Morphologic and Taxonomic studies of the genus *Leucas* R.Br. (Lamiaceae) in Southern Peninsular India.

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in
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By

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CERTIFICATE

Certified that the thesis entitled "**Morphologic and Taxonomic studies of the genus Leucas R.Br. (Lamiaceae) in Southern Peninsular India**" submitted by Mr. P. Sunojkumar for the degree of **Doctor of Philosophy** in Botany of the University of Calicut is a bonafide record of research work done by him in this Department under my supervision. This has not previously been formed the basis for the award of any degree/ diploma.

Calicut University
08 April 2005

Prof. (Dr.) Philip Mathew

DECLARATION

The thesis entitled "Morphologic and Taxonomic studies of the genus Leucas R.Br. (Lamiaceae) in Southern Peninsular India" submitted by me for the degree of Doctor of Philosophy in Botany of the University of Calicut has not been formed the basis for the award of any degree/ diploma to the best of my knowledge.

Calicut University

08-04-2005

P. Sunojkumar

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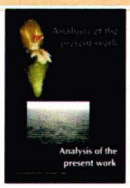


INTRODUCTION

P. Sunojkumar “Morphologic and Taxonomic studies of the genus Leucas R.Br. (Lamiaceae) in Southern Peninsular India” Thesis. Department of Botany, University of Calicut, 2005

Introduction

"The first step in wisdom is to know the things themselves; this notion consists in having the true idea of the object; objects are distinguished and known by their methodical classification and appropriate naming; therefore Classification and Naming will be the foundation of our Science."

Linnaeus (1953)

1. INTRODUCTION

Mans' understanding of the rich plant diversity on earth and its relationships to human life is largely based on the systematic studies. Among the three types of systematic studies —floristic, experimental and revisionary (Stuessy, 1975), the third one covers a middle ground between floristic and experimental approaches by showing detailed relationship among taxa usually at the generic level and below. The elaborate data formulated in revisionary studies including description, key, distribution map and interpretation of relationships will help in classification and to determine the phylogeny of the plant kingdom. This emphasizes the need for additional taxonomic revision of plant kingdom at the generic level.

A true revision reflecting all these information which form a stimulus for future study is lacking for many angiospermic genera in India. This is true in the case of family Labiatae (Lamiaceae) especially of the largest Indian genus *Leucas* R.Br. It is on the light of this information a true taxonomic revisionary study of this genus based on morphologic character of fresh specimens is attempted.

The quality and need of a "good taxonomic revision" was emphasized by Stuessy (1975) quoting what Gray (1875) said almost a century ago "Easy as the work may seem, the number of botanists who are able to elaborate a genus and draw up fairly good botanical descriptions is wonderfully small. The thing is quite possible if mere literary compilation is intended; but something more than this is

needed." While attempting this revisionary study I paid special attention to this comments and the six criteria formulated by Stuessy (1975) for a good revisionary work: (1) precision and thoroughness in gathering of comparative data of all types; (2) ability to recognize discontinuities in sets of comparative data (3) ability to relate observed discontinuities in sets of data to the various fixed ranks of the taxonomic hierarchy; (4) precision and thoroughness of description of recognized taxa (5) precision and thoroughness of documentation in literature, specimen citations, and nomenclature; and (6) precision, thoroughness, and clarity of expression in the final written treatment.

Morphologic characters are used as the basis of taxonomic analysis from the very beginning. In spite of the technological revolutions and its implication in scientific research that in turn propels the revolutions in taxonomy, the role of morphometric data has the prime importance in taxonomic analysis. This is largely because, the predominent role of taxonomy is identifying the rich diversity which is practically possible only through comparative morphology.

My interest in this family for a taxonomic study arises mainly due to two reasons. Firstly, it is one of the most advanced gamopetalous families that have large species diversity in India, but still in need of proper study. This is evident from the fact that among the 250 genera and 6700 species (Mabberely, 1987), reported so far, 70 genera and 425 species are available in India. Of this, 261 are endemic to India (Mukerjee, 1940). Members of the family have pan tropical

distribution, spread mainly over the warmer and temperate regions of the Africa, Asia and Indomalayan regions. High diversity and endemism in India has biogeographic and evolutionary importance that was not attempted so far for this family and the genus *Leucas* R.Br. in particular. This fact points to the need of a thorough field study and taxonomic revision.

Secondly, the members of this group possess high economic potentialities, but the prevailing 'identity crises' hinders the research in other disciplines for its sustainable utilization. The members of the family include many culinary and aromatic herbs that are less used commercially. Many have other valuable and medicinal properties. Henrich (1992) pointed out that the family is of outstanding importance in its use in indigenous medical system, being ranked third in ethnobotanical importance in studies of medicinal plants used by North American and Indian cultures, and probably the same picture would be found in rural and primitive societies elsewhere in the world.

As a prelude to the entire family revision I have attempted with great zeal the genus *Leucas* R.Br. which is the largest genera of the mint family Labiatae (Lamiaceae) in India. Altogether, there are 99 species and 37 varieties known for the genus in the world. Of this, 41 species and 9 varieties are represented in India. (Sebald, 1980; Singh, 2001; Sunojkumar & Mathew, 2002). The southern part of the Peninsular India harbours 80% of the Asian species and is an endemic area for a wide spectrum of species and varieties found in hills and plains alike.

Species belonging to this genus are herbs or undershrubs and distinguished by its white biliabiate corolla with lower lip longer than the white or golden brownish hooded upper lip. The nature of divergent anthers and didynamous stamens, included in the upper lip of corolla, hairy, nerved and toothed calyces with annulate corolla tubes are other distinguishing characters. But the delimitation of the species in this genus cause alarming difficulties to the botanists owing to the high variation in the nature of leaves, indumentum, appearance of calyx, teeth, nature of mouth cilia and bracteoles. This diversity and existence of polymorphism among the members of the species existing in this geographical area resulted in the accumulation of names and varieties. Due to this, the genus as such badly needs a revision. But due to geographical delimitation of the species many such work done in other parts of the world (Vatke, 1875; Gurke, 1895; Sebald, 1980) were not applicable to Indian taxa.

In the revisionary work of Mukerjee (1940), this genus found in Indian empire was revised but a thorough and critical observation has not been conducted in the southern part of the country. This study conducted about 60 years back does not hold relevance now as a revision worth to recognise discontinuities among local populations on the basis of enlightenment of new taxa and nomenclatural changes. In this context a revisionary study of Peninsular Indian *Leucas* is aimed at.

After a preliminary survey of the available literature and herbarium specimens it was well cleared that herbarium material is not sufficient to resolve the

taxonomy of this genus. Extensive field studies conducted in many parts of this area and the fresh material collected and cultivated for close observations revealed that living plants exhibit additional and minute characters which are of paramount importance were not clearly seen from herbarium material. Many information on the character of the plant may lose on the way from growth site to the herbarium. The phenomenon of infraspecific variation and speciation within the genus cannot be satisfactorily investigated with herbarium specimens, which may also contain wrong identification and data. Because of this the revisionary study conducted by Singh (2001), contemporary to our work and published in a monographic form based on the available herbarium material from India is found to be scanty in many respects as a revision work. The character analysis based on dried herbarium specimen and vague illustrations were not much helpful in recognizing infraspecific taxa even for taxonomy workers. Moreover due to wrong identifications of types, the nomenclatural treatment and taxonomic distinction between species is felt to be unwary and it only left more lacunae yet to be filled in by a revisionist.

According to Stuessy (1975), in revisionary studies, when all other factors being equal, the more field work a researcher is able to do, the better will be his resultant treatment. A refined classification produced solely from herbarium material tends to be myopic in their treatment of relationships.

The same was opined recently by Gentry (1990) while working on the flora of Malaysia. According to him, "the knowledge of a field botanist can and must

take preeminence over that of a herbarium based monographer. This is the case of closely related taxa that co-exist together in exactly the same forest, but behaves as a distinct species. In other words, they pass the test of sympathy".

The present study is attempted to collect all the species from its type locality and include minor and novel information supported by proper diagrams wherever found necessary. All of the established taxa have been clarified through determinations and cross checking with the type specimens and protologue. Matching with extensive body of herbarium material not only determined the species identity but also gave a clear picture of its distribution. Nomenclatural changes have been made in consultation with experts in the fields of Lamiacean taxonomy wherever found necessary. New and available information on ecology, phytogeography and floral biology have also been included to add precision. Many species and varieties have been rediscovered after many years.

Finally an attempt is made to include quantitative synthesis of data involving phenetics and cladistics. Phenetic analysis of the genus has been attempted to find out the relationship among the species. Cladistic methods were used to trace out the Phylogeny of the Asian monophyletic sections of the genus *Leucas* R.Br. This was attempted in collaboration with experts from outside India. Eventually, my endeavour to fill in the existing lacunae in *Leucas* taxonomy were felt to be a gratifying one.

1.1 SYSTEMATICS

1.1a. Family Lamiaceae

Lamiaceae (Labiatae) is one of the largest and highly evolved angiosperm family considered to be originated as early as in the Cretaceous period (Hedge, 1986). Members of this family attracted the attention of layman and Botanists alike due to its wide economical importance. Circumscription of this family and its close relatives were a serious concern for the taxonomists from the very beginning.

The family was included in the order Lamiales by Bentham (1876) together with family Verbenaceae. This is followed by Cronquist (1981), Thorne (1981) and Takhtajan (1986). The boundary between the Labiatae and Verbenaceae is unclear. Traditionally they have been distinguished on the basis of stylar position; terminal in the Verbenaceae and gynobasic in the Labiatae. However there are some members where the gynoecium is intermediate in structure, the ovary being shallowly four-lobbed and the style neither terminal nor fully gynobasic. It is now widely accepted that Labiatae evolved from Verbenaceae (Cantino, 1990). However there are still a few genera that cannot confidently be assigned to one family. Recently due to the advancement in molecular studies and numerical phenetic and phylogenetic analysis, the circumscription of the family has undergone much alteration. Cantino et al. (1992) and Judel et al. (2000) has transferred many genera traditionally placed in Verbenaceae into Lamiaceae on the basis of phylogenetic systematics. This recent addition of isolated endemics from

Verbenaceae in diverse parts of the world into Lamiaceae, strengthened Hedge's (1986) view of cretaceous origin of Labiatae.

Since de Jussieu first used the name Labiatae in 1789, the family limits have remained virtually the same. The first overall account of the classification of Lamiaceae at family and genus level was Bentham's *Labiatarum genera et species* (1832-1836). In this classification he recognized eleven tribes for this family, which was later, reduced into eight tribes in de Candolle's Prodromous (1848) and in Genera Plantarum (1876). These pioneering works by Bentham (1848; 1876) has got its own importance as evident from the words of John Lindley, then Professor of Botany at University College, London that "...we are indebted to our friend Mr. Bentham, by whom Labiatae have been made a particular study, and to whom we confidently look for rescuing them from a state of confusion, that has gradually been increasing since the days of Linnaeus, until it has become the disgrace of Botany."

A comprehensive classification of the world Labiatae that is most widely used today is prepared by Briquet (1895-1897) in his *Die natürlichen Pflanzenfamilien* is based heavily on the work of Bentham (1832-1836, 1848, 1876). In this he increased the rank of some of the taxa and reclassified a few genera. Bentham's tribes were raised to subfamily level and the boundary of subfamily Stachyoideae (renamed as Lamioideae by Sanders and Cantino, 1984) has been enlarged by merging Bentham's two largest tribes and two smaller ones.

The classification of Labiatae and its relationship to other families has been in serious need of re-evaluation, ever since the early papers of Junel (1934) and Erdtman (1945). On the basis of palynological features, an alternative classification of Labiatae was proposed by Erdtman (1945). He suggested that the Labiatae is composed of two natural groups that differ in their pollen features and divided the family into two subfamilies: the Lamioideae, with tricolpate pollen shed in two celled stage and the other Nepetoideae, with hexacolpate pollen shed in three celled stage. According to Cantino and Sanders (1986), this classification also is highly congruent with Bentham's (1876) tribal classification. Four of Bentham's tribes comprising subfamily Lamioideae, and the other four comprising subfamily Nepetoideae. The former subfamily, usually characterized by tricolpate, binucleate pollen, albuminous seeds, spatulate embryo and the presence of iridoid glycosides, shows a closer relationship to the Verbenaceae, from which family it was widely believed the Labiatae had arisen. On the other hand the Nepetoideae, with many more species, is usually characterized by hexacolpate, trinucleate pollen, exalbuminous seeds, investing embryo and the presence of volatile terpenoides.

In 1964, Melchior, in the 12th edition of the *Syllabus der pfanzenfamilien*, give an up-dated synopsis of the supra-generic taxa, largely based on those of Bentham and Briquet. He recognized nine subfamilies of which the stachyoideae with twelve sections was by far the largest and most diverse. These nine subfamilies were grouped into three not formally named taxa, each with three subfamilies. These system is proposed based on a combination of simple

morphological charactes, linked to geographical distribution and also with their pollinators (van der Pijl, 1972).

The classifications proposed by Wunderlich (1967) also coincide well with Briquet's classification. She classified Lamiaceae into six subfamilies: Prostantheroideae, Ajugoideae, Scutellarioideae, Lamioideae, Nepetoideae, Catopherioideae (corrected according to ICBN by Sanders and Cantino, 1984).

The numerical phenetic study conducted by El-Gazzar & Watson (1970a) based on forty-six characters, involving one hundred and sixty genera of Labiatae, seventeen of Verbenaceae, three of Dicrastylidaceae, and two of Stilbaceae provided further support for Erdtman's subfamilies. The two principal branches of their phenograms correspond to Erdtman's subfamilies.

However the genus *Leucas* was treated in Lamioideae in all the system proposed so far. However Hedge (1992) opined that a substantial number of the currently recognized subfamilies and tribes are artificial, due to undue emphasis has been given to particular features and often very few characters have been used in the definition of the higher taxa.

In an attempt to give a monophyletic status to the family Labiatae and its subfamilies, Cantino, Harley & Wagstaff (1992), proposed a classification system based on their phylogenetic analysis (Cantino, 1992 a, b). This system corresponds

very closely with Wunderlich's system (1967) at the subfamily level, but adopted Erdtman's circumscription of the subfamily Nepetoideae. In their newly proposed system the authors have recognized eight subfamilies: Ajugoideae, Chloanthoideae, Lamioideae, Nepetoideae, Pogostemonoideae, Scutellarioideae, Teucrioideae, and Viticoideae. The main innovations in this system is that the steps have been taken to re-assign a major parts of the Verbenaceae to the Labiatae, in an attempt to resolve some of the problems of polyphyly and paraphyly. At the same time, the Chloanthaceae, previously recognized either as a separate family or as a subfamily of Verbenaceae, is now reduced to a subfamily of Labiatae and contains within it the genera that formerly comprised the Prostanthereae. The Teucrioideae is another subfamily recognized here, that includes elements formerly included both in the Labiatae and the Verbenaceae. The subfamily Viticoideae that include members of Verbenaceae has been added and a new sub family Pogostemonoideae has been constructed. This new system of classification gives a different outlook to the family Labiatae, as it now includes large forest trees like Teak and plants with fruits varying from traditional four nutlets to large fleshy druplets. It will surely take some time for the botanical community to come in terms with this radically different concept for the family Labiatae.

Table (1) gives a comparative outline of different classification of Labiatae and the position of *Leucas* in each system.

<table>
<tr><th>Bentham (1876)</th><th>Briquet (1895-1897)</th><th>Erdtman (1945)</th><th>Wunderlich (1967)</th><th>Cantino et al. (1992)</th></tr>
<tr><td>Tri.: Ajugeae ("Ajugoideae")</td><td>SF.: Ajugoideae</td><td rowspan="6">SF.: Lamioideae</td><td>SF.: Ajugoideae</td><td>SF.: Ajugoideae</td></tr>
<tr><td>Tri.: Prostanthereae</td><td>SF.: Prostantheroideae</td><td>SF.: Prostantheroideae</td><td>SF.:Teucrioideae (include verbenacean members)</td></tr>
<tr><td>Tri.: Prasieae</td><td>SF.: Prasioideae</td><td rowspan="2">SF.: Lamioideae*</td><td>SF.: Pogoste-monoideae</td></tr>
<tr><td rowspan="3">Tri.: Lamieae* ("Stachydeae")</td><td>SF.: Scutellarioideae</td><td>SF.: Lamioideae*</td></tr>
<tr><td rowspan="4">SF.: Lamioideae* ("Stachyoideae"</td><td>SF.: Scutellarioi-deae</td><td>SF.: Scutellarioideae</td></tr>
<tr><td rowspan="5">SF.: Nepetoi-deae</td><td rowspan="4">SF.: Nepetoideae</td><td rowspan="3">SF.: Nepetoideae</td></tr>
<tr><td>Tri.: Nepeteae</td></tr>
<tr><td>Tri.: Salvieae ("Monardeae")</td></tr>
<tr><td>Tri.: Mentheae ("Satureineae")</td></tr>
<tr><td rowspan="3">Tri.: Ocimeae ("Ocimoide-ae")</td><td>SF.: Ocimoideae</td><td rowspan="2">SF.:Chloranthoi-deae (include verbenaean members)</td></tr>
<tr><td>SF.: Lavanduloideae</td></tr>
<tr><td>SF.: Catopherioideae</td><td>SF.: Catopherioi-deae</td><td>SF.: Viticoideae (Verbenacean members)</td></tr>
</table>

(* Place of *Leucas* R.Br. in each system; Abbreviations: Tri. = Tribe; SF.: = Subfamily)

Table: 1. Comparison of classification of Lamiaceae by Bentham (1896), Briquet (1876), Erdtman (1945), Wunderlich (1967) Cantino et al. (1992) and the position of the genus *Leucas* R.Br. in each systems. Nomenclature follows Sanders and Cantino (1984)

1.1b. Genus *Leucas* R.Br.

The genus *Leucas* is one among the 250 genera of the family Lamiaceae and has pantropical distribution. The immediate ancestor of the genus is not known and the phylogenetical relations are largely obscure (Hedge, 1992). The genus is

relatively rich in primitive characters. There are shrubby species, the leaves (bracts) subtending the verticillasters are not bracteose, the inflorescence is often not separated from the vegetative part of the plant and also not formed to a condensed spike like or head like false inflorescence. The number of flowers is not fixed. This genus can be distinguished from other members of the *Lamiaceae* by its 6-10 toothed calyx and white flower with lower lip of corolla longer than the bearded upper lip. It shows similarity to *Anisomeles* (Bentham 1848) but the latter has a calyx, which are equally five lobed and nerved.

The genus was originally included in *Phlomis* by *Linnaeus* (1753), Forskal (1775), Retzii (1779), Jacquin (1781), Swartz (1788), Vahl (1794), Willdenovio (1800), Roth (1821), and was transferred to *Leucas* by Brown (1810).

The only full and most comprehensive monographic account of *Labiatae* with infra familial classification and descriptions of every then known species is that of the Bentham (1832–36) which he later modified in De Candolle's Prodromous (1848) and the *Genera Plantarum* (1876). He placed the genus *Leucas* in the tribe *Stachydeae* and subtribe *Lamieae* near to *Otostegia* and *Lasiocarys* together with other 21 genera. Briquet (1895 – 1897) placed *Leucas* in the Subtribe *Lamiinae* together with many other genera such as *Phlomis, Physoleucas, Leonotis, Eremostachys, Notochaete, Galeopsis, Lamium*. Most of the subsequent authors dealing with classification of *Lamiaceae* in floras and text books like Komarov (1954); Clapham, Tutin and Warburg (1962); Gleason and Cronquist, (1963);

Melchior (1964) are either repetitions or minor modifications of the treatment of Briquet (1896 summarised by Airyshah 1966) and make no appreciable contribution towards the better understanding of the arrangement of the genera.

Wunderlich (1967), even though neither diagnosed her taxa nor listed the genera included in her classification, but it is clear from her notes that she also followed Briquet in the circumscription of taxa.

El-Gazzar & Watson (1970a) who used numerical methods to investigate relationship within *Labiatae* and *Vebenaceae* placed *Leucas* in the group of *Anisomeles* and several other genera like Marrubium not included in the sub tribe *Lamieae*. The African and Arabian species of *Leucas* were revised by Sebald (1980) considered the northeast tropical African to Arabian *Otostegia* section *Otostegia* as the closest relative of *Leucas*. They agree in the characters of inflorescence, corolla, stamens, and in the mode of hairiness with *Leucas*. Otostegia species have almost equally long style branches that are present in some Asian *Leucas* members also. The condition of having the fruiting calyces easily breaking off from the plant was suggested to be a common origin in *Otostegia* sect *Otostegia* and *Leucas* section *Physoleucas*. The relationship of the monotypic *Isoleucas* from South Yemen with *Leucas* on the corolla and stamen characters was first described by Schwartz in 1939. According to him, *Isoleucas* has as in *Otostegia* and *Leucas* at the margin of the upper lip, a dense beard of stiff simple several-celled hairs. He also opined that one may regard *Isoleucas* as a "missing

link" between *Leucas* and *Otostegia* on the one side and other genera of the Laminae which possess branched hairs but also some characters occurring in *Leucas*. The combination of branched hairs at the outside of the corolla upper lip with a beard of simple hairs at the margin is to be found in a part of the *Eremostachys* and *Phlomis* species. Both genera are separated from *Leucas* by a number of other characters.

The distinctive bird pollinated genus *Leonotis* was also considered as a possible relative of *Leucas* by Sebald (1980) because of the simple hairs and bearded nature at the outside of the upper lip. Its flowers are however yellow or red as in some Asiatic species of *Leucas*. In *Leonotis* the calyces have10 ribs, 10 teeth and unequal style branches as in *Leucas*. Equally 10-ribbed calyces as they are typical for most *Leucas* species occur only in a few Laminae genera as in *Otostegia, Isoleucas, Leonotis* and *Ballota*.

Due to the presence of similar zygamorphic calyces and the absence of branched hairs, Sebald (1980) consider the genus Acrotome Benth ex Endl. also as a probable relative of *Leucas*.

Hedge (1992) in his provisional attempt to indicate some generic relatiaonship among the *ca.*180 *Lamiacean* genera in Europe, Mediteranean and South-West Asia, considered *Leucas* as closely related to *Otostegia, Marrubium* and *Roylea* (Table. 2).

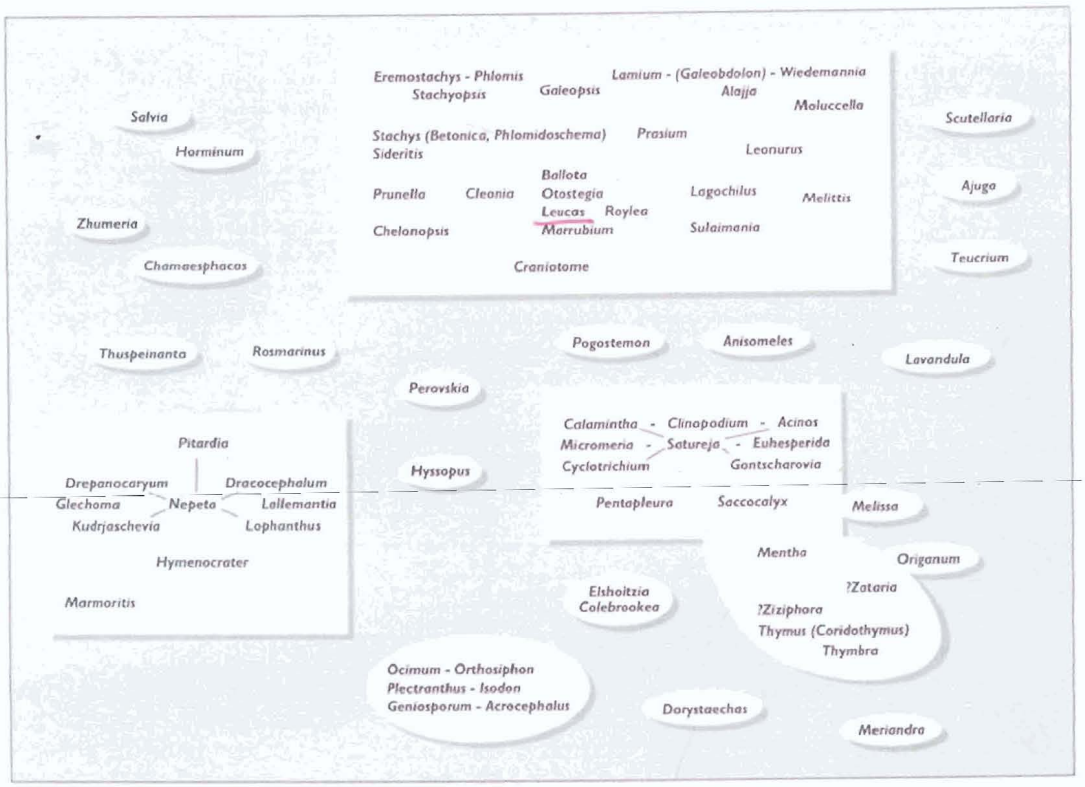


Table.: 2. Relationship of *Leucas* with other genera (Hedge, 1992)

He gave a scarcely independent status to *Leucas* and *Roylea*. According to him in recent years the cladistic approach together with the utilization of wide range of character has given a new insight into the family and its internal and external relationships. To quote what Bentham had to say about the *Labiateae* in 1834 "Everything brings further proof of the possibility of reducing nature to anything like a mathematical accuracy" has well applied in the new infrafamilial phylogenetic classification and status to genera of *Labiateae* emended by Cantino, Harlye & Wagastaff (1992). In this *Leucas* was included in the subfamily *Lamioideae*

together with many other genera and assigned to tribal status. According to this system *Leucas* (from Africa and Asia), *Leonotis* (from Africa) and *Otostegia* (from Africa and Asia) are apparently related, resembling each other mainly by having a beard along the margin of the upper lip of corolla, usually 10 lobbed calyx and by the absence of branched hairs.

Ryding (1993), after investigating pericarp anatomy opined that in common with most *Lamioideae, Otostegia* and *Isoleucas*, the nutlet of many *Leucas* species have a thick sclerenchyma region (bone cell layer). According to him due to the presence of a thin to strongly reduced sclerenchyma region the African species of *Leucas* are near related with *Leonotis* and *Acrotome* species than with the Asiatic *Leucas* species. Only some *Leucas* species (*L. neuflizeana* Courbon, *L. aequistylosa* Sebald, *L. stachydiformis* Briq. and *L. nubica* Benth.) of north east tropical Africa and Arabia are nearly related to Asiatic *Leucas*.

1.1c. Infrageneric classification

Soon after the establishment of the genus by Robert Brown, transfer of a good number of species earlier designated in *Phlomis* and its grouping based on similarities was initiated by Sprengel (1825). He classified all the then known seventeen species into two broad infrageneric sections ***Fruticosae*** and ***Herbaceae***, based on its habitat. The largest section ***Herbaceae***, characterized by herbaceous

plants include fifteen species whereas ***Fruticosae***, the sub-shrubby to shrubby forms contain two species.

But a comprehensive study of this genus based on a wide collection from Asian countries was done by Bentham (1830), depending on Wallich's collection. He listed thirty-four species in four groups viz., ***Hemistoma, Plagiostoma,*** **Astrodon** and ***Ortholeucas***. These four groups were established as sections by Bentham in *Labiatarum Genera et Species* (1834). The section ***Hemistoma*** is characterized by oblique calyx which is splitted above and produced below, many flowered and bracteoles equal to the calyx. Whereas in ***Ortholeucas***, the mouth is equal, with naked throat and minute bracteoles. In ***Astrodon***, the calyx mouth is equal and the throat is villous, bracteoles equals the calyx in size. In the most advanced fourth section ***Plagiostoma***, the calyx is turbinate with oblique mouth and projecting upper part. The throat in this group is glabrous or nearly so and bracteoles equal to the calyx in size. Keeping these four sections, Bentham (1834) added one more section ***Loxostoma*** to include an Arabian species *L. glabrata* that is characterized by a calyx with oblique mouth and produced lateral and lower side, the bracteoles are minute.

This system of five-section treatment was followed by Endlischer (1838) in his Genera Plantarum. In de Candolles Prodromous, Bentham (1848) added one more section ***Physoleucas*** to accommodate another distinct Arabian species *L. inflata*, which had inflated calyx, contracted mouth, minute bracteoles and

inflorescence with 6–10 flowers. Altogether he had included fifty-one species of *Leucas* and three species of *Lasiocorys* in these six sections. Of this, forty-one species are occurring in Asia and the rest in Africa and Arabia. He followed the same infrageneric treatment in his monumental work *Genera Plantarum* (Bentham, 1876) also.

Gurke (1894, 1895) while working on Arabian *Leucas* followed Benthams view and created one more section *Lasiocarys* to accommodate seven African endemic species which are shrubs, almost sessile leaves, short and oblique calyx with 5 – 10 lobes and minute bracteoles.

Briquet (1895–97) also followed Bentham and Gurke in his six sectional treatment of the genus to include African and a few Asian species.

Hooker (1885), while describing plants of Indian sub-continent followed Bentham (1830) to include Indian *Leucas* in four sections.

Baker (1900) reorganized the African *Leucas* species in Flora of tropical Africa under three sections: Astrodon, Plagiostoma and Laxostoma. The sections Physoleucas and Ortholeucas were included in Astrodon, because of the common character of not possessing an obliquely produced mostly ten teethed calyx. The section Hemistoma included in section Loxostoma because both sections have abaxially produced calyx limbs. He has enumerated sixty-six *Leucas* and six

Lasiocarys in three sections, but of these, six are not *Leucas* species. Baker's concept of reducing section number might not seem a right way to a better classification as this does not give a true systematic treatment.

After a gap of many years since then, a thorough study of *Leucas* species available in Africa was carried out by Sebald (1980). He followed Gurke (1895) and included all Arabian species into twelve sections viz *Stachydiformis, Spiculifolia, Physoleucas, Neuflizeana, Lasiocorys, Ogadenia, Virgatae, Squarrosicymae, Loxostoma, Somalensis, Hemistoma, and Plagiostoma* with ***Hemistoma*** being the largest representative.

Very recently Singh (2001) treated fifty taxa of Indian *Leucas* in seven sections. He retained sections ***Hemistoma***, ***Plagiostoma*** and ***Astrodon*** of Bentham and split ***Ortholeucas***, and ***Plagiostoma*** to include ***Stricta***, ***Leucas*** (Ortholeucas), ***Hyssopifolia*** and ***Diffusa*** as new sections. However, this treatment especially the creation of section ***Stricta*** is controversial as the characters used are not relevant in some members and form an unnatural group.

1.1d. History of the genus

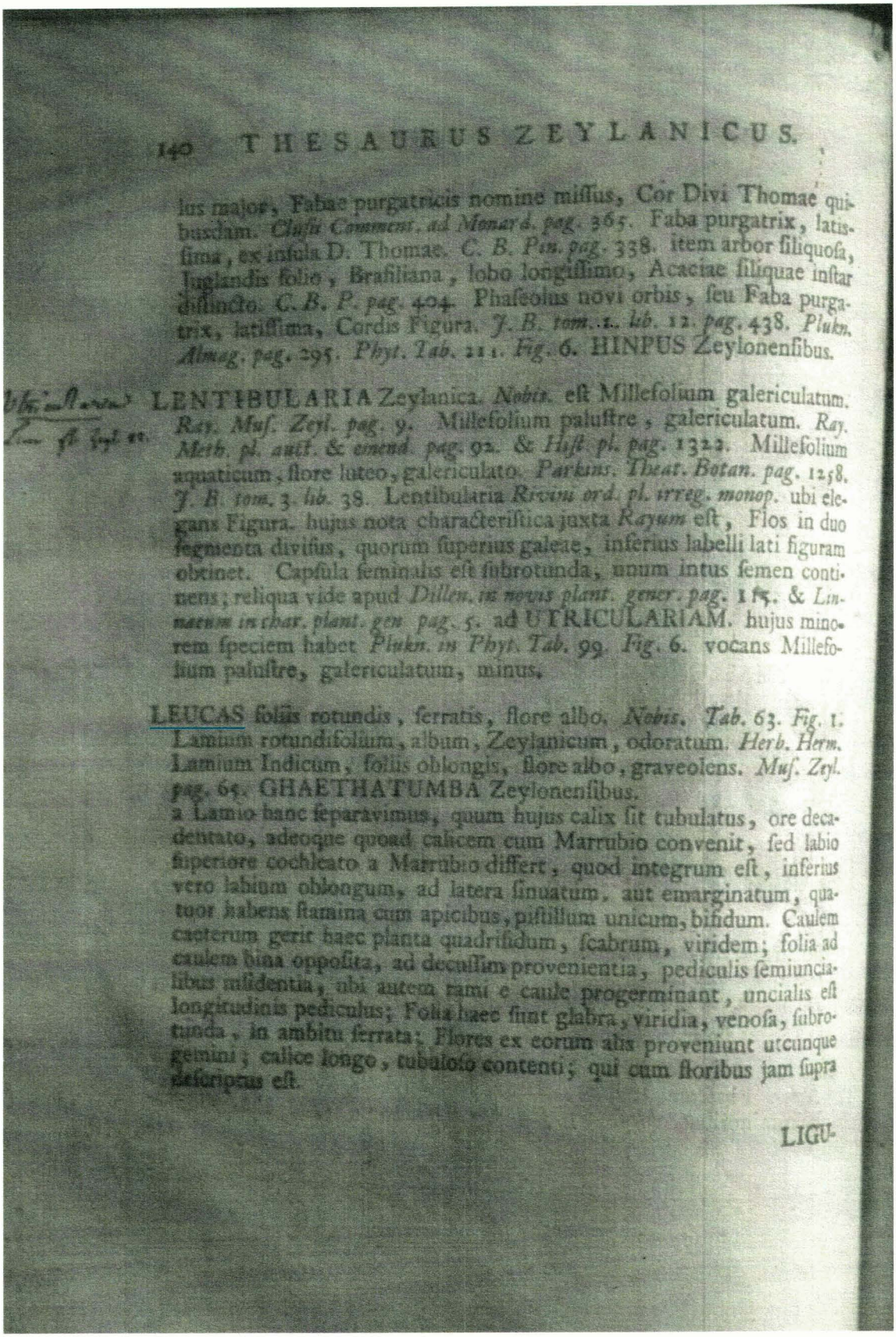
Leucas, as a medicinal herb of high therapeutic value was well known as "Dronapushpi" in many ancient Sanskrit literature pertaining to indigenous

medicine. Illustrations of this plant in botanical work appeared first in Van Rheed's **Hortus Malabaricus** (1678-1693), in which Rheed named it as **Tumba** in vernacular language (Malayalam script) based on collections from the Malabar coast.

During the pre-Linnaean period the genus was identified by Johannes Burman (1707-1778) in his **Thesaurus Zeylanicus** (1737) as "*LEUCAS foliis rotundis, serratis, flore albo*". This treatment was based on a plant collected by Paul Hermann (1648-1695) from Ceylon and named as *Lamium indicum, foliis oblongis, flore albo graveolens.* with vernacular name "Ghaetha tumba" in **Museum Zeylanicum** (1717) a slim book which lists Hermann herbarium (Desmond, 1992).

Linnaeus (1753), included his collection of *Leucas* species in *Phlomis* (*P. zeylanica, P. indica*), *Leonurus* (*L. indicus*) and in *Nepeta* (*N. indica*). N L Burmann (1768) treated his father J. Burman's *Leucas foliis rotundis*..... as a synonym of *Nepeta indica* of Linnaeus and also considered Rheed's Tumba is of *Leonurus indicus*.

Jacquin (1760) treated his collection of a *Leucas* species from Martinica as *Clinopodium martinicense*. Following Linnaeus, Retzii (1779) and Swartz (1788) effectively transferred Jacquin species into *Phlomis* as *P. martinicensis*. Retzii (1779) also named his own collection of a species from China as *Phlomis chinensis*.



140 THESAURUS ZEYLANICUS.

lus major, Fabae purgatricis nomine miſſus, Cor Divi Thomae quibusdam. *Cluſii Commenſ. ad Monard. pag.* 365. Faba purgatrix, latiſſima, ex inſula D. Thomae. *C. B. Pin. pag.* 338. item arbor ſiliquoſa, Juglandis folio, Braſiliana, lobo longiſſimo, Acaciae ſiliquae inſtar diſtincto. *C. B. P. pag.* 404. Phaſeolus novi orbis, ſeu Faba purgatrix, latiſſima, Cordis Figura. *J. B. tom.* 1. *lib.* 12. *pag.* 438. *Pluken. Almag. pag.* 295. *Phyt. Tab.* 211. *Fig.* 6. HINPUS Zeylonenſibus.

LENTIBULARIA Zeylanica. *Nobis.* eſt Milleſolium galericulatum. *Ray. Muſ. Zeyl. pag.* 9. Milleſolium paluſtre, galericulatum. *Ray. Meth. pl. auct. & emend. pag.* 92. & *Hiſt. pl. pag.* 1322. Milleſolium aquaticum, flore luteo, galericulato. *Parkins. Theat. Botan. pag.* 1258. *J. B. tom.* 3. *lib.* 38. Lentibularia *Rivini ord. pl. irreg. monop.* ubi elegans Figura. hujus nota characteriſtica juxta *Rayum* eſt, Flos in duo ſegmenta diviſus, quorum ſuperius galeae, inferius labelli lati figuram obtinet. Capſula ſeminalis eſt ſubrotunda, unum intus ſemen continens; reliqua vide apud *Dillen. in novas plant. gener. pag.* 115. & *Linnaeum in char. plant. gen. pag.* 5. ad UTRICULARIAM. hujus minorem ſpeciem habet *Pluken. in Phyt. Tab.* 99. *Fig.* 6. vocans Milleſolium paluſtre, galericulatum, minus.

LEUCAS foliis rotundis, ſerratis, flore albo. *Nobis. Tab.* 63. *Fig.* 1. Lamium rotundifolium, album, Zeylanicum, odoratum. *Herb. Herm.* Lamium Indicum, foliis oblongis, flore albo, graveolens. *Muſ. Zeyl. pag.* 65. GHAETHATUMBA Zeylonenſibus.

a Lamio hanc ſeparavimus, quum hujus calix ſit tubulatus, ore decadentato, adeoque quoad calicem cum Marrubio convenit, ſed labio ſuperiore cochleato a Marrubio differt, quod integrum eſt, inferius vero labium oblongum, ad latera ſinuatum, aut emarginatum, quatuor habens ſtamina cum apicibus, piſtillum unicum, bifidum. Caulem caeterum gerit haec planta quadrifidum, ſcabrum, viridem; folia ad caulem bina oppoſita, ad decuſſim provenientia, pediculis ſemiuncialibus inſidentia, ubi autem rami e caule progerminant, uncialis eſt longitudinis pediculus; Folia haec ſunt glabra, viridia, venoſa, ſubrotunda, in ambitu ſerrata; Flores ex eorum alis proveniunt utcunque gemini; calice longo, tubuloſo contenti; qui cum floribus jam ſupra deſcriptus eſt.

LIGU-

Fig.: 1. Thesaurus zeylanicus page no. 140 in which the term *Leucas* appeared first

Fig. 1a: Type of *Leucas biflora*. (Thesaurus zeylanicus p. 140; t. 63; f. 1.) (from Paris Herbarium. P)

Vahl (1794) recognized Herman's collection of Indian material as *Phlomis* and given the species name *Phlomis biflora.* He also treated one more species *Phlomis urticifolia* based on King's collection from India and Forskal's collection from Arabia.

At the beginning of 18th centuary, Willdenovio named a species *Phlomis decemdentata* in his **Species Plantarum** (1800) and in **Hortus Berolensis** (1809), enumerated his collection of a new species *Phlomis aspera* from Caramania.

During the same time Robert Brown (1810) found it suitable to separate the white bilabiate flowered species from *Phlomis* and put under a new genus name *Leucas.* He selected the genus name from the first word of Burman's (1737) multinial name "*LEUCAS*.....' to refer to the white colour of the flower ("*Leucas* is an ancient Greek name for some herb now unknown to us, so called on account of its whiteness"...Smith, 1812) He described a new species *Leucas flaccida* based on Bank's collection from Australia—Nova Hollanda, which now form the type species of the genus. Together with this he also transferred eight of the earlier species names used by Linnaeus, Swartz, Vahl, Willdenovio and Retzii into *Leucas* but was not expressively done. In another publication after one year Robert Brown (1811) expressively made this transfer for three species. Smith (1812) validly described all the earlier names with proper reference to earlier works. He also used a nomen novum *Leucas lavandulifolia* to describe Linnaeus *Leonurus indicus.*

Roth (1821), without knowing Robert Brown's treatment again used the genus name *Phlomis* to describe *Leucas* species in his **Nova Plantarum Species,** which described new taxa that he had collected from India. He used the name *Phlomis linifolia* for *Leucas lavandulifolia* and *Phlomis pluckenti* for *Leucas aspera.* Four new species *Phlomis cephalotes, Phlomis nutans, Phlomis montana and Phlomis hirta* were named by him based on Benjamin Heyne's collection from oriental India.

1.1e. Taxonomy of *Leucas* —Indian scenario.

Knowledge of plants and its grouping based on utility purposes were used widely in India from time immemorial. But floristic and Botanical systematics of Indian plants had its inchoation during the colonial period. Botanical impression of *Leucas* appeared first in Van Rheede's **Hortus Malabaricus** (1678- 1693). This work had a great leverage on the subsequent workers like Herman in using the vernacular name *Tumba.*

Earlier Botanical studies in India were instituted by Europeans. William Roxburg, the superintendent (1793-1813) of Indian Botanical Garden made extensive collection of plants from Bengal and east coast. His **Hortus Bengalensis** (1814) enumerating plants of Botanic Garden, Calcutta includes four species of *Leucas.* He also gave descriptions of ten species including four new names under the genus name *Phlomis* in **Flora Indica** (1832).

Almost during the same time, extensive collection of plants from Southern parts of India was made by Robert Wight. He made comprehensive Illustrations of a species of *Leucas* in his famous **Illustrations of Indian Botany** (1831) and seven in **Icones Plantarum Indiae Orientalis** (1838-1853).

Botanical knowledge of *Leucas* species had its pinnacle in Asia, especially in Indian empire when William Wallich published his **Plantae Asiaticae Rariores** (1830). In this work, George Bentham described 34 species mainly based on Wallich's and Wight's collections. Later, Bentham published a monograph **Labiatarum Genera et Species** (1834) on Labiateae, in which he described forty two species for this genus in the world, spreading over Asia, Africa and Arabia. This includes several species he had collected from India. Later in De Candolle's **Prodromous Systematis Naturalis Regni Vegetabilis** (1848), he increased the total number of *Leucas* by forty-eight.

History of Floristic studies in India marked its peak when J D Hooker published **Flora of British India** (1872-1897). In this monumental work, spread in seven volumes, the family Lamiaceae and included genus *Leucas* was treated in volume fourth. In this, Hooker recorded 38 species and many varieties treated after a summarization of all the earlier works and his own collections. Three new species and several varieties were newly named by him.

During the same time floristic studies of Labiatean plants in Africa were published by Gurke (1895, 1905) in a series of volumes. More than forty seven species reported from this area were much different from Indian species. This include two African species, *L. urticifolia* and *L. martinicensis*, reported from India. After Gurke, floristic account of African species of *Leucas* was dealt by Baker (1900), Morton (1962) and Angulo (1970).

Fyson (1915) had given an account of the endemic species of *Leucas* seen in one of the biodiversity hot spots of South India –the Pulney hills. Gamble's **Flora of Presidency of Madras** (1915–1936) is a comprehensive work giving a detailed floristic account and an identification key for thirty-one species and seven varieties. This amount to seventy eight percent of *Leucas* species reported from Asia.

A true revisionary study of Labiatae so far known from Indian empire had been undertaken by Mukerjee (1940). In his published work, 43 species and 11 varieties of *Leucas* were described in detail with an artificial key for identification. It is considered as a comprehensive study undertaken after Bentham (1834) on this genus, giving enough illustrations and an artificial key for each taxa.

Taxonomic revisionary studies supported with comparative morphology of a number of specimens from different herbaria were carried out by Oskar Sebald (1977a; 1977b; 1978; 1980) for African and Arabian *Leucas*. This work is a land mark for *Leucas* taxonomy in this area. In this, Sebald reported the common

occurrence of 4 species of *Leucas* in Africa, Arabia and Asia. Among the fifty-six species and forty-four varieties reported, many are new combinations based on true taxonomic analysis verified with type specimens. While working on the Flora of Arabia, Hedge (1982) reported an interesting endemic species of *Leucas* from Oman. He named this as *Leucas dhofarensis* Hedge & Sebald. According to Hedge this is a relatively relict species because it shares the character of both section Hemistoma and Physoleucas. With this species the total number of Arabian *Leucas* becomes eleven. Thus this genus becomes the third largest genus in Arabian Peninsula.

Taxonomic studies and field collections of South Indian *Leucas* had been carried out elaborately in the recent past. This gave birth to many state floras, district floras and research publications enlightening the species diversity and new taxa endemic in this area. The major local floras published, research work conducted and reports of the various projects undertaken on the genus *Leucas* in South India are enumerated below (Table: 3).

State/ District name	Author of the flora	Year of public-cation	No. of species
I. ANDHRA PRADESH STATE			
Vizakapatanam	Venkateswarulu et al.	1972	3
Srikakulam	Rao & Sreeramulu	1986	6

West Godavari	Rao et al.	1986	4
Anantapur	Pullaiah & Yesoda	1989	7
Nallamalais	Ellis	1990	4
Vizakapatanam *	Rao	1991	4
Adilabad	Pullaiah et al.	1992	3
Kurnool	Raju & Pullaiah	1995	7
Nizambad	Pullaiah & Rao	1995	5
Flora of A P (Vol:3)	Pullaiah & Moulali	1997	19
Krishna	Lakshminarayana et al.	1997	6
Medak	Pullaiah et al.	1998	6
Guntur	Pullaiah et al.	2000	4
Rangareddi	Pullaiah & Mohammed	2000	4
II. KARNATAKA STATE			
Bangalore	Ramaswamy & Razi	1973	6
Hassan	Gandhi in Saldanha & Nicolson	1976	7
Chickmagalur	Yoganarasimhan et al.	1981	4
Mysore	Rao & Razi	1981	17
South Canara	Arora et al.	1981	3
Flora of Karnataka	Saldanha et al.	1984	18
Eastern Karnataka V: 2	Singh	1988	7
Coorg (Kodagu)	Kesavamurthy & Yoganarasimhan	1990	9
Udupi	Bhat	2003	2
III. KERALA SATATE			
Calicut	Manilal & Sivarajan	1982	3
Quilon	Mohanan	1987	5
Cannanore	Ramachandran & Nair	1988	9
Silent Valley	Manilal et al.	1988	6
Kasaragod*	Ansari	1989	5

Malappuram*	Babu	1990	4
Palghat	Vajravelu	1990	7
Pathanamthitta*	Anilkumar	1993	4
Thiruvananthapuram	Mohanan & Henry	1994	7
Tenmala	Subramanian	1995	5
Nilambur	Sivarajan & Mathew	1996	4
Trissur	Sasidharan & Sivarajan	1996	4
Shenduruny WLS**	Sasidharan	1997	2
Periyar Tiger Reserve**	Sasidharan	1998	8
Chinnar**	Sasidharan	1999	7
Alapuzha*	Sunil	2001	3
Agasthya mala	Mohanan & Sivadasan	2002	3
Parambikulam**	Sasidharan	2002	5
Mannavan Shola*	Kishorekumar	2004	8
IV. TAMIL NADU STATE			
Nilgiris & Pulney hill Vol: 1	Fyson	1915	6
Madras	Mayuranathan	1929	4
Flora of T N Analysis	Henry et al.	1987	29
Courtallum	Nair & Nayar	1987	2
Coimbatore	Chandrabose & Nair	1988	3
Central TN	Matthew	1991	15
Periyar*	Venkatasubramanian	1992	10
Pulney hills	Matthew	1998	12
Fl. T N Karnatic	Rani & Matthew	1983	10

* Ph.D Thesis; ** Research Reports

Table 3. Number of *Leucas* R.Br. species mentioned in the Indian states and district floras

Subbarao and Kumari (1968) reported a new species *Leucas mukerjiana* from Andhra Pradesh. Shetty and Vivekanandan (1968), Chandrabose and Srinivasan (1975), Subbarao and Kumari (1969) reported new varieties based on their collection from the same area. While making an inventory of the plant diversity of Gulf of Mannar biosphere reserve of Ramanathapuram district in Tamil Nadu, Umamaheswari and Daniel (1999) reported a new herbaceous species, *Leucas anandaraoana* from an isolated small island. In a recent comprehensive revisionary study of Indian *Leucas* for the Flora of India Project, Singh (1997; 2001) recognized forty species of *Leucas* in India including a new species *Leucas manipurensis*.

Very recently we have published a detailed description and Taxonomy of the new species *Leucas beddomei* (Sunojkumar & Mathew, 2002) and *Leucas sebaldiana* (in print) recognized, based on our research work.

1.2. AREA OF PRESENT STUDY

1.2a. Physiography

Present study area, the southern part of Peninsular India comprises four states Kerala, Karnataka, Tamil Nadu, Andhra Pradesh and Union territories of Mahe and Pondicherry. This peninsula is a triangular plateau, flanked on the east by Bay of Bengal, South by Indian Ocean and West by Arabian Sea. Southern peninsula represents the core area of Indian peninsula with regard to its vegetation and varied life forms. Lying on the south of Maharashtra, Madhya Pradesh and Orissa states, the triangular plateau covers an area of 4,67,186 sq. km of Indian territory.

Physical conditions of a geographical area set the context within which the varieties of life forms develop. The physiographic peculiarities and varied bio-climatic regimes supported extensive variety of ecosystems and vegetation in South India.

Peninsular plateau is highest in the south west and slopes eastwards. The Western Ghats rise abrupt in the south western coastal plains with an average height of 1200 m. Lying parallel to the sea coast, this continuous hill ranges show discontinuity in the Palakkad gap. In the southern part of this gap are the Anamalai, Cardamom hill ranges. Anamudi in the Anamalai hills is the highest peak (2695 m) in the peninsular India.

STUDY AREA

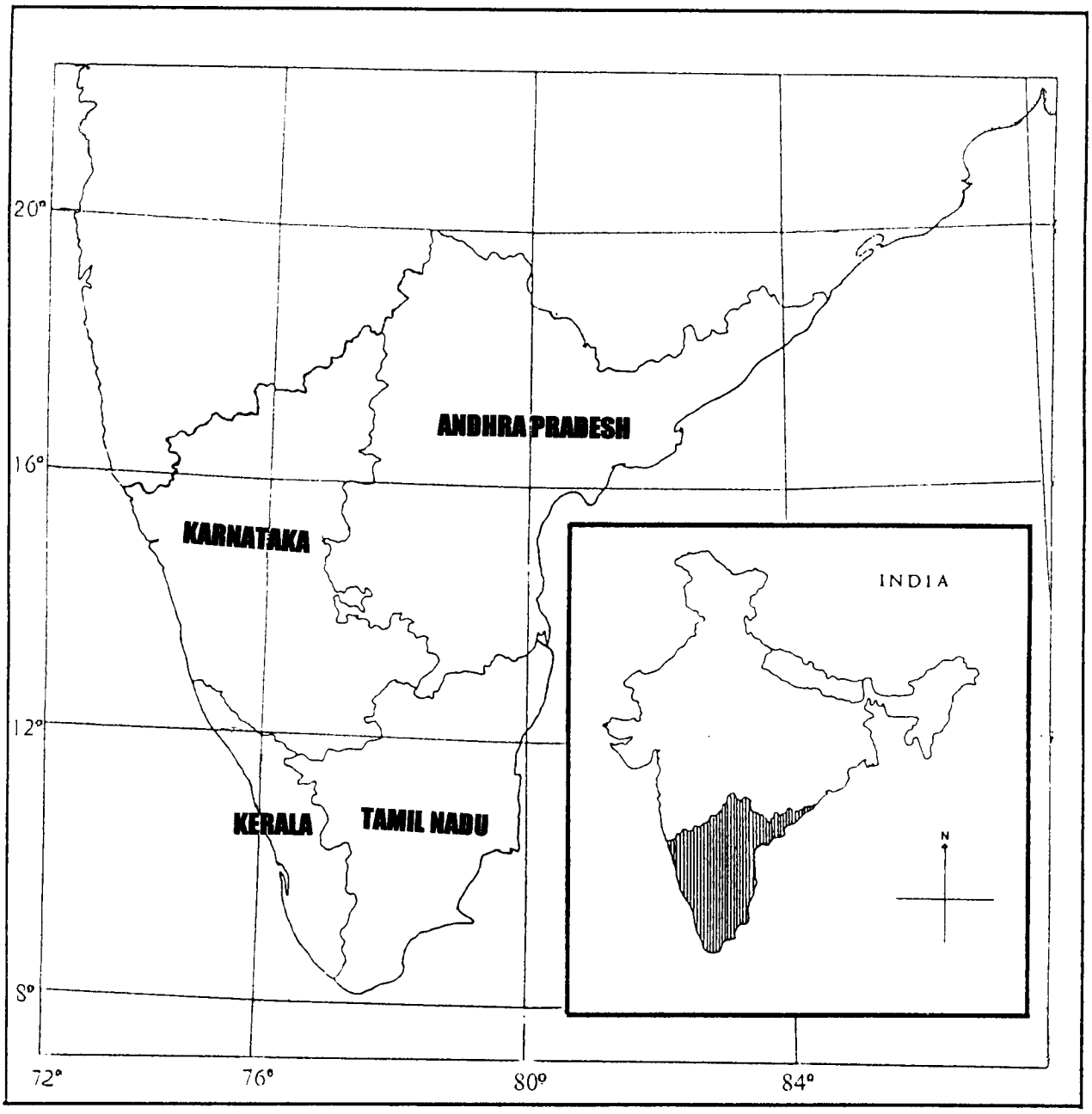


Fig. 1: Map of the Study area (Southern Peninsular India)

Eastern side of plateau is marked by a series of isolated hills known as Eastern Ghats. Streching from the Mahanadi river valley to the Nilgiris, this dissected plateau form the eastern borders of the Peninsular Plateau. The eastern edge of the Nilgiri, Anamalai, and Palani Hills are also parts of the Eastern Ghats (Mani, 1974). There are some isolated hills in the southern end. The average height of Eastern Ghat is 450-1200 m with a wide gap in between Godavari Krishna valley.

The Eastern Ghat joins the Western Ghat in the Nilgiri plateau. This is an extensive plateau about 35 miles long and 20 miles broad and formed by a series of undulating hills and valleys (Ranganathan, 1938). The average height of this plateau is 1950 m and the highest peak Doddabetta attains a height of 2637 m. This plateau is named as Nilgiri biosphere reserve and is considered as the hot-spot of biodiversity and endemism. Western side of Peninsula is flanked by Malabar Coast and eastern side by Coromandel coast. On the eastern coast, towards the southern end lies a group of small islands which is named as the Mannar biosphere reserve.

The Deccan plateau lies the middle of both Western and Easten Ghat. This region is a comparatively dry elevated tableland interspersed with numerous isolated hills, has generally light rainfall and dry climate (Henry et al., 1996). Among the three physiographic divisions of the Deccan plateau, the South Deccan Plateau lies in the South India. Due to the complex physiography, South Deccan Plateau is again divided in to Telengana plateau, Rayalaseema uplands, Karnataka plateau and Tamil Nadu uplands. Karnataka plateau is again divided into North Karnataka

plateau and Mysore plateau towards the southern end. Mysore plateau is the loftiest and most well defined plateau of southern India, lies in between Eastern Ghats and Nilgiris. Mysore plateau is again divided into the hilly area the Malnad; and the Maidan, which is mostly plains.

The southern peninsular plateau is drained by a number of rivers and innumerable little streams. Peninsular rivers are entirely fed by monsoon and often more or less dry in summer. The coastal rivers are relatively small streams drain the western side of the Western Ghats and pass through narrow plains and flow into the Arabian sea. The inland rivers are big with a fan shaped catchment area and have extensive deltaic deposits. The inland rivers flowing west pass through mountain ridges and they are narrow and lack delta on their mouth. The main inland rivers in Deccan plateau are Godavari, Krishna and Kaveri. The longest river of Deccan, the Godavari coves 10% of the total area of India. Krishna is the third largest in India and second longest in Peninsula. The southern state Kerala is drained by about 44 rives and number of lakes.

Southern Peninsular India contains a large number of big and small lakes and swamps. Larger lakes play certain role in controlling the local climatic conditions and provide ideal habitat for some specific group of plants. Several swamps both freshwater and saline occur in this region. These are low-lying lands where the water table has reached the land surface. In swamps, vegetation grows in abundance

and turned to peat in long run. Several such high land peat bogs are occurring in Nilgiri hills and the soil is very humid there.

The geology of Indian peninsula is relatively complex. Western Ghat do not correspond to any particular geological formations (Pascal, 1988). The southern Western Ghats belong to the highly varied pre-Cambrian shield. The common feature of these rocks is that they are devoid of fossils, heterogeneous in origin and more or less thoroughly reshuffled by new intrusions, faults and metamorphism. The Dharwar system, considered to be among the oldest in Indian is well represented on the Karnataka plateau. It fans out from Kudremukh region in three directions; east to Mysore, north to Goa and to west coast direction.

The crystalline rocks that form a major part of the peninsula are the 'peninsular gnesis'. They are heterogeneous mixture of gnesis and different kinds of intrusive granites. They are encountered almost all along the ghats and in Tamil Nadu district of Tirunelvli, Madurai, Coimbatore, Tiruchirapalli areas. Pre-Cambrian Cuddapah and Kurnool system are seen in Cuddapah and Kurnool districts and extending to Nallamalai hills. Palaeozoic upper Gondwana rocks are seen in districts like Rajamundry, Vijayawada and Guntur of Andhra Pradesh and Madras, Tiruchirapalli and Ramanathapuram of Tamil Nadu.

The different types of rocks in South India contribute to an equal diversity of soil in the region. Geographically Peninsular Indian soils are Mature soils. This

includes three categories, Red soil, Black soil and Laterite or Lateitic soils.

Laterite soils are generally reddish or yellowish-red and turn black on exposure to sun. It consists of 90-95% iron, aluminium, titanium, manganese oxides and are deficient in lime and organic materials. These are found in regions of alternate wet and dry seasons in Easten and Westen Ghats and in Tamil Nadu. They occur along west coast and in some parts of the east coast. In Karnataka, laterite soils occur in the western parts of the districts of Shimoga, Hassan, Chikmagalur, Mysore and Coorg. In Kerala, this occurs in lower as well as in higher elevations (Subramanyam & Nayar, 1974).

Black soils are found in Ramanathapuram and Tirunelveli districts of Tamil Nadu and parts of Karnataka and Andhra Pradesh. The black colour is due to the presence of superficial iron in the rocks and the colour varies.

Red soils are distributed mainly in Karnataka and Tamil Nadu. The red soils of Tamil Nadu constitute nearly two third of the cultivated area. The soils are rather shallow, open in texture and have a pH of 6.6 to 8.0. In Karnataka these type of soil predominate in districts of Bangalore, Kolar, Mysore, Tumkur and Mandya. Loamy red soils are rich in district covering Western Ghats. In Telangana divisions of Andhra Pradesh, both red and black soils predominate (Murthy et al., 1996).

1.2b. Climate and Rainfall.

Vegetation of an area is determined by several variables of climatic factors. South Indian climate may be broadly described as tropical monsoon type. The alteration of north easterly surface winds during the northern hemisphere in winter and south westerly wind during summer are referred to as the North East and South West Monsoon. There are four seasons (Murthy et al., 1996).

1) Summer season (inter monsoon season): starts from March onwards and extended up to May last. Temperature in this season may goes up to 45°C. During this season most of the rivers and lakes in Peninsular India dry up and most of the herbaceous plants perish.
2) Monsoon season (south-west): The South West monsoon starts in South India towards the end of May and continue up to October. The western side of the Western Ghat is on the threshold of southwest monsoon and receives a rainfall of 203-254cm, and the eastern side lies in the rain-shadow area of the Peninsula (Subramanyam & Nayar, 1974). Western Ghat and Western coast receives almost 6 months rain where as on the eastern coast it decreases.
3) Post-Monsoon season: South West Monsoon begins to withdraw from October and second inter-monsoon season starts in October.
4) Winter season: By the end of November this season commences and is very active in December. This season is also called North East monsoon period and causes heavy rainfall in South Eastern parts of Tamil Nadu.

The regimes of rainfall vary from one part to other in South India. The typical tropical regime has rains beginning late May and terminating in October, the peak being in July (Meher-Homji, 1996). In the east coast of Tamil Nadu, near Tirunelveli district, the bulk of rain is received in October-November from the North East Monsoon. The combined effect of NE monsoon and SW monsoon is felt in the Nilgiris, which prolongates the moist climate here. The rainfall is not only low but also erratic during the SW monsoon season over the Coromandel Coast. The character of rainfall in June, July and August at Madras and Pondichery are conventional thunderstorms.

South West monsoon has two peaks in Mysore, in April and October. Ooty of Nilgiri has three peaks, July, April and October (Meher-Homji, 1996). The Western Ghat experience a whole range of climatic gradients both altitudinal as well as latitudinal in the amount of total rainfall, peak rainy season, its duration, number of rainy days, maximum and minimum temperature seasonal duration, wind velocity etc. (Nair, 1991).

REVIEW OF LITERATURE

P. Sunojkumar "Morphologic and Taxonomic studies of the genus Leucas R.Br. (Lamiaceae) in Southern Peninsular India" Thesis. Department of Botany, University of Calicut, 2005

Review of Literature

The Hermann Volumes

Review of Literature

"There is no better way to learn taxonomic procedure than to try to identify material with the help of a good monograph".

—MAYER ET AL. (1953)

2. REVIEW OF LITERATURE

2.a. Anatomy

Although Lamiaceae is a large family, their wood anatomy has little been studied to date mainly because the members of this family are herbs and only a few are large shrubs or small trees (Carlquist, 1992). However the data derived from the work of some anatomists like Eames (1929), Metcalf and Chalk (1950), Carlquist (1992) etc. indicate that floral and stem anatomy of Lamiaceae have ecological, phylogenetic and systematic significance.

In the genus *Leucas* R.Br. very little anatomical work has been done and adequate data are not available for majority of Indian species (Singh, 2001). However, the data available for many species indicate that anatomical data will be a taxonomic tool for species delimitation in this genus.

Histology and Vasculature: Shah et al. (1972), Shah and Unnikrishnan (1968) have contributed to the vasculature patterns of axillary buds in Lamiaceae members including *Leucas*. In *Leucas aspera* Link they reported two-traced unilacunar node and that the bud traces in axillary buds are associated with leaf sympodium which give rise to axillary leaf traces and the strands traverse the internode above. Gupta and Bhambie (1977) after studying species of Lamiaceae reported that unilacunar two-traced condition is met within *Leucas cephalotes* Spreng. and *Leucas lanata*

Benth. The unitraced condition is suggested to be derived from the two traced condition due to the fusion. Vascularisation in petiole in Lamiaceae has limited systematic significance due to the occurance of same pattern in different genus and variation in individuals of same species. Floral histogenesis and development of leaves in *Leucas* were studied by Kumar and Tyagi (1979; 1981) and reported a comparatively rapid and homoblastic growth of leaves in *Leucas* than other genera of Lamiaceae. Kumari (1982), while studying the morphology and vascular supply of calyx in a few members of the Lamiaceae for evolutionary studies concluded that the calyx in Lamiaceae has attained higher levels of evolution than any other gampetalous members. Among the members of this family, *Leucas* shows the fusion of calyx lips up to the mouth rim and only the ends of the lip veins are visible as teeth. In sepal veins, the conjoint laterals fail to divide. This entire feature shows that there is a synchronous evolution in exomorphic as well as anatomical features in this genus that represent the most evolved member in the family.

Tyagi (1989) has done anatomical studies on *Leucas* species and reported that this genus commonly has eight vascular bundles arranged in a ring but in *Leucas ciliate* Benth. and in *Leucas stelligera* Benth. ten and twelve bundles are seen. She also reported that three types of nodal configuration (1) unilacunar unitraced (as in *Leucas cephalotes* Spreng., *Leucas martinicensis* R.Br., *Leucas decemdentata* Sm., *Leucas stelligera* Benth., *Leucas urticifolia* Sm., *Leucas prostrate* Gamble, *Leucas lavandulifolia* Sm.); (2) Unilacunar two-traced (as in *Leucas stricta* Benth., *Leucas lanata* Benth., *Leucas ciliate* Benth., *Leucas biflora*

Sm., *Leucas nutans* Spreng.) and (3) unilacunar-unitraced and two traced (as in *Leucas aspera* Link). She also opined that the leaves in *Leucas* are not truly opposite but is probably derived from alternate condition.

Stomata: Characters of stomata viz., structure, development, distribution and density per leaf area were correlated with taxonomic delimitation in Lamiacean members (Metcalf and Chalk, 1950). In most of the members of this family, hypostomatic leaves were found but intrageneric variation in this character has been reported in members of *Leucas* and *Ocimum* by Inamder and Bhatt (1972). They recorded the common occurrence of two types of stomata in *Leucas* —anomocytic and diacytic, based on their origin and nature of subsidiary cells. Abu-Asab and Cantino (1987), and Cantino (1990), studied the distribution, position and type of stomata in many species of Labiatae, subtribe Melittidinae for a phylogenetic consideration and opined that the morphology of stomatal complexes and intrageneric variation has systematic and phylogenetic significance in *Leucas* and other members of Lamiaceae. Cantino (1990) also reported the presence of two-celled diacytic and three celled diallelocytic stomata in *Leucas* and anomocytic type is the most frequent appearance.

Recently, Tyagi (1998) has studied in detail the structure, ontogeny and distribution of stomata in floral and vegetative organ of *Leucas* with an evolutionary view. She has studied the development of meristamoid in thirteen species of *Leucas* and identified different type of stomata —anomocytic, paracytic, transitional type,

haplocytic, diacytic, anomocytic, amphicytic and cyclocytic. Accoarding to the distribiution of stomata on the leaves, she grouped the *Leucas* species into hypostomatic and amphistomatic following Inamder and Bhatt (1972) and Abu-Asab and Cantino (1987). However a true intraspecific variation in the stomatal character instead of overlapping feature were not noticed in this genus and this limits its taxonomic importance.

Trichome: Taxonomic values of trichome are pertinent in the genus *Leucas* because of the wide distribution of species in different habitats. Much stress on this characters for taxonomic analysis has been observed in earlier taxonomic works. Hooker (1885) had given paramount importance on trichome character in his taxonomic treatment of species and varieties. Trichome structure and its organographic distribution are correlated to the ecogeography and offers a worth taxonomic marker in this genus.

Metcalf and Chalk (1950), recognized trichome types into two main types: non-glandular and glandular. El-Gazzar and Watson (1970a) observed non-glandular and glandular trichomes in some species of *Leucas* for a taxonomic analysis of the family using numerical methods. They had observed the marrubioid type of non-glandular hairs on the leaf surface of *Leucas helianthimifolia* Desf., a character of the subtribe stachyoideae. Formation of four celled glandular hairs after fertilization on the ovular surface of *Leucas urticifolia* Sm. has been noticed by Dwivedi and Joshi (1978).

Abu-Asab and Cantino (1987) observed that simple, unisexual trichomes were found on the leaves of most species of Lamiaceae and the variety in cell members of trichomes may prove to be of use in taxonomic studies of intrageneric and intergeneric taxa recognisation. They found it appropriate to use the term subsessile for the characteristic essential oil secreting glandular trichome of the family Labiatae (including the genus *Leucas*), which was recognized and named differently by different authors (Solender, 1908; Metcalf & Chalk, 1950). They also opined that the extensive variety in their complexity offers considerable potential as taxonomic characters. Cantino (1990) found that among different types of glandular trichomes type 4 (with head composed of four cells) and 5 (head more than four cells, with radial walls) are present in subfamily Nepetioideae and Lamioideae which include the genus *Leucas.*

While studying the significance of trichome in Lamiacean members, Pandey (1989) recorded the presence of six types of unicellular, seven types of bicellular, eight types of uniseriate, three types of glandular and the occurance of peltate glands among the twelve species of *Leucas* in South India. He reported the occurrence of five bicellular and three uniseriate types of trichomes in *Leucas*, a character new to the family Labiatae. Among the twelve species of *Leucas* studied, certain forms of trichomes are found only in one member, ie. unicellular acereate in *Leucas urticifolia* Sm. and unicellular acuminate in *Leucas biflora* Sm. He also pointed out the significance of trichome in recognising intrageneric taxa.

Since a comprehensive data concerning the trichome types are lacking in many species of *Leucas*, a detailed study may provide an authentic criteria in intrageneric systematics and phylogeny in this genus.

Nutlets: The fruits of Lamiaceae consist of four achene or nutlike fruitlets, enclosed in a persistant calyx. Usefulness of nutlet characters in the classification of the Labiates has been demonstrated by many workers (Bilimovitsch, 1935; Wojciechowska, 1961; 1966; Makarova, 1967; Hedge, 1970). On the basis of pericarp structure of nutlets Bilimovitsch (1935) and Wojciechowska (1966) presented informal subfamilial classification of European Labiates.

In the genus *Leucas*, Sebald (1973; 1977a; 1977b; 1978; 1980) studied the variation in nutlet shape and surface in different species. The detailed description and illustration given by him is used as taxonomic characters in infrageneric sectional treatment. Cantino (1992a) used differences in fruit type, surface structure and fleshiness of the nutlets as a charactrs in cladistic analysis of the family.

Ryding (1992b) studied the myxocarpy in Lamiaceae and reported that no mucilage has been found on the nutlet surface of the three species of *Leucas* he had studied. He used the term exocarp (epicarp), mesocarp and bonecell to describe the pericarps of *Leucas* species, which is 25-130 μm thick and consists of 4-6 layers of cells under microscopic observation.

While undertaking a monumental study of the pericarp structure of 73 species of *Leucas* and related genera of the subfamily Lamioideae, Ryding (1993) reported that in the Asiatic *Leucas* the nutlets have rounded apex or a truncated apex with blunt edges. Those of *Leucas lavandulifolia* Sm., *Leucas aspera* Link, *Leucas zeylanica* R.Br., *Leucas vestita* Benth., *Leucas hyssopifolia* Benth., *Leucas cephalotes* Spreng. and *Leucas rosmarinifolia* Benth. have a more or less flat and foot like structure at the base with the rather large scar at the proximal side. The surface is mat and almost so, and glands are lacking. He observed that the exocarp cells in most of the species have been differenciated into two distinct layers — "ordinary exocarp cells and pitcells" and with violet pigment in mesocarp cells.

Based on the comparison of epicarp characters Ryding (1993) opinioned that in nutlet characters, African species of *Leucas* differ from Asiatic species. Due to the presence of thin bone cells and a violet pigment in the mesocarp of *Leonotis* and *Leucas*, he opinioned that the genus *Acrotome* and *Leonotis* might be closely related to African section of the *Leucas*. Asiatic *Leucas* form another group because they lack glands and apical ribs on the nutlets and have the veins more or less displaced from the distal nutlet edges and possess thick layer of bone cells, two layered mesocarp cells and crystals. He emphasized that the pericarp structure supports Bentham's (1832-1836; 1848) infrageneric classification of Asiatic *Leucas* and Sebalds's (1980) classification of African species, both with few exceptions. This pericarp study (Ryding, 1993) confirmed Bentham's view of the similarity of *Leucas hyssopifoloia* Benth. to the section Ortholeucas than to the section Plagiostoma, and

the closeness of section Ortholeucas to African members and deviation of Astrodon and Plagiostoma from African members.

While carrying out a cladistic analysis based on the pericarp characters, Ryding (1995) concluded that the *Leonotis* and *Acrotome*, which have thin or obsolete sclerids, may well have evolved from *Leucas* with similar cells. He also pointed out that the variation in pericarp character of *Leucas* and *Plectranthus* has been useful in intrageneric systematics.

2.b Cytology

Emphasis of cytological characters in practical taxonomy has been mainly on "chromosome and their various attributes". Lewis (1957) has pointed out that "chromosomes derive their prominence as a tool in taxonomy from their direct relation to the genetic system of which they are an integral part". Different types of chromosomal data have been used taxonomically, including numbers, shape and size, behaviour in meiosis and DNA content (Stuessy, 1990). Chromosome number has been used most often in taxonomic work due to ease of observation and its discrete nature. The importance of chromosome numbers has led to many cyto-taxonomic studies in the genus *Leucas* by many workers. Notable among these studies are enumerated in the table (no. 4) given below.

Name of the taxa	Chrom. No.		Author of the work.	Year of publication
	2n	n		
Leucas angularis Benth.		16	Saggo & Bir	1982, 1983
Leucas aspera Link	22		Jha & Sinha	1960
"	28		Gill	1970
"	22		Pal	1971
"	28	14	Vij & Kashyap	1975, 1976
"	22		Ayyangar & Vembu	1980
"	22		Krishnan	1980
"		11	Saggo & Bir	1982, 1986
"		14	Gill	1984
		11	Cherian & Kuriachan	1991
Leucas biflora Sm.	26,30,32		Pal	1971
"	28	14	Cherian & Kuriachan	1984, 1991
Leucas capitata Desf.	28		Sidhu & Bir	1983
"		11	Saggo & Bir	1983
Leucas cephalotes Spreng.	28		Mehra & Gil	1968
"	28		Gil	1970
"	22		Vij & Kashyap	1975, 1976
"	22		Krishnappa & Basavaraj	1982
"		14	Gil	1984
		11	Singh et al.	1991
Leucas chinensis Benth.		15	Saggo & Bir	1982,1983
		14	Cherian & Kuriachan	1984
Leucas ciliate Benth.	22		Krishnappa & Basavaraj	1982
Leucas clarkei Hook. f.		11	Saggo & Bir	1982,1983
Leucas deflexa Hook. f.	28		Renard, et al.	1983

Leucas diffusa Benth.	22		Jha & Sinha	1960
"	22		Ayyangar & Vembu	1980
"	22		Krishnan	1980
"	22		Vembu & Sampathkumar	1980
"		11	Cherian & Kuriachan	1984
Leucas eriostoma Hook. f.	22		Krishnappa &Basavaraj	1982
Leucas helianthimifolia Desf.		11	Saggo & Bir	1982, 1983
"	22		Saggo & Bir	1983
"		11	Cherian & Kuriachan	1984
Leucas hirta Spreng	22		Jha & Sinha	1960
"	22		Ayyangar & Vembu	1980
"	22		Vembu & Sampathkumar	1980
"	22		Krishnappa &Basavaraj	1982
"		11	Saggo & Bir	1983
Leucas lamiifolia Desf.		11	Saggo & Bir	1982b, 1983
Leucas lanata Benth.	28		Jha & Sinha	1960
Leucas lanata Benth.	28		Gil	1970
"	30		Bhat et al.	1975
"		14	Bir & Saggo	1981, 1984
"	28		Krishnappa &Basavaraj	1982
"		14	Gil	1984
Leucas lanceaefolia Desf.	22		Krishnappa & Basavaraj	1982
"		11	Saggo & Bir	1983b
Leucas linifolia Spreng.	22		Chopde	1965
"		11	Saggo & Bir	1982

Leucas lavandulifolia Sm.	22		Jha & Sinha	1960
"	22		Krishnappa & Basavaraj	1982
"		11	Saggo & Bir	1982
Leucas marrubioides Desf.		14	Cherian & Kuriachan	1981
Leuca martinicensis B. Br.		14	Gil	1978
"	28		Krishnappa & Basavaraj	1982
Leuca mollissima Benth.	28		Gil	1970
"	28		Krishnappa & Basavaraj	1982
		14	Gil	1984
" var. *scaberula*		14	Saggo & Bir	1981
" "		14	Bir & Saggo	1981
Leucas montata Spreng.	28		Krishnappa & Basavaraj	1982
Leucas mutans Spreng.	28		Jha & Sinha	1960
"		14	Bir & Saggo	1980, 81, 84
Leucas procumbens Desf.	15		Saggo & Bir	1982,1983
Leucas stricta Benth.	11	22	Cherian & Kuriachan	1991
Leucas suffruticosa Benth.	22		Jha & Sinha	1960
"	22		Krishnan	1980
Leucas urticifolia Sm.	28		Krishnappa & Basavaraj	1982
Leucas vestita Benth.		11	Saggo & Bir	1982,1983
"	22		Cherian & Kuriachan	1984
"	22		Thoppil & Jose	1995
Leucas zeylaica R.Br.		11	Saggo & Bir	1983

Table: 4. List of chromosome numbers in *Leucas* obtained in different studies

2.c. Embryology

Many workers emphasized systematic importance of embryological data in Labiatae. Several authors such as Billings (1909), Schnarf (1917), Junel (1937), Davis (1966), and Wunderlich (1967) have called for taxonomic reanalysis of the family on the light of embryological variation in Labiatean members.

A perusal of the literature shows that except a few, the embryology of many members of the family including *Leucs* R.Br. have not been worked out. Murthi (1941) and Jaitley (1968) have studied the endosperm development in some species of *Leucas* and reported variation in the number of nuclei in the micropylar endosperm haustorium of closely related and among the same species of *Leucas* (12 – 19 nucleate in *Leucas aspera* Link, 5 nucleate in *Leucas biflora* Sm., 12 nucleate in *Leucas cephalotes* Spreng. and 8 nucleate in *Leucas mollissima* Benth.).

Kumari (1976) while studying the endosperm development in Labiateae reported that in *Leucas* the endosperm development is of Stachys type and that the structural variation in the haustoria in this family has no taxonomic significance due to the variation among the members of the same species.

Dwivedi and Joshi (1988) contributed to the embryology of *L. urticifolia* Sm. According to them in this species the embryosac development is Polygonum type.

The endosperm development is of Stachys type and embryo development follows Mentha variation of Onagrad type. They also reported that glandular hairs are present on the ovules, the epicarp is mucilagenous on the 3 layered seed coat and the seed is endospermic in this species.

Megagametophyte development in Labiateae were studied by Rudall and Clark (1992) and from the data obtained they opinioned that in Lamiaceae, the two potentially more useful taxonomic characters at the generic or subfamilial level are the shape of the mature embryosac, and endosperm formation. They emphasise the need of more embryological data and critical assessment in Lamiaceae for a systematic and phylogenetic study.

2.d. Palynology

The relation of pollen morphology and plant taxonomy has been rightly pointed by Erdtmen (1945, 1952). Based on the available data he pointed out that pollen morphologically, Labiatae is characterised by two pollen types, viz., tri- (or tetra-) and hexacolpate grains. After comparing pollen morphological data and cytological facts, he concluded that at the time of shedding, tricolpate grains in Labiatae are binucleate and hexacolpate grains are trinucleate.

Based on this coincidence of cytological and taxonomical features he commented that the two pollen types might eventually support a tentative division of the Labiatae sensu Briquet (1896) into two groups Lamioideae and Nepetioideae,

which possibly deserve the rank of subfamilies. His survey of the division Lamioideae (which includes Leucas) reveals that the majority of the genera have tricolpate, inoperculate pollen with a tectate-perfora to microreticulate exine, suprareticulate sculpturing and simple columellate.

Risch (1956) conducted a broader survey of the family using light microscope and emphasized gross pollen morphology (size, shape, colour etc.) and distinguished several "form types" in the pollen of Labiatae.

An extensive survey of Labiatae pollen morphology, including many genera whose pollen had not previously been described was published by Wunderlich (1967). Her results strongly support Erdtman's (1945) proposed delimitation of the Labiatae into two sub-families —Lamioideae and Nepetoideae. The validity of these two subfamilies were reevaluated by Cantino and Sanders (1986) and recommended that classification of Labiatae should recognize Erdtmans subfamilies.

Abu-Asab and Cantino (1992) while analyzing the phylogenetic implications of the pollen morphology in sub-familily Lamioideae found that, the pollen grains of gynobasic styled Lamioideae are usually tricolpate, suboblate to euprolate, the colpi lack opercula and the columella are simple. This examination includes 17 species of the genus *Leucas* also. They used outgroups comparison method to assess the character polarity for assessing synapomorphies for phylogenetic hypothesis and

opinined that the synapomorphies of derived characters (in Lamiaceae and Verbinaceae) confirm the polyphyletic origin of Labiatae.

Gill and Chinnappa (1982), has done palynological study of some Labiatae of Himalayan region. Taxonomic and evolutionary significance of pollen morphology has been emphasized by Nair (1991). But a comprehensive study of the palynology at infrageneric level in Labiatae, especially for the genus *Leucas* has not been attempted so far.

2.e. Phytochemistry

The history of chemistry in plant classification dates back to the earliest Materia Medica of Discordies (ca. 300 B.C). Plant grouping based on their medicinal properties are as old as the age of herbalists (1470-1670). Phytochemical data offers a look at relationships of plants via internal characters and through a comparison of DNA sequences offers taxonomic importance.

The family Labiatae has centuries been acknowledged as a group of considerable pharmaceutical and culinary interest (El-Gazzar & Watson, 1970b) and it is the second largest source of culinary herbs (Richardson, 1992). Taxa belonging to this family are rich in a number of classes of flavanoids which have proved useful for chemotaxonomic purpose within the family at the infra familial and infra generic level (Thomas-Barberan, 1992). According to Cole (1992), the anti-insect, anti-

bacterial and anti-fungal activities of Labiatae may be due to their rich source of terpenoids.

Varieties of compounds with taxonomic value have been identified in Labiatae. Presence of lithospermic acid, a derivative of rosmarinic acid, is known only from Labiatae and Boraginaceae (Molgaard & Ravan, 1986). Cole (1992) opinioned that the taxonomic significance of terpenoids in Labiatae is evident in the division of Erdtmans subfamilies –the Lamioideae and Nepetioideae. It is said that Nepetioideae are oil rich i.e. higher than 0.5% volatile oil on a dry weight basis whilst the Lamoideae are oil poor, generally lesser than 0.1%.

The genus belongs to the subfamily Lamioideae were not chemically explored much. This may be due to the lesser quantity of volatile oils in them. But still there are some worth contribution by some workers. Mahato & Pal (1986) elucidated the structure of linifolioside, an isopamarane rhamo-glucoside from *Leucas linifolia* Spreng. (*Leucs indica* (L.) R.Br.) Singh et al. (1988) attempted the taxonomy of flavanoids in a few *Leucas* species. Pradhan et al. (1990) isolated a triterpenoid lectone from *Leucas aspera* Link. Hasan et al. (1991) examined the chemical components in the different parts of *Leucas* species. Thoppil & Jose (1995) attempted the cytological and biochemical analysis of *Leucas vestita* Benth. using the essential oil and reported the presence of rich monoterpenoids in it. He also pointed out its economic importance due the aromatic and medicinal qualities.

Jelani et al. (1993) have quantitatively analysed the presence of inorganic metals in the leaves of some *Leucas* species and recorded the absence of Cadmium in *Leucas cephalotes* Spreng. and absence of Nickel in *Leucas stricta* Benth. and *Leucas zeylanica* R.Br. The phenetic analysis of the distribution pattern of phytochemical constituents in *Leucas aspera* Link, *Leucas biflora* Sm., *Leucas cephalotes* Spreng., *Leucas lavandulifolia* Sm. and *Leucas mollissima* Benth. conducted by Kumari & Radhakrishnaiah (1998) shows that *Leucas cephalotes* Spreng. strikes a discordant note and form a lone cluster where as all other form another cluster. Based on this study, Singh (2001) has placed *Leucas cephalotes* Spreng. in a different and new section 'stricta'. But this seems to me a very unnatural group for me. This is because all the members in this proposed group shows similar floral character, annual herbaceous nature, and typical lanceolate leaves typical of others members of the section Plagiostoma. A thorough study based on all species is needed to establish the phytochemical similarity among *Leucas* members.

2. f. Medicinal and Economic uses

Importance of *Leucas* R.Br. as a medicinal herb was mentioned as early as in the 'Ayurveda', —the ancient Sanskrit Vedic literature pertaining to Indian system of medicine. The name 'Kutumbika' used in the 'Charaka Samhita' composed by the great Ayurvedic physician Charaka in the pre-Buddhist period (Kiritkar & Basu, 1918) is identified as *Leucas*. The Ayurveda Nighantus (Râja Nighantu, Sodala

Nighantu, Prīya Nighantu, Madana Pala Nighantu, Abhidana-manjari, Bhāvaprākasa) composed during the Mohammedan period of Indian History (between 12^{th} and 16^{th} centuries) used the Sanskrit name 'Dronapushpī' to refer to the medicinal and therapeutic properties of *Leucas*. Perusal of the Hindi version of these Nighantus, interpreted based on the original literature of Narahari Pandit by Tripathi (1982) reveal that 'Dronapushpī' has sweet, pungent, bitter, saltiest as well as with heavy and dry properties. Even though it has sweet taste after digestion its penetrating character and hot potency aggravate 'pitta' and alleviates the 'vatakaphaja' stages of the disease. It increases the digestive fire and promotes taste sensation and also increases the intellectual capacity. It is also written that *Leucas* is capable of expelling out waste products from the body. It helps in subsiding edema in the body and also relieves piles, diabetes and it is beneficial in 'Vatapaitika' stages of disease such as fever, Jaundice and in respiratory diseases.

Therapeutic uses of the *Leucas* practiced and still following in Indian systems of medicine are also mentioned in these books. In Bhāvaprākasa Nighantu written based on Indian Materia Medica of Bhavamisra (c 1600 – 1600 AD) says that 5 – 10 ml of juice from leaves and flowers of *Leucas* dissolved in hot water can be taken as a decoction against fever and especially against Malaria fever (Pandey, 1986). In Sōdala Nighantu, it is written that filtered juice from plant dripping in the eyes and noses prevent the jaundice disease and also helps in clearing the yellowish colour of the eyes.

Due to the lack of character description, the identity of the source plant 'Dronapushpī' is controversial. In many of these Nighantus, different names like *Leucas aspera* Link, *Leucas linifolia* Spreng., *Leucas zeylanica* R.Br., *Leucas cephalotes* Spreng. are given. According to some workers like Drury (1873), Kirtikar & Basu (1918), Vaidya (1982), Chopra et al. (1956), Dronapushpī is *L. linifolia* Spreng.. Where as Nadkarni (1954), Ahuja (1965), Chunekar (1982), Sharma (1983), Sharma (1996) consider it as *Leucas cephalotes*. Still others like Kurup et al (1979), Mooss (1980), Nesamony (1985) consider it is *Leucas aspera* Link. Sivarajan and Balachandran (1994), opinioned that *Leucas stricta* Benth.is known by this name.

The plant is known in South India as 'Tūmba' in vernacular languages and used widely as an unavoidable ingredient in many folk medicines. Bathing with water boiled along with leaves after delivery will protect the mother from diseases. Two teaspoonful of juice of leaves concentrated with jaggery taken in before food cleares the abdomen and relieves from gas formation. Juice of flowers and leaves can be given to children 2-3 times a day against worm infection is found useful. Keeping the squeezed and crushed leaves of *Leucas* at the site of scorpion bite relieves the poison effects. A paste made of *Leucas* leaves and coconut oil is found effective against skin disease like psoriasis.

The vernacular name Tūmba had been used by Van Rheed in his Hortus

Malabaricus (1678-1693). Thereafter the identity of this had been interpreted differently by different workers as *Leucas aspera* Link (Mabberley, 1977; Nicolson et al., 1988); *Leucas indica* (L.) R.Br. (Burmann, 1768) and as *Leucas zeylanica* R.Br. (Dennstedt, 1818) as *Leucas stricta* Benth. (Sivarajan & Balachandran, 1994). According to Khory & Kartak (1999), *Leucas cephalotes* Spreng., *Leucas aspera* Link and *Leucas linifolia* Spreng. are known by the same name. However all these species are considered and used by common people as 'Tūmba' in medicine.

According to some Ayurvedic and Botanical works, different species of *Leucas* has got their own properties and are used for various medicinal uses, as mentioned in the table 5 below.

Species name	Medicinal properties	Medicinal and economic uses
Leucas aspera Link	Antibacterial, antidote, antipyretic, antiseptic, insecticidal.	Leaves: are applied successfully for psoriasis and other chronic eruptions (Drury, 1873), used against chronic rheumatism, applied for psoriasis, scabies and chronic skin diseases. Plant extract is used as antibacterial against *Micrococcus pyogenes* and *Escherichia coli* and as an antidote against snake venom (Kirtikar & Basu, 1918; Rastogi & Mehrotra, 1993; Agarwal, 1997). Flowers: given in cold effect. Root: paste is applied externally in head ache (Agarwal, 1997).

Leucas cephalotes Spreng.	Anthelmintic, stimulant, diaphoretic, expectorant, heating, indigestible, insecticidal, laxative, pungent taste and flavour, cause 'vata' and 'pita'	Leaves: are useful against bronchitis, jaundice, inflammations, asthma, dyspepsia, paralysis, glaucoma, fever and urinary discharges. Fresh juice is applied externally on scabies; leaves in combination with other drugs are prescribed for scorpion sting (Kirtikar & Basu, 1918); juice is used against cough and cold, intestinal catarrh, infusion as an insecticide (Ahuja, 1965). Used to cure parasitic infection, (Dash & Kashyap, 1987); dried, powdered leaves mixed with 1-2 black pepper when sniffed provide instant relief from migraine (Singh & Khan, 1990); as a medicine for constipation, ear-ache, eye disease, head ache, malaria, piles, tooth and gum trouble, in wounds and also as a vegetable in chutney in Purulia, West Bengal (Jain, 1991), fresh juice applied externally in scabies (Agarwal, 1997); used against nasal catarrh, externally applied in skin eruptions (Khory & Katrak, 1999). Two teaspoonful of decoction of leaves and flower heads mixed with *Memordica charantia* is given 2-3 times a day for 10-15 days to cure jaundice (Pranti & Chaudhury, 2003). Flowers: crushed whorls boiled in mustard oil applied externally on forehead and temporal bones provides instant relief from headache (Singh & Khan, 1990) syrup made from flowers are used as a remedy for cough and cold (Agarwal, 1997).

Leucas indica R.Br.	Anthelmintic, antimicrobial, aphrodisiac, carminative, dermatosis, expectorants laxative. popultice in old sores and sedative, stomachic, vermifuge,	Leaves: Singhalese attribute miraculous curative power to this plant. People at North West province of Sri Lanka use leaf juice as a remedy for snake bite, headache and cold (Drury, 1873). Leaves used in Mauritius for treating respiratory complaints (Bauton, 1857, 1864), useful in piles, sore eyes and snakebites. Leaves when roasted and eaten with salt have febrifugal properties. At Lakhimpur in Assam, it is used for loss of appetite. The leaves are wrapped up in a plantain leaf, heated and eaten decreases the appetite first, and then increases (Kirtikar & Basu, 1918). Used as cyanogenetic which is powerful antimicrobial (Agarwal, 1997).
Leucas zeylanica R.Br.	Antibiotic, germicidal	Leaves: in Ceylon the leaves are bruised and a teaspoonful of the juice given which is sniffed as a remedy in snakebite. The juice is also employed in headache and colds, used against snakebite (Kirtikar & Basu, 1918). Juice is used against scabies and skin diseases, extracts given in cold effects and headache (Agarwal, 1997)
Leucas decemdentata Sm.	Antiseptic, germicidal	Leaves: in Polynesia, used for treating gonorrhea (Zepernick, 1972) and in Tahiti, the crushed leaves are used for dressing in sores (Petard, 1986). An infusion of this is used in New Caledonia for treating infections of the digestive system. (Rageau, 1973)

Leucas martinicensis R.Br.	Vermifuge laxative	Used in Ethiopia for fumigation in diseases. Juice is used against malaria and also as an ingredient in tonic for children in Kenya (Sebald, 1980). Used against fever, hysteria and in joint pains in Brazil. It is burnt to expel mosquitoes in Nigeria. In India the extract is given in gastro intestinal disorders (Agarwal, 1997)
Leucas stelligera Benth.	Carminative, emmenago-gue, stimulant	
Leucas urticifolia Sm.		At Gomawal in Beluchistan, the plant is used as a cure for fever (Kirtikar & Basu, 1918) Useful against fevers (Agarwal, 1997)

Table. 5: Attributed medicinal properties and uses of *Leucas* R.Br. in various literatures.

MATERIALS

P. Sunojkumar “Morphologic and Taxonomic studies of the genus Leucas R.Br. (Lamiaceae) in Southern Peninsular India” Thesis. Department of Botany, University of Calicut, 2005

Materials and Methods

Materials and Methods

"Field guides are instruments of the pleasure of pure knowledge "
- VON BAEYER

3. 1. MATERIALS

3. 1a. Type collection and typification.

"Names of the labels are often wrong!
No identification is to be trusted!
All human, including specialists make mistakes!
There is precisely more misidentified specimen than correctly named material!"

–Veldcamp (1987)

Keeping this warning in mind, I have attempted in collecting type specimens and protologues of all the taxa for the precise identification, as aimed by the original author. The protologues and old literature were collected from Indian and foreign libraries and in contact with experts in the field of Lamiacean taxonomy. Protologues were carefully studied to find out the types and their depository. These laborious and time-consuming tasks were achieved by direct and indirect methods. In a direct way I have used different volumes of Taxonomic literature by Stafleu & Crown (1986) to find out the type location and personal history of all the pioneer taxonomists in this field. Index Herbariorum (Holmgreen et al, 1990) is used to find out the details of the herbaria and the corresponding address of the curators. In an indirect way I have referred the type details in various revisionary monograps and journals to find out the type location of earlier taxonomists. As Europeans initiated the Indian floristic studies during colonial period, an historical account of their activities in India (Desmond, 1992) was studied to find out their type collection.

Correspondences were made to the Curators and Directors of different herbaria (ABD, B, BM, BP, BR, C, CANB, CGE, DBN, E, G, GH, GRA, H, HAL, K, LE, LINN, LIV, M, MEL, P, PR, W, and WELT) and requested for loan of type specimens. Lamiacean experts of these herbaria were also contacted for the same purpose. All these activities carried out during the last five years ultimately resulted in the availability of almost all the type specimens including types of synonyms.

Sl. No	Name of the herbaria	Acro-nym	Total number of specimens
1	Herbarium, Botanisches Garten und Botanisches Museum, Berlin, Germany	**B**	01 03 *
2	British Museum, England, UK	**BM**	01 02 *
3	Herbarium, Nationale Plantentium van Belgie, Belgium	**BR**	11 **
4	Herbarium, Botanical Museum, University of Copenhagen, Denmark	**C**	05 * 09 **
5	Herbarium, Royal Botanical Garden, Edinburgh, Scotland, UK	**E**	07
6	Herbarium, Royal Botanical Gardens, Kew, England, UK	**K**	52 ***
7	Herbarium, Laboratorie de Phanerogamie, Museum National d'Historie Naturelle, Paris, France	**P**	13 03 ****
8	Central National Herbarium, BSI, Kolkatta, India	**CNH▪**	20
9	Madras Herbarium, Coimbatore, India	**MH▪**	07
	Total		**134**

(*photographs; **photocopies; ***cibachrome; ****slides. ▪Indian herbaria)

Table **6**: Table showing the availability of type specimen from different herbaria.

Various Indian herbaria were visited (CAL, MH,) and contacted (BLAT) for types of old and newly described species types. Types in the form of actual specimens, cibachrome, photographs, photocopies and digital images send as e-mail attachments were collected from various herbaria and the same after study were returned to the respective herbaria. The various herbaria contacted and the numbers of specimens obtained were given in the table 6, furnished above.

Need of typification of a few species of *Leucas* were realised when it was informed from Berlin herbarium (B) that Benjamin Heyne's specimen identified by Roth had been lost from their collection due to the huge fire which broke out during second World War (1939 – 1945). Later, much information about this fact was made available from Taxonomic Literature also (Stafleu & Crown, 1986).

There were eight species of *Leucas* treated under the genus *Phlomis* by Roth (1821) based on specimens received from Benjamin Heyne, collected from '*Indiae orientali*'. Among the eight, four species were named and established by Roth based solely on Heyne's specimens. These specimens were deposited in the general herbarium of Berlin. Valid transfer of these species from *Phlomis* into *Leucas* was affected by Sprengel (1825), mentioning Roth's species as basionyms. Due to the loss of original specimens, which were to become the type, typification became necessary. After contacting all the herbaria viz. B, BR, C, CAL, CGE, G, GH, H, K, and LE where Heyne's specimens were deposited, duplicates of Heyne's original collection from India, matching with Roth's protologue descriptions were not

available from any of the Herbaria. The one set of probable specimens of Heyne received from Kew contain his names and collection dates. Close observation of the available data on the sheets and the information about Heynes collection time did not give a clear idea that these specimens were collected by Heyne and observed by Roth. After a great deal of discussion with Dr. Alan Paton of Kew Herbarium, who observed the original specimen, it is decided not to go for lectotypification of these sheets, instead neotypification is opted.

Neotypification of these four species viz., *Leucas montana, Leucas hirta, Leucas cephalotes* and *Leucas mutans* were carried out using fresh specimens collected from South India, as a part of this study. These neotyps were deposited in CALI herbarium. Details of these neotypes were mentioned under each species in the 'taxonomy' chapter 4.4.

3. 1b. Specimen Collection and Herbarium reference

Southern part of the Peninsular India covers four states at an area of 4, 67, 186 square kilometers. This region is rich in varied type of forests and diverse habitats found in plains and hillside. Lying on the tropical area, the climate also is very conducive in producing rich and diverse vegetation ranging from small herbs to huge trees and lianas. Luxuriant growth of these diverse vegetation and habitats ranging from plains and hills to wetlands are really challenging for field studies.

While planning for this research work it was decided to take up the challenge of exploration in these diverse habitats. Even after perusing many published floras and preserved herbarium specimens, the exact locality of many plants, especially the type localities were not clear. This is mainly because many plants were collected once or very few times quite so many years back. The herbarium prepared some 50-120 years back; contain no adequate information regarding the locality. Many of the still older specimens, which form the type specimens, contain no label at all. The condition is same in the protologues also. The fragmentary information "India Orientali", "Peninsular India Orientalis", "Nielgiris", "Malabar", "Anamalay hills" etc. give only an indication that these are South Indian specimens. Tailor made information pinpointing the locality is not available for 80% of the taxa. Since many are narrow endemic to South India and are preserved only a few square kilometer area, pinpointing the locality were a tedious and time-consuming task.

As many of the *Leucas* plants are annual or perennial herbs and depending on the monsoon for flowering, field collection and photography become a difficult task due to heavy rain at many occasions. Different and restricted flowering time of the plants necessitates collection at different seasons in the same area. September to February were experienced to be the peak time for *Leucas* collection. Apart from these natural and unavoidable problems, the availability of vehicles to travel in the remote area and permission to collect plants from restricted area were of another set of difficulties to be overcooked. Public vehicles were used to travel to distant area and walking on foot to the deep forest area were the limitations in field exploration.

Much of the diversity rich area in South India are protected under law and preserved as National parks and Wild Life Sanctuaries, entry in these areas were restricted. Due to this problem field collection in the type locality of many species were not easy tasks. Non-availability of permission, due to cumbersome procedure and neglected attention towards taxonomic research and researchers from the forest departments were also to be overcome. Many times we were turned back from entering inside the forest area. All these limitations were not considered as a hindrance to my enthusiasm for a good collection.

Within a period of six years, I have collected plants from all the four states and visited all the type localities. Except three species, *L. nepetaefolia, L. mukerjiana,* and *L.anandaraoana,* all the other species were collected from more than one locality

3. 2. METHODS

3.2a Working strategy

All the plants were collected in duplicates of 5-6 numbers from each locality for herbarium preparation. Few flowering twigs with flowers and seeds were preserved in FAA (Formalin Aceto Alcohol mixtures) in PVC bottles for microscopic studies of morphology and line drawings. Field notes and labels were prepared for a proper documentation. The habitats of plants were observed from the field itself and are marked in the field note.

The materials after collection were immediately brought into laboratory for a careful study of micro characters. Photographs of possible specimens were made using a Nikon SLR camera and micro-morphology was observed under a Wild Heerbugg Typ 308700 stereo microscope. Line diagrams of all the important parts were made using a camera lucida fitted with the stereomicroscope. Microscopic photographs of possible specimens were also made using a ZE 188 Stemi DV4 stereo microscope fitted with a Sony DSC75 digital camera. Herbarium sheets were prepared for all the specimens and the same were poisoned with Mercuric Chloride and deposited in the CALI herbarium.

All measurements of body parts were done using fresh or preserved specimens. Line drawings were prepared from fresh specimens. For every measurement at least 5 specimens were examined and the mean value were taken. Most of these plants are grown in gardens and this facilitates easy measurements and drawings. Character differences in plants grown in natural habitats and those grown in gardens were compared to found out the extent of polymorphism in each taxa.

Visiting insects and bees were studied wherever possible. Photographs were taken and the insect was caught alive using a mosquito net and the same were identified with the help of Entomologists from the Department of Zoology, University of Calicut.

In the analysis part, authors of plant names have been abbreviated following Brummit & Powell (1992). The terminology used is mainly in accordance with Stearn (1983). Local names of the plants are mainly collected from the field and a few standard literatures are also consulted. Interactions with local peoples were made to get information regarding the local usage of plants in indigenous medicines and other practices.

Polymorphism, especially in vegetative characters are a common feature noticed in many *Leucas* species. To overcome this problem and to find out the extent of variation, a wide variety of herbarium sheets deposited in various Indian herbaria (CAL, CALI, KFRI, MH, SKU, TBGT) were consulted. This helped much in analyzing the diversity, distribution, extent of polymorphism and infraspecific variation in each taxa.

Apart from the type collection, the novelties of specimens collected were confirmed by discussion with experts in the field of Lamiacean taxonomy. These new materials were send to them for cross checking with material available over there. Identity of *Leucas sebaldiana* was established after a great deal of discussion with Dr. Alan Paton of Royal Botanical Gardens, Kew (K) and Dr. Oskar Sebald of Stattliches Museum für Naturkunde, Rosenstein, Stuttgart, Germany (STH). Specimens and photographs of this and related species *Leucas vestita* Benth. and its varieties were sent to these herbarium and is deposited there. The identity of *Leucas marrubioides* Desf. were established by cross checking with other specimens and

probable types available in Paris (P) herbarium. This is done as not many leaf characters were available in the Holotype. Dr. Therry Deroin of this institute was contacted for the same purpose. Nomenclatural problems especially for *Leucas decemdentata* and *Leucas indica* were discussed with Dr. Oskar Sebald, Dr. Alan Paton and indirectly with Dr. Steve Cafferty of British Museum (BM) and corrected.

Dr. Olof Ryding, Department of Botany, University of Copenhagen, Denmark did a great deal of help to me when I was facing the risk of Cladistic analysis. Availability of suitable software (PAUP) was a major problem. Dr. Ryding were kind enough to run the data matrix I have prepared in his own computer and the relevant trees observed were send to me via e-mail. He used PAUP ver. 3.1 (Swofford, 1993) and the trees were made available in the form of verbal trees as his computer printer faced lot of problems. I have converted the verbal trees into trees using MS Excel software following the methodology used in PAUP and other phylogenetic softwares.

3. 2b. Definition of Measurements

Definitions of terms used in this dissertation are given in the chapter on Morphology. All the measurements were done on fresh and preserved specimens. Dried herbarium specimens were used only for three species that were not able to collect afresh. Observations of macro characters were done using a graph paper fitted on the backside of a plane glass slide and also with a measurement scale.

Stem thickness was measured at the broadest base portion, above the ground. Lengths of 5-8 branches were measure and mean value is mentioned. Measurements of leaves were made on the fully matured leaves, referred to as "cauline leaves". Length of lamina and petiole were given separately to avoid confusion.

Bracteole size is measured after stretching the same in between two microscopic slide kept above a graph paper, under the stereomicroscope. Breadth of the broadest base portion is considered.

Calyx length and pedicel length were treated separately on fully developed and flowering calyces. Lengths of fruiting calyces were measured separately as there is enlargement in size of calyx at fruiting stage. In the case of bent and oblique calyx the length of adaxial (side near the main stem) and abaxial (side away from the main stem) were measured separately. Length of calyx teeth from the free end to the mouth rim and the breadth of broadest base were measured under stereomicroscope.

Total lengths of corolla were measured by adding the length of tube and lower lip together. This is done because; in majority of species lower length and tube are the longer parts. Upper lobe lengths were measured separately from the anterior end to the portion attached to the tube. Lower lip measurements were made after stretching the same in between two microscopic slides. The broadest area of

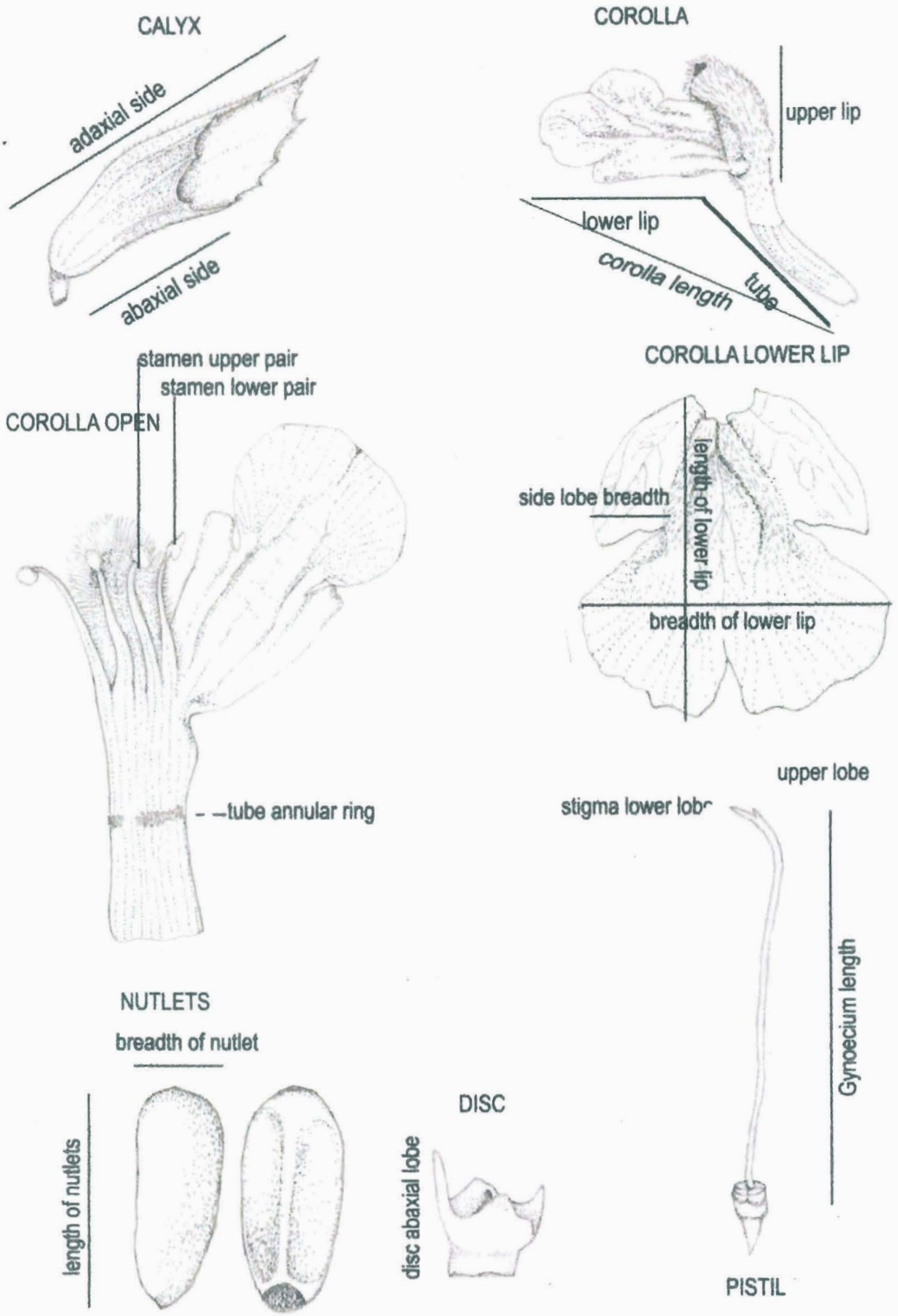


Fig. 2: Definition of measurements

the middle lobe (usually at the margin) and those of side lobe (at the free end) were made under stereomicroscope.

Length and breadth of anther lobes, stigma lobes, ovary locules and nutlets were made in millimeters under a compound microscope using a standardized occular micrometer. Linear measurements of stigma lobes at the longest portion were made for all the species. Disc shape and size were measured on a comparative basis using a graph paper under stereomicroscope.

Nutlets lengths and breadths were first observed under stereomicroscope and then under compound microscope for actual values. Fully ripen seeds (5-10 nos.) were measured and mean value is taken in millimeters. Lengths from the hilum to the distal end were measured and for breadth, the broadest area is taken into consideration.

3. 2c. Abbreviations used.

In the present work many abbreviated words have been used, following the international standards adopted for Botanical systematics. Many herbaria acronyms have been used in accordance with the Index Herbariorum and latin words used according to standard abbreviations used in Botanical Latin. The common abbreviations used are mentioned below with their Latin and English meanings.

Acronym	Full name
B	Botanical Garden and Museum, Berlin, Germany.
BM	British Museum, England, UK.
BLAT	Blater Herbarium, Mumbai
BR	National Herbarium, Belgium.
C	Botanical Museum, University of Copenhagen, Denmark
CAL	Central National Herbarium, Kolkatta
CALI	Calicut University Herbarium, Calicut
CANB	Australian National Herbarium, Canbara, Australia
CGE	Herbarium, Cambridge University.
DBN	National botanical Garden, Goasnevin, Dublin, Ireland
E	Royal Botanical Garden, Edinburgh, Scotland, UK.
G	Conservatorie et jardin Botaniques de la ville, Geneva
GRA	Botanical Research Institute, Grahamstown, S. Arfrica.
K	Royal Botanical Garden, Kew, England, UK.
KFRI	Kerala Forest Research Institute, Trissur, Kerala
LINN	Linnaean Society of London, England, UK
LIV	Botany Department, Liverpool Museum, England, UK.
M	Botaniche Staatssammlung, menzinges Strasse, Germany
MEL	National Herbarium of Victoria, RBG, Australia.
MH	Madras Herbarium, Coimbatore, Tamil Nadu
P	Laboratorie de Phanerogamie, Museum National d'Historie naturelle, Paris, France.
RF	Reserve forest
SKU	SK University, Anantapur, Andhra Pradesh
TBGT	Tropical Botanical Garden, Thiruvananthapuram
W	Natural History Museum, Wienna, Austria.
WELT	National Museum of New Zeland, Wellington.
MSL	Mean sea level

Abbreviation	Latin term	English term or definitions
auct	auctorum	of authors
auct. non	non auctorum	not of authors
ca	circa	about
comb. nov	combination nova	new combination
descry.	description	description
e.g.	exempli gratia	for example
emend.	emendation	emended
non	non	not
sp. nova	species nova	new species
stat. nov	status novus	taxon altered in rank, but retains specific names from former rank, used when the change is made
syn	synonymum	synonym
trans nov	translation nova	new transfer, taxon altered in position, but keeps species name from former
vidi; (!)	vidi	i have seen it
s.d		without collection data
pro		for, instead of
holo.; iso.; neo.		holotype; isotype; neotype
Sans.,Tam., Tel.		Sanskrit, Tamil, Telugu

3.3 TAXONOMIC CONCEPTS

Do species really exist in nature? Is a question that still remains to be answered satisfactorily. Whether species really exists or is it still a conceptual entity created by systematists is continued to be a hot discussion even in the present time.

Attempts to answer this most complicated problem, which the Biologists ever faced, led to the origin of many systems of classification which itself become part of historical periods in biological systematics. According to Mishler (2000), among these historical periods of systematics only Ancient Greek systems through Linnaeus, Natural and Phylogenetic systems are true revolutions in the conceptual basis of systematics.

This piece of work on the taxonomy of the genus *Leucas* is based on the concept that species really exist in Nature and that it has an objective reality as well as an evolutionary reality. Like many other plant genus, *Leucas* also has an evolutionary history, evolved gradually and attained the states of a genus. It can also be assumed on the light of evolutionary concepts that this genus like many others, is still undergoing evolution, which in turn may change its status in future. These evolutionary processes resulted in change of morphological features needed for adjustment in new set up and according to the underlying change. Therefore morphological changes are considered as visible expression of the underlying changes needed for adaptation, i.e. in effect, morphological features occurred and inherited in a group of individuals which has related course of evolutionary history and relationships. Thus, practically, morphological character relationships are considered here for the present study to subdivide the genus *Leucas* into species and further grouping of them into sections. In theory, morphological species concept has been employed here in the genus *Leucas* for systematic consideration.

Thus the relation of 'morphological changes resulted parallel with evolutionary changes', in effect employ the evolutionary or phylogenetic species concept also. Throughout this work, the taxonomy is studied based on different morphologic characters and evolution is traced based on gradation in character changes.

Regarding the infra specific taxa ranks, the concept of Linnaeus is followed largely and used the term 'varieties' for infra specific variants. This is because, the fresh specimens collected from the field shows that differences in the geographical and ecological set up is not a problem in the repeated appearance of variants in many generation of species in the same area. Usually a variety is considered to occur sympatrically without ecological difference between them. This is well clear in the case of *Leucas vestita* and its varieties found co-exist in the same area.

The 19th century concept of sub-species is not well considered in *Leucas* as there is no specific line of deviation noticed in any of the variants in any species which can be considered as evolving in a separate line, rather the variation noticed are minor variation within the species which shows all the basic character of a species.

Gradual changes in a population, with many intermediate forms, which cannot be explained in definite terms and appear largely due to ecological differences in the separated geographical areas are eliminated from infraspecific

rank as they are eco-phenotypes which show plasticity in their characters.

Populations having a definite discrete character differences that is stable for generation, not due to ecological features and can be defined in definite taxonomic terms are considered as varieties. Polymorphism of characters has been avoided while considering infra specific ranks and this is possible by comparing a number of fresh specimens in their natural habitats with those growing in garden raised in different ecological set up. Comparison of wide variety of herbarium materials supplemented this view.

Sectional classification of different species is based mainly on character similarity among species on a supra specific level. This is in other words involves phenetic concept but geographical relationships and ecology also are considered to group them naturally.

ANALYSIS OF THE PRESENT WORK

P. Sunojkumar “Morphologic and Taxonomic studies of the genus Leucas R.Br. (Lamiaceae) in Southern Peninsular India” Thesis. Department of Botany, University of Calicut, 2005

Analysis of the present work

Analysis of the present work

"The laws of biology are written in the language of diversity"

4. ANALYSIS OF THE PRESENT WORK

4.1. PHYTOGEOGRAPHY AND ENDEMISM.

Owing to the lack of reliable fossil record, the history of the origin of *Leucas* R.Br. is obscure. However Hedge (1986) opinioned that the origin of the family may go back to Cretaceous period. From the floral structure and herbacious nature, the family is considered as one of the most highly evolved. Through out the family there is a trend towards a reduction in flower size combined with actinomorphy. If there is any increase in the number of flowers in the verticillasters, the whorls are often condensed into terminal head or spikes. Apart from this hypothesis there is no clear indication of its origin and evolution.

The genus *Leucas* is comparatively less studied member in this family. Phytogeographical affinities and relevance of endemic forms have not been studied in a comprehensive way. The revisionary study of the African and Arabian species conducted by Sebald (1980) through light into the endemic status of the genus in this part of the globe. According to Hedge (1982) there are two centers for the genus, Africa and Asia. In the Africa the greatest diversity is between east and northeast tropical Africa and in Asia it is in Peninsular India. He also proposed that the ancestral root of the genus were located between these two centers, in an area where they are now extinct (Hedge, 1982).

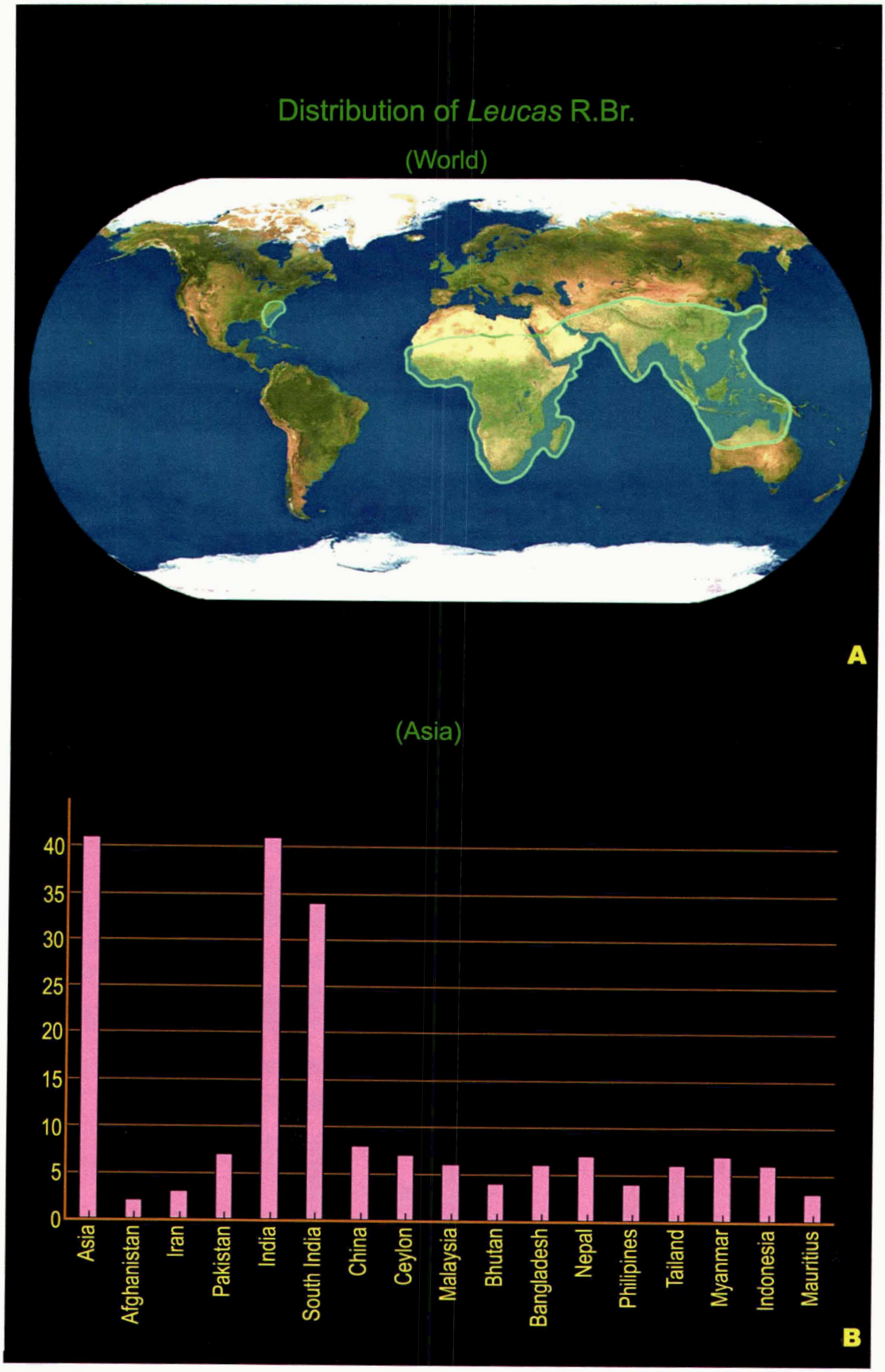


Fig.: 3. Distribution of *Leucas* R.Br. A. distribution map; B. Distribution graph

This pan-tropical genus has about 98 species known (Sebald, 1980; Hedge, 1982; Mukerjee, 1940; Singh, 2001). The total distribution is presented in the figure 2. A (numbers may exceed based on the interpretation of the species), 56 are represented in Africa (Sebald, 1980) 13 species in Arabia (Sebald, 1980; Hedge, 1982) and 41 in India (Singh, 2001; Sunojkumar & Mathew 2002). Almost all the species found in Asian continent are represented in India (Fig. 2. B). These constitute 42% of the total species known and are morphologically diverse from the African species. Only four species are represented in both regions. *Leucas martinicensis* R.Br. and *Leucas urticifolia* Sm. are African species distributed in Asia. Whereas *Leucas lavandulifolia* Sm. and *Leucas aspera* Link. are Asian species found growing in Eastern Africa as introduced weeds. Some of the species found in both regions have extended distribution in the Arabian Peninsula. Few endemic species are also found in this region. American and Australian continent represent one species each. With its tropical climate and suitable topographic features, nature has endowed southern part of the Indian peninsula with great potential for biological wealth.

Diversity of flora, concentration of endemic species and their level in biological hierarchy are the criteria used to divide the world flora into phytogeographic divisions.

In the most recent divisions of world flora, Takhtajan (1986) divided South India under two provinces (1) Malabar province and (2) Deccan province, under

Indian region.

Based on the useful data available from floristic works and phytogeographical affinities of Indian flora, India has been divided into eleven phytogeographical divisions (Balakrishnan, 1996). Of these divisions, south India represents the following divisions.

(1) **No. 8**: **Southern Western Ghat, and West Coast:** A narrow strip of land, 1600 km long, lies between 8° 20'-20° 4' north latitude and 73°- 77' east longitudes (Vajravelu & Vivekanandan, 1996). Three southern states; Karnataka, Kerala, Tamil Nadu and Union Territory of Mahe are coming under this region. The average altitude ranges from 300-1500 m with Anamudi the highest peak attains an altitude 2695 m. This region has highest biodiversity value and is considered as one of the hottest hotspots of the world. (Myers et al., 2000). The humid tropic belt of the Western Ghats possesses three types of forests: tropical moist deciduous, tropical semi-evergreen and tropical evergreen. According to Subramanyam & Nayar (1974), the Western Ghat can be divided into four phytogeographical regions. (1) Western Ghats from river Tapti to Goa (2) Western Ghats from river Kaliei to Coorg (3) Nilgiri, and (4) the Anamalai, Palni and Cardamom hills. Of this the last three divisions comes under Southern Peninsular India.

(2) **No. 9: Deccan:** A broad based inverted triangle shaped comparatively dry elevated tableland interspersed with numerous isolated hills. This lies in between

the Indian phytogeographical divisions 8 and 10. Of the three divisions of Deccan, only the 'Southern Deccan Plateau' comes under South India and this includes parts of Karnataka, Andhra Pradesh and Tamil Nadu. Tropical dry deciduous, tropical moist deciduous and tropical thorn forests are found in this region.

(3) **No. 10**: **Eastern Ghats and Coromandel Coast:** A 1750 km long assemblage of discontinuous hills, plateau, narrow basins and gorges with elevation up to 1750 m. This lies between 77°-22' to 85 °- 20'E longitudes and 11°- 30' to 20°- 0' N latitudes. The Eastern Ghats extend in a northeast southwest direction in the Indian peninsula covering an area of about 75,000 sq km. Two phytogeographical divisions recognized for the Eastern Ghats are (1) the northern sal divisions; extend from the east to the Godavari-Krishna gap and (2) the southern Deccan divisions, south to this division. One more division, 'the southern division' comprises the eastern scarps of the Nilgiri, Palni, Shevroy and Anamalai hills were added by Mani (1974). Eastern Ghat divisions contain different types of forests ranging from evergreen and shola forests in the southern part to dry as well as moist deciduous and low hill scrub jungle vegetation towards the east and northern side.

Phytogeographical analysis attempted in the present study reveals that about 33 species of *Leucas* are found in Southern Peninsular India (Table. 7 & 8). This represents 33% of total species and 80% of Asian *Leucas* reported so far. Within this rich species diversity, 15 species which amount to 15% of the total species are found endemic to this region. This endemicity point to the fact that 37 % of Asian *Leucas*

are found only in South India. Apart from this, the infra specific taxa identified for some species are also exclusively endemic here. The endemic taxa found in Southern Peninsular India are given in the table 7.

It is evident from the present study that among the three phytogeographical divisions of Southern peninsular India, diversity of *Leucas* are higher in the Southern Western Ghat region. Of the 33 species identified in Southern Peninsula, this region shows an extensive diversity of 24 species. Apart from this, of the 8 varieties, 6 are also found here. This reveals that 73% of Southern peninsular *Leucas* taxa are found in Western Ghat region. Followed by this, Eastern Ghat shows second larger diversity of 20 species and 3 varieties, which amount to 60% of Southern peninsular species. Diversity is comparatively less in Deccan region with 15 species, which account for 45% of southern peninsular diversity.

Western Ghat *Leucas* diversity differs in the three southern regions. Highest diversity is seen in Nilgiri region (23 species and 3 varieties). Most of these species are found in high altitude, above 1000 metres. Anamalai, Palni and Cardamomum hill ranges shows second large diversity (15 species and 3 varieties). Species diversity in the Western ghat region south of Goa up to Coorg also amount to fifteen species.

Eastern Ghat region shows difference in the floristic element from the Western Ghat. This is true in *Leucas* also. But taxa like *Leucas eriostoma* Hook.f. found in the Western ghat show its extended distribution in the Eastern Ghat,

especially in the Bababudan hill ranges, which has a distinct floristic links with that of Western Ghat (Meher-Homji, 2001). Some species are present exclusively in the Easten Ghat. Species diversity in this region is higher in the region south of river Godavari, in the Southern Deccan division. About 17 species and 2 varieties are found here and of this some are found only in this region. Northern Sal division of Eastern Ghat harbours twelve species and 2 varieties.

Almost 15 species found in both Western and Eastern Ghat is extended towards the Deccan region, with highest diversity in the Mysore plateau.

This analysis shows that members belonging to the section Plagiostoma is the most highly established *Leucas* group and are evenly distributed in almost all Asian countries. Distribution of species like *Leucas aspea* Link, *Leucas indica* R.Br., *Leucas martinicensis* R.Br., *Leucas stricta* Benth. and *Leucas zeylanica* R.Br. belonging to the section Plagiostoma is wide and extended in all the three phytogeographical divisions and also in other parts of India and Asia. Species like *Leucas biflora* Sm., *Leucas marrubioides* Desf. and *Leucas montana* Spreng., belonging to the section Ortholeucas are also distributed in the Eastern ghat, Western ghat and in Deccan region. These species are extended their distribution in South India and some of them escaped to the wet-zone areas (areas of over 250 cm rainfall per year) of South, East and South East Asian countries. Except *L. stelligera* Benth. and *L. vestita* Benth., species belonging to the section Astrodon are almost restricted to southern part of India.

SN	Name of the taxa	Section	Altitude (m)	Phyto. region	Distribution
1	*L. anandaraoana* Umamaheswari & Daniel	Ortholeucas	MSL	EG_2	Mannar Bio. Reserve
2	*L. beddomei* Sunojkumar & P.Mathew	Lanceaefolia	1770	WG_3	Wayanad
3	*L. decemdentata* var. *sebastiana* V.Singh	Ortholeucas	900-1300	EG_1	Vizakapatanam
4	*L. eriostoma* Hook. f.	Lanceaefolia	1200-1600	$WG_{2,3}$	Canara to Wayanad
5	" var. *lanata* Hook. f.	Lanceaefolia	1920	EG_2	Bababudan
6	*L. helianthimifolia* Desf.	Helianthimifolia	1500-1900	$WG_{3,4}$	Nilgiri, Idukki
7	*L. hirta* Spreng.	Astrodon	1500-	$WG_{2,3,4}$	Idukki, Nilgiris
8	*L. indica* var. *indica* R.Br.	Plagiostoma	±1800	WG_3	Nilgiris
9	*L. lamiifolia* Desf.	Lanceaefolia	1000-1500	$WG_{2,3}$	Kudachadri, Nilgiri,
10	*L. lanceaefolia* Desf.	Lanceaefolia	1500-2634	$WG_{3,4}$	Nilgiris, Idukki
11	*L. mukerjiana* Subbarao & Kumari	Ortholeucas	1300	EG_1	Vizakapatanam
12	*L. nepetaefolia* Benth.	Ortholeucas	1000	EG_2	Nellore, Cuddapah
13	*L. prostrate* Gamble	Astrodon	1400-1920	EG_2 WG_3	Nilgiris, Yercaud,
14	*L. pubescens* Benth.	Ortholeucas	1400-1600	WG_4	Idukki
15	*L. rosmarinifolia* Benth.	Helianthimifolia	2200-2500	WG_3	Nilgiris
16	*L. sebaldiana* Sunojkumar	Astrodon	1394	WG_3	Wyanad
17	*L. suffruticosa* Benth.	Helianthimifolia	2100-2550	WG_3	Nilgiris
18	*L. vestita* var. *angustifolia* Hook. f.	Astrodon	1200	WG_3	Silent Valley
19	*L. vestita* var. *sericostoma* Hook.f.	Astrodon	1500-1800	WG_4	Idukki
20	*L. vestita* var. *oblongifolia* Hook. f.	Astrodon	1500-1800	WG_4	Idukki
21	*L. wightiana* Benth.	Plagiostoma	MSL-	EG_2	Tirunelveli Kanyakumari

$WG_{2,3,4}$ = Western Ghat regions, 2, 3, & 4; $EG_{1,2}$ = Eastern Ghat regions 2, & 3 (altituide in metres)

Table 7: Endemic taxa found in Southern Peninsular India and their distribution.

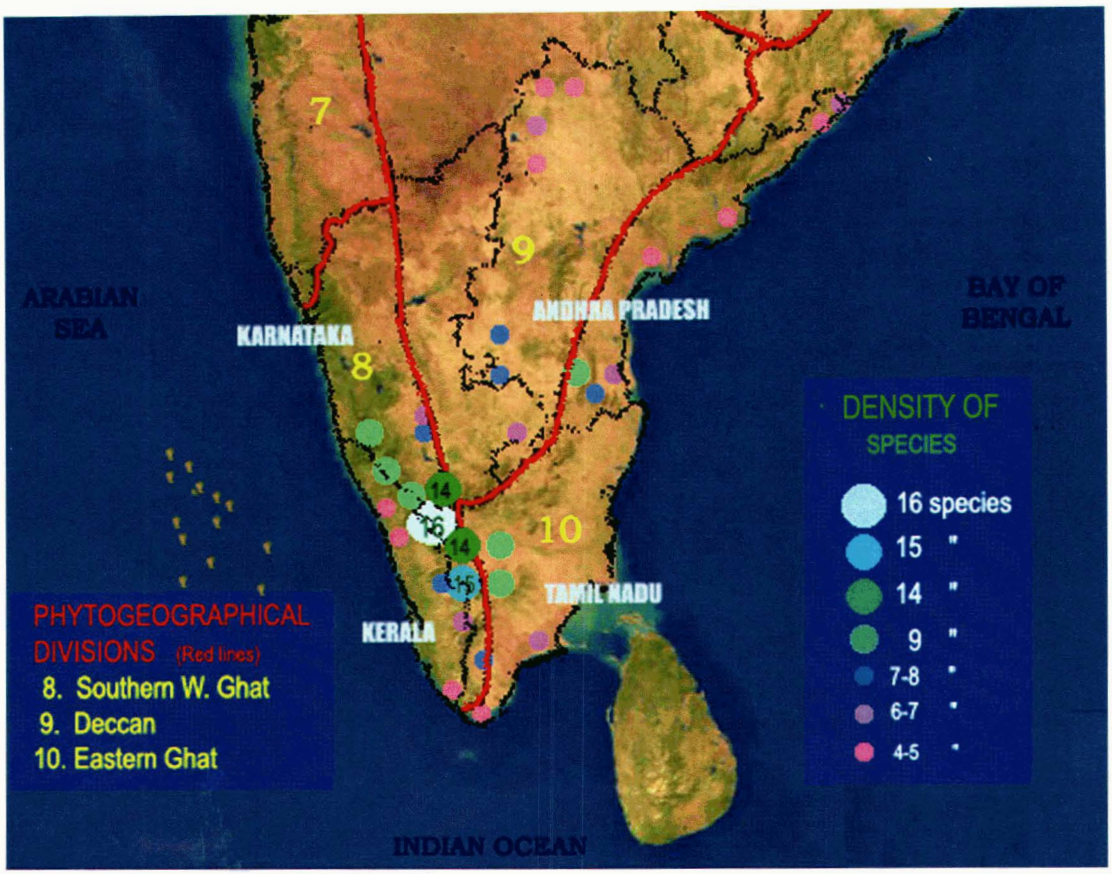
SN	Name of the species	Section	Distribution. (World)	Distribution in South India
1	*Leucas angularis* Benth.	Ortholeucas	SI, SL	WG 2, 3, 4
2	*L. aspera* (Willd.) Link.	Plagiostoma	SI, SL, NE, PH, SEA, CA	WG 2, 3, 4; EG 1, 2 3 & D
3	*L. biflora* Sm.	Ortholeucas	SI, IN, SL, BA	WG 2, 3 4; EG 1, 2, 3 & D
4	*L. cephalotes* Spreng.	Plagiostoma	SI, SL, IN, CA, SEA	EG 1, 2 & D
5	*L. chinensis* Benth.	Ortholeucas	SI, C	WG 3, 4
6	*L. decemdentata* var. *decemdentata* Sm.	Ortholeucas	SI, IN, SL, CA, SEA	EG 1, 2 & D
7	*L. diffusa* Benth.	Plagiostoma	SI, IN*	EG 1, & 2; D
8	*L. indica* var. *lavandulifolia* Sunojkumar	Plagiostoma	SI, IN, SL, SEA, CA	WG 2, 3 4; EG 1, 2, 3 & D
9	*L. lanata* var. *lanata* Benth.	Ortholeucas	SI, IN, CA, SEA	EG 1, 2 & D
10	*L. lanata* var. *candida* Haines	Ortholeucas	SI, IN*	WG3 & EG1,2
11	*L. marrubioides* Desf.	Ortholeucas	SI, SL, MA	WG 2, 3, 4; EG 1, 2 3 & D
12	*L. martinicensis* R.Br.	Plagiostoma	SI, Asia, Arabia, Africa	WG 2, 3, 4; EG 1, 2, 3 & D
13	*L montana* Spreng.	Ortholeucas	SI, IN*	WG 2, 3; EG 1, 2 & D
14	*L. nutans* Spreng.	Plagiostoma	SI, IN, PA, MY	EG 1, 2 & D
15	*L. stelligera* Benth.	Astrodon	SI, IN, SL	WG 2, 3 &D
16	*L. stricta* Benth.	Plagiostoma	SI, IN, MY	WG 2, 3, 4; EG 1, 2, 3 & D
17	*L. urticifolia* Sm.	Hemistoma	SI, Asia, Arabia, Africa	WG 2, 3, 4; EG 1, 2, 3 & D
18	*L. vestita* Benth.	Astrodon	SI, IN, NE, BH, C, TH	WG 2, 3, 4 & EG 2, 3
19	*L. vestita* var. *ciliate* (Benth.) Sunojkumar	Astrodon	SI, IN, NE, BH, C, TH	WG 2, 3, 4 & EG 2, 3
20	*L. zeylanica* R.Br.	Plagiostoma	SI, IN, SL, SEA, CA	WG 2, 3, 4; EG 1, 2, 3 & D

*=Indian endemic; BA = Bangladesh, C = China, CA = Central Asian countries, IN = India, MY = Myanmar, NE = Nepal, PA = Pakistan, PH = Philippines, SEA = South East Asian countries, SI = south India, SL = Sri Lanka, EG1 = Eastern Ghat Northern Sal Division, EG2 = Eastern Ghat Southern Deccan Division, EG3 = Eastern Ghat South division, WG2 = Western Ghat from river Kaliei to Coorg, WG3 = Nilgiris, WG4 = Anamalai, Palni and Cardamomum area and D = Deccan Division.

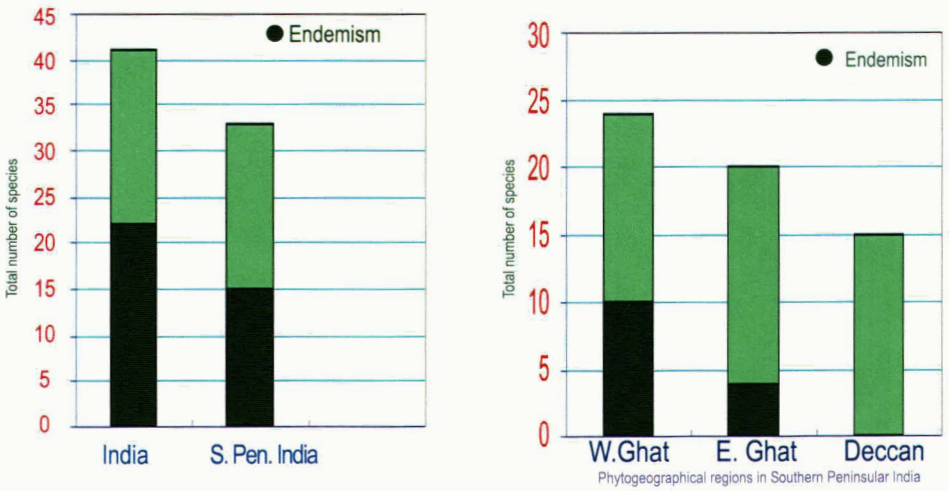
Table **8**: Distribution of *Leucas* R.Br. species in Southern Peninsular India (excluding endemic taxa)

According to Ahmedullah & Nayar (1987), the distribution and concentration of endemic plants in a particular region is an index to overall phyogeography of the area. It is evident from the present study that among the three phytogeographical divisions of South India, endemic density of Asian *Leucas* is higher in the Southern Western Ghat region. Of the 33 species 15 are endemic to Southern Peninsula. This means that about 45% of species found in Southern peninsula are endemic. These constitute about 37% of Asian species and 15% of total species. Apart from this 6 varieties identified for species like *Leucas eriostoma* Hook.f., *Leucas indica* (L.) R.Br., *Leucas vestita* Benth. are also endemic in Southern part (Table. 7). Among the endemics, 10 species and 5 varieties are found exclusively in Southern Western Ghats only. Majority of these Western Ghat endemics are restricted its distribution in the Nilgiri Plateue (10 species and 2 varieties) *Leucas vestita* var. *angustfolia* Hook.f. and *Leucas indica* var. *indica* R.Br. are exclusively endemic here and their distribution are strictly confined to some hill ranges only. Followed by this region, Eastern Ghat region represent second highest endemism with 4 endemic species and 2 varieties. Deccan region do not have any endemic *Leucas* taxa.

The distribution of a species in a particular centre is correlated with its place in the sectional grouping. Due to this fact the distribution of species are analyzed section wise, based on the infrageneric classification proposed in this work. It is interesting to note that endemic taxa belonging to the section Helianthimifolia and majority of the Astrodon and Lanceaefolian taxa are all seen only at an altitude



Leucas diversity in different phytogeographical zones of Southern Peninsular India.



Graph showing the comparative analysis of *Leucas* diversity and endemism

Fig. 4: Analysis of species diversity and endemism of Leucas in Southern Peninsular India.

above 1500 m in Southern Western Ghat region. Most of the endemic taxa are found exclusively in the Nilgiri biosphere area and others in Anamudi Cardamomum hill ranges. Endemic members of the section Ortholeucas are mostly in Eastern Ghat region (except *L. pubescens* Benth.). In the section wise analysis all the members belonging to the section Helianthimifolia (100%) are Southern Peninsular endemic, followed by section Lancaefolia (80%), section Astrodon (60%), section Ortholeucas (31%) and section Plagiostoma (12.5%). No endemic species is found in section Hemistoma.

Affinity with Sri Lanka, and SE Asia.

Many others (Mani, 1974; Karanth, 2003) pointed out that Sri Lanka exhibit geographical and vegetational similarity with Southern Western Ghat region. Among the total 6 species of *Leucas* reported from Sri Lanka (Cramer, 1981), 5 species, *Leucas angularis* Benth., *Leucas biflora* Sm., *Leucas indica* (L.) R.Br., *Leucas marrubioides* Desf. and *Leucs zeylanica* (L.) R.Br., are found in Southern Western Ghat region. *Leucas angularis* Benth. is restricted only to the wet-zone of these two regions.

Most of the species found in China, Nepal, Bhutan, Bangladesh, Burma and other South East Asian Archipelagos are common Peninsular Indian species. This is same in Central Asian countries like Pakistan and Afganisthan.

Distribution of *L. martinicensis* R.Br. and *L. urticifolia* Sm. in Arabian peninsula and North West Asian countries supports Ryding's (1998) view that these species have migrated from Africa to South India through Arabia. Similarly *Leucas indica* (L.) R.Br. and *Leucas aspera* Link are introduced plants in Africa (Sebald, 1980)

Distributions of *L. chinensis* Benth. (in South India and China) and *L. vestita* Benth. (in South India and Bangladesh) are examples of disjunct distribution. This also supports the view that the wet-zone vegetation in this area represent relict of a former continuous distribution (Mani, 1974; Karanth, 2003).

4. 2. ECOLOGY

4.2a. Habitat Study

The practice of using ecological information in taxonomic description dated back to pre-Linnaean period, in folk taxonomy. Knowledge on preferred habitat, seasonality of flowering and pollination mechanisms are useful not only for the taxonomic judgement but also helps in analysing distribution of particular taxa. Mention about the need of recording locality, geographic region, political province, climate and soil etc., is seen in the "*Methodus*" of Linnaeus (1736; translated by Schmidt, 1952).

The habitat study of the *Leucas* R.Br. species were done while collecting the plant from the field. Locality recorded in the herbarium labels were also compared for reaching a conclusion about the preferred habitat and ecology of each species. As seeds of many species were not germinating, small plants with intact roots or branches with roots were collected from the field to plant in the gardens to study the environmental influence on the growth of each plant. Since most of the herbarium labels were vague and did not give any significant information about the nature of habitat, information obtained from field trips was relied mostly.

Observation of plants in the field and experimental garden (raised in low land area in Calicut University Botanical garden and in home garden) revealed the following interesting facts:

- Most of the plants growing high altitude are incapable of growing in low altitude places.
- Even if grow, the high altitude plants fails to flower in low land area.
- Altered natural habitat of high altitude plants does not produce viable seeds, even if they flower.

Altitude and climate have direct influence on the growth and distribution of *Leucas* plants. This factor may seem to play a great role in speciation and distribution of *Leucas*. Infra specific variants are restricted in isolated small territories in high altitude area also corroborates the view that altitudinal and climatic variation may be a speciation factor in *Leucas*. On the basis of ecological

data it is recognised that the different species of *Leucas* may fall mainly into two categories.

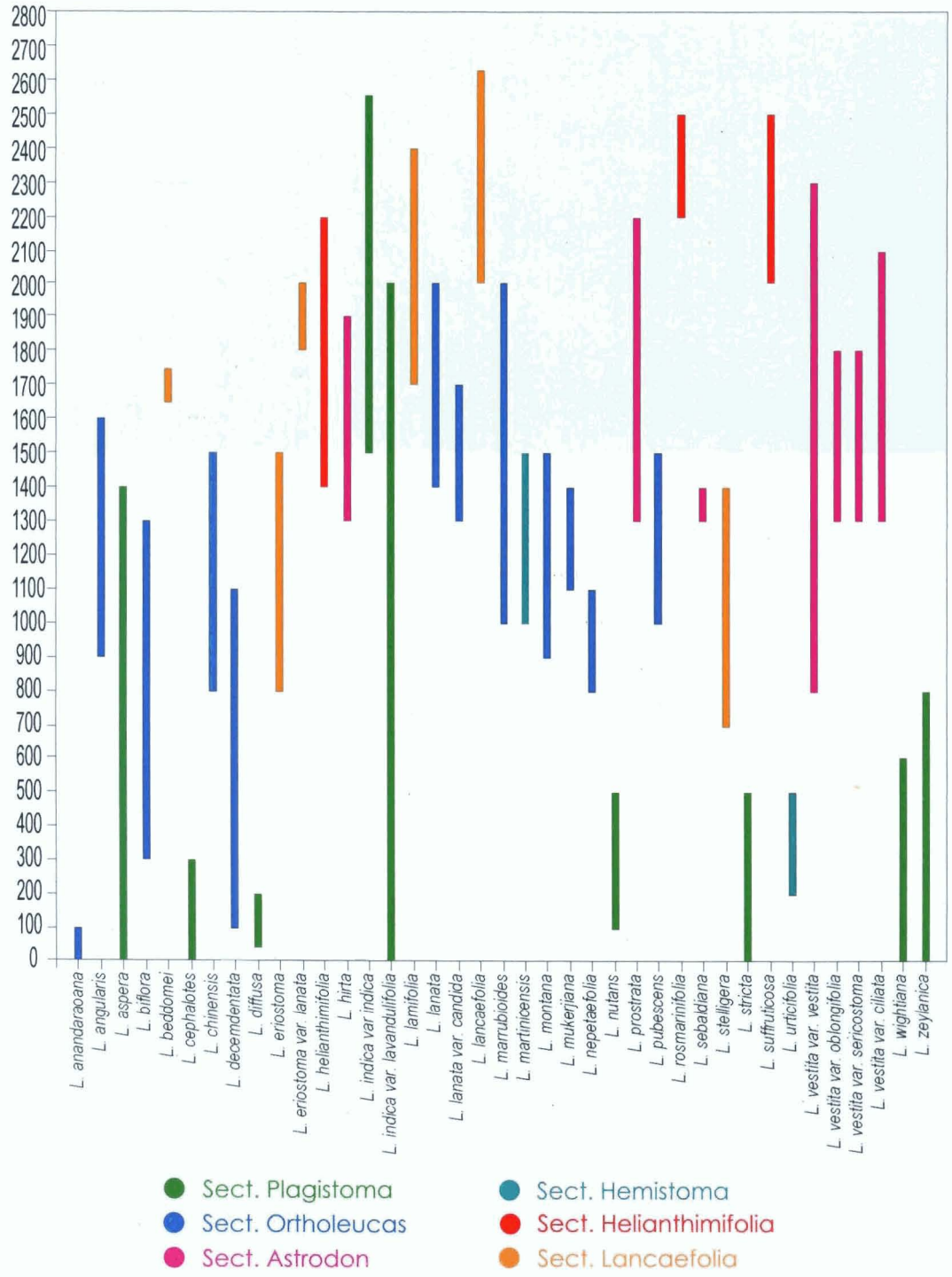
1) Species found in low altitude
2) Species found in medium and high altitude

Species found in low altitude are all members of the section Plagiostoma. They are all annual herbs, distributed over a wide range of habitats viz. sea coast, farm land, paddy fields, open habitats, near wet lands, plantations, road sides and disturbed human settlements. They thrive well from sea level to ±800 m altitude.

Among the low altitude plants, *Leucas indica* (L.) R.Br., *Leucas aspera* (Willd.) Link, *Leucas zeylanica* (L.) R.Br., *Leucas cephalotes* (Roth) Spreng. and *Leucas stricta* Wall ex Benth. are the most widely distributed species in Southern Peninsular India.

Leucas cephalotes and *Leucas stricta* are distributed mainly in Eastern ghat and Deccan regions. Where as *Leucas indica*, *Leucas aspera* and *Leucas zeylanica* show luxuriant growth as weeds up to an altitude up to 800 m. *Leucas indica* is the most widely established *Leucas* plant seen almost all districts of South India, at an altitude ranging from sea level to 2600 m. *Leucas wightiana* Wall. ex Benth. is found in the low altitude scrub jungle area in southern parts of Tamil Nadu and adjacent places. *Leucas diffusa* Benth. and *Leucas nutans* (Roth) Spreng. are found

Fig.5: Known altitudinal variation of different species of *Leucas* R.Br. Found in Southern Peninsular India. (altitude in metres)



in limited localities in South India, mostly as weeds in the waste places. *Leucas anandaraoana* Umamaheswari & Daniel is a member of section Ortholeucas which is reported only from a small island at sea level in Mannar Biosphere Reserve in Ramanathapuram district in Tamil Nadu.

High altitude plants are found at an altitude ranging from 800–2600 m. On the basis of height of the locality and climate, there is difference in the diversity and density of *Leucas* in Peninsular India. The high altitude plants are further divided into (1) **Low hill forest species** and (2) **Montane species** found at an altitude above 1500 m.

The forest species are not found as undergrowth in thick forest but are found on the margins as typical forest border plants. They are seen in forest openings and degraded areas and as part of secondary vegetation. Depending up on the forest types, geographical pecularities and climate, *Leucas* shows differentiation in their species content and population. In Southern Peninsular India, the areas around Southern Western ghat usually contain semi-evergreen and moist deciduous forests up to an altitude of 1500 m. Same types of forest are noticed in the Southern division of Eastern ghat also. Where as towards the Southern Deccan division of Eastern ghat and Deccan division, the forests are usually low hill scrub jungle and dry deciduous types.

Species like *Leucas vestita* Wall. ex Benth., *Leucas prostrate* Gamble,

Leucas pubescens Benth., *Leucas marrubioides* Desf., *Leucas biflora* (Vahl) R.Br., *Leucas angularis* Wall. ex Benth., *Leucas lanata* Wall. ex Benth., *Leucas eriostoma* Hook. f., *Leucas stelligera* Wall. ex Benth. *and Leucas martinicensis* (Jacq.) R.Br. are found in the semi evergreen and moist deciduous forests only. Among these species, *L. vestita, L. marrubioides* and *L. chinensis* extend their distribution even to montane grasslands also. Replanting seedlings and juvenile plants of *L. vestita, L. marrubioides, L. lanata, L. eriostoma* and *L. prostrata* into low land garden did not flower at all. Moreover some of them show stunted growth only. Species like *L. angularis* and *L. biflora* are able to establish and reproduce even in low land.

Towards the low scrub jungle and deciduous forests in the Karnataka, Andhra Pradesh and Tamil Nadu, species like *Leucas decemdentata* R.Br., *Leucas montana* (Roth) Spreng., *Leucas mukerjiana* Subbarao & Kumari, *Leucas nepetaefolia* Wall. ex Benth. and *Leucas martinicensis* (Jacq.) R.Br. are noticed. Most of these species belongs to the section Ortholeucas and are able to establish in garden raised in low land area, but fails to establish a viable population there. *Leucas martinicensis*, an African species is found in both semi-evergreen and scrub jungle areas. *Leucas eriostoma* and *Leucas stelligera* belonging to the section Lanceaefolia are found in the semi evergreen and deciduous forest openings of Kerala-Karnataka border only.

Montane species found at an altitude above 1500 m are not at all reported in low altitudes. It is assumed that the peculiar temperate climates experienced in hill

tops are essential for the growth of these plants. All the species found here are endemic to Southern Peninsular India, exhibiting a xerophytic nature.

Among the montane species, some are true grassland species, found growing among grasses. Species like *Leucas hirta* (Roth) Spreng., *Leucas sebaldiana, Leucas suffruticosa* Benth. and *Leucas rosmarinifolia* Benth. are very short perennial under shrubs. Among these species, *Leucas sebaldiana* is found among tall grasses which grows up to 1 m, where as the others are found among very small grasses which attains a height up to 40 cm only. They have a thick woody basal stem and comparatively small, mostly linear and chartaceous leaves. *Leucas sebaldiana,* the endemic species belongs to the section Astrodon when planted in low land area grew well but fails to flower. *Leucas eriostoma* var. *lanata* Hook.f. are seen as an endemic variety in the high altitude (alt. ±1920 m) area of Bababudan hills in Chikmagalur district and in Talakavery area in Kodagu district only. It may be due to the temperate climate that this variety exhibits variation in the stable morphological characters like dense villous hairs on the whole body including flowering parts. They also exhibit stunted growth habit typical of high altitude plants. The most widely established species is *Leucas indica,* found in all habitat ranging from sea level to 2600 m. The *Leucas indica* var *indica,* shows dense hairy nature, characteristic of high altitude plants and are endemic in the Nilgiri plateau.

Species like *Leucas lanceaefolia* Desf., *Leucas lamiifolia* Desf., and *Leucas beddomei* Sunojkumar & P.Mathew are found in the border of montane evergreen

Grasslands (above 1000m)

Shola grasslands (above 2200m alt)

Scrub jungle at MSL

On rocky hills

Shola -grasslands ecotone area

Shola hil tops (Above 2300 m alt.)

Fig.: 6. Various types of habitats of *Leucas* in South India.

(shola) forests only. These species are growing in the boundaries of forest and exhibit character typical of shola plants. They are woody shrubs with stunted growth, possess thick periderm, and dense tomentum on stem and leaves. These plants, belonging to the section Lanceaefolia are all South Indian endemic plants with very limited distribution. When planted in the plains these plants fail to grow. Distribution and density of these plants reveal that typical temperate climate characteristic of shola forest are innevitable for their growth.

Altitude and climate variation have direct influence on the distribution of *Leucas*. Many plants on replanting in low altitude area fail to establish and reproduce. Rooted stem cutting in flowering stage when transferred to gardens in low land area produce flowers in some species. But when young plants of the same species grew in same gardens did not produce flowers. This means that cold atmosphere is very much essential for the physiological function necessary for flowering in many plants. This points to the fact that altitude and climate factors also may be a decisive factor in speciation and distribution of *Leucas* species.

4.2b. Identification of insect visitors

The species of Labiatae are predominantly bee-pollinated (van der Pijl, 1972; Stebbins, 1974; Faegri & van der Pijl, 1979; Huck, 1992). Ecology of the Mediterranean Labiataes were studied by Petanidou (1996) and reported that

Lamiaceae pollinating insects belong primarily to Hymenoptera and secondarily to Diptera. Among the Hymenoptera visiting Labiatae, solitary bees were the most important group being active throughout their flowering season. He attributed one reason for this is that Labiatae were the main host plants at the end of the flowering season, i.e. during the hot and rainless summer. Compared to non-Labiataes, Labiataean plants were visited by the large sized and long-tounged bees (viz. Anthophoridae, Apidae and Megachilidae).

BEES			
N	**Name**	**Family**	**Order**
1	*Amegolla* sp.	Apidae	Hymenoptera
2	*Amegilla* sp.	Apidae	Hymenoptera
3	*Xylocopa* sp.	Apidae	Hymenoptera
4	*Apis dorsata dorsata* Fabricius	Apidae	Hymenoptera
5	*Thyreus* sp.	Apidae	Hymenoptera
6	*Noama* sp.	Halictidae	Hymenoptera
7	*Halictus* sp.	Halictidae	Hymenoptera
8	*Megachola* sp.	Megachilidae	Hymenoptera

Table **9**: Common bee visitors of *Leucas*

Pollination biology of the genus *Leucas* is not well studied. Vogel (1954), reported that bees are the main pollinators in South Africa. But no information is available regarding this genus found in Asia.

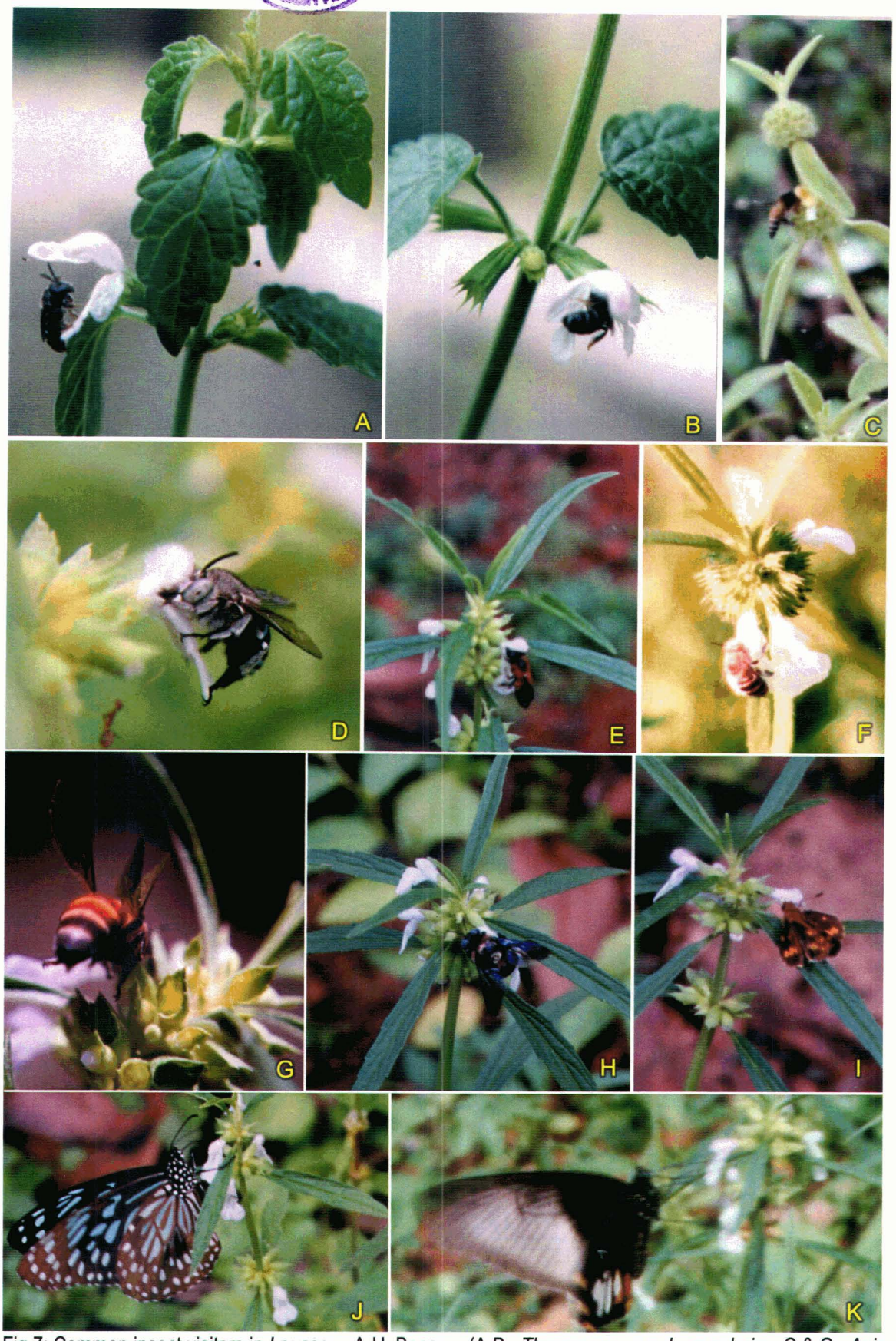


Fig.7: Common insect visitors in *Leucas*. A-H. Bees; (A-B. *Thyreus* sps. on *L. angularis*; C & G. *Apis dorsata dorsata* on *L. beddomei* & *L. indica*; D & F. *Amegills* sps. on *L. indica* & *L. stricta*; E. *Megachola* sps. on L. indica; H. *Xylocopa* sps. on *L. indica*); I-K. Butterflies on *L. indica*. (I. *Potanthus* sps. J. *Tirumala septentrionis*; K. *Pachliopta aristolochiae*).

The present study identified few common insect visitors which are listed in Table 9 and 10. These visitors are identified on *Leucas angularis* Benth., *Leucas beddomei* Sunojkumar & P.Mathew, *Leucas eriostoma* Benth., *Leucas decemdentata* Sm., *Leucas indica* R.Br., etc. Among the common Bee visitors, all belonging to the order Hymenoptera, in which the members of the family Apidae predominates. Regular butterfly visitors are belonging to the order Lepidoptera.

BUTTERFLIES				
N	**Name**	**Common name**	**Family**	**Order**
1	*Potanthus* sp.	Dart	Hesperiidae	Lepidoptera
2	*Suastus gemius* Fabricius	Idian Palm Bob	Hesperiidae	Lepidoptera
3	*Tirumala septentrionis* Butler	Dark Blue Tiger	Nymphalidae	Lepidoptera
4	*Euploea core*	Common Indian Crow	Nymphalidae	Lepidoptera
5	*Pachliopta aristolochiae* Fabiicius	Common Rose	Papilionidae	Lepidoptera
6	*Eurenia hecabe* Linnaeus	Common Grass yellow	Pieridae	Lepidoptera
7	*Castalius rosimon* Fabricius	Common Pierrot	Lycaenidae	Lepidoptera

Table **10**: Common butterfly visitors of *Leucas*

4.3. MORPHOLOGY

A comparative analysis of all morphological character is much helpful not only in identifying the relationships among species in a particular genus but also its grouping in sections. Systematists entail the precise observation of organisms and without accurate comparative morphology, classification of any sort is impossible. As far as the Asian *Leucas* is concerned, a few infrageneric classification is already existing (Bentham, 1830; 1848; Singh, 2001) which is based mostly on the character similarities traced from the herbarium materials. Bentham's classification is basic to the entire genus in Lamiaceae, but changes are inevitable due to its origin almost two centuries back. However, treatment based on herbarium specimens do not fully trace out its true relationships because of scanty data. It is on the light of this fact; fresh specimens were compared, from the field and in the experimental gardens. Morphology of all the major parts and growth nature were compared to reach a final conclusion for sectional classification. Comparative morphological analyses of major characters are mentioned below under separate side headings, to facilitate sectional classification, which are given in the taxonomic part. A total of 33 species found out in South India are considered in six sections, viz., Plagiostoma, Hemistoma, Ortholeucas, Astrodon, Lanceaefolia, and Helianthimifolia, where the last two are new sections, new to this genus, identified as a result of comparative morphological analysis.

4.3a. Growth forms and habit

Growth found in species of *Leucas* examined is different and broadly it can be considered as annuals or perennials. Closely related species are found to possess similar growth forms and the characters is given importance in taxonomic judgment of species and section wise classification. Generally the vegetative and flowering shoots are herbaceous and short lived. Main stems are either herbaceous or woody. Plants grown in garden using small uprooted plants or seeds are found to exhibit a life span ranging from four months to a few years.

In *Leucas*, the plant body has three definite zones in perennial forms. The top most enrichment zone bears inflorescence. Below this zone, the shoot is suppressed in growth with leaves almost fully grown. The innovation zone at base have resting shoots which will develop in the next growing season. In respect of growth forms and habit the genus can roughly divided into 3 types (1) annual herbs, (2) perennial herbs (3) sub shrubs and shrubs.

Of the thirty-three species of *Leucas* studied, eight are true annual herbs, with a life span almost less than one year. Species like *L. aspera, L. diffusa, L. cephalotes, L. indica, L. zeylanica, L. wightiana, L. stricta* and *L. nutans* are of this type. The main stem may exhibit thickening towards the base in some species, which attain a height up to 60 cms. They are erect on the ground, bearing a number of branches. Certain others like *L. diffusa* and *L. nutans* do not have an erect nature

due to weak branches. All these annual herbs germinate during monsoon season and complete their life after flowering, within one year. Species like *L. wightiana* lives up to 5 months only, where as others like *L. indica, L. aspera,* and *L. cephalotes* live up to one year if water is available. All these species have linear-lanceolate leaves, produce large number of flowers in terminal 2-3 verticils and withers entirely without any regeneration. All these species are found in mean sea-level and are included in the section Plagiostoma. However the African species *L. urticifolia* and *L. martinicensis,* included in the section Hemistoma are also have the same growth forms and habit.

Species having a herbaceous nature and grow more than one year, from one and half year to two years are called perennial herbs. Rather than 'biennial', they are better called as perennial because some of these species grow more than 2 years; depend up on conducive environmental conditions. These plants produce long branches and the leaves are usually ovate type. Flowers are produced in many axillary verticils and these branches dies after fruiting or stops producing new leaves. New branches starts producing from the base of main stem or on the older branches which continue to produce flowers for the next season. Because of this, the branches do not grow in length but new one produce from the old stem maintains growth.

Since the basal stems continue to produce new branches for 2-3 season it appear as thick. Plants belonging to this category may live up to 3 years and then

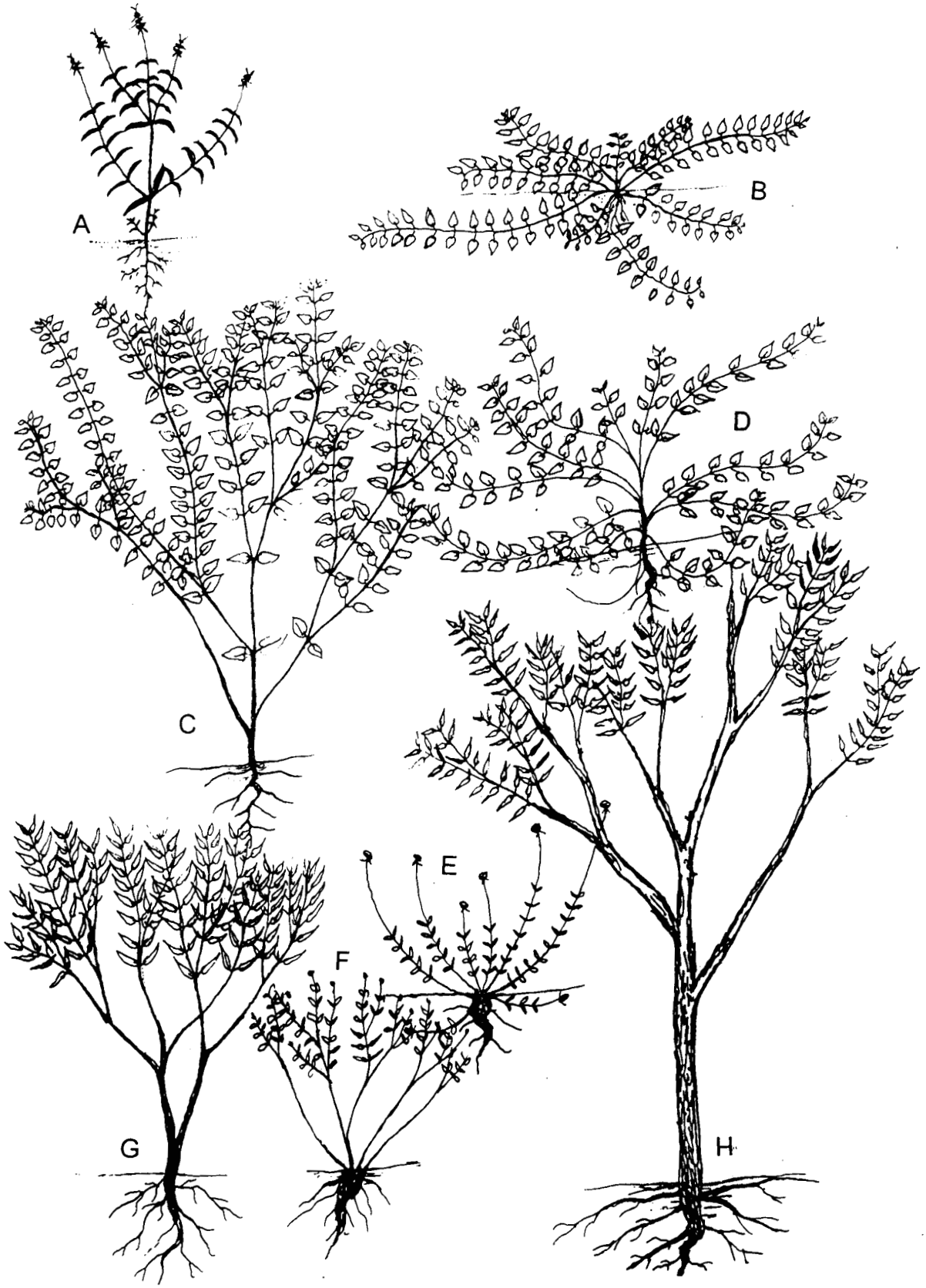


Fig. 8: Growth habit of South Indian *Leucas*. **A**. Annual herb; **B-D**. Perennial herb; **E-F**. Perennial herb with woody stem; **G-H**. Perennial sub shrub.

withers. Members of the section Astrodon and Ortholeucas are of this type. Among these plants, few of them are having a typical prostrate growth form. Branches of these plants are decumbent and often produce roots at nodal region and these rooted branches can grow as separate plant. This mode of vegetative propagation is common in *L. biflora, L. prostrata, L. vestita* and *L. sebaldiana*. Others, belonging to the section Ortholeucas shows long branches, spreading from the main stem and producing new branches from the basal portion. Some of the plants like *L. lanata* and *L. mukerjiana* of this section are typical xerophytic plants found only in drier parts. They exhibit a thick chartaceous leaves and the whole body is covered with dense tomentum. Where as plants like *L. angularis, L. chinensis,* and *L. pubescens* are seen only on wet evergreen forest margins. *L. montana, L. decemdentata* and *L. marrubioides* usually seen in deciduous forests.

Plants like *L. helianthimifolia, L. suffruticosa,* and *L. rosmarinifolia* are dwarf in their appearance but their basal stem shows a thick, woody, amorphous nature due to a perennial life over a few years. Their main stem lives underground with a long woody taproot. Branches, which are not fleshy, are continued to produce from the basal stem, which produce flowers terminally and withers. New branches continued to produce from the basal stem, as a result it appear woody and amorphous with thick periderm. Growth of these plants from the basal stem may last for a few years. Plants belongs to this sections are having linear oblong, entire, 2-6 mm broad leaves which exhibit a xerophytic nature and found exclusively on the shola grasslands, above 2000 m. They are grouped in the new section

Helianthimifolia. However this type of growth nature is noticed in *L. hirta*, belonging to the section Astrodon.

Species like *L. beddomei, L. eriostoma, L. stelligera, L. lamiifolia* and *L. lanceaefolia* are having an erect basal stem which is thick and woody. They live for a few years, and attain a height up to 2 m. are usually called as subshrubs or undershrubs. *L. lamiifolia* and *L. lanceaefolia*, which attain a height up to 2 m., have basal stem which is up to 4 cm in diameter and are shrubby in appearance. All plants belongs to this section have lanceolate leaves and are found in high altitude ranging from 1000-2000 m. *L. lanceaefolia, L. beddomei* and *L. lamiifolia* are typical shola grassland ecotone plants, where as *L. eriostoma* and *L. stelligera* are found in open areas of deciduous forests and evergreen forests. All these species, having a stationary main stem, which produce new branches on it, and bears flowers towards their tips, are grouped in the new section Lanceaefolia.

4.3b. Stem

Stem in the genus *Leucas* are mostly quadrangular. However a few species show typical terete nature. The true shape of stems can be seen in tender branches. Nature of main stem shows a range from true fleshy herbaceous to thick woody form. Generally the nodal portion shows a slight swollen appearance and this is prominent in annual herbaceous members of section Plagiostoma. Depending up on

the growth form, the nature of main stem shows variation. In the annual herbaceous species, the stem is fleshy, green, quadrangular grooved. The angles are always obtuse without a sharpe edge. The stems are mostly short hispid with deflexed hairs. In the perennial herbs, the stems are either grooved as in section Astrodon or non grooved as in section Ortholeucas. The non grooved quadrangular stems shows a sharp acute angles and short deflexed soft hairs. Whereas grooved stems are hispid to ciliate, with erect stiff hairs and obtuse angles. Basal parts of these plants are thick with a slight periderm formation. However the stems are having a general herbaceous appearance. In *L. nepetaefolia*, belonging to the section Ortholeucas, the branches are usually terete.

In sub shrubs and shrubs the basal stem is woody, with thick periderm, even with lenticels. (as in *L. lamiifolia* and *L. lanceaefolia*). They show a diameter ranging from 1cm to 4 cm. Stems are rigid and erect, often produce adventitious roots to support its erect nature (in *L. eriostoma, L. beddomei* and *L. stelligera*). Basal stem is amorphous and woody in *L. hirta, L. rosmarinifolia, L. suffruticosa* and *L. helianthimifolia.* This is due to their continued growth over a few years without internodal elongation. The stem produce new shoots every year and as a result of the continued growth, it enlarges with time and become subterraneous. Enlargement of the stem contribute to the lignification of outside portion, are usually dark in colour and covered with a thick periderm. Along with stem, roots also grows and the thick stem base together with root stock form an amorphous structure

below the surface and are called as 'woody root stock' . The young branches produced on the woody root stock are terete with thick epidermis.

Tender stem in all the species are fleshy with dense villous soft hairs towards the tip. Mature stem in species like *L. angularis* and *L. pubescens* become hollow with a long cavity in the middle due to the disintegration of soft tissues. Internodal elongation is different in different species. In section Helianthimifolia, the members show a reduced internodes as a result there is overlapping of adjacent leaves as in *L. rosmarinifolia.*

4.3c. Leaves.

Morphology of leaves are taxonomically important in *Leucas.* The leaf shape, size, indumentum, lamina texture, tip, base, margin, and petiole length are character used for taxonomic analysis. Nature of petiole varies from almost sessile to definitely petiolate and the length may vary from 2 mm to 3 cm. Leaf margins, tip and base shows much variation and the term serrate to crenate, obtuse to acute, cuneate to rounded, cordate or truncate with intermediate character terms are used following the terminology used by (Hickey, 1973).

Generally members of the section Plagiostoma are having a linear lanceolate shape with serrate appearance. Variation of this basic shape is seen in different members. Even though the length and breadth of leaves varies in different population collected from different parts, the basic shape is same. In *L. diffusa* the leaves are oblong and margin is entire, with comparatively small size than other members of this section. In *L. nutans* and *L. cephalotes*, the leaves are more or less lanceolate. In almost all the members, leaf tip is obtuse with different degree of variation. The leaves are petiolate to sessile, and in the former case, the margins of the lamina are more or less decurrent along the petiole. Leaf base is mostly long cuneate and narrowed. Petiole size may range from 3 mm to 1.5 cm. Lamina is more or less having a same texture, they are thin but not papery so the term slightly coriaceous is used. The number of secondary veins (Hickey, 1973) are usually 3-4, which are prominent on the lower side.

In members of section Ortholeucas, the leaves are basically ovate. Species like *L. pubescens*, *L. chinensis*, *L. biflora*, *L. montana*, *L. angularis*, *L. anandaraoana*, *L. mukerjiana* and *L. lanata* are having typical ovate nature but in *L. marrubioides*, and *L. nepetaefolia* the shape may attain orbicular form, with crenate margins and obtuse tip. Basal portion show variation from truncate to slightly cuneate. Except in the case of *L. lanata*, *L. montana*, *L. mukerjiana* and *L. marrubioides*, the leaves are thin and pubescent. In *L. lanata* and *L. mukerjiana* leaves are chartaceous due to dense tomentum.

In section Astrodon, leaves are basically oblong; tip obtuse, base rounded and margin crenate. In *L. vestita* var. *vestita* and *L. sebaldiana*, lamina size may range up to 13 cms with 6-7 parallel secondary veins. In *L. hirta*, the leaves are small thick, coriaceous and 3-4 serrated from the middle towards the tip. Infra specific variants of *L. vestita* shows variation in leaf shape and size. Lamina is lanceolate and acute in variety *ciliata*, oblong lanceolate in var. *angustifolia* where as broadly ovate in var. *oblongifolia*. In var. *sericostoma* leaf base may show cordate appearance.

A remarkable variation is noticed in the members of section Helianthimifolia where the leaves are generally linear oblong, entire, obtuse with revolute margins. In *L. suffruticosa*, up to 4 leaves are found on a node, overlapping with adjacent nodes due to reduced internodes. In *L. helianthimifolia* up to 3 leaves are seen in a node. In all the three members of this section, leaves are small, 2-6 mm broad, with highly reduced petioles.

The degree of leaf pubescens varies from pubescent to densely villous. Majority of the leaves are hispid with deflexed (antrorse or retrorse) hairs. Both surface (upper & lower) are having same type of hairs (except in *L. marrubioides*) but the density is more on the lower side. In *L. marrubioides* lower surface contain marrubioid hairs. The thickness of lamina varies between the species and is

determined by their ecology. In *L. montana* it is noticed that the plant collected from the field having a thick fleshy coriaceous lamina develop thin leaves on the same plant when transferred to garden raised at sea level. This shows that leaf thickness is liable to a great phenotypic plasticity and so was not to be considered in taxonomic judgement. Species growing in shola-grassland are thicker where as those growing in forest and open places have thinner leaves. Similarly colour of the leaves (in fresh condition) shows variation in different members. Dark green is noticed in *L. suffruticosa, L. rosmarinifolia* and *L. vestita* where as pale green is noticed in all the Plagiostoma members except *L. aspera* and *L. wightiana.* Yellowish green is noticed in *L. hirta, L. prostrata, L. beddomei* and *L. lamiifolia.* In *L. helianthimifolia,* the leaves are grayish green.

4.3d. Inflorescence

Nature of inflorescence in Labiatae have been studied much earlier by Bentham (1832-1836) and Briquet (1896). They are generally consists of cymes arranged along a racemosely branched axis of indefinite growth. In *Leucas* the cymes are well developed and the inflorescence altogether are called as verticillaster. It consists of whole cymes on both sides of the main axis. The cymes in *Leucas* are scorpioid type with reduced pedicils for each flower. The bracts (another name for floral leaves) are frondose (leaf like), like other cauline leaves with same texture and indumentum in all species. Bracteate leaves are subtending

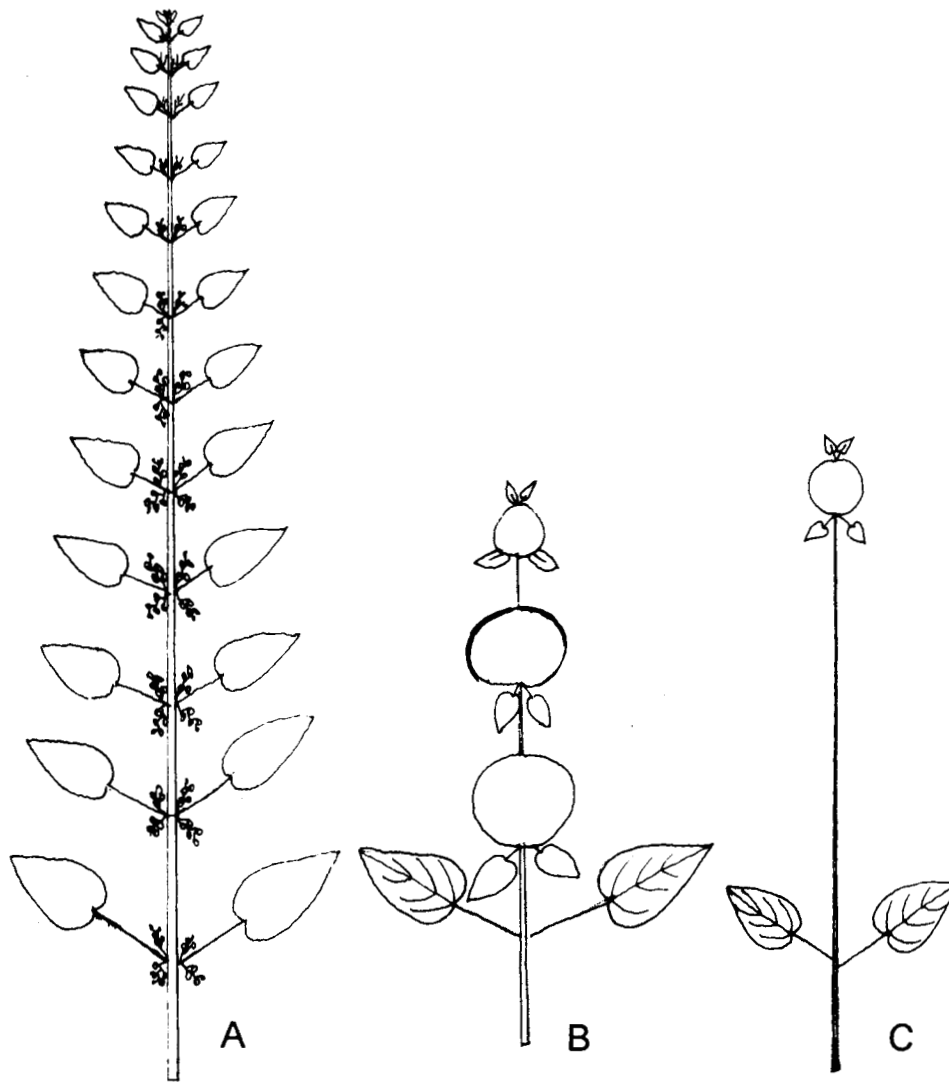


Fig. 9: Inflorescence types in *Leucas* species. A. Many axillary clusters; B. Terminal 1-3 verticils; C. Terminal on a long axis.

the whole cymes (half of verticillaster). The bracteoles are subtending the flowers and branchlets within the cymes.

Nature of inflorescence bearing axis, number and position of verticillaster and the number of flowers in each verticils vary in this genus. In the members included in section Ortholeucas, many verticillaster (10-18) are seen towards the tip, on the flowering branch. Because of this it may appear as axillary and the term "inflorescence in many axilary clusters" are used in description part to denote the type of inflorescence. Number of flowers in species like *L. biflora* are very limited, 1-4 in a cyme. Where as it is 10-20 in species like *L. marrubioides*, *L. decemdentata*, *L. lanata* etc. The pedicel and branchlets are highly reduced in most cases (below 1 mm) but may extent up to 2-3 mm in species like *L. angularis*. The whole inflorescence appear as a long raceme on the flowering branch.

In section Plagiostoma and Astrodon, the inflorescence appear almost terminal with 1-3, rarely up to 5 (as in *L. wightiana*) verticals towards tip. The term "terminal" is used for this type of inflorescence in the description part. Each verticals are dense 20-35 flowered, and appear as 'head like' due to reduced pedicils and branchlets surrounded by an involucre of bracteoles. In *L. wightiana*, due to the highly reduced axis, the inflorescence axis appear as spike with the basal one the broadest. Bracteate leaves are seen projecting in between the spike like

inflorescence. In *L. aspera*, the uppermost two are closely appressed due to maximum reduction of internodes in between. This gives a two-tired appearance to the inflorescence. In *L. cephalotes*, the inflorescence appears as head like.

In species like *L. suffruticosa* and *L. helianthimifolia*, the internode just below the verticillaster (1-2 on an axis) shows much elongation than the other internodes. As a result of this the inflorescence appear on the tip of an elongated axis. This character has taxonomic as well as ecologic importance.

In the section Lanceaefolia, the number of verticillaster in the flowering axis may grow up to five. Each verticillaster is globose, many flowered spaced by long internodes in between.

The appearance of inflorescence in terminal verticillaster is "head like" with flowers arranged centrifugally with older flowers at central and younger ones towards periphere. The bracteoles are imbricately arranged in the periphere. This condition resulted due to a twist in pedicils towards the upper side to produce flowers vertically. The bracteoles which are almost equal to calyces are displaced towards lower side where it grows straight, adjacent to calyx, horizontally and the upper half take a bent towards calyx tube. All the bracteoles then together form an

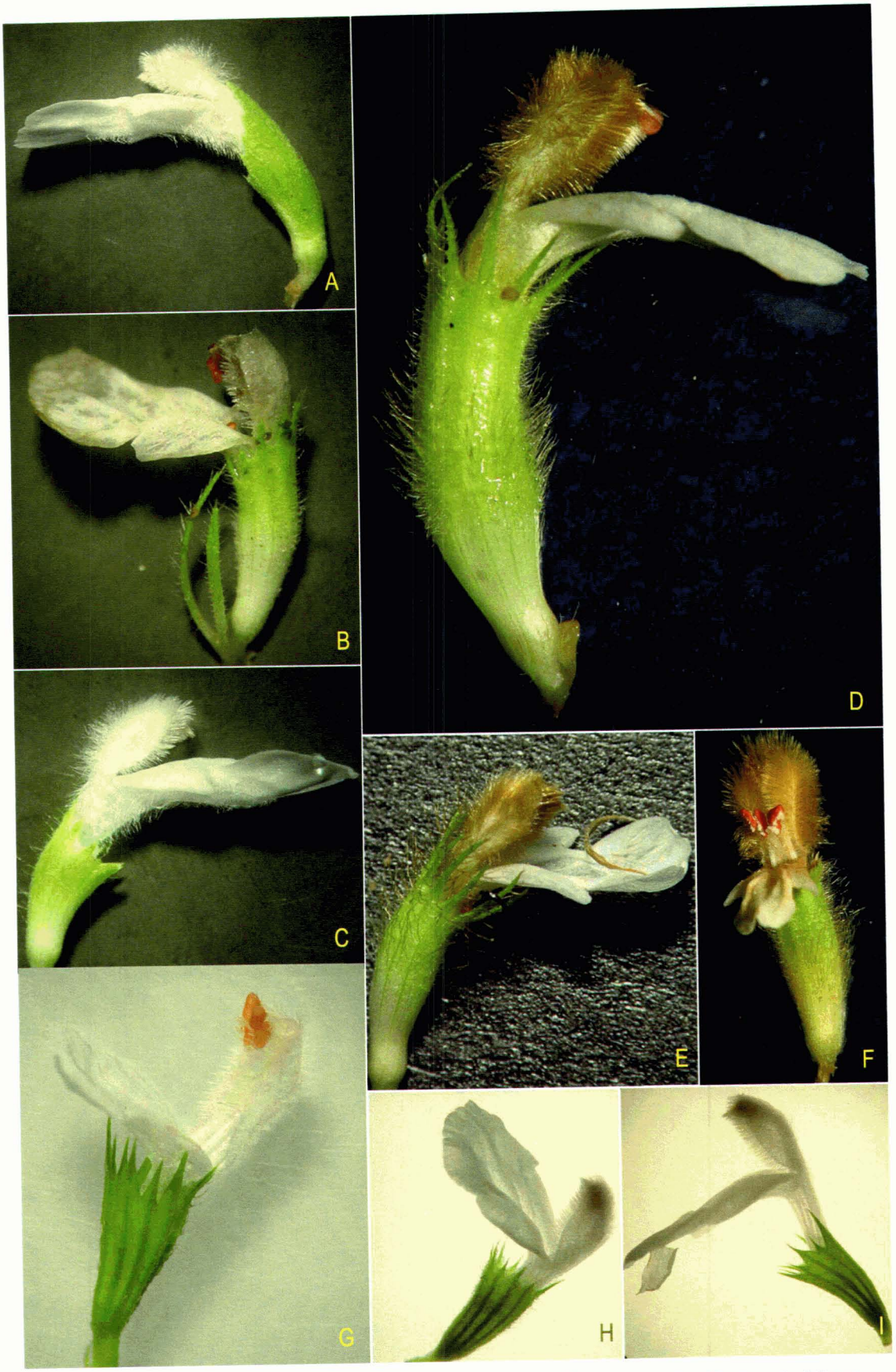


Fig. 10: Flowers in *Leucas*. A. *L. indica;* B. *L. aspera;* C. *L. zeylanica;* D. *L. sebaldiana;* E. *L. vestita;* F. *L. beddomei;* G. *L. biflora;* H. *L. decemdentata;* I. *L. angularis.*

involucre around the calyx. This is more clear when the bracteoles are foliaceous as in *L. cephalotes* and in *L. sebaldiana*. Reduction of pedicils and inflorescence branches produce flowers very adjacent to each other. In *L. sebaldiana*, due to different size and bent nature of calyces, the inflorescence do not have a regular outline. In all cases the main axis produce a pair of leaves outside, projecting beyond the inflorescence.

In the 'axillary clusters type,' the cymes are rather lax with flowers hold vertically and horizontally. The pedicils in this type will be longer if the number of flowers are lesser (as in *L. biflora*) and is shorter if numbers of flowers are more (as in *L. marrubioides*). The bracteoles are filiform, much smaller than calyces, inconspicuous and are displaced towards the bottom as in *L. angularis, L. decemdentata*, and in *L. chinensis*.

4. 3e. Bracteoles

The structure of bracteoles is much differs from bracts. The bracts are frondose, similar to cauline leaf where as the bracteoles are much smaller, equal to calyx or much smaller than that. Several features of the bracteoles, which have been considered as significant character in these genera are their shape, size, indumentum and nature of arrangement.

In sections Plagiostoma, Asterodon, Hemistoma, Lanceaefolia and Helianthimifolia that produce terminal inflorescence, the bracts are almost equal to the calyx. They are usually subsessile, convexly rounded or bent to surround the flowers in the form of an involucre. They bent upwards and expose their lower surface outwards. Shape may vary from linear to lanceolate or in some cases foliaceous. Almost all of them are provided with ciliate hairs at margins and outside lower portion. Species like *L. cephalotes, L. nutans* and *L. sebaldiana* produce foliaceous bracteoles with a distinct midrib and 2-3 secondary veins, they resemble a miniature leaf with thin texture and ciliate margins. In all other species of section Plagiostoma and Astrodon, bracteoles are linear.

In *L. helianthimifolia* and *L. suffruticosa*, the bracteoles are thick, straight, only half the size of calyx and much reduced in number. They are minutely tomentose and form a close structure at the base and outside of flowers. In *L. rosmarinifolia* bracteoles are equal to calyx lanceolate and ciliate. In the sub shrubby plants of section Lanceaefolia, bracteoles are rather thick.

In the species included in the section Ortholeucas, the bracteoles are filiform, narrowly linear and tomentose. Mostly they are minute structure, much smaller than calyx but some are equal to calyx as in *L. marrubioides*. In other members,

they are much reduced, some time up to one-fourth the size of calyx. Bracteoles in these species are very weak structure, seen scattered below their flowers.

4.3f. Calyx

Nature of calyx is the most important stable character used for species identification in the genus *Leucas*. Generally the calyx is tubular to campanulate and there is wide variation in the form of tube, shape and size of teeth and nature of indumentum that are unique and taxonomically very important in each species. The degrees of vaiation in calyx features are more in species belonging to different sections (as treated in this work). Most of these variations can be understood as adaptations to the different dispersal mechanisms presumed to occur in this genus.

Nature of calyces in Asian species is much different from African species. Asian species are 8-10 toothed with ciliate hairs at the mouth and there is no lobation for the calyx. Where as in African species, the calyx is 5-10 toothed, without cilia and with various degree of lobation at the mouth region.

In Asian *Leucas* calyx size ranges from 6-13 mm. In the annual herbaceous members included in the section Plagiostoma, the calyx shows unequal size in the

adaxial and abaxial side. Adaxial side is the side that is close to the main axis and the opposite side is called abaxial side. The vaiation in size may be due to the oblique nature of mouth or due to bent nature of tube. The degree of obliqueness of mouth and nature of bent in the tube is different in different species. Usually calyx teeth are extension of the longitudinal nerves of tube. There are usually 10 nerves and teeth in Asian *Leucas* except in *L. zeylanica*, where the calyx contains only 8 teeth. In *L. indica*, there is a slight fusion of anterior tooth with the two small lateral teeth on both sides. This adnation may sometime not present in different members of the same population. In *L. stricta* the teeth are 2.5-3 mm long and almost equal. In all other members the teeth are 0.5-1.5 mm long. In species like *L. indica, L. zeylanica* and *L. wightiana*, the anterior tooth is larger than others. Usually the mouth is very oblique in *L. indica, L. aspera, L. wightiana, L. cephalotes* and *L. nutans* but it is semi oblique in *L. zeylanica* and *L. stricta*. Ciliate hairs in the mouth rim are not common in annual herbaceous form but it is prominent in *L. stricta* where the hairs are turned towards the center of mouth, closing it partially. In *L. cephalotes* the calyx tube is straight but the mouth is very oblique with a tuft of small ciliate hairs. *L. nutans* shows a 90° bent for the tube and the mouth is very oblique.

In the two members *L. martinicensis* and *L. urticifolia* of the section Hemistoma, the tube is slightly bent. In the former the anterior teeth is 2-3 times longer than other teeth and this impart oblique appearance to the mouth. In the

latter, the calyx mouth shows two lobes as in other African species.

In the section Ortholeucas, the members are characterized by tubular straight calyx with 10 almost equal or subequal sized teeth. The tube is ribbed and hispid outside entire length along the 10 longitudinal nerves. Slight variation of the common character is noticed as a unique character in each species. In *L. angularis* and *L. biflora* the teeth are thin flat, triangular structure with a midrib. In *L. decemdentata*, the tube is thin, with slight bent and the teeth are filiform with narrow long hairs. *L. pubescens* has a cylindrical calyx which is slightly fleshy and inside upper half hispid. In *L. montana, L. mukerjiana* and *L. lanata* the teeth is slightly fleshy, short and hispid. In *L. chinensis*, the calyx is unique with a funnel shape and stellately spreading equally sized teeth.

Members of the section Astrodon shows quite a different type. Here the calyx tube is straight and the mouth is densely ciliate with golden coloured shining hairs form a cone shaped dome over mouth. The teeth are 2-3 mm long, linear, spreading out and hispid. This condition is seen in *L. hirta, L. prostrata* and *L. vestita*. However slight variation of this condition is seen in *L. sebaldiana* where the tube shows slight bent in the middle, mouth cilia are an extension of the hairs present in the tube upper half and the teeth are straight, almost parallel.

In section Helianthimifolia, the calyx is tomentose, short campanulate with a narrow base and wide ciliate mouth. In *L. rosmarinifolia*, the mouth cilia is as long as or longer than teeth.

In sub shrubby species of section Lanceaefolia, the tube is straight, but show variation within each member. In *L. eriostoma*, the calyx tube is thin and reticulate in the upper part where as lower part is leathery. Mouth is dense ciliate with long hairs. In *L. beddomei*, tubular calyx is fully leathery, long hispid and mouth ciliate. In *L. stelligera* and *L. lamiifolia*, the calyx shows resemblances in the nature of teeth as spreading fleshy triangular densely hispid structure. In *L. lanceaefolia*, the tube mouth is wide and very short ciliate.

In almost all the species, the calyx shows prolongation during the maturation of seeds. In species like *L. stelligera* and *L. eriostoma*, the calyces grow almost double the size than when they are in anthesis stage. Mouth cilia closes the opening of calyx when the corolla falls down and protect the seeds inside the tube until it fully mature. Together with the maturation of seeds the mouth cilia falls down which allow the seeds to escape out of calyx tube. In plants with terminal inflorescence, the entire inflorescence falls down much later than the seed maturation. Where as in plants with axillary clusters, the calyces may retain on the axils even after the liberation of seeds for a long time and falls singly.

Fig.11a: Calyces in *Leucas:* A. *L. aspera;* B. *L. indica;* C. *L. zeylanica;* D. *L. stricta;* E. *L. diffusa;* F. *L. cephalotes;* G. *L. wightiana;* H. *L. nutans;* I. *L. urticifolia;* J. *L. martinicensis;* K. *L. prostrata;* L. *L. vestita;* M. *L. sebaldiana;* N. *L. helianthimifolia;* O. *L. suffruticosa.*

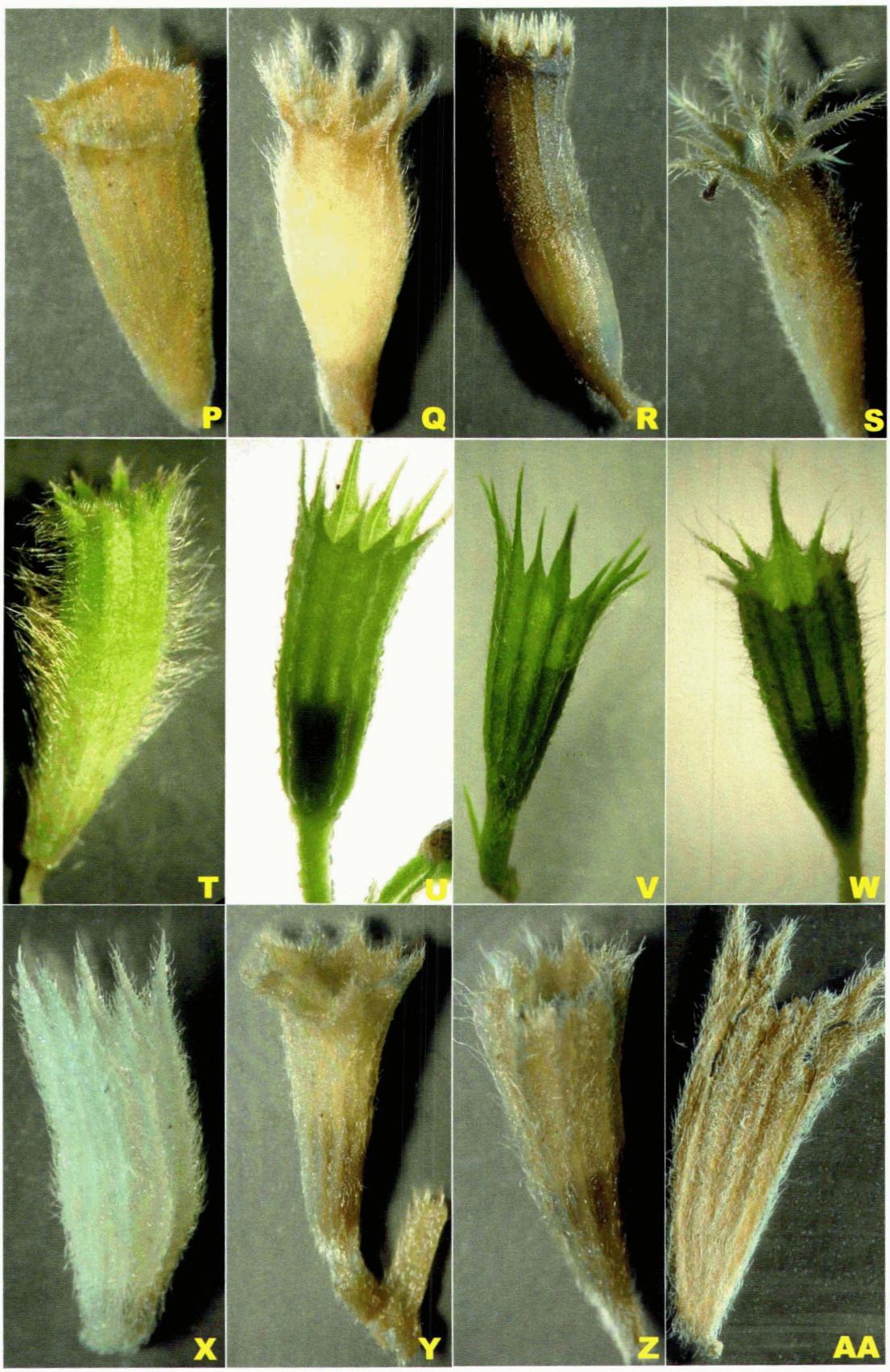


Fig. 11b: Calyces in *Leucas:* P. *L. lanceaefolia;* Q. *L. lamiifolia;* R. *L. eriostoma;* S. *L. stelligera;* T. *L. beddomei;* U. *L. angularis;* V. *L. biflora;* W. *L. decemdentata;* X. *L. pubescens;* Y. *L. chinensis;* Z. *L. montana;* AA. *L. anandaraoana.*

4.3g. Corolla

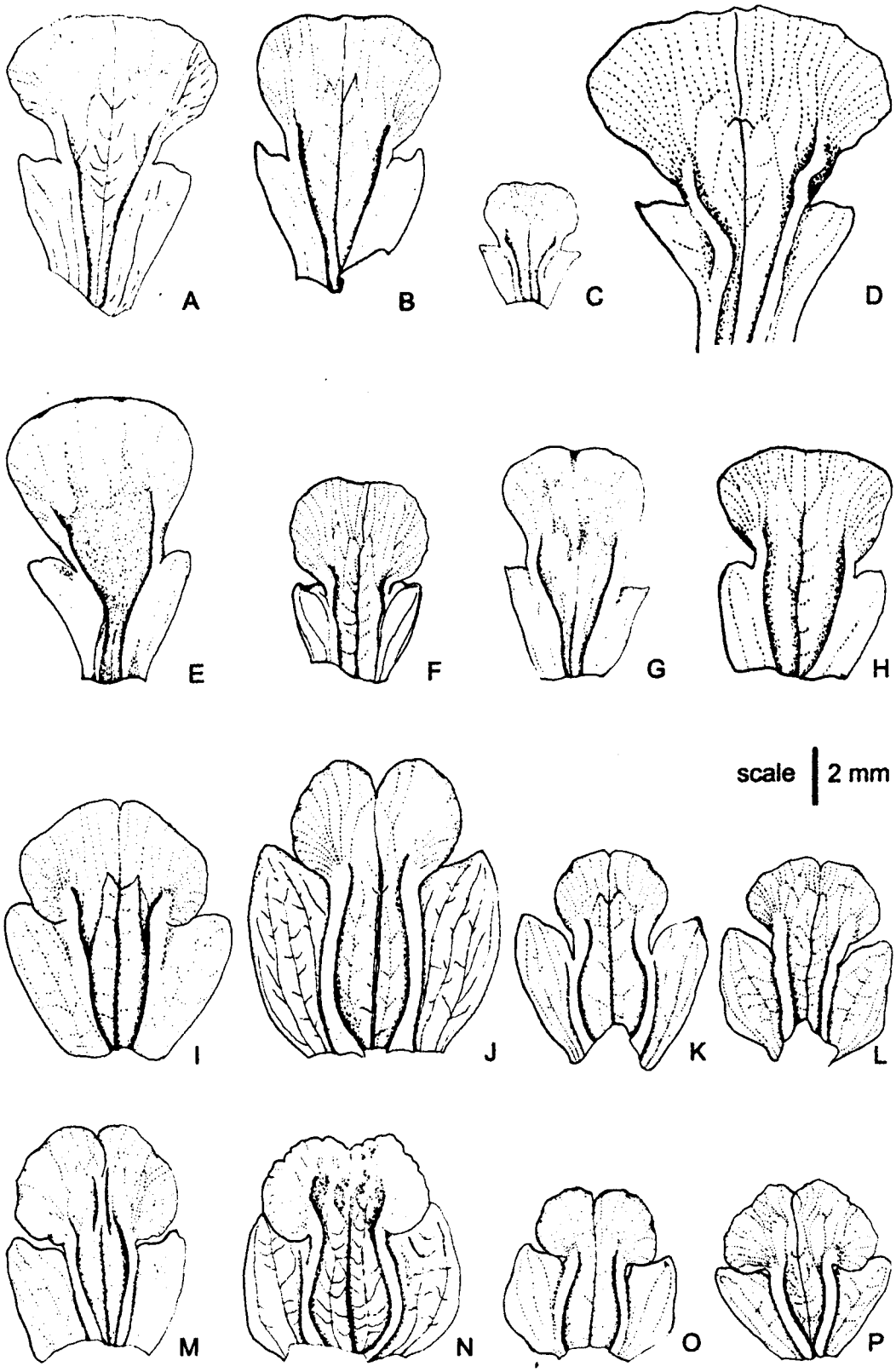
The corolla in *Leucas* differ notably in size and shape from that of the other genera in the sub tribe Lamineae. Corolla in *Leucas* is two lipped and long tubular at the base. The upper lip is rounded at the apex, villous to densely villous outside and glabrous within. The margin is ciliate with long hairs. Upper lip is white or yellowish brown coloured which encloses stamens and stigma inside. The lower lip is composed of three sub equal lobes. The nature of middle lobe varies and may be flattened (fan shaped) or slightly arched (emarginate). The tube in most of the species are long, as long as lower lip but in a few species it is smaller than lower lip and there is a ring of fleshy hairs inside.

Variation in the corolla is a character highly useful in taxonomic judgement. In the section Plagiostoma which consists of annual herbaceous members, corolla is fully white coloured. The upper lip is provided with white coloured thin short but dense hairs, which extent up to the top of tube. Margin of upper lip is ciliate and these ciliate hairs show blackening at the anterior most tip as in most of the species. The lower lip is obliquely attached with tube and is larger than tube and upper lip. Middle lobe of lower lip is fan shaped without any lobation and the two lateral sides are 1-1.5 mm broad, 4-5 times longer than broad.

In some species like *L. indica*, the lower side of lower lip is hairy but it is absent in some others. Corolla tube is almost equal to or smaller than lower lip and provided with an undulating and discontinuous ring of fleshy hairs almost at the middle. Tube is glabrous above and below this ring. Corolla size is little smaller in *L. wightiana* than others. In *L. nutans*, the lower lip is attached very obliquely. Species like *L. aspea, L. indica, L. zeylanica, L. cephalotes* and *L. stricta* the corolla is almost same in appearance.

In the section Astrodon also the lower lip is fan shaped and attached obliquely with the tube. Upper lip in the members of this section are coloured except in *L. prostrata* which is white. *L. vestita, L. sebaldiana* and *L. hirta* shows golden yellowish to brownish yellow coloured upper lip and the hairs are much denser and longer than that of section Plagiostoma.

Species included in the section Ortholeucas shows a corolla shape entirely different from others. Corolla is purely white coloured and the lower lip is attached horizontally (at 90°) to the tube and the lower lip is emarginate with two equal lobes separated by a deep cut in the middle. Size and shape of lobes has variation in different members. Upper lip is elongated, bent towards the anterior portion and the margin is slightly emarginate. Outside hairs are not longer and dense as that of the members in Astrodon or Helianthimifolia. Tube is long, inside annulate, sometime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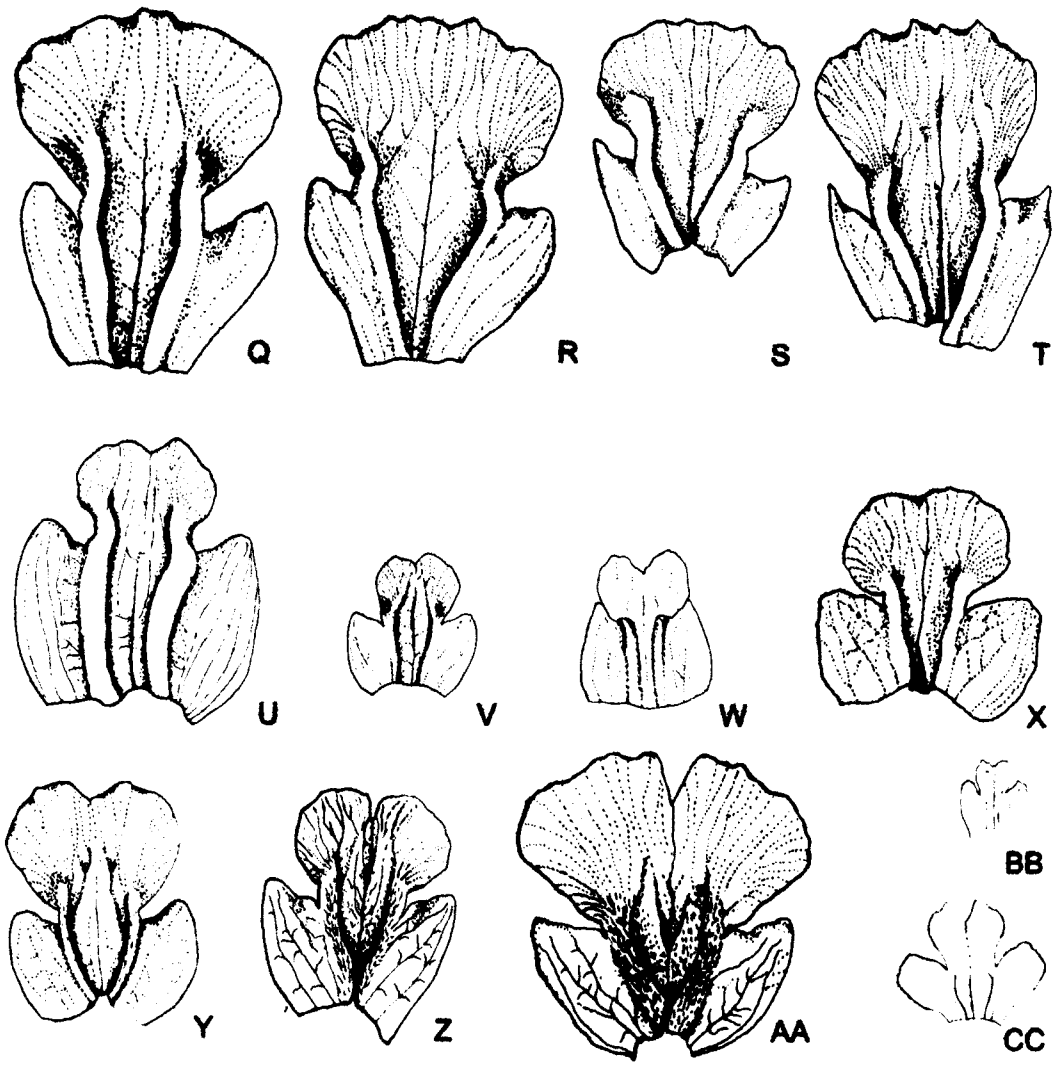


Fig. 16: Lower lip of corolla in *Leucas* species. A. *L. diffusa*; B. *L. aspera*; C. *L. wightiana*; D. *L. stricta*; E. *L. indica*; F. *L. nutans*; G. *L. zeylanica*; H. *L. cephalotes*; I. *L. decemdentata*; J. *L. pubescens*; K. *L. angularis*; L. *L. montana*; M. *L. marrubioides*; N. *L. chinensis*; O. *L. biflora*; P. *L. lanata*; Q. *L. sebaldiana*; R. *L. hirta*; S. *L. vestita*; T. *L. prostrata*; U. *L. lamiifolia*; V. *L. beddomei*; W. *L. eriostoma*; X. *L. lanceaefolia*; Y. *L. stelligera*; Z. *L. suffruticosa*; AA. *L. helianthimifolia*; BB. *L. martinicensis*; CC. *L. urticifolia*.

(A-H. sect. Plagiostoma; I-P. sect. Ortholeucas; Q-T. Sect. Astrodon; U-Y. Sect. Lanceaefolia; Z-AA. Sect. Helianthimifolia; BB-CC. Sect. Hemistoma)

scale | 2mm. (all figures)

show slight bent as in members like *L. angularis*, and *L. decemdentata*. In *L. biflora* the tube is much smaller than lower lip.

In section Helianthimifolia, the corolla is unique in many characters than other section. The upper lip is much broader and larger with very dense, closely arranged off-white coloured hairs forming an enlarged hood with hairs spreading in all directions. This upper lip persists on the calyx several days after anthesis, even after the withering of lower lip. Tube is much smaller, almost half as that of lower lip and there is no annulate hairy ring in the middle, instead the tube is provided with a number of longitudinal rows of fleshy hairs below the stamens, up to the middle. The lower lip is emarginate and provided with dense hispid hairs on the upper portion of middle lobe as well as on the side lobes, near the tube. All these characters are not found in any other members.

In sub shrubby members, the corolla middle lobe is emarginate but there is much variation from species to species. In *L. eriostoma, L. beddomei* and *L. lanceaefolia,* the middle lobe is smaller than side lobes. In *L. stelligera* and *L. lanceaefolia*, the middle lobe is not sharply emarginate. In *L. beddomei*, upper lip is coloured with dense oppositely arranged hairs. In *L. martinicensis* and *L. urticifolia*, the lower lip is emarginate, smaller than tube.

4.3h. Androecium

Stamens are didynamous in *Leucas* like in many other genus of Lamiaceae. All the four stamens are free but are inserted close to each others on the dorsal side of the corolla tube. The two lower stamens are attached relatively deep at about 1.5 mm below the tube mouth and are as long as the upper lip. The upper pair are attached about 1 mm below the tube mouth and are slightly shorter than the lower pair. Filaments of all the stamens are slightly bent forward, towards the lower lip. In most of the species the filaments are provided with minute arachenoid hairs at the middle. Anther lobes are generally red coloured but the depth of colour varies in species to species. The anthers are elliptic to slightly reniform but in some species it is almost rounded. Anthers of the entire stamen are almost same size. Generally the two theca are confluent and form a single room but appearance is different in different species. In the perennial herbaceous members of section Ortholeucas the anthers appear as almost rounded in bud and in opened flowers but in annual herbaceous members of section Plagiostoma it appears roughly two lobed with a slight construction at the connection part while in others species of section Helianthimifolia, Astrodon and Lanceaefolia the anthers appear two well lobed structure with almost 2-3 times longer than broad. The middle construction is well seen and sometime the two sides seen divergent from each other. In all case, the anthers open linearly with two equal parts on both sides. In the members of section Hemistoma, in *L. martinicensis* and *L. urticifolia*, the stamens are much shorter and the anthers are almost half the size of filaments.

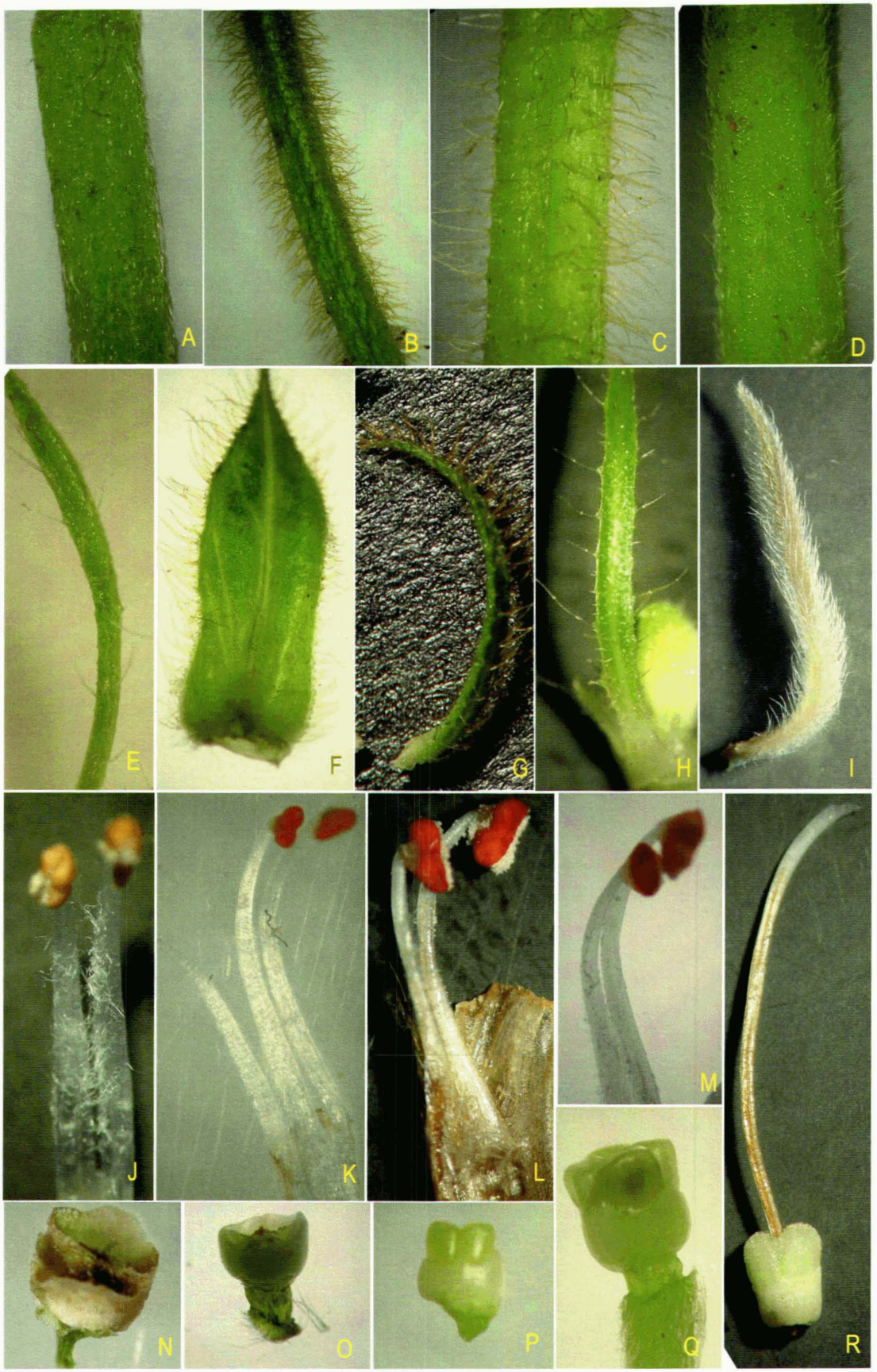


Fig. 13: A-D. hairs on branches; E-I. different types of bracteoles; J-M. stamens and anther lobes; N-O. basal disc; P-Q. ovary locules; R. entire pistil. (D & E. *L. aspera*; B & G. *L. vestita*; A & H. *L. zeylanica*; F. *L. sebaldiana*; I. *L. lamiifolia*; K & Q. *L. angularis*; M & O. *L. biflora*. K & R. *L. beddomei*)

4.3i. Gynoecium

Leucas also share the basic structure of gynoecium in other members of Lamiaceae. According to Briquet (1896), the ovaries in Lamiaceae are basically dimerous, but as each carpel is divided by a false wall, four rooms are formed, all containing one ovule which form four nutlets after fertilization. The style is gynobasic and stigma lobes are bifid. The stigmatic lobes show variation in Asian *Leucas*. In *L. angularis*, *L. biflora*, *L. chinensis* like members of section Ortholeucas, the stigma lobes are almost equal. But in all other species they are unequal with lower half much longer than other. The upper lobe is almost reduced. The same case is noticed in many of the African members. In *L. martinicensis* and *L. urticifolia*, the stigma lobes are provided with minute hairs.

Base of style is constructed and is still narrowed in between the ovary locules. After anthesis the style breaks off at the construction and fall off with corolla where as other part below the construction retain with the ovary. This is seen persisting on the basal disc even after the maturation of seeds.

4.3j. Disc

Disc in *Leucas* species are four lobbed with the lobes alternating with ovary, just like in other Labiates. In most of the Asian *Leucas*, the lobes are almost equal

but in many of the African species the abaxial lobe is slightly elongated (Sebald, 1980). This is seen in *L. martinicensis* and *L. urticifolia*, the abaxial lobe is much (2-3 times) elongated than other lobes and is fleshy. In many Asian species like *L. nutans, L. stelligera* and *L. eriostoma*, the abaxial lobe appear slightly longer than other but is not a conspicuous structure and so less useful in taxonomic analysis. When the nutlets mature fully, the disc also dries up and the connection between nutlets and disc detaches and the latter falls down. Generally the lobes are almost free in herbaceous species like *L. zeylanica, L. stricta* and *L. indica* where as it is flat cup shaped in species like *L. pubescens, L. prostrata, L. marrubioides, L. montana, L. chinensis, L. biflora* and *L. lanceaefolia*.

4.3k. Nutlets

Nutlets in *Leucas* is of much taxonomic importance. Morphological characters like size, shape, colour, presence or absence of glandular and eglandular hairs are characters given much consideration. Generally in their appearance the nutlets are rather uniform. They are usually slightly elongate trigonous structure with almost two-sided proximal or adaxial side and a rounded abaxial or distal side. In cross section they appear to be triquetrous. Top may be rounded or sometime it is truncate, flattened or oblique with a regular margin. Basal portion in many cases are very narrowed while in others it is flattened.

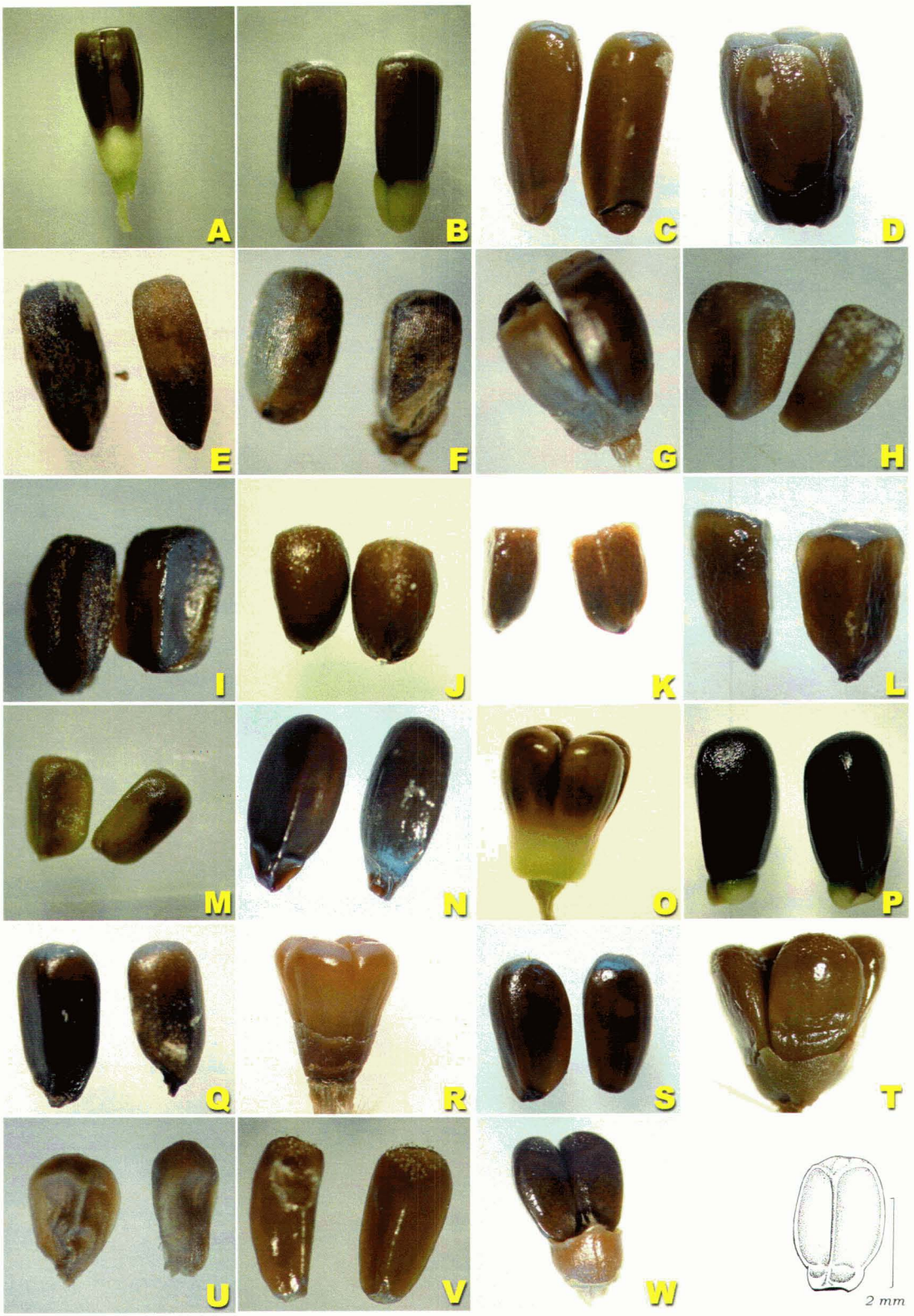


Fig. 14: Nutlets of *Leucas:* A. *L. aspera;* B. *L. zeylanica;* C. *L. cephalotes;* D. *L. diffusa;* E. *L. stricta;* F. *L. nutans;* G. *L.wightiana;* H. *L. pubescens;* I. *L. chinensis;* J. *L. biflora;* K. *L. montana;* L. *L. decemdentata;* M. *L. angularis;* N. *L. prostrata;* O. *L. vestita;* P. *L. sebaldiana;* Q. *L. eriostoma;* R. *L. lamiifolia;* S. *L. lanceaefolia;* T. *L. beddomei;* U. *L. helianthimifolia;* V. *L. urticifolia;* W. *L. martinicensis.*

Usually in members of Plagiostoma section, the seeds are elongated cylindrical structure, 1.5–2.5 times longer than broad. They are usually brownish coloured, smooth and show almost truncate top with a slight rounded nature at middle. The base is in all these species are flat with a comparative broad connection to the disc.

In Ortholeucasian members, nutlets are flat, 0.5–1.5 times longer than broad. Top is truncate and the surface is almost concave with a definite margin. Base is narrowed with a small attachment portion and nutlets looks top shaped. A few members like *L. mukerjiana* show eglandular hairs on top and bottom. In Astrodon members, the nutlets are cylindrical with the abaxial side ridges are not prominent towards the upper half. They are generally smooth shining with rounded top and narrow base.

In Hemistoma, the top is concave and obliquely inclined plane towards the proximal side. Stalked glandular hairs are present on the top, which is usually found in African species. In section Lanceaefolia, the nutlets are 1–2.5 times longer than broad. They are shining, with rounded top and the proximal side has two flat planes towards the lower portion. In *L. beddomei*, glandular non-stalked hairs are present on the top. They are light brown to darkish brown coloured.

4. 4. TAXONOMY

4. 4a Genus Leucas R.Br.

Leucas R.Br., Prodr. 504.1810; Ait.f., Hort. Kew. ed. 2. 3: 409. 1811; Sm. in Rees, Cyclop. XX. 1812; Link, Enum. Pl. Hort. Berol. 2: 113. 1822; Spreng. in L., Syst. Veg., ed. 16, II: 742. 1825; Benth. in Wall., Pl. As. Rar. 1: 60. 1830; Labiat. Gen. Spec. 3 (fasc. 6): 602. 1834; in DC., Prodr. XII: 523. 1848; Sonder, Linnaea 23: 85. 1850; Walpers, Ann. Bot. Syst. 3: 269. 1852; Courbon, Ann. Sci. Nat. 4. Ser. Bot. 18: 145. 1862; Hook.f., J. Proc. Linn. Soc. Bot. 7: 213. 1864; Benth., Fl. Australia. 5: 90. 1870; Oliver, Trans. Linn. Soc. 29: 139. 1875; Vatke, Osterr. Bot. Z. 25: 95. 1875; Linnaea. 40: 180. 1876; Benth. & Hook.f., Gen. Pl. II: 1213. 1876; Boissier, Fl. Orientalis 4: 778. 1879; Vatke, Linnaea 43: 96. 1880; Balfour, Proc. Roy. Soc. Edinburgh XII: 91. 1884; Hook.f., Fl. Br. India 4: 680. 1885; Oliver, J. Linn. Soc. (Bot) 21: 403. 1885; Ascherson & Schweinf, Ill. Fl. Egypt 122. 1889; Baker in Dyer (ed), Fl. Trop. Africa 5 (3): 472. 1900; Engler & Hochgeb. Fl. Trop. Africa: 370. 1892; Gurke in Engler, Pflanzenw. Ostafr. C: 342. 1895; & Bot. Jaharb. Syst. 22: 129. 1897; Baker, Kew. Bull. 1895: 225. 1895; Briquet in Engler & Prantl, Nat. Pfl. Fam. 4/3a: 250. 1896; Bull. Soc. Roy. Bot. Belg. 36: 59. 1897; Baker, Kew. Bull. 1898: 162. 1898; Fl. Trop. Africa 5: 472. 1900; Moore, J. Bot. 38: 464. 1900; Briquet, Bull. Her. Boiss. Ser. 2. 8: 1088. 1903; Cooke, Fl. Bombay 2: 463. 1906; Prain, J. Proc. As. Soc. Bengal. 74/3: 717. 1908; Chevalier, J. Bot., Ser. 2. 2: 127. 1909; Sacleux, Bull. Mus. Nat. Paris 16: 402. 1910; Skan, Fl.

Capensis. 5/1: 369. 1910; Duthie, Fl. Gangetic Plain 2: 248. 1911; De Wildeman, Contr. Fl. Katanga: 169. 1921; Ann. Soc. Sci. Burx. 41: 57. 1922; Haines, Bot. Bihar & Orissa 4: 746. 1922; Blatter, Fl. Arabia 8/4: 381. 1923; Gamble, Fl. Pres. Madras. 2: 1143. 1924; Chiovenda, Fl. Somalia: 281. 1929; Bullock, Kew Bull. 1932: 503. 1932; Schwartz, Fl. Top. Arabia: 222. 1939; Mukerjee, Rec. Bot. Surv. India. XIV (1): 1940; Robyns, Bull. Jard. Bot. Brux. 17: 68. 1943; Robyns, Fl. Sperm. Parc Nat. Albert 2: 155. 1947; Tackholm et al., Students Fl. Egypt. 149. 1956; Andrews, Flow. Pl. Sudan 3: 213. 1956; Morton, J. Linn. Soc. (Bot.) 58: 273. 1962; Morton, Fl. West. Trop. Africa 2: 469. 1963; Backer & Brink, Fl. Java 2: 622. 1965; Compton, Fl. Swaziland. 66. 1966; Keng, Gard. Bull. Singapore 24: 13. 1969; Launert & Schreiber, Prodr. Fl. Sudw. Africa. 123: 16. 1969; Angulo, Bull. Jard. Bot. Belg. 40: 365. 1970; Ross, Fl. Natal 303. 1972; Gilli, Ann. Nat. Mus. Wien 77: 38. 1973; Agnew, Upl. Kenya Wild Flow. 620. 1974; Keng in Steenis, Fl. Malesiana 8: 337. 1978; Sebald, Stuttg. Beitr. Naturk. Ser. A. 341: 1-200. 1980; L.H.Crammer in Dassan. & Fosberg (eds.) Rev. Hand. Fl. Ceylon III: 181. 1981; Fosberg & Sachet, in Smithsonian Contr. Bot. 47: 24-26. 1981; J.R.Press in H.Hara et al, En. Pl. Nepal 3: 155. 1882; Codd, Fl. South Africa 28 (4): 39. 1985; Hedge in Ali & Nasir, Fl. Pakistan 192: 155. 1990; Smith & Darwin in Smith, Fl. Vitiensis Nova 5: 235-239. 1991; Shu in Zheng-yi & Raven, Fl. China 17: 141. 1994; Pulliah & Moulali, Fl. Andhra Pradesh 2: 767. 1997; V.Singh, Mon. Indian Leucas. 1-180. 2001.

—Type species: *Leucas flaccida* R.Br. Australia, Nova Hollandia, near

Endeavous river 1770, *Banks & Solender* (holo. **BM** !) (synonym of *Leucas decemdentata* (Willd.) R.Br. ex Sm.).

Lasiocorys Benth., Labiat. Gen. Spec. 3 (fasc. 6): 600. 1834; Meyer, Comm. 2: 241. 1838; Benth. in DC., Prodr. XII: 543. 1848; Richard, Tent. Fl. Abyssinia. 2: 201. 1851; Jaub & Spach, Ill. Pl. Or. 4: 126. 1853; Vatke, Osterr. Bot. Z. 25: 96. 1875; Benth. & Hook.f., Gen. Pl. 2: 1213. 1878; Franchet, Sert. Somal. 57. 1882; Balfour, Proc. Roy. Soc. Edinburgh XII: 92. 1884; Kuntze, Jahrb. Konigl. Bot. Garten 4: 271. 1886; Engler, Bot. Jahrb. Syst. 10: 268. 1888; & Hochgeb. Fl. Trop. Africa 370. 1892; Baker, Fl. Trop. Africa 5: 469. 1900; Skan, Fl. Capensis 5/1: 372. 1910; Blatter, Fl. Arabia 8/4: 382. 1923; Wuld, Kirkia 5: 50. 1965; Compton, Fl. Swaziland: 66. 1966; Ross, Fl. Natal: 303. 1972; Dyer, Gen. South. Africa Flow. Pl. 1: 527. 1975.

Blandina Rafin., Fl. Telluriana 3: 88. 1837.

Elbunis Rafin., Fl. Telluriana 3: 88. 1837.

Enedon Rafin., Fl. Telluriana 3: 88. 1837.

Hetrepta Rafin., Fl. Telluriana 3: 88. 1837.

Heptrilis Rafin., Fl. Telluriana 3: 89. 1937.

Physoleucas Jaub. & Spach, Ill. Pl. Or. 5: 48. 1855; Walpers, Ann. Bot. Syst. 5: 667. 1859; Schwartz, Fl. Trop. Arabia. 224. 1939; Briquet in Engler & Prantl, Nat. Pfl. Fam. 4/3a: 252. 1896.

Phlomis L., Sp. Pl. 2: 584. 1753; & Syst. Nat. 2: 1101. 1759; Murray, Syst. Veg. (ed. 13): 450. 1774; Forskal, Fl. Aegptico Arabia 107. 1775; Jacquin, Ic. Rar. 1: 11, n. 10. 1781/ 87; Coll. Bot. Chem. Hist. Nat. 1: 154. 1787; Swartz, Nov. Gen.

Sp. Pl. 88. 1788; Vahl, Symb. Bot. 3: 76. 1794; Swartz, Fl. India Occ. 2: 1009. 1800; Thunberg, Prodr. Pl. Capensis 95. 1800; Willd., Sp. Pl. 3: 17. 1800; Persoon, Syn. Pl. 2: 126. 1807; Willd., Enum. Pl. Horti. Berolensis 620. 1809; Roth, Nov. Pl. Sp. 259. 1821; Thunberg, Fl. Capensis (ed. Schulters): 446. 1823; Schumacher, Beskr. Guin. Pl. 263. 1827.

Clinopodium acut. non L.: Jacquin, Enum. Syst. Pl. 25. 1760; & Sel. Strip. America 173. 1763.

Leonurus acut. non. L.: L., Syst. Nat. 2: 1101. 1759; Burm.f., Fl. India: 127. 1768; Moench, Meth.: 401. 1794.

Ballota acut. non L.: Benth., Labiat. Gen. Spec. 3 (fasc. 6): 599.1834; & in DC., Prodr. XII: 521. 1848; Schwartz, Fl. Trop. Arabia 225. 1939; Patzak, Ann. Nat. Mus. Wien 63: 33. 1959.

Stout shrubs or undershrubs or spreading perennial or annual herbaceous plants, 30 cm to 200 cm high, aromatic, rarely with short glandular hairs, mostly hairy, rarely glabrous or subglabrous, indumentum pubescent to villous. Leaves without stipules, opposite, rarely 3–4 fasicled, undivided, margin entire or crenate to serrate, rarely spinously dentate, sessile or petiolate. Inflorescence terminal, to subterminal, or axillary clusters of few to many, poor to rich flowered verticillasters. Bracts of the verticillaster halves always leaf-like (fronds) and persistent. Bracteoles present, tiny, or as long as calyx, hairy. Pedicels obscure or a few millimeters long. Calyx tubular, obconic or sub-campanulate, from flowering to fruiting time much or little prolongating, with 10 ribs, rarely fewer; tube straight or

upper part bent forward; mouth not produced at one side or produced abaxially or adaxially; teeth 5–10, sub equal to equal or anterior long produced; sometime rim of mouth provided with a transverse veins and inside long ciliate with sparse or dense tuft of long hairs; tube inside mostly glabrous or short-haired, rarely near the upper part transversely veined with a fringe of long hairs; outside nearly glabrous to densely covered with a silky, woolly or villous indumentum. Corolla white or pink, bi-lipped; tube straight or bent weakly, outside at the upper part whitish hairy, inside with or without an annulus of short hairs, sometime provided with rows of small fleshy hairs above; upper lip straight or somewhat arcuate, concave, top rounded and emarginate, rarely almost weakly bi-dentate, outside white or yellowish brown hairy, inside at the margin with a dense fringe or beard of stiff, long white hairs; lower lip tri-lobed, about as long or longer than upper lip; middle lobe much larger than the lateral lobes, obcordate, trapezoid or fanshaped, reaching 1/3 to 2/3 length of the whole lower lip; lateral lobes oblong to ovate, obtuse or emarginated at the top. Stamens 4, didynamous, ascending, in the upper lip, all with two divaricate, partly somewhat confluent thecae; lower (abaxial) stamen pair free somewhat below the top of the corolla tube and about as long as the upper lip, rarely shorter; upper pair of stamens free at the top of the corolla tube and a little shorter than the upper lip; filaments hairy, often arachenoid, without an appendix. Disc 4 lobed, abaxial lobe enlarged much, or little larger than lateral and adaxial or equal. Style glabrous; stigma unequally bifid or rarely almost equally bifid, mostly as long as the adaxial stamens and between these fixed by the arachenoid hairs. Nutlets 4, not always fully developing, oblong-trigonous to obovoid, top truncate or rounded, glabrous or with

sessile glands, rarely with short hairs; pericarp smooth or rugose to knobby.

Distribution: Pantropical, mostly in paleotropical, in African, Asian and Arabian continents. Only one species in both Neotropics and Australian continents

Note: This description given above fit for all the species of *Leucas* so far described.

4.4b. Sectional treatment

Based on the comparative morphology, the South Indian *Leucas* were divided into six sections. Two new sections viz. sect. Helianthimifolia and sect. Lanceaefolia were created by dividing the sect. Astrodon. This division is done as these species treated in the two sections possesses certain charactes which is entirely different from the present Astrodon members. Eventhough these three sections are very much related, they show different lines of character changes. It is also assumed that the earliest workers like Bentham were not given much consideration to the habit and microcharacter of *Leucas* species and as a result these species were treated together. This is evident in their description of characters in each sections. Microscopic observation of characters gave more light into their similarity and dissimilarity, as a result a new sectional classification is proposed here.

The species *L. martinicensis* is treated in sect. Hemistoma following Sebald (1980). This is done on the light of similarity in charactes of other Hemistoman

species found in Africa. Singh's (2001) view of section Diffusa and section Stricta has not considered here as the members included in these sections has no natural similarities, rather they show close similarity with members included in other groups. This is seen in the case of *L. stricta*, which is very similar to other Plagiostoma members in the floral and vegetative characters. Except on the nature of calyx teeth and mouth cilia, there is no difference noticed for this species. Similarly *L. wightiana*, formerly consided as a variety of *L. aspera* and *L. cephalotes* also shows Plagiostoman characters. Because of this the position of sect. Stricta has not considered here.

Section Diffusa (Singh, 2001) contain species *L. helianthimifolia*, *L. suffruticosa*, *L. diffusa* and *L. longifolia*. Here also no similarity is noticed among *L. longifolia* and *L. helianthimifolia* even in a single major character, worth to consider as a separate section. *L. longifolia* and *L. diffusa* has corolla typical as that of other Plagiostoma members and *L. helianthimifolia* and *L. suffruticosa* has characters very similar to that of *L. rosmarinifolia* included in sect. Astrodon.

Based on the unique character noticed, *L. helianthimifolia*, *L. suffruticosa*, and *L. rosmarinifolia* is considered here in a new section Helianthimifolia. Section Lanceaefolia is created as a new section to include species, which are woody, erect sub shrubs to shrubs. They are noticed only on high altitude and have corolla much different from others. The major character of each sections considered here is given below.

A. *Section* **Plagiostoma** Benth. in Wall., Pl. As. Rar. 1: 60. 1830; Labiat. Gen. Spec. 3 (fasc. 6): 614. 1834; in DC., Prodr. XII: 530. 1848; Hook.f., Fl. Brit. India 4: 687. 1885; Gurke, Bot. Jahrb. Syst. 22: 135. 1895.

Calyx turbinate to tubulose, mouth oblique, anterior side produced, verticillasters globose, many flowered, mostly solitary, bracteoles equals calyx. It is also identified (here) that these species are annual herbs and leaves mostly linear lanceolate, nutlets 2-3 times longer than broad.

Bentham (1830) enumerated 12 species under this section. In 1834, he retained 8 species and 2 new were added. This section includes mostly Asian species. Position of *L. martinicensis* in this section (Bentham, 1848; Singh, 2001) is controversial and it is treated here not belongs to this section.

B. *Section* **Ortholeucas** Benth. in Wall., Pl. As. Rar. 1: 61. 1830; Labiat. Gen. Spec. 3 (fasc. 6): 606. 1834; in DC., Prodr. XII: 524. 1848; Hook.f., Fl. Brit. India. 4: 680. 1885.

Somewhat lax and often poor flowered whorls, mostly short bracteoles, calyces tubular with an even or slightly oblique mouth, mostly 10 teeth, inner side not bearded. Differ from other Asian *Leucas* sections, this section has characters (identified here) ovate leaves, stem quadrangular not grooved, bracteoles filiform, flowers in many axillary clusters.

Bentham (1830) enumerated 16 species under this section but no type species is mentioned. In 1834, he included 19 species and all are Asiatic. Gurke (1895) mentioned 8 African species for this section. However these 8 species are not nearer related to the Asiatic species of this section, and they are distributed in other sections (Sebald, 1980). The section according to Bentham (1830; 1848) occur only in Asia.

C. *Section* **Astrodon** Benth. in Wall., Pl. As. Rar. 1: 61. 1830; Labiat. Gen. Spec. 3 (fasc. 6): 611. 1834; in DC., Prodr. XII: 528. 1848; Hook.f., Fl. Brit. India 4: 684. 1885; Gurke, Bot. Jahrb. Syst. 22: 135. 1895.

Calyx tubular, with an equal, bearded or ciliate mouth, with 10 often spreading teeth, whorls mostly rich flowered, have distinct bracteoles.

Bentham (1830) enumerated 6 species in this section and added further 4 species in 1834. All the species included in this section are Asiatic species and is revised here.

D. *Section* **Hemistoma** Benth. in Wall., Pl. As. Rar. 1: 60. 1830; Labiat. Gen. Spec. 3 (fasc. 6): 605. 1834; in DC., Prodr. XII: 523. 1848; Hook.f., Fl. Brit. India 4: 607. 1885.

Dense, rich flowered whorls, conspicuous bracteoles, tubular, lower (abaxial) side produced. Other character attributed are (identified here) small corolla, almost

included in the calyx, tube longer than upper and lower lip.

Among the species included in this section only *L. martinicensis* and *L. urticifolia* are found in Asia. All other species (represent about half of African species) are found in Africa only.

E. *Section* **Helianthimifolia** Sunojkumar *sect. nov.*

Perennial herb, stem woody, amorphous, mostly underground, branches terete, herbaceous, leaves opposite or whorled, entire, whorls terminal, calyx cup shaped, upper lip of corolla strongly hooded, lower lip provided with hispid hairs on upper side, tube not annulate.

F. *Section* **Lanceaefolia** Sunojkumar *sect. nov.*

Perennial sub shrub, stem erect, woody, ligneous, whorls in teminal 2-4 axils, calyx tubular, mouth straight, corolla tube longer than lower lip.

Key to the sections

1 Annual, herb; calyx slightly bent, mouth oblique due to different length of abaxial and adaxial side of tube.....2

Perennial, herb or small shrubs; calyx straight, mouth not oblique, abaxial and adaxial side tube length same.....3

2 Plant 30–150 cm high; corolla as long as or smaller than calyx, lower lip emarginate, shorter than tube; nutlet top bear sessile glands.....
.....**1. Hemistoma**

Plant 20–60 cm high; corolla longer than calyx, lower lip fan shaped, longer than tube; nutlet top without glands.....**2. Plagiostoma**

3 Stem quadrangular, not grooved; calyx mouth not ciliate.....**3. Ortholeucas**

Stem quadranglar grooved or terete; calyx mouth densely ciliate.....4

4 Spreading herb; calyx teeth 2–3 mm, spreading out, lower lip of corolla fan shaped, not emarginate.....**4. Astrodon**

Low shrub to undershrub, calyx teeth up to 1 mm rarely up to 2 mm, erect, lower lip of corolla emarginate.....5

5 Stem thick, amorphous, grow mostly along the surface of ground, branches terete, herbaceous; leaves 1.5–6 mm broad; corolla tube smaller than lower lip.....**5. Helianthimifolia**

Stem woody, ligneous, grow straight, branches quadrangular grooved, thick; leaves 7–50 mm broad; corolla tube longer than lower lip.....
.....**6. Lanceaefolia**

Sl No	Name of species	Bentham			Hook. f (1885)	Briquet (1896)	V.Singh (2001)	Present treatment
		Pl. As. Rar (1830)	Labiat. Gen. Spec. (1834)	DC., Prodr. (1848)				
1	*L. anandaroana*	-	-	-	-	-	Hyss.	Orth.
2	*L. angularis*	Orth.	Orth	Orth	Orth	Orth	Orth	Orth
3	*L. aspera*	Plag.	Plag.	Plag.	Plag.	Plag.	Plag.	Plag.
4	*L. beddomei*	-	-	-	-	-	-	Lanc.
5	*L. biflora*	Orth.	Orth.	Orth.	Orth.	Orth.	Orth.	Orth.
6	*L. cephalotes*	Plag.	Plag.	Plag.	Plag.	Plag.	Stri.	Plag.
7	*L. chinensis*	Orth.	Orth.	Orth.	Orth.	Orth.	Orth.	Orth.
8	*L. decemdentata*	Orth.	Orth.	Orth.	Orth.	Orth.	Orth.	Orth.
9	*L. diffusa*	-	Plag.	Plag.	Plag.	Plag.	Diff.	Plag.
10	*L. eriostoma*	-	-	-	Astr.	Astr.	Astr.	Lanc.
11	*L. helianthimifolia*	Astr.	Astr.	Astr.	Astr.	Astr.	Diff.	Heli.
12	*L. hirta*	Astr.	Astr.	Astr.	Astr.	Astr.	Astr.	Astr.
13	*L. indica*	Plag.	Hemi.	Plag.	Plag.	Plag.	Plag.	Plag.
14	*L. lamiifolia*	Astr.	Astr.	Astr.	Astr.	Astr.	Astr.	Lanc.
15	*L. lanata*	Orth.	Orth.	Orth.	Orth.	Orth.	Orth.	Orth.
16	*L. lanceaefolia*	Astr.	Astr.	Astr.	Astr.	Astr.	Astr.	Lanc.
17	*L. marrubioides*	Orth.	Orth.	Orth.	Orth.	Orth.	Orth.	Orth.
18	*L. martinicensis*	Plag.	Plag.	Plag.	Plag.	Plag.	Plag.	Hemi.
19	*L. montana*	Orth.	Orth.	Orth.	Orth.	Orth.	Orth.	Orth.
20	*L. mukerjiana*	-	-	-	-	-	Orth.	Orth.
21	*L. nepetaefolia*	Orth.	Orth.	Orth.	Orth.	Orth.	Orth.	Orth.
22	*L. nutans*	Plag.	Plag.	Plag.	Plag.	Plag.	Stri.	Plag.
23	*L. prostrata*	Astr.	Astr.	Astr.	Astr.	Astr.	Astr.	Astr.
24	*L. pubescens*	-	Orth.	Orth.	Orth.	Orth.	Hyss.	Orth.
25	*L. rosmarinifolia*	Astr.	Astr.	Astr.	Astr.	Astr.	Astr.	Heli.
26	*L. sebaldiana*	-	-	-	-	-	-	Astr.
27	*L. stelligera*	Astr.	Astr.	Astr.	Astr.	Astr.	Astr.	Lanc.
28	*L. stricta*	Plag.	Plag.	Plag.	Plag.	Plag.	Stri.	Plag.
29	*L. suffruticosa*	-	Astr.	Astr.	Astr.	Astr.	Diff.	Heli.
30	*L. urticifolia*	Hemi.	Hemi.	Hemi.	Hemi.	Hemi.	Hemi.	Hemi.
31	*L. vestita*	Astr.	Astr.	Astr.	Astr.	Astr.	Astr.	Astr.
32	*L. wightiana*	Plag.	Plag.	Plag.	Plag.	Plag.	Stri.	Plag.
33	*L. zeylanica*	Plag.	Plag.	Plag.	Plag.	Plag.	Plag.	Plag.

Astr.= Astrodon; Diff.= Diffusa; Heli.= Helianthimifolia; Hemi.= Hemistoma; Hyss.= Hyssopifolia; Lanc.=Lanceaefolia; Orth.= Ortholeucas; Plag.= Plagiostoma; Stri.= Stricta.

Table.: **11**. Sectional treatment of *Leucas* in earlier and present works

4.4c. Key to the species

1. Annual herbaceous; calyx tube bent, adaxial and abaxial side length not equal, mouth mostly oblique, teeth differ in size 2

   Perennial herb with thick basal stem or shrub; calyx straight, adaxial and abaxial side length equal, moth not oblique, teeth almost equal 12

2. Plant 30–150 cm high; corolla 5–9 mm long, as long or smaller than calyx, lower lip emarginate, shorter than tube; nutlets top with glandular hairs 3

   Plant 20–60 cm high; corolla 13–15 mm long, longer than calyx, lower lip fan shaped, longer than tube; nutlet top without glandular hairs 4

3. Leaves ovate; calyx bi-lobbed, posterior lobe produced with 3 teeth, anterior teeth not large..... **30. L. urticifolia**

   Leaves lanceolate; calyx not lobbed, posterior teeth not produced, anterior teeth much larger than others.....**18. L. martinicensis**

4. Bracteoles many, membraneous, foliaceous with distinct midrib and lateral veins, margin ciliate, ... 5

   Bracteoles few, not membraneous, linear, midrib not distinct, provided with scattered hairs 6

5. Erect plant, up to 60 cm high, stem grooved; leaves serrate with 9–12 teeth, inflorescence terminal, head like, dense globose, 2–3.5 cm across, calyx straight ..... **6. L. cephalotes**

Straggling, up to 30 cm, stem not grooved; leaves remotely serrate with 7–9 teeth; inflorescence axillary clusters, not globose, up to 2 cm across, calyx bent at the middle..... **22. L. nutans**

6. Diffuse, stem much reduced, branches 5–20 cm long; leaves oblong, 1.5–3.5 cm long, 3–7 mm broad, margin entire.....**9. L. diffusa**

Erect, stem up to 60 cm high; leaves linear-lanceolate, 3–12 cm long, 5–16 mm broad margin remotely to clearly serrate.....7

7. Mouth not oblique, rim ciliate with long hairs turned towards the mouth opening, teeth 10, up to 2.5 mm long, almost equal sized...**28. L. stricta**

Mouth oblique, cilia absent or inconspicuous; teeth 8–10, up to 1 mm long, anterior teeth larger than the laterals..... 8

8. Verticils 5–6, very closely arranged giving a spike like appearance; calyx 4–5 mm long (in flower), tube not bent, outside fully tomentose, mouth short ciliate; teeth 10, fully dense hirsute..... **32. L. wightiana**

Verticils 2–4, distinct clusters; calyx 5–10 mm long, tube bent, outside lower half glabrous, light yellowish, upper hispid, mouth not clearly ciliate teeth 8–10, not dense hairy.....9

9. Calyx turbinate abaxial side 5–5.5 mm, abaxial 6–6.5 mm, not produced, mouth semi-oblique; teeth 7–8.....**33. L. zeylanica**

Calyx tubular, abaxial side 4–5 mm, adaxial 8–11 mm, much produced, mouth very oblique; teeth 10 10

10. Verticils dense, semi-globose, many flowered; calyx upper half membraneous, reticulate, outside with bristle like scattered hairs, inside pubescent, teeth not fused, 1–1.25 mm long, almost equal..... .....**3. L. aspera**

Verticils lax to many flowered; calyx fully leathery, thick, outside dense pubescent, inside glabrous, teeth 0.5–1 mm long anterior teeth 2–3 times longer, prominently spinuous, sometimes fused with adjacent laterals, much produced giving a lobster clawed appearance.....11

11. Stem and leaves puberulous; bracteoles few, shorter than calyx, straight, puberulous; calyx adaxial side 8–9 mm, abaxial side 4–5 mm; adaxial teeth 1 mm, others 0.5–0.7 mm; nutlets 2.5 mm x 1.3 mm .... **13b. L. indica** var. **lavandulifolia**

Stem and leaves hispid; bracteoles many, equal or longer than calyx recurved dense hispid; calyx adaxial 11–12 mm, abaxial 5–7 mm; adaxial teeth 1.5–3 mm long, others 1–1.5 mm; nutlets 3–3.6 mm long 1.6 mm broad.....**13a.L. indica** var. **indica**

12. Calyx teeth 2–3 mm long, linear, ±0.3 mm broad at base, stellately spreading, hirsute with long shining golden yellowish or silvery hairs; corolla lower lip obliquely attached, median lobe fan shaped, not emarginate 13

Calyx teeth 0.5–1.5 mm long, triangular with broad base or fleshy subulate or filiform with narrow hairs all over; corolla lower lip attached perpendicularly, middle lobe emarginate with spreading equal halves 20

13. Branches 30–60 cm long; leaves up to 5 cm long, marginal teeth 3–5, lateral veins 3–4, not glandular punctate, flowers fully white.....14

Branches up to 150 cm long; leaves 6–12 cm long, marginal teeth with 7–19, lateral veins 5–8, glandular punctate, corolla upper lip brownish to golden brown coloured 15

14. Branches weak, prostrate or spreading, tip procumbent; stem herbaceous rooting at nodes; leaf base rounded, margin crenulate; calyx 6–7 mm .....**23. L. prostrata**

Branches rigid, erect; basal stem amorphous, woody; lamina base narrowed to cuneate, margin serrate to cuneate from middle onwards; calyx 9–10 mm.....**12. L. hirta**

15. Bracteoles foliaceous with distinct midrib and lateral branches; calyx bent, varying length of calyx impart irregular margin for verticils, mouth not ciliate, teeth erect .....**26. L. sebaldiana**

Bracteoles linear-lanceolate, not foliaceous; calyx straight, almost same length verticil margin regular, mouth dense ciliate, cilia form inverted cone over mouth, teeth stellately spreading out 16

16. Calyx mouth cilia longer than teeth.....**31e. L. vestita** var. **sericostoma**

Calyx mouth cilia smaller than teeth 17

17. Leaves narrowly elliptic-lanceolate, secondary vein 3–4, base cuneate or long narrowed, pubescent..... **31b. L. vestita** var. **angustifolia**

Leaves ovate-lanceolate or ovate-oblong with 6–8 parallel secondary veins base rounded, dense hispid to villous.....18

18. Leaves lanceolate, margin serrate, tip acute.....**31c. L. vestita** var. **ciliata**

Leaves ovate-lanceolate or ovate-oblong, margin crenate..... 19

19. Leaves broadly ovate, up to 5 cm long, 3.5 cm broad; hairs on the stem, leaves and calyx dense, soft, white silvery shining; bracteoles tip divergent; .....**31d. L. vestita** var. **oblongifolia**

Leaves ovate-oblong, up to 13 cm long, 6 cm broad; hairs on the stem, leaves and calyx golden yellow or brownish; bracteoles recurved.....

.... **31a. L. vestita** var. **vestita**

20. Low shrub, basal stem thick woody or a stout shrub, branches terete or angular grooved; leaves mostly oblong–lanceolate; inflorescence 1–4 sub-terminal verticals; beacteoles linear-lanceolate; corolla upper lip off-white or yellowish white.....21

Spreading herb, basal stem not woody, branches quadrangular not grooved; leaves mostly ovate; inflorescence many, axillary verticils; bracteoles filiform; corolla pure white.....29

21. Low shrub, 30–45 cm high, basal stem amorphous, branches herbaceous, terete; leaves 2–4 in each node, oblong to linear-oblong, 0.2–0.6 cm broad, tomentose-strigose; calyx 5–6.5 cm long; corolla tube smaller than lower lip..... 22

Erect undershrub to stout shrub, 1–2 m high, stem erect ligneous, branches thick quadrangular, longitudinally grooved; leaves 2 in each node, linear-lanceolate, 0.8–5 cm broad, pubescent or hispid; calyx 8 mm–15 mm long; corolla tube usually longer than lower lip..... 24

22. Leaves 2 on every node, opposite-decussate lamina 1.5–2.5 cm long, stem and leaves covered with long antrorse bristle like hairs; verticals subtended by a pair of leaves, on a 10–30 cm long scapiform axis ..... **29. L. suffruticosa**

Leaves ternate or fasicled, 2–4 leaves on each node, up to 7 cm long; stem and leaves covered with soft tomentose hairs; verticils subtended by 3–4 leaves; on a 1–10 cm long axis 23

23. Leaves dark brown in dried specimens; bracteoles as long as or longer than calyx, linear-lanceolate, ciliate margin, villous outside, with 1 mm long hairs; calyx mouth cilia 2–3 times longer than teeth, erect, very dense, persist on the seeding calyx.....**25. L. rosmarinifolia**

Leaves sandal coloured on fresh and dried specimen; bracteoles smaller than half or one third the size of calyx, subulate, softly tomentose with thin hairs; calyx mouth cilia as long as teeth, turned towards the middle of the mouth, do not persist on dried specimens ....**11. L. helianthimifolia**

24. Stout shrub, 1.5–2 m high; lamina margin entire, revolute; corolla tube half exerted, not annulate within.....**16. L. lanceaefolia**

Under shrub or stout shrub, 1–1.5 m high; lamina serrate or crenate, not revolute; corolla tube completely inserted, inside annulate 25

25. Stout shrub, base 3–4 mm thick, leaves 2.5–5 cm broad; bracteoles 5 cm, calyx mouth not ciliate, inside upper half hispid; corolla tube inside glabrous..... **14. L. lamiifolia**

Undershrub, base 1–1.5 mm thick, leaves 0.7–2.5 cm broad; bracteoles 6–8 mm long; calyx mouth dense ciliate, inside glabrous, longitudinal rows of dense fleshy hairs inside corolla tube 26

26. Leaves membraneous, thin, bracteoles recurved below the whorls; calyx teeth 2 mm long, stellately spreading; mouth cilia smaller than teeth .....**27. L. stelligera**

Leaves coriaceous, bracteoles erect; calyx teeth smaller than 1mm, erect; mouth cilia equal to or longer than teeth 27

27. Calyx fully hispid outside; corolla upper lip brownish yellow coloured; nutlets glandular dotted at top .....**4. L. beddomei**

Calyx upper half thin, hispid, lower half leathery, glabrous; corolla white coloured; nutlets not glandular dotted 28

28. 60–160 cm high, leaf margin serrate, leaves short tomentose; calyx teeth 0.6–0.8 mm, short hispid.....**10a. L. eriostoma** var. **eriostoma**

20–40 cm high, leaf margins crenate, stem and leaves covered with long, soft villous hairs, calyx teeth 1–1.2 mm long, dense villous..... .....**10b. L. eriostoma** var. **lanata**

29. Calyx 10–14 mm long, funnel shaped, tube abruptly dilated at the mouth, teeth stellately spreading outward, broadly triangular, base 1.5–2 mm

broad, tube inside with a ring of dense long hairs at middle, hispid above.....**7. L. chinensis**

Calyx 5–10 mm long, fully tubular up to the mouth, teeth erect, base up to 1 mm broad, tube inside not hispid, glabrous 30

30. Branches terete, leaves orbicular, as long as broad .....**21. L. nepetaefolia**

Branches fully quadrangular, leaves ovate-lanceolate, longer than broad 31

31. Leaves thin, membraneous, minutely pubescent; calyx teeth 1.5–2 mm or more not thick, tip not filiform 32

Leaves thick, coriaceous, hispid to tomentose or villous; calyx teeth 0.5– 1 mm, thick, filiform 36

32. Procumbent herb, branches up to 45 cm long, often rooting; lamina 2–3.5 cm long, 1–2 cm broad; verticals mostly 2 flowered; calyx up to 5 mm long, inside with a ring of hairs; corolla tube 4 mm long, smaller than lower lip.....**5. L. biflora**

Erect or spreading herb, branches 100–150 cm long; lamina 5–10 cm long, 3–6.5 cm broad; verticals many flowered, calyx 6–10 mm long, inside not annulate, corolla tube 6–8.5 mm long, as long as or longer than lower lip 33

33. Older branches mostly hollow; calyx 8–10 mm; corolla tube fully inserted in calyx, stigma lobes equal, nutlet top flat or slightly rounded.....34

Older branches not hollow, calyx 6–7 mm long; corolla tube half inserted in calyx; stigma lobes unequal; nutlets top concave.....35

34. Leaves ovate-lanceolate, 1.5–2 times longer than broad; calyx membraneous, teeth 2–6 mm long, pubescent, inside glabrous.....**2. L. angularis**

Leaves ovate, almost as broad as long; calyx fleshy, teeth 1–2 mm long, densely hispid-tomentose, tube inside upper half hispid .....
.....**24. L. pubescens**

35. Branches erect, retrorse pubescent; petiole 2–3.5 cm; lamina membraneous, minutely pubescent; calyx outside pubescent, inside glabrous; corolla 16 mm long .....**8a. L. decemdentata** var. **decemdentata**

Branches, spreading, soft villous; petiole 1–1.5 cm; lamina thinly coriaceous, densely villous; calyx outside soft tomentose to villous, inside upper half pubescent; corolla 14 mm long.....
.....**8b. L. decemdentata** var. **sebastiana**

36. Bracteole narrowly and asymmetrically obovate, margin ciliate, glabrous inside, not filiform .....**1. L. anandaraoana**

Bracteoles linear, filiform, with thin, long ±1 mm long retrorse hairs.....37

37. Lamina lowerside short tomentose, with >1 mm long white or grey white deflexed hairs, upper pubescent, veins not impressed, rough in dried specimen 38

Lamina lower dense silky or velvetty with <1 mm long dense hairs upper tomentose to velvetty, veins impressed, not rough when dried.....39

38. Lamina upper rugose, bracteoles as long as calyx, calyx teeth unequal 2–3 mm long, inside glabrous. .....**17. L. marrubioides**

Lamina not rugose, bracteoles smaller than calyx, teeth equal, 0.5 mm long, inside just above middle a ring of hairs and pubescent above ....**19. L. Montana**

39. Leaves sessile or sub-sessile, ovate, base cordate; calyx tube 5 mm long; corolla 11 mm long; nutlets rugose with non-glandular hairs on both ends..... **20. L. mukerjiana**

Leaves petiolate; petiole 5–10 mm long, ovate-lanceolate or ovate-oblong, base rounded or shortly cuneate; calyx tube 9–10mm long; corolla 13–15 mm long; nutlets shining, not hairy 40

40. Leaves grayish in dried specimen, bracteoles equal to calyx; calyx teeth 2–3 mm long..... **15a. L. lanata** var. **lanata**

Leaves upper side dark brown when dry; bracteoles half smaller than calyx; calyx tube 1–1.5 mm long.....**15b. L. lanata** var. **candida**

4.4d. Treatment of the species.

1. **Leucas anandaraoana** Umamaheswari & Daniel, Kew Bull. 54: 1003-1005. 1999; V.Singh, Mon. Indian Leucas 36. 2001.

—Type: India, Tamil Nadu, Ramanathapuram, Gulf of Mannar Biosphere Reserve, Upputhanni Island, 1st Feb. 1994, *Daniel 101669* (holo. CAL !, iso. MH !).

Erect herb, annual, branches spreading up to 45 cm high, obtusely quadrangular, not grooved, stem clothed with deflexed pubescent hairs. Leaves opposite, petiole 1.5–3.5 cm long, 1–2.5 cm broad, ovate, truncate at base, acute, crenate with 6–7 teeth, tomentose above, velvety beneath, nerves obscure above, prominent beneath. Inflorescence axillary clusters, each up to 15 flowered, almost sessile. Bracteoles 7–8 mm long, narrowly and asymmetrically obovate, sparsely hairy or glabrous inside, villous outside. Calyx straight, tube 7–7.5 mm long, dense hispid outside, longitudinally ribbed, inner pubescent, teeth 10, alternately longer and shorter, 1.5–2.5 mm long, triangular villous and filiform tip. Corolla white, ±15 mm long, tube 8–8.5 mm long, provided with an oblique ring of glandular hairs inside; lower lip tri-lobbed, middle lobe ±7 mm long, emarginate, glabrous, lateral lobes ±4.5 mm long, oblong; upperlip oblong, obovate, anterior tip slightly emarginate, concave, outside densely hairy, margin ciliate. Stamens upper pair small, filaments 7–8.5 mm long, anthers orange red coloured. Ovary lobes 1 mm long, disc four lobbed, style ±12 mm long, bifid, lobes unequal, lower lobes longer

than upper. Nutlets ± 1 mm long, oblong-obovate, triangular, base narrowed, top rounded.

Etymology: The species was named in honour of Dr. T. Ananda Rao, former Deputy Director of BSI, Kolkatta, who has contributed grately to the ecology and floristics of Indian coasts.

Flowering and fruiting: January–April.

Habitat: Found in open sandy areas at sea level, restricted to a small island.

Distribution: Endemic to India, confined to a small island in the Gulf of Mannar Biosphere in Tamil Nadu.

Specimens examined: **TAMIL NADU: Ramanathapuram Dt.**: Gulf of Mannar Biosphere Reserve, Upputhanni Island, Western side, c. 2 m, fl. 1st Feb. 1994, *Daniel 101669A* (CAL); *101669 C, D* (MH).

Notes: According to the authors who described this taxa, it shows a close similarity with *Leucas decemdentata* Sm. but the character of bracteoles being narrowly and asymmetrically obovate and equal to calyx in size distinguishes it from the above mentioned taxon. The other character like sessile flowers, calyx tube 7–7.5 mm, glabrous inside, teeth 1.5–2 mm, triangular are all character shared by *Leucas decemdentata* var. *sebastiana* (Subbarao & Kumari) V.Singh.

For the present work it is attempted to collect fresh specimen of this plant, to trace out more morphological character for supporting the status of the species. The

Fig. 15: A. *Leucas anandaraoana* -isotype; B-F. *Leucas angularis* (B. habit; C. a twig; D. nutlets on disc; E. leaf tip; F. flower)

attempts were failed as permission to enter the area is denied by the concerned authorities due to political and technical reasons. Since fresh specimens were not available, more comment on the status and relationship of this species is not possible. Types were examined and the description given by the original authors is followed. All the specimens of this taxa deposited in Indian herbaria also were examined. Few character excluded by the original author also are included.

2. Leucas angularis Wall. ex Benth., in Wall. Pl. As. Rar. 1: 62. 1830; Benth., Labiat. Gen. Spec. 3. (fasc. 6): 608. 1834; in DC., Prodr. XII: 526. 1848; Hook.f., Fl. Brit. India 4: 684. 1885; Trimen, Handb. Fl. Ceylon 3: 385. 1895; Gamble, Fl. Pres. Madras 2: 1151. 1924; Mukerjee, Rec. Bot. Surv. India XIV (1): 181. 1940; Abeywick., Ceylon J. Sci. Biol. Sci. 2 (2): 20. 1959; L.H.Cramer, in Dassan. & Fosberg (eds.), Rev. Handb. Fl. Ceylon III: 187. 1981; Ramach. & V.J.Nair, Fl. Cannanore 365. 1988; Manilal, Fl. Silent Valley 218. 1988; V.Singh, Mon. Indian Leucas 38. 2001.

—Type: Ceylon *s. coll., s.n.*, in Herbarium Lindl. *non vidi*

Leucas marrubioides var. *pulneyensis* Hook.f., Fl. Brit. India 4: 684. 1885.

—Type: India, Pulney mountains, *Wight s.n* (K) *non vidi.*

Leucas pubescens sensu The., Enum. Pl. Zeyl. 240. 1860 *non* Benth. 1834.

Straggling herb, perennial from stem base and root stock, older stems sometimes become hollow, branches herbaceous, slender 1–2.5 m long, 2–6 mm

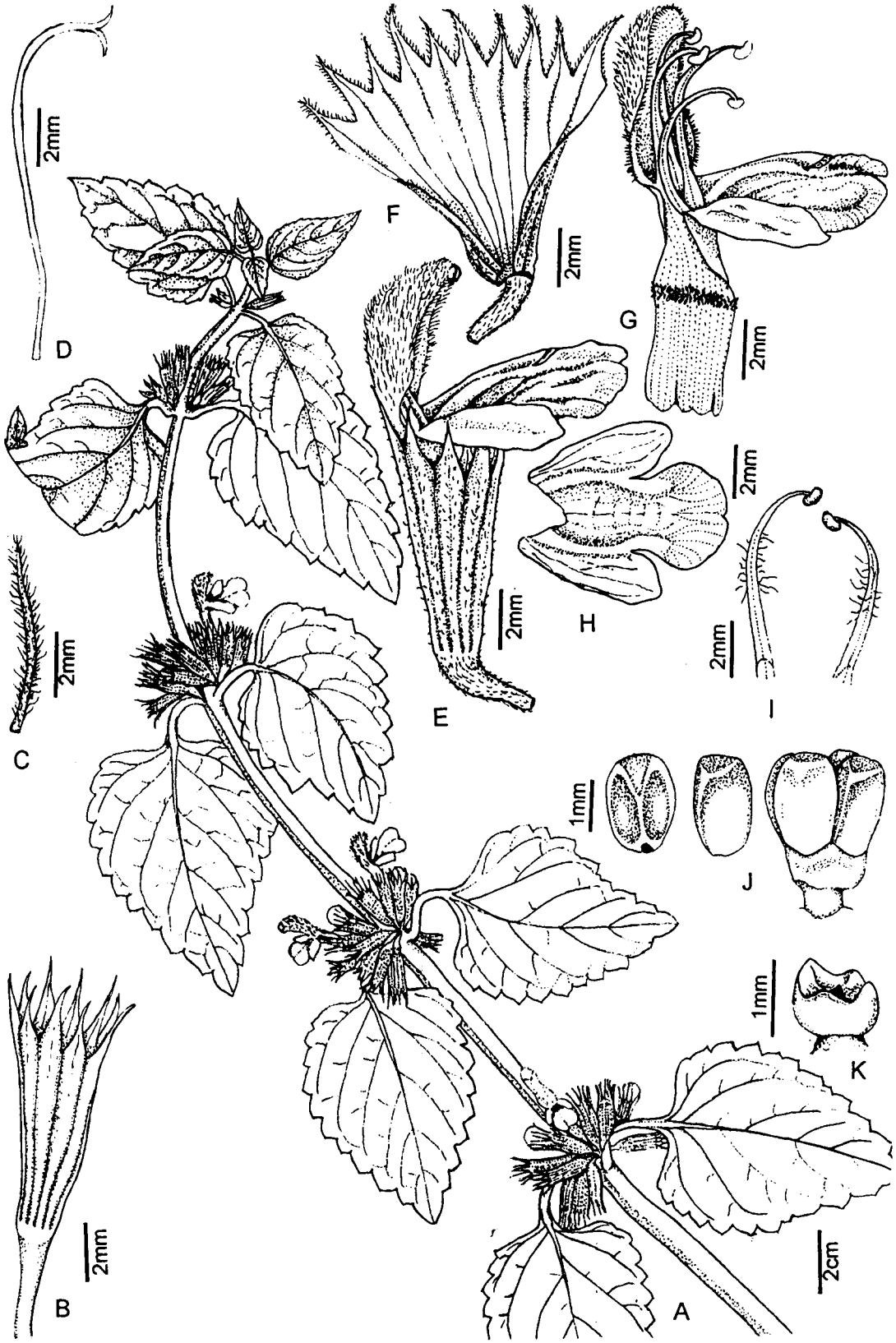


Fig. 16: *Leucas angularis* Benth. A. Habit; B. Calyx; C. Bracteole; D. style with stigmatic lobes; E. Flower; F. Calyx split open; G. Corolla split open; H. Corolla lower lip; I. Stamens; J. Nutlets; K. Disc.

thick, acutely quadrangular, not grooved, pubescent, hairs 0.2–0.4 mm long, retrorse, dense; internode 7–11 cm long. Leaves opposite, decussate, petiole 1.5–2.2 cm long; lamina 5–8 cm long, 3.2–5 cm broad, membraneous, triangular ovate to triangular lanceolate, acute, truncate to sub-cordate base, margin coarsely crenate to serrate, lowerside and margin puberulous, upperside almost glabrous, sometime slightly and remotely puberulus, secondary veins 4, prominent beneath. Inflorescence many, in the axils of bracteate leaves, 2–25 flowers in each cluster, cymes rather lax. Bracteoles straight, linear subulate, few numbered, 3–6 mm long, 0.3–0.4 mm broad, up to half as long as calyx or smaller, filiform, hispidly hairy. Flowers pedicellate; pedicels 1.5–2.5 mm long. Calyx 8.5–10 mm long, straight, tubular, narrowed at the base, moderately widened at the mouth, obconical, tube thin, prominently ribbed longitudinally, fully pubescent outside, hairs <0.5 mm, adpressed, inside fully glabrous, mouth straight, vide open; teeth 10, straight, subequal 2–6 mm long, about one-fourth to three-fourth the length of tube, triangular, base 1 mm broad, tip acute, outside pubescent, with a prominent mid vein leading from the tube (seeding calyx slightly larger, up to 13 mm long). Corolla white, ±16 mm long, fully included in the calyx, tube 8–8.5 mm long, slightly bent forward, above outside white hairy, inside half length annulate with a discontinuous ring of fleshy hairs; lower lip 7.5 mm long, middle lobe 4.5 mm broad at free end, emarginate, less broader than middle part, free end of side lobes 2 mm broad, slightly oblique, margin slightly revolute; upper lip 6 mm long, upper portion slightly bent forward, concave, enclosing stamen and stigma, outside hardly bearded with small white woolly hairs, margin ciliate. Staminal filaments slightly hairy,

lower pair longer than upper pair; anther lobes light red coloured, 0.6 mm long, 0.5 mm broad, theca confluent. Disc cup shaped in flowers, fleshy, basal portion slightly bulged, abaxial lobes slightly longer than the other lobes. Ovules, 0.5 mm long, locules above rounded without glands and hairs. Style 14–14.5 mm long, slightly bent; stigma bi-lobbed, lobes almost equal, slightly curved outside. Nutlets ±1.9 mm long, ±1 mm broad, oblong, shining, black coloured, top almost flat, truncate, obtusely triangular in cross section.

Etymology: The species name denotes the characteristic quadrangular nature of the stem and branches.

Flowering and Fruiting: Peak flowering season; July—January.

Habitat: Usually found in the margins of semi evergreen forests of Western Ghat, usually grows among bushes and grasses in the shade; altitude above 800 m. The plant may live from 1.5–2 years depending up on the climate.

Distrubution: Found in South India and Sri Lanka. In South India, this is found in Southern Western Ghats in Kerala and bordering areas of Tamil Nadu.

Specimen examined: **KERALA: Idukki Dt.**: Old Deviculam, 2nd Oct. 1993, *A.G. Pndurangan & E.S.Santhoshkumar 18237* (TBGT); Chinnar, Alampetty, *K.K. Sajeev 11799* (KFRI); **Kannur Dt.**: Arunapparai, 9th Feb. 1978, *V.S.Ramachadran 53840* (CALI); Nedumpoyil, 27th Feb. 1979, *V.S.Ramachandran 61965* (MH); Begur RF, 19th June 1979, *V.S.Ramachandran 62683* (MH); Tolpetty, 8th Aug, 1979, *V.S.Ramachandran 63759* (CAL, MH); **Kottayam Dt.**: Devicolam, Dec. 1910,

A.Meebold 13457 (CALI); Devicolam, Petimudi, 8th Feb. 1970, *B.V.Shetty 33477* (MH); **Malappuram Dt.**: Gudallur road, 2nd Oct. 1981, *P.Mathew 28777* (CALI); Nadukani, 10th Dec. 1988, *V.Geetha 1858* (CALI); Nilambur, 10th, Dec. 1988, *V.P.Premalatha 3254* (CALI); **Palakkad Dt.**: Attapadi valley, 13th, Oct. 1910, *C.E.C.Fischer 2324* (CALI); Silent Valley, Kukkali, Panthanthodu, 21st Sept. 1977, *K.N.Subramanyan 7054* (FRC); **Pathanamthitta Dt.**: Goodrickal RF, Moozhiyar to Kakki road side, 20th Oct. 1983, *K.N.Subramanyan 9802* (FRC); **Wyanad Dt.**: Begur range, Hilldale RF, 23rd Nov. 1983, *K.N.Subramanyan 9772* (FRC); Lakkidi, 14th Nov. 1987, *P.S.Ajitha 13321* (CALI); 4th Nov. 1987, *A.C.Jayalakshmi 12788* (CALI); Triveni, 19th July 1994, *A.G.Pandurangan 1930* (TBGT); Tirunelli, 26th Nov. 1995, *K.Radhakrishnan 26537* (TBGT); Tusharagiri, 9th Dec. 1998, *Sunojkumar CU49614* (CALI); Hair pin 8 ghat road side, 5th June 1999, *Sunojkumar CU49619* (CALI); Chembra estate, 11th Oct. 2003, *Sunojkumar CU88132* (CALI); **TAMIL NADU: Anna Dt.**: Manjaleer Hepareas Kodai hill, 21st May 1987, *K.Ramamurthy 85935* (MH); **Coimbatore Dt.**: Karudimalai, 16th Sept. 1970, *M.V.Viswanathan MVV763* (MH); **Madurai Dt.**: Kodaikanal, Bear shola, 1st July 1901, *Bourne 2037* (CALI); Kodaikanal, Berberis shola, 30th May, 1899, *Boama 1334* (MH); way to Poomparai-Kodaikanal, 22nd Apr. 1965 *K.Ramamurthy 23353* (MH); Picinic shola, 19th Sept. 1968, *D.B.Deb 30992* (MH); **Nilgiris Dt.**: Kotagiri-Mamaram, 24th Oct. 1956, *K.Subramony 1128* (CAL, MH); Marappalam-Burliar road, 26th Dec. 2002, *Sunojkumar CU88116* (CALI); **Tirunelveli Dt.**: Kalakkad, Sengaltheri, 22nd, Mar. 1979, *K.N.Subramanyan 7467* (FRC).

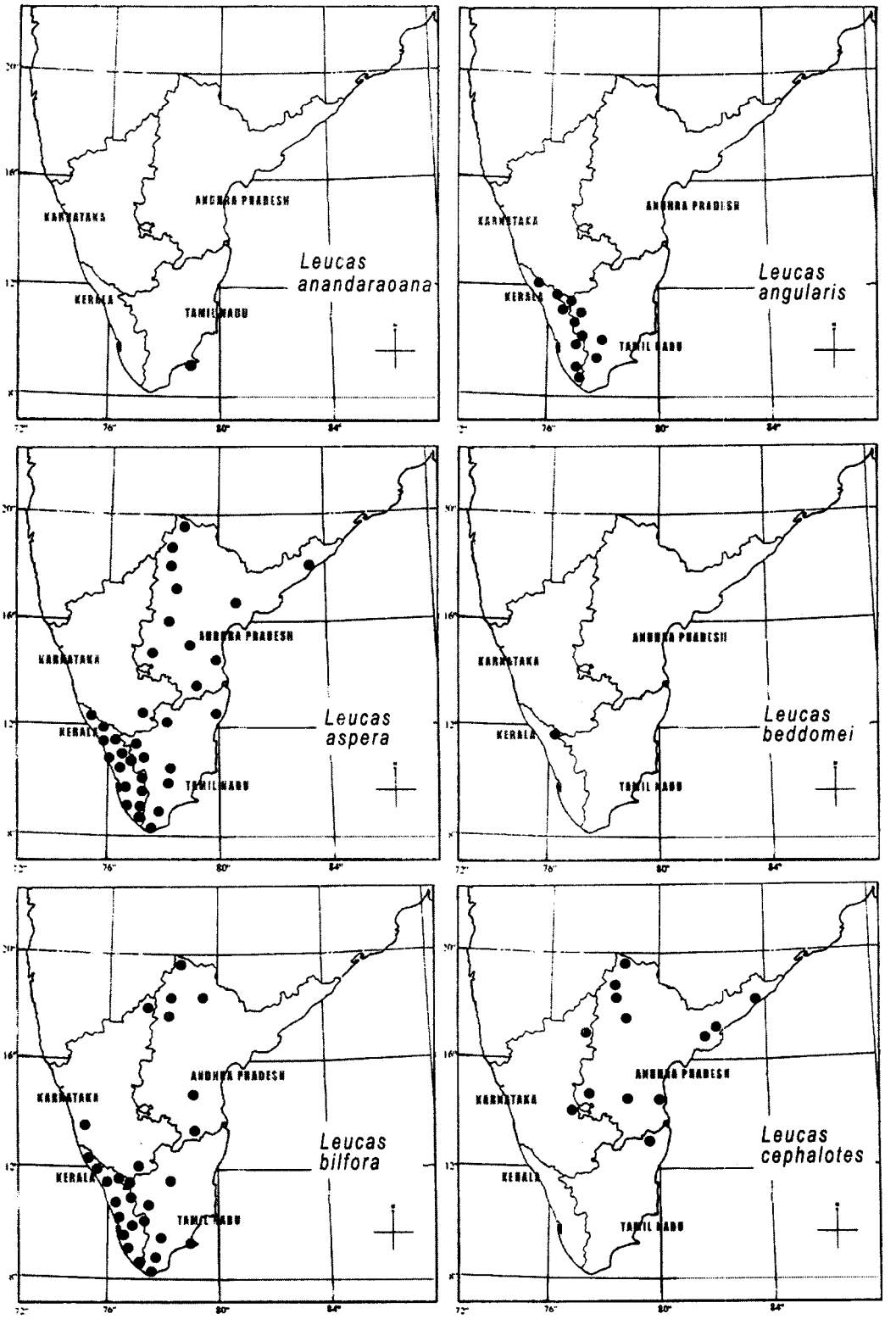


Fig.: 17 Distribution map of *Leucas* species in Southern Peninsular India.

Notes: This species is closely allied to *Leucas pubescens* Benth. and can be distinguished by its short size; leaves being membraneous and ovate-lanceolate; membraneous calyx tube with long teeth; and small bracteoles. Even though found in semi evergreen hilly areas, this plant flourishes well in experimental garden at an altitude ±20 m above sea level.

3. Leucas aspera (Willd.) Link, Enum. Hort. Berol. 2: 113. 1822; Spreng. in L., Syst. Veg. ed. 16, II: 743. 1825; Benth., Labiat. Gen. Spec. 3 (fasc. 6): 615. 1825; in DC., Prodr. XII; 532. 1848; Hook.f., Fl. Brit. India 4: 690. 1885; Cooke, Fl. Bombay Pr. 2: 645. 1906; Prain, Bengal Pl. 855. 1908; Koord, Ex. Fl. Java 3: 146. 1912; Haines, Bot. Bihar & Orissa 4: 751. 1922; Merr. Enum. Philip. Fl. Pl. 3: 410. 1923; Merr, En. Philip. 3: 410. 1923; Gamble, Fl. Pres. Madras. 2: 1150. 1924; Mukerjee, Rec. Bot. Surv. India XIV (1): 166. 1940; Quis, Medic. Pl. Philip. 828. 1951; Duthie, Fl. Upp. Gangetic. Plains 2: 113. 1960; Back. & Bakh.f., Fl. Java 2: 623. 1965; Keng, Gard., Bull. Singapore 24: 101. 1969; J.Venkates. et al., Fl. Vizakapatanam 164. 1972; C.J.Bamber, Pl. Punjab 215. 1976; Keng, Fl. Malesiana 1: 8. 338. 1978; R.R.Rao & Razi, Syn. Fl. Mysore Dist. 511. 1981; R.S.Rao et al., Fl. W. Godaveri 333. 1986; K.K.N.Nair & M.P.Nayar, Fl. Courtallum 2: 259. 1987; Sriniv. in A.N.Henry et al., Fl. Tamil Nadu Ser. I. 2: 175. 1987; Chandrab. & N.C.Nair, Fl. Coimbatore 244. 1988; N.P.Singh, Fl. East. Karnataka 2: 517. 1988; Pullaiah

& Yesoda, Fl. Anantapur Dist. 201. 1989; Hedge in Ali & Nasir, Fl. Pakistan 192: 159. 1990; J.L.Ellis, Fl. Nallamalais 333. 1990; K.M.Matthew, Ex. Fl. Cent. Tamil Nadu 403. 1991; Pullaiah et al., Fl. Adilabad Dist. 175. 1992; Shu in Zheng-yi & Raven, Fl. China 17: 143. 1994; M.Mohanan & A.N.Henry, Fl. Thiruvananthapuram 366. 1994; Pullaiah & B.R.P.Rao, Fl. Nizamabad Dist. 183. 1995; K.N.Subraman., Fl Thenmala 286. 1995; Raju & Pullaiah, Fl. Kurnool Dist. 381. 1995; K.Lakshimin et al., Fl. Krishna Dist. 243. 1997; Pullaiah & Moulali, Fl. Andhra Pradesh 2: 768. 1997; Pullaiah et al., Fl. Medak Dist. 186. 1998; K.M.Mathew, Fl. Pulney Hills 2: 994. 1999; Pullaiah & S.Mohammed, Fl. Renga Reddi Dist. 175. 2000; Pullaiaha et al., Fl. Guntur Dist. 287. 2000; V.Singh, Mon. Indian Leucas 43. 2001.

Phlomis aspera Willd., Enum. Hort. Berol. 2: 621. 1809.

—Type: Habitat Caramania, *Willd. 10951* (holo. **B** dig. photogr !).

Phlomis plukenetii Roth, Nov. Sp. 261. 1821.

—Type: Plucken., Alm. p. 81, t. 80, f. 7.

Leucas plukenetii Spreng., in L., Syst. Veg. ed. 16, II: 743. 1825; Benth. in Wall., Pl. As. Rar. 1: 60. 1830; J.R.Press in H.Hara et al., En. Fl. Pl. Nepal 3: 157. 1982.

—Type: same as *Phlomis pluckentii*

Phlomis esculenta Roxb., Hort. Bengalensis 44. 1814; Fl. India 3: 10. 1832; Wall. Cat. Herb. Ind. No. 2522. 1829.

—Type: India. *Roxburgh, non vidi.*

Leucas dimidata sensu Benth. in DC., Prodr. XII: 532. 1848. *non* (Roth) Spreng. in L., Syst. Veg. ed. 16, II: 744. 1825.

—Type: India, *s.coll.*, *s.n.*, Wall Cat No. *2523* (holo. **K** cibachrome !)

Leucas minahassae Koord ex Boerl, Handl. 2: 2. 716. 1899. & Koord-Schum, Syst. 3: 112. 1914. *nomen.*

Leucas oblique Buch-Ham ex Dillwyn, Rev. Hort. Malab. 57. 1939.

—Type: as that of *P. pluckentii*.

Erect annual herb, 30–50 cm high, stem obtusely quadrangular and grooved; branches many, hispid, hairs spreading; internodes 5–15 cm long. Leaves opposite decussate; petiole 0.5–1 cm long, lamina 2–10 cm long, 0.5–3 cm broad, approximately 2–3 times longer than broad, slightly coriaceous, linear–lanceolate or long elliptic, base narrowed and cuneate, obtuse tip, margin slightly to deeply serrate with 4–7 long teeth, lateral veins 4–5, prominent beneath, puberulous on both side with minute glands at the lower side. Inflorescence teminal, sometime upper 3–5 axils, sub–globose clusters, up to 3 cm diameter at base, whorls very close and often appressed to the next lower cluster, many flowered. Bracteoles many, 10 mm long, 0.8 mm broad at base, recurved towards the axis, narrowly linear spinulose apex, long bristle like hairs at margin and outside. Flowers almost sessile to very short pedicellate. Calyx tubular, adaxial side 8–11 mm long, abaxial side 7–8 mm, slight bent at middle, prominently 10 nerved longitudinally, each nerve excurrent in a teeth, inside pubescent, base thick, narrowed, outside glabrous, above nutlet portion membraneous, reticulate, hispid, provided with long bristle like scattered hairs; mouth very oblique, rim annulate with thick veins, some time internal pubescent hairs slightly projects outside mouth gives a ciliate appearance; teeth 10, tip

subulate, spinulose, 1–1.25 mm long, anterior longest, hispid with bristle like hairs. Corolla white, 13–15 mm long; tube 5–7 mm long, included in calyx tube, outside hairy above, inside middle annulate with oblique and discontinuous ring of fleshy hairs; lower lip ±8 mm long, middle lobe 6.5 mm wide, fan shaped, side lobes 1.5 mm broad at free end, acuminate, base narrowed, margin slightly revolute; upper lip 6 mm long, concave, bent, white spreading hairs outside, margins ciliate. Stamens included in the upper lip, upper pair shorter than the lower, filaments hairy, anther lobe 0.9 mm long, 0.5 mm broad, confluent theca. Disc cup shaped, distinct equally sized four lobes. Ovary locules 1 mm high, top rounded. Style 10 mm long, bent towards upper side; stigma unequally bi-lobbed, lower lobe 0.6 mm long, upper 0.06 mm long. Nutlets 2.5 mm long, 1 mm broad, dark brownish, glabrous shining, proximal sides flat, oblong outside, apex truncate and slightly rounded, narrowed at base.

Etymology: The species name derived from the Latin term '*aspero*' which means 'rough'. By the usage of '*caule tetragono aspero*', the author (Willdenovio, 1800) might be ascribing to the rough nature of the stem because of pickles.

Flowering and fruiting: Throughout the year, especially from July–February.

Habitat: Weed in cultivated fields, wetlands, open places, roadsides, and railway tracks. Common in plains at sea level but will also be found in hilly area up to 800 m above sea level.

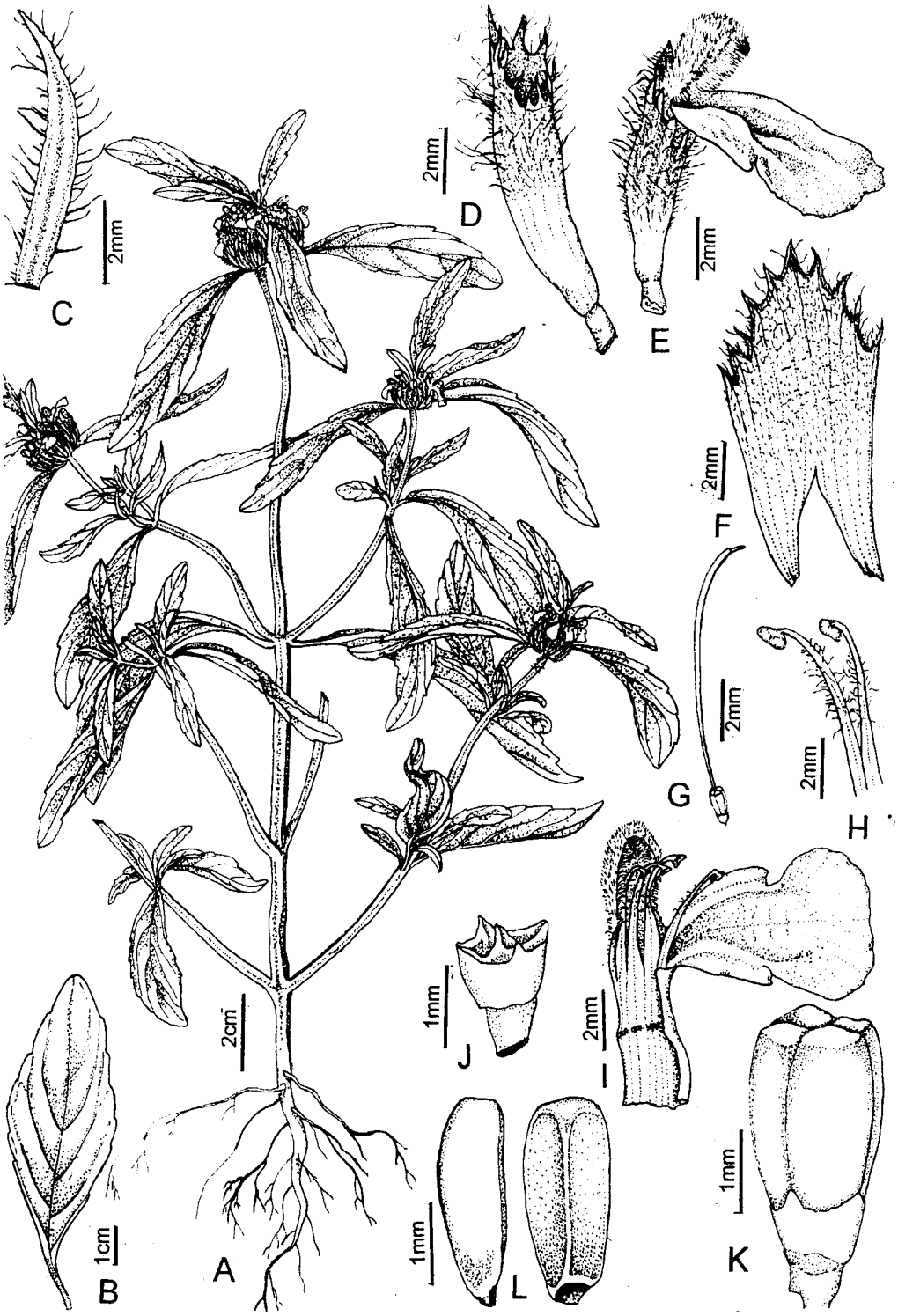


Fig.:**18**. *Leucas aspera* (Willd.) Link. A. Habit; B. Leaf; C. Bracteole; D. calyx; E. Flower; F. calyx split open; G. Pistil; H. Stamens; I. Corolla split open; J. Disc; K & L. Nutlets.

Distribution: Tropical African and in Asian countries: Sri Lanka, Myanmar, Pakistan, Nepal, Bhutan, China, Philippines, Malaysia, Thailand, and Mauritius. Common in all Indian states, in South India it is found in all four states.

Economic importance: During the study it is noticed that people use the crushed leaves for wound covering and against scabies. The juice is used by the local people in Nelliampathy area in Kerala for treating small wounds even that happend in the eyes. Hindu people use this for various religious activities. Used very commonly in folk medicine as an ingredient in many medicines, especially those given to children. Detailed usage is given in chapter 2. f.

Specimens examined: Peninsular India orientalis, 1866, *Wight 2161* (MH); **ANDHRA PRADESH: Adilabad Dt**.: Suthermott, 8th Dec. 1985, *T.Pullaiah, et al. 4106* (SKU); Keslapur, 13th Dec. 1988, *G.Obulesu & P.V.Prasanna 4568* (SKU): **Anantapur Dt**.: Peddipalli farm, 15th Aug. 1981, *N.Yesoda 269* (SKU); Tadapati–Bugga, 7th Oct. 1981, *T.Pullaiah 431* (SKU); Mudukota RF, 9th Jan. 1983, *T.Pullaiah & N.Yesoda 973* (SKU); Koppanm, 7th Feb. 1987, *V.R.Krishnan 1295* (SKU); S. K University campus, 23rd Oct. 2001, *Sunojkumar CU49660* (CALI); Kalasamudram, 24th Oct. 2001, *Sunojkumar CU49661* (CALI); **Chitoor Dt**.: Pakala jn. Railway stn. 25th Oct. 2001, *Sunojkumar CU49666* (CALI); **Cuddapah Dt**.: Palakonda hills, 15th July 1989, *C.Subbarayalu 9369* (SKU); **Guntur Dt**.: Mannanav forest, 26th Feb. 1994, *T.S.Rani & T.D.C.Kumar 13604* (two sheets)

(SKU); Vajrala Thanda, 11th May 1998, *D.M.Rao 21122* (SKU); **Kurnool Dt.**: Erramalai hills, 29th May 1983, *R.R.V.Raju 1392* (SKU); Gani fields, 2nd Dec. 1983, *T.Pullaiah & A.Ahmad 1924* (SKU); Mamalapadu, 12th Dec. 1984, *A.Ahmad 1967* (SKU); **Medak Dt.**: Nagulabanda, 21st Aug. 1992, *C.Prabhakar 11324* (SKU); Patten fields, 14th Nov. 1992, *T.Pullaiah & C.Prabhakar 12120* (SKU); **Nellore Dt.**: Bairakonda, 9th Jan. 1989, *D.A.Moulali 8336* (SKU); **Nizamabad Dt.**: Kammarpally fields, 1st Oct. 1987, *T.Pullaiah & B.R.P.Rao 6244* (SKU); **Rangaraddi Dt.**: Kusumo samudaram, 2nd Jan. 1991, *M.S.Mohamad 11026* (SKU); **Vizakapatanam Dt.**: Burra caves, 17th May 1988, *D.A.Moulali 5966* (SKU); **KERALA: Alapuzha Dt.**: Thanneermukkam, 29th Dec. 1990, *M.S. Swaminathan & V.P.Prasad 95629* (MH); **Ernakulam Dt.**: Atiampalli, 23rd Aug. 1978, *Anilkumar 33985* (TBGT); **Idukki Dt.**: Chinnar, Chengamperu, 1999, *K.K.Sajeev 11703* (KFRI); Chinnar, 18th Jan. 2004, *Sunojkumar 88143* (CALI); **Kannur Dt.**: 20th Aug. 1988, *V.S.Ramachandran 64031* (MH); **Kollam Dt.**: Chittar, 31st July 1978, *C.N.Mohanan 55354* (MH); **Kozhikode Dt.**: Chettikulam beach, 8th Oct. 2003, *Sunojkumar CU88128* (CALI); **Palakkad Dt.**: Valayar dam site, 11th July 1963, *J.Joseph 17089* (MH); Attapady, 20th Dec. 1969, *E.Vajravelu 33182* (MH); Parambikulam, Vengoli, 2002, *P.Sujanapal 19640* (KFRI); **Trissur Dt.**: Chiklai, 29th Sept. 1982, *K.Ramamurthy 74947* (MH); **TAMIL NADU: Chennai Dt.**; Siruvani adivaram, 28th Aug 1960, *A.N.Henry ANH 486* (MH); **Coimbatore Dt.**: Talavadi, 6th Mar. 1931, *K.C.Jacob 47* (MH); Thekkumalai, 25th Nov. 1956, *K.M.Sebastine 1499* (MH); Kuridimalai, 18th July 1956, *K.Subramanyam 301* (MH); Attakatti, 25th June 1962, *J.Joseph 14168* (MH); Nallamalai RF, 25th Nov. 1962, *K.Ramamurthy 14116*

(MH); Coimbatore, 30th Nov. 1962, *K.N.Subramaniam 195* (FRC); Medukkarai, 9th Aug. 1962, *C.P.Sreemadhavan CPS24* (MH); Chidambaram park, 4th Oct. 1964, *M.Chandrabose 28565* (MH); Saibaba colony, 26th Dec. 1965, *K.Chandrabose 28077* (MH); Forest College estate, 18th Dec. 1969, *K.N.Subramaniam 3878* (FRC); **Dharmapuri Dt**.: Vempatti Harur, 14th Nov. 1977, *E.Vajravelu 51840* (MH); **Madurai Dt**.: Natham, 21st Apr. 1958, *K.Subramanyam 5723* (MH); **Namakkal Dt**.: Karavali, on the way to Kollimalai, 26th Dec. 2000, *Sunojkumar CU49655* (CALI); **South Arcot Dt**.: Pelakuppam farm, 19th Aug. 1930, *V.Narayanasamy 4017* (MH); Parangippettam, 10th Feb. 1979, *K.Ramamurthy 58172* (MH); **Tirunelveli Dt**.: Courtallum water falls, 15th July 1998, *Sunojkumar CU49601* (CALI); Vijayanarayanam, 15th Mar. 2000, *Sunojkumar CU49623* (CALI); Papanasam, Karayar, 24th Sept. 2001, *Sunojkumar CU49655* (CALI); Mahendragiri, 24th Sept. 2001, *Sunoj kumar CU49656* (CALI); **Kanyakumari Dt**.: Nagercoil, Keeripara, 5th Aug. 2000, *Sunojkumar CU49629* (CALI); Keeripara, 23rd Sept. 2001, *Sunojkumar CU49654* (CALI); **Vellore Dt**.: Pattrakad FR, 21st Nov. 1975, *K.N.Subramaniam 5399* (FRC); Vandalur RF, 24th Aug. 1982, *K.N.Subramaniam 8492* (FRC); Srivilliputhur, 8th Nov. 1990, *S.R.Srinivasan 94407* (MH).

Notes: This plant is not very common in Malabar cost as that of other related species. The identity of *Leucas aspera* (Willd.) Link also is in confusion in many regional floras. Even the interpretation of *Leucas* in Van Rheede's Hortus Malabaricus (Nicolson et al., 1988) as *Leucas aspera* (Willd.) Link is an error due to false taxonomic judgement. On examining the illustration and notes given in Hortus

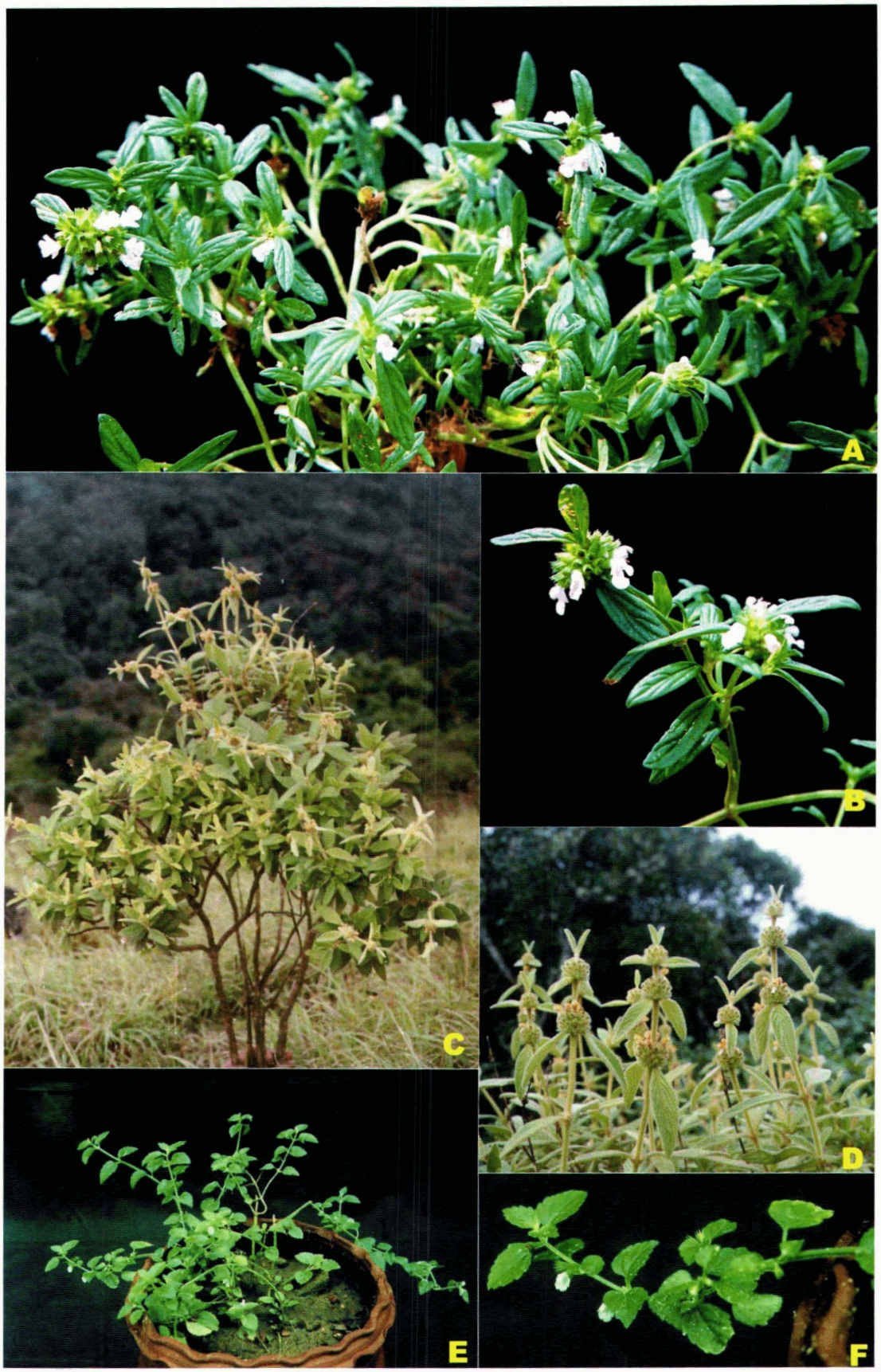


Fig. 19: A-B. *Leucas aspera* Link.; C-D. *Leucas beddomei* Sunojkumar & P.Mathew; E-F. *Leucas biflora* Sm.

Malabaricus it is clear that what Rheede aimed is not *Leucas aspera* (Willd.) Link, instead it is *Leucas indica* (L.) R.Br. The specimen collected by the interpreters (*C.R.Suresh CU10139 & CU10053*) from Malabar and deposited in CALI, is wrongly identified as *Leucas aspera* (Willd.) Link. One of these specimens was *Leucas indica* (L.) R.Br and all other five sheets were of *Leucas zeylanica* (L.) R.Br.

Identity of *Leucas aspera* is a confusing topic for taxonomists. From the close allies like *Leucas indica, Leucas zeylanica, Leucas stricta* and *Leucas wightiana* it is easily identified by the floral characters; globose verticals, tubular calyx with 10 distinct teeth and very oblique mouth.

4. Leucas beddomei (Hook.f) Sunojkumar & P.Mathew, *Rheedea* 12 (2): 169-174. 2002.

Leucas hirta (Roth) Spreng. var. *beddomei* Hook.f, Fl. Brit. India 4: 687. 1885; Gamble, Fl. Pres. Madras. 2: 1153. 1924; Mukerjee, Rec. Bot. Surv. India XIV (1): 176. 1940; V.Singh, Mon. Indian Leucas. 93. 2001.

Type:— India, Kerala, Wayanad, Chembra peak, 5000 ft., *Beddome s.n.* –type of *Leucas hirta* var. *beddomei* Hook.f. (holo. **K**, cibachrome !).

Erect, sub shrub, 0.45–1 m tall, basal part woody; stem obtusely quadrangular, grooved, softly villous with spreading 1–1.5 mm long golden brown hairs; tender stem densely villous. Leaves opposite decussate; petiole 1–1.5 mm

long; lamina 5–10 cm long, 2–3 cm broad, elliptic, obtuse, base angustate, margin crenulate with 16–19 convex teeth, upper surface ciliate with 4–5 impressed parallel veins, lower surface veins projecting, hispid, hairs spreading. Inflorescence in upper 4–5 axils, dense, many flowered. Bracteoles 7–8 mm long, 1 mm broad at base, as long as calyx, linear elliptic divergent, ciliate with 1–1.5 mm long hairs. Bud oblong, center bulged, ends narrowed, teeth inwardly directed. Flowers shortly pedicellate. Flowering calyx ± 8 mm long, densely ciliate with 1–2 mm long hairs, inside glabrous, tube narrowed below, upper half prominently nerved, ribbed; mouth straight, villous with a ring of very short hairs, smaller than teeth, not visible outside; teeth 10, recurved in bud, short, less than 1 mm long, ciliate. Corolla 10–10.5 cm long; tube 6–7 mm long, fully included, above outside hairy, inside middle annulate with fleshy hairs, above annulus hairy up to stamens, hairs fleshy; lower lip 4 mm long, white, 3 lobed, middle lobe 2.5 mm broad emarginate, margin regular, rounded, side lobes 1.5 mm broad, oblong; upper lip erect, densely bearded with brownish yellow and yellowish white hairs, arranged in opposite direction. Staminal filaments hairy, fleshy hairs at base; anther lobes 1.4 mm long, 0.75 mm broad. Style slender, 10.5 mm long; stigma lower lobe 0.26 mm long, subulate, upper lobe minute. Disc 4 equal lobed. Nutlets 3.3 mm long, 1.4 mm broad, elliptic, triquetrous, top rounded and gland dotted, below smooth, shining, light brown.

Etymology: The species is named after the first collector of this material Colonel H. Beddome.

Flowering and fruiting: September – March.

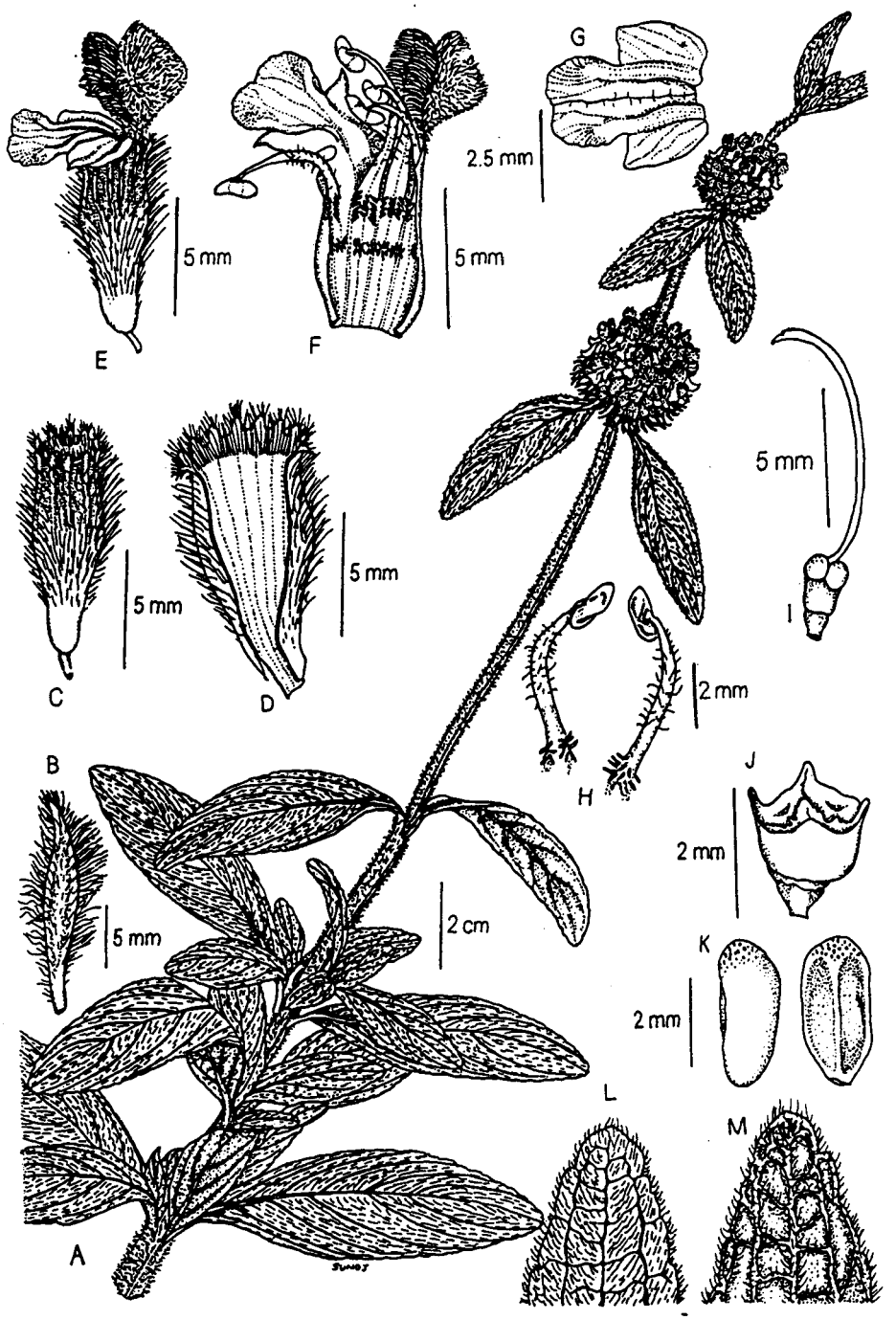


Fig. 20 *Leucas beddomei* (Hook. f.) Sunojkumar & P. Mathew: A. Habit – a flowering twig; B. Bract; C. Calyx; D. Calyx - split open; E. Flower; F. Corolla - split open; G. Lower lip of corolla; H. Stamens; I. Pistil; J. Basal disc; K. Nutlets; L. Apical portion of leaf – upper surface; M. Apical portion of leaf – lower surface

Fig. 21: Type specimen of *Leucas beddomei* Sunojkumar & P.Mathew (Herbarium Beddome *s.n.* from K)

Habitat: Specimens of this taxon were collected from the peak of Chembra hills, 1770 m. in Wyanad district where a population is present on the ecotone region of Shola forest and grasslands. Gamble (1924) pointed that this is available in South Canara also but no specimen collected from this part is available.

Distribution: Endemic to South India.

Specimen examined: **KERALA: Wyanad Dt.**: Chembra peak, N.11° 32.14, E.0.76° 04.976, *Sunojkumar CU 49631* (CALI, SKU) & 11th Oct. 2003, *Sunojkumar CU88131* (CALI).

Note: Hooker (1885) treated this plant as *Leucas hirta* var. *beddomei,* as a variety based on Beddome's collection from Chembra hills. After this no report of the collection of this plant was available (Singh, 2001). Gamble (1924) pointed out that this plant is available in Wayanad and South Canara, based only on the same collection made by Beddome. The same view was followed by Mukerjee (1940) and Singh (2001) without citing any additional specimens. Singh (2001), in his revision of *Leucas* R.Br. in India has pointed out that he could not collect or see any specimens of this taxon other than the type.

After collecting this plant from the type locality, after about 120 years and a critical study of the fresh specimens revealed striking differences between this plant and *L. hirta,* especially on its floral, bract and nutlet characters.

Character	L. hirta	L. beddomei	L. eriostoma
Habit	Suffruticose 30–50 cm	Erect branching under shrub, ± 1 m.	Erect spreading herb with woody base
Leaf	2.5–3.5 x 1–1.3 cm,	5–10 x 2–3 cm,	4–9.5 x 1–1.8 cm,
Margin	3–4 serrated	16–19 crenulated	8–9 long serrated
Petiole	0–0.3 cm	1–1.5 cm	0–1 cm
Inflorescence	Terminal	In several axis	In several axis
Bract	10 x 1.5 mm	7–8 x 1 mm	5 x 0.3 mm, linear,
Bud	Campanulate, ciliate	Elliptic, ciliate	Tubular, glabrous
Teeth	1.5 x 2 mm, divergent	<1 mm, recurved	1 mm, spreading
Calyx villai	Long hairs, arranged in a cone over the mouth, closing it	Very small, not seen outside	Long dense silky, forming a tuft over the mouth
Calyx tube	Fully ciliate	Fully ciliate	Glabrous
Corolla	19–19.5 mm	10–10. 5mm	10–10.5 mm
Corolla upper lip	White, dense hairs spreading in all direction	Brownish yellow and yellowish white hairs arranged oppositely	White, hairs spreading
" lower lip (median lobe)	10–11 x 8–8.5 mm not lobed	4–4.5 x 2.5–2.8 mm, emarginated	4–4.5 x 2.5–2.8 mm, emarginated
Nutlet size	3 x 1.7 mm	3.3 x 1.4 mm	2.6 x 1.1 mm
Glands on nutlet	Absent	Present	Absent

Table. 12: Character differences of *L. hirta, L. beddomei* and *L. eriostoma*

Apart from the superficial resemblances of leaves and calyx this recently collected material shows more similarity to *Leucas eriostoma* Hook.f. However the unique character combination noticed in this plant is substantiating enough to treat it as a species rather than a variety under *L. hirta*. Therefore, it is decided to elevate its rank to that of a species. The striking differences of three related species are given in table: 12.

5. Leucas biflora (Vahl) R.Br. ex Sm. in Rees., Cycl. XX: 1812; Spreng. in L., Syst. Veg., ed. 16, II: 744. 1825; Benth. in Wall., Pl. As. Rar. 1: 62. 1830; Labiat Gen. Spec. 3 (fasc. 6): 610. 1834; in DC., Prodr. XII: 527. 1848; Wight, Icon. Pl. Ind. Orient. III. 2. t. 866. 1844-45; Hook.f., Fl. Brit. India 4: 683. 1885; Trim., Handb. Fl. Ceylon 3: 386. 1895; Cooke, Fl. Bombay Pr. 2: 469. 1906; Gamble, Fl. Pres. Madras 2: 1150. 1924; Mukerjee, Rec. Bot. Surv. India XIV (1): 180. 1940; Abeywick, Ceylon J. Sci. Biol. Sci. 2 (2): 220. 1959; J.Venkates. et al., Fl. Vishakhapatanam Dist. 164. 1972; R.R.Razi & Razi, Syn. Fl. Mysore Dist. 511. 1981; L.H.Cramer in Dassan. & Fosberg (eds.), Rev. Handb. Fl. Ceylon III: 186. 1981; Manilal & Sivar., Fl. Calicut 239. 1982; R.S.Rao et al., Fl. West. Godavari Dist. 333. 1986; Sriniv. in A.N.Henry et al., Fl. Tamil Nadu Ser. I. 2: 175. 1987; K.K.N.Nair & M.P.Nayar, Fl. Courtallum 2: 259. 1987; Chandrab. & N.C.Nair, Fl. Coimbatore Dist. 244. 1988; N.P.Singh, Fl. East. Karnataka II: 518. 1988;

Ramach. & V.J.Nair, Fl. Cannanore 365. 1988; Manilal, Fl. Silent Valey 219. 1988; K.R.K.Murthy & Yoganar., Fl. Coorg. Dist. 356. 1990; K.M.Matthew, Fl. Cent. Tamil Nadu 403. 1991; Pullaiah et al., Fl. Adilabad Dist. 175. 1992; M.Mohanan & A.N.Henry, Fl. Thiruvananthapuram Dist. 366. 1994; K.N.Subraman., Fl. Thenmala 287. 1995; Sasidh. & Sivar., Fl. Trissur Dist. 361. 1996; Pullaiah & B.R.P.Rao, Fl. Nizamabad Dist. 243. 1997; K.Lakshmin. et al., Fl. Krishna Dist. 243. 1997; Pullaiah & Moulali, Fl. Andhra Pradesh 2: 769. 1997; Pullaiah et al., Fl. Medak Dist. 187. 1998; K.M.Matthew, Fl. Pulney Hills 2: 995. 1999; V.Singh, Mon. Indian Leucas 49. 2001.

Phlomis biflora Vahl, Symb. Bot. 3: 77. 1794; Roxb., Fl. India 462. 1832.

—Type: India Orientali, *Burman*, Thes. Zeyl. 140. t. 63. f. 1. (**P** photo. !).

[*Lamium indicum, foliis oblongis, flore albo graveolens* Herm., Mus. Zeyl. 65. 1717.]

[*Leucas foliis subrotundis serratis, flore albo*. Burm., Thes. Zeyl. 140. 1737.]

Nepeta indica sensu Burm.f., Fl. Indica 126. 1768 (*non* L. 1753)

—Type: same as *Phlomis biflora.*

Leucas biflora R.Br. Prodr. 504. 1810 *nomen.*

—Type: same as *Phlomis biflora.*

Leucas procumbens Desf., Mem. Mus. Natl. Hist. Paris. 11: 7 t. 3 f. 2. 1822; Benth. in Wall., Pl. As. Rar. 1: 62. 1830; Benth., Labiat. Gen. Spec. 3 (fasc. 6): 610. 1834; in DC., Prodr. XII: 527. 1848; Hook.f., Fl. Br. India 4: 683.

1885; Duthie, Fl. Upp. Gang. Pl. 2: 115. 1960; Haines, Bot. Bihar & Orissa 4: 749. 1922; Ramach. & V.J.Nair, Fl. Cannanore 367. 1988.

—Type: Ceylon, *Leschenault s.n.* (holo. **P** !)

Leucas biflora var. *procumbens* (Desf.) Gamble, Fl. Pre. Madras 2: 1151. 1924; Mukerjee, Rec. Bot. Surv. India XIV (1): 180. 1940; K.N.Subraman., Fl. Thenmala 288. 1995.

—Type: same as *Leucas procumbens* Desf.

Annual procumbent herb, branches long 15–45 cm long, 1–1.5 mm thick, arising from root stock, spreading on the ground, rooting at nodes, tip ascending, acutely quadrangular, not grooved, internodes up to 4 cm long, pubescent with deflexed hairs on the angles. Leaves opposite, petiole 5–8 mm long, lamina 2–3.5 cm long, 1–2 cm broad, ovate-lanceolate to oblong, obtuse tip, base rounded to cuneate, coarsely serrate with 5–6 teeth, short pubescent on both sides, dense pubescent on lower veins, lateral veins 4–5, prominent beneath. Inflorescence lax 1–2, sometimes up to 4 flowered clusters in many axils, pedicels 1–2 mm long. Bracteoles minute up to 2.5 mm long, 0.2 mm broad, smaller than half of the calyx, filiform with long silky hairs. Calyx tubular campanulate, thin, 5 mm long, straight, base narrowed, longitudinally ribbed along veins, inside a ring of hairs at middle of upper half, outside fully hispid, mouth straight, wide; teeth 10, subequal, 1.5–2 mm long, straight, triangular with broad base and pointed tip, mid vein distinct, hispid outside; calyx and pedicel enlarge in seeding stage. Corolla white, 10 mm long, tube 4 mm long, included in calyx, inside half annulate with a wavy ring of fleshy hairs;

lower lip 6 mm long, middle lobe 4 mm wide, emarginate free end, side lobes 2 mm wide, slightly overlap with back of middle lobe, almost oval margin, revolute; upper lip 5 mm long, concave, outside white hairy, margin slightly emarginate at anterior end, ciliate. Staminal filaments hairy at middle, middle pair short, longer pair slightly project outside corolla lip; anthers 0.75 mm long, 0.5 mm broad, bright reddish coloured, theca confluent. Disc cup shaped, unequal lobes, abaxial 0.6 mm, slightly longer, others 0.3 mm long. Ovary lobes 0.25 mm high, trigonal, flat above. Style 9.5 mm long, slightly bent, stigma lobes almost equally bi-lobbed, 0.6 mm long, bent. Nutlets 1.9 mm long, 1.2 mm broad, black coloured, ellipticus, inside proximal side flat planes, outside oval, top flattened with obtuse edges, upper half not smooth lower half smooth.

Etymology: The species name is derived from the nature of inflorescence mostly with two flowers on opposite axils.

Flowering and fruiting: Throughout the year.

Habitat: The plants prefer shady atmosphere and are found growing among other herbs in the semi evergreen forests, establishes well in experimental gardens at sea level also; altitude 100 –1000 m.

Distribution: India and Sri Lanka. In India this species occur in almost all the Southern and Central Indian states.

Specimens examined: **ANDHRA PRADESH: Adilabad Dt**.: Sone, 14th June 1989, *G.Obelesu & B.R.P.Rao 9421* (SKU); **Chitoor Dt**.: Panapakkam hills, 27th Feb.

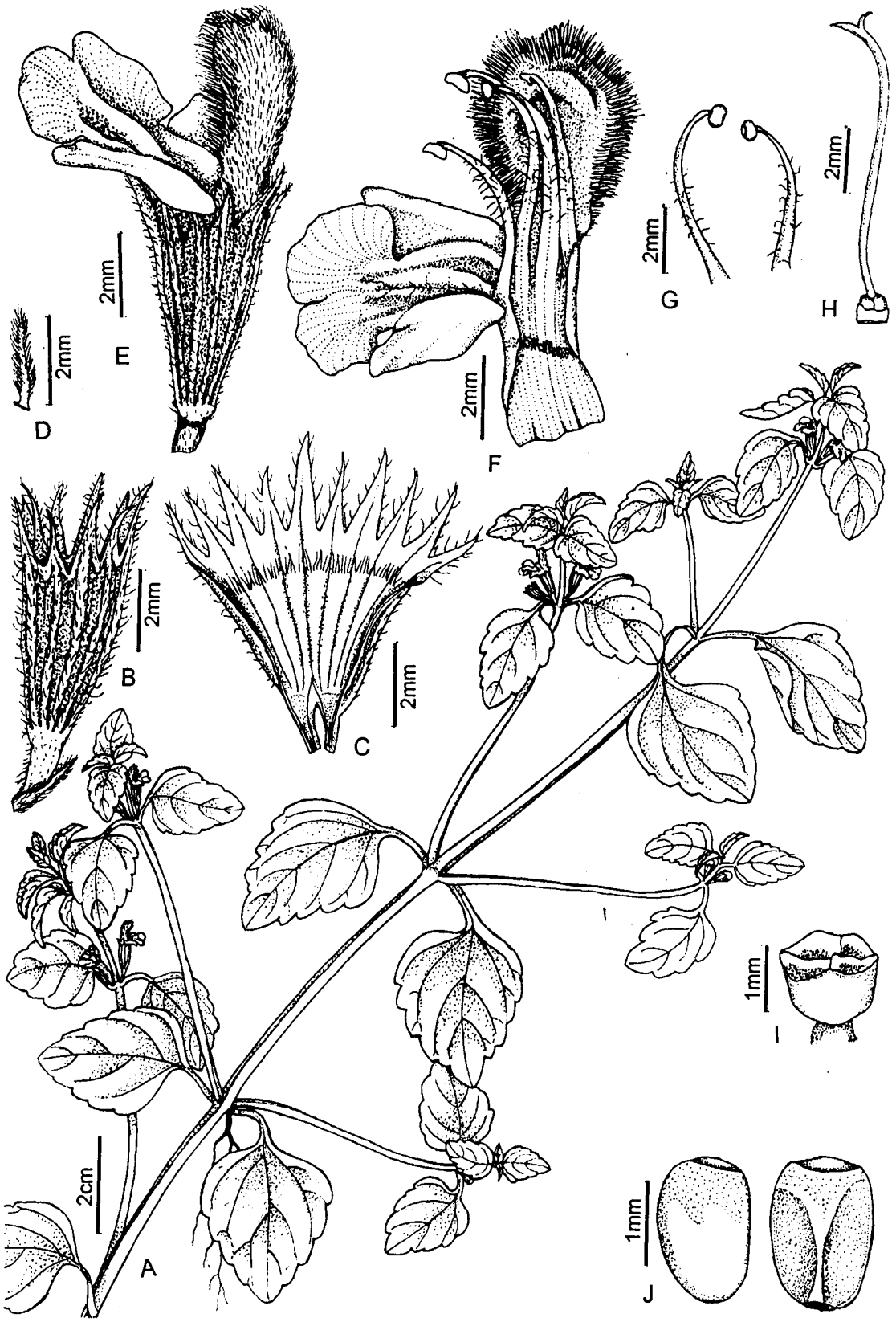


Fig. 22: *Leucas biflora* Sm. A. Habit; B. Calyx; C. Calyx split open; D. Bracteole; E. Flower; F. Corolla split open; G. Stamens; H. Pistil; I. Disc; J. Nutlets.

1918, *C.E.C.Fischer 4262* (CAL); Shikarline, 4th Oct. 1974, *G.V.S.Rao 45985* (MH); Ambakkam, 18th Oct. 1987, *D.R.Charyulu 1704* (CAL); **Cuddapah Dt**.: Taduku RF., 8th May 1988, *D.A.Moulali 5948* (SKU); Palakonda hills–Cuddapahatt, 10th Oct. 1988. *C.Subbarayndu & D.A.Moulali 7652* (SKU); Guvalacheruvu–Devarakona, 11th Dec. 1988, *R.V.Reddy 8103* (SKU); Lankamalai–Ranibavivegt, 17th July 1994, *S.R.S.Reddy 13005* (SKU); **Karimnagar Dt**.: Bhatipalli, 7th Feb. 1988, *M.R.R.Prasad 809* (MH); **Medak Dt**.: Pachammaralu, 28th Jan. 1992, *B.R.P.Rao & C.Prabhakar 11434* (SKU); Gangapur RF, 13th Nov. 1992, *T.Pullaiah & C.Prabhakar 12091* (SKU); NSF fields, 30th Nov. 1992, *B.R.P. Rao & C.Prabhakar 11656* (SKU); **Nizambad Dt**.: Mondivadak, 11th Mar. 1988, *T.Pullaiah & B.R.P.Rao 6367* (SKU); Nayaram 10th Mar. 1990, *B.R.P.Rao 9707* (SKU); West Godavari Dt.: Kovvura–Palivedala, 8th June 1988, *D.A.Moulali 6587* (SKU); **KARNATAKA: Bidar Dt**.: Humnabad river bank, 18th Nov. 1978, *S.R. Ramesh & K.P.Sreenath KFP4521* (CAL); **Mysore Dt**.: Somirhwar, 14th Oct. 1962, *R.S.Raghavan 83209* (CAL); **Shimoga Dt**.: Hulikal ghat, 5th Aug.1979, *C.J. Saldanha et al., KFP8900* (CAL); **KERALA: Idukki Dt**.: Vazhathope, 18th Feb. 1982, *N.Mohanan 73372* (MH); Thekkady 1998, *J.Augustine JA18605* (KFRI); Chinnar, 1999, *K.K.Sajeev 11524* (KFRI); **Kannur Dt**.: (Cannanore).: Panatteur, 10th Oct. 1977, *R.Ansari 64861* (MH); Begur forest, 23rd Nov. 1977, *V.S.Ramachandran 52318* (MH); Aralam, 11th Nov. 1978, *V.S. Ramachandran 58669* (MH); Kannoth RF,7th Nov. 1978, *V.S.Ramachandran 58284* (MH); Arunappatai, 7th Feb. 1978, *V.S.Ramachandran 53840* (MH); Tolpetty, 9th July 1978, *V.S.Ramachandran 57512* (MH); Aralam, 26th Feb. 1979, *V.S.Ramachandran*

61947 (MH); Mattanoor, 21st Jan. 1979, *V.J.Nair & R.Ansari 59751* (CAL, MH); Karimbam, 18th July 1981, *R.Ansari 70923* (MH); Mathamangalam, 7th Sept. 2002, *Sunojkumar CU49689* (CALI); **Kasaragod Dt**.: Parappa, 21st Sept. 2002, *Sunojkumar CU49690* (CALI); **Kollam Dt**.: Kolakutty-Ranni RF, 9th Sept. 1998, *N.Anilkumar 794* (MH); Shenduruney, Kattalappara, 1997, *N.Sasidharan 10574* (KFRI); **Kottayam Dt**.: Punaloor, 24th Aug. 1913, *M.R.Rao 1410* (CAL); Lockhert gap, 10th Oct. 1963, *K.M.Sebastine 17503* (MH); Vandiperiore, 22nd Sept. 1964, *K.Vivekanandan 20389* (MH); Mookenpetty, 4th Dec. 1991, *M.Dan 13406* (TBGT); **Kozhikode Dt**.: 1857, *J.S Gamble 41458* (MH); Pambara estate, 18th Aug. 1964, *J.E.Ellis 20483* (MH); Kutiyadi, 27th June 1965, *B.D.Naithani 24667* (MH); Chedaleth, 11th May 1965, *J.E.Ellis 20483* (MH); Peruvannamuzhi, 14th Nov. 1989, *K.Ajitha 2131* (CALI); **Palakkad Dt**.: Mukkali, 14th July 1969, *E.Vajravelu 32097* (MH); Panthanthode, 19th Dec. 1969, *E.Vajravelu 33160* (MH); Karivara, 20th Sept. 1977, *J.Joseph 51408* (MH); Singaniparai to Vattaparai, 28th May 1979, *E Vajravelu 62845* (MH); Silent Valley dam area, 8th Oct. 1979, *N.C.Nair 64431* (MH); Aruvampara slope, 19th Jan. 1980, *P.Bhargavan 65589* (MH); Parambikulam, 2002, *P.Sujanapal PS19533* (KFRI); **Trissur Dt**.: Peechi, 16th Dec. 1978, *N.Sasidharan 371* (KFRI); **Thiruvanantha-puram Dt**.: Kerala University campus, 3rd Dec. 1977, *M.Mohanan 52716* (MH); Thenmala, 9th June 1977, *T.Uma 20950* (CALI); City road side, 23rd June 1980, *T.Usha 30042* (CALI); Shankumukham, 12th May 1993, *M.Dan 14503* (TBGT); Thiruvallam, 20th June 1996, *P.S. Jothish 27785* (TBGT); **TAMIL NADU: Chingalpet Dt**.: Vandalur Kelambakan road, 1st Oct. 1974,. *A.N.Henry 45527* (MH); **Coimbatore Dt**.: Varapalayam, 6th July 1956,

K.Subramanyam 146 (MH); Varapalayam, 27th Apr. 1956, *K.Subramanyam 19* (CAL); Chinnathadagam, 10th Aug. 1956, *K.M.Sebastine 516* (MH); Karudimalai, 16th Nov. 1956, *K.Subramanyam 1343* (CAL); Vellingiri hills, 11th Feb. 1957, *K.M.Sebastine 2254* (MH); Maruthamalai 16th July 1957, *K.M.Sebastine 285* (CAL); Gingee RF, 8th Aug. 1961, *K.Ramamurthy 13051* (MH); Nellimalai RF, 25th Aug. 1962, *K.Ramamoorthy 14827* (CAL, MH); Nanjandaparam, 12th Dec. 1965, *M. Chandrabose 28857* (MH); Marutamalai, 17th Jan. 1999, *D.B.Deb 31377* (MH); **Kanyakumari Dt**.: Panagudi- Kathadimartaikadu, 9th Sept. 1969, *B.V.Shetty* 32298 (MH); Muthukuzhi vayal, 31st Aug. 1976, *A.N.Henry 48160* (CAL); Maruthuvamalai, 1st Aug. 1977, *A.N.Henry 49513* (MH); Mahendragiri, 2nd Mar. 1989, *N.Mohanan 8100* (TBGT); Nagercoil, Keeripara, 5th Aug. 2000, *Sunojkumar CU49629* (CALI); Keeripara, 23rd Sept. 2001, *Sunojkumar CU49654* (CALI); **Madura Dt**.: Kodaikanal ghat, 7th July 1901, *Bourne 2128* (CAL); Highway wise, 6th Sept. 1925, *K.C.Jacob 17532* (MH); Gavigundumalai, 21st Feb. 1958, *K.Subramanian 5399* (MH); Near Suruli falls, 24th June 1959, *K.Subramanyam 8188* (MH); Ganguvarpatti, 18th June 1961, *K.M.Sebastine 12648* (CAL, MH); **Nilgiris Dt**.: Kilkatagiri shola, 17th Nov. 1970, *E.Vajravelu 36987* (MH); Anaikatty, 15th July 1972, *G.V.S.Rao 40546* (MH); Bimka shola, 21st July 1972, *G.V.S.Rao 40598* (MH); **North Arcot Dt**.: Perumal temple hill, 14th Feb. 1986, *M.B.Viswanathan 1100* (MH); **Ramanathapuram Dt**.: Virusadi Mudaliaruthu, 12th Dec. 1971, *E.Vajravelu 39368* (MH); Karaikudi, 1st Dec. 1977, Gomuki dam site, 18th Jan. 1978, *K.Ramamurthy 52883* (CAL); *N.C.Nair 52993* (MH); Mudaliaruthu, 18th Feb. 1979, *S.R.Srinivasan 60945* (MH); Mudaliaruthu to Virusadi, 18th Feb. 1979, *N.C.Nair &*

S.R.Srinivasan 60945 (CAL); **Salem Dt**.: Kolli hills, 19th Apr. 1978, *A.Mohan RHT13134* (CAL); **South Arcot Dt**.: Gomuki dam site, 18th Jan. 1978, *K.Ramamurthy 52833* (MH); **Tirunelveli Dt**.: Sengaltheri, 15th Feb. 1913, *D.Hooper & M.S.Ramaswami 39208* (CAL); Mancholai, 28th Feb. 1928, *K.M.Sebastine 5447* (MH); Courtalum, 23rd July 1957, *K.Subramanyam 3743* (MH); Kodumadi, 9th Nov.1959, *K.M.Sebastine 9598* (CAL); Sengaltheri, 31st Aug. 1963, *A.N.Henry 17378* (MH); Tirukuramkudi, 17th Feb. 1972, *S.Karthikeyan 40151* (MH); Karumundiyamman temple, 25th Dec.1980, *E.Vajravelu 76462* (MH); Upper Kodayar, 18th May 1986, *N.Mohanan 3446* (TBGT); Courtallum, 19th Nov. 1988, *K.V.Jayakumar 684* (CALI); Upper Kodayar, 17th July 1998, *N.Mohanan 8558* (TBGT); Courtallum, 12th Dec. 1999, *Sunojkumar CU49620* (CALI).

Note: Robert Brown's transfer of *Phlomis biflora* Vahl into *Leucas* (together with other names: *zeylanica, martinicensis, urticifolia, decemdentata, chinensis, indica and glabrata*) was not valid because the combination was not expressively made. (Article **33.1** of Code of nomenclature (St. Louis code, (Greuter et al., 2000), page 51) which say "A combination is not validly published unless the author definitely associates the final epithet with the name of the genus or species or with its abbreviation". Here, Robert Brown's treatment gives only a name under the general title *Leucas*. This is not valid according to this article). Smith made this transfer valid in 1812. Desfontaine's treatment of this as a separate species Leucas *procumbens* and Gamble's treatment as a separate variety under *Leucas biflora* were

mainly due to the leaf shape differences. On examination of different populations from various localities, and plants raised in gardens, it is understood that leaf shape is a polymorphic character, which shows a slight variation in different localities, and there is no stable morphological difference between *Leucas biflora* and *Leucas procumbens*. Original type specimens of both names have been examined before reaching this conclusion.

This plant was collected for the first time by Paul Hermann from Ceylon in pre-Linnaean period and given a polynomial name "*Lamium indicum, foliis oblongis, flore albo graveolens*" in his Museum zeylanicum (1717). Later Johannes Burman treated this in his Thesaurus Zeylanicus (1737) as "*LEUCAS foliis rotundis, serratis, flore albo*". This forms the basis for Robert Brown (1800) to select the name *Leucas* for the genus.

6. Leucas cephalotes (Roth) Spreng., in L., Syst. Veg., ed. 16, II: 743. 1825; Benth. in Wall., Pl. As. Rar. 1: 60. 1830; Labiat. Gen. Spec. 3 (fasc. 6): 616. 1834; Wight, Icon. Pl. India Orient. II: 1. t. 387. 1840; Benth. in DC., Prodr. XII: 532. 1848; Boiss., Fl. Or. 4: 779. 1979; Hook.f., Fl. Brit. India 4: 686. 1885; Cooke, Fl. Bombay Pr. 2: 466. 1906; Prain, Bengal Pl. 856. 1908; Haines, Bot. Bihar & Orissa 4: 750. 1922; Gamble, Fl. Pres. Madras 2: 1150. 1924; Mukerjee, Rec. Bot. Surv. India XIV (1): 168. 1940; Duthie, Fl. Upp. Gangetic Pl. 2: 251. 1960; H.Hara, Fl. East. Him. 277. 1966; J.Venkates. et

al., Fl. Vizakapatanam 163. 1972; J.R.Press in H.Hara et al., En. Pl. Nepal 3: 156. 1982; R.S.Rao et al., Fl. West. Godavari 333. 1986; Sriniv. in A.N.Henry et al., Fl. Tamil Nadu Ser. I. 2: 175. 1987; N.P.Singh, Fl. East. Karnataka 2: 518. 1988; Pullaiah & Yesoda, Fl. Anandapur Dist. 201. 1989; Hedge in Ali & Nasir, Fl. Pakistan 192: 161. 1990; Smith & Darvin in Smith., Fl. Vit. Nova 5: 235. 1991; Pullaiah et al., Fl. Adilabad Dist. 175. 1992; Shu in Zheng-yi & Raven, Fl. China 17: 143. 1994; Pullaiah & B.R.P.Rao, Fl. Nizamabad 283. 1995; Raju & Pullaiah, Fl. Kurnool 381. 1995; K.Lakshmin. et al., Fl. Krishna Dist. 243. 1997; Pullaiah et al., Fl. Medak Dist. 187. 1998; Pullaiah & S.Mohammed, Fl. Ranga Rddi Dist.175. 2000; Pullaiah et al., Fl. Guntur Dist. 287. 2000; V.Singh, Mon. Indian Leucas 53. 2001.

Phlomis cephalotes Roth. Nov. Pl. Sp. 262. 1821; Roxb., Hort. Bengalensis 44. 1814 (*nom. nud*); Fl. India 461. 1832.

—Type: India, Andhra Pradesh, East Godavari Dt., Samilcottah, 12th Nov. 2003, *Sunojkumar CU 88133* (**CALI**; **neotype designated here**)

Leucas capitata Desf., in Mem. Mus. Natl. Hist. Paris 11: 8. t. 4. 1824.

—Type: Ceylon *s. d.*, (holo. **P** !)

Annual herb, erect, 30–45 cm high, profusely branching, basal stem 5–7 mm thick; branches herbaceous, 2–4 mm thick, obtusely quadrangular and centrally grooved, clothed with pubescent deflexed hairs, tender stem below the inflorescence densely ciliate; internodes 5–20 cm long. Leaves opposite, decussate, petiole 0.5–1.5 cm long, pubescent; lamina 5–9 cm long, 1.2–2.8 cm broad, papery, elliptic to

elliptic lanceolate, sub-acute, base cuneate, margin serrate with 9–12 teeth, secondary veins 4–5, thick, pubescent, mixed with long hirsute hairs on the lower surface and margins, upper softly pubescent, glandular punctate. Inflorescence terminal, comparatively large, 2–3.5 cm in diameter, dense globose cluster, many flowered. Bracteoles many, 13–14 mm long, 4–4.5 mm broad, membraneous, lanceolate, foliaceous with a distinct midrib and lateral veins, recurved, imbricating, form involucre below the inflorescence, tip acute, hispid on abaxial side margin ciliate. Flowers ±1 mm long pedicellate. Calyx tubular, straight, anterior side 9 mm log, posterior 8–8.5 mm, upper half outside prominently ribbed, reticulate, hispid 1–1.5 mm long scattered hairs, lower half glabrous, inside upper half hispid, mouth semi oblique, thick annular veins present at the rim, ciliate, hairs erect; teeth 10, sub-equal, 1.25–1.5 mm long, 0.3 mm broad at base, almost the same size of mouth cilia, spinulose, erect, hispid; fruiting calyx much elongated, up to 18 mm long, 5 mm wide, bulged at middle above the nutlets. Corolla fully white ±17 mm long, tube 9 mm long, fully included in the calyx, inside at half length annulate with a ring of fleshy hairs; lower lip 8 mm long, middle lobe 6 mm broad at free end, lateral lobes oblong, 1.5 mm broad at free end, margin revolute; upper lobe white, 5 mm long, concave shaped, outside white hairy, margin ciliate with long hairs, anterior most hairs with blackened tips. Stamens included within upper lip of corolla; upper pair shorter than lower; filaments hairy; anther lobes 1.2 mm long, 0.55 mm broad, almost twice longer than broad, theca almost confluent. Disc cup shaped, 4 elongated lobes, each ±0.75 mm long. Ovary 1 mm high, top rounded. Style ±12.5 mm long, apex bended; stigma unequally lobed, lower lobe 0.7 mm long, upper 0.06

mm broad. Nutlets 3.5 mm long, 1.25 mm broad, oblong, brownish, smooth, top triangular and rounded obtusely triangular in cross section or almost rounded.

Vernacular names: Dronapushpi (Sans.), Tumba, Tumbakeera (Tam.), Tummi (Tel.).

Etymology: The species name seems to be derived from the latin term "*cephalus*" means head. (*cephalotus* = having a head) Probably referring to the head shaped inflorescene with many imbricate, foliaceous bracteoles forming an involucre.

Flowering and fruiting: July – December.

Habitat: Weed in cultivated fields, wetlands, open places, roadsides, and railway tracks. Grows well in MSL and up to 200 m.

Distribution: Common in all Indian states, South East Asian and Central Asian countries. In South India it is seen in Andhra Pradesh, Karnataka and Tamil Nadu.

Specimens examined: **ANDHRA PRADESH: Adilabad Dt.**:Dubba, 25th Aug. 1987, *S.Obelesu & S.Prasanna 4834* (SKU); **Anantapur Dt.**: Tadapatri-Bugga, 7th Oct. 1981, *T.Pullaiah & N.Yesoda 430* (MH, SKU); **East Godavari Dt.**: Rajamundry, Samilcottah, 12th Nov. 2003 *Sunojkumar CU 88133* (CALI); **Karimnagar Dt.**: Kodimial, 17th July 1964, *G.V.S.Rao 20026* (MH); **Krishna Dt.**: Ganginini, 8th Aug. 1985, *P.Venkanna 5675* (MH); **Kurnool Dt.**: Erramalai hills, Ghani RF, 2nd Dec. 1983, *Pullaiah & P.R.V.Raju 1787* (SKU); Erramalai hills,

Fig. 23: *Leucas cephalotes* Spreng. A. Habit; B. Bracteole; C. Calyx; D. Calyx split open; E. Flower; F. Corolla split open; G. Stamens; H. Pistil; I. Nutlets; J. Disc.

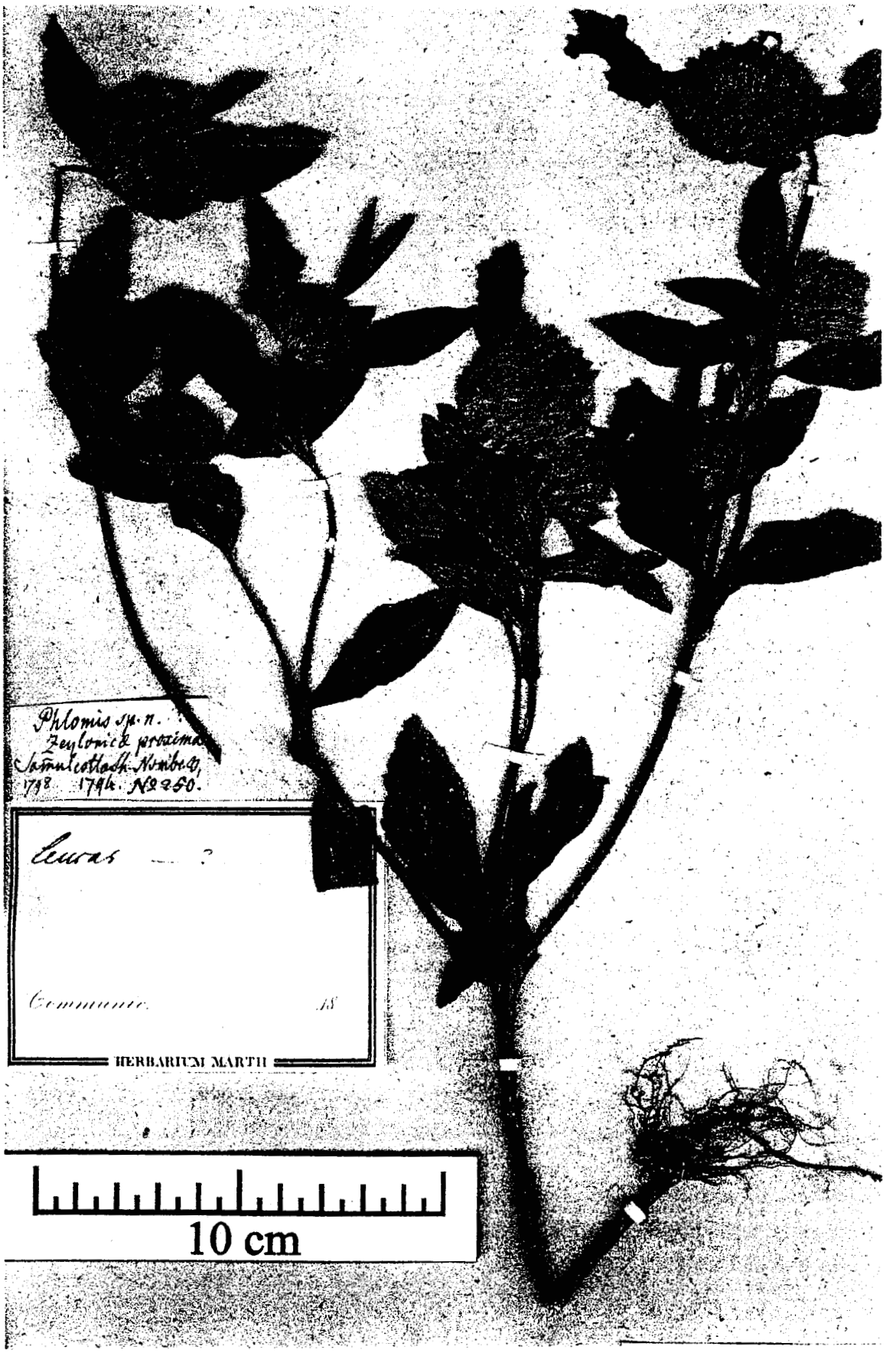


Fig.: 24. *Leucas cephalotes* (Roth.) Spreng. (Roxburgh; herbarium from **BR**)

Ramallakota RF, 4th Dec. 1983, *R.R.V.Raju 1833* (SKU); Vengannabavi plains, 6th May 1984, *A.Ahamed 2071* (SKU); Kammavaripalle, 12th Nov. 1984, *Pullaiah & P.V.Prasanna 2797* (SKU); **Medak Dt.**: Narsapur-Pegarikutta, 23rd Sept. 1958, *K.M.Sebastine 6646* (MH, CAL); Nasarpur RF, 17th Aug. 1994, *Pullaiah & Prabhakar 14027* (SKU); **Nalconda Dt.**: Nagarjunasagar, 12th Dec. 1959, *K.M. Sebastine 9725* (MH, CAL); **Nellore Dt.**: Giddaluir, 9th Nov. 1906, *C.A.Barber 8081* (CAL); **Nizambad Dt.**: Annavan RF, 7th Oct. 1989, *B.R.P.Rao & C.P.Raju 7176* (SKU); **Rangareddi Dt.**: Mekuvaripalle, 19th Aug. 1994, *M.S.Mohammed & Pullaiah 11048* (SKU); **Srikakulam Dt.**: Salur 6th Sept. 1962, *N.P.Balakrishnan 901* (CAL); Donubai near Pubbadaguda, 12th Dec. 1985, *N.R.Rao 83611* (MH); **Vizakapatanam Dt.**: 9th Dec. 1923, *K.C.Jacob 17107* (CAL).

Notes: This species was described by Roth (1821) based on a herbarium collected by Benjamin Heyne from Peninsular India. Sprengel (1825), validly transferred this species from *Phlomis* into *Leucas,* mentioning Roth's specimen as basionym. The original Heyne material was deposited in the general herbarium of Berlin (B), had been destroyed during second World War. Lectotypification of the same was attempted. Except from Kew no other herbaria had Heyne's supposed duplicates. The sheets obtained from K (cibacrome) and BR (photo) which contain the information... '*Phlomis* sps. *zeylanica* proximal Samilicottah, 3rd November 1794' was examined carefully. The sheet also contains Heyne's name and character description as..... "petiolate, lanceolate, remote serrate, obtuse leaves, imbricate bracts and 10 equal teeth". But there are still a few major differences between the

protologue desription and the description on the sheet. Protologue says leaves are *'grosse serratis'* not remote serrate, leaf shape is *ovali-lanceolatis* rather than *lanceolate*. Due to these differences and since there is no hundred percent confirmation that these are the specimen collected by Heyne and observed by Roth while describing the species, it is decided to go for neotypification.

For a neotype, I have selected a specimen collected from Samilcottah, a small village near Rajamundry in East Godavari district in Andhra Pradesh. This specimen was collected as there is information about 'Samilcottah' on the one sheet I obtained from Kew herbarium. This specimen is hereby designated as the neotype and the same is deposited in Calicut University Herbarium (CALI).

This species is found in many Indian states and is commonly considered as the source plant of 'Dronapushpi' mentioned in the Ancient Sanskrit literatures. This plant is usually not found in Kerala. But it is found in many research papers and Ph.D dissertations, especially dealing with phytochemistry (Thoppil, 1993) that this is collected from Kerala. On my personal examination of these literatures, photos and the specimens collected, I could see that this is not *Leucas cephalotes* but some other species (*Leucas indica*). This may happened due to false taxonomic identification. This species differ from its close relatives by its head like inflorescence with imbricating foliaceous bracteoles and long straight calyx with oblique mouth. All other related species have bent calyx and linear bracteoles.

7. Leucas chinensis (Retz. ex R.Br.) Benth. in Wall., Pl. As. Rar. 1: 62. 1830; Labiat. Gen. Spec. 3 (fasc. 6): 606. 1834; in DC., Prodr. XII: 524; Hook.f., Fl. Brit. India 4: 681. 1885; Gamble, Fl. Pres. Madras 2:1151. 1924; Mukerjee, Rec. Bot. Surv. Ind. XIV (1): 182. 1940; A.N.Henry et al., Fl. Tamil Nadu Ser. I. 2: 175. 1987; K.M.Matthew, Fl. Cent. Tamil Nadu 403. 1991; Shu in Zheng-yi & Raven, Fl. China 17: 141. 1994; Sasidh. & Sivar., Fl. Trissur Dist. 361. 1999; V.Singh, Mon. Indian Leucas 59. 2001.

Phlomis chinensis Retz., Obs. Bot. 2: 19. 1791

—Type: China, *Retzius, s.n.* (holo. **LUND**)

Blandina chinensis (Retz.) Rafin., Fl. Tellur. III: 88. 1837. —Type: *Phlomis chinensis as above.*

Leucas chinensis var. *lanata* Hook.f., Fl. Brit. India 4: 682. 1885.

—Type: India, Vellyengry hills, April 1850, *Wight, 2165.* (holo. **K** cibachrome !).

Straggling herb, perennial from thick basal stem and root stock, branches long, up to 1 m high, obtusely to acutely quadrangular, not grooved, tomentose, with retrorse hairs; internodes 6–9 cm long, tender branches densely tomentose. Leaves opposite, decussate, petiole 1.5–2.5 cm long, tomentose; lamina, 3–6 cm long, 3–5 mm broad, coriaceous, broadly ovate sometime sub-orbicular, tip obtuse to acute, base truncate to sub-cordate sometime rounded to cuneate, margin crenate or dentate, usually as broad as long, lower side dense tomentose, upper dense pubescent to short tomentose, provided with four lateral veins. Inflorescence few flowered lax clusters in many axils, 3–7 flowers in each clusters, pedicles 2–3.5 mm

long. Bracteoles very few, minute, 2–3 mm long, linear, straight, ciliate, tip filiform. Calyx straight, funnel shaped, tube 10–14 mm long, longitudinal nerves 10, prominently ribbed outside excurrent in teeth, outside tomentose to villous, hairs thin, long, deflexed, inside with a ring of dense long hairs at middle and hispid above, tube abruptly dilated at mouth, 6–8 cm wide; teeth 10, equal sized, 2 mm long, base 1.8 mm broad, broadly triangular and stellately arranged, tip spinulose, densely hairy both side, hairs >1 mm long. Corolla white, 17 mm long; tube 8 mm long, included in the calyx tube, inside middle annulate with a discontinuous ring of fleshy hairs, abaxially little up, laterally bend down, tube dilated at top; lower lip of corolla 9 mm long, middle lobe 7 mm broad, emarginate, almost rounded on both side, lateral lobes 2.5 mm broad, obliquely narrowed at back end, front end overlap with the hind portion of middle lobe; upper lip 6 mm long, base slightly bulged, top bent, concave, dense white hairs outside, margin ciliate. Staminal filaments hairy middle; anthers 0.8 mm long, 0.5 mm broad, slightly longer than broad, bright reddish coloured, almost rounded with confluent theca. Disc cup shaped, abaxial lobe slightly longer, other lobes equal. Ovary locules 0.5 mm high, top rounded, trigonal, shining. Style 15 mm long, bent; stigma bifid, almost equal lobes, lower 0.9 mm long, upper 0.75 mm. Nutlets 1.85 mm long, 1.3 mm broad, black, shining, oblong, top rounded, middle triangular.

Etymology: The species name means 'Chinese *Leucas*'.

Flowering and fruiting: Peak season is from August—December, and occassionally flower in January — March also.

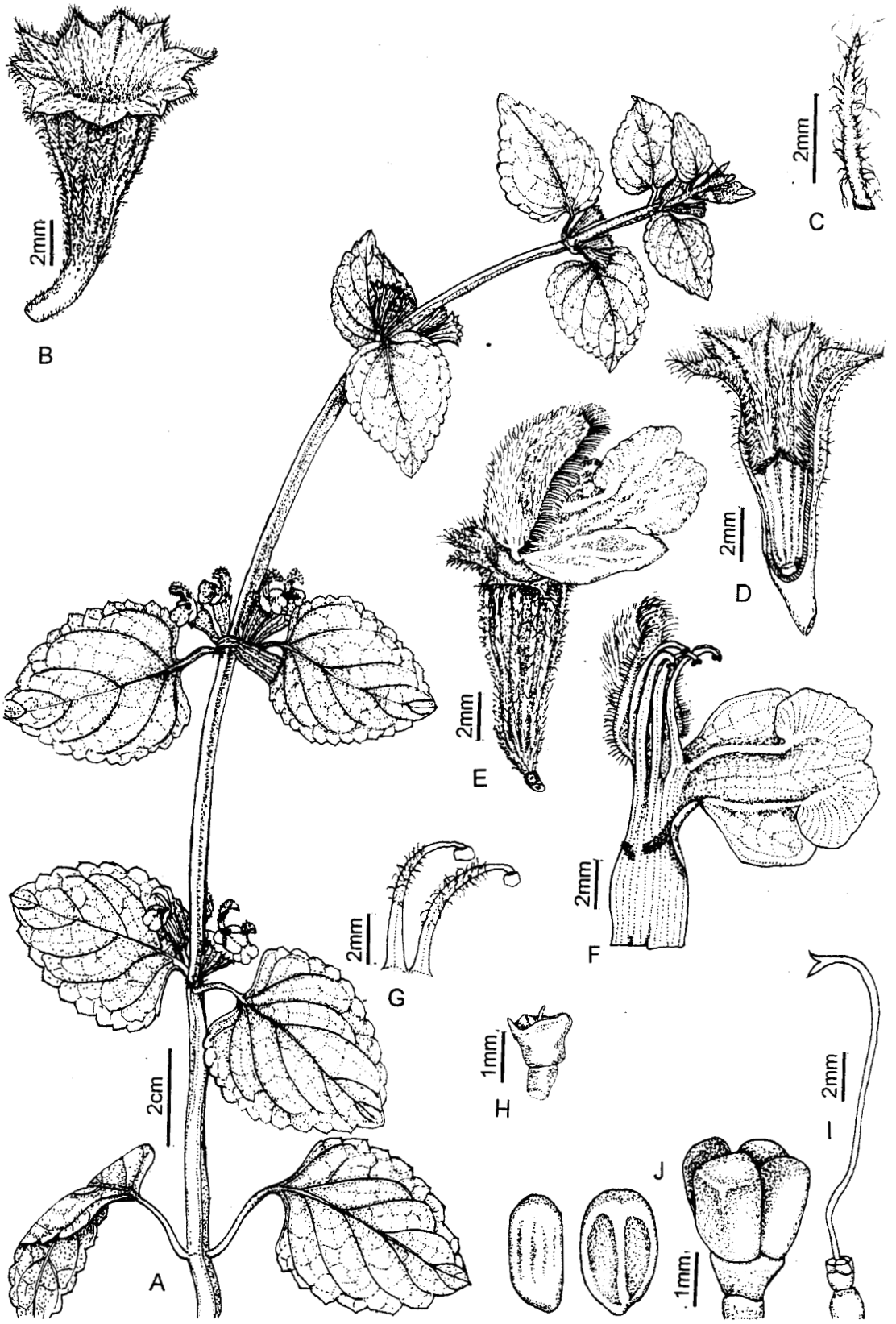


Fig.: **25.** *Leucas chinensis* (R.Br.) Benth. A. Habit; B. Calyx; C. Bracteole; D. Calyx split open; E. Flower; F. Corolla split open; G. Stamens; H. Disc; I. Pistil; J. Nutlets.

Habitat: Found in the semi evergreen forests at an altitude above 800 m and among other bushy herbs. This species prefers cold climate and shady atmosphere.

Distribution: South India and China (disjunct distribution). In South India this is reported only from Southern Western Ghats.

Specimens examined: Peninsular India Orientalis, Oct. 1882, *Wight s.n.* (K); **KERALA:** South Malabar, 25th Jan. 1910, *C.E.C.Fischer 1698* (CAL); **Idukki Dt.**: Upper Vaguvarai, 18th Jan. 2004, *Sunojkumar CU88141* (CALI); **Palakkad Dt.**: Parambikulam, Nov. 1910, *A.Meebold 12379* (CAL); Siruvani near Sadivayi, 2nd July 1963, *K.N.Subramaniam 774* (FRC); Siruvani, Adivaram, 13th Aug. 1960, *A.N.Henry 270* (MH); Thannipallam, 4th Sept. 1960, *A.N.Henry 550* (MH); Nelliampathy, Seetharkundu, 26th July 1990, *N.Sasidharan 5673* (KFRI); Parambikulam, Thunakkadavu, Nov. 2002, *P.S.Sujanapal 19022* (KFRI); Nelliampathy, Victoria Kurisumala, 18th May, 2000, *Sunojkumar CU49626* (CALI); 31st May, 2001, *Sunojkumar CU49650* (CALI); **Trissur Dt.**: Parambikulam, 22nd Nov. 1962, *K.M.Sebastine 15309* (MH); Thunakadavu, 28th Oct. 1964, *K.M.Sebastine 22375* (MH); Ponmudi, 17th Jan. 1989, *N.Sasidharan 5270* (KFRI); Sholayar, 21st Mar. 1989, *N.Sasidharan 5356* (KFRI); **TAMIL NADU: Coimbatore Dt.**: Poonachi Anamalais, 10th Oct. 1901, *C.A.Barber 3687* (MH); Karadimalai, 31st July 1919, *S.R.Raju & Ratnavelu 18662* (CAL); Vellanigiri hills, 23rd Feb. 1932, *J.Joseph 12732* (MH); Siruvani 18th Dec. 1956, *K.Subramanyam 1789* (MH); Attakatti, 6th July 1961, *J.Joseph 12732* (CAL); Anamodamalai, 31st Aug. 1962, *C.P. Sreemadhavan CPS146* (MH); Karappurayan hills 29th Mar. 1963,

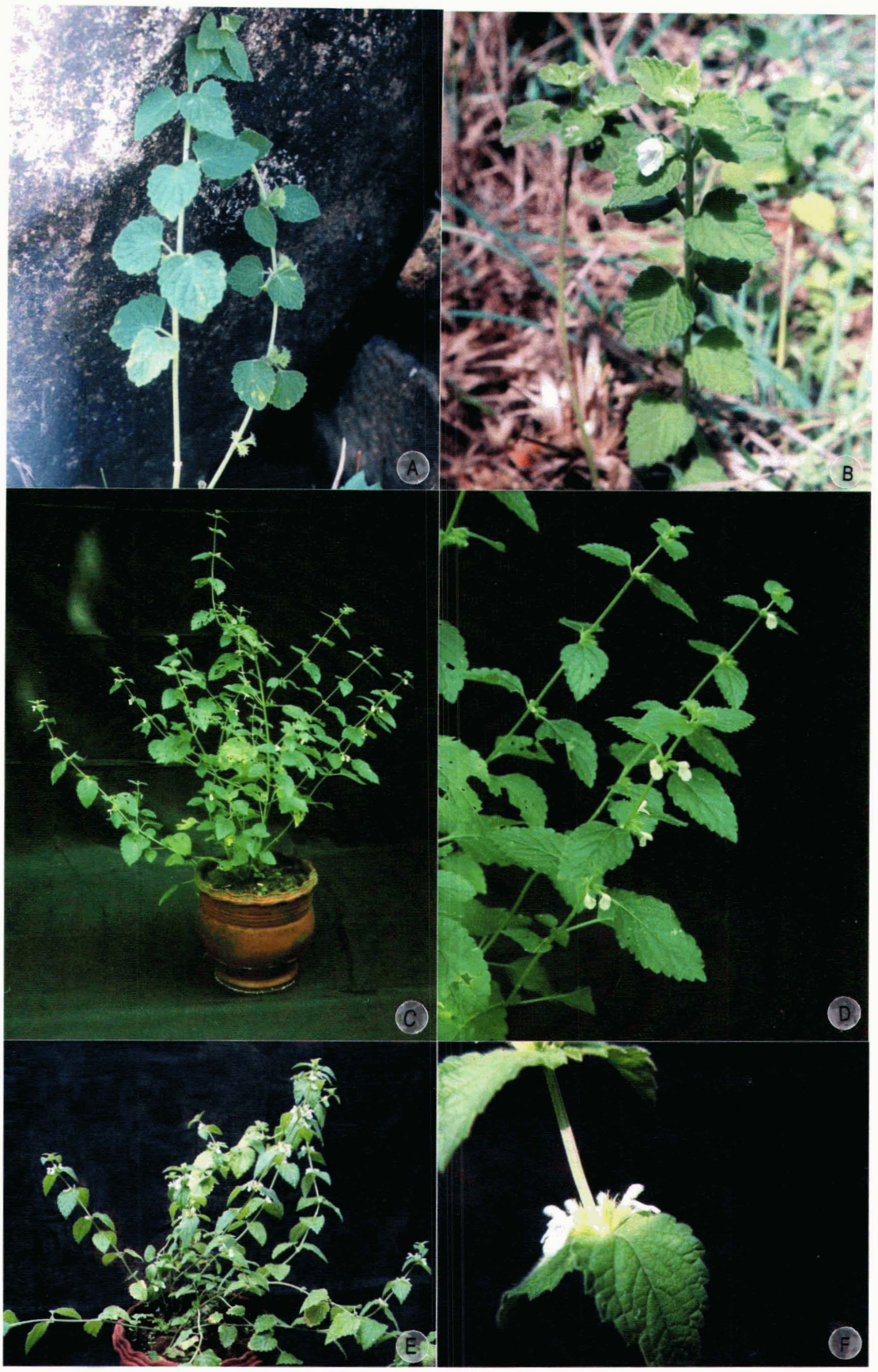


Fig. 26: A-B. *Leucas chinensis* Benth.; C-D. *Leucas decemdentata* Sm. var. *decemdentata*; E-F. *Leucas decemdentata* var. *sebastiana* V.Singh.

C.P. Sreemadhavan CPS526 (MH); Siruvani, 24th Oct. 1968, *D.B.Deb 31086* (MH); Attakatti, 24th July 1978, *M.Chandrabose 57274* (MH); **Madurai Dt.**: Kodaikkanal Ghat, 21st July 1901, *Bourne 2072* (MH).

Notes: Hooker treated a variety for this species due to the wooly nature of the stem and leaves. This specimen is collected from Ramakkalmedu area in Idukki district. Type specimens of both were compared with original specimen. Since no floral character difference is noticed, it is decided not to separate this as a distinct variety, rather treated as ecophenotypes. The occurrence of this species in Southern Western Ghat area and in China may be due to a disjunct nature of distribution.

8. Leucas decemdentata (Forst. ex Willd.) R.Br. ex Sm. in Rees, Cycl. XX. 1812; Benth., Labiat. Gen. Spec. 3 (fasc. 6): 609. 1834; in DC., Prodr. XII: 526. 1848; Smith & Darwin in Smith, Fl. Vit. Nova 5: 237. 1991; V.Singh, J. Econ. Taxon. Bot. 22: 2. 388. 1998; Mon. Indian Leucas 67. 2001.

Phlomis decemdentata Willd., Sp. Pl. 3: 124. 1800.

—Type: *Willd. s.n.* (holo. **B** digital photo. !).

Stachys decemdentata Forst.f., Fl. India Australia Prodr. 91. 1786.

—Type: Australia, Queensland, Near Endeavour river, 17th June – 3rd August, 1770. *Joseph Banks & Daniel Solander, s. n.* (holo. **BM** !).

Ballota pilosa Lour Fl. Cochinch. 364. 1790. —Type: *Stachys decemdentata* as above.

Leucas decemdentata R.Br., Prodr. 504. 1810.

Leucas flaccida R.Br. Prodr. 505. 1810; Sm. in Rees, Cycl. XX: 1812; Benth., Labiat. Gen. Spec. 3 (fasc. 6): 609. 1834; in DC., Prodr. XII: 526. 1848; Miq., Fl. India Bat. 2: 979. 1859; Benth., Fl. Australia 5: 90. 1870; Hook.f., Fl. Brit. India. 4: 684. 1885; Warb., Bot. Jahrb. 13: 425. 1891; K.Sch & Laut, Fl. Schutzgeb 528. 1900; Mansfield, Bot. Jahrb 62. 378. 1929; Mukerjee, Rec. Bot. Surv. India. XIV (1): 179. 1940; Keng, Gard. Bull. Sing. 24: 107. 1969; Sriniv. in A.N.Henry et al., Fl. Tamil Nadu. Ser. I. 2: 176. 1987.

—Type: same as that of *Stachys decemdentata* above.

Phlomis moluccana Roxb., Hort. Beng. 95. 1814 *nom. nud.*; Fl. India 462. 1832.

—Type: India, Bengal, *Roxburg 2650* (holo. **BR** photograph !) .

Phlomis pilosa Roxb., Hort. Beng. 43. 1814. *nom. nud*; Fl. India 462. 1832.

—Type: India, Bengal, *Roxburg s.n.* (holo. **BR** photograph !).

Leucas stachyoides Spreng. in L., Syst. Veg. ed. 16. II: 743. 1825

—Type: as that of *P. decemdentata* above

Phlomis chinensis (*non* Retz.) Blume, Bijdr. 829. 1826

—Type: *Blume 2187 non. vidi.*

Leucas melissaeflora Benth. in Wall., Cat. No. 2062. 1829.

—Type: India, Irawaddi, *s. coll.*, Wall., Num. *2062* (holo. **K** microfiche !)

Leucas melissaefolia Benth. in Wall. Pl. As. Rar. 1: 62. 1830.

—Type: India, Irawaddi, *s. coll.*, Wall., *2062* (holo. **K** microfiche !).

Leucas parviflora Benth. in Wall., Pl. As. Rar. 1: 62. 1830.

—Type: India, Irawaddi. *s. coll.*, Wall., Num *2061* (holo. **K** microfiche !).

Leucas mollissima Benth. in Wall., Pl. As. Rar. 1: 62. 1830; Labiat. Gen. Spec. 3 (fasc. 6): 607. 1834; in DC., Prodr. XII: 525. 1848; Hook.f., Fl. Brit. India. 4: 682. 1885; Cooke, Fl. Bombay Pr. 2: 468. 1906; Merr. & Rolef, Philip J. Sc. 5: Bot. 381. 1910; Haines, For. Fl. Chota Nagpur 493. 1910; Merr., En. Philip. 3: 411. 1923; in Trans. Am. Phil. Soc. 24: 2. 339. 1935; Hend, J. Mal. Br. As. Soc. 17: 66. 1939; Mukerjee, Rec. Bot. Surv. India XIV (1): 184. 1940; Keng, Gard. Bull. Sing. 24: 106. 1969; Nasir & Ali, Fl. W. Pakistan 616. 1972; Gandhi in C.J.Saldanha & Nicolson, Fl. Hassan Dist. 504. 1976; R.R.Rao & Razi, Syn. Fl. Mysore Dt. 512. 1981; L.H.Cramer in Dassan. & Fosberg, (eds.) Rev. Handb. Fl. Ceylon 3: 185. 1981; J.R.Press in H.Hara et al., En. Fl. Pl. Nepal 3: 157. 1982; R.S.Rao et al., Fl. W. Godavari 334. 1986; J.L.Ellis, Fl. Nallamalais. 332. 1990.

—Type: Pundua Hills, December 1824, *s. coll.* Wall. Num. *2054/2* (holo. **K** cibachrome!); Nepal, Nag Arguton, 1821, *s. coll.*, Wall. Num. *2054/1* (iso. **K** cibachrome !).

Leucas pilosa Benth. in Wall., Pl. As. Rar. 1: 62. 1830; in DC., Prodr. XII: 526. 1848 (incl. var. *pubescens*); Hook.f., Fl. Brit. India 4: 683. 1885; Mukerjee, Rec. Bot. Surv. India XIV (1): 179. 1940

—Type: India, Irawaddi, no. 256, *s. coll.*, 1826, Wall. Num. 2058 (holo.**K** microfiche !; iso. **CAL** !).

Leucas javanica Benth, Labiat. Gen. Spec. 3 (fasc. 6): 611. 1834; Hassk, Cat. Hort. Bog. 133. 1844; in Zoll. Nat. Geneesak. Arch. N. 1. 2: 591. 1845, incl. var. *littoralis* Zoll.; Benth. in DC., Prodr. XII: 528. 1848; Miq., Fl. India Bat. 2: 980. 1859. incl. var. *horsfieldiana* Miq., Back. & Back.f., Fl. Java 2: 622. 1965; Keng, Gard. Bull. Sing. 24: 105. 1969.

—Type: as *Phlomis chinensis* above

Isodoea flaccida (R.Br.) Rafin., Fl. Tell. 3: 88. 1836.

—Type: *Leucas flacida* R.Br. as above.

Leucas flaccida var. *petiolaris* Benth., Fl. Australia 5: 90. 1870.

Leucas mollissima var. *scaberula* Hook.f., Fl. Brit. India 4: 682. 1885; Gamble, Fl. Pre. Madras 2: 1151. 1924; Mukerjee, Rec. Bot. Surv. India XIV (1): 184. 1940; J.R.Press in H.Hara et al., En. Fl. Pl. Nepal 3: 157. 1982; K.M.Mathew,. Fl. Cent. Tamil Nadu 404. 1991; Raju & Pullaiah, Fl. Kurnool Dist. 382. 1995; K.Lakshmin. et al., Fl. Krishna Dist. 244. 1997.

—Type: India, Khasiya mts. *s.col. 230.* (holo. **K** cibachrome !).

Leucas montana var *mollissima* Haines, Bot. Bihar & Orissa 4: 748. 1922.

—Type: as that of *Leucas mollissima* var. *scaberula* above.

Leucas montana var *pilosa* Haines, Bot. Bihar & Orissa 4: 749. 1922.

—Type: India, Rajmahl, 7th Aug. 1820, *s.col. s.n.*, Wall. Num. *2058 β* (holo. **K** cibachrome !).

Leucas flaccida var. *scaberula* Duthie, Fl. Upp. Gang. Pl. 2: 115. 1960; A.N.Henry et al., Fl. Tamil Nadu Ser. I. 2: 176. 1987; Pullaiah & Moulali, Fl. Andhra Pradesh 2: 770. 1997.

—Type: as that of *Leucas mollissima* var. *scaberula* above.

a. var. **decemdentata**

Erect herb, perennial from thick and woody basal stem and rootstock, branches long and erect, 1–1.5 m long, obtusely quadrangular, not grooved, covered with retrorse pubescent hairs, internodes up to 12 cm long. Leaves opposite, decussate, petiolate; petiole 2–3.5 cm long, pubescent; lamina 5–10 cm long, 3–6.5 cm broad, membraneous, ovate to ovate lanceolate, obtuse to cuneate at base, acute to obtuse tip, margin crenate to serrate with 9–10 teeth, 4–5 lateral veins, prominent on lower side, dense pubescent, upper glabrous to minute pubescent. Inflorescence many, axillary lax clusters, 2–9 flowered, sometime many flowered. Bracteoles few numbered, 2–6 mm long, base 0.2 mm broad, smaller than calyx, erect, loosely arranged, filiform dense hairy. Flowers pedicellate; pedicels 0.5–1.2 mm long (slightly enlarged in fruit). Calyx tubular campanulate, straight, 6–7 mm long, longitudinally ribbed along the veins, pubescent outside, glabrous inside, mouth straight, not ciliate; teeth 10, almost equal, 1.5–2 mm long, straight, triangular, tip pointed, base broader, provided with hairs. Corolla white, 16 mm long; tube 8 mm long, slightly bent forward, half included in the calyx tube, above slightly hairy, inside at half length annulate with a ring of hairs, abaxially little raised, laterally bent down; lower lip 8 mm log, middle lobe margin 6.5 mm broad, emarginate almost rounded, side lobes 2 mm broad, oblong, free end slightly overlap with middle lobe back side, margin slightly revolute; upper lip slightly broadened at base, bent towards tip, slightly notched at the anterior tip, concave, outside white hairy,

margin ciliate. Stamens fully included in the upper lobe, upper pair short, filaments middle hairy; anthers reddish coloured, 1 mm long, 0.5 mm broad, with confluent theca. Disc cup shaped, four lobbed, abaxial lobe slightly longer than other lobes. Ovary 1 mm high, trigonal, above flat and concave. Style 12.5 mm long, bent above, stigma unequally 2 lobbed, lower lobe 0.9 mm long and bent, upper lobe 0.2 mm long. Nutlet 1.5 mm long, 1mm broad, dark brown coloured, acutely trigonal at middle, top slightly concave, with a distinct margin, base obliquely narrowed.

Etymology: The species name *decemdentata* means 'ten toothed' in Latin.

Flowering and fruiting: Flowers from May—January; peak flowering season: September—December

Habitat: Found in deciduous forests, near cultivated areas, sandy or stony soils, in Eastern Ghats and Deccan regions; up to 1000 m from sea level.

Distribution: Growing in Asian and Australian continents. In Asia it is found in almost all Asian countries. In South India, it is seen in Andhra Pradesh, Karnataka and Tamil Nadu.

Specimens examined: **ANDHRA PRADESH:** Ganjam, Hill in Ramalkwah, Mar 1886, *J.S.Gamble 17066* (CAL); **Cuddapah Dt.**: Rampa hill, July 1914, *M.S.Ramaswami 1513* (CAL); Jyothi RF., 11th Nov. 1988, *D.A.Moulali 8315* (SKU); **East Godavari Dt.**: Mantur, 28th Nov. 1902, *C.A.Barber 4938* (MH); Maredumalai, 21st June 1965, *G.V.S.Rao 62503* (MH); Gollarayi konda Mekalametta, 18th Sept. 1980, *G.V.S.Rao 67534* (MH); Sitharam, Mallamma konda, 19th Sept. 1980, *G.V.S.*

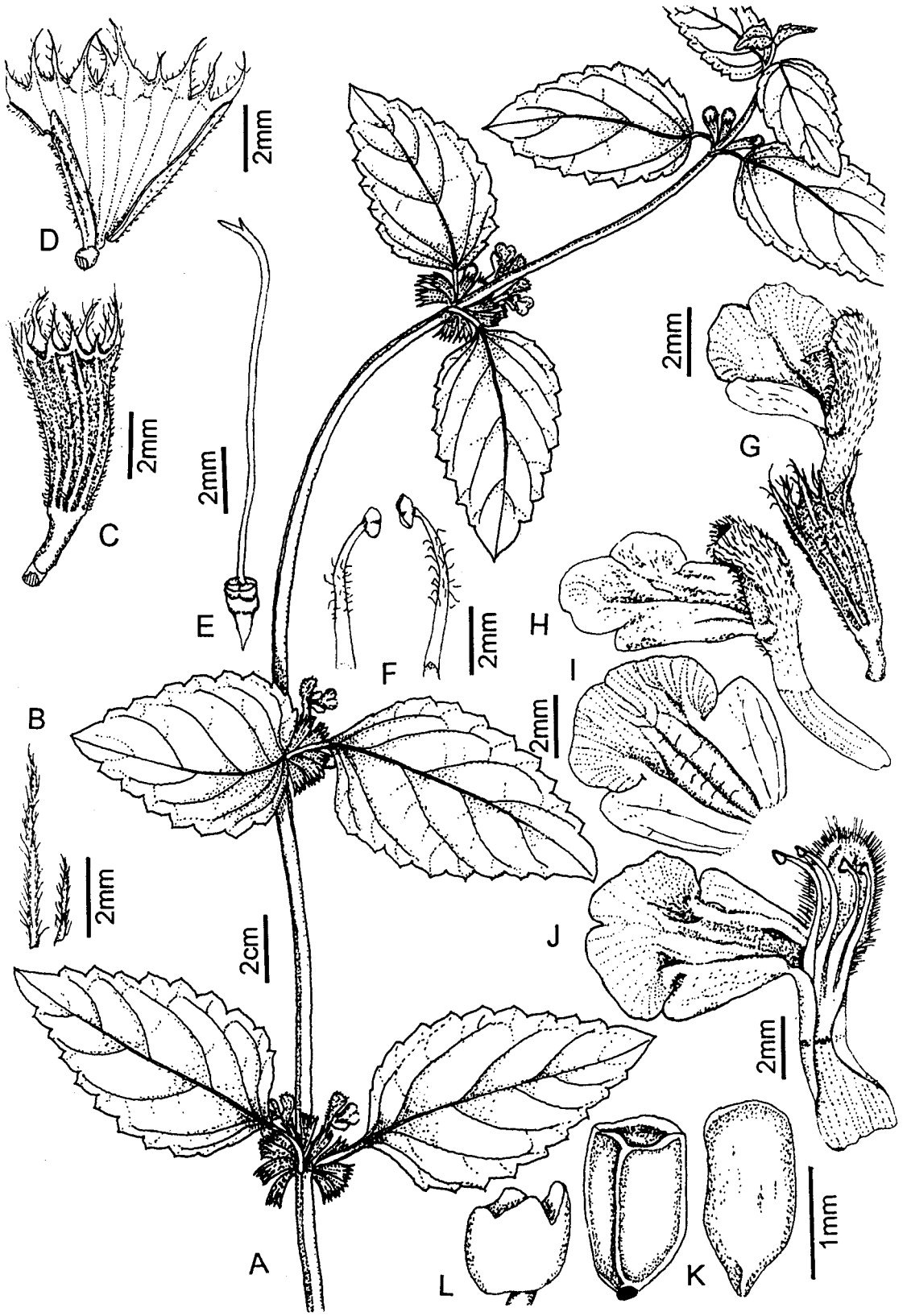


Fig. 27: *Leucas decemdentata* var. *decemdentata* Sm. A. Habit; B. Bractcoles; C. Calyx; D. Calyx split open; E. Pistil; F. Stamens; G. Flower; H. Corolla; I. Corolla lower lip; J. Corolla split open; K. Nutlets; L. Disc.

Fig. 28: Type specimen of *Leucas decemdentata* Sm. var. *decemdentata* (Herbarium J. Banks & D. Solander, 1770 s.n.; from BM)

Rao 67579 (CAL); Kallamamidi RF., 25th Sept. 1980, *G.V.S.Rao 68560* (CAL); **Kurnool Dt**.: Nellamalaias, Way to Ramanapenta, 25th Oct. 1964, *J.L.Ellis 22203* (MH); Nallamalaias, way to Ramanapenta, 28th Nov. 1969, *J.E.Ellis 32649* (MH); Upper Ahobilam, 30th Sept. 1984, *R.R.V.Raju 2757* (SKU); Peddamantanala, 5th Dec. 1984, *R.R.V.Raju & P.V.Prasanna 2359* (SKU); **Srikakulam Dt**.: Salur, 7th Sept. 1962, *N.P.Balakrishnan 985* (CAL); Sunki from Salur, 24th May. 1979, *G.V.S.Rao 62503* (MH); **Vizakapatanam Dt**.: Krishnapuram, Jun. 1900, *C.A.Barber 2005* (MH); Bara konda RF., 9th Dec. 1923, *K.C.Jacob 17127* (MH); Arakuvalley, 23rd Aug. 1960, Arakuvalley, 15th Sept. 1961, *N.P. Balakrishnan 594* (CAL); *N.P.Balakrishnan 10741* (MH); Simhachalam, 31st Nov, 1963, *D.C.S.Raju 571* (CAL); Anantagiri, 11th May 1964, *G.V.S.Rao 19451* (MH); Madgole to Paderu, 25th August 1966, *G.V.S.Rao 28089* (MH); Minumuluru, 23rd Dec. 1967, *G.V.S.Rao 29615* (MH); S. Kota towards Punyagiri, 23rd Dec. 1969, *G.V.S.Rao 32776* (MH); Anantagiri, 26th Dec. 1969, *G.V.S.Rao 32819* (MH); Lambasingi, 16th Nov. 1970, *J.L.Ellis 37187* (MH); Rayamanupakala, 18th Apr. 1976, *G.V.S.Rao 47390* (CAL); Vizakapatanam, 1st Oct. 2001, *Sunojkumar CU49657* (CALI); Arakuvalley, 24th Dec. 2001, *Sunojkumar CU49682* (CALI); **Warangal Dt**.: Pakhal RF., 28th Nov. 1960, *K.M.Sebastine 11647* (MH); **KARNATAKA: Belgaum Dt**.: Khanapur, 27th Oct. 1978, *C.J.Saldanha KFP3681* (CAL); **KERALA: Palakkad Dt**.: Chindaki forest, 9th Oct. 1965, *E.Vajravelu 26012* (MH); **TAMIL NADU: Coimbatore Dt**.: Ichipalli RF., 13th Aug. 1929. *V.Narayanaswamy 18798* (MH); **Salem Dt**.: Chinnakalrayans, 29th June 1978, *N.Venugopal RHT14500* (CAL); South Arcot Dt.:

Kalrayans, Kallipparai, 13th June 1978, *K.M.Mathew & N.Venuguoal RHT13887* (CAL).

Notes: This taxon was first collected by Sir Joseph Banks from Australia, near Endeavour River and named as *Stachys decemdentata*. While establishing the genus *Leucas*, Robert Brown (1810) described this as a new species *L. flaccida* and mentioned it as the type (as 'T') of this genus. However Willdenovio's *Phlomis decemdentata* published in 1800 is an identical taxa which was proved after examining the types of both names. According to rule of priority, *Phlomis decemdentata* (transferred correctly into *Leucas decemdentata* by Smith in 1812) gets the priority over *Leucas flaccida* as the correct species name and the later forms a taxonomic synonym.

Again according to the Article **10.1** of the Botanical code (St. Louis 2000) which says "The type of a name of a genus or of any subdivision of a genus is the type of a name of a species. For purpose of designation or citation of a type, the species name alone suffices" Thus *Leucas flaccida* can be retained as the type species of the genus.

b.var. **sebastiana** (Subbarao & Kumari) V.Singh, Mon. Ind. Leucas 77. 2001.

Leucas mollissima var. *sebastiana* Subbarao & Kumari, Bull. Bot. Surv. India XI: 3 & 4. 452-453. t. 1-7. 1969; Samaddar & Roy, Addl. Elem. Indian Flora 1: 261.

1997. —Type: India, Andhra Pradesh, Vizakapatanam, Cherukonda, 4th Jan. 1968, *Subbarao & Kumari 29743A* (holo. **CAL** !); *Subbarao & Kumari 29743B–N* (iso. **MH** !)

Leucas flaccida var. *sebastiana* (Subbarao & Kumari) P.Ramarao, J. Econ. Taxon. Bot. 12: 378. 1988; Moulali & Pullaiah, J. Bom. Nat. Hist. Soc. 87: 472. 1990; Pullaiah & Moulali, Fl. Andhra Pradesh 2: 770. 1997.

Different from var. *decemdentata*, this variety has distinguishing features as: spreading nature with dense velvetty tomentose stem. Leaves short petiolate; petiole 1–1.5 cm; lamina coriaceous, dense villous, base rounded or cordate. Flowers sessile or very short pedicellate. Calyx densely villous outside and inside upper half pubescent with hairs extend above the mouth. Corolla slightly shorter with 14 mm length, tube straight, 5.5–6 mm long, fully included in the calyx.

Etymology: The variety is named in honour of late Dr. M. K. Sebastine, Regional Botanist, Botanical Survey of India, Coimbatore.

Flowering and fruiting: August–February.

Habitat: Found in deciduous forest openings and among dry scrub jungle plants at an altitude above 900 m. The plant flourishes well when replanted in low land gardens at Calicut.

Distribution: Endemic to Vizakapatanam district of Andhra Pradesh.

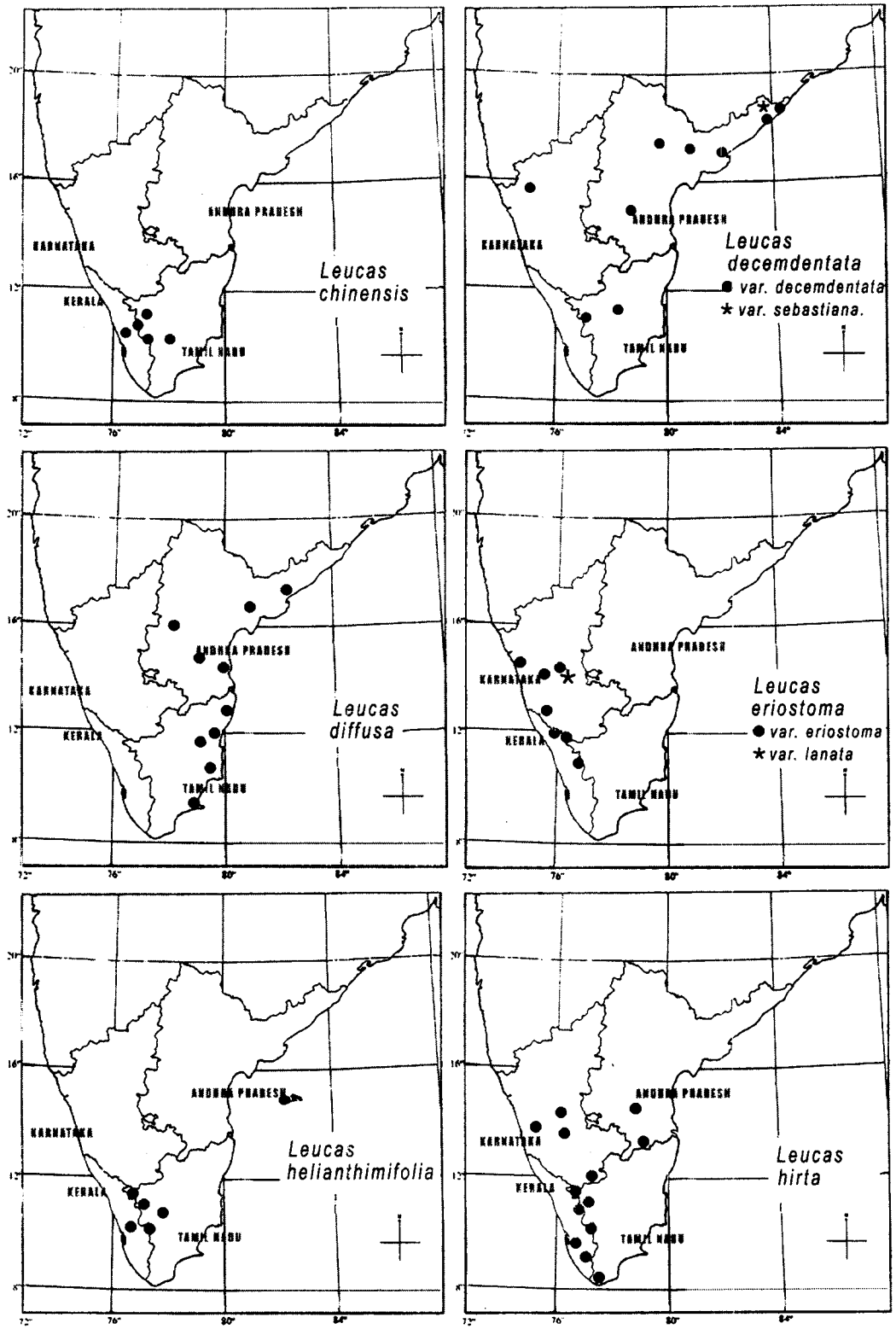


Fig.: 29 Distribution map of *Leucas* species in Southern Peninsular India.

Specimens examined: **ANDHRA PRADESH: Vizakapatanam Dt**.: Minumularii to Kappakonds, 24th Dec. 1967, *Subbarao & Kumari 29633A*–F (MH); Arakuvalley, 2nd Dec. 2002, *Sunojkumar CU49694* (CALI); **KERALA: Calicut Dt**.: Elathur (cultivated), 10th Jan. 2003, *Sunoj kumar 88121* (CAL).

Note: The two varieties can be identified based on the key given in chapter 4.4.c in the 'Key to the species' part.

9. Leucas diffusa Benth., Labiat. Gen. Spec. 3 (fasc. 6): 615. 1834; in DC., Prodr. XII: 531. 1848; Hook.f., Fl. Brit. India 4: 689. 1885; Gamble., Fl. Pres. Madras. 2: 1150. 1924; Mukerjee, Rec. Bot. Surv. India XIV (1): 171. 1940; A.N.Henry et al., Fl. Tamil Nadu Ser. I. 2: 175. 1987; N.P.Singh, Fl. East. Karnataka 2: 518. 1988; Pullaiah & Moulali, Fl. Andhra Pradesh 2: 770. 1997; K.M.Mathew, Ex. Fl. Cent. Tamil Nadu 403. 1999; Pullaiah et al., Fl. Guntur Dist. 287. 2000; V.Singh, Mon. Indian Leucas 80. 2001.

—Type: *Phlomis diffusa* India, near Madras, Herbarium Rottlerianum, *604* (holo. **K** cibachrome !)

Phlomis dimidata Roth, Nov. Pl. Sp. 260. 1821.—Type: same as above

Phlomis zeylanica sensu Roth, Nov. Pl. Sp. 260. 1821. *non* L. 1753.

Leucas dimimata (Roth) Spreng. in L., Syst. Veg. ed. 16, II: 744. 1825; Benth. in Wall., Pl. As. Rar. 1: 61. 1830. —Type: same as above.

Fig. 30: Type specimen of *Leucas diffusa* Benth. (Herbarium Rottlerianum 604; from K)

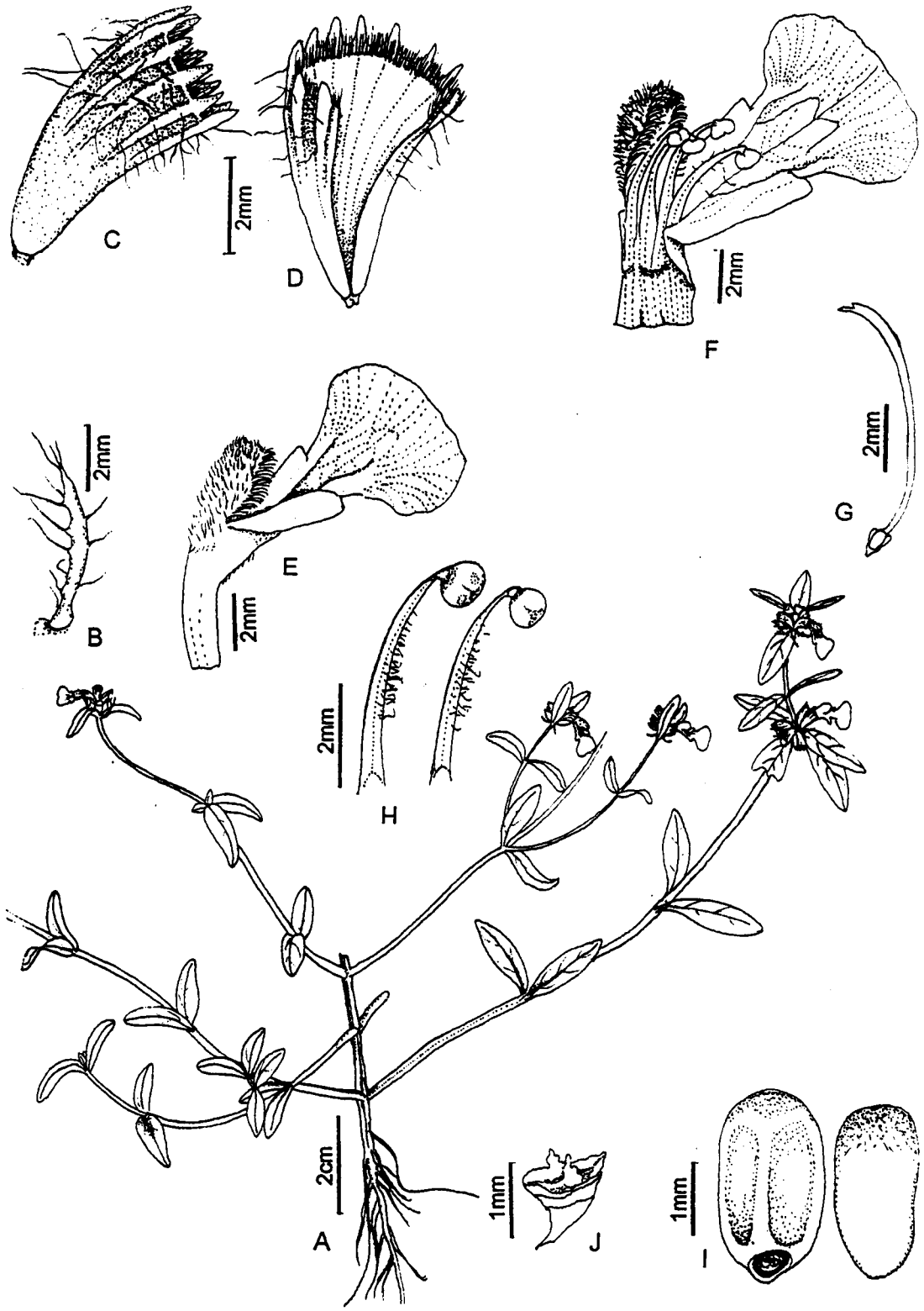


Fig. 31: *Leucas diffusa* Benth. A. Habit; B. Bracteole; C. Calyx; D. Calyx split open; E. Corolla; F. Corolla split open; G. Pistil; H. Stamens; I. Nutlets; J. Disc.

Annual, diffusely branching herb, main stem highly reduced, 2–5 cm high, long tap root, well rooted on the ground; branches spreading, 10–20 cm long, 1.5–2.5 mm thick, quadrangular, grooves not prominent, pubescent with retrorse hairs; internodes in main stem 2–3.5 mm long, in branches 5–21 cm long. Leaves opposite, decussate; petiole up to 2 mm long, sometime sessile, pubescent; lamina coriaceous, 1.5–3.5 cm long, 3–7 mm broad, 3–4 times longer than broad, linear to linear-oblong, base narrowed to cuneate, tip obtuse, margin entire, upper side hispid with sparse hairs turned towards the tip, below softly pubescent, glandular, veins projecting beneath. Inflorescence terminal solitary, sometimes up to 2–3 nodes, few flowered clusters, 1–1.5 cm across, each subtended by a pair of bracteate leaves. Flowers sessile to 1 mm long pedicellate. Bracteoles few numbered, ±5 mm long, 0.5 mm broad, slightly recurved, as long as calyx, linear, stiff, ciliate with 1–1.5 mm long hairs, tips acute. Calyx tubular, adaxial side 5.5 mm long, abaxial side 4.5 mm, base narrowed, upper half ribbed along the veins, outside fully pubescent with very small hairs, intermixed with hispid, 1–1.5 mm long stiff hairs, tube inside glabrous, mouth, truncate, not oblique, rim annulate with a thick ring of veins, ciliated with long silvery hairs turned towards the middle of mouth and closing it partially, teeth 10, sub equal, 0.6–0.7 mm long, 0.3 mm broad, equal to mouth cilia; fruiting calyx slightly larger. Corolla white colored, 14–14.5 mm long; tube 5.5 mm, included in the calyx tube, above outside hairy, inside annulated with a discontinuous ring of fleshy hairs; lower lip 9 mm long, obliquely attached, middle lobe fan shaped, 7 mm broad, side lobe oblong, 1.5 mm broad at free end, margin slightly revolute; upper lip 4 mm long, concave, outside dense white hairy, margin ciliate, anterior most hair

tips slightly black coloured. Staminal filaments hairy, anthers ±0.9 mm long, ±0.6 mm broad with confluent theca. Disc cup shaped, four almost equal lobes. Style ±7.5 mm long, slightly bent; stigma bilobed, lower lobe 0.54 mm long, upper lobe reduced 0.06 mm. Nutlet ±2.1 mm long, ±1 mm broad, base narrowed, oblong, light brown coloured, middle obtusely triangular, upper rounded, with few eglandular hairs.

Etymology: Species name denotes 'diffuse habit' of the plant.

Flowering and fruiting: September—February.

Habitat: Plant found growing as a weed among small grasses in waste places; sea level to 100 m. altitude.

Distribution: Indian endemic plant. Found in the Eastern ghat and Deccan regions of Andhra Pradesh and Tamil Nadu.

Specimens examined: **ANDHRA PRADESH: Cuddapah Dt.**: Gunjana river side, 9th Nov. 1962, *J.L.Ellis 14972* (MH); Balapalle, 10th Nov. 1962, *J.L.Ellis 14988* (MH); Balapalli, 22nd Feb. 1963, *J.L.Ellis 15755* (CAL); **East Godavari Dt.**: Indrapalam-paddy fields, 25th Dec. 2001, *Sunojkumar CU 49684* (CALI); **Guntur Dt.**: Nizampatanam, 15th Apr. 1988, *V.Ramakrishnaias 6815* (SKU); **Kurnool Dt.**: Erramalai hills, Owk RF, 27th Feb. 1984, *R.R.V.Raju 3029* (SKU); **Nellore Dt.**: Kollurupad, 16th Sept. 1917, *C.E.C.Fischer 4161* (CAL); Ramayapatanam, 26th Jan. 1929, *K.C.Jacob 18357* (MH); Muttur-east coast, 8th Jan 1989, *D.A.Moulali 8324* (SKU); **TAMIL NADU: Chennai Dt.**: Madras beach, Oct. 1932, *K.N.Iyer s.n*

(TBGT); **Chinglepet Dt.**: Vandalur RF, 2nd Oct. 1974, *A.H.Henry 45559* (MH); **North Arcot Dt.**: Tippukadu RF, 22nd Nov. 1963, *K.Ramamurthy 17656* (MH); Veeramakkam, 12th Jan. 1985, *M.B. Viswanathan, 687* (MH); Kundasramam, 15th Nov. 1986, *M.B.Viswanathan 1295* (MH); Veerambakkom, 12th Jan. 1988, *M.B.Viswanathan 687* (CAL); **Ramanathapuram Dt.**: Mandapam, Sumythoppu, 5th Dec. 1977, *N.C.Nair 53106* (CAL, MH); Pamban, 20th Dec. 1986, *V.Balasubramaniam 1002* (MH); Thiruvegampattu, 17th Nov. 1989, *V.Balasubramaniam 2270* (CAL, MH); Sathirakudi, 14th Nov. 1989, *V. Balasubramaiam 2221* (CAL); **South Arcot Dt.**: Marakkanam, 9th Sept. 1977, *K. Ramamurthy 51109* (MH); Chettupattu to Pennathur, 19th Feb. 1979, *K.Ramamurthy* 60320 (CAL, MH); Annamalai Nagar, 31st Jan. 1958, *K.M.Sebastine 5234* (CAL, MH); **Tanjore Dt.**: Point Calimere, 17th Jan. 1961, *J.L.Ellis 11753* (CAL, MH).

Notes: This is a diffusely growing herb with oblong smooth margined leaves. By this feature this plant resembles *Leucas helianthimifolia* Benth. and may be due to this reason, Singh (2001) treated this in his newly created section 'Diffusa' together with *Leucas helianthimifolia, Leucas longifolia* and *Leucas suffruticosa.* However this plant has no other resemblances with either *Leucas helianthimifolia* or *Leucas suffruticosa* and there is wide differences between them. *Leucas diffusa* is an annual herb having the common characters of section 'Plagiostoma', especially in floral characters. The texture of leaves, nature of bracteoles, calyx, colour and shape of corolla are all very similar to that of *Leucas indica, Leucas strica* and other

members of section Plagiostoma. So there is no relevane of the section Diffusa here and treated this species in section Plagiostoma.

10. Leucas eriostoma Hook.f., Fl. Brit. India 4: 686. 1885; Gamble, Fl. Pres. Madras 2: 1154. 1924; Mukerjee, Rec. Bot. Surv. India XIV (1): 176. 1940; Gandhi in C.J.Saldanha & Nicolson, Fl. Hassan Dist. 503. 1976; R.R.Rao & Razi, Syn. Fl. Mysore Dist. 511. 1981; N.P.Singh, Fl. East Karnataka 2: 518 1988; Ramach. & V.J.Nair, Fl. Cannanore, 365. 1988; K.R.K.Murthy & S.N.Yoganara. Fl. Coorg 357. 1990; V.Singh, J. Econ. Taxon. Bot. 22: 2. 388. 1998; Mon. Indian Leucas 82. 2001.

—Type: *Phlomis eriostoma* Peninsular India Orientalis, Wyanad, Manantoddy, Nov. 1835. *Heyne. s.n.* (holo. **K** cibachrome !)

Leucas eriostoma var. *heynii* Hook.f., Fl. Brit. India 4: 686. 1885.

—Type: India, Wyanad, *Heyne s.n.* (holo. **K** cibachrome !)

Leucas eriostoma var. *latifolia* Hook.f., Fl. Brit. India 4: 686. 1885.

—Type: Peninsular India Orientalis, *Wight 2153* (holo. **K** cibachrome !)

a. var. **eriostoma**

Perennial, bushy sub shrub, erect, 20 cm to 160 cm high, stem thick, woody, up to 1 cm thick, often rooting on old stems, tomentose to short velvety with dark green coloured dense hairs, branches obtusely quadrangular, grooved, hispid to tomentose, degree of hairiness varies, lower internodes 1–3 cm, towards tip 4–8 cm,

tender stem tomentose to villous. Leaves opposite, decussate, petiole 2–3 mm long; lamina 6–9 cm long, 1–1.5 cm broad, 5–6 times longer than broad, lanceolate to linear–lanceolate, acute to obtuse tip, base cuneate, narrowed to the petiole, margin serrate with 14–16 teeth, 5–6 secondary veins, prominent at the lower side and provided with hirsute hairs, upper side hispid, veins impressed. Inflorescence globose clusters in upper 3–4 axils, dense and many flowered, 1–2.5 cm across. Bracteoles many, erect, 6–8 cm long, 0.3–0.8 mm broad at base, linear lanceolate, acute, ±0.5 mm long silvery hairs outside, margin ciliate. Flowers pedicellate, pedicels 1 mm long. Calyx tubular, ±6 cm long, 2 cm diameter, cylindrical, straight, narrowed at base, outside upper half prominently nerved, reticulate, hispid, thin papery, lower half glabrous, thick, leathery, inside fully glabrous, mouth straight, annulate with a ring of veins, ciliated with a circle of long dense silvery hairs forming an inverted cone over mouth; teeth 10, almost equal, 0.6–0.8 mm long, almost one third the size of mouth cilia, straight, spinescent, subulate, hairy; calyx in fruiting stage much enlarged, up to 13 mm long, bent in the middle, lower half of adjacent calyx close together and upper half divergent, tube bulged in the middle, above nutlets 3–3.5 mm diameter; mouth slight oblique, tube lower half leathery with longitudinal fibers, teeth elongate up to 1 mm. Corolla white, 10–11 mm long, tube 5.5–6.5 mm long, fully included in the calyx tube, above outside white hairy, inside annulate with discontinuous ring of dense fleshy hairs, above this portion hairy with fleshy hairs in longitudinal rows; lower lip 4–4.5 mm long, broader at the attachment portion than free end, lower portion slightly thickened and provided with white hairs, middle lobe 1.75–2 mm long, 2.5–3 mm broad, emarginate, side lobes

1.5 mm broad, longer than the middle lobe, back side of middle lobe and front side of side lobes overlapping; upper lip 4 mm long, concave, provided with long white hairs outside and ciliate margins. Stames included in the upper lip sometime project after anthesis, lower pair longer, filaments with slender hairs in the middle and dense fleshy hairs at base attachment portion; anthers ±1.1 mm long, ±0.3 mm broad, reddish coloured, theca confluenta. Disc cup shaped, abaxial lobe slightly longer than the other lobes. Ovary locules ±0.6 mm long, above rounded and smooth. Style 7–7.2 mm long, bent; stigma unequally bi-lobbed, lower lobe 0.36 mm long, upper lobe minute. Nutlets 2.1 mm long, 0.9 mm broad, oblong, cylindrical, dark brown coloured, smooth and shining, middle obtusely triangular, top rounded.

Etymology: The species name eriostoma may be derived from the latin term '*erio*' means woolly. Probably due to the woolly nature of plant.

Flowering and fruiting: October–February.

Habitat: Usually found in the shady margins of semi evergreen forests, open areas and waste places; above 800 m.

Distribution: Endemic to South India, on Southern Western ghat in Kerala, Tamil Nadu and Karnataka states.

Specimens examined: **KARNATAKA: Shimoga Dt.**: Agumbe, 28th Nov. 1983, *K.Shanthi 1032* (CALI); **South Canara Dt.**: Thalakkavery, 5th Nov. 1981, *S.R. Srinivasan 72330* (MH); Thalakavery, 28th Dec. 2001, *Sunojkumar CU49648* (CALI); Nagodi on the way to Kudachatri, 12th Oct. 2000, *Sunojkumar 49635*

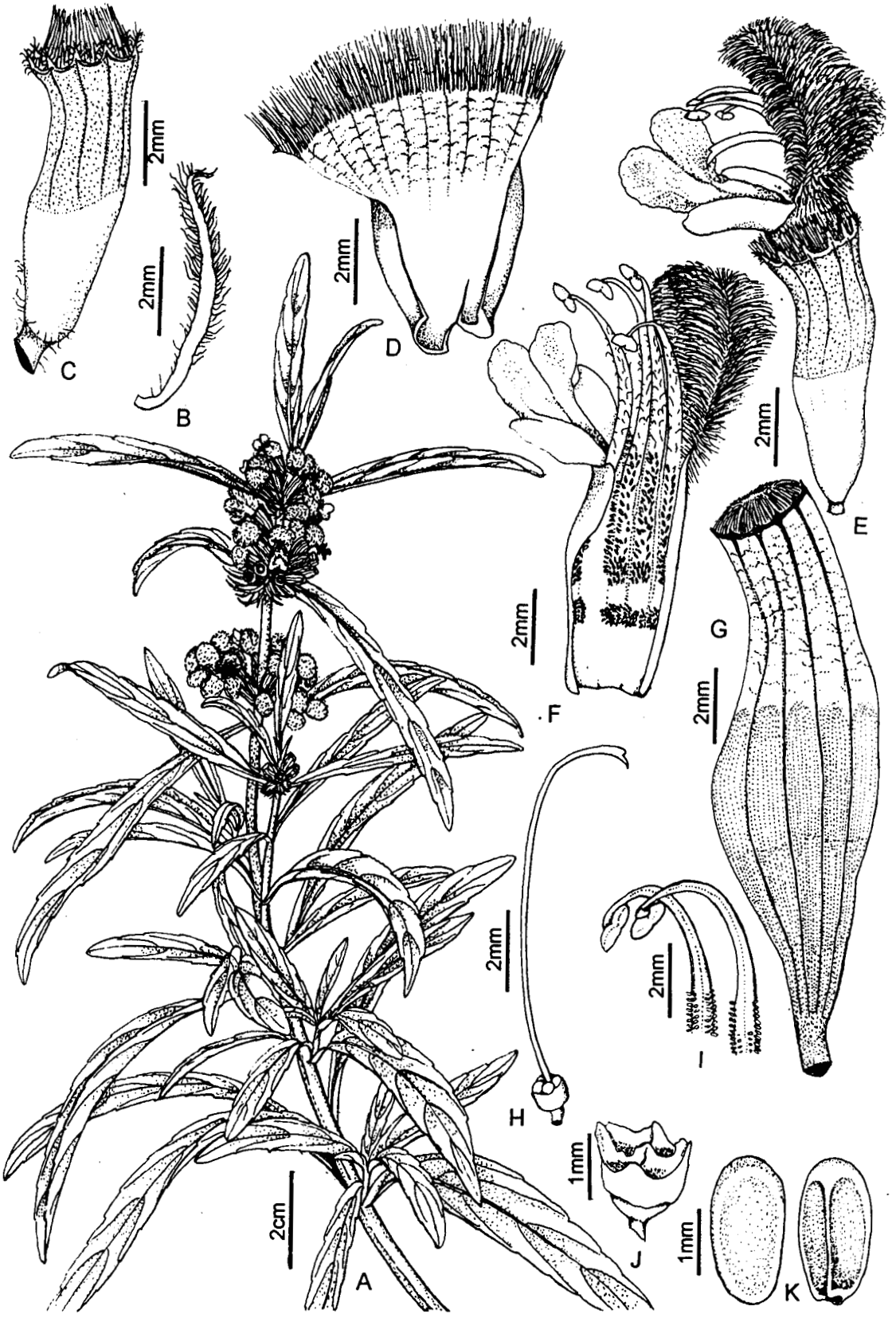


Fig. 32: *Leucas eriostoma* var. *eriostoma* Hook.f. A. Habit; B. Bracteole; C. Calyx; D. Calyx split open; E. Flower; F. Corolla split open; G. Calyx at seeding stage; H. Pistil; I. Stamens; J. Disc; K. Nutlets.

(CALI); Kudachatri, 12th Dec. 2003, *Sunojkumar CU88124* (CALI); Jersopa riverside, 26th Dec. 2003, *Sunojkumar CU88138*; **Udupi Dt.**: Kollur, 28th Oct. 1990, *T.Razee 2867* (CALI); **KERALA: Kannur Dt.**: Chandanathodu, 8th Nov. 1978, *V.S.Ramachandran 58603* (MH); Brahmagiri, 6th Mar. 1979, *V.S. Ramachandran 62139* (MH); Chunda, Theerthundamalai, 24th Feb. 1979, *V.S.Ramachandran 61375* (MH); **Palakkad Dt.**: Way to Palghat, 6th Mar. 1984, *N.C.Nair 70584* (MH); **Thiruvananthapuram Dt.**: TBGRI medicinal garden, 2nd Oct. 1990, *M.Dan 5922* (TBGT);**Wayanad Dt.**: Manimala, 25th Oct. 2000 *Sunojkumar CU49638* (CALI).

Notes: Apart from the proper species, Hooker treated four varieties in Flora of India (1885) for this species. On analysis of the type specimens of all varieties and a number of herbarium materials, it became clear that there exhibit high polymorphism in the life form and leaf shapes among different populations and within populations, probably due to the local climatic differences. Among the varieties identified by Hooker (1885), var. *heynii* and var. *latifolia* are slight variation within the proper species, and are only polymorphic forms. The variety *longifolia* is only a polymorphic form of *Leucas stelligera* as evident from its floral character. The other two varieties, var. *stocksii* and var. *lanata* however exhibit a remarkable difference from the proper species in their short bushy and dense villous nature and also in some floral characters. Due to this both varieties are merged and treated as a distict variety '*lanata*'.

b. var. **lanata** Hook.f., Fl. Brit. India 4: 686. 1885; Gamble, Fl. Pres. Madras 2: 1154. 1924; Mukerjee, Rec. Bot. Surv. India XIV (1): 177. 1940; V.Singh, Mon. Indian Leucas 84. 2001.

—Type: India, Bababudan hills, *Wight . s.n.* (holo. **K** cibachrome !)

Leucas eriostoma var. *stocksii* Hook.f., Fl. Brit. India 4: 686. 1885.

—Type: *s. coll., s.n.* herb. Stocks (holo. **K** cibachrome !)

Sub shrub, 20–45 cm high, branches herbaceous, spreading, covered with white, erect, soft, villous 1–1.5 mm long hairs. Leaves mostly sessile, sometimes petiole up to 9 mm long, villous; lamina 3–6 cm long, 0.7–2 cm broad, lanceolate to oblong lanceolate, obtuse, margin crenate with 11–18 teeth, both side dense villous. Bracteoles outside villous, margin ciliate with 1 mm long white hairs. Calyx outside upper half villous, lower half pubescent, teeth 1–1.2 mm long, compactly covered with dense >1 mm long hairs, mouth cilia 3 mm long dense hairy.

Etymology: The variety name refers to the hairy (*lanatum*) nature of the plant.

Flowering and fruiting: October–February.

Habitat: Found in montane grasslands above 1500 m.

Distribution: South Indian endemic.

Specimens examined: **KARNATAKA: Chikmagalur Dt**.: Bababudan hills, 12th Dec. 2002, *Sunojkumar CU88701* (CALI).

Fig. 33: *Leucas eriostoma* Hook.f. (type specimen of different varieties) A. var. *eriostoma*; B. var. *lanata* Hook.f.; C. var. *longifolia* Hook.f.; D. var. *stocksii* Hook.f. (all from Kew Herbarium)

Fig. 34: A-C. *Leucas eriostoma* Hook.f. var. *eriostoma*; D. *Leucas eriostoma* var. *lanata* Hook.f.; E-F. *Leucas helianthimifolia* Desf. (B. fruiting stage; C-D. flowering stage)

11. Leucas helianthimifolia Desf., in Mem. Mus. Natl. Hist. Paris 11: 2. t. 1. f. 1. 1824; Benth., Labiat. Gen. Spec. 3 (fasc. 6): 612. 1834; in DC., Prodr. XII: 528. 1848; Hook.f., Fl. Brit. India 4: 1885; Fyson, Fl. Nilgiri & Pulney 1: 333. 1915; Gamble, Fl. Pres. Madras 2: 1152. 1924; Mukerjee, Rec. Bot. Surv. India XIV (1): 174. 1940; Sriniv. in A.N.Henry et al., Fl. Tamil Nadu Ser. I. 2: 176. 1987; V.Singh, J. Econ. Taxon. Bot. 22: 2. 389. 1998; Mon. Indian Leucas 86. 2001.

—Type: India, Nillygerry, (Nilgiris) *Leschenault* s.n. (holo. **P** !)

Leucas ternifolia Desf. in Mem. Mus. Natl. Hist. Paris 11: 4. t. 2. f. 2. 1824; Benth., Labiat. Gen. Spec. 3 (fasc. 6): 612. 1834; in DC., Prodr. XII: 529. 1848; Wight, Icon. Pl. Ind. Orient, IV: 3. t. 1453. 1848; Gamble, Fl. Pres. Madras 2: 1152. 1924; Mukerjee, Rec. Bot. Surv. India XIV (1): 173. 1940.

—Type: India, Nillygerry (Nilgiris), *Leschenault 206.* (holo. **P** !)

Small under shrub, about 20–45 cm high, perennial, stem base and root stock thick and woody, profusely branching; branches erect, 1.5–2 mm thick, terete not angular, not grooved, clothed with minutely to densely tomentose up to 1 mm long soft, antrorse hairs; internodes 0.3–5 cm long, reduced towards the tip, sometimes internodes below the inflorescence elongated up to 7 cm. Leaves whorled, 2–3 on nodes, sometime very rarely opposite; petiole 1.5–2 mm, tomentose; lamina 1.2–3 cm long, 3–7 mm broad, chartaceous, oblong to linear oblong, base obtuse to slightly cuneate, tip obtuse or sub acute, margin entire, slightly revolute, lower side tomentose on the veins, woolly with very small off-white coloured hairs in between the veins, veins not clear outside, upper side tomentose with ±1 mm long antrorse

hairs. Inflorescence terminal, solitary or in upper 2–3 axils, produced on much elongated (up to 10 cm) axis, 8–20 flowered, each subtended by a whorl of three bracteate leaves. Bracteoles very few, straight, 2.5–5 mm long and 0.5 mm broad, subulate, setaceous, half or two third the length of calyx, linear, acute, tomentose to short villous. Flowers almost sessile. Calyx campanulate, straight, 5.5–7 mm long, finely tomentose outside, hairs turned towards the mouth, nerves not clear outside, mouth truncate, up to 3.5 mm wide, ciliate with 1.5 mm long silvery hairs, turned towards the centre of the mouth, teeth 10, almost equal, 0.4–0.8 mm long, 0.5 mm wide, triangular, straight, subulate, tip pointed and stiff. Corolla 12–13 mm long, fully off white coloured, tube 5 mm long, straight, included in calyx, inside not annulate, provided with longitudinal row of fleshy hairs; lower lip 7–8 mm long, slightly deflexed on the tube, middle lobe large, 5.5 mm broad emarginate at free end, side lobes 2 mm broad at free end, margin revolute, provided with hairs near the junction of tube and at the attachment part; upper lip 5 mm long, concave, margin ciliate, outside strongly bearded with very dense off white coloured spreading hairs, forming characteristic hood. Staminal filaments hairy, anthers 1.3 mm long, 0.5 mm broad, reddish coloured, with divergent theca. Disc cup shaped, equally four lobbed. Ovary locules rounded at top. Style 8 mm long, bent forward; stigma lobes unequally bi lobbed, lower lobe 0.7 mm long, upper 0.03 mm long. Nutlets oblong, 1.8 mm long, 1 mm broad, light brown, slightly conical, narrowed at base, top rounded and smooth obtusely triangular in cross section.

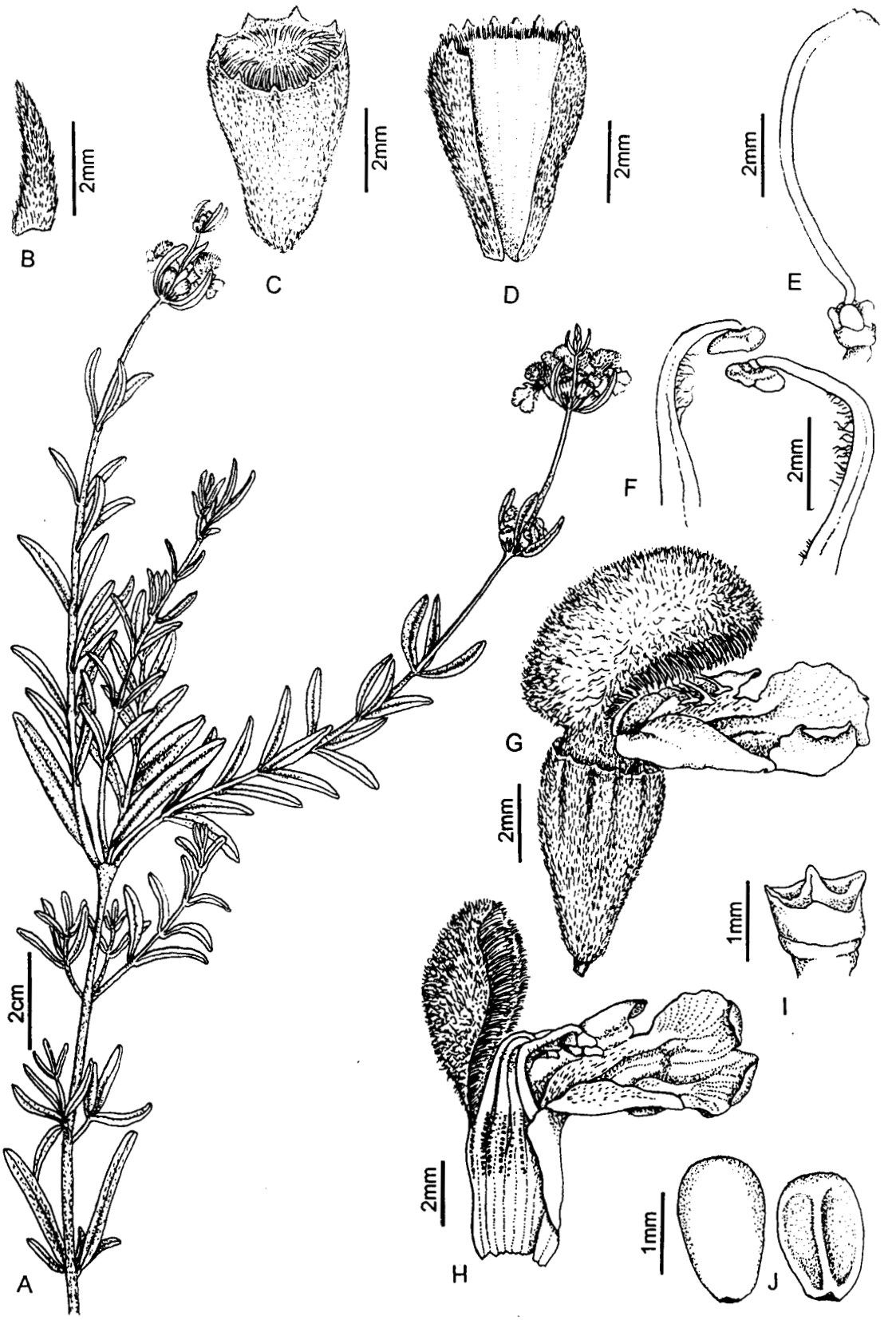


Fig. 35: *Leucas helianthimifolia* Desf. A. Habit; B. Bracteole; C. Calyx; D. Calyx split open; E. Pistil; F. Stamens; G. Flower; H. Corolla split open; I. Disc; J. Nutlets.

Etymology: The species name means '*helianthimum* like leaves', appertain to its similarity with the plant *Helianthemum vulgare.*

Flowering and fruiting: Peak flowering season is September–February. Occassional flowering is noticed in other seasons also in some herbarium records.

Habitat: Found in open grasslands and among bushy herbs. This plant require cold climate characteristic of high altitude; above 1500 m.

Distribution: South Indian endemic. Found in Westerh Ghats, in Nilgiri biosphere area and in Anamalai cardamom hill ranges.

Specimens examined: Peninsular India orientalis, *Wight 2159* (CAL); **KERALA: Idukki Dt.**: Anamalai, 10th Oct. 1911, *C.A.Babber 4037* (MH); Kanthaloor, near Mannavan shola, 30th Mar. 1978, *Nambiar 267* (KFRI); Eravicolam western slopes, 4th Dec. 1987, *P.Bhargavan 87328* (CAL, MH); Mattupetty, 9th Jan. 1989, *S.George 6523* (CALI); Rajamalai, 8th Jan., 1989, *A.Mini 3813* (CALI); Guderale, 18th Sept. 1992, *M.A.Jabbar & E.S. Santhoshkumar 14491* (TBGT); Rajamala, 1st June 1995, *B. Ajaykumar 23592* (TBGT); Gundumala, 30th Sept. 1998, *Sunojkumar CU49610* (CALI); Rajmahal hills, 1st Oct. 1998, *Sunojkumar CU49613* (CALI); Munnar to Deviculum, 14th Nov. 2001, *Sunojkumar CU 49684* (CALI); **Kottayam Dt.**: Deviculam, 16th June 1963, *K.M.Sebastine 16532* (MH); Umaiyamalai, 17th Nov. 1965, *B.V. Shetty 26469* (MH); Deviculam, 11th Sept. 1968, *D.B.Deb 30488* (MH); **TAMIL NADU: Coimbatore Dt.**: Thanakkumalai, 17th Feb. 1980, *M. Chandrabose 65833* (CAL, MH); **Madurai Dt.**: Upper Palani grassy slopes, 19th Aug. 1911, *C.E.C.Fischer 2874* (CAL); Foot of Alagur hills, 10th June 1957,

K.Subramanyan 3343 (CAL); Kodaikanal, near pillar rock, 27th July 1965, *K.M.Sebastine 24570* (MH); Kodaikanal, pillar rock, 13th Feb. 1974, *M.Madhavi 1749* (CALI); Kodaikanal, 13th Feb. 1974, *A.R.M.Bai 4545* (CALI); **Nilgiris Dt.**: Coonoor, 7th Mar. 1870, *C.B.Clarke 10497* (CAL); Ooty, June 1886, *J.S.Gamble 17454* (MH); Coonoor, 11th Feb. 1899, *Prain s.n.* (CAL); Coonoor, 27th Sept. 1910, *C.E.C. Fischer 2413* (CAL); Coonoor, Oct. 1910, *A.Meebold 11886* (CAL); Kottabettu, Illithorai, 8th Oct. 1956, *K.M.Sebastine 961* (MH); Reserve forest near Manjoor, 24th May 1957, *K.M.Sebastine 3343* (MH); Kunnacombai, 1st Sept. 1957, *K.M.Sebastine 4206* (CAL, MH); Keti hills, 31st Mar. 1958, *K.M.Sebastine 5700* (CAL, MH); Bimaka shola, 26th Aug. 1970, *G.V.S.Rao 36375* (MH); Kodanad, near Koramedu taluk, 13th Nov. 1970, *E.Vajravelu 36881* (MH); Avalanche, Mullimund, 26th Dec. 1970, *B.V.Shetty 37601* (MH); Lakkidi, 20th Mar. 1972, *K.Vivekanandan 40396* (MH); Selas Hulikal Droog, 30th Nov. 1972, *E.Vajravelu 43142* (MH); Ooty-Emerald, 25th Dec. 2002, *Sunojkumar CU49677* (CALI).

Notes: Based on Leschenault's herbarium collected from Nilgiri hills, Desfontaine described *Leucas helianthimifolia* and *Leucas ternifolia*. However examination of the holotypes (original specimen) of both names reveal that there is no remarkable difference between the two and the only difference found in the two types is the leaf size and shape. Examination of a large number of herbarium specimens and fresh specimens collected from the field made clear the polymorphic nature of leaves in *Leucas helianthimifolia*. Since the character differences between these two species are not stable, it is decided to follow Hooker's treatment of merging the two.

12. Leucas hirta (Roth) Spreng. in L., Syst. Veg., ed. 16, II: 743. 1825; Benth., Labiat. Gen. Spec. 3 (fasc. 6): 613. 1834; in DC., Prodr. XII: 530. 1848; Hook.f., Fl. Brit. India 4: 687. 1885; Gamble, Fl. Pres. Madras 2: 1153. 1924; Mukerjee, Rec. Bot. Surv. India IV (1): 176. 1940; Gandhi in C.J.Saldanha & Nicolson, Fl. Hassan Dist. 503. 1976; R.R.Razi & Razi, Syn. Fl. Mysore Dist. 511. 1981; Sriniv. in A.N.Henry et al, Fl. Tamil Nadu Ser. I. 2: 176. 1987; Manilal, Fl. Silent Valley 219. 1988; Pullaiah & N.Yesoda, Fl. Anandapur Dist. 201. 1989; K.R.K.Murthy & Yoganar. Fl. Coorg. Dist. 357. 1990; K.M.Matthew, An. Ex. Fl. Cent. Tamil Nadu. 403. 1991; M.Mohanan & A.N.Henry, Fl. Thiruvananthapuram Dist. 367. 1994; K.N.Subraman., Fl. Thenmala 288. 1995; Sasidh. & Sivar., Fl. Trissur Dist. 361. 1996; Pullaiah & Moulali, Fl. Andhra Pradesh 2: 771. 1997; K.M.Matthew, Fl. Pulney hills 2: 995. 1999; V.Singh, Mon. Indian Leucas. 90. 2001.

Phlomis hirta Roth, Nov. Pl. Sp. 264. 1821

—Type: India, Kerala, Idukki Dt., Gundumala, 30th Sept. 1998, *Sunojkumar CU49609* (CALI) **Neotype designated here.**

Leucas rufescens Benth. in Wall., Cat. Herb. Ind. No. 2053. 1829. *nom nud.*

—Type: India, *s.coll., s.n.* (holo. **K** cibachrome !)

Leucas helianthimifolia sensu Benth. in Wall., Pl. As. Rar. 1: 61. 1830. *non* Desf. 1824. —Type: as that of *Phlomis hirta* above.

Low shrub, perennial, basal stem and root stock long, thick, woody, amorphous; branches 30–50 cm high, 1.5–3 mm thick, obtusely quadrangular,

grooves not clear, clothed with retrorse minute tomentose hairs, densely tomentose at stem tip; internodes 2–8 cm long. Leaves opposite, decussate, sessile to 3 mm long petiolate, tomentose; lamina 2.5–3.5 cm long, 1–1.3 cm broad, coriaceous, elliptic or oblong sometime obovate, obtuse tip, narrowed to slightly cuneate at base, serrated with 3–4 teeth, mostly at half from the middle, scabrid with short retrorse hispid hairs on both surfaces, lateral veins 4, prominent and hirsute beneath. Inflorescence terminal, 1–2 verticils at the end of branches, 1.5–2.5 cm diameter, many and dense flowered. Bracteoles many 8–10 mm long, 1–1.5 mm broad, as long as calyx, linear–lanceolate, recurved, acute tip, outside hispid, margin ciliate with long 1–1.5 mm long hairs. Flowers short pedicillate. Calyx ±10 mm long, tubular–campanulate, straight, base narrowed, inside glabrous, outside hispid with sparse 0.5–1.5 mm long hairs, veins prominent; mouth truncate, rim annulate with a ring of thick veins, ciliate with dense golden yellowish hairs forming a cone over the mouth and closing the opening, mouth cilia as long as the teeth; teeth 10 sub-equal, 2 mm long, base 0.5 mm broad, triangular subulate, fleshy, hispid, mixed with long ±1 mm long ciliate hairs. Corolla fully white, ±20 mm long; tube 9 mm long, included in calyx, inside middle annulate with a ring of fleshy hairs; lower lip 11 mm long, middle lobe 8 mm broad, fan shaped, side lobes 2 mm broad at free end, margin revolute; upper lip 6.5 mm long, concave, margin ciliate, outside hooded with dense white cottony hairs in all direction. Staminal filaments hairy at the middle; anther lobes 1.24–0.48 mm broad. Disc cup shaped, all the four lobes are almost equal. Ovary locules rounded, ±0.9 mm height. Style ±14 mm long; stigma lobes unequal, lower ±1.5 mm long, upper ±1.2 mm. Nutlets ±3 mm long, ±1.6 mm

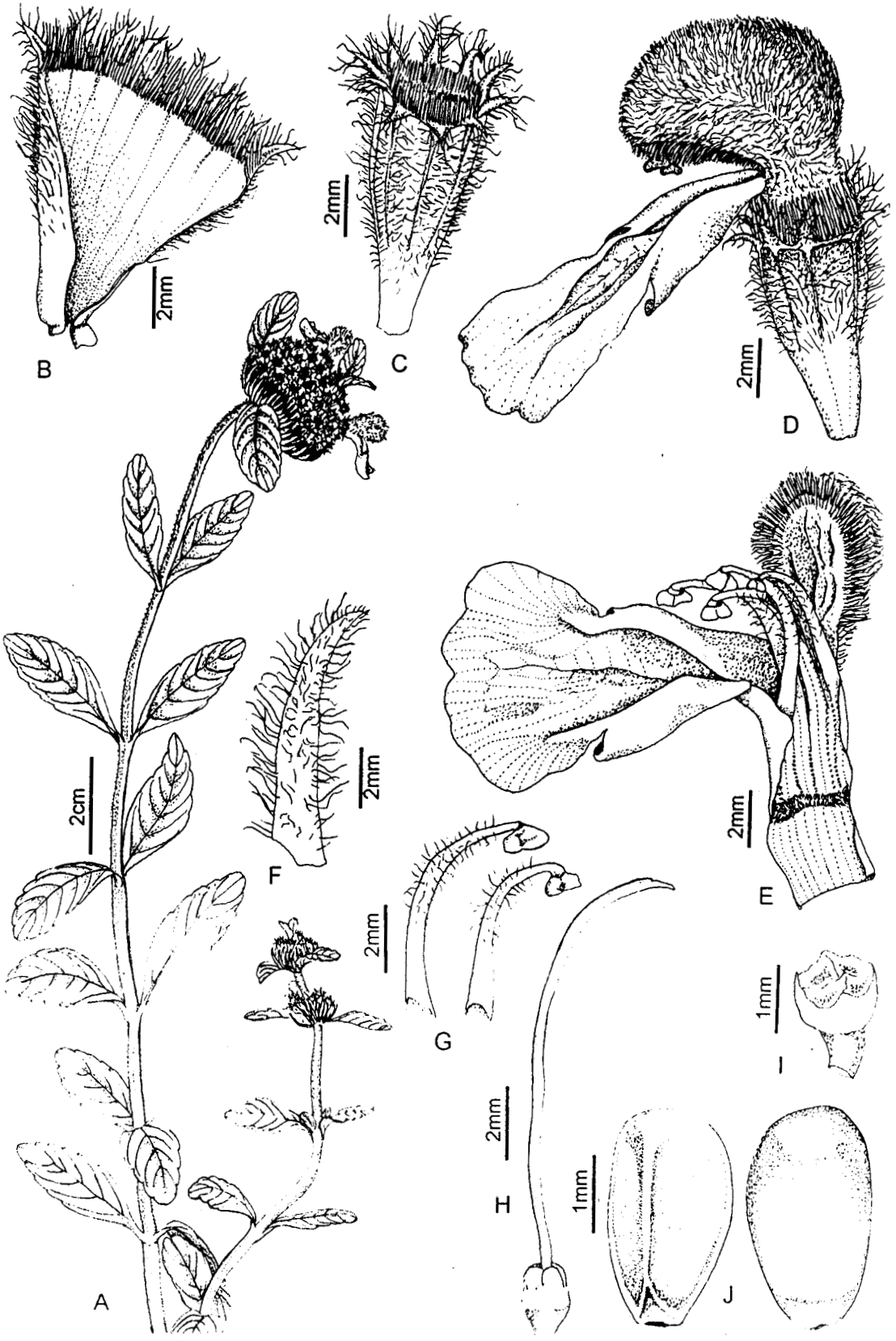


Fig. 36: *Leucas hirta* Spreng. A. Habit; B. Calyx split open; C. Calyx; D. Flower; E. Corolla split open; F. Bracteole; G. Stamens; H. Pistil; I. Disc; J. Nutlets.

broad, dark brown–black coloured, oblong, obtusely triangular in cross section, apex rounded.

Etymology: The species name is supposed to be derived from the Latin word '*hirtis*' means hairy, probably referring to the hairy nature of the plant.

Flowering and fruiting: Peak flowering season is August–December, occassional flowering is noticed in January–July also.

Habitat: Usually found growing in the montane temperate grasslands, at an altitude above 1300 m; prefer low temperature, and high rainfall.

Distribution: Endemic to South India, in the Southern Western Ghat regions, growing well in Nilgiri and Anamalai hill ranges.

Economic importance: During the study it is noticed that people use this plant as a medicinal herb, as an ingredient in few Ayurvedic decoction in the Ramakkalmedu region of Idukki district, Kerala. The specific use is not made available because of supernatural belief of the local people.

Specimens examined: **ANDHRA PRADESH: Chitoor Dt.**: Palmaner, 18th Apr. 1918, *C.E.C.Fischer 4312* (CAL, FRC); Tirumala hills, Dharmagiri, 27th June, 1987, *D.Rangacharyulu 1466* (MH); **Cuddapah Dt.**: Aug. 1809, *J.S.Gamble 21258* (CAL, MH); **KARNATAKA: Hassan Dt.**: Near Hirisave, 25th Sept. 1979, *C.J.Saldanha KFP 9416* (CAL); **Mysore Dt.**: Bandipur, 28th Sept. 1964, *B.D. Naithani 21278* (MH); **Tumkur Dt.**: Hill near Rayanpalya, 14th Apr. 1979, *P.Prakash & B.R.Ramesh KFP 6671* (CAL); **KERALA: Idukki Dt.**: Kumili, Dec. 1910,

A.Meebold 997 (CAL); Pachakkanam, 3rd Oct. 1976, *K.Vivekanandan 98574* (CAL); Vandamedu to Kattappana, 28th Sept. 1981, *C.N.Mohanan & B.Ramanyeem 72074* (MH); Thannikudy, 1st Oct. 1972, *B.D.Sharma 42374* (MH); Pachakkanam, 3rd Oct. 1976, *K.Vivekanandan 48594* (MH); Chinnar, Vanchikulam, *K.K.Sajeev 15992* (KFRI); Periyar, Thekkady, *J.Augustine 18440* (KFRI); Gundumala, 30th Sept. 1998, *Sunojkumar CU49609* (CALI); Ramakkalmedu, 16th Nov. 2001, *Sunojkumar CU49677* (CALI); **Kottayam Dt**.: Marayur, 18th June 1963, *K.M.Sebastine 16555* (MH); Deviculam, 14th Oct. 1963, *K.M.Sebastiane 1751* (MH); Top station, 13th Sept. 1968, *D.B.Deb 30806* (MH); **Palakkad Dt**.: Silent Valley, 24th Sept. 1977, *R.Ansari 51476* (MH); Chembothy, 13th Jan. 1993, *E.S.Santhoshkumar 15587* (TBGT); **Pathanamthitta Dt**.: Pampakakki Goadrical RF, 25th Dec. 1988, *N.Anilkumar 1357* (CAL); Pancharamannu, 29th Apr. 1994, *S.Binu 21516* (TBGT); **TAMIL NADU: Coimbatore Dt**.: Marudhamalai, Kologathukattu, 24th June 1930, *V.Narayanaswami 3133* (MH); Hassanur Kottadi-path, 11th Mar. 1931, *K.C.Jacob 260* (MH); Attakatti, 4th July, 1961, *J.Joseph 12662* (CAL, MH); On the way to Hamptons peak, 23rd Feb. 1964, *J.E.Ellis & C.P.Sreemadhavan 20008* (MH); Maruthamalai, 17th Jan. 1969, *D.B.Deb 31378* (MH); Maruthamalai, 27th Oct. 1971, *M.V.Viswanadhan MVV1077* (MH); Chinnar-Chittar, 5th Aug. *1986, K.Ramamurthy 78328* (CAL, MH); **Kanyakumari Dt**.: on the way to Mahandragiri from Sengamal estate, 11th Sept. 1969, *B.V.Shetty 32342* (MH); **Madurai Dt**.: Poolathur, 24th Oct. 1977, *M.Chandrabose 51672* (CAL, MH); Palani-Kodaikanal, 17th Feb. 1978, *M.Chandrabose 53381* (CAL, MH); **Nilgiris Dt**.: Way to Kudumalais from Kargudi, 1st Oct. 1928, *Narayanaswamy & S.R.Raju 18818* (MH); Mudumalai, 20th July 1960,

K.Subramanyan 10485 (CAL, MH); Mudaliaruthu, 22nd July 1965, *E.Vajravelu 24841* (MH); Avarihalla RF, 19th Aug. 1970, *B.D.Sharma 35616* (MH); Doddagatti, 23rd June 1970, *B.V.Shetty 34361* (MH); from Anaikatty towards Ebanad, 23rd Nov. 1970, *G.V.S.Rao 37330* (MH); Manjoor, 9th Aug. 1988, *S.Khan 5630* (TBGT); **North Arcot Dt**.: On the way to Kambukudi, 8th Sept. 1958, *K.Subramanyan 6510* (CAL, MH); **Ramanathapuram Dt**.: 18th Feb. 1979, *N.C.Nair 60947* (CAL); **Salem Dt**.: Yercaud-Balmadies estate, 19th Dec. 1958, *K.Subramanyan 7542* (CAL, MH); Yercaud, Kaveri peak, 4th Nov. 1968, *D.B.Deb 31251* (MH); Attur, 26th June 1978, *N.Venugopal 14325* (CAL); **South Arcot Dt**.: Kallaikurichi, 15th June 1976, *K.M.Matthew & N.Venugopal RHT 14015* (CAL).

Note: Roth (1821) established this species under *Phlomis* based on Benjamin Heyne's specimen collected from 'Indiae orientali'. These specimens deposited in the general herbarium of Berlin (B) were destroyed during the 1939 – 1945 World War (Stafleu, 1986). Due to the loss of original specimens, which were to become the type, lectotypification became necessary. After contacting many herbaria Heynes's specimens studies by Roth were not available. Only one specimen obtained from Kew (which contain Heyne's name) also does not contain relevant information to be considered as a Lectotype. Because of this Neotypification is attempted.

The protologue contain locality information in broader sense as 'India orientali' without any other precise information. Due to this, a plant from South

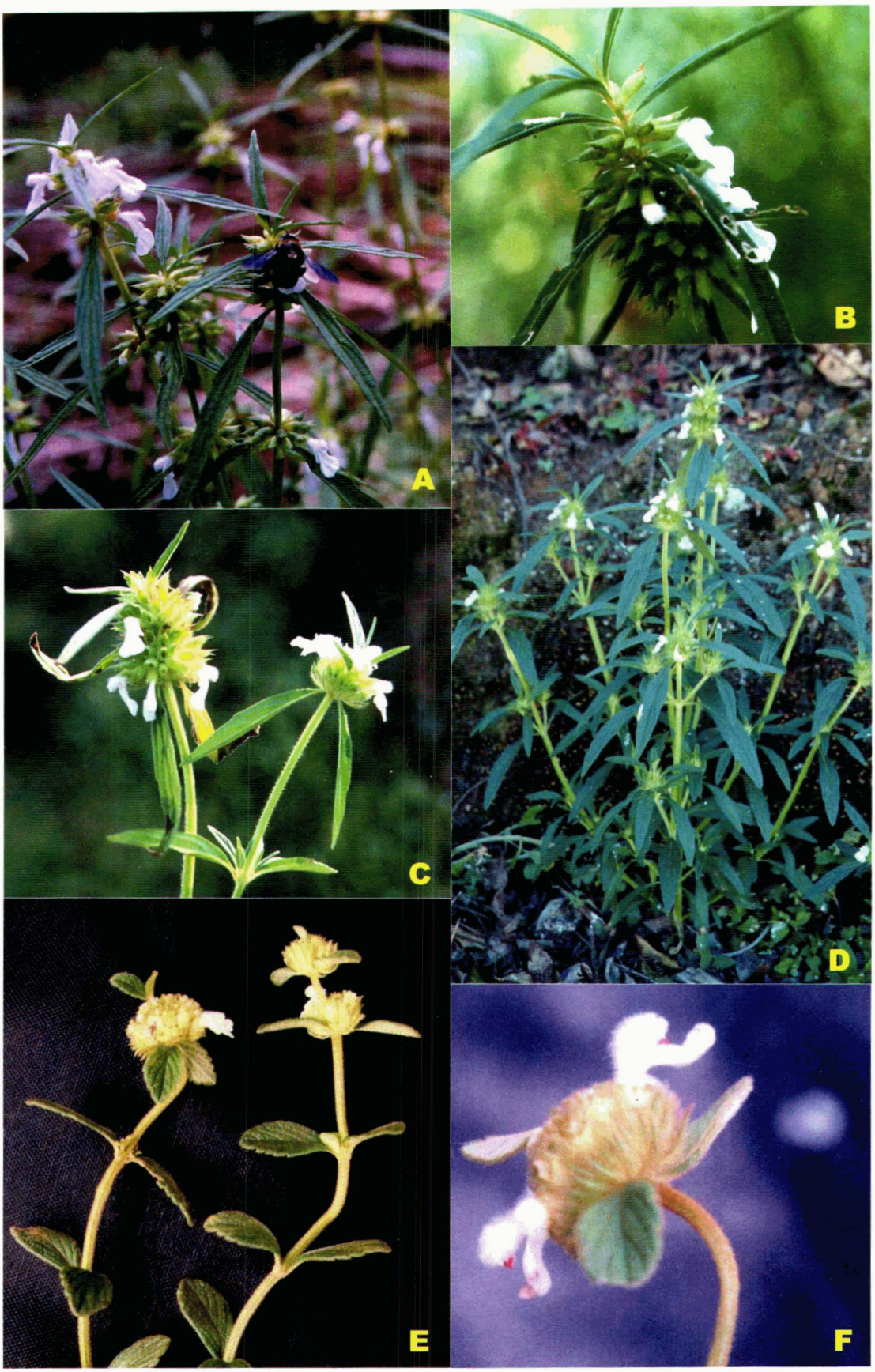


Fig. 37: A-B. *Leucas indica* R.Br. var. *lavandulifolia* Sunojkumar; C-D. *Leucas indica* R.Br. var. *indica*.; E-F. *Leucas hirta* Spreng.

India, collected from the Idukki district of Kerala is fixed as the type. This specimen character is matching with the protologue information. The neotypified specimen is deposited in CALI herbarium.

13. Leucas indica (L.) R.Br. in Ait.f., Hot. Kew ed. 2, 3: 409. 1811; Sm. in Rees, Cycl. XX: 1812.

Phlomis indica L., Sp. Pl. 585. 1753.

—Type: India, Nilgiri Hills, Pykara, 1878, *G. King s.n.* (neo. A.Paton in Taxon 50: 516. 2001. **K** cibachrome !).

Leucas indica (L.) R.Br. Prodr. 504. 1810. *nomen.*

Leucas indica (L.) R.Br. ex Sm. in Rees, Cycl. XX: 1812 *nom. illeg.* (*superfl.*) — Type: India, *Burmann s.n.* (holo. **LINN** photo. !)

Leucas indica (L.) R.Br. ex Vatke, Oestrr. Bot. Z. 25: 95. 1875; J.R.Press in H.Hara et al., En. Fl. Pl. Nepal 3: 156. 1982; Sriniv. in A.N.Henry et al., Fl. Tamil Nadu Ser. I. 2: 176. 1987; Ramach. & V.J.Nair, Fl. Cannanore 366. 1988; K.R.K.Murthy & S.N.Yoganar., Fl. Coorg. 358. 1990; Moulali & Pullaiah, J. Econ. Taxon. Bot. 15: 2. 454. 1991; K.M.Matthew, Ex. Fl. Cent. Tamil Nadu. 403. 1991; M.Mohanan & A.N.Henry, Fl. Thiruvananthapuram 362. 1994; Pullaiah & B.R.P.Rao, Fl. Nizamabad 284. 1995; Sasidh. & Sivar. Fl. Trissur 361. 1996; Pullaiah & Moulali, Fl. Andhra Pradesh 2: 771. 1997; K.M.Matthew, Fl. Pulney hills 2: 996. 1999; N.Mohanan & Sivadh., Fl.

Agasthyamala 534. 2002. *nom. illeg.* (a later homonym of *L. indica* (L.) R.Br. ex Sm.).

—Type: India, *Burmann s.n.* (holo. **LINN** photo. !)

a. var. **indica**

(—Type and basionyms same as that of species)

Leucas linifolia (Roth) Spreng. var. *decipiens* Hook.f., Fl. Brit. India 4: 691. 1885; Duthie, Fl. Gangetic Plains 2: 113. 1960; Chandrab. & Sriniv., Bull. Bot. Surv. India XVII (1–4) 165. 1975.

—Type: 3 syntypes *Hoenacker* 1234, *Hoenacker s.n, Wight s.n.* (**K**)

Leucas lavandulifolia Sm. var. *decipiens* (Hook.f.) Chandrab. & Sriniv. Bull. Bot. Surv. India XVII: 165. 1978.

—Type: as that of *L. linifolia* var. *decipiens* above.

Leucas indica (L.) Vatke var. *decipiens* (Hook.f.) Bennett, J. Econ. Taxon. Bot. 5: 452. 1985. *nom. illeg.*; Sriniv. in A.N.Henry et al., Fl. Tamil Nadu Ser. I. 2: 175. 1987.

—Type: as that of *L. linifolia* above.

Erect annual herb, 15–75 cm high, basal stem thick herbaceous, up to 6 mm across, branching profusely; branches obtusely quadrangular, grooved, hispid, hairs ±1 mm long erect or retrorse; internodes 5–10 cm long, below the inflorescence attaining up to 30 cm, nodal portion often slightly dilated. Leaves opposite, petiole very short, 2–10 mm, pubescent; lamina 4–12 cm long, 5–16 mm broad, herbaceous

to slightly coriaceous, linear to narrowly lanceolate, base longly narrowed from the middle and extending up to the petiole, tip acute, margin remotely to finely serrate, often slightly turned down, secondary vein 4–5, prominent beneath, lowerside puberulus and with colourless glands, above puberulous without glands. Inflorescence 1–4 verticillasters per branch, terminal, each 1.5–3 cm across, dense, 10–30 flowered, sub-globular, adjacent whorls very close. Bracteoles many, narrowly linear, 10–12 mm long, equal to or longer than the calyx, recurved below the flowers, dense ciliate with ±1.5 mm long whitish hairs. Flowers subsessile to 1 mm long pedicillate. Calyx obconical, tube thick and slightly bent, adaxial side produced to give a lobster clawed appearance to the tube, abaxial 5–7 mm long, adaxial 11–12 mm, pale green coloured, ribs weakly prominent outside but strongly produced adaxially, outside dense hispid, inner side almost glabrous, mouth very oblique, rim thick with annular veins, adaxial side much produced; teeth 10, anterior 1.5–3 mm long, prominent and characteristic structure, triangular, acute, thick spinuous and sharp pointed tip, hispid, lateral and abaxial teeth much smaller, 1–1.5 mm long, acute, two lateral teeth often half to fully fused with the adaxial teeth; fruiting calyx thicker and prolongate. Corolla white 13–15 mm long; tube 6–7 mm long, above outside hairy, inside half length with an oblique ring of fleshy hairs; lower lip 7–8 mm long, obliquely downward produced, middle lobe 5–6 mm broad, fan shaped, margin slightly undulate, lower side slightly hairy with glands, middle lobe large, side lobes oblong, 1.5–2 mm wide at free part, oblique, asymmetrically notched; upper lip 3.5–4.5 mm long, shorter than the lower lip, straight forward, concave, rounded at the tip, outside whitish wooly, margin long ciliated. Staminal

filaments hairy, lower pair longer than upper and as long as the upper lip; anthers light reddish coloured, 0.6 mm long, 0.4 mm broad, with confluent theca. Disc cup shaped, 0.8 mm high, abaxial lobe slightly longer. Ovary locules 0.6–1 mm high, top moderately rounded. Style 10.5–11 mm long; stigma unequally bilobbed, lower 0.6 mm long, upper 0.2 mm. Nutlets dark brown, 3–3.5 mm long, 1.4–1.6 mm broad, smooth shining, oblong, triangular in cross section, top almost rounded.

Etymology: The species name means 'East Indian *Leucas*'.

Flowering and fruiting: Through out the year, especially August –December.

Habitat: Found as a weed in the grass lands, roadsides, among bushes and along stream banks.

Distribution: Found as an endemic herb only in Nilgiri hills in Tamil Nadu.

Specimen examined: **TAMIL NADU: Nilgiris Dt.**: Marapalam, 20th Jan. 1957, *K.M.Sebastine 2103* (MH); Coonoor, 1st Mar. 1963, *C.P.S.Madhavan CPS900* (MH); Avalanchi, Mullimund, 14th June 1970, *B.V.Shetty 34233* (MH); Bokkampuram RF, 12th Aug. 1970, *B.D.Sharma 35388* (MH); Moyar, 18th Aug. 1970, *B.D.Sharma 35585* (MH); Coonoor, 25th Sept. 1986, *B.G.Singh 12407* (FRC); Ooty-Pykara, 24th Dec. 2002, *Sunojkumar CU88108* (CALI); Avelanchi powerhouse, 25th Dec. 2002, *Sunojkumar CU88109* (CALI); Kotagiri, 20th Dec. 2002, *Sunojkumar CU88112* (CALI); Kodanad view point, 26th Dec. 2002, *Sunojkumar CU88115* (CALI); Burliar road, 26th Dec. 2002, *Sunojkumar CU88118* (CALI); Dodabetta, 28th Dec. 2002, *Sunojkumar CU88120* (CALI).

b. var. **lavandulifolia** (Sm.) Sunojkumar **stat. nov.**

Leucas lavandulifolia Sm. in Rees., Cycl. XX: 1812; Prain, J. Asiat. Soc. Bengal. 2. Nat. Hist. 74: 719. 1907; Merr., Fl. Manila 412. 1912; Costerus & J.J.Sm., Ann. Jard. Bot. Btzg. 32: 29. 1922; Merr., En. Philip 3: 411. 1923; Ridd., Fl. Mal. Pen. 2: 650. 1923; Mukerjee, Rec. Bot. Surv. India XIV (1). 167. 1940; Backer & Backh.f., Fl. Java. 2: 623. 1965; H.Hara, Fl. East. Himalaya 277. 1966; Keng, Gard. Bull. Singpore XXIV: 103. 1969; Ross, Fl. Natal 303. 1972; Chandrab. & S.R.Sriniv., Bull. Bot. Surv. India XVII (1-4): 164. 1975; Gandhi in C.J.Saldanha & Nicolson, Fl. Hassan Dist. 503. 1976; Keng, Fl. Males. 1, 8: 338. 1978; Sebald, Stuttgarter Beitr. Naturk. Ser. A. 341: 188. 1980; R.R.Rao & Razi, Syn. Fl. Mysore Dist. 512. 1981; Codd in Leistner, Fl. South. Africa 28 (4): 40. 1985.

—Type: as *Leonuarus indicus* L. India, *Burmann s.n.* (holotype, **LINN** photo.!)

Leonurus indicus L., Syst. Nat. ed. 10: 1101. 1759; Sp. Pl. (ed. 2) 817. 1763; Burm.f., Fl. Indica 127. 1768.

—Type: India, *Burmann s.n.* (holo. **LINN** photo. !)

Phlomis zeylanica β *acut. non* L. Sp.Pl. 1753: Murray, Syst. Veg. ed.13, p. 450. 1774; Jacq., Ic. Pl. Rar. 1: 11. t. 111. 1781; Raspe, Pflanzensystem 7: 507. 1789. t. 57. f. 2; Willd., Sp. Pl. 123. 1800; Roxb., Fl. India (III. 9): 461. 1832. Blance, Fl. Filip. 475. 1837.

—Type: as *Leonuarus indicus* L.

Phlomis linifolia Roth, Nov. Sp. Pl.: 260. 1821.

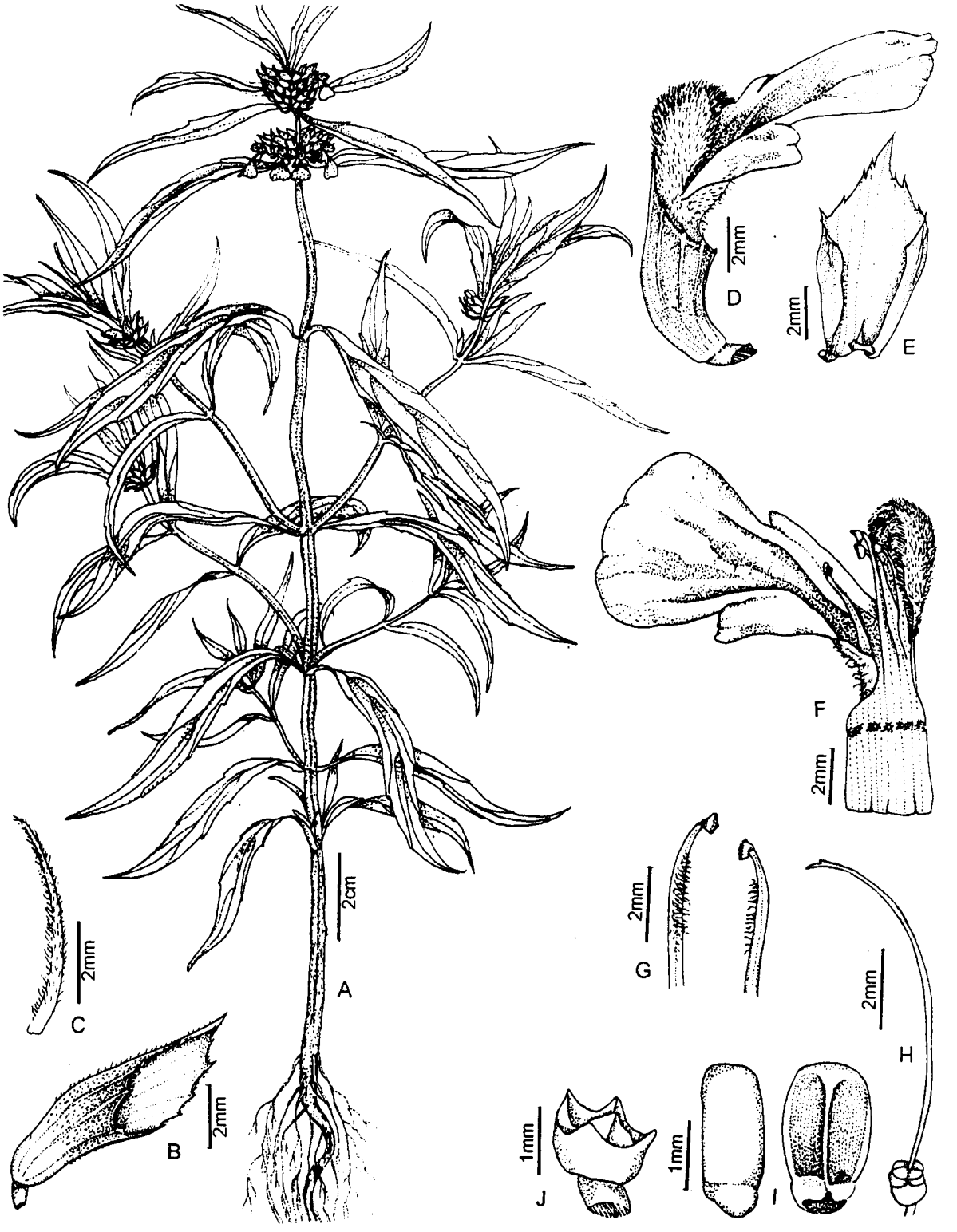


Fig.: **38**. *Leucas indica* (L.) R.Br. var. *lavandulifolia* A. Habit; B. Calyx; C. Bracteole; D. Flower; E. Calyx split open; F. Corolla split open; G. Stamens; H. Pistil; I. Nutlets; J. Disc.

—Type: India, *Heyne s.n.* (**B** destroyed)

Leucas linifolia (Roth) Spreng. in L., Syst. Veg. ed. 16, II: 743. 1825; Benth., Labiat. Gen. Spec. 3 (fasc. 6): 617. 1834; Hassk., Cat. Hort. Bog. 133. 1844; Zoll., Nat. Genseek. Arch. N.1. 2: 591. 1845; Benth. in DC., Prodr. XII: 533. 1848; Miq., Fl. India Bat. 2: 983. 1859; Vill., Nov. App. 165. 1880; Hook.f., Fl. Br. India 4: 690. 1885; Vidal., Rev. Pl. Vasc. Philip. 214. 1886; Koord., Exk. Fl. Java. 3: 146. 1912; Haines, Bot. Bihar & Orissa IV: 751. 1922; Gamble, Fl. Pres. Madras 2: 1149. 1924; Fosberg & Sachet, Smithson. Cont. Bot. 47: 25. 1981.

—Type: as *P. linifolia.*

Hetrepta lavandulifolia (Sm.) Rafin., Fl. Tellur. 3: 88. 1837.

Different from var. indica in having stem and leaves puberulous with fine erect and appressed hairs. Bracteoles few numbered, small, 3–8 cm long, straight, linear, puberulous with fine adpressed hairs. Calyx smaller, adaxial side 8–9 mm, abaxial side 4–5 mm, thick, bent, teeth 10, smaller, adaxial teeth 1 mm long, others 0.5–0.7 mm long, spinescent. Nutlets slightly smaller, 2.5 mm long, 1.3 mm broad at middle.

Etymology: The variety name means 'lavender leaved *Leucas*'

Flowering and fruiting: Through out the year, especially during August–December.

Habitat: Weed in cultivated fields, wetlands, open places, rubbish dumps, roadsides, railway tracks, along stream banks in sandy soil or rocks and in grass lands.

Common in sea level planes, and hilly area up to 2500 m above sea level. This species is the most widely distributed among all the Asian *Leucas*.

Distribution: Pantropical, found in Asia, Africa and Arabia. It is an Asian species, found in all Asian countries where *Leucas* is represented. According to Sebald (1980) it is an introduced weed in Africa. In South India, it is found very common everywhere.

Specimens examined: **ANDHRA PRADESH: Anantapur Dt**.: Kalasamudram, 24th Oct. 2001, *Sunojkumar CU49622* (CALI); **Chitoor Dt**.: Thirumalai, Ammoribai, 11th Oct. 1958, *K.Subramanyan 6887* (MH); Tirumalai, 18th June 1969, *G.V.S.Rao 31942* (MH); Nerabylu, 24th June 1969, *G.V.S.Rao 32014* (MH); Ranjungunta, 1st Oct. 1974, *M.Chandrabose 45201* (MH); Nagalapuram, *D.A.Moulali 10108* (SKU); Tirumala hills, 25th Oct. 2001, *Sunojkumar CU49677* (CALI); **Vizakapatanam Dt**.: Arakuvaley, 23rd Aug. 1960, *N.P.Balakrishnan 10783* (MH); Arakuvalley, 24th Dec. 2001, *Sunojkumar CU49681* (CALI); **KARNATAKA: Chikmagalur Dt**.: Bababudan hills, 12th Dec. 2002, *Sunojkumar CU88102* (CALI); Kemmangundi, 13th Dec. 2002, *Sunojkumar CU88103* (CALI); **North Canara Dt**.: Jog falls, 26th Dec. 2003, *Sunojkumar CU88135, CU88136* (CALI); Jersopa, 26th Dec. 2003, *Sunojkumar CU88167* (CALI); **Shimoga Dt**.: Sagaur, 25th Dec. 2003, *Sunojkumar CU88133* (CALI); **Udupi Dt**.: on the way to Kudachadri, 12th Oct. 2000, *Sunojkumar CU49636* (CALI); **KERALA: Idukki Dt**.: Upper Vaguvarai, Dhanush valley, 13th Oct. 1989, *P. Bhargavan 90909* (MH); Periyar Tiger Reserve, Uppupara, *J.Augustine 13189* (KFRI); Chinnar, Alampetty, *K.K.Sajeev 15686* (KFRI);

Gundumalai, 30th Sept. 1998, *Sunojkumar CU49607* (CALI); Munnar-Deviculum, 12th Oct. 2001, *Sunojkumar CU49673* (CALI); Ramakkalmedu, 16th Nov. 2001, *Sunojkumar CU49680* (CALI); **Kannur Dt.**: Cannanore, Oct. 1988, *J.S.Gamble BSI41344* (MH); Manantavady, 11th Feb. 1978, *V.S.Ramachandran 53877* (MH); Tolpetty, 6th July 1978, *V.S. Ramachandran 54155* (MH); Tellicherry Fish farm, 21st Feb. 1978, *V.S.Ramachandran 54121* (MH); Tellicherry Near Fort, 15th July 1978, *V.S.Ramachandran 57625* (MH); Pazhassi dam site, 21st Jan. 1979, *V.S.Ramachandran 59060* (MH); Kannoth, 25th Feb. 1979, *V.S.Ramachandran 61914* (MH); Mattannur, 21st Jan. 1979, *V.J.Nair 59744* (MH); Kottiyur, 22nd Jan. 1979, *V.J.Nair 59814* (MH); Chanathode, 3rd Sept. 1979, *V.S.Ramachandran 62238* (MH); Kannavam, 21st Feb. 1979 *V.S.Ramachandran 60080* (MH); Backal, 2nd Sept. 1979, *V.S.Ramachandran 60018* (MH); Ezhimala, 28th June 1980, *R.Ansari 67878* (MH); Chovva, 14th June 1997, *P.S. Jothish 35355* (TBGT); Payyanur-Edat, 1st Sept. 2002, *Sunojkumar CU49687* (CALI); Mathamangalam, 7th Sept. 2002, *Sunojkumar CU49688* (CALI); **Kasaragod Dt.**: Kasaragod city, 26th Jan. 1999, *R.Ansari 59916* (MH); 26th Jan. 1979, *V.S.Ramachandran 59254* (MH); Parappa, 20th Sept. 2002, *Sunojkumar CU49691* (CALI); **Kollam Dt.**: Ranni, Kariamplassu, 1st Sept. 1977, *N.C.Nair 50774* (MH); Shenduruny, Umiyar, *B.George 10714* (KFRI); **Kozhikode Dt.**: Kuttiyadi submergible area, 24th June 1965, *B.D.Naithani 24199* (MH); **Malappuram Dt.**: Calicut University campus, 15th July 1971, *V.V.Sivarajan 1380* (CALI); 8th Feb. 1986, *J.Majeed 8406* (CALI); 17th July 1998, *Sunojkumar CU49602* (CALI); Villuniyal, 15th Aug. 1998, *Sunojkumar CU49605* (CALI); **Palakkad Dt.**: Near Dhoni river, 26th May, 1964, *E.Vajravelu 19094* (MH); Silent

Valley, near hanging bridge, 5th Oct. 1979, *N.C.air 64291* (MH); Silent Valley Aruvampara grasy slopes, 8th Oct. 1979, *N.C.Nair 64424* (MH); Nelliampathy, 1st July 1994, *K.Radhakrishnan 19736* (TBGT); **Pathanamthitta Dt**.: 13th May, 1978, *C.N.Mohanan 55526* (MH); **Trissur Dt**.: Peechi, 29th July 1987, *N.Sasidharan 4978* (KFRI); Vazhachal, 26th June 1996, *A.G.Pandurangan & G.Rajkumar 30553* (TBGT); **Thiruvananthapuram Dt**.: Near Nilampur, 12th May 1978, *M.Mohanan 54808* (MH); Kompa, 28th Sept. 1993, *N.Mohanan 11525* (TBGT); **Wayanad Dt**.: Tirunelli, 18th jan. 1995, *K.Radhakrishnan 23749* (TBGT); 26th Nov. 1995, *Radhakrishnan 26527* (TBGT); Tirunelly, 8th Aug. 1998, *Sunojkumar CU49603* (CALI); near Kalindi river, 8th Aug, 1998, *Sunojkumar CU49604* (CALI); Pookodu lake, 5th June 1999, *Sunojkumar CU 49618* (CALI); Chembra hills, 7th Sept. 2000, *Sunojkumar CU49632* (CALI); Chembra peak, 11th Oct. 2003, *Sunojkumar CU88130* (CALI); **PONDICHERRY:** Railway station, 10th July 1987, *R.Rajan 86225* (MH); 19th Nov. 1990, *G.Praseena 4510* (CALI); **TAMIL NADU: Coimbatore Dt**.: Yalavadi, 6th Mar. 1931, *K.C.Jacob & J.David 46* (MH); Attakatti, 6th July 1961, *J.Joseph 12743* (MH); BSI garden, 30th Sept. 1963, *C.P. Sreemadhavan CPS 902* (MH); Chinnar, Chitoor MHEP areas, Anaimalai, 4th Aug. 1986, *V.Lakshmanan 83468* (MH); **Dharmapuri Dt**.: Harur-Vampatti, 14th Nov. 1977, *E.Vajravelu 51840* (MH); **Madurai Dt**.: Combai river bed, 14th June 1961, *K. M.Sebastine* 12565 (MH); Pannikadu to ganguvarpattu, 20th Sept. 1968, *D.B.Deb 31053* (MH); **Namakkal Dt**.: Kollimalai–Solakadu, 26th Dec. 2000, *Sunojkumar CU49644* (CALI); **Nilgiris Dt**.: Naduvattam, 2nd Oct. 1956, *N.P.Balakrishnan 153* (MH); On the way to Naduvattam from Devarshola, 21st July 1960, *K.Subramanyam*

10500 (MH); **Periyar Dt**.: Bhavani-Kattalai Barrages areas, 3rd Dec. 1986, *K.Ramamurthy 84603* (CAL); **Salem Dt**.: Yercaud, 18th Nov. 1990, *A.Bindu 2958* (CALI); Yercaud, 25th Dec. 2000, *Sunojkumar CU49642* (CALI); **South Arcot Dt**.: Vellimalai, Gomuki, 7th Feb. 1983, *K.Ramamurthy 77371* (CAL); **Tirunelveli Dt**.: Courtallum, near Tirumalai koil, 27th April 1957, *K.Subramanian 2971* (MH); **Trichi Dt**.: Pudukkottai, Sithannavasal, 24th June 1965, *K.Ramamurthy 24929* (MH).

Notes: The nomenclature of *Leucas indica* is very complicated and the true identity of this plant was not known till the end of this work. The species was known as *Leucas lavandulifolia* even in many recent revisionary works (Mukerjee, 1940; Sebald, 1980; Singh, 2001). *Leucas lavandulifolia* Sm. is a name used by Smith, while transferring *Leonurus indicus* of Linnaeus into *Leucas*. Linnaeus established *Leonurus indicus* (in L., Sys. Nat. ed. 10, 1101, 1759; and in L., Sp. Pl. ed. 2, 1763) based on Burman's specimens from India. While transferring *Leonurus indicus* in to *Leucas*, Smith (1812) used a *nomen novum L. lavandulifolia* because he found there exists already one *Leucas indica* based on *Phlomis indica* L. So in order to avoid repetition of names he used a new name and the subsequent workers have continued the same.

Willdenovio (1800) considered *Leonurus indicus* of Linnaeus as a variety under *Phlomis zeylanica*. In 1821, Roth used a new name *Phlomis linifolia* for a plant, which was wrongly named as *Phlomis zeylanica* by Murray (1774). This

plant was, in fact a specimen of *Leonurus inducus* of Linnaeus as revealed from the protologue (Roth, 1821).

In 1982, Flora Malesiana bulletin (Anonymous, 1982) has given a correction and according to them the correct name for *Leucas indica* will be *Leucas linifolia.* Notes given against this treatment point out that " Smith's name is illegitimate as a superfluous name since he cited *Leonurus indicus* as a synonym. *Leonurus indicus* can no longer be transferred to *Leucas,* because of *Leucas indica* R.Br. ex Spreng, based on *Phlomic indica* L."

Later, few workers also have used *Leucas indica* for this taxon (Moulali & Pullaiah, 1991) as according to them "*Leucas lavandulifolia* Sm. is a superfluous name as this plant already had a prior validly published name *Leucas indica* given by Robert Brown in 1875 (it is 1810; not 1875 as printed in the paper), based on *Leonurus indica*". They used ICBN articles in support of using the name *Leucas indica.*

Confusion still exists regarding the identity of *Leucas indica* based on *Phlomis indica* L. Very recently, Linnaeus typification project team attempted typifying Linnaean names in *Leucas* (Jarvis et al., 2001) and according to them *Phlomis indica =Leucas zeylanica* (L.) R.Br., as a "*syn. nov*" and a neotype has been selected for *Phlomis indica* by A. Paton [India, Nilgiri Hills, Pykara, 1879, *G.King s.n.* (K)]. Their conclusion also had given as "–This name has not been in use for

Fig. 39: Neotype of *Leucas indica* R.Br. (Herbarium G. King. *s.n.*; from K) [neotype designated by A.Paton]

many years. From Linnaeus' lengthy description, he evidently had mateial available to him but this is now lost. It seems very likely that this name referred to the same species which Linnaeus described as *P. zeylanica* in 1753, and a neotype has been chosen to formalize this, with *P. indica* now falling into the synonymy of *L. zeylanica*."

This treatment seems to me as a mistake because of various reasons. Linnaeus had mentioned two species in Species Plantarum (1753) and his treatment indicate that both *Phlomis indica* and *Phlomis zeylanica* are different taxa, seen by him. In the same way, Willdenovio's (1800) treatment indicate that *Phlomis zeylanica* and *Leonurus indicus* are different, and may be because of the close similiarity he has included the later as a variety of the former.

Because of this confusion, I went through the Linnaean literature on *Phlomis indica* and it seems that his description on *P. indica* is clear even though no type material exist now for supporting it. The calyx character given is sufficient to identity that *Phlomis indica* and *Leucas lavandulifolia* are the same. This forced me to check *Leonurus indicus* description and types (from BM), which ultimately revealed that both *Phlomis indica* and *Leonurus indicus* are taxonomis synonyms.

It may be because of following the mistakes in Gamble's identity, marked on the sheet that the specimen is *Leucas zeylanica*, Alan Paton reached in the wrong conclusion about *Phlomis indica* is the synonym of *L. zeylanica*. This mistake is

repeated by Gamble in his Flora of Presidency of Madras and is followed by many subsequent workers.

This fact has been informed to A. Paton, who neotypified the same. After a great deal of discussion with him and indirectly with the Steve Cafferty (of BM and who himself being one of the author of this article, appeared in Taxon 50, 507-523), my conclusion about the identity of *Phlomis indica* L. is found correct and accepted by them (personal correspondance). As a result of this the nomenclature is changed and which is given above.

Again, on receiving the type cibacrome of the neotype by A.Paton from Kew, I found one more error in the neotypified herbarium. The herbarium selected by A.Paton for typification is another variey established for this species by Hooker (1885), who treated this in *Leucas linifolia* (Roth) Spreng. As there are two varieties for this species, confirmed by this study on fresh specimens, the nomenclature again is found changed. This is because it is not possible to declare the selection of neotype (by A.Paton) invalid according to ICBN Article: **9.17** (St. Louis code, 2000) which says: "The author who first designate a lectotype or a neotype must be followed, but that choice is superseded if (a) the holotype or, in the case of a neotype, any of the original material is rediscovered; the choice may also be superseded if one can show that (b) it is in serious conflict with the protologue and another element is available that is not in conflict with the protologue, or that (c) it is contrary to Article 9.12". Since in Paton's neotype there is apparently no conflict

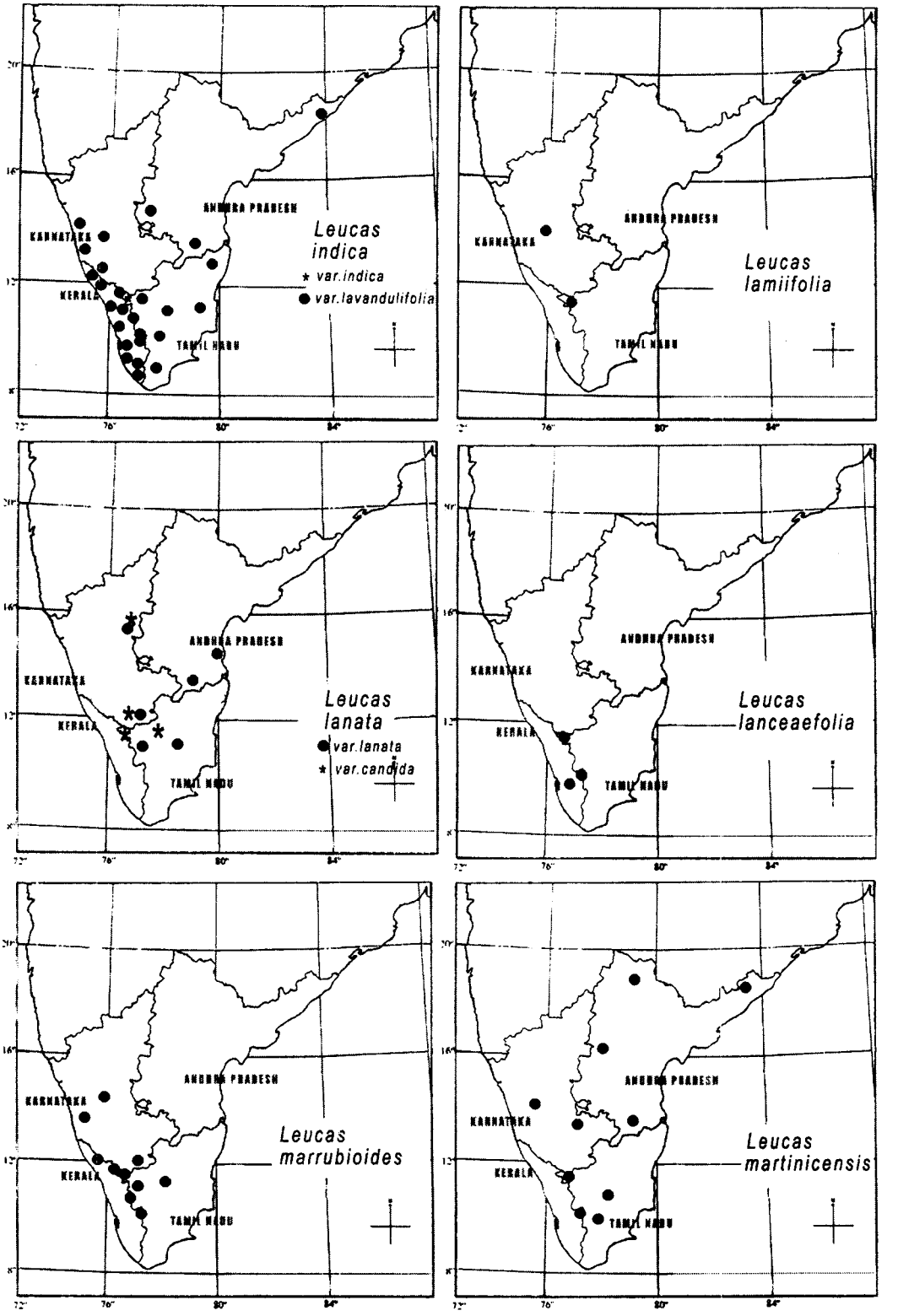


Fig.: 40. Distribution map of *Leucas* species in Southern Peninsular India.

with the protologue, it is choosen as a correct typification and based on this *Leucas linifolia* var. *decipiens* established by Hooker, will be changed into *Leucas indica* var. *indica* as this specimen is neotypified for *Phlomis indica* by A.Paton. Accordingly the other one variety become a new variety named here as *Leucas indica* var. *lavandulifolia* Sunojkumar *stat. nov.* (nomenclatural change in print)

14. Leucas lamiifolia Desf., in Mem. Mus. Natl. Hist. Paris 11: 4. t. 2. f. 1. 1824; Benth., Labiat. Gen. Spec. 3 (fasc. 6): 613. 1834; in DC., Prodr. XII: 529. 1848; Hook.f., Fl. Brit. India 4: 686. 1885; Gamble, Fl. Pres. Madras. 2: 1153. 1924; Mukerjee, Rec. Bot. Surv. India XIV (1): 175. 1940; Sriniv. in A.N.Henry et al., Fl. Tamil Nadu Ser. I. 2: 177. 1987; Pullaiah & Moulali, Fl. Andhra Pradesh 2: 772. 1997; V.Singh, Mon. Ind. Leucas 95. 2001.

—Type: India, Nellygerry, *Leschenault 299*. (holo. **P** !)

Erect, perennial, stout shrub, 1–1.75 m high, stem woody, thick, base 2–4 cm across, ligneous with thick periderm, profusely branching; branches obtuse angular, grooved, long tomentose to villous, hairs erect silvery 2–2.5 mm long; internodes 6–11 mm long, tender stem densely villous. Leaves opposite, petiole 1.5–2.5 cm long, villous; lamina 7–13 cm long 2.5–5 cm broad, two and half times longer than broad, coriaceous, lanceolate, tip acute, base long cuneate to shortly attenuate, margin serrate with 20–23 teeth, secondary veins 9–10, lower surface densely hispid, hairs 2

mm long, spreading, mainly on the veins, upper surface villous, hairs 2 mm long, in between the veins, glandular punctuate, margin ciliate. Inflorescence on terminal 3–4 axils, many and dense flowered, sub-globose, up to 3.5 cm across. Bracteoles 1.5 cm long, base 2.5 mm broad, as long as calyx, many, straight below the inflorescence, not forming an involucre, lanceolate, acute apex, densely villous outside and margins. Flowers very short to 2 mm long pedicellate. Calyx 1.3–1.5 cm long, tubular, base narrowed, middle bulged, throat slightly constructed, outside fully tomentose, upper half outside ribbed at the veins, hairs hispid 1–1.5 mm long, inside upper two third portion hispid with ±1 mm long hairs, mouth straight, cilia absent; teeth 10, stellately spreading, alternately long and short, 2–3 mm long, triangular, base 1–1.5 mm broad, tip acute, outside long tomentose, hairs 1 mm long, inside short pubescent. Corolla white, ±17 mm long, tube 10 mm long, included in the calyx tube, glabrous outside, inside a tuft of fleshy long hairs forming an annular ring about 7 mm from the base; lower lip 8 mm long, middle lobe 4.5 mm broad, emarginate, side lobes 2 mm broad; upper lobe 8 mm long, concave, strongly bearded with dense white hairs spreading in all directions, margin ciliate, hairs long. Staminal filaments hairy at middle, upper pair shorter than the lower pair; anthers 1.8 mm long, 0.57 mm broad. Disc cup shaped, 1.5 mm high, lobes almost equal. Ovary locules 1.2 mm high, rounded upper side. Style 15 mm long, stigma bilobbed, lower lobe ±0.7 mm long, upper 0.06 mm long. Nutlets 4 mm high, 2 mm broad, dark black coloured, shining, oblong, base narrowed, top almost rounded, acutely triangular in cross section.

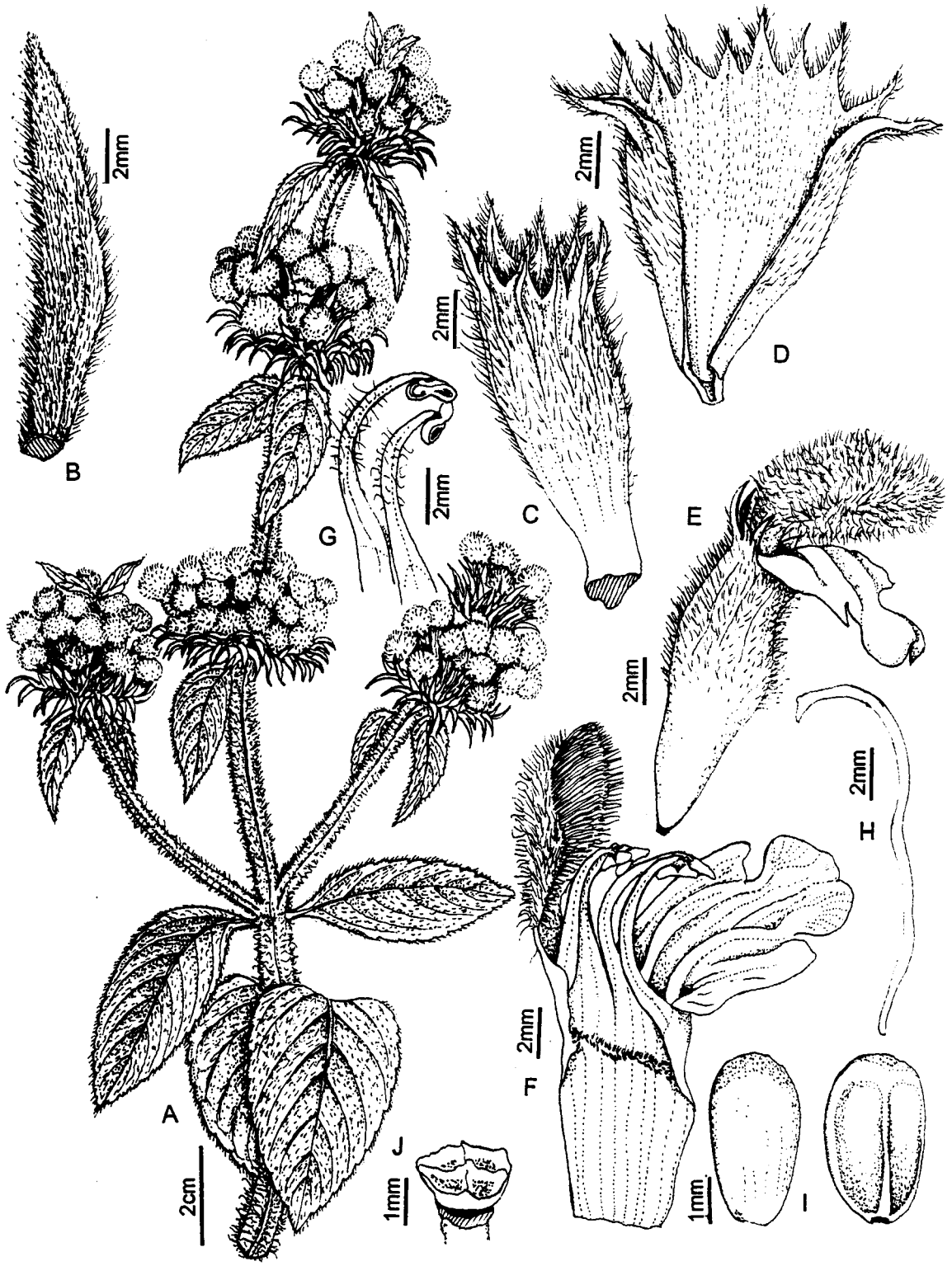


Fig. 41: *Leucas lamiifolia* Desf. A. Habit; B. Bracteole; C. Calyx; D. Calyx split open; E. Flower; F. Corolla split open; G. Stamens; H. Style & stigma lobes; I. Nutlets; J. Disc.

Etymology: The species name '*lamiifolia*' means 'Lamium like leaves', denoting the similarity of this plant with the genus *Lamium.*

Flowering and fruiting: December—March.

Habitat: This shrub is growing only on the hilltops at an altitude above 1500 m, on the shola margins and among other shrubby plants.

Distribution: South Indian endemic found growing in the hilltops of Nilgiris and Kudachatri hills only; very rare.

Specimens examined: India orientali, *Wight 2163* (CAL); **KARNATAKA: Shimoga Dt**.: Kudachadri hilltop, 12th Feb. 2003, *Sunojkumar CU88126* (CALI); **TAMIL NADU: Nilgiris Dt**.: Coonoor, Old mount, Mar 1883, *J.S.Gamble 11578* (CAL, MH); Muttanad, 13th Apr. 1916, *C.E.C.Fischer 3941* (CAL); Kotagiri, Apr. 1918, *s. coll. RDA 347* (MH); Bikkapattimund, 15th Jan. 1921, *C.E.C. Fischer 4610* (CAL); Near East Varahapallam dam, 22nd Dec. 1970, *B.V.Shetty 37543* (MH); Ebanad to Bikkapattimund, 12th Sept. 1970, *G.V.S.Rao 36642* (MH); Kinnakurai to Carrington, 3rd Jan. 1971, *B.V.Shetty 36785* (MH).

15. Leucas lanata Wall. ex Benth. in Wall., Pl. As. Rar. 1: 61. 1830; Labiat. Gen. Spec. 3 (fasc. 6): 607. 1834; in DC., Prodr. XII: 525. 1848; Hook.f., Fl. Brit. India 4: 681. 1885; Cooke, Fl. Bombay Pr. 2: 468. 1906; Prain, Bengal Pl. 856. 1908; Haines, Bot. Bihar & Orissa 4: 747. 1922; Gamble, Fl. Pres. Madras 2: 1151. 924; Duthie, Fl. Upp. Gangetic plain. 2: 114. 1960; R.R.Rao & Razi,

Syn. Fl. Mysore Dist. 511. 1981; J.R.Press in H. Hara et al., En. Fl. Pl. Nepal 3: 156. 1982; Sriniv. in A.N.Henry et al., Fl. Tamil Nadu Ser. I. 2: 177. 1987; N.P.Singh, Fl. East Karnataka 2: 518. 1988; Hedge in Nasir & Ali (eds.), Fl. W. Pakistan 192: 157. 1990; Pullaiah & Moulali, Fl. Andhra Pradesh 2: 772. 1997; V.Singh, J. Econ. Taxon. Bot. 22(2): 389. 1998; K.M.Mathew, Fl. Pulney hil. 2: 996. 1999; V.Singh, Mon. Indian Leucas 97. 2001.

—Type: Indiae orientali, Deyra Dhoun, Sirmore, Kamaon, 1825, *Wight s.n.* Wall. Cat. Herb. no. *2055*. (holo. **K** !; iso. **K** cibachrome !)

Marrubium mollissimum D.Don, Prodr. Fl. Nepal 112. 1825.

Leucas collina Dalz in Hook.f., Kew. J. 2: 338. 1850.

Leucas lanata sensu Baker, Fl. Trop. Africa 5: 482. 1900 *non* Benth. 1830

Leucas lanata var *nagpurensis* Clarke in Haines, Bot. Bihar & Orissa 4: 747. 1922.

a. var. **lanata**

Perennial herb, up to 60 cm height, semi woody basal stem and root stock, base up to 1 cm thick, branches herbaceous, spreading, 3–5 mm thick, obtusely quadrangular, not grooved, densely woolly or sub silky, hairs erect or spreading; internodes 3–6 cm long. Leaves opposite, petiolate; petiole 5–10 mm long, tomentose; lamina 3.5–5.5 cm long, 1.6–2.5 cm broad, one and half times longer than broad, thick, chartaceous, usually ovate sometime ovate lanceolate or ovate oblong, acute sometime obtuse, base rounded sometime triangular or slightly cuneate, margin crenate serrate with 11–22 small teeth, lateral veins 4–5, impressed above, lower side shining with dense soft silky tomentose hairs, ±1 mm long, upper

side less dense tomentose. Inflorescence in many axillay clusters towards the tip, many dense flowered. Bracteoles many, linear, erect, as long as calyx 10–12 mm long, 0.7–0.8 mm thick, filiform due to 1–1.5 mm long dense silky villous hairs. Flowers pedicellate; pedicel 1–1.5 mm long. Calyx ±10 mm long, straight, tubular, cylindrical thick and chartaceous, prominently 10 ribbed along veins, outside dense silky villous, inside glabrous at lower half, tomentose at upper half and hairs projects out of the mouth, mouth straight, rim annulate with a ring of thick veins; teeth 10, alternately long and short, 2–3 mm long, base 0.9–1.1 mm broad, triangular, acute tip filiform base broad, silky tomentose; fruiting calyx up to 12 mm long. Corolla white, 14–15 mm long; tube fully included in the calyx, 6–7 mm long, annulate inside middle with a ring of fleshy hairs; lowerlip 8 mm long, middle lobe emarginate, 6 mm broad, side lobes 2 mm broad at the free end, slightly overlapping with middle lobes, margins revolute, upper lobe 6 mm long, concave, outside hairs white spreading, margin cilate. Staminal filaments hairy at middle, upper pair shorter; anther lobes reddish coloured, 1mm long, 0.5 mm broad. Disc flattened cup shaped lobes reduced, abaxial side slightly longer. Ovary locules 5–6 mm long, top triangular. Style 15 mm long; stigma unequally lobbed, lower lobe 0.99 mm long, slightly bent, upper lobe 0.09 mm long. Nutlets 1.4 mm long, 1.1 mm broad at middle, oval shaped, dark brown, shining, top flat triangular, truncate, obtuse edges, obtusely triangular in cross section.

Etymology: The species name denotes the 'woolly, long, curly hairs' characteristic of the plant.

Fig. 42: Type specimen of *Leucas lanata* Benth. (Wight s.n.; from K)

Flowering and fruiting: August—March.

Habitat: The species is found in deciduous forest openings; above 1000 m.

Distribution: In Asian countries like India, Indo-China, Myanmar, Nepal, Pakistan, South China and Thailand. In South India it is found in Andhra Pradesh, Karnataka and Tamil Nadu.

Specimens examined: **ANDHRA PRADESH**: **Chitoor Dt.**: Talakona, 7th Nov. 1987, *D.Rangacheryulu 1798* (MH); **Nellore Dt.**: Mullemkonds hills block-B Velikonds reserve, 26th July 1914, *M.S.Ramaswami 1256* (CAL); **KARNATAKA: Mysore Dt.**: Bandipur, Oct. 1910, *A.Meebold 11462* (CAL); Nandi Droog, 17th Sept. 1911, *R.D.Anstead M121* (MH); Bandipur Hanumat koil, 26th, Jan 1965, *B.D.Naithani 23169* (MH); **TAMIL NADU: Coimbatore Dt.**: Honnathitta rest house compound, 16th Feb. 1965, *K.N.Subramaniam 1854* (FRC); Kudiramadai, 29th July 1930, *V.Narayanaswamy 3945* (MH); Hassanur, 9th March 1931, *K.C.Jacob & F.David 154* (MH); Thekkumalai, 12th Dec. 1956, *K.M. Sebastine 1735, 1986* (MH); Vadakkumalai Vettakarankoil, 8th Jan 1970, *M.V.Viswanathan MVV364* (MH); **Nilgiris Dt.**: Segur river bank, 25th Aug. 1970, *G.V.S.Rao 36287* (MH); Kunjapanai, 1st Feb. 1972, *E.Vajravelu 43608* (MH); Kiel Kunda Pegumba halli, 17th Feb. 1973, *E.Vajravelu 43608* (MH); Ramadoorg, 1880, *R.H.Beddome 41695* (MH); Masamagudi, Kallathi Road, 19th Feb. 1982, *K.N.Subramanian 7954* (FRC); **Salem Dt.**: Periyakalrayans, 26th June 1978, *K.Murugesan 14903* (CAL); **South Arcot Dt.**: Melpat, 29th Sept. 1899, *C.A.Barber 1113* (MH).

Notes: In Baker's Flora of tropical Africa, *Leucas lanata* Benth.is mentioned. But there is no specimen of *Leucas lanata* Benth. collected from Africa in any herbaria of Europe. This information is available from Dr. Oskar Sebald of Germany who confirmed the same while working for African revision of *Leucas* and according to him it is a mistake in Baker's flora (personal communication).

b. var. **candida** Haines, Bot. Bihar Orissa 4: 747. 1922; Gamble, Fl. Pres. Madras 2: 1151. 1924; V.Singh, J. Econ. Taxon. Bot. 22(2): 389. 1998 & Mon. Indian Leucas 100. 2001.

—Type: India, Orissa, Sirguja Mountains, *Haines s.n.* (holo. **K** cibachrome !)

Differ from var. *lanata* this is having the stem and leaves clothed with dense shining white tomentum. Leaves coriaceous not thick, upper surface hispid, veins not impressed, dark brown in dry specimens. Bracteoles shorter than half the size of calyx, up to 5 mm long and 4 mm braoad. Pedicels 1–3 mm long; calyx not thick and fleshy, teeth slightly smaller, 1–1. 5 mm long.

Flowering and fruiting: August–February, occasional flowering is noticed in other months also in many herbarium records.

Habitat: In the margins and openings of shola forests and evergreen forests; above 1500 m. altitude.

Distribution: Endemic to India, found in Karnataka, Orissa and Tamil Nadu.

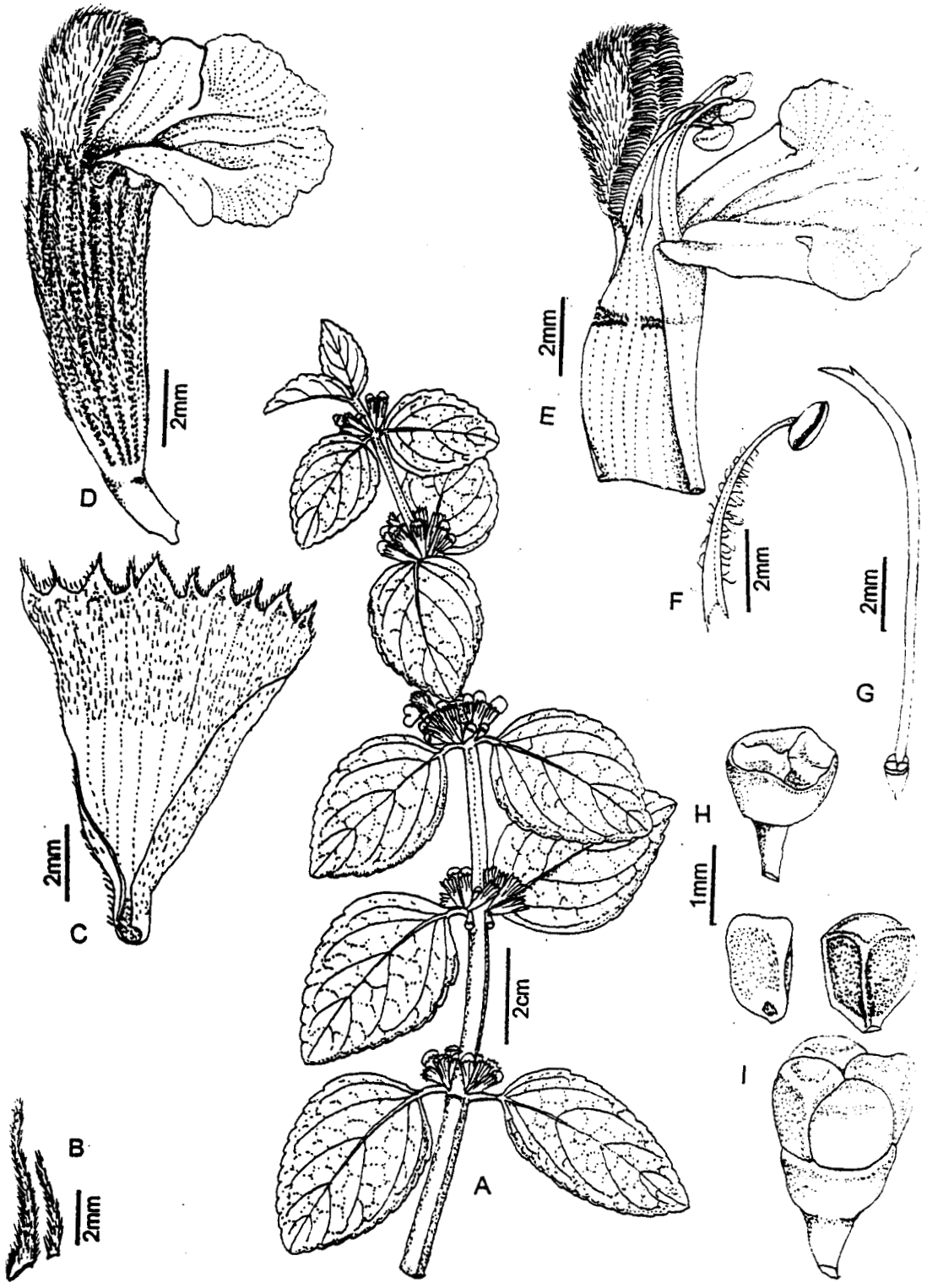


Fig. 43: *Leucas lanata* var. *candida* Haines. A. Habit; B. Bracteole; C. Calyx split open; D. Flower; E. Corolla split open; F. Stamen; G. Pistil; H. Disc; I. Nutlets.

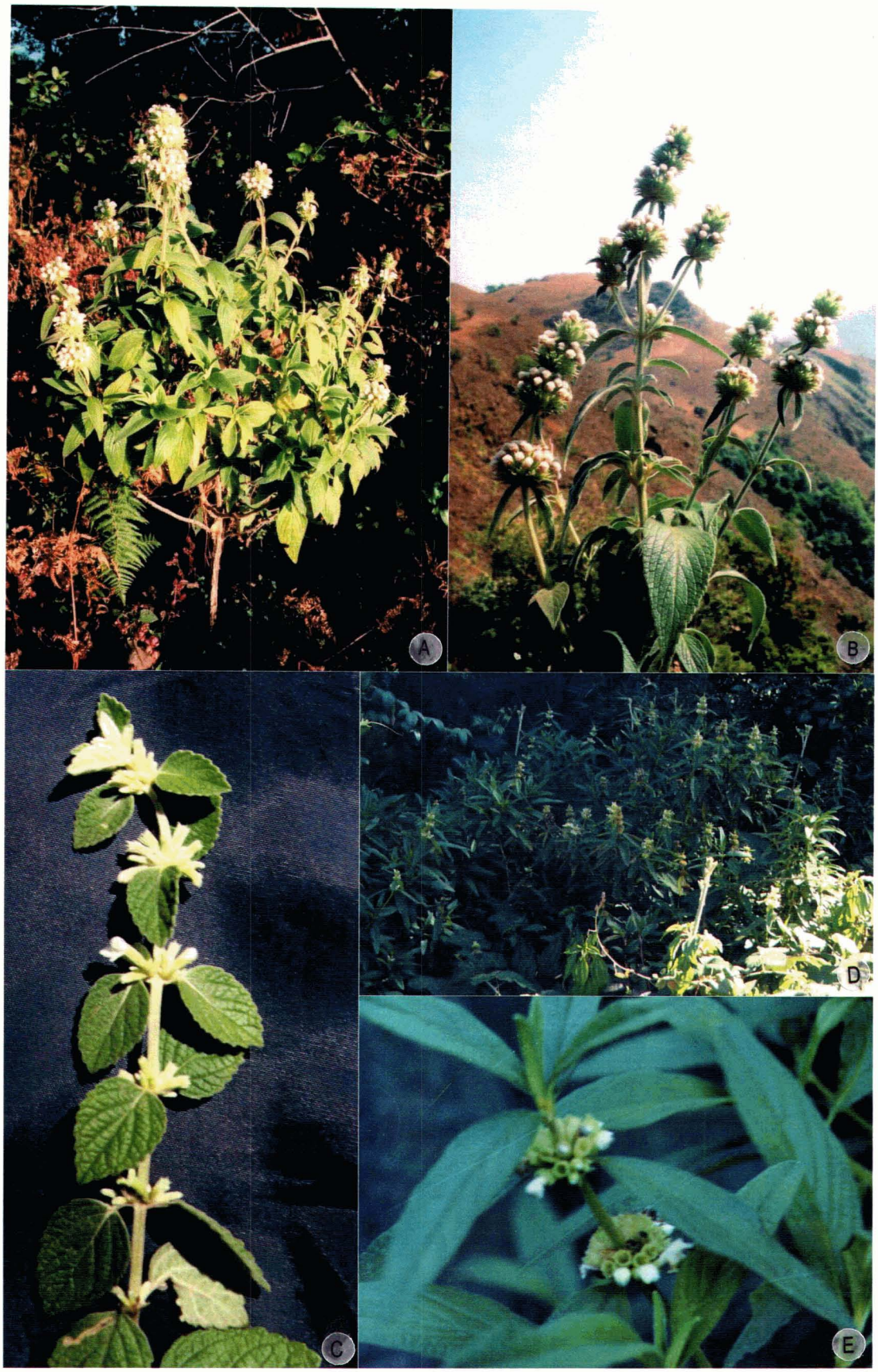


Fig. 44: A - B *Leucas lamiifolia* Desf.; C. *Leucas lanata* var. *candida* Haines. D - E. *Leucas lanceaefolia* Desf.

Specimens examined: **KARNATAKA: Bellary Dt**.: Ramadroog, 1880, *H. Beddome s.n.* (MH); **Mysore Dt**.: Nandi Droog, 17th Sept. 1911, *R.P.Anstead M121* (MH); on the top of a hill near Hanumat koil Bandipur, 26th Jan. 1965, *B.D. Naithani 23169* (MH); **TAMIL NADU: Nilgiris Dt**.: Marappalam, 31st July 1957, *K.M.Sebastine 4102* (MH); near Woodbridge estate Gudalur, 18th Nov. 1958, *K.M.Sebastine 7398* (MH); way to Mamoram kunjapanai, 4th Aug. 1970, *E. Vajravelu 35208* (MH); Segur park towards Sokkanahalli, 23rd Aug. 1970, *G.V.S. Rao 36210* (MH); Bimaka shoa, 25th Aug. 1970, Sirur to Ebanad, 30th Aug. 1970, *G.V.S.Rao 36453* (MH); *G.V.S.Rao 36287* (MH); Marappalam Burliar Road side, 29th Apr. 1971, *N.C.Radhakrishnan 38130* (MH); Bokkapuram reserve forest, 21st Nov. 1971, *N.C.Radhakrishnan 38945* (MH); 19th Feb. 1972, *B.D.Sharma 39855* (MH); Marappalam forest, 7th July 1973, *E.Vajravelu 44342* (MH); Marapalam-Burliar road side, 21st Dec. 2002, *Sunojkumar CU88127* (CALI); **Periyar Dt**.: Dhimbam Hassanur Forest, 24th Aug. 1984, *E.Vajravelu 80670* (MH).

16. Leucas lanceaefolia Desf., in Mem. Mus. Natl. Hist. Paris 11: 5. t. 2, f. 2. 1824; Benth. in Wall., Pl. As. Rar. 1: 61. 1830; Labiat.. Gen. Spec. 3 (fasc. 6): 1834; in DC., Prodr. XII: 529. 1848; Hook.f., Fl. Brit. Ind. 4: 685. 1885; Fyson, Fl. Nilgiri & Pulney 1: 334. 1915; Gamble, Fl. Pres. Madras 2: 1153. 1924; Mukerjee, Rec. Bot. Surv. Ind. XIV (1): 174. 1940; Sriniv. in A.N.Henry et al., Fl. Tamil Nadu Ser. I. 2: 177. 1987; Wight, Icon. Pl. India Orient. IV: 3. t.

1452. 1849; Manilal, Fl. Silent Valley 219. 1988; Pullaiah & Moulali, Fl. Andhra Pradesh 2: 772. 1997; K.M.Matthew, Fl. Pulney hills 2: 996. 1999; V.Singh, Mon. Indian Leucas 102. 2001.

—Type: India, Nellygerry, *Desfontaine, 77* (holo. **P** !)

Leucas lanciformis Wall., Cat. Herb, Ind. No. 2759. 1831. *nom. nud.*

Perennial shrub, erect, 2–2.5 m high, stem thick and woody, 2–3.5 cm across, branches obtusely quadrangular, longitudinally grooved, often appear as terete in tender branches, rufus tomentose with short dense erect hairs 0.5 mm; internodes 3–10 cm. Leaves opposite, decussate; petiole 0.5–1 cm, tomentose; lamina 6–10 cm long, 1–2.5 cm broad, coriaceous, lanceolate, sub acute or obtuse, narrowed to short cuneate at base, margin entire or crenulate from the middle upwards, sometime slightly revolute, lower surface white tomentose veins projecting, upper surface scaberulous, hairs minute pubescent, gland dotted; in dried specimen dark above and grey beneath. Inflorescence in terminal 4–5 axils, dense, many flowered, up to 2.5 cm across. Bracteoles 7–10 mm long, as long as calyx, thick, linear laneolate, divergent, spinulose tip, tomentose, hispid, hairs 0.5–1 mm long. Flowers almost sessile. Calyx 8–10 mm long, tubular straight, campanulate, outside fully tomentose, veins longitudinally ribbed and ending in teeth, inner glabrous, mouth wide circular, veins forming a thick annulus at the rim, long ciliate, hairs erect, as long as teeth; teeth 10, sub-equal, 0.5–1 mm long, subulate erect spine tipped, tomentose. Corolla 14 mm long, white, tube ±9 mm long, slightly bent and half inserted in the calyx tube; upper half hairy outside, inside not annulate, provided

with minute glandular hairs below the stamens; lower lip 6 mm long, tri-lobed, middle lobe slightly emarginate, 5 mm broad at the free end, side lobes 2 mm broad at the free end, 1.5 times longer than broad; upper lip ±4 mm long, concave outside, densely bearded, hairs white. Stamens bent sometime seen outside, provided with few arachenoid hairs at middle, glandular hairs at base; anther lobes 1.35 mm long, 0.42 mm broad, theca divaricate. Disc shallowly cup shaped, slightly four equal lobbed. Style ±13 mm long; stigma bi-lobed, lower lobe 0.5 mm long, upper lobe reduced. Nutlets 3.5 mm long and 1.5 mm broad, light brown coloured, trigonous lower side, smooth shining, oblong at distal side, top rounded.

Etymology: The species name denotes the 'lanceolate leaf' of the plant.

Flowering and fruiting: Peak flowering season is September–March, occasional flowering occurs in other seasons also.

Habitat: Found only in the margins of shola forests and among bushes, at an altitude ranging from 1500–2500 m. This plant require typical shola climate to flourish.

Distribution: Endemic to South India, found in Kerala and Tamil Nadu in an area coming under Nilgiri Biosphere reserve and Anamudi ranges.

Specimens examined: Peninsular India Orientalis, *Wight 2152* (CAL); **KERALA: Idukki Dt.**: Eravikulam hut, western slopes, 4th Dec. 1982, *P.Bhargavan 87332* (CAL, MH); Upper vaguvarai, Dhanar valley, 18th Oct. 1989, *P.Bhargavan 90999* (MH); **Kottayam Dt.**: Umaiya malai shola, 17th Nov. 1965, *B.V.Shetty 26489* (MH);

Fig.: **45**. *Leucas lanceaefolia* Desf. A. Habit; B. Bracteole; C. Calyx; D. Calyx split open; E. Flower; F. Corolla split open; G. Stamens; H. Pistil; I. Disc; J. Nutlets.

Kanthaloor forest, 24th Jan.1964, *K.M.Sebastine 18429* (MH); Near Mannavan shola, way to Kanthalloor, 30th Mar. 1978, *Nambiar 269* (KFRI); **TAMIL NADU: Nilgiris Dt**.: Ooty, 20th Mar. 1870, *C.B.Clarke 11096* (CAL); Ootacamund, 6th Sept. 1876, *G.King 112* (CAL); Ootacamund, May 1883, *J.S.Gamble 1147* (CAL); Dodabetta, Jan. 1883, *J.S.Gamble 11938* (CAL); Ootacamund, Sept. 1884, *J.S.Gamble 15328* (CAL); Ootacamund, Oct. 1910, *A.Meebold 11785* (CAL); Ootacamund, Kodapamund, 16th Sept. 1930, *V.Narayanaswami 4397* (MH); Ooty, Governer shola, 9th July 1970, *J.L.Ellis 34546* (MH); Pykara, 31st Aug. 1970, *B.D.Sharma 35958* (MH); Archpooza, Upper Bhavani, 1st June 1970, *B.V.Shetty 34021* (MH); Upper Bhavani to Bangitappal, 19th Dec. 1070, *B.V.Shetty 37491*(MH); Pykara grassy slopes, 21st Oct. 1972, *J.L.Ellis 43277* (MH); Nilgiri peak RF, Mudimund 4th Feb. 1971, *J.L.Ellis 37845* (MH); Dodabetta, 27th Nov. 1971, *N.C.Radhakrishnan 39030* (MH); Bangihalla, 4th Apr. 1972, *K.Vivekanandan 40698* (MH); Bangihalla to Bangitappal, 21st Oct. 1972, *K.Vivekanandan 43008* (MH); Pykara, Orchidarium-Glenmorgan road, 17th Oct. 1981 *E.Vajravelu 76484* (CAL, MH); Ooty-Avelanchi dam, 3rd June 2001, *Sunojkumar CU49652* (CALI); Dodabetta peak, 27th Dec. 2002, *Sunojkumar CU 881199* (CALI).

Note: This plant can be distinguished from all other species by its tall (up to 2 m.), woody, structure. The leaves are chartaceous, thick and entire. Often this plant is noticed in interior parts of Shola forests.

Fig.46: (A) *Leucas lanceaefolia* Desf. (isotype); (B) *Leucas helianthemifolia* Desf. (holotype); (C) *Leucas lamiifolia* Desf. (isotype); (D) *Leucas marrubioides* Desf. (holotype)

17. Leucas marrubioides Desf., Mem. Mus. Natl. Hist. Paris 11: 6. t. 3. f. 1. 1824; Benth. in Wall., Pl. As. Rar. 1: 61. 1830; Lab. Gen. Spec. 3 (fasc. 6): 611. 1834; DC., Prodr. XII: 528. 1848; Thw., Enum. Pl. Zey. 240. 1860; Hook.f., Fl. Brit. India 4: 683. 1885; Trimen, Handb. Fl. Ceylon III: 385. 1895; Fyson, Fl. Nilgiri & Pulney 1: 330. 1915; Gamble, Fl. Pres. Madras. 2: 1152. 1924; Mukerjee, Rec. Bot. Surv. India XIV (1): 181. 1940; Abeywick., Ceylon J. Sci., Biol. Sci. 2 (2): 220. 1959; Gandhi in C.J.Saldanha & Nicolson, Fl. Hassan Dist. 504. 1976; L.H.Cramer in Dassan. & Fosberg (eds.), Rev. Handb. Fl. Ceylon III: 185. 1981; R.R.Rao & Razi, Syn. Fl. Mysore Dist. 512. 1981; Sriniv. in A.N.Henry et al., Fl. Tamil Nadu Ser. I. 2: 177. 1987; Ramach. & V.J.Nair, Fl. Cannanore 367. 1988; K.R.K.Murthy & Yoganar., Fl. Coorg. Dist. 358. 1990; K.M.Matthew, Fl. Cent. Tamil Nadu 404. 1991; Fl. Pulney hills. 2: 996. 1999; V.Singh, Mon. Indian Leucas 115. 2001.

—Type: Ceylon, *Desfontaine s.n.* (holo. **P** !)

Leucas indica Moon, Cat. Pl. Ceylon: 44. 1824 *nom nud.*

Leucas javanica Benth. var. *montana* Zoll., Nat. Geneesk. Arch. N. 1. 2: 569. 1845; Miq., Fl. India Bat. 2. 980. 1859.

Leucas marrubioides var. *pulneyensis* Fyson, Fl. Nilgiri & Pulney 1: 331. 1915.

Leucas javanica Benth. forma *montana* (Zoll.) Backer & Brink, Fl. Java 2: 622. 1965.

Straggling annual or short-lived perennial herb; branches spreading, 30–75 cm long, basal stem 3.5 mm thick, tender stem acutely quadrangular, not grooved,

tomentose, hairs ±0.3 mm long, retrorse; internodes 5–9 cm long. Leaves opposite, decussate, petiolate; petiole up to 2.5 cm long in vegetative axis, short up to 0.5 cm in flowering axis, tomentose; lamina 2.5–4.5 cm long, 2–3 cm broad ovate to sub-orbicular, tip obtuse to rounded, base rounded to cordate, margin serrate to crenate with 8–9 teeth, reticulate, side-veins 3–5, lower side silky dense tomentose in between the veins and appear white hoary in dried specimens, upper rather rugose due to impressed veins and lax tomentose hairs. Inflorescence in several lax axillary verticils in flowering branches, 8–12 flowers in each cluster. Bracteoles not many; 5–10 mm long, 0.2–0.4 mm broad at base, as long as calyx or smaller, straight, filiform, dense soft silky villous outside and margins. Pedicels short up to 0.5 mm long. Calyx tubular, 5–6.5 mm long at anthesis, slightly enlarged in fruit, straight, campanulate, prominently ribbed outside, silky villous, glabrous within, mouth straight; teeth 10, unequal 2–3 mm long, filiform, hairs silky villous. Corolla white, ±17 mm long, tube 8 mm long, included in the calyx tube, inside middle annulate with a ring of hairs; lower lip 8.5–9 mm long, middle lobe 7–7.5 mm broad, free end emarginate, lateral lobes 2 mm broad at free end, slightly revolute, upper lip 4 mm long, concave, hardly bearded with white soft hairs outside. Stamens fully included in the upper lip of corolla, lower pair longer, filaments hairy in the middle; anthers 0.8 mm long, 0.5 mm broad. Disc cup shaped with abaxial lobe slightly longer than the other lobes. Ovary locules 0.2 mm high, above moderately rounded. Style 11.5 mm long, upper side slightly bent, stigma bilobbed, lower lobe longer 0.75 mm long, upper lobe 0.12 mm long. Nutlets 1.8 mm long, 1 mm broad, dark brown, not smooth, oblong, obtusely triangular in cross section, top rounded.

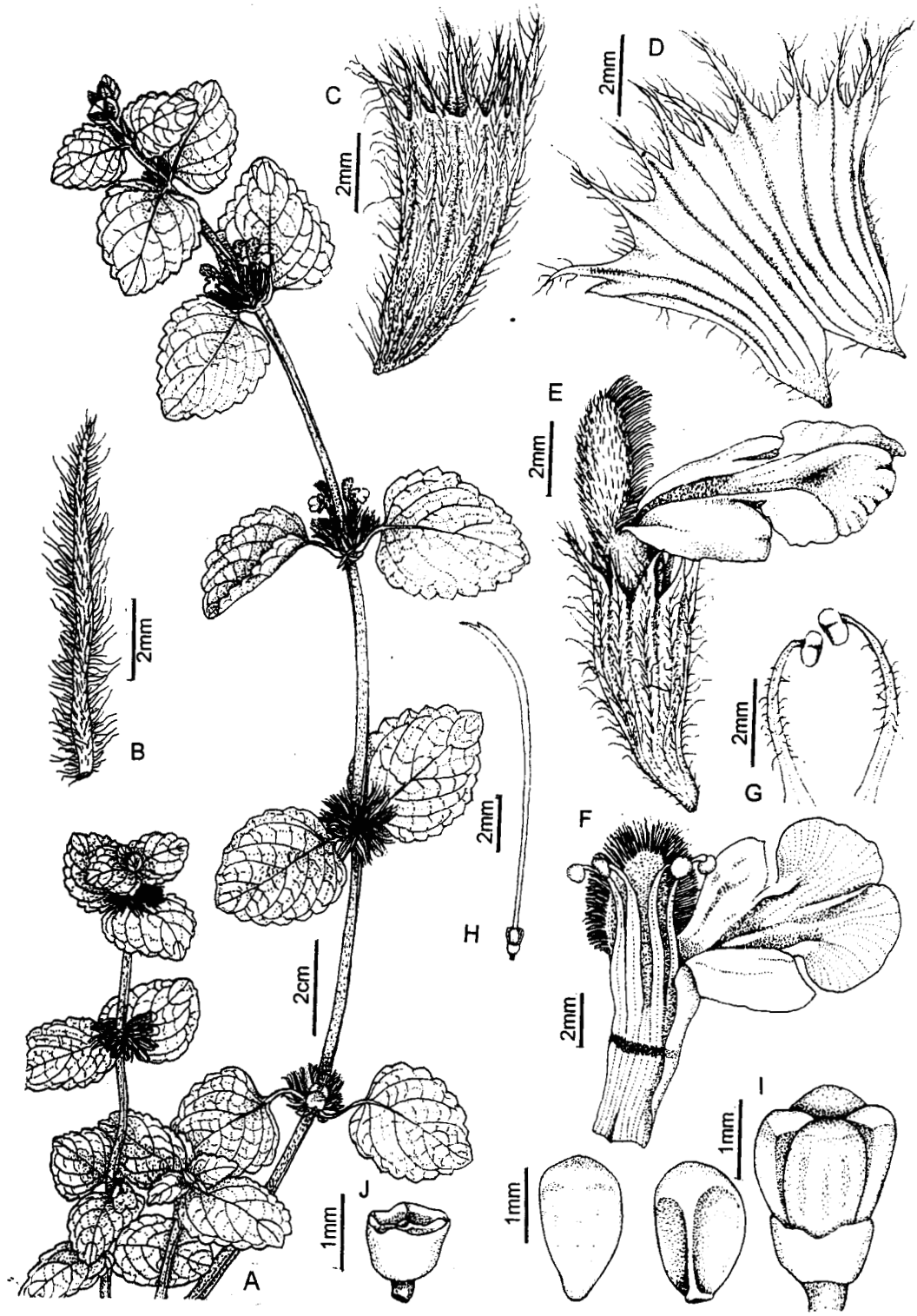


Fig.: **47.** *Leucas marrubioides* Desf. A. Habit; B. Bracteole; C. Calyx; D. Calyx split open; E. Flower; F. Corolla split open; G. Stamens; H. Pistil; I. Nutlets J. Disc.

Etymology: The species name appertain the relationship of this plant with its close relative '*Marrubium peregrinum*'

Flowering and fruiting: August–January

Habitat: Found in the margin and openings of semi-evergreen forests in Western and Eastern Ghats, on the grasslands and roadsides; altitude up to 1000 m.

Distribution: Found in all South Indian states, Sri Lanka and Malaysia.

Specimens examined: **KARNATAKA: Chikmagalore Dt.**: Kalledevarapura, 30th Nov. 1978, *S.R.Ramesh & K.R.Keshavamurthy KFD4965* (CAL); Aldur road, 26th Dec. 1978, *K.R.Krishnamurthy & party KPP5089* (CAL); Kemmangundi, 1st Dec. 1983, K.*Shanthi 1173* (CALI); Kemmangundi, 13th Dec. 2002, *Sunojkumar CU88107* (CALI); **Mysore Dt.**: Hannagerigudda near Tirthumala, 28th Sept. 1962, *R.S.Raghavan 82734* (CAL); Kanagalyudda near Tirthahalli, 19th Aug. 1963, *R.S.Raghavan 90029* (CAL); Bandipur, 24th Aug. 1964, *B.D.Naithani s.n* (MH); **Shimoga Dt.**: Agumbae, 2nd Dec. 1983, *C.C.Leena s.n* (CALI); **KERALA: Idukki Dt.**: Kumili, Dec. 1910, *A.Meebold 12998* (CAL); Thekkady, 27th Jan. 1965, K.Vivekanandan, 23009 (MH); Thekkady, Okkarai, 29th Sept. 1972, *B.D.Sharma 42362* (MH); Thekkady, 23rd Dec. 1974, *K. Vivekanandan 23009* (MH); Thekkadi, 8th Oct. 1976, *K.Vivekanandan 48611* (MH); Ramakkalmedu, 16th Nov. 2001, *Sunojkumar CU49678* (CALI); **Kannur Dt.**: Tolpetty RF, 21st Nov. 1977, *V.S.Ramachandran 52277* (CAL, MH); Hill dale, 17th Nov. 1978, *V.S.Ramachandran 58774* (CAL, MH); Begur R.F, 3rd Mar. 1979, *V.S.Ramachandran 62015* (CAL, MH); **Palakkat Dt.**: Siruvani, 22nd Nov. 1990,

L.Sailaja 3650 (CALI); **Wyanad Dt**.: Kuppadi, Sultan Bathery, 6th Feb, 1964, *J.E.Ellis 185521* (MH); Kuppadi RF, 5th June 1985, *R.T.Balakrishnan 42012* (CAL); 12th Aug, 1964, *J.E.Ellis 19946* (MH); **TAMIL NADU: Coimbatore Dt**.: Kollegal, 7th July 1930, *V.Narayanaswami 3694* (MH); Aiyinigiri Betta, Gedderal, 15th Mar. 1931, *K.C.Jacob 347* (MH); Thekkumalai, 25th Oct. 1956, Forest College campus, 12th Dec. 1982, *S.K.Nair 35821* (CALI); *K.M.Sebastine 848* (MH); SBI campus, 5th Jan, 1987, *N.Bhanu 4022* (CALI); **Namakkal Dt**.: Kollimalai-Solakadu, 26th Dec. 2000, *Sunojkumar CU49645* (CALI); **Nilgiris Dt**.: Ootacamand, Sept.1883, *J.S.Gamble 12702* (CAL); Coonoor Ooty old road, 1883, *J.S.Gamble s.n.*(MH); Gudalur, Nov. 1884, *J.S.Gamble 15569* (MH); Coonor, Oct. 1889, *J.S.Gamble 21431* (MH); Near Benne rest house, 16th July 1950, *K.Subramanyan 10388* (CAL, MH); Thekkumalai, 25th Sept. 1956, *K.M.Sebastine 848* (CAL); Road to Kodanad, Kotagiri, 1st Jan, 1957, *K.Subramanyan 1933* (MH); Near woodbriar estate – Gudalur, 18th Nov. 1958, *K.M.Sebastine 7398* (CAL); Way to Dodabetta from Kargudi, 23rd June 1970, *B.V.Shetty 34376* (MH); Shola near Kodanad estate, 21st July 1970, *E.Vajravelu 35002* (MH); Shola near view point, Kodanad, 12th Nov. 1970, *E.Vajravelu 36850* (MH); Doddai Kombai, 4th Jan. 1971, *B.V.Shetty 37008* (MH); Curzon valley, 24th Jan. 1972, *E.Vajravelu 39618* (MH); Forest near Mulli, 1st Aug. 1975, *E.Vajravelu 46398* (MH); Kodanad view point, 26th Dec. 2002, *Sunojkumar CU88114* (CALI); **Salem Dt**.: Shevaroys orchidarium, 2nd Dec. 1964, *A.V.N.Rao 18274* (MH); Yercaud, Kaveri peak, 4th Nov. 1968, *D.B.Deb 31257* (MH); Yercaud, Way to Manjakuttai, 15th Feb. 1969, *D.B.Deb 31393* (MH); Yercaud Ladies seat, 7th Nov. 1978, *N.Venugopal RHT 19083* (CAL); Yercaud, 16th

Dec. 1982, *K.P.V.Prabha 36239* (CALI); Yercaud, 15th Dec. 1983, *Vijayan 35945* (CALI); Yercaud, 24th Dec. 2000, *Sunojkumar CU49641* (CALI).

Notes: This species can be distinguished from its close allies *Leucas montana* and *Leucas mukerjiana* by the leaf possessing tomentose texture consisting of curly marrubioid haires.

18. Leucas martinicensis (Jacq.) R.Br. in Ait.f., Hort. Kew. ed. 2, 3: 409. 1811; Sm. in Rees, Cycl. XX. 1812; Spreng. in L., Syst. Veg. ed. 16, II: 744. 1825; Benth., Labiat. Gen. Spec. 3 (fasc. 6): 617. 1834; Meyer, Comm.1 (2): 242. 1837; Rich., Tent. Fl. Abyss. 2: 200. 1851; Benth. in DC., Prodr. XII: 533. 1848; Schweinf., Beitr. Fl. Aeth.: 123. 1867; Hook.f,. Fl. Br. India 4: 688. 1885; Engler, Hochgeb. Fl. Trop. Africa: 370. 1892; Gurke, Bot. Jahrb. Syst. 22: 135. 1895; Baker, Fl. Trop. Africa 5: 479. 1900; Hiern, Cat. African Pl. Welw. 4: 876. 1900; Cooke, Fl. Bombay Pr. II: 467. 1906; Prain, J. As. Soc. Beng. LXXIV. 2: 718. 1907; Prain, Bengal Pl. 856. 1908; Skan, Fl. Capensis 5 (1): 371. 1910; Haines, Bot. Bihar & Orissa 4: 750. 1922; Blatter, Fl. Arabia 8: 381. 1923; Gamble, Fl. Pres. Madras 2: 1149. 1924; Schartz, Fl. Trop. Arabia: 222. 1939; Mukerjee, Rec. Bot. Surv. India XIV (1): 169. 1940; Cufodontis, Enum. Pl. Aeth.: 810. 1962; Andrews, Flow. Pl. Sudan 3: 215. 1956; Morton in FTWA ed. 2, 2: 470. 1963; Launert & Schreiber, Prod. Fl. Southwest Africa 123: 18. 1969; Angulo, Bull. Jard. Bot. Nat. Belg. 40: 377. 1970; Gandhi in

C.J.Saldanha & Nicolson, Fl. Hassan Dist. 504. 1976; V.N.Naik, Fl. Osmanabad 274. 1979; Sebald, Stuttgarter. Beitr. Naturk. Ser. A 341: 179. 1980; R.R.Rao & Razi, Fl. Mysore Dist. 512. 1981; Codd. in Leistner, Fl. Southern Africa 28 (4): 40. 1985; Sriniv. in A.N.Henry et al., Fl. Tamil Nadu Ser. I. 2: 177. 1987; N.P.Singh, Fl. East. Karnataka 2: 519. 1988; K.M.Matthew, Ex. Fl. Cent. Tamil Nadu 404. 1991; Shu in Zheng-yi & Raven, Fl. China 17: 143. 1994; Pullaiah & Moulali, Fl. Andhra Pradesh 2: 773. 1997; K.M.Matthew, Fl. Pulney hills 2: 997. 1999; V.Singh, Mon. Indian Leucas 118. 2001.

Clinopodium martinicense Jacq., Enum. Pl. Carib.: 25. 1760; Sel. Strip. America: 173, t. 177, f. 75. 1763; Ic. Pl. Rar. 1: 11. 1781; Coll. 1: 154. 1787. pro syn. *Phlomis caribaea*; Swartz, Prodr. Descry. Veg. Ind. Occ.: 88 .1788. pro-basionym.

Phlomis martinicensis (Jacq.) Swartz, Prodr. Descry. Veg. Ind. Occ.: 88. 1788; Willd., Sp. Pl. 3: 123. 1800; Enum. Hort. Berolensis 2: 621. 1809.

Phlomis caribaea Jacq., Ic. Rar. 1: 11, Nr. 110. 1781; Jacq., Coll. 1: 154. 1787; Swartz, Fl. India Occ. 2: 1009. 1800; Persoon, Syn. Pl. 2: 127. 1806; Benth., Labiat. Gen. Spec. 3 (fasc. 6): 617. 1834. pro. syn. *Leucas martinicensis.*

—Type: In Martinica, 1755-1759, *s.coll.*, *s.n.* herb. Vahl (C photo.!). In 'C' there is specimen under *Clinopodium martinicensis*, by Banks. Sir Joseph Banks had acquired Jacquin specimens. If this specimen belongs to the type material is of course not sure, because there is missing any statement of origin. In 'W' (ex herb. Jacq.f.) is a specimen under *Phlomis caribaea* without any

statement of origin, therefore also not sure originating of the type material. In 'S' is a specimen named by Swartz ("Swartz scripsit") as *Phlomis martinicensis*, also without a note of origin. All these specimens are clearly *Leucas martinicensis* (Jacq.) R.Br. Besides the problem to find safe type specimens, the identity of the species with its different synonyms is not doubtful.

Leucas martinicensis R.Br. Prodr.: 504. 1810 *nomen.*

Leucas ringoeti De Wildem., Contr. Et. Fl. Katanga: 169. 1921; de Wildem., Ann. Scient. Soc. Brux. 41: 59. 1921; Angulo, Bull. Jard. Bot. Nat. Belg. 40: 377. 1970.

—Type: Katanga, Shinsendu, *Himble 496* (**BR** photo. !)

Leucas schimperi Hochst. ex A.Br., Flora 24: 279. 1841. *nom. nud.*; Rich, Tent. Fl. Abyss. 2: 200. 1851. pro syn.; *Leucas martinicensis* var. *schimperi* (Hochest. ex A.Br.) Fiori, N. Giorn. Bot. Ital. 20: 327. 1913.

—Type: Athiopien, bei Adoa, 30. 9. 1837 fl., *Schimper 15* (**BR**)

Phlomis mollis Schum. et Thonn. in Schum., Beskr. Pl. Guin.: 263. 1827; 37. 1829; Junghans, Bot, Tidskr. 57: 340. 1961.

—Type: Guinea, *Thonning 310* (**C** !)

Leonurus parviflorus Moench, Meth.: 401. 1794; Benth., Labiat. Gen. Spec. 3 (fasc. 6): 617. 1834.

Leucas elliotii Baker, Fl.Trop. Africa 5: 477. 1900.

—Type: Kenya, *Scott-Elliot 6566* (**K** holo.)

Erect annual herb, attaining a height of 20–120 cm, stem 2–4 mm across, branches herbaceous, obtusely quadrangular, grooved in all four sides, clothed with retrorse patent brown or white, 0.5–1.5 mm long hairs, internodes 5–15 cm long. Leaves opposite; petiole 2–2.5 cm long, hirsute, lamina 5–12 cm long, 1.5–5 cm broad, two and half times longer than broad, thin, slightly coriaceous, ovate-lanceolate or lanceolate, base attenuate, tip obtuse to sub-acute, margin distinctly deeply serrate with 8–12 long teeth, lower dense hirsute, upper hirsute, with 4–5 secondary veins, poroduced beneath. Inflorescence dense globose verticillasters, up to 12 axils, many flowered, 2–3 cm across. Bracteoles many, 8 mm long, base ±0.3 mm, as long as or sometimes longer than calyx, linear or linear lanceolate recurved, ciliate with <1 mm long hairs. Flowers pedicellate, pedicels up to 0.5 mm long, prolonged up to 2 mm in seeds. Calyx 5–6 mm long, tubular, middle bent, base narrowed, upper half slightly widened, reticulate, inner side glabrous, prominently ribbed and fully hispid outside, mouth slightly wider, rim provided with a ring of veins, inconspicuously ciliate; teeth 10, anterior teeth ±4 mm long, nearly twice as long as the rest which are 1.5–2.5 mm long, lanceolate, ciliate with fine spiniscent tip; tube enlarged, ±7 mm long in seeding stage. Corolla white, 5–6 mm long, almost fully included in calyx tube, lips are smaller than the calyx teeth; tube ±4 mm long, not seen out of calyx tube, inside glabrous, not annulated; lower lip ± 1.8 mm long, middle lobe emarginate, 1 mm broad at free side, lateral lobes widely elliptic, 0.5–0.7 mm long and wide; upper lobe ±1.3 mm long, concave, anterior end emarginate, outside white hairy margin ciliate. Staminal filaments slightly hairy, half included in corolla tube, upper pair short; anthers ±0.5 mm long and ±0.3 mm

broad. Disc cup shaped, four lobbed, abaxial lobe 1.4 mm long, higher than ovarium, other lobes 0.5 mm high. Ovary locules 1 mm high, above plane and obliquely inclined towards the centre, edges obtuse, provided with glandular stalked hairs. Style 4–5 mm long; stigma lobes unequal, lower lobe 0.45 mm long, tip curved down, upper lobe 0.09 mm. Nutlets ±1.8 mm long, 1 mm broad, ob-ovoid, obtusely triangular in cross section, top obliquely concave and inclined to the proximal side, provided with stalked glandular hairs, top margin obtuse.

Etymology: The species name means 'West Indian *Leucas*'.

Flowering and fruiting: September–January, but occasional flowering in other seasons also noticed in some records.

Habitat: Found in semi evergreen and deciduous forest openings at an altitude above 800 m.

Distribution: Pan-tropical distribution, found in Africa, Arabia and Asian. In South India this is found in all the four states.

Specimen examined: **ANDHRA PRADESH: Chitoor Dt.**: Horsely konda, 31st Aug. 1918, *C.E.C.Fischer 4423* (CAL); Horsely hills, 12th Jan. 1987, *D. Rangacharyulu 1079* (CAL, MH); **Karimnagar Dt.**: Kodimial, 19th Dec. 1964, *G.V.S.Rao 21843* (MH); **Kurnool Dt.**: Peddamantanalu, 5th Dec. 1984, *R.R.V.Raju & P.V.Prasanna 2360* (SKU); **Vizakapatanam Dt.**: Anantagiri, 17th Oct. 1964, *G.V.S.Rao 21727* (MH); Arakuvalley, Borah caves, 24th Dec. 2001, *Sunojkumar CU49683* (CALI); **KARNATAKA: Chikmagalur Dt.**: Kemmangundi, 13th Dec. 2002, *Sunojkumar*

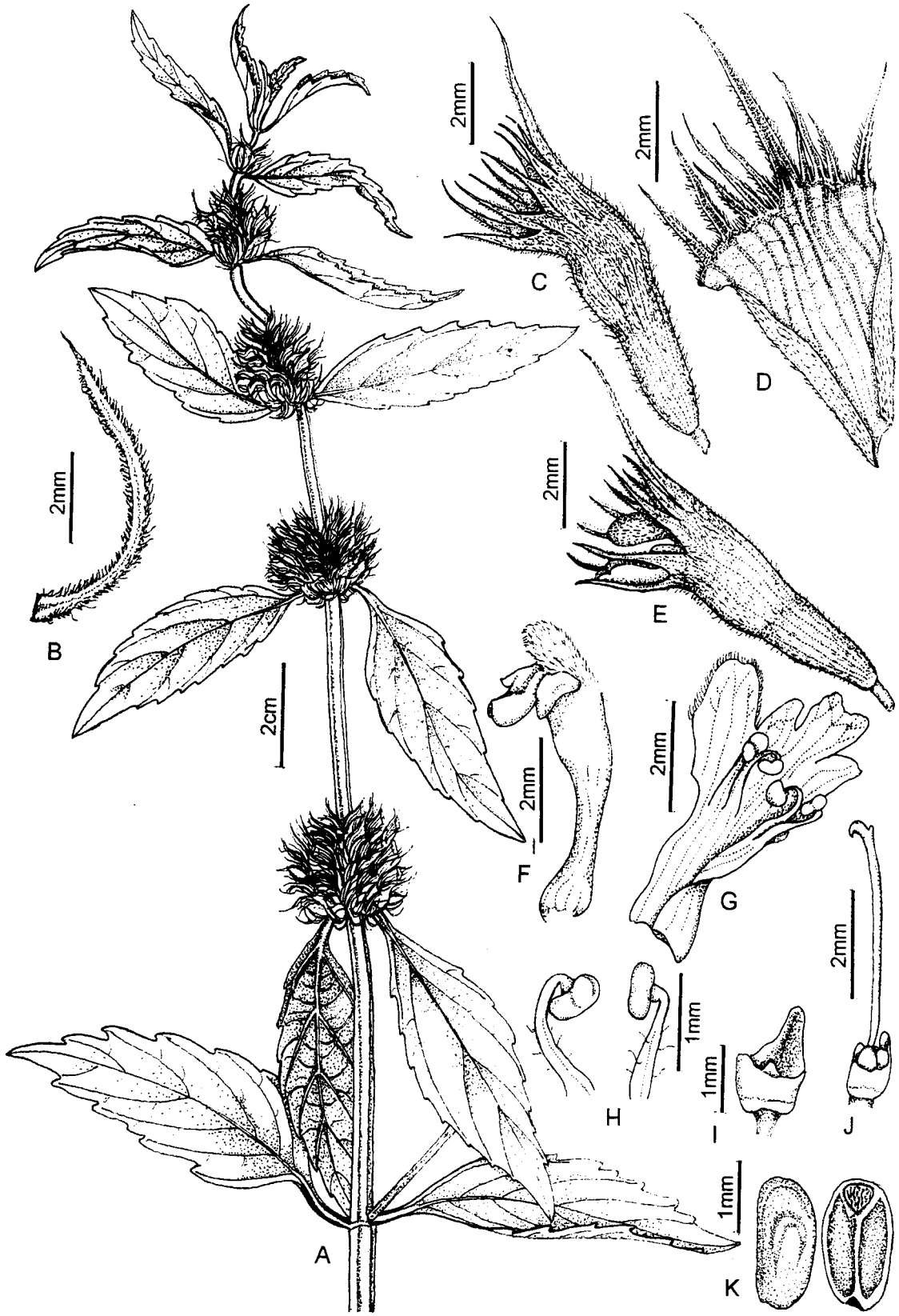


Fig.: **48**. *Leucas martinicensis* (Jacq.) R.Br. A. Habit; B. Bracteole; C. Calyx; D. Calyx split open; E. Flower; F. Corolla; G. Corolla split open; H. Stamens; I Disc; J. Pistil; K. Nutlets.

CU88106 (CALI); **Shimoga Dt**.: Agumbe, 2nd Dec. 1983, *S.Joseph s.n* (CALI); **KERALA: Idukki Dt**.: Chinar, 7th oct. 1994, *E.S. Santhoshkumar 17599* (TBGT); Chinnar, Alampetti, *N.Sasidharan NS5912* (KFRI); Chinnar, 18th Jan, 2004, *Sunojkumar CU88142* (CALI); **TAMIL NADU: Coimbatore Dt**.: Vellapatti, Bolampattuvally, 15th Dec. 1910, *C.E.C.Fischer 2421* (CAL); Kollegal, 10th Dec. 1930, *V.Narayanaswamy 19764* (MH); Hassanur, 10th Mar. 1931, *K.C.Jacob 254* (MH); Thekkumalai, Chinnathadakam, 17th Sept. 1956, *K.M.Sebastine 766* (CAL, MH); Kuridimalai, 13th Dec. 1956, *K.Subramanyan 1751* (CAL, MH); Attakatti, 24th Oct. 1961, *J.Joseph 13270* (MH); Ethuwarai slope, 21st Nov. 1962, *C.P.Sreemadhavan CPS 316* (MH); Palamalai, 17th Sept. 1969, *M.V.Viswanathan MVV157* (MH); Vettakaran koil, 20th Oct. 1971, *M.V. Viswanathan MVV 1074* (MH); **Dharmapuri Dt**.: Cattle breeding farm, 17th Nov. 1977, *E.Vajravelu 51924* (CAL, MH); **Madurai Dt**.: Palani –Savarikadu, 19th Feb. 1978, *M.Chandrabose 54209* (CAL, MH); **Nilgiris Dt**.: Mudumalai RF, 18th Nov. 1958, *K.M.Sebastine 7362* (MH); Sirur, 13th Nov. 1970, *G.V.S.Rao 37211* (MH); Avarihalla RF, 20th Nov. 1971, *N.C.Radhakrishnan 38191* (MH); Kargudi, 28th Oct. 1972, *K.Vivekanandan 43100* (MH); **North Arcot Dt**.: way to Kambukudi, 12th Dec. 1958, *K.Subramanyan 7416* (CAL, MH); **Salem Dt**.: Marappur, 16th Feb. 1915, *C.E.C.Fischer 11645* (CAL); Hoganiakkal river bank, 25th May 1965, *E.Vajravelu 24138* (MH); Yercaud-Pakada point, 25th Dec. 2000, *Sunojkumar CU49641* (CALI).

Notes: This pantropical species is of African origin (Sebald, 1980) found distributed in countries of Africa, Arabia and Asia. The section wise inclusion of this taxon is

controversial. Sebald (1980) has included this in sect. Hemistoma. But Singh (2001) included this in sect. Plagiostoma, due to the adaxial calyx teeth being the longest, like other Plagiostoman members. But on a comparative study of all the taxa included in Plagiostoma it is clear that the in many character, *Leucas martinicensis* (Jacq.) R.Br. is not related to other Plagistoma members, except the anterior tooth size. Even though the adaxial tooth is the longest, the nature of tube relates this with other Hemistoman members found in Africa. The adaxially produced calyx is due only to the tooth size and there are probably hybrids with this character (as in African species *Leucas songeana* Sebald), which are included in section Hemistoma.

It is assumed from the present study that *L. martinicensis* (Jacq.) R.Br. belongs to the section Hemistoma together with *L. urticaefolia* (Vahl) Sm. This is because there are many other character like 'rich and dense flowered inflorescence in many axils, small size, almost fully included nature of corolla lobes in the calyx, (also in *L. bakeri* Hiern), herbaceous nature and African origin. Moreover the morphology of corolla of *L. martinicensis* is same as that of other Hemistoman members found in Africa.

The actual type specimen is in confusion as there are a few herbarium sheets that can be considered as types. On consultation with Dr. Oskar Sebald (from Staatliches Museum fur naturkunde, Germany) who examined these sheets while working on the taxonomy of African *Leucas*, the information regarding a few sheets

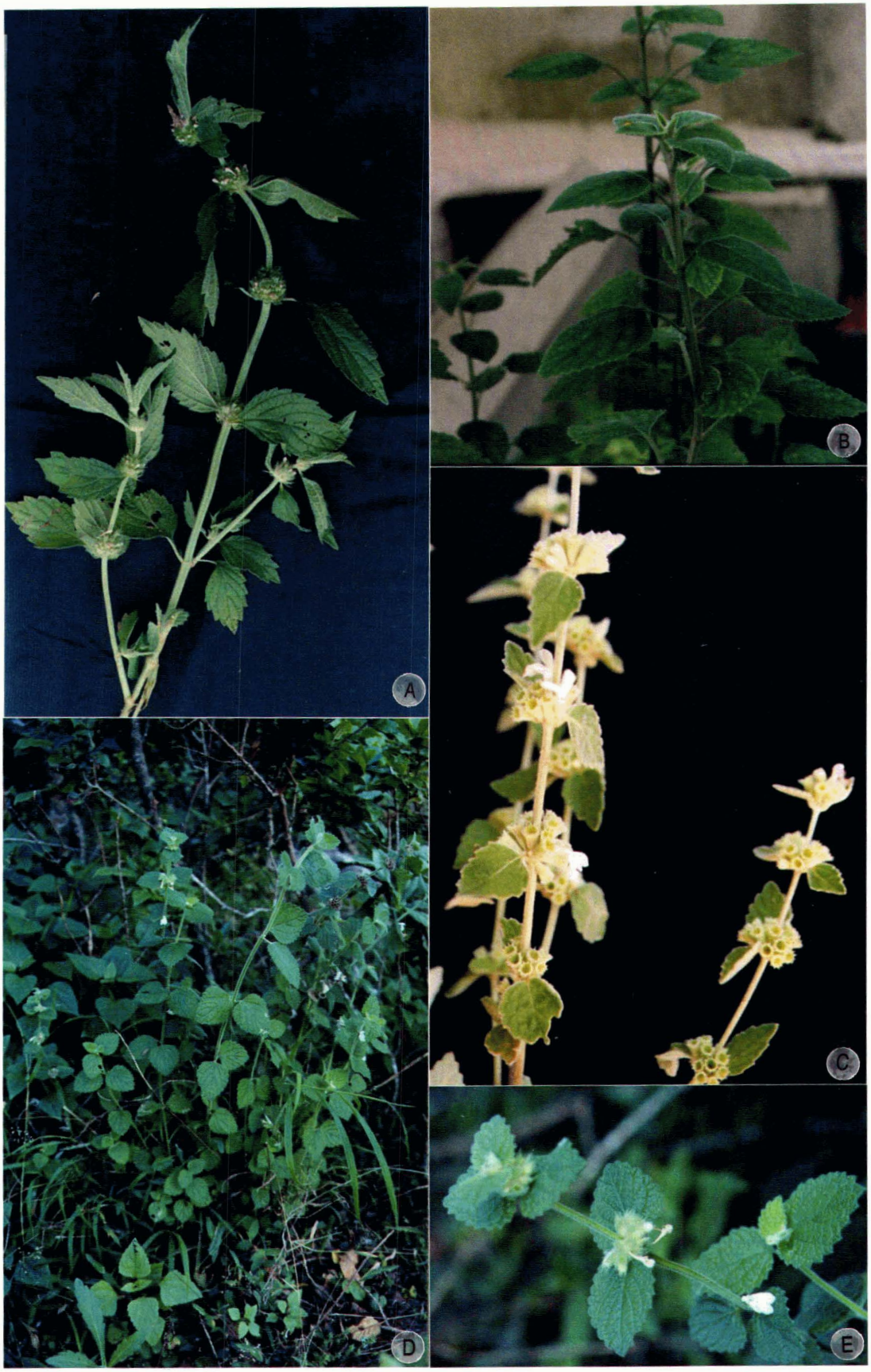


Fig. 49: A. *Leucas martinicensis* R.Br.; B-C. *Leucas montana* Spreng.; D-E. *Leucas marrubioides* Desf.

as probable types are available, which are mentioned above. The sheets obtained from 'C' and other herbaria are identical with the specimen collected from different parts of India, for this study. This plant is a medicinal herb in Africa but not widely used in Indian sub-continent.

19. Leucas montana (Roth) Spreng. in L., Syst. Veg. ed. 16. II: 742. 1825; Benth. in Wall., Pl. As. Rar. 1: 61. 1830; Labiat. Gen. Spec. 3 (fasc. 6): 607. 1834; in DC., Prodr. XII: 525. 1848; Hook.f., Fl. Brit. India 4: 682. 1885; Cooke, Fl. Bombay Pr. 2: 469. 1906; Prain, Bengal Pl. 856. 1908; Haines, Bot. Bihar & Orissa 4: 748. 1922; Gamble, Fl. Pres. Madras 2: 1151. 1924; Mukerjee, Rec. Bot. Surv. India. XIV (1): 182. 1940; R.R.Rao & Razi, Syn. Fl. Mysore Dist. 512. 1981; Sriniv. in A.N.Henry et al., Fl. Tamil Nadu Ser. I. 2: 177. 1987; N.P.Singh, Fl. East. Karnataka 2: 519. 1988; Pullaiah & Moulali, Fl. Andhra Pradesh 2: 773. 1997; V.Singh, J. Econ. Taxon. Bot. 22(2): 390. 1998; Mon. Indian Leucas 121. 2001.

Phlomis montana Roth., Nov. Pl. Sp. 263. 1821.

—Type: Peninsular India, Andhra Pradesh, Chitoor., Tirupati, near Akasaganga, 25th Oct. 2001, *Sunojkumar CU49669* **(CALI) Neotype designated here.**

Leucas montana var. *wightii* Hook.f., Fl. Brit. India. 4: 682. 1885; Gamble, Fl. Pres. Madras 2: 1151. 1924.

—Type: Peninsular India orientalis, *Wight, 2545* (holotype **K** cibachrome !)

Fig.: 50. *Leucas montana* (Roth.) Spreng. (Wight 2152; herbarium from **E**)

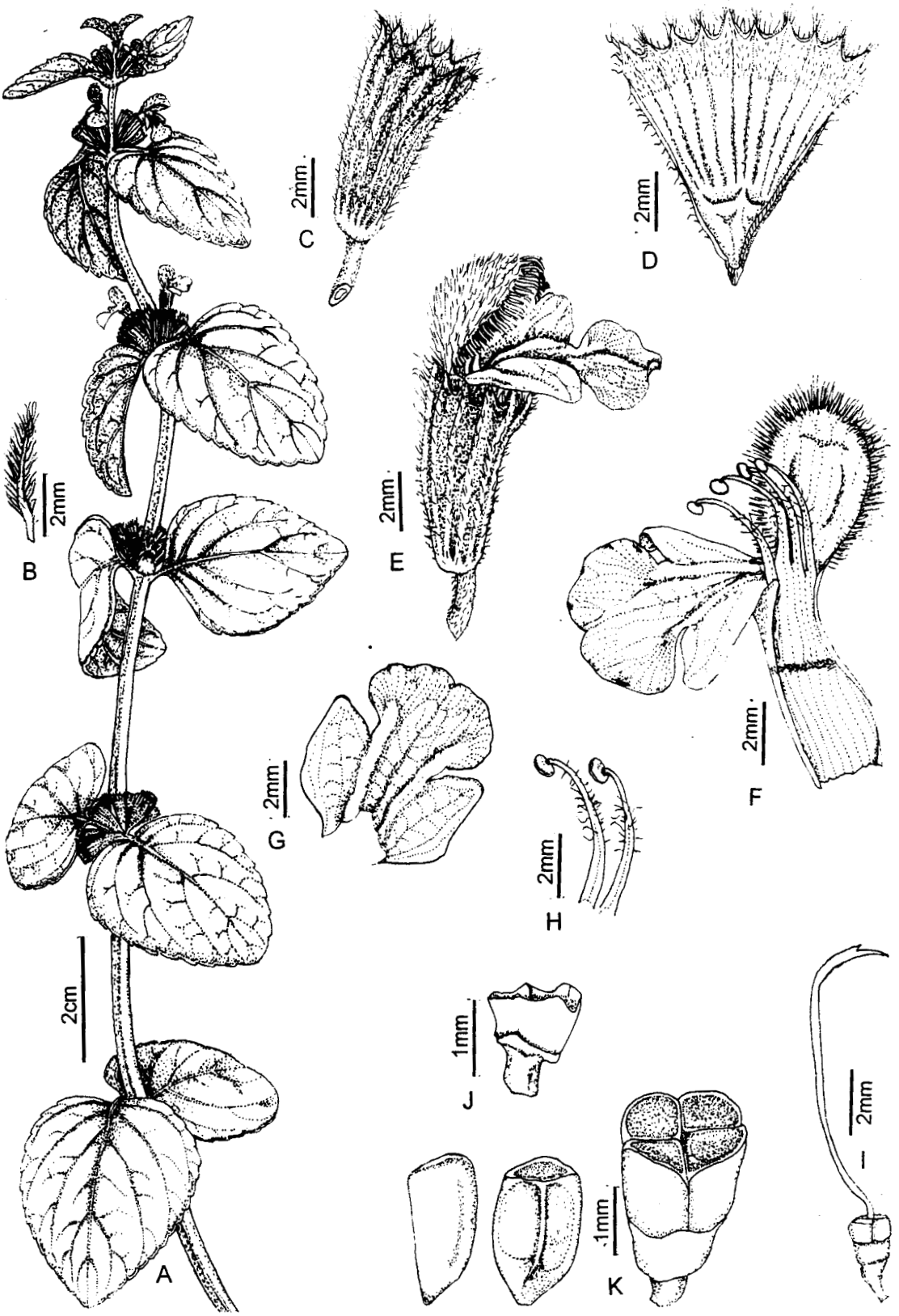


Fig.: **51**. *Leucas montana* (Roth.) Spreng. A. Habit; B. Bracteole; C. Calyx; D. Calyx split open; E. Flower; F. Corolla split open; G. Corolla lower lip; H. Stamens; I. Pistil; J. Disc; K. Nutlets.

Leuas montana (Roth) Spreng. forma *hamiltoniana* (Wall. ex Benth.) Haines, Bot. Bihar & Orissa 4: 749. 1922.

Leuas montana (Roth) Spreng. forma *parviflora* Haines, Bot. Bihar & Orissa 4: 749. 1922.

Straggling under shrub, perennial from the root stock and basal stems, base 6–10 mm thick; branches 1–1.5 m long, 2–3 mm diameter, obtusely quadrangular, not grooved, pubescent with retrorse hairs; internodes 5–8 cm long. Leaves opposite, petiolate; petiole 2–4 cm long, pubescent; lamina, 5–8 cm long, 4–5 cm broad, one and half times longer than broad, thick coriaceous, ovate, obtuse tip, base truncate to rounded, crenate to serrate margin with 11–12 slightly mucronate teeth, 3–5 secondary veins, lower surface tomentose with grey white deflexed hairs, upper pubescent with sericeous hairs, appear dark brown in dried leaves. Inflorescence in many axillary clusters in flowering branch, 6–13 flowered. Bracteoles few, 3–5 mm long, 0.4 mm broad, erect, filiform and densely villous with sericeous antrorse hairs. Flowers pedicellate, pedicel 0.5–1.5 mm long (slightly prolongates in seeding stage). Calyx tubular, 6–7 mm long, campanulate, straight, narrowed towards the base, outside fully ribbed prominently, ribs excurrent as teeth, fully dense tomentose with 0.4 mm long hairs especially on the ribs, inside glabrous, just above the middle is a ring of hairs and pubescent above, mouth straight, not provided with ciliate hairs; teeth 10, sub-equal, 0.5 mm long, 0.5 mm broad at base, fleshy, trigonal, tip pointed, subulate and straight, provided with villous hairs. Corolla white, 12–14 mm long, tube 6–7 mm long, included in the calyx, above outside white hairy, inside middle

annulate with a ring of minute hairs; lower lip 6.5–7 mm long, middle lobe 4.5 mm broad, emarginate, side lobes 2 mm wide, margin revolute; upper lip white ±5 mm long, concave, dense hairy outside and ciliate margins. Staminal filaments minutely hairy; anthers ±0.75 mm long, ±0.45 mm broad. Disc flattened cup shaped, abaxial lobes ±0.36 mm long, slightly longer than other lobes. Ovary locules ±0.66 mm high, above flat triangular and slightly concave, glands absent. Style 10.5–11 mm long, top slightly bent, stigma lobes unequal, bent, lower lobe 1.2 mm long, upper 0.15 mm. Nutlets 2.1 mm long, 0.9 mm broad, dark brown, cylindrical, narrowed and pointed at base, obtusely triangular in cross section, top flat, slightly concave and obliquely produced towards the distal margins.

Etymology: The species name 'montana' means 'growing on mountains'.

Flowering and fruiting: Peak flowering season is August – December, but occasionally flower in January–July also.

Habitat: Usually found in dry deciduous forests, along roadsides, open places, among bushy plants and in sandy soils; altitude ±800 m.

Distribution: Endemic to India, found in South Indian states Karnataka, Andhra Pradesh. It is also found in other states like Bihar and West Bengal.

Specimens examined: **ANDHRA PRADESH: Chitoor Dt.**: Papanasam falls, 14th Nov. 1958, *K.Subramaniam 6949* (MH); Tirumalai, 17th June 1969, *G.V.Subbarao 31918* (MH); Near Japali temple, 30th Sept. 1974, *G.V.Subbarao 45918* (MH); Tirumala hills, 27th Nov. 1986, *D.Rangacharyulu 94* (MH); Tirupati, near

Akasaganga, 25th Oct. 2001, *Sunoj kumar CU49669* (CALI); **Vizakapatanam Dt.**: Simhachalam hills, 1st Jan. 1988, *D.A.Moulali 6545* (SKU); **KARNATAKA: Chikmagalur Dt.**: Kemmangundi, 13th Dec. 2002, *Sunojkumar CU88105* (CALI); **TAMIL NADU:** Mandaparai, Vellore, 21st Nov. 1975, *K.N.Subramaniam 5503* (FRC); **Coimbatore Dt.**: Bariyur hills, 16th Aug 1929, *V.Narayanasamy 18974* (MH); **Nilgiris Dt.**: 1857, *A.F.B.Bleghorussy 41519* (MH); **North Arcot Dt.**: Thakanakuppam, 15th July 1958, *K.Subramanyam 6110* (MH); Nilgiri hills, 6th Dec. 1984, *M.B.Viswanathan 565* (MH); **Tirunelveli Dt.**: Mahendragiri hills, Mar. 1884, *J.S.Gamble s.n* (MH).

Note: This species was established by Roth (1821) under the genus *Phlomis* based on Benjamin Heyne's specimen collected from 'Indiae orientali'. Due to the loss of original specimens, typification became necessary. Correspondences were made to the herbaria where Heyne's material is deposited. Except a single specimen each from 'CAL' and 'K', no other Herbaria have specimens treated as Heyne's duplicates. Thse specimens were examined and after a long discussion with Lamiacean expert Dr. A.Paton from Kew, found to be not suitable for lecto-typification and neotypification is attempted as a solution. A specimen collected from Akasaganga in Tirupati hills in Andhra Pradesh, matching with all the information in the protologue is selected here as the Neotype and the same is deposited in CALI herbarium. This specimen is exactly the same as that of Heyne's doubtful specimen obtained from K and CAL.

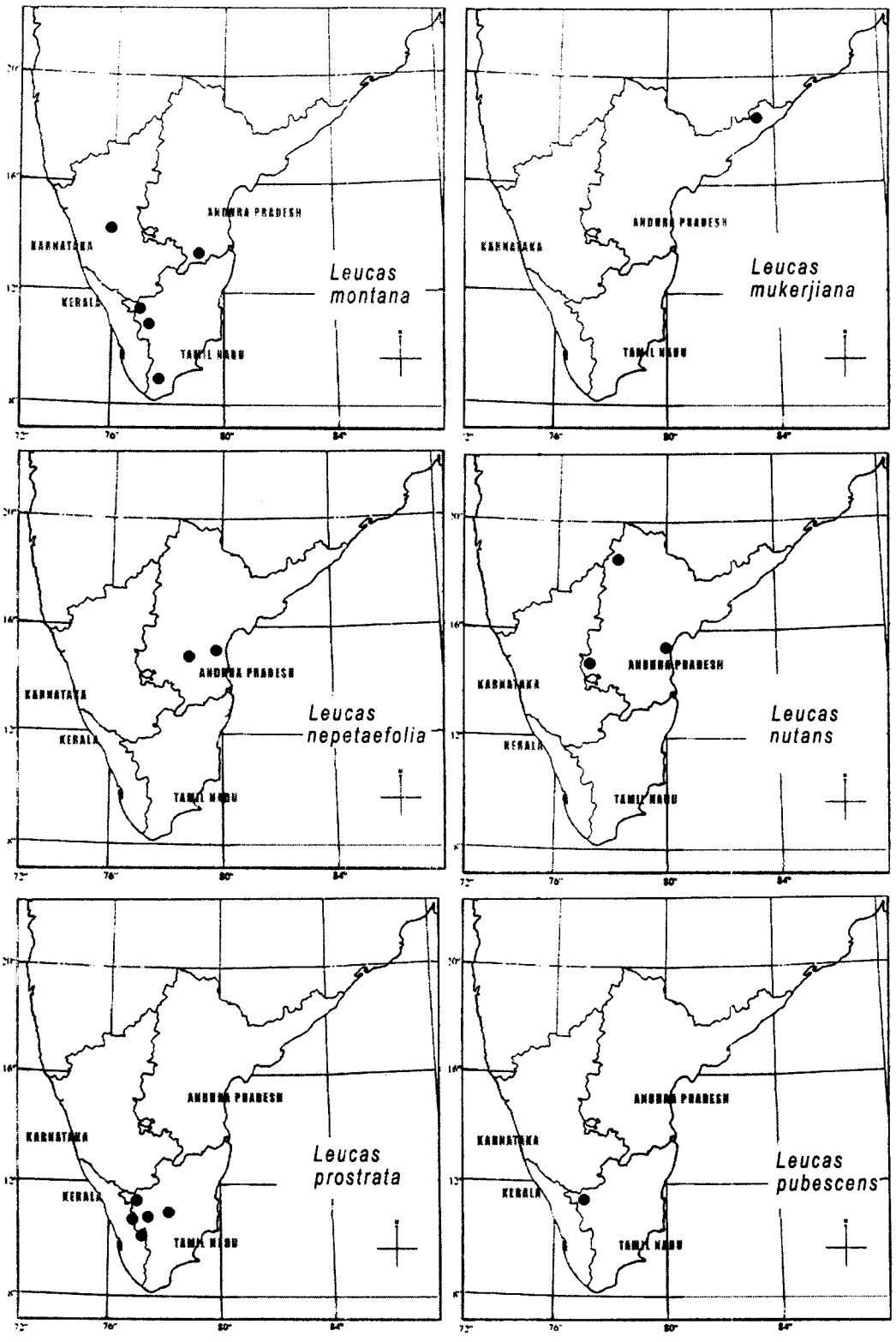


Fig.: 52. Distribution map of *Leucas* species in Southern Peninsular India.

20. Leucas mukerjiana Subbarao & Kumari, in Bull. Bot. Surv. India 10 (3 & 4): 358. f. 1-8. 1969; Samaddar & Roy, Addl. Elem. Indian Fl. 1: 262. 1997; Pullaiah & Moulali, Fl. Andhra Pradesh 2: 773. 1997.

—Type: India, Andhra Pradesh, Vishakapatanam, Cherukonda, 1300m, 29th Aug. 1996, *G.V. Subbarao 28182* (holo. **CAL** !); *G.V.Subbarao 28182 B-D* (iso. **MH** !); *Subbarao & Kumari 29741 A-U* (para. **MH** !)

Decumbent herb, up to 45 cm high, stem obtusely quadrangular, not grooved, covered with white retrorse silky hairs. Leaves sessile, 1.8–3.7 cm long, 1.4–3.4 cm broad, thick, ovate, base cordate, tip obtuse to acute, margin coarsely dentate, densely velvety on both sides, secondary veins 5–6 pairs, midrib and lateral nerves impressed above and raised below. Inflorescence in many axils, verticils dense, few to many flowered. Bracteoles 2–4 mm long, equal to or shorter than the calyx, straight, filiform and villous with dense long hairs. Calyx tube ±5 mm long, campanulate, straight, provided with 10 prominent nerves form ribs outside, inside almost glabrous, villous outside, mouth truncate, inside ciliate from the throat upwords; teeth 10, longer than the mouth cilia, 1–1.5 mm long, straight, subequal, triangular base and pointed tip, villous with 3 mm long hairs. Corolla white ±11 mm long, tube ±5 mm long, much exerted in the calyx tube, inside glabrous and naked; lower lip ±6 mm long, middle lobe larger, emarginate at free end, side lobes obtuse at free end; upper lip concave, covered with dense hairs outside, margin ciliate with white hairs. Stamens upper pair shorter; anthers connivent, cells divaricate, ultimately confluent. Disc 4 equal lobbed. Style with unequally

bilobbed stigma, upper lobe minute, lower lobe 2 mm long. Nutlets 1 mm long, grey, rugose, triquetrous, obovoid, top triangular slightly convex, obtuse margin, dull and hairy at the top and base.

Etymology: The species is named in honour of Dr. Mukerjee, ex-Keeper, Central National Herbarium, who was a specialist in Indian Lamiaceae.

Flowering and fruiting: August–January.

Habitat: On the margins and openings of deciduous forests; alt. above 1300 m

Distribution: Endemic to Andhra Pradesh, in Vizakapatanam district only.

Specimens examined: **ANDHRA PRADESH: Vizakapatanam Dt.**: Cherukonda, 29th Aug. 1996, *G.V.Subbarao 28182A-D* (CAL, MH); *Subbarao & Kumari 29741* A-U (MH).

Note: This species is a narrow endemic reported only from the type locality. It is not able to collect this plant from the field, as the exact locality was not able to pinpoint during my search in Vizakapatanam district. The descriptions given are taken from the protologue. However I have referred the herbarium specimens deposited in Indian herbaria.

21. Leucas nepetaefolia Wall. ex Benth. in Wall., Pl. As. Rar. 1: 62. 1830; Labiat. Gen. Spec 3 (fasc. 6): 609. 1834; in DC., Prodr. XII: 527. 1848; Hook.f., Fl. Brit. India 4: 681. 1885; Gamble, Fl. Pres. Madras 2: 1150. 1924; Mukejee,

Rec. Bot. Surv. India XIV (1): 177. 1940; Pullaiah & Moulali, Fl. Andhra Pradesh 2: 774. 1997; R.R.Rao & Razi, Fl. Mysore Dist. 512. 1981.

—Type: In Indiae orientalis Peninsula, herbarium Madras, *s.coll*, *s.n*; Wall. Cat. Herb. Ind. No. *2526* (holo. **K** cibachrome !)

Herbaceous, branches terete, slightly hoary, with minute hairs; internodes 2–6 cm long. Leaves petiolate; petiole 1–1.5 mm long slender; lamina 1.5–2.5 cm long, 1.5–2 cm broad, almost as broad as long, slightly coriaceous, orbicular, rounded to subcordate at base, margin crenate with 6–7 teeth, pubescent above, tomentose beneath, provided with 3–4 secondary veins. Inflorescence in few flowered clusters at several axils. Bracteoles minute, 1.5–2 mm long, setaceous, few numbered, straight, tomentose. Calyx about 6–7 mm long, obconic, campanulate, straight, provided with 10 nerves and ribbed, inner glabrous, outer tomentose; teeth 10, short, 0.5–1 mm long, triangular with broad base and pointed tip. Corolla white, lips nearly equal, lower lip tri-lobed, middle lobe emarginate, upper lip concave with white hairs outside and margins. Nutlets ±2 mm long, grayish.

Etymology: The species name means 'Nepeta like leaves'.

Flowering and fruiting: November–March.

Habitat: Found in forest openings and grasslands of deciduous forests over an altitude of 1000 m.

Distribution: Endemic to South India, along Eastern Ghat region in Andhra Pradesh state.

Fig. 53: Type specimen of *Leucas nepetaefolia* Benth. (Wall. Cat. No. 2526; from K)

Specimen examined: Peninsular India Orientalis, (CAL) **ANDHRA PRADESH: Cuddapah Dt.**: Sidhout, near the stream in Golapalle RF., 20th Mar. 1957, *S.K.Wagh 5883* (BLAT); **Nellore Dt.**: Udayagiri near kona, *S.K.Wagh 6704* (BLAT).

Notes: Live specimen of this species is not able to collect from South India even after an extensive field study in the sites already mentioned in the herbarium sheets. Except the two sheets in Blatter (BLAT) herbarium no specimen of this species is available in any other Indian herbaria. Flora of Andhra Pradesh specimens were examined from SKU and no specimen similar to type specimen is found out. There is every reason to believe that this is a critically endangered species. The character described above is based on the type specimen available from Kew and Central National Herbarium, Kolkatta.

Singh's (2001) mention of this plant availability in Mysore and Tamil Nadu is based on the wrong identification of specimens in Madras Herbarium (MH). The identity of specimen cited in the monograph (*A.S.Rao 80202*, MH) also is not *L. nepetaefolia*.

22. Leucas nutans (Roth) Spreng. in L., Syst. Veg., ed. 16, II: 743. 1825; Benth., Labiat. Gen. Spec. 3 (fasc. 6): 616. 1834; in DC., Prodr. XII: 532. 1848; Hook.f., Fl. Brit. India 4: 688. 1885; Cooke, Fl. Bombay Pr. 2: 469. 1906;

Haines, Bot. Bihar & Orissa 4: 750. 1922; Gamble, Fl. Pres. Madras 2: 1149. 1924; Mukerjee, Rec. Bot. Surv. Ind. XIV (1): 169. 1940; Duthie, Fl. Upp. Gangetic Pl. 2: 114. 1960; V.N.Naik, Fl. Osmanabad Dist. 274. 1979; Sriniv. in A.N.Henry et al., Fl. Tamil Nadu Ser. I. 2: 177. 1987; N.P.Singh, Fl. East. Karnataka 2: 519. 1988; Hedge in Nasir & Ali (eds.), Fl. W. Pakistan 192: 162. 1990; K.M.Matthew, Fl. Cent. Tamil Nadu 404. 1991; Pullaiah & Rao, Fl. Nizamabad 284. 1995; Raju & Pullaiah, Fl. Kurnool 382. 1995; Pullaiah & Moulali, Fl. Andhra Pradesh 2: 774. 1997; K.Lakshmin. et al., Fl. Krishna Dist. 243. 1997; Pullaiah et al., Fl. Medak Dist. 187. 1998; Pullaiah & Mohammed, Fl. Ranga Reddi Dist. 175. 2000; V.Singh, Mon. Indian Leucas 127. 2001.

Phlomis nutans Roth. Nov. Pl. Sp. 263. 1821.

—Type: Peninsular India, Andhra Pradesh, Anantapur, SK University campus, 22nd Oct. 2001, *Sunojkumar CU49651* (**CALI**) (**Lectotype designated here**).

Leucas decurva Benth. in Wall., Pl. As. Rar. 1: 60. 1830; Wall., Cat. Herb. Ind. No. 2050. 1829. *nom nud.* —Type: Indiae orientali *s.coll., 2050* (**K** cibacrome !)

Dwarf annual herb, 15–30 cm high, stem herbaceous; branches straggling and diffuse, 1.5–2.5 mm diameter, obtusely quadrangular, not grooved, covered with lax pubescent, retrorse hairs; internodes 4–11 cm long. Leaves opposite, decussate; petiole 7–9 mm, pubescent; lamina 2–6 cm long, 1.2–2 cm broad, thin coriaceous, oblong-lanceolate, tip obtuse, minutely serrate with 7–9 teeth, base narrowed to

cuneate, veins appressed above and produced below, lower glandular punctuate and pubescent on the veins, upper minutely pubescent to almost glabrous. Inflorescence axillary clusters, dense flowered, whorls up to 2 cm in diameter, many, dense flowered. Bracteoles 7–8 mm long, 1.5–1.8 mm broad, as long as or smaller than calyx, lanceolate, foliaceous with a definite mid rib and lateral veins, thin, narrowed at base into a short stalk, acute to acuminate tip, margin ciliate. Flowers up to 1 mm long pedicillate. Calyx 8–10 mm long, tubular, falcately decurved in the middle, strongly ribbed and hispid outside with ±1 mm long hairs, pubescent within, mouth oblique, produced on the upper side, sparsely ciliate with silky white hairs; teeth 10, sub equal, 1.5–2.2 mm long, longer than mouth cilia, triangular at base, 0.5 mm broad, hispid, tip acute to acuminate, anterior teeth longest, base of the two side teeth fused with the anterior one forming a tri-lobed structure; fruiting calyx slightly longer and bulged. Corolla fully white, ±15 mm long; tube 8 mm long, slightly bent, inside middle annulated with a ring of fleshy hairs; lower lip 7 mm long, middle lobe 5 mm broad and fan shaped, side lobes oblong, free end 1.5 mm broad and notched at middle, margin revolute; upper lobe 4 mm long, concave, bearded with white hairs outside. Stamens fully included; filaments hairy at middle; anther lobes 0.54 mm long, 0.24 mm broad. Disc cup shaped, four lobbed, abaxial lobes slightly longer than the other lobes. Ovary locules 0.9 mm long, top rounded. Style 11 mm long; stigma lobes unequal, upper lobe 0.06 mm long, lower 0.3 mm. Nutlets ±2.2 mm long, 1 mm broad, brownish coloured not smooth, oblong, acutely triangular in cross section, top rounded, glands absent.

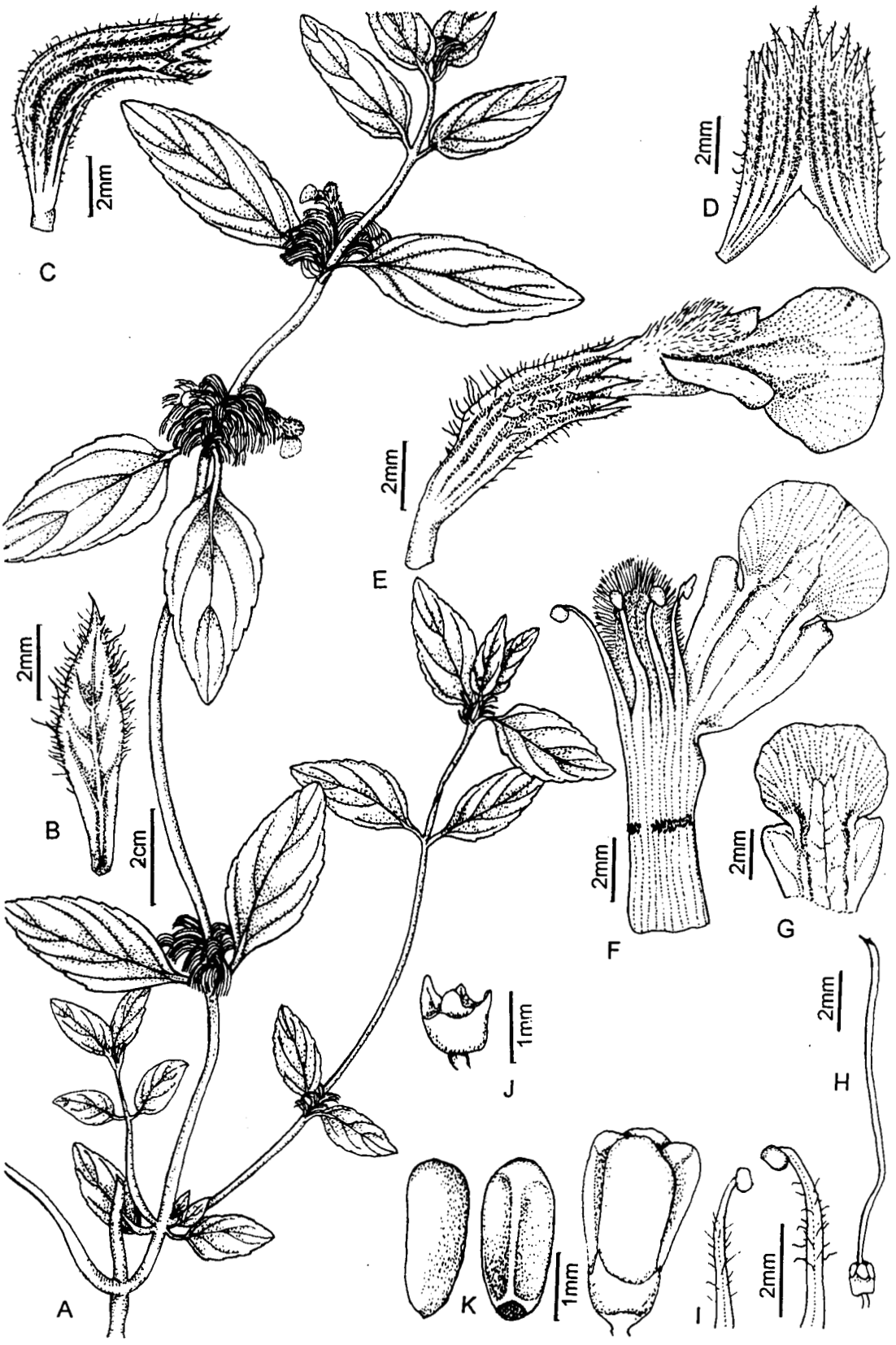


Fig. 54: *Leucas nutans* Spreng. A. Habit; B. Bracteole; C. Calyx; D. Calyx - split open; E. Flower; F. Corolla split open; G. Corolla lower lip; H. Pistil; I. Stamens; J. Disc; K. Nutlets.

Flowering and fruiting: August–December.

Habitat: Growing in plains, and open places among herbaceous plants.

Distribution: Found in the Eastern Ghat regions of South India, North and Central Indian states, Pakistan and Myanmar.

Specimens examined: Peninsular Indiae orientalis, Nov. 23, 1798, *Heyne s.n.*, (Herbarium Rottlerianum, K); **ANDHRA PRADESH: Anantapur Dt.**: SK University campus, 22nd Oct. 20012, *Sunojkumar 49659* (CALI); **Medak Dt.**: Narasapur RF, 18th Aug. 1994, *T.Pullaiah & C.Prabhakar 14053* (SKU); **Nellore Dt.**: Nelloor, *Wall Cat. No. 2523* (CAL).

Note: This species was described by Roth (1821) based on Heyne's specimen collected from India orientali. The original type herbarium was destroyed in Berlin (B) during the 1939–1945 world war (Stafleu & Crown, 1986). Due to the loss of original type specimens, typification became necessary. Except from Kew herbarium, no specimen treated as Heyne's duplicates were available. The only doubtful specimen available from Kew bears the details Peninsular Indiae orientalis, Nov. 23, 1798, *Heyne s.n.*, (Herbarium Rottlerianum, K). This after careful observation revealed that there is no direct evidence that this is Heyne's original collection seen by Roth while describing the species. Due to the non-availability of types, Neotypification was attempted based on a specimen collected from Anandapur district of Andhra Pradesh. This neotypified specimen is deposited in Calicut University Herbarium (CALI).

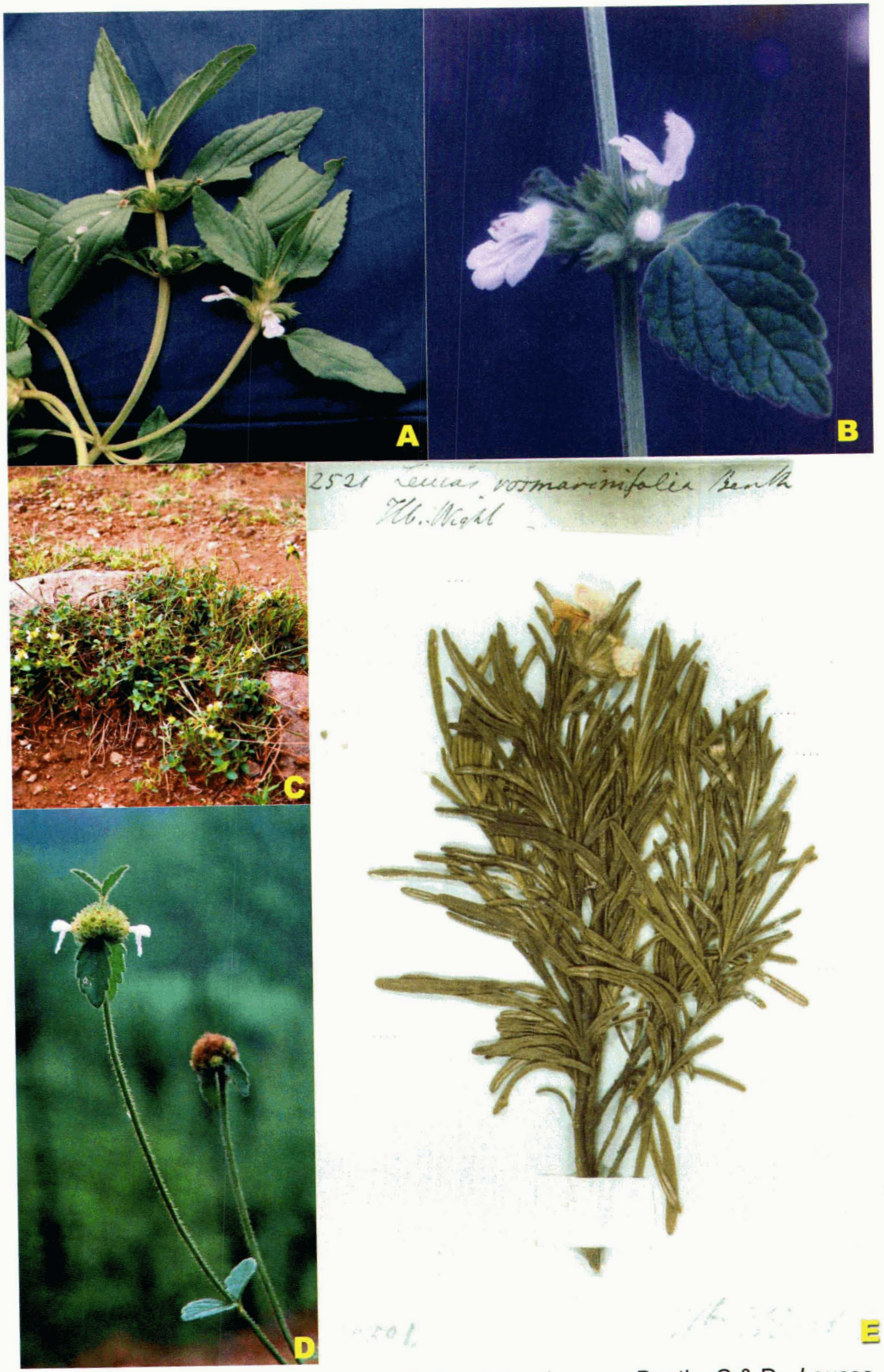


Fig. 55: A - *Leucas nutans* Spreng.; B - *Leucas pubescens* Benth.; C & D - *Leucas prostrata* Gamble; E - *Leucas rosmarinifolia* Benth. (Holotype).

23. Leucas prostrata (Hook.f.) Gamble, Fl. Pres. Madras 2: 1154. 1924; Mukerjee, Rec. Bot. Surv. India XIV (1): 175. 1940; R.R.Rao & Razi, Fl. Mysore Dist. 512. 1981; Sriniv. in A.N.Henry et al., Fl. Tamil Nadu Ser. I. 2: 177. 1987; Manilal, Fl. Silent Valley 220. 1998; K.M. Matthew, Ex. Fl. Cent. Tamil Nadu 404. 1991.

Leucas hirta var. *prostrata* Hook. f., Fl. Brit. India 4: 687. 1885.

—Type: India, Mountains of Nilghiri & Kurg, *Hooker & Thomson, s.n* (holo. **K** !; iso. **K** ! both cibachrome).

Prostrate herb, annual, stem reduced, thick, sometimes amorphous, nodal regions knot like; branches often ascending, 20–70 cm long, often rooting, obtusely quadrangular, longitudinally grooved, densely tawny hispid, with erect 1.5–2 mm long bristle like hairs, tender part densely villous towards the tip; internodes 2.5–13.5 cm long. Leaves opposite, petiole 0.5–1.2 cm, tawny hispid; lamina 1.8–5 cm long, 1.5–3.1 cm broad, slightly coriaceous, glandular punctuate, ovate or oblong-ovate, rarely rounded, base rounded, tip obtuse, margin obtusely and distinctly crenulate, some time undulate, both sides tawny hispid with bristle like stiff antrorse hairs, 1–1.5 mm long, lateral veins 3–4, prominent and densely hispid below. Inflorescence sub-terminal, solitary, semi-globular, dense, many flowered, above and subtended by a pair of bracteate leaves, verticils bearing axis 11–23 cm long. Bracteoles many, 11–12 mm long, base 1–1.2 mm broad, longer than calyx, linear-lanceolate, tip acute, inwardly recurved and turned towards the flowers, outside and margin bristly ciliate with 1–1.5 mm long hairs. Flowers up to 1 mm long

pedicellate. Calyx ±6.5 mm long, tubular, campanulate, straight, narrowed towards the base, outside fully hispid with small erect hairs, ribs not prominent, inside glabrous, mouth annulate with a ring of thick veins, long dense ciliate, ciliate hairs golden yellowish, forming an inverted cone over the mouth; teeth 10, almost equal sized, 2.5–3 mm long, 0.3 mm broad, longer than mouth cilia, linear acute, spreading outward, provided with ±1 mm long bristly hairs. Corolla ±16 mm long, fully white, tube ±7 mm long, inside annulate with a ring of fleshy hairs in the middle; lower lip fan shaped, obliquely attached to tube, middle lobe 9 mm long and 7.5 mm broad, side lobes 1.8 mm broad at free end, obliquely produced in front, margin revolute; upper lip 5.5 mm long, concave, provided with white woolly hairs outside, margin white ciliate. Staminal filaments hairy in the middle, 0.9–1 mm long and 0.6 mm broad, anther lobes reddish coloured, theca divergent. Disc cup shaped, lobes 1 mm high, almost equal, not fleshy. Style 11 mm long; stigma lobes unequal, lower lobe 0.9 mm long, upper 0.09 mm. Ovary locules 0.7 mm high, triangular, shining, top rounded. Nutlets 2.5–3 mm long, 1.3–1.5 mm broad, dark brown, size oblong, cylindrical, triangular in cross section, base narrowed and top rounded.

Etymology: The species name is derived from the prostrate habit of the plant.

Flowering and fruiting: Peak flowering season is July–December, but occasional flowering is reported up to July in some regions.

Habitat: The plant is noticed in the rocky area; among herbs and in grasslands; altitude 1200–2200 m.

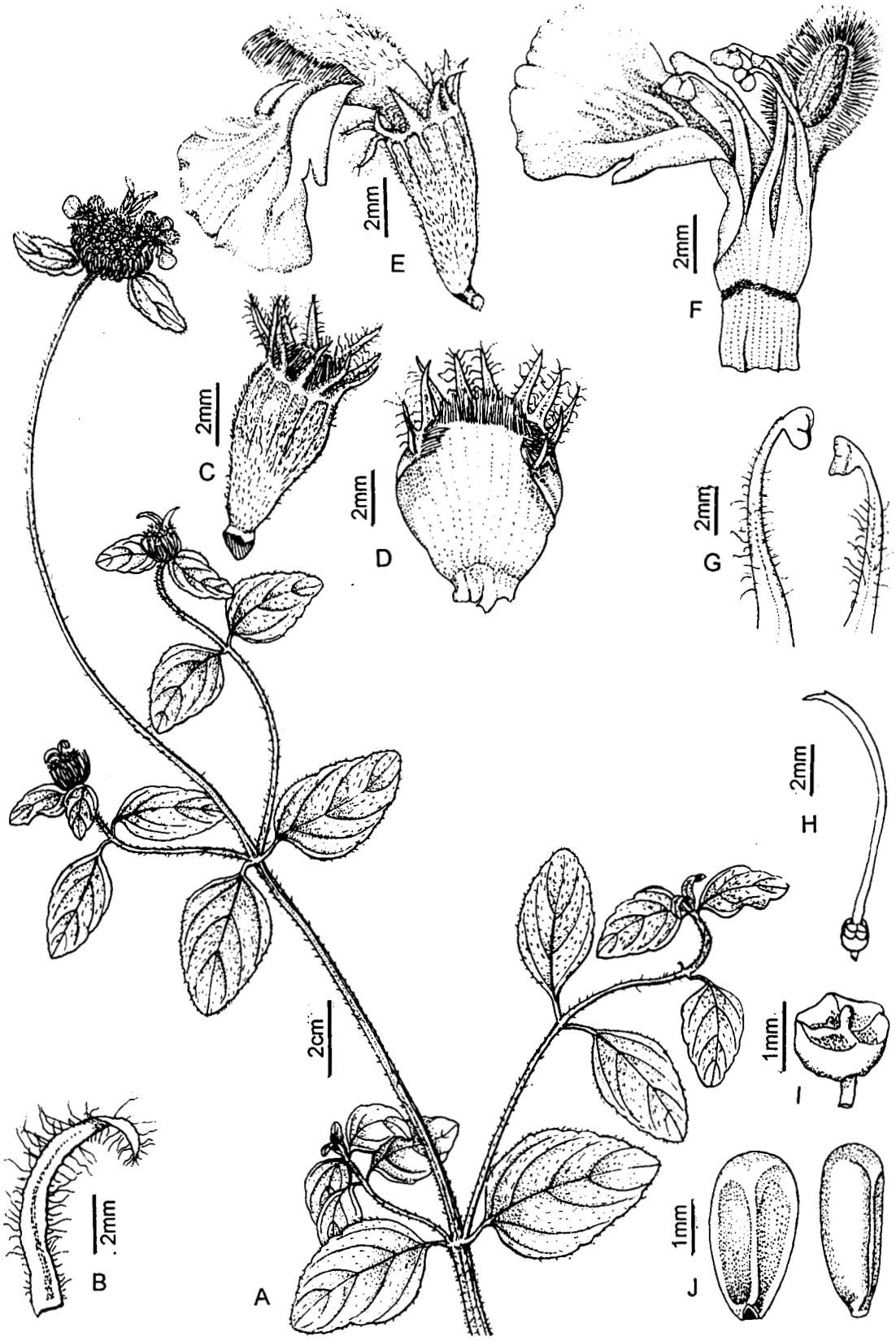


Fig. 56: *Leucas prostrata* Gamble A. Habit; B. Bracteoles; C. Calyx; D. Calyx split open; E. Flower; F. Corolla split open; G. Stamens; H. Pistil; I. Disc; J. Nutlets.

Distribution: South Indian endemic, found in the Southern Western Ghat regions of Kerala and Tamil Nadu.

Specimens examined: Peninsular India orientalis, *Wight 2154* (CAL); **KERALA: Idukki Dt.**: Nellipara slope way to Mappara, 7th Feb. 1981, *N.C.Nair 70109* (MH); **Palakkat Dt.**: Kundipuzha dam site, 10th Mar. 1975, *E.Vajravelu 46259* (FRC); Muthukulam RF, 30th May 1979, *E.Vajravelu 62896* (CAL, MH); Karasurya malai, 30th Oct. 1979, *E.Vajravelu 48770* (MH); **TAMIL NADU: Coimbatore Dt.**: Konnamalai upper slopes, 18th Sept. 1963, *C.P.Sreemadhavan CPS 828 & CPS 390* (MH); Vellingiri hills, 26th May 1976, *R.Gopalan 49829* (MH); **Nilgiris Dt.**: Coonoor, 15th Mar. 1870, *C.B.Clarke 10913* (CAL); Coonoor, 31st July 1878, *G.King 112/26* (CAL); Ooty, Aug. 1886, *J.S.Gamble 18025* (CAL); Wellington, 21st April, 1944, *I.Sinclain 89* (CAL); Kottagiri, Thattapalam, 24th Oct. 1956, *K.Subramanyam 1125* (MH); Coonoor, upper Tiger shola, 25th July 1957, *K.M.Sebastine 4009* (CAL, MH); Gudulur, Naduvattom, 25th July 1960, *K.Subramanyan 10571* (MH); Bimaka shola, 26th Aug. 1970, *G.V.S.Rao 36338* (MH); Kodanad slopes, 19th July 1970, *E.Vajravelu 34901* (MH); Balmadier estate shola, 2nd, Feb. 1971, *J.L.Ellis 37840* (MH); Bikkamanor forest, 4th Aug. 1972, *E.Vajravelu 41952* (FRC); Kodanad view point, 26th Dec. 2002, *Sunojkumar CU88113* (CALI); **Salem Dt.**: Shevaroi hills, *Perrottet 60* (CAL); Orchidarium, *A.V.N.Rao 18233* (MH); Yercaud, 24th Dec. 2000, *Sunojkumar CU49640* (CALI).

Note: This plant is closely allied to *Leucas hirta* (Roth) Spreng. in floral characters

but different from it in having an annulate, herbaceous prostrate habit and the corolla being purely white.

24. Leucas pubescens Benth., Labiat. Gen. Spec. 3 (fasc. 6): 610. 1834; DC., Prodr. XII: 528. 1848; Hook.f., Fl. Brit. India 4: 684. 1885; Gamble, Fl. Pres. Madras 2: 1152. 1924; Mukerjee, Rec. Bot. Surv. India XIV (1): 181. 1940; R.R.Rao & Razi, Fl. Mysore Dist. 512. 1981; Sriniv. in A. N. Henry et. al., Fl. Tamil Nadu Ser. I. 2: 177. 1987; K.M.Matthew, Ex. Fl. Cent. Tamil Nadu 404. 1991; V.Singh, Mon. Indian Leucas 133. 2001.

Leucas marrubioides var. *glabrior* Benth. in Wall., Pl. As. Rar. 1: 61. 1830.

Leucas marrubioides Wall., Cat. Herb. Ind. No. 2524. 1829. *nom nud.*

—Type: Indiae Orientalis Peninsula, 1827, *Wight 2524a* (holo. **K** cibachrome !).

Herb, perenniating from root stock, basal part up to 8 mm thick; branches long, herbaceous, straggling, 1–1.5 m high, acutely quadrangular, not grooved, pubescent to retrorsely tomentose hairs, tender stem densely tomentose; internodes 5–20 cm long, often older stems become hollow. Leaves opposite, decussate, petiolate; petiole 1–1.4 cm long, tomentose; lamina 2.5–4 cm long, 2.3–3 cm broad, almost equally broad as long, thin, broadly ovate, base slightly cuneate to truncate or sometime sub-cordate, tip obtuse, margin broadly and coarsely crenate with ±11

teeth, secondary veins 4, dense pubescent to slightly tomentose on the lower side, less pubescent upper side. Inflorescence lax cluster in many axils, 6–7 flowers in each cluster. Bracteoles highly reduced and few numbered, 4–7 mm long, 0.3–0.4 mm broad, smaller than calyx, erect, linear filiform, villous. Flowers pedicellate, pedicels up to 1 mm long. Calyx 9–10 mm long, tubular and cylindrical, coriaceous, almost same diameter from base to top, outside longitudinally ribbed and ribs excurrent in teeth, hispid, more hairs on the ribs, inside upper half densely hispid; teeth 10, straight, subequal, 1–2.2 mm long, straight, triangular with broad base and pointed tip, densely hispid to tomentose. Corolla white, 19–20 mm long; tube 9–10 mm long, included in the calyx tube, glabrous, inside middle annulate with an undulating ring of fleshy hairs; lower lip 10 mm long, middle lobe 6 mm broad, emarginate with almost rounded lobes, side lobes 2.5 mm broad at free end, 7.5 mm long, tip obtuse and margin slightly revolute; upper lobe white, ±7 mm long, concave, base dilated, tip slightly bent, outside woolly tomentose hardly bearded with white cottony hairs, margin ciliate. Staminal filaments not hairy, lower pair longer than upper, anthers 0.54–0.6 mm long, 0.3–0.33 mm broad, light red coloured. Disc fleshy, cup shaped abaxial lobe fleshy and slightly enlarged than other lobes. Ovary locules smaller than 1mm, top shaped, almost rounded tip. Style ±17.5 mm long, top slightly bent; stigma bifid with two almost equal lobes, lower ±1.1 mm long, upper ±0.7 mm. Nutlets ±1.5 mm long, 0.8–0.85 mm broad, brownish, waxy surface, oblong, abruptly pointed at base, flat and truncate at top, obtusely triangular in cross section.

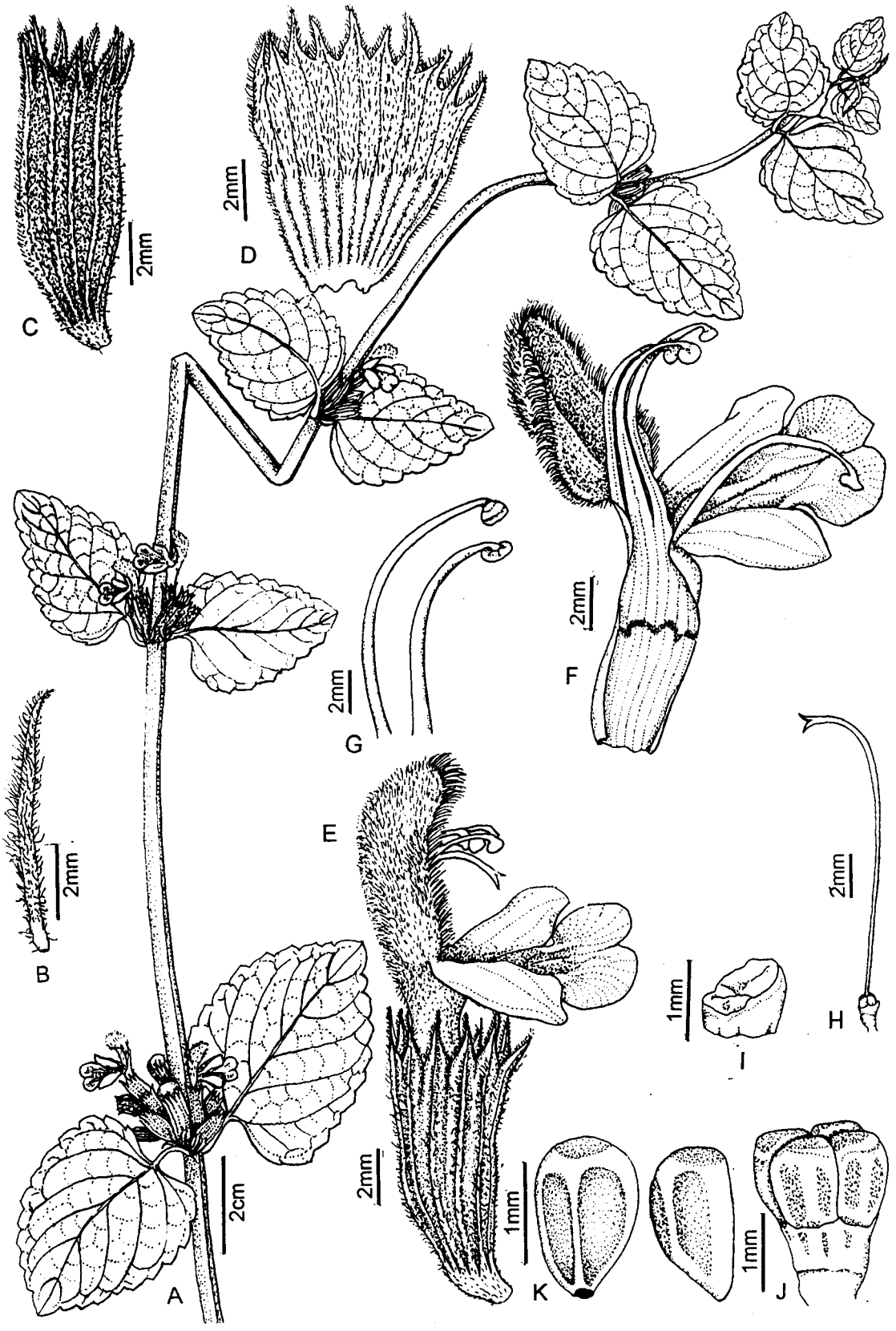


Fig. 57: *Leucas pubescens* Benth. A. Habit; B. Bracteole; C. Calyx; D. Calyx split open; E. Flower; F. Corolla split open; G. Stamens; H. Pistil; I. Disc; J & K. Nutlets.

Fig.: 58. *Leucas pubescens* Benth. (Wight 2156; herbarium from **E**)

Etymology: The species name designates the pubescent nature of the plant.

Flowering and fruiting: September–December.

Habitat: Growing in the margins and openings of semi-evergreen forests; among bushy herbs at an altitude above 1000 m. Prefer wet and shady atmosphere.

Conservation: IUCN Red list (1997) rating **I** (Rao et al., 2003)

Distribution: Found in the Southern Western Ghat regions, in Idukki district of Kerala and in Nilgiri biosphere area.

Specimens examined: India Orientalis Peninsula, Madras, Nagapatam, *Wight 2156* (E); **KERALA: Idukki Dt**.: Munnar, Gundumala, 30th Sept. 1998, *Sunojkumar 49608* (CALI); Munnar, Deviculum, 12th Nov. 2001, *Sunojkumar 49672* (CALI).

Note: This taxan is closely allied to *Leucas angularis* Benth., but differ from the latter in having a large size of the plant, leaves ovate with almost equal length and breadth; a long bracteoles; few number of flowers; coriaceous, long and cylindrical calyx which are hispid inside. This taxon is not widely distributed, endemic to Southern Western Ghat only.

25. Leucas rosmarinifolia Wall. ex Benth., in Wall. Pl. As. Rar. 1: 61. 1830; Benth., Labiat. Gen. Spec 3 (fasc. 6): 612. 1834; Wight, Icon. Pl. Ind. Orient. IV: 3. t. 1455. 1849; Benth. in DC., Prodr. XII: 528. 1848; Hook.f., Fl. Brit.

India 4: 685. 1885; Fyson, Fl. Nielgiri & Pulney 1: 331. 1915; Gamble., Fl. Pres. Madras 2: 1152. 1924; Mukerjee, Rec. Bot. Surv. Ind. XIV (1): 173. 1940; Sriniv. in A.N.Henry et al., Fl. Tamil Nadu Ser. 1. 2: 178. 1987; V.Singh, Mon. Indian Leucas 134. 2001.

—Type: India orientalis peninsula, *Wight, s.n.* Wall. Cat. No. *2520* (holo. **K** cibachrome !)

Low undershrub, erect, perennial, 30–60 cm high, stem base thick, woody, up to 1 cm thick; branches terete, 2–4 mm thick, greenish grey, tomentose with <1 mm long appressed hairs; internodes reduced, 1–2 cm long, nodes slightly dilated. Leaves sessile, 3–4 at each node, fasicled, rarely opposite; lamina 1.5–6 cm long, 1.5–4 mm broad, chartaceous, broadly acute or obtuse, base cuneate, entire, both margin revolute, both side tomentose to strigose with 0.25–0.5 mm long appressed hairs, veins appressed above, lower side prominent, densely woolly tomentose, lateral veins not prominent. Inflorescence terminal, 1–2 verticils per branch, spaced by 1–3 cm long internodes, each whorl subtended by 2–3 bracteate leaves. Flowers sessile of 1 mm long pedicellate. Bracteoles 8–9 mm long, 0.8 mm broad, as long as or longer than calyx, linear-lanceolate, recurved, ciliate to villous, hairs up to 1 mm long, tip acute. Calyx 6–6.5 mm long, straight, campanulate, turbinate, outside fully tomentose with appressed hairs, inside glabrous, mouth truncate, dense ciliate with 2–3 mm long silky white hairs, cilia longer than teeth, very conspicuous, persist in the seeding calyx, teeth 10, equal, 0.5 mm to 1 mm long, spinuous, trigonal, base up to 0.8 mm broad, tip acute, fully hispid. Corolla white, persist for 2–3 days, 15–

16 mm long; tube 5 mm long, outside hairy above, inside with longitudinal rows of hairs from mouth to the centre, not annulate, lower half glabrous; lower lip 10 mm long, middle lobe emarginate, 10 mm broad, pubescent on upper side, dense hairy on lower side, side lobes oblong, 1.8–2 mm broad; upper lip 5 mm long, concave, outside hooded with white dense long hairs, margin ciliate. Staminal filamens hairy in the lower half, provided with fleshy hairs at the attachment portion; anthers slightly reddish coloured, elongated with divaricate theca. Disc flat cup shaped, lobes 4, equal sized. Style 11 mm long, upper portion bent; stigma bifid, lower lobe 2–3 times longer than upper. Nutlets oblong, 2–3 mm long, 1.5 mm broad, light grayish brown coloured triangular at middle, top rounded.

Flowering and fruiting: September–March.

Habitat: Found as a montane grassland species, seen at at altitude above 2000m, among small grasses.

Distribution: Endemic to South India, reported only from Ooty and suburban area of Nilgiri Biosphere area.

Specimens examined: Indiae orientalis, 1866-67, *R.Wight 2158* (MH); **TAMIL NADU: Nilgiris Dt.**: Ooty, 2nd Feb. 1973, *E.J.M.Florence 5222* (CALI); Coonoor, 1883, *M.A.Lawson s.n. BSI Acc. No. 41600* (MH); Nilgiris, May, 1883, *J.S.Gamble 11656* (CAL), Nilgiris, May 1886, *J.S.Gamble 17295* (CAL, MH); Coonoor, 11th Feb. 1899, *Prain s.n.* (CAL); Ootacamund, Oct 1910, *A.Meebold 11779* (CAL); Ootacamund, Umbrella tree, 17th June 1919, *s.coll. No.500* (MH); Kukul Betta, 29th

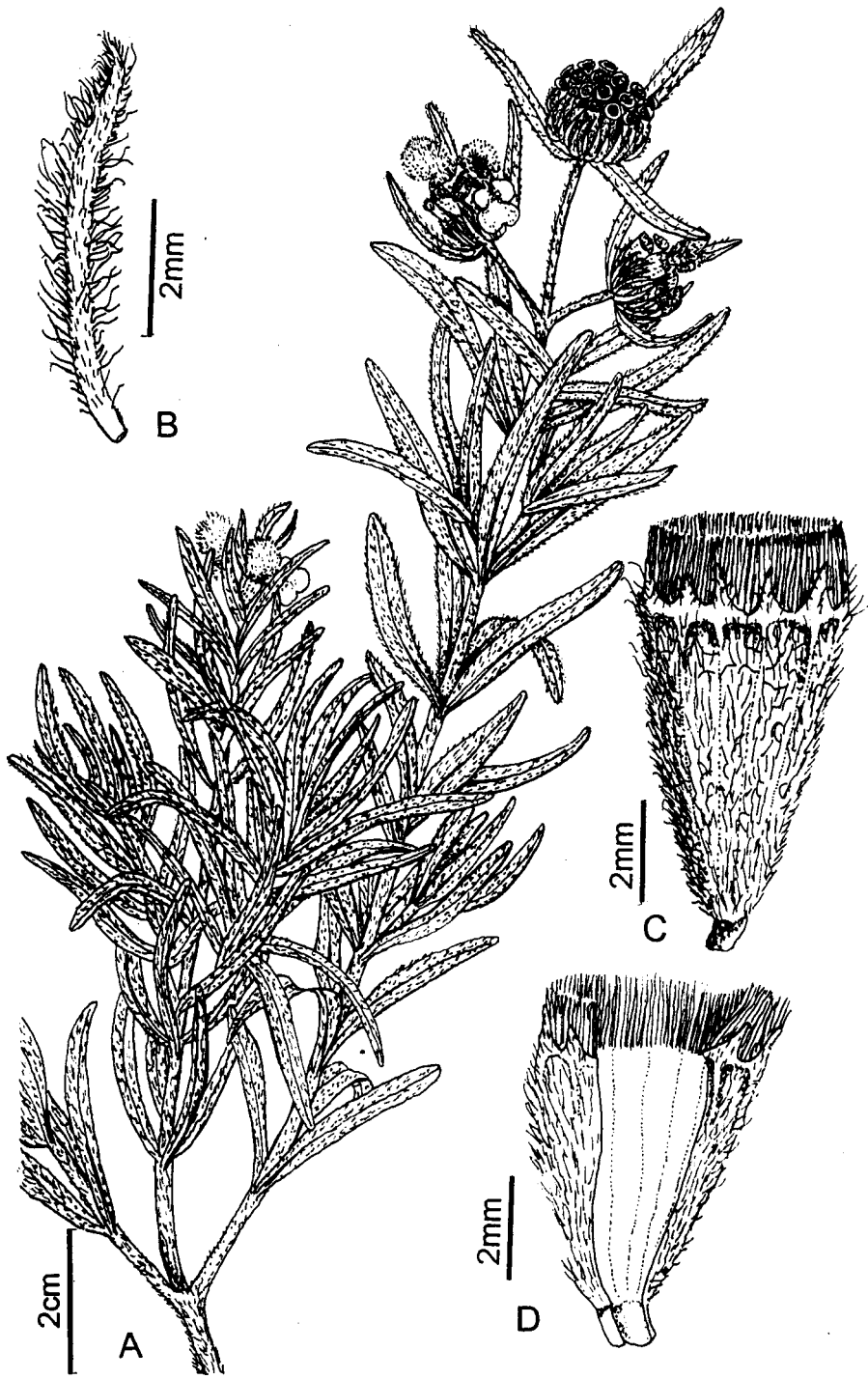


Fig.: **59**. *Leucas rosmarinifolia* Benth. A. Habit; B. Bracteole; C. Calyx; D. Calyx split open.

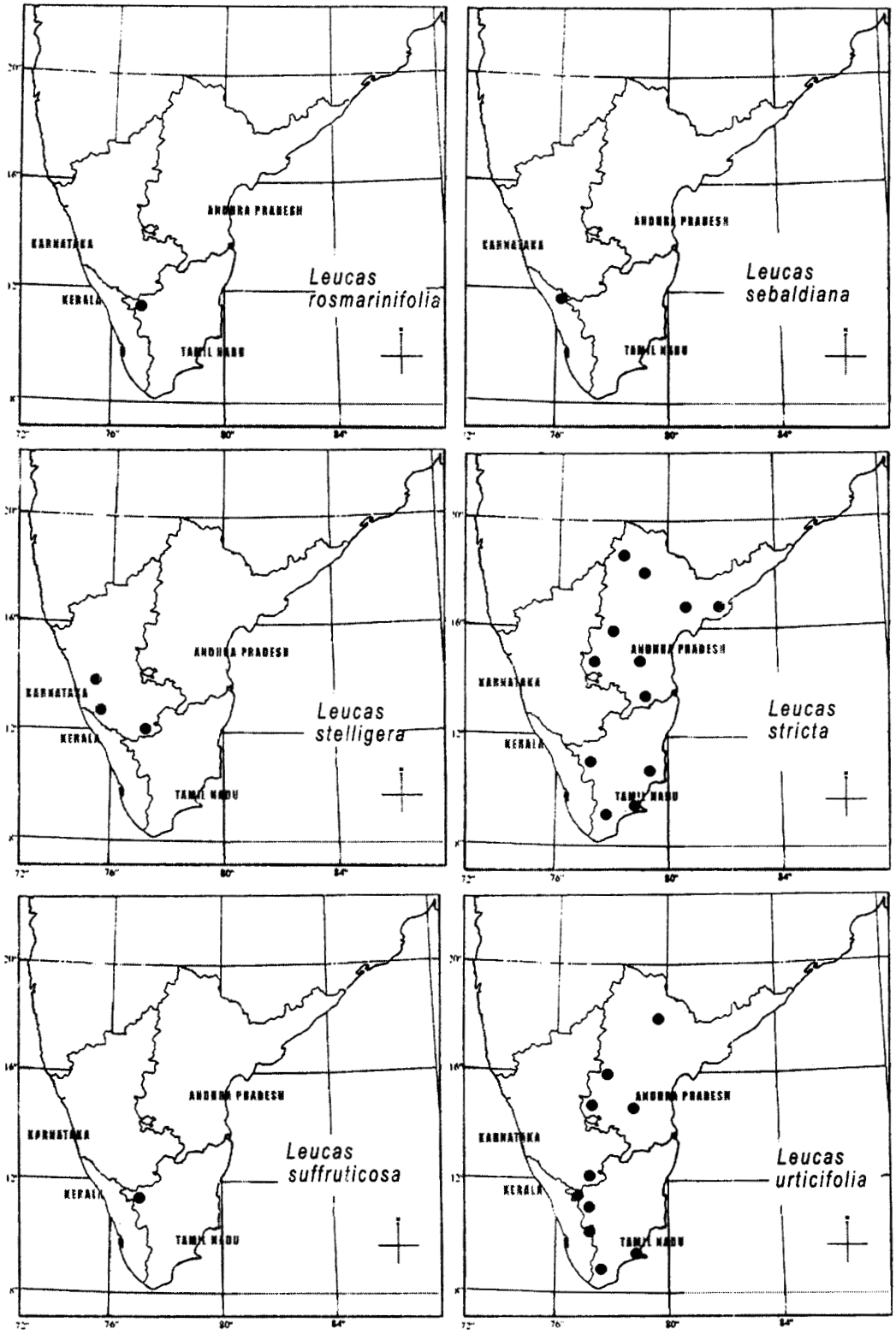


Fig.: 60. Distribution map of *Leucas* species in Southern Peninsular India.

Nov. 1970, *G.V.S.Rao 37394* (MH); Dodabetta RF, 27th Nov. 1971, *N.C.Radhakrishnan 39043* (MH); Dodabetta forest, 22nd Oct. 1981, *E.Vajravelu 76508* (CAL, MH); Avalanchi dam, 3rd Nov. 2001, *Sunojkumar CU49653* (CALI).

Note: This species shows resemblances with *Leucas helianthimifolia* and *Leucas suffruticosa* and can be distinguished by its long erect stem, leaves fasicled, overlapping at nodes. The inflorescence not produced on an elongated axis. Bracteoles equal to calyx, lanceolate, ciliate.

26. Leucas sebaldiana Sunojkumar **spec. nov.** (in print; *Candollea*)

Leucas vestita arcte affinis, sed differt inflorescentia constanti ex verticillastro uno ambitu irregulari, bracteolis fere frondosis, calyce longiore bracteolis flexo magnitudine varianti, ore sine ciliis genuinis.

—Type: INDIA: Kerala, Wayanad Dist., Chembra peak, 11° 32.75′N, 076°05.045′E, ca. 1394m, 7 Oct. 2000 (fl.), *Sunojkumar CU49630* (holo. **K** !; iso. **CALI** !).

Straggling herb, perennial from basal stem and root stock, 1–1.5 m long, basal stem 1–1.5 cm thick, woody; branches long, roughly obtusangular and grooved, often appear as terete, hispid with 1–1.5 mm long golden brown hairs,

tender stem densely hirsute; internodes 5–27 cm long. Leaves opposite, decussate, ovate to lanceolate, 3–8 cm long and 3–5.5 cm broad, almost two times longer than broad, subacute, sometimes obtuse, base rounded to obtuse, margin serrated with 15–19 teeth, secondary veins 5–7, prominent beneath, lower surface hirsute, especially on the veins, upper glandular punctuate, rugose on fresh specimen, hispid, hairs 1–1.7 mm long; petiole 1–2 cm long, hispid. Inflorescence a terminal solitary verticillaster subtended by a pair of leaves, 2.5–3.5 cm across, sub-globose with uneven margin due to the varied length and divergent nature of the flowers, dense many-flowered. Bracteoles 12–17 mm long, 3–3.5 mm broad, recurved, imbricately arranged and forming an involure below the flowers, foliaceous with a distinct midrib and 3–4 lateral veins, smaller than calyx, acute to acuminate tip, densely hispid with silvary hairs outside, margin ciliate. Flowers 15–25, pedicel ±1 mm long. Calyx tubular, size varying, 1.5–2 cm long, narrowed and glabrous towards the base, slightly bulged and dense long hispid in the middle, upper half tubular, forwardly bent, short hispid, reticulate and longitudinally ribbed, inside the tube densely villous at the upper half, hairs projecting outside the mouth giving a ciliate appearance, veins forming a thick annulus at the mouth; teeth 10, straight, subequal, 3–4 mm long, long subulate with triangular base and acuminate tip, outside and margin of the teeth hispid with spinulose hairs; fruiting calyx more bulged in the middle. Corolla 22–24 mm long, tube 10–11 mm long, slightly bent and fully included in the calyx, annulate around the middle inside with a ring of fleshy hairs; lower lip white, 10–13 mm long, middle lobe fan shaped and 8–9 mm broad, side lobes small, 2 mm wide at the free end, margins slightly revolute, tips

asymmetrically notched; upper lip yellowish brown, 5–6 mm long, rounded and concave with hairs in all directions. Stamens fully included and as long as the upper lip of corolla, upper pair shorter; filaments hairy; anthers reddish coloured, 1.5 mm long and 0.4 mm broad with confluent thecae. Disc cup shaped and equally four-lobed. Carpel locules ±1 mm high, above moderately rounded. Style15–16 mm long, slender and upper portion bent forwards; stigma lobes unequal; lower lobe 0.6 mm long; upper 0.15 mm long. Nutlets 2.9–3 mm long and 1.7 mm broad at middle, black, oblong, obtusely triangular in middle cross section, top rounded and glabrous.

Etymology: The species is named after Dr. Oskar Sebald, Staatliches Museum fur Naturkunde, Stuttgart, Germany in appreciation of his contribution to Lamiaceae systematics, especially on the genus *Leucas* R.Br.

Flowering and fruiting: September–February.

Habitat: Extremely rare, found in semi shady places at the margins of grasslands in temperate evergreen (shola) forest.

Distribution: Endemic to South India, a small population is known from a single locality in the Chembra hills at an altitude of ±1394 m.

Specimens examined: **KERALA**: **Wayanad Dt.**: Chembra peak, 7th Oct. 2000, *Sunojkumar CU49630* (CALI); 11th Oct. 2003, *Sunojkumar CU88129* (CALI); Calicut University botanical garden (cultivated), 22nd Jan. 2004, *Sunojkumar CU88144* (CALI).

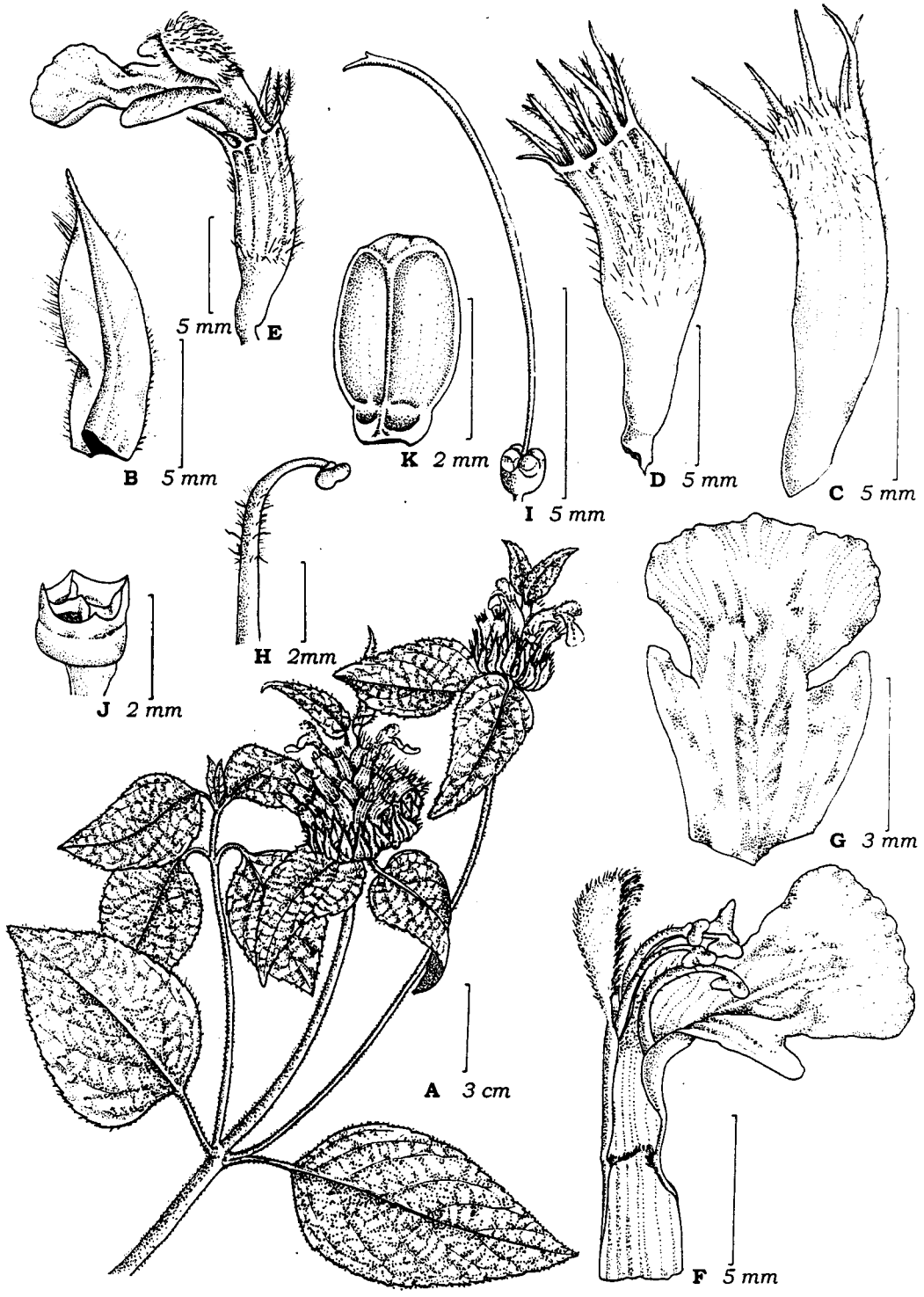


Fig. 61: *Leucas sebaldiana* Sunojkumar A. Habit; B. Bracteole; C. Calyx split open; D. Calyx; E. Flower; F. Corolla split open; G. Corolla lower lip; H. Stamen; I. Pistil; J. Disc; K. Nutlet

Fig. 62: *Leucas sebaldiana* Sunojkumar A & G - flowering twig; B - inflorescence; C - stem; D - flower; E - bractole; F - nutlets.

Notes: *Leucas sebaldiana* is included in the infra-generic section Astrodon, together with its close relative *Leucas vestita* Wall. ex Benth. This new species can be distinguished from *Leucas vestita* based on the characters shown in Table 13. *Leucas vestita* consists of five varieties in South India (Hook.f., 1885; Shetty & Vivekanandan, 1968), which are distinguished mainly based on the leaf shape, colour and comparative size of mouth cilia. This new species is distinct from all the known varieties of *Leucas vestita*.

Table. **13**: Comparison between *Leucas sebaldiana* and *Leucas vestita*.

Character	***Leucas sebaldiana*** sp. nov	***Leucas vestita*** Wall. ex Benth.
1. Branches	100–150 cm long, appear as terete	60–80 cm long, obtusely quadrangular and grooved
2. Inflorescence	terminal, solitary	upper 2-3 nodes
" size	3–3.5 cm diameter	2–2.5 cm diameter
" margin	uneven due to varied length of calyx	regular with uniform calyx
3. Bracteoles	3–3.5 mm broad, foliaceous with midrib and lateral veins	1–1.5 mm broad at base, linear-lanceolate, not foliaceous
4. Calyx tube	upper half bent, divergent from the main axis	straight, compactly arranged
" size	15–20 mm long	8–10 mm long
" mouth	not ciliate	densely ciliate, hairs sometimes longer than teeth, forming an inverted cone over mouth.
" teeth	erect	spreading
" inside	upper half densely villous	glabrous or pubescent
5. Corolla	22–24 mm long	15–16 mm long.

27. Leucas stelligera Wall. ex Benth., Pl. As. Rar. 1: 61. 1830; Benth., Labiat. Gen. Spec. 3 (fasc. 6): 613. 1834; DC., Prodr. XII: 529. 1848; Hook.f., Fl. Brit. Ind. 4: 686. 1885; Cooke, Fl. Bomb. Pr. 2: 470. 1906; Gamble, Fl. Pres. Madras 2: 1154. 1924; Mukerjee, Rec. Bot. Surv. India XIV (1): 177. 1940; Sriniv. in A.N.Henry et al., Fl. Tamil Nadu Ser. I. 2: 178 1987; V.Singh, Mon. Indian Leucas 136. 2001.

—Type: Indiae Orientali, Aurungabad, March 1823, *s.coll, s.n* (Wall. Her. No. *2049*) (holo. **K**; iso. **K** cibachrome !)

Leucas eriostoma var. *longifolia* Hook.f., Fl. Brit. India 4: 686. 1885

—Type: Peninsula India Orientalis, *Wight, 2153.* (holo. **K** cibachrome !)

Leucas hamatula Arn. Pugill. Pl. India Or. 37. 1836.

Erect undershrub, perennial, 50–130 cm high, basal stem thick and woody, about 1–1.5 cm thick, tomentose with dark green texture, young branches herbaceous, obtusely quadrangular, grooved, ciliate with 0.5–1 mm long hairs, tender stem densely ciliate at tip, internodes 3–8 cm long. Leaves opposite, petiole 6–8 mm long, tomentose; lamina 4.5–9.5 cm long, 1–2.8 cm broad, membraneous to slightly coriaceous, linear-lanceolate to lanceolate, cuneate to narrowed at base into petiole, tip sub acute, margin serrate with 8–11 teeth, secondary veins 5–7, impressed above, prominent beneath, gland dotted and scabrous with hispid spreading hairs below, more on the veins, above scabrous with 1 mm long hirsute hairs. Inflorescence in terminal 1–3 axils, many flowered dense globose clusters,

±2.2 cm diameter, cluster enlarge in size during fruit setting and attains 3.5 cm diameter. Bracteoles many, 11–12 mm long, as long as calyx recurved, linear, ±1 mm broad, proximal side grooved and glabrous, outside dense hispid, margin ciliate, with 1 mm long hairs. Calyx tubular campanulate, straight, 8–11 mm long, slightly constructed and bent below the mouth, base narrowed, with sparse hispid hairs, upper half prominently ribbed and dense hispid mixed with long ciliate hairs up to 1 mm long, inside fully glabrous, mouth truncate and annulate with a ring of veins, provided with dense silver coloured straight ciliate hairs, teeth 10, linear, acute tip, 2 mm long, stellately spreading, longer than the mouth cilia; in fruiting stage calyx much prolongate, attain up to 13 mm, tube lower half become leathery and upper half reticulate. Corolla white, 16 mm long; tube 8 mm long, included in the calyx, above outside hairy, inside middle with an oblique ring of fleshy hairs, above longitudinally hairy with fleshy hairs up to the base of stamens; lower lip 7.5–8 mm long, tri-lobbed, middle lobe 5.5 mm broad and emarginate at free end, lower side hairy, side lobes 1.5 mm at free end, margin revolute, free from middle lobe; upper lobe 5 mm long, concave, densly hairy outside with silver coloured hairs, margin ciliate. Staminal filaments hairy, hairs at the attachment are fleshy; anthers 1.2–1.7 mm long, 0.5–0.6 mm broad, theca divergent. Disc cup shaped, fleshy with abaxial lobe slightly taller than the other lobes. Ovary locules 0.7 mm high, top rounded. Style 12 mm long; stigma bifid, lower lobe 0.6 mm long, upper 0.06 mm. Nutlets 2.5 mm long, 1.3 mm broad at middle, black, oblong, cylindrical, top rounded, acutely triangular in cross section, surface not smooth, slightly rugose with fine

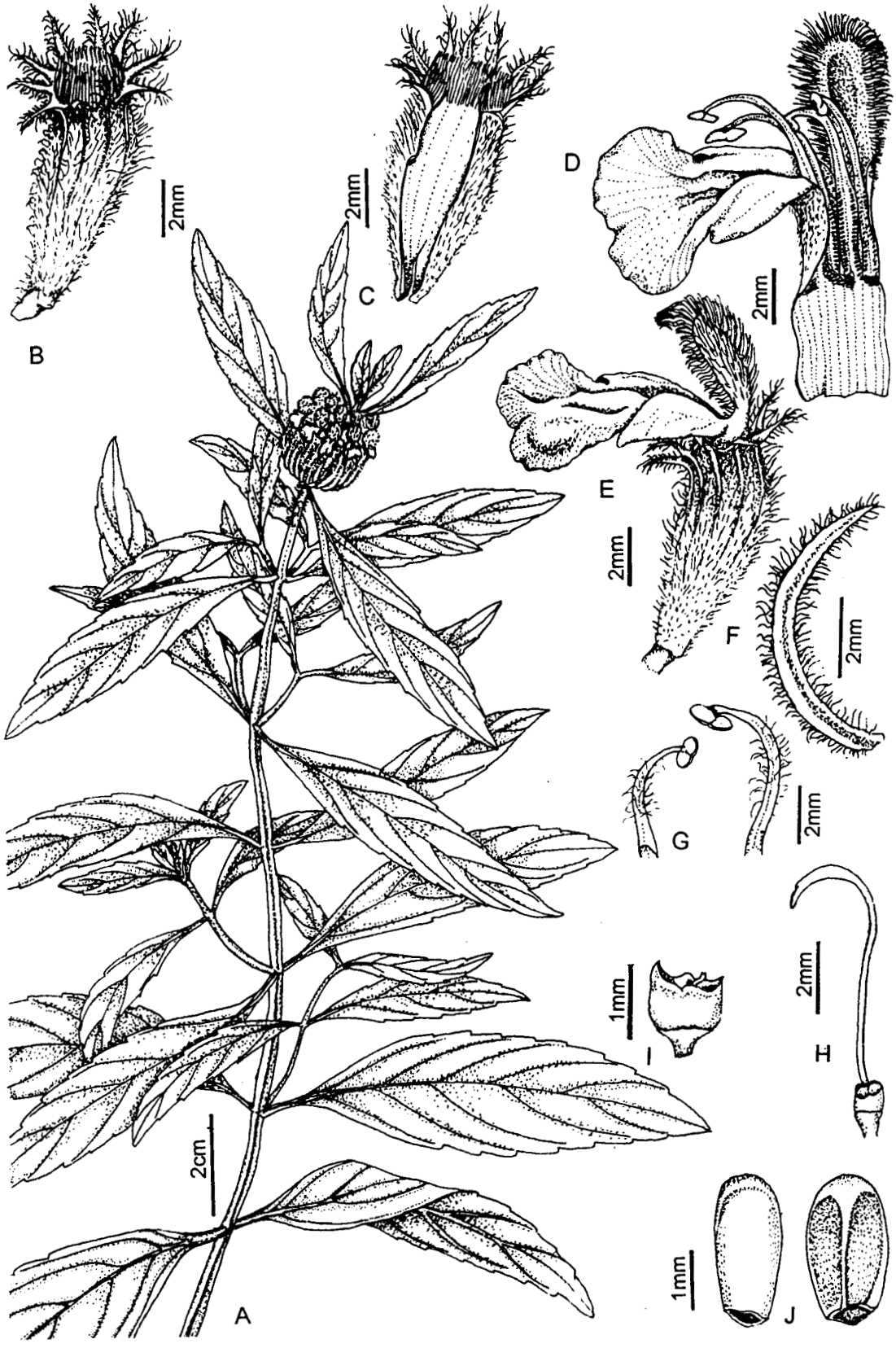


Fig. 63: *Leucas stelligera* Benth. A. Habit; B. Calyx; C. Calyx split open; D. Corolla split open; E. Flower; F. Bracteole; G. Stamens; H. Pistil; I. Disc; J. Nutlets.

Fig. 64: Type specimen of *Leucas stelligera* Benth. (Wall. Herb. no.2049; from K)

eglandular hairs.

Etymology: The species is derived from the *'recurvo stellatis'* nature of calyx; means calyx star like, referring to the orientation of teeth. (*stellatis* = star like)

Flowers and fruiting: October–February.

Habitat: Found in grass lands and in the margins and openings of deciduous forests at an altitude 800–1200 m.

Distribution: India, Sri Lanka; in South India this is found in Karnataka and Karnataka–Kerala bordering hills.

Specimens examined: **KARNATAKA: Mysore Dt**.: Vankeabbi falls, 16th May 1960, *R.S.Raghavan 62563* (CAL); **South Canara Dt**.: Someshwar, 16th Feb. 1940, *S.R.Raju 572* (MH); **Shimoga Dt**.: Agumbae ghat road, 16th Apr. 1958, *S.D.Mahajan s.n* (CAL); Nagodi on the way to Kodachadri hills, 12th Oct. 1000, *Sunojkumar CU49634* (CALI); Kodachadri, 12th Feb. 2003, *Sunojkumar CU88123* (CALI).

28. Leucas stricta Wall. ex Benth., Pl. As. Rar. 1: 61. 1830; Benth., Labiat. Gen. Spec. 3 (fasc. 6): 614. 1834; in DC., Prodr. XII: 531. 1848; Hook.f., Fl. Brit. India 4: 688. 1885; Cooke, Fl. Bombay Pr. 2: 467. 1906; Prain, Bengal Pl. 856. 1908; Haines, Bot. Bihar & Orissa 4: 750. 1922; Gamble, Fl. Pr. Madras

2: 1150. 1924; Mukerjee, Rec. Bot. Surv. India. XIV (1): 170. 1940; N.P.Singh, Fl East. Karnataka 2: 519. 1988; Raju & Pullaiah, Fl. Kurnool Dist. 187. 1998; Pullaiah et al., Fl. Guntur Dist. 287. 2000; V.Singh, Mon. Indian Leucas 138. 2001.

—Type: India, Pulical hills, *Heyne s.n.* (holo. **K** cibachrome !).

Phlomis stricta Wall. Cat. Herb. No. 2045. 1829 *nomen* —Type as above.

Leucas stricta *sensu* Baker, Fl. Trop. Africa 5. 484. 1900; Manilal & Sivar., Fl. Calicut 239. 1982. *non* Benth 1830.

Erect slender annual herb, attaining a height of 15–50 cm, basal part 4–6 mm across, branches ascendeing, obtusely quadrangular, grooved, hispid with1–1.5 mm long hairs, tender stem below the inflorescene densely villous. Leaves opposite, sub-sessile to 3 mm long petiolate; lamina 3.5–7 cm long, 6–10 mm broad, thin, linear-oblong to lanceolate, base long cuneate, tapering and overlapping with petiole, tip broadly acute to obtuse, margin elsewhere entire or remotely and sparingly serrate with 5–6 minute teeth, upper side and margin long pubescent, lower side veins sparingly hispid. Inflorescence terminal sometime another whorl develops on the subtending node, sub-globose, rich and dense flowered, some time the internodes below the inflorescence elongate. Bracteoles 7–8.5 mm long, 0.8–0.9 mm broad, as long as calyx, linear lanceolate, bent or recurved towards the flowers, ciliate with 1–2 mm long hairs, tip acute. Flowers 1–2 mm long pedicellate. Calyx narrowly funnel shaped to tubular, middle of the tube bent, abaxial side 5.5–6 mm

long adaxial side 7–10 mm long, upper half of the tube inside minutely pubescent, outside upper half prominently ribbed along the veins, dense pubescent, hairs 1–1.5 mm long, scattered, lower half glabrous, mouth annulate with a ring of thick veins, dense ciliate, hairs turned towards the mouth opening; teeth 10, longer than mouth cilia, anterior teeth large, 2.5–3 mm long, 0.6 mm broad at base, others up to 2 mm long, sub-equal, straight, tip acute, pubescent and mixed with long hairs. Corolla white 21 mm long; tube 7 mm long, included in the calyx, inside middle annulate with a discontinuous ring of hairs; lower lip 14 mm long, middle lobe fan shaped, margin wavy, ±11 mm broad, side lobes narrow towards back, 1.5 mm broad and slightly notched at the front free end, margin slightly emarginate; upper lobe 5 mm long, concave, outside white dense hairy margin ciliate with a slight blackish colour at the anterior end. Disc cup shaped, lobes almost equal. Ovary locules trigonal, 0.8 mm high, top flat. Style 9.5 mm long; stigma bifid, lower lobe 0.3 mm long, upper lobe reduced. Nutlets 3 mm long 1.5 mm broad, dark brown, surface not smooth, oblong, cylindrical, flat at base attachment part, obtusely triangular middle, top rounded and trigonal.

Vernacular: Tumba (Tamil)

Etymology: The species name 'stricta' is derived from the nature of stem '*caule erecto, stricto*' means stem straight and upright. (*stricto*= straight)

Flowering and fruiting: August–March.

Fig. 65: *Leucas stricta* Benth. A. Habit; B. Bracteole; C. Calyx; D. Calyx split open; E. Flower; F. Stamens; G. Pistil; H. Disc; I. Corolla split open; J. Nutlets.

Fig. 66: A-B. *Leucas stelligera* Benth.; C-E. *Leucas suffruticosa* Benth.; F-G. *Leucas stricta* Benth.; (A. fruiting stage; B, E & G. flowering stage)

Habitat: Found as a weed in law land sandy area, among grasses in scrub jungle and waste places.

Distribution: Found in Asian countries Myanmar and India. In South India this is found in Andhra Pradesh, Karnataka and Tamil Nadu.

Specimens examined: **ANDHRA PRADESH: Anantapur Dt.**: Mudukota RF, 9th Jan. 1983, *T.Pullaiah & N.Yesoda 978* (SKU); SK University campus, 22nd Oct. 2001, *Sunojkumar CU49658* (CALI); Kalasamudram, 24th Oct. 2001, *Sunojkumar CU49663* (CALI); **Chitoor Dt.**: Tirupati, Akasaganga, 25th Oct. 2001, *Sunojkumar CU49668* (CALI); **Cuddapah Dt.**: Palkonda RF, Guvvalcheruvu, 23rd Aug. 1958, *K.Subramanyan 6429* (CAL, MH); Guvvalcherulu RF, near forest guest house, 23rd Sept. 1988, *R.V. Reddy & R.R.V.Raju 7806* (SKU); **East Godavari Dt.**: Vadapalli, 31st, Dec. 1901, *A.G.Bourne 3321* (CAL); **Gundur Dt.**: Chintela Thanda, 26th Nov. 1984, *V.Ramakrishnaias 3234* (SKU); **Karimnagar Dt.**: East of Bhupatipur, 23rd July 1964, *G.V.S.Rao 20195* (MH); Kondagathi, 26th Aug. 1987, *M.R.R.Prasad 464* (MH); **Kurnool Dt.**: Way to Dhangabavikonda Chelamov, 15th Oct. 1964, *J.L.Ellis 22017* (MH); Way to Balagram Ahobilam, 28th Aug. 1965, *J.L.Ellis 25537* (MH); Kammavaripalle, 11th Nov. 1984, *T.Pullaiah & G.Obulesu* 3391 (SKU); **Medak Dt.**: Way to Pegarikutta, 23rd Sept. 1958, *K.M.Sebastine 6658* (CAL, MH); **TAMIL NADU: Coimbatore Dt.**: Forest rangers College, *K.N.Subramaniam 457* (FRC); **Ramanathapuram Dt.**: Karaikudi, Kundanav RF, 28th Nov. 1977, *N.C.Nair 51743* (CAL, MH); **Thanjavur Dt.**: 19th May 1978, *V.J. Nair 56521* (CAL, MH); **Tirunelveli Dt.**: Vijayanarayanam Naval Base, 1st Dec.1999, *Sunojkumar CU49621*

(CALI); Vijayanarayanam, 15th Mar. 2000, *Sunojkumar CU49624* (CALI).

Note: This species is mostly found in Eastern Ghat region of South India. Different from the related species, this possess bend calyx with 2.5 mm long teeth, almost equal sized; mouth provided with long ciliate hairs, turned towards the centre.

29. Leucas suffruticosa Benth., Labiat. Gen. Spec. 3 (fasc. 6): 611. 1834; Wight, Icon. Pl. Ind. Orient. IV: 3. t. 1454. 1849; Benth. in DC., Prodr. XII: 528. 1848; Hook.f., Fl. Brit. India 4: 685. 1885; Fyson, Fl. Nilgiri & Pulney 1: 331. 1915; Gamble., Fl. Pres. Madras 2: 1152. 1924; Mukerjee, Rec. Bot. Surv. India XIV (1): 173. 1940; R.R.Rao & Razi, Syn. Fl. Mysore Dist. 512: 1981; Sriniv. in A.N.Henry et al., Fl. Tamil Nadu Ser. I. 2: 178. 1987; V.Singh, Mon. Indian Leucas 142. 2001.

—Type: Peninsula India orientalis, Nilgiris, *Wight, s.n.* Wall. Cat. No. *2157* (holo. **K** cibachrome !; iso. **K** !, **E** !).

Low suffruticose undershrub, perennial from woody, amorphous basal stem, prominent taproot; branches many, 10–30 cm long, terete, slender, rigid, ascending often decumbent, terete, densely fulvous-tomentose with <1 mm long antrorse hairs, internodes much reduced towards the base, 2–10 mm long, sometimes up to 3 cm long towards tip. Leaves opposite decussate; sessile to 2 mm long pedicel; lamina

1.5–2.5 cm long, 4–6 mm broad, dark green coloured in living specimens, coriaceous, fleshy, linear-oblong, broadly acute to obtuse tip, base obtuse to slightly cuneate, margin entire, recurved; upper surface hirsute with stiff bristle like 1 mm long hairs all along and margins, midrib appressed, lateral veins not prominent, lower surface veins prominent, white tomentose, dense hairs on midrib and 2–3 lateral veins. Inflorescence terminal, 1–2 verticil per branch, on a much elongated, 10–30 cm long golden yellowish coloured axis, sometime another whorl may develop below, each subtended by a pair of leaves. Bracteoles setaceous, 3–3.5 mm long, half as long as calyx, linear straight, tip acute, villous outside and margins, proximal side glabrous. Flowers almost sessile. Calyx 6 mm long, slightly golden yellowish coloured, straight, campanulate, base narrowed, broad up to 4.5 mm towards mouth, outside fully tomentose hairs appressed, longitudinally ribbed towards the mouth, glabrous within, mouth truncate, provided with ciliate silvery 1 mm long hairs, turned towards the mouth opening; teeth 10, erect, spinulose equal to the mouth cilia. Corolla off-white coloured, persist afresh on the calyx for 2–3 days, 15–16 mm long; tube included in the calyx 5.5–6 mm long, outside above villous, longitudinal rows of fleshy hairs inside below the mouth up to the centre, glabrous below; lower lip 10 mm long, almost double the size of tube and upper lip, middle lobe emarginate with a deep cut in the centre, 10 mm broad at free side, thick and hispidly hairy on both side towards the proximal side, more on lower portion, side lobes oblong, 1.8–2 mm broad at the middle, obliquely produced towards margin, slightly revolute; upper lip 6–6.5 mm long, concave, enclose stamens and stigma, conspicuously white bearded outside with a dense tuft of hairs, margin

ciliate. Staminal filaments hairy towards the lower part; anthers light reddish coloured, elongate, 1.5–1.7 mm long, 0.3–0.4 mm broad, 3–4 times longer than broad, theca divaricate. Disc saucer shaped, lobes 4, reduced, equal sized. Style 11 mm long, bent towards the upper part; stigma bifid, lower lobe longer, 0.9 mm long upper lobe reduced, 0.06 mm long. Nutlets ±3 mm long, ±1.6 mm broad towards tip, narrowed towards base, not smooth, slightly rough and pale brown coloured.

Etymology: The species name refers to the 'suffruticose' habit of the plant.

Flowering and fruiting: September–March, occasional flowering in June & July is recorded in some herbarium collections.

Ecology: Found as a montane grassland species, above an altitude of 2000–2500 m among grasses, which attain a height up to 30 cm.

Distribution: A South Indian endemic found only in the Nilgiri biosphere reserve area, especially in the Ooty and suburban area.

Specimens examined: Peninsular Indiae orientalis, *R.Wight 2157* (CAL); **TAMIL NADU: Nilgiris Dt**.: Ootacamund, 6th Sept. 1878, *G.King 112* (CAL); Nilgiris, June 1883, *J.S.Gamble 11809* (CAL); Pykara, Oct 1910, *A.Meebold 11684* (CAL); Ooty-Pykara, 29th Mar. 1917, *s.coll. 15260* (MH); Ooty, Muri dairy farm 15th Sept. 1930, *V.Narayanaswamy 4377* (MH); Naduvattom, 4th Oct. 1956, *N.P. Balakrishnan 229* (MH); Ooty-Wenlock Downs, 9th July 1970, *J.L.Ellis 34573* (MH); Upper Bhavani grasslands, 1st June 1970, *B.V.Shetty 34053* (MH); Thalakundha, 27th Sept. 1970, *B.D.Shaarma 35830* (MH); Dodabetta, 27th Nov. 1971, *N.C.Radhakrishnan 39039*

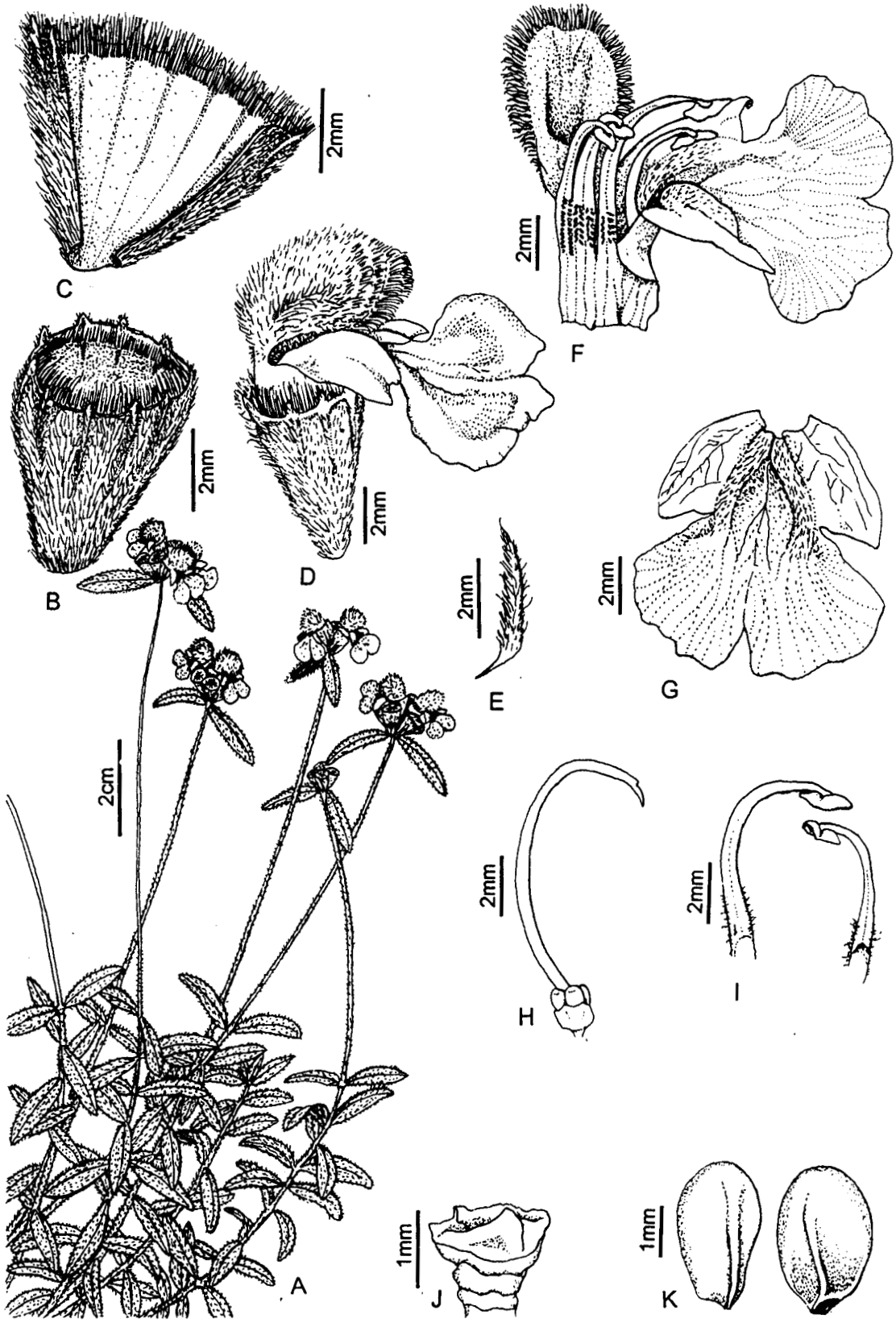


Fig. 67: *Leucas suffruticosa* Benth. A. Habit; B. Calyx; C. Calyx split open; D. Flower; E. Bracteole; F. Corolla split open; G. Corolla lower lip; H. Pistil; I. Stamens; J. Disc; K. Nutlets.

(MH); Pykara, Open grass lands, 21st Oct. 1972, *J.L.Ellis 43285* (MH); Mullimund, 12th Oct. 1972, *K.Vivekanandan 42917* (MH); Osamund-Koilmund, Sandinalla forests, 19th Oct. 1981, *E.Vajravelu 76502* (MH); Avalanchi near power house, 25th Dec. 2002, *Sunojkumar CU88111* (CALI); Naduvattom, Royal valley estate hill top, 6th Nov. 2004, *Sunojkumar CU88147* (CALI).

Notes: Among Wight's collections, *No. 2157* and *2158*, no mention about type specimen is available in the protologue. *No. 2157* (from Kew) is selected as the holotype because it is the specimen seen by Bentham while establishg the species. The locality name Nilgiris appeared in both protologue and herbarium. Other specimens are seems to be part of same collection and treated as isotypes. The specimen is collected from a height above 2000 m, and is not found below this height in the same hills. Usually this plant grows in black soils found in shola grasslands together with grasses. This species is very close to *L. rosmarinifolia* and *L. helianthimifolia,* but can be distinguished by its opposite leaves and verticils produced on a long axis.

30. Leucas urticifolia (Vahl) Sm. in Rees, Cyclop. XX. 1812; Spreng. in L., Syst. Veg., ed. 16, II: 743. 1825; Benth. in Wall., Pl. As. Rar. 1: 60. 1830; Labiat. Gen. Spec. 3 (fasc. 6): 605. 1834; in DC., Prodr. XII: 524. 1848; Wight, Icon. Pl. Ind. Orient. IV: 3. t. 1451. 1849; Richard, Tent. Fl. Abyssnica 2: 199. 1851; Schweinf., Beits. Fl. Aeth. 123. 1867; Boiss., Fl. Or. 4: 778. 1879; Hook.f., Fl.

Brit. India 4: 680. 1885; Balf., Trans. Roy. Soc. Edinb. 31: 242. 1888; Deflers, Voy. Yemen 189. 1889; Baker, Fl. Trop. Africa 5: 489. 1900; Prain., Bengal Pl. 855. 1906; Cooke, Bombay Fl. 2: 464. 1908; Haines, Bot. Bihar & Orissa 4: 747. 1922; Blatter, Fl. Arabia 8/4: 382. 1923; Gamble, Fl. Pres. Madras 2: 1149. 1924; Chiovenda, Fl. Somalia 281. 1929; Schwartz, Fl. Trop. Arabia 223. 1939; Mukerjee, Rec. Bota. Surv. India XIV (1): 166. 1940; Andrews, Flow. Pl. Sudan 3: 216. 1956; Tackholm, Stud. Fl. Egypt 149. 1956; Duthie, Fl. Upp. Gangetic Plains 2: 112. 1960; Cufodontis, Enum. Pl. Aeth. 812. 1962; Sebald, Stuttg. Beitr. Naturk. A. 341: 133-134. 1980; R.R.Rao & Razi, Syn. Fl. Mysore Dist. 512. 1981; Sriniv. in A.N.Henry et al., Fl. Tamil Nadu Ser I. 2: 178. 1987; N.P.Singh, Fl. East Karnataka 2: 520. 1988; Chabdrab. & N.C.Nair, Fl. Coimbatore Dist. 244. 1988; Pullaiah & Yesoda, Fl. Anandapur Dist. 202. 1989; Hedge in Ali & Nasir, Fl. Pakistan 192: 158. 1990; K.M.Matthew, Ex. Fl. Cent. Tamil Nadu 404. 1991; Raju & Pullaiah, Fl. Kurnool 383. 1995; Pullaiah & Moulali, Fl. Andhra Pradesh 2: 774. 1997; K.M.Matthew, Fl. Pulney hills 2: 998. 1999; Pullaiah & Mohammed, Fl. Renga Reddi Dist. 175. 2000; V.Singh, Mon. Indian Leucas 144. 2001 (*Leucas urticaefolia* = *L. urticifolia*).

Phlomis urticifolia Vahl, Symb. Bot. 3: 76. 1794; Willd., Sp. Pl. 3: 124. 1800; Pers., Syn. Pl. 2: 127. 1806.

—Type: Indiae orientali, *Konig, s.n.* herbarium Liebmann (syntype **C** photo !); Arabia, *Forskal. s.n., non vidi.*

Enedon urticifolia (Vahl) Rafin., Fl. Tell. 3: 88. 1837.

—Type: *Phlomis urticifolia* as above.

Leucas coleae Baker, Kew Bull. 1985: 226. 1895; Fl. Trop. Africa 5: 488.1900; Cufodontis, Enum. Pl. Aeth.: 809. 1962.

—Type: Somalia, Golis Range, 1894/ 95, *Cole s.n.* (holo **K**) *non vidi.*

Leucas affinis R.Br. in Salt, Voy. Abyssinia, App. N. 64. 1814. *nom. nud.*

—Type: Abyssinia, *Salt s.n.* (holo. **BM**).

Ballota arabica Presl, Abh. Konigl. Bohm. Ges. Wiss. 5. Ser., 3: 529. 1845. *nom. nud* —Type: Arabia 12. 2. 1836 fl., fr., *Schimper 818* (**BM, K**).

Hemistoma ovata Ehrenberg ex Benth. in Wall., Pl. As. Rar. 1: 60. 1830. pro. Syn. *L. urticifolia, nom. nud.*

Erect annual herb, 15–100 cm high; branches herbaceous, tetragonous, obtusangular, grooved, dense pubescent with retrorse hairs; internodes 3–7 cm long. Leaves opposite, petiole 1.2–2.5 cm long, pubescent, grooved; lamina 3.5–7.5 cm long, 2.5–5 cm broad, membraneous, gland dotted below, ovate, obtuse to acute tip, rounded or cuneate at base, margin deeply crenate-serrate with 10–11 teeth, upperside glabrate or finely pubescent with minute hairs, below dense pubescent with tiny hairs, lateral veins 4–5, appressed above, prominent beneath. Inflorescence in many clusters almost in all axils, many and dense flowered, 1.5–2.5 cm in diameter. Bracteoles many, recurved, as long as calyx, 7–12 mm long, 0.9–1 mm broad, linear- lanceolate, sometimes slightly foliaceous with prominent midrib, aristate-acuminate, both side hispid and mixed with ±1 mm long ciliate hairs. Flowers almost sessile. Calyx tubular, cylindrical, broad at middle, straight, adaxial

side 7–9 mm long, abaxial side 5–6 mm long and produced as a lobe with 3 long teeth, outside fully dense pubescent and mixed with long up to 1 mm long scattered hairs, upper half prominently ribbed, reticulate veined, inside fully pubescent, mouth very oblique with a ring of veins, abaxial long teeth 1–1.5 mm long, 0.5 mm broad, tip aristate, triangular base, lateral teeth small 0.5–0.8 mm long; fruiting calyx prolongate, up to 10–11 mm long. Corolla white, ±9 mm long, tube 5.5 mm long, not annulate inside, glabrous outside; lowerlip ± 3.5 long, middle lobe emarginate, 2 mm broad at free side, side lobes oblong, 1.25 mm broad, pubescent outside and margins; upper lobe ± 2.7 mm long, concave, hairy outside. Stamens very short, filaments hairy; anthers 0.75–0.8 mm long, 0.3 mm broad, divergent theca. Disc cup shaped, abaxial lobe large, two times longer than other lobes and ovary lobes. Ovary locules provided with glandular stalked hairs above. Style 6.5 mm long, tip forwardly bent, stigma hairy with minute hairs, lower lobe 0.3 mm long, upper lobe reduced. Nutlets black coloured, oblong, 2 mm long, 1 mm broad, obtusely triangular at middle, top flat, obtuse and ridged margin, inclined to the centre, provided with numerous stalked glandular hairs.

Etymology: The species name is a Latin word means 'nettle-leaves *Leucas*'

Flowering and fruiting: July–January.

Ecology: Weed in cultivated fields, wetlands, open places, roadsides, and railway tracks.

Distribution: Africa, Arabia and Asia; pan-tropical

Fig. 68: Type specimen of *Leucas urticifolia Sm.* (herbarium Konig. *s.n.* from C)

Fig. 69: *Leucas urticifolia* Sm . A. Habit; B. Calyx; C. Bracteole; D. Calyx split open; E. Flower; F. Corolla; G. Corolla split open; H. Corolla lower lip; I. Disc; J. Nutlets; K. Stamens; L. Stigma.

Specimens examined: **ANDHRA PRADESH: Anantapur Dt.**: 6th Oct.1981, *T.Pullaiah 403* (MH); Tadpatri, 6th Oct. 1981, *Pullaiah & Yesoda 403* (SKU); Pennahobilam, *D.A.Moulali 10101* (SKU); **Cuddapah Dt.**: Palakonda hills 15th July 1989, *C.Subbarayndu 9370* (SKU); **Kurnool Dt.**: Erramalai hills, Madhavaram R.F., 10th Nov. 1983, *R.R.V. Raju 1648* (SKU); Erramalai hills, Veldurthi R.F., 1st Dec. 1983, *R.R.V.Raju 1713* (SKU); Ramalakota R.F., 4th Dec. 1983, *R.R.V.Raju 1848* (SKU); Ganifields, 2nd Dec. 1983, *Pullaiah et al. 1932* (SKU); Peddamantanala, 5th Dec. 1984, *R.R.V.Raju & P.V. Prasanna 2360* (SKU); **Prakasam Dt.**: Parsiprakasam 4th Dec. 1983, *R.K.Mohan 328* (CAL); **KARNATAKA: Mysore Dt.**: Mysore & Karnatic, *Thomson, Wall Cat 2052,* 2 sheets (CAL); Gundulpet, 27th Aug.1964, *B.D.Naithani 21267* (MH); **KERALA: Idukki Dt.**: Chinnar, Alampetty, *K.K.Sajeev 18283* (KFRI); **TAMIL NADU: Coimbatore Dt.**: *Lawson, 41317* (MH): 8th Nov.1943, *P.Daniel 86651* (MH); Varapalayam, 2nd Aug.1956, *K.Subramanyam 453* (MH); 17th Sept.1962, *C.P.Sreemadhavan CPS176* (MH); Forest college estate 18th Sept. 1967, *K.N.Subramanian 2762* (FRC); Saibaba colony, 3rd Aug.1968 *M.Chandrabose 30590* (MH); TNAU campus, 10th Jan.1993 *N.Rajagopalan 97769* (MH); Forest college estate, 30th Nov. 2002, *K.N.Subramanian 197* (FRC); Forest college campus, 5th Dec. 2002, *Sunojkumar CU49695* (CALI); **Nilgiris Dt.**: Sirur,13th Nov.1070, *G.V.S.Rao 37207* (MH); **Ramanathapuram Dt.**: Chitrangudi, 11th Nov.1989, *V.Balasubramaniam 2201* (MH) Virudanagar, 09th Sept.1949, *Ramamoorthy 93778* (MH); **Salem Dt.**: Woddapatta R.F., 28th Niv.1994, *E.Vajravelu 21986* (MH);

Tirunelveli Dt.: Vijayanarayanam Naval base, 1st Dec. 1999, *Sunojkumar CU49621* (CALI); 10th Jan 2002, *Sunojkumar CU49686* (CALI).

Notes: *Leucas urticifolia* is one of the widely distributed species. It is found in all tropical areas where *Leucas* is reported. It is believed (Sebald, 1980) that this is an African species where three varieties are noticed. However in Asian continent only one variety is found.

31. Leucas vestita Wall. ex Benth. in Wall., Pl. As. Rar. 1: 61. 1830; Benth., Labiat. Gen. Spec. 3 (fasc. 6): 613. 1834; Wight, Icon. Pl. Ind. Orient. t. 338. 1840; Benth. in DC., Prodr. XII: 530. 1848; Hook.f., Fl. Brit. India 4: 686. 1885: Fyson, Fl. Nilgiri & Pulney 1: 334. 1915; Gamble, Fl. Pres. Madras 2: 1153. 1924; Mukerjee, Rec. Bot. Surv. India XIV (1): 175. 1940; Rani & K.M.Matthew in K.M.Matthew, Fl. Tamil Nadu Carnatic 3(1): 1266. 1983; Sriniv. in A.N.Henry et al., Fl. Tamil Nadu Ser. I. 2: 178. 1987; Ramach. & V.J.Nair, Fl. Cannanore 367. 1988; Pullaiah & Yesoda, Fl. Anantapur Dist. 202. 1989; K.M.Matthew, Ex. Fl. Cent. Tamil Nadu 405. 1991; M.Mohanan & A.N.Henry, Fl. Thiruvananthapuram 367. 1994; Raju & Pullaiah, Fl. Kurnool Dist. 383. 1995; Pullaiah & Moulali, Fl. Andhra Pradesh 2: 775. 1997; V.Singh, J. Econ. Taxon. Bot. 22(2): 389. 1998; K.M.Matthew, Fl. Pulney hills 2. 998. 1999; V.Singh, Mon. Indian Leucas 149. 2001.

—Type: Indiae orientalis provincial, Sillet, 1829, *Wallich, s.n.* (Herb. Ind. No. *2046)* (holo. **K** cibachrome !).

a. var. **vestita**

Annual or short lived perennial herb, basal stem 2–5 mm thick, semi-woody; branches 30–60 cm long, erect or decumbent, sometime spreading on the ground, rooting from the older nodes, obtusely quadrangular, grooved, clothed with erect or deflexed 1 mm long golden yellowish hairs; internodes 10–15 cm long. Leaves opposite, petiole 1–3 cm long, hispid; lamina 2.5–13 cm long, 1.6–6 cm broad, slightly chartaceous, dark green coloured, broadly ovate to oblong, tip sub-acute to obtuse, base cuneate to obtuse, margin crenate with 10–13 teeth from apex to base, side-veins 6, veins parallel, yellowish coloured, glandular punctate upper side, laxly to densely long hispid with 1 mm long antrorse hairs on both side, lower side veins prominent, hirsute. Inflorescence terminal solitary, a pair of tender leaves project above the whorls, sometime 2 verticils per branch, each subtended by a pair of bracteate leaves, internodes below the inflorescence sometime prolonged, whorls 2–3 cm across, many, dense flowered, globose, regular margins. Bracteoles 10–13 mm long, 1.5 mm broad at base, many, recurved, form an involucre below the flowers, linear-lanceolate, acute, outside hispid, margin dense ciliate with 1–1.5 mm long stiff hairs. Pedicels ±1 mm long, slightly enlarging in fruit. Calyx 8–10 mm long at anthesis, tubular, straight, upper half ribbed at veins, outside basally yellowish-white, glabrous, distal half green, covered with short hairs, with a tuft of 1.5 mm long, spreading hairs on the upper half, inside pubescent on the distal third, mouth annulate with a thick ring of veins, long ciliate, cilia smaller than the teeth, turned towards the centre and forming an inverted cone above, closing the opening in bud and fruiting stage; teeth 10, sub-equal, 3–5 mm long, stellately spreading,

linear-subulate, tip acute, ciliate, hairs 1 mm long (tube bulged above nutlets, enlarged up to 13 mm in fruit). Corolla ±16 mm long, tube ±8 mm long, fully included in the calyx, inside half length annulate with a ring of fleshy hairs; lower lip ±8 mm long, white coloured, obliquely attached, middle lobe 5 mm broad at free end, fan shaped, side lobes oblong, 1.25 mm broad, margin slightly revolute; upper lip ±5 mm long, golden brownish coloured, concave, dense brownish coloured spreading hairs outside, margin ciliate. Staminal filaments hairy at the middle; anther lobes 1.8 mm long, 0.6 mm broad, reddish coloured, theca confluent, lobes divergent, thrice longer than broad. Disc cup shaped, almost equally four lobbed. Ovary locules 2 mm long, upper side rounded. Style 14 mm long; stigma lobes unequal, lower 0.81 mm long, upper reduced to 0.09 mm. Nutlets 2.9 mm long, 1.4 mm broad, dark brown coloured, shining, oblong, obtusely triangular in cross section, top flat-rounded, base not narrowed.

Etymology: The species name denote the 'hairy clothing' of the plant.

Flowering and fruiting: September–May.

Habitat: Found at forest margins, on rocky hillsides, grasslands; 800–2200 m.

Distribution: India, Bangladesh.

Specimens examined: **ANDHRA PRADESH: Anantapur Dt.**: Mudukota RF, 9th Jan. 1983, *T.Pullaiah & N.Yesoda 974* (MH); **KARNATAKA: Shimoga Dt.**: Jogfalls, 3rd Dec. 1983, *V.A.Vasantha 1270* (CALI); **South Canara Dt.**: Sampagi, 7th Nov. 1900, *C.A.Barber 2211* (MH); 29th Dec. 1918, *Subramanya 15724* (MH);

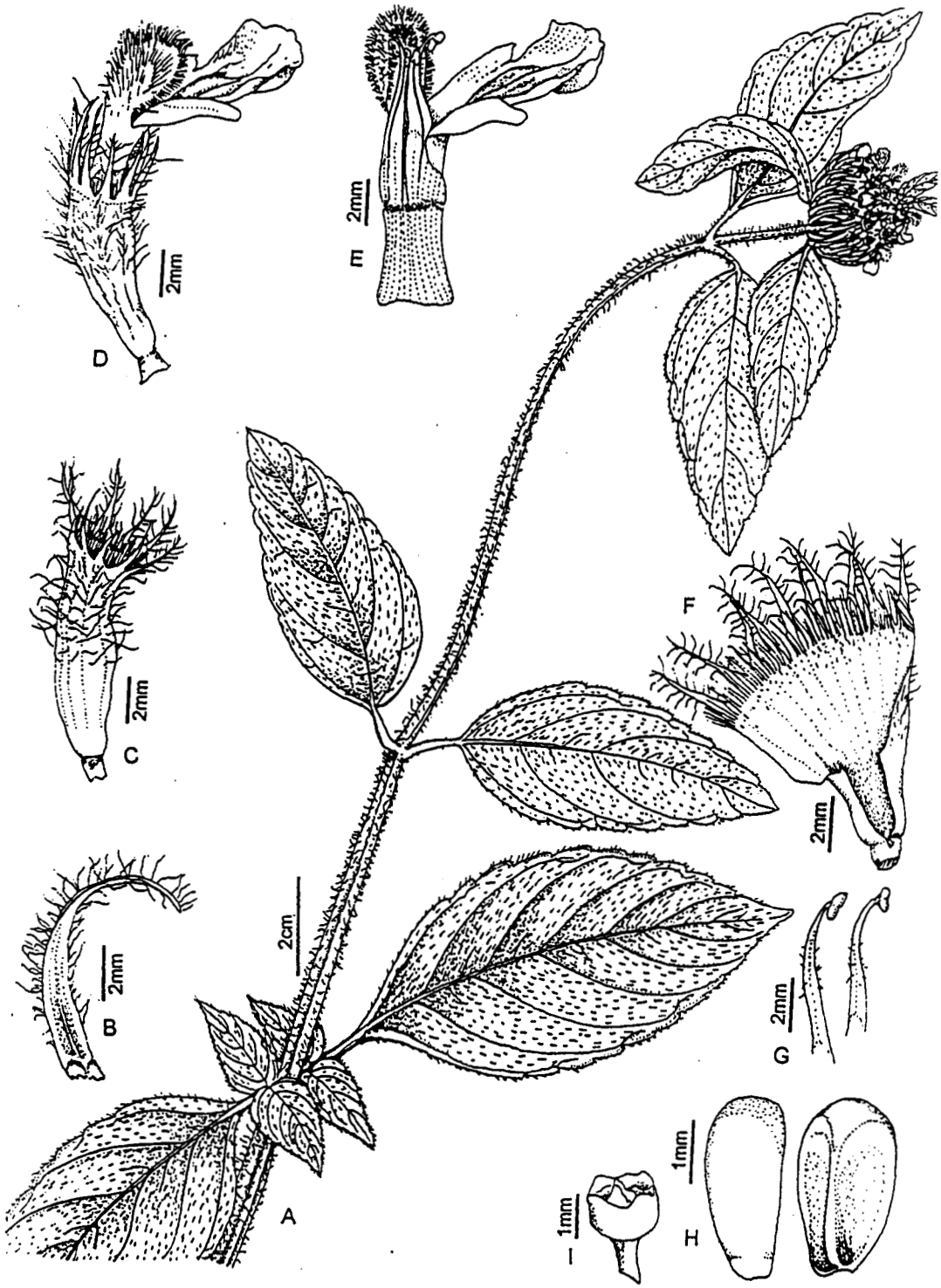


Fig. 70: *Leucas vestita* Benth. var. *vestita*. A. Habit; B. Bracteole; C. Calyx; D. Flower; E. Corolla split open; F. Calyx split open; G. Stamens; H. Nutlets; I. Disc.

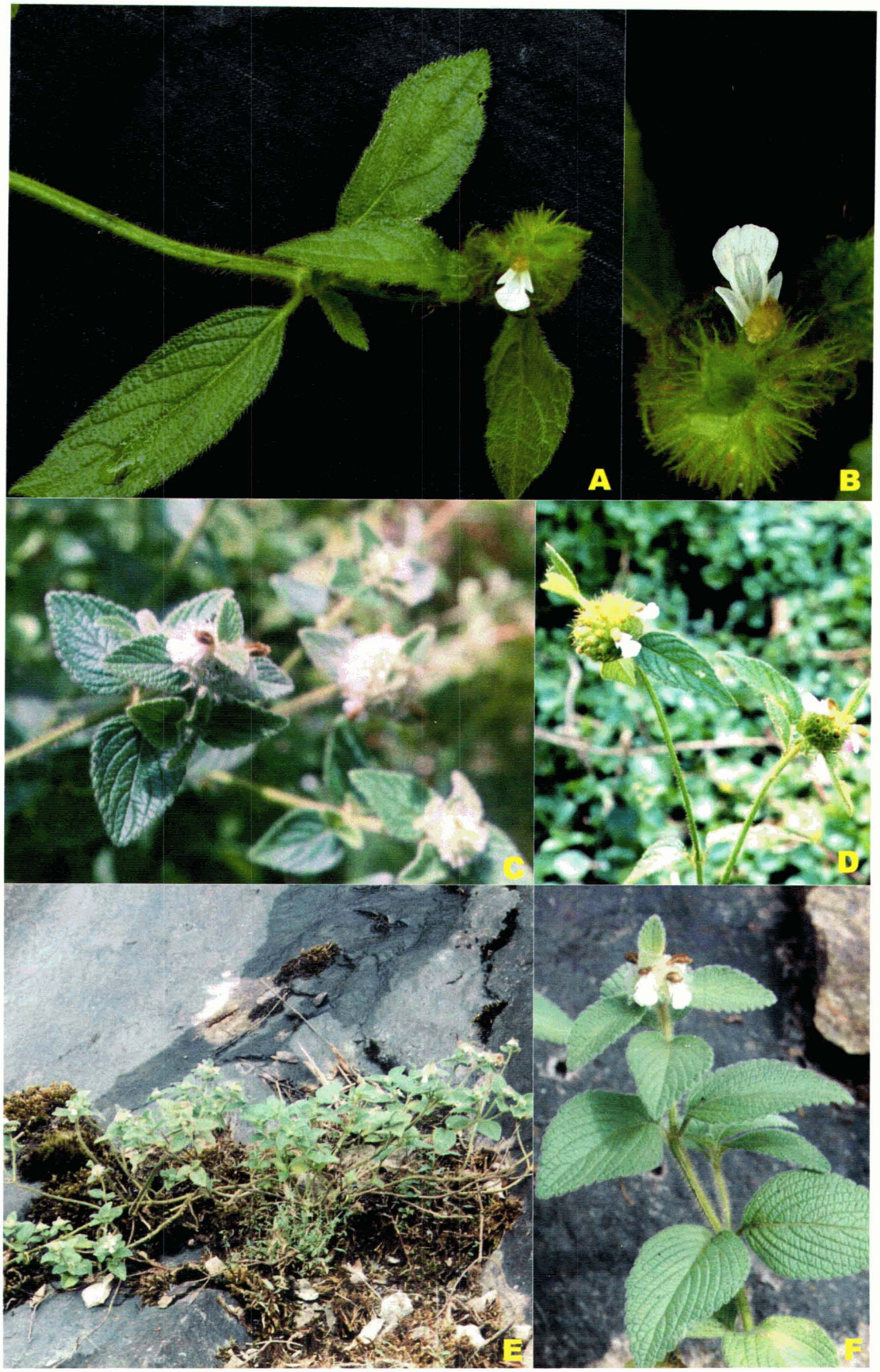


Fig. 71: *Leucas vestita* Benth. (A-B. var. *vestita*; C. var. *sericostoma*; D. var. *ciliata*; E-F. var. *oblongifolia*)

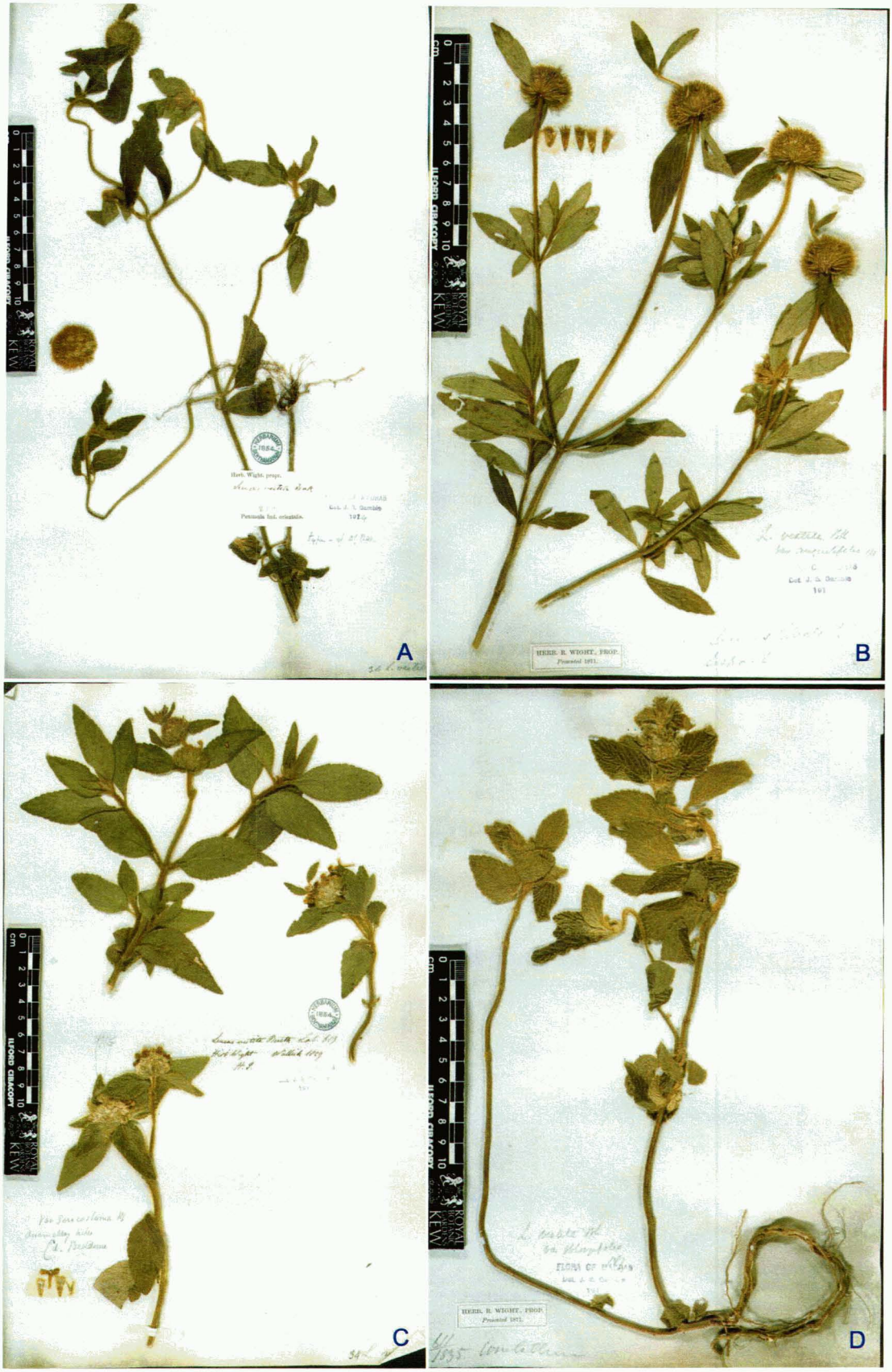


Fig. 72: *Leucas vestita* Benth. (type specimen of different varieties) A. var. *vestita*; B. var. *angustifolia* Hook.f.; C. var. *sericostoma* Hook.f.; D. var. *oblongifolia* Hook.f. (all from Kew Herbarium)

Gundia, 26th Nov. 1927, *S.R.Raju & Nagantha 18219* (MH); Nagodi, on the way to Kudachadri, 12th Oct. 2000, *Sunojkumar CU49637* (CALI); Talakkaveri, 28th Dec. 2001, *Sunojkumar CU49649* (CALI); Kudachadri, 12th Feb. 2003, *Sunojkumar CU88122 & CU88125*; **KERALA: Idukki Dt.**: Pambare, 7th Sept. 1911, *C.E.C. Fischer 2928* (MH); Anamalai hills, 24th May 1915, *C.E.C.Fischer 3816* (MH); Kulamavu -Idukki, 25th Sept. 1981, *C.N.Mohanan & B.Ramanujam 71983* (MH); 7th Nov. 1981, *B.Ramanujam 72408* (MH); Neymakkadu, 6th Oct. 1994, *Santhoshkumar 17573* (TBGT); Kalvarimala, *J.Augustine 12729* (KFRI); **Kannur Dt.**: Tolpetty to Tirunelli, 24th Nov. 1977, *V.S.Ramachandran 52342* (MH); Tolpetty, 14th Nov. 1978, *V.S.Ramachandran 58733* (MH); Brahmagiri, 5th Mar. 1979, *V.S.Ramachandran 62114* (MH); Panathur, 28th Dec. 1980, *R.Ansari 70056* (MH); **Kozhikode Dt.**: Kakkayam dam-Ambalapara, 11th May 2003, *Sunojkumar CU88127* (CALI); **Kottayam Dt.**: Kurisumala, 3rd May 1984, *V.T.Antony 475* (MH); **Pathanamthitta Dt.**: Pambavalley, 5th Oct. 1992, *S.Binu 14190* (TBGT); **Thiruvananthapuram Dt.**: Ponmudi rest house, 13th Sept. 1977, *N.C.Nair 50999* (MH); Ponmudi, 6th Nov. 1984, *J.Jacob 3926* (CALI); **Wyanad Dt.**: Sultan Battery, Kuppadi, 6th Feb. 1964, *J.L Ellis 185321* (MH); Tirunelli, 25th Nov. 1995, *Radhakrishnan 26516* (TBGT); Lakidi, way to Pookode lake, 7th Oct. 2000, *Sunojkumar CU 49633* (CALI); **TAMIL NADU**: **Coimbatore Dt.**: Ponnachibetta, 7th Feb. 1930, *V.Narayanaswamy 19580* (MH); Kollegal, Anabetta Bellaje, 10th July 1930, *V.Narayanaswami 3837* (MH); **Kanyakumari Dt.**: Balamore to MK Vayal, 26th Aug. 1976, *A.N.Henry 47553*(CAL, MH); Muthukuzhi vayal grassy slopes, 29th Sept. 1980, *A.N.Henry 47553* (CAL); **Madurai Dt.**: Pulney mountains, Sept. 1830,

Wight 2155 (CAL); Silver cascade, Kodaikanal, 14th Oct. 1919, *K.C.Jacob 16085* (MH); way to Poomparai-Kodaikanal, 22nd Apr. 1965, *K.Ramana 23352* (MH); Picinic shola, 19th Sept. 1968, *D.B.Deb 30996* (MH); Kodaikanal, 14th Feb. 1974, *B.K.Nayar & Unnikrishnan 2649* (CALI); Kodaikanal, 13th Feb. 1974, *K.V. Sankaran* 8807 (KFRI); Kodaikanal, 11th July 1979, *K.K.Harindran 32494* (CALI); Ravutharmottai, Bodimuttu, 30th Dec. 1984, *K.Ravikumar 2023* (MH); **Nilgiris Dt.**: Naduvattam-Gudulur road, 18th Jan. 1961, *B.V.Shetty 11902* (MH); Kuzhivayal RF, 26th Nov. 1972, E.Vajravelu 43495 (MH); Gudallur-Killur, 23rd Feb. 1973, *E.Vajravelu 43702* (MH); **Salem Dt.**: Yercaud ladies seal-Shevaroys, 7th Nov. 1978, *N.Venugopal RHT19081* (CAL); **Tirunelveli Dt.**: way to Manjanam parai, 4th Sept. 1963, *A.N.Henry 17451* (MH); Naterikal, 24th Sept. 1967, *E.Vajravelu 29291* (MH); Courtallum, 8th July 1979, *K.K.Harindran 27245* (CALI).

b. var. **angustifolia** Hook.f.

Hook.f. Fl. Brit. India. 4: 687. 1885; V.Singh, J. Econ. Taxon. Bot. 22(2): 389. 1998; & Mon. Indian Leucas 149. 2001.

—Type: Indiae, Kerala, Palghat, Silent Valley, Sisparah, herbarium *Wight, s.n.* (holo. **K** cibachrome !).

Different from other varieties; this is tall, branches with soft spreading hairs. Leaves 4–5 cm long, 1–1.5 cm broad, elliptico-lanceolate, obtuse, cuneate to narrowed base, margin obscurely serrate, 6–7 teethed, secondary vein 3–4. Calyx 8–9 mm long, tubular, teeth 2.5–3 mm long.

Etymology: The variety name denotes the '*angustate*' nature of leaf of the plant.

Habitat: This variety was collected only from the evergreen forests of Silent Valley area; alt. 2000–2200 m.

Distribution: India, endemic to South India.

Specimens examined: **KERALA: Palakkad Dt.**: Sisparah, *Wight s.n.* (K).

c. var. **ciliata** Sunojkumar **var. nov**.

Leucas ciliata Benth. Wall. ex Benth. in Wall., Pl. As. Rar. 1: 61. 1830; Benth., Labiat. Gen. Spec. 3 (fasc. 6): 613. 1834; in DC., Prodr. XII: 530. 1848; Hook.f., Fl. Brit. India 4: 687. 1885: Cooke, Fl. Bombay Pr. 2: 471. 1906; Gamble, Fl. Pres. Madras 2: 1153. 1924; Mukerjee, Rec. Bot. Surv. India XIV (1): 174. 1940; H.Hara, Fl. East. Himalaya 277. 1966; C.J.Saldanha & Nicolson, Fl. Hassan Dist. 503. 1976; R.R.Rao & Razi, Syn. Fl. Mysore Dist. 511. 1981; J.R.Press in H.Hara et al., En. Pl. Nepal 3: 156. 1982; Sriniv. in A.N.Henry et al., Fl. Tamil Nadu Ser. I. 2: 178. 1987; Ramach. & V.J.Nair, Fl. Cannanore 366. 1988; K.R.K.Murthy & S.N.Yognar., Fl. Coorg 356. 1990; Shu in Zheng-yi & Raven, Fl. China 17: 142. 1994; M.Mohanan & A.N.Henry, Fl. Thiruvananthapuram 366. 1994; V.Singh, Mon. Indian Leucas 61. 2001.

—Type: Indiae Orientali, Nepalia, *Heyne. s.n.* (Wallich Herb. No. 2046) (holo. **K** !; iso. **K** cibachrome !).

Leucas ciliata Wall ex Benth. var. *hirsute* Benth., Labiat. Gen. Spec. 3 (fasc. 6): 614. 1834; in DC., Prodr. XII: 530. 1848

—Type: India Orientali, Bangladesh, Sillet, *Heyne, s.n.* (holo. **K** cibachrome)

Fig. 73: *Leucas vestita* var. *ciliata* Sunojkumar A. Habit; B. Calyx

Different from other varieties; this has 10–20 cm long internodes. Leaves 5–8 cm long, 2–3.5 cm broad, lanceolate, acute to slightly acuminate, serrate with 10–12 teeth, ciliate.

Etymology: The variety name denotes the '*ciliate*' nature of the plant.

Habitat: This variety usually grows in high altitude areas, among other bushy herbs, in the waste places and forest openings; alt.1500–2200 m.

Distribution: India, Indo-China, Bhutan, Thailand and Nepal. In India this is growing in almost all the states.

Specimens examined: **KARNATAKA: Coorg Dt.**: Bagamundala, 2nd Feb. 1976, *T.A. Rao & B.C.Banerjee 11463* (CAL); Mercara Bhagamandala road, 22nd Aug. 1978, *S.R. Ramesh KFP 2274* (CAL); **Mysore Dt.**: Meguvalli, 31st Oct. 1960, *R.S.Raghavan 67988* (CAL); Kilandur, Hubical, 21st Mar. 1964, *R.S.Raghavan 97043* (CAL); **KERALA: Idukki Dt.**: Peermedu, 9th Dec. 1970, *M.Sivadasan 546* (CALI); Deviculam, 12th Dec. 1970, *M.S.Sasikala 1231* (CALI); Narakkanam, Kottapara, 23rd Aug. 1977, *K.Vivekanandan 50490* (MH); Near Mannavan shola, way to Kanthalloor, 30th Mar. 1978, *Nambiar 257* (KFRI); Kulamavu, 3rd Oct. 1983, *C.N.Mohanan 79932* (MH); Peeramedu, 23rd, Nov. 1988, *V.P.Premalatha 3166* (CALI); Thekkady, *J.Augustine JA14439* (KFRI); Deviculum-Munnar, 12th Nov. 2001, *Sunojkumar CU49671*(CALI); **Kannur Dt.**: Chandanathode, 10th Dec. 1967, *J.E.Ellis 29552* (MH); Tolpetty, 14th Nov. 1978, *V.S.Ramachandran 58733* (CAL); Bramahagiri, 5th Mar. 1979, *V.S.Ramachandran 6214* (CAL);

Chandanathode, 11th Aug. 1979, *V.S. Ramachandran* 63904 (MH); Parathur, 28th Dec. 1980, *R.Ansari 70056* (CAL); **Kottayam Dt**.: Pamba, 24th June 1968, *D.B.Deb 30339* (MH); **Palakkad Dt**.: Parambikulam submergible area, 20th Nov. 1962, *K.M.Sebastine 15035* (CAL, MH); Karapara top, 24th Dec. 1980, *N.C.Nair 69788* (CAL); Karimalagopuram, *P.Sujanapal 19600* (KFRI); **Trissur Dt**.: Ponmudi, 29th July 1988, *N.Sasidharan 5177* (KFRI); **Thiruvananthapuram Dt**.: Ponmudi upper samtoricum, 16th Aug. 1980, *M.Mohanan 69206* (CAL, MH); Ponmudi, 6th Nov. 1984, *A.M.Rama 4726* (CALI); **TAMIL NADU: Kanyakumari Dt**.: Mahendragiri slopes, 30th July 1966, *B.V.Shetty 28043* (MH).

d. var. **oblongifolia** Hook.f.

Hook.f. Fl. Brit. India. 4: 687. 1885

—Type: India, Tamil Nadu, Courtallum, 1835, *Wight 611* (holo. **K** cibachrome !).

Distinguished by its bushy habit, pale green coloured, silvary white, shining, ciliate hairs all over the body. Leaves 8–15 mm long petiolate, lamia 3–6.5 mm long, 2.5–3.5 mm broad, broadly ovate–rounded, or broadly oblong, 6–7 parallel veined, rounded or cuneate base, tip broadly obtuse or rounded, margin crenate with 8–11 teeth. Inflorescence solitary. Bracteoles tip divergent. Calyx ±7 mm long, mouth cilia silvery white, smaller than teeth. Corolla 21 mm long.

Etymology: The variety name denotes the shape of leaves.

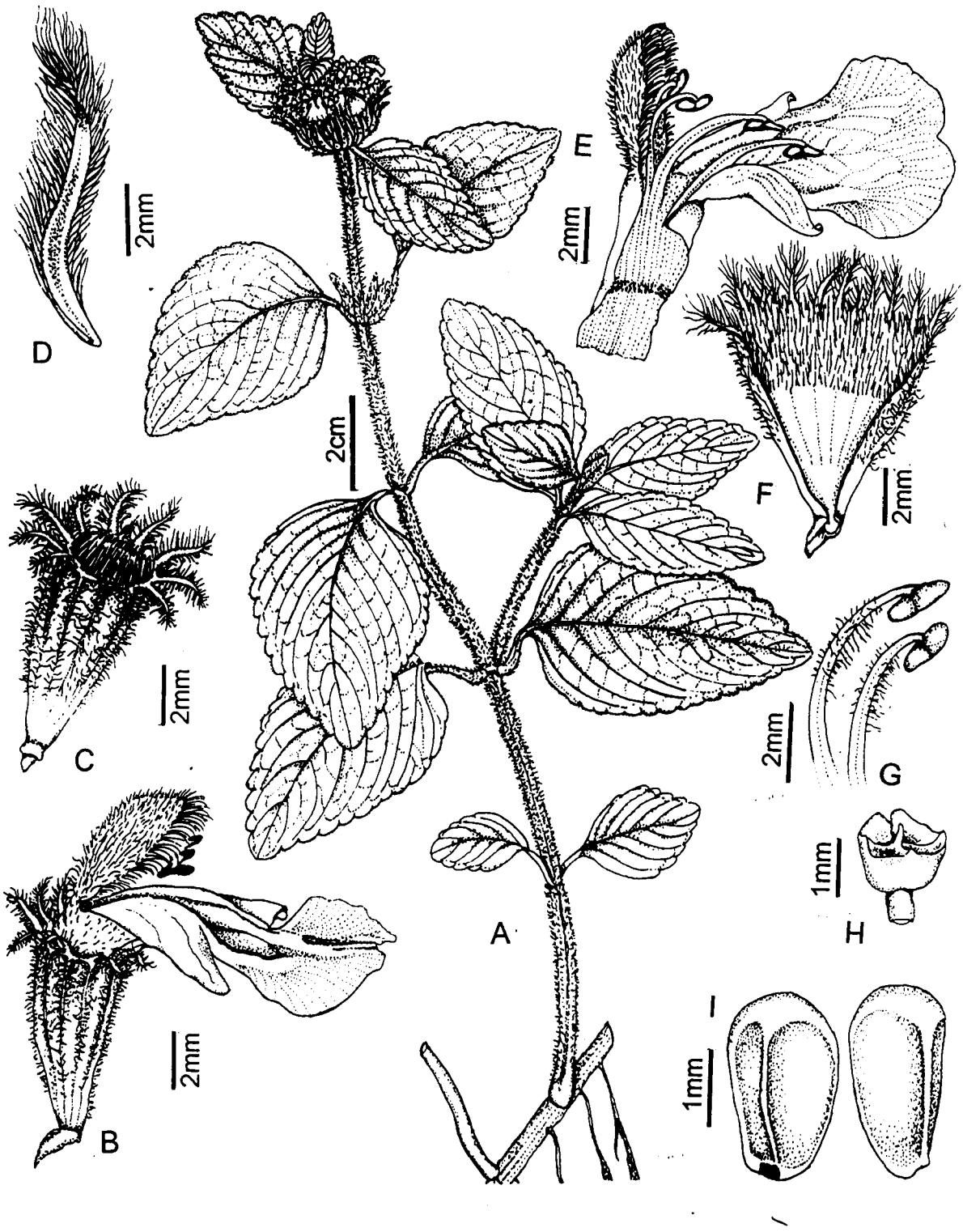


Fig. 74: *Leucas vestita* var. *oblongifolia* Hook.f.: A. Habit; B. Flower; C. Calyx; D. Bracteole; E. Corolla split open; F. Calyx split open; G. Stamens; H. Disc; I. Nutlets.

Habitat: This variety usually grows in high altitude areas, in open places, in rocky surfaces among grasses and other small bushy herbs, 1500–2200 m.

Distribution: Endemic to South India, reported only from Southern Western ghat region.

Specimens examined: India, 1836, *Wight 730* (K); **KERALA: Idukki Dt.**: Deviculum, 12th Nov. 2001, *Sunojkumar CU 49675* (CALI)

e. var. **sericostoma** Hook.f.

Hook.f. Fl. Brit. India. 4: 687. 1885

—Type: India, Anamalay hills, *Beddome s.n.* (holo. **K** cibachrome !).

Leucas vestita var. *devicolamensis* Shetty & Vivek, Bull. Bot. Surv. India. 10 (2): 236. 1968; V.Singh, J. Econ. Taxon. Bot. 22(2): 387. 1998; & Mon. Indian Leucas 152. 2001.

—Type: India, Kerala, Kottayam Dt., Devicolam, 11th Aug. 1967, *Shetty & Vivekanandan 28372A* (holo. CAL !; iso. *28372 B–S*, CAL, MH !; para. *26441 A–G*, CAL, MH !)

Bushy undershrub, below 1 m high, profusely branching, tawny villous with dense spreading hairs. Leaves 0.3–1.6 cm long, lamina 1.5–7 cm long, 1.5–3 cm broad, ovate or broadly ovate, obtuse, base rounded or cordate, lateral veins 4–7. Inflorescence usually solitary verticils, rarely two. Calyx ±0.9 mm long, mouth cilia dense, conspicuous, longer than teeth. Corolla 15 mm long.

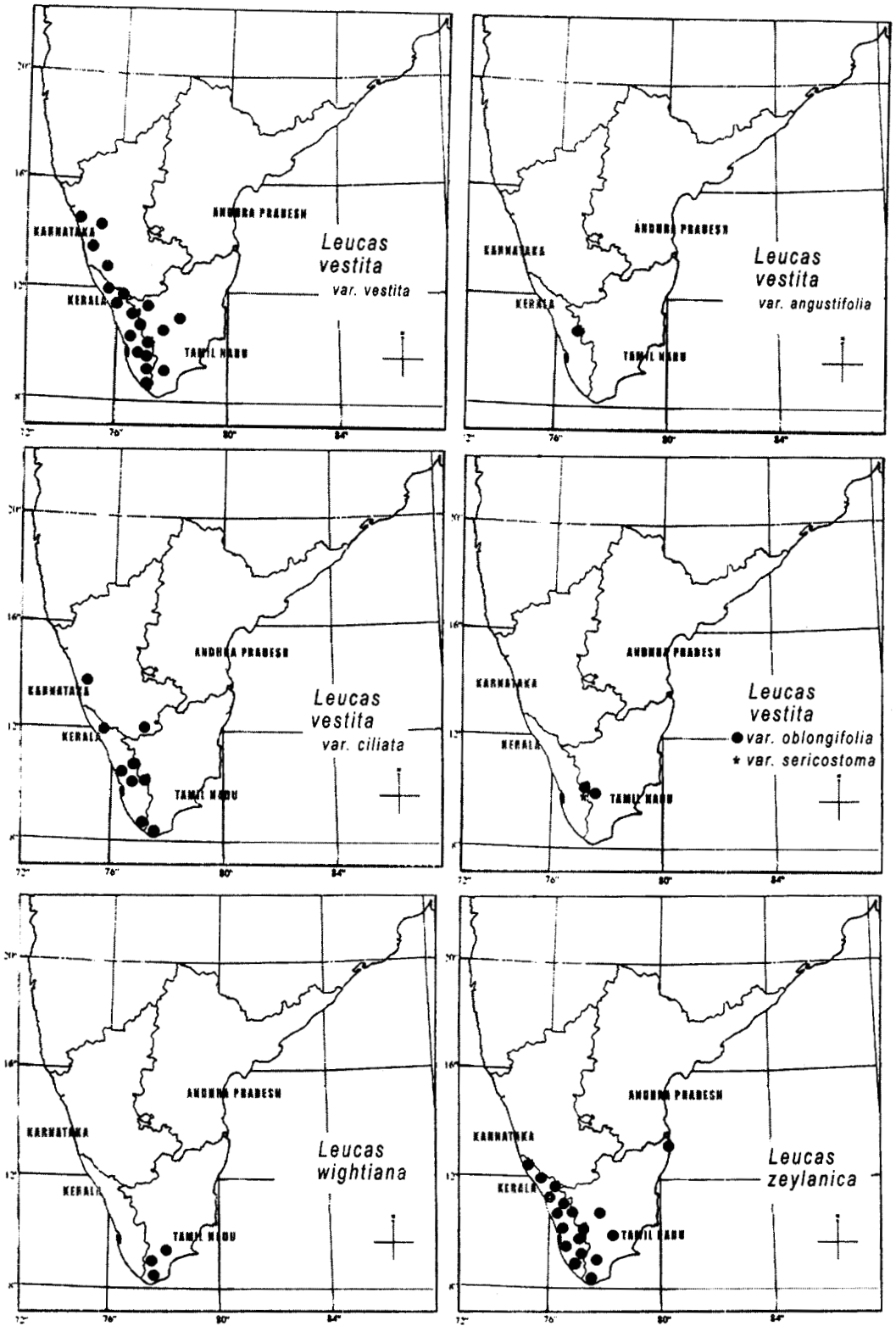


Fig.: 75. Distribution map of *Leucas* species in Southern Peninsular India.

Habitat: This variety usually grows in high altitude areas, in open places, on the top of hills, among bushy herbs and grasslands, 1500–2200 m.

Distribution: Endemic to South India, reported only from Southern Western ghat region.

Specimens examined: **KERALA: Idukki Dt.**: Kottayam Dt., Devicolam, 11th Aug. 1967, *Shetty & Vivekanandan 28372A–S*; 16th Nov. 1965, *Shetty & Vivekanandan, 26441 A–G*; Anamudi slopes, Rajamalai side, 6th Feb. 1970, *B.V.Shetty 33427* (MH); Rajamala, 1st Oct. 1998, *Sunojkumar CU49612* (CAL).

Note: Hooker (1885) has identified three varieties for this species: var. *oblongifolia* Hook.f., var. *sericostoma* Hook.f., and var. *angustifolia* Hook.f. Later one more variety; var. *devicolamensis* Shetty & Vivek. is added with this species (Shetty & Vivekanandan, 1968). After observing the types of all these varieties and a large number of herbarium deposited in Indian herbaria it become clear that this species exhibit high polymorphism in India. Observing a number of fresh specimens, especially from the Anamalai hills of Southern Western Ghat region, strengthen the fact that local variation is very high in vegetative charactes. Leaf shape and texture is a polymorphic form in this species and therefore a number of ecophenotypes observed in this species may not be considered as distinct varieties, due to intermediate forms. But variation in stable taxonomic characters, including difference in basic leaf shape is observed in a few collections and the same feature is noticed in many herbarium specimens collected earlier from the same locality.

These stable characters are considered here in determining these varieties and due to these reasons the circumscription of this species is changed, which is considered here.

Singh (2001), opined that var. *oblongifolia* Hook.f. is not distinguishable from proper species due to the occurrence of intermediate forms and he has merged it with proper species. However, it is not sure from the published literature that he has consulted the type specimen before reaching this conclusion. After checking the type (holotype from K), and observing the micro-character of fresh specimen collected from the type locality, it is confirmed that this variety truly exhibit variation, on leaf, bracteoles, calyx and indumentum which are worth enough to consider as a variety and therefore re-instigated the status.

Similarly, Singh (2001) retained the status of var. *devicolamensis* and var. *sericostoma* as distinct varieties. According to him, the differences observed in the leaf shape; broadly ovate-cordate in the former and ovate-lanceolate with cuneate base in the latter is distinct character worth to distinguish both as varieties also not stands well as a stable character. Moreover the type mentioned against var. *sericostoma* available at British Museum (BM) is incorrect, which also through light into the fact that this conclusion has been made not by comparing with type specimen. After observing the type specimen (from K), and comparing the leaf character in the type specimens of both varieties as well as the fresh specimen collected from the type locality, it is very clear that the leaf base character is

polymorphic, with wide range of variation noticed even in different parts of the same plant. In effect it can be assumed from the published literature that the original authors who establishd var. *devicolamensis* may not consider the nature of var. *sericostoma*, the very closely allied form, before reaching their conclusion. On the light of the fact that var. *devicolamensis* cannot be distinguished from var. *sericostoma*, it is decided here to merge the former with the latter.

Again, within the 'concept of species' in this genus, and the nature of varieties observed in this species, very close relative of this species, which was established in the days of Bentham is reviewed.

Leucas ciliata Benth. is a species established by Bentham as early as in 1830 together with *Leucas vestita*. The character differences of both species are not clear from the protologue. Except on leaf characters; *L. ciliata* is "*foliis petiolatis, elliptico-vel ovato-oblongis, attenuates, crenatis vel serratis*" and *L. vestita* is "*foliis petiolatis, ovatis vel ovato-lanceolatis crenatis*", no other remarkable difference is noticed. After observing the type specimens (4 sheets from K), and fresh specimens, I could not find any other differences except on the leaf character that in *L. ciliata* a definite serrate condition and acute tip is noticed. Hundreds of herbarium sheets deposited in various Indian herbaria are also compared.

This ultimately concluded that *L. ciliata* and *L. vestita* are only varieties and is to be merged. But the leaf characters noticed in *L. ciliata* and considering its

distribution over a large geographical area are worth to give it a status of a variety and is thus treated as *L. vestita* var. *ciliata* Sunojkumar *var.nov*. The nomenclatural problem noticed (for priority on two names appeared in same protologue, in same page) while merging both species is tackled using ICBN article 11.5; example 18 of St. Louis Code (Greuter et al., 2000).

In the case of var. *angustifolia*, the type specimen reveals no striking differemces except on the leaf character. This specimen is having elliptic-lanceolate leaves, which are also noticed in var. *ciliata* and some workers like C.B.Clarke who attempted the taxonomy of this taxa mentioned the same even on the type sheet. Since no fresh specimen are available from the locality mentioned in the sheet, it is not fully right to comment much on this specimen and therefore this variety is treated as such, following Hooker (1885).

It is pertinent to mention here that the variation noticed in var. *oblongifolia*, var. *sericostoma* and var. *angustifolia* are higher and stronger than that notcied in var. *ciliata* from var. *vestita*. This also supports the view that *L. ciliata*, which shows comparatively little variation from *L. vestita* is to be merged with the latter. Singh (2001) mention that *L. vestita* is endemic to India is not correct as the type specimen itself is collected from Syllat, a place in Bangladesh.

Character differences observed in different varieties of L. vestita are mentioned below (in table no. 14).

Characters	Leucas vestita				
	var. *vestita*	var. *ciliata*	var. *angu-stifolia*	var. *oblongifolia*	var. *seri-costoma*
Habit	decumbent herb	decumbent herb	-	bushy herb	decumbent herb
Stem hairs	golden yellowish	golden yellowish	golden yellowish	silvery white	silvery white to yellowish
Leaf size	2.5–13 x 1.6–6 cm	5–8 x 2–3.5 cm	4–5 x 1–1.5 cm	3–6.5 x 2.5–3.5 cm	1.5–7 x 1.5–3 cm
Leaf shape	ovate-oblong	lanceolate	elliptic-lanceolate	broadly ovate-rounded	broadly ovate
Leaf tip	obtuse	acute	obtuse	obtuse	obtuse
" margin	deep crenate	sub serrate	serrato crenate	deep crenate	deep crenate
" " teeth	10–13	8–12	6–7	9–10	4–7
Lateral veins	6–7	6–7	3–4	5–8	4–7
Base	rounded	rounded	cuneate to narrowed	rounded	obtuse to cordate
Calyx tube	8–10 mm	8–10 mm	8–9 mm	6–7 mm	8–9 mm
Mouth cilia	golden yellowish, smaller than teeth	golden yellowish, smaller than teeth	golden yellowish, smaller than teeth	silvery white, smaller than teeth	slightly yellowish, longer than teeth
Bracteoles	recurved	recurved	recurved	divergent	recurved

Tab.: 14. Comparison of characters in different varieties in *Leucas vestita*

32. Leucas wightiana Wall. ex Benth. in Wall., Pl. As. Rar. 1: 60. 1830; Hook.f., Fl. Brit. India 4: 690. 1885; Gamble, Fl. Pres. Madras 2: 1150. 1924; Mukerjee, Rec. Bot. Surv. India. XIV (1): 172. 1940; Rani & K.M.Matthew in K.M.Matthew, Fl. Tamil Nadu Carnatic 3: 1267. 1983; Sriniv. in A.N. Henry et al., Fl. Tamil Nadu Ser. I. 2: 178. 1987; K.M.Matthew, Ex. Fl. Cent. Tamil Nadu 2: 180. 1987; Venu & Daniel, J. Swamy Bot. Cl. 17: 69-74. 2000; V.Singh, Mon. Indian Leucas 155. 2001.

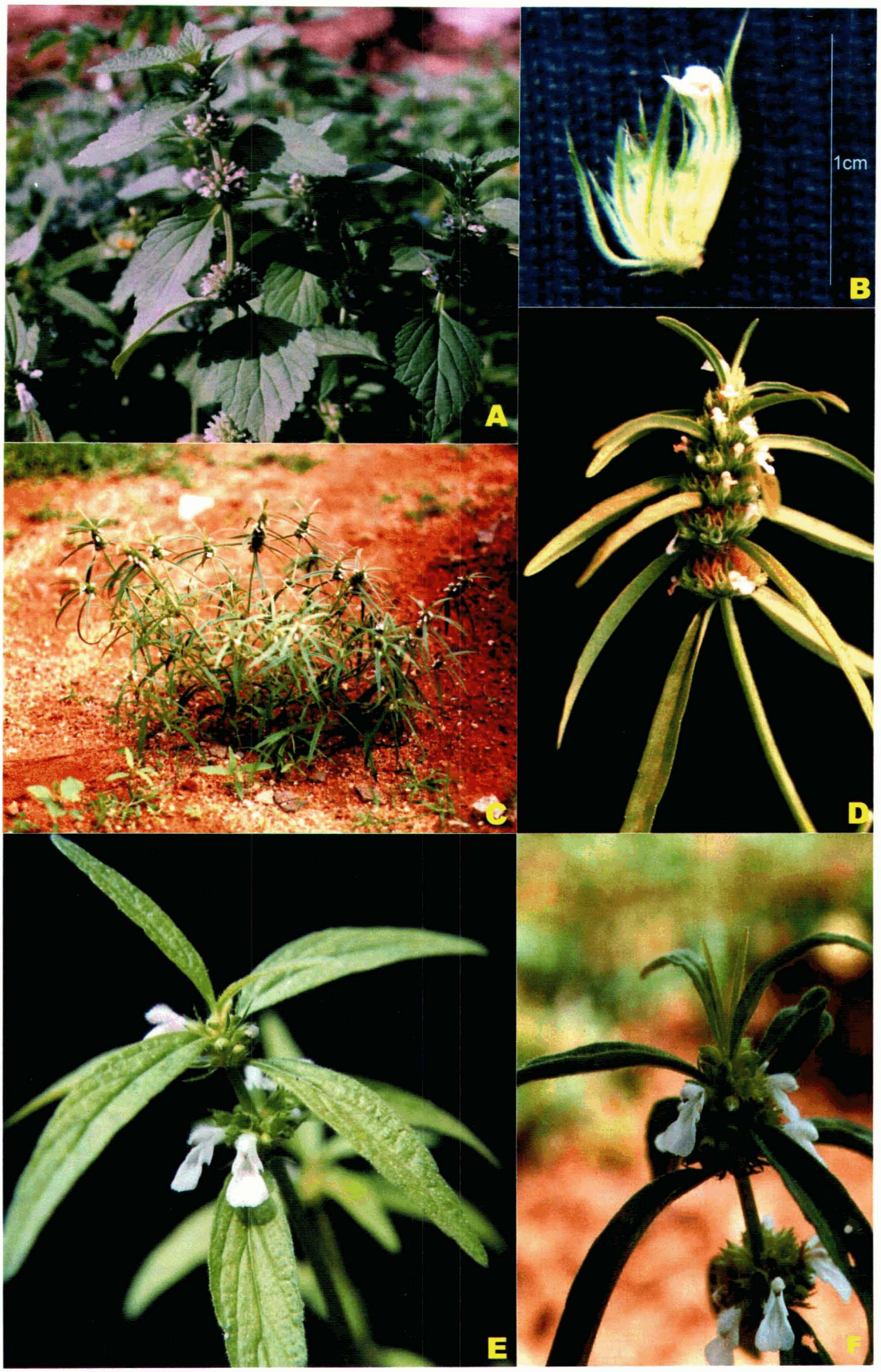


Fig. 76: A-B. *Leucas urticifolia* Sm.; C-D. *Leucas wightiana* Benth.; E-F. *Leucas zeylanica* (L.) R.Br. (B. single flower with bracteoles)

—Type: Peninsular India orientali, *Wight 2553*. (holo. **E** photo !), syntype: **E** !, **CAL** !)

Leucas aspera (Willd.) Link var. *wightiana* (Wall.) Benth. Labiat. Gen. Spec. 3 (fasc. 6): 616. 1834; & in DC., Prodr. XII: 532. 1848.

—Type: same as above.

Erect annual herb, 15–60 cm high, basal stem up to 1 cm broad, profusely branching; branches herbaceous, obtusely quadrangular and grooved, scabrid, clothed with retrorse hispid hairs, nodal portion slightly dilated; internodes usually 5–12 cm long, up to 20 cm below the inflorescence. Leaves opposite, sub sessile to 2–4 mm long petiolate; lamina 4–9 cm long, 0.3–0.7 cm broad, more than ten times longer than broad, slightly coriaceous, gland dotted beneath, linear sometimes slightly lanceolate obtuse tip, narrowed to the base or long cuneate, extending to the petiole, margin almost entire, sometimes obscurely or distinctly 3–4 serrated, secondary veins 3–4, prominent below, upper surface pubescent with antrorse hairs, lower densely pubescent, more on veins and margins. Inflorescence 5–6 verticils towards the tip, each subtended by a pair of bracteate leaves, indumentum same as that of cauline leaves; flowering nodes often closely arranged and appressed giving a 3–6 cm long spike like appearance with bracteate leaves projecting in between; lower most verticil up to 2 cm diameter, terminal small, 0.5–0.8 cm broad. Bracteoles many equal or smaller than calyx, 4–6 mm long, 0.4 mm broad, linear outside, tomentose, margin ciliate, hairs 0.5–0.8 mm long, tip acute. Calyx tubular straight, dorsal side 4.5–5 mm long, slightly produced, abaxial side 4–4.5mm, thick

chartaceous and narrowed at base, reticulate, dilated upwards, upper half prominently nerved, tomentose, mixed with hispid hairs, 0.5–0.8 mm long, inside glabrous, mouth oblique, dense ciliate; teeth 10, longer than mouth cilia, fleshy rigid, anterior largest, 1–1.25 mm long, produced, laterals 0.5 mm long, tip acute, sharply pointed, spinescent, fully hirsute. Corolla white, 8 mm long; tube 4 mm long, outside upper half white hairy, inside middle annulated with a ring of hairs; lower lip 4 mm long, obliquely attached to tube, middle lobe 3–3.5 mm wide, fan shaped at free end, lower side hairy, side lobes 0.5 mm broad at free ends, margin revolute and obtusely produced, upper lobe 2–2.5 mm long, concave, fan shaped, provided with white long wolly hairs outside and margins. Staminal filaments hairy; anther 0.6 mm long and 0.3 mm broad, theca divergent. Disc equally four lobbed, lobes three fourth the length of ovary locule. Ovary 0.4 mm high, top triangular and plane. Style 4.5 mm long, top forwardly bent; stigma bilobed, lower lobe 0.06 mm long and slightly bent upper 0.33 mm long. Nutlets 2 mm long 1.2 mm broad, light brown coloured, surface not smooth, oblong, top triangular and concave, surface slightly hairy, middle obtusely angular, triangular at the proximal side, oval outside, middle slightly bulged than ends.

Etymology: The species was named after Robert Wight, who first collected this plant.

Flowering and Fruiting: October–March.

Habitat: Plants germinate during monsoon season and complete its life cycle within 6 months. Found growing at sea level in open sandy areas of typical scrub

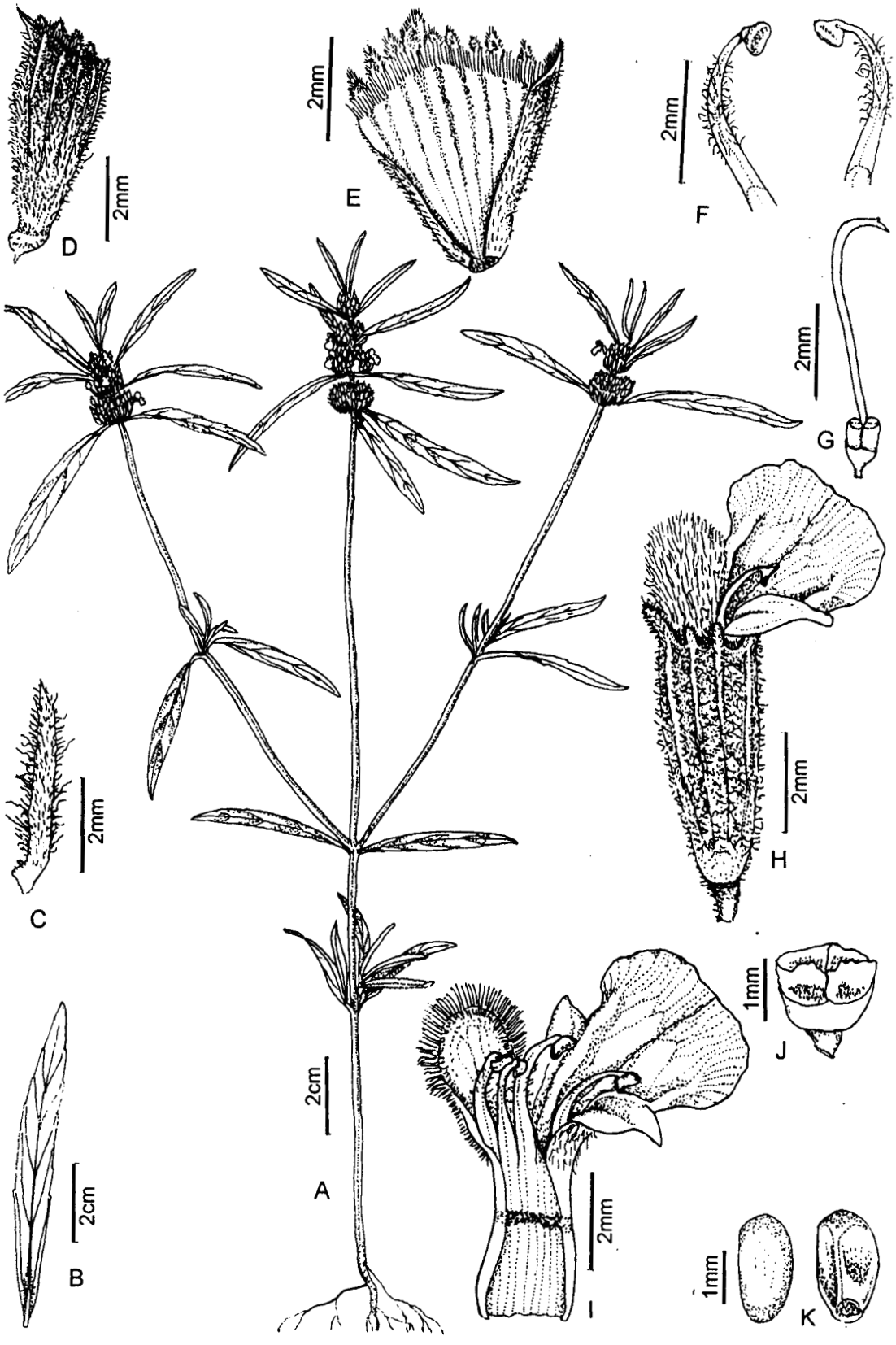


Fig. 77: *Leucas wightiana* Benth. A. Habit; B. Leaf; C. Bracteole; D. Calyx; E. Calyx split open; F. Stamens; G. Pistil; H. Flower; I. Corolla split open; J. Disc; K. Nutlets.

jungle, together with *L. aspra* and *L. stricta* in Southern Tamil Nadu where rainfall and water availability is scare.

Conservation: IUCN Red List (1997) rating **I**. (Rao, 2003).

Distribution: Endemic to South India, found growing in Southern Tamil Nadu. Few plants are collected from Andhra Pradesh.

Specimens examined: **ANDHRA PRADESH: Chitoor Dt.**: Chandragiri fort, 12th Jan. 1989, *A.Moulali & P.S.P.Babu 8363* (SKU); **TAMIL NADU: Maduri Dt.**: Chugapatti Alagar hills, 14th Feb. 1958, *K.Subramanyan 5294* (MH); **Ramanathapuram Dt.**: Soyalgudi, 8th Dec. 1977, *N.C.Nair 53191* (MH); **South Arcot Dt.**: Kallakuruchi, Vallupuram route, 24th Oct. 1983, *K.Ramamurthy 80804* (MH); **Tirunelveli Dt.**: Vijayanarayanam, 20th Dec. 1998, *Sunojkumar CU49616* (CALI); Vijayanarayanam, 15th Mar. 2000, *Sunojkumar CU49622* (CALI); 10th Jan. 2002, *Sunojkumar CU49685* (CALI).

Notes: This species is considered as a very rare plant (Venu & Daniel, 2000). However I could collect a dense population in the scrub jungle area of Tirunelveli and Kanyakumari district in Southern Tamil Nadu. This plant is a monsoon dependent small herb completes its life cycle within six to seven months. May be due to this reason this is not much represented in Indian herbaria. The spike like very dense and condensed inflorescence at the terminal portion is very characteristic and which can easily distinguish it from its close relatives.

33. Leucas zeylanica (L.) R.Br. in Ait.f., Hort. Kew ed 2, 3: 409. 1911; Sm. in Rees., Cycl. XX. 1812; Spreng. in L., Syst. Veg. ed. 16, II: 742. 1825; Benth. in Wall., Pl. As. Rar. 1: 60. 1830; Wight, Ill. Indian Bot. t. 176. 1831; Benth., Labiat. Gen. Spec. 3 (fasc. 6): 614. 1834 & in DC., Prodr. XII: 531. 1848; Miq., Fl. India Bat. 2: 742. 1859; Hook.f., Fl. Brit. India 4: 689. 1885; Trimen, Handb. Fl. Ceylon 3: 387. 1895; Cooke, Fl. Bombay Pr. 2: 465. 1908; Koord, Exk. Fl. Java 3: 146. 1912; Prain, in Journ. As. Soc. Beng. 74: 2. 718. 1907; Ridl., Fl. Malayan Pen. 2: 650. 1923; Merr., En. Philip. 3: 411. 1923; Gamble, Fl. Pres. Madras 2: 1150. 1924; Barlet, Pap. Mich. At. Sc. 6: 35. 1926; Merr., Pl. Elm. Born 268. 1929; Mansfeld, Bot. Jahrb. 62. 378. 1929; Mukerjee, Rec. Bot. Surv. India XIV (1): 171. 1940; Hend, Mal. Nat. J. 6. 392, t. 362. 1950; Quis, Medik. Pl. Philip. 821. 1951; Abeywick, Ceylon J. Sci., Biol. Sc. 2 (2): 220. 1959; Back & Bakh.f., Fl. Java 2: 623. 1965; Keng, Gard. Bull. Sing. 24: 101. 1969; Keng, Fl. Malesiana 1: 8. 338. 1978; L H.Cramer in & Dassan. & Fosberg (eds.), Rev. Handb. Fl. Ceylon 3: 183. 1981; R.R.Rao & Razi, Syn. Fl. Mysore Dist. 543. 1981; Sriniv. in A.N.Henry et al., Fl. Tamil Nadu Ser. I. 2: 178. 1987; N.P.Singh, Fl. East Karnataka 2: 521. 1988; M.Mohanan & A.N.Henry, Fl. Thiruvananthapuram 367. 1994; Shu in Zheng-yi & Raven, Fl. China 17: 142. 1994; Pullaiah et al., Fl. Medak Dist. 187. 1998; V.Singh, Mon. Ind. Leucas 157. 2001.

Phlomis zeylanica L., Sp. Pl. 586. 1753; Roth, Nov. Sp. Pl.: 260. 1821.

—Type: Herbarium *Hermann*, Thes. Zey. 1: 1, *n 227.* (lecto. **BM** photo !) (Lectotype designated by Hedge.)

Fig. 78: Type specimen of *Leucas zeylanica* (L.) R.Br. (Herbarium Hermann 227; from BM)

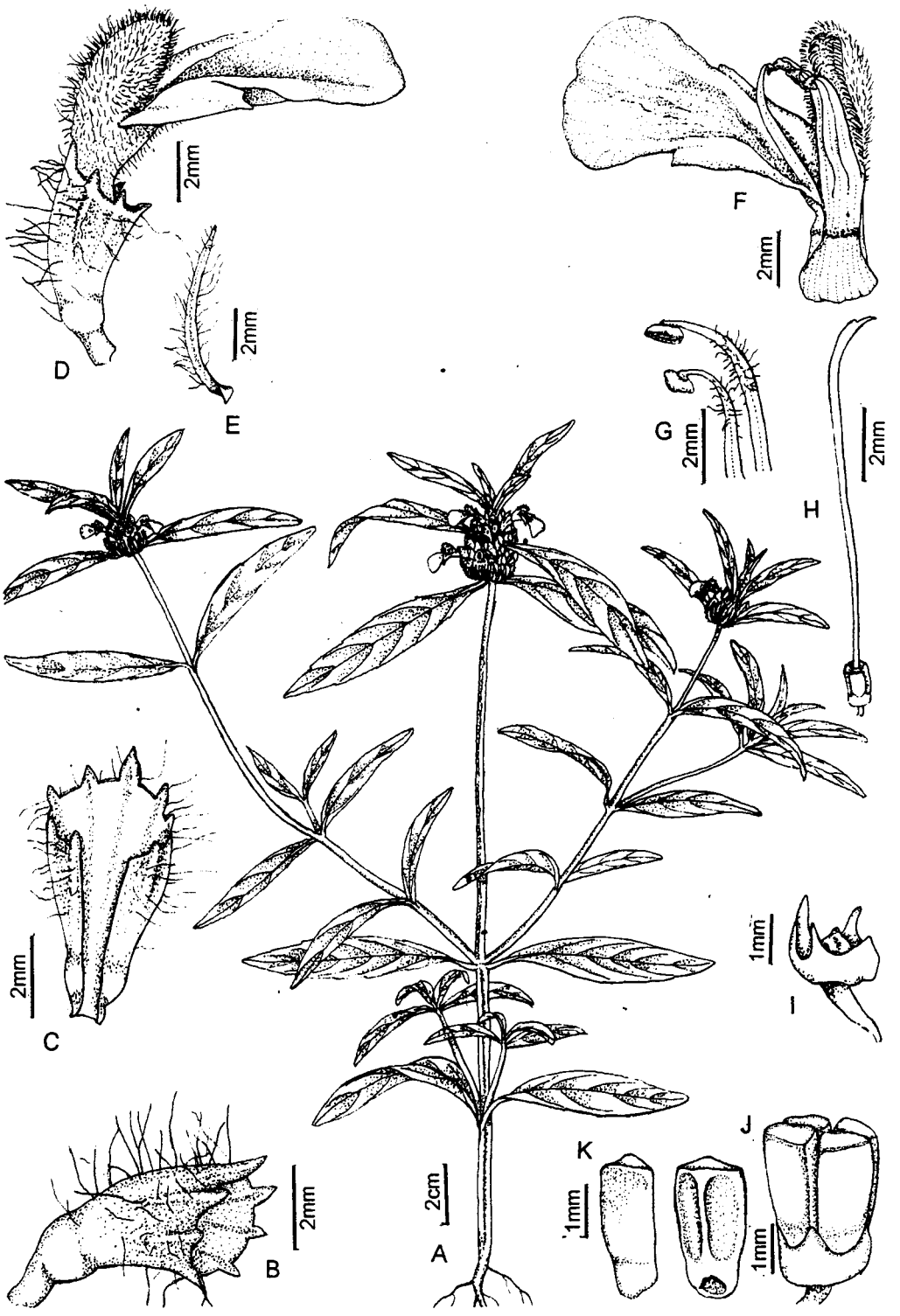


Fig.: **79**. *Leucas zeylanica* (L.) R.Br. A. Habit; B. Calyx; C. Calyx split open; D. Flower; E. Bracteole; F. Corolla split open; G. Stamens; H. Pistil; I. Disc; J & K. Nutlets.

Leonurus marrubiastrum *sensu* Burm.f., Fl. India 127. 1768. *non* L. 1753.

—Type: same as *Phlomis zeylanica* above

Phlomis obliqua Thunb. Fl. Java 15. 1825

Phlomis cephalotes *sensu* Bl., Bijdr. 830. 1826 *non* Roth 1821.

Leucas malayana Hance ex Walp. Ann. Bot. Syst. 3: 269. 1852-1853; Miq., Fl. India Bat. 2. 984. 1854.

Leucas bancana Miq., Fl. India Bat. Suppl. 1: 572. 1861; Koord-Schum, Syst. Verz. 1: 254, p. 3. 1910.

Nepeta hirsuta *sensu* Lour. Fl. Cochinch. 366. 1790 *non* L. 1753.

Leucas involucrata Benth. in Wall., Cat. No. 2047. 1829; Prain, Bengal Pl. 856. 1908. *nom. nud*

Leucasis zeylanica (L.) Rafin., Fl. Tell. 3: 88. 1837.

Leucas stricta *sensu* Manilal & Sivar. Fl. Calicut 239. 1982. *non* Benth. 1830.

Erect annual herb, 10–50 cm high, basal stem up to 7 mm thick, branches obtusely quadrangular, grooved, nodes sometimes slightly dilated, hispid with ±1 mm long hairs, tender stem dense ciliate; internodes 3–15 cm long. Leaves opposite; petiole 2–7 mm long, hispidulous, overlapping with the lamina base; lamina 3–7 cm long, 0.6–1.6 cm broad, four times longer than broad, slightly coriaceous, lanceolate or oblong to linear–lanceolate, base long cuneate or tapering into petiole, tip obtuse to acute, margin entire or serrulate with 4–5 minute teeth, secondary veins 4, prominent beneath, uniformly but sparsely beset with spreading

hispidulous hairs, paler and sub-glaucescent beneath in fresh leaves, with spreading hispidulous hairs on the nerves, hairs on both sides antrorse. Inflorescence terminal, 1–3 verticils per branch, subglobose, dense cluster, 12–18 mm across, up to 30 flowered, sometimes adjacent whorls very close due to reduced internodes. Bracteoles ±7 mm long, 0.5 mm thick, as long as calyx, few in number, erect, linear spinescent, tip acute, hispidulous with stiff 1–1.5 mm long sparse hairs, straight or turned towards the tip. Flowers sessile or up to 1 mm long pedicels. Calyx turbinate, slightly curved, abaxial side 5–5.5 mm long, adaxial side 6–6.5 mm long, diameter at base 1 cm and towards mouth 3 mm; inside upper one third portion pubescent, hairs extend up to the rim of the mouth giving a minute ciliate appearance, lower two third portion glabrous, outside lower half glabrous and shining, upper half hirsute with 1–2 mm long hairs, mouth oblique, with a thick annular veins, teeth 7–8, thick and fleshy, anterior teeth 1 mm, others 0.5 mm long, linear subulate, hirsute; calyx slightly prolongate in fruiting stage, attain 8 mm length. Corolla white, ±15 mm long; tube 6–7 mm long, half included in the calyx, above outside white hairy, inside at half length annulate with a discontinuous and wavy ring of fleshy hairs; lower lip 9 mm long, middle lobe largest, fan shaped, 6 mm broad wavy margin, lateral lobes 1 mm broad, margin slightly revolute; upper lip 4 mm long, concave with spreading tomentose silvery white hairs outside, margin ciliate. Staminal filaments hairy, lower pair of stamens larger than the upper pair; anther lobes light reddish coloured, 1.1 mm long, 0.4 mm broad, theca divaricate. Disc cup shaped, with 4 lobes, abaxial side 0.9 mm high, slightly longer

than other lobes which are 0.6 mm high. Style 10 mm long; stigma bifid, lower lobes 0.4 mm long, upper lobe highly reduced. Nutlets 3.5–4 mm long, 1.3 mm broad, dark black coloured, oblong, acutely triangular at middle, top flat triangular.

Vernacular name: Tumba, Ana tumba (Mal.), Tumbai (Tam.).

Etymology: The species name means 'Ceylon *Leucas*'.

Flowering and fruiting: Peak flowering season is August–January. Occassional flowering is noticed in other seasons also in some records.

Habitat: Found as a weed in cultivated fields, wetlands, open places, roadsides and waste places. Grow well on MSL and up to 500 m altitudes.

Distribution: Found in Asian countries: Bangladesh, China, India, Malaysia, Mauritious, Philippines, Sri Lanka and Thailand. In South India, this is found in Karnataka, Kerala and Tamil Nadu. This is a common herb in Malabar cost.

Specimens examined: **KERALA: Alapuzha Dt.**: Vandanam, 8th Aug, 1999, *S.Menon 17670* (TBGT); **Idukki Dt.**: Vallakkadavu, *K.P. Rajesh & J.Augustine 15427* (KFRI); **Kottayam Dt.**: Deviculum, 11th Oct. 1963, *K.M.Sebastine 17514* (MH); Changanachery, Perunna, 14th Jan. 1964, *N.C.Nair 19099* (MH); **Kozhikode Dt.**: Calicut city, 10th Dec. 1931, *G.V.Narayana 6211* (MH); Beypore, 9th July 1971, *V.V.Sivarajan 1291* (CALI); Kadalundy, 20th May 1976, *C.P.Ravindran 18111* (CALI); Elathur, 20th May 1999, *Sunojkumar CU49617* (CALI); 20th Oct. 2002,

Sunojkumar CU49693; **Malappuram Dt.**: Ramanattukara, 21st Jan. 1971, *V.V.Sivarajan 927* (CALI); Calicut Univ. campus, 9th Sept. 1978, *A.Nair 24248* (CALI); Pattambi, 9th Aug. 1984, *M.Princy 2151* (CALI); Chandanakavu, 10th Aug. 1986, *A.Babu 38228* (CALI); Idimuzhikkal, 11th Sept. 1991, *C.Thulasi 5413* (CALI); Calicut Univ. campus, 10th Feb. 1992, *U.Sreelatha 5110* (CALI); Chelembra, 24th Apr. 1992, *T.Rajasree 2806* (CALI); CU Campus, 20th Oct. 2002, *Sunojkumar CU49692* (CALI); **Palakkad Dt.**: Kanjarumpuzha submergible area, 26th Oct. 1964, *K.M.Sebastine 21078* (MH); Vidhyadh nagar, 15th July 1997, *P.S.Jothish 35360* (TBGT); **Pathanamthitta Dt.**: Maniyaar, 29th Jan. 1988, *N.Anilkumar 443* (MH); Triveni, 20th Dec. 1994, *A.G.Pandurangan & Rajkumar 12708* (TBGT); **Thiruvananthapuram Dt.**: Way to Neyyar dam from Kattakadu, 18th Apr. 1973, *J.Joseph4208* (MH); Kompa, 28th Sept. 1993, *N.Mohanan 11509 & 11525* (TBGT); TBGRI near rock garden, 28th June 1996, *G.Madhu 27644* (TBGT); Palode, 6th May 1997, *G.Madhu 33886*; **Trissur Dt.**: Kunnankuzhy, 26th June 1996, *A.G.Pandurangan & G.Rajkumar 30553 & 30411* (TBGT); **Wayanad Dt.**: Wayanad, 10th Aug. 1978, *M.Jacob 24177* (CAL); **TAMIL NADU: Nilgiris Dt.**: Anaikatty-Kedar halla, 21st Aug. 1970, *G.V.S.Rao 36132* (MH); **Tirunelveli Dt.**: Courtallum, *K.K.N.Nair 5368* (CAL).

4. 5. NUMERICAL METHODS

Numerical taxonomy was coined by Sokal and Sneath (1963) as "the numerical evaluation of the affinity or similarity between taxonomic units and the ordering of these units into taxa on the basis of their affinities". Later they have modified this into " the grouping by numerical methods of taxonomic units into taxa on the basis of their character states" (Sneath and Sokal, 1973). This means that numerical taxonomy is a method used to determine phenetic relationships among organisms.

4. 5a. PHENETICS

According to Stuessy (1990), "Phenetics is a classification based on numerous precisely delimited characters (with carefully coded states) of equal weight and their comparison by an explicit method of grouping. A general sense is to obtain a measure of overall similarity." In short, phenetics is a method used to find out the relatiaonship by overall similarity, based on all available characters without any weighing.

To trace the relationships of *Leucas* species found in South India, a phenetic approach following the principles and methods of Sneath and Sokal (1973) is followed here.

Methodology: The basic methodology involved is:

(1) Selection of taxa for study (these are called as Operational Taxonomic Units (OTUs) by Sneath and Sokal, 1963): for this, here, all the South Indian Species of *Leucas* are considered, but due to the non availability of all the characters, *Leucas nepetaefolia* and *Leucas anandaraoana* are avoided. Thus altogether there are 31 species selected as OTUs.

(2) Selection of characters: the characters selected are given in the table. 15.

(3) Description and measurement of character states: these are also given in the table no. 15.

(4) Comparison of states: this is given in the table character states of OTUs (table no. 16)

(5) Ranking of all OTUs into the categories of the taxonomic hierarchy: this is presented in the different phenograms given (phenogram 1-)

Procedure followed: The qualitative or discrete characters are coded as numerical values for different states as 0, 1, 2 etc. where as quantitative or overlapping characters are coded as having more than one states following the method used by Thiele (1993) and Ryding (1998). Total 39 characters were selected of which, 9 were (31-39) continuous characters. The similarity and percentage disagreement were calculated by arranging all the 39 characters against 31 OTUs and a character matrix is prepared. Similarity percentage of the matrix was calculated using the formula

$$S = \frac{NS}{NS + ND} \times 100$$

Where S= similarity value expressed in percentage; NS= No. of positive features shared by two OTUs and ND= number of positive features in one OTU and negative in the other.

The character state matrix of OTUs was used for cluster analysis using the software STATISTICA (Release 5.0 for Windows) installed in to a Pentium IV computer. Using the Unweighted pair-group average (UPGMA) and Weighted pair-group average (WPGMA) differently, statistical tests like percentage disagreement and euclidian distances were performed to cluster the data. In both weighted and unweighted cases the phenograms generated were found to be alike and was suitable for clusteing the OTUs.

CN	**Character states**
1	Habit: (0) shrub, sub-shrub with woody stem; (1) perennial herb with woody rootstock; (2) annual with herbaceous stem
2	Stem: (0) quadrangular; (1) terete.
3	Stem surface: (0) longitudinally grooved; (1) not grooved.
4	Leaf: (0) opposite; (1) ternate/ fasicled.
5	Leaf: (0) membraneous; (1) coriaceous (2) chartaceous.
6	Leaf margins: (0) serrate/ crenate; (1) entire or almost so.
7	Leaf surface: (0) Glabrous-minutely pubescent; (1) characteristically tomentose to ciliate.

8 Fruiting calyx and fruits (0) falling with the entire cyme; (1) dispersing solitarily.

9 Inflorescence nature: (0) axillary cluster; (1) many flowered sub-globular, terminal 1-3 axis; (2) terminal on a long axis.

10 Most flower rich cymes in the inflorescence: (0) 2-3 flower; (1) 5-15 flower; (2) 15-30; (3) >30 flower.

11 Bract nature: (0) divergent or recurved; (1) erect.

12 Bract form: (0) filiform; (1) lanceolate; (2) foliaceous.

13 Dorsal and ventral side of calyx tube: (0) almost equal in length; (1) dorsal side longer; (2) ventral side longer.

14 Calyx tube: (0) widely funnel shaped at the apex; (1) cylindrical or moderately widened at the apex.

15 Calyx tube outside: (0) upper half hairy lower glabrous; (1) fully hairy.

16 Length of eglandular hairs outside the calyx: (0) up to 1 mm.; (1) 1-1.5 mm.

17 Calyx: (0) 10 teethed; (1) 8-6 teethed

18 Calyx teeth: (0) all teeth equal in size; (1) dorsal long lateral small; (2) ventral long lateral small.

19 Teeth structure: (0) subulate/ linear; (1) triangular with broad base and pointed tip.

20 Calyx mouth: (0) open, without hairs; (1) ciliate with a tuft of long hairs

21 Hair colour of the upper lip of corolla: (0) white; (1) coloured.

22 Adaxial side of lower lip: (0) not hairy; (1) hairy at bottom; (2) upper hairy near the tube mouth and lateral lobes.

23 Corolla lower middle lobe: (0) emarginate; (1) fan shape.

24 Corolla tube inside: (0) annulate at middle ; (1) not annulate.

25 Corolla tube inside below the stamens, above the annulus: (0) not hairy; (1) with fleshy hairs in longitudinal rows.

26 Stamen stalk: (0) hairy in the middle; (1) not hairy.

27 Glands at the apex of the ovary lobe: (0) absent; (1) present.

28 Length of disc lobes (0) same; (1) not same, abaxial longer

29 Nutlet apex: (0) rounded; (1) subtruncate/ truncate with rounded edge; (2) truncate or concave with a sharp edge.

30 Nutlet: (0) flat near the base; (1) narrowed near the base.

31 Leaf blade length/ width: (0) <2; (1) 2-3; (2) 3-4.5; (3) >4.5.

32 Bract length/ width: (0) >10; (1) 4-10; (2) 2-4; (3) <2.

33 Teeth length/ base breadth: (0) 1-2; (1)<5; (2) 5-10(3) 10-20; (4) > 20.

34 Length of the corolla: (0) >24mm.; (1) 19-24mm.; (2) 15-19 mm.; (3) 11-15; (4) 9-11; (5) 7-9; (6) <7.

35 Margin of the upper lip of corolla: (0) hardly bearded; (1) strongly bearded, with hairs in all direction.

36 Length of the lower lip/ upper lip of corolla: (0) <0.8; (1) 0.8-1.2; (2) 1.2-1.6; (3) >1.6.

37 Length of the anther/ width: (0) >1.6; (1) 1.3-1.6; (2) <1.3.

38 Length of the lower style branch/ upper branch (0) <1.5; (1) 1.5-2; (2) 2.3; (3) >3.

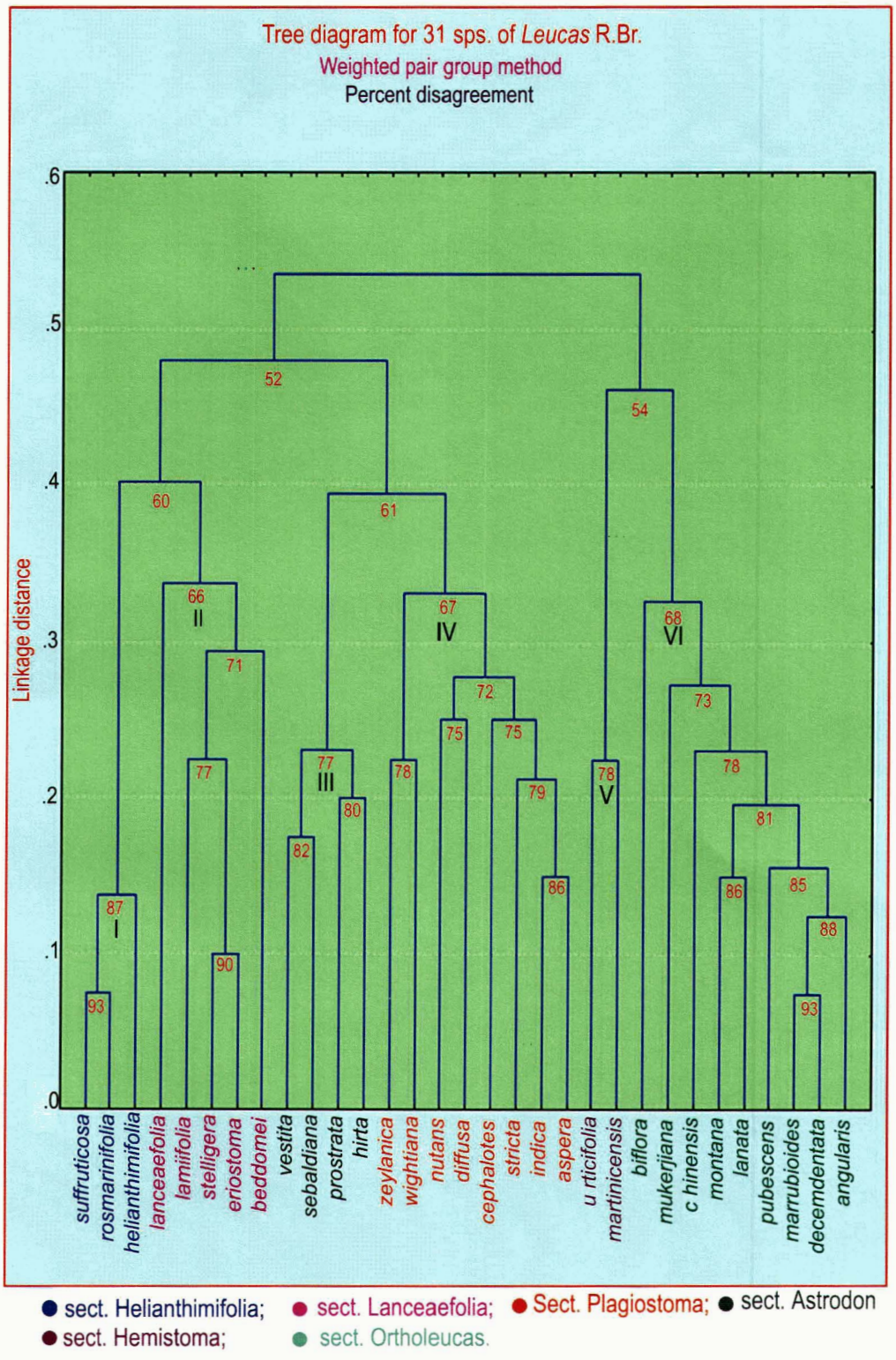
39 Nutlet length/ width (0) <1.5; (1) 1.5-1.8; (2) 1.8-2.2; (3) >2.2.

Table.: 15. Character and character state used for phenetic analysis

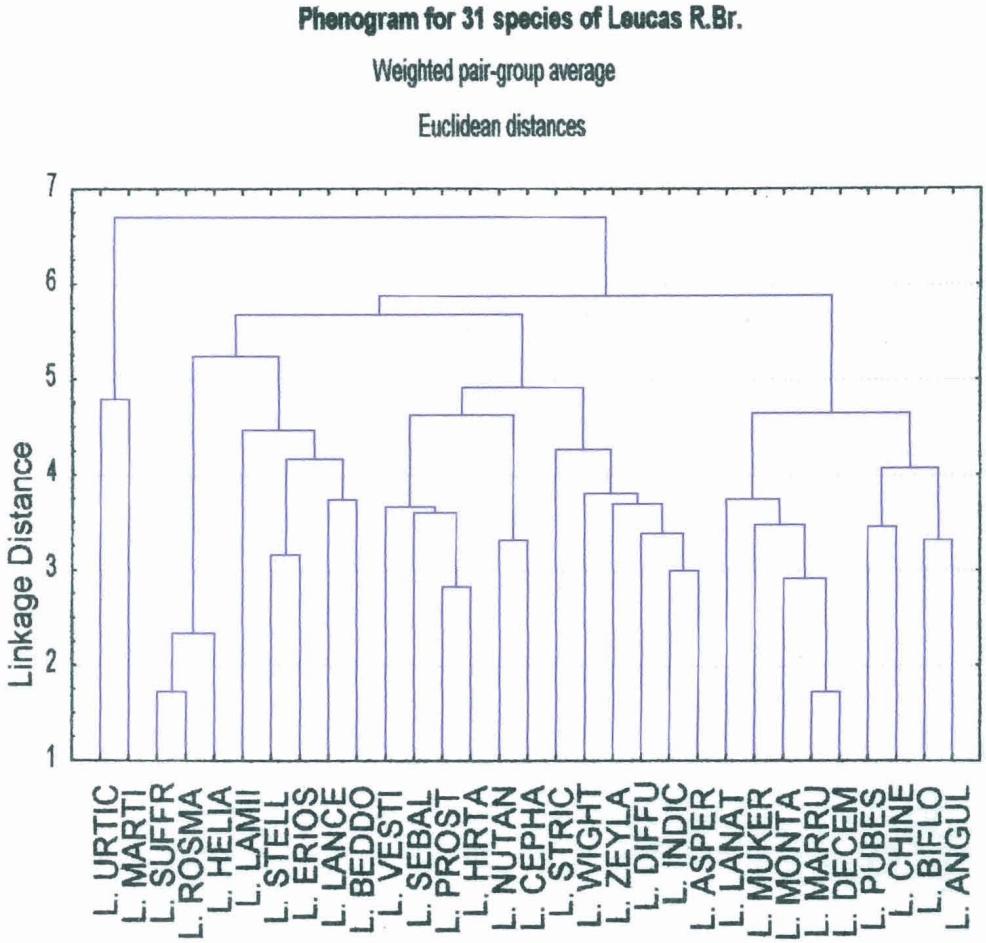
Analysis of the Phenogram: The phenogram obtained clearly reveal the relationship among 31 species of *Leucas* (OTUs) found in Southern Peninsular India. It shows that, 31 species falls under 6 clusters, corresponding to 6 sections, as in the new classification proposed for this genus based on comparative morphology.

OTUs	10 20 30 1234567890123456789012345678901234567 89
L. anandaraoana	20101001011101101101000000000 11201
L. angularis	10100001011001100001000000100110012011 11
L. aspera	20001000120111010010000100000101113020 31
L. beddomei	00002010121101000001110011010001103110 33
L. biflora	20100001001001101001000000000100024011 01
L. cephalotes	20001000120211012000100100000001212020 33
L. chinensis	10101001011100102001000000000010002021 10
L. decemdentata	10100001011001100001000000000210012020 31
L. diffusa	20101100110111110000100100000001113031 32
L. eriostoma	00001000121101000000101000000000100011 032
L. helianthimifolia	11111110221100100001112011000012103120 32
L. hirta	00011010120100110000100100000001111120 31
L. indica	20101000120111000010000100000103013021 32
L. lamiifolia	00001010121101100001000000000001002100 02
L. lanceaefolia	00101100121100100001000011100001013010 32
L. lanata	10102011011001102001000000000111013020 30
L. marrubioides	10101001011001100001000000000110012030 31
L. montana	10101001011001100001000000000211003020 33
L. martinicensis	20001000030101100010000010011201026021 31
L. mukerjiana	10102011011001100000000000010010013031 32
L. nepetaefolia	11100001011001100001000000000100 00
L. nutans	20101000020211102011000100000001113030 32
L. prostrata	10110010220100110000100100000000122120 32
L. pubescens	10100001011001102001000000100110010020 00
L. rosmarinifolia	11111110211100100000102011000013013120 32
L. sebaldiana	10001010120101112000110100000000221130 32
L. stelligera	00001000121101000000101000000000212211 032
L. stricta	20001000120111010000100100000010302103 232
L. suffruticosa	11101110211100100000102011000013103120 32
L. urticifolia	20000000030121103020000010011200005020 32
L. vestita	10001010120101010000110100000000114212 032
L. wightiana	20001000121110100010101100000103014030 31
L. zeylanica	20001000121110010110000100000102002030 33

Table.: 16. Character states of the OTUs arranged



Phenogram 1: Phenogram showing the cluster of *Leucas* species (numerals below the branches show similarity percentage)



Phenogram 2: WPGA Euclidean distance

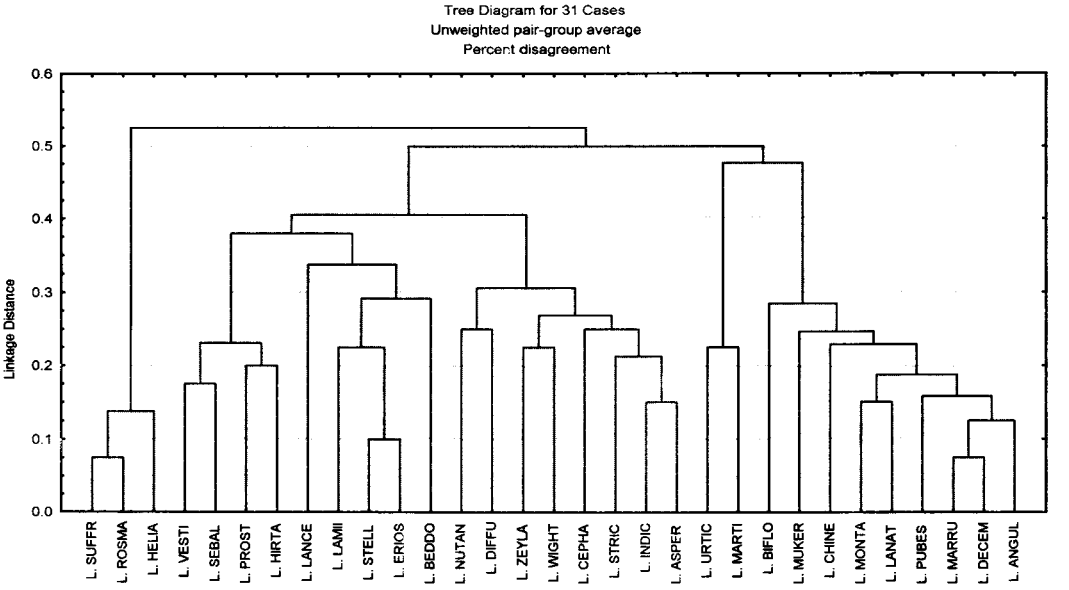
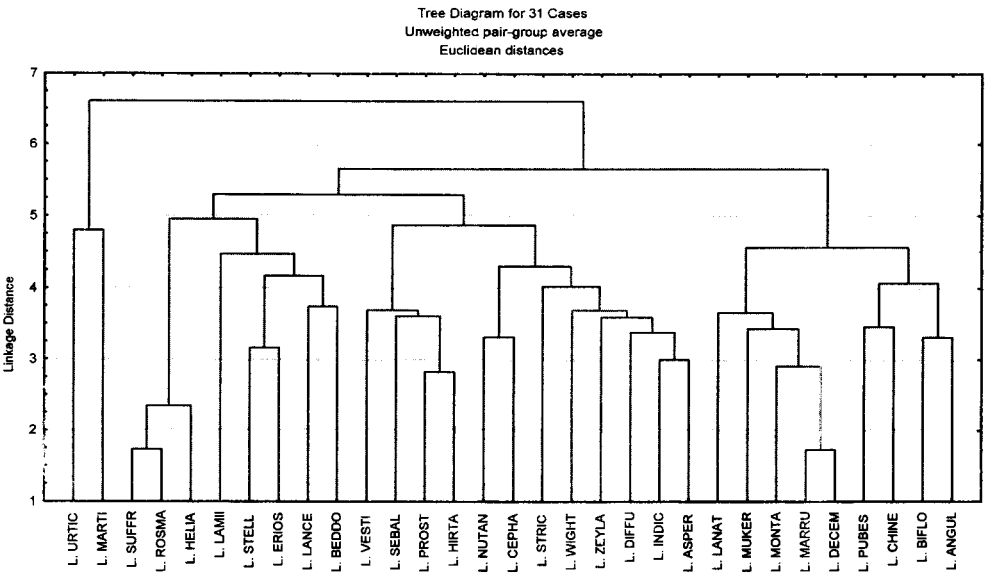


Fig.: Phenogram **3**: showing the percent disagreement (UPGMA)



Phenogram **4**: showing the cluster (UPGMA)

In the Ist cluster, *L. suffruticosa*, and *L. rosmarinifolia* shows 93% similarity. *L. helianthimifolia* joins with this group with 87% similarity. This three species are members of the section Helianthimifolia, characterised by their perennial woody, amorphous underground stem, narrow leaves which are 2-3 in a node, corolla tube provided with fleshy hairs in longitudinal rows, not annulate, and lower lip adaxial side provided with dense hairs. These members show a unique calyx, not shared by any other members of this genus.

In the IInd cluster there are 5 species, *L. lanceaefolia, L. lamiifolia, L. eriostoma, L. stelligera* and *L. beddomei.* All these are members of newly proposed section Lanceaefolia. They share the character as sub shrubs, woody with erect stems, and emarginate corolla lips. *L. eriostoma* and *L. stelligera* are 90% similar, mostly in their vegetative and corolla characters. *L. lamiifolia* joins this group with 77% similarity, followed by *L. beddomei* 71% similarity. *L. lanceaefolia* ultimately joins with these four species with 66% similarity. *L. lanceaefolia* differs from other in the nature of leaves being entire and pubescent, calyx funnel shaped and corolla tube without annular ring inside.

Cluster III consists of 4 species, *L. vestita, L. sebaldiana, L. hirta* and *L. prostrata.* All these are treated as the only members in section Astrodon in the new sectional classification here. *L. vestita* and *L. sebaldiana* are very close with 82% similarity. These two are very much related in their vegetative character and differ on their bracteole and calyx characters only. *L. prostrata* and *L. hirta* are very

similar on their floral character and differ in vegetative character only. Both share 80% similarity. These two sub-clusters show 77% similarity in between.

Cluster IV consists of 8 species, all are members of section Plagiostoma. They are all annual herbaceous members with quadrangular grooved stem, calyx bent or with oblique mouth, and corolla lower lip fan shaped. In this *L. indica* and *L. aspera* exhibit very close relationship with 86% similarity. To this group, *L. stricta* joins with 79% affinity, followed by *L. cephalotes* with 75% similarity. Towards this group *L. nutans* and *L. diffusa* shows 75% similarity. *L. zeylanica* and *L. wightiana* are similar with 78% similarity and this shows relationship with other members by 67% similarity.

Cluster V consists of two species, *L. martinicensis* and *L. urticifolia* with 78% similarity. These two species are African species belong to the section Hemistoma and are much different from others.

Cluster VI, is the largest in South Indian *Leucas*, consists of 9 species, all are perennial herbs, with quadrangular non grooved stem, tubular straight calyx, equal sized teeth, mouth not ciliate, corolla lower lip emarginate, perpendicularly attached with tube, filiform bracteoles and nutlets base narrowed. They are all belongs to the section Ortholeucas recognized by Bentham as early as in 1830. Within this, *L. marrubioides* and *L. decemdentata* exhibit very close similarity of 93%. Towards this group *L. angularis* cluster with 88% and *L. pubescens* cluster with 85%

similarity. *L. montana* and *L. lanata* are very similar with regards to their leaf and calyx character. Both show 86% similarity and joins with other species by 81% similarity. With a 78% similarity, *L. chinensis* and with 73% similarity *L. mukerjiana* joins this bigger group. Ultimately *L. biflora* joins other members with 68% similarity. This species shows slight difference as being annual procumbent herb with corolla tube smaller than lower lip.

Interpretation of Phenograms: This cluster analysis produced a hierarchical classification of *Leucas* species, which were useful in analysing the sectional treatment done using morphological methods. A strong support for the new six sectional classifications based on comparative morphology, is thus available by numerical methods also. Bentham's section Astrodon is hereby split to include two more sections viz. Helianthimifolia and Lanceaefolia, and retained Astrodon with limited members. It is also proved that sect. Helianthimifolia and Lanceaefolia shows close similarity (60%) where as new Astrodon members show more similarity with members of section Plagiostoma. This is because Astrodon members are herbaceous, have fan shaped corolla lip and similar verticilaster as that of Plagiostoma. Within Astrodon the close similarity of *L. vestita* and *L. sebaldiana* give a phenetic supports for the assumption that they are very similar as recorded in the taxonomic treatment in part (chapter. 4.4d), while describing the new species.

The high similarity of African species *L. martinicensis* and *L. urticifolia* underline the concept that both are members of the section Hemistoma, as followed

in this thesis. This is in sharp contradiction with the classification followed by Bentham (1848) and Singh (2001).

Members of section Ortholeucas are very clearly distinguished from others by their unique character of quadrangular non-grooved stems. They form a cluster that shows similarity with African species than with Asian species.

Finally the six clusters formed in the phenogram can be treated as six sections and this sectional treatment support very well with the sectional classification already proposed through comparative morphological analysis in this work.

4. 5b. CLADISTICS

Phylogeny of *Leucas* group has been studied by Ryding (1998) using cladistic method. He used morphological character for preparing data matrix which cover mainly African species and related genus like *Bellota, Otostegia, Acrotome* and *Leonotis* as out groups. The cladograms obtained shows *Leucas* species from Asia (excluding Arabia) and Socotra form monophyletic group. Based on this work, Ryding (1998) suggested that *Leucas* is suggested to have originated in northeast tropical Africa and to have migrated from this area over Arabia to the Indian subcontinent.

It is on the light of these findings the relationships within Asian group, which consist of about 40 species, are attempted. This work is attempted in consultation with and following the method used by Dr. Olof Ryding of Botanical Museum, University of Copenhagen, Denmark. Apart from the South Indian species, all the known Asian species of *Leucas* found elsewhere in India and other Asian countries were considered in this analysis. Fresh specimen were analysed for preparing data for South Indian species where as dried herbarium specimens, protologues and earlier works (Hooker, 1885; Mukerjee, 1940; Singh, 2001) were consulted for other species.

While attempting this analysis, two factor were felt difficult i.e., the non availability of a proper software (PAUP) and the lack of many relevant information regarding a few species of *Leucas* not found in South India.

Non-availability of software at my disposal was a major problem as this analysis need to run the matrix several times using different character at different time. In spite of my effort this problem remained and ultimately this difficulty also overcame by the help of Dr. Oloy Ryding, who prepared the trees using his own computer system at his Laboratory. The prepared trees were send in the form of verbal trees through electronic mails and the same were converted into actual tree form using MS Excel software in my personal computer. Even though trees were constructed, the exact way the matrix has been handled is not fully clear and again the trial and error method of using different character states at different times is not

made possible. However the most parsimonious trees obtained will ultimately gave an idea about the status of matrix prepared.

Character and character states: A character is a feature (attributes or observable part) of an organism. In practical applications, a character is a part of an organism that can be described, figured, measured, weighed, counted, scored or otherwise communicated by one biologist to another (Witey, 1980). In otherwords, it is an aspect of an organism that can be passed down genetically through evolutionary time and still be recognizable (Judel, 2000). This can be for example, petal colour, inflorescence, structure or plant habit all known to be under genetic control and are genetically inherited from one generation to the next.

The variation among similar structure must be described by dividing the character into character states. This is a hypothesis of underlying genetic control where it is assured that underlying genes have switched over evolutionary time to produce variation. The characters states used in this study are recognized by finding one or more distinct discontinuities i.e. a gap or non-overlap in the character value when comparing all species in the genus. In other words the character are discrete.

Characters are often regarded as qualitative or quantitative. Based on the mathematical properties of the number that express the date, the characters are either discrete or continuous. Again the characters are often called as overlapping and non-overlapping (disjunct) which reveal the pattern of variability. Non-overlapping data have gaps between adjacent states and overlapping date lacks such gaps.

Larger gaps reflected well in ancestral branching than smaller gaps and are useful in elucidating ancestral history. Both continuous and discrete character may show overlapping or non-overlapping pattern of variability in a particular taxa. According to Stevens (1991), character used in phylogenetic analysis should be discrete and without overlap; and overlapping character should be excluded from initial cladistic analysis. But relevant information, important in finding out evolutionary branching are present in continuous character also but is hidden in the continuities and are not accessible. Excluding continuous character may not result a good cladogram revealing hierarchy as the remaining characters, which contribute to the finding of a hierarchy may be very few. According to Thiele (1993), such continuous characters may track phylogeny as accurately as "quantitative: morphological data.

According to Wiens (1995) polymorphic (overlapping) characters can have significant phylogenetic information. Thus continuous characters and /or characters that have an overlapping variation pattern should not be excluded a priori from cladistic analysis.

It is pertinent to mention that results in morphological cladistic method depend on the usage of character that shows distinct discontinuities (discrete characters). When so many characters are continuous or sub continuous, the character coding requires extra attention. Not only a careful presentation of character and character states is needed but also the processing of these data matrix using suitable software on a trial basis is important.

Usage of cladistic method on an infra-generic level usually contains species whose identity is very complex and are very close to one another. These related species are assumed to have much subcontinuous and continuous character as 'key' characters. If parallel evolution occurred or hybridization involved it is very difficult to reveal hierarchy and in many cases, cladistic analysis will not be successful in revealing relationships.

Thus continuous character cannot be excluded from analysis and due to this fact various methods of transforming more or less continuous character into character states have been proposed. In the gap weighing method proposed by Thiele (1993), used fragmented continuous characters where he coded taxa by their mean values. However Ryding (1998) opposes this view and according to him, the use of mean value may lead to false resolution of relationship, if the range of values overlaps extensively among taxa. He preferred to code polymorphic taxa as having more than one state.

Following the views of Dr. Olof Ryding, I also used the same method and many continuous and overlapping character have considered for analysis. Also in the genus *Leucas*, very few characters are found useful for cladistic analysis if continuous and sub continuous characters are avoided.

Choice of outgroups: All the species of *Leucas* so far identified in Asia are considered for analysis. It is already identified by many workers that *Leonotis*

nepetaefolia is a close relative of *Leucas* (Hedge, 1992; Ryding, 1998) and it being the only very close relative of *Leucas* in Asia is included as outgroup. *L. martinicensis* and *L. urticifolia*, even though common in Asia are African species are considered as outgroup here. On the light of Ryding (1998) finding that Asian group is monophyletic and Asian *Leucas* clade is most closely related to north east African species like *L. neuflizeana, L. aequistylosa, L. nubica* and *L. stachydiformis*, these species are also considered as out-groups.

Notes on characters: Details regarding the terminology used in character and character states are described in detail in the morphology and taxonomy part. Among the character and character states, some are true discrete characters (character number 1,3,4,5,23,37,41,43,49,50). Few multi state characters are considered as ordered by assuming the fact that a basic course of evolutionary change over time had produced this multi state in *Leucas*. Even though ordering of state of character is a controversial topic it is followed here.

Table: 17. Characters and states used in cladistic analysis. Unless otherwise stated, the characters are treated as unordered

SN	Character	Character states
1	Habit:	(0) shrub, sub-shrub or perennial herb with woody stem; (1) perennial herb with woody root & or rootstock; (2) annual with herbaceous stem
2	Growth nature:	(0) straight, perpendicular to ground; (1) ascending /straggling; (2) decumbent/ stoloniferous.

3 Stem: (0) quadrangular; (1) quadrangular – hollow; (2) terete.

4 Stem surface: (0) longitudinally grooved; (1) not grooved.

5 Leaves: (0) opposite; (1) ternate/ fasicled.

6 Leaf blade length/ width (ordered): (0) <2; (1) 2-3; (2) 3-4.5; (3) >4.5.

7 Leaves: (0) membraneous; (1) coriaceous / chartaceous.

8 Leaves margins: (0) serrate/ crenate; (1) entire or almost so.

9 Leaves surface: (0) Glabrous-minutely pubescent; (1) characteristically tomentose to ciliate.

10 Fruiting calyx and fruits (ordered): (0) remaining on the plant or falling with the entire cyme; (1) dispersing solitarily, normally later than at maturity; (2) dispersing solitarily at maturity.

11 Inflorescence nature: (0) axillary cluster; (1) many flowered sub-globular, terminal 1-3 axis; (2) terminal on a long axis.

12 Most flower rich cymes in the inflorescence (ordered): (0) 1 flower; (1) 2-3 flower; (2) 4-6 flower; (3) 7-9 flower; (4) >10 flower.

13 Bract length/ width (ordered): (0) >10; (1) 4-10; (2) 2-4; (3) <2.

14 Bract nature: (0) divergent or recurved; (1) erect.

15 Bract form: (0) filiform; (1) lanceolate; (2) foliaceous.

16 Dorsal and ventral side of calyx tube: (0) almost equal in length; (1) dorsal side longer; (2) ventral sidelonger.

17 Calyx tube (including enlarged dorsal or ventral side): (0) straight or almost so; (1) straight to slightly curved in the basal and central part, more strongly recurved near the mouth.

18 Calyx tube: (0) widely funnel shaped at the apex; (1) cylindrical or moderately widened at the apex; (2) inflated and then narrowed at the apex.

19 Calyx tube outside: (0) upper half hairy lower glabrous; (1) fully hairy.

20 Length of eglandular hairs outside the calyx: (0) up to 1 mm.; (1) 1-1.5 mm.

21 Internal eglandular hairs of the tube: (0) absent or almost so; (1) forming a distinct annulus in the central part, but absent or sparse in the proximal or distal part; (2) hairy from the mouth to the central part; (3) fully hairy from mouth to base.

22 Length of the eglandular hairs of the internal calyx tube: (0) <1 mm; (1) > 1 mm.

23 Calyx: (0) 10 teethed; (1) 8-6 teethed; (2) 5 teethed.

24 Calyx teeth: (0) all teeth equal in size; (1) dorsal long lateral small; (2) ventral long lateral small.

25 Teeth length/ base breadth (ordered): (0) 1-2; (1)<5; (2) 5-10(3) 10-20; (4) > 20.

26 Teeth structure: (0) subulate/ linear; (1) triangular with broad base and pointed tip.

27 Calyx with veins: (0) not forming a distinct annulus; (1) forming a thick annulus at the mouth.

28 Calyx mouth: (0) open, without or weakly haired, an extension of inner hairs; (1) villous with a tuft of long hairs produced at the rim of the mouth.

29 Calyx mouth cilia: (0) short hairs at the rim not closing the mouth opening; (1) long hairs forming a cone over the mouth, closing it in bud and seed.

30 Seeding calyx length/ flowering calyx length (ordered): (0) 1; (1) 1.2 – 1.5; (2) 1.5 and above.

31 Length of the corolla (ordered): (0) >24mm.; (1) 19-24mm.; (2) 15-19 mm.; (3) 11-15; (4) 9-11; (5) 7-9; (6) <7.

32 Hair colour of the upper lip of corolla: (0) white; (1) coloured.

33 Margin of the upper lip of corolla: (0) hardly bearded; (1) strongly bearded, with dense tuft of long hairs in all direction.

34 Lower lip of corolla: (0) not withering at anthesis; (1) withering at anthesis.

35 Adaxial side of lower lip: (0) not hairy; (1) hairy at bottom; (2) upper hairy near the tube mouth and lateral lobes.

36 Length of the lower lip/ upper lip of corolla (ordered): (0) <0.8; (1) 0.8-1.2; (2) 1.2-1.6; (3) >1.6.

37 Corolla lower middle lobe: (0) emarginated; (1) fan shaped.

38 Corolla tube inside: (0) annulate at middle with hairs; (1) not annulate.

39 Corolla tube inside below the stamens, above the annulus: (0) not hairy; (1) with fleshy hairs in longitudinal rows.

40 Length of the anther/ width (ordered): (0) >1.6; (1) 1.3-1.6; (2) <1.3.

41 Stamen stalk: (0) hairy in the middle; (1) not hairy.

42 Length of the lower style branch/ upper branch (ordered): (0) <1.5; (1) 1.5-2; (2) 2.3; (3) >3.

43 Glands at the apex of the ovary lobe: (0) absent; (1) present.

44 Length of abaxial lobe of disc / length of other lobes (ordered): (0)1; (1) 1-1.5; (2) >1.5.

45 Nutlet length/ width (ordered): (0) <1.5; (1) 1.5-1.8; (2) 1.8-2.2; (3) >2.2.

46 Nutlet apex (ordered): (0) rounded; (1) subtruncate/ truncate with rounded edge; (2) truncate or concave with a sharp edge.

47 Nutlet: (0) flat near the base; (1) not flat near the base.

48 Eglandular hairs on nutlet: (0) absent; (1) present.

49 Thickness of sclerenchyma regions in the pericarp (ordered): (0) >45 μm; (1) 45-31 μm; (2) 30-26 μm; (3) 25-19; (4) 20-16; (5) 15-5; (6) <5.

50 Diploid chromosome number (ordered): (0) 22; (1) 24; (2) 26; (3) 28; (4) 30; (5) 32.

Character states	1	11	21	31	41
Weight of states	**6666623623**	**6126666622**	**6366166661**	**1666626663**	**6263233611**
Leonotis nepetaefolia	1000000001	041111110A	30011100–1	2101001002	031122106K
Leucas anandaraoana	2101001011	0411100110	10001100–0	2000010000?	0?? ?????? ?
Leucas aequistylosa	2100000000	040102A100	2102201000	6000220102	100102005?
Leucas angustissima	2000031101	0211111100	0–01A010–1	2000031002	??0?30????
Leucas angularis	1111000001	0401000110	0–001101–0	2000010001	1101111025
Leucas aspera	20000E1000	141111A101	20011000–0	S00013100D	0300110050
Leucas beddmei	0000011010	141110010A	0–00011101	3110010010	031130002?
Leucas biflora	2201000002	0A01000010	10002100–1	4000010001	0000111053
Leucas cephalotes	20000E1000	142121A101	2000100102	E00003100D	0300300030
Leucas chinensis	1101001012	0201000010	20000100–1	2000020001	0101001023
Leucas ciliate	11000K1010	140010011A	0–00201111	1100031010	0300300010
Leucas clarkei	2000031100	1S11101110	2002201101	E0000E1???	??0??0?0?0
Leucas decemdentata	1101000002	0301000110	0–001100–0	2000020000	0301121053
Leucas deodikarii	1100000001	0411100110	0–002100–1	200012000?	?101A0?0??
Leucas diffusa	2101011100	131111111A	0–00101100	3000031001	0300200030
Leucas eriostoma	0000031010	1401100100	0–00001112	4010110010	0301201070
Leucas helianthimifolia	0021121110	D411100110	0–00011100	3010220110	0300201070
Leucas hirta	1100011010	141010011A	0–00110110	1010021010	0301100000
Leucas hyssopifolia	1000030100	1S01010100	20000000–A	S000?3?0?2	0301EA102?
Leucas indica	2000031000	1401111100	0–A11100–1	T000131001	0300210030
Leucas lamiifolia	0000011010	140010011A	20000110–0	2010000000	00A02000?3
Leucas lanata	11010A1011	0S01000110	20001100–1	S0000E0000	0301A11053
Leucas lanceaefolia	0001031100	1S01100010	0–00111001	3000010110	1301200?0
Leucas longifolia	2000031101	0K01000110	0–00001100	3000131000	030?0000??
Leucas macrantha	1100031101	1411011101	1–01A0?0–A	1000011?0?	?30???? ???
Leucas marrubioides	1101001011	0S01000110	0–001100–0	2000030000	0300101053
Leucas martinicensis	20000A1000	1401111110	2001210001	6000010101	0E12D00063
Leucas montana	1101001001	0T0100011A	2000000000	3000020000	0301321073
Leucas mukerjiana	1101001011	0401000110	0–00100100	3000030001	0300200170
Leucas nepetaefolia	1121000001	0E01000110	??000100–0	?0000?000?	0?????????
Leucas neuflizeana	20000D000A	0T11020110	20021100–1	R000010000	1112AA0?5?
Leucas nubica	20000A0000	0S01100100	2100A010–0	50000D0A00	0D102D005?
Leucas nutans	2101011000	0411211110	2001110100	3000031000	0300200053
Leucas prostrata	1200001010	D410100110	0–00201110	2000021000	030020002?
Leucas pubescens	1111000001	0301000110	20001100–1	1000020000	100101102?
Leucas rosmarinifolia	0021131100	1401100110	0–00101110	S010220110	030020100?
Leucas sebaldiana	1100001010	D42021110A	210020100D	1110031010	030020002?
Leucas stachydiformis	00000A000A	04A1000100	2A20301101	E010010000	000110003?
Leucas stelligera	0000021000	1411100110	0–00201111	2010120010	030120002?
Leucas stricta	2000031000	140111110A	2001201100	1000131002	0300200070
Leucas suffruticosa	0121131110	2311000110	0–00001100	3010220110	0300201070
Leucas urticifolia	20000A0000	0411121110	3002A000–1	L000020100	0312211053
Leucas vestita	01000E1010	140010011A	B000401111	2100021010	03012000E0
Leucas wightiana	2000031100	14A1110110	0–01101101	5000131000	030011012?
Leucas zeylanica	2000021000	140111110A	0–110010–1	2000131000	0301320020

?=unknown; – =inapplicable; Polymorphic taxa are coded with the following symbol: A= (o&1); B= (0&2); C= (0&3); D=(1&2); E= (2&3); F= (0&4); G= (0&2&3); H= (0&1&2); I= (0&1&2&3) J= (0&2&3); K= (1&2&3); L= (4&5); M= (5&6); N= (0&1&2&3&4&5); P= (1&2&3&4&5); Q= (3&4&5); R= (3&4&5&6); S= (3&4); T= (2&3&4); U= (2&3&4&5); V= (all states); X= (4&5&6);Y= (1&2&3&4&5&6); Z=(1&2&3&4). Character states are weighted to give all characters equal total weight. (Character weights are shown at the top, in bold)

Table.: **18.** Character by Taxon Matrix for cladistic analysis.

Results: The length of the most parsimonious tree obtained from the matrix is 1284 with a consistency index (CI) 0.259 and retention index (RI) 0.618. Consensus of the seven most parsimonious trees obtained is shown in tree: 1. followed by consensus of most parsimonious trees and the 1 step longer trees (tree 2), 2 step longer trees (tree 3) and 3 step longer trees (tree 4). *L. ciliata* and *L. nepetaefolia* are removed from the analysis because the *L. ciliata* emerged near *L. vestita* (due to this reason the former is merged with the latter) and *L. nepetaefolia* merged in the large clade of *L. decemdentata, L. lanata, L. biflora* etc.

Leucas ciliata and *Leucas nepetifolia* are removed from the analysis

Length of the most parsimonious trees: 1284
CI: 0.259
RI: 0.618

Consensus of the 7 most parsimonious trees (TREE: 1)

('Leo-nepetaefolia',(anandaraoana,((angularis,pubescens),(biflora,chinensis), decemdentata,deodikarii,lanata,(marrubioides,mukerjiana),montana)),(aequistylosa, nubica),angustissima,aspera,(beddmei,((eriostoma,stelligera),((hirta,(prostrata, sebaldiana)),vestita)),((helianthimifolia,rosmarinifolia,suffruticosa),lancaefolia), lamifolia,stachydiformis),cephalotes,clarkei,diffusa,(hyssopifolia,macrantha), indica,(longifolia,wightiana),martinicensis,neuflizeana,nutans,stricta,urticifolia,zeyla nica)

Consensus of the most parsimonious trees and the 1 step longer trees (TREE: 2)

('Leonotis nepetaefolia',(anandaraoana,((angularis,pubescens),(biflora,chinensis),
decemdentata,deodikarii,lanata,(marrubioides,mukerjiana),montana)),
aequistylosa,angustissima,aspera,beddmei,cephalotes,clarkei,diffusa,
eriostoma,((helianthimifolia,rosmarinifolia,suffruticosa),lancaefolia),
hirta,(hyssopifolia,macrantha),indica,lamifolia,(longifolia,wightiana),
martinicensis,neuflizeana,nubica,nutans,prostrata,sebaldiana,stachydiformis,
stelligera,stricta,urticifolia,vestita,zeylanica)

(TREE: 3)
Consensus of the most parsimonious trees and the up to 2 steps longer trees

('Leo-nepetaefolia',(anandaraoana,(angularis,pubescens),biflora,chinensis,
decemdentata,deodikarii,lanata,marrubioides,montana,mukerjiana),aequistylosa,
angustissima,aspera,beddmei,cephalotes,clarkei,diffusa,eriostoma,
((helianthimifolia,rosmarinifolia,suffruticosa),lancaefolia),hirta,
hyssopifolia,indica,lamifolia,(longifolia,wightiana),macrantha,martinicensis,
neuflizeana,nubica,nutans,prostrata,sebaldiana,stachydiformis,stelligera,stricta,
urticifolia,vestita,zeylanica)

(TREE: 4)
Consensus of the most parsimonious trees and the up to 3 steps longer trees

('Leo-nepetaefolia',(anandaraoana, (angularis,pubescens),biflora,chinensis,
decemdentata,deodikarii,lanata,marrubioides,montana,mukerjiana),
aequistylosa,angustissima,aspera,beddmei,cephalotes,clarkei,diffusa,
eriostoma,((helianthimifolia,rosmarinifolia,suffruticosa),lancaefolia),
hirta,hyssopifolia,indica,lamifolia,longifolia,macrantha,martinicensis,
neuflizeana,nubica,nutans,prostrata,sebaldiana,stachydiformis,stelligera,
stricta,urticifolia,vestita,wightiana,zeylanica)

Bremer support values of the more strongly supported clades that are not collapsed in the last consensus tree:

Large clade of 11 species: 5
angularis-pubescens clade: 4

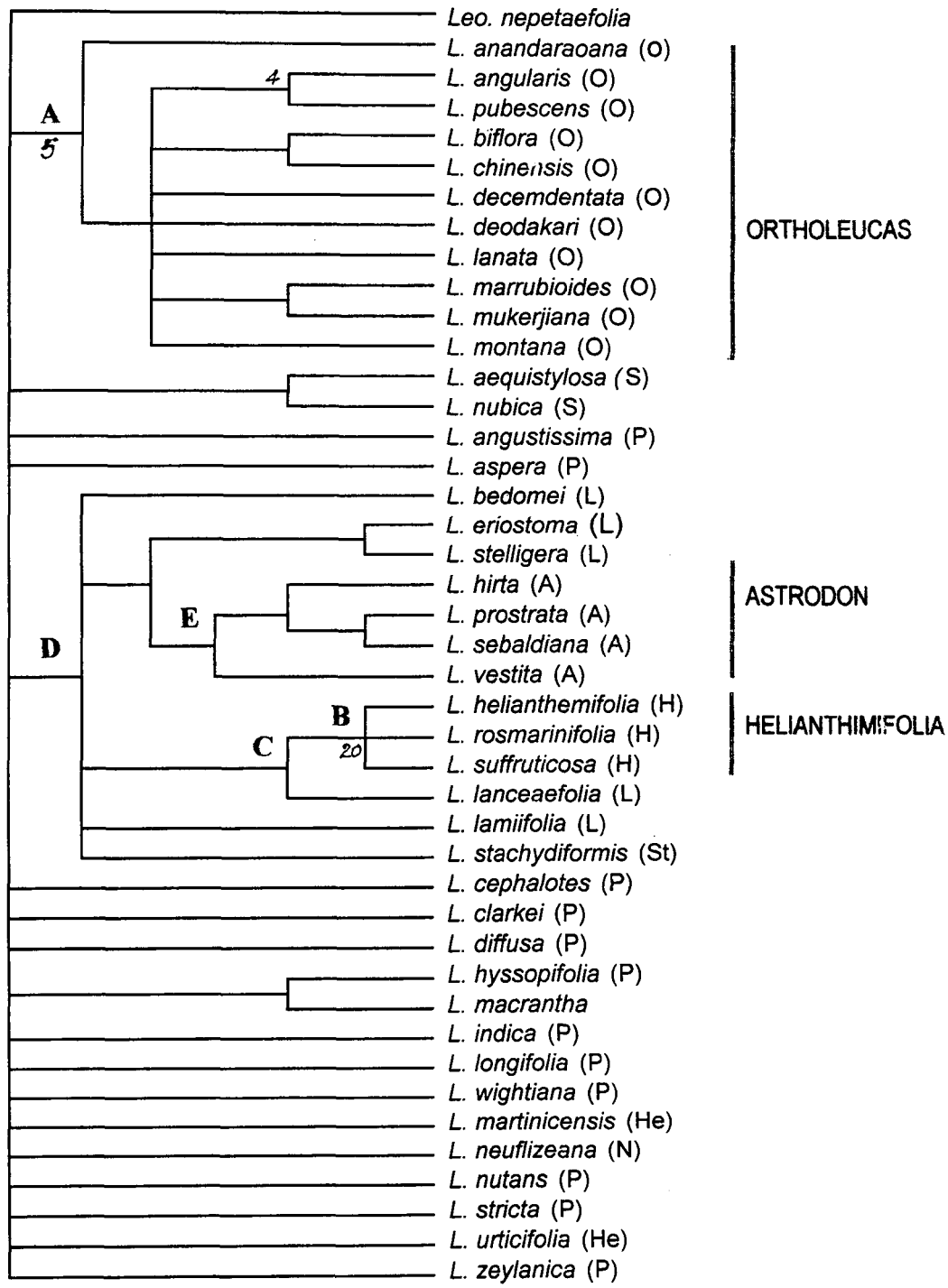
helianthimifolia-rosmarinifolia-suffruticosa-lancaefolia clade: 6
helianthimifolia-rosmarinifolia-suffruticosa clade: 20

In the consensus of the 7 most parsimonious trees, the in-group taxa are divided into 5 main clades viz., (1) clade A: in which all the members of section Ortholeucas form a clade; (2) clade B: all the members of section Helianthimifolia; (3) clade C: members of section Helianthimifolia and *Leucas lanceaefolia* form a clade; (4) clade D: members of sections Helianthimifolia, Lanceaefolia and Astrodon (5) clade E: members of section Astrodon form a clade.

Here, the clades D and E collapse from 1 step longer trees onwards. This reveals the less support for these clades. (less Bremmer support value). The Bremmer support values are calculated from the additional trees (eg: the clade that collapse already in the one step longer trees get the Bremmer support value one. The clade that collapse first in the two step longer trees get the value two etc.)

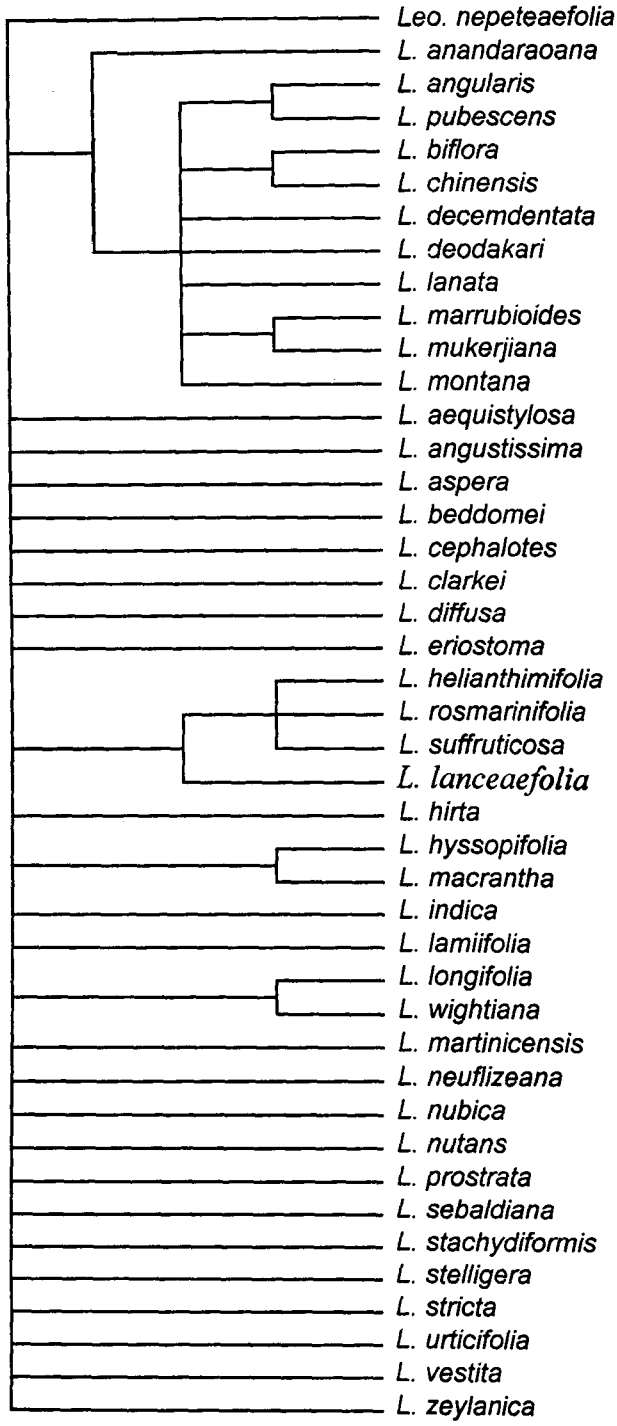
Consensus of the most parsimonious trees: 1284

(CI : 0.259; RI : 0.618)



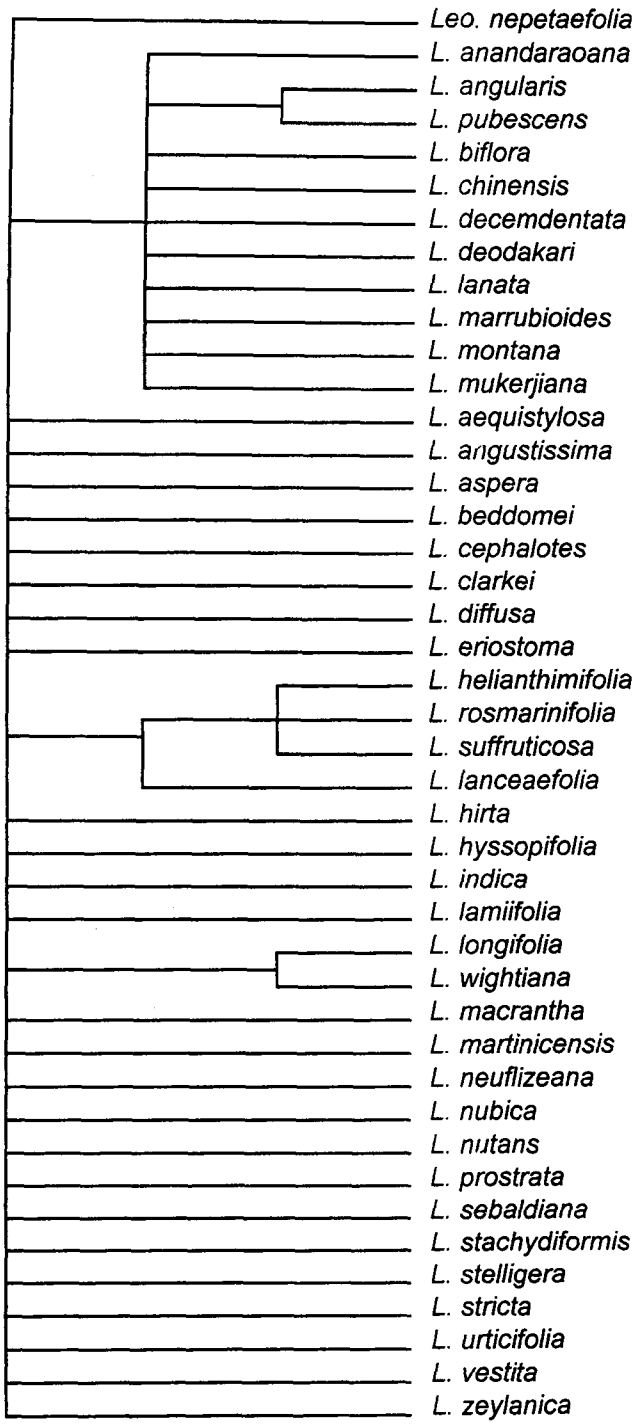
Dendogram 1

Consensus of the most parsimonious trees and the 1 step longer trees



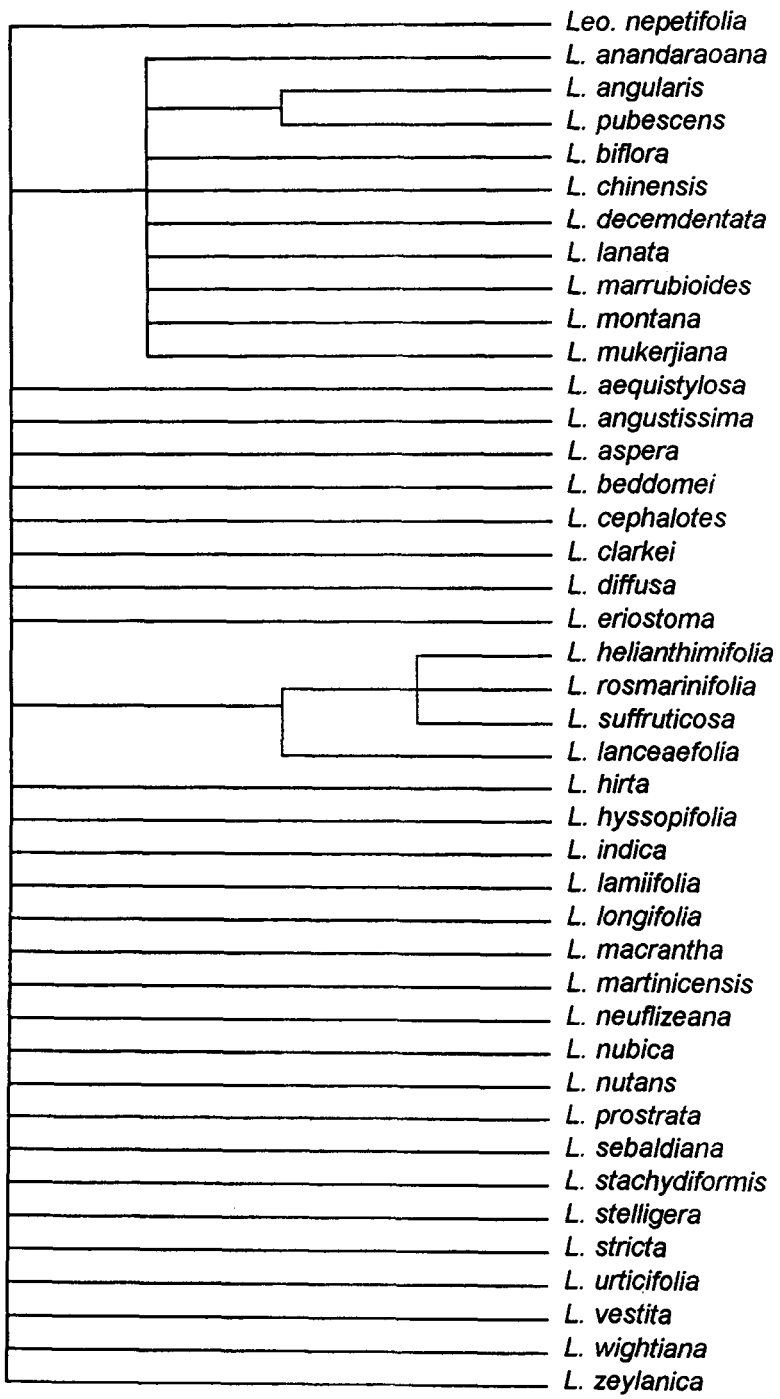
Dendogram 2

Consensus of the most parsimonious trees and the up to 2 step longer trees



Dendogram 3

Consensus of the most parsimonious trees and the up to 3 step longer trees.



Dendogram 4

Even though the pattern obtained in the cladogram of *Leucas* is not satisfactorily explain the evolutionary hierarchy of each taxa, many interesting facts can be interpreted in the pattern. Few explanations can support the difficulties encountered in finding a refined hierarchical pattern among all the species in this analysis. Distinct from African species, Asian species are morphologically similar especially the members of Plagiostoma. Many of the species are distinguished either by autapomorphies (a derived character in a terminal taxon, diagnosis the terminal but is uninformative about the relationship to other terminals) or different combination of characters, which are usually difficult to describe as character states. No good grouping characters (synapomorphies: i.e. apomorphy shared by two or more terminal taxa which diagnosis a clade or monophyletic group) have been found among them. Due to this fact many parallelism are found in the basal part of the tree.

This is particularly true in the case of sect. Plagiostoma, which fails to produce a hierarchy with sect. Hemistoma. This may be because many 'key character' of sect. Hemistoma, which are truly distinct from other sections are not considered elaborately in the analysis. Synapomorphic characters of sect. Hemistoma need to be given more emphasis. Membes of sect. Plagiostoma are annual herbs, may have originated through a process of hybridization or allopolymorphy. Adaptation to same habitats may lose their characters revealing hierarchy.

The nature of largest clade of eleven species reveal a monophyletic origin of this group. All these eleven members are earlier included in the sect. Ortholeucas by Bentham (1848), based on their similarities. Now it is proved an evolutionary background also for this section. All these members share several common and unique characters like quadrangular non-grooved stem, emarginated corolla, filiform bracteoles, ovate leaves, axillary inflorescence etc.

Even within this clade, *L. pubescens* and *L. angularis* have a common ancestor. They share unique character like growth habit and hollow stems. Similar case is noted in the case of *L. biflora* plus *L. chinensis* and *L. marrubioides* plus *L. mukerjiana* relationships. However, in both these two cases, the Bremmer support value is low as both the clades disappear in the 2 and 3 step longer trees.

From the tree obtained here it is clear that *L. helianthimifolia, L. rosmarinifolia* and *L. suffruticosa* form a monophyletic group. This is justified by the high Bremmer support value for this clade in the tree. Creation a new section Helianthimifolia consisting of these three members is justified through phylogenetic analysis. *L. lanceaefolia* also joins this group, may be due to the several parallel character like entire leaves, calyx shape, non-annular corolla tube etc noted in this taxa. Inclusion of these taxa in sect. Helianthimifolia, however cannot be supported when we attribute a different line of evolution of character in this taxon (lack of

homology of character). This is evident when closely observe all such character in *L. lanceaefolia* and members of sect. Helianthimifolia.

Another clade consisting of *L. hirta, L. prostrata, L. sebaldiana* and *L. vestita* underline the importance of restructuring of section Astrodon. Even though this clade disappear from one step longer tree onwards, the unique character noted for these 4 species like, globose many flowered verticillaster, calyx tube and teeth nature, orientation of dense mouth cilia, and the lower lip of corolla being fan shaped all suggest its separation from other species.

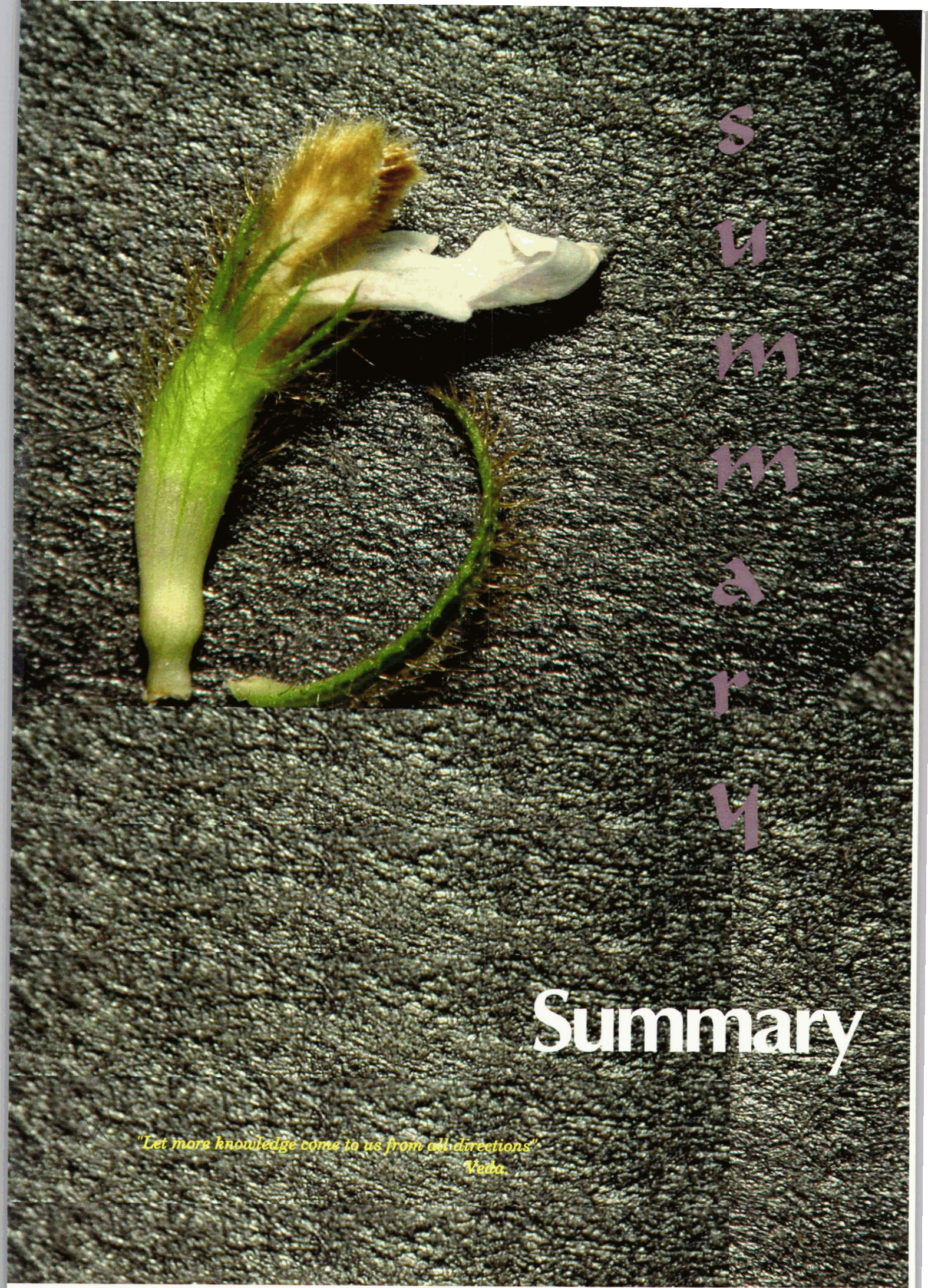
The nature of sect. Lanceaefolia, proposed in this work has not much support from this analysis. Sect. Helianthimifolia, Astrodon and Lanceaefolia (members of Bentham's (1948) sect. Astrodon) together form a large clade. It can be assumed that within this large clade evolution occurred in two different lines and two sister groups formed where as other species like *L. lamiifolia* and *L. beddomei* remain parallel in itself, without much deviation. L. *eriostoma* and *L. stelligea*, having a same evolutionary ancestor also evolved in parallel with sect. Astrodon and sect. Helianthimifolia. The sub-shrubby nature in all the members included in the new sect. Lanceaefolia, however cannot be definitely considered as a parallel evolution, but the nature of morphological similarities in these members suggest all to be

places in a separate section. Hence the section Lancefolia. However an evolutionary support for this section is not available.

Although relationships of sections were not proved clearly, this analysis as a preliminary step to find the nature of relationships in the monophyletic Asian *Leucas* is worth that it forms a basis for further studies. The analysis done here and the result obtained is not satisfactory enough to trace the phylogeny of Asian group. More over on hand analysis of data on a trial and error basis using software is required for comparison of results to reach a conclusion about the relationships. Analysis of relationships within a monophyletic group is rather difficult to trace out. So further splitting of character and use of molecular markers may prove to clear the phylogenetic relationships in Asian *Leucas*.

SUMMARY

P. Sunojkumar “Morphologic and Taxonomic studies of the genus Leucas R.Br. (Lamiaceae) in Southern Peninsular India” Thesis. Department of Botany, University of Calicut, 2005



Summary

"Let more knowledge come to us from all directions"
Veda.

5. SUMMARY

Taxonomic studies of Asian *Leucas* were initiated by Bentham (1830, 1848) as early as two centuries back. His works were mainly based on materials collected by Wallich and Wight from Oriental India. These studies have indicated that Southern Peninsular India has the highest diversity of Leucas species in Asia. After Bentham, following him, Hooker (1885) treated Indian *Leucas* as a part of his monumental Flora of India work.

Even though these two workers treated the species found on a wide geographical area, special attention were given to the species found in South India. Gamble's Flora of Presidency of Madras covers a wide geographical area which include a major part of diversity rich South Indian Peninsula. He had included 31 species of *Leucas* in his work. Following this, a true revision of Indian *Leucas* was successfully attempted by Mukerjee, covering the Indian empire as a whole. He has mentioned 32 species of *Leucas* in South India. Very recently, a revision done as a part of Flora of India work by Singh (2001) included all the recently reported taxa also. This work treated 32 species in South India.

It is important to mention that all these earlier works were based entirely on the dried herbarium sheets already collected by a few pioneering workers and

deposited in various European and Indian herbaria. Recent works by Singh is just based on herbarium deposited in Indian herbaria only.

As opinioned by various workers (Stuessy, 1975; Gentry, 1990), it is a fact that mere herbarium study will not resolve the taxonomy and phylogeny of *Leucas* as these plants have flowers which are very small and delicate and is not well preserved in herbarium materials. Moreover, habit and habitat information, which is important in taxonomic judgement, is not included in any of the earlier works. It is on this context a comprehensive study of the taxonomy of *Leucas* based on field study and fresh specimen is attempted here.

After an extensive and intensive field trips conducted to the nook and corner of South Indian Peninsula, hundreds of living specimens have collected. Careful analysis of morphological characters and comparing the same with the type specimens yield a precise identifiction of taxa at the species level. Altogether, 33 species and 8 varieties have been identified in Southern part of Peninsular India. This include all the species treated in recent (Singh, 2001) works except *Leucas ciliata*, which is reduced to a variety of *Leucas vestita*.

Nature of polymorphism is very high in this genus, in the vegetative character, especially on leaf characters viz. shape, texture, indumentum and petiole length. The nature of *Leucas chinensis* var. *lanata* identified by Hooker has not considered here on the light of polymorphic nature of vegetative characters.

Similarly, due to the same reason, *Leucas montana* var. *wighti,* also identified by Hooker did not consider valid.

Morphology of calyx is the most stable and dependable characters for species identification in *Leucas*. Size and nature of tube, position of bent, nature of obliqueness of mouth, mouth cilia, and teeth structure are characters used in species identification. Following this, nature of bracteoles, and corolla is considered.

Nature of corolla and its taxonomic significance is not clearly available in any of the earlier works. This is probably due to the characters being taken from dried specimen, which do not preserve the features of corolla. Corolla lower lip whether emarginated or fan shaped; attachment of tube whether perpendicular or oblique are characters noticed only in fresh specimens. A comparative morphology of all the species is worked out to reach a conclusion about sectional treatment. The habitat of plants including the nature of forest and surrounding type of vegetation were not available in earlier works. Similarly the true habit of the plant whether annual herb or perennial herb or sub shrub were noted and attributed taxonomic value here. Micro characters of anther lobes and disc lobes including their relative size is considered in taxonomic analysis.

An important gain in this work is the new sectional classification consisting of six sections. Bentham (1848), considered four sections for Asian *Leucas* and his largest section Astrodon is splitted here to include two new sections viz. sect.

Helianthimifolia and sect. Lanceaefolia. Among the 33 species, 8 are included in Plagiostoma, 11 are included in Ortholeucas, 3 in Helianthimifolia, 4 in Astrodon, 5 in Lanceaefolia and the remaining two African species are treated in sect. Hemistoma.

Comparative morphology of all the species treated in Benthams (1948) Astrodon if found to possess micro characters enough to group them into three, and the same is treated as three different sections here. Construction of sect. Helianthimifolia is considered here because of the unique nature of the three species included in this section. These species are perennial herbs with a very thick woody amorphous underground stem on which herbaceous branches produced. The most striking feature is the increased number of leaves (2-4) in a node. Many characters of corolla also are entirely different from that of sect. Lanceaefolia. The erect, sub shrubby form of Lanceaefolia also is different from members of Astrodon. An evolutionary support also for sectional classification is obtained from the cladistic analysis done here. This new sectional classification proposed in this work contradict with that proposed in Singh's (2001) work. Singh's sections has not considered here as there is no natural relationships observed among the different taxa treated in his sections.

Due to the non availability of fresh specimens and the inadequacy of the data available in the protologue, the nature of three species *L. anandaraoana, L. nepetaefolia* and *L. mukerjiana* cannot be reviewed fully but the observation of the

type herbarium revealed its key characters for sections wise consideration. A thorough analysis of character in *L. anandaraoana* and *L. nepetaefolia* is required as they show unique characters (bracteole shape and terete nature of stem) as revealed from the protologue.

Comparative morphology of *Leucas* studied were good enough to differentiate the species found in South India. Matching of collected specimens with type specimens added accuracy in identification. It is also a fact that almost 40% of types mentioned in Singh's (2001) revision is found not correct when true type specimen is collected for this study. It is hope that the elaborate description given and the precise illustration presented here based on camera lucida drawing can help in the easy identification of *Leucas* species found in South India. Photographs of species and varieties provided will also yield easiness in identification.

Pollination study in *Leucas* is not at all attempted so far. A preliminary study of common insect visitors is attempted here identified a number of bees and butterflies. Even though it cannot say precisely that the insects identified here are true pollinators, frequent visit of these insects in a number of species indicate that they may be involved in pollinating *Leucas* species. A thorough study is needed in this sector.

The six sectional classification proposed for *Leucas* species found in Southern Peninsular India, based on comparative morphology is well supported by

the phenograms obtained after Phenetic study of the relationships. The six clusters obtained after cluster analysis indicate six sections with reasonable similarity percentage. Thus phenetic analysis also supports six sectional classification.

It is worth to mention that a clear picture of the phylogeny of Asian monophyletic *Leucas* group may sometime be available if molecular marker based species diversity is analysed through cladistics. The wide variety of species and endemic form point to the fact that South India represents the secondary centre of origin of *Leucas*. All the species and varieties so far reported from South India were considered very comprehensively for this revision completed here.

* * *

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7.1 APPENDIX

INDEX TO BOTANICAL NAMES

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APPENDIX.

7.2 PUBLICATIONS

(1). Sunojkumar, P & P. Mathew 2002. *Leucas beddomei* (Hook. f.) Sunojkumar & P. Mathew (Lamiaceae) a new status and name for *Leucas hirta* var. *beddomei* Hook. f. —a little known endemic from India. *Rheedea* **12(2)**: 169-174.

(2). Sunojkumar, P. 2005. Diversity and phytogeography of the genus Leucas R.Br. (Lamiaceae) with special reference to South Indian Endemics. In: Pandey, A. K., Jun Wen & J. V. V. Dogra (Eds.) Plant Taxonomy: Advances and Relevance. CBS Publishers and Distributors, New Delhi.

(3). Sunojkumar, P. 2005. *Leucas sebaldiana* Sunojkumar (Lamiaceae) –a new species from India. *Candollea*. (Accepted for publication)

7.3 AWARDS WON

(AS PART OF THIS RESEARCH WORK)

National

- "Dr. Rolla S. Rao award" for the best paper presented at the 13th annual conference of IAAT held at T M Bhagalpur University, Bihar on 14 & 15th Nov. 2003.

International

- "Research Grant Award 2005" of International Association for Plant Taxonomy (IAPT), Vienna, Austria. (This award is given to 10 young researchers on global level in consideration of their ongoing Taxonomic research work. It carry $1000 and a certificate from the Secretary General of IAPT.