.5 mm long; posterior lip oblong, erect or slightly decurved, with 3 short teeths at the apex, anterior lobe with two oblique lobes; tube ventrally saccate, constricted at the throat, pubescent with scattered sessile gland on its outer surface. Corolla light yellow or cream color, 6–7.5 mm long, upper lobes incurved, pubescent with scattered yellow or orange coloured sessile glands on its outer surface. Stamens 4, free, attached at the mouth of the corolla tube, didynamous, posterior pair attached just below anterior but not united, filament of posterior ca. 3 mm long, anterior pair ca. 2 mm long, appendages absent, included in anterior corolla lip; anthers bilobed, dorsifixed, ca. 0.75 mm long, dehisces longitudinally. Style ca. 8 mm long, stigma bifid ca. 0.2 mm long. Nutlets brown, oblong, 1 × 0.7 mm, slightly pointed at the apex.

Phenology:—Flowering and fruiting observed from February to June.

Distribution:—Endemic to Southern Western Ghats of India. So far reported only from Tamil Nadu.

Habitat and Ecology:—On exposed rocky hill slopes and shady areas with moist soil near to shola borders.

Specimens examined:—Kerala. Wayanad District: Periya 36, Gurukula Sanctuary , 24 February 2017, *Shinoj, Smitha & Soumya 151046* (CALI!), 15 January 2016, *Shinoj & Smitha 145428* (CALI!). **Tamil Nadu.** Theni District: Near Varaiyaatumottai peak, Venniar Estate, Pachakumatchi Hills, 1800 m, 28 May 1989, *Lakshmanan & Ravikumar 91708* (K!); Tirunelveli District: 12 June 1899, *C.E. Barber 421* (MH!); Kannikatti, 12 June 1899, *Barber 421* (K!); Kalakad to Sengelteri, 23 September 1915, *s.coll. 12400* (MH!); Mahendragiri, 17 September 1916 *sn. 13155* (MH!); Naterikal to Sengelteri, 25 September 1916 *sn.13602* (MH!); 1 March 1917 *s.n. 14443* (MH!); Kakkachi, 1666 m, 15 October 1957, *K.M. Sebastine 4508* (MH!); Kalakad hills, *s.d.*, *s.coll.*, *s.n.* (MH!); Arankattumalai, Kakkachi, 1733 m, 7 May 1958, *K.M. Sebastine 5827* (MH!); Thulukkamparai, Thirukurungudi, 900 m, 17 February 1972, *S. Karthikeyan 40157* (MH!); Upper Kodayar, Valve house side, 1300 m, 30 September 1980, *A.N. Henry 68886* (MH!); Papanasam Hills, *s.d.*, *Beddome, s.n.* (K!); Peedakkadu, 1050 m, 1 April 1991, *R. Gopalan 91763* (MH!); Kannikatti, Upper Kodayar, Mancholai to Kakkachi, 15 January 2016, *Shinoj & Prashob 145417* (CALI!); Upper Kodayar, Mancholai to Kakkachi, 21 July 2016, *Shinoj, Geethika & Arun 145491* (CALI!).

Conservation status:—*Anisochilus robustus* is found at an altitude above 1500 m along shola borders in humid areas. We have collected it from Manjolai and Kakkachi areas of Upper Kodayar region and found that the species is facing a high risk of habitat destruction. Moreover many mature individuals were met in coffee plantations. Therefore, we suggest that it should be classified as Vulnerable (VU) according to the criteria A4 of IUCN (2012).

Notes:—The identity of *Anisochilus henryi* was bit confusing, a thorough study was carried out and found that it is only a variant of *A. robustus* the variation shown was solely due to higher altitude and cannot be considered for species circumscription.

10. Anisochilus scaber Benth. in DC., Prodr. 12: 81. 1848; Hook.f., Fl. Brit. India 4: 627. 1885; Gamble, Fl. Madras 2: 1127. 1921; Mukerjee, Rec. Bot. Surv. India 14 (1): 56. 1940; Ahmedullah & Nayar, Endem. Pl. Indian reg; 1: 135. 1986; Vajr. Fl. Palghat Dist. 373. 1990; N. Mohanan, Fl. Agasthyamala 529. 2002; S. Sudee & A. Paton, Kew. Bull. 64(2): 244. 2009. **Type**:— INDIA. Deccan Peninsula, Courtallum, *Herb. Wight 2520* [isotype: K, K000674681, digital image!]. **(Plate 74, 75 & 82 D)**

Prostrate annual or perennial succulent herbs, upto 60 cm high; woody basal stem and root stock, base 0.8–2 cm in diameter, profusely branching; branches 50–60 cm rooting at nodes, purple or green, terete, scabrous to tomentose with 2–6 mm, long hairs; internodes 0.8–2.5 cm long. Leaves opposite decussate, petiole 1–2 cm long, scabrous, lamina ovate 4–6 × 2.5–5 cm, succulent, base rounded, apex obtuse, margin crenate with 15–20 teeths, lateral veins 5–6, veins prominent beneath, lower surface tomentose or villous, scabrous above, minute sessile glands present on both the surfaces. Inflorescence mostly with a single terminal congested spike, rarely 2–4 lateral heads in an inflorescence; individual spike heads mainly long cylindrical both young and in fruit, 30–60 mm long; peduncle 15–30 cm long. Bracts dome shaped 4.5–6 × 5.5–6.5 mm, pubescent; bracteole dome shaped 3–4 mm across, villous outside, glabrous inside. Calyx ovoid to cylindrical 3.8–4 × 2–2.3 mm when posterior lip opened and 2.3–2.5 × 2–2.2 mm when posterior lip closed, pubescent with bright red sessile glands; fruiting calyx 3.5–4 mm long; posterior lip 1-lobed acute to acuminate, ciliate to villous; hairs 4–5 celled. Corolla 9.8–10.2 × 4.2–4.5 mm long, with pale pink corolla tube and purple corolla lips, base of the corolla tube narrow and glabrous. Stamens 4, free, attached at the mouth of the corolla tube, didynamous, posterior pair attached just below anterior but not united, filament of posterior ca. 3 mm long, anterior pair ca. 4 mm long, appendages absent, included in anterior corolla lip; anthers bilobed, dorsifixed, ca. 0.7 mm long, dehisces longitudinally. Style ca. 10 mm long, stigma bifid ca. 0.4 mm long. Nutlets brown round to ellipsoid ca. 1.2 × 1 mm.

Phenology:—Flowering from August to December, fruiting from September to January.

Distribution:—Endemic to Southern Western Ghats of India. So far reported only from Kerala and Tamil Nadu.

Habitat and Ecology:—On moist exposed rocky slopes amongst grasses above 300 m.

Specimens examined:—Kerala. Ernakulam District: Mamalakkandom, near U.P. School, 18 December 2016, *Shinoj 151035* (CALI!); Kollam District: Old Courtallum, 650 m, 19 December 1978, *C.N. Mohanan 59542* (MH!); Kottayam District: Thenmala, Palaruvi top, 18 August 2016, *Shinoj, Geethika & Janeesha 145492* (CALI!); Trivandrum District: Neyyar, Agasthya medicinal garden, 30 September 2015, *Shinoj, Soumya & Janeesha 138386* (CALI!); Ananirathi, 600 m, 1 October 2015, *Shinoj, Soumya & Resmi 138387* (CALI!); near Agasthya Park, 1 October 2015, *Shinoj, Soumya & Resmi 138388* (CALI!); Wayanad District: Mananthavady, Periya 36, Gurukula Sanctuary, 12 December 2014, *Shinoj & Sunojkumar138346* (CALI!); *ibid.,* 24 February 2017, *Shinoj, Smitha & Soumya 151052* (CALI!). **Tamil Nadu.** Dindigul District: Thulukkamparai, 940 m, 29 November 1969 *B.V. Shetty 32973* (MH!); Manjumalai, 1000 m, 2 April 1991, *R. Gopalan 91800* (MH!); Kanniyakumari District: Perunchani, 180 m, 3 September 1976, *A.N. Henry 48208* (MH!); Keeriparai waterfalls, 400 m, 3 October 1980, *A.N. Henry 68901* (MH!); Mahendragiri, 17 September 1916, *s.coll.*

13143 (MH!); lower Kodayar to Kanyakumari, Vazhukkalpara, 20 July 2016, *Shinoj & Geethika 145486* (CALI!); lower kodayar, 20 July 2016, *Shinoj & Geethika 145489* (CALI!); Tirunelveli District: Sengaltheri, 26 September 1916, *s.coll. 13653* (MH!); Kodayar, Manimuthar Dam area, 300 m, 24 June 1957, *K.M. Sebastine 3566* (MH!); Mancholai, 1000 m, 10 May 1958, *K.M. Sebastine 5860* (MH!); Tirunelveli District: Kodayar, Mancholai, 1000 m, 10 may 1958 *K.M. Sebastine 5860* (MH!); way to Naterikal, 1000 m, 20 September 1967, *E. Vajravelu 29175* (MH!).

Conservation status:—According to Vajravelu (1990) this species is common in Palghat District of Kerala whereas Mohanan and Sivadasan (2002) reported this species as rare in southern Western Ghats. During our exploration in Western Ghats we were able to collect few specimens from Neyyar Wild Life Sanctuary of Trivandrum District in Kerala and lower Kodayar of Tirunelveli District in Tamil Nadu. In Ananirathi hill area of Neyyar these plants are common and we were able to see many individuals in mature stage. The estimated number is more than 10,000 mature plants in Neyyar area. Even though this is coming under protected area some individuals were also seen in human inhabited areas of Neyyar and in lower Kodayar of Tirunelveli. There is a chance that the existence of these plants will be under threat in near future due to anthropogenic activities in exposed areas. Based on all these observations we consider it as Near Threatened (NT) under IUCN category.

Notes:—*Anisochiulus scaber* is morphologically a highly variable species. The plant shows variation in inflorescence size, spike number, corolla colour, etc. Variable nature from scabrous to tomentose or Villous were noticed on trichome characters in different populations. Plants with purple inflorescence axis, 1–3 congested spike and small leaf and scabrous stem from Neyyar region shows marked differences from the plants with pale pink peduncle, 5 congested spike, large tomentose leaf and villous stem collected from Palaruvi. The plant was grown in CUBG and the vegetative characters were observed to be stable.

11. Anisochilus shoolamudianus Sunil & Naveen Kum., Webbia 70: 217. 2015. **Type**:—INDIA, Kerala, Ernakulam District, Edamalayar Forest Range, Shoolamudi, 1216 m, 26 December 2014, *Sunil & Naveen Kumar 6918* (holotype: MH, isotype: CALI). **(Plate 76 & 82 E)**

Erect annual suffruticose herb or stout under shrub, 80–100 cm high, base 1.5–2.5 cm in diamteter. Stem profusely branching; branches 40–60 cm long, tomentose, scattered yellow sessile glands present among hairs, leaf scars prominent, terete with short internodes and appressed silvery tawny tomentose surface, longitudinal grooves appear during drying. Leaves sessile, whorled, 3–4 per node, alternate with the next whorl at the other node giving a rosette or whorled appearance, mainly congested towards the apical region, obovate to oblanceolate 3–8 × 0.6–1.8 cm, base attenuate, apex obtuse, margin entire, silvery or tawny tomentose on both surface, veination invisible due to succulent nature and tomentose hairs; often with axillary young leaves; petiole 0–5 mm long. Inflorescence terminal, a single congested spike at all branch tips, 5–18 cm long, dense, many flowered. Bracts caducous, 1–2 × 0.6–1 mm, sessile, ovate with acute tip densely pubescent with sessile glands. Calyx ovoid ca. 2×1.5 mm, 5-toothed; posterior lip 0.7–0.9 mm long, 3-lobed, recurved, or deflexed and concealing throat after anthesis; anterior lip 1–1.2 mm long, 2-lobed, tube glabrous inside, densely tomentose outside intermingled with orange coloured sessile glands; fruiting calyx 2–3 × 2–2.2 mm. Corolla exserted from calyx tube 3.5–3 mm, pale yellow or off white colour; posterior lip shortly 4-lobed, 0.5–0.6 mm long, orbicular; anterior lip entire, elongate, concave at younger stage and convex at older stage, longer than posterior; 2–2.2 × 1–1.2 mm, obtuse to rounded at apex; tube gradually dilated towards throat pubescent with orange colour sessile glands outside. Stamens 4, didynamous, declinate, exserted, exceeding the anterior corolla lip, glabrous, inappendiculate, anterior pair slightly longer; posterior and anterior pairs attached on corolla throat at the base of anterior corolla lobe, included in anterior corolla lip; filaments free, posterior pair ca. 1.6 mm long, anterior pair ca. 1.2 mm long, anther light brown coloured at maturity, back usually with sessile glands, often confluent; ca. 0.6 mm long. Disc 0.5–0.6 mm, oblique, anterior lobe prominent, exceeding the ovary, yellow to orange colour. Ovary glabrous, quadripartite, 0.2–0.25 mm long. Style 4.5–5 mm long; stigma purple, shortly bifid with equal lobes, 0.22–0.25 mm long. Nutlets dark brown to black ovoioid, 1–1.2 × 0.6–0.8 mm, smooth, mature nutlets usually producing mucilage when wetted.

Phenology:—Flowering and fruiting were observed during November to February.

Distribution:—Endemic to South India. In Western Ghats so far reported only from Shoolamudi Hill top of Ernakulam District.

Habitat and Ecology:— Seen on wet open rock surfaces amongst grasses at an altitude above 1200 m.

Specimens examined:—Kerala. Ernakulam District: Edamalayar, Varium, Shoolamudi hill top, 1124 m, 10^0 13'42.177"N & $76^0$51'9.590"E, 15 December 2016, *Shinoj, Manu Philip & Nikhil 151020* (CALI!).

Conservation status:—*Anisochilus shoolamudianus* is found at an altitude of about 1120 m on the wet rocky grasslands. So far it is reported only from type locality, i.e. Shoolamudi Hill top of Ernakulam District. We have collected it from there and noticed that the species is restricted to this area with an area of occupancy smaller than 100 km^2. Based on field observations, it is estimated that the total number of mature individuals of this endemic species does not exceed 100. These herbaceous plants are found on rock surfaces and there is chances for habit destruction due to frequent visits of elephants. Therefore, we suggest that it should be categorised as endangered (EN) according to the criteria B2a, B2b (III) of IUCN (2012, 2017).

Notes:—This plant shows more similarities to the species *Anisochilus argenteus* rather than *A. adenanthus*. The authors of the species compared it to *A. adenanthus*, but the plant is very close to *A. argenteus* and differs only in the elongated nature of inflorescence, leaf and habit. But the character is stationary and observed in the whole population on the Shoolamudi hills.

12. *Anisochilus suffruticosus* Wight, Icon. Pl. Ind. Orient. 4: t. 1437. 1849 as '*suffruticosum*' 91. 1851; Hook. f., Fl. Brit. India 4: 628. 1885; Gamble, Fl. Madras 2: 1128. 1921; Mukerjee, Rec. Bot. Surv. India 14 (1): 60. 1940; B.D. Sharma, Fl. Nilgiri Dist. A Checklist. 226. 1975; Ahmadullah & Nayar, Endem. Pl. Indian reg. 1: 135. 1986; H.J. Noltie, The Botany of Robert Wight. Regnum Veg. 145: 299. 2005; S. Sudee & A. Paton, Kew. Bull. 64(2): 246. 2009. **Type**:—INDIA. Deccan Peninsula, Western Ghats, Nilghiri Hills, western slopes at Sispara, Ex Herb. Wight Propr, *Wight lc. t. 1437*. (holotype: K,K000674769, digital image!). **(Plate 77 & 82 F)**

Erect stout undershrub, up to 1 m tall. Stems woody, branched, round-quadrangular or quadrangular, glabrescent to rusty tomentose with prominent broad circular leaf scars. Leaves petiolate, opposite decussate, congested at the end of branches; lamina ovate lanceolate, 20 –40 × 7–15 mm, base obtuse or cuneate, apex acute, margin entire or obscurely crenulate, thick, densely brownish-yellow velvety-tomentose and deeply reticulate between veins beneath, lateral veins 5–7, stout and raised beneath, brownish tomentose above; petiole short, up to 10 mm long, tomentose. Inflorescence terminal and axillary, simple or branched, often congested at the tip of all branches; spike-like head narrow cylindric, up to 70 mm long and 6 mm wide; peduncles long and slender, 50–70 mm long, pubescent; bracts minute, early caducous. Calyx ovoid, 0.8–1 mm long at anthesis, pubescent; fruiting calyx 2.5–3 mm long; posterior lip shortly oblong, truncate, rounded or obscurely 3-toothed at apex, slightly deflexed after anthesis but not concealing throat, pubescent; anterior lip truncate to obscurely 2-lobed, membranous and adpressed on tube; tube ventrally saccate around the middle, slightly constricted at throat, pubescent. Corolla white with a pale purple shade, 5–6 mm long, pubescent; tube tubular, deflexed from above the base. Nutlets dark brown, ovoid or ellipsoid, 0.7–0.8 × 0.5–0.6 mm.

Phenology:—Flowering and fruiting from December– February.

Distribution:—Endemic to Nilgiris in India, so far reported only from Western Ghats western slopes at Sispara, Nilgiris.

Habitat and Ecology:—On exposed rocks or rocky cliffs.

Specimens examined:—Kerala. Palakkad District: Silent Valley National Park, western slopes at Sispara, *s.d*., Ex Herb. Wight Propr, *Wight lc. t. 1437*. (holotype: K!).

Conservation status:—Endemic to the Nilghiri Hills. The extent of occurrence would appear to be less than 100 km^2 from the collections seen. We visited the Sispara areas and Anginda –a nearby area of Sispara of Silent Valley N.P., Palakkad District in Kerala but no specimen could be observed. So this species can be considered Critically Endangered (CR) as it fulfils the criteria B1a & B1b (V) of CR of IUCN category.

Notes:—The description made above is solely based on the type and the revisionary work of Suddee and Paton (2009). The authors were not able to collect the plant though visited the type locality twice in different seasons.

The herborized specimens show similarities to *Anisochilus plantagineus* but a bunch of inflorescence arising from the tip make it a distinct one.

13. *Anisochilus wightii* Hook.f., Fl. Brit. India 4: 628. 1885; Gamble, Fl. Madras 2: 1128. 1921; Mukerjee, Rec. Bot. Surv. India 14: 59. 1940; Ahmadullah & Nayar, Endem. Pl. Indian reg, 1: 135. 1986; S. Sudee & A. Paton, Kew. Bull. 64(2): 244. 2009. **Type**:—INDIA. Deccan Peninsula, Anamallay Mts, July 1851, *Herb. Wight 2132/1* (holotype: K, K000674675, digital image!). **(Plate 78, 79 & 82 E)**

Erect annual or perennial succulent herb, 60–80 cm high. Stem base 1–2.5 cm in diameter, profusely branching, branches 40–60 cm long, quadrangular to terete, pubescent. Leaves opposite decussate, petiole 2–5 cm long, the size of the leaf markedly becomes shorter towards the tip giving a rosette appearance at the upper region, pubescent; lamina orbicular 3–6 × 3–6 cm, base truncate to rounded, obtuse at apex, margin crenate with 8–12 teeth with purple margins, secondary veins 4–5, tomentulose beneath, pubescent above, minute sessile glands present on both the surfaces, veins prominent on both the surface. Inflorescence with terminal branched congested spike; lateral spikes 2–4; individual spike heads long tetragonal, 40–100 mm long, 2.5–3 mm broad; dark purplish, pubescent. Bracts rhombeus 2–2.2 × 1.5–1.6 mm, pubescent; bracteole ovate 1–1.4 × 1– 1.2 mm, pubescent outside, glabrous inside. Calyx ovoid to cylindrical 3.5–4 × 2–2.2 mm when posterior lip opened and 2.5–2.6 × 2–2.2 mm when posterior lip closed, pubescent with yellow sessile glands; fruiting calyx 4.5–5 mm long; posterior lip 1-lobed obtuse, ciliate. Corolla 8–10 × 2.8–3 mm long, with dark violet to purple coloured, tube narrow at base, glabrous; lips outside strigose with yellow sessile glands, mainly at middle and anterior lip; hairs 3–4 celled. Stamens 4, free, attached at the mouth of the corolla tube, didynamous, posterior pair attached just below anterior but not united, filament of posterior 1.8–2.2 mm long, anterior pair 1.4–1.6 mm long, appendages absent, included in anterior corolla lip; anthers bilobed, dorsifixed, 0.35–0.38 mm long, dehisces longitudinally. Style 7.5–8 mm long, stigma bifid 0.4–0.5 mm long. Nutlets brown ovoid to ellipsoid 0.8–1 × 0.7–0.75 mm.

Phenology:— Flowering and fruiting from July to December.

Distribution:—Endemic to South India.

Habitat and Ecology:—On exposed wet rock surfaces intermingled with grasses.

Specimens examined:—Kerala. Palakkad District: Dhoni forest, Korakkallu, 26 September 2013*, Shinoj, Prasad M.G. & Vimal 135552* (CALI!); Nelliampathy, Manpara, 10 December 2014, *Shinoj, Prasad M.G. & Vimal 151100* (CALI!). **Tamil Nadu.** Deccan Peninsula, Anamallay Mts, July 1851, *Wight 2132/1* (L!, isotype); Anamalais, Poonachi ghat, 8 October 1901, *C.E. Barber 3607* (MH!); around Attakatti, 900 m, 4 July 1961 *J. Joseph 12687* (MH!); Dindigul, Kodaikanal Distr., Puthur Kavalapatti path, 500 m, 2 May 1988, *Matthew RHT 52871* (K).

Conservation status:—According to Henry et al. (1987) this species is rare. Manickam et al. (2003) suggested a small extent of occurrence for this species in Tirunelveli Hills. An assessment of threatened plants of the Kerala Forest (www.keralaforest.org) cited this species as endangered. We collected the specimens from Dhoni forest area and Nelliampathy hills of Palakkad. In Dhoni I was able to see a disturbed population of only very few species but in Nelliampathy a luxuriant growth was found. During my research period I have visited twice in Pulney Hills especially in Kodaikanal areas but was either unlucky to see the specimen or it is pity to understand that the plant is undergoing severe habitat destruction there. So it can be treated under Vulnerable (VU) according to the criteria B2b of IUCN category.

Notes:—*Anisochilus wightii* is an elegant succulent herb with purple colour margined leaf and elongated dark purple tetragonal or pyramidal congested spike. This plant shows similarities to *A. scaber* but in inflorescence nature, leaf nature, spike shape, calyx, etc. shows marked differences.

14. Anisochilus sp. 1 **(Plate 80 & 82 F)**

Procumbent annual or perennial succulent herb, 60–100 cm high. Stem base 1–2 cm in diameter, profusely branching, branches 40–60 cm long, terete, pubescent to hirsute. Leaves opposite decussate, ovate, 3–6 × 2–4 cm, base truncate to rounded, apex obtuse, margin serrate, 20–25 teeth, secondary veins 4–5, tomentulose beneath, glabrescent to slightly pubescent above, minute sessile glands not seen, veins prominent on both the surface; petiole 3–6 cm long. Inflorescence with terminal branched congested spike, lateral spikes 4 (rarely 6), individual spike heads long tetragonal, 3–7 mm long, 1.5–2.5 cm broad, white, tomentulose. Bracts deltoid ca. 1.8–2 × 1.4–1.8 mm, pubescent outside, glabrous inside. Calyx ovoid to cylindrical 2–2.5 × 1.4–1.8 mm when posterior lip opened and 1.2–1.6 mm long when posterior lip closed, tomentose with yellow sessile glands; fruiting calyx 3–3.5 mm long; posterior lip 1-lobed, apex acute to acuminate, margin ciliate. Corolla 9–10 × 3.8–4 long, white or pale violet; tube slightly narrow and glabrous at base; lip strigose outside with yellow sessile glands; hairs 3–4 celled. Stamens 4, free, attached at the mouth of the corolla tube, didynamous, posterior pair attached just below anterior but not united, filament of posterior ca. 4–4.2 mm long, anterior pair ca. 3–3.2 mm long, appendages absent, included in anterior corolla lip; anthers bilobed, dorsifixed, ca. 0.5–0.6 mm across, dehisces longitudinally. Style ca. 7.8–8 mm long, stigma bifid ca.0.22 –0.25 mm long. Nutlets brown broadly ovoid to orbicular ca. 0.9 × 0.75 mm.

Phenology:—Flowering and fruiting from September to January.

Distribution:—Endemic to Western Ghats.

Habitat and Ecology:—On exposed wet rock surfaces in dry mixed deciduous.

Notes:—*Anisochilus* sp. 1 is an elegant succulent herb with white flowers and slender spikes. This species shows close similarities to *Anisochilus wightii* in possessing elongated slender spike heads 5–7 in number but differs from the later in possessing some unique characters like ovate leaf without purple margin, moreover terete stem, longer petiole, smaller heads, floral parts and white corolla colour.

3. Scutellaria L.

Scutellaria L., Sp. Pl. 598. 1753; D. Don, Prodr. Fl. Nepal.109. 1825; Benth. in Wall. Pl. Asiat. Rar. 1: 67. 1830; Benth., Edwards's Bot. Reg. 18: t. 1493.1832; Benth. in DC., Prodr. 12: 412. 1848; Hook. f., Fl. Brit. India 4: 667. 1885; H. Trimen, A Hanb. Fl. Ceylon 3: 382. 1895; T. Cooke, Fl. Bombay 2: 545. 1905; Gamble, Fl. Pres. Madras 2: 1142. 1921; B.D. Sharma, Fl. Nilgiri Dist. 225. 1975; B.D. Sharma et al., Fl. Karnataka 235. 1984; R.S. Rao et al., Fl. Goa, Diu, Daman, Dadra & Nagar haveli 2: 351. 1986; B.G. Kulkarni, Fl. Sindhudurg 363. 1988; Manilal, Fl. Silent Valley 224. 1988; Kesh. Murthy & S.N. Yogan. Fl. Coorg 363. 1990; S.M. Almeida, Fl. Sawantwadi 1: 350. 1990; M. Mohanan & A.N. Henry, Fl. Thiruvanthapuram 373. 1994; S. Deshpande et al., Fl. Mahabaleshwar 488. 1995; Sivar. & P. Mathew, Fl. Nilambur 555. 1996; K.M. Mathew, Fl. Palni Hills 1016. 1999; N.P. Singh et al., Fl. Maharashtra, Dicot. 2: 762. 2001; S.R. Yadav & M.M. Sardesai, Fl. Kolhapur Dist. 385. 2002; Mandar & Lakshmin., Fl. Bhagwan Mahavir 198. 2013.

Key to species of the species of *Scutellaria* in Western Ghats

1a. Leaves more than three times longer than the breadth, corolla yellow .... **3**. ***Scutellaria oblonga***

1b. Leaves less than three times longer than breadth, corolla blue, lavender or pale purple **2**

2a. Straggling herb, leaves deltoid, leaf margin with ≤8 teeth .... **1**. ***Scutellaria colebrookeana***

2b. Erect or procumbent herb, leaves ovate to orbicular, leaf margins with >8 teeth..**3**

3a. Internodes short giving a rosette appearance, leaf apex round .... **2. *Scutellaria discolor***

3b. Internodes long, no rosette appearance, leaf apex acute to acuminate. **4**

4a. Procumbent habit, bracts rhomboid, corolla >1 cm .... **5. *Scutellaria wightiana***

4b. Erect habit, bracts ovate to leafy, corolla <1 cm. .... **4. *Scutellaria violacea***

1. *Scutellaria colebrookeana* Wall. ex Benth. in Wall., Pl. Asiat. Rar. 1: 67. 1830; K.M. Matthew, Fl. Palni Hills 1016. 1999.

≡ *Scutellaria violacea* var. *colebrookeana* (Wall. ex Benth.) Hook.f., Fl. Brit. India 4: 668. 1885. **Type**:—INDIA. Peninsular India, *s.d.*, *Heyne 2135* (holotype: K, K000820768, digital image!). **(Plate 83, 84 & 92 A)**

Perrenial, straggling herb, 50–100 cm high; stem base 0.5–1 cm in diameter, branches creeping, branches 20–80 cm long, quadrangular, glabrous to pubescent; internodes 3–7 cm long. Leaves opposite decussate, triangular, 2–5 × 2–5 cm, thick, base truncate, apex acute, margin crenate to serrate with 4–7 teeth, reticulately nerved, secondary veins 4–6, mid vein prominent beneath, lower glabrous to glabrescent, petiole 2–5 cm long, glabrous to glabrescent. Inflorescence terminal racemes, 6–20 cm long, slightly dense towards apex, 2–3 cm across, many flowered; pedicels comparatively long, 4–5 mm long. Bracteoles ovate to rhomboid, 2.8–3.2 × 1.4–1.6 mm, acute to obtuse tip, pubescent. Flowers 15–40 per inflorescence. Calyx bilipped, 2.8–3.2 mm long in flower, 3.2–4 mm in fruit, hood or sail like structure at midway of upper lip 1.2–1.3 mm in flower, 3–4 mm in fruit, hispid outside, glabrous inside; lips equal, 0.4–0.6 × 2–2.2 mm. Corolla 10–13 mm long, tube 7–8 mm long, curved, bluish to lavender; pubescent to hispid outside, glabrous inside;

lower lip, 4.5–5 × 4–4.2 mm long, unilobed; upper lip 2.6–2.8 trilobed, middle lobe 1.4–1.6 × 2.4–2.8 mm, broadly semicircular, lateral lobes slightly narrower 1.4–1.6 × 0.6–0.7 mm. Stamens 4, included in the upper lip of corolla, didynamous; posterior pair 6.6–6.9 mm long, anterior pair 4.6–4.8, filaments slightly villous at base; anthers white or violet ca. 0.8 mm across. Disc 0.5 mm long. Style 10–11 mm long, slender; stigma lobes equal, posterior 0.3 mm long, anterior very short less than 0.05 mm. Nutlets 4, ca. 0.3 × 0.4 mm.

Phenology:—Flowering and fruiting was observed from August to January.

Distribution:—Endemic to South India mainly in Southern Western Ghats.

Habitat and ecology:—Intermingled with grasses in open margins of evergreen forests above 900 m.

Specimens examined:— **Kerala.** Wayanad District: Mananthavady, Periya 36, Gurukula Sanctuary, 12 December 2014, *Shinoj & Sunojkumar 138348* (CALI!), *ibid*, 14 September 2015, *Shinoj, Smitha & Soumya 138375* (CALI!). **Tamil Nadu.** Coimbatore District: Pulneys, Kodaikanal Ghat, 6 May 1899, *Bourne 27512* (MH!); Anamalai, near waterfall, 25 September 1931, *C. Rajasekhara Mudaliar 94150* (MH); Attakatti, 1000 m, 6 July 1961, *J. Joseph* (MH!); Dindigul District: Sirumalai, Vellimalai, 1119 m, 19 December 2013, *Shinoj, Sreejith & Kabeer 135983* (CALI!); Kanyakumari District: Mahendragiri slope, 1000 m, 29 July 1966, *B.V. Shetty 28035* (MH!); Alagiapandipuram, Estate bungalow to Kurusadi Mottai, 1200 m, 23 September 1998, *V.S. Manickam XCH 17459* (XCH!); Mahendragiri, Kurusadi Mottai, 900 m, 27 March 1999, *V.S. Manickam XCH 18699* (XCH!); Ramanathapuram District: way to Umbummedu, Ayyanar koil, 950 m, 23 September 1971, *E. Vajravelu 38728* (MH!); Tirunelvely District: Mundanthurai, 500 m, 23 September 1943, *D. Daniel & S.R. Raju 20439*

(MH!); Kuthiraivelli, 1050 m, 31 August 1963, *A.N. Henry 19801* (MH!); Kannikatti-Kallivayalpil, 850 m, 7 July 1964, *A.N.Henry & M. Chandrabanu 19801* (MH!); Thirlakkumparai, 730 m, 29 November 1969, *B.V. Shetty 32969* (MH!); Cheekkalamoodu, way to Kannikatty, 375 m, 21 May 1988, *R. Gopalan 88618* (MH!); Ambai Kakkachi road, 1400 m, 20 December 1996, *V.S. Manickam XCH 11844* (XCH!); Ambasamudram, Agastyar Hills, Injukuli, 950 m, 4 August 1998, *V.S. Manickam XCH 16732* (XCH!); Nanguneri, Kalakkad view point, 800 m, 16 June 1999, *V.S. Manickam XCH 19477* (XCH!); Manjolai to Kakkachi, 5 January 2016, *Shinoj* & *Prashob 145419* (CALI!); Kalakkad, Mundanthurai Tiger Reserve, near Karayar dam, 6 January 2016, *Shinoj* & *Prashob 145419* (CALI!).

Conservation status:—*Scutellaria colebrookeana* is found at an altitude above 1000 m among grasses. We have collected it from Manjolai and Kakkachi areas of Upper Kodayar region and found that the species is facing high risk of habit destruction. Moreover many mature individuals were met in Coffee plantations. During our field trips we had collected the specimen only from Tamil Nadu region, from Sirumalai and Kodayar. Therefore, we suggest that it should be classified as Vulnerable (VU) according to the criteria A4 of IUCN (2012, 2017).

Notes:—This species is very close to *Scutellaria violacea* and many authors treated it under a variety of the latter. The plant differs from *S. violacea* in possessing long straggling habit with smaller deltoid leaf with fewer serrations and smaller floral organs compared to the later.

2. Scutellaria discolor Wall. ex Benth. in Wall., Pl. Asiat. Rar. 1: 66. 1830; Hook.f., Fl. Brit. India 4: 667. 1885; T. Cooke, Fl. Bombay 545. 1906; Gamble, Fl. Pres. Madras 2: 1142. 1921; Mukerjee, Rec. Bot. Surv. India 14: 145. 1940; B.D. Sharma et al., Fl. Karnataka 218. 1984; R.S. Rao et al., Fl. Goa, Diu, Daman, Dadra & Nagar haveli 2: 351. 1986; B.G. Kulkarni, Fl.

Sindhudurg 363. 1988; Kesh. Murthy & S.N. Yogan., Fl. Coorg 363. 1990; S.M. Almeida, Fl. Sawantwadi 1: 350. 1990; S. Deshpande et al., Fl. Mahabaleshwar 488. 1995; P. Singh et al., Fl. Maharashtra Dicot. 2: 762. 2001; S.R. Yadav & M.M. Sardesai, Fl. Kolhapur Dist. 385. 2002; Mandar & Lakshmin., Fl. Bhagwan Mahavir 198. 2013. **(Plate 85, 86 & 92 B)**

= *Scutellaria indica auct non* L.: D. Don, Prodr. Fl. Nepal.109. 1825.

Type:—NEPAL, 1821, *Wallich 2134-1* (holotype: K, K000639588, digital image!).

= *Scutellaria colebrookeana* Zoll. & Moritzi in A. Moritzi, Syst. Verz. Java: 54. 1846.

= *Scutellaria heteropoda* Miq., Fl. Ned. Ind. 2: 972. 1859.

= *Scutellaria zollingeriana* Briq., Annuaire Conserv. Jard. Bot. Genève 2: 104 .1898.

= *Scutellaria salvia* H.Lév., Bull. Acad. Int. Géogr. Bot. 24: 252. 1914.

= *Scutellaria discolor* var. *elatior* Benth. in Wall., Pl. Asiat. Rar. 1: 66. 1830.**Type**:—BANGLADESH, Sylhet, *Silva F. de 2134* (holotype: K, K000820799, digital image!).

var. *discolor*

Erect herb, 10–20 cm high; stem base 0.5–1.5 cm in diameter, branching rarely, branches 8–10 cm long, quadrangular, glabrous to pubescent; internodes short 1–2 cm long, giving a rosette appearance. Leaves opposite deccusate; ovate to orbicular, 4–8 × 3–8 cm, thin, base cordate or attenuate, apex obtuse or rounded, margin crenate to serrate with 18–15 teeth, reticulately nerved, secondary veins 3–5, veins prominent beneath, lower surface glabrous to pubescent; petiole short, 0.7–1.2 cm long, glabrescent to pubescent. Inflorescence terminal racemes, 6–20 cm long, slightly dense towards apex, lax below, 1.5–2.5 cm across, flowers 15–40, arranged opposite decussate to spiral towards apex; pedicels short, 0.2–0.3 cm long. Bracts ovate, 0.4–0.5 cm, tip acute, glabrous to glabrescent. Calyx bilipped without teeth, 2–2.3 mm long in flower, 3–3.5 mm in fruit, hood or sail like structure present on the midway of upper lip 1–1.2 mm in flower, 3–4 mm in fruit, glabrescent outer surface, glabrous inside; lips equal, 0.3–0.5 × 2–2.2 mm long. Corolla 9–12 mm long; tube 5–6 mm long, curved, bluish to lavender, pubescent to hispid outside, glabrous inside; lower lip, 4–4.5 × 3.8–4 mm long, unilobed; upper lip 2.2–2.5mm long trilobed, middle lobe ca. 1–1.2 × 2–2.3 mm, broadly semicircular, lateral lobes slightly narrower ca. 1–1.2 × 0.4–0.5 mm. Stamens 4, included in the upper lip of corolla, didynamous; posterior pair 6.2–6.5 mm long, anterior pair 4–4.2 mm, filaments slightly villous at the base; anthers white or violet ca. 0.6 mm across. Disc, 0.5 mm long. Style 8–9 mm long, slender; stigma lobes unequal, posterior 0.2 mm long, anterior very short less than 0.05 mm. Nutlets 4, ca. 0.4 × 0.4 mm.

Phenology:—Flowering and fruiting was observed from July to March.

Distribution:—Tropical Asia to South China. In Western Ghats it is mainly distributed in Karnataka and Kerala states of Western Ghats.

Habitat and ecology:—Mainly found on vertical rock surfaces and lateritic wall at evergreen, semi evergreen forests and grasslands above 800 m.

Specimens examined:—**Karnataka.** Belgaum District: Chorla, *Nilesh V Malpure 2619* (SUK!); Shimogha District: Kodachadri grassland (on lateritic all cuttings), 4 January 2013, *Shinoj & Prasad E.R. 290170* (CALI!); Megharhalli to Shimogha road (around 71 km after Megharhalli), 17 October 2014, *Shinoj, Satheesh & Prasad M.G. 138337* (CALI!); Jog falls (near a bridge and river), 472 m, 22 January 2015, *Shinoj, Shravan & Srinivas*

138353 (CALI!); Chikkamagaluru District: Sringeri, Kigga, Narasimhaparvatha (on the way to hill), 23 January 2015*, Shinoj, Shravan & Srinivas 138356* (CALI!). **Kerala.** Idukki District: Mathikettan Shola N.P., Choondal, near campshed, 4 November 2015, *Shinoj, Smitha & Syam 145404* (CALI!); Wayanad District: Muthanga Forest, 05 July 2013*, Shinoj & Soumya 290190* (CALI!); Muthanga, Ponkuzhi, 21 August 2013, *Shinoj & Smitha 135517* (CALI!).

Conservation status:—Based on herbarium assessment, literature survey and field works, it is presumed that the species is fairly widespread in Western Ghats. We collected the plant mainly from Kerala and Karnataka, were dense population were observed. According to the world checklist of selected plant families, this species is distributed from Tropical Asia to south China. This indicates that the area of occupancy is much more than 20000 km^2. As per all the above mentioned data this species can be assessed under the category Least Concerned (LC) following IUCN guidelines.

Notes:—The vegetative characters of this species is very distinct from other species found in Western Ghats. It possesses moreover a rosette habit with broadly ovate or orbicular leaves with obtuse apex. This species is found mostly on vertical rock surface and lateritic wall cuttings mainly in drier areas unlike the others which is mainly found in wet areas intermingled with grasses.

3. Scutellaria oblonga Benth., Edwards's Bot. Reg. 18: t. 1493. 1832; Hook. f., Fl. Brit. India 4: 667. 1885; H. Trimen, A Hanb. Fl. Ceylon 3: 383. 1895; Gamble, Fl. Pres. Madras 2: 1142. 1921; Sivar. & P. Mathew, Fl. Nilambur 555. 1996. **(Plate 87, 92 B)**

Scutellaria rivularis sensu B.D. Sharma et al., Fl. Karnataka 235. 1984.

Type:—an Illustration in Edwards's Bot. Reg. 18: t. 1493. 1832 (holotype).

Erect herb, 10–30 cm high; stem base 0.3–0.8 cm in diameter; branches 8–15 cm long, quadrangular, glabrous to pubescent, internodes short 1–3 cm long. Leaves opposite deccusate, oblong to narrow ovate, 3–4 × 1–1.5 cm, thin, base cuneate or attenuate, apex acute, margin entire or slightly serrate with 4–6 vague teeth, reticulately nerved, secondary veins 3–4, mid vein prominent beneath, lower surface glabrous to pubescent; petiole short, 1–1.2 cm long, glabrescent to pubescent. Inflorescence terminal racemes, 6–12 cm long, lax, flowers arranged opposite decussate; pedicels short, 0.3–0.4 cm long. Bracts ovate, 0.2–0.3 cm, acute tip, glabrous to glabrescent. Calyx bilipped, 1.8–2 mm long; hood or sail like structure at middle of upper lip 0.8–1 mm in flower, 2.5–3 mm in fruit; outer surface glabrescent; both upper and lower lip equal in length 0.2–0.3 × 1–1.2 mm. Corolla 8–12 mm long, tube 5–6 mm long, curved, yellowish, glabrescent outside; lower lip 4–5 × 3–4 mm long, unilobed; upper lip 3–4 mm long trilobed.

Phenology:—Flowering and fruiting was observed from July to March.

Distribution:—Mainly distributed in Sri lanka and also in India. According to Global Biodiversity Information system this species is found in Stockholm, Sweden. Herbarium reference and literature survey states that this species is distributed in Karuvarakund areas of Silent Valley National Park, Kerala and Pykara area of Ooty, Tamil Nadu in India.

Habitat and ecology:—This species is mostly confined to wet surface near to water bodies.

Specimens examined:—**Kerala.** Palakkad District: way to Poovan cholai, Silent Valley R.F., 1100 m, 7 March 1984, *M.C. Nair 81106* (MH!); Silent Valley, 14 January 1993, *A. Nazarudeen 10101* (TBGT!). **Tamil Nadu.** Nilgiris District: Parsons Valley, Ooty, 2125 m, 10 July 1970, *J.L. Ellis 34604* (MH!); Pykara, June 1899, *s.coll. s.n.* (MH!).

Conservation status:—This species is found fairly widespread in Sri Lanka as per the herbarium assessment and literature survey conducted as a part of this study. We were not able to collect live specimen though we visited the distribution areas in Kerala and Tamil Nadu in different seasons which clearly depicts that this species is rare in India. But the area of occupancy is much more than 20000 km^2. So this species can be treated under the category Least Concerned (LC) following IUCN rules.

Notes:—The description made above is based on herbarium and type illustration. The vegetative characters of this species is also very distinct from other species found in Western Ghats. It possesses a linear to oblong leaf. According to the literature survey and herbarium study it is noted that this species is found mostly near wet surface near to water bodies.

4. Scutellaria violacea B. Heyne ex Benth. in Wall., Pl. Asiat. Rar. 1(3): 66. 1830; H. Trimen, A Hanb. Fl. Ceylon 3: 382. 1895; B.D. Sharma et al., Fl. Karnataka 235. 1984; B.D. Sharma et al., Fl. Karnataka 225. 1984; R.S. Rao et al., Fl. Goa Diu Daman Dadra & Nagar haveli 2: 351. 1986; Manilal, Fl. Silent Valley 224. 1988; M. Mohanan & A.N. Henry, Fl. Thiruvanthapuram 373. 1994; K.M. Mathew, Fl. Palni Hills 1016. 1999. **Type**:—INDIA, *s.d, Heyne 2136-1* (holotype: K, K001115281, digital image!).

(Plate 88, 89 & 92 C)

=*Scutellaria violacea* var. *glabrior* Benth. in Wall., Pl. Asiat. Rar. 1: 67. 1830. **Type**:—SRI LANKA, *s.d., s.coll. 2136β* (holotype: K, K001115282, digital image!).

=*Scutellaria floribunda* Benth. In DC. Prodr. 12: 418. 1848.

=*Scutellaria violacea* var. *floribunda* (Benth.) Hook.f., Fl. Brit. India 4: 668. 1885. **Type**:—SRI LANKA, *Walker, s.n.* (holotype: K, K000820793, digital image!).

=*Scutellaria violacea* var. *glabra* Trimen, Syst. Cat. Fl. Pl. Ceylon: 70. 1885.

var. ***violacea***

Perrenial, erect herb, 30–80 cm high; stem base 0.5–1.2 cm in diameter, branches 15–40 cm long, quadrangular, glabrous to pubescent; internodes 2–6 cm long. Leaves opposite deccusate; ovate, 4–8 × 2–5 cm, thin, base cordate or attenuate, apex acute to acuminate, margin crenate to serrate with 10–15 teeth, reticulately nerved, secondary veins 4–6, veins prominent beneath, lower surface slightly pubescent, more on veins; petiole 2–5 cm long, glabrescent to pubescent. Inflorescence terminal racemes, 6–20 cm long, slightly dense towards apex very lax below, 2–3 cm across, many flowered; pedicels short, 0.2–0.3 cm long. Bracts ovate to leafy, 0.2–0.5 cm, tip acute to obtuse, pubescent; bracteoles linear 0.05–0.1 cm long, present on middle of pedicel. Flowers less, 15–25 in an inflorescence. Calyx bilipped, 3.8–4.2 mm long in flower, 4–4.2 mm long in fruit; hood or sail like structure present at middle of upper lip 1–1.2 mm long in flower, 4–5 mm long in fruit; outer hispid or hirsute, inside glabrous; both upper and lower lip equal in length 2–2.2 × 4–4.5 mm. Corolla 1.4–1.6 mm long, tube 9–10 mm long, straight, lower part included in calyx, pale violet, lavender, pinkish or white with pink or violet shade, pubescent to pilose outside, slightly glabrous to glabrescent inside; lower lip, 5.5–6 mm long, unilobed; upper lip three lobed, middle lobe 4–4.5 mm long, ca. 5 mm broad, broadly ovate, lateral lobes slightly shorter and narrower broader ca. 2.4 × 1 mm broad. Stamens 4, included in the posterior lip of corolla, posterior pair 5.5–6 mm, anterior pair slightly larger 8.5–9 mm, filaments pale yellow, glabrous; anthers white or straw coloured ca. 0.8 mm across. Disc 0.3–0.4 mm long. Style 14–15 mm long, slender; stigma lobes unequal, posterior 0.3 mm long, anterior very short less than 0.05 mm long. Nutlets 4, ca. 0.5 × 0.48 mm with narrow base and broadly ovate apex.

Phenology:—Flowering and fruiting was observed mainly from September to March. But occasional flowering is noticed beyond this period .

Distribution:—Himalaya to South China and Java. In southern Western Ghats this species is found in majority of forest areas of Kerala and Tamil Nadu.

Habitat and ecology:—This species is mostly confined to moist surfaces in forest with enough leaf mulch.

Specimens examined:— **Kerala.** Idukki District: Munnar, Devikulam, elev. 1675 m, 14 June 1963, *K.M. Sebastian 16486* (MH!); Devikulam, 1500 m, 28 January 1964, *K.M. Sebastian 18498* (MH!);Kurisumala, 980 m, 12 September 1984, *V.T. Antony 697* (MH!); Thekkady, 825 m, 22 December 1974, *K. Virekanthan 45394* (MH!); Munnar, Way to Eravikulam hut, 1000 m, 14 October 1989, *P. Bhargavan 90942* (BM!); Dhanus Valley, Upper Vaguvarai, 1000 m, 17 October 1989, *P. Bhargavan 90973* (MH!); Anamudi Shola N.P. (Forest road side), 13 December 2012*, Shinoj, Prasad & Vimal 290146* (CALI!); Munnar, Anamudi Shola N.P. (Forest road side), 13 December 2012*, Shinoj, Prasad & Vimal 290145* (CALI!); Gundumalai (Forest inside tea estate), 14 December 2012*, Shinoj, Prasad & Vimal 290153* (CALI!); Eravikulam (Rajamala hill valleys), 15 December 2012*, Shinoj, Prasad & Vimal 290158* (CALI!); Mathikettan shola N.P., Choondal, near cardamom plantation, 4 November 2015, *Shinoj, Smitha & Syam 145403* (CALI!); Devikulam (Forest floor near a lake), 2 January 2014*, Shinoj, Prasad & Vimal 135940* (CALI!); Eravikulam, on the way to Anamudi, 5 November 2015, *Shinoj & Smitha 14506* (CALI!); Mathikettan shola N.P., on the way to Vellapara from Campshed, 19 December 2016, *Shinoj & Syam 151031* (CALI!); Kannur District: Brahmagiri, 950 m, 6 March 1979, *V.S. Ramachandran 62140* (MH!); Trivandrum District: Agasthyamala, Pongalapara, 7 October 2014, *Shinoj, Prasad M.G. & Vimal 138332* (CALI!);

Bonacaud top division, 900 m, 19 May 1979, *M. Mohan 61873* (MH!); Wayanad District: Muthanga, Ponkuzhi, 21 August 2013, *Shinoj & Smitha 135522* (CALI!); *ibid*, *Shinoj, Smitha & Soumya 138377* (CALI!); Kurichermala, 28 October 2013, *Shinoj & Smitha 135581* (CALI!); Kurichermala, 28 October 2013, *Shinoj & Smitha 135579* (CALI!); Periya 36, Gurukula Sanctuary, 14 September 2015; Tirunelly, Brahmagiri, (on the way to Pakshipathalam) 1300 m, 16 October 2015, *Shinoj & Manjula 138397* (CALI!). **Tamil Nadu.** Coimbatore District: Attakatti to Valparai, Anamalai, 1300 m, 14 December 1960, *N.P. Balakrishnan & J.L. Ellis 117204* (MH!); *ibid.,* 1000 m, 6 July 1961, *J. Joseph 12746* (MH!); Dindigul District: Pulney, Kodaikanal, Shembaganur Shola, 6000 ft, 13 September 1905, *C.A. Barber 7282* (MH!); Madurai District: high way mts, 4600 m, 10 September 1925, *K.C. Jacob 17665* (MH!); Aruna estate, 1550 m, 24 October 1959, *K. Subramanyan 9507* (MH!); Pambar forest, 1750 m, 16 September 1968, *D.B. Deb 30898* (MH!); Sengamal Solai, Panagudi, 840 m, 10 September 1969, *B.V. Shetty 32325* (MH!); High wavy Estate, 19 May 1992, *V. Lakshmanan 99586* (MH!); Nilgiris District: Ooty, Doddabetta, 10 June 1883, *s.coll. 445* (MH!); Kattabettu to Doddabetta road, 2000 m, 7 January 1957, *K. Subramanyan 2004* (MH!); Kateri road, 1666 m, 19 January 1957, *K.M. Sebastian 2027* (MH!); Tiger Shola, Aderly road from Coonoor, 2000 m, 25 March 1957, *K.M. Sebastian 2655* (MH!); Kolagir to Ooty road, 1900 m, 8 March 1969, *D.B. Deb 31536* (MH!); Pakasuranmalai, 1750 m, 12 March 1969, *D.B. Deb 31675* (MH!); Doddabetta, (after Doddabetta junction, before 2nd hair pin curve), 19 December 2013, *Shinoj & Vimal 135919* (CALI!); Kodaikanal, on the way to Pillar rock, 1940 m, 25 February 2014, *Shinoj, Sreejith & Kabeer 135997* (CALI!); Coimbatore, Velliyangiri, 30 September 2016, *Shinoj & Nikhil 151003* (CALI!); Tirunelveli District, Kodayar, Kakkachi path, 1300 m, 20 December 1996, *V.S. Manickam 11826* (XCH!); Kanikkatti hills, Inchikuli, 500 m, 8 June 1997, *V.S. Manickam 12980*

(XCH!); Tenkasi, Courtallum Hills, Tekkumalai estate, Kuliratti path, 850 m, 23 June 1998, *V.S. Manickam XCH 16215* (XCH!); Nanguneri, Nambikoil, Thirukurungudi hills, 600 m, 11 July 1998, *V.S. Manickam 16488* (XCH!); Ambai Papanasam, near Valayar river, 900 m, 9 April 1999, *V.S. Manickam 18977* (XCH!); Kanyakumari district: Alagiapandipuram, Mahendragiri hills, forest near to Kurusadi mottai, 1200 m, 24 September 1998, *V.S. Manickam s.n.* (XCH!); Virudhunagar District: Kurathividuthi estate, Seithur Hills, 1200 m, 11 November 1989, *S.R. Srinivasan 86970* (MH!).

Conservation status:—This species is found fairly widespread from Himalaya to South China and Java and the area of occupancy is much more than 20000 km^2. So this species can be treated under the category Least Concerned (LC) following IUCN rules.

Notes:— This species is very close to *Scutellaria wightiana* but differs from the later by possessing erect habit, elongated branched racemes, dialated inferior lip of corolla, etc.

5. Scutellaria wightiana Benth. in Wall., Pl. Asiat. Rar. 1: 67. 1830; Gamble, Fl. Pres. Madras 2: 1142. 1921; B.D. Sharma et al., Fl. Karnataka 235. 1984; B.D. Sharma et al., Fl. Karnataka 225. 1984; Kesh. Murthy & S.N. Yogan., Fl. Coorg 363. 1990; K.M. Mathew, Fl. Palni Hills 1016. 1999; Kesh. Murthy & S.N. Yogan., Fl. Coorg 363. 1990. **Type**:— INDIA, *s.l., s.d., s.coll. 2708* (holotype: K, K001116875, digital image!). **(Plate 90, 91 & 92 D)**

= *Scutellaria wightiana* var. *microphylla* Benth. in Wall., Pl. Asiat. Rar. 1: 67. 1830. **Type**:—INDIA, *Wight 2708β* (holotype: K, K001116875, digital image!).

Annual or perrenial, procumbent herb, 30–50 cm high; stem base 0.5–1.2 cm in diameter, branching at the base, branches 15–40 cm long, quadrangular to terete, glabrous to pubescent; internodes 1.5–3.5 cm long. Leaves opposite deccusate; ovate, 3–6 × 2–4 cm, thick, base cordate, apex acute or slightly obtuse, margin crenate to slightly serrate with 6–10 teeth, reticulately nerved, secondary veins 4–6, veins prominent beneath, lower surface hirsute, especially on veins; petiole 1.5–3.5 cm long, pubescent to hispid. Inflorescence terminal racemes, 5–15 cm long, slightly dense towards apex, lax below, 2.5–3 cm across, many flowered; pedicels long 0.4–0.5 cm long. Bracts rhomboid, 4–4.2 × 3.4–3.6 mm, acute to obtuse tip, glabrous with ciliate margin. Flowers limited in number, around 15–20 in an inflorescence. Calyx bilipped, 3–3.2 mm long in flower, 3.6–4 mm in fruit; hood or sail like structure present at the middle of upper lip 1.2–1.6 mm in flower, 4–5 mm in fruit; outer hirsute to hoary tomentose, inside glabrous; both upper and lower lip equal in length 0.8–1.2 × 3.5–4 mm. Corolla 1–1.4 cm long, tube 7.5–8 mm long, slightly bent and curved upwards and lower part gibbose in nature, pale violet, pinkish or white with pink or violet dots or shade on the anterior lobe of corolla, pubescent outside, pilose inside, mainly the upper lip near to the attachment of stamens; lower lip, 5.5–6 mm long, unilobed; upper lip three lobed middle lobe 4.5–5 mm long ca. 5 mm broad, broadly ovate, lateral lobes slightly shorter and narrower broader ca. 2.2 × 1.2 mm broad. Stamens 4, included in the posterior lip of corolla, posterior pair 5–5.5 mm, anterior pair slightly larger 7–7.5 mm, filaments white with a violet shade towards tip, slightly pubescent towards the base; anthers white or off white ca. 0.4 mm across. Disc 0.25–0.3 mm long. Style 11–13 mm long, slender; stigma lobes unequal, posterior 0.25 mm, anterior very short less than 0.05 mm long. Nutlets 4, ca. 0.5 × 0.4 mm with narrow base and broadly ovate apex.

Phenology:—Flowering and fruiting was observed mainly from September to March.

Distribution:—Endemic to southern Western Ghats especially in Kerala and Tamil Nadu.

Habitat and ecology:—This species is mostly confined to moist surfaces in forest floors and also among rocky crevices near to shola borders.

Specimens examined:—**Kerala.** Ernakulam District, Edamalayar, Varium to Shoolamudi hill, 15 December 2016, *Shinoj, Manu Philip & Nikhil 151023* (CALI!); Palakkad District: Nelliampathy, on the way to Minampara, 24 June 2014, *Shinoj, Prasad M.G. & Vimal 138319* (CALI!); Minampara, 11 December 2016, *Shinoj 151016* (CALI!); Nelliampathy, Minampara, after forest check post, 20 September 2015, *Shinoj 145407* (CALI!); Silent Valley N.P. Mundakanchola (Forest floor), 31 October 2013, *Shinoj & Vimal 135605* (CALI!); Forest floor, on the way to Unginda, 1 November 2013, *Shinoj & Vimal 135604* (CALI!); on the way to Sispara from Walakkad (Forest floor), 6 February 2014, *Shinoj & Vimal 135971* (CALI!). **Tamil Nadu.** Coimbatore District: Konalar, Anamalai Hills, 1900 m, 17 November 1980, *M. Chandrabanu 69003* (MH!); Velliyangiri, 30 September 2016, *Shinoj, Nikhil & Pradeep 151003* (CALI!); Kanyakumari District: way to Mahendragiri Peak, Pangudi, 1100 m, 8 February 1983, *A.N. Henry 77003* (MH!); Madurai District: Madurai, 27 July 1965, 2000 m, *K.M. Sebastian 24557* (MH!); Nilgiris District: Avalanche, 2000 m, 13 June 1970, *B.V. Shetty 34207* (MH!); Longwood R.F., Kotagiri, 2050 m, 27 July 1970, *E. Vajravelu 35105* (MH!); Naduvalla, 1800 m, 26 November 1971, *N.C. Radhakrishnan 39010* (MH!); Shola Near Doddabetta road, 23 June 1986, *M.K. Janarthanan 83027* (MH!).

Conservation status:—This species is endemic to Western Ghats mainly in Kerala and Tamil Nadu region. In the forest areas of Kerala where it was seen only as few population less than 100 mature individuals, but the distance between the places of distribution was more than 200 km, which indicates that the area of occupancy is more than 20000 km^2. After analysing herbarium data we could not confirm the exact distribution as this species show close resemblance with *Scutellaria violacea* which is a wide spread species. Hence we treat this species under Data Deficient (DD) category following IUCN guidelines.

Notes:—This species is very close to *Scutellaria violacea* but differs from the later by possessing procumbent habit, simple inflorescence, gibbose nature and more curved nature of corolla, subequal nature of anterior and posterior lip of corolla and leaf characters.

CHAPTER 8
ANALYSIS AND DISCUSSION

MORHOLOGY

8.1. Vegetative morphology

8.1.1. Habit

Lamiaceaen plants are mostly herbs and shrubs but rarely trees. The genus *Pogostemon* is mostly woody herbs or undershrubs. Some delicate marshy herbs with soft stems (eg: *Pogostemon deccanensis*) and woody perennial shrubs (eg: *Pogostemon plectrantoides, P. benghalensis,* etc.) are also present in these group. Erect, ascending and prostrate (eg: *Pogostemon auricularius*) stems with quadrangular, sub terete or terete (in some shrubby forms like *Pogostemon benghalensis*) stems can be seen in this genus. Hair pattern shows much variation from glabrous or glabrescent (eg: *Pogostemon travancoricus*) to variety of hair forms like hirsute, sericious, hispid, pilose, tomentose, etc. In some herbaceous forms like *Pogostemon deccanensis, P. cruciatus, P. salicifolius,* etc. of the sub genus *Dysophyllus* basal branching is rare but in all other forms branching is common and a vigorous branching pattern can be met with *Pogostemon mollis* with woody perennial stem. The plants show much variation in the length of the branches from few centimetres (eg: *Pogostemon deccanensis*) to about 2.5 m in some woody shrubs like *Pogostemon plectrantoides* and *P. benghalensis. Pogostemon paniculatus* is the only species which shows sympodial growth and having a zig zag nature in branches.

The genus *Anisochilus* are succulent herbs with carnose stems, but woody robust forms are also rarely seen in this genus like *Anisochilus robustsus.* In a few plants the ridges and furrows are prominent on the stem like that in *Anisochilus adenanthus*. Most of the species coming under the section *Anisochilus* are decumbent, ascending or deliquescent but the section *Stiptanthus* includes erect plants with vivid branching pattern. Hair pattern of this genus also shows much variation from glabrous or glabrescent to variety of hair forms like hirsute, scabrous, hispid, tomentose, villous, etc. Younger stems are quadrangular which becomes terete when mature. Prominent leaf scars can be seen in some species like *Anisochilus plantagineus, A. suffruticosus, etc.* Whereas intrapetiolar hairs of pilose nature can be met with in *Anisochilus carnosus*. Smaller plants with branches decumbent which remain appressed like *Anisochilus kanyakumariensis* to large erect forms like *Anisochilus adenanthus* can be seen in the same genus.

The genus *Scutellaria* are mostly herbaceous forms with erect or ascending branches. Rarely much reduced main branch with rosette arrangement of leaves can be seen in *Scutellaria discolour.* Both quadrangular and terete stems with pubescent to hispid nature can be seen in this genus from Western Ghats. Underground root tubers are also a characteristic feature of this genus.

8.1.2. Leaves

Leaves are usually simple and arranged opposite decussate in most of the shrubby land forms of genus *Pogostemon* whereas a whorled arrangement can be seen in the sub genus *Dysophylla* with three to four leaves (eg: *Pogostemon quadrifolius, P. salicifolius,* etc.). Upto twelve leaves per nodes in some marshy forms like *Pogostemon deccanensis*. All the species coming under the Western Ghats shows simple leaves with short petioles (eg: *Pogostemon deccanensis, P. cruciatus,* etc.) to long petioles in shrubs like *Pogostemon benghalensis, P. travancoricus,* and herbs like *P. paludosus*. An ovate to lanceolate leaf shape is common among the species coming under the sub genera *Pogostemon* and *Allopogostemon*. But orbicular leaves (eg:

Pogostemon mollis) and cordate leaves (eg: *Pogostemon speciosus*) are also seen. The sub genus *Dysophyllus* is characterised by having a lanceolate to linear lanceolate leaf shape with a marginal outward folding. In majority of the species the leaf apex is acute to acuminate, but obtuse leaf apex is observed in *Pogostemon mollis, P. mysuroides,* etc. Leaf base of cuneate to truncate is observed in the sub genus *Pogostemon* (*Pogostemon benghalensis, P. gardneri, P. heyneanus,*etc.) and some species of section Racemosus eg: *Pogostemon paludosus.* Cordate leaf base is a characteristic feature of the section Glabriusculus of the sub genus *Allopogostemon* (*Pogostemon travancoricus, P. speciosus, P. hedgei, P. peethapushpam,* etc.). Serrate, double serrate (eg: *Pogostemon paludosus, P.benghalensis,* etc.) to duble crenate (eg: *Pogostemon travancoricus, P. peethapushpam,* etc.) are the common leaf margins of this genus with an exception of inciso crenate (eg: *Pogostemon gardneri, P. purpurascens,* etc.) and poly serrate (eg: *Pogostemon plectrantoides,* etc.) also seen. The leaf margins of some species of the subgenus *Dysophylla* are entire (eg: *Pogostemon deccanensis, P. cruciatus,* etc.). A variety of hair forms like hirsute, sericious, hispid, pilose, tomentose, etc are observed on leaf surfaces **(Plate 93 &94).**

Leaf characters of the two sections of the genus *Anisochilus* also shows characteristic features which make them separate. The section *Anisochilus* have ovate (eg: *Anisochilus scaber, A. paniculatus,* etc.); orbicular (eg: *Anisochilus wightii, A. kanyakumariensis,* etc.); or cordate leaves (eg: *Anisochilus carnosus*). Whereas in the section *Stiptanthus* the leaves are obovate (eg: *Anisochilus dysophylloides, A. plantagineus* etc.); oblanceolate eg: (*Anisochilus argenteus, A. shoolamudianus,* etc.); or lanceolate (eg: *Anisochilus adenanthus*). Mostly opposite decussate leaves with rarely whorled (eg: *Anisochilus argenteus, A. shoolamudianus,* etc.) arrangement of leaves are observed in the genus. The leaves are less than 10 cm in majority of species except *Anisochilus robustus* which have leaves reaching a length upto

20 cm. Leaf bases varies from attenuate (eg: *Anisochilus adenanthus*), obtuse or round (*Anisochilus eriocephalus, A. scaber,* etc.) to cordate (*Anisochilus carnosus*) in some forms. Leaf apex is mainly obtuse or round but acute to acuminate (*Anisochilus carnosus, A. robustus,* etc.) is also seen in some species. Leaf margins can be entire (*Anisochilus argenteus, A. plantagineus, A. adenenthus,* etc.), crenate (*Anisochilus scaber, A. carnosus, A. wightii,* etc.), crenulate (eg: *Anisochilus kanyakumariensis*) or sinuate (eg: *Anisochilus eriocephaluis*). Leaf margins with deep purple colour is observed in some species like *Anisochilus wightii* and *A. scaber*. Tomentose (eg: *Anisochilus dysophylloides*); tawny tomentose (eg: *Anisochilus argenteus, A. shoolamudianus,* etc.); villous to silky villous (eg: *Anisochilus adenanthus*); scabrous (eg: *Anisochilus scaber*), etc. are the major hair patterns seen in leaves. **(Plate 95)**.

Leaves of the genus *Scutellaria* of Western Ghats are simple ovate to cordate (*Scutellaria violaceae* , *S. wightianana,* etc.); orbicular (*Scutellaria discolor*) or oblong (*Scutellaria oblonga*). Cordate leaf base is common but cuneate leaf base can be seen in *Scutellaria oblonga.* Leaf apex is mainly acute to acuminate with an exception of obtuse or rounded in *Scutellaria discolour.* The commonly seen leaf margins are serrate to crenate (*Scutellaria violaceae, S. wightianana, S. colebrookeana* etc.), but serrulate (*Scutellaria oblonga*) is also seen **(Plate 96)**.

8.2. Floral Morphology

8.2.1. Inflorescence

Like most Lamiaceaen members the inflorescence of the genus *Pogostemon* is also a terminal verticillate thyrse which has a spike like appearance. A simple terminal spike, a terminal spike with two lateral spikes and more than two lateral spikes giving a panicle appearance can be seen as separate categories among the species. A single verticillaster is seen in majority of the species (*Pogostemon atropurpureus, P. speciosus, P.travancoricus, P. mollis,* etc.). Branched inflorescence is a characterstic feature of the subgenus *Pogostemon* and mostly the terminal inflorescence is accompanied by only two laterals like in *Pogostemon gardnerii,* more than two lateral inflorescence units (*Pogostemon benghalensis, P. plectrantoides,* etc.), sometimes the lateral branches are numerous giving a panicle appearance like in, *Pogostemon paniculatus*. The only exception of this subgenus is *Pogostemon purpurascens* with a single terminal inflorescence. Inflorescence of this genus is densely arranged with a very few lax arrangement towards the base but a lax arrangement throughout is observed in some species of the section Racemosus (eg: *Pogostemon paludosus*), Glabriusculus (eg: *Pogostemon travancoricus, P. speciosus,* etc.), and zygocalyx (eg: *Pogostemon wightii*) of the subgenus *Allopogostemon.*

(Plate 97–103).

The inflorescence of the genus *Anisochilus* is mainly congested spike heads, whereas in some species of the section *Stiptanthus,* typical terminal verticillaster (eg: *Anisochilus adenanthus*) or branched inflorescence giving a panicle appearance (eg: *Anisochilus robustus*) can also be seen. The number and nature of spike heads varies among the species. A single terminal congested spike is observed in some species of the section *Stiptanthus* (eg: *Anisochilus argenteus, A. shoolamudianus, A. plantagineus, A. dysophylloides,* etc.). A terminal head with two to six lateral heads (eg: *Anisochilus carnosus, A. scaber, A. kanyakumariensis,* etc.) or numerous heads with secondary and tertiary branching giving a panicle appearance from a long terminal pedunle (eg: *Anisochilus paniculatus*) and numerous inflorescence arising from all axils with branched or single spike heads on long peduncles (eg: *Anisochilus eriocephalus*) is also seen.

(Plate 104–108).

The inflorescence of genus *Scutellaria* of Western Ghats are single terminal raceme (eg: *Scutellaria wightiana, S. oblonga, S. colebrookeana* and *S. discolor*) or branched raceme, usually two lateral branches (eg: *Scutellaria violaceae*). In *Scutellaria discolor* the flowers are arranged spirally.

(Plate 109–110).

8.2.2. Bracts and bracteoles

Bracts are prominent in majority of the genus in Lamiaceae and the arrangement, shape and size varies even in a single species. They are large and conspicuous in the sub genus *Pogostemon* and also there is a continuum in size and shape from bracts to bracteoles (eg: *Pogostemon plectrantoides, P. benghalensis, etc.*). The shape of the bracts varies among from broadly ovate or orbicular (eg: *Pogostemon plectrantoides, P. benghalensis, etc.*), ovate (eg: *Pogostemon heyneanus*), spathulate (eg: *Pogostemon peethapushpam, P. deccanensis, P. auricularius,* etc.), lanceolate or linear (eg: *Pogostemon atropurpureus, P. travancoricus,* etc.). The bracts and bracteoles are mostly hairy and ciliate with acute or acuminate margins.

The bracts and bracteoles of the genus *Anisochilus* are mainly early caducous broad or narrow, ovate with acuminate tip (eg: *Anisochilus argenteus*), ovate to lanceolate with acuminate tip (eg: *Anisochilus argenteus*), lanceolate (eg: *Anisochilus robustus*), deltoid with acuminate tip (eg: *Anisochilus eriocephalus, A. scaber, A. paniculatus, A. kanyakumariensis,* etc.), or rarely rhomboid (eg: *Anisochilus robustus*). The bracteoles are pubescent to villous and ciliate in most of them.

The bracts and bracteoles of the genus *Scutellaria* of Western Ghats are mainly leaf like to ovate or rarely rhomboid (*Scutellaria wightiana*) with ciliate margins.

8.2.3. Calyx

Calyx in the family Lamiaceae is bilipped with four to five teeths. The calyx in *Pogostemon* may be companulate, tubular or infundibular. It may be actinomorphic or zygomorphic (eg: *Pogostemon wightii*) with five teeths. The calyx in the subgenus *Allopogostemon* is normally tubular (eg: *Pogostemon atropurpureus, P. speciosus,* etc.) or infundibular whereas in the subgenus *Pogostemon,* it is infundibular (eg: *Pogostemon benghalensis, P. plectrantoides,* etc.). The calyx in the subgenus *Dysophyllus* is mainly companualte (eg: *Pogostemon auricularius, P. deccanenesis,* etc.). The calyx is green or greenish purple (eg: *P. benghalensis*) in most of the species, but a dark purple coloured calyx is seen in *Pogostemon travancoricus.*

(Plate 111–112).

The calyx characters of the genus *Anisochilus* is of great taxonomic importance as the name itself (a Greek term, '*Aniso*' means unequal and '*chilus*' means lipped) portrays the unequal lips of the calyx and classification of the genus into two sections is mainly based on the calyx characters. A gamosepalous calyx with 5 lobes or teeth is present at the top of the calyx tube. The arrangement of upper or posterior lip and lower or anterior lip can be in two forms 1 posterior / 4 anterior with anterior lip with much reduced 4 teeth giving an appearance of truncate lip (eg: *Anisochilus carnosus, A. scaber, A. wightii,* etc.) or 3 posterior / 2 anterior in which the posterior 3 teeth's may be much reduced giving an appearance of only a single lobe and the anterior lip can be more or less entire or prominently 2 lobed. (eg: *Anisochilus adenanthus, A. argenteus, A. dysophylloides,* etc.).

(Plate 113)

The calyx of the genus *Scutellaria* is bilabiate with round or entire lips sealing off the calyx in fruits and the calyx hairs are same as those found in inflorescence. Scutellum, a small, rigid, erect, sail like or hooded structure is found projecting from the exterior of the posterior lip of calyx. It is usually less than or equal to 6 mm tall and wide. The scutellum acts as a lever which enlarges in the fruit enabling the upper lip of the calyx to be removed and help in dispersal of the seeds. **(Plate 114)**

8.2.4. Corolla

Violet, lavender or pale violet to white colour with purple or straw coloured corolla is normally seen in majority of *Pogostemon* species but white colour corolla is seen in subsection *Racemosus.* Creamy white, yellow or pale green corolla is seen in some species of the subsection Glabriusculus of the Sub genus *Allopogostemon* (eg: *Pogostemon travancoricus, P. hedgei, P. peethapushpam,* etc.). Bilipped corolla with upper three lobes and lower one is seen mostly with distinct corolla tube. The median lobes of the upper corolla lip are slightly longer and narrow compared to the lateral lobes of upper lip (eg: *Pogostemon plectrantoides, P. benghalensis, P. paniculatus, P. purpurescens,* etc.). The corolla lips remain half closed even after anthesis in majority of the species coming under the subsection *Glabriusculus* also the corolla tube is seen filled with nectar in these species (eg: *Pogostemon travancoricus, P. hedgei, P. peethapushpam,*etc.). **(Plate 115 & 116)**

Corolla is 2 lipped with slender decurved tube and inflated throat is seen in the genus *Anisochilus.* The decurved nature of the corolla tube is more prominent in some species of the section A*niosochilus* (eg: *Aniosochilus scaber, A. carnosus, A. eriocephalus, A. wightii,* etc.), a slight curvature is seen in some other species of the same section (eg: *A. paniculatus, A. kanyakumariensis, Aniosochilus* sp.1 etc.), whereas almost a straight corolla tube is seen in the other section *Stiptanthus* (eg: *Aniosochilus adenanthus, A. plantagineus, A. argenteus, A. shoolamudianus,* etc.). The outer surface of the corolla lobe is mostly covered with red, orange or yellow coloured sessile gland in almost all the species of this genus with more distribution on posterior lip. The anterior lip of the corolla is mostly single and boat shaped in most of the species coming under the section *Aniosochilus* (eg: *Aniosochilus scaber, A. carnosus, A. eriocephalus, A. wightii,* etc.).

(Plate 117)

In the genus *Scutellaria* a corolla colour with various combinations of pink, violet (*Scutellaria violacea, S. wightiana,* etc.), blue (*Scutellaria discolor, S. violacea, S. colebrookiana,* etc.), and yellow can be met. Corolla shape is more or less common in all the species of Western Ghats. A bilabiate corolla of unequal lips with large round lower lip with a small notch in the middle of the margin and beared galeate upper lip enclosing the anthers is usually seen. The lower lip of corolla of *Scutellaria wightiana* is broader than the upper lip where as in *Scutellaria violacea,* the lower lip of corolla is wavy and longer instead of broad. This character can be vividly seen if we look the corolla from the top, as the anterior lip is not much seen from the top in *Scutellaria violacea,* but it can be seen well in *Scutellaria wightiana* as the anterior lip is broad and the teeth of posterior lips are narrow and remain very closer. **(Plate 118)**

8.2.5. Stamens and anther

Exerted stamens with monoliform hairs near the corolla mouth or beyond are a key character of the genus *Pogostemon.* This character is maintained in majority of the species from small herbaceous forms in the marshes (eg: *Pogostemon deccanensis , P. cruciatus, P. salicifolius,* etc.) to the suffruticose shrubs in open forest lands (eg: *Pogostemon benghalensis, P. plectrantoides, P. gardneri,* etc.). The species coming under the subsection *Glabriusculus* (eg: *Pogostemon atropurpureus, P. speciosus, P. travancoricus,* etc.), is unique with naked stamens, i.e. they are lacking the beaded hairs on the staminal filament though there are some scattered pilose hairs at the base of the filament. In most species of the sub genera *Pogostemon* (eg: *Pogostemon benghalensis, P. plectrantoides, P. paniculatus,* etc.) and *Dysophyllus* (eg: *Pogostemon deccanensis, P. cruciatus, P. quadrifolius,* etc.) hairs lack on the lower part and the base of the filament though a few simple hairs may be found. The base of filament is villous with short sharp hairs is seen mostly in the subgenus *Allopogostemon* (eg: *Pogostemon mollis, P. paludosus, P. wightii,* etc.). Anthers are unilocular or one celled and the breadth almost equalling the length. The anthers open linearly at the tip.

In *Anisochilus* the stamens are declinate and arranged very close to the anterior or lower lip of corolla. They arise from the base of the lower lip at different heights and hence anterior pair slightly longer. Anthers reniform and synthecous with red or orange coloured sessile glands at the back side of the anther. The stamens do not show much variation in this genus though length and colour slightly varies.

The anterior stamens of the genus *Scutellaria* is longer than the posterior. The difference in length between the anterior and posterior pairs is prominent in this genus compared to the other two. In contrast to the genus *Anisochilus* in which the stamens are arranged inside the anterior lip of the corolla, the stamens in *Scutellaria* are found exerted out of the corolla tube but arranged inside the posterior lip of corolla. The anthers of the species found in Western Ghats is level with the corolla lips and is not exerted or remain half way down the tube as the other members of this genus. The anthers are around 1 mm long, posterior pair have convergent thecae, whereas the anterior pair being dimidiate due to abortion of the posterior or upper theca. Anther slits and stamina filaments are ciliate in these species (Paton, 1990).

8.2.6. Ovary

Superior ovary with two united carpels, four lobed ovary with two locules and gynobasic style arising from between the ovary lobes and axile placentation is the characteristic of the family Lamiaceae and this character is common in all the three genera discussed here. The presence of disc is a special character of taxonomic importance in them. In the genus *Pogostemon,* both symmetrical and asymmetrical disc (eg: *Pogostemon deccanensis*) can be seen, Bhatti & Ingrouille (1997). The anterior side of the disc is well developed in the genus *Anisochilus.* In some species like *Anisochilus dysophylloides* disc is bright orange in colour. Ovaries are situated on a peg like gynophores in the genus *Scutellaria* the base of which is often variously modified to form a nectar.

8.2.7. Style and Stigma

Styles in the genus *Pogostemon* is liner and long with bifid stigma and in majority of the species the lobes of the stigma are equal (ca.1 mm). The style of the genus *Anisochilus* is declinate with shortly bifid equal or sub equal stigma lobes. The lobes are in most cases less than 0.6 mm long. The style is long and forwardly bent in *Scutellaria* with unequally bilobed stigma. The posterior lobe of the stigma is highly reduced in this genus.

8.2.8. Nutlets

The nutlets between the species showed marked differences in the genus *Pogostemon.* The nutlets of the subgenus *Dysophyllus* are oblong with smooth epidermal surface but orbicular is seen in *P. deccanensis.* A wide range of shapes like oblong, orbicular, ovoid, obovoid, lanceolate to linear lanceolate, ellipsoid, etc. has been observed in the sub genera *Pogostemon* and *Allopogostemon* (Bhatti & Ingrouille, 1997). Glands are seen in the subsection *Glabriusculus* (eg: *Pogostemon speciosus, P. peethapushpam,* etc.).

Nutlets may be orbicular (eg: *Anisochilus scaber, A. paniculatus,*etc.), ovoid (eg: *Anisochilus argenteus, A. dysophylloides, A. shoolamudianus,* etc.), ellipsoid (eg: *Anisochilus eriocephalus, A. plantageneus, A. wightii,* etc.), or oblong (eg: *Anisochilus robustus*), and slightly flattened smooth. The nutlets produce mucilage when wetted.

Nutlets in general show great variation, but not much variation is observed in the genus coming under Western Ghats. The surface may be smooth or papillate i.e. with ridges or bands (eg: *Scutellaria violacea*) .

CHAPTER 9
SUMMARY

The family Lamiaceae is considered as one of the largest family in the order Lamiales with 236 genera and around 7173 species worldwide. *Pogostemon* Desf. is a well defined genus of the subfamily Pogostemonoideae with flowers having exerted stamens bearing monoliform hairs. The genus comprises of 80 species distributed mostly in moist to mesic forest or damp areas in South Tropical Africa, Tropical and sub tropical Asia to North West Pacific (Harley et al., 2004). More than 50 percentage of this genus with more than 10 endemic species are reported from India. Various species within the genus are of much importance due to the presence of strong scented, essential volatile oil, extracted from the dried tops (mainly shrubby forms like *Pogostemon benghalensis, P. heyneanus, P. plectrantoides,* etc.). Increasing interest in these compounds in incense, perfumes, and cosmetics introduced new areas of research and the development of new cultivars which pose a serious threat in recognition of these species. This genus was characterised by having aromatic oils, exerted and monoliform hairs, prominent bracts, second inflorescence, etc. Diversified habits ranging from delicate herbs to suffruticose shrubs and habitats ranging from marshy areas to dry hill tops among grasses or rocky surfaces are shown by these plants **(Plate 119 &120).** The arrangement of leaves, inflorescence pattern, size and shape of bracts, nutlets nature, etc. are some other important characters which help in delimitation of the taxa.

Anisochilus (Lamiaceae) is an Asian genus of herbs and shrubs comprises of 20 species which belongs to the subtribe Plectranthinae in tribe Ocimeae of the subfamily Nepetoideae (Harley et al. 2004). It is characterised by the spike-like head, sessile or subsessile fruiting calyx with posterior lobes decurved or deflexed and concealing the throat after anthesis. Out of the 20 species, 17 are found in India, with 10 species reported only from South India including the two recently reported species (Sunil et al. 2015, Shinoj & Sunojkumar, 2018)**.** These plants are mainly distributed on rock surfaces and seen intermingled with grasses **(Plate 121 & 122)**.

Scutellaria, commonly known as skullcaps is a large, sub-cosmopolitan genus of the subfamily Scutellarioideae with 360 currently recognised species (Harley et al. 2004). The genus is characterised by the scutellum, a small, rigid, erect, sail like or hooded structure protruding from the outer surface of the posterior lip of calyx. In India only less than 3 percent of the total species are reported. This genus is mostly confined to damp forest floors with leaf mulch and rock surfaces covered with mosses in evergreen forests and riversides **(Plate 123)**.

Literature survey was carried out using (1) online resources like www.biodiversitylibrary.org, www.botanicus.org, and www.archives.com. (2) institutional libraries like BSI Calcutta, BSI, Southern Circle Coimbatore, Shivaji University Kolhapur, BSI Pune, TBGRI Trivandrum, KFRI Trissur, IFGTB Coimbatore, FRLHT Bangalore and (3) internet repositories like INFLIBNET, and INFONET.

Extensive field trips were conducted in the forest areas of five states of India namely Maharashtra, Goa, Gujarat, Karnataka, Kerala and Tamil Nadu states coming under one of the biodiversity rich area, the Western Ghat. During field trips 3–4 accessions of each specimen were collected. Variations were studied by critically examining multi accessions of species from different localities. From the collected samples, 3–4 twigs were dried and preserved as herbarium vouchers for future references and these are deposited in Calicut University Herbarium (CALI). A complete data on the collection details of each specimen such as locality, altitude, vegetative characters, stem and leaf nature, flower colour, odour, nature of fruit, etc were noted in the field book. Using Leica M80 Stereo Microscope fitted with a digital camera, important characters were microscopically observed and the field photographs were taken using Sony α 55, DSLR Camera. Micro-morphological studies of mericarps of new and similar species were done using Jeol JSM—6390LV/ JED—2300 scanning electron microscope with 20 kV voltage at STIC, Cochin University, Kerala. Dried specimens deposited in various herbaria like BLAT, BSI, CAL, CALI, FRC, KUBH, KFRI, MH, FRLH, SUK, TBGT, XCH etc. were visited and references were made. Lamiacean specimens including type materials of three genera *Pogostemon*, *Anisochilus* and *Scutellaria* were also accessed from online Herbaria like BM, E, K, L, LINN and P. Descriptions of species and recognized varieties were made by combining the data collected. Botanical Latin (Stearn 1998) was used for standard botanical terms in description. Nomenclatural clarifications were made according to the Shenzhen International Code of Nomenclature for algae, fungi, and plants (ICN; Turland et al. 2018). Author names were based on the guidelines provided by Brummitt and Powell (1992) and herbarium acronyms were used based on Index Herbariorum.

The present study reports 40 taxa of the family Lamiaceae, under three genera coming under separate sub families Lamioideae (*Pogostemon*), Nepetoideae (*Anisochilus*) and Scutellarioideae (*Scutellaria*). The diversity of the genera *Pogostemon* and *Scutellaria* was seen more towards the southern Western Ghats, especially in the Nilgiris and Anamalais. The genus *Anisochilus* was seen more towards the drier parts of the Western Ghats, i.e. eastern slopes of Western Ghats or towards the Deccan peninsula. Among the three genera, *Pogostemon* ranks first in number of species i.e, 21 species in Western Ghats with 7 endemics. The genus *Anisochilus* with 14 species and 10 endemics followed by *Scutellaria* with 5 species and 2 endemics comes the last.

A list of the species coming under these three genera in Western Ghats is presented below:

I. *Genus:* Pogostemon Desf.

1. Subgenus*: Pogostemon*

Pogostemon benghalensis (Burm.f.) Kuntze

Pogostemon gardneri Hook.f.

Pogostemon heyneanus Benth.

Pogostemon paniculatus (Wild.) Benth.

Pogostemon plectrantoides Desf.

Pogostemon purpurescens Dalzell

2. Subgenus: *Allopogostemon*

2.1. Section: *Racemosus*

2.1.a. Subsection: *Racemosus*

Pogostemon mollis Benth.

Pogostemon nilagiricus Gamble

Pogostemon paludosus Benth.

2.1.b. Subsection: *Glabriusculus*

Pogostemon atropurpureus Benth.

Pogostemon hedgei Sampathkumar

Pogostemon peethapushpam Pradeep

Pogostemon speciosus Benth.

Pogostemon travancoricus Bedd.

2.2. Section: *Zygocalyx*

Pogostemon wightii Benth.

3. Subgenus*: Dysophyllus*

3.1. Section*: Dysophyllus*

Pogostemon auricularius (L.) Hassk

Pogostemon myosuroides (Roth) El Gazzar & L.Watson

*Pogostemon quadrifoius (*Benth.) F. Muell

Pogostemon salicifolius (Dalz.ex.Hook.f.) El Gazzar & L. Watson

3.2. *Section : Verticillatus*

Pogostemon cruciatus (Benth.) Kuntze

Pogostemon deccanensis (Panigrahi) Press

II. Genus : *Anisochilus* Wall. ex Benth.

1. Section : *Anisochilus*

Anisochilus carnosus (L.f.) Wall

Anisochilus scaber Benth.

Anisochilus paniculatus Benth.

Anisochilus kanyakumariensis Shinoj & Sunojk.

Anisochilus wightii Hook.f.

Anisochilus eriocephalus Benth.

Anisochilus sp. 1

2. Section : S*tiptanthus*

Anisochilus adenanthus Dalzell

Anisochilus argenteus Gamble

Anisochilus dysophylloides Benth.

Anisochilus plantaginieus Hook.f.

Anisochilus suffruticosus Wight

Anisochilus shoolamudianus Sunil & Naveenkumar

Anisochilus robustus Hook.

III. Genus : *Scutellaria* L.

Section : *Scutellaria*

Scutellaria colebrookeana Wall.

Scutellaria discolor Colebr.

Scutellaria oblonga Benth.

Scutellaria violaceae Heyne ex. Benth.

Scutellaria wightiana Benth.

9.1 New taxa discovered

The present study identified two new species from the Western Ghats. A new species, *Anisochilus kanyakumariensis* Shinoj & Sunojk., is described from Kanyakumari District of Tamil Nadu. *Anisochilus kanyakumariensis* is similar to *A. carnosus* and *A. paniculatus*, but differs from both species by its decumbent habit, orbicular leaf, short petiole, narrow cylindrical inflorescence, ovate bracteoles, densely villous calyx and villous corolla. Another new species of *Anisochilus* has been collected from Tamil Nadu and is yet to be published.

9.2 Nomenclatural problems solved

Several nomenclatural problems were identified in these three genera coming under the family Lamiaceae during the present study and were clarified by analysing the available literature and type specimens. The important findings related to the nomenclature are following:

Anisochilus eriocephalus Benth. is resurrected from the synonym of *Anisochilus carnosus* (L.f.) Wall., to the species level. Both the plants look similar and it is difficult to differentiate both from herbarium specimens, the numerous inflorescences arising from a single plant and the woolly nature of inflorescence of *Anisochilus eriocephalus* were observed to be a very distinct character from *Anisochilus carnosus*. Hence we raised the status of *Anisochilus eriocephalus* to a distinct species. A research paper describing this problem is under review.

The identity of an Indian species *Anisochilus petraeus* J. Mathew & Yohannan has been revised and found that it is conspecific to *A. carnosus*. The difference in characters noted by the authors of this species turns out to be a temporal variation resulting due to ecophysiological factors and could not be used for taxa differentiation. We did a thorough survey of the type location of this newly published species and found out that the variation shown by these plants are only due to physiological effects resulting from the ecological and habitat difference. A thorough observation of the floral parts were carried out after collection and its identity was confirmed to be *A. carnosus* and the name *Anisochilus petraeus* J. Mathew & Yohannan turned to be a new synonym.

Seven new synonyms have been introduced to the genus *Pogostemon* Desf.

1. ***Pogostemon pubescens*** Benth. is identified as a new synonym to *Pogostemon benghalensis* **(**Burm.f.) Kuntze, a highly variable species.

2. ***Pogostemon rajendranii*** R. Sasi and R. Sivalingam is identified as a new synonym to *Pogostemon mollis* Benth.

3. ***Pogostemon rotundatus*** Benth. and ***Pogostemon vestitus*** Benth. are identified as new synonyms to *Pogostemon nilagiricus* Gamble.

4. ***Pogostemon raghavendranii*** R. Murugan & Livingst., is identified as a new synonym to *Pogostemon hedgei* V.S. Kumar & B.D. Sharma.

5. ***Pogostemon erectus*** (Dalzell) Kuntze is also synonymised under *Pogostemon deccanensis* (Panigrahi) Press.

6. ***Pogostemon speciosus var. filiformis*** V.S. Kumar& B.D.Sharma is a new synonym of *Pogostemon speciosus* Benth.

All these synonymisation were done after thorough study of literature, herbarium specimens and fresh plants collected from multiple localities in different seasons.

9.3 New distributional records

Pogostemon cruciatus (Benth.) Kuntze is an elegant plant found in Nepal, India, China and Thailand. About its distribution in Peninsular India, Wight (1850) mentioned doubtfully, ‘station uncertain, but I think Malabar’; Gamble (1924) also stated, ‘West Coast, perhaps Malabar’. There is no recent collection of this species reported from any part of India or deposited at any major Indian herbaria. Bhatti and Ingrouille (1997), did not mention its distribution in South India. In Indian herbaria the South Indian material of these species is represented only by the collection of Keshavamurthy et. al. *5087* (CAL). During one of field works conducted as a part of the study, we could collect an interesting population of this species from a shallow pond in the open places of deciduous forests in Western Ghats in Wayanad district of Kerala. Efforts were made to conserve this fast disappearing plant by introducing this species in the Calicut University Botanical Garden (CUBG).

The species *Pogostemon peethapushpum* was described by Pradeep (1998), as a rare endemic from Vellarimala in Kozhikode district of Kerala. Very small population of this species was found as undergrowth in a wet evergreen forest at an altitude of 1200 m. There after this species has not been reported from anywhere in Kerala or outside. During our field trip to the Chickmagalur District in Karnataka state we have found another small population of this species almost in the same habitats. It is interesting that the new population is only the second locality for this rare plant, reported for the first time from Karnataka state. The new locality noticed is also facing lot of threats due to anthropogenic reasons conservation measures are to be initiated to save this taxon from extinction.

9.4 Typification

Four taxa of the genus *Pogostemon* are lectotypified and one taxa is neotypified in the present study after thorough study of protologues, types, herbariums and live specimens. The taxa typified are listed below:

1. *Pogostemon gardneri* Hook.f.

Type:—INDIA. Nilgiris, Sisspara, *Wight 2122,* (K, K000479999 digital image!) Lectotype designated here.

2. *Pogostemon heyneanus* Benth.

Type:—INDIA. *Heyne 1532* (K, K000509678, digital image!) Lectotype designated here.

3. *Pogostemon mollis* Benth.

Type:—INDIA. Peninsular India Orientalis. *Wight 2124* (K, K000509676, digital image!) Lectotype designated here.

4. *Pogostemon paludosus* Benth.

Type:—INDIA. Nilgiris, *s.n., s.coll.,* (K, K000848025, digital image!) Neotype designated here.

5. *Pogostemon speciosus* Benth.

Type:—INDIA. Peninsular India, 13 November 1869, *Wight. 2128* (P, P00737563, digital image!). Lectotype designated here.

9.5 Endemism

The present investigation revealed that nineteen species of Lamiaceae under the three genera of the present study are found endemic to Western Ghats of India. Of these, 7 species of *Pogostemon* viz., *P. atropurpureus* Benth., *P. hedgei* V.S. Kumar & B.D. Sharma, *Pogostemon nilagiricus* Gamble, *Pogostemon paludosus* Benth., *Pogostemon peethapushpam* Pradeep, *Pogostemon speciosus* Benth. and *Pogostemon travancoricus* Bedd. were found strictly endemic to Western Ghats.

The degree of endemism is found more profound in the genus *Anisochilus.* Out of the fourteen species found in Western Ghats 10 species viz., *Anisochilus adenanthus* Dalzell & A. Gibson, *Anisochilus scaber* Benth., *Anisochilus dysophylloides* Benth., *Anisochilus kanyakumariensis* Shinoj & Sunojk., *Anisochilus suffruticosus* Wight, *Anisochilus wightii* Hook.f., *Anisochilus plantaginieus* Hook.f., *Anisochilus shoolamudianus* Sunil & Naveenkumar, & *Anisochilus* sp. 1. are endemic to Peninsular India mainly in Western Ghats.

Altogether five species of *Scutellaria* were identified in Western Ghats including 2 endemics viz., *S. wightiana* Benth. *S. colebrookeana* Wall. ex Benth.

9.6 Conservation measures

Attempts have been made to conserve some of the rare species at Calicut university Botanical Garden (CUBG). Apart from CUBG, some plants were conserved in a Botanical Santuary in Wayanad to grow these plants under suitable climate there. A majority of these species are annual herbaceous plants, hence they disappeared when season gets off. Some taxa are strictly habitat specific and could not be conserved in the Garden. The survival rate of the genus *Anisochilus* was found to be 92% in Wayanad and 40% in CUBG. The genus *Pogostemon* showed 90% survival in Wayanad and 60% in CUBG. The genus *Scutellaria* showed 100% survival in both gardens.

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APPENDICES

INDEX TO SCIENTIFIC NAMES

T

W

Appendix 1. Comparison of characters of *Pogostemon* species in Western Ghats

Sl. No.	Characters	P. benghalensis	P. gardneri	P. heyneanus	P. paniculatus	P. plectrantoides	P. purpurascens	P. mollis	P. nilagiricus	P. paludosus	P. atropurpureus
1.	Habit	Suffruticose, erect herb or undershrub	Annual, erect undershrub or shrub	Annual, erect herb	Annual, erect herb or undershrub	Suffruticose, erect herb or undershrub	Annual, erect herb or undershrub	Annual, erect herb or undershrub	Annual ascending herb or undershrub	Annual, erect or straggling herb	Perrenial, erect herb
2.	Stem	Quadrangular	Terete to quadrangular	Quadrangular,	Quadrangular	Quadrangular	Terete to quadrangular	Quadrangular to terete	Quadrangular to terete	Quadrangul ar	Quadrangular
3.	Leaf size	8–22 × 6–18 cm	5–10 × 4–8 cm	6–10 × 4–10 cm	5–8 × 4–6 cm	7–25 × 6–18 cm	5–12 × 4–10 cm	3–5 × 2–3 cm	2–3 × 1.5–2.5 cm	4–8 × 3–7 cm	8–12 × 5–8 cm
4.	Lamina shape	Ovate	Ovate,	Ovate to elliptic	Ovate	Ovate	Ovate	Ovate	Ovate	Ovate	Ovate
5.	Leaf margin	Serrate to double serrate, 15–25 teeth	Serrate to inciso-crenate, 6–7 major teeth	Serrate, double serrate or crenate, 10–15 major teeth	Serrate to inciso-crenate 4–5 major teeth	Serrate to double or polyserrate 15–25 sharply pointed teeth, rarely entire near to inflorescence	Serrate to inciso-crenate, 6–8 major teeth	Serrate to double serrate, 9–12 teeth,	Serrate to crenate, 9–12 teeth,	Crenate to double crenate with 7–10 major teeth,	Crenate to double crenate with 15–25 teeth
6.	Petiole	3–6 cm long glabrescent to pubescent	3–5 cm long pubescent to hispid	5–8 cm long glabrescent	3–5 cm long pubescent to hispid	5–7 cm long glabrescent to pubescent	3–5 cm long pubescent to tomentose	1–1.8 cm long pubescent	0.4–0.6 cm long, hirsute to hirsutulous	4–8 cm long glabrous	5–7 cm long, glabrescent to pubescent
7.	Inflorescenc e	Terminal and axillary congested spike	Terminal congested spike with two lateral spikes, rarely axillary towards the branch tip	Terminal branched congested spike with two or more lateral spikes, axillary towards the branch tip	Unilateral panicle	Terminal and axillary congested spike	Terminal congested spike with two lateral spikes, rarely axillary towards the branch tip	Terminal congested spike	Terminal congested spike	Single terminal lax spike	Terminal racemes
8.	Pedicel	0.5–2 cm long	Sessile	1.5–3 cm long	Sessile	Sessile	2–3 cm long	0.5–1 cm long	0.5–1 cm long	1.5–3 cm long	0.5–2 cm long
9.	Bracteole	ca. 6 × 3.5 cm	Leafy, ca. 1.5 × 1 cm	Leafy, ca. 7–8 × 4–5 mm	Leafy, ca. 0.5 × 0.25 cm	ca.10 × 6 mm	Leafy, ca. 2 × 2.5 cm	Leafy	Ovate or lanceolate 7–8 × 1.8–2.2 mm	Leafy	Caducous

10.	Calyx: length and lobation	Tubular, 5–6 mm long calyx teeth 5, equal linear to lanceolate, 3–4 mm long	Tubular to companulate, 4.8–5.2 mm long calyx teeth 5, equal triangular, 1.7–2 × 0.8–1 mm	Tubular, 4–4.2 mm long, calyx teeth 5, equal triangular, ca. 1 × 0.6 mm.	Tubular, ca.4 mm long, calyx teeth 5, equal triangular, ca. 1 × 0.8 mm	Tubular, ca. 5 mm long, calyx teeth 5, equal ovate, 1 × 0.8 mm	Tubular, 5.2–5.5 mm long calyx teeth 5, equal linear to lanceolate, 2–2.5 × 0.7 mm	Ovate 2.5–4 × 1.4– 1.6 mm, calyx teeth 5 Ovate, equal ca. 0.8–1 × 0.5–0.6 mm	Tubular, 4.5–5 × 1.4– 2 mm, calyx teeth 5, equal ca. 2–2.5 × 0.5–0.8 mm,	Ovate to tubular, 4.5–5 × 2–2.4 mm, Calyx teeth 5, equal ca. 0.8–1 × 0.8–1 mm.	Companulate, 5–6 mm long, calyx teeth 5, linear to lanceolate, 1.2–1.6 mm long, lower two teeths little longer than the upper three and the tips remain bent upwards, ciliate.
11.	Corolla length	7–8 mm long, tube 3–3.2 mm long	6–7 mm long tube 4.8–5.2 mm long	4.5–5.5 mm long, tube 2.5–3.2 mm long	6–7 mm long, tube 3.8–4.2 mm long	8 mm long, tube 6 mm long	Corolla 5–6 mm long, tube 2.8–3.2 mm long	5–5.5 mm long, tube 2–2.5 mm long	6–7× 2–2.5 mm long, tube 2–2.5 mm long	5–6.5 mm long, tube 3.5–4 mm long	Corolla 7–7.5 mm long, tube 3–3.5 mm long
12.	Stamens	Didynamous filaments ca. 7mm long. Anthers white to pale violet ca. 0.4mm across.	Didynamous condition not prominent; ca. 6 mm long, Anthers white to pale violet ca. 0.5 mm across.	Didynamous; upper pair ca. 4 mm long, lower two ca. 4.5 mm, anthers white to pale violet ca. 0.4 mm across	Didynamous condition not prominent; ca. 4.8 mm long, anthers white to pale violet ca. 0.5 mm across.	Didynamous; filaments long, ca. 8mm, anthers white to pale violet ca. 0.7mm across.	Didynamous; upper pair ca. 5mm long, lower two ca. 7mm Anthers white to pale violet ca. 0.4mm across.	Didynamous; upper pair ca. 4.5–4.7 mm long, lower two ca. 4.2–4.4 mm long Anthers white to pale violet ca. 0.3–0.4mm across.	Subequal; ca. 4–4.2 mm long. Anthers white ca. 0.5–0.6mm across.	Didynamous; upper pair ca. 7.5–8 mm long, lower two ca. 6.5–7 mm long, Anthers white to brownish when mature, ca. 0.4–0.5 mm across.	Didynamous; filaments long, 12.5–13.5 mm, Anthers pale yellow or straw coloured ca. 0.5mm across
13.	Ovary Disc	0.6 mm long	1.4 × 1 mm.	6mm long.	ca. 0.2 × 0.4 mm.	0.5 mm long, larger compared to nutlets.	0.4 × 0.55 mm	0.25–0.26 mm	0.5–0.6 × 0.7–0.8 mm.	0.8–1× 1–1.2 mm	0.6 mm long
14.	Style	ca. 7 mm long	ca. 6 mm long	ca. 5 mm long	ca. 6.2 mm long	ca. 1.3 mm long	ca. 7 mm long	ca. 5.5–6 mm long	ca. 8–9 mm long	ca. 7–9 mm long	14–15 mm long
15.	Stigma	lobes equal, 1mm long	lobes equal, ca. 1.2mm long	lobes equal, ca. 0.5 mm long	lobes equal, ca. 0.8 mm.	lobes equal, 1mm long	lobes equal, ca. 1.3mm long	lobes equal, ca. 1.3mm long	lobes equal, ca. 0.8–1mm long	lobes equal, ca. 1.3–1.5 mm long	lobes equal, 0.57mm long
16.	Nutlets	*c.* 0.533 × 0.366 mm, oblong.	ca. 0.67 × 0.86 mm, disc shaped.	ca. 0.5 × 0.4 mm, Orbicular.	ca. 0.24 × 0.16 mm, ovate.	*c.* 0.856 × 0.524 mm, oblong.	ca. 0.65 × 0.56 mm, Ovate to orbicular.	ca. 0.25 × 0.20 mm, Obovate to orbicular.	ca. 0.28–3 × 0.18–0.25 mm, Obovate to orbicular.	ca. 0.25 × 0.20 mm, Obovate to orbicular.	*c.* 0.318 × 0.233 mm

Appendix 2. Comparison of characters of *Pogostemon* species in Western Ghats

Sl. No.	Characters	P. hedgei	P. peethapushpum	P. speciosus	P. travancoricus	P. wightii	P. auricularius	P.myosuroides	P. quadrifolius	P. salicifolius	P. cruciatus	P. deccanensis
1	Habit	Scandent shrub	Scandent shrub	Perennial, erect herb	Perennial, erect herb	Annual erect herb or undershrub	Annual procumbent herb	Annual erect herb or undershrtub	Annual erect herb or undershrtub	Annual erect herb	Annual erect herb	Annual erect or procumbent herb
2	Stem	quadrangular, hirsute with 0.8–1.5 mm long white hairs	obtusely quadrangular, wedged, pubescent with 0.2–0.4 mm long white hairs	quadrangular, pubescent with 1–2 mm long white hairs	quadrangular, pubescent with 1–2 mm long white hairs	quadrangular to terete, pubescent to distantly villous; 1.7–2mm long hairs	quadrangular, pilose;	Terete, pubescent	Round to elliptic in cross section, hairy	Round to elliptic in cross section	Terete	Terete.
3	Leaf size	4–8 × 3–6 cm,	3.5–7 × 2.5–5 cm,	8–12 × 5–8 cm,	8–12 × 5–8 cm,	5–9 × 3–7 cm,	4–8 × 2–4 cm,	2.5–8 × 0.4–1 cm,	3–10 × 0.5–1 cm,	4–8 × 0.5–1 cm,	4–8 × 0.5–1 cm,	8–12 × 1.1–1.4 mm,
4	Lamina shape	Ovate to sub orbicular	Ovate to sub orbicular,	Ovate,	Ovate,	Ovate,	Ovate	Linear to lanceolate,	Linear to lanceolate	Linear to lanceolate	Linear to lanceolate,	Linear to lanceolate
5	Leaf margin	Double or multicrenate to double serrate with 12–20 teeth	Double or multicrenate to double serrate with 10–18 teeth	Crenate to double crenate with 15–25 teeth	Crenate to double crenate with 15–25 teeth	Serrate to double serrate with 8–12 major teeth	Serrate to double serrate with 12–20 teeth	Serrate to serulate with 7–15 teeth	Serrate to serulate with 12–20 teeth	Serulate to entire	Entire, revolute	Entire, revolute
6	Petiole	4–7 cm long, pubescent	4–7 cm long, pubescent	5–7 cm long, glabrescent to pubescent	5–7 cm long, glabrescent to pubescent	4–8 cm long equaling the size of leaf	2–3 mm long, pilose	2–3 mm long, pubescent	2–3 mm long, pubescent	3–5 mm long, pubescent	sessile	sessile
7	Inflorescence	Terminal racemes	Axillary cymose	Terminal racemes	Terminal racemes	Terminal spike	Terminal congested spike	Terminal congested spikes with two or more lateral spikes on all branch tips	Terminal congested spikes on all branch tips	Terminal congested spikes on all branch tips	Terminal congested spikes	Terminal congested spikes
8	Pedicel	pedicellate	pedicellate		short, 0.5–2 cm long	short, 0.5–1 cm long	long, 5–10 cm long.	short or absent, 0.1–0.2 cm long.	short or absent, 0.1–0.2 cm long	Sessile		Sessile

9	Bracteoles	Leafy 1–1.2 cm long , ovate, bracteoles linear 2.2–2.4 × 0.3–0.4 mm, shorter than calyx, obtuse tip, hirsute with white hairs outside, margin ciliate.	0.6–0.8 cm long , linaer to spathulatebracteoles linear 2.2–2.4 × 0.1–0.2 mm,	Caducous, bracteoles linear 1.5 × 0.25 mm, ciliate,	Caducous, bracteoles linear 1.5 × 0.25 mm, ciliate,	Leafy; bracteoles, ca. 4–4.2 × 1–1.2 mm, slightly villous.	Leafy; bracteoles spatulate to narrowly elliptic, ca. 1.8–2.4 × 1–1.2 mm, villous,	Bracteoles ovate, ca. 1–1.2 × 0.5–0.7 mm,	Oblanceolate , ca. 2.4–2.7 × 0.5–0.6 mm, bracteoles oblong , ca. 1.2–1.4 × 0.2–0.3 mm,	Bracteoles ovate, ca. 1–1.2 × 0.5–0.6 mm,	Bracteoles ovate to spatulate, ca. 2–2.5 × 0.5–0.6 mm	Bracteoles ovate to spatulate, ca. 2–2.5 × 0.3–0.4 mm, base cuneate, apex acute to acuminate, margin ciliate, villous.
10	Calyx: length and lobation	Companulate, 6.2–6.6 × 2.3–2.5 mm long, calyx teeth 5 in number, linear to lanceolate, 2.2–2.6 mm long, ciliate	Companulate, 6.2–7 × 2.3–2.5 mm long, calyx teeth 5 in number, linear to lanceolate, 2.2–2.6 mm long.	Companulate, ca. 6 mm long calyx teeth 5 in number, linear to lanceolate, ca. 3 mm long,.	Companulate, ca. 6 mm, calyx teeth 5 in number, linear to lanceolate, ca. 3 mm long,.	Ovate, 3.5–4 × 1.4– 1.6 mm ,calyx teeth 5 in number; equal ca. 0.8–1 × 0.5–0.6 mm.	Companulate, 1–1.4 × 0.8–1 mm ,calyx teeth 5 in number; equal ca. 0.3–0.5 × 0.3–0.5 mm	Companulate, 1–1.2 × 0.8–1 mm ,calyx teeth 5 in number; equal ca. 0.2–0.4 × 0.2–0.3 mm,	Companulate, 1.8–2.2 × 0.8–1 mm, calyx teeth 5 in number; equal ca. 0.4–0.5 × 0.4–0.5 mm,	Companulate, 1–1.2 × 0.8–1 mm , calyx teeth 5 in number; equal ca. 0.3–0.5 × 0.3–0.4 mm,	Companulate, 1–1.2 × 0.8–1 mm; calyx teeth 5 in number; equal ca. 0.25–0.4 × 0.2–0.4 mm,	Companulate, 1.4–1.8 × 1–1.5 mm; calyx teeth 5 in number; equal ca. 0.4–0.6 × 0.4–0.5 mm, villous.
11	Corolla length	8–9 mm long, tube 3.8–4.2 mm long	7–9 mm long, tube 3.8–4.2 mm long	ca. 6 mm long, tube ca.2.5 mm long	ca. 6 mm long, tube ca.2.5	4.2–4.7 mm long, tube 2–2.5 mm long	2.5–3.5 mm long, tube 1.5–2.5 mm	1–1.2 mm long, tube 0.5–0.6 mm long,	2–2.5 mm long, tube 1.4–1.6 mm long	2–2.3 mm long, tube 1.8–2 mm long,	2.5–3 mm long, tube 2–2.2 mm long,	1.5–1.8 mm long, tube 1–1.2 mm long,
14	Stamens	4, didynamous; filaments long, 10–12 mm,. anthers pale yellow or straw coloured ca. 0.75 × 0.84 mm.	4, didynamous; filaments long, 10–12 mm; anthers pale yellow or straw coloured ca. 0.8 × 1 mm.	4, didynamous; filaments of posterior pair ca. 9 mm long, anterior pair ca. 8 mm long ,anthers pale yellow or straw coloured ca. 0.7mm across.	4, didynamous; filaments of posterior pair ca. 9 mm long, anterior pair ca. 8 mm long anthers pale yellow or straw coloured ca. 0.7mm across	4, didynamous; upper pair ca. 4.2–4.5 mm long, lower two ca. 4–4.2 mm long, anthers purple to dark brown when mature, ca. 0.2–0.3mm across.	4, didynamous; upper pair ca. 4.2–4.5 mm long, lower two ca. 4–4.2 mm long, anthers purple to brown ca. 0.3–0.4mm across.	4, filaments almost exerted ate equal length; filaments ca. 0.5–0.6 mm long, anthers straw coloured ca. 0.05–0.06 mm across.	4, filaments almost exerted ate equal length; filaments ca. 4.2–4.5 mm long, anthers purple ca. 0.2–0.25 mm across	4, filaments almost exerted at equal length; filaments ca. 1–1.3 mm long, anthers ca. 0.12–0.14 mm across	4, filaments almost exerted at equal length; filaments ca. 4.5–4.7 mm long, anthers ca. 0.41–0.44 mm across.	4, filaments almost exerted at equal length; filaments ca. 2.5–2.9 mm anthers ca. 0.20–0.25 mm across.

15	Ovary Disc	0.92–0.95 × 0.98–1 mm long	0.92–0.95 × 0.98–1 mm long.	0.5 mm long.	0.5 mm long.	0.25–0.27 mm long	0.23–0.25 mm long.	0.12–0.14 mm long	0.28–0.3 mm long, 4 lobed, lobes ca. 1mm long.	ca. 0.1 mm long, slightly 4 lobed, lobes alternating with nutlets.	ca. 0.2 mm long.;	ca. 0.2 mm long.
16	Style	10–13 mm long, slender	12–15 mm long, slender;	ca. 8 mm long, slender;	ca. 8 mm long, slender;	ca. 5.5–6 mm long, slender;	ca. 5–5.2 mm long, slender;	ca. 1–1.2 mm long;	ca. 4.2–4.5 mm long, slender;	ca. 4.5–5 mm long, slender;.	ca. 5–6 mm long, slender	ca. 3.5–4 mm long, slender
17	Stigma	lobes equal, 1.2–1.4 mm.	lobes equal, 1–1.2 mm.	lobes equal, ca. 1mm.	lobes equal, ca. 1mm.	lobes equal, ca. 0.23–0.25 mm.	lobes equal, ca. , 0.3–0.32 mm.	lobes equal, ca. , 0.4–0.5 mm.	lobes unequal, ca. , 0.8–1 mm.	lobes unequal, ca. , 0.2–0.3 mm	lobes equal, ca. , 1–1.3 mm. Nutlets 4, ca. 0.6 mm × 0.4 mm, oblong, brown, smooth.	lobes equal, ca. , 0.6–0.7 mm..
18	Nutlets	*c.* 0.34 × 0.37 mm, suborbicular,	Nutlets 4, *c.* 0.42 × 0.47 mm, suborbicular	Nutlets 4, *c.* 0.672× 0.567 mm, oblong .	Nutlets 4, *c.* 0.672× 0.567 mm, oblong.	Nutlets 4, ca. 0.25 × 0.20 mm, obovate to orbicular.	Nutlets 4, ca. 0.35 × 0.15 mm, ellipsoid.	Nutlets 4, ca. 0.1mm × 0.08 mm, ovate.	Nutlets 4, ca. 0.2 mm across × 0.15 mm, orbicular.	Nutlets 4, ca. 0.52 mm × 0.37 mm, oblong.	Nutlets 4, ca. 0.6 mm × 0.4 mm, oblong.	Nutlets 4, ca. 0.5 mm × 0.45 mm, orbicular.

Appendix 3. Comparison of characters of *Anisochilus* species in Western Ghats

Sl. No.	Characters	A. adenanthus	A. argenteus	A. carnosus	A. dysophylloides	A. eriocephalus	A. kanyakumariensis	A. paniculatus
1.	Habit	Erect annual brittle herb or under shrub upto 200 cm high	Ascending or decumbent annual succulent herb or stout under shrub upto 80 cm high,	Erect annual succulent herbs, upto 100cm high	Erect annual brittle herb or under shrub, upto 100 cm high, perennial from woody basal stem and root stock, base 1.5–2 cm in diameter	Erect or ascending annual or short lived perennial succulent herbs with deliquescent stem reaching a length upto 40–120 cm	Decumbent annual or short lived perennial herbs, branches succulent, 50–70 cm long.	Erect or ascending annual succulent herbs, upto 100 cm high.
2.	Stem	Quadrangular and grooved, hispid mainly on the ridged part, glabresent at furrows; internodes 6–15 cm long	Terete, grooved when dry, silvery tawny tomentose surface; internodes 0.5–1 cm long	Quadrangular, grooved when dry, pubescent; internodes 3–5 cm long	Terete, hollow with prominent leaf scars, tomentose, internodes 2–5 cm long	Rounded, glabrescent to pubescent	Terete, glabrescent to pubescent.	Pale green pubescent , round or obscurely quadrangular without intra petiolar hairs.
3.	Phyllotaxy	Whorled, 3–4 per node	Whorled, 3–4 per node, alternate with the adjacent whorl at the other node giving a rosette or whorled appearance	Opposite decussate	Opposite decussate	Opposite decussate	Opposite decussate	Opposite decussate;
4.	Leaf size	7–10×2–3 cm	2–4.5 × 1–1.5 cm	4–8×4–6 cm	3–5×2–3 cm	3–6×3–4 cm	4–5 × 3–4 cm	4–6×2–3 cm
5.	Lamina shape	Linear, base rounded, apex acute	Obovate to oblanceolate, base cuneate, apex obtuse,	Broadly ovate, carnose, base cordate, apex acute	Obovate, base cuneate, apex obtuse	Orbicular to ovate sarcous, base rounded or obtuse, apex rounded or obtuse	Orbicular, apex rounded or obtuse,	Lamina elliptic to obovate, base rounded or shortly cuneate, apex obtuse or rounded,
6.	Leaf margin	Entire or serrulate	Entire or serrulate,	Crenate with 15–20 teeth,	Entire or serrulate	Sinuate	Crenulate,	Crenate,
7.	Texture	Pubescent above, tomentose beneath	Thick, chartaceous, silvery or tawny tomentose hairs on both surface	Pubescent above, minute sessile glands present on both the surfaces	Tomentose	Glabrescent to pubescent on both surfaces, minute sessile glands present on both surfaces	Adaxial surface rusty tomentose, abaxial surface tomentose,	Pubescent above tomentose beneath, minute sessile glands present on both the surfaces,
8.	Petiole	Absent	Absent	3–5 cm long	0.3–0.5mm long	Short, 1–2 cm, glabrescent to pubescent.	Short, 1–2 cm long, pubescent.	Petiole 1–2 cm, pubescent.
9.	Inflorescence	Mostly with a single long terminal spike on all branch tips, 15–30	Terminal, congested spike, subtended by a pair of leaves, 4–	Mostly terminal branched; both main and secondary	Terminal or axillary congested spike or verticillaster, 3–5	Terminal and axillary, branched, both main and	Terminal, main axis 15–20 cm long; secondary branches 5–7, arranged	Terminal, profusely branched giving a panicle appearance,

		cm long.	7.5 cm long	branches end in a congested spike, 3–7 in an Inflorescence arranged opposite decussate with a single terminal spike and 2–6 lateral spikes; individual spike heads long tetragonal in young and cylindical in fruit, 30–60 mm long.	cm long	secondary branches end in a congested spike, 3–5 in an inflorescence, arranged opposite decussate with a single terminal head and 2–4 lateral heads; individual spike heads globose or cylindical both in bud and in fruit, 10–40 mm long.	opposite decussate, each 5–10 mm long, both main and secondary branches end in a congested spike which are ovoid to cylindrical ≥20 mm long.	individual spike heads short ≤ 20 mm long and c. 80 mm wide.
10.	Bract	ca. 10×3 mm, caducous, sessile, ovate with acuminate tip, pubescent.	ca. 1.5×1 mm, caducous, sessile, ovate-lanceolate with acuminate tip, densely villous.	Ovate ca. 4–4.2 × 2.8–3 mm, pubescent with sessile glands on both surfaces	ca. 1.8–2 ×1–1.2 mm, caducous, sessile, ovate with acuminate tip, villous with ciliate margin	Ovate ca. 1.5×0.8 mm sarcous, pubescent with sessile glands on both surfaces	Dome-shape, 1.5 × 1.6 mm, early caducous	Ovate, c. 1.6 × 1.4 mm, early caducous;
11.	Calyx	ca. 2×1.2 mm, obliquely 5-toothed; tube oblique, usually constricted at throat and ventrally saccate around the middle, glabrous inside, tomentose outside;	ca. 1.8–2.2 × 1.4–1.7 mm, 5-toothed; tube glabrous inside, densely tomentose outside.	ca. 2.8–3×1–1.2 mm when posterior lip opened, ca. 1.8–2 × 0.8–1 mm when closed, pubescent with bright red sessile glands	ca. 1.9– 2.1×1.3–1.5 mm, 5-toothed	Ovoid to globose ca. 3.5×2.5 mm with posterior lip opened and ca. 2.5×2.5 mm with posterior lip closed, woolly;	Ovoid, 2–3 mm long when posterior lip opened and 1.5–2 mm long when posterior lip closed, densely villous;	Ovoid to cylindrical ca. 1.8–2.3×1–1.2 mm when posterior lip opened and ca. 1.2 – 1.4 ×1–1.2 mm when posterior lip closed, pubescent with red sessile glands;
12.	Calyx: posterior lip	3-lobed, recurved, or deflexed and concealing throat after anthesis;	3-lobed, recurved, or deflexed and concealing throat after anthesis	Single lobed acute to acuminate, ciliate to villous; hairs 4–5 celled.	posterior lip 3-lobed, recurved, or deflexed and concealing throat after anthesis	posterior lip 1-lobed acute to acuminate, ciliate to villous; hairs 4–5 celled.	posterior lip 1-lobed, acute to acuminate, ciliate to villous, hairs 4–5 celled.	posterior lip 1-lobed acute to acuminate, ciliate.
13.	Calyx: anterior lip	anterior lip 2-lobed, short, sometimes appearing truncate, minutely toothed;	anterior lip 2-lobed, tube glabrous inside, densely tomentose outside	anterior lip obscure, teeth 4, pubescent	anterior lip 2-lobed, tube glabrous inside, pubescent outside forming villous towards the base	anterior lip obscure, teeth 4, densely villous outside	anterior lip obscure, teeth 4, glabrascent to pubescent	anterior lip obscure, teeth 4, glabrascent to pubescent
14.	Fruiting calyx	ca. 4mm long; hairs 4–5 celled.	ca. 2–2.2mm long	ca. 2.8–3.2mm long	ca. 2.5–2.7mm long	ca. 5 mm long	ca. 3–3.5 mm long	fruiting calyx ca. 3 mm long;
15.	Corolla	bi-lipped, exerted from calyx tube, 4.8–	bi-lipped, exserted from calyx tube, ca.	bi-lipped, ca. 8.5–10 ×4–4.2 mm long,	bi-lipped, exserted from calyx tube ca.	bi-lipped, ca. 10×4 mm long, with pale	4–5 mm long from base to top of lower lip,	ca. 7.8–8.1 × 3.9–4.2 mm, white with a pale

		5.2 ×2.8–3 mm, white.	3.5×3 mm, pale yellow or off white.	with lavender corolla tube and dark blue corolla lips, base of the corolla tube narrow and glabrous or distantly villous.	3.5–3.7×3–3.2 mm, pale violet or purple	violet corolla tube and dark violet corolla lips, base of the corolla tube narrow and densely villous outside.	white with a pink tinge at inner surface of posterior teeth, corolla base tube funnel shaped and densely villous outside.	purple colour, base of the corolla tube narrows forming a near funnel shaped. Outer surface of corolla lip mainly at the middle and anterior lip pubescent outside with red sessile glands.
16.	Corolla: posterior lip	shortly 4-lobed, sub-equal with larger median lobes, 0.7–0.8 mm, lateral lobes shorter ca. 0.2 mm	shortly 4-lobed, lobes curved outside	posterior lip shortly 4-lobed, 0.7–0.9 mm long;	posterior lip shortly 4-lobed, sub-equal with larger median lobes	posterior lip shortly 4-lobed, subequal, 0.5–0.7 mm;	posterior lip shortly 4-lobed, sub-equal, 0.15–0.2 mm;	posterior lip shortly 4-lobed, , sub-equal with larger median lobes; lobes 0.2–0.22 mm
17.	Corolla anterior lip	ca. 2 mm long, entire, concave, longer than posterior	entire, elongate, concave at younger stage and convex at older stage, longer than posterior	anterior lip entire, elongate, concave at younger stage and convex at older stage, longer than posterior; 1.6–2 × 1–1.4 mm, obtuse to rounded at apex	anterior lip entire, elongate, concave at younger stage and convex at older stage, longer than posterior	anterior lip entire, elongate, 3.2–3.5 mm concave at younger stage and convex at older stage , longer than posterior	anterior lip entire, elongate, 1.4–1.7 mm concave at younger stage and convex at older stage , longer than posterior	anterior lip entire, elongate, 3–3.2 mm concave at younger stage and convex at older stage , longer than posterior
18.	Stamens	4, didynamous, declinate, slightly exserted, not exceeding the anterior corolla lip, glabrous, inappendiculate, anterior pair slightly longer; posterior and anterior pairs attached on corolla throat at the base of anterior corolla lobe, included in anterior corolla lip; filaments free, posterior pair ca. 1.3 mm long, anterior pair ca. 1.8 mm long;	Stamens exserted, exceeding the anterior corolla lip, inappendiculate, attached on corolla throat at the base of anterior corolla lobe included in anterior corolla lip, anterior pair slightly longer; posterior and anterior pairs; filaments free, glabrous, posterior pair ca. 2–2.2 mm long, anterior pair ca. 1.6–1.8 mm long,	Stamens 4, free, attached at the mouth of the corolla tube, didynamous, posterior pair attached just below anterior but not united, filament of posterior ca. 1.8–2.2 mm long, anterior pair ca. 2.8–3 mm long, appendages absent, included in anterior corolla lip	declinate, exserted, exceeding the anterior corolla lip, glabrous, inappendiculate, anterior pair slightly longer; posterior and anterior pairs attached on corolla throat at the base of anterior corolla lobe, included in anterior corolla lip; filaments free, posterior pair ca. 2–2.3mm long, anterior pair ca. 1.5–1.8 mm long, anther reniform, synthecous, back usually with sessile glands, often confluent;	Stamens 4, free, attached at the mouth of the corolla tube, didynamous, posterior pair attached just below anterior but not united, filament of posterior ca. 2.2 mm long, anterior pair ca. 2.7 mm long, appendages absent, included in anterior corolla lip; anthers bilobed, dorsifixed, ca. 0.35 mm long, violet (when mature), dehisces longitudinally	Stamens 4, free, attached at mouth of the corolla tube, didynamous, posterior pair attached just below anterior but not united, filament of the posterior 1.5–2 mm long, of the anterior pair 2–2.5 mm long, included in anterior corolla lip; anthers bilobed, dorsifixed, ca. 0.3 mm long, orange to brown (when mature), dehisces longitudinally	Stamens 4, free, attached at the mouth of the corolla tube, didynamous, posterior pair attached just below anterior but not united, filament of posterior ca. 4.6 mm long, anterior pair ca. 3.4 mm long, appendages absent, included in anterior corolla lip; anthers bilobed, dorsifixed, ca. 0.75 mm long, dehisces longitudinally.

19.	Ovary Disc	lobed, anterior side well-developed, exceeding the ovary	lobes obscure, creamy yellow with orange colour sessile glands.	cup shaped unequally 4 lobed with anterior lobe enlarged ca. 4–4.2 mm, lateral lobes 2–2.2 mm long	lobed, bright orange colour, anterior side well-developed, exceeding the ovary.	cup shaped subequal, 4 lobed, lobes 2–2.2 mm long	cup shaped subequal, 4 lobed, lobes 2.2–2.5 mm long	cup shaped unequally 4 lobed with anterior lobe enlarged ca. 1–1.2 mm, lateral lobes 0.2–0.3 mm long
20.	Style	ca. 10 mm long, declinate	ca. 5 mm long	8–10 mm long	style ca. 2.5–2.7mm long	style 9.5–10 mm long	ca. 5 mm long,	ca. 10 mm long,
21.	Stigma	shortly bifid with sub-equal branches, longer one ca. 0.15mm long	shortly bifid with equal lobes, ca. 0.23 mm long.	stigma 0.18–2 mm long, bifid.	shortly bifid with equal lobes, ca. 0.24–0.28 mm long	stigma shortly bifid with equal lobes, ca. 0.2 mm long	stigma shortly bifid with equal lobes, ca. 0.2 mm long	stigma bifid ca. 0.2 mm long.
22.	Nutlets	ca. 0.2 mm across, ovoid to orbicular, smooth, shining, basal scar small, mature nutlets usually producing mucilage when wetted.	ovoid, 1–1.2×0.6–1 mm, smooth, mature nutlets usually producing mucilage when wetted	ca. 0.6–0.7 × 0.4–0.5 mm brown round to ellipsoid.	ca. 0.24–0.28 ×0.22–0.25 mm, ovoioid, smooth, shining	brownish, ovoid or ellipsoid	Mericarps circular or widely elliptic, 818–824 µm × 745–750 µm brownish, surface undulate, reticulate, cells faintly polygonal	brown round to ellipsoid ca. 3–3.2×1.7–2 mm.

Appendix 4. Comparison of characters of *Anisochilus* species in Western Ghats

Sl. No.	Characters	A. plantagineus	A. robustus	A. scaber	A. shoolamudianus	A. suffruticosus	A. wightii	Anisochilus sp.
23.	Habit	Erect or ascending dwarf undershrub, up to 50 cm high.	Erect robust shrub, reaching a height of 3 m.	prostrate annual or perennial succulent herbs, upto 60 cm high	erect annual suffruticose herb or stout under shrub, 80–100 cm high, base 1.5–2.5 cm in diamteter, profusely branching; branches 40–60 cm long, tomentose with intermingled with scattered yellow sessile glands and prominent leaf scars.	erect stout undershrub, up to 1 m tall.	erect annual or perennial succulent herb, 60–80 cm high,	procumbent annual or perennial succulent herb, 60–100 cm high,
24.	Stem	Stems woody like, branched upwards, terete, pubescent to slightly tomentose with prominent circular leaf scars.	Stems round to quadrangular, ridged with prominent groove on each face, pubescent to slightly tomentose, prominent leaf scars amidst hairs, sessile glands present on stem surface.	woody basal stem and root stock, base 0.8–2 cm in diameter, profusely branching; branches 50–60 cm rooting at nodes, purple or green, terete, scabrous to tomentose with 2–6 mm, long hairs; internodes 0.8 – 2.5 cm long.	terete with short internodes and appressed silvery tawny tomentose surface, longitudinal grooves appear during drying.	woody, branched, round-quadrangular or quadrangular, glabrescent to rusty tomentose with prominent broad circular leaf scars.	stem base 1–2.5 cm in diameter, profusely branching, branches 40–60 cm long, somewhat quadrangular, to terete, pubescent	stem base 1–2 cm in diameter, profusely branching, branches 40–60 cm long, terete, pubescent to hirsute
25.	Phyllotaxy	Opposite decussate, congested at branch tips, sessile or subsessile	Opposite, decussate	opposite decussate	Leaves sessile, whorled, 3–4 per node, alternate with the next whorl at the other node giving a rosette or whorled appearance, mainly congested towards the apical region,	opposite decussate, congested at the end of branches;	opposite decussate, the size of the leaf markedly becomes shorter towards the tip giving a rosette appearance at the upper region	opposite decussate,

26.	Leaf size	3–4 × 2–3 cm,	7–20 × 5–15 cm	4–6×2.5–5 cm	3–8 × 0.6–1.8 cm	20 –40 ×7–15 mm	3–6×3–6 cm	3–6 ×2–4 cm
27.	Lamina shape	oblong, obovate or ovate, , base cuneate, apex obtuse to round	Broadly ovate, base obtuse or rounded, apex acute or obtuse	lamina ovate succulent, base rounded, apex obtuse,	obovate to oblanceolate base attenuate, apex obtuse	lamina ovate lanceolate, base obtuse or cuneate, apex acute	lamina orbicular base truncate to rounded, obtuse at apex,	ovate, base truncate to rounded, apex obtuse
28.	Leaf margin	margin entire or obscurely crenate,	crenate	margin crenate with 15–20 teeths,	margin entire	margin entire or obscurely crenulate	margin crenate with 8–12 teeth with purple margins	margin serrate, 20–25 teeth
29.	Texture	thick, pubescent to tomentose above, lateral veins 5–7, prominently raised beneath;	fleshy, pubescent to tomentose above, red sessile gland found scattered on the lower surface	lower surface tomentose or villous , scabrous above, minute sessile glands present on both the surfaces	silvery or tawny tomentose on both surface	thick, densely brownish-yellow velvety-tomentose and deeply reticulate between veins beneath, lateral veins 5–7, stout and raised beneath; brownish tomentose above	tomentulose beneath, pubescent above, minute sessile glands present on both the surfaces, veins prominent on both the surface	tomentulose beneath, glabrescent to slightly pubescent above, minute sessile glands not seen, veins prominent on both the surface
30.	Petiole	Petiole 3–4 mm long, tomentose.	up to 3.5 mm long, pubescent to tomentose	petiole 1–2 cm long, scabrous;	petiole 0–5 mm long	petiole short, up to 10 mm long, tomentose	petiole 2–5 cm long	petiole 3–6 cm long
31.	Inflorescence	Terminal, simple, congested spike narrow cylindric, up to 90 mm long and 2.5–3 mm wide; peduncles short and stout, 3–4 mm long, reddish, pubescent;	Terminal, 15–40 cm long, 2–2.5 cm wide; branched slender lax spike, rarely congested	Mostly with a single terminal congested spike, rarely 2–4 lateral heads in an inflorescence; individual spike heads mainly long cylindrical both young and in fruit, 30–60 mm long; peduncle 15–30 cm long.	Terminal, a single congested spike at all branch tips, 5–18 cm long, dense, many flowered.	Terminal and axillary, simple or branched, often congested at the tip of all branches; spike-like head narrow cylindric, up to 70 mm long and 6 mm wide;	Terminal branched congested spike; lateral spikes 2–4; individual spike heads long tetragonal, 40–100 mm long, 2.5–3 mm broad; dark purplish, pubescent	Terminal branched congested spike; lateral spikes 4 (rarely 6); individual spike heads long tetragonal, 3–7 mm long, 1.5–2.5 cm broad; white, tomentulose

						peduncles long and slender, 50–70 mm long, pubescent;.		
32.	Bract	Ovate, minute, early caducous.	Lanceolate, base orbicular, tip acute, margin ciliate, pubescent, caduceus, remain congested near the tip of inflorescence	dome shaped ca. 4.5–6 × 5.5–6.5 mm, pubescent;	caducous, 1–2 × 0.6–1 mm, sessile, ovate with acute tip densely pubescent with sessile glands.	bracts minute, early caducous	rhombeus ca. 2–2.2×1.5–1.6 mm, pubescent	deltoid ca. 1.8–2 × 1.4–1.8 mm, pubescent outside, glabrous inside
33.	Calyx	ovoid, 1–1.2 mm long at anthesis,densely tomentose; posterior lip shortly oblong, truncate, rounded or obscurely 3-toothed at apex, slightly deflexed after anthesis but not concealing throat, tomentose; anterior lip truncate or obscurely 2-lobed, membranous and adpressed on tube; tube ventrally saccate around the middle, slightly constricted at throat, pubescent. fruiting calyx 1.5–2 mm long;	ovoid, 1–1.5 mm at anthesis, densely pubescent, fruiting calyx 2.5–3.5 mm long	ovoid to cylindrical ca. 3.8–4 × 2–2.3 mm when posterior lip opened and ca. 2.3–2.5 × 2–2.2 mm when posterior lip closed, pubescent with bright red sessile glands;	ovoid ca. 2×1.5 mm, 5-toothed; tube glabrous inside, densely tomentose outside intermingled with orange coloured sessile glands;	ovoid, ca. 0.8–1 mm long at anthesis, pubescent; tube ventrally saccate around the middle, slightly constricted at throat, pubescent.	ovoid to cylindrical ca. 3.5–4×2–2.2 mm when posterior lip opened and ca. 2.5–2.6 × 2–2.2 mm when posterior lip closed, pubescent with yellow sessile glands;	ovoid to cylindrical 2–2.5 × 1.4–1.8 mm when posterior lip opened and 1.2–1.6 mm long when posterior lip closed, tomentose with yellow sessile glands
34.	Calyx: posterior lip		Oblong, erect or slightly decurved, with 3 short teeths at the apex,	1-lobed acute to acuminate, ciliate to villous; hairs 4–5 celled	ca. 0.7–0.9mm long, 3-lobed, recurved, or deflexed and concealing throat after anthesis	Shortly oblong, truncate, rounded or obscurely 3-toothed at apex, slighdy deflexed after	1-lobed obtuse, ciliate	1-lobed , apex acute to acuminate, margin ciliate.

						anthesis but not concealing throat, pubescent		
35.	Fruiting calyx			ca. 3.5– 4mm long	ca. 2–3 × 2–2.2m	2.5–3 mm long	ca. 4.5–5mm long;	3–3.5 mm long
36.	Corolla	White to pale yellow, 8–9 mm long, pubescent; tube tubular, deflexed from above the base. longitudinally	light yellow or cream color, 6–7.5 mm long, upper lobes incurved, pubescent with scattered yellow or orange coloured sessile glands on its outer surface	ca. 9.8–10.2 × 4.2–4.5 mm long, with pale pink corolla tube and purple corolla lips, base of the corolla tube narrow and glabrous.	Exerted from calyx tube ca. 3.5–3 mm, pale yellow or off white colour; tube gradually dilated towards throat pubescent with orange colour sessile glands outside.	white with a pale purple shade, 5–6 mm long, pubescent; tube tubular, deflexed from above the base	ca. 8–10 × 2.8–3 mm long, with dark violet to purple coloured corolla tube and corolla lips, base of the corolla tube narrow and glabrous. Outer surface of corolla lip mainly at the middle and anterior lip strigose outside with yellow sessile glands; hairs 3–4 celled.	9–10 × 3.8–4 long, tube and corolla lips white or pale violet, base of the corolla tube slightly narrow and glabrous. Outer surface of corolla lip mainly at the middle and anterior lip strigose outside with yellow sessile glands; hairs 3–4 celled.
37.	Stamens	4, free, attached at the mouth of the corolla tube, didynamous, posterior pair attached just below anterior but not united, filament of posterior ca. 1.5 mm long, anterior pair ca. 1 mm long, appendages absent, included in anterior corolla lip; anthers bilobed, dorsifixed, ca. 0.5 mm long, dehisces	4, free, attached at the mouth of the corolla tube, didynamous, posterior pair attached just below anterior but not united, filament of posterior ca. 3 mm long, anterior pair ca. 2 mm long, appendages absent, included in anterior corolla lip; anthers bilobed, dorsifixed, ca. 0.75 mm long, dehisces longitudinally.	4 free, attached at the mouth of the corolla tube, didynamous, posterior pair attached just below anterior but not united, filament of posterior ca. 3 mm long, anterior pair ca. 4 mm long, appendages absent, included in anterior corolla lip; anthers bilobed, dorsifixed, ca. 0.7 mm long, dehisces longitudinally.	4, didynamous, declinate, exserted, exceeding the anterior corolla lip, glabrous, inappendiculate, anterior pair slightly longer; posterior and anterior pairs attached on corolla throat at the base of anterior corolla lobe, included in anterior corolla lip; filaments free, posterior pair ca. 1.6 mm long, anterior pair ca. 1.2 mm long, anther light brown coloured at maturity, back usually with sessile glands, often confluent;ca. 0.6 mm long.	data defficient	4, free, attached at the mouth of the corolla tube, didynamous, posterior pair attached just below anterior but not united, filament of posterior ca.1.8 –2.2 mm long, anterior pair ca. 1.4–1.6 mm long, appendages absent, included in anterior corolla lip; anthers bilobed, dorsifixed, ca. 0.35–0.38 mm long, dehisces longitudinally.	4, free, attached at the mouth of the corolla tube, didynamous, posterior pair attached just below anterior but not united, filament of posterior ca.4–4.2 mm long, anterior pair ca. 3–3.2 mm long, appendages absent, included in anterior corolla lip; anthers bilobed, dorsifixed, ca. 0.5–0.6 mm across, dehisces longitudinally.

38.	Style	8–9 mm long,	ca. 8 mm long,	ca. 10 mm long	ca. 4.5– 5 mm long;	data defficient	ca. 7.5–8 mm long,	ca. 7.8–8 mm long,
39.	Stigma	Bifid ca. 0.4 mm long.	Bifid ca. 0.2 mm long	Bifid ca. 0.4mm long	Shortly bifid with equal lobes, ca. 0.22–0.25 mm long	data defficient	Bifid ca.0.4 –0.5mm long	Bifid ca.0.22 –0.25 mm long
40.	Nutlets	Dark brown, ovoid or ellipsoid, ca. 0.4 × 0.3 mm.	Brown, oblong, 1 × 0.7 mm, slightly pointed at the apex	Brown round to ellipsoid	Dark brown to black ovoioid , 1–1.2×0.6–0.8 mm, smooth, mature nutlets usually producing mucilage when wetted.	Bark brown, ovoid or ellipsoid, 0.7–0.8 ×0.5–0.6 mm.	Brown, ovoid to ellipsoid ca. 0.8–1×0.7–0.75 mm.	Brown broadly ovoid to orbicular ca. 0.9 × 0.75 mm

APPENDIX 6
LIST OF PUBLICATIONS

1. **K. Shinoj** & P. Sunojkumar (2018) , *Anisochilus kanyakumariensis* (Lamiaceae): a new species from the Western Ghats, India. ***Phytotaxa*** 333 (1): 099-107.

2. **Shinoj, K.** and Sunojkumar P., A checklist of the genus *Pogostemon* Desf. in Southern Western Ghats. *South Indian Journal of Biological Sciences*, 2016. 2(1): 46-51.

3. Sunojkumar P., Sampathkumar V., **Shinoj K.,** Prasad M.G. & Jayesh P. Joseph (2014) Notes on the distribution of two rare *Pogostemon* species (Lamiaceae) in South India , *International Journal of Plant Animal and Environmental Sciences.*4 (3): 674-675.

Other publications

1. M. G. Prasad, K. P. Vimal, **K. Shinoj** & P. Sunojkumar (2014). First record of *Vandellia diffusa* (Linderniaceae) in Asia. ***Phytotaxa*** 163 (1): 054-057.

2. Vimal KP, **Shinoj K**, Prasad MG, & Sunojkumar P (2018). *Leucas dhonimalayensis* (Lamiaceae), a new species from Peninsular India. *Ann. Bot. Fennici* 55: 289–292.

APPENDIX 7
PAPERS PRESENTED IN SEMINARS

1. **Shinoj, K.** and Sunojkumar P., Studies on the natural population and taxonomy of *Pogostemon* (Lamiaceae) in the Southern Western Ghats. Poster session. 24th Annual Conference of Indian Association for Angiosperm Taxonomy (IAAT) and **International Conference** on Trends in Plant Systematics (TIPS), held on 31stOctober-2nd November 2014, at Bharathidasan University, Tiruchirappalli, Tamil Nadu.

2. **Shinoj, K.** and Sunojkumar P., Studies on the Leaf characters and Inflorescence architecture of the genus *Pogostemon* Desf. in Western Ghats. Oral session. National Seminar on Advancement of Biosystematics on Biodiversity Conservation from 8th- 9th October 2015, held at Sree Narayana College, Sivagiri, Varkala, Kerala.

3. **Shinoj, K.** and Sunojkumar P., A checklist of the genus *Pogostemon* Desf. in Western Ghats. Oral session. National Seminaron “Emerging trends in Herbal Technology”. 7th to 9th October 2015 held at Department of Botany, St. Thomas College, Trissur.

4. **Shinoj, K.** and Sunojkumar P., Taxonomy and distribution of the genus *Pogostemon* Desf. (Lamiaceae) in Western Ghats. Oral session. Silver Jubilee Conference of IAAT and Council Meeting of IAPT & International Seminar on Advancement in Angiosperm Systematics and Conservation from 19th to 21st November 2015 held at Department of Botany, University of Calicut, Kerala.

5. **Shinoj, K**. and Sunojkumar P., Taxonomy and phytogeography of the genus *Anisochilus* Wall. (Lamiaceae) in Western Ghats. Oral session. XXVI Annual Conference of IAAT and International Seminar on Conservation and sustainable Utilization of Biodiversity from 7th to 9th November 2016 held at Department of Botany, Shivaji University, Kolhapur.

Taxonomic Studies on the genera *Pogostemon* Desf., *Anisochilus* Wall. ex Benth., and *Scutellaria* L. (Lamiaceae) of the Western Ghats of India

Submitted to the
University of Calicut in partial fulfilment of
the requirement for the degree of

DOCTOR OF PHILOSOPHY IN BOTANY

SHINOJ, K.

DEPARTMENT OF BOTANY
UNIVERSITY OF CALICUT
KERALA, INDIA
JANUARY 2019

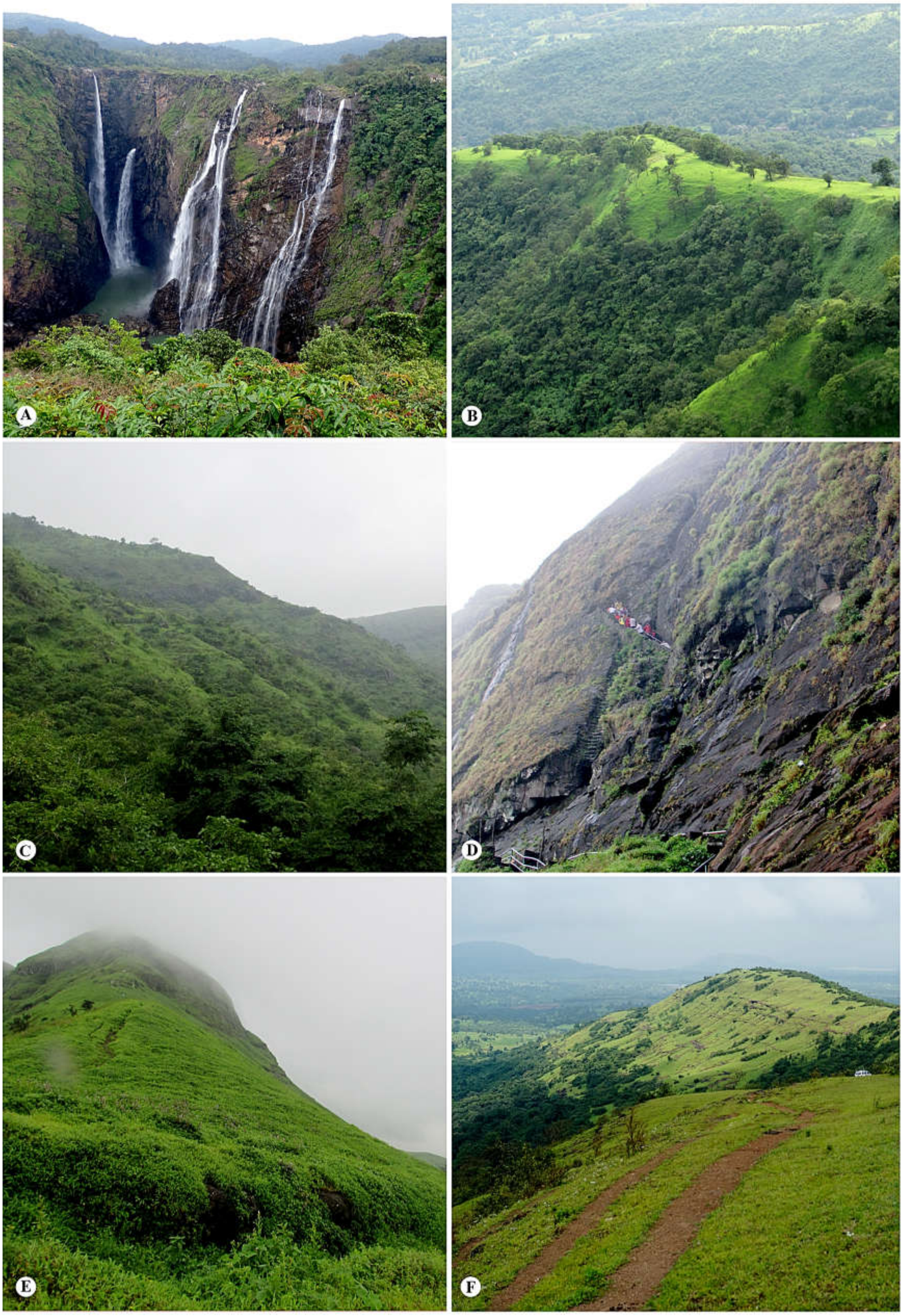


Plate 2. Different vegetation zones of Western Ghats **A.** Jog falls; **B.** Anuskura; **C.** Mahabaleswar; **D-E.** Brahmagiri; **F.** Chaukul.

Plate 3. Different Vegetation zones of Western Ghats, **A**. Lower Vaguvarai,; **B**. Umayamalai; **C.** Maruthwamalai **D.** Neyyar; **E.** Minampara, Nelliampathy; **F.** Mathikettan Shola

Plate 4. Different vegetation zones of Western Ghats, **A-B** Kurichermala; **C-D** Chembra; **E-F** Pakshipathalam

Plate 5. Different vegetation zones of Western Ghats, A. Agastharmala; B. Athirumalai; C. Seethalangiri; D. Mullayanagiri; E. Bababudangiri; F. Bhadra W.L.S.

Plate 6. Different vegetation zones of Western Ghats, A. Unginda, Silent Valley; B. Girra Falls; C. Sisspara; D. Shendurney; E. Anamudi shola; F. Devicolam

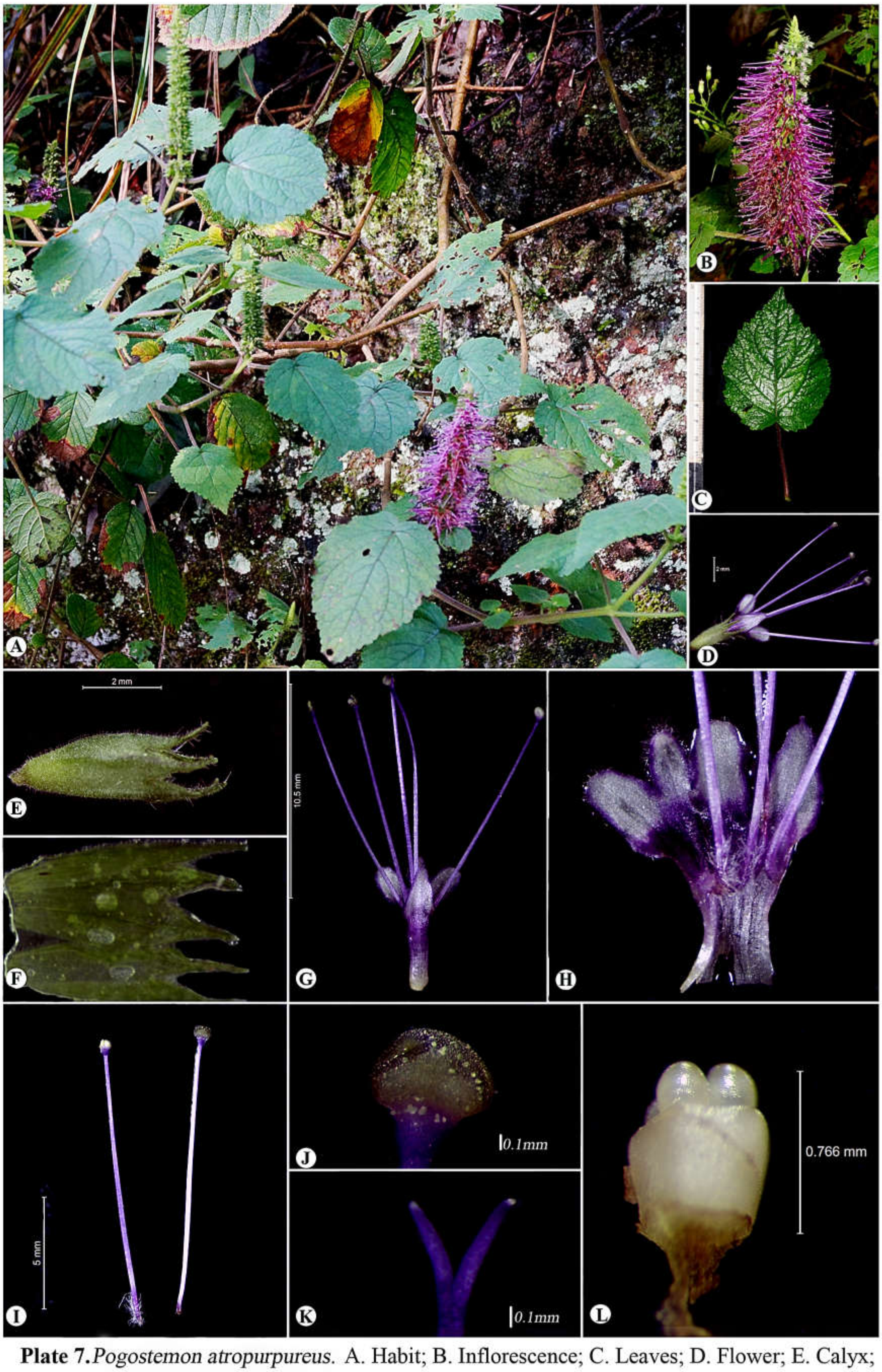


Plate 7. *Pogostemon atropurpureus.* A. Habit; B. Inflorescence; C. Leaves; D. Flower; E. Calyx; F. Calyx opened; G. Corolla; H. Corolla opened; I. Stamen; J. Anther; K. Stigma; L. Ovary.

Plate 8. Holotype of *Pogostemon atropurpureus* (P00737543, "Reproduced by the permission of the Muséum National d'Histoire Naturelle, Paris").

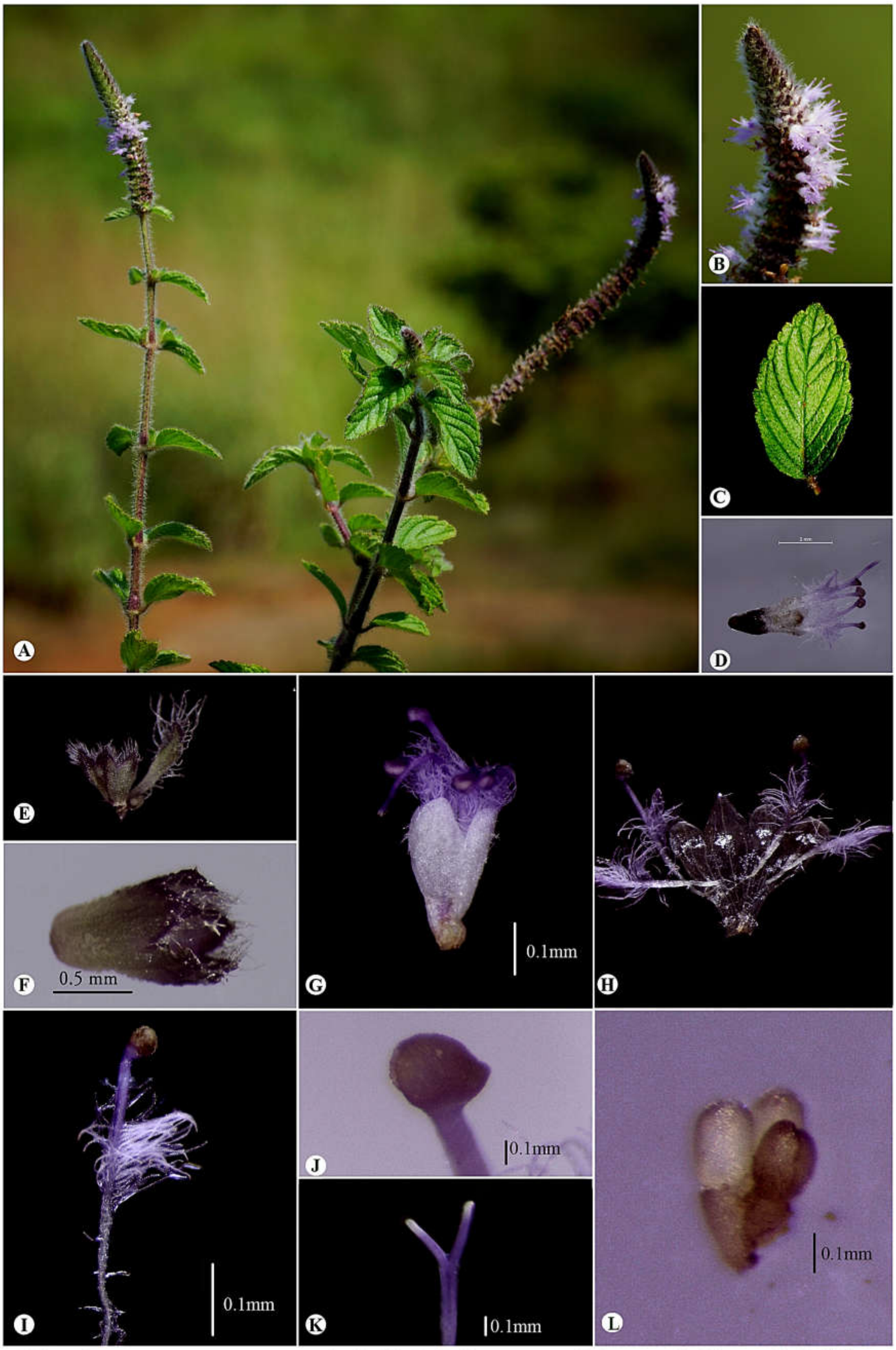


Plate 9. *Pogostemon auricularius* A. Habit; B. Inflorescence; C. Leaves; D. Flower; E-F. Calyx; G. Corolla; H. Corolla opened; I. Stamen; J. Anther; K. Stigma; L. Ovary with disc.

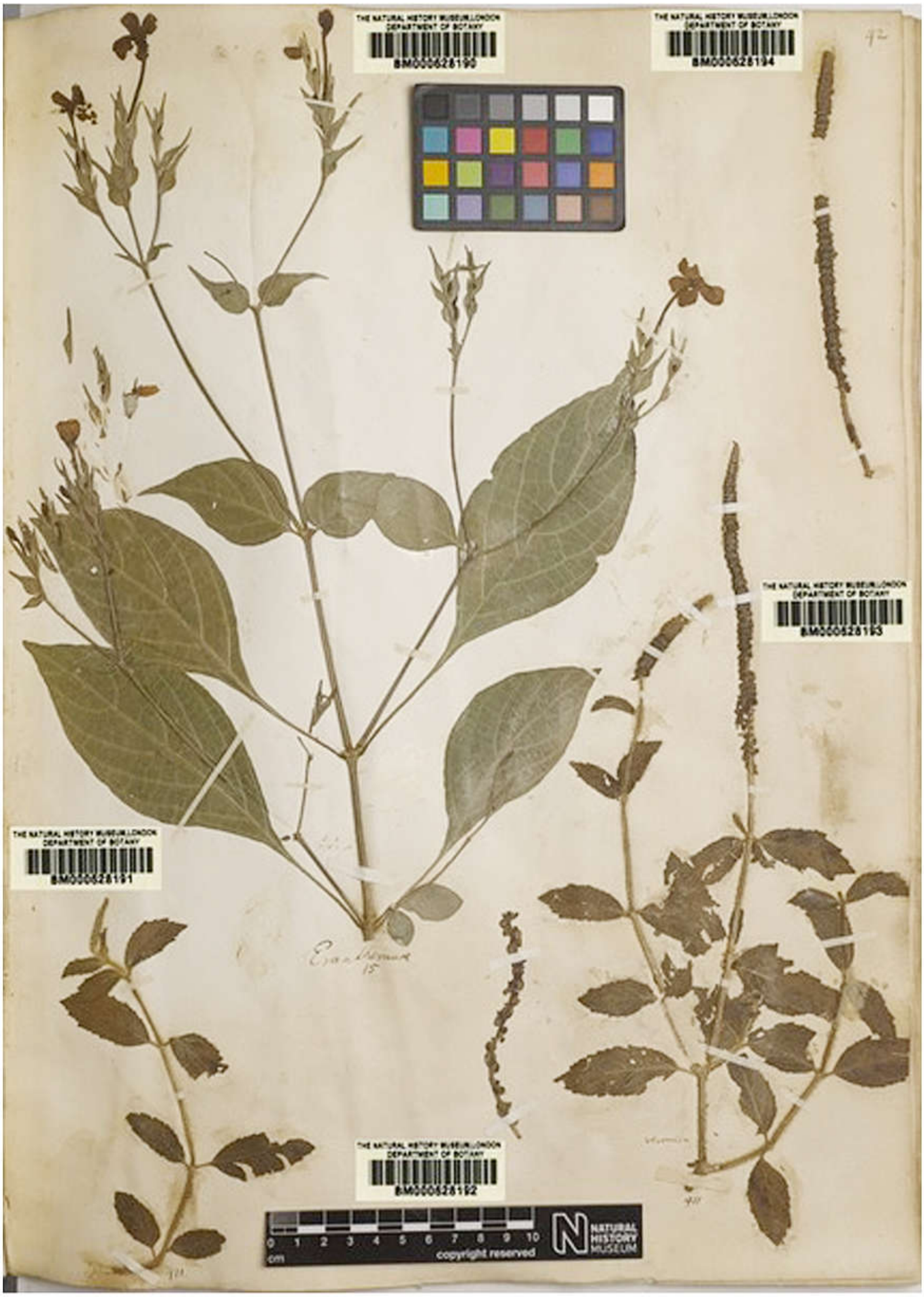


Plate 10. Holotype of *Pogostemon auricularius* (BM000628193, "Reproduced by the permission of the Natural History Museum, London").

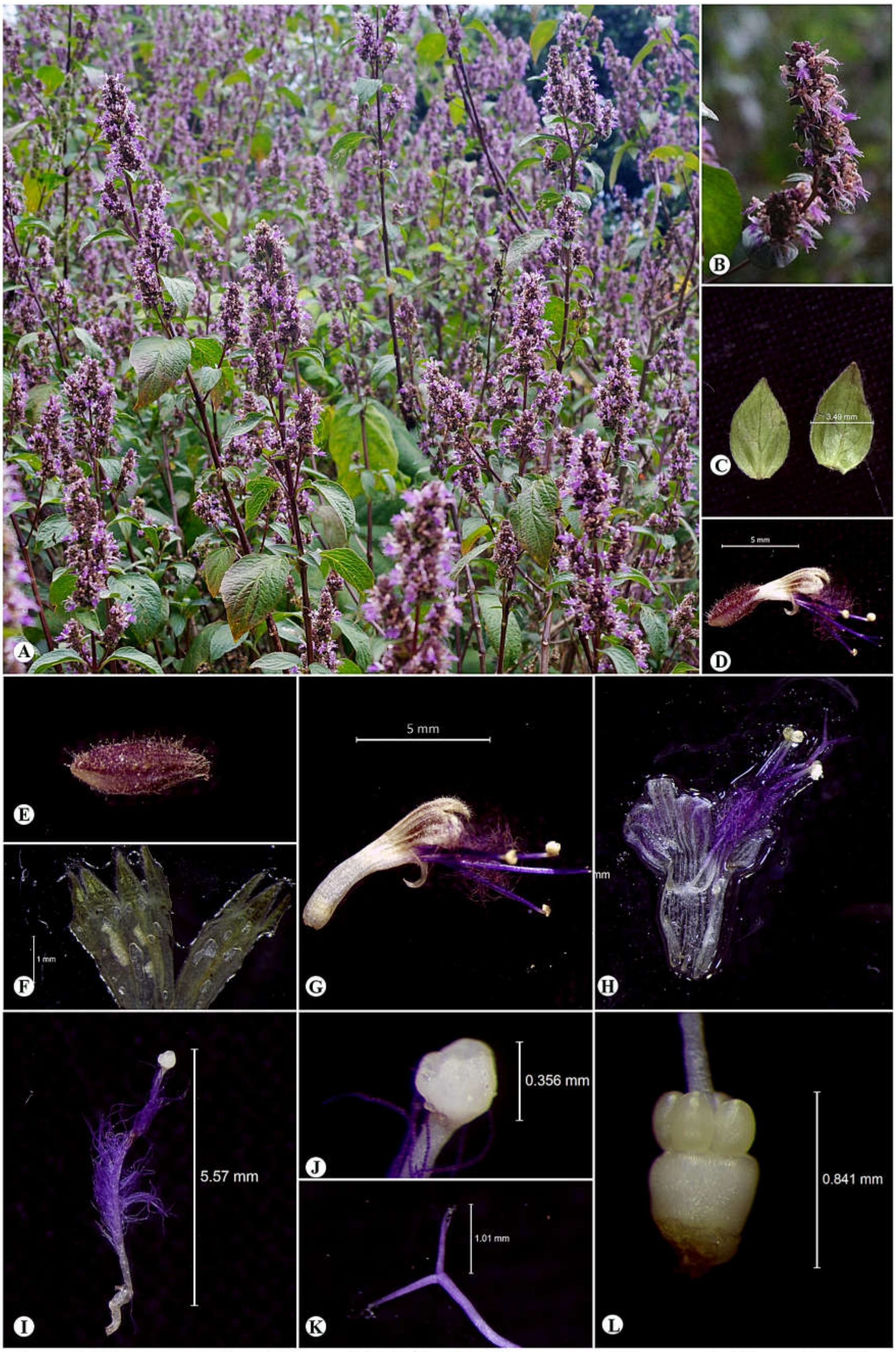


Plate 11. *Pogostemon benghalensis*. ßA. Habit; B. Inflorescence; C. Leaves; D. Flower; E. Calyx; F. Calyx opened; G. Corolla; H. Corolla opened; I. Stamen; J. Anther; K. Stigma; L. Ovary.

Plate 12. Type –an illustration of *Pogostemon benghalensis* (Burm.f., Fl. Ind. 126, t.38, f.3).

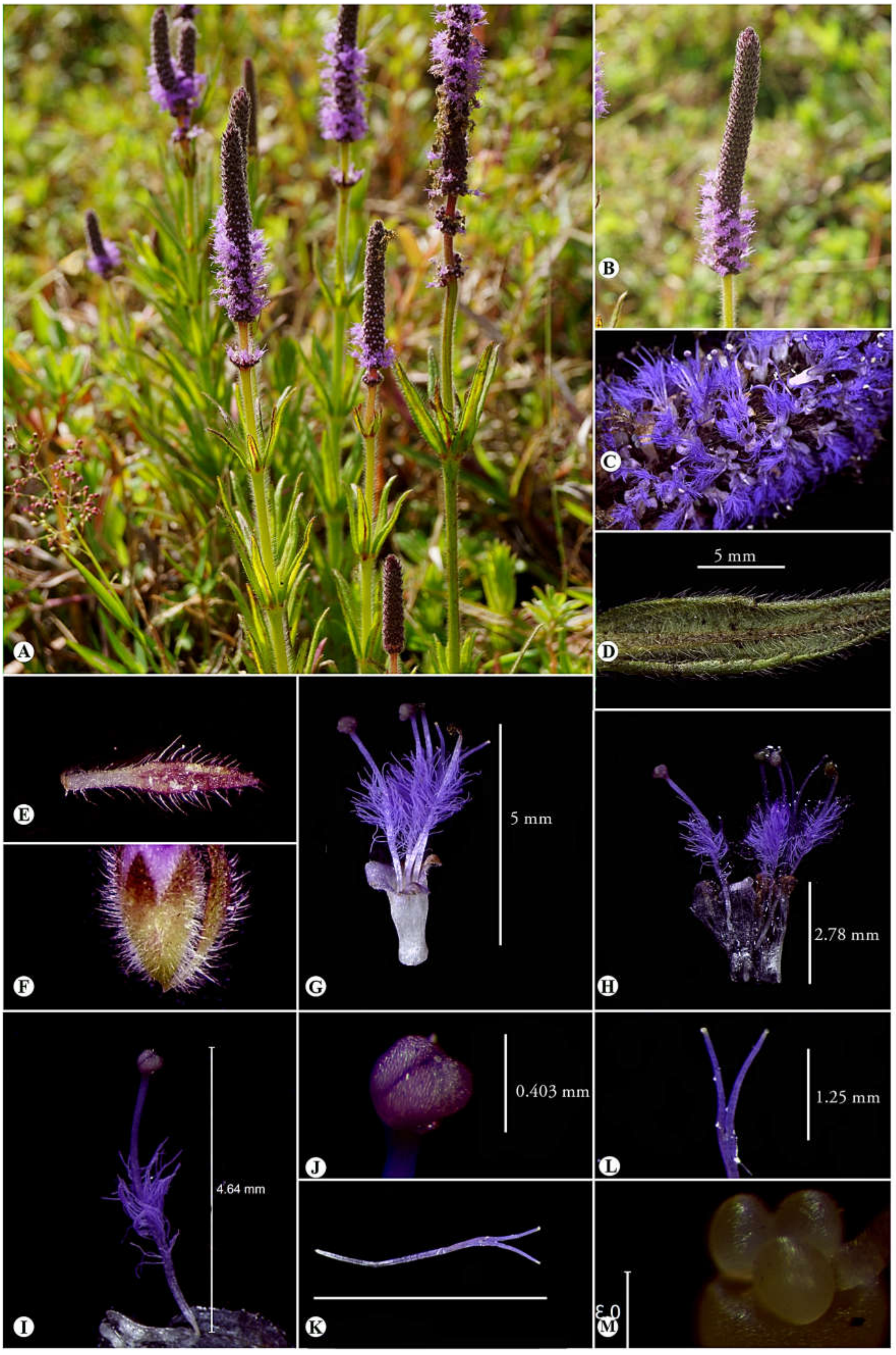


Plate 13. *Pogostemon cruciatus.* A. Habit; B-C. Inflorescence; D. Leaf; E. Bracteole; F. Calyx; G. Corolla; H. Corolla opened; I. Stamen; J. Anther; K. Style with stigma; L. Stigma; M. Ovary

Plate 14. Lectotype of *Pogostemon cruciatus* (K000848012, "Reproduced by the permission of the board of trustees of Royal Botanical Gardens, Kew").

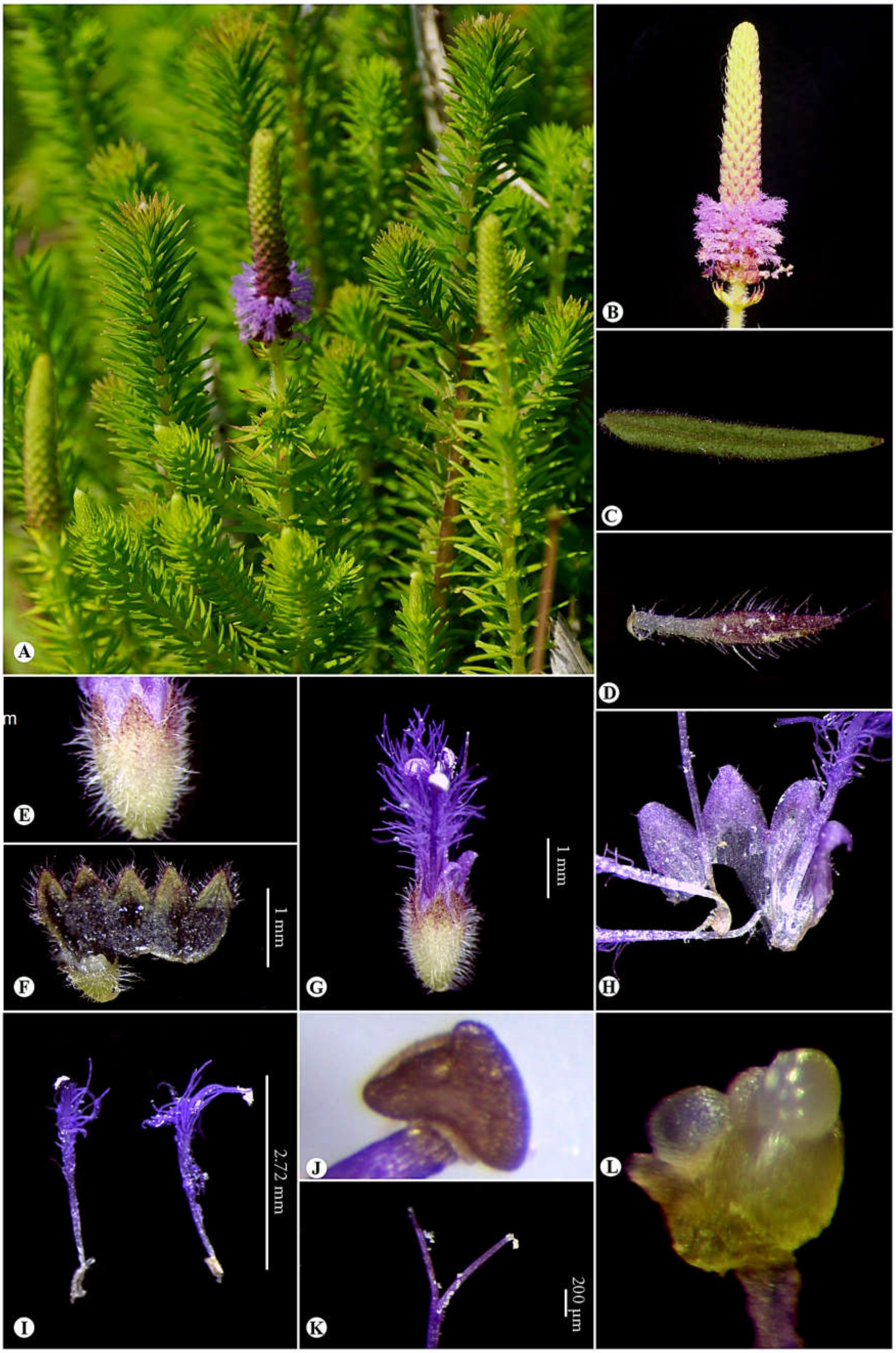


Plate 15. *Pogostemon deccanensis.* A. Habit; B. Inflorescence; C. Leaves; D. Bracteole; E. Calyx; F. Calyx opened; G. Flower; H. Corolla opened; I. Stamen; J. Anther; K. Stigma; L. Ovary.

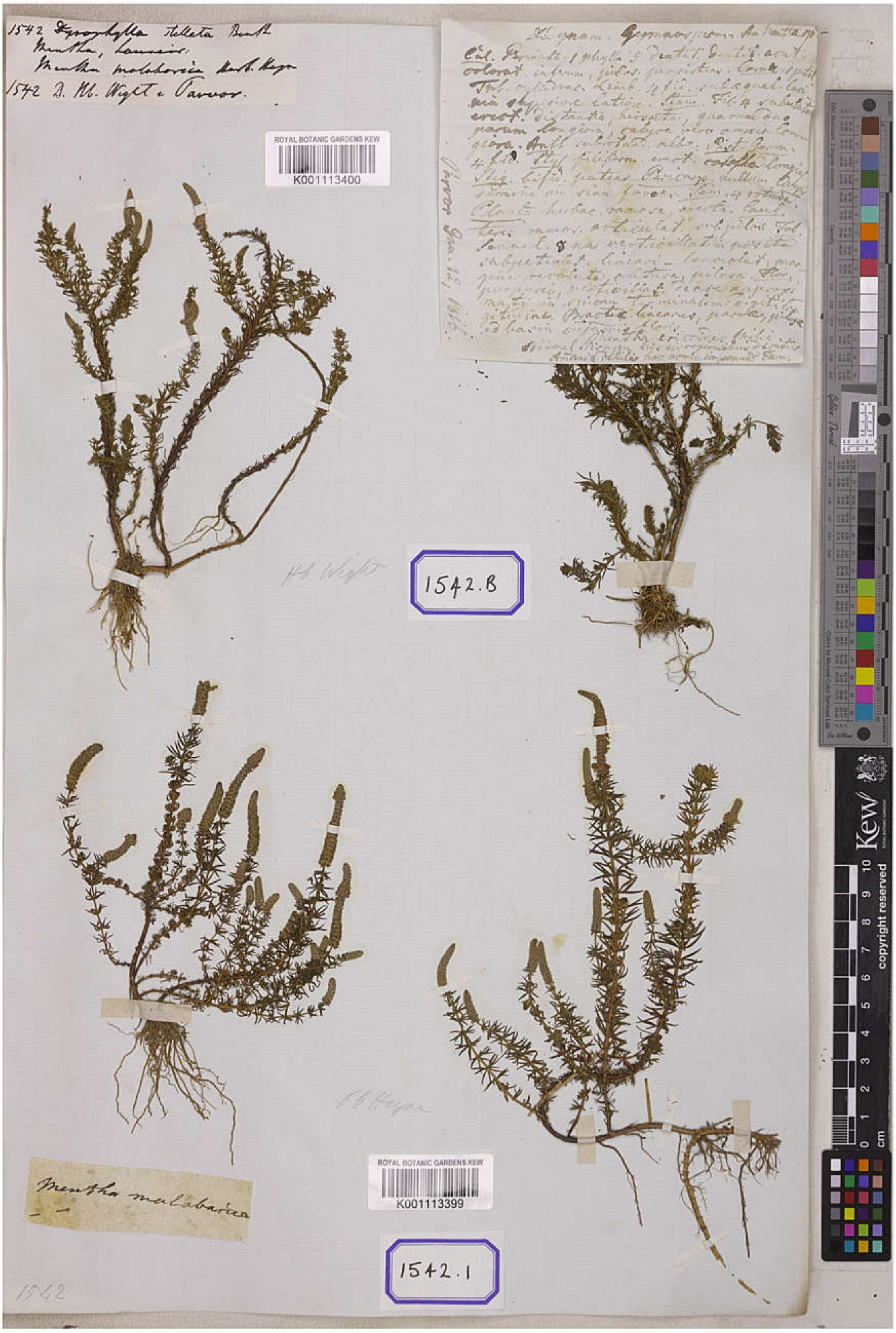


Plate 16. Type of *Pogostemon deccanensis* (K001113399 "Reproduced by the permission of the board of trustees of Royal Botanical Gardens, Kew").

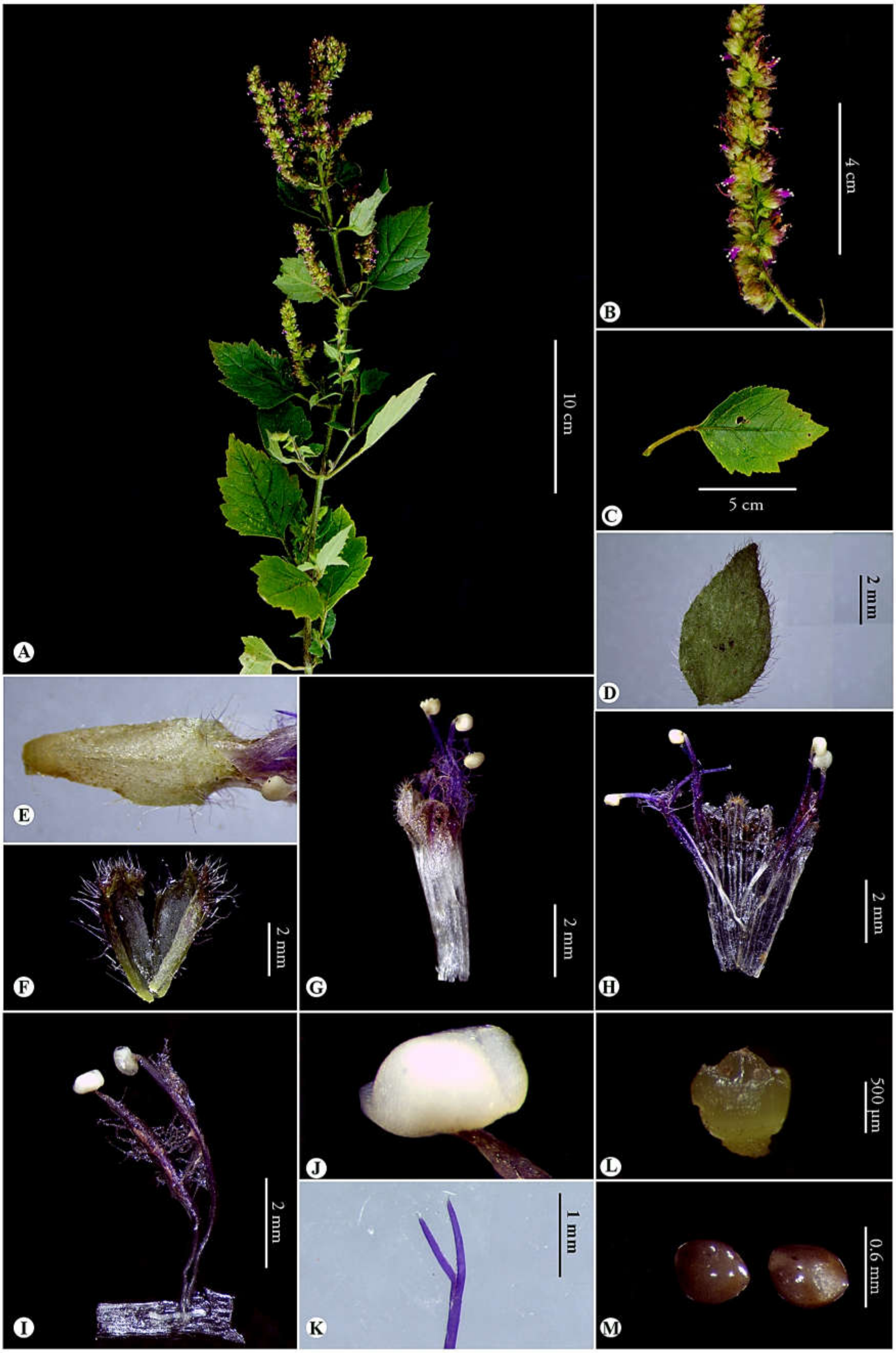


Plate 17. *Pogostemon gardneri.* A. Habit; B. Inflorescence; C. Leaf; D. Bracteole; E. Calyx; F. Calyx opened; G. Corolla; H. Corolla opened; I. Stamen; J. Anther; K. Stigma; L. Disc; M. Nutlets.

Plate 18. Lectotype of *Pogostemon gardneri* (K000479999, "Reproduced by the permission of the board of trustees of Royal Botanical Gardens, Kew").

Plate 19. *Pogostemon heyneanus.* A. Habit; B. Inflorescence; C. Leaf; D. Bracteole; E. Calyx; F. Calyx opened; G. Corolla; H. Corolla opened; I. Stamen; J. Anther; K. Stigma; L. Ovary; M. Nutlets.

Plate 20. Lectotype of *Pogostemon heyneanus* (K000509678, "Reproduced by the permission of the board of trustees of Royal Botanical Gardens, Kew").

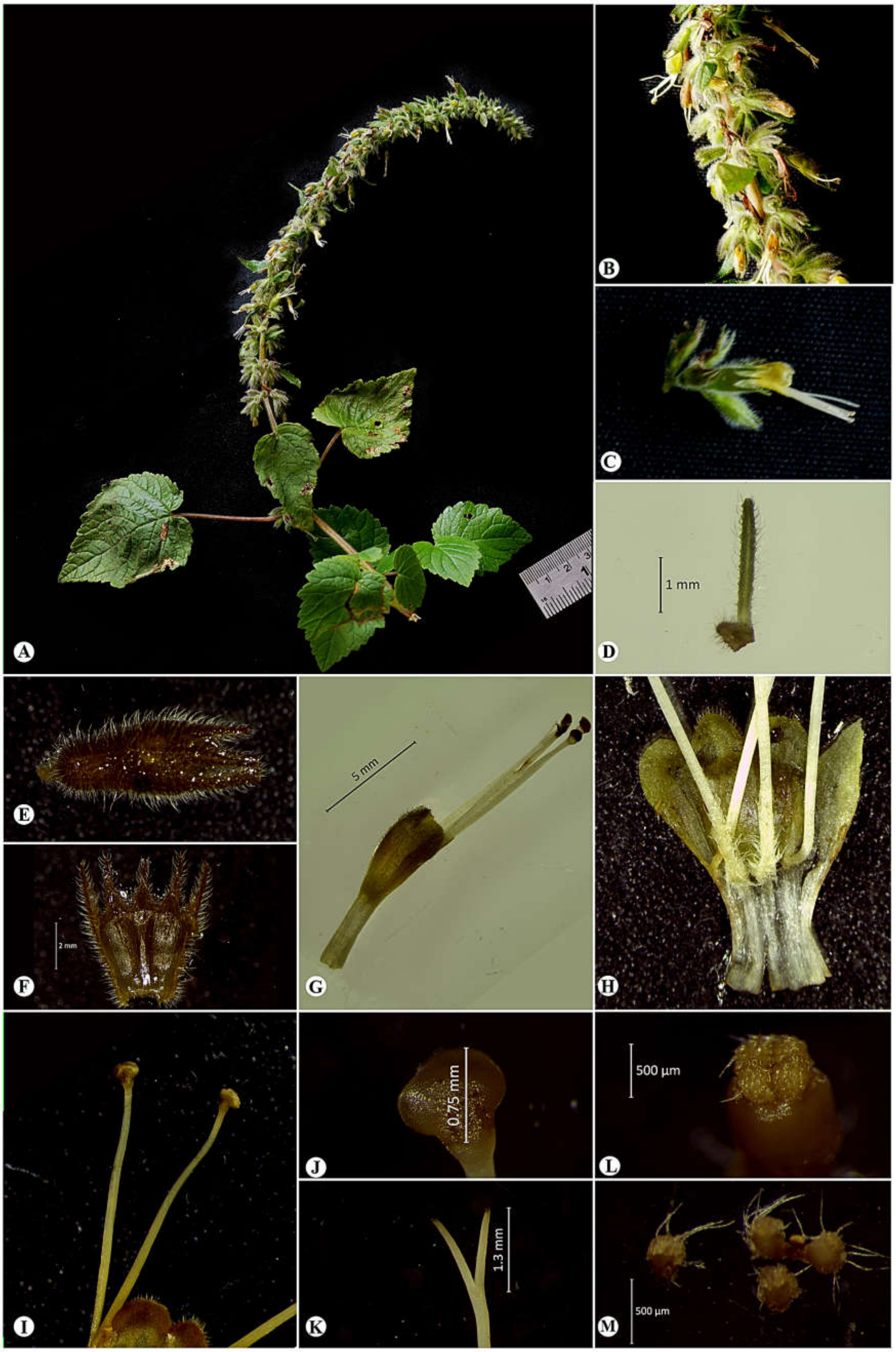


Plate 21. *Pogostemon hedgei.* A. Habit; B. Inflorescence; C. Flower; D. Bracteole; E. Calyx; F. Calyx opened; G. Corolla; H. Corolla opened; I. Stamen; J. Anther; K. Stigma; L. Ovary; M. Nutlets.

Plate 22. Holotype of *Pogostemon hedgei* (MH00000919, "Reproduced by the permission of the Botanical Survey of India, Kolkata").

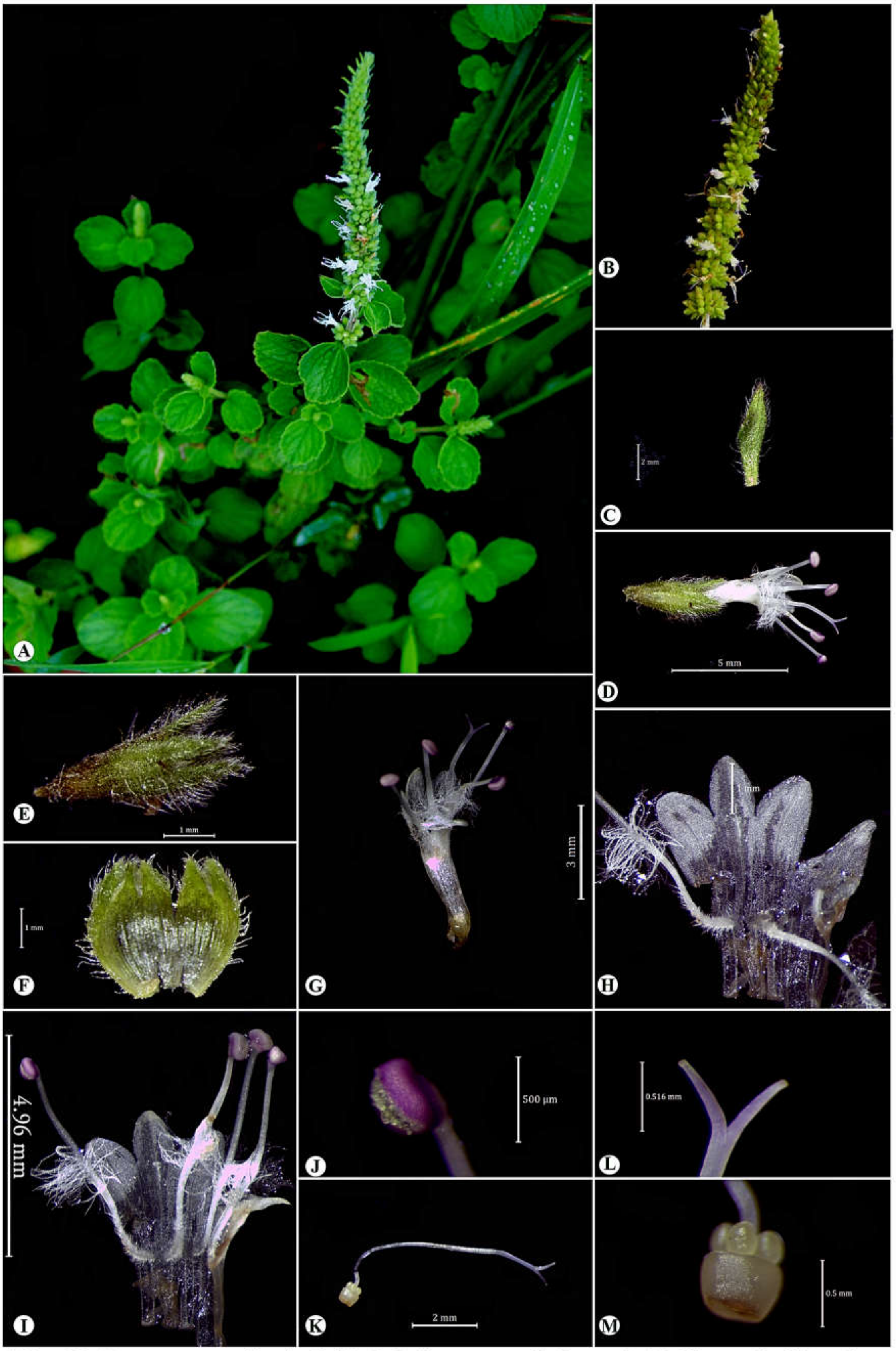


Plate 23. *Pogostemon mollis*. A. Habit; B. Inflorescence; C. Bracteole; D. Flower; E. Calyx; F. Calyx opened; G. Corolla; H. Corolla opened; I. Stamens; J. Anther; K. Gyonecium; L. Stigma; M. Ovary.

Plate 24. Lectotype of *Pogostemon mollis* (K000509676, "Reproduced by the permission of the board of trustees of Royal Botanical Gardens, Kew").

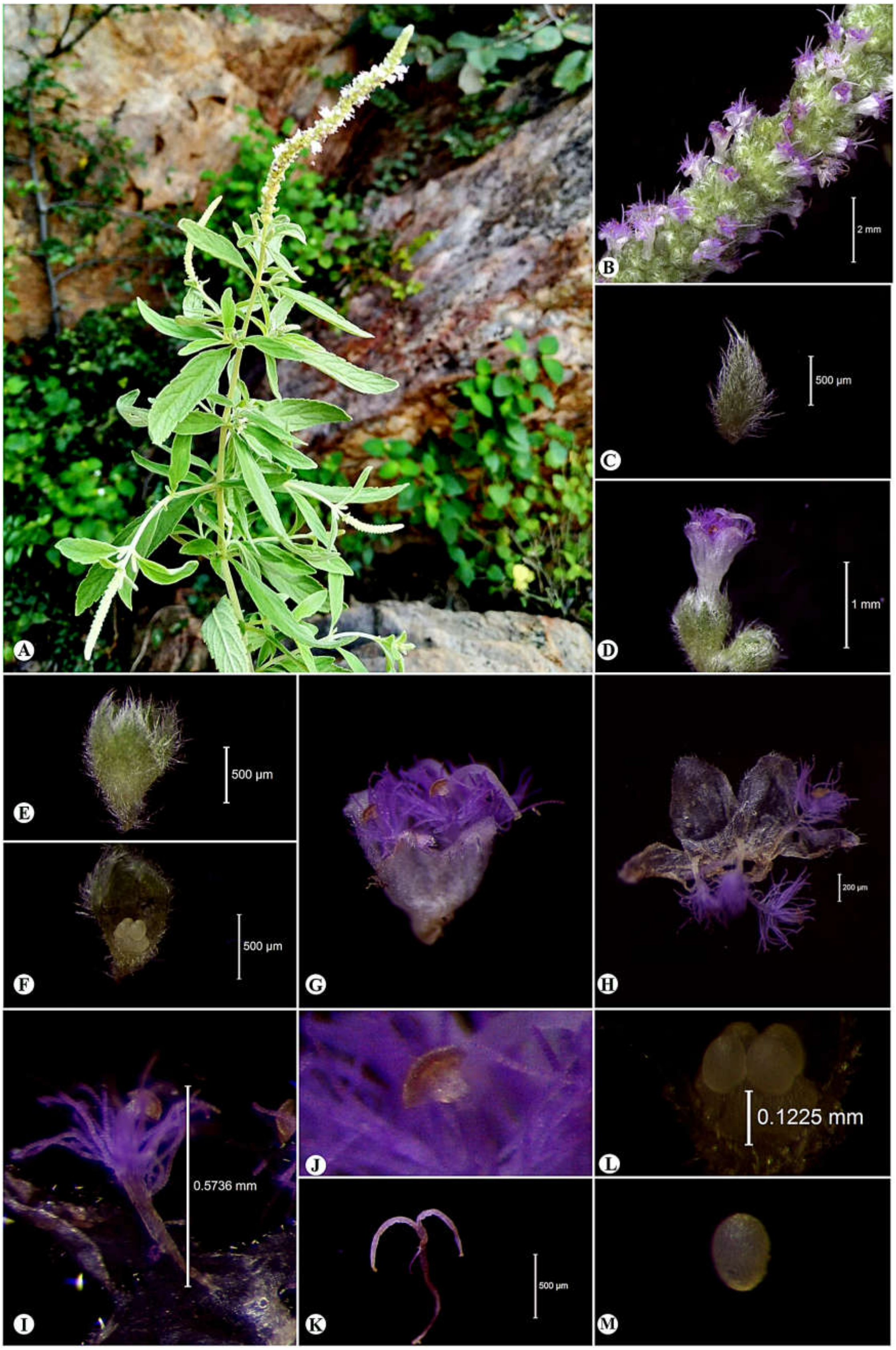


Plate 25. *Pogostemon myosuroides.* A. Habit; B. Inflorescence; C. Bracteole; D. Flower; E. Calyx; F. Calyx opened; G. Corolla; H. Corolla opened; I. Stamens; J. Anther; K. Stigma; L. Ovary; M. Nutlet.

Plate 26. Isotype of *Pogostemon myosuroides* (K000509700, "Reproduced by the permission of the board of trustees of Royal Botanical Gardens, Kew").

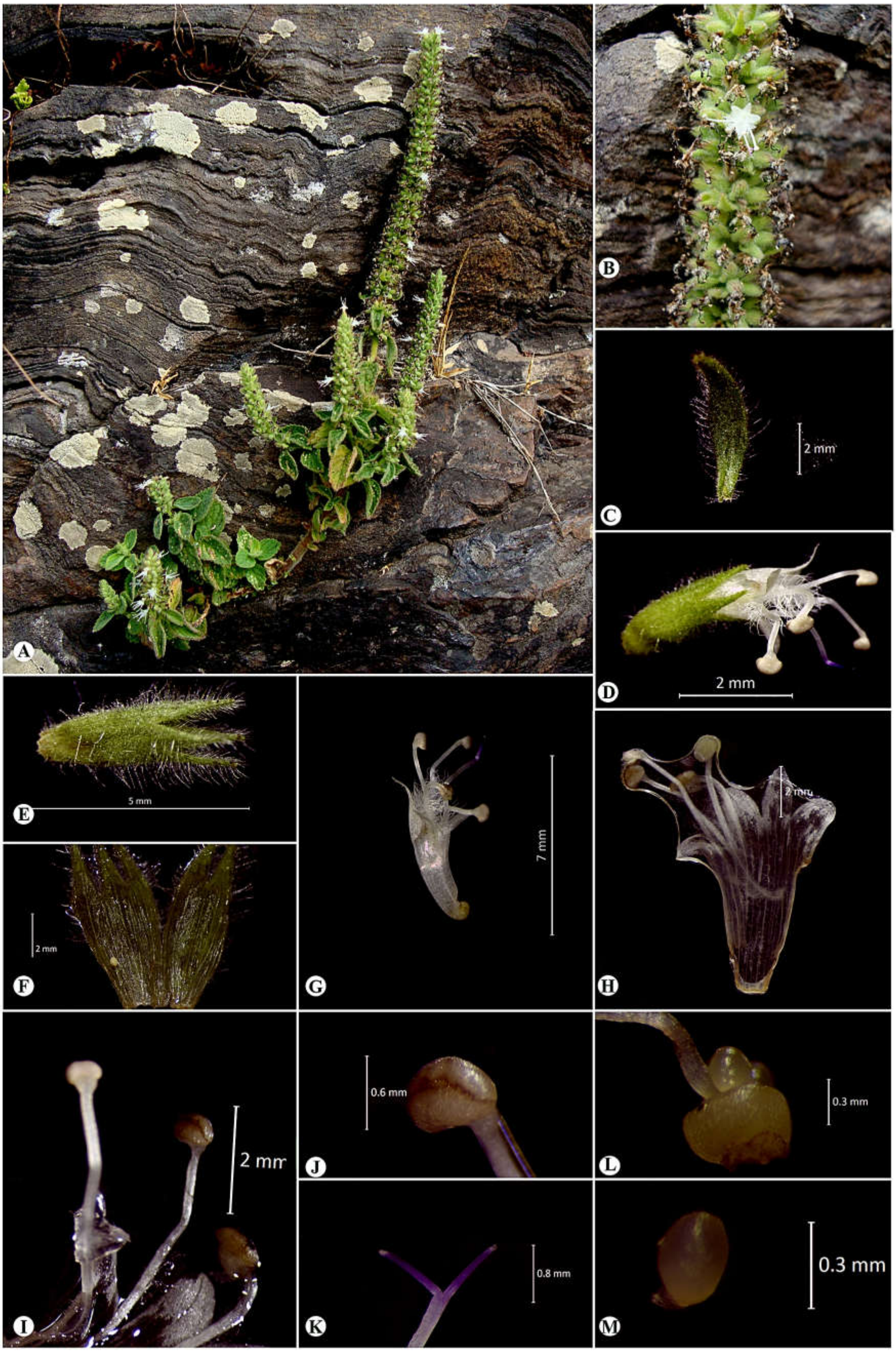


Plate 27. *Pogostemon nilagiricus.* A. Habit; B. Inflorescence; C. Bracteole; D. Flower; E. Calyx; F. Calyx opened; G. Corolla; H. Corolla opened; I. Stamens; J. Anther; K. Stigma; L. Ovary; M. Nutlet.

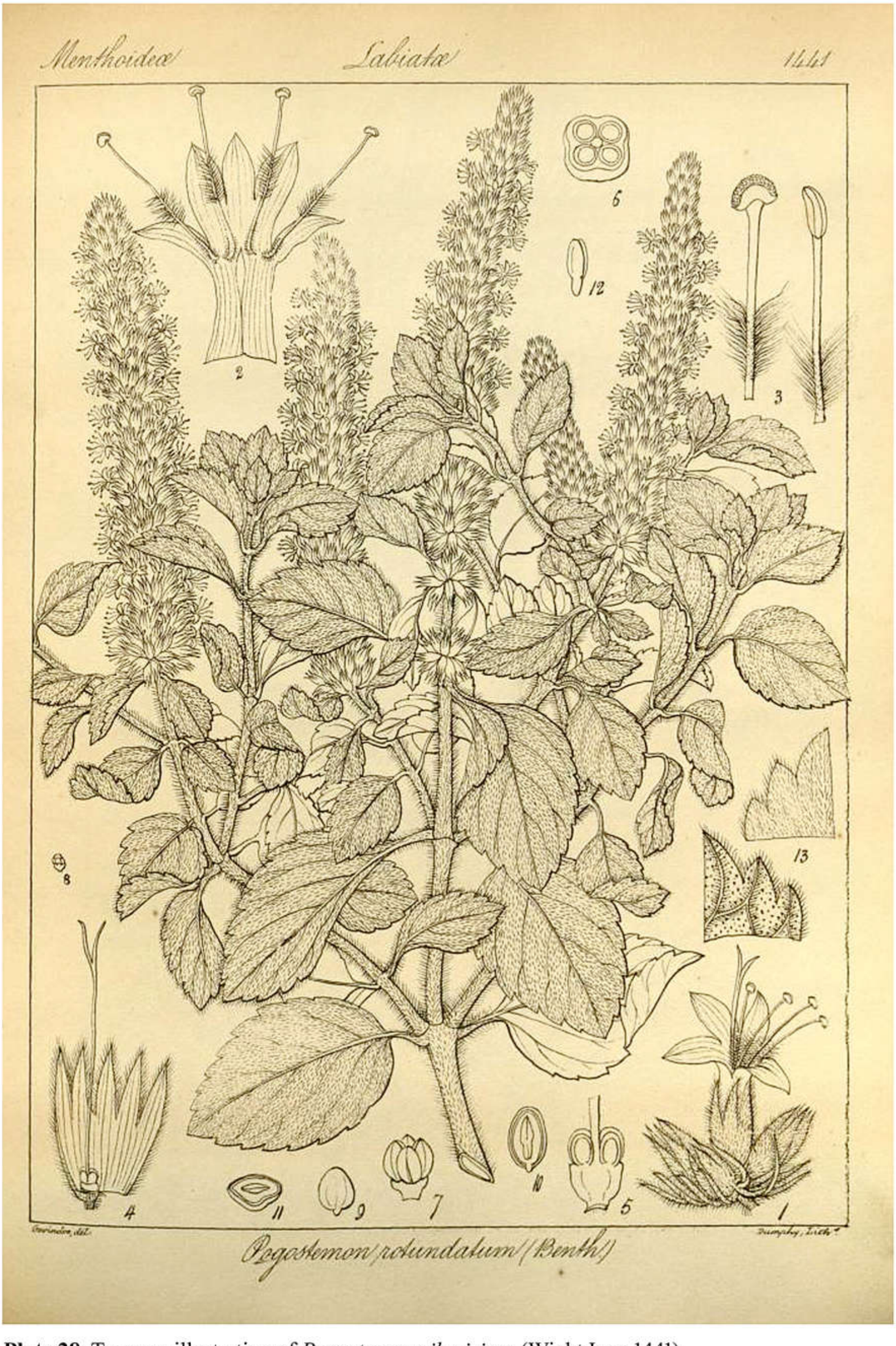


Plate 28. Type–an illustration of *Pogostemon nilagiricus* (Wight Icon 1441).

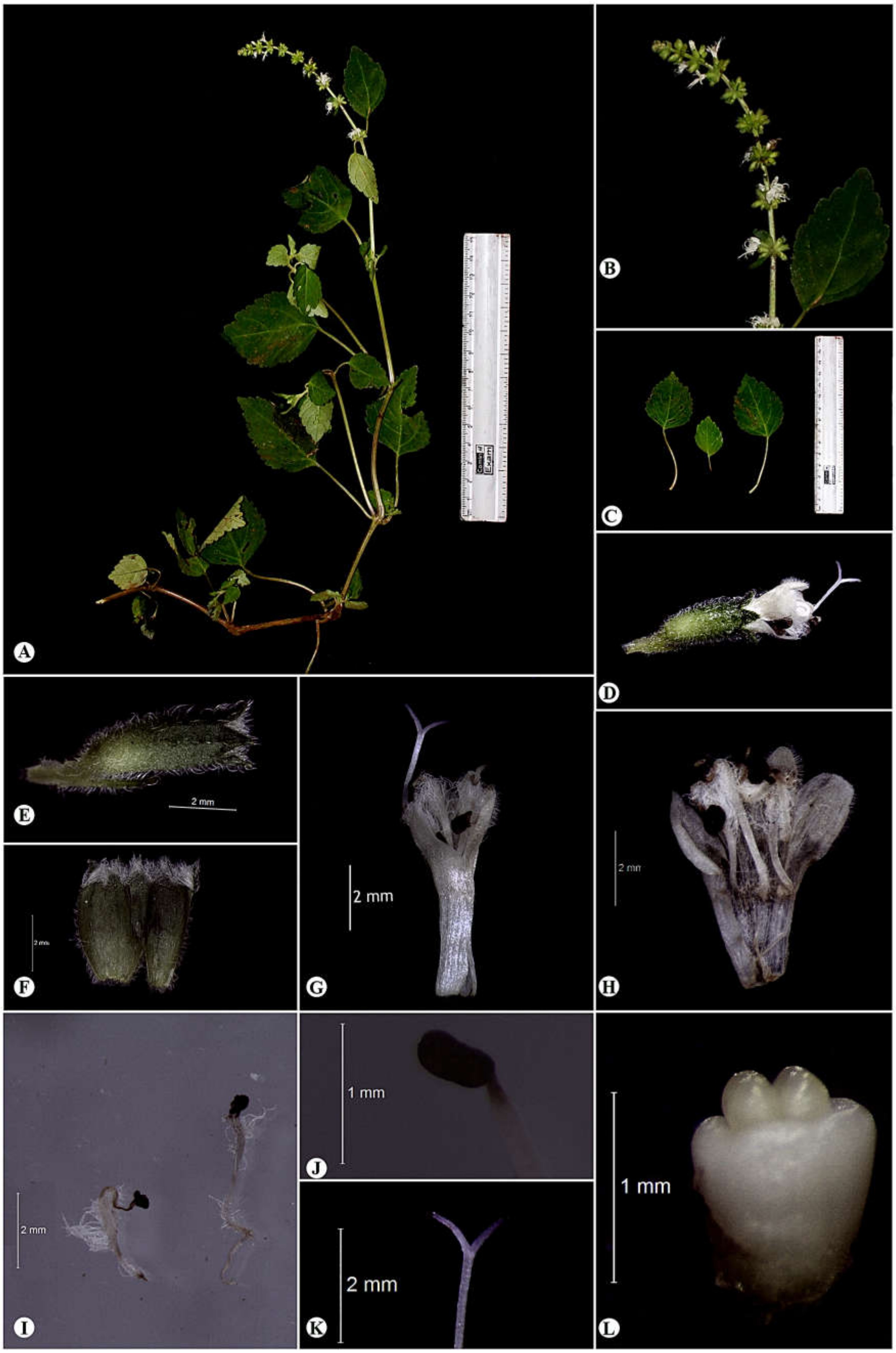


Plate 29. *Pogostemon paludosus*. A. Habit; B. Inflorescence; C. Leaves; D. Flower; E. Calyx; F. Calyx opened; G. Corolla; H. Corolla opened; I. Stamens; J. Anther; K. Stigma; L. Ovary.

Plate 30. Neotype of *Pogostemon paludosus* (K000848025, "Reproduced by the permission of the board of trustees of Royal Botanical Gardens, Kew").

Plate 31. *Pogostemon paniculatus.* A. Habit; B. Inflorescence; C. Bracteoles; D. Flower; E. Calyx; F. Calyx teeth; G. Corolla; H. Corolla opened; I. Stamens; J. Anther; K. Stigma; L. Ovary; M. Nutlet.

Plate 32. Holotype of *Pogostemon paniculatus* (K000509695, "Reproduced by the permission of the board of trustees of Royal Botanical Gardens, Kew").

Plate 34. Isotype of *Pogostemon peethapushpum* ("Reproduced by the permission of Department of Botany, University of Calicut").

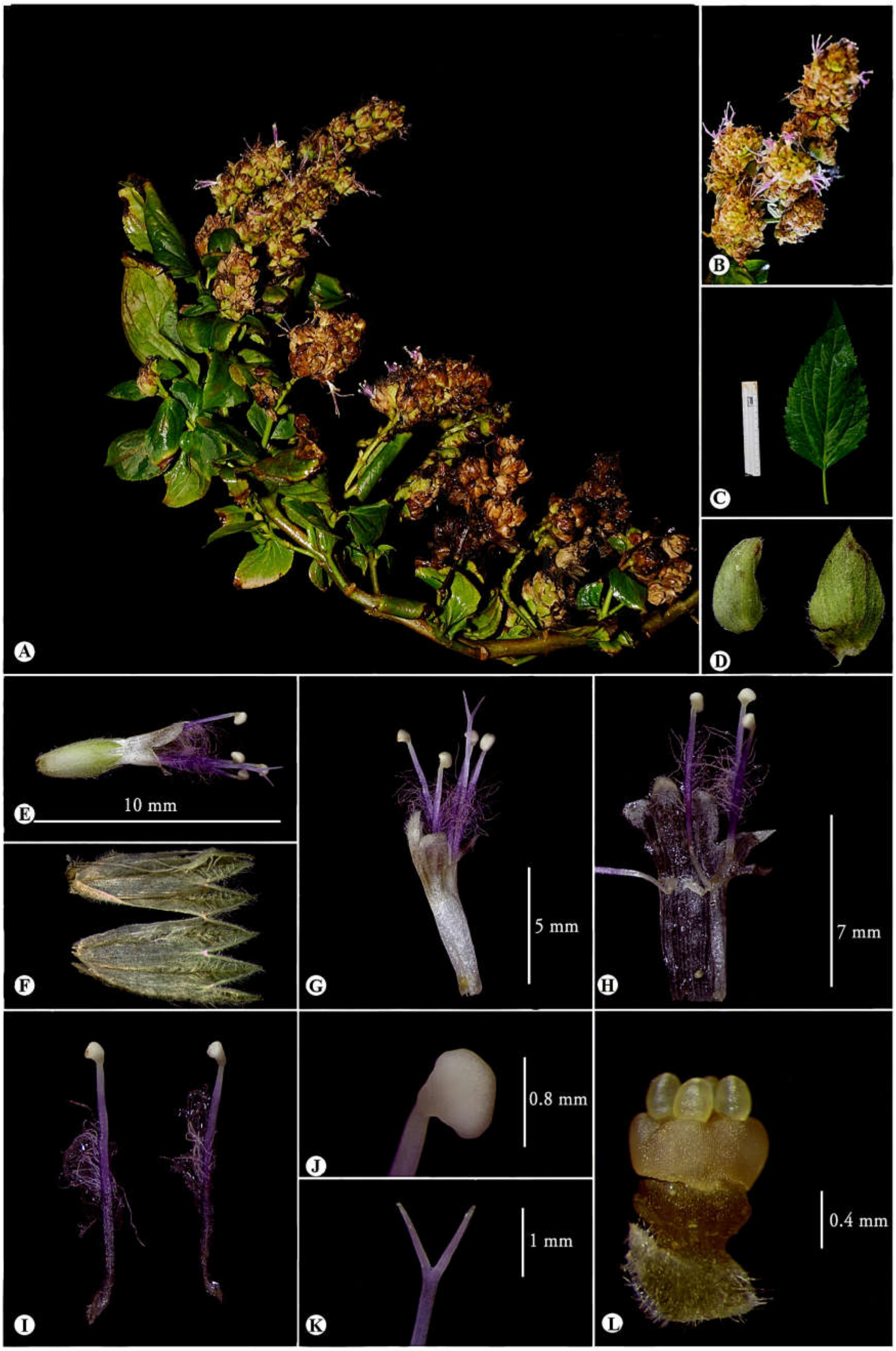


Plate 35. *Pogostemon plectrantoides.* A. Habit; B. Inflorescence; C. Leaf; D. Bracteoles; E. Flower; F. Calyx opened; G. Corolla; H. Corolla opened; I. Stamens; J. Anther; K. Stigma; L. Ovary.

Plate 36. Type–an illustration of *Pogostemon plectrantoides* ("Mém. Mus. Hist. Nat. 2: 155, t. 6").

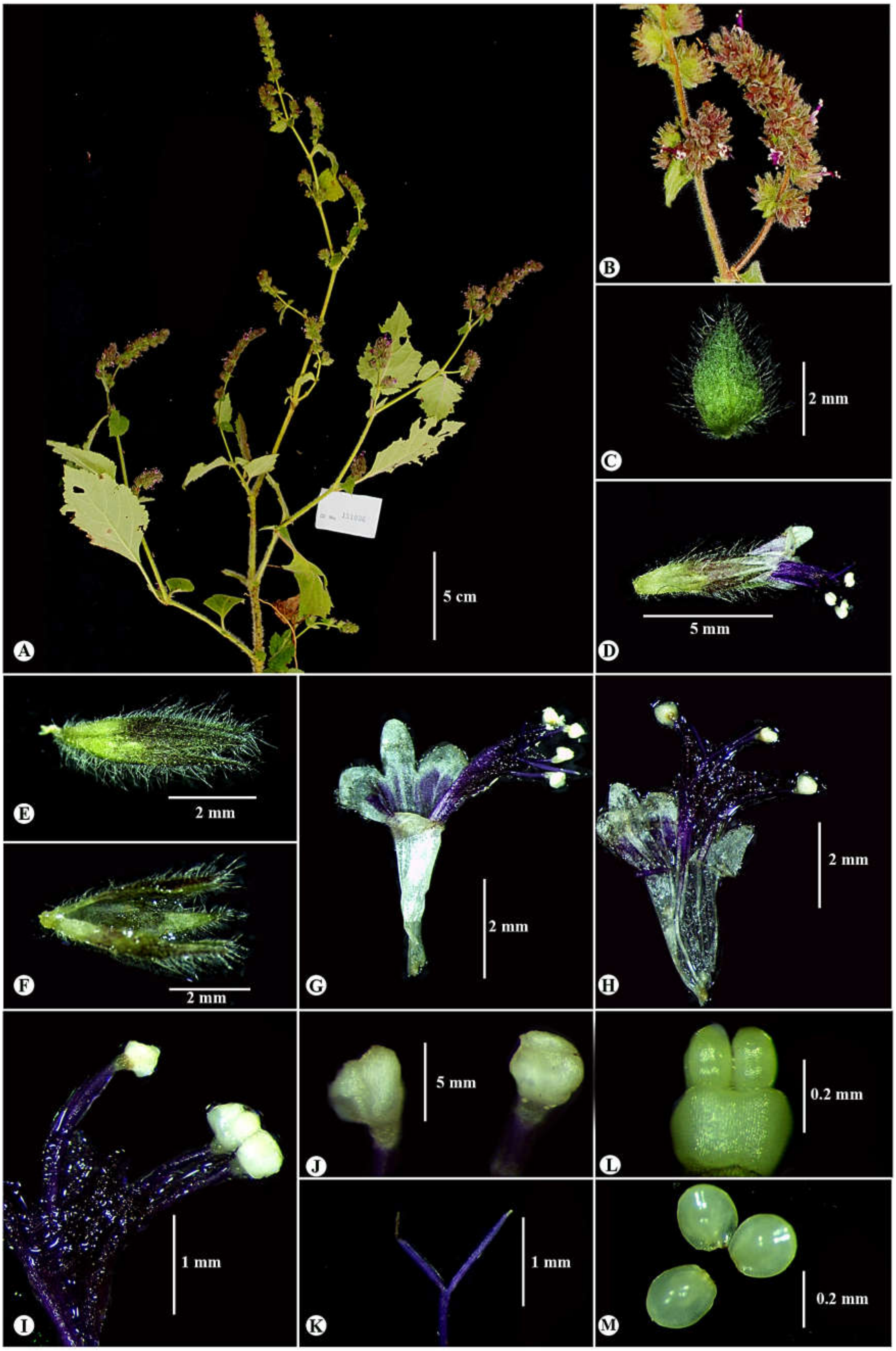


Plate 37. *Pogostemon purpurascens*. A. Habit; B. Inflorescence; C. Bracteole; D. Flower; E. Calyx; F. Calyx opened; G. Corolla; H. Corolla opened; I. Stamens; J. Anthers; K. Stigma; L. Ovary; M. Nutlets.

Plate 38. Lectoype of *Pogostemon purpurascens* (K000848043, "Reproduced by the permission of the board of trustees of Royal Botanical Gardens, Kew").

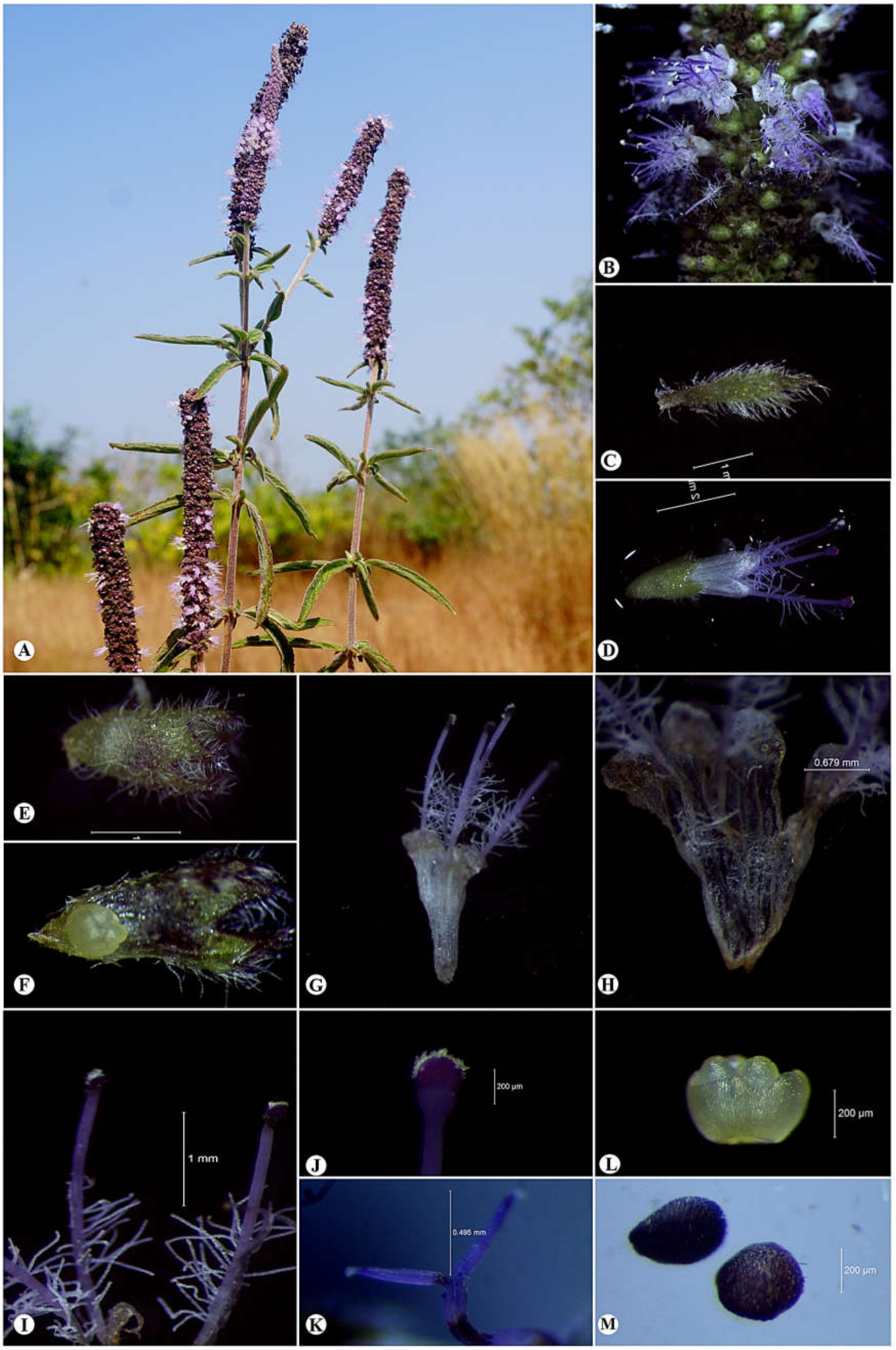


Plate 39. *Pogostemon quadrifolius.* A. Habit; B. Inflorescence; C. Bracteole; D. Flower; E. Calyx; F. Calyx opened; G. Corolla; H. Corolla opened; I. Stamens; J. Anther; K. Stigma; L. Ovary; M. Nutlets.

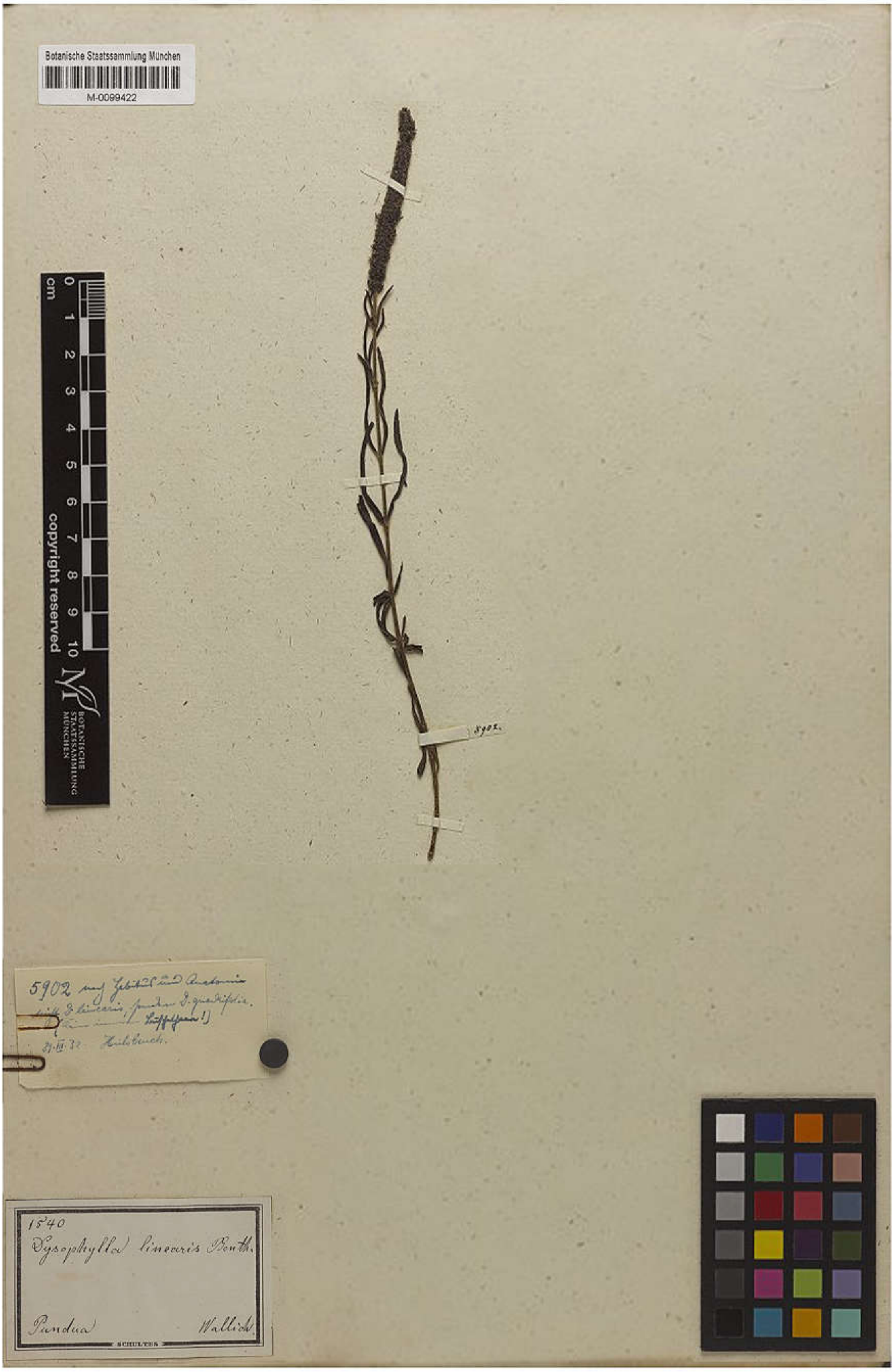


Plate 40. Isotype of *Pogostemon quadrifolius* (M0009942, “Reproduced by the permission of the Botanische Staatssammlung München”).

Plate 41. *Pogostemon salicifolius.* A. Habit; B-C. Inflorescence; D. Leaf; E. Bracteole; F. Calyx; G. Calyx opened; H. Stamens; I. Stigma; J. Ovary with disc; M. Nutlets.

Plate 42. Lectotype of *Pogostemon salicifolius* (E00301420, "Reproduced by the permission of the Royal Botanic Garden Edinburgh, Edinburgh").

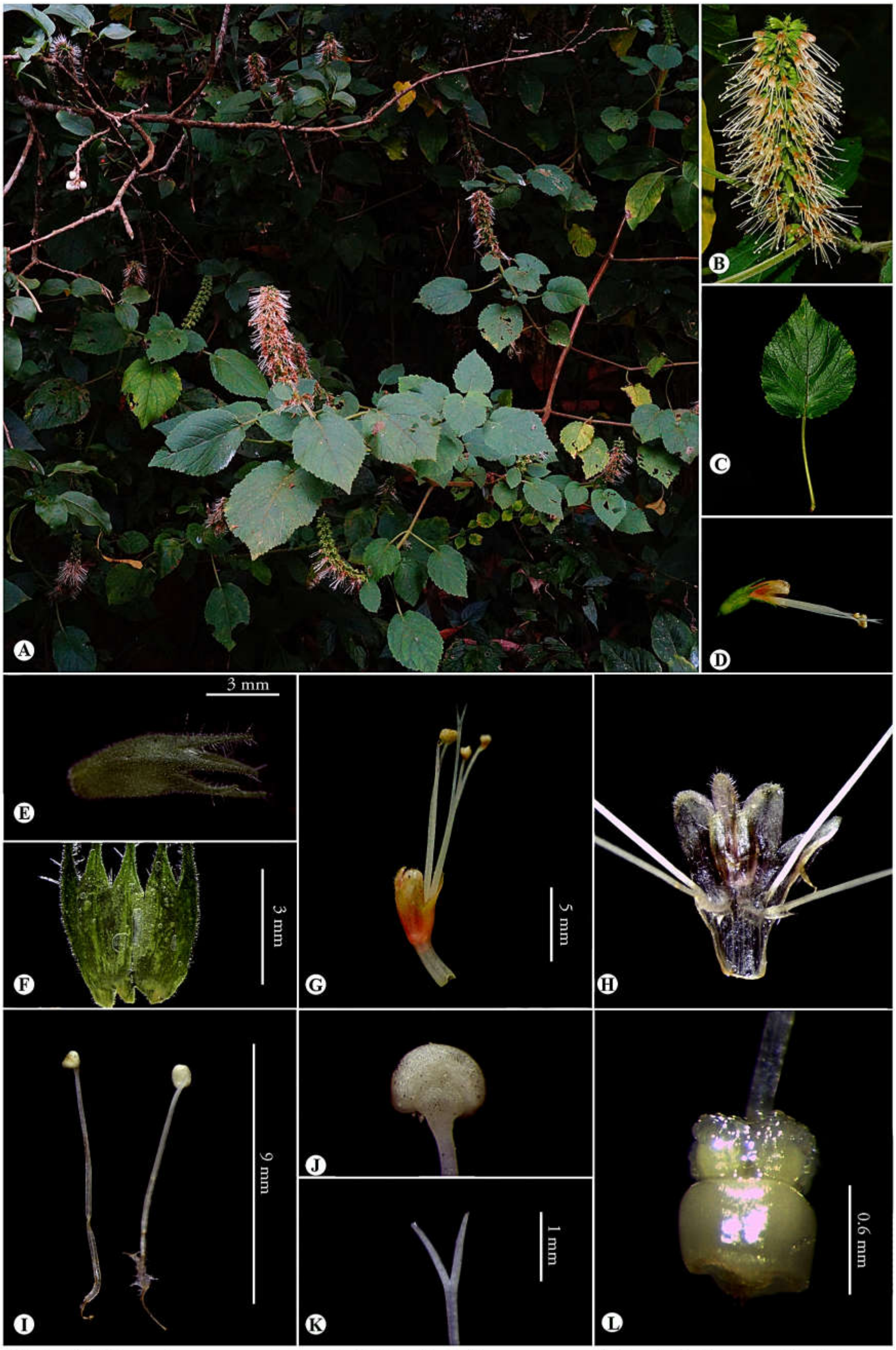


Plate 43. *Pogostemon speciosus.* A. Habit; B. Inflorescence; C. Leaf; D. Flower; E. Calyx; F. Calyx opened; G. Corolla; H. Corolla opened; I. Stamens; J. Anther; K. Stigma; L. Ovary.

Plate 44. Lectotype of *Pogostemon speciosus* (P 00737563, "Reproduced by the permission of Museum of Natuaral Histoire Naturelle, Paris").

Plate 45. *Pogostemon travancoricus.* A. Habit; B-C. Inflorescence; D. Flower; E. Calyx; F. Calyx opened; G. Corolla; H. Corolla opened; I. Stamens; J. Anther; K. Stigma; L. Ovary; M. Nutlets.

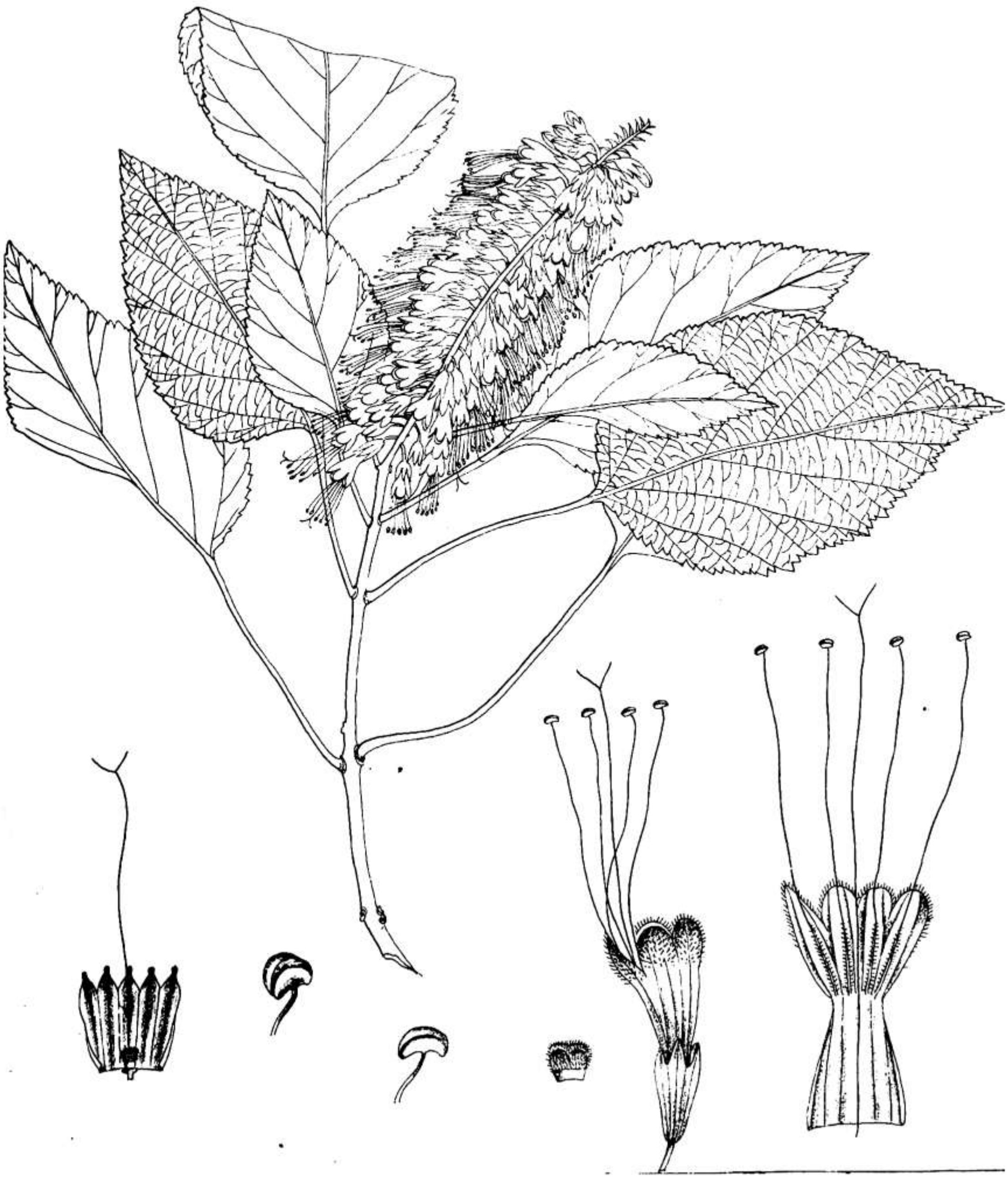


Plate 46. Type–an illustration of *Pogostemon travancoricus* (Icones Plantarum Indiae, PlateCLIX).

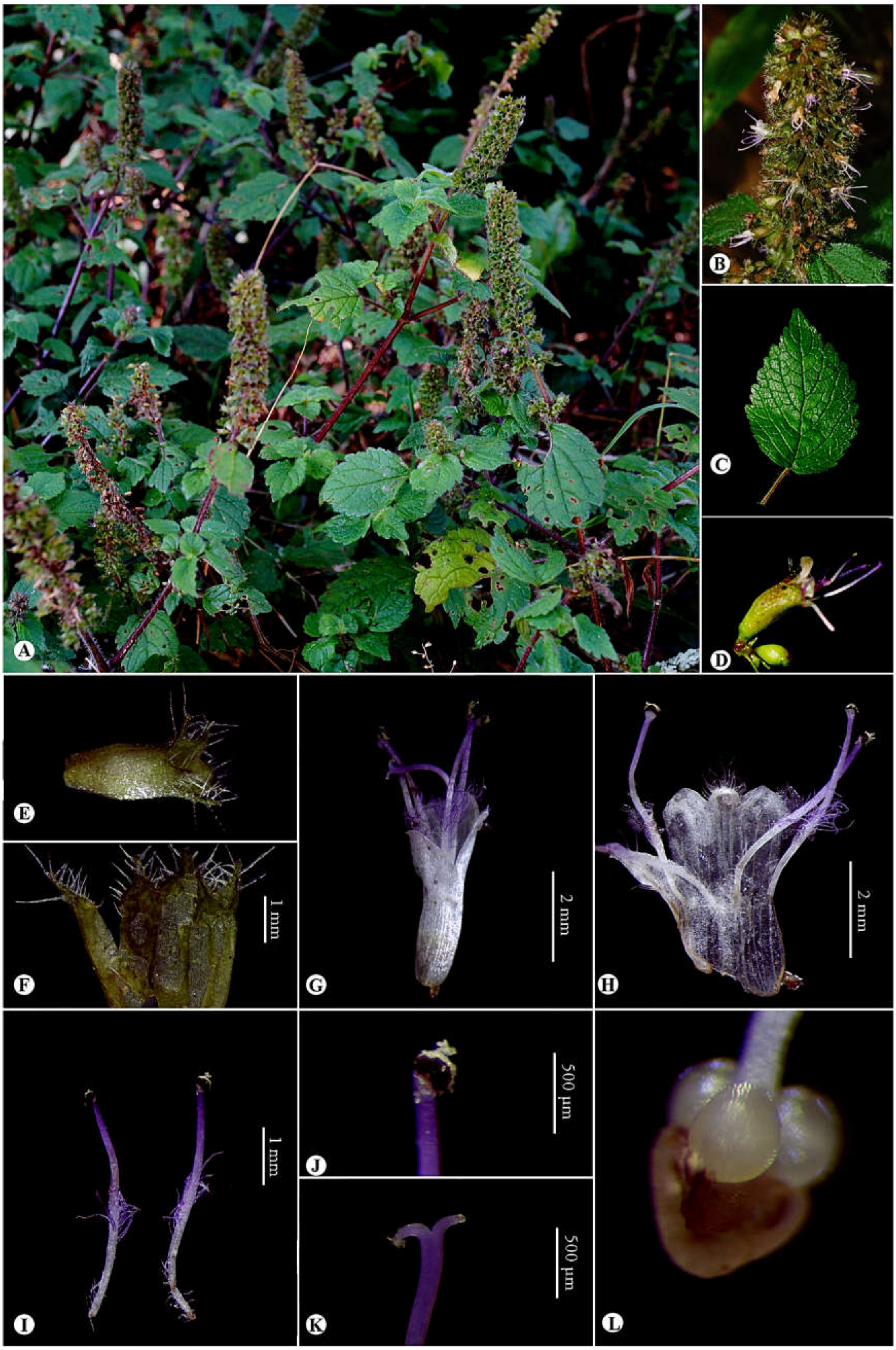


Plate 47. *Pogostemon wightii.* A. Habit; B. Inflorescence; C. Leaf; D. Flower; E. Calyx; F. Calyx opened; G. Corolla; H. Corolla opened; I. Stamens; J. Anther; K. Stigma; L. Ovary.

Plate 48. Holotype of *Pogostemon wightii* (P00737571, "Reproduced by the permission of Museum of Natuaral Histoire Naturelle, Paris").

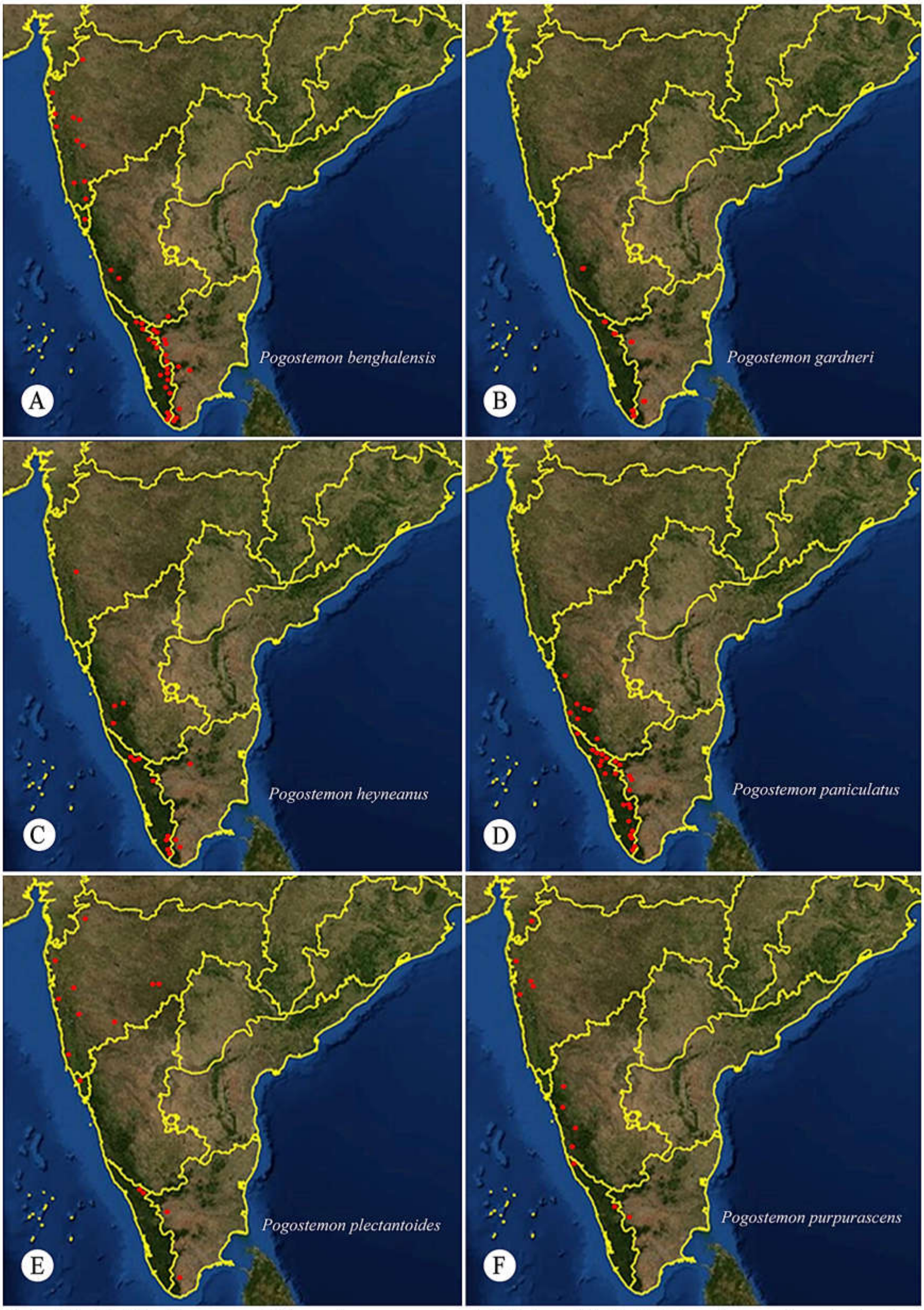


Plate 49. Distribution map of *Pogostemon* species in Western Ghats A. *Pogostemon benghalensis*; B. *P. gardneri*; C. *P. heyneanus*; D. *P. paniculatus*; E. *P. plectrantoides*; F. *P. purpurescens*.

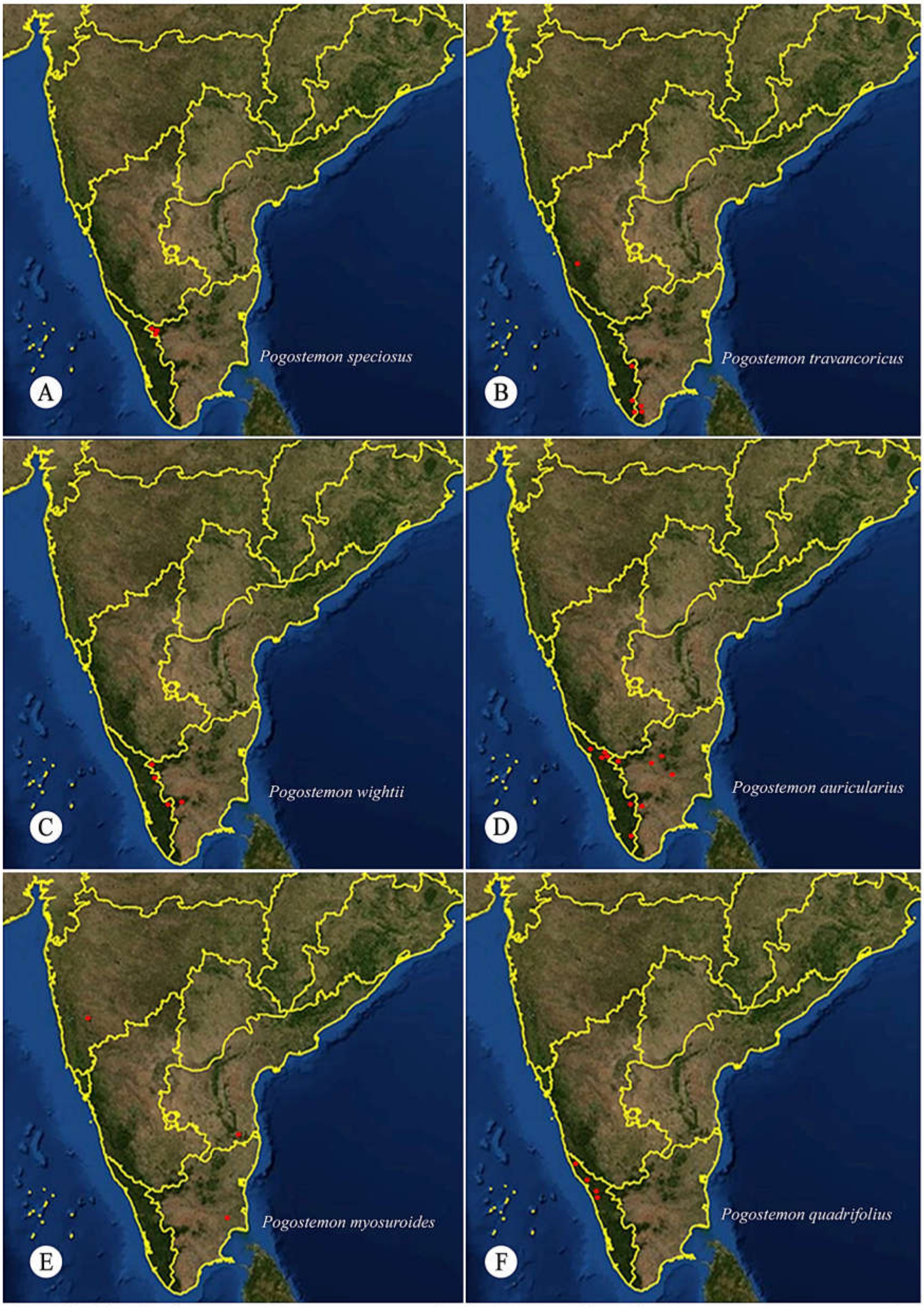


Plate 50. Distribution map of *Pogostemon* species in Western Ghats A. *Pogostemon speciosus*; B. *P. travancoricus*; C. *P. wightii*; D. *P. auricularius*; E. *P. myosuroides*; F. *P. quadrifolius*.

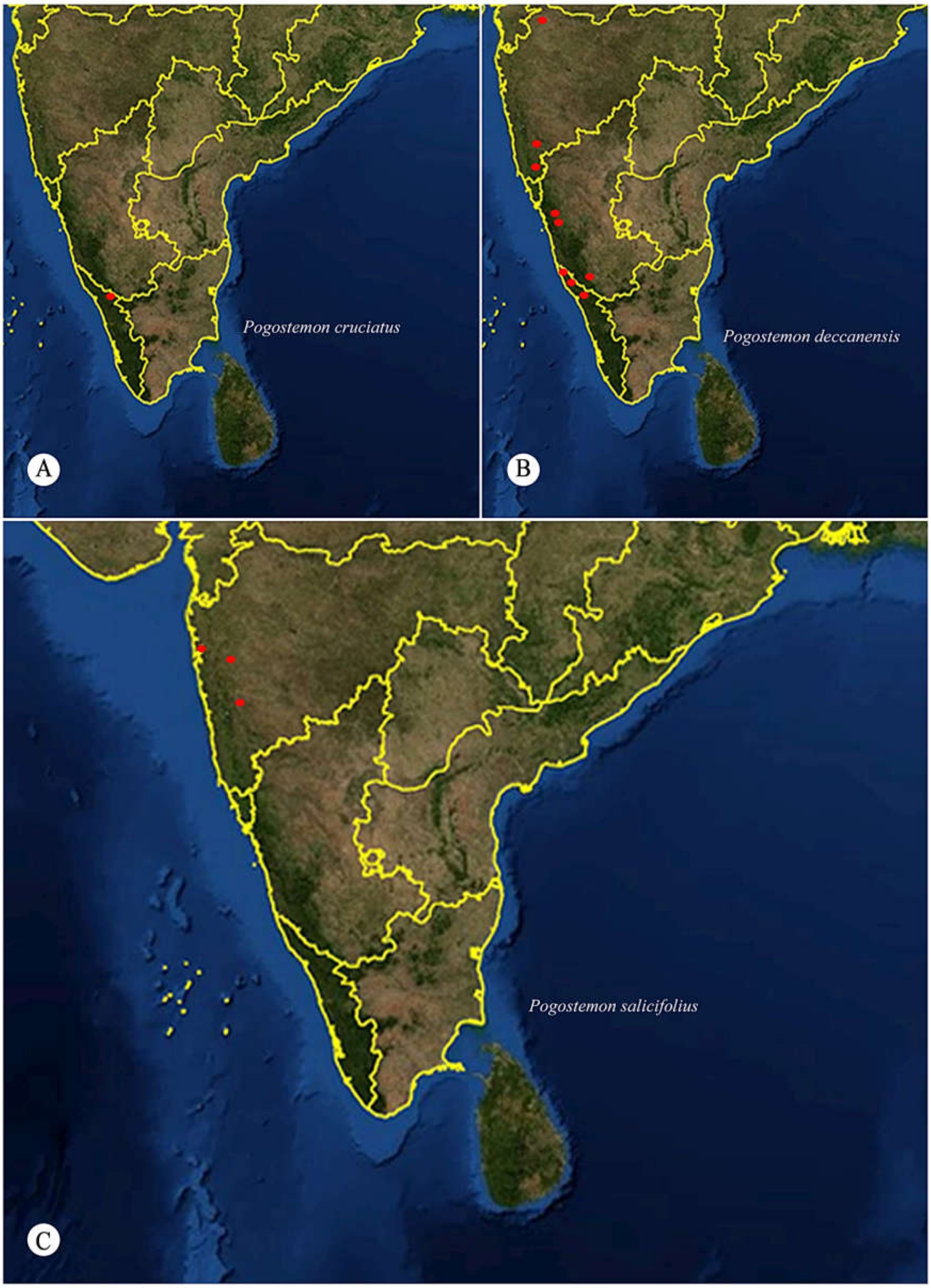


Plate 51. Distribution map of *Pogostemon* species in Western Ghats A. *Pogostemon cruciatus*; B. *P. deccanensis*; C. *P. salicifolius*.

Plate 33 . *Pogostemon peethapushpum*. A. Habit; B. Inflorescence; C. Flower; D. Bracteoles; E. Calyx; F. Calyx opened; G. Corolla; H. Ovary with disc; I. Stamens; J. Anther; K. Stigma; L. Nutlets.

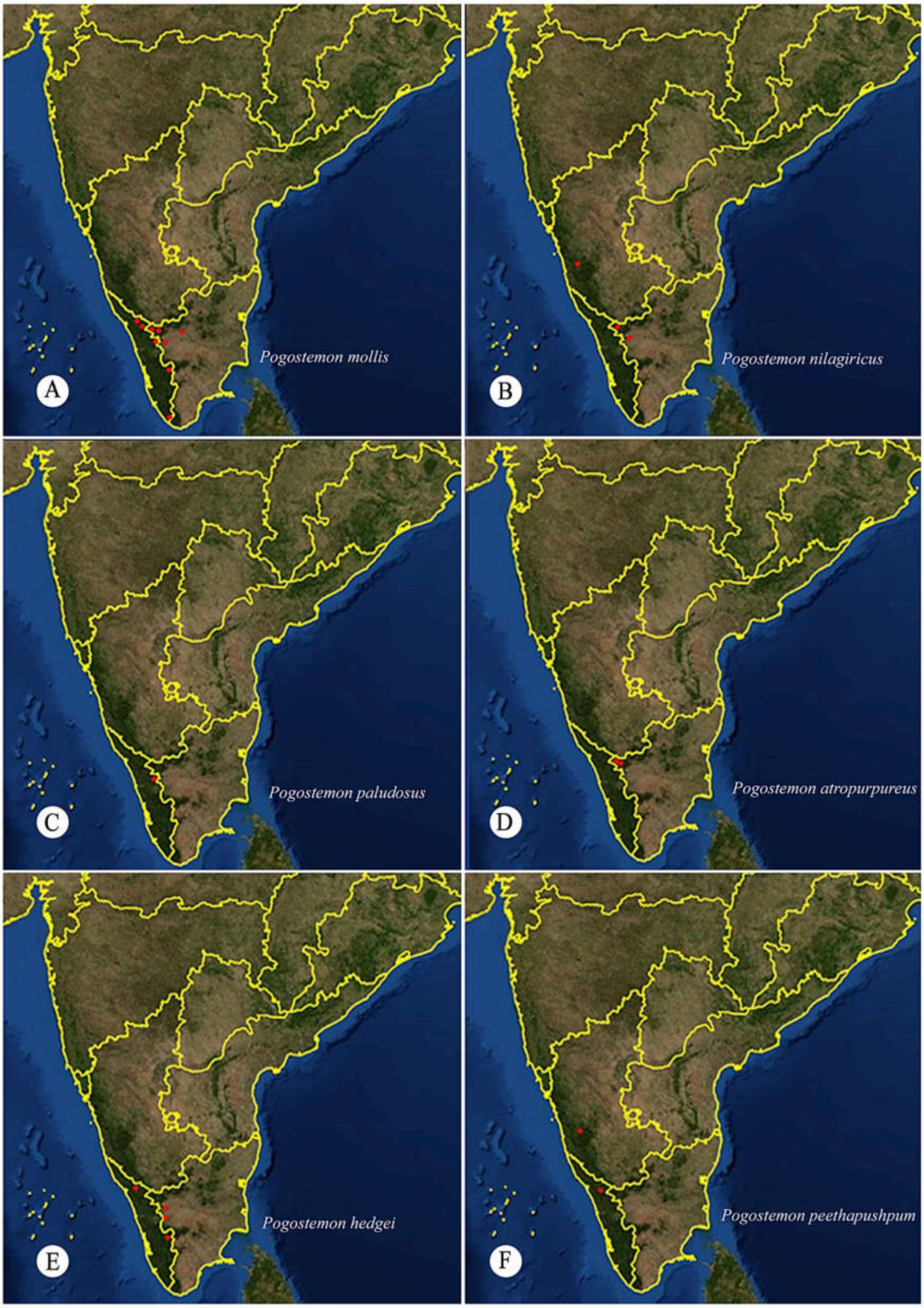


Plate 52. Distribution map of *Pogostemon* species in Western Ghats A. *Pogostemon mollis*; B. *P. nilagiricus*; C. *P. paludosus*; D. *P. atropurpureus*; E. *P. hedgei*; F. *P. peethapushpam*.

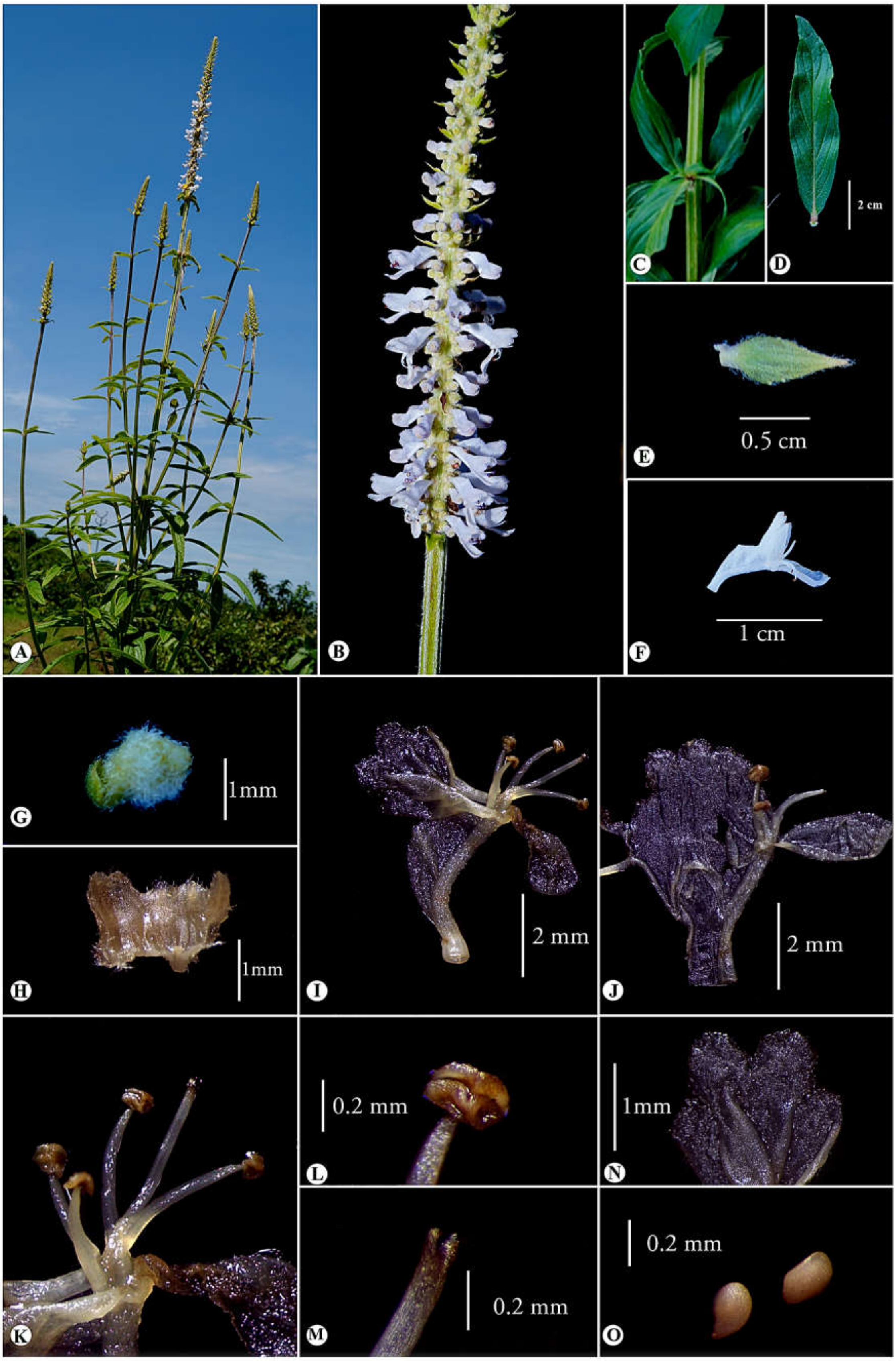


Plate 53. *Anisochilus adenanthus* A. Habit; B. Inflorescence; C. Node; D. Leaf; E. Bracteole; F. Corolla; G. Calyx; H. Calyx opened; I. Corolla; J. Corolla opened; K. Stamen; L. Anther; M. Stigma; N. Corolla upper lip; O. Nutlets.

Plate 54. Holotype of *Anisochilus adenanthus* (K000674763, "Reproduced by the permission of the board of trustees of Royal Botanical Gardens, Kew").

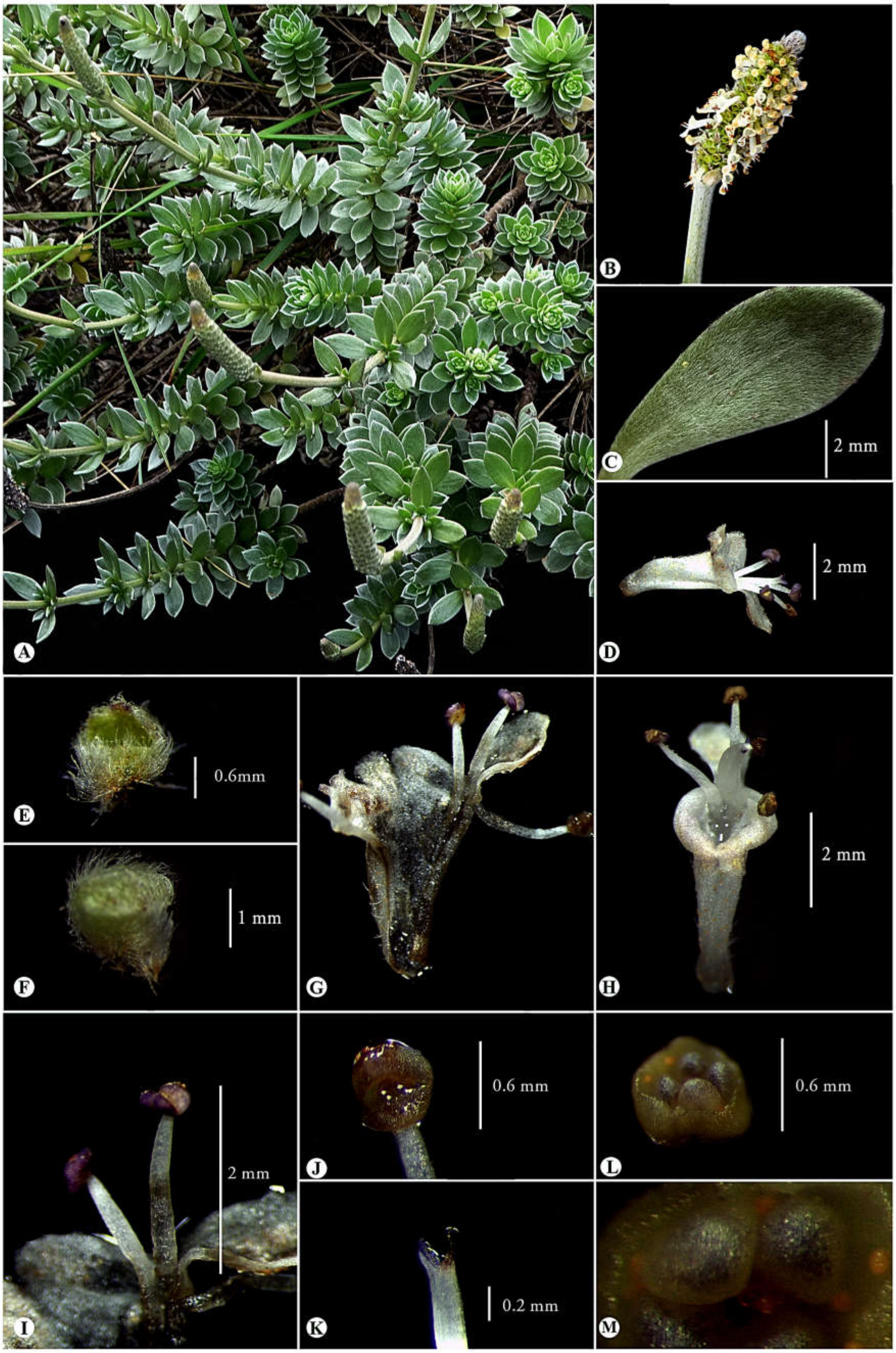


Plate 55. *Anisochilus argenteus.* **A.** Habit; **B.** Inflorescence; **C.** Leaf; **D.** Flower; **E-F** Calyx; **G.** Corolla opened; **H.** Corolla; **I.** Stamen; **J.** Anther; **K.** Stigma; **L.** Ovary with disc; **M.** Nutlets.

Plate 56. Lectotype of *Anisochilus argenteus* (K000674753, "Reproduced by the permission of the board of trustees of Royal Botanical Gardens, Kew").

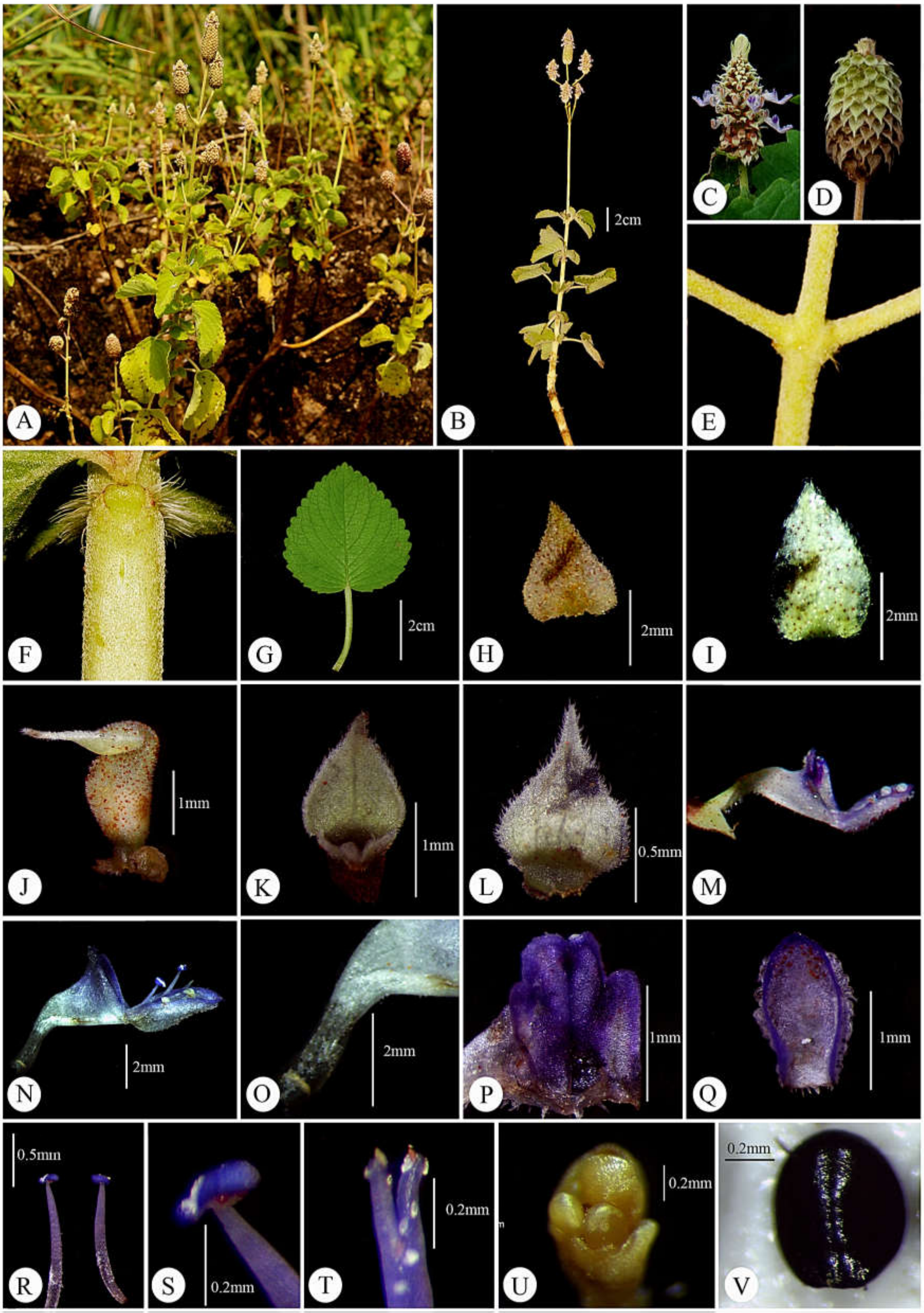


Plate 57. *Anisochilus carnosus* A-B. Habit; C-D. Inflorescence; E. Peduncle; F. Stem with node possessing interpetiolar hairs; G. Leaf; H. Bract; I. Bracteole; J-K. Calyx; L. Calyx upper teeth; M. Flower; N. Corolla; O. Corolla tube base; P. Corolla upperlip; Q. Corolla lowerlip; R. Stamen; S. Anther; T. Stigma; U. Ovary; V. Seed.

Plate 58. Holotype of *Anisochilus carnosus* (C10012982, "Reproduced by the permission of the National History Muceum, Denmark").

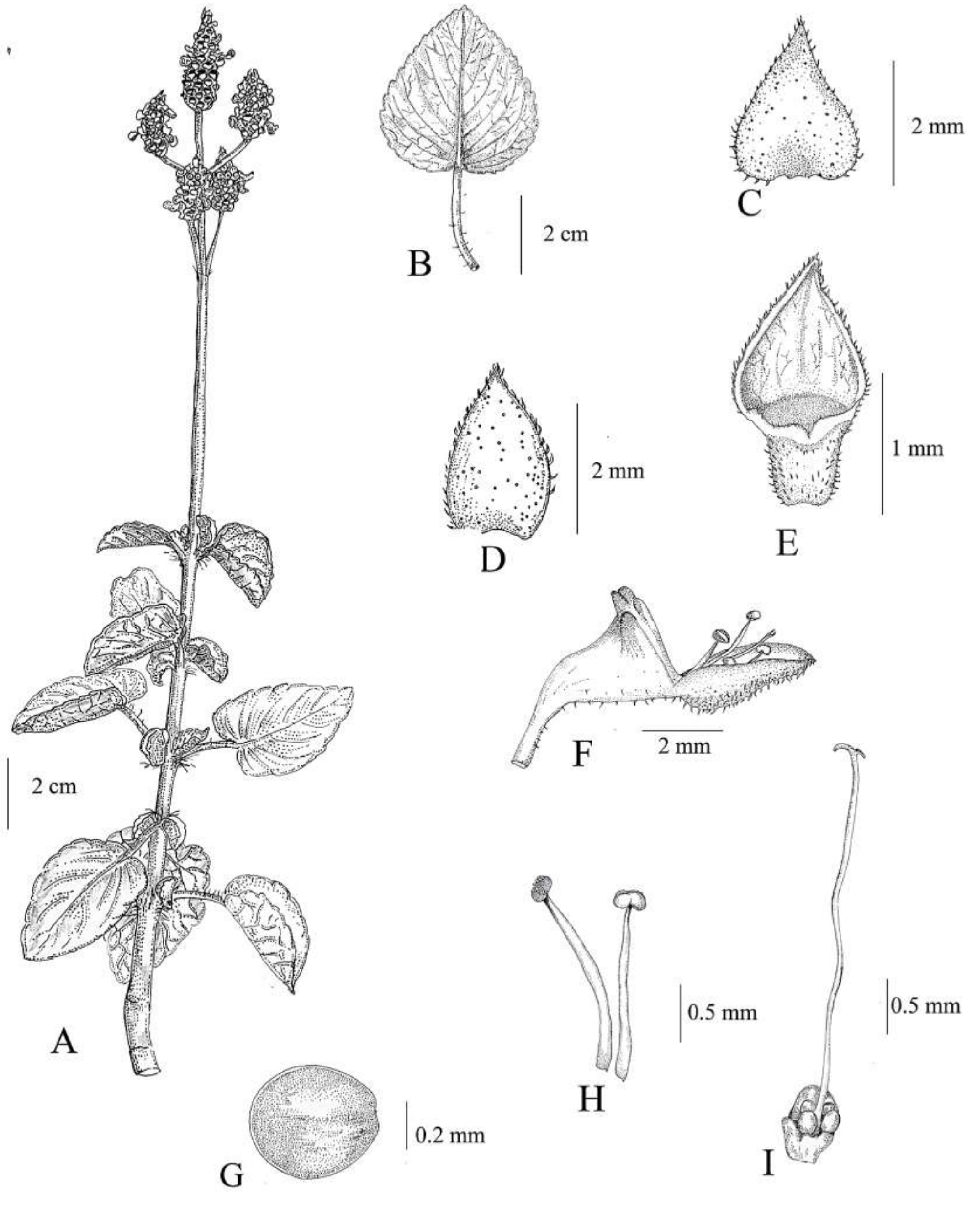


Plate 59. Illustration of *Anisochilus carnosus* A. Habit; B. Leaf; C. Bract; D. Bracteole; E. Calyx; F. Corolla; G. Seed; H. Stamen; I. Gynoecium.

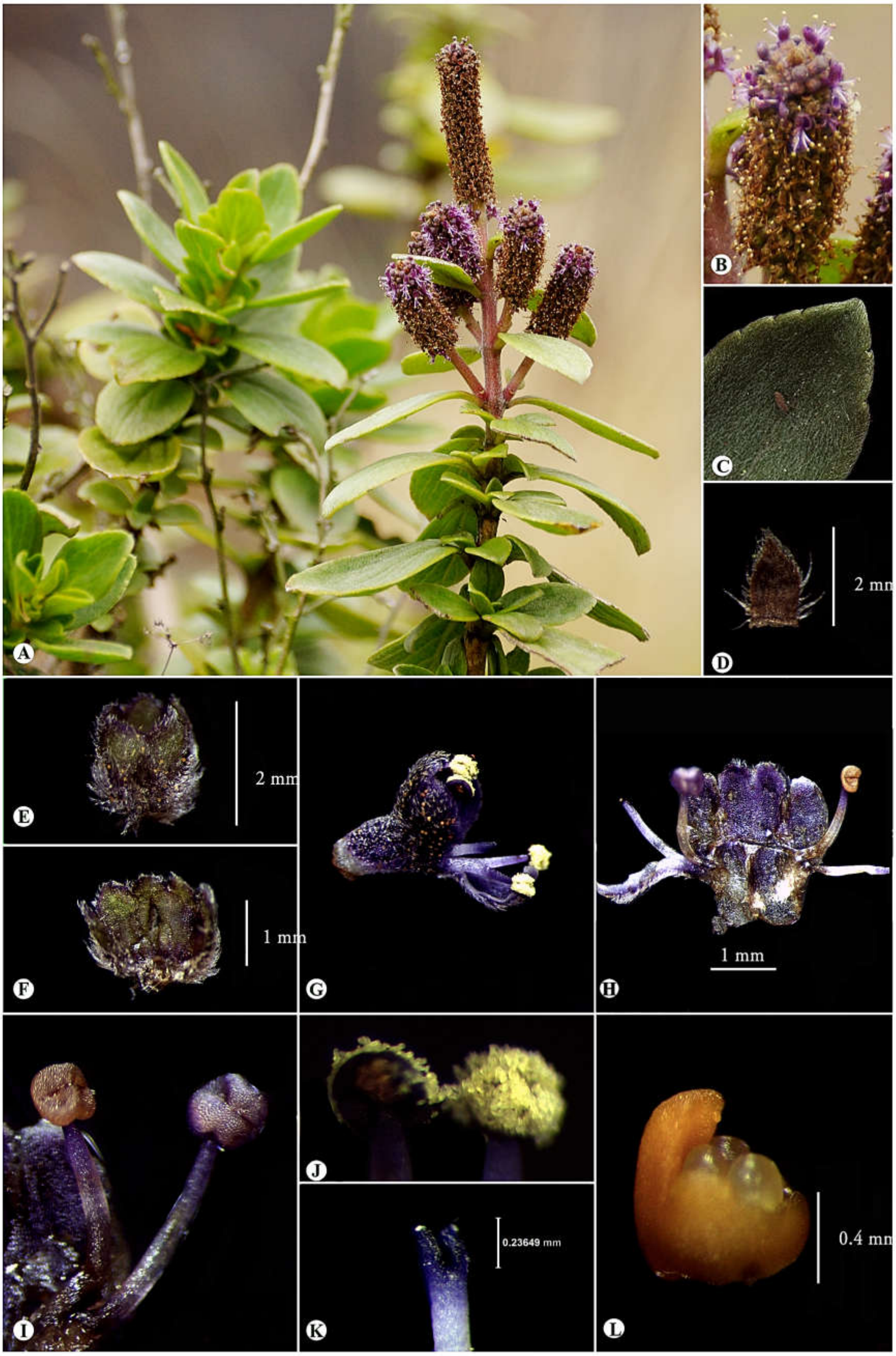


Plate 60. *Anisochilus dysophylloides.* **A.** Habit; **B.** Inflorescence; **C.** Leaf; **D.** Bract; **E-F** Calyx; **G.** Corolla; **H.** Corolla opened; **I.** Stamen; **J.** Anther; **K.** Stigma; **L.** Ovary with disc.

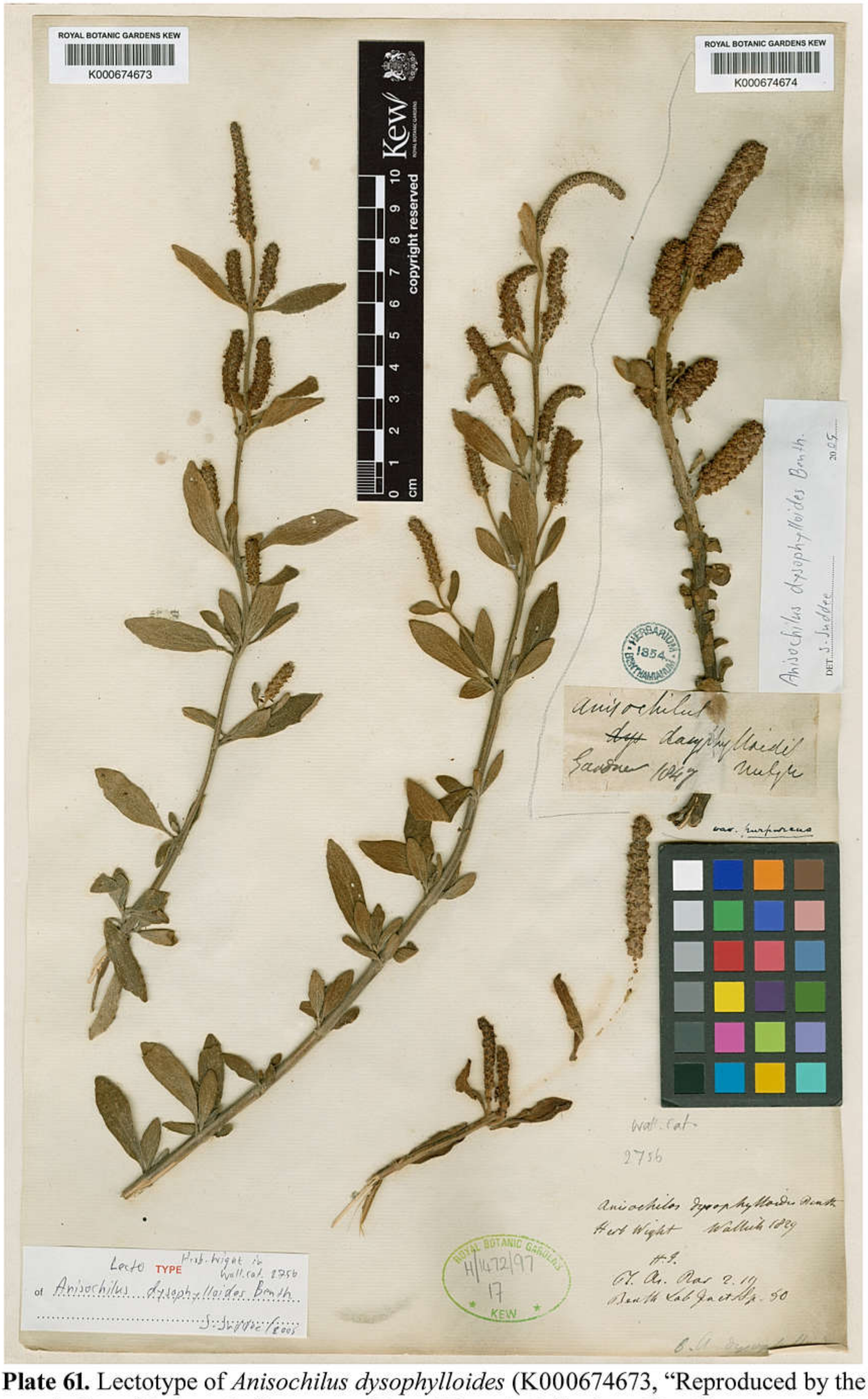


Plate 61. Lectotype of *Anisochilus dysophylloides* (K000674673, "Reproduced by the permission of theboard of trustees of Royal Botanical Gardens, Kew").

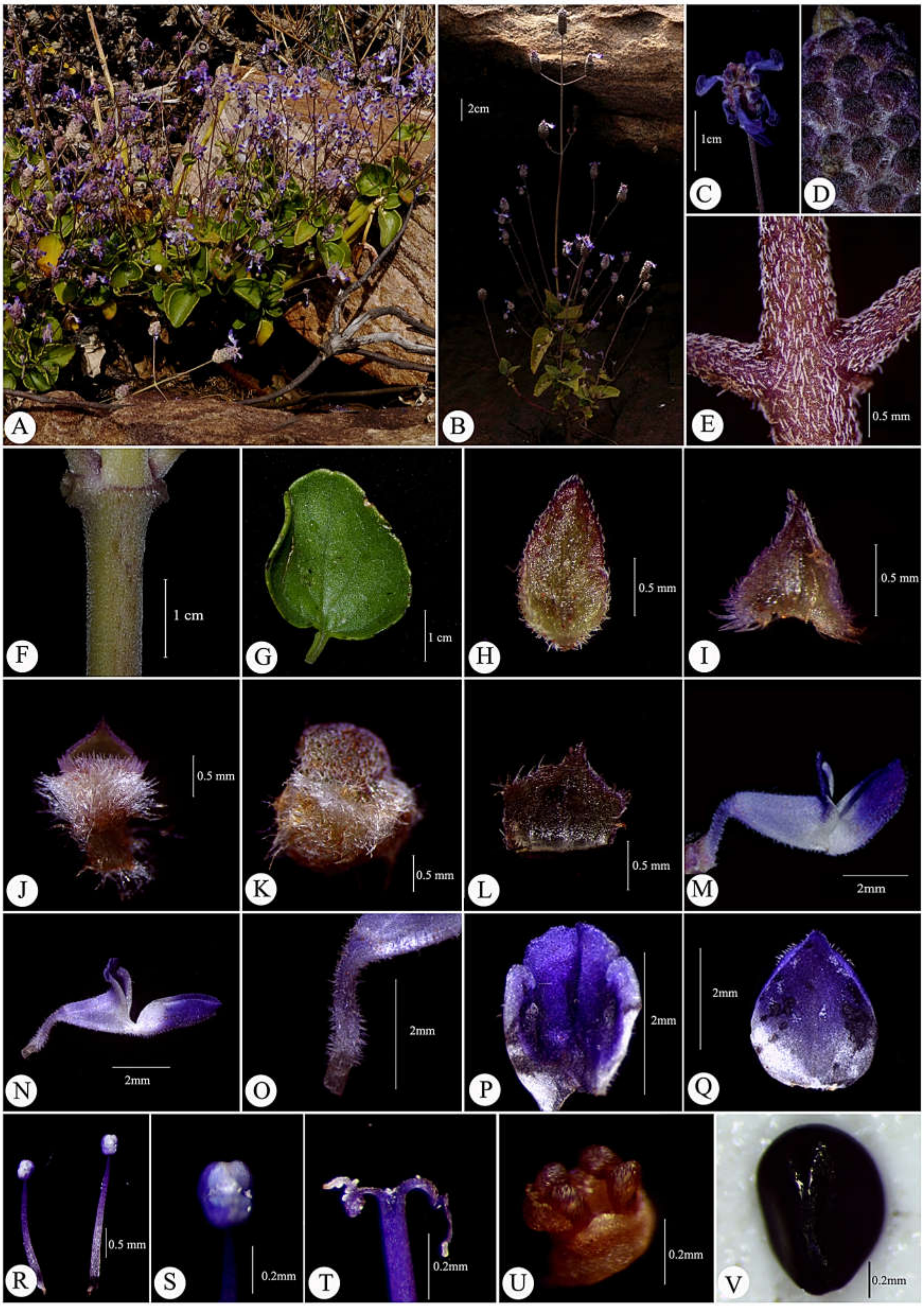


Plate 62. *Anisochilus eriocephalus* A-B. Habit; C-D. Inflorescence; E. Peduncle; F. Stem with node possessing interpetiolar hairs; G. Leaf; H. Bract; I. Bracteole; J-K. Calyx; L. Calyx upper teeth; M. Flower; N. Corolla; O. Corolla tube base; P. Corolla upperlip; Q. Corolla lowerlip; R. Stamen; S. Anther; T. Stigma; U. Ovary; V. Seed.

Plate 63. Lectotype of *Anisochilus eriocephalus* (K000674678, "Reproduced by the permission of the board of trustees of Royal Botanical Gardens, Kew").

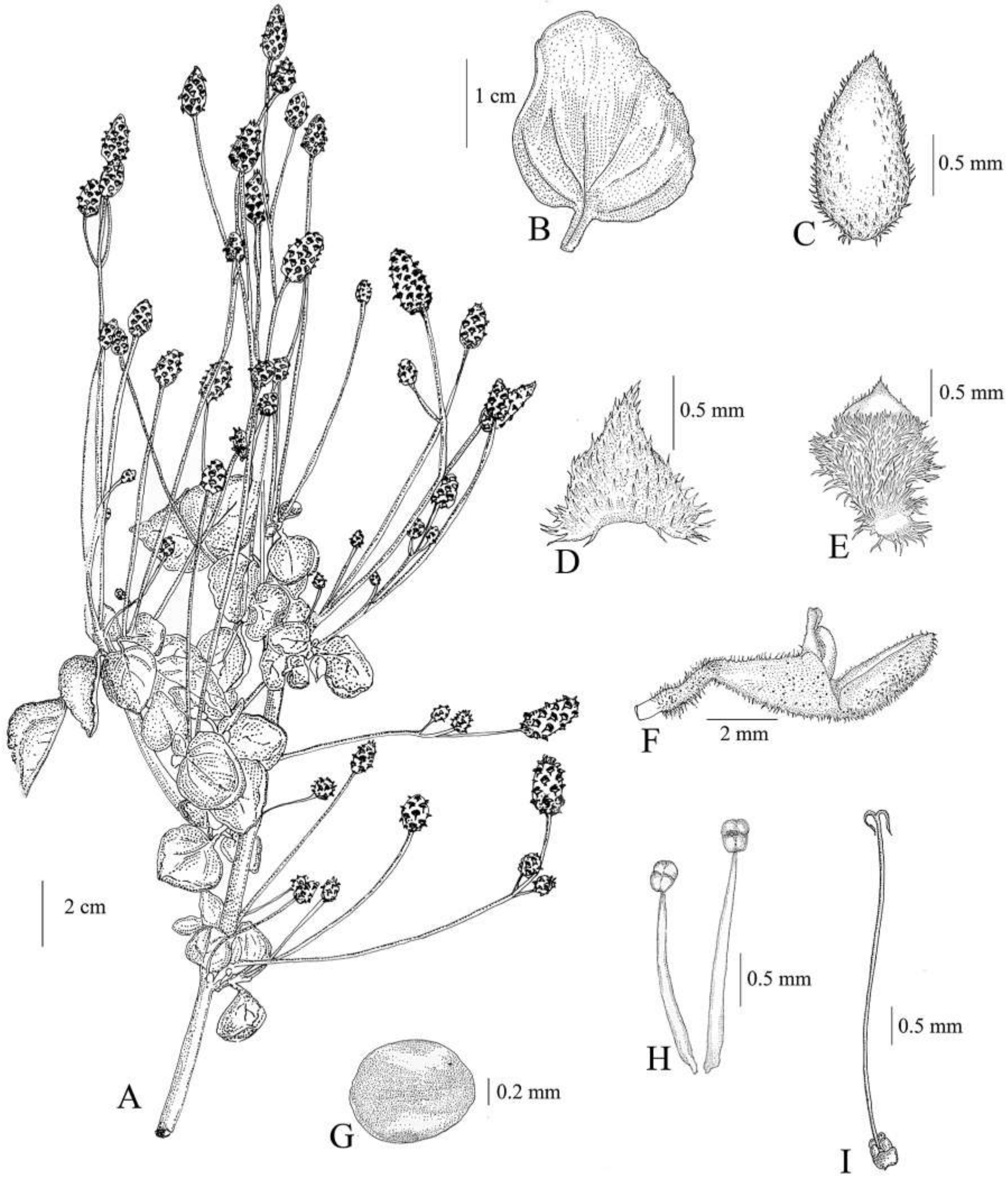


Plate 64. *Anisochilus eriocephalus* A. Habit; B. Leaf; C. Bract; D. Bracteole; E. Calyx; F. Corolla; G. Seed; H. Stamen; I. Gynoecium.

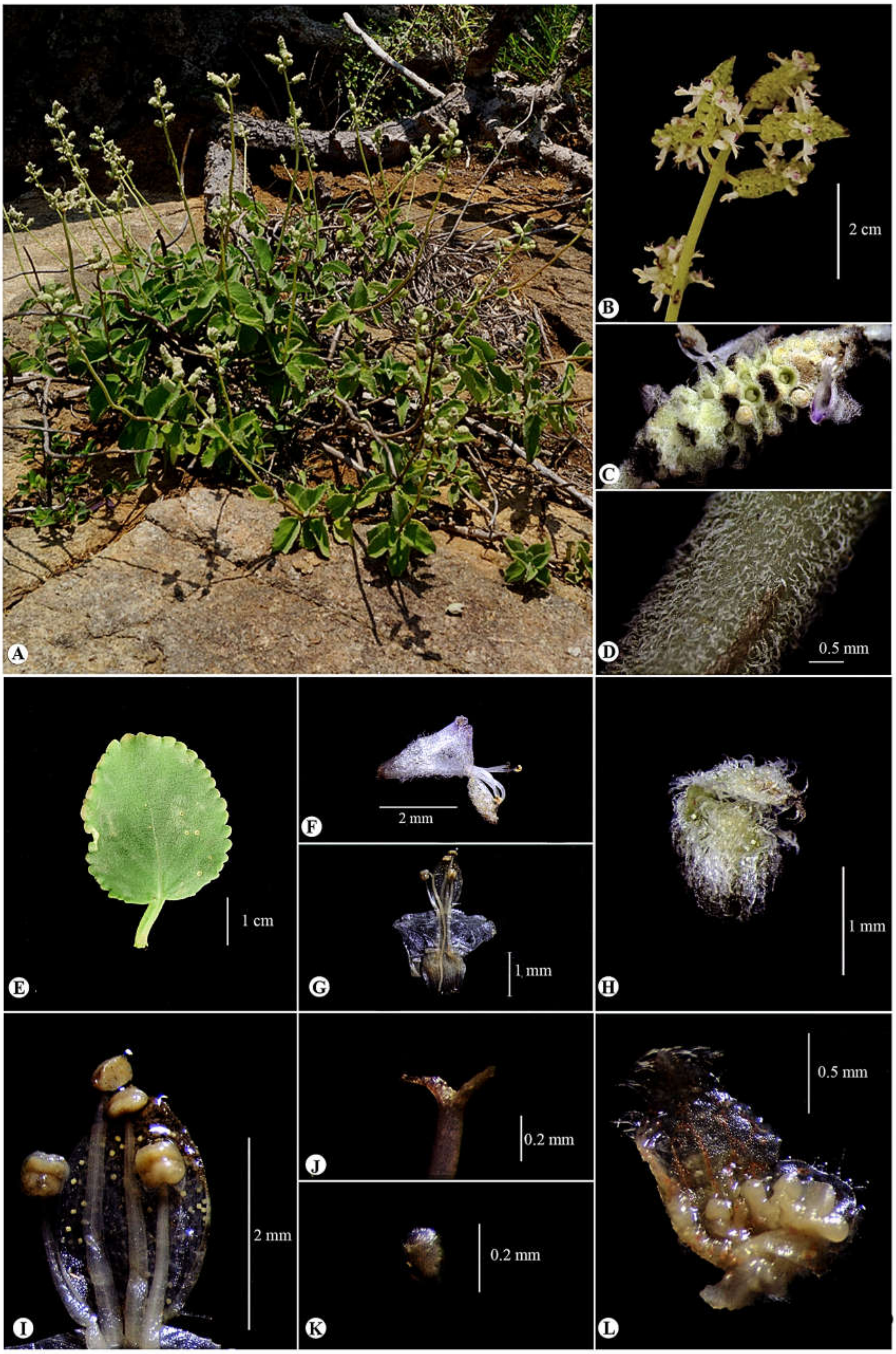


Plate 65. *Anisochilus kanyakumariensis* A, Habit; B. Inflorescence; C. Single congested spike; D. Stem; E. Leaf; F. Corolla; G. Corolla opened; H. Calyx; I. Stamens; J. Stigma; K. Nutlet; L. Calyx Opened.

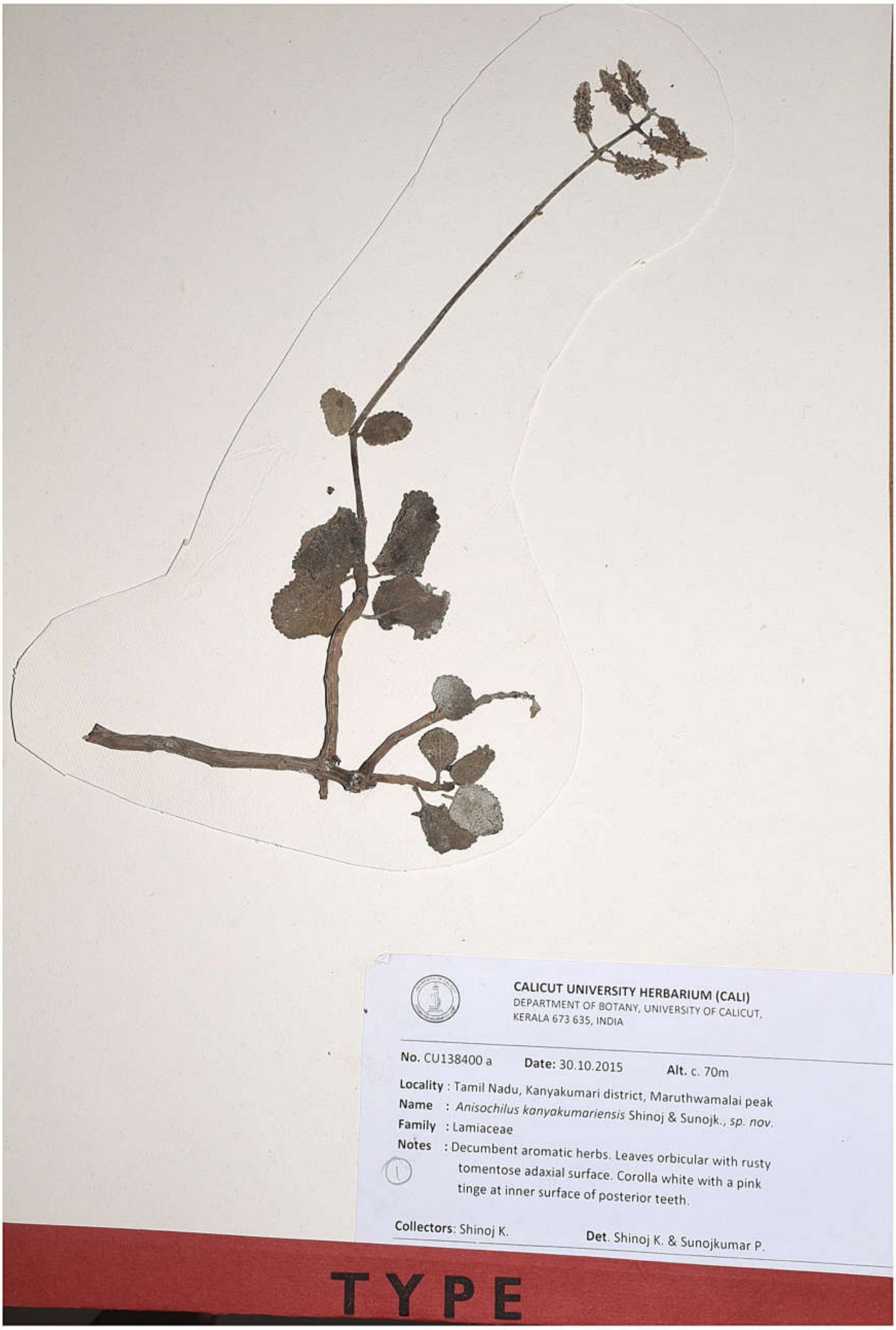


Plate 66. Holotype of *Anisochilus kanyakumariensis* (CU138400 a, CALI).

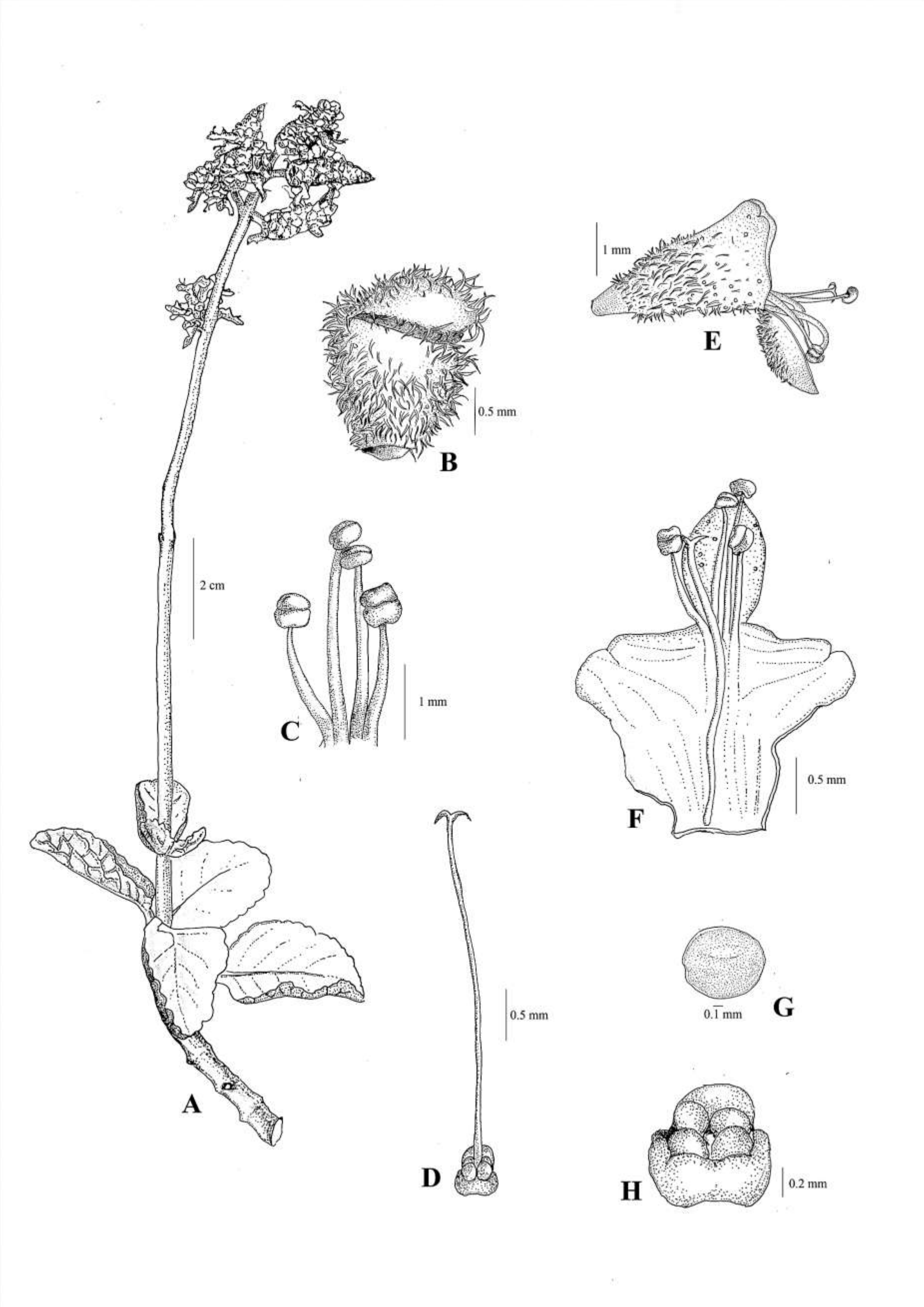


Plate 67. Illustration of *Anisochilus kanyakumariensis* A. Habit; B. Calyx; C. Corolla; D. Corolla opened; E. Stamen; F. Gynoecium; G. Ovary; H. Nutlets.

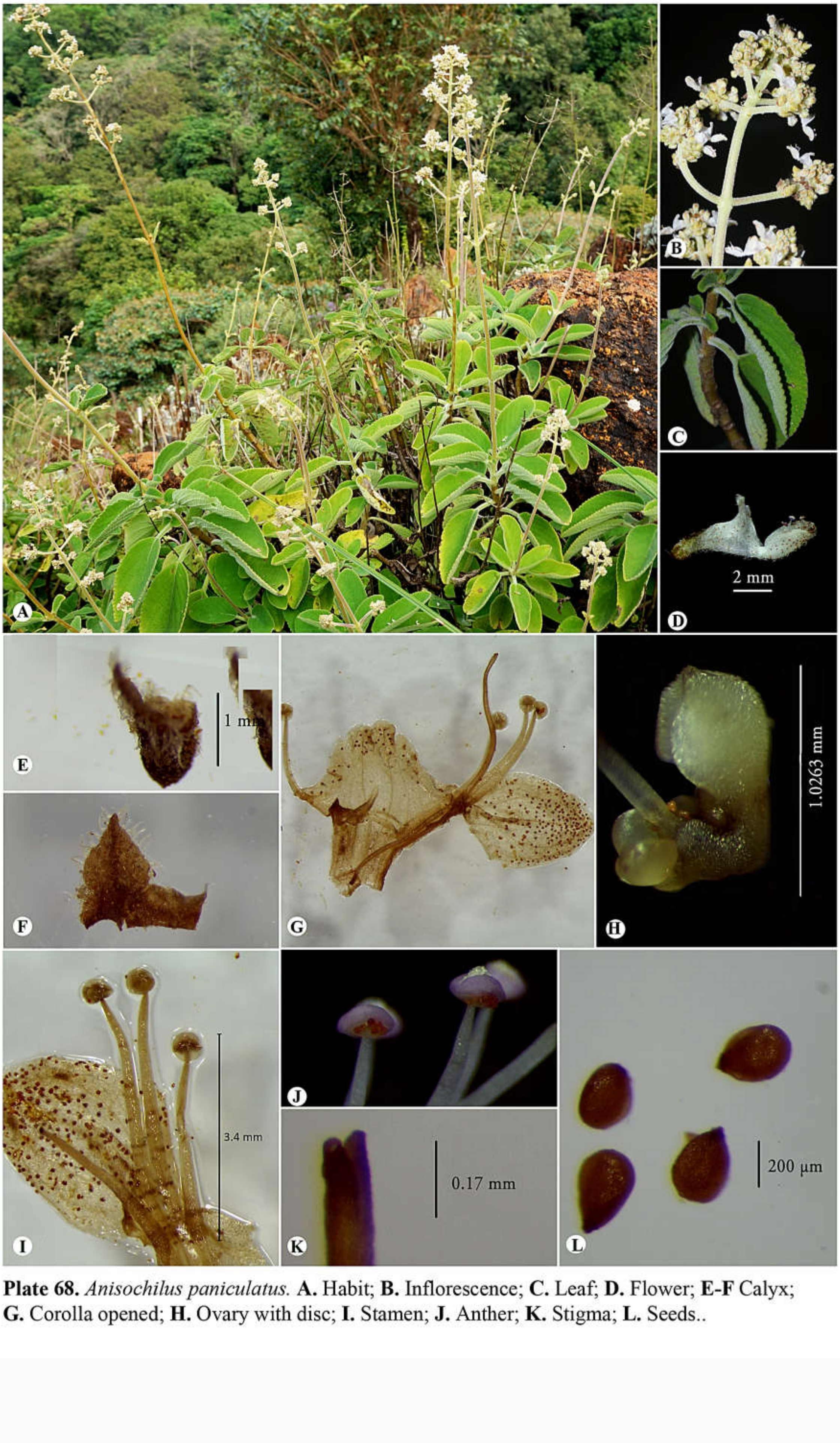


Plate 68. *Anisochilus paniculatus.* **A.** Habit; **B.** Inflorescence; **C.** Leaf; **D.** Flower; **E-F** Calyx; **G.** Corolla opened; **H.** Ovary with disc; **I.** Stamen; **J.** Anther; **K.** Stigma; **L.** Seeds..

Plate 69. *Anisochilus paniculatus* (K000674751, "Reproduced by the permission of the board of trustees of Royal Botanical Gardens, Kew").

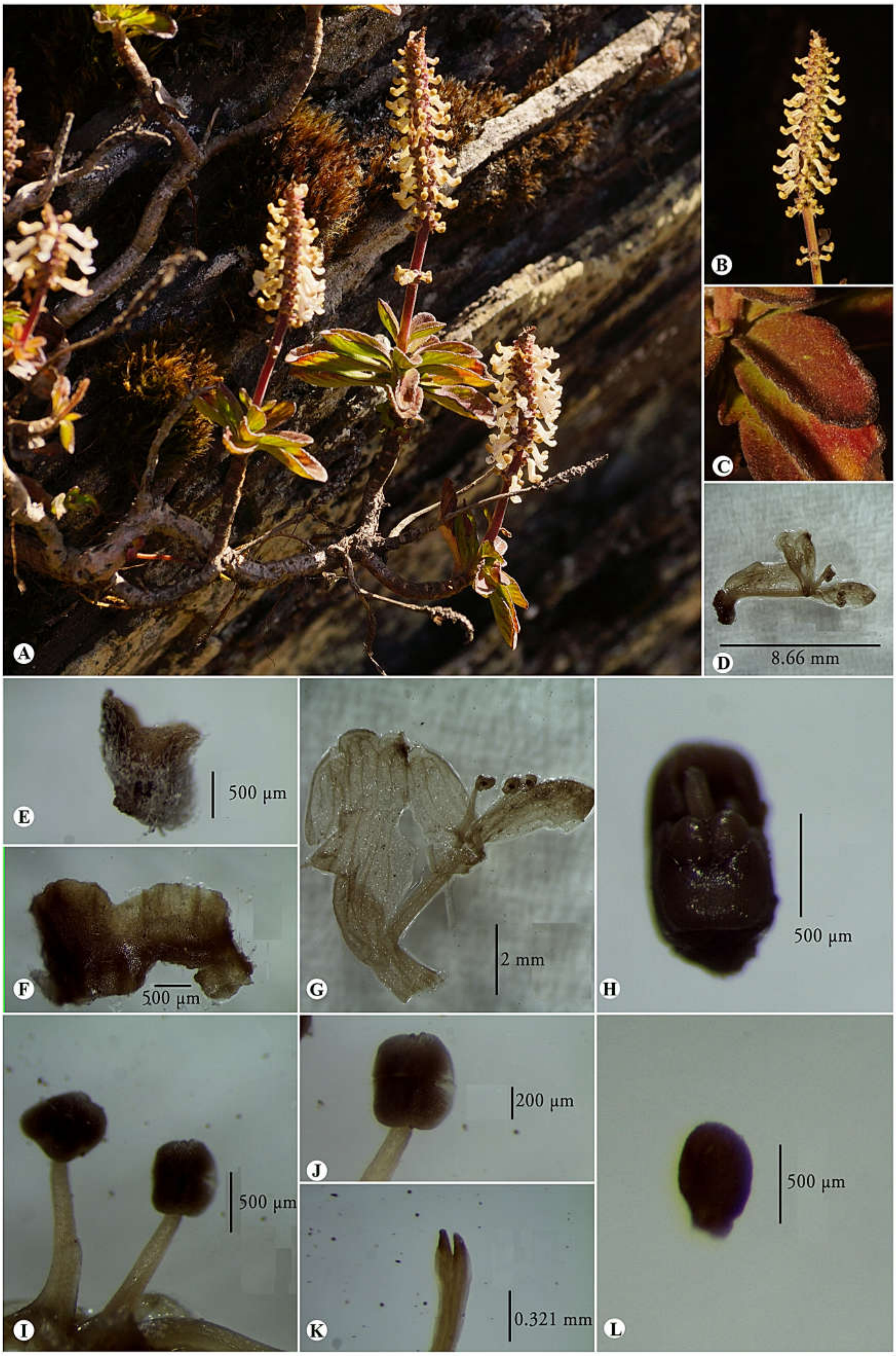


Plate 70. *Anisochilus plantagineus* A. Habit; B. Inflorescence; C. Leaf; D. Flower; E. Calyx; F. Calyx opened; G. Corolla opened; H. Ovary; I. Stamen; J. Anther; K. Stigma; L. Nutlet.

Plate 71. Lectotype of *Anisochilus plantagineus* (K000674770, "Reproduced by the permission of the board of trustees of Royal Botanical Gardens, Kew").

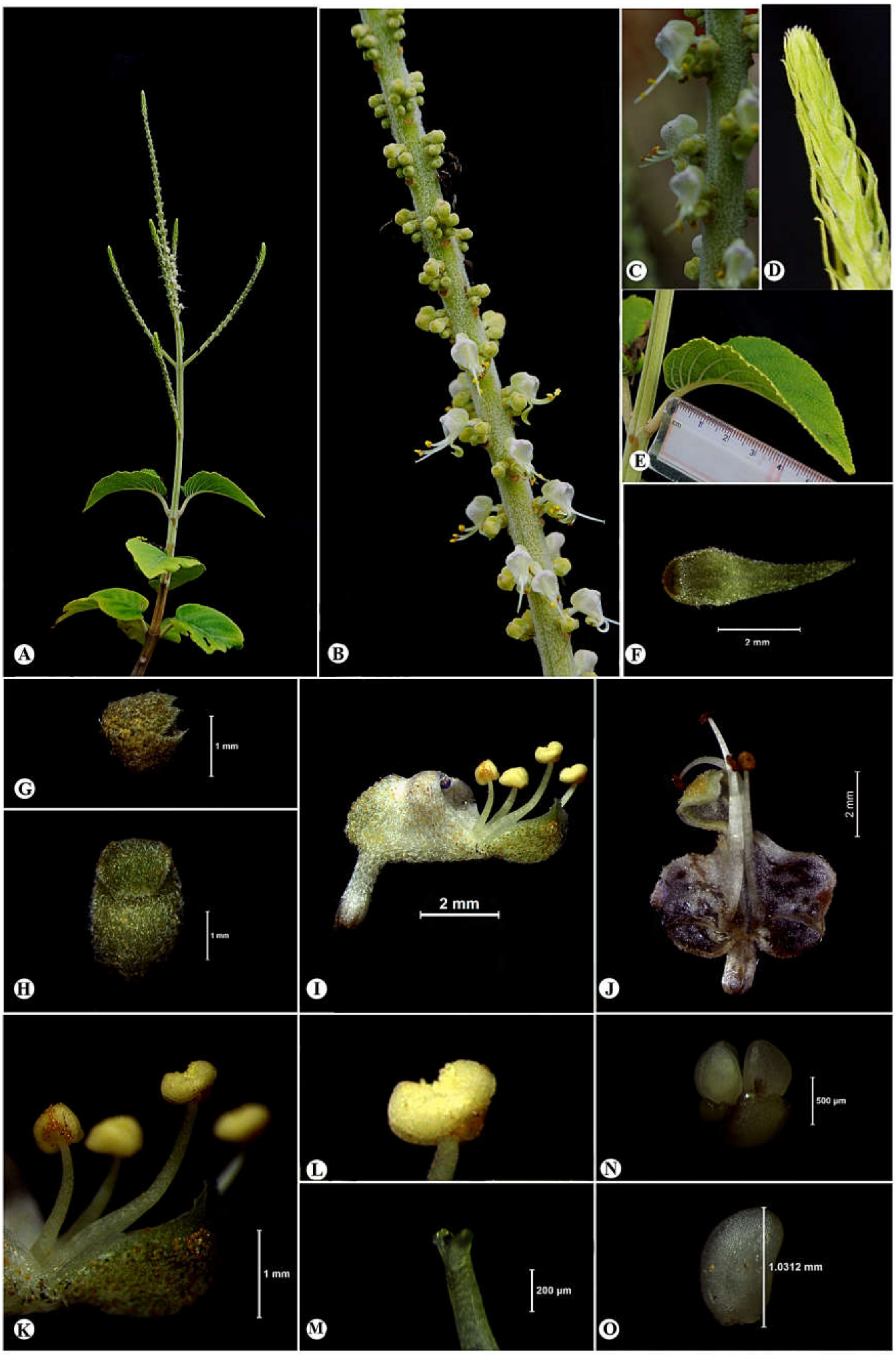


Plate 72. *Anisochilus robustus* A. Habit; B-D. Inflorescence; E. Leaf; F. Bracteole; G-H. Calyx; I. Corolla; J. Corolla opened; K. Stamens; L. Anther; M. Stigma; N. Ovary; O. Nutlets.

Plate 73. Holotype of *Anisochilus robustus* (K000674766, "Reproduced by the permission of the board of trustees of Royal Botanical Gardens, Kew").

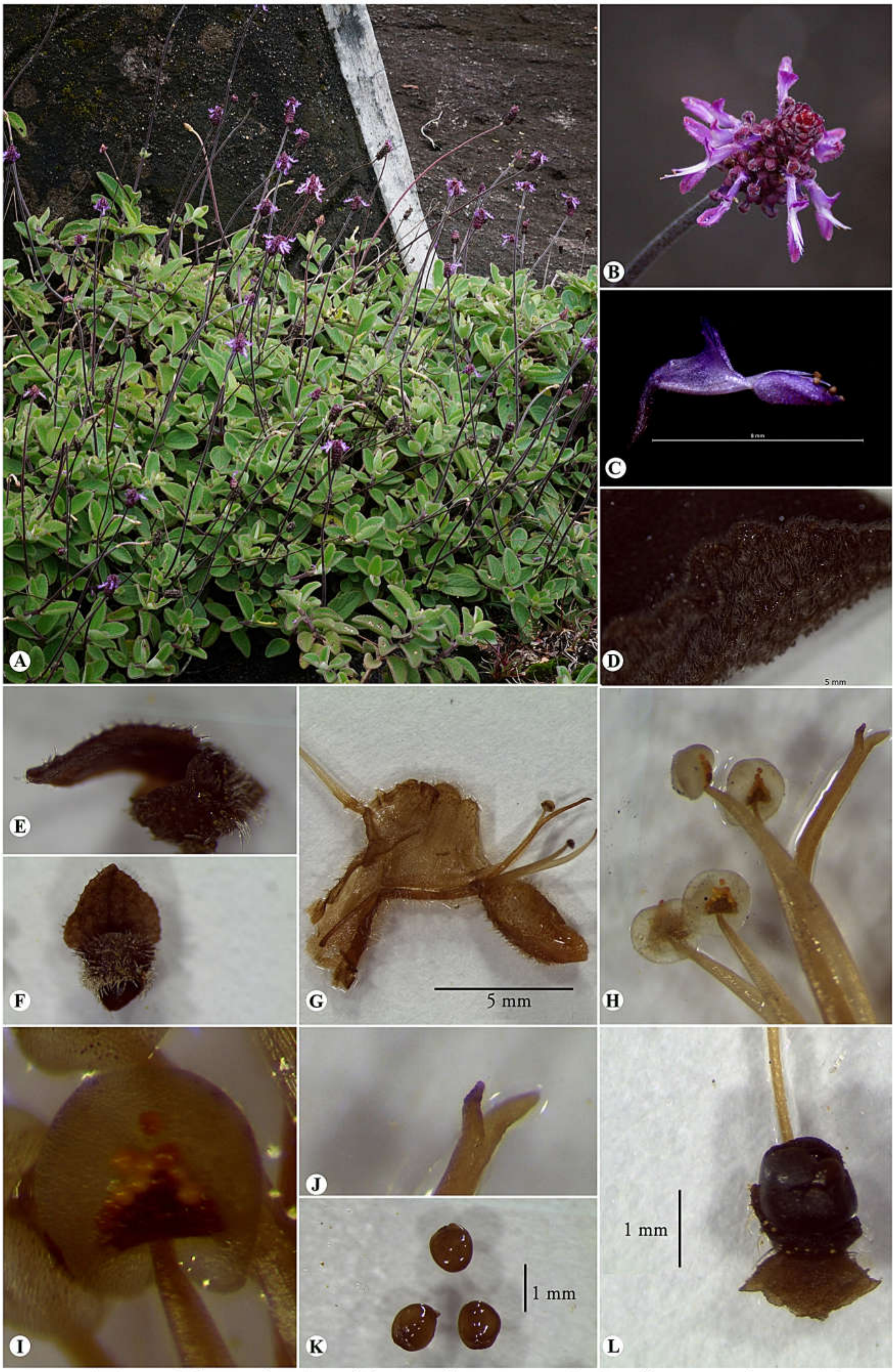


Plate 74. *Anisochilus scaber* A. Habit; B. Inflorescence; C. Corolla; D. Leaf; E-F. Calyx; G. Corolla opened; H. Stamens; I. Anther; J. Stigma; K. Nutlets; L. Ovary

Plate 75. Isotype of *Anisochilus scaber* (K000674681, "Reproduced by the permission of the board of trustees of Royal Botanical Gardens, Kew").

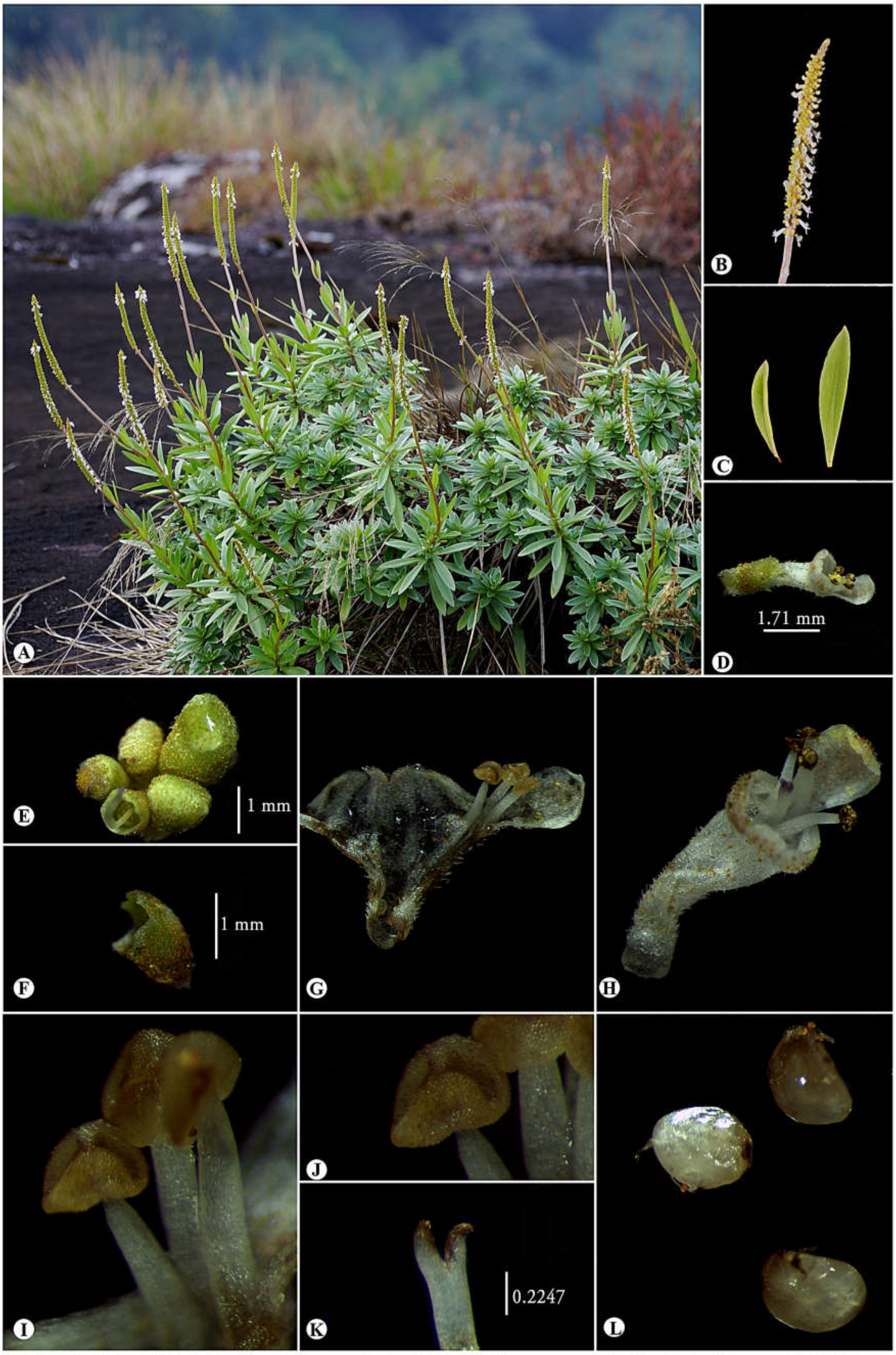


Plate 76. *Anisochilus shoolamudianus.* **A.** Habit; **B.** Inflorescence; **C.** Leaf; **D.** Flower; **E-F** Calyx; **G.** Corolla opened; **H.** Corolla; **I.** Stamen; **J.** Anther; **K.** Stigma; **L.** Nutlets.

Plate 77. Holotype of *Anisochilus suffruticosus* (K000674769, "Reproduced by the permission of the board of trustees of Royal Botanical Gardens, Kew").

Plate 78. *Anisochilus wightii* **A.** Habit; **B.** Inflorescence; **C.** Flower; **D.** Corolla; **E.** Calyx; **F.** Calyx opened; **G.** Corolla opened; **H.** Gynoecium; **I.** Stamen; **J.** Anther; **K.** Stigma; **L.** Ovary with disc; **M.** Nutlet.

Plate 78. *Anisochilus wightii* **A.** Habit; **B.** Inflorescence; **C.** Flower; **D.** Corolla; **E.** Calyx; **F.** Calyx opened; **G.** Corolla opened; **H.** Gynoecium; **I.** Stamen; **J.** Anther; **K.** Stigma; **L.** Ovary with disc; **M.** Nutlet.

Plate 79. Holotype of *Anisochilus wightii* (K000674675, "Reproduced by the permission of the board of trustees of Royal Botanical Gardens, Kew").

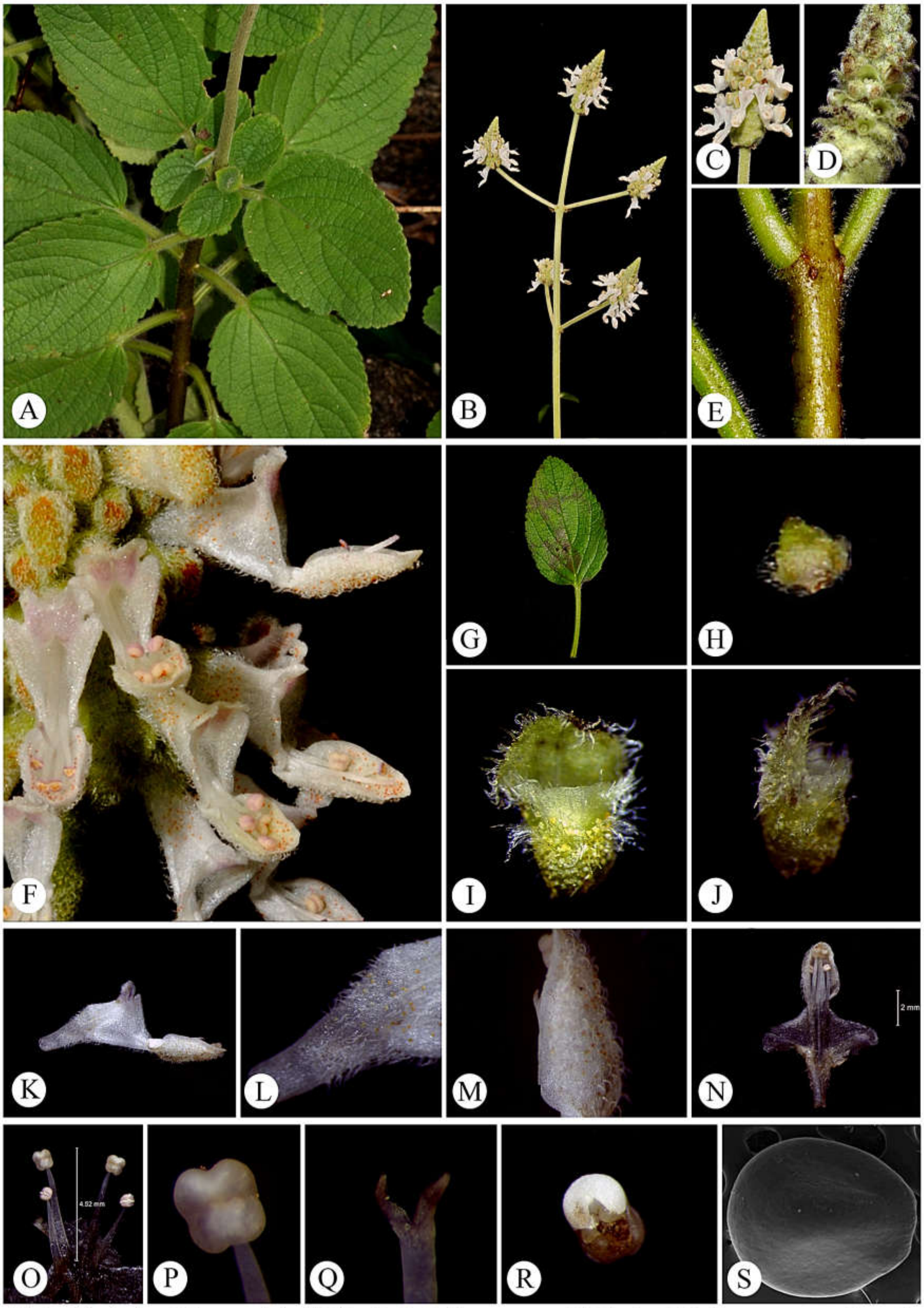


Plate 80. *Anisochilus* sp. 1 A. Habit; B-D. Inflorescence; E. Node; F. Inflorescence enlarged; G. Leaf; H. Bracteole; I-J. Calyx; K-M. Corolla; N. Corolla opened; O. Stamens; P. Anther; Q. Stigma; R. Ovary; S. Nutlet.

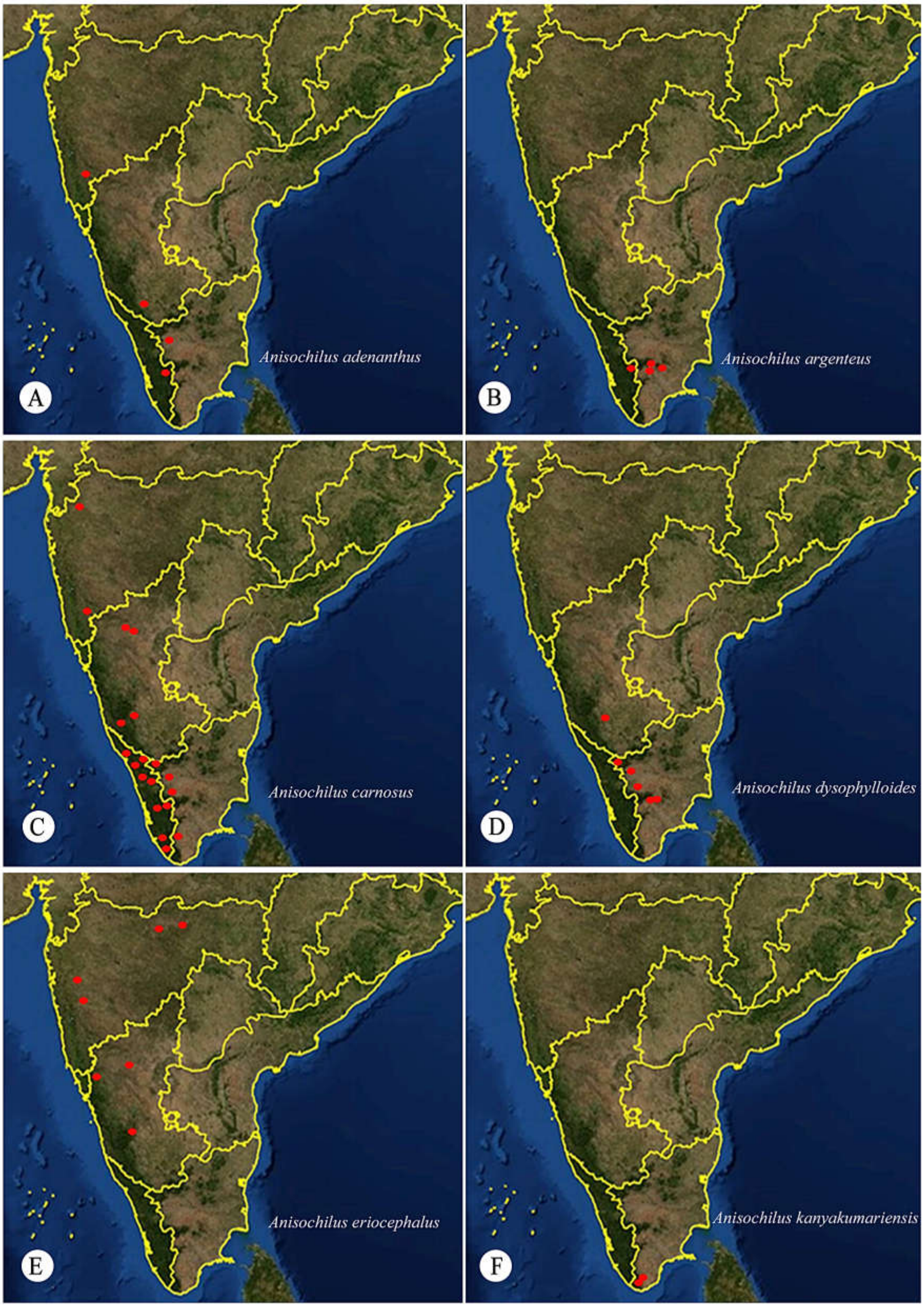


Plate 81. Distribution map of *Anisochilus* species in Western Ghats A. *Anisochilus adenanthus*; B. *A. argenteus*; C. *A. carnosus;* D. *A. dysophylloides*; E. *A. eriocephalus*; F. *A. kanyakumariensis.*

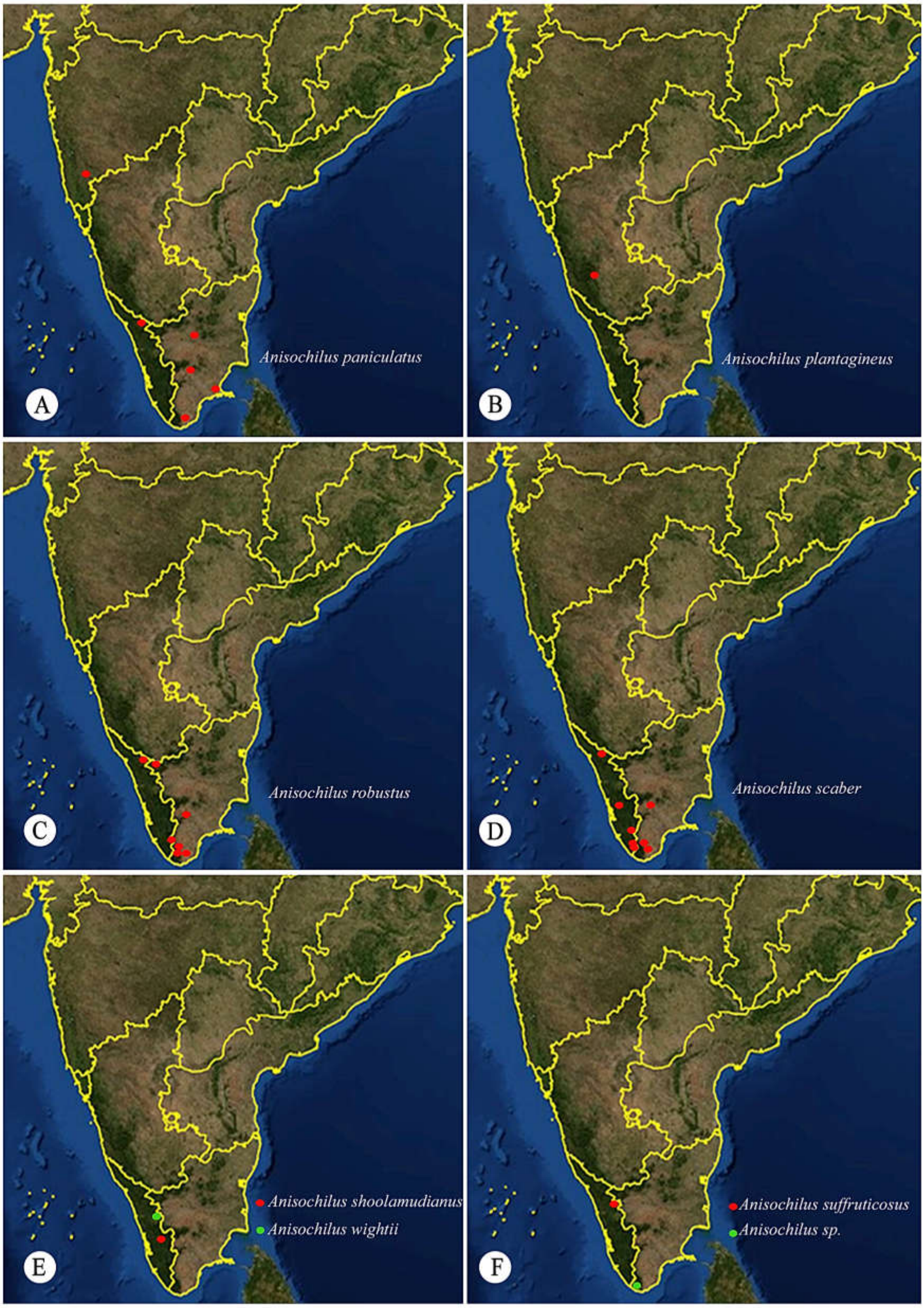


Plate 82. Distribution map of *Anisochilus* species in Western Ghats A. *Anisochilus paniculatus*; B. *A. plantaginieus*; C. *A. robustus;* D. *A. scaber*; E. *A. shoolamudianus, A. wightii*; F. *A. suffruticosus, A. sp. 1.*

Plate 83. *Scutellaria colebrookeana* A. Habit; B. Inflorescence; C. Leaf; D. Flower; E. Bracteole; F. Calyx; G. Calyx opened; H. Corolla opened; I. Stamen; J. Anther; K. Stigma; L. Ovary; M. Nutlets.

Plate 84. Lectotype of *Scutellaria colebrookeana* (K000820768 "Reproduced by the permission of the board of trustees of Royal Botanical Gardens, Kew").

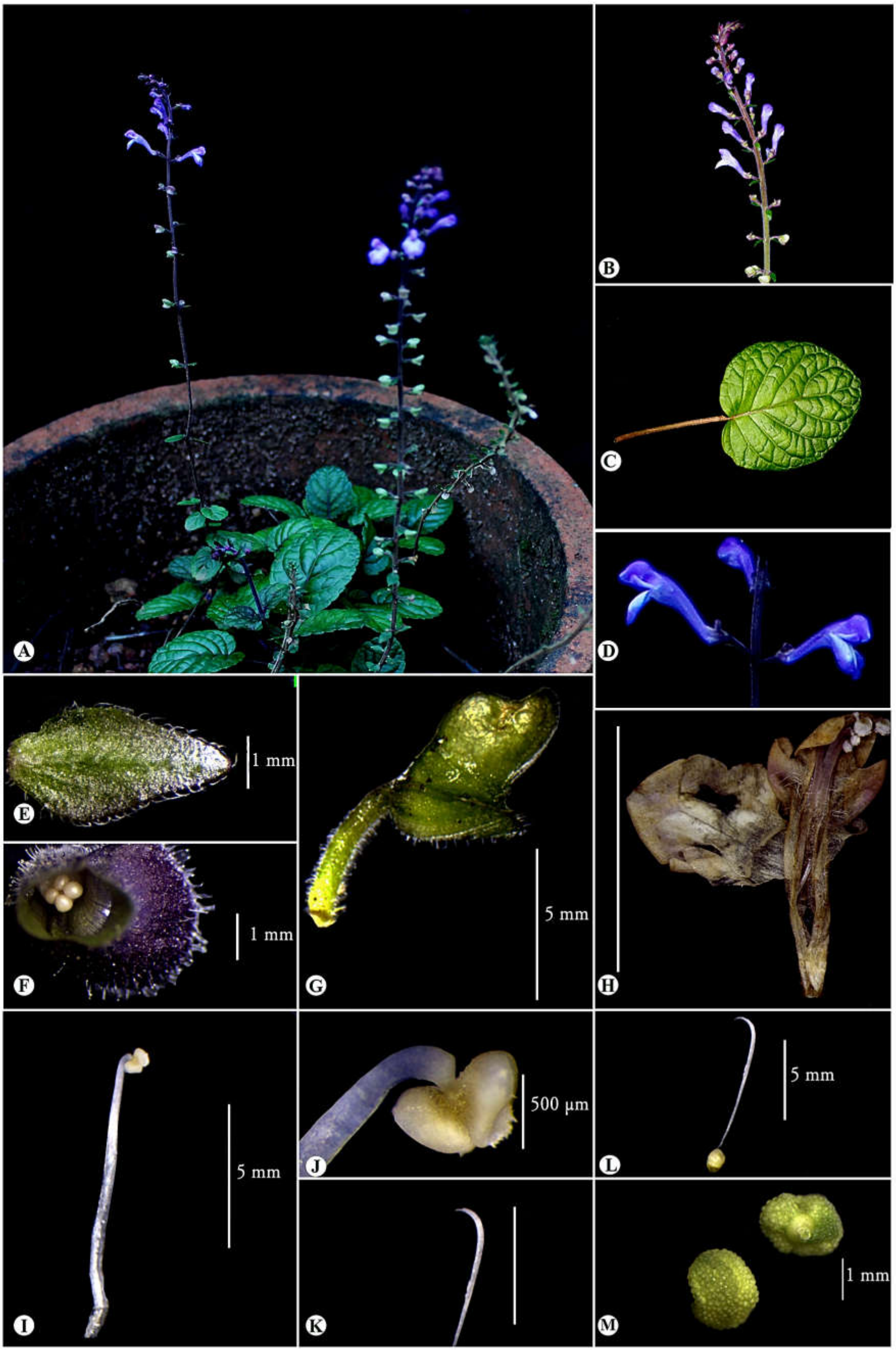


Plate 85. *Scutellaria* discolor var. *discolor* A. Habit; B. Inflorescence; C. Leaf; D. Flowers; E. Bracteole; F-G. Calyx; H. Corolla opened; I. Stamen; J. Anther; K. Stigma; L. Gynoecium; M. Nutlets.

Plate 86. Holotype of *Scutellaria discolor* (K000639588, "Reproduced by the permission of the board of trustees of Royal Botanical Gardens, Kew").

Plate 87. Type–an illustration of *Scutellaria oblonga* (in Edwards's Bot. Reg. 18: t. 1493).

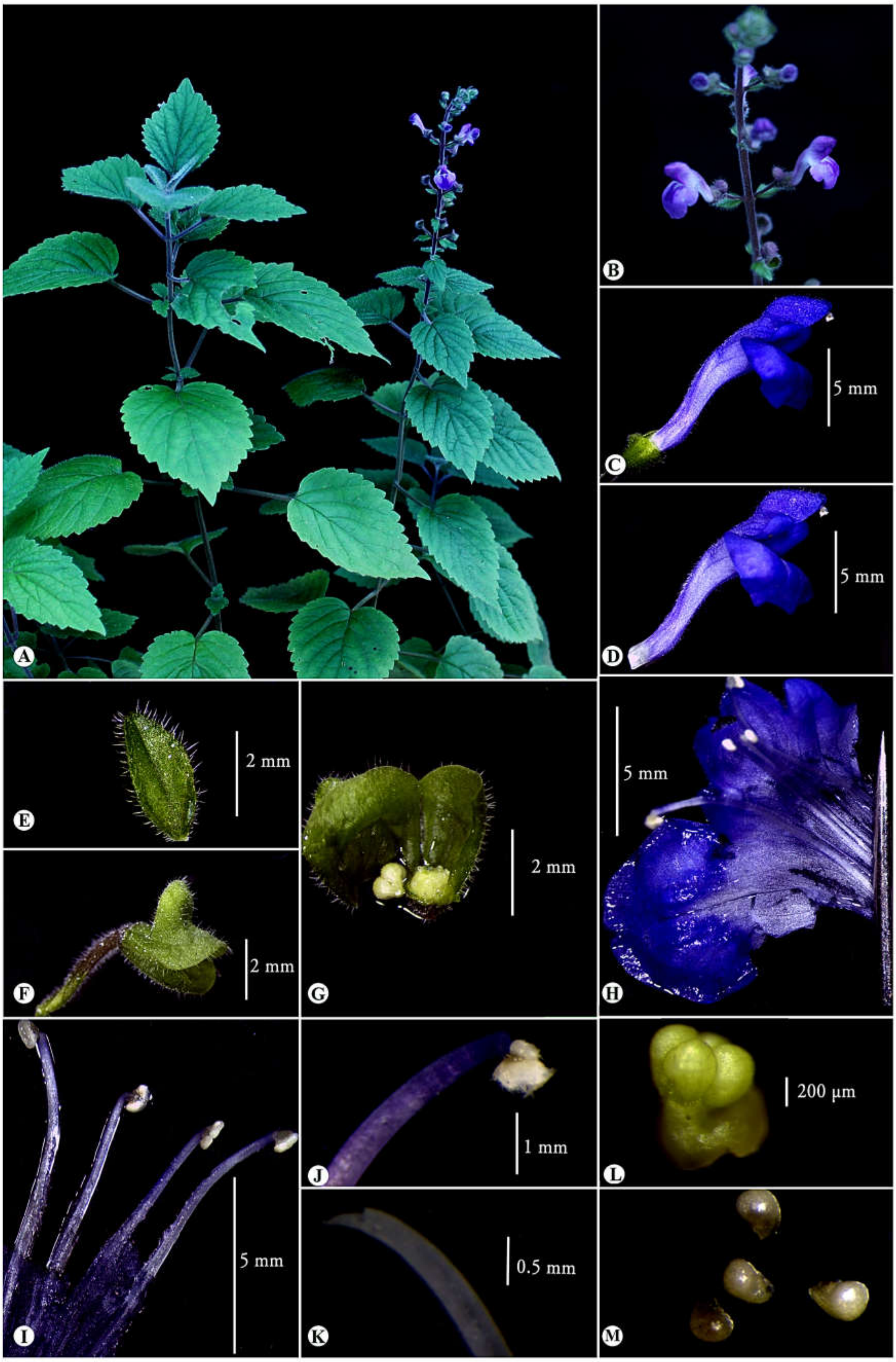


Plate 88. *Scutellaria violacea* var. *violacea* A. Habit; B. Inflorescence; C. Flower; D. Corolla; E. Bracteole; F. Calyx; G. Calyx opened; H. Corolla opened; I. Stamens; J. Anther; K. Stigma; L. Ovary; M. Nutlets.

Plate 89. Holotype of *Scutellaria violacea* (K001115281, "Reproduced by the permission of the board of trustees of Royal Botanical Gardens, Kew").

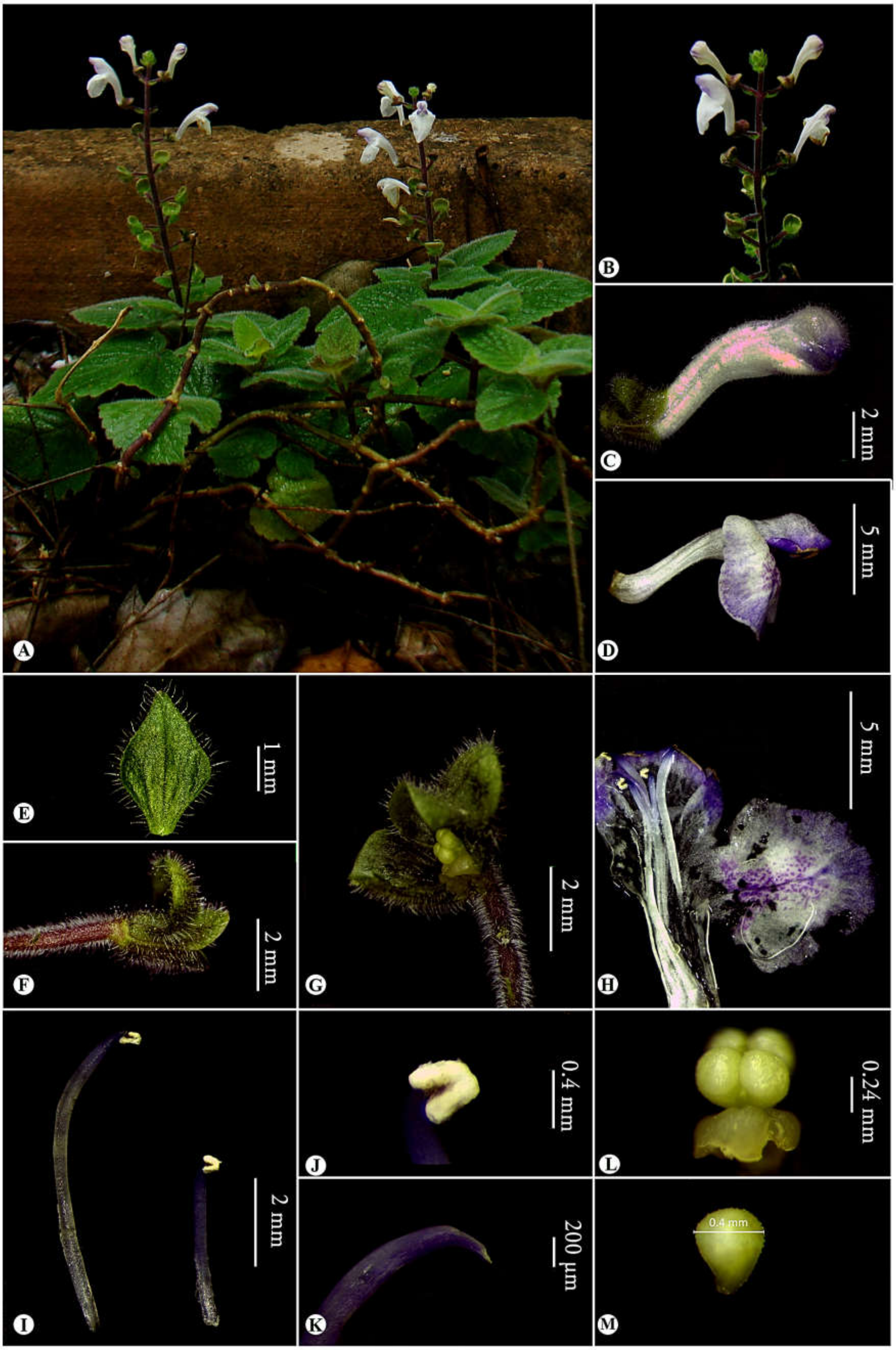


Plate 90. *Scutellaria wightiana* A. Habit; B. Inflorescence; C. Bud; D. Corolla; E. Bracteole; F. Calyx; G. Calyx opened; H. Corolla opened; I. Stamens; J. Anther; K. Stigma; L. Ovary; M. Nutlets.

Plate 91. Holotype of *Scutellaria wightiana* (K001116875, "Reproduced by the permission of the board of trustees of Royal Botanical Gardens, Kew").

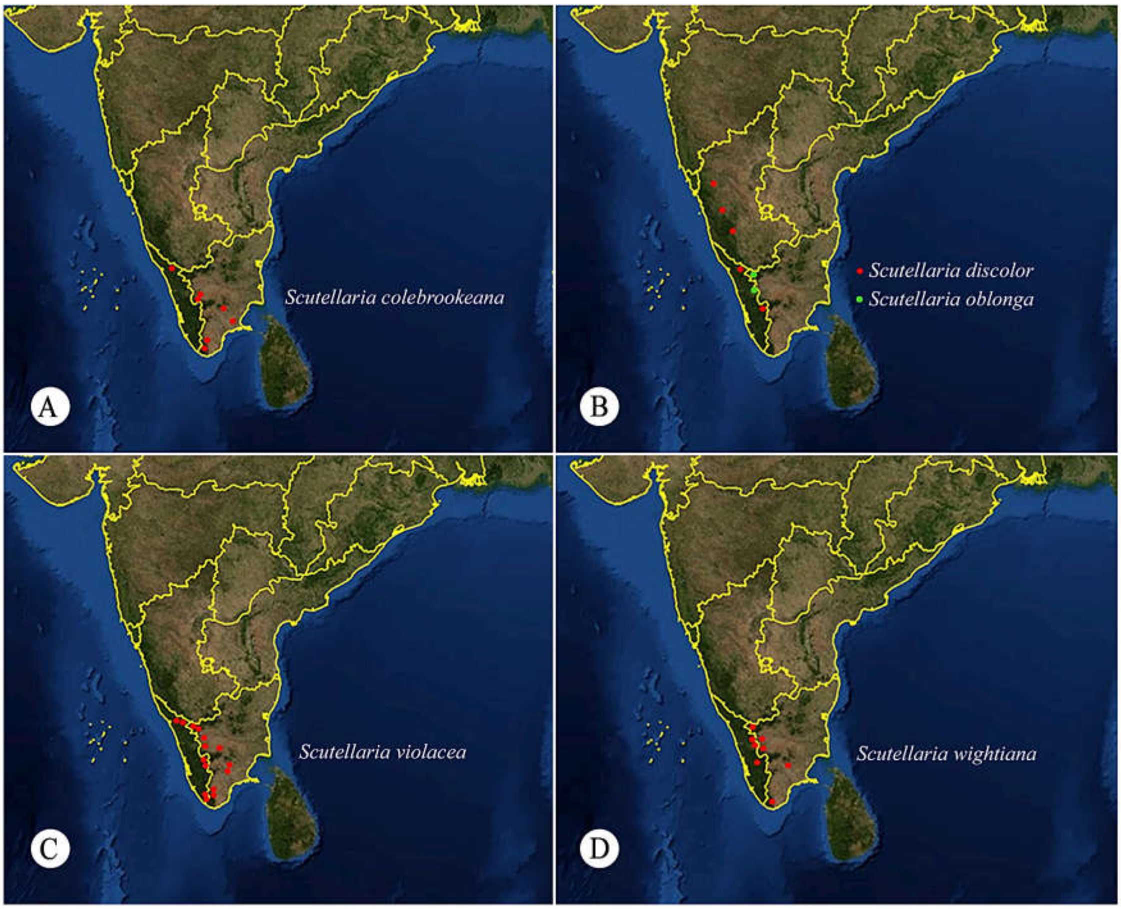


Plate 92. Distribution map of *Scutellaria* species in Western Ghats A. *Scutellaria colebrookeana*; B. *S. discolor, S. oblonga*; C. *S. violacea*; D. *S. wightiana*.

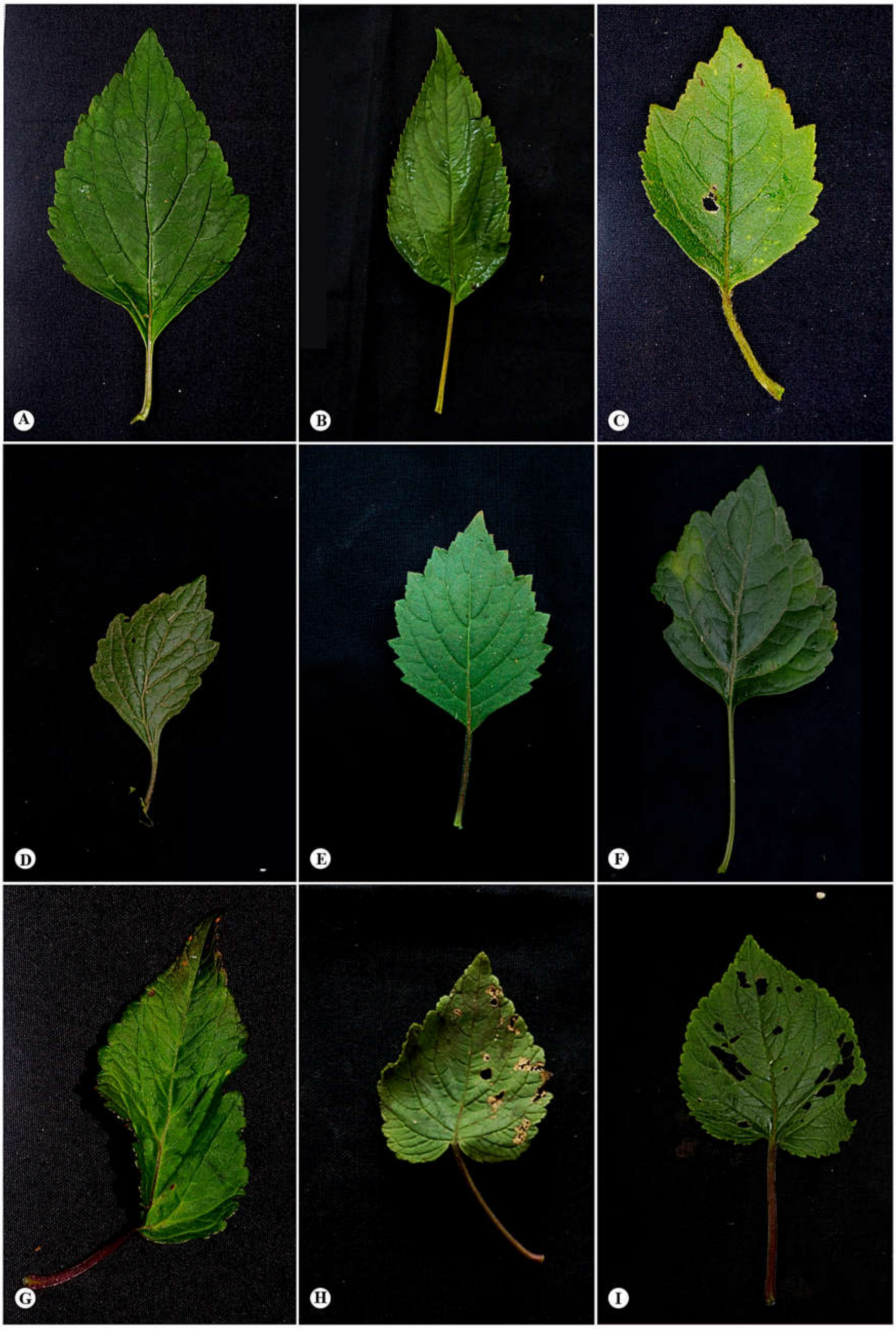


Plate 93. Leaf A. *Pogostemon benghalensis*; B. *P. plectrantoides*; C. *P. gardneri*; D. *P. purpurescens*; E. *P. paniculatus*; F. *P. heyneanus*; G. *P. travancoricus*; H. *P. hedgei*; I. *P. peethapushpam*.

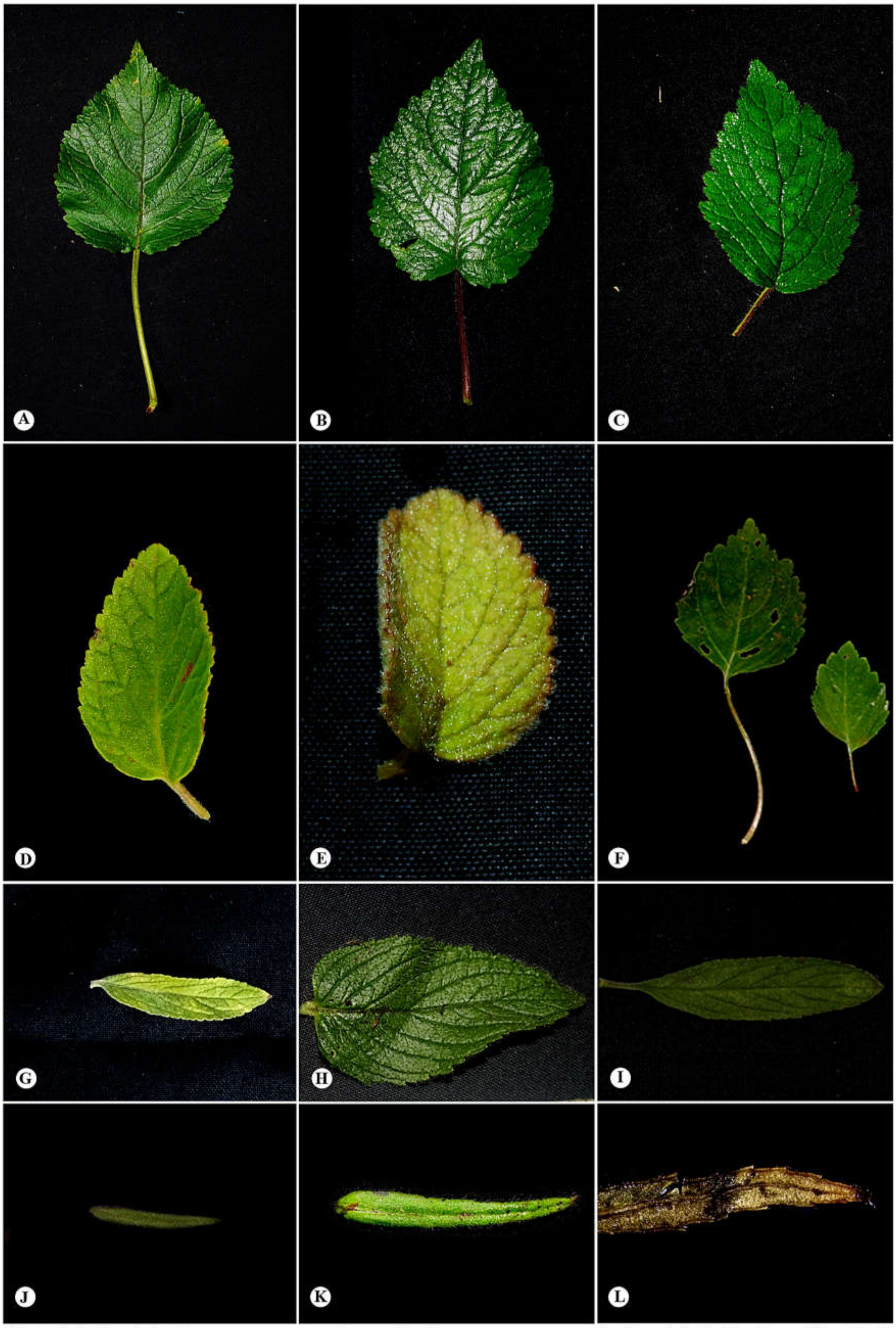


Plate 94. Leaf A. *Pogostemon speciosus*; B. *P. atropurpureus*; C. *P. wightii*; D. *P. mollis*; E. *P. nilagiricus*; F. *P. paludosus*; G. *P. quadrifolius*; H. *P. auricularius*; I. *P. myosuroides*; J. *P. deccanensis*; K. *P. cruciatus*; L. *P. salicifolius.*

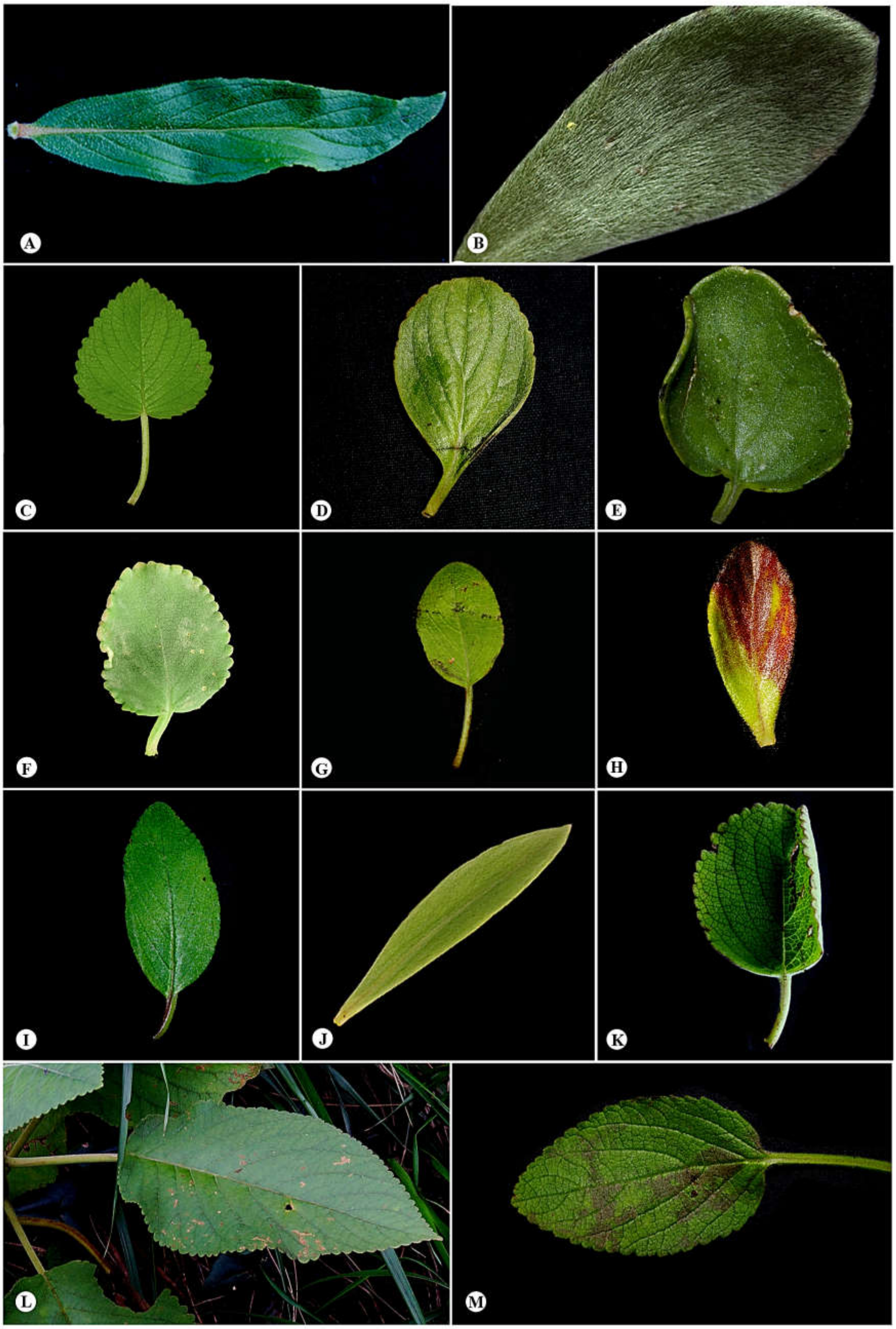


Plate 95. Leaf A. *Anisochilus adenanthus*; B. *A. argenteus*; C. *A. carnosus*; D. *A. dysophylloides*; E. *A. eriocephalus*; F. *A. kanyakumariensis*; G. *A. paniculatus*; H. *A. plantaginieus*; I. *A. scaber*; J. *A. shoolamudianus*; K. *A. wightii*; L. *A. robustus*; M. *A. sp. 1.*

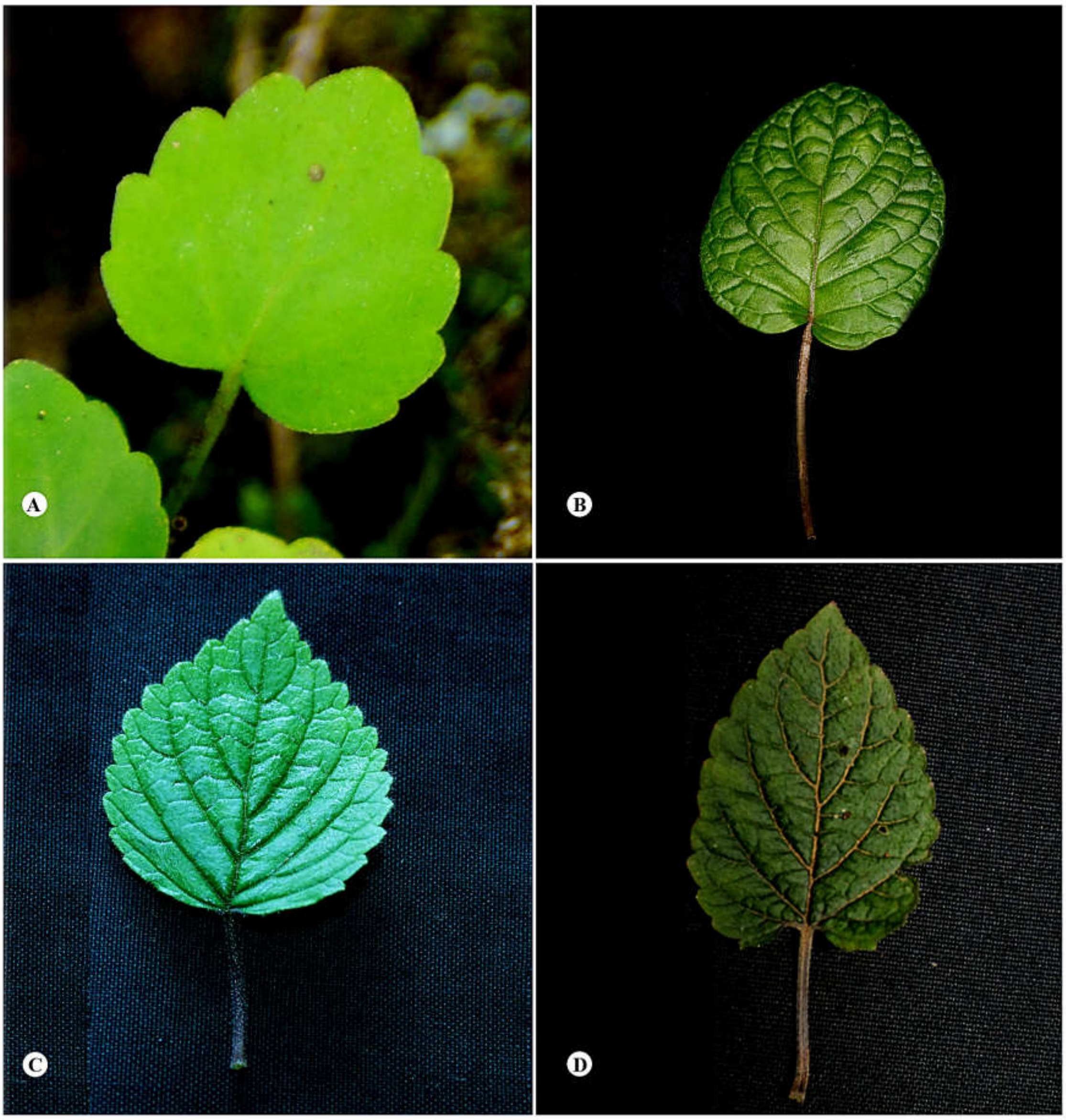


Plate 96. Leaf A. *Scutellaria colebrookeana*; B. *S. discolor*; C. *S. violacea*; D. *S. wightiana.*

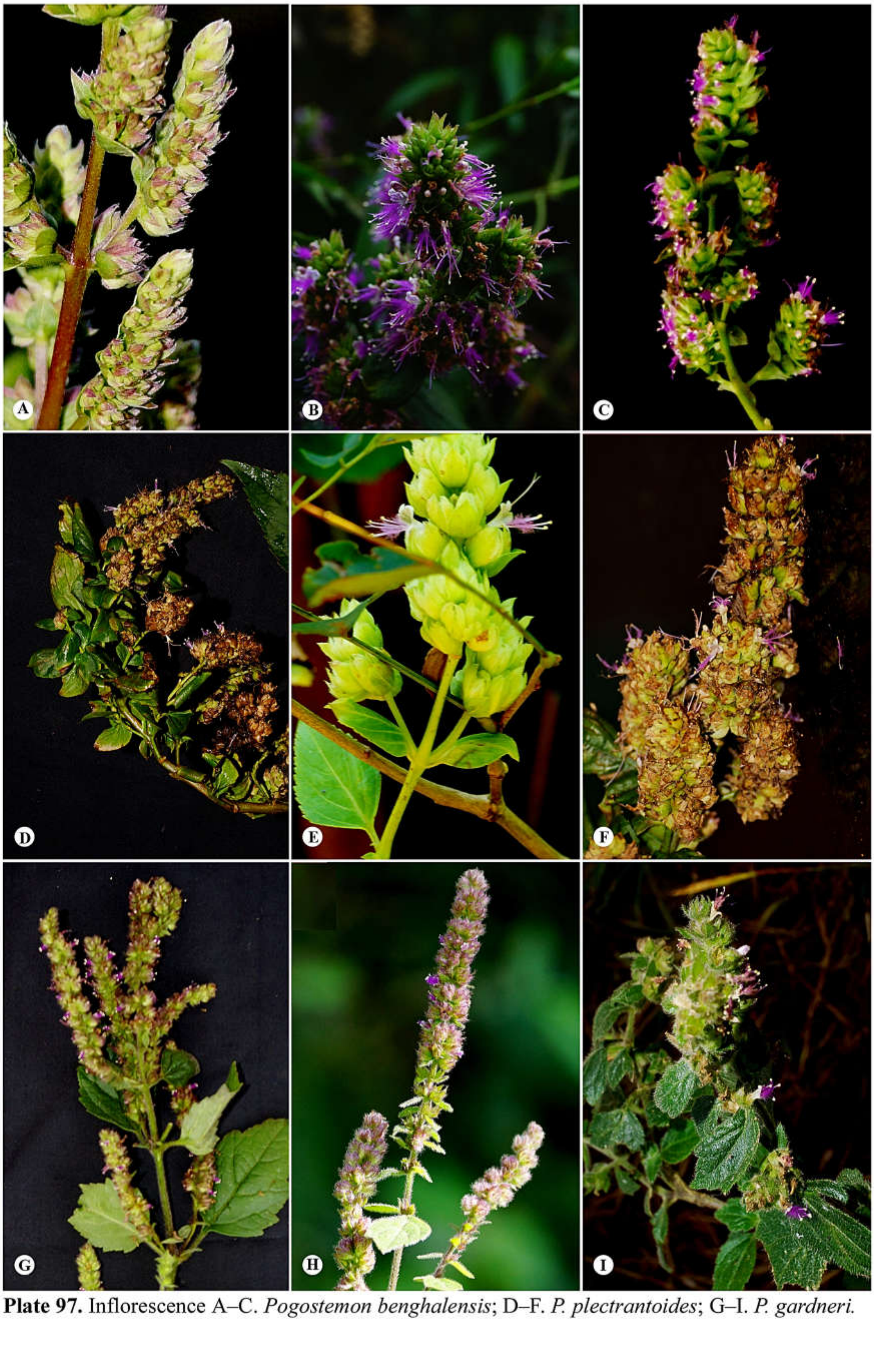


Plate 97. Inflorescence A–C. *Pogostemon benghalensis*; D–F. *P. plectrantoides*; G–I. *P. gardneri.*

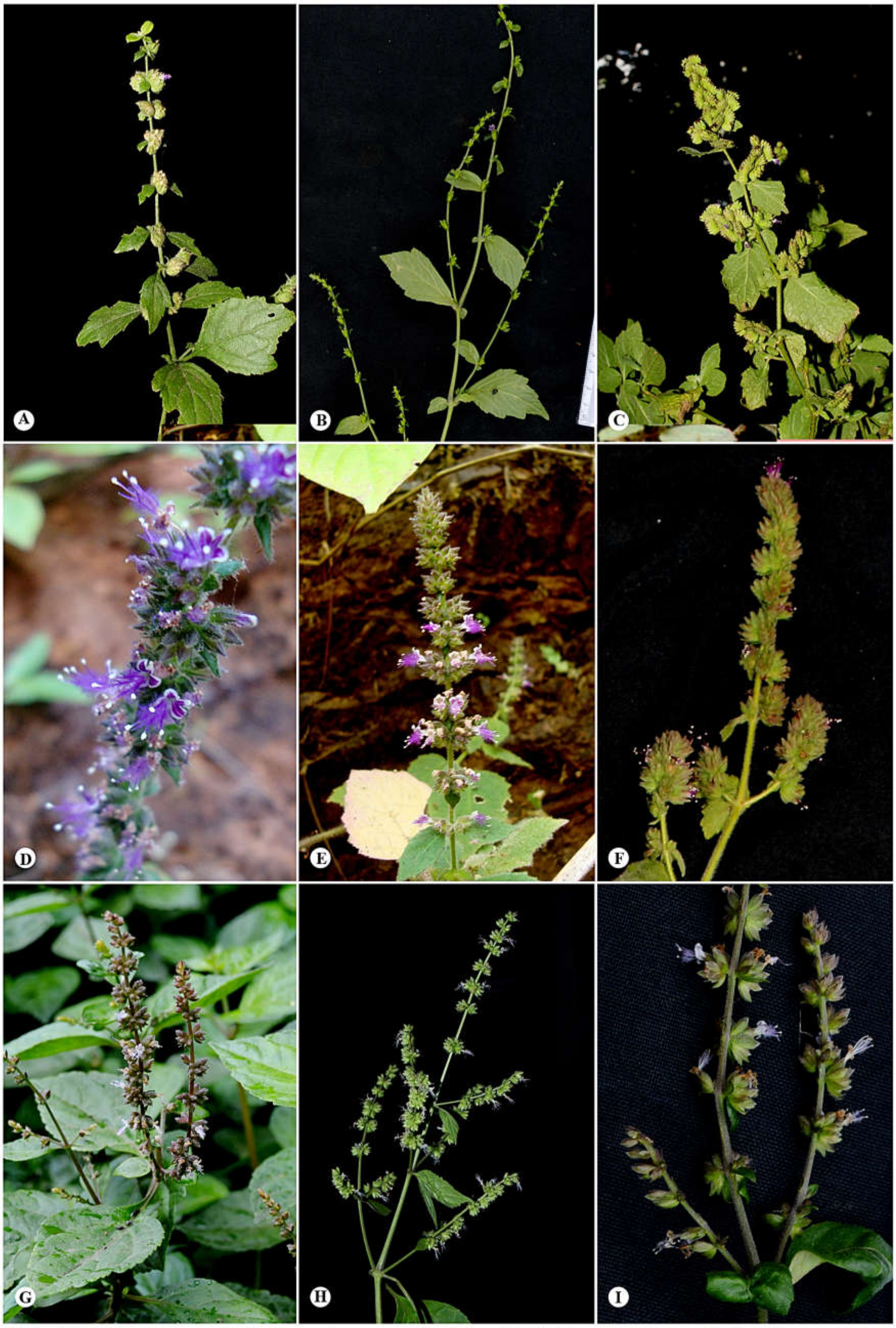


Plate 98. Inflorescence A–C. *Pogostemon paniculatus*; D–F. *P. purpurescens*; G–I. *P. heyneanus*.

Plate 99. Inflorescence A–C. *Pogostemon travancoricus*; D–F. *P. peethapushpam*; G–I. *P. hedgei.*

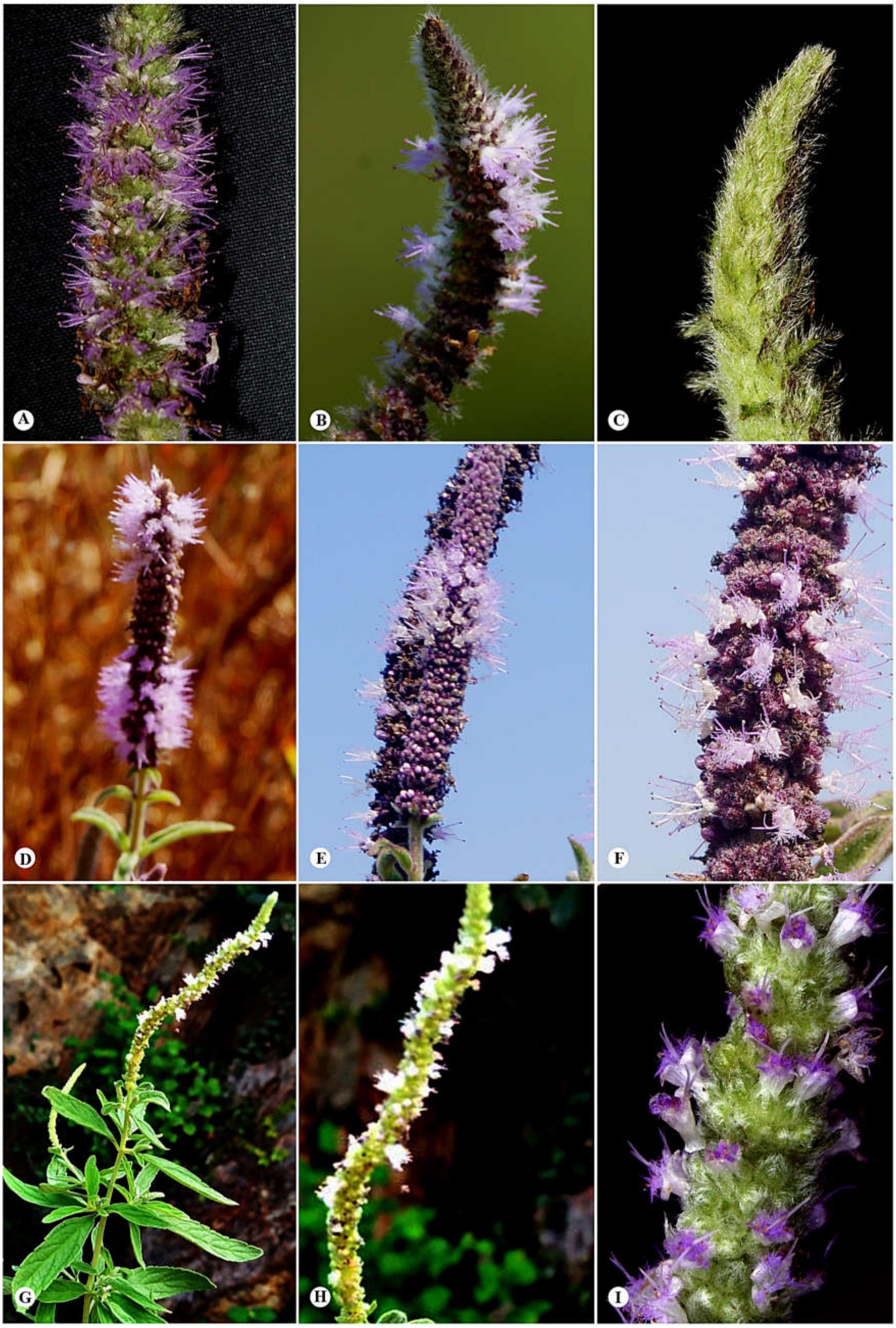


Plate 100. Inflorescence A–C. *Pogostemon auricularius*; D–F. *P. quadrifolius*; G–I. *P. myosuroides.*

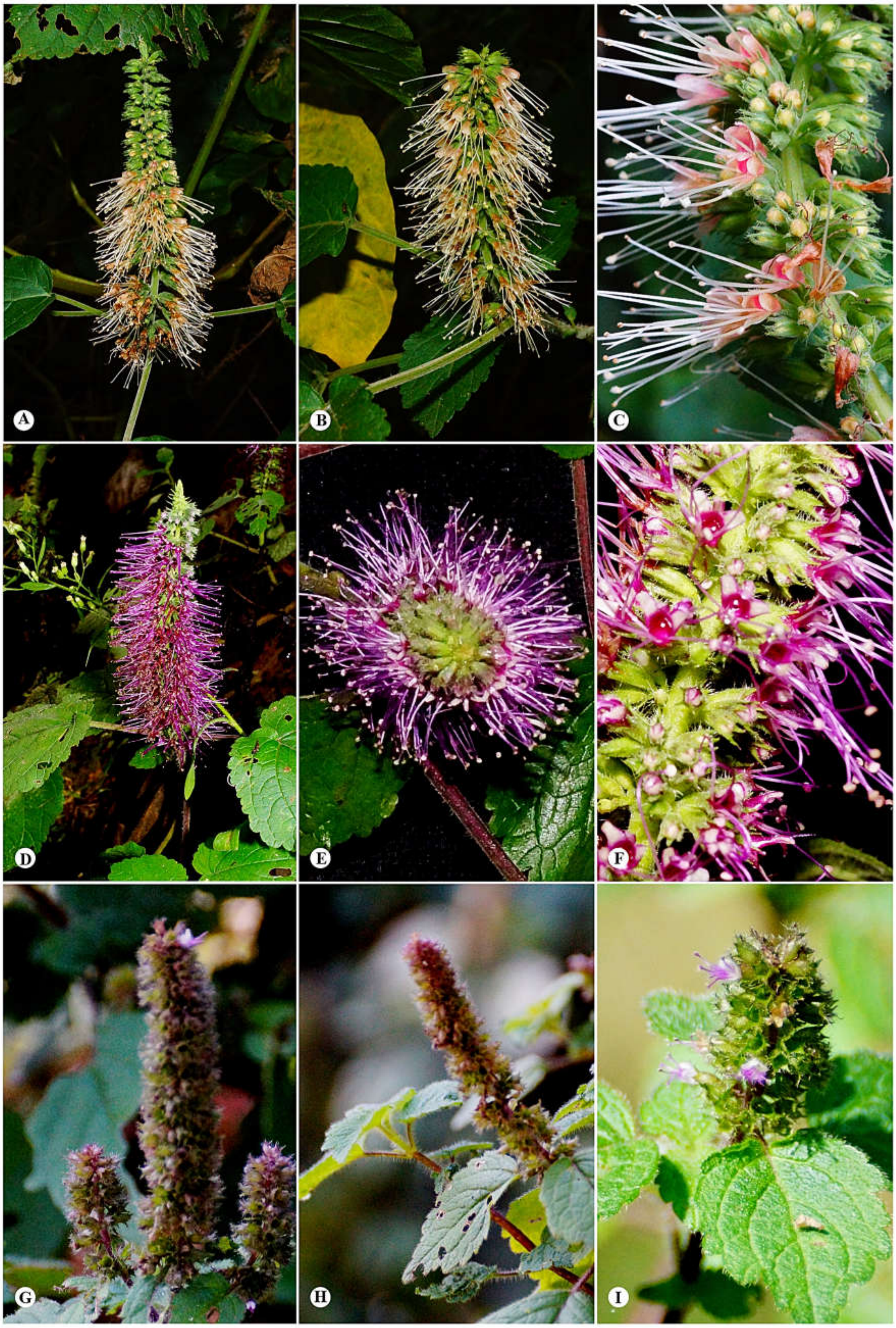


Plate 101. Inflorescence A–C. *Pogostemon speciosus*; D–F. *P. atropurpureus*; G–I. *P. wightii.*

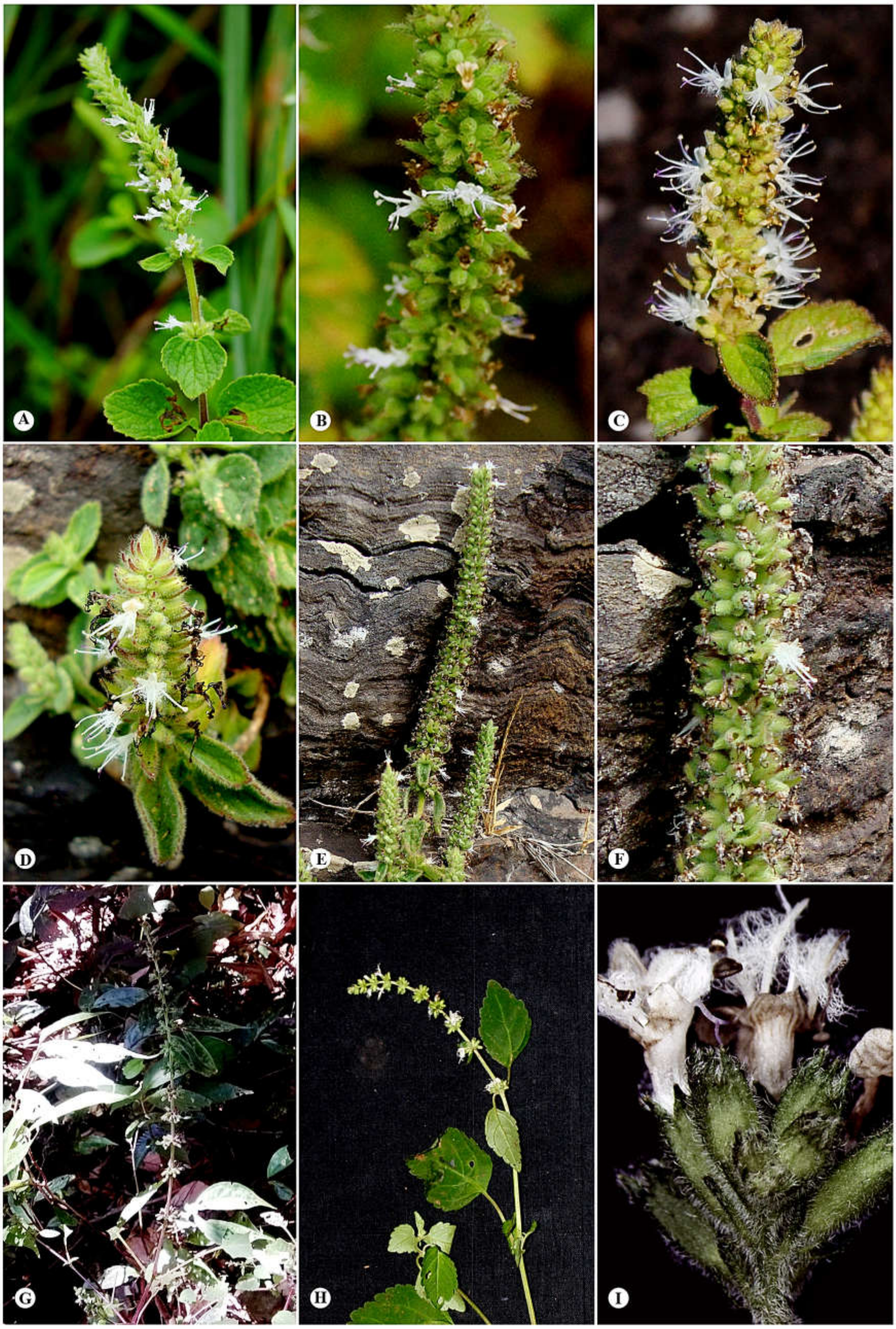


Plate 102. Inflorescence A–C. *Pogostemon mollis*; D–F. *P. nilagiricus*; G–I. *P. paludosus*.

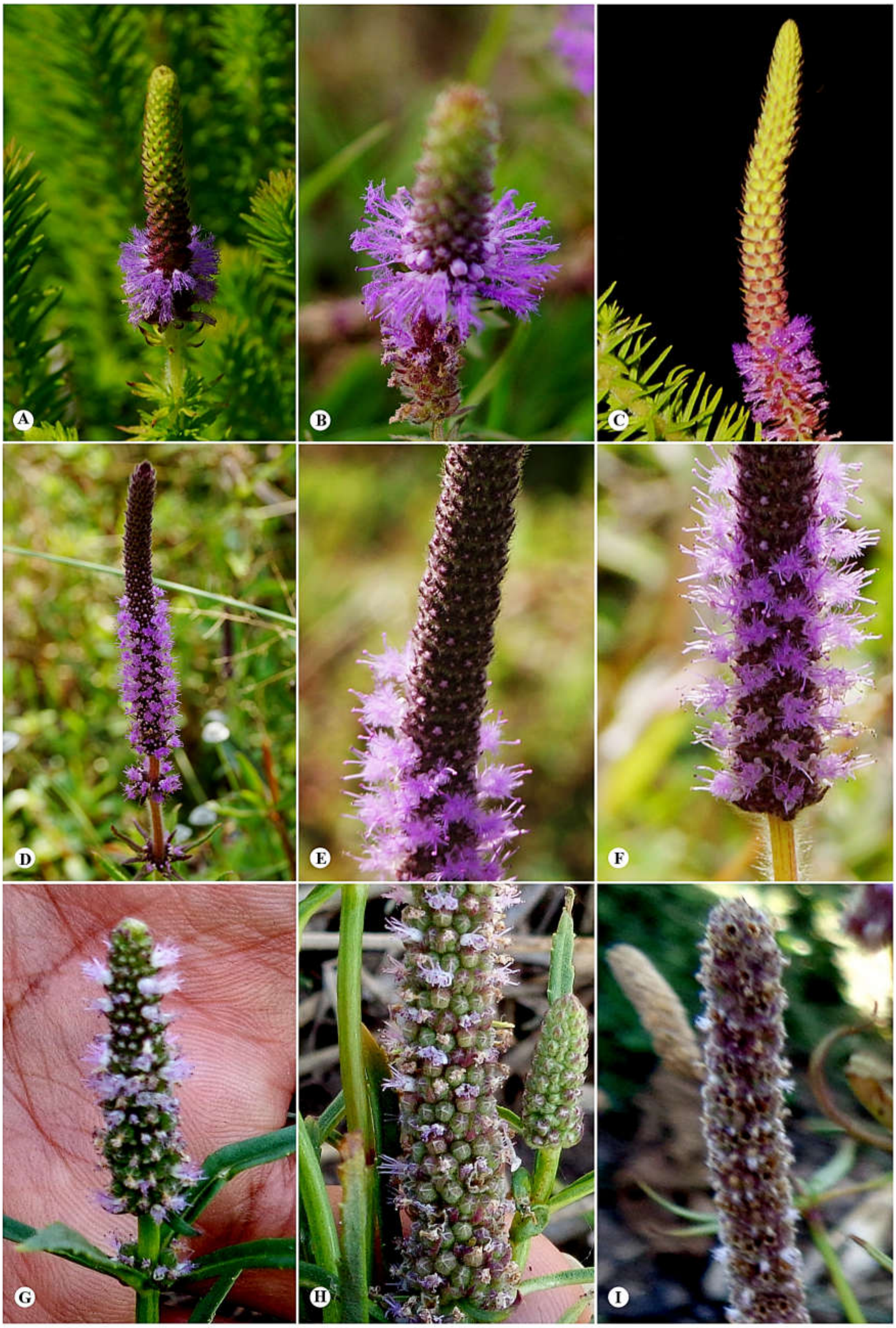


Plate 103. Inflorescence A–C. *Pogostemon deccanensis*; D–F. *P. cruciatus*; G–I. *P. salicifolius.*

Plate 104. Inflorescence A–C. *Anisochilus dysophylloides*; D–F. *A. argenteus*; G–I. *A. shoolamudianus.*

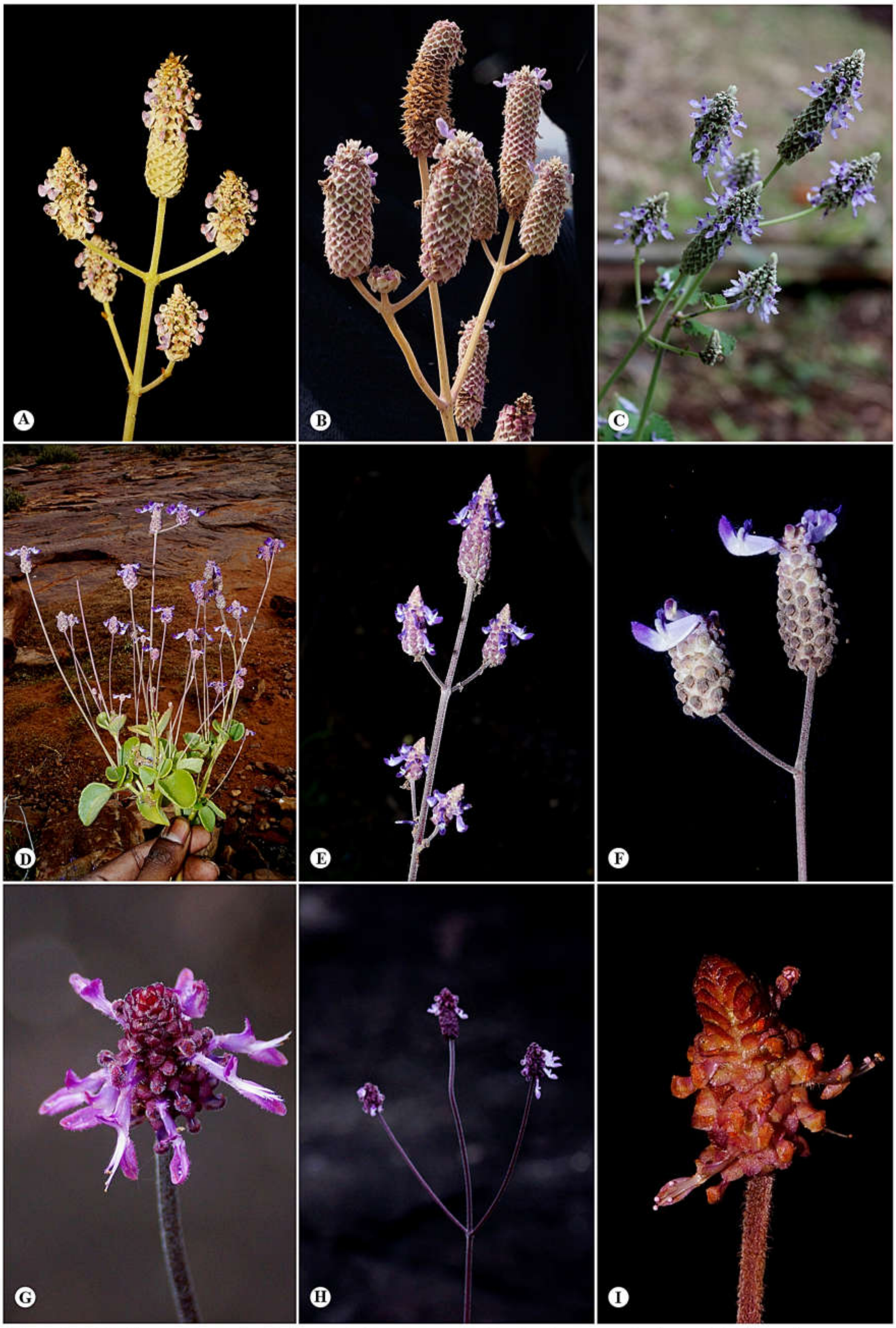


Plate 105. Inflorescence A–C. *Anisochilus carnosus*; D–F. *A. eriocephalus*; G–I. *A. scaber.*

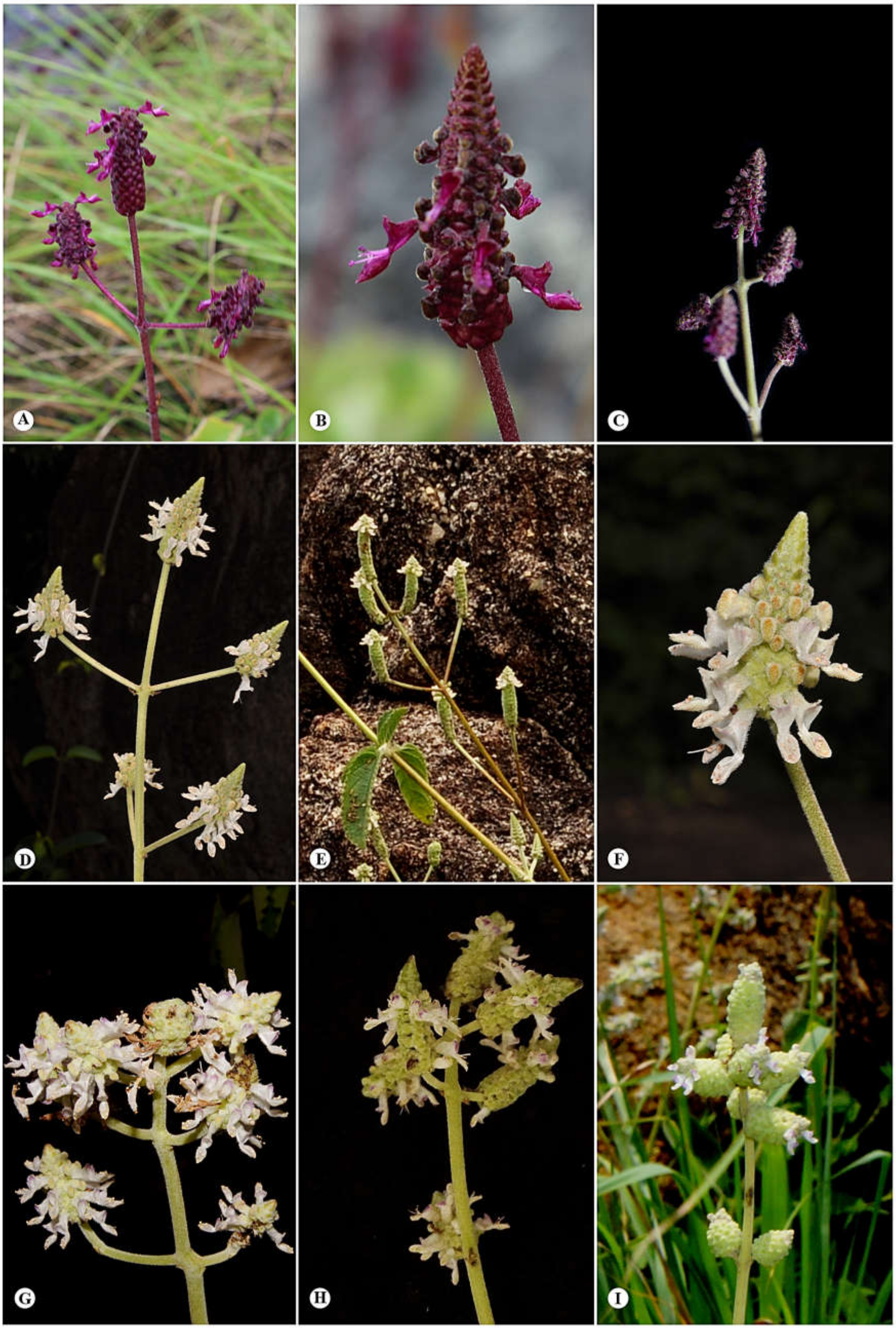


Plate 106. Inflorescence A–C. *Anisochilus wightii*; D–F. *A. sp. 1.*; G–I. *A. kanyakumariensis.*

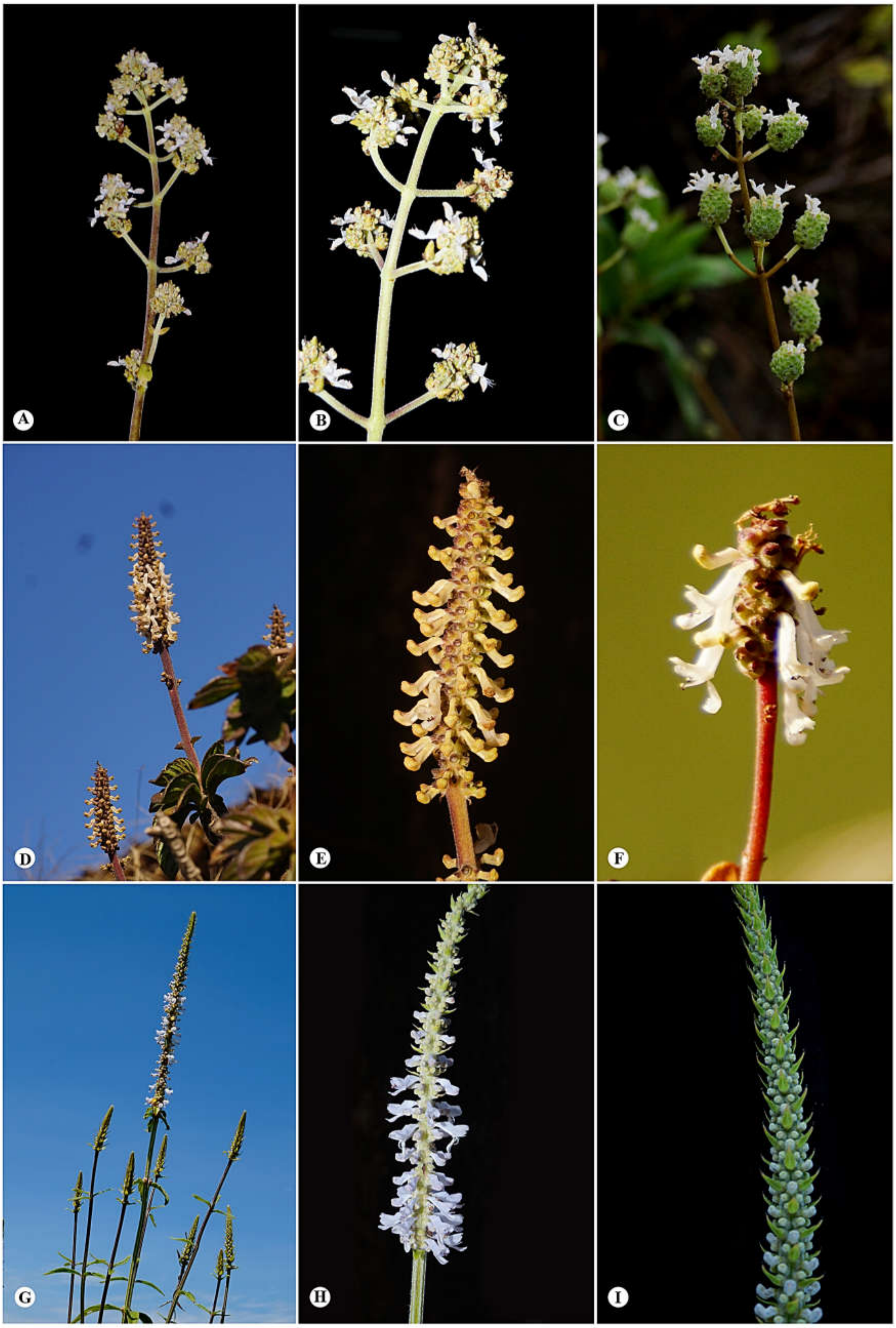


Plate 107. Inflorescence A–C. *Anisochilus paniculatus*; D–F. *A. plantaginieus*; G–I. *A. adenanthus*.

Plate 108. Inflorescence A–C. *Anisochilus robustus*; D–F. *A. suffruticosus*.

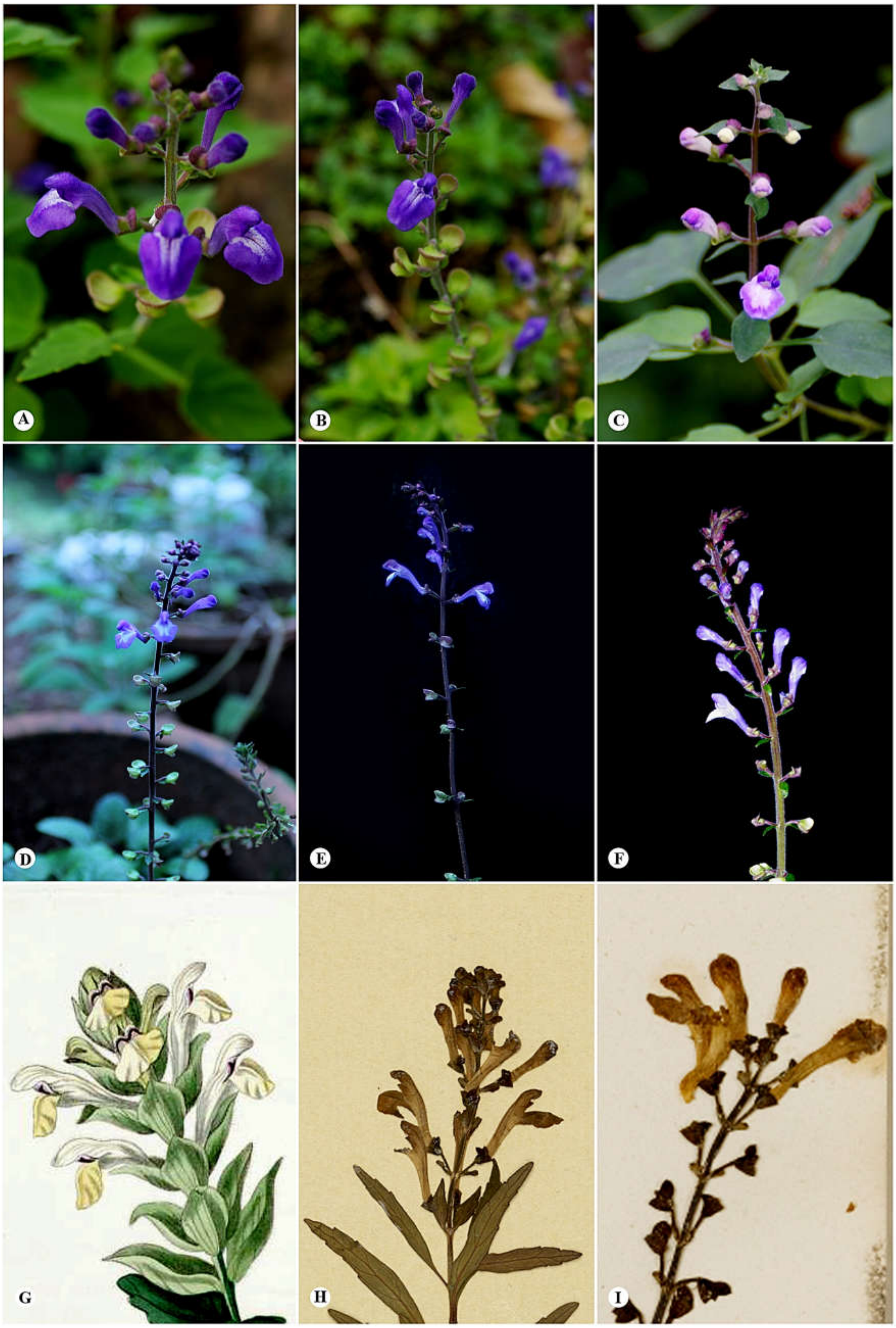


Plate 109. Inflorescence A–C. *Scutellaria colebrookeana*; D–F. *A. discolor;* G–I. *S. oblonga.*

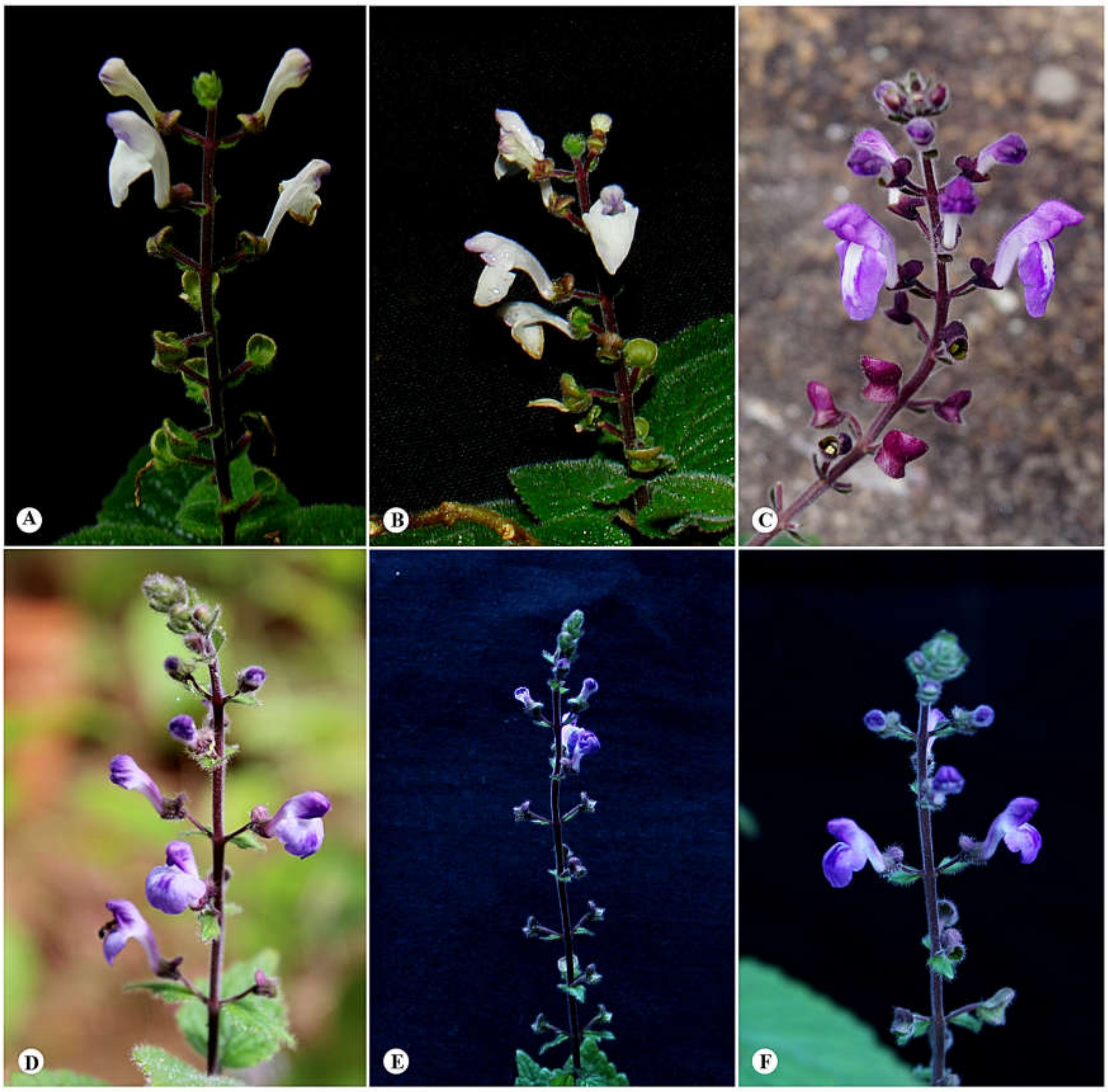


Plate 110. Inflorescence A–C. *Scutellaria wightiana*; D–F. *A. violacea.*

Plate 111. Calyces A. *Pogostemon benghalensis*; B. *P. plectrantoides*; C. *P. gardneri*; D. *P. purpurescens*; E. *P. paniculatus*; F. *P. heyneanus*; G. *P. travancoricus*; H. *P. hedgei*; I. *P. peethapushpam*

Plate 112. Calyces A. *Pogostemon speciosus*; B. *P. atropurpureus*; C. *P. wightii*; D. *P. mollis*; E. *P. nilagiricus*; F. *P. paludosus*; G. *P. quadrifolius*; H. *P. auricularius*; I. *P. myosuroides*; J. *P. deccanensis*; K. *P. cruciatus*; L. *P. salicifolius.*

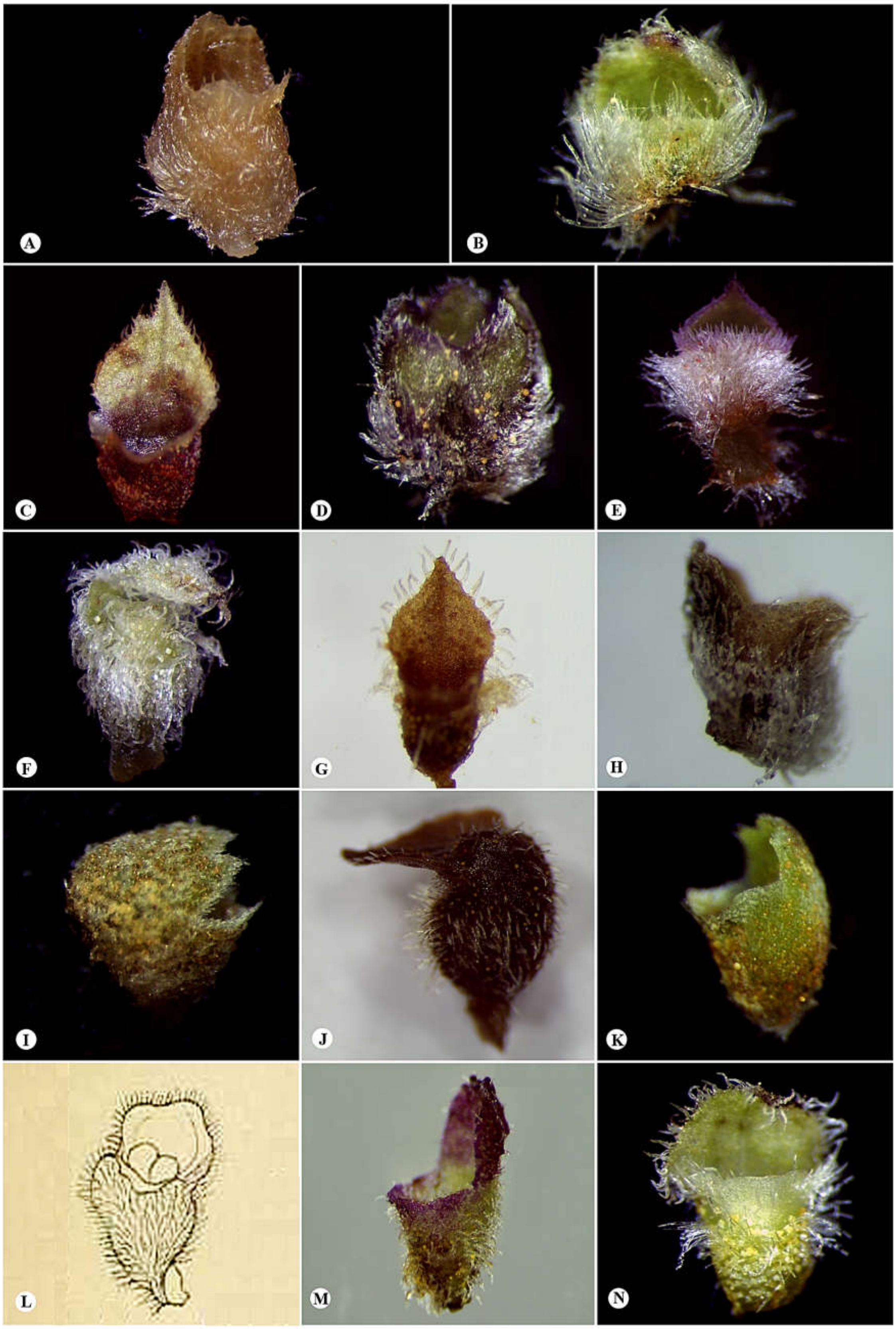


Plate 113. Calyces A. *Anisochilus adenanthus*; B. *A. argenteus*; C. *A. carnosus*; D. *A. dysophylloides*; E. *A. eriocephalus*; F. *A. kanyakumariensis*; G. *A. paniculatus*; H. *A. plantaginieus*; I. *A. robustus*; J. *A. scaber*; K. *A. shoolamudianus*; L. *A. suffruticosus*; M. *A. wightii*; N. *A. sp. 1.*

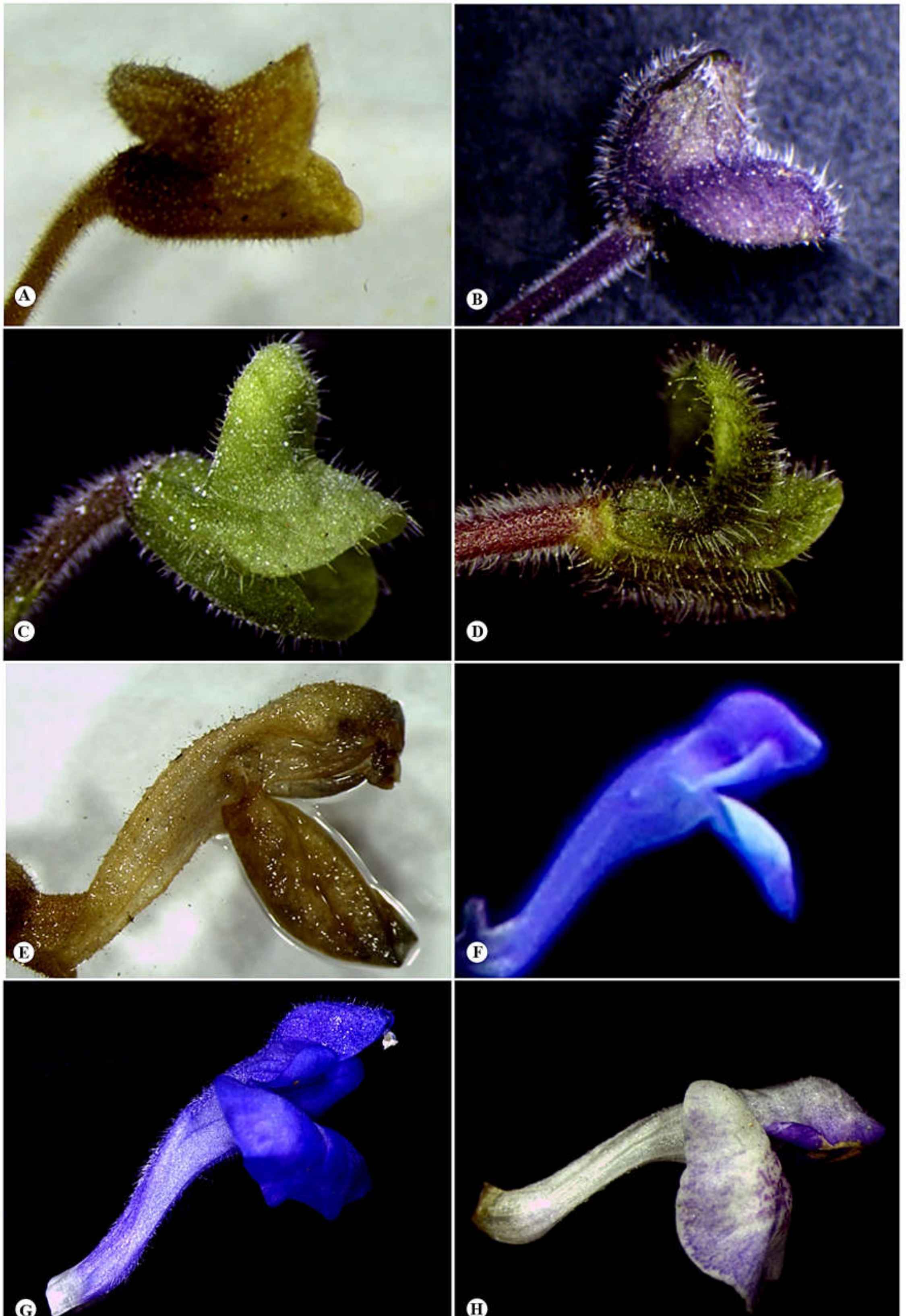


Plate 114. Calyces and Corolla. A–E. *Scutellaria colebrookeana*; B–F. *S. discolor*; C–G. *S. violacea*; D–H. *S. wightiana.*

Plate 115. Corolla A. *Pogostemon benghalensis*; B. *P. plectrantoides*; C. *P. gardneri*; D. *P. purpurescens*; E. *P. paniculatus*; F. *P. heyneanus*; G. *P. travancoricus*; H. *P. hedgei*; I. *P. peethapushpam.*

Plate 116. Corolla A. *Pogostemon speciosus*; B. *P. atropurpureus*; C. *P. wightii*; D. *P. mollis*; E. *P. nilagiricus*; F. *P. paludosus*; G. *P. quadrifolius*; H. *P. auricularius*; I. *P. myosuroides*; J. *P. deccanensis*; K. *P. cruciatus.*

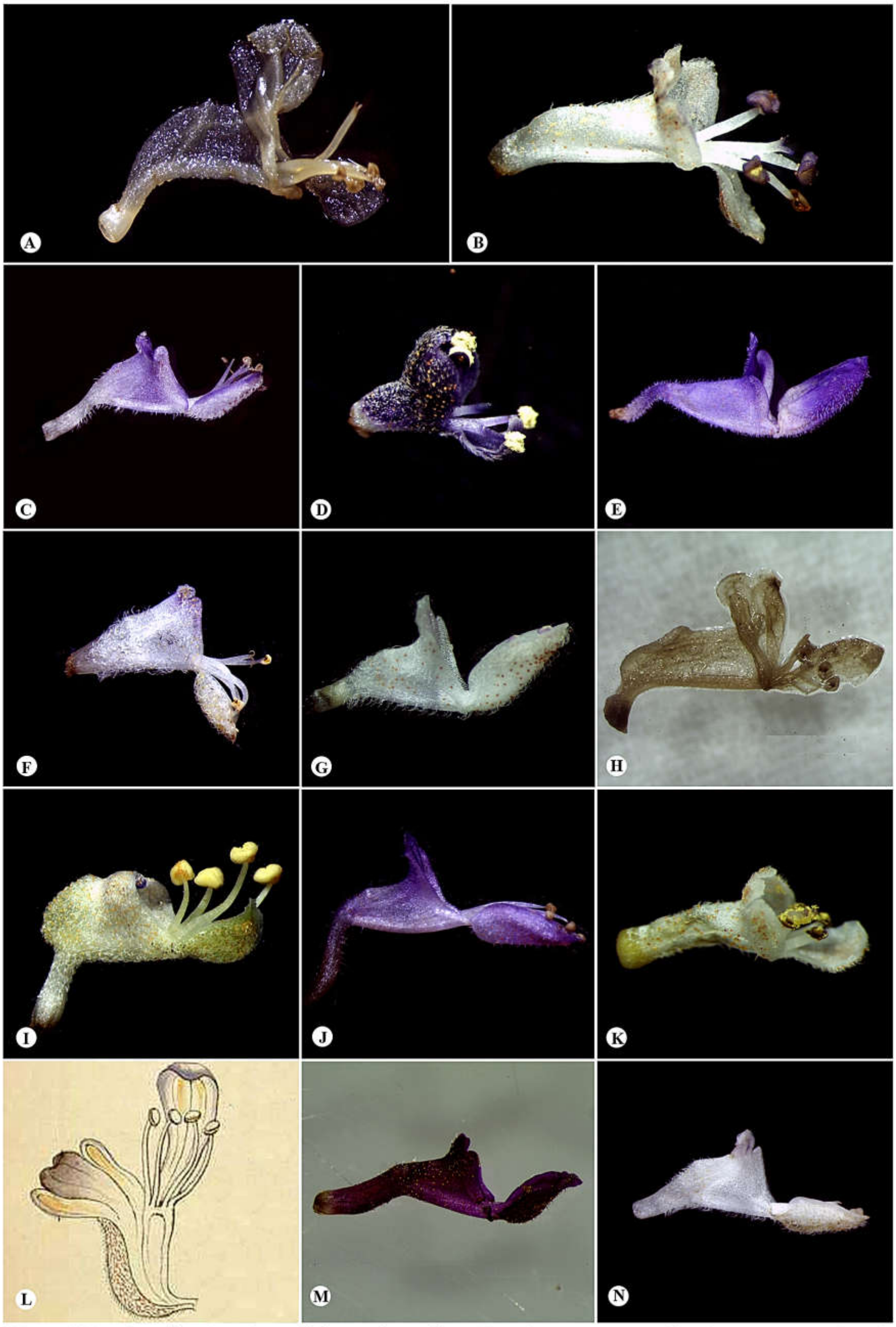


Plate 117. Corolla A. *Anisochilus adenanthus*; B. *A. argenteus*; C. *A. carnosus*; D. *A. dysophylloides*; E. *A. eriocephalus*; F. *A. kanyakumariensis*; G. *A. paniculatus*; H. *A. plantaginieus*; I. *A. robustus*; J. *A. scaber*; K. *A. shoolamudianus*; L. *A. suffruticosus*; M. *A. wightii*; N. *A. sp. 1.*

Plate 119. Habitat of *Pogostemon*. A. Rock crevices; B. Intermingled with rocky grass lands; C. Forest margins; D–E. Lateritic wall cuttings; F. Evergreen forest floor.

Plate 120. Habitat of *Pogostemon*. A–B. Marshy areas; C–D. Rocky surfaces; E. Damp areas; F. Grass lands.

Plate 121. Habitat of *Anisochilus*. A–B. Rock surfaces; C. Shola forest border; D–E. Rock crevices; F. Rock surfaces.

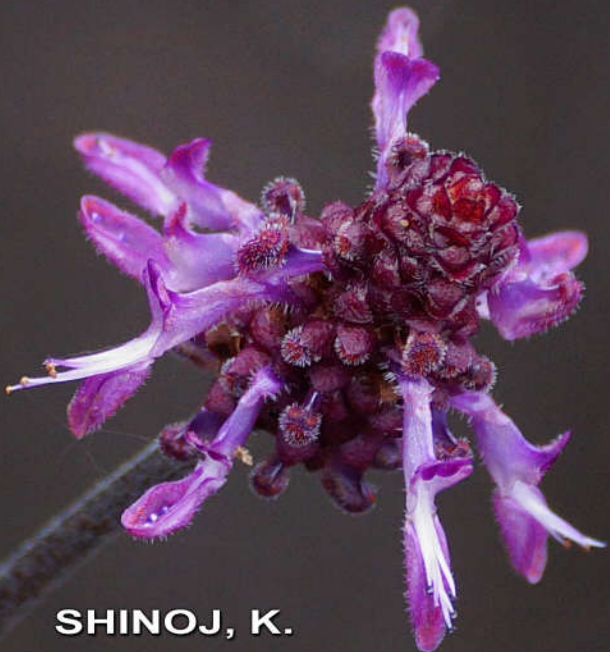
Plate 122. Habitat of *Anisochilus*. A. Rock surfaces; B. Scrub jungle; C. Wet rock surfaces; D. Rock śsurfaces with grasses; E–F. Rock crevices.

Plate 123. Habitat of *Scutellaria.* A–B. Rocky surfaces with moss; B–C. Evergreen forest floor; D–F. Shola forest.

Taxonomic Studies on the genera *Pogostemon* Desf., *Anisochilus* Wall. ex Benth., and *Scutellaria* L. (Lamiaceae) of the Western Ghats of India

Submitted to the
University of Calicut in partial fulfilment of
the requirement for the degree of

DOCTOR OF PHILOSOPHY IN BOTANY



SHINOJ, K.

DEPARTMENT OF BOTANY
UNIVERSITY OF CALICUT
KERALA, INDIA

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