

**A TAXONOMIC REVISION OF *FINLAYSONIA* and
STREPTOCAULON (PERIPLOCOIDEAE;
APOCYNACEAE)**

by

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CHAPTER 1

1.1 Introduction

The Gentianales, originally described by Jussieu (1789), consist of five families, namely the Apocynaceae, Gelsemiaceae, Gentianaceae, Loganiaceae and Rubiaceae. Several common vegetative, floral and phytochemical characteristics are shared by these families (Angiosperm Phylogeny Group (APG), 1998). The vegetative forms range from small alpine herbs to large, woody, rainforest trees with opposite, entire leaves, often with stipules and colleters. Many ornamentals and economically important trees, such as *Catharanthus* L., *Cinchona* L., *Coffea* L. and *Strychnos* L. (APG, 1998) belong to this group. The Apocynaceae is the second largest family in the Gentianales consisting of 4800 species distributed among 480 genera at present, while the largest family, the Rubiaceae, comprises about 13000 species in 620 genera (APG, 1998).

Delimitation of the Apocynaceae has varied considerably and controversy concerning the status of the family has persisted for many years. This being due to the fact that the Apocynaceae (Apocynoideae) and the Asclepiadaceae (Asclepiadoideae) share more similarities with each other than with the rest of the Gentianales, and in a number of characters there is a gradation from the Apocynaceae to the Asclepiadaceae (Endress, 2001). The Apocynaceae was first described by Jussieu (1789) and he divided the 24 known genera into three unnamed, artificial and therefore, unusable groups. Robert Brown (1810) split the *Asclepideae verae* (Asclepiadaceae) from the *Apocineae* (Apocynaceae) based on characters of the androecium, where pollen of the Asclepiadaceae coalesce into pollinia attached to translators or pollen carriers while the Apocynaceae have single grained pollen and no pollen carriers (Brown, 1810; Endress and Bruyns, 2000; Endress, 2001). Schlechter (1914, 1924) amended Brown's division of the Asclepiadaceae and split the Asclepiadaceae into two families, namely the Asclepiadaceae and Periplocaceae. This division was again based on differences in pollen presentation and transfer, with the Asclepiadaceae presenting pollen in pollinia attached to a clip or corpusculum and the Periplocaceae pollen are grouped in tetrads,

deposited onto a spathulate translator or pollen carrier (Endress and Bruyns, 2000; Endress, 2004). Schlechter's concept of these two families was supported by a number of taxonomists and persisted until the end of the 1900's (Bullock, 1956; Hutchinson, 1973; Dyer, 1975; Kunze, 1993; Liede and Kunze, 1993; Venter and Verhoeven, 1993; Swarupnandan et al., 1996; Omlor, 1996).

The Periplocoideae was established when Brown (1810) divided the Asclepiadaceae into three groups, namely Asclepideae (now the subfamily Asclepiadoideae), the Periploceae (presently the subfamily Periplocoideae) and the genus *Secamone* R.Br. that he did not assign to a formal category (now recognized as representing the subfamily Secamonoideae) (Endress and Bruyns, 2000; Endress, 2001, 2004).

Historically therefore, the Periplocaceae has been treated as a family related to the Asclepiadaceae but after recent re-evaluation of the evidence, it became clear that the Periplocaceae could not be regarded as a separate family (Endress and Bruyns, 2000; Endress, 2001, 2004). The initial separation by Schlechter (1905) was based mainly on the presence/absence of pollinia and translator presentation. Apart from the common morphological characteristics, such as milky latex, flowers with coronas, fruit composed of paired follicles and seed often with a coma of hairs, shared by the Periplocaceae, Asclepiadaceae and Apocynaceae (Verhoeven, Venter and Kotze, 1989), Verhoeven and Venter (1998) determined that several genera/tribes in the Periplocaceae/Periplocoideae possess pollen in pollinia, these being *Atherolepis* Hook.f., *Decalepis* Wight & Arn., *Finlaysonia*, *Gymnantherae* R.Br., *Gongylosperma* King & Gamble; *Hemisdemus* R.Br., *Meladerma* Kerr., *Raphionacme* Harv. (partly), *Stelmacrypton* Baill., *Streptocaulon*, *Streptomanes* K.Schum. and *Utleria* Bedd. ex Benth. Furthermore, Kunze (1993) established that the upper part of the adhesive disc and stalk of the pollen translator in the Periplocaceae is similar to the clip or corpusculum of both the Asclepiadaceae and Secamonoideae. Endress (2001) established the anatomical similarity between the translator stalk in the Periplocoideae to the clip or corpusculum of the Asclepiadaceae and Secamonoideae in cross-section, confirming Kunze's view. The Apocynaceae was historically distinguished from the Periplocaceae and Asclepiadaceae based on the single-grained pollen and absence of

translators in the Apocynaceae. However, a band-like translator is present in both *Apocynum* L. and *Forsteronia* G.Mey. (Apocynoideae, Apocynaceae) that are homologous to those of the Periplocaceae, thus indicating a relationship between the Periplocaceae and the Apocynaceae (Schick, 1982). *Apocynum* also possesses pollen in tetrads (Nilsson et al., 1993). Also, in contrast to Schlechter's amendment of Brown's (1810) division of the Asclepiadaceae, was the evidence from morphological and *rbcL* studies which do not support the monophyly of the Asclepiadaceae and the Periplocaceae, but confirm a close relationship between the Apocynaceae and Periplocaceae (Judd et al., 1994; Sennblad and Bremer, 1996; Endress, 1997; Sennblad, 1997).

Because of the complexity of the flower and especially the androecium-gynoecium complex or gynostegium, the early morphological studies and deductions based on a single or few selected characteristics led to misconceptions and thus unnatural grouping of genera. However, the use of as many characteristics as possible and not placing undue emphasis on one or two easily observable features are most likely to produce natural classifications. Therefore, based on an encompassing morphological investigation, Endress (2001) has established that in a number of characters there is a gradation between the groups/subfamilies of both the Apocynaceae and Asclepiadaceae, with no clear demarcation between these families. Several botanists (Wanntorp, 2007; Civeyrel et al., 1998; Judd et al., 1994) regarded the Apocynaceae as paraphyletic and thus proposed the amalgamation of the Apocynaceae and Asclepiadaceae in order to make the group monophyletic. The combination of the Asclepiadaceae and Apocynaceae to form the all inclusive Apocynaceae *sensu lato*, was also supported by Safwat (1962), Thorne (1992); Takhtajan (1997), Endress (2001) and Venter and Verhoeven (2001).

However, the most compelling evidence for uniting the Apocynaceae and Asclepiadaceae was obtained from detailed and extensive morphological studies as well as the rapidly growing body of molecular information. Data obtained from *rbcL* sequencing showed that the position of the Asclepiadaceae within the Apocynaceae *sensu lato* is well supported and therefore the recommendation of the amalgamation of

the Asclepiadaceae and Apocynaceae was supported (Sennblad and Bremer, 1996, 2000; Endress, 2001, 2004). Today the Apocynaceae *sensu lato* comprises five subfamilies, namely Rauvolfioideae, Apocynoideae, Periplocoideae, Secamonoideae and Asclepiadoideae. However, molecular studies by Potgieter and Albert (2001) do not support the monophyly of the Apocynoideae and Rauvolfioideae as delimited by Endress and Bruyns (2000) but the monophyly of the Asclepiadoideae, Secamonoideae and Periplocoideae, respectively, was supported. The controversy regarding these five subfamilies is clearly not resolved.

The type genus of the Periplocoideae, *Periploca* L., was first described in 1753 by Linnaeus, who placed it in the order Pentandria Digynia. The number of accepted genera in Periplocoideae has changed considerably over the years and is still in flux. Considering the small size of the subfamily, a disproportionately high number of monotypic and ditypic genera were named. This may be due to a variety of factors including the extreme diversity where closely related species may differ greatly in morphology, the undercollection of many taxa, particularly in Asia, resulting in poorly known taxa (Venter and Verhoeven, 1997; Meve and Liede, 2004), and the small, yet highly complex flower, which is extremely difficult to interpret from herbarium material (Ionta and Judd, 2007). In their revision of the Periplocoideae, Venter and Verhoeven (2001) proposed the synonymy of a number of species and genera, most of them monotypic genera from Asia and some new combinations. They finally recognized 181 species in 31 genera.

Two of the larger Asian genera of the Periplocoideae are *Finlaysonia* and *Streptocaulon*. *Finlaysonia* was described by Nathaniel Wallich citing as type species *F. obovata* Wall. in honour of George Finlayson (1790 – 1823) a naturalist and surgeon in the service of the East India Company (Ang et al., 2010). *Streptocaulon* was described by Wight and Arnot (1834), citing *S. kleinii* Wight & Arn. as the type species. Both genera were described from specimens collected in India and Indonesia (Venter and Verhoeven, 1997).

The genera *Finlaysonia* and *Streptocaulon* are very closely related and consist of woody climbers, though two species are shrubs. Both genera are restricted to the Asian subcontinent, with the exception of *Finlaysonia obovata* that is also present, although rare, in the Northern Territory and Cape York Peninsula of Australia (Duke, 2006).

In both genera, several name changes at both generic and species levels have occurred, while some genera and species have been declared synonyms. There is presently uncertainty as to the actual number of species in either of the genera. Initially, according to Venter and Verhoeven (1997) and Klackenberg (1999), *Streptocaulon* consisted of nine species and *Finlaysonia* had eight species, adding the original three species to the *Finlaysonia* synonym *Meladerma* with three species and one species of both *Atheropis* and *Stelmacrypton* (Venter and Verhoeven, 1997). However, according to Venter and Verhoeven (2001) *Streptocaulon* had seven species and they added two more *Streptocaulon* species, but placed two other species in synonymy, thus the total number of *Streptocaulon* species remained nine.

1.2 Aim of study

The African genera of the Periplocoideae were revised by Venter and Verhoeven (2001) and have been the subject of a number of publications, including revisions of *Tacazzea* Decne., *Periploca*, *Raphionacme*, *Schlechterella* K.Schum., *Ectadium* E.Mey., *Baseonema* Schltr. & Rendle and *Batesanthus* N.E.Br. At present, very little work has been done on the Asian periplocoideae.

Taxonomy provides a basic understanding of the components of biodiversity which is necessary for effective decision making about conservation and sustainable use. The knowledge of biodiversity is necessary in order to make decisions on areas or habitats, plant species, genera or families to protect especially against human exploitation and destruction. Sustainable use of natural resources also depends on the knowledge of local biodiversity. In Singapore, for instance, the total area covered by Mangrove forest declined with the dawn of urban development since the 1960s (Hilton and Manning, 1995). This habitat destruction has led to the reduction in *Finlaysonia obovata* numbers

with less than 50 mature individuals left in the wild (Davison, 2008). Taxonomy also provides guidelines for bioprospecting.

Finlaysonia obovata and *Streptocaulon juvenas* are known to contain active compounds with potential medicinal and agricultural applications. Useful but undiscovered compounds may well be present in other species of *Finlaysonia* and *Streptocaulon*.

This study of the genera *Finlaysonia* and *Streptocaulon* forms part of a comprehensive revision of the Asian genera of the Periplocoideae. The aim of this investigation is to identify characteristics for effective delimitation of the genera *Finlaysonia* and *Streptocaulon* as well as their respective species, to correct their nomenclature, to describe their different species, determine phylogenetic relationships, establish distribution patterns and to compile identification keys.

CHAPTER 2

MATERIALS AND METHODS

2.1 Taxonomic treatment

2.1.1 Micromorphology

As no fresh plant material was available, rehydrated samples from herbarium specimens had to be used for the micro-morphological investigation.

2.1.1.1 Leaf epidermal surfaces

Leaf samples were rehydrated in 3% phosphate-buffered glutaraldehyde for 48 hours. Rectangular pieces of these leaves, measuring 3 x 3 mm, were dehydrated in an alcohol series, critically point dried, mounted on aluminium stubs with epoxy glue, painted at the corners with silver paint, sputter coated with gold and examined with a Joel Winsen 6400 electron microscope at 10kv and a working distance of 15 mm. Micrographs of both upper and lower epidermis were taken at magnifications x80, x200, x400 and x600. The epidermal surfaces were described using the terminology of Wilkinson (1979).

2.1.1.2 Seed coat surfaces

Where mature fruit were available on herbarium specimens, dried seeds were collected. The seeds were mounted on aluminium stubs with epoxy glue, painted with silver paint, sputter coated with gold and examined with a Joel Winsen 6400 scanning electron microscope at 5kv and a working distance of 15 mm. Micrographs of both upper and lower seed surfaces were taken at magnifications x80, x100, x200 and x400. Seed coats were described following the terminology of Barthlott (1981) and Boesewinkel and Bouman (1984). An AX 70 Olympus microscope and a CC 12 soft imaging system camera were used to take pictures of whole seeds.

2.1.1.3 Floral morphology

Flowers, where available, were collected from herbarium specimens and rehydrated by heating in a diluted soapy solution. The flowers were then dissected and mounted on specimen cards using herbarium glue. An Olympus SZ-61 Stereomicroscope was used for viewing the flowers and measuring and sketching the floral parts.

2.1.1.4 Pollen morphology

Due to the scarcity of floral material and absence of pollen on most herbarium specimens, pollen morphology was described according to Verhoeven and Venter, (1998). Representing *Finlaysonia* are the species *F. pierrei* (*Atherolepis pierrei* var. *pierrei glabra* Kerr, in Verhoeven and Venter, 1998), *F. obovata* (*F. maritima* Backer ex K. Heyne, in Verhoeven and Venter, 1998), *F. khasiana* (*Stelmacrypton khasianum* (Kurz) Baill., in Verhoeven and Venter, 1998), *F. insularum* (*Meladerma insularum* King & Gamble, in Verhoeven and Venter, 1998) and *Streptocaulon* by *S. juvenas* (*S. griffithii* Hook.f., in Verhoeven and Venter, 1998)) and *S. cumingii* (Turcz.) Vill.

2.1.2 Morphological description

The distribution of *Finlaysonia* and *Streptocaulon* are restricted to Asia. Fifteen species, eight in *Finlaysonia* and seven in *Streptocaulon*, were described. As very little collecting has been done in recent decades, most of the specimens used were older than 50 years, some even older than 100 years. In some species only a few specimens were available which encumbered the investigation. Most of the specimens had very little data about plant habit and ecology. Therefore, morphological descriptions and/or ecological discussion are incomplete in some instances, as indicated. The macromorphological investigation included observations and measurement of the vegetative, floral, fruit and seed characteristics using an Olympus SZ-61 Stereomicroscope.

2.1.3 Typification

All available type material was seen and photographed. Type literature was confirmed for all species and synonyms were declared where applicable. Typification was done in

accordance with the guidelines provided in the International Code of Nomenclature (McNiel et al., 2006). Lectotypes, selected from isotypes or syntypes, were declared where holotypes were not cited by the author or were not known from his collection or could not be located.

2.2 Terminology

2.2.1 Vestiture

Vestiture types and characteristics are described in accordance with the definitions given by Beentje (2010). He defines vestiture as anything on or arising from a plant surface that makes it non-glabrous, such as hairs (indumentum), scales, papillae, glands and warts.

Vestiture types observed in *Finlaysonia* and *Streptocaulon* are described as hispid, hirsute, lanuginose, pilose, pubescent, puberulent, puberulous, scabrid, scabridulous, tomentose and villous (Beentje, 2010).

- ▶ Hispid refers to long stiff hair or bristles, more bristly than hirsute (Fig. 2.2.1 i).
- ▶ Hirsute describes a surface covered in rather course stiff hairs (Fig. 2.2.1 j).
- ▶ Lanuginose (lanate) refers to woolly, long and interwoven hairs (Fig. 2.2.1 e).
- ▶ Lenticellate refers to the presence of lenticels.
- ▶ Pilose refers to short thin hairs (density unspecified) (Fig. 2.2.1 k).
- ▶ Pubescent describes a surface covered with dense fine, short, soft hairs; downy (Fig. 2.2.1 f).
- ▶ Puberulent indicates minutely pubescent, hairs hardly visible to the naked eye (Fig. 2.2.1 a).
- ▶ Puberulous refers to a rather dense covering of very soft, short hairs (Fig. 2.2.1 b).
- ▶ Scabrid indicates rough to the touch, resulting from the presence of minute stiff hairs (Fig. 2.2.1 c). Scabridulous is minutely scabrid.
- ▶ Tomentose describes short soft hairs, somewhat matted (Fig. 2.2.1 g).
- ▶ Verrucose means warty, referring to surfaces covered in little excrescences or bumps (Fig. 2.2.1 d).

► Villose indicates a surface covered with long, soft, weak straggly hairs (Fig. 2.2.1 h).

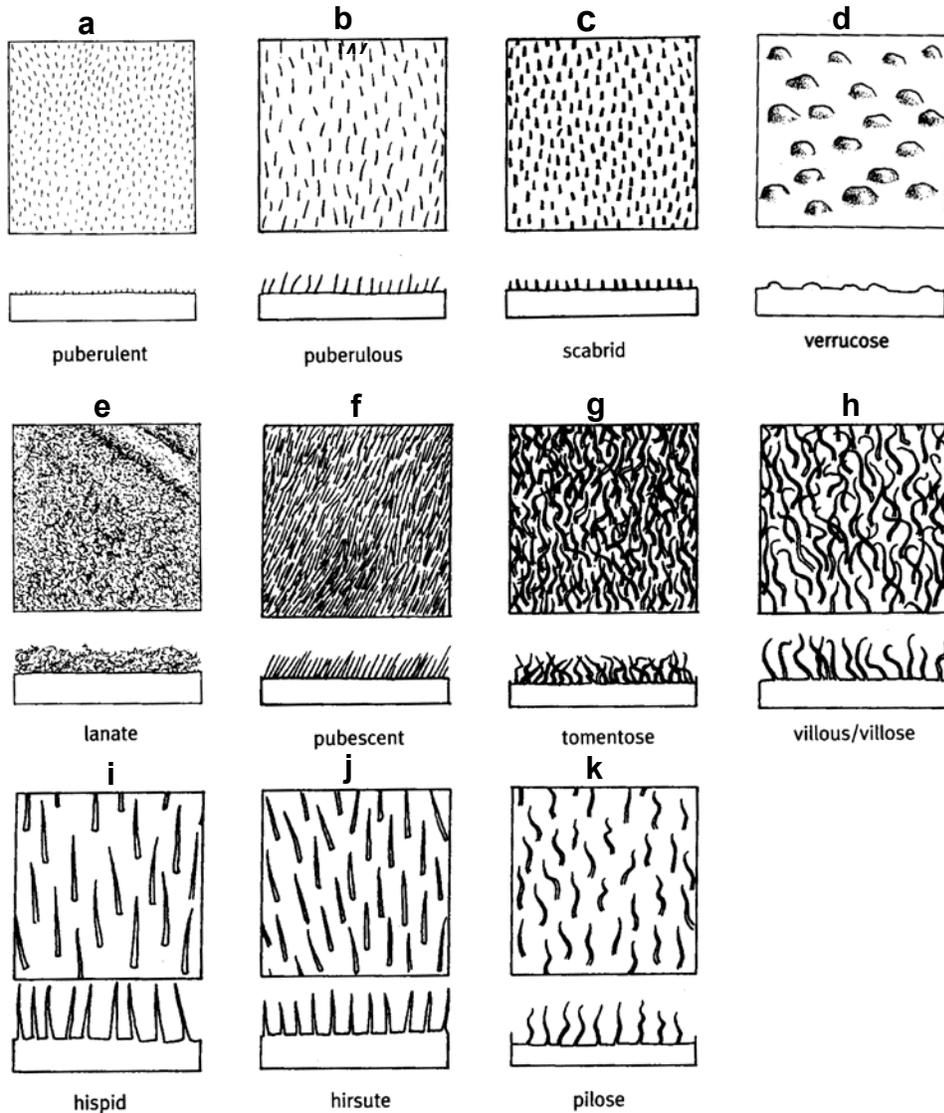


Fig. 2.2.1 Types of vestitures in *Finlaysonia* and *Streptocaulon* (From Beentje (2010)).

2.2.2 Leaf venation

Veins on leaves are differentiated in terms of size. The single, primary vein (or main vein, midrib) is the thickest of all the veins and occurs in the centre of the leaf from apex to base. The secondary veins (lateral veins) are the next size class that branch off from the primary vein. Different venation types are the result of the growth behaviour and

orientation of the secondary veins. The next order of branches from the secondary veins are the tertiary veins. Arrangement of the tertiary veins is termed percurrent if the tertiary veins from opposite secondary veins join. The quaternary veins are the next finer order of veins branching from the tertiary veins (Hickey, 1979). The tertiary and quaternary veins are termed higher order venation in this study (Fig. 2.2.2 a)

The leaf venation type in *Finlaysonia* and *Streptocaulon* is camptodromous as identified from Hickey (1979). Camptodromous venation is defined by secondary veins that do not terminate at the leaf margin. This venation type is subdivided into brochidodromous and eucamptodromous. The brochidodromous type is characteristic of the leaves of these two genera, while the eucamptodromous type only occurs in a few species. When secondary veins become upturned at the tips, connecting to the superadjacent secondaries to form prominent marginal loops it is termed brochidodromous (Fig. 2.2.2 b), while in the eucamptodromous type secondary veins become upturned and gradually diminish apically inside the margin, connecting to the superadjacent secondaries by a series of cross veins without forming prominent marginal loops (Hickey, 1979) (Fig. 2.2.2 c).

The orientation of the lateral veins in *Finlaysonia* and *Streptocaulon* could be described as arched, divaricate or patent. Lateral veins are regarded as arched when the angle between lateral veins and main vein is less than 45° (Fig. 2.2.2 d), divaricate when the angle is more than 45° but less than 90° (Fig. 2.2.2 e) and patent when the angle is about 90° (Fig. 2.2.2 f).

Areoles are the smallest areas of the leaf tissue surrounded by veins, which taken together, form a continuous field over most of the leaf surface. Veinlets are the freely ending veins found inside the areoles (Fig. 2.2.3 a–f). There are different developmental phases of the areoles. When the areoles are well developed, they have meshes of relatively consistent size and shape (Fig. 2.2.3 j), imperfect if they have meshes of irregular shape, more or less variable in size (Fig. 2.2.3 i), incomplete if the closed meshes has one or more sides of the mesh not bounded by a vein, giving rise to anomalously large meshes of highly irregular shape (Fig. 2.2.3 h) and areolation lacking (Fig. 2.2.3 g).

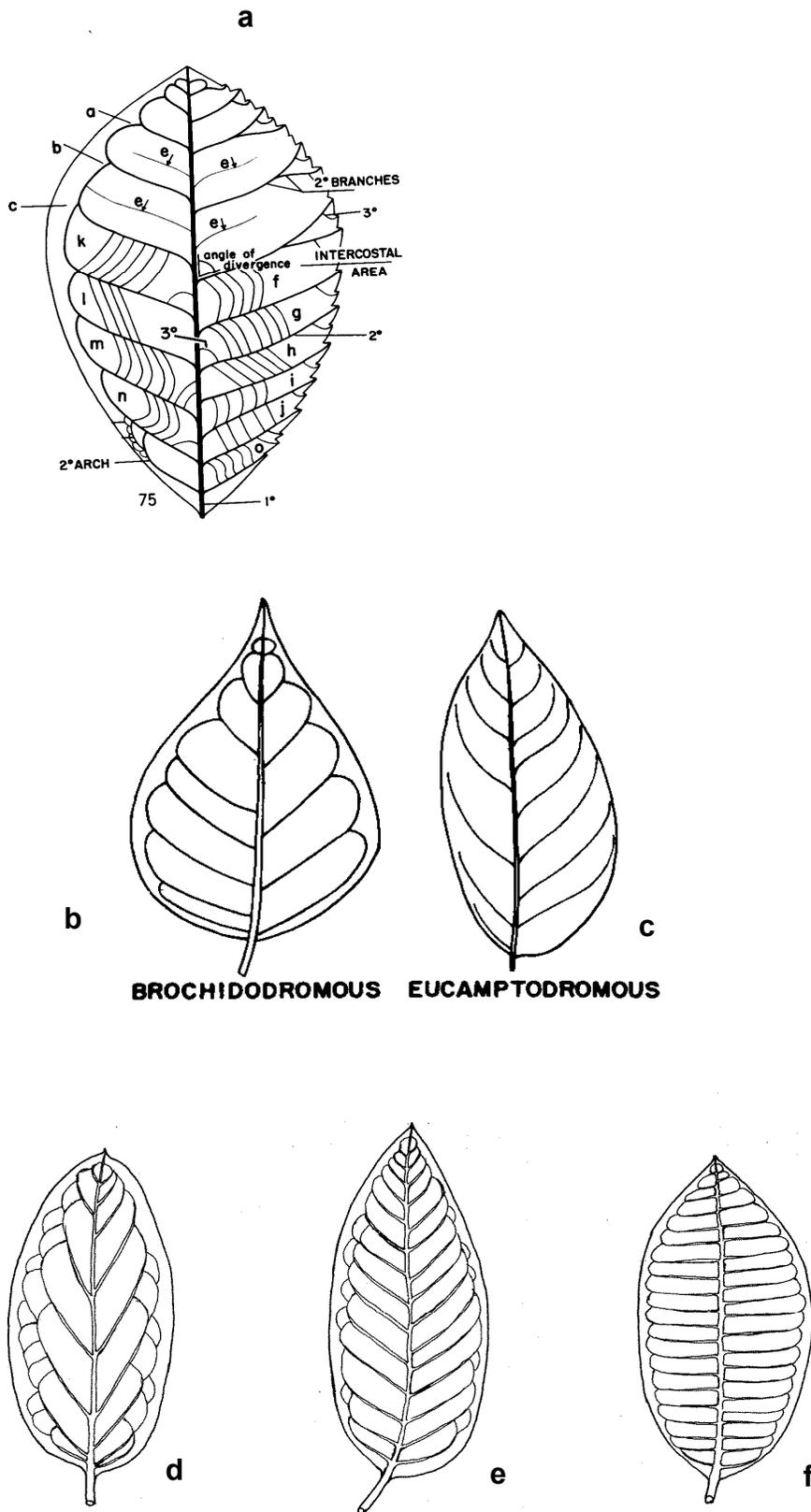
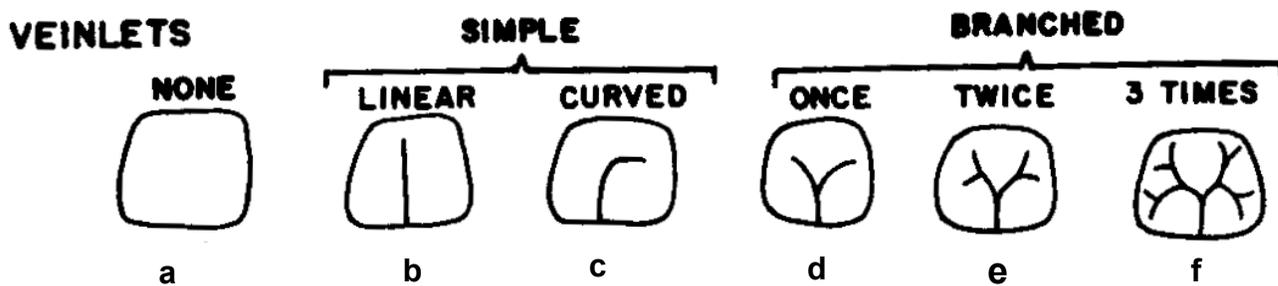


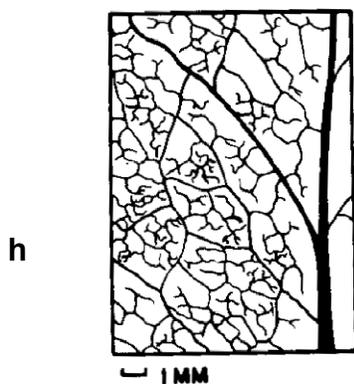
Fig. 2.2.2 Leaf architectural features: a: order of venation, b–c: types of venation, d–f: orientation of lateral veins (a–f: From Hickey (1979)).



AREOLE DEVELOPMENT



LACKING



INCOMPLETE

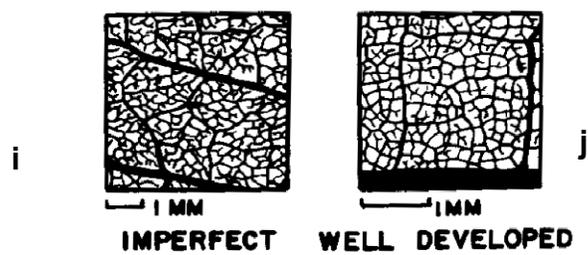


Fig. 2.2.3 Leaf architectural features: a–f: veinlets, g–j: areole development (a–j: From Hickey (1979)).

2.2.3 Colleters

The term “colleter” is derived from a Greek word ‘colla’ meaning glue, referring to their sticky secretions (Hanstein, 1848). Thus, colleters in general term refers to secretory structures (Thomas, 1991). These secretory structures have had various interpretations based on position and structural or morphological identity with other secretory structures, such as nectaries. Colleters are therefore identified based on morphology. In the Apocynaceae colleters are of the standard type, consisting of a multicellular stalk of varying length and a head composed of a central core of parenchyma cells surrounded by radially elongated epithelial cells (Thomas and Dave, 1991). Colleters in the Apocynaceae are found on the adaxial side of petiole, bract, bracteole, calyx and corolla and are usually associated with petiolar hairs (Thomas, 1991). Dave and Patel (1975) associated colleters with nectaries because of a superficial similarity regarding distribution pattern, early appearance and structure. Thomas and Dave (1991) found that colleters did not function as nectaries, are considered as multicellular secretory structures that secrete a mucilaginous or resinous substance which covers and protects developing meristems.

2.2.4 Inflorescence

The periplocoideae inflorescence is cymose. The cyme may be a simple or compound dichasium, or a simple monochasium but mostly the periplocoideae cyme consists of a simple or compound dichasium with monochasial branches. Inflorescences are termed open when flowers are spread out on longer pedicels, but where the flowers are closely grouped the inflorescence is called compact. Bracts occur at every branching point in the inflorescence and along the length of peduncles, these being opposite on dischasial peduncles, alternate or clustered on monochasial peduncles and rarely opposite on monochasial peduncles.

2.2.5 Structural terminology of the flower

The Periplocoideae flower exhibits complex and specialized features as part of a particular pollination syndrome. The complexity of the flower, coupled with its morphological variation and intricate pattern of unique character combinations led to a special terminology to accurately describe these features.

A generalised structure of the flower of *Finlaysonia* and *Streptocaulon* is shown in Fig. 2.2.4. The corolla consists of a bowl-shaped corolla tube inverted at the apex with lobes spreading or reflexed. In both genera only a single corona, the lower or primary corona, is present. The corona consists of 5 lobes, alternating with corolla lobes, and inserted on the inversion of the corolla tube. Each corona lobe is differentiated into a foot (base) and upper segment. The coronal feet are fused with the staminal filament bases (Fig. 2.2.5 a) and the interstaminal nectaries, together forming a coronal annulus on the corolla tube inversion. Vertical pollinator guide chutes occur between the stamens, each chute directly above a shelf-like nectary.

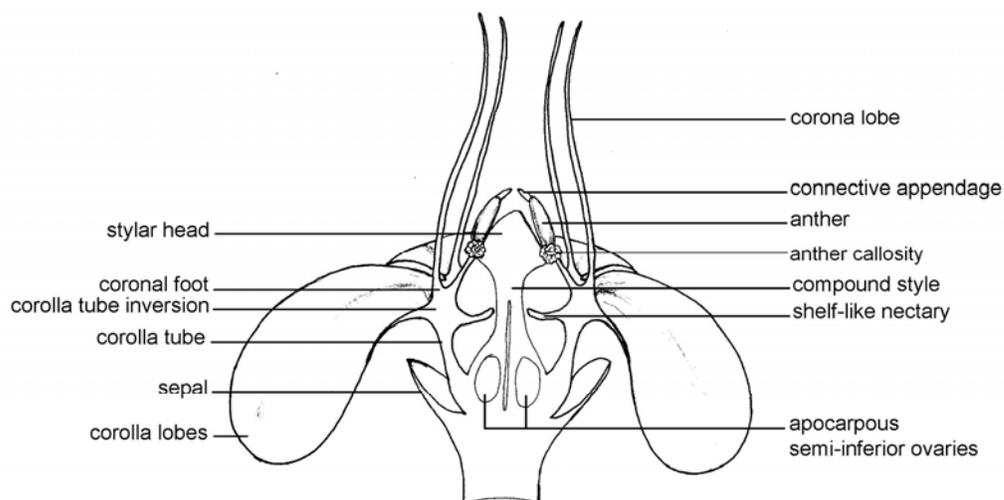


Fig. 2.2.4 Diagrammatic longitudinal section representing a generalised flower of *Finlaysonia* and *Streptocaulon*.

Each anther consists of two thecae combined by a connective between. The connective tissue between the thecae culminates apically in a connective appendage, variously shaped in the different species. Each theca carries a number of pollen tetrads, fused

into two pollinia, thus, four pollinia per anther. Basal callosities of white spongy tissue are present at the bases of thecae in some species. Anthers are fused to the stylar head (Fig. 2.2.5 b) via their inner bases or callosities to form a gynostegium.

The gynoecium consists of two apocarpous, half-inferior, many-ovuled ovaries (Fig. 2.2.5 b and c). The two styles are fused into a compound style, which apically dilates into the stylar head (style-head or stigmatic head). Translators are secreted on the upper surface of the stylar head (Fig. 2.2.5 c). A translator consists of a receptacle (spoon), stype (stalk) and viscidium (sticky disc). The receptacle can be variously shaped, such as ovate, broadly ovate, elliptic or broadly elliptic. Four pollinia are shed onto the receptacle, two pollinia from each adjacent anther theca. Interstaminal nectaries occur at the base of corolla tube inversion, fused laterally with the coronal feet and staminal filaments, and are shelf-like with raised rims pressing against the style.

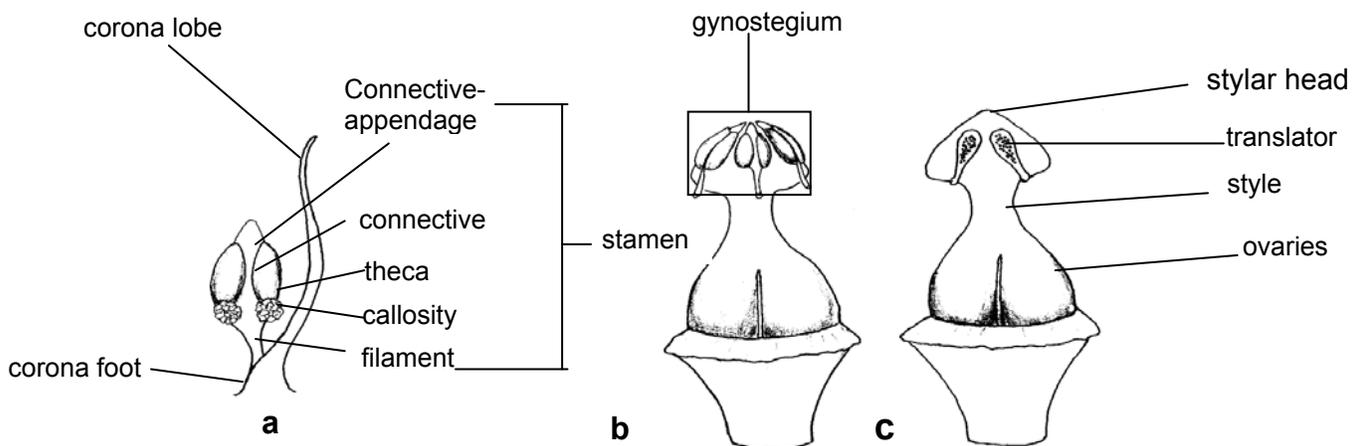


Fig. 2.2.5 Parts of flower (a) showing fusion of stamen and corona (b) showing semi-inferior ovaries; fused style with stamens fused to and connivent over stylar head; (c) showing pistil and translators on stylar head.

2.3 References

The following additional literature was used in the species descriptions:

- Nomenclature citations and designation of types were done in accordance with the International Code of Botanical Nomenclature (McNiel et al., 2006).
- Spelling and abbreviations of author names followed Brummitt and Powell (1976).
- Spelling and abbreviations of taxonomic literature as in Stafleu and Cowan (1976).
- Herbaria acronyms cited as in Holmgren et al. (1990).
- Leaf shape descriptions followed the Systematic Association Committee for Descriptive Biological Terminology (1962), Lawrence (1951) and Beentje (2010).

Specimens from the following herbaria were examined:

- ABD – Herbarium, Plant and Soil Science Department, University of Aberdeen, Aberdeen, Scotland, United Kingdom.
- BM – Herbarium, Botany Department, The Natural History Museum, London, United Kingdom.
- BRI – Queensland Herbarium, Department of Primary Industries, Queensland, Australia.
- E – Herbarium, Royal Botanic Garden, Edinburgh, Scotland, United Kingdom.
- K – Herbarium, Royal Botanic Gardens, Kew, Richmond, England, United Kingdom.
- K-W – Herbarium of the Honourable East India Company [“Wallich Collection”], Herbarium, Royal Botanic Gardens, Kew, Richmond, England, United Kingdom.
- L – Rijksherbarium, Leiden, Netherlands.

- MO –Herbarium, Missouri Botanical Garden, Saint Louis, Missouri, U.S.A.
- P – Herbier, Laboratoire de phanerogamie, Museum National d,Histoire Naturelle, Paris, France.
- SINU – Herbarium, Botany Department, National University of Singapore, Singapore.
- Pencil drawings on certain specimens in P and K were used (permission granted).

2.4 Mapping

Maps were drawn using DIVA V.5.2.0.2 (Hijmans et al., 2005) after the data was imported from the database created in BRAHMS V.6.50. Coordinates were determined using The Atlas of the World (1985) and Google Earth 6.2.2.6613 (www.google.com/earth/index.html). In cases where locality names have changed, the most recent names are given in brackets.

2.5 Format of referencing

Referencing in the text and reference list follows for the most part the instructions of the South African Journal of Botany for taxonomic papers. References in the reference list are arranged in alphabetical order and then in chronological order. Where an author has published more than one paper in the same year, small alphabetical letters are used to indicate the various papers. If the same author published on his own as well as first author with co-authors, the single authored papers appear first in the reference list, followed by the co-authored papers.

2.6 Phylogenetic treatment

Morphological characteristics from vegetative parts, flowers and fruit of the 15 species were used for the phylogenetic analysis. Data were collected from herbarium specimens only. The initial matrix comprised 59 characters, both macro- and micro-morphological

(Appendix 1, Table 6.2, p. 251). A second matrix, comprising 38 characters, resulted after characters with a homoplasy index of less than 0.5 were eliminated (Appendix 2, Table 6.3, p. 256). The choice of outgroup, *Raphionacme brownii* Harv., was based on the phylogenetic analysis of the Periplocoideae by Ionta and Judd (2007). *Raphionacme* forms part of the “Grooved translator clade” and of the clade sister to the “Asian clade” which includes *Finlaysonia* and *Streptocaulon*. A second outgroup, *Cryptolepis buchananii* Roem. & Schult., from the clade sister to the “Grooved translator clade” was included in one analysis. The characteristics of *Raphionacme brownii* were adopted from Verhoeven and Venter (1997) and Venter (2009).

The matrices were generated in Mesquite Version 2.75 (Maddison and Maddison, 2011) while the cladistical analysis was performed using PAUP* 4.0 beta version 10 (Phylogenetic Analysis Using Parsimony) (Swofford, 2002). Heuristic searches were performed on both matrices with all characters given unit weight (Fitch parsimony, Fitch, 1971). The following settings were used for all the searches: maximum trees 10 000, characters were coded to be unordered, in effect for the trees was TBR (Tree Bisection/Reconstruction), MulTrees (Multiple trees) and Steepest Descent, holding 2 trees at each step.

Bootstrap percentages (Felsenstein, 1985) were calculated performing 1000 replicates for each matrix. Values above 75% were regarded as strong support, 60% to 74% as moderate support and below 60% as unacceptable.

CHAPTER 3

PERIPLOCOIDEAE

3.1 Introduction

The Periplocoideae is an old-World taxon that probably originated in Africa before the split of the southern continents. This would have facilitated migration to Madagascar (Venter and Verhoeven, 1997). The Asian Periplocoideae probably migrated from Africa via the European/Arabian contact zone during a wetter period. Possible long-distance dispersal may have played a role in the history of the sub-family. The restriction of the Periplocoideae to the Old-World, that is Africa, Madagascar, Europe, Asia and Australia, supports this view (Venter, 1997).

The Periplocoideae are widely distributed and grow in a wide range of environments. Members occur in tropical and subtropical regions, growing in tropical evergreen rainforest, tropical seasonal (monsoon) rainforest and swamps, woodlands, grassland, desert and semi-desert (Venter and Verhoeven, 1997). Although widely distributed in Africa, the Periplocoideae is completely absent from the southern winter rainfall region or Cape Floristic kingdom of South Africa. However, a few species like *Periploca angustifolia* Labill. and *P. gracilis* Boiss. occur in the winter rainfall region of the Mediterranean macchia of North Africa and southern Europe (Venter and Verhoeven, 2001).

The Periplocoideae is the second smallest subfamily in the Apocynaceae. Within the subfamily, the largest genus is *Raphionacme* Harv. comprising of 36 species and 2 subspecies, followed by *Cryptolepis* R.Br. (30 species), *Pentopetia* Decne. (23 species), *Periploca* L. (13 species), *Camptocarpus* Decne. (9 species) and *Streptocaulon* (9 species) (Klackenbergh, 1999; Venter and Verhoeven 1997). The largest number of genera, namely 19, occur in Africa (61%), followed by Asia with 11 (35%), Madagascar with 5 (16%), Europe with 1 (3%) and Australia with 1 (3%) (Venter and Verhoeven, 1997, 2001).

3.2 Vegetative and floral morphology

The majority of the Periplocoideae genera and species are woody climbers, some very large (*Mondia* Skeels., *Myriopteron* Griff. and *Tacazzea* Decne.). Some occur as erect or straggling shrubs (*Sacleuxia* Bail. and *Ischnolepis* Jump & H.Perrier) or herbaceous geophytes (*Raphionacme*) and epiphytes (*Epistemma* D.V.Field & J.B.Hall. and *Sarcorrhiza* Bullock) (Venter and Verhoeven, 1997, 2001). Periplocoideae never form a dominant part of the vegetation but usually occur as single plants, although large lianas can be very conspicuous (Venter and Verhoeven, 2001).

The flowers of the Periplocoideae are complex and adapted to animal pollination as indicated by the presence of a colourful corolla and corona, nectaries, a gynostegium resulting from the fusion of stamens and styler head, and translators for the distribution of pollen which are borne in tetrads or pollinia (Venter and Verhoeven, 2001). According to Venter and Verhoeven (1997) the flower with its complexity, morphological variation and intricate pattern of unique character combinations, has been of taxonomic importance for the delimitation of genera within the Periplocoideae. Numerous botanists have studied and contributed in some way to the understanding of the subfamily, delimitation of genera and species, and relationships. Linnaeus (1754) described *Periploca* L. the type genus of the Periplocoideae, citing filiform corona lobes and hairy anthers as distinguishing characteristics. Since then, different taxonomists have added other distinguishing characters. Brown (1810) used the distinctness of the corolla tube, position and shape of the corona lobes and presence or absence of hairs on the stamens. Bentham (1876) considered the composition of the inflorescence, corolla shape, number of corona lobes, position and fusion of the stamens, pollen type and vegetative form of importance. Other distinguishing characters of taxonomic importance proposed by Brown (1902, 1907) included venation of the corolla lobes, variation in the length of the upper corolla tube, absence or presence of interstaminal discs or scales (inner or secondary corona/nectaries) and apical appendages. Shape of the corolla and corona as well as vegetative characteristics were important to Hutchinson and Dalziel (1963) and Bullock (1954, 1962). Venter and Verhoeven (2001) regarded the presence of a corolline corona, corona-like nectaries, fusion of the stamens and styler head into a

gynostegium, and pollen borne in tetrads or pollinia that are shed onto translators as important taxonomic features in the Periplocoideae. They used these distinctive characters to describe the genera within the Periplocoideae.

3.3 Micromorphology

3.3.1 Leaf epidermal surfaces

The epidermis constitutes the outermost cell layer of plants hence leaf epidermal characteristics are readily observable. Functionally and morphologically the epidermal cell characteristics are not uniform, being under strong gene control with little influence by the environment (Barthlott, 1981). This is why leaf surfaces have been the subject of more investigations than other plant surfaces and since many of the variable features are constant within taxa, they often have taxonomic applications (Rudal, 1987). Different epidermal characteristics are of value at different taxonomic levels. Barthlott (1981) regards cuticular striations, epicuticular wax and cell shape as mainly useful at lower taxonomic levels, while secondary wall thickenings are useful in determining relationships at higher taxonomic levels. The epidermal cell characteristics that were investigated in this study of *Finlaysonia* and *Streptocaulon* include primary sculpture, relief of surface or secondary sculpture caused by cuticular striations and epicuticular secretions or tertiary sculpture caused by waxes and related substances.

Primary sculpture of epidermal cells is the result of several characteristics including the outline of the cells, anticlinal wall patterns, relief of the cell boundaries and curvature of the periclinal walls (Barthlott, 1981). Adedeji et al. (2007) used the anticlinal wall pattern on the adaxial surface of the leaf to separate species within the genera of the *Solanaceae*. In the taxonomic study of *Cryptolepis*, Joubert (2007) found the epidermal cell shape, periclinal and anticlinal wall shape useful to delimit species within the genus.

Secondary sculpture or relief of surface is the result of cuticular striations, filiform and reticulate folding, ridges and wrinkles. Striation can be described in terms of length, orientation, pattern and distribution of the striations (Wilkinson, 1979).

Tertiary sculpture, which is caused by waxes and other related substances, could be family or genus specific and hence, are valuable diagnostic characters (Barthlott, 1981). However, the micro-morphology of epicuticular secretions is influenced to some extent by environmental conditions. In older leaves the secretions may be eroded and completely disappear (Barthlott, 1981).

Trichomes are another useful epidermal characteristic and are frequently present, easily observable and are diverse in appearance and occurrence. The usefulness of trichomes in delimiting taxa involves their presence/absence, type, structure and distribution. Rao and Ramayya (1977) used the structure and distribution of trichomes to separate two species of *Malvastrum* in India. Inamder et al. (1990) also reported on the structure, ontogeny, organographic distribution and taxonomic significance of trichomes in the *Curcubitaceae*.

Other useful characters are stomatal features which, according to Wilkinson (1979) are taxonomically valuable in several families. Stomatal characteristics include distribution and arrangement, shape and arrangement of subsidiary cells, shape of the guard cells and stomatal ledge, and stomatal size.

3.3.2 Seed coat surfaces

Seeds as the reproductive units of flowering plants are present in all species. The diversity of seed structure evolved under different environmental pressures and often proves to be of taxonomic value (Boesewinkel and Bouman, 1984). Brisson and Peterson (1976) are of the opinion that when seeds of the same developmental stage are studied, coupled with the fact that seed coat characteristics are stable during long periods of storage, they become reliable tools for resolving taxonomic problems. The value of seed coat characteristics for taxonomic studies further increases because seeds are easily prepared for SEM studies as no complicated procedures are involved. However, the value of seed surface characteristics alone is usually limited unless used in combination with other characteristics (Brisson and Peterson, 1976).

In the Periplocoideae, seed coat surfaces have received little attention. The only taxonomic publications containing data on seed characteristics are the taxonomic account of *Stomatostemma* N.E.Br. by Venter and Verhoeven (1993) and the taxonomic revision of South African species of *Cryotolepis* R.Br. by Joubert (2007).

The four seed coat characteristics investigated in this study are cellular arrangement, shape of cells (primary sculpture), fine relief of the cell wall (secondary sculpture) and epicuticular secretions (tertiary sculpture) (Barthlott, 1981).

The arrangement of epidermal cells is usually of minor taxonomic value, but could be of systematic significance, usually in distinguishing taxa at species and genus levels. Cellular arrangement may not be visible by SEM, but can easily be analyzed where different types of cells are interspersed to form a supercellular pattern (Barthlott, 1981).

Primary sculpture is the most significant characteristic of the seed coat surface. Characteristics of the primary sculpture, according to Barthlott (1981), include the outline of cells, anticlinal wall shape, relief of cell boundary and curvature of outer periclinal walls.

Secondary sculpture includes striate, reticulate, smooth or micropapillate surfaces which may result from cuticular sculpture, secondary wall thickening or subcuticular or cuticular inclusions (Boesewinkel and Bouman, 1984). The characteristics of striations that are taxonomically useful include length, orientation, pattern and distribution of striations (Wilkinson, 1979).

Tertiary sculpture results from epicuticular secretions such as waxes which rarely occur in seeds and are usually of little taxonomic value (Boesewinkel and Bouman, 1984). This might probably be due to the fact that epicuticular secretions are influenced to some extent by environmental conditions and are also eroded with ageing and eventually disappear, and for taxonomic research, invariably, mature and dry seeds are used for studying their coat characteristics.

3.3.3 Translators and pollen

Historically, Brown (1810) included the Periploceae (Periplocoideae), Asclepiadeae (Asclepiadoideae) and *Secamone* (Secamonoideae) in the Asclepiadaceae on the basis of morphological similarities, namely the presence of translators.

In the Periplocoideae flower 5 pollen translators are secreted on the upper style-head surface, in positions that alternate with the staminal anthers surrounding the style-head. A translator is uniquely spatulate in shape (spoon-shaped) consisting of a receptacle (spoon), stype (stalk) and viscidium (sticky disc). The stype or stalk that connects the receptacle and the adhesive disc is usually easily distinguishable from the spoon, although the transition may be very gradual in some taxa, making the two parts indistinguishable (Venter and Verhoeven, 1997).

Pollen of the Periplocoideae occurs as tetrads where four pollen grains are fused together or pollinia where all the pollen grains of an anther theca are fused in two more or less oblong elliptic bodies. At anthesis pollen tetrads from adjacent anther thecae are shed onto the translator receptacle where the tetrads adhere. The viscidium is positioned in such a way on the style-head margin that it will come in contact with a visiting pollinator reaching for nectar in the corolla tube (personal observation). When touched the viscidium adheres to the pollinator's head or proboscis and the whole translator with its load of pollen is thus pulled out from between the anthers and transported to another flower where the pollen may rub off onto the receptive lower surface of the style-head.

Classically, the Periplocoideae were distinguished from the Secamonoideae and Asclepiadoideae by the occurrence of pollen in tetrads, in contrast to the latter two subfamilies that bear pollen in pollinia. However, recent studies revealed that a number of Periplocoideae genera (five of the twenty-one Asian genera and two of the African genera) also possess pollinia (Verhoeven and Venter, 1998; Ionta and Judd, 2007). Thus, the Periplocoideae is unique in having taxa both with and without pollinia (Ionta and Judd, 2007). Apart from the pollinia being shed onto a translator at anthesis in the Periplocoideae as opposed to the pollinia forming part of the translator structure in the

Asclepiadoideae and Secamonoideae, pollinia in the Periplocoideae lack the pollinium wall (ectexine) of Asclepiadoideae and Secamonoideae, and the tetrads that form a pollinium are only loosely agglutinated (Ionta and Judd, 2007).

A pollinium consists of the contents of one microsporangium (pollen sac), forming one pollen-unit according to Verhoeven and Venter (1994, 1998). The pollinium features they investigated and described are pollinium shape, size, distal walls (exine and granular strata), proximal walls (exine and granular strata) and inner walls (granular strata and intine). The distal walls of the tetrads face towards the outside (circumference) of the pollinium; the proximal walls separate tetrads on the inside of the pollinium; the inner walls separate individual pollen grains of a tetrad (Fig. 3.1.1) (Verhoeven and Venter, 1994).

Palynological data is clearly of value in differentiating between subfamilies of the Apocynaceae and give some indication of the phylogenetic relationships of the subfamilies, as well as relationships of genera and species within the subfamilies (Schill and Jäkel, 1978; Endress et al., 1990; Kunze, 1993; Venter and Verhoeven, 2001; Joubert, 2007). Walker and Doyle (1975) listed the pollen unit, pollen apertures and pollen wall architecture to be of taxonomic systemic value in the Apocynaceae, as well as the pollen carrier (translator). However, at genus and species levels, palynological characteristics show a high level of homogeneity and as a result are of little taxonomic importance (Verhoeven and Venter, 1993).

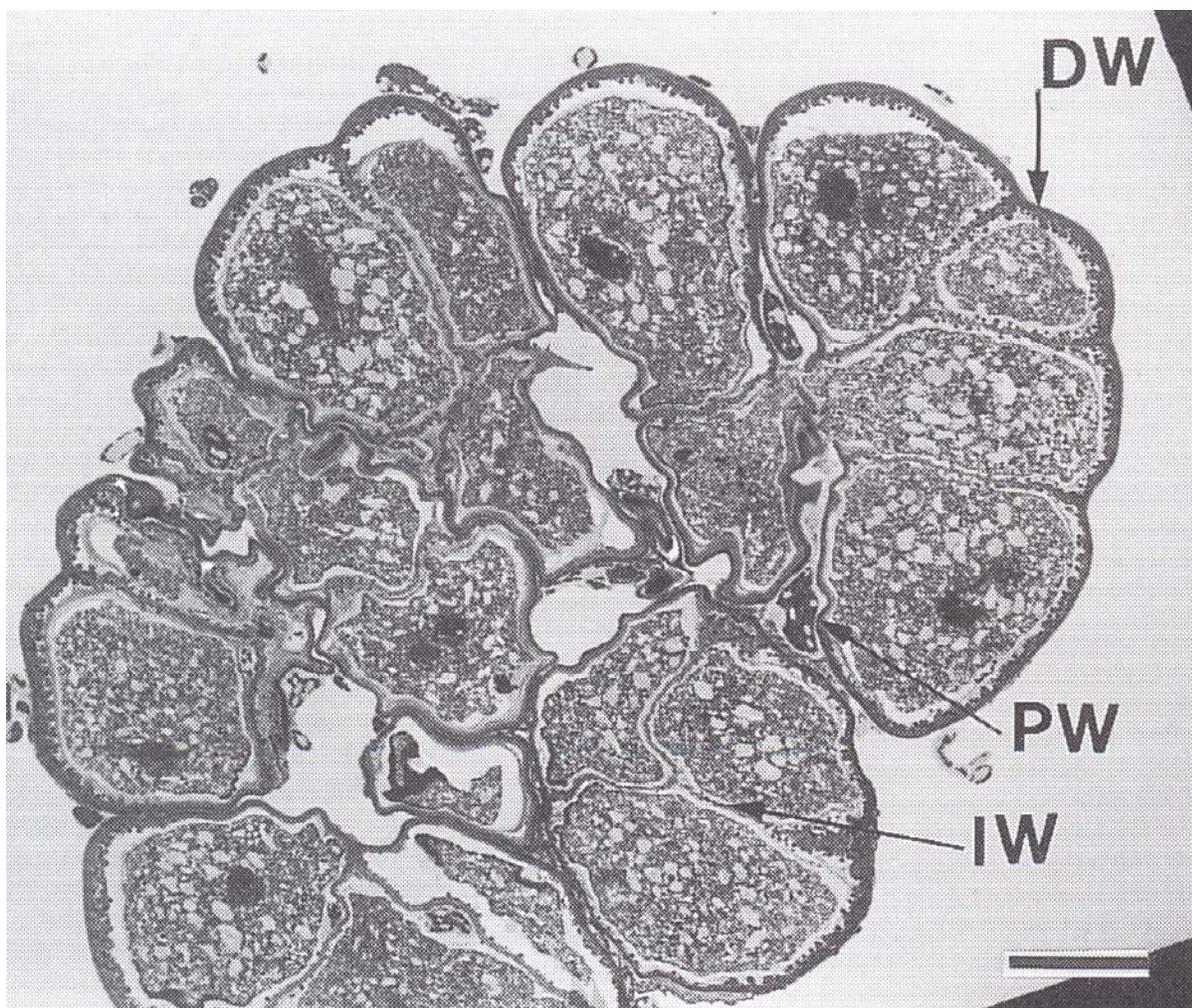


Fig. 3.1.1 Structural pollinium architecture in *Hemidesmus indicus* (Willd.) Schult. showing distal wall (DW), proximal wall (PW) and inner wall (IW). Scale bar = 10 μ (duplicated from Verhoeven and Venter, 1998).

3.4 Economic value

The phytochemistry of the Periplocoideae is poorly studied (Joubert, 2007). However, in some genera, compounds of medicinal and economic value have been isolated. In the genus *Cryptolepis* compounds from the roots of *C. sanguinolenta* (Lindl.) Schltr. (Paulo et al., 2000), the roots and leaves of *C. buchaniini* Roem. & Schult. (Purushothaman et al., 1988) and the roots of *C. apiculata* K.Schum. (Hegnauer, 1964) have been found to have antimicrobial and antiplasmodial (antimalarial) activities. Aqueous extracts of the

roots of these species are claimed by Ghanaian herbalists to be effective in the treatment of infections such as urogenital infections (Boye and Oku-Ampofo, 1983). However, cytotoxicological investigations have not been done to validate the efficacy and safety of this traditional remedies. An ancient use of *Cryptolepis* species has been in the dyeing of textiles and leather (Saxton, 1965).

Some of the tuberous Periplocoideae are claimed to have medicinal value. The tuberous roots of *Mondia whitei* (Hook.f.) Skeels are used as a traditional medicine for the treatment of abdominal ailments and poor appetite (Hutchings et al., 1996). The tuber of some *Raphionacme* species are collected as a source of water, medicine and food, but this could also be poisonous. The tuber of *Streptocaulon wallichii* have been used as tonic in Burma (collector's note). "Bitinga" rubber was isolated commercially from *R. utilis* N.E.Br. (Venter, 2009a).

Triterpene acid extracted from *Finlaysonia obovata* leaves has shown antibacterial activity against fish pathogens (Mishra and Sree, 2008). Mohato and Sen (1997) also reported on the beneficial biological properties of triterpene acid as being antitumoural, anticancerous, antiviral, antimicrobial and anti-inflammatory. *F. obovata* with its attractive foliage and interesting looking fruits, coupled with the fact that it often grows in dry habitat, can be cultivated as an ornamental plant (Ang et al., 2010).

In the genus *Streptocaulon*, leaf extracts from *S. juvenas* inhibit the proliferation of cancer cells in humans and animals (Ueda et al., 2002). In China *S. juvenas* roots are further used medicinally for the treatment of dysentery and stomach ache, and the leaves are used externally for the treatment of snake poisoning and abscesses (Ping-tao et al., 1995).

3.5 Diagnostic characteristics of the Periplocoideae

The Periplocoideae are mostly climbers, sometimes with tubers. The leaves are opposite, simple and mostly with colleters in their axils. Flowers are bisexual, actinomorphic, pentamerous. Corolla with shallow to deep corolla tubes. Corona of corolline lobes arising in various positions on the corolla tube wall, always alternating with the petals, usually fused with the stamens and nectaries. The stamens are also epipetalous and alternating with the petals, but at a lower level than the corona; the anthers are in tetrads or pollinia, these shed onto spatulate translators embedded on the styler head and alternating with the anthers. The gynostegium comprises of two unilocular ovaries, their styles apically fused forming the styler head. The follicles are usually paired, each with numerous comose seeds.

3.6 Key to the genera

Abaxial leaf epidermis densely hairy, or if not, then anther callosities absent AND corolla lobes glabrous on both surfaces [*S. cumingii*]; anther callosities absent; corolla lobes glabrous on both surfaces ***Streptocaulon***

Abaxial leaf epidermis glabrous to sparsely hairy; anther callosities present, or if not, then anther callosities absent AND corolla lobes puberulous on the inside [*F. pierre*], corolla lobes hairy on both surfaces or on either outside or inside , but if glabrous on both surfaces, then petiole longer than 15 mm [*F. insularum*] ***Finlaysonia***

CHAPTER 4

TAXONOMY OF *FINLAYSONIA*

4.1 Generic description

FINLAYSONIA Wall., *Plantae Asiaticae Rariorum* 2: 48, ad t. 162 (1831); Hook.f., *Flora of British India* 4(10): 7 (June 1883); Costantin, *Finlaysonia*. In *Flora Generale de L'Indo-Chine*: 19 (1912).

Type species: *Finlaysonia obovata* Wall.

= *GURUA* Buch.-Ham. ex Voigt, *Hortus Suburbanus Calcuttensis*: 544 (1845). *nom. illeg.*

= *ATHEROLEPIS* Hook.f., *Flora of British India*, 4(10): 8 (June 1883); Hook.f. In *Hooker's Icones Plantarum*: 26-27, tab. 1433 (Dec. 1883); Venter & R.L.Verh. in *Annals of the Missouri Botanical Garden* 88: 564 (2001).

Type species: *Atherolepis wallichii* (Wight) Hook.f.

= *HANGHOMIA* Gagnep. & Thénint in *Bulletin de la Société Botanique de France* 83: 392 (1936); Venter & R.L.Verh. in *Annals of the Missouri Botanical Garden* 88: 565 (2001).

Type species: *Hanghomia marseillii* Gagnep. & Thénint.

= *MELADERMA* Kerr in *Kew Bulletin* 1938: 445 (1938); Venter & R.L.Verh. in *Annals of the Missouri Botanical Garden* 88: 565 (2001).

Type species: *Meladerma puberulum* Kerr.

= *STELMACRYPTON* Baill. in *Bulletin Mensuel de la Société Linnéenne de Paris* 2: 812 (1890); Venter & R.L.Verh. in *Annals of the Missouri Botanical Garden* 88: 565 (2001).

Type species: *Stelmacrypton khasianum* (Kurz) Baill.

Macromorphology

Evergreen climbers with probable exception of *Finlaysonia decidua* that may be deciduous. **Stems** vary from a few to 20 mm in diameter [see notes, p. 33], woody; erect or twining; bark usually with prominent longitudinal ridges, glabrous or hairy with dirty white to copper-coloured hair; lenticellate; interpetiolar nodes ridged; colleters axillary and on interpetiolar ridges, narrowly turbinate, glabrous, reddish-black to black, colleters seemingly absent in *Finlaysonia decidua*. **Leaves** opposite, petiolate to sessile; petiole adaxially grooved; blade simple, coriaceous or herbaceous, margin entire, venation pinnate, secondary veins arched, divaricate or patent, brochidodromous, rarely eucamptodromous, tertiary veins reticulate or weakly percurrent, with or without veinlets, areoles mostly well developed.

Inflorescences terminal and/or axillary, cymose, few to numerous flowered; bracts one or two per node, opposite or alternate, margins glabrous to fimbriate; colleters on nodes of primary, secondary and tertiary peduncles, in association with bracts, reddish to reddish-black, narrowly turbinate. **Floral buds** with corolla lobes overlapping anti-clockwise. **Flowers** bisexual, actinomorphic, pentamerous, semi-epigynous. **Sepals** free, glabrous to puberulous outside, glabrous inside, margins entire, sometimes fimbriate; colleters at inner base of sepals, two per sepal, free and narrowly turbinate or two colleters from adjacent sepals fused into an ovate or orbicular compound colleter, reddish-black. **Corolla:** glabrous or hairy; tube short, inverted at coronal annulus, shallowly campanulate or bowl-shaped; lobes longer than tube, reflexed or spreading, margins entire. Only lower (primary) **corona** present, inserted on inversion of corolla tube, exerted from corolla tube, pentamerous; lobes consist of a broadened foot and an upper segment. **Stamens** inserted on inversion of corolla tube and fused to inner bases of coronal feet, connivent over stylar head, filamentose; anther basally fused to stylar head, thecae whitish, each with a globose basal callosity except in *F. pierrei*, dehisce with full or half length lateral slits; connective glabrous to hairy, connective appendage prominent and connivent over stylar head; pollinia 4 per anther, 2 per theca, oblong-ovoid to oblong-ellipsoid. **Nectaries** 5, interstaminal, below corolla tube inversion, fused laterally with coronal feet and staminal filament bases, forming vertical chutes between stamens directly above nectaries, each nectary shelf-like with erect, thickened rim (incrassate) pressing against style. **Gynostegium** exerted. **Pistil:**

ovaries 2, semi-inferior, free, placentation marginal, ovules numerous; styles 2, terete, fused towards stylar head, glabrous; stylar head pentangular, glabrous, apex acute to obtuse; translators embedded in upper surface of stylar head, alternating with anthers, spatulate, divided into receptacle, stype and viscidium; receptacle ovate to broadly ovate or obovate, stype filiform to linear-terete; viscidium disc-shaped. **Fruit** is of paired follicles, divergent to horizontal, pericarp texture leathery, glabrous to slightly pubescent, apex attenuate to apiculate. **Seed** reddish to dark brown, ovate and compressed to narrowly ovoid, surfaces smooth or warty, margins usually entire; coma at micropylar end, pale coppery to creamy white. Coma is replaced by marginal ring of hair in *Finlaysonia obovata*.

Micromorphology

The adaxial **leaf epidermal surfaces** are glabrous or with varied indumentum. The cuticle is usually smooth to slightly striated with parallel to slightly wavy striations that are restricted to cells or crossing cellular boundaries.

The abaxial epidermal surfaces are glabrous to scabrid to villous, sometimes restricted to main and lateral veins. Leaves are hypostomatic with stomata usually randomly oriented except in *Finlaysonia obovata* where the stomata are arranged in clusters.

The upper **seed coat surface** is smooth, finely pitted or with ridges. The margins are entire, warty or fimbriate. Epidermal cells vary in shape and are tightly or loosely packed. The upper seed coat surface sculpture also varies. The cuticle is smooth.

The lower seed coat surface and margin is smooth with or without a narrow central longitudinal ridge. Epidermal cells vary in shape and surface sculpture varies. The cuticle is smooth to granular and/or slightly striated.

Pollinia consist of tetrads grouped together in an oblong-ovoid to oblong-ellipsoid bodies. Pores are absent on the distal pollen walls but usually present on the proximal pollen walls. Where pores of adjacent tetrads are opposite to each other, the tectum and granular stratum of the adjoining tetrads may be fused. The distal wall exine is smooth and consists of an outer compact stratum (tectum) subtended by a granular stratum. The proximal walls have the same exine stratification as the distal wall with an

outer compact stratum (tectum) subtended by a granular stratum. The inner walls consist of granular stratum and intine with or without wall tectum and wall bridges. (Verhoeven and Venter, 1998).

Distribution and habitat

Finlaysonia species are widely distributed throughout tropical Asia, with the highest concentration of species (5 out of 8) in Thailand (Fig. 4.1.1).

The habitat ranges from hill slopes to river banks, often on calcareous soils. This genus is a component of communities of thorny savannah, scrub jungle or mangrove forests. Flowering occurs throughout the year, peaking in the northern hemisphere's summer.

Notes

Height of plant and stem diameter can not be determined from herbarium specimens, especially where the labels do not contain this information.

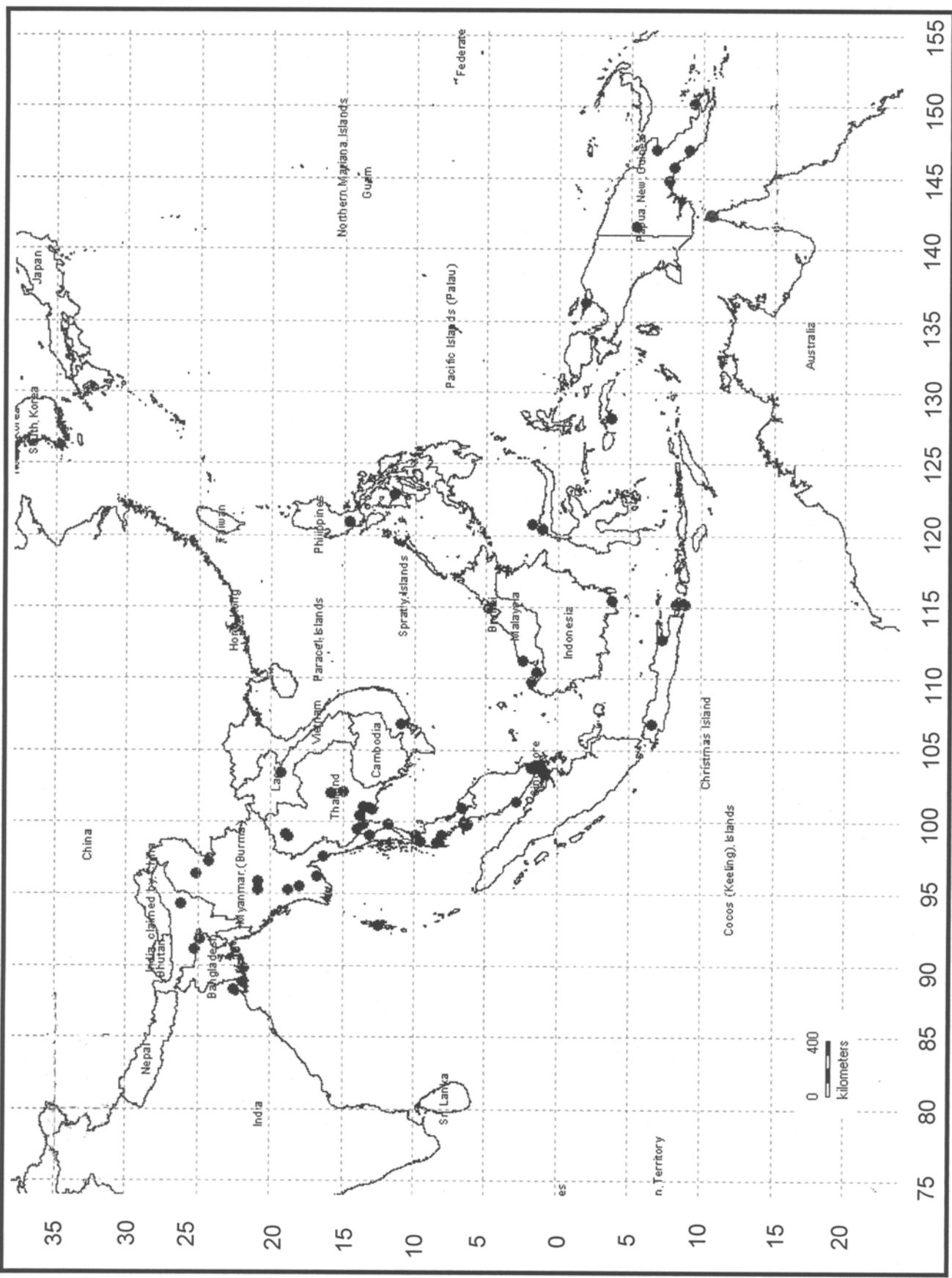


Fig. 4.1.1 Geographical distribution of the genus *Finlaysonia* in Asia

4.2 Description of *Finlaysonia* species

4.2.1 *Finlaysonia decidua* (Kerr) Venter and A.M.Venter, *comb. nov.*

Basionym: *Meladerma deciduum* Kerr in Kew Bulletin 1938: 447 (1938), Venter & R.L.Verh. in Annals of the Missouri Botanical Garden 88: 565 (2001).

Type: Thailand, Chiangmai, Ban Pa Sak, *Kerr 2834* (K (sheet 1)!, lectotype, here designated; BM!, K (sheet 2)!, isolectotypes) (Fig. 4.2.1).

= *Finlaysonia insularum* (King & Gamble) Venter in Venter & R.L.Verh., Annals of the Missouri Botanical Garden 88: 565 (2001) [see Confusing synonymy, No. 1, p.120]. [Notes, No. 1, p. 49].

Type: Malaysia, Kedah, small islands near Langkawi, Curtis 3684 (CAL, holotype?; K!, isotype? [see Notes, No. 2, p. 49]).

Macromorphology

Climbers, probably deciduous (see notes, p. 39). **Stems:** bark glossy, purple, puberulous on younger stems becoming glabrous in older stems, nodes tomentose, hair copper-coloured; colleters not observed. **Juvenile leaf** sessile; blade linear, 6 x 1.5–2 mm, herbaceous, densely tomentose on both surfaces, hair dirty white, apex attenuate, base cuneate.

Inflorescences terminal and axillary, open dichasia, terminating in monochasial branches, each with 4–5 flowers; primary peduncles 3 mm long, secondary peduncles 3 mm long, densely tomentose with silver to coppery hairs; pedicels 7–12 mm long, densely tomentose; bracts on peduncles narrowly triangular-ovate and naviculate, 1–2 mm long, densely tomentose on abaxial surfaces. **Floral buds** ovoid, 1 mm long, apices round. **Sepals** broadly ovate to triangular, 1 x 1 mm, abaxially densely tomentose, apices obtuse to round; colleters not seen. **Corolla** green; tube bowl-shaped, ± 0.5 mm long, both surfaces glabrous; lobes narrowly ovate to oblong-ovate, semi-succulent, 3–3.8 x 1–1.5 mm, outside densely pubescent with white hair, inside glabrous, margins membranous and fimbriate, apices rounded. **Corona** lobes filiform, herbaceous, ± 2 mm long, glabrous, apices entire; coronal feet ovoid, fleshy and dark reddish-black, glabrous.

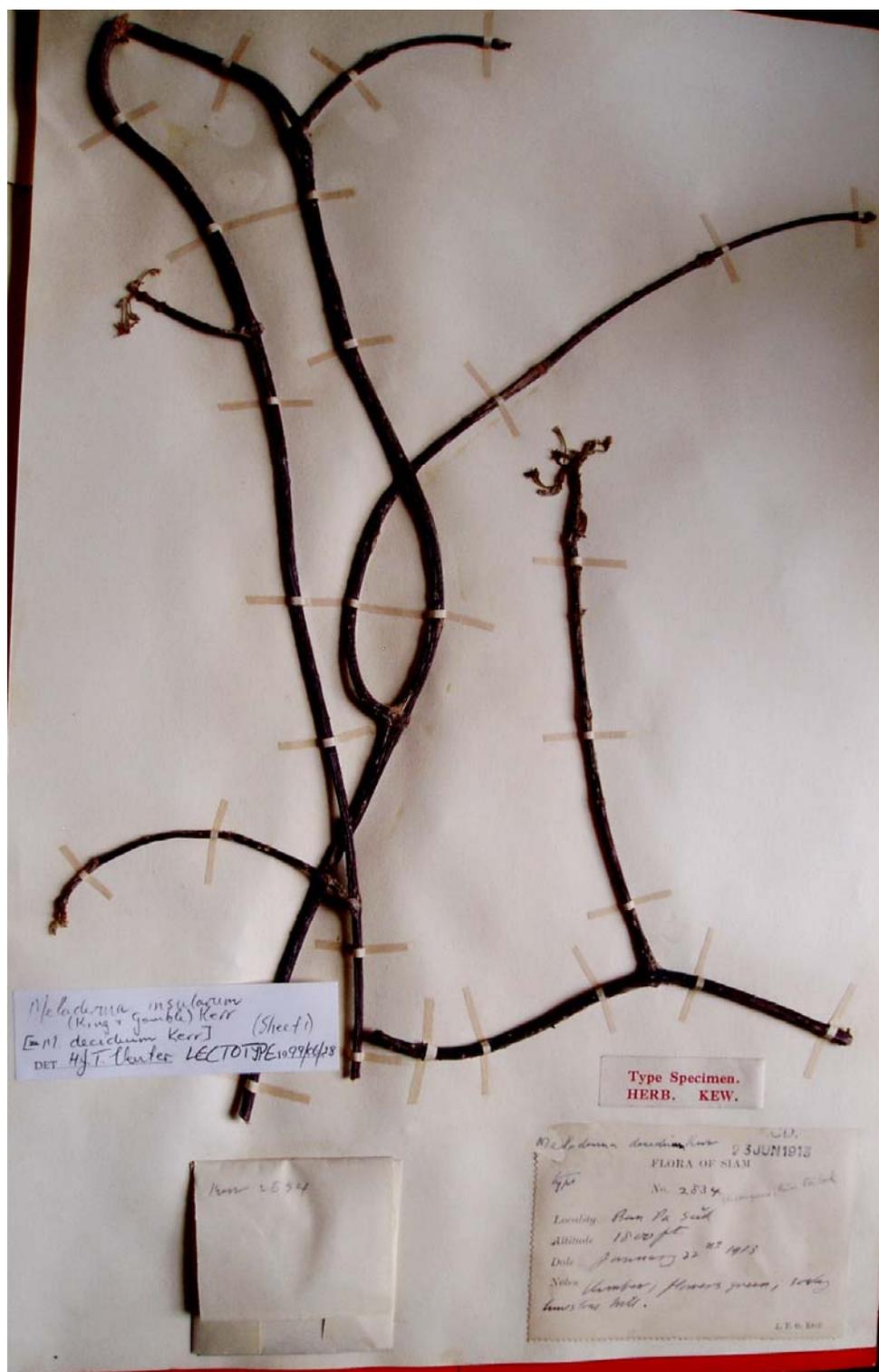
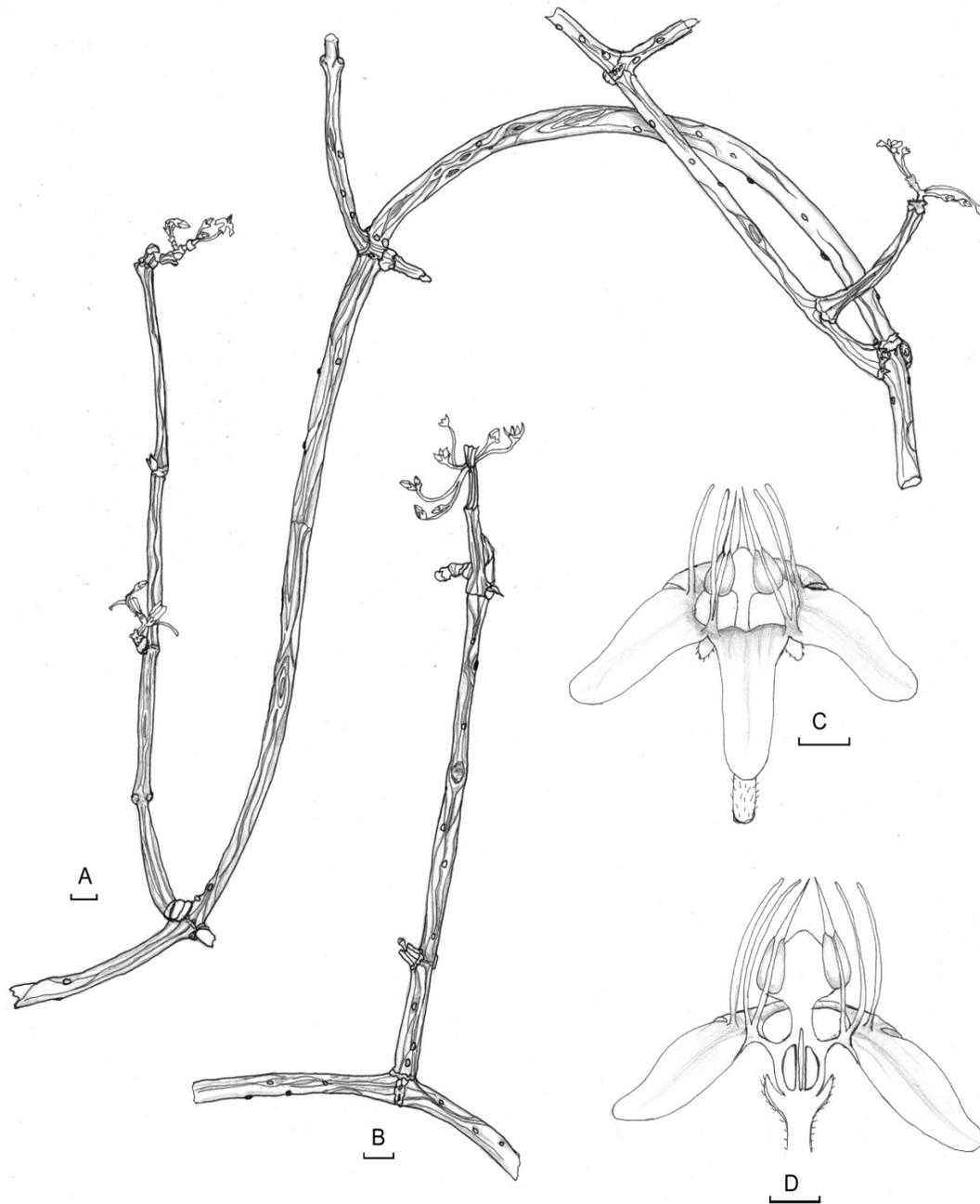


Fig. 4.2.1 Type specimen of *Finlaysonia decidua* (Kerr) Venter & A.M.Venter (Kerr 2834, lectotype (K)).

Stamens: filament terete, ± 0.5 mm long, curved, glabrous; anther glabrous, 1–1.1 x 0.2 mm; thecae oblong, with basal callosities, dehiscent with half length lateral slits; connective pale cream-coloured, glabrous, linear between thecae, connective appendage attenuate. **Nectary** rim without interstaminal lobules. **Pistil:** style ± 0.7 mm long; stylar head sub-globose, 0.6 x 0.5 mm, apex obtuse; translator ± 0.75 mm long, receptacle broadly obovate and grooved, apex emarginate, stype linear but folded. **Fruit** and seed unavailable. (Fig. 4.2.2).



R. H. S.
28/02/2012

Fig. 4.2.2 *Finlaysonia decidua*. A and B: leafless stem with inflorescences; C: external view of flower; D: longitudinal section of flower showing inverted corolla tube, filiform corona lobes, stamens, ovaries, style and stylar head. Scale bars: A, B = 10 mm; C, D = 1 mm. [A, B, C and D: *Kerr 2834 (K)*].

Micromorphology

No micro-morphology could be done as only type material was available.

Distribution and habitat

The type of *Finlaysonia decidua* was collected in Thailand on limestone hills (Fig. 4.2.3). Flowering occurred in June.

Notes

Only the type specimens of this species are available. The stems in all three duplicates are leafless except for one juvenile leaf on the holotype. The absence of leaves led to the epithet “decidua” and the assumption of deciduousness.

Specimens examined

Thailand:

- 18° 60'N, 99° 07'E: Chiangmai, Ban Pa Sak, *Kerr, A.F.G. 2834*, (K (sheet 1), lectotype; BM, K (sheet 2), isotypes).

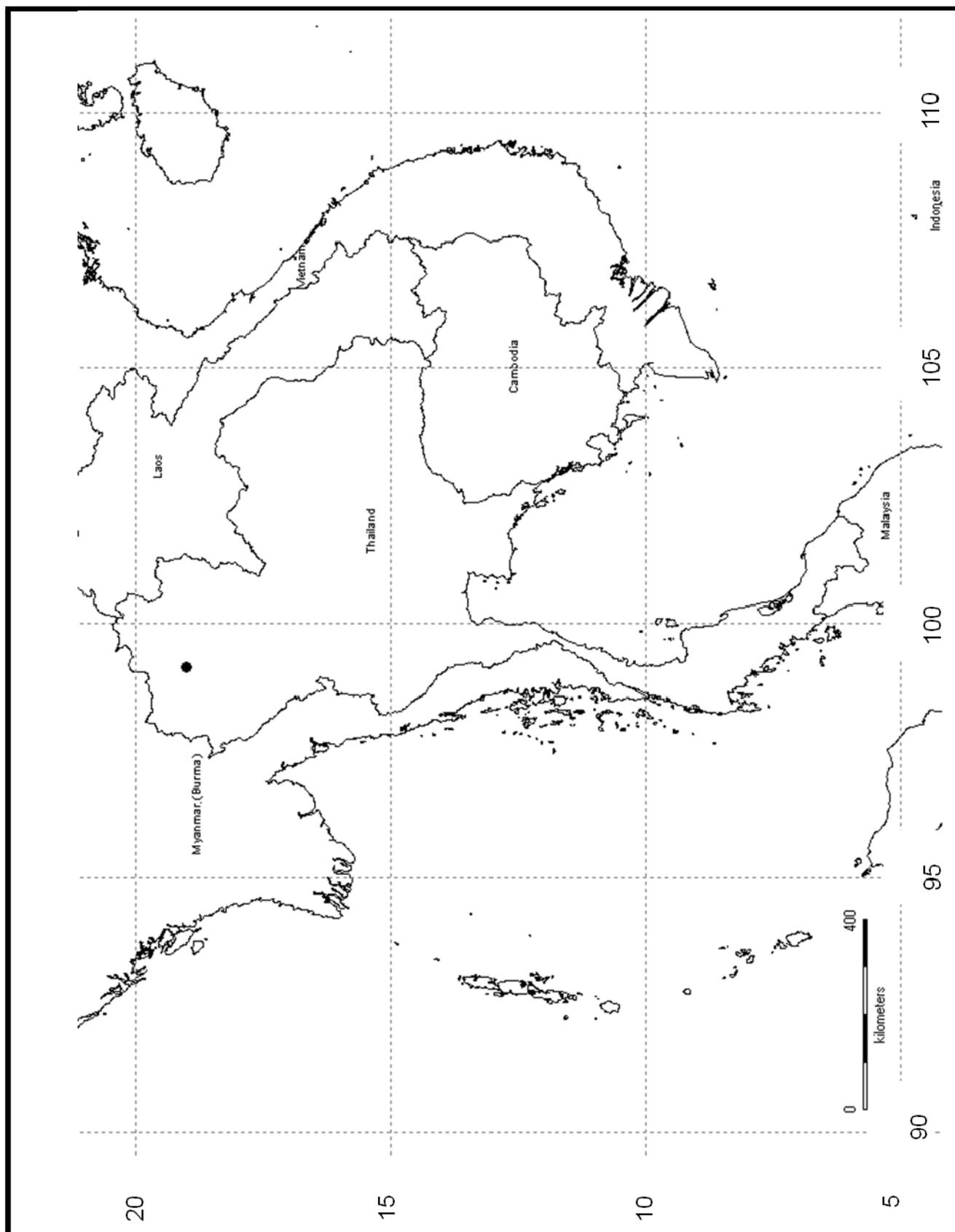


Fig. 4.2.3 Geographical distribution of *Finlaysonia decidua*

4.2.2 *Finlaysonia insularum* (King & Gamble) Venter in Venter & R.L.Verh., *Annals of the Missouri Botanical Garden* 88: 565 (2001) [see Confusing synonymy, No. 1, p. 120].

Basionym: *Gymnanthera insularum* King & Gamble in *Journal of the Asiatic Society of Bengal* 74: 514 (1908) [see Notes. No. 1, p. 49].

Type: Malaysia, Kedah, small islands near Langkawi, *Curtis 3684* (CAL, holotype?; K!, SING-scan (2 sheets)!, isotypes?) [see Notes, No. 2, p. 49] (Fig. 4.2.4).

= *Meladerma insularum* (King & Gamble) Kerr in *Kew Bulletin* 1938: 445 (1938); Venter & R.L.Verh. in *Annals of the Missouri Botanical Garden* 88: 565 (2001).

Homotypic synonym.

= *Meladerma decida* Kerr in *Kew Bulletin* 1938: 447 (1938); Venter & R.L.Verh. in *Annals of the Missouri Botanical Garden* 88: 565 (2001).

Type: Thailand, Chiangmai, Ban Pa Sak, *Kerr 2834* (K (sheet 1)!, lectotype, here designated; BM!, K (sheet 2)!, isolectotypes).

= *Meladerma puberulum* Kerr in *Kew Bulletin* 1938: 447 (1938); Venter & R.L. Verh. in *Annals of the Missouri Botanical Garden* 88: 565 (2001).

Type: Thailand, Prachuap, *Put 285* (K!, holotype; BM!, L!, isotypes).

Macromorphology

Climbers. **Stems:** bark glossy, purple to reddish-purple, glabrous to puberulous; nodes glabrous to puberulent, hairs dirty white; colleters few. **Leaves** petiolate; petiole 15–26 x 0.5–1 mm, glabrous to rarely densely puberulous; axil sparsely puberulous; blade elliptic, rarely ovate, 65–87 x 18–37(–41) mm, herbaceous, glabrous on both surfaces, main vein glabrous to puberulous, apex acute to acuminate or obtuse-mucronate, base cuneate, round or obliquely round, margin may be recurved and undulating, venation brochidodromous, rarely eucamptodromous, 14–21 secondary veins on either side of

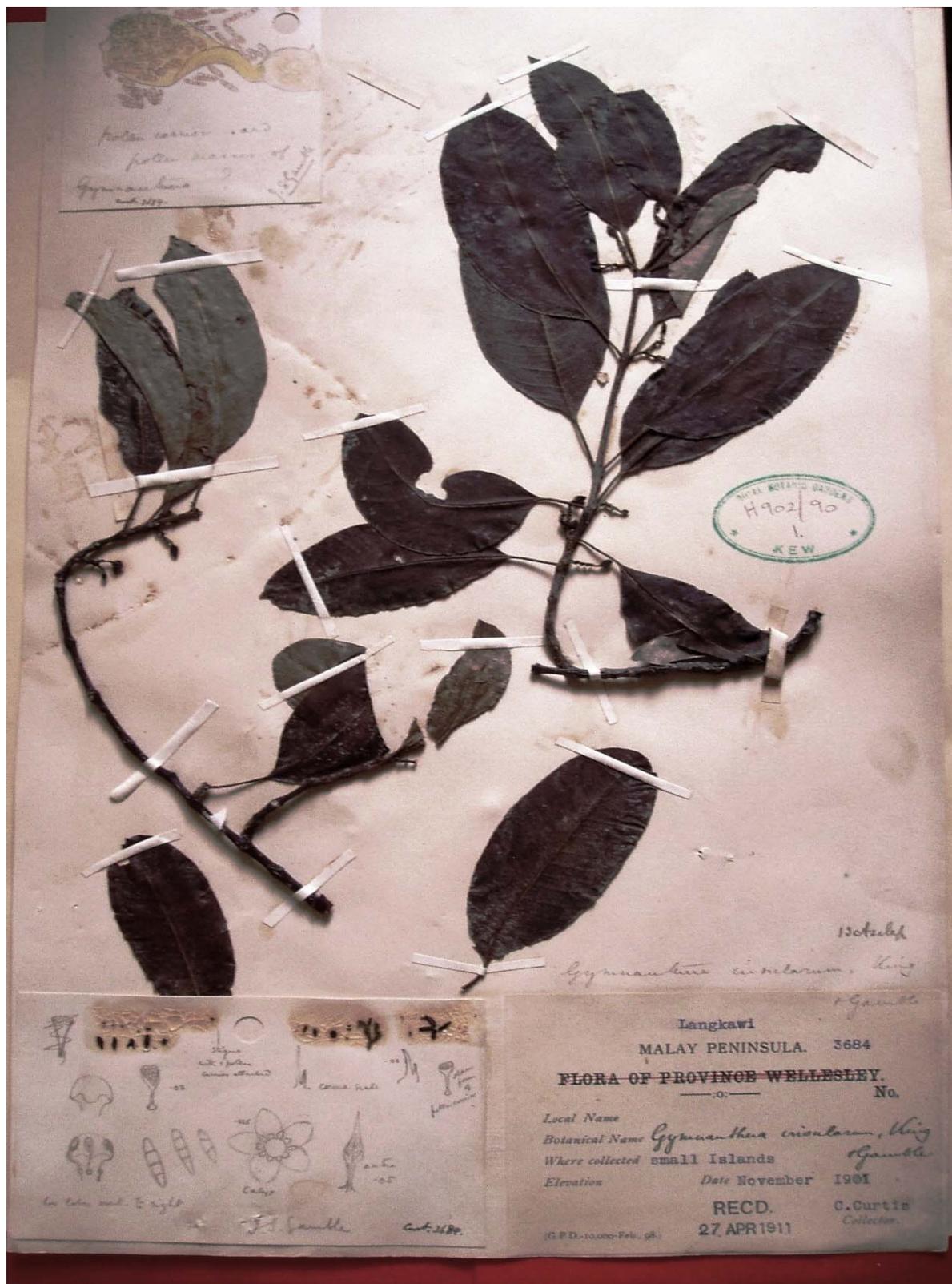


Fig. 4.2.4 Type specimen of *Finlaysonia insularum* (Kerr) Venter (Curtis 3684, isotype (K)).

main vein, divaricate, tertiary venation random reticulate, areoles well developed, without veinlets.

Inflorescences terminal and axillary, open dichasia terminating in monochasial branches or only monochasia, each with 3–4 flowers; primary peduncles 2–7 mm long, secondary peduncles \pm 8 mm long, puberulous with adpressed curved whitish hairs, tertiary peduncles not seen; pedicels 3–7 mm long, puberulous; bracts opposite to decussate and densely stacked on dichasial peduncles or alternate on monochasial branches, narrowly to broadly triangular, or triangular-ovate to ovate-attenuate, naviculate, 1–1.5 mm long, outer surface and margins puberulous with adpressed hairs.

Floral buds 2–3 mm long, deltoid-ovoid; apices acute to obtuse. **Sepals** triangular-ovate, broadly triangular to broadly triangular-ovate, 0.7–1 x 0.8–1 mm, densely puberulent on outer surface and margins, apices acute to obtuse; colleters simple.

Corolla green outside, violet inside; tube bowl-shaped, 0.2–1 mm long, glabrous on both surfaces to rarely puberulous on outside; lobes narrowly ovate to oblong-ovate, 2.4–4 x 1–2 mm, semi-succulent and rugose, glabrous on both surfaces, apices obtuse.

Corona lobes filiform, herbaceous, 1.5–2 mm long, maroon, glabrous, apices entire; coronal feet ovoid, herbaceous, glabrous. **Stamens:** filament terete to linear-terete, 0.5–1 mm long, erect to curved-erect, glabrous; anther glabrous, ovate, oblong-ovate to hastate, 0.8–1.3 x 0.4–0.8 mm; thecae oblong-ovate, 0.2 mm long, with basal callosities, dehisce with half length slits, connective glabrous, appendage pale cream, deltoid, glabrous; pollinia oblong-ovoid to oblong-elliptic. **Nectary** rim without interstaminal lobules.

Pistil: styles 0.4–1 mm long; stylar head broadly ovoid, 0.4–0.6 x 0.5–0.6 mm, apex bluntly obtuse; translator receptacle ovate to angular-ovate and funnel-like to carry pollinia, apex shallowly split, stype linear-terete. **Follicles** dark brown, horizontal, narrowly ovoid, 95–105 x 4–5 mm, pericarp surface puberulous and herbaceous, apex attenuate; seed dark brown, 5 x 1 mm long, oblong-obovate; coma creamy white, 35–40 mm. (Fig. 4.2.5).

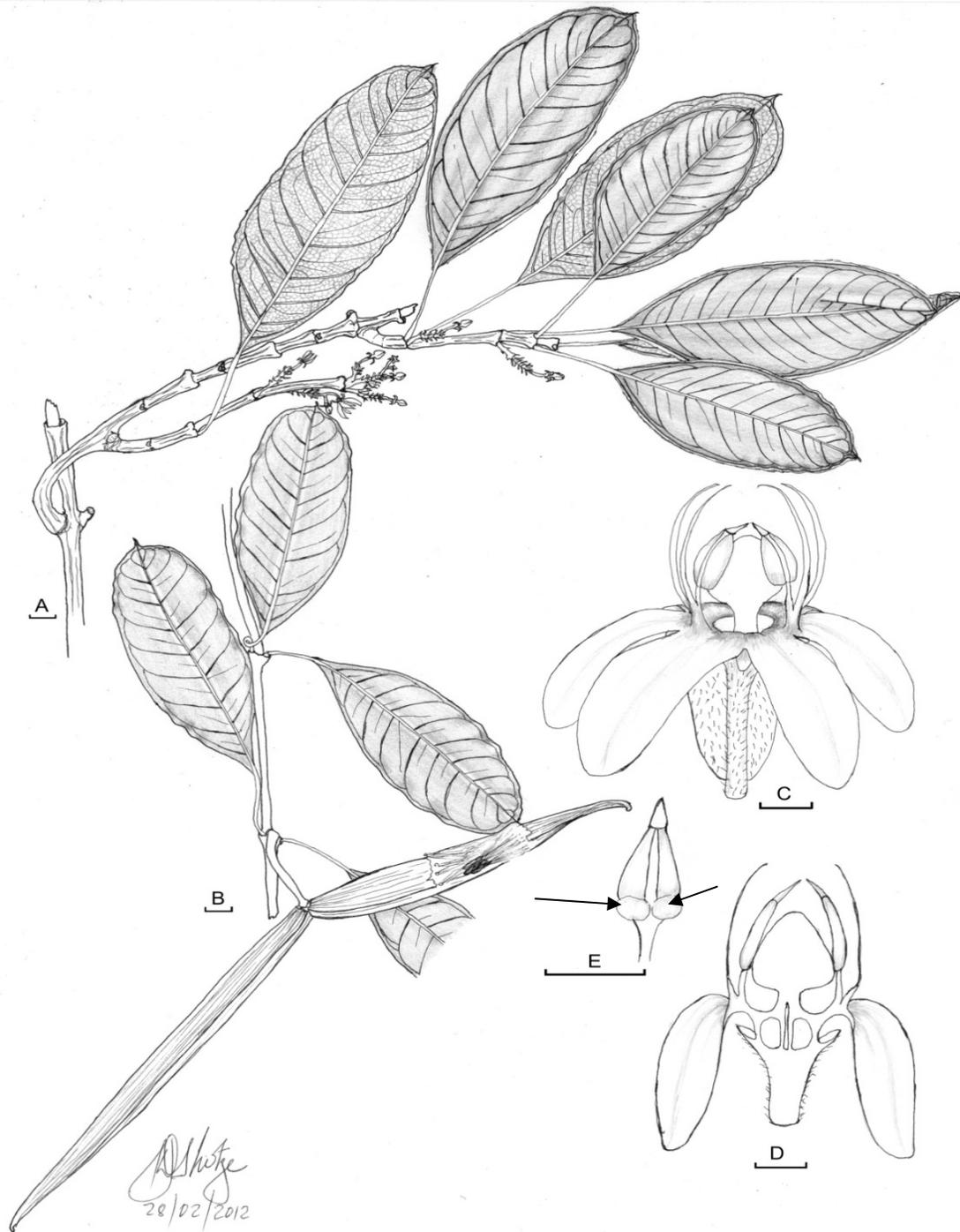


Fig. 4.2.5 *Finlaysonia insularum*. A: stem with leaves and inflorescences; B: stem with leaves and follicles; C: external view of flower showing inverted corolla tube; D: longitudinal section of flower showing corona lobes, stamens ovaries, style and styler head; E: stamens showing thecae with basal callosities (↓) and apically deltoid connective. Scale bars: A, B = 5 mm; C, D = 1 mm; E = 1 mm. [A, C, D and E: *Whitemore 12970 (K)*; B: *Marcan 986 (K)*].

Micromorphology

Adaxial **leaf epidermal** cells are pentagonal in shape. Outer periclinal cell walls of the adaxial **leaf epidermis** are tabular. The adaxial epidermis is glabrous (Fig. 4.2.6 A). The cuticle is slightly striated. Striations are randomly oriented. Cuticular folds occur (Fig. 4.2.6 B). No wax is present.

On the abaxial leaf epidermis the epidermal cells are tetra- to pentagonal. Outer periclinal walls are not clearly distinguishable. The abaxial epidermis is glabrous (Fig. 4.2.6 C). The cuticle is densely striated. Striations are randomly oriented (Fig. 4.2.6 D). No wax is present.

The leaves are hypostomatic. The stomata are elliptic with narrow stomatal ledges, slightly sunken and randomly arranged (Fig. 4.2.6 D).

The upper **seed coat** surface and margin is smooth (Fig. 4.2.7 A). Epidermal cells are round, tetra- to pentagonal and are loosely packed (Fig. 4.2.7 B). Outer periclinal walls are tabular to slightly concave. Anticlinal walls are curved. The cuticle is smooth (Fig. 4.2.7 C).

The lower seed coat surface and margin is smooth with a narrow central longitudinal ridge (Fig. 4.2.7 D). Epidermal cells on the central longitudinal ridge are elongate, tetra- to pentagonal and are tightly packed (Fig. 4.2.7 E). Outer periclinal walls are concave. Anticlinal walls are straight. Epidermal cells towards the margin are isodiametric to tetragonal and are loosely packed (Fig. 4.2.7 F). Periclinal walls are concave. Anticlinal walls are curved. The cuticle is smooth.

Pollen tetrads are grouped together forming an oblong-ovoid to oblong-ellipsoid pollinium, 27–142 x 95–110 μm in size (Fig. 4.2.8 A). Pores may be present on the distal wall (Fig. 4.2.8 C). The granular stratum of the distal wall consists of large granules in the inside (Fig. 4.2.8 B). Inner wall consists of tectum, granular stratum and intine with wall bridges (Fig. 4.2.8 D). (Venter and Verhoeven, 1998).

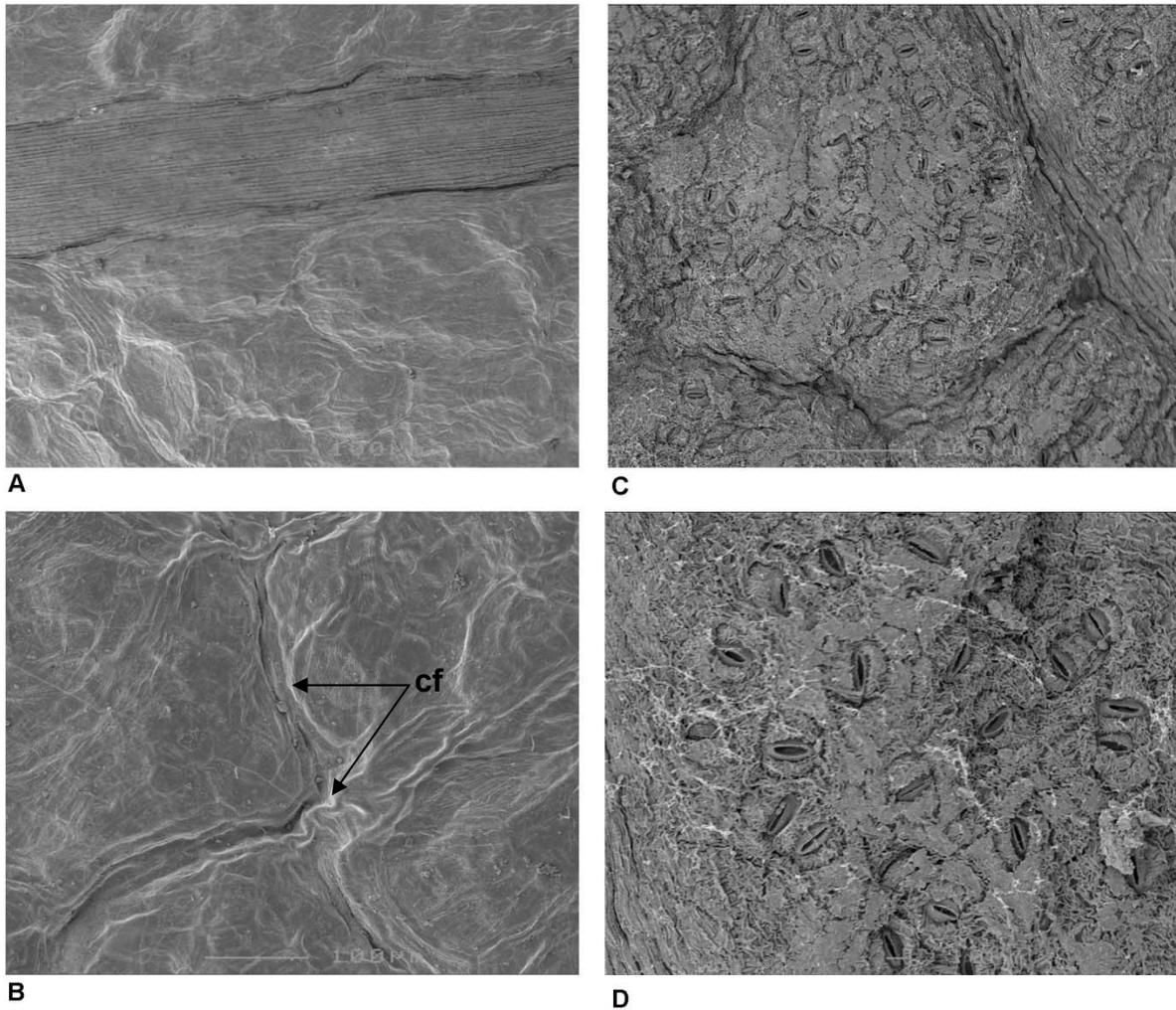


Fig. 4.2.6 *Finlaysonia insularum*. A: adaxial leaf showing glabrous epidermis; B: adaxial epidermis showing slightly striated cuticle and cuticular folds; C: abaxial epidermis showing glabrous epidermis; D: abaxial epidermis showing stomata and dense striations, cf: cuticular fold. Magnification: A, C = x80; B, D = x200. [A–D: Marcan 986 (K)].

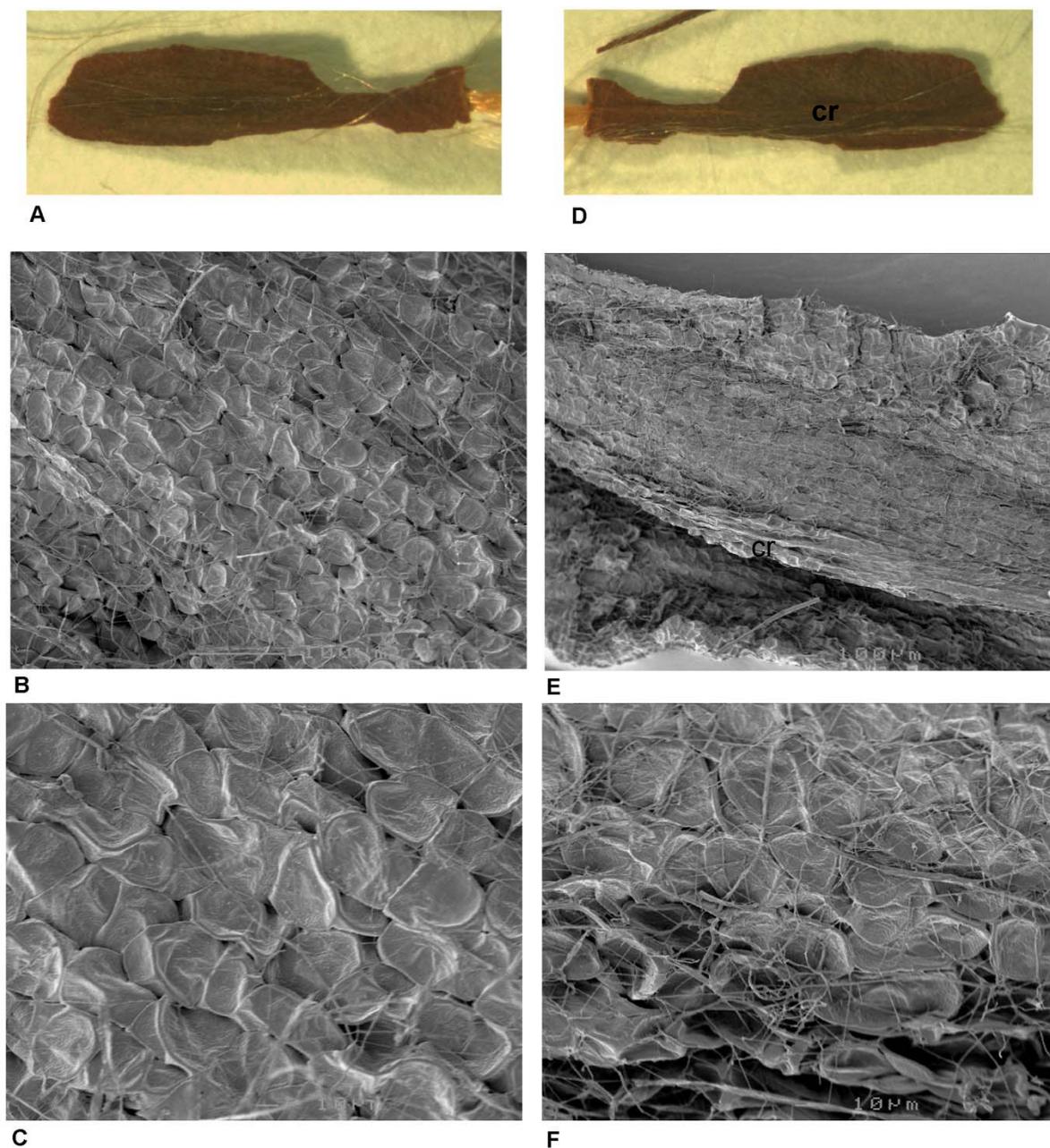


Fig. 4.2.7 *Finlaysonia insularum*: A: upper seed surface; B, C: upper seed coat showing loosely packed epidermal cells with smooth cuticle; D: lower seed surface showing a narrow central longitudinal ridge; E: lower seed coat showing narrow central ridge (cr) with elongate, tetra- to pentagonal tightly packed cells; F: lower seed coat with isodiametric to tetragonal epidermal cells and smooth cuticle towards margin. Magnification: B, E = x80; C, F = x200. [A–F: Marcan 986 (K)].

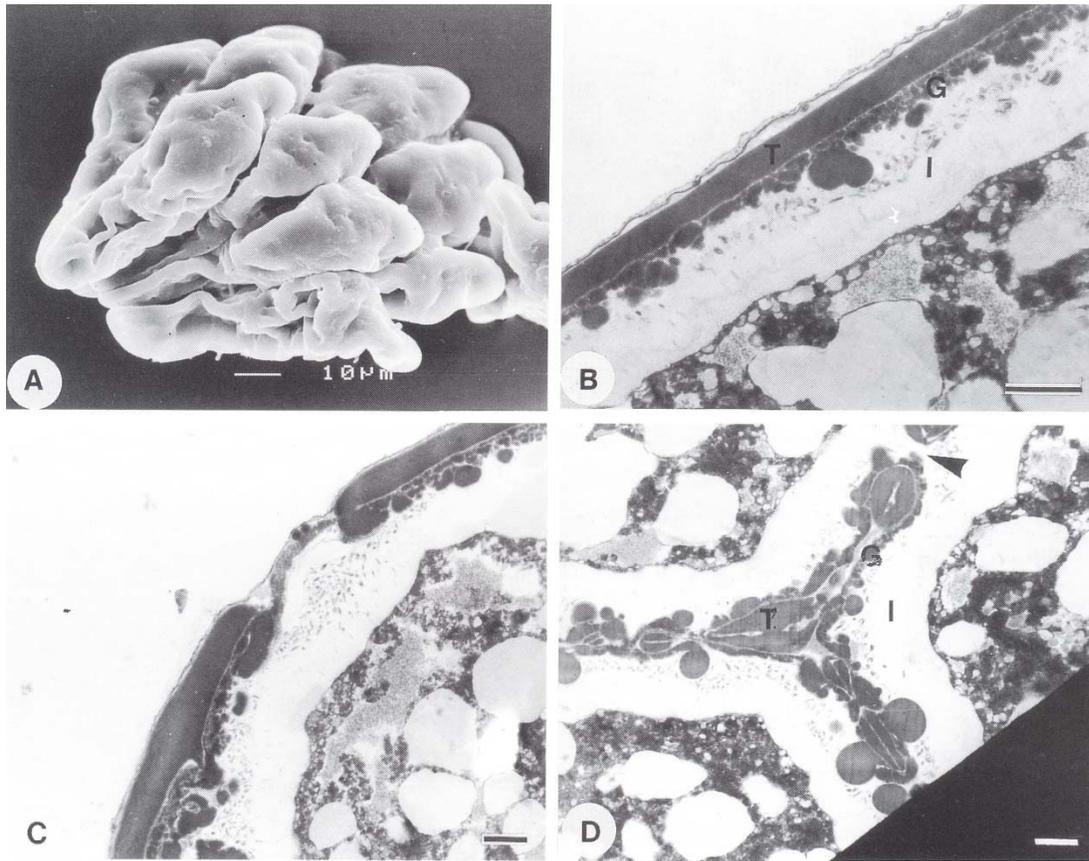


Fig. 4.2.8 Pollinium and pollen wall architecture of *Finlaysonia insularum* (= *Meladerma insularum*). A: shape of pollinium; B: distal wall showing tectum (T), granular stratum with large granules in the inside (G) and intine (I); C: distal wall with pore; D: inner wall, with wall bridges (arrow head), consisting of tectum (T), granular stratum (G) and intine (I). Scale bars: A = 10 μ ; B–D = 1 μ . [A–D: duplicated from Verhoeven and Venter (1998)].

Distribution and habitat

Finlaysonia insularum is found in Thailand and Malaysia, growing mostly on limestone hills on the mainland and on the small islands (Fig. 4.2.9). This climber is often found in tree canopies. Flowering occurs in summer months.

Notes

1. The epithet "*insularum*" means coming from an island (insular).
2. Venter & Verhoeven (2001) state that the type specimen in Kew is not indicated as the holotype. George King did not indicate where the holotype was housed but because he was superintendent of the Calcutta Botanic Gardens, they assume that the holotype is in the Central National Herbarium, Calcutta (CAL). Up till now, attempts to confirm this have been unsuccessful.

Specimens examined

Malaysia:

- 06° 17'N, 99° 52'E: Kedah, Langkawi south east, on Pulau Chupak, *Chin, S.C.* (K).
- 06° 20'N, 99° 45'E: Langkawi, *Curtis, C. 3684* (K, isotype).
- 06° 21'N, 99° 50'E: Langkawi island, north coast, along road to Tanjong Rhu, *Whitmore, T.C. 12970* (K, L).
- 06° 28'N, 99° 58'E: Tanjong Rhu (= Neru), Langkawi, *Haupt & Nur 7562* (K).
- 08° 28'N, 98° 32'E: Pulau Panji, Pungah, *Haupt & Nur 4006* (K).
- 09° 57'N, 99° 04'E: Chumphon, Take, Langsuan, *Put 1628* (K).

Thailand:

- 13° 10'N, 100° 56'E: Ban Sriracha (= Sriracha), *Kerr, A.F.G. 4177* (K).
- 13° 34'N, 101° 04'E: Bang Son, Chumpawn, *Put 1058* (K).
- 13° 49'N, 100° 29'E: Bangkok, Papanom, *Marcen, A. 986* (K).
- 18° 60'N, 99° 07'E: Chiangmai, Ban Pa Sak, *Kerr, A.F.G. 2834* (K).

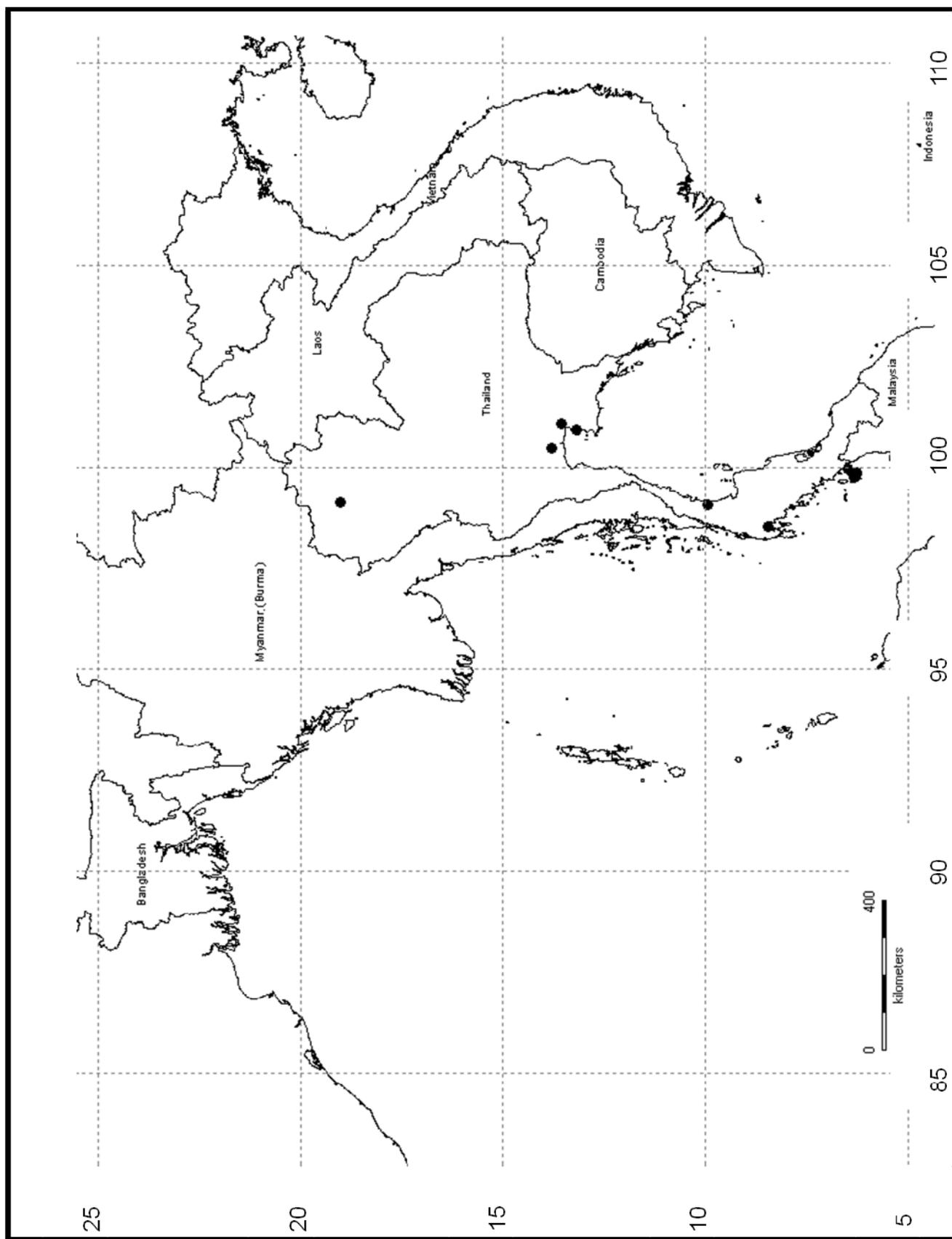


Fig. 4.2.9 Geographical distribution of *Finlaysonia insularum*

4.2.3 *Finlaysonia khasiana* (Kurz) Venter in Venter & R.L.Verh., *Annals of the Missouri Botanical Garden* 88: 565 (2001).

Basionym: *Pentanura khasiana* Kurz in Hook.f., *Flora of British India* 4: 4 (1883).

Types: India, Khasia Mountains, *J.D.H. & T.T. Kurz s.n.*, commissioned for Dr. King, anno 03/1883 (K!, lectotype, designated by Venter & R.L.Verh. (2001) (Fig. 4.2.10); Khasia Mountains, *Kurz 357*, commissioned from HBC, anno 09/1878 (K!, syntype); Khasia Mountains, *J.D. Hooker & T. Thomson*, anno 1859 (BM!, L! [see Notes, p. 58], P!, syntypes [see Venter & Verhoeven: 565 (2001)]).

= *Stelmacrypton khasiana* (Kurz) Baill. in *Bulletin Mensuel de la Société Linnéenne de Paris* 2: 812 (1890); Venter & R.L.Verh. in *Annals of the Missouri Botanical Garden* 88: 564 (2001). Homotypic synonym.

= *Hanghomia marseillii* Gagnep. & Thénint in *Bulletin de la Société Botanique de France* 83: 392 & Fig. 1 & 2 (1936).

Type: Laos, Region Xieng-Khonang, Plateau Tran-Ninh, *M. André s.n.* (P!, holotype).

= *Periploca acuminata* Rahman & Wilcock in *Botanical Journal of the Linnean Society* 110: 373 (1992).

Type: Bangladesh, Sylhet Tamabil-Jaflong Hills, *Rahman & Hossain 56* (ABD!, holotype; BM!, K! (2 sheets), isotypes).

Macromorphology

Climbers. **Stems:** bark yellowish brown, puberulent; nodes puberulent with dirty white hairs; colleters numerous. **Leaves** petiolate; petiole 6–15(–20) x 1 mm, puberulous; axil villous; blade elliptic, 80–115 x (20–)30–35(–42) mm, herbaceous and glossy, glabrous on both surfaces, main vein sparsely scabridulous adaxially becoming more densely puberulous towards petiole, hair dirty white, apex acuminate, base cuneate, rarely obtuse, venation brochidodromous, 8–14 secondary veins on either side of main vein, arched and divaricate, tertiary venation weakly percurrent, areole development incomplete, with veinlets.



Fig. 4.2.10 Type specimen of *Finlaysonia khasiana* (Kurz) Venter (J.D.H. & T.T. Kurz s.n., lectotype (K)).

Inflorescences axillary, compact monochasia with 1–3 flowers each, primary peduncles \pm 2 mm long, secondary peduncles \pm 2 mm long, tertiary peduncles absent, puberulous, with simple white curved hairs; pedicels 2–7 mm long, puberulous; bracts densely arranged around peduncles, ovate to narrow triangular-ovate, naviculate, 1.5–3 x 0.5–2

mm, scabridulous with white hairs on outside and margins. **Floral buds** 3–4 mm long, narrowly to broadly ovoid, apices acute to obtuse. **Sepals** broadly ovate or triangular-ovate to broadly triangular-ovate, 1–1.5 x 0.7–1 mm, glabrous, apices acute to obtuse; colleters free. **Corolla** pink to yellow; tube bowl-shaped, 1–1.5 mm long, glabrous on the outside, pubescent on inside with white hairs; lobes ovate to triangular-ovate, 2–3 x 1.3–2.5 mm, coriaceous or herbaceous, outside glabrous, inside pubescent with white hairs, margins membranous to fimbriate; apices acute to obtuse. **Corona** lobes concave-ovate, \pm 0.5 mm long, apices attenuate and entire, glabrous to pubescent with white hairs; coronal feet ovoid and fleshy, glabrous. **Stamens:** filament terete to linear-terete, 0.5–1 mm long, erect to curved-erect, hairy; anther oblong to oblong-ovoid, 1.5 x 0.5 mm; thecae whitish, oblong to narrowly obovoid, with basal callosities, dehiscent with half length slits, connective hairy, connective appendage violet and hairy, linear with rhomboidal apex; pollinia oblong-ovoid. **Nectary** rim without interstaminal lobules. **Pistil:** style 0.5–0.7 mm long; stylar head broadly angular-ovoid, 1 x 0.8–1 mm, apex obtuse to acute; translator receptacle broadly ovate, centrally furrowed and folded funnel-shaped, apex shallowly split, style terete. **Follicles** dark brown, horizontal, narrowly falcate-ovoid, 22 x 5 mm long, pericarp surface glabrous and herbaceous; apex acute and hooked; seed not seen. (Fig. 4.2.11).

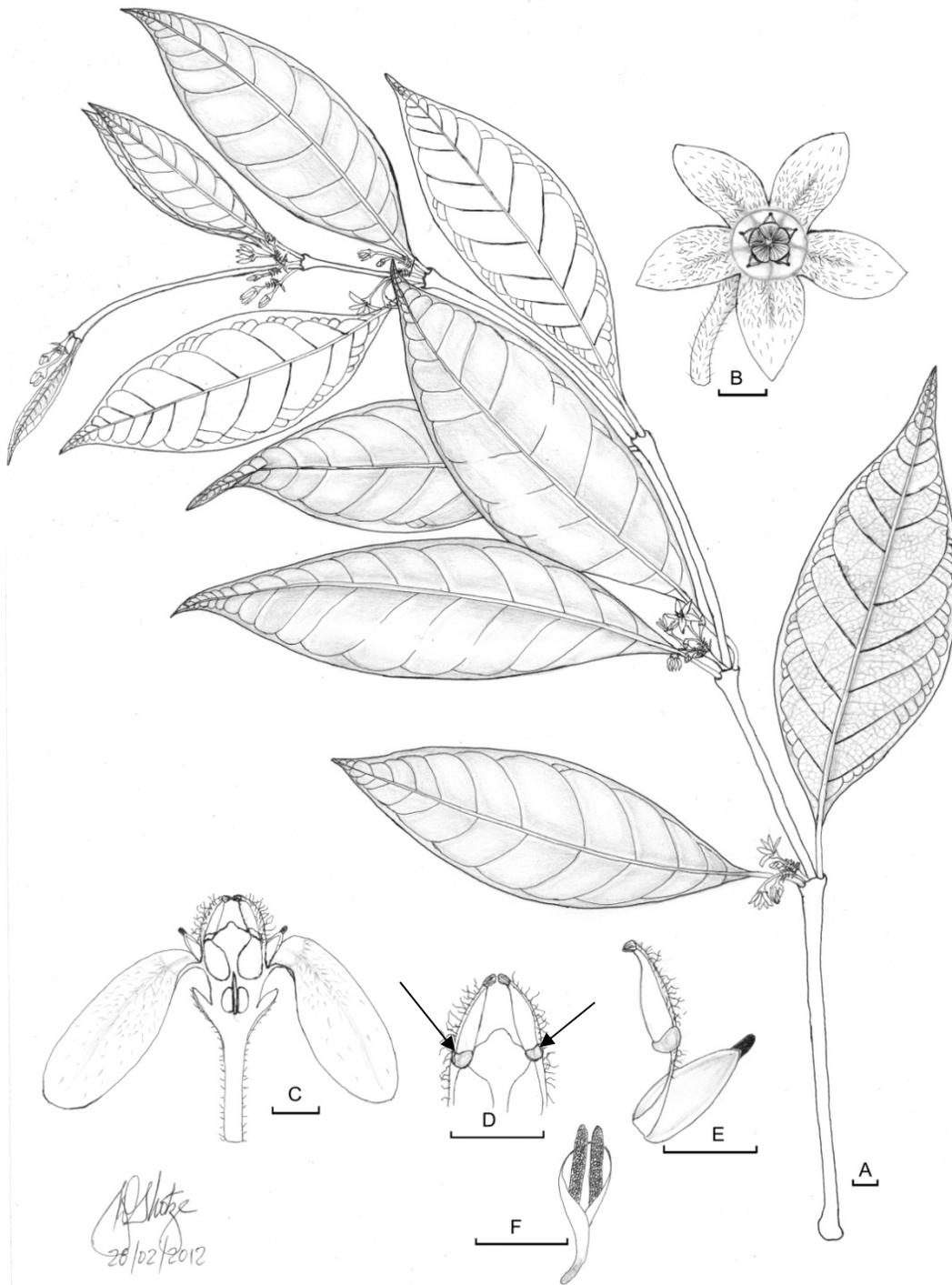


Fig. 4.2.11 *Finlaysonia khasiana*. A: stem with leaves and inflorescences; B: external view of flower; C: longitudinal section of flower showing inverted corolla tube, corona lobes, stamens, ovaries, style and stylar head; D: gynostegium showing stylar head and stamens with basal callosities (\downarrow) and hairy connectives; E: concave-ovate corona lobe and stamen; F: translator with broadly ovate receptacle, folded into a funnel containing two of four pollinia. Scale bars: A = 5 mm; B, C = 1 mm; D, E, F = 1 mm. [A: Henry 13097 (K); B, C, D, E, F: Bor 5601 (K)].

Micromorphology:

Adaxial **leaf epidermal cells** are tetra- to pentagonal in shape. Outer periclinal cell walls are concave to tabular but anticlinal walls are straight. Adaxial leaf epidermis is sparsely scabridulous (Fig. 4.2.12 A). The cuticle is striated. Striations are thick, slightly wavy, radiating from centre of cell and restricted to them, rarely crossing cellular boundaries. Wax particles may be present. (Fig. 4.2.12 B, C).

The abaxial leaf epidermal cells are tetragonal in shape. Outer periclinal walls are convex. Anticlinal walls are straight to slightly curved. Scabridulous hairs are restricted to the main and lateral veins. The cuticle is slightly striated. Striations are slightly wavy. Well defined striations covering subsidiary cells are perpendicular to guard cells or parallel form a peristomatal ring (Fig. 4.2.12 D, E). No wax is present.

The leaves are hypostomatic. Stomata are narrowly ovoid to elliptic and covered by a narrow stomatal ledge. They are randomly arranged and level with the surrounding epidermal cells (Fig. 4.2.12 E).

Pollen tetrads are agglutinated forming an oblong-ovoid pollinium, 291 – 335 x 156 – 175 μm in size (Fig. 4.2.13 A). Distal wall exine is smooth and consist of a compact stratum (tectum) subtended by a granular stratum (Fig.4.2.13 B). The proximal wall has the same exine stratification as the distal wall with tectum and granular stratum. Proximal wall tectum of adjoining tetrads may be fused (Fig. 4.2.13 C). Inner walls consist of a tectum, granular stratum and intine with wall bridges (Fig. 4.2.13 D). (Venter and Verhoeven, 1998).

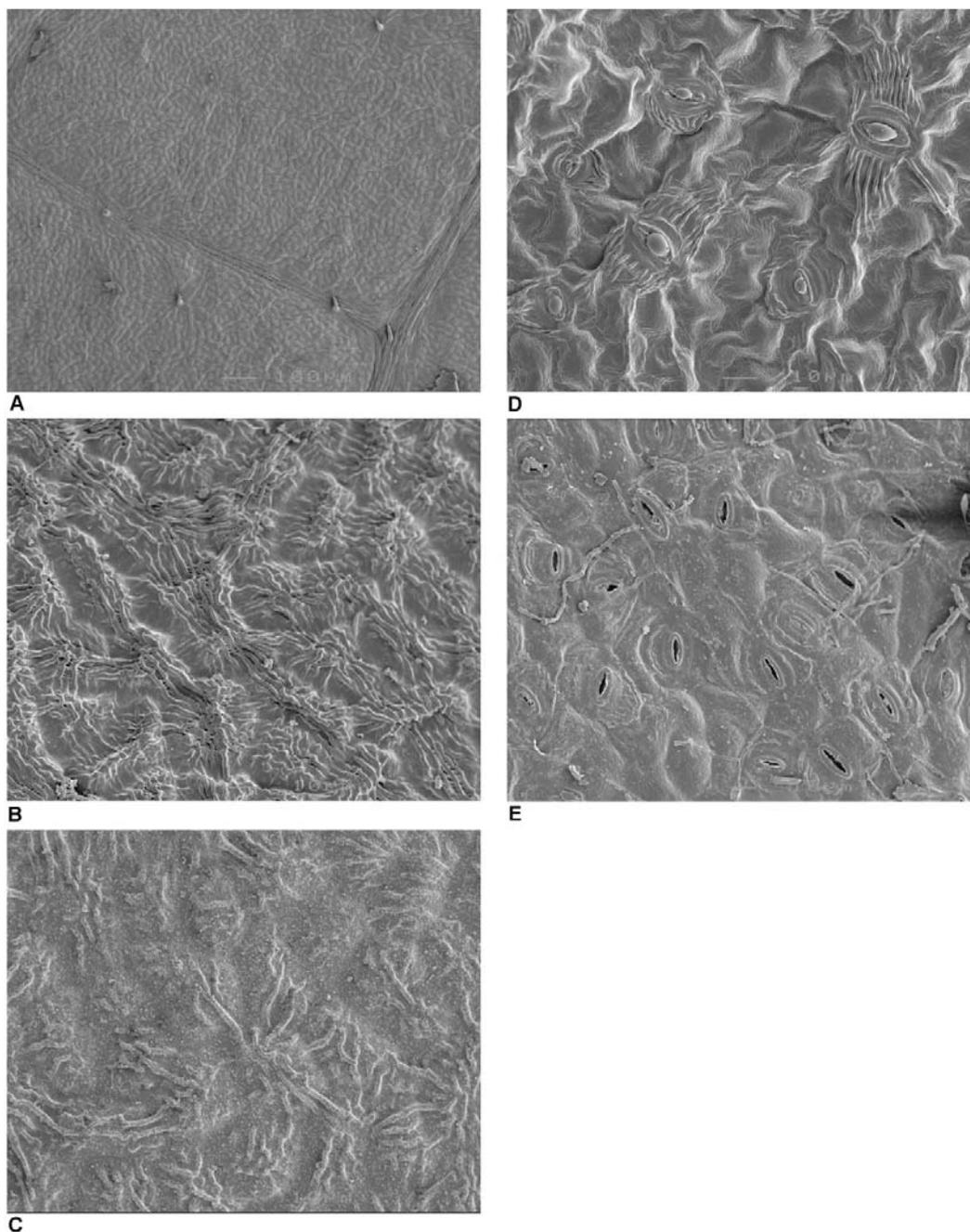


Fig. 4.2.12 *Finlaysonia khasiana*. A: adaxial epidermis showing sparsely distributed trichomes; B: adaxial epidermis showing striated cuticle, without wax; C: adaxial epidermis showing striated cuticle with small wax particles; D, E: abaxial epidermis showing glabrous epidermis with stomata and cuticle with peristomatal rings and striations perpendicular to stomata. Magnification: A = x80; B, C, D, E = x200; [A, B, D: *Bor 5061* (K); C, E: *Thompson 954* (K)].

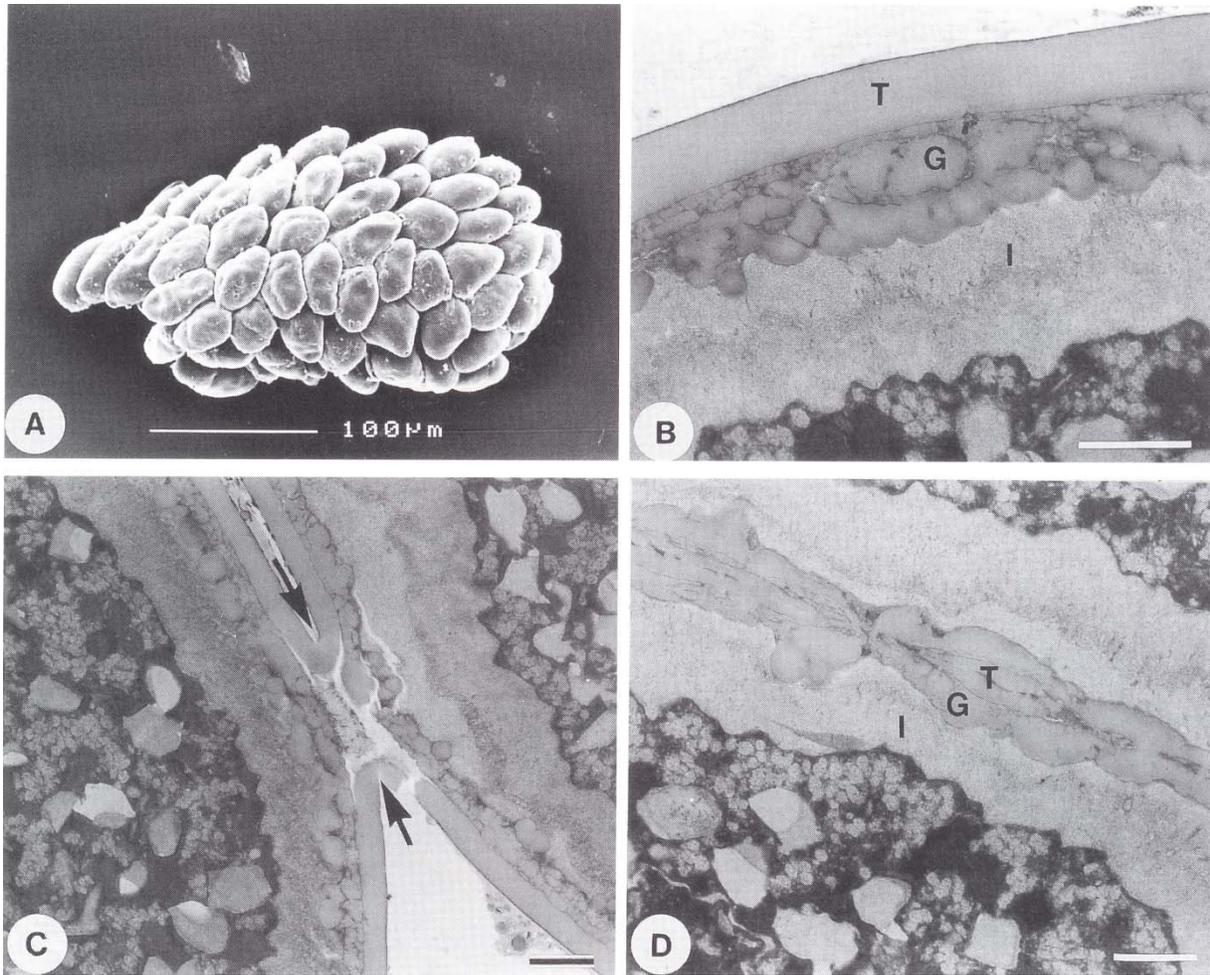


Fig. 4.2.13 Pollinium and pollen wall architecture of *Finlaysonia khasiana* (= *Stelmacrypton khasianum*). A: shape of pollinium; B: distal wall showing tectum (T), granular stratum (G) and intine (I); C: fusion of two tetrads on proximal wall (arrows); D: inner wall showing tectum (T), granular stratum (G) and intine (I) with wall bridges. Scale bars: A = 100 µ; B–D = 1 µ. [A–D: duplicated from Verhoeven and Venter (1998)].

Distribution and habitat

Finlaysonia khasiana is found in Bangladesh, China (Yunnan), India (Assam) and Laos (Fig. 4.2.14). This species grows on hills. Flowering occurs between July and August.

Notes

The specimen in Leiden is without any date, but the material and handwriting on the sheet is the same as that in British Museum. It is therefore regarded as a syntype.

Specimens examined

Bangladesh:

- 24° 53'N, 91° 51'E: Sylhet District, Tamabil-Jaflong Hills, *Rahman & Hossain 56* (ABD, holotype of *Periploca acuminata*; BM, K (2 sheets), isotypes).

China:

- Grid reference unknown: Yunnan, *Anderson, D.J.* (K).
- Grid reference unknown: Yunnan, N. Szemov? *Henry, A. 12061* (K).
- Grid reference unknown: Yunnan, N. Sjemes? NW mountains, *Henry, A. 13097* (K).

India:

- 25° 15'N, 91° 10'E: Megalaya District, Khasia Mountains, *Kurz, J.D.H. & T.T. s.n.*, commissioned for Dr. King, anno 03/1883 (K, lectotype).
- 25° 15'N, 91° 10'E: Megalaya District, Khasia (=Khasi) Hills, *Kurz 357* (K, syntype).
- 25° 15'N, 91° 10'E: Megalaya District, Khasia Mountains, *Hooker, J.D. & Thomson, T. 954* (K).
- 25° 15'N, 91° 10'E: Megalaya District, Khasia Mountains, *Hooker, J.D. & Thomson, T., anno 1859* (BM, L, P, syntypes).
- 25° 15'N, 91° 10'E: Megalaya District, Khasia Mountains, *Hooker, J.D. & Thomson, T. 1746* (K, L, P).
- 26° 10'N, 94° 15'E: Assam Province, Naga Hills, Injaonea, *Bor, N.L. 5061*(K).
- 26° 10'N, 94° 15'E: Assam Province, Naga Hills, Emilomi, *Bor, N.L. 2620* (K).

Laos:

- 19° 21'N, 103° 23'E: Region Xieng-Khonang, Plateau Tran-Ninh, *André, M. s.n.* (P, holotype of *Hanghomia marseillii*).

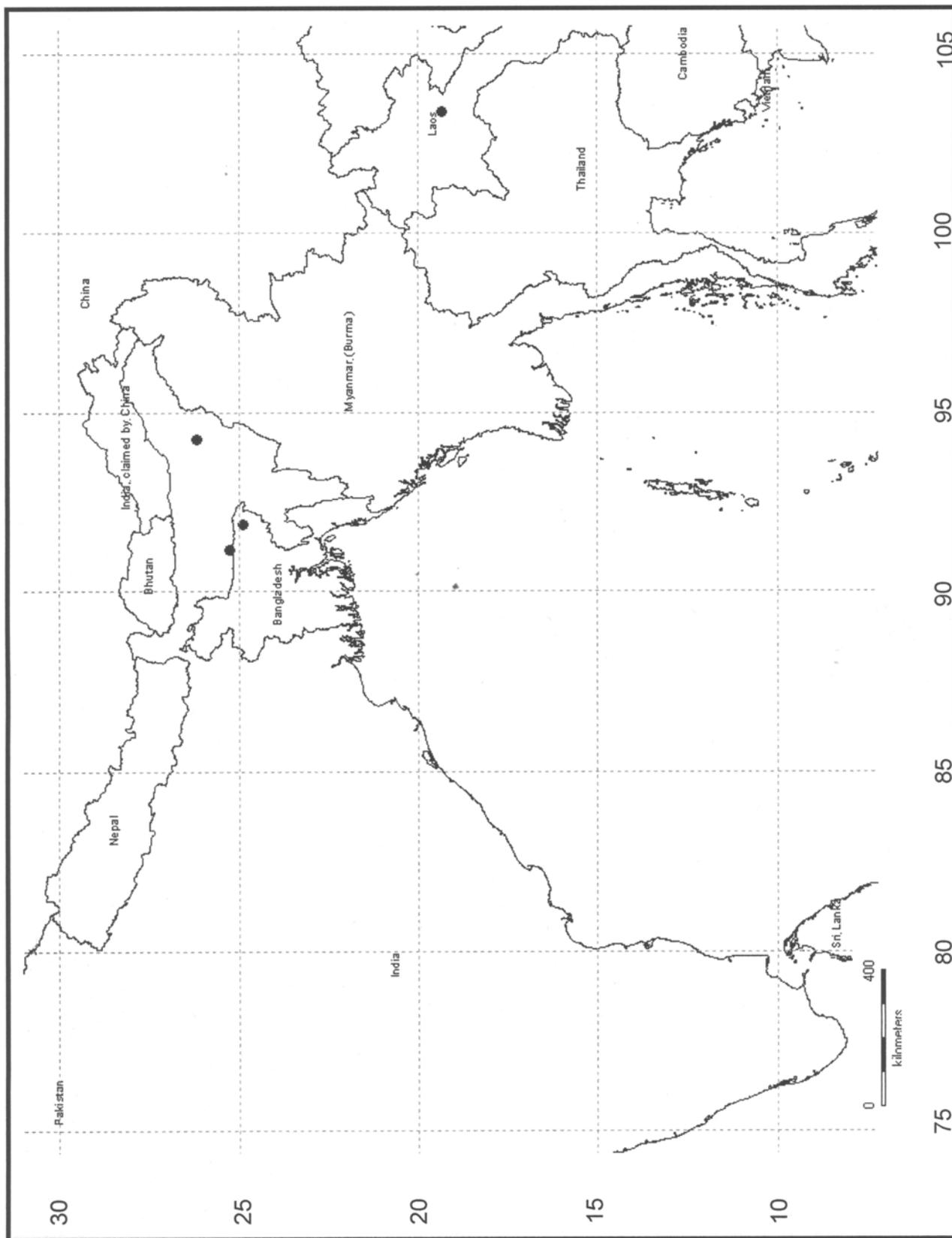


Fig. 4.2.14 Geographical distribution of *Fimalysonia khasiana*

4.2.4 *Finlaysonia obovata* Wall., *Plantae Asiaticae Rariorum* 2: 48, t. 162 (1831); Wight, *Contributions to the Botany of India*: 65 (1834); Drury, *Handbook of Indian Flora* 2: 213 (1866); Hook.f., *Flora of British India* 4: 7-8 (1885); Costantin, *Flora Generale de L'Indo-Chine*: 20 (1912); Blanco, *Novissima Appendix ad Floram Philippinarum*: 132 (1880); Merr., *Species Blancoanae*: 314 (1918).

Types: Burma, River Martabamiae, estuary of the Irawaddi, anno 1827, *K-W 4466A* (K-W!, holotype); Bangladesh, Sundriban = *K-W 4466B* (K-W!, syntype) [see Notes, No. 1, p. 69] (Fig. 4.2.15).

= *Gurua obovata* (Wall.) Buch.-Ham. ex Voigt, *Hortus Suburbanus Calcuttensis*: 544 (1845).

Type: India, Sunderban, *Buchanan-Hamilton 757* (E-scan!, isosyntype) [see Notes, No. 2, p. 69].

= *Tabernaemontana cirrhosa* Blanco, *Flora Filipinas*: 115 (1837).

Type: not designated, synonymy after Villar, *Nov. App.*: 1880; confirmed by Merrill (1918).

Macromorphology

Lianas. **Stems:** bark glossy, reddish-brown, glabrous, nodes glabrous; colleters numerous. **Leaves** petiolate; petiole 10–15(–20) x 2–3 mm, glabrous; axil glabrous to slightly villous; blade obovate to elliptic, 81–115(–123) x 33–66 mm, coriaceous, glabrous on both surfaces, apex obtuse-mucronate to acuminate, rarely obtuse, base cuneate to obliquely cuneate, rarely obliquely round, venation brochidodromous, 10–16 secondary veins on either side of main vein, divaricate, nearly patent, tertiary venation random reticulate, areoles well developed, rarely incomplete, without veinlets.



Fig. 4.2.15 Type specimen of *Finlaysonia obovata* Wall. (K-W 4466B, holotype (K-W)).

Inflorescences axillary, open, dichasial or dichasia with monochasial branches, each with 3 to 15 flowers, primary peduncles 12–13 mm long, secondary peduncles 8–16 mm long, tertiary peduncles 4–7 mm long, scabridulous; pedicels 3–5 mm long, glabrous to scabridulous; bracts opposite on dichasial peduncles, alternate on monochasial peduncles, ovate to broadly triangular-ovate, naviculate, 1.5–2 x 1–2 mm, glabrous with fimbriate margin. **Floral buds** orbicular, 3–4 mm long, apex obtuse. **Sepals** broadly ovate, 1 x 1.2–1.3 mm, glabrous with fimbriate margins, apices acute to obtuse; colleter compound. **Corolla** cream coloured to pale yellow to pale green, speckled brown outside; tube shallowly campanulate, 1–1.5 mm long, glabrous outside, inside villous; lobes ovate to oblong-ovate, 3–5 x 2–3.5 mm, coriaceous, outside glabrous, inside villous with white hair, margins partly membranous and partly hairy, apices obtuse. **Corona** lobes filiform, 2–2.5 mm long, apices entire, glabrous; coronal feet ovoid, 0.5 x 0.8 mm, herbaceous, glabrous. **Stamens:** filament 0.5–0.7 mm long, terete, curved-erect, glabrous; anther glabrous, oblong-ovate, 1–1.2 x 0.4–0.5 mm; thecae whitish, oblong-ellipsoid to oblong-ovoid with basal callosities, dehiscent with half length slits, connective glabrous, connective appendage purple, conical, glabrous; pollinia oblong-ellipsoid. **Nectary** rim without interstaminal lobules. **Pistil:** styles terete, 0.6–1 mm long; stylar head broadly angular-ovoid, glabrous, 0.7–0.8 x 0.4–0.6 mm, apex acute, acute-obtuse to notched; translator receptacle broadly ovate folded funnel-like, apex shallowly split, stype filiform. **Follicles** dark brown, horizontal, keel-shaped, 60–74 x 25–34 mm, pericarp surface glabrous and coriaceous; apex incurved, attenuate; seed reddish-brown, 15–20 x 7–12 mm, obovate, broad and flat; coma absent, margin winged and fimbriate. (Fig. 2.4.16).

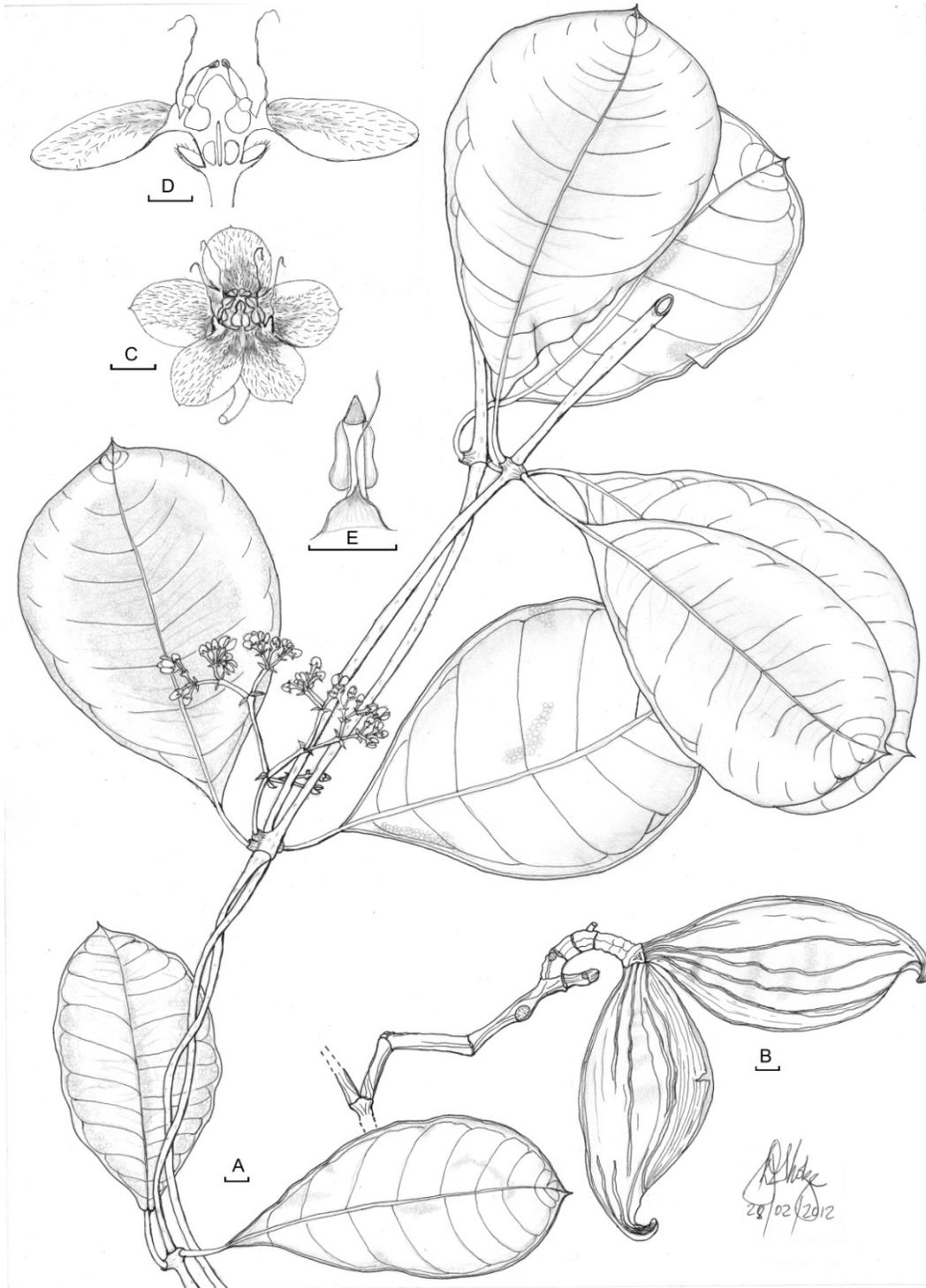


Fig. 4.2.16 *Finlaysonia obovata*. A: stem with leaves and inflorescences; B: stem with keel-shaped follicles; C: external view of flower; D: longitudinal section of flower showing inverted corolla tube, corona lobes, stamens, ovaries, style and styler head; E: stamen showing thecae, apically deltoid connective appendage and filament inserted at inner base of broadened coronal foot. Scale bars: A, B = 5 mm; C, D, E = 1 mm. [A: *Ngadiman* 376 (K) and *Chua* 22/94 (K); B: *Sidiyisa* 1395 (K); C, D and E: *Robinson* 6349 (K)].

Micromorphology:

The adaxial **leaf epidermal cells** are tetragonal to rhombic. Outer periclinal cell walls are concave to tabular. Anticlinal walls are straight. Adaxial epidermis is glabrous. The cuticle is smooth to slightly striated (Fig. 4.2.17 A). Striations are slightly wavy. Cuticular folds may occur (Fig. 4.2.17 B). No wax is present.

On the abaxial epidermis cell shape is not clearly distinguishable. Outer periclinal cell walls are tabular. Abaxial leaf epidermis is glabrous (Fig. 4.2.17 C). Cuticle is smooth to slightly striated. Striations are slightly wavy. No wax is present.

The leaves are hypostomatic. The stomata are elliptic with peristomatal rims and broad stomatal ledges (Fig. 4.2.17 D). Stomata are slightly sunken or level with the surface. Stomata are arranged in clusters with definite distance from each cluster (Fig. 4.2.17 C).

The upper **seed coat** surface is smooth with winged and fimbriate margin (Fig. 4.5.4 A). Epidermal cells are isodiametric, penta- to hexagonal and are tightly and uniformly packed (Fig. 4.2.18 B). The outer periclinal walls are tabular. Anticlinal walls are straight to wavy. The cuticle is smooth to slightly striated (Fig. 4.2.18 C).

The lower seed coat surface is morphologically similar to the upper seed coat from the photograph taken with a light microscope (Fig. 4.2.18 A). Epidermal cells at the center are elongate, tetragonal and linearly arranged with convex periclinal walls. Anticlinal walls are straight (Fig. 4.2.18 D). Epidermal cells towards the margin (outer region) are pentagonal to contorted (Fig. 4.2.18 E). Outer periclinal walls are tabular to convex. Anticlinal walls are straight to undulating. The cuticle is smooth to slightly striated (Fig. 4.2.18 E).

Pollen tetrads are grouped together forming an oblong-ellipsoid pollinium 183–313 x 129–183 μm (Fig. 4.2.19 A). Pores were present in proximal walls (Fig. 4.2.19 B). The granular stratum shows osmiophilic material between granules (Fig. 4.2.19 D). Inner walls consist of granular stratum and intine without wall bridges (Fig. 4.2.19 C). Pointed outgrowths with thick granular layer are characteristic of these species (Fig. 4.2.19 D) (Venter and Verhoeven, 1998).

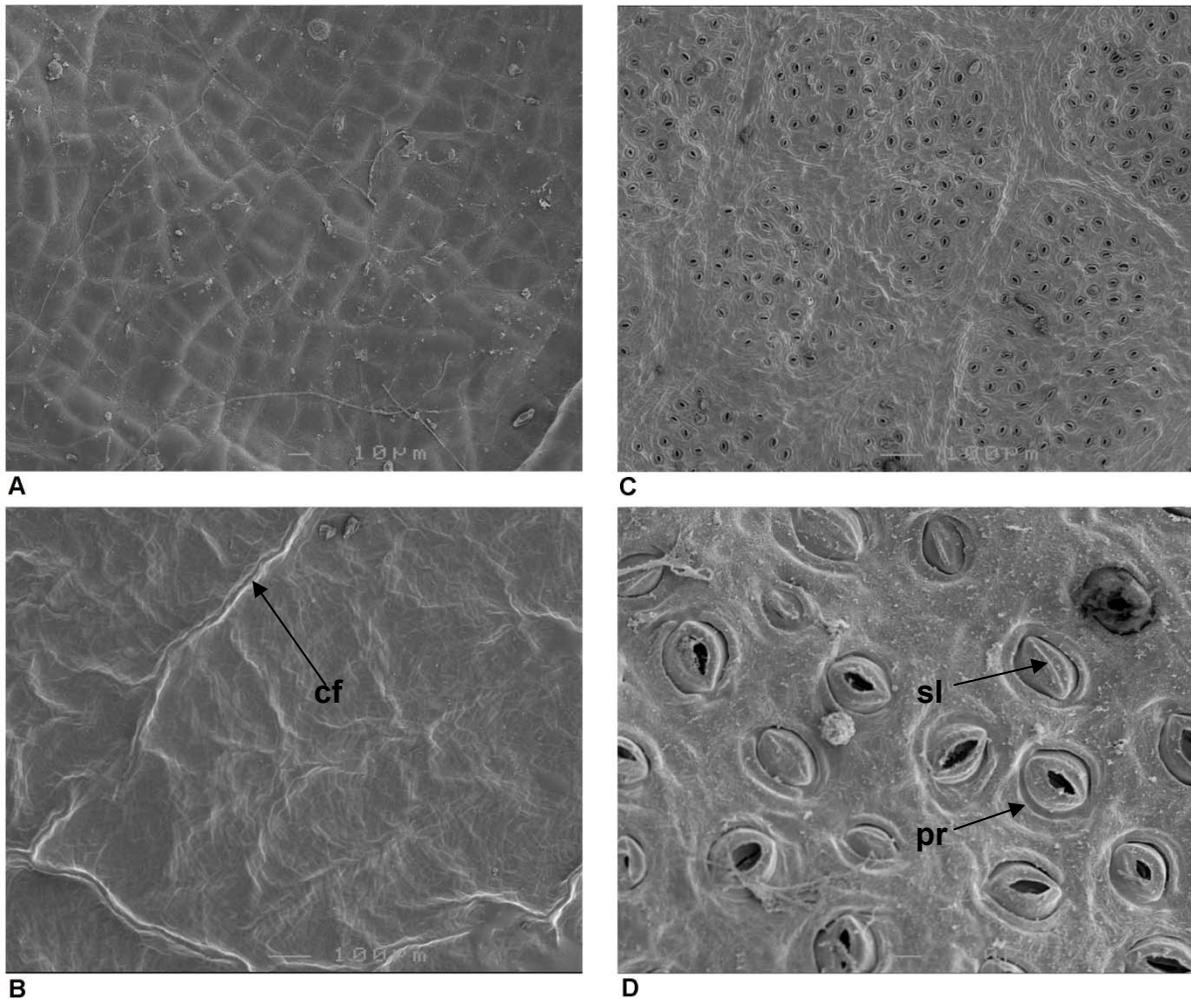


Fig. 4.2.17 *Finlaysonia obovata*. A: adaxial epidermis showing smooth cuticle; B: adaxial epidermis showing smooth cuticle and cuticular fold; C: abaxial epidermis showing glabrous epidermis and clustered stomatal arrangement; D: abaxial epidermis showing elliptic stomata with peristomatal rims and broad stomatal ledges; cf: cuticular fold; sl: stomatal ledge; pr: peristomatal rim. Magnification: A, C = x80; B, D = x200. [A, C: Kerr 1420 (K); B, D: Ngadiman 376 (K)].

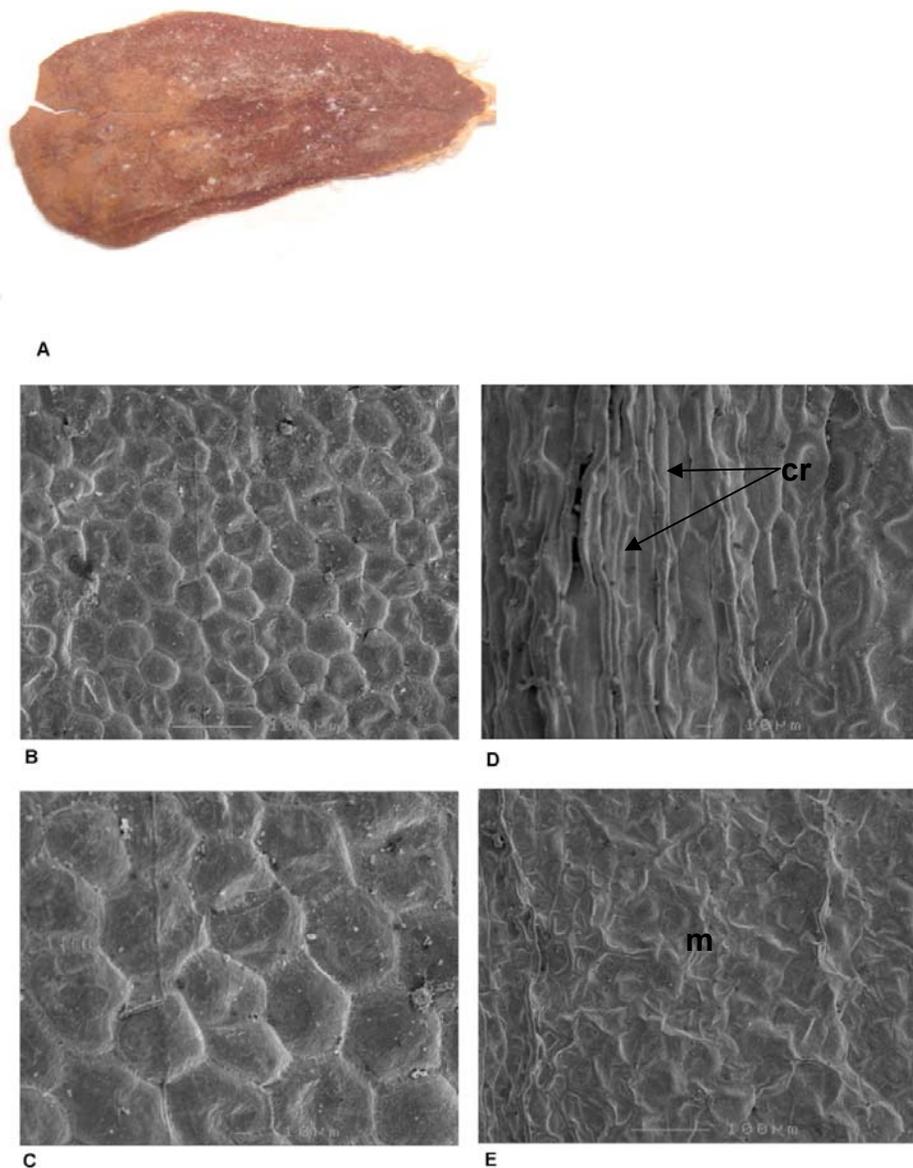


Fig. 4.2.18 *Finlaysonia obovata*. A: upper seed coat showing smooth surface, winged and fimbriate margin; B, C: upper seed coat showing isodiametric, penta- to hexagonal epidermal cells, tabular periclinal walls and straight anticlinal walls; D: lower seed coat showing elongated, tetragonal cells at the central region; E: lower seed coat showing contorted cells towards margin; cr: central region; m: marginal region. Magnification: B = x200; C, D, E = x400. [A–E: Van Rooyen 3303 (K)].

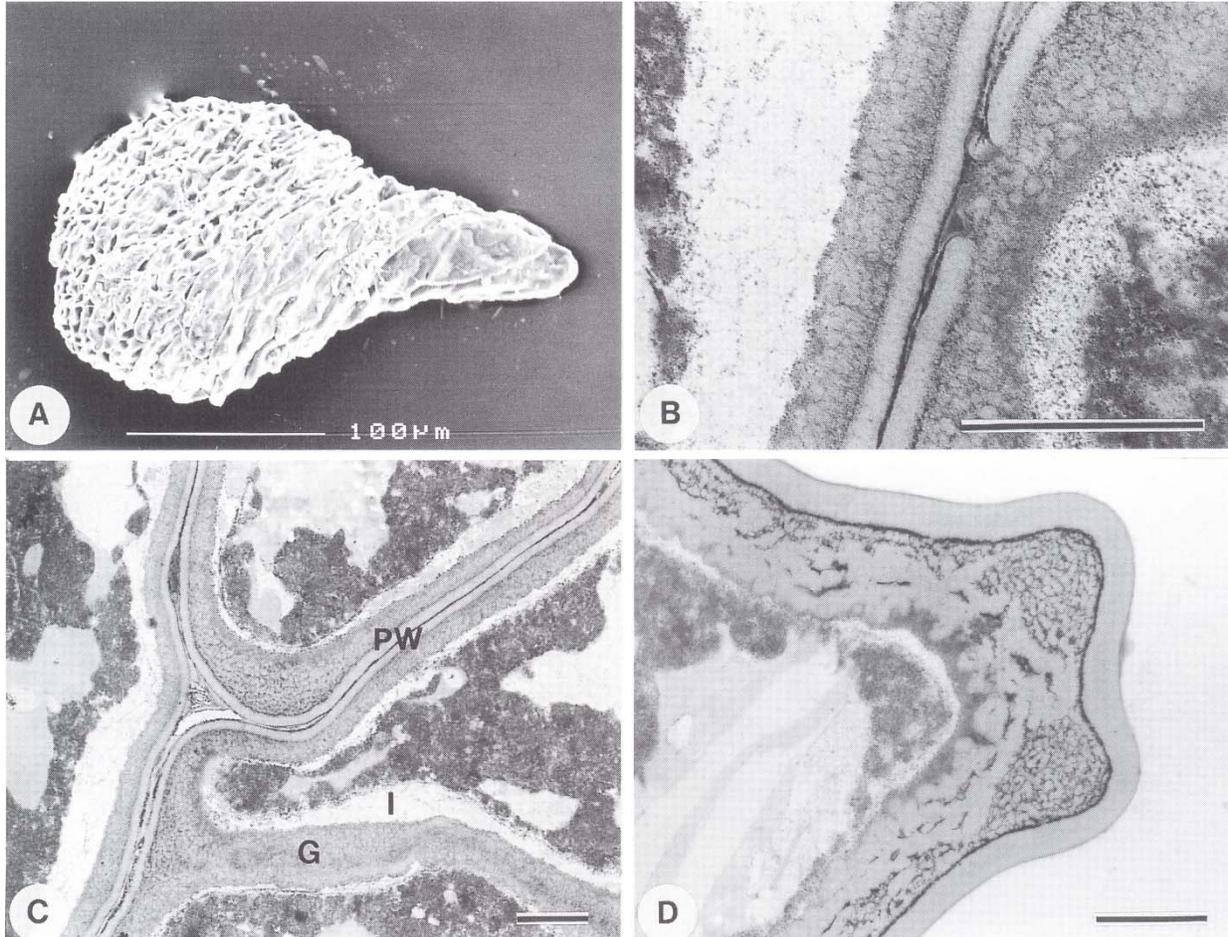


Fig. 4.2.19 Pollinium and pollen wall architecture of *Finlaysonia obovata* (= *F. maritima*). A: shape of pollinium; B: pores on the proximal wall between tetrads; C: proximal walls (PW) between tetrads and inner walls consisting of granular stratum (G) and intine (I) without wall bridges; D: pointed outgrowths with thick granular stratum and osmiophilic material between granules. Scale bars: A = 100 μ ; B–D = 1 μ . [A–D: duplicated from Verhoeven and Venter (1998)].

Distribution and habitat

Finlaysonia obovata is widely distributed over Asia and Australasia in Bangladesh, Brunei, India (Calcutta), Indonesia, Malaysia (Langkawi islands), Myanmar, Papua New Guinea, Philippines, Singapore, Thailand, Vietnam and Australia in the north of the Cape York Peninsula, Queensland (Fig. 4.2.20) and the Northern Territory where the species is known to be rare (Duke, 2006).

Finlaysonia obovata commonly climbs in and over forest canopies in mangrove swamps and tidal river banks. Flowering occurs throughout the year, peaking during the summer months of July and August.

Notes

1. In the Herbarium of the Honourable East India Company two sheets (K-W 4466A and B) have been placed in the type file of *Finlaysonia obovata*. The locality information on specimen 4466A corresponds with the information given by Wallich in the type description of this species (River Martabamiae), although no type is indicated. Therefore, 4466A is considered to be the holotype. On specimen 4466A's label Wallich also indicates the presence of 4466B with locality the Sunderbans corresponding to the label on specimen B, collected in September 1809 and given the name *Gurua obovata*. In his description Wallich explained that he has chosen the generic name *Finlaysonia* commemorating his friend, Dr. Finlayson, before he was aware of Dr Hamilton's provisional name of *Gurua* for this new genus, probably in reference to this second specimen, K-W 4466B, which is therefore considered as a syntype.

2. Voight gave a very brief description of *Gurua obovata* and a specific locality, but did not designate a type specimen. According to Edinburg (E) this species is represented by the collection *Buchanan-Hamilton 757*, anno 23/09/1800 in Edinburg Herbarium and which is annotated as *Gurua obovata*. This specimen is regarded as an isosyntype. The whereabouts of any other syntypes could not be determined.

Specimens examined

Australia:

- 12° 38' 44'S, 141° 53'E: Queensland, Cape York Peninsula, Nesbit River, *Forster*, *P.I. PIF 7088* (BRI).

Bangladesh:

- 21° 50'N, 89°50'E: Sundar-ban (= Sundri-ban), *K-W 4466B* (K-W, syntype).

Brunei:

- 04° 53'N, 114°56'E: Bandar Seri Begawan (= Brunei town), *Van Niel, J.P. 3781* (L).
- 04° 53'N, 114°56'E: Bandar Seri Begawan (= Brunei town), *Van Niel, J.P. 3806* (L).

India:

- 21°56'N, 88°53'E: West Bengal, Sunder-ban Government Reserve Forest, *Heinig, R.L. s.n.* (P).
- 22°34'N, 88°22'E: Calcutta, salt lakes, *Clarke, C.B. 21609* (K).

Indonesia:

- 00°50'N, 103°20'E: Riau Islands, Pulau Kundur, *Teruga, Z. 2779* (K, L).
- 01°08'N, 120° 23'E: Sulawesi coast, 31 km north of Poso to Parigi-poso, *Sidiyasa, K. 1395* (K).
- 01° 50'N, 120° 47'E: Coast of Sulawesi, Poso, *Leeuwenberg, et al. 1395* (K).
- 03°43'S, 128°12'E: Molukken, Amboina Island, *Robinson, C.B. 89* (L).
- 03° 47'S, 115° 27'E: Borneo, Satui (= Satul), *Kerr, A.F.G. 14250* (K, L, P).
- 06°35'S, 106°47'E: Bogor, west Flores, southern part, coast near Mborong, *Kosterman 22082* (K, L).
- 07°16'S, 112°45'E: Java, Soerabaja, *Massart s.n.* (L).
- 08° 15'S, 115° 10'E: Bali, Sanur (instead of Sangel), *De Voogd, C.A.N. 2035* (L).

- 08° 47'S, 115° 13'E: Bali, northwest Bena Bay, north of Tuban, *Gordon, D. & Bougher, A. M26* (L).

Malaysia:

- 01°26'N, 110°30'E: Sarawak Forest, Berloben, 10 km Tebakang to Tebedu, *Yii & Othman S. 46237* (K).
- 01°22'N, 103°54'E: Johore, south Sedill, Kampong Ladang, *Corner, E.J.H. 28647* (K).
- 01°49'N, 103°47'E: Johore, 11.5 miles from Kota Tinggi to Mersing, *T. and P. 867* (Phytochemical survey) (K).
- 01°48'N, 109°46': Sarawak, near Sematan Air Field, *Chai, P. & Ching, Y. S. 39948* (L).
- 02°25'N, 111°16'E: Sarawak, Kuala Paloh, seaward side of Loba Paloh, *Chai P. et al. S.30664* (K).
- 02°51'N, 101°23'E: Selangor, Pulau Carey, *Rintz, R.E. 95* (L).
- 06°21'N, 99°48'E: Langkawi Island, Terutan, Teloh Wai, *Robinson, H.C. 6349* (K).
- Grid reference unknown: *Maingay M. D. 1104* (K).

Myanmar:

- 12°30'N, 92°45'E: Andamans, *Helper 1048* (K).
- 13°10'N, 99°05'E: Tenasserim (now Tanintharye), *Helper 3749* (K).
- 16° 23'N, 97° 35'E: River Martabamiae, *K-W 4466A* (K-W, holotype).

New Guinea (including Papua New Guinea):

- 01°50'S 136°18'E: Yapen (= Japen-Biak), Sei Popoma near Serui (= Seroei), *Van Dijk, L.J. 701* (L).
- 05°20'S, 141°36'E: Mount Jaya, *Purudyatmika, P. 10415* (K).
- 06°44'S, 147°00'E: Busu river, 13 miles north of Lae, Morobe District, *Hartley, T. 11926* (K).

- 07°34'S 144° 49' E: Gulf District, Subdistrict Baimuru, tributary of Era River, *Croft, J. & Vinas, A. LAE61302* (L).
- 07°58'S, 145°46'E: Gulf District, Kerema Bay, 5 miles NW of Kerema, *Schodde, R. 4205* (K).
- 08°59'S, 146°58'E: Central District, Kairuku (= Kaituku) Subdistrict, 8 km SW of Kanosia, *Darbyshire, P.J. 631* (L).
- 08°59'S, 146°58'E: Kanosia, *Carr, C.E. 110022* (L).
- 09°20'S, 150°15'E: Milne Bay District, Cape Vogel Peninsula, *Brass, L.J. 21694* (L).
- 09°20'S, 150°15 'E: Milne Bay District, Cape Vogel Peninsula, *Brass, L.J. 21707* (L).

Philippines

- 11°30'N, 122°53'E: Capiz Province, Panay Island, *Ramos, M. & Edano, G. (Bureau of Science no. 31503)* (K, P).
- 14°35'N, 120°58'E: Manila, Amboina, *Robinson, C.B. 89* (K).

Singapore:

- 01° 17'N, 103° 47'E: Singapore, *Tan et al. 1/1994* (SINU).
- 01° 25'N, 103° 45'E: Kranji Nature Reserve, *Ngadiman 317* (K).
- 01°26'N, 103°44'E: Kranji Mangroves, facing Strait of Johor, *Maxwell, J.F. 81/70* (L).
- 01° 26'N, 103° 50'E: Simgi, Simpong, *K-X Tan 1293* (SINU).
- 01° 18'N, 103° 44'E: Jurong, *Medley, H.N. s.n., anno 1890* (K).

Thailand:

- 06°40'N, 101°01'E: Province Satun, south of Satun, *Larsen, K. et al. 41165* (P).
- 08°07'N, 99°06'E: Krabi, *Kerr, A.F.G. 17475* (L, P).
- 09°35'N, 98°36'E: Kapoe (= Kapôr), Ranuury, *Kerr, A.F.G. 16766* (K).
- 12°55'N, 100°52'E: Klung, Chantatum, *Kerr, A.F.G. 17947* (K).

Vietnam:

- 10°58'N, 106°50'E: Bien Hoa Province, Bao-Chiang, *Pierre*, L. 3401 (P).

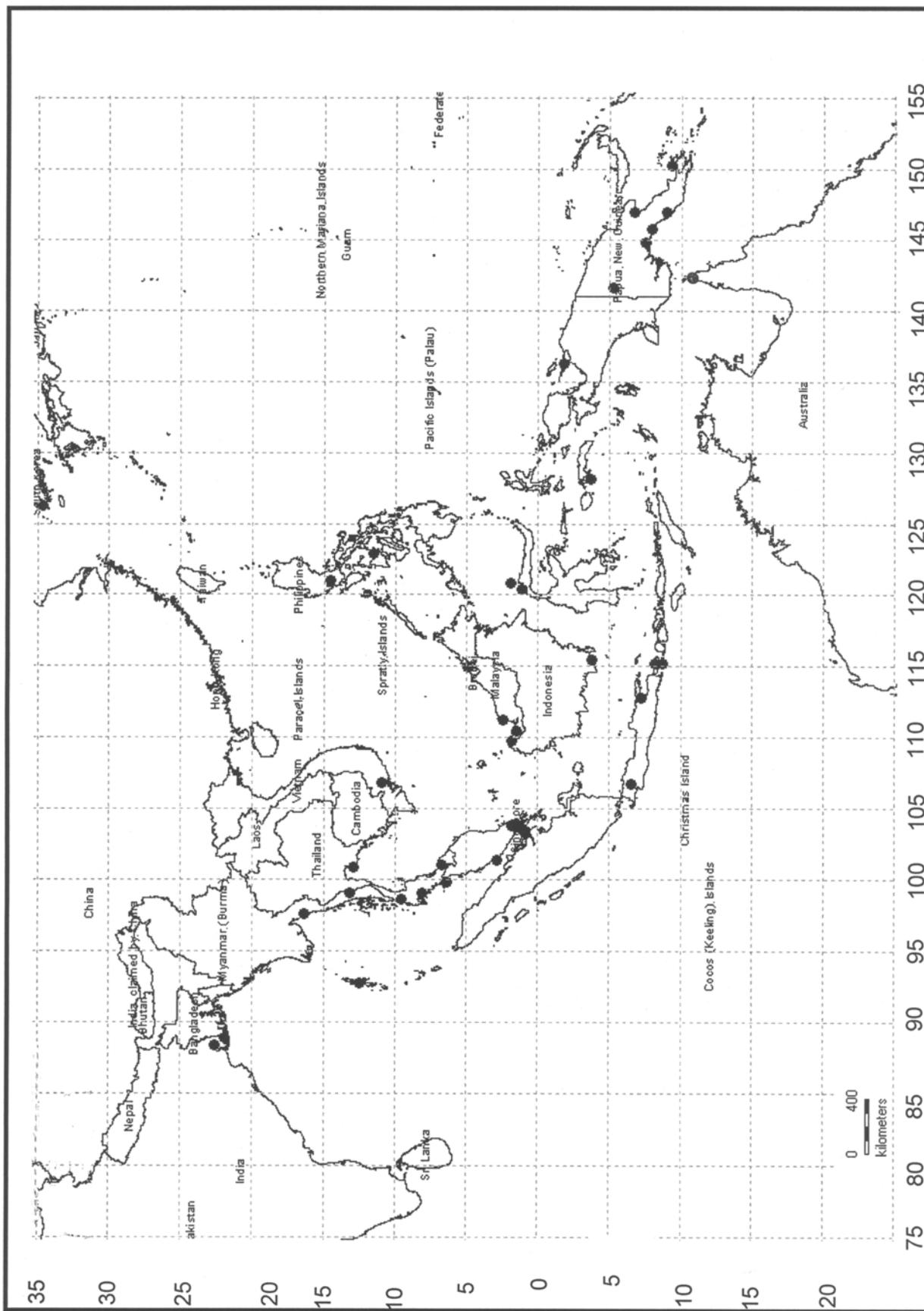


Fig. 4.2.20 Geographical distribution of *Finlaysonia obovata*

4.2.5 *Finlaysonia pierrei* (Costantin) Venter in Venter & R.L. Verh., *Annals of the Missouri Botanical Garden* 88: 565 (2001).

Basionym: *Atherolepis pierrei* Costantin in Lecomte, *Flore Générale de Indo-Chine* 4: 29 (1912).

Type: Vietnam, Provence Bien-hoa, Bao-chiang, *Pierre 4376* (P!, lectotype designated by Venter (2001); BM!, P (6 sheets)!, K!, isotypes) [see Notes, No. 1, p. 83] (Fig. 4.2.21).

= *Atherolepis pierrei* var. *glabra* – *nom. nud.*, *In shed.* [see Notes, No. 2, p. 83].
Specimens: Thailand, Bangkok, *Kerr 3706* (BM!, K!).

Macromorphology

Climbers. **Stems:** bark pale reddish-brown, glabrous to pubescent; nodes puberulent with dirty white hairs; colleters numerous. **Leaves** subsessile to petiolate; petiole 0.5–1.5 x 1 mm, puberulent; axil villous; blade oblong-ovate to obovate, rarely narrowly elliptic, 30–73(–87) x 10–25(–30) mm, herbaceous, glabrous to pilose on both surfaces or on veins only, apex obtuse-mucronate, rarely acute, base cordate to round, rarely cuneate, venation brochidodromous, 8–13 secondary veins on either side of main vein, divaricate, tertiary venation random reticulate, areoles imperfect, with veinlets.

Inflorescences axillary, compact dichasia terminating in monochasial branches, each with 5–6 flowers; peduncles 0.5–1 mm long on dichasial branches, 4 mm long on monochasial branches, pubescent with white hairs; pedicels 1–2 mm long, pubescent; bracts opposite at branching point of peduncles to densely stacked on monochasial peduncles, broadly ovate, naviculate, 2 x 2–2.5 mm, outside and margins pubescent with white hair. **Floral buds** conical, 4 mm long, apices attenuate. **Sepals** narrowly ovate to broadly ovate, 1.7–2.0 x 0.6–2.2 mm, outside pubescent with white hair; apices acute to acuminate; colleters free. **Corolla** pale green to yellow with reddish tinges; tube bowl-shaped, 1 mm long, glabrous on the outside to slightly puberulous on the inside; lobes ovate, 4–5 x 2 mm, coriaceous, outside glabrous, inside puberulous with white hairs, margins fimbriate, apices acute to acuminate or attenuate. **Corona** lobes basally

concave-ovoid, apically cylindric-filiform, 0.5–1.2 mm long, glabrous; coronal feet oblong-ovoid, glabrous to papillose on outside. **Stamens:** filament linear to linear-terete,

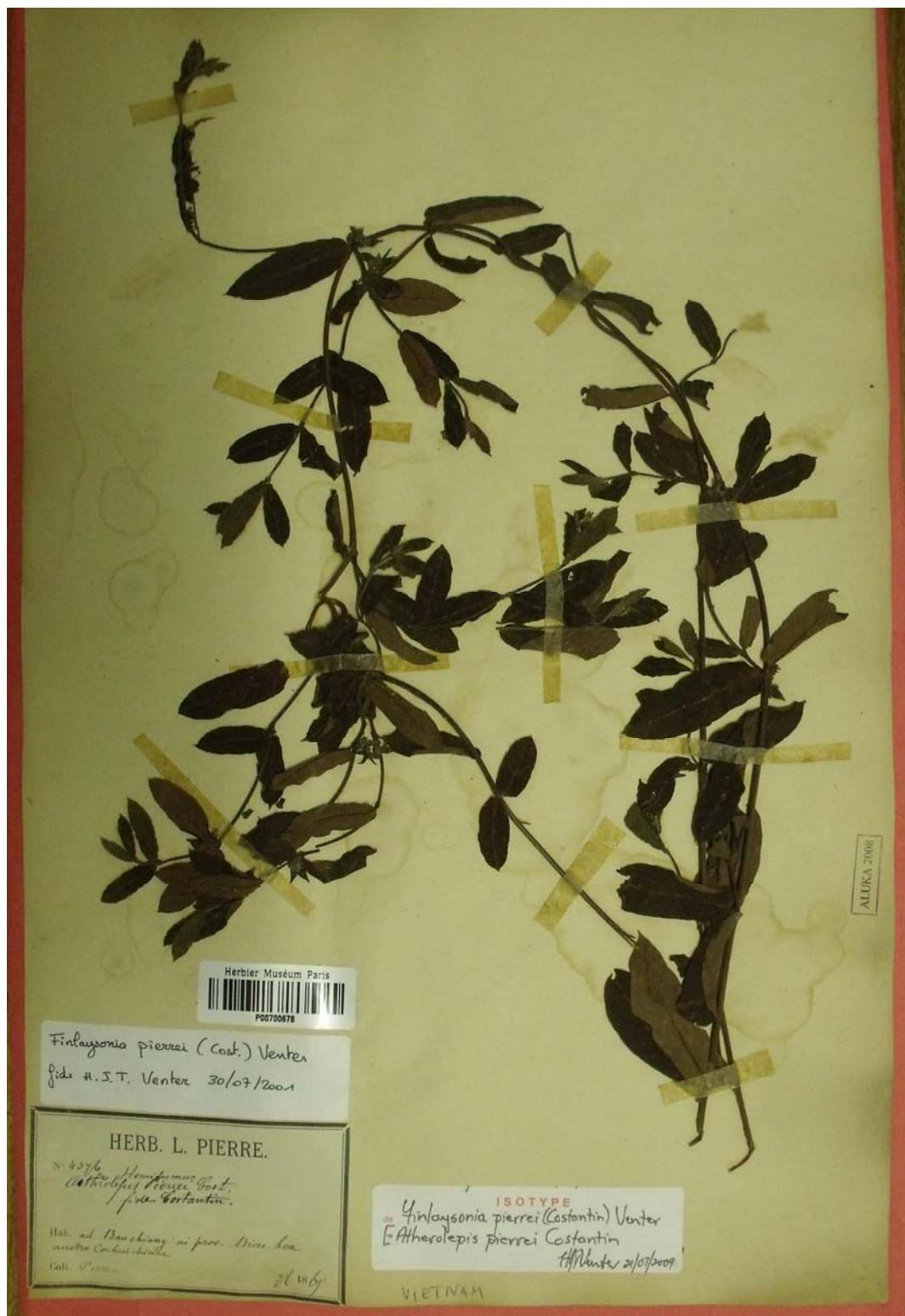


Fig. 4.2.21 Type specimen of *Finlaysonia pierreii* (Costantin) Venter (*Kerr* 3706, isotype (P)).

0.5–0.8 mm long, erect; anther glabrous, narrowly ovate to ovate-elliptic, 0.9–1 x 0.4–0.5 mm; thecae narrowly ovate to oblong-ovate with no basal callosities, dehiscent with full length slits, connective glabrous, connective appendage darker-coloured than other cells, conical to deltoid, glabrous; pollinia oblong-ovoid. **Nectary** rim without interstaminal lobules. **Pistil**: styles \pm 0.5 mm long; stylar head broadly angular-ovoid, 0.6–1 x 1–1.2 mm, apex obtuse to bluntly obtuse; translator receptacle ovate, stype terete. **Follicles** dark brown, horizontal, falcate-ovoid, 40 x 10 mm, pericarp surface glabrous and coriaceous, apex acute and hooked; seed dark brown, 5–6 x 2 mm, narrowly oblong-ovoid; coma pale coppery coloured, 25–45 mm long. (Fig. 4.2.22).



Fig. 4.2.22 *Finlaysonia pierrei*. A: stem with leaves and inflorescences; B: longitudinal section of flower showing inverted corolla tube, corona lobes, stamens, ovaries, style and styler head; C: semi-inferior ovaries, style and gynostegium; D: inner and outer views of stamen and basally concave-ovate to apically filiform corona lobe; E: translator carrying four pollinia. Scale bars: A = 5 mm; B, C, D, E = 1 mm. [A, C, D: *Pierre 4376 (P)*; B, E: sketches from *Larsen et al. 31732 (L)*].

Micromorphology

The adaxial **leaf epidermal cells** are tetragonal to hexagonal in shape (Fig. 4.2.23 B, C). Outer periclinal cell walls are convex (Fig. 4.2.23 B) to tabular (Fig. 4.2.23 C). The adaxial epidermis may be sparsely pilose or glabrous, distributed over the lamina or restricted to main and lateral veins only (Fig. 4.2.23 A). The cuticle striations are randomly oriented, wavy, radiating from the centre of the cells and restricted within cell boundaries or rarely crossing cellular boundaries. No wax is present (Fig. 4.2.23 C).

Where visible, the abaxial epidermal cells are tetra- to pentagonal. Outer periclinal cell walls are tabular. The abaxial epidermis may be hairy or glabrous. The hairs are dense and pilose (Fig. 4.2.23 D). The cuticle striations are parallel, perpendicular to stomata and are continuous over intercellular boundaries (Fig. 4.2.23 E). Wax particles are restricted to the main vein (Fig. 4.2.23 F).

The leaves are hypostomatic. Stomata are elliptic with narrow stomatal ledges, and are randomly oriented and level with the epidermal surface (Fig. 4.2.23 E).

The upper **seed coat** surface has ridges with a warty margin which are formed by raised epidermal cells (Fig. 4.2.24 A). Epidermal cells are isodiametric, tetra- to pentagonal and are tightly packed (Fig. 4.2.18 B). The outer periclinal walls are tabular. Anticlinal walls are straight. The cuticle is smooth (Fig. 4.2.24 C).

The lower seed coat surface has flat broad suture ridges (Fig. 4.2.24 D). Epidermal cells are round to pentagonal with convex outer periclinal walls (Fig. 4.2.24 E). Anticlinal walls are wavy. Cuticle is smooth (Fig. 4.2.24 F).

Pollen tetrads are grouped together forming an oblong-ovoid pollinium (Fig. 4.2.25 A), 210–417 x 112–192 μm . No pores were observed in proximal surface. However, pores were observed in proximal walls (Fig. 4.2.25 B). The tectum and granular stratum of adjoining tetrads may be fused where pores of adjoining tetrads are opposite to each other (Fig. 4.2.25 B, C). The granular stratum of the distal wall have relatively few larger granules towards the base of the stratum (Fig. 4.2.25 D). The proximal wall has the same exine stratification as the distal wall with tectum and granular stratum (Fig. 4.3.25 E). Inner walls are made up of a granular stratum and intine with wall bridges. (Venter and Verhoeven, 1998).

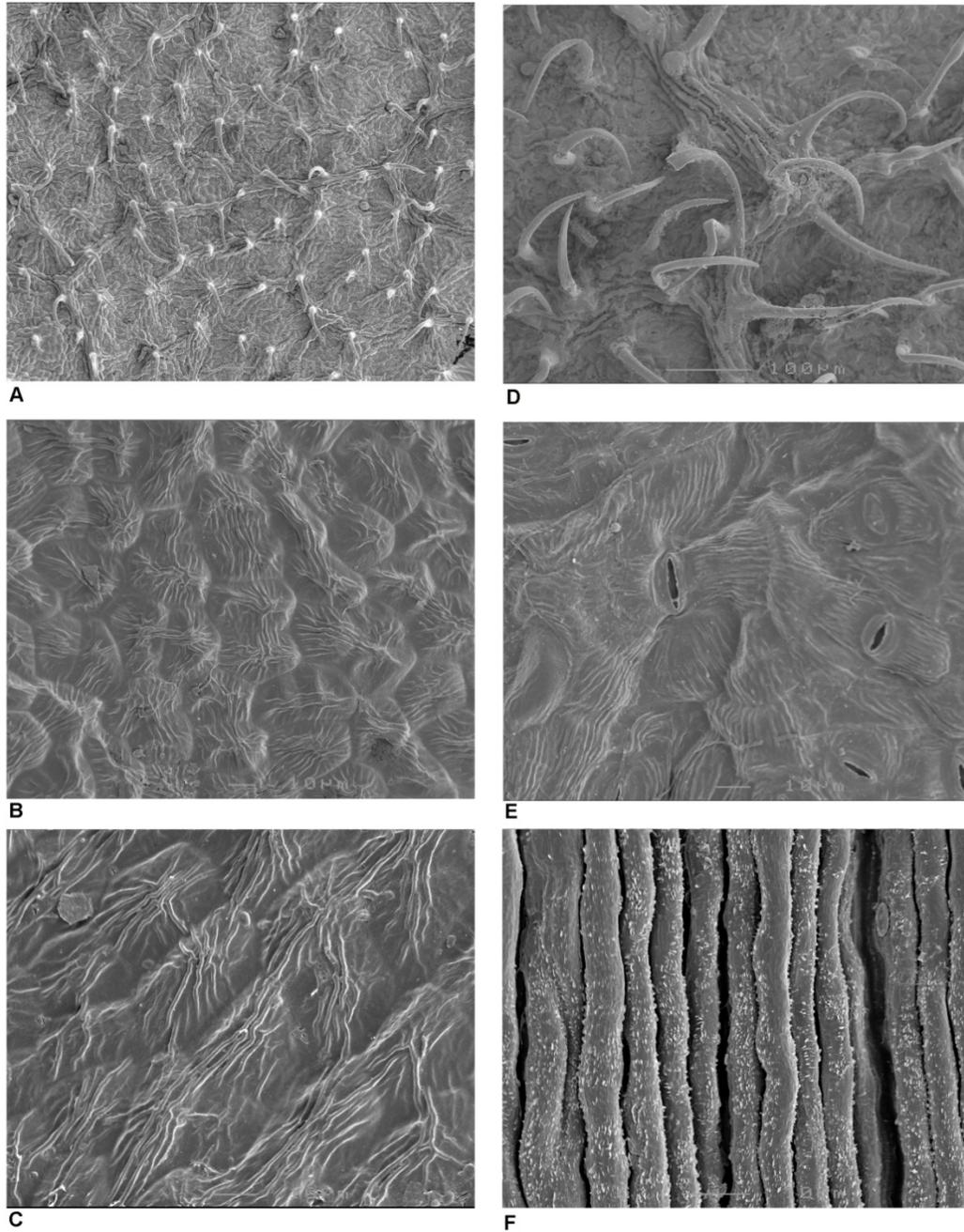


Fig. 4.2.23 *Finlaysonia pierrei*. A: adaxial epidermis showing trichomes; B, C: adaxial epidermis showing tetra- to hexagonal shaped epidermal cells and dense parallel to wavy striations; D: abaxial epidermis showing trichomes; E: abaxial epidermis showing stomata, parallel to wavy striations, perpendicular to stomata; F: abaxial epidermis showing small particles of wax on main vein. Magnification: A = x80; B–F = x200. [A, F: *Larsen et al.* 31723 (K); B: *Kerr* 20486 (K); C, D: *Puin* 4376 (K); E: *Marcan* 1047 (K)].

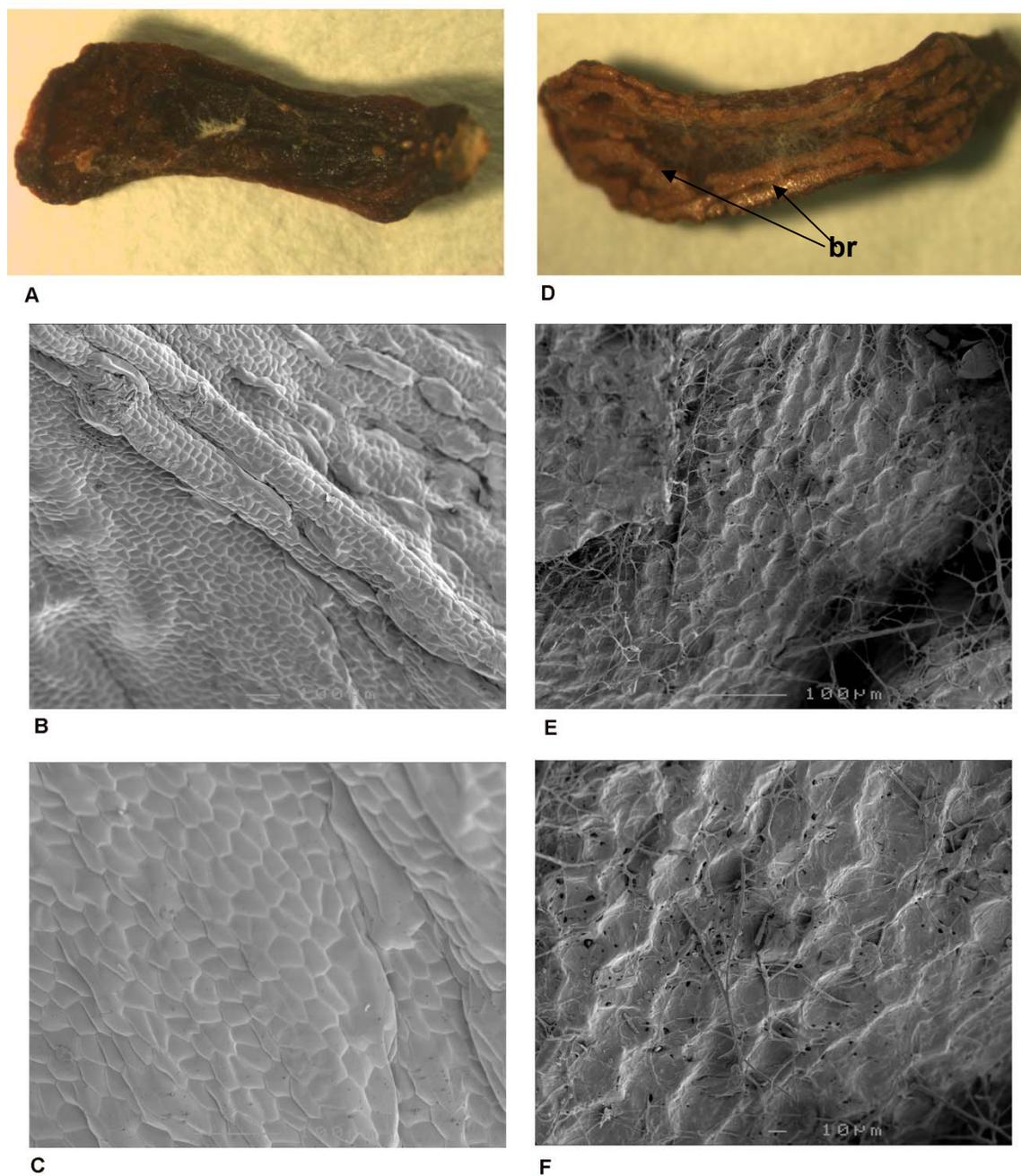


Fig. 4.2.24 *Finlaysonia pierrei*. A: upper seed coat showing ridged surface and warty margin; B,C: upper seed coat showing isodiametric, tetra- to pentagonal tightly packed cells with smooth cuticle; D: lower seed coat showing flat broad ridges; E, F: lower seed coat showing epidermal cells with convex periclinal walls and smooth cuticle; br: broad ridge. Magnification: B = x100; C, E = x200; F = x400. [A–F: *Marcan 1047 (K)*].

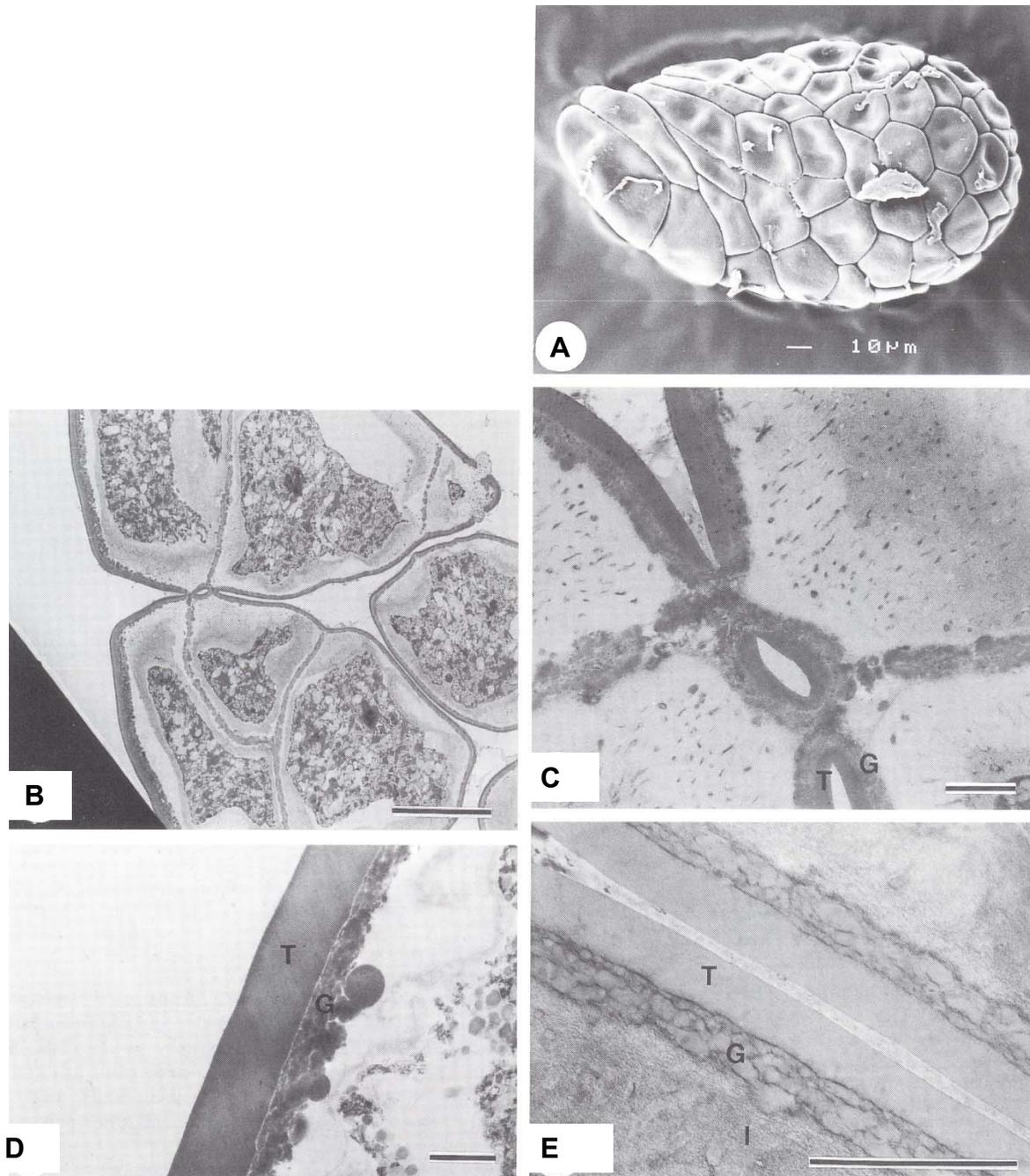


Fig. 4.2.25 Pollinium and pollen wall architecture of *Finlaysonia pierrei* (= *Atherolepis pierrei*). A: shape of pollinium; B, C: fusion of two tetrads; D: distal wall showing tectum (T) and granular stratum (G) with few larger granules; E: proximal wall showing same exine stratification as the distal wall, with tectum (T), granular stratum (G) and intine (I). Scale bars: A, B = 10 μ ; C–E = 1 μ . [A–E: duplicated from Verhoeven and Venter (1998)].

Distribution and habitat

Finlaysonia pierrei occurs in Thailand and Vietnam (Fig. 4.2.26). This species grows in scrub jungle and dry thorny savanna, and is often found in hedgerows and along river banks. Flowering occurs between May and July.

Notes

1. In Kew Herbarium there are 2 sheets in the *Atherolepis pierrei* type file. The specimen on the second sheet differs from the other isotypes in K and P in having glabrous leaves and long, narrowly cylindrical follicles. This specimen can therefore not be regarded as an isotype of *Finlaysonia pierrei*.

2. An extensive search in the literature for the publication of the name *Atherolepis pierrei* var. *glabra* was unsuccessful. The name appears on the *Kerr 3706* specimen and is most likely a *nomen nudum*. The specimen characteristics are those of *Finlaysonia pierrei*.

Specimens examined

Thailand:

- 13° 32'N, 99° 49'E: Ratchaburi (= Rat'buri), *Marcan, A. 1797* (K, L).
- 13° 49'N, 100° 29'E: Bangkok, *Larsen, Nielsen and Santisuk 31723* (K, L, P).
- 13° 49'N, 100° 29'E: Bangkok, *Kerr, A.F.G. 3666* (K), *3706* (BM, K), *3868* (BM, K), *10091* (K).
- 13° 49'N, 100° 29'E: Bangkok, *Marcan, A. 230* (K), *1047* (K), *2067* (K).
- 13° 49'N, 100° 29'E: Bangkok, *Put s.n.*, anno 12/02/1932 (BM).
- 14° 01'N, 99° 31'E: Kanchanaburi (= Kanburi), *Marcan, A. 877* (K).
- 14° 58'N, 102° 07'E: Korat (= Karat), Ban Zai, *Kerr, A.F.G. 20486* (K).
- 15° 48'N, 102° 02'E: 50 km south of Chaiyaphum, *Pierre, L. 4377* (K).
- 18° 47'N, 98° 60'E: Chiang Mai, *Kerr, A.F.G. 3307* (K); *s.n.*, anno 06/1921 (K).

Vietnam:

- 10°58'N, 106°50'E: Province Bien-hoa, Bao-chiang, *Pierre, L. 4376* (P, lectotype; BM, P (5 sheets), K, isotypes).

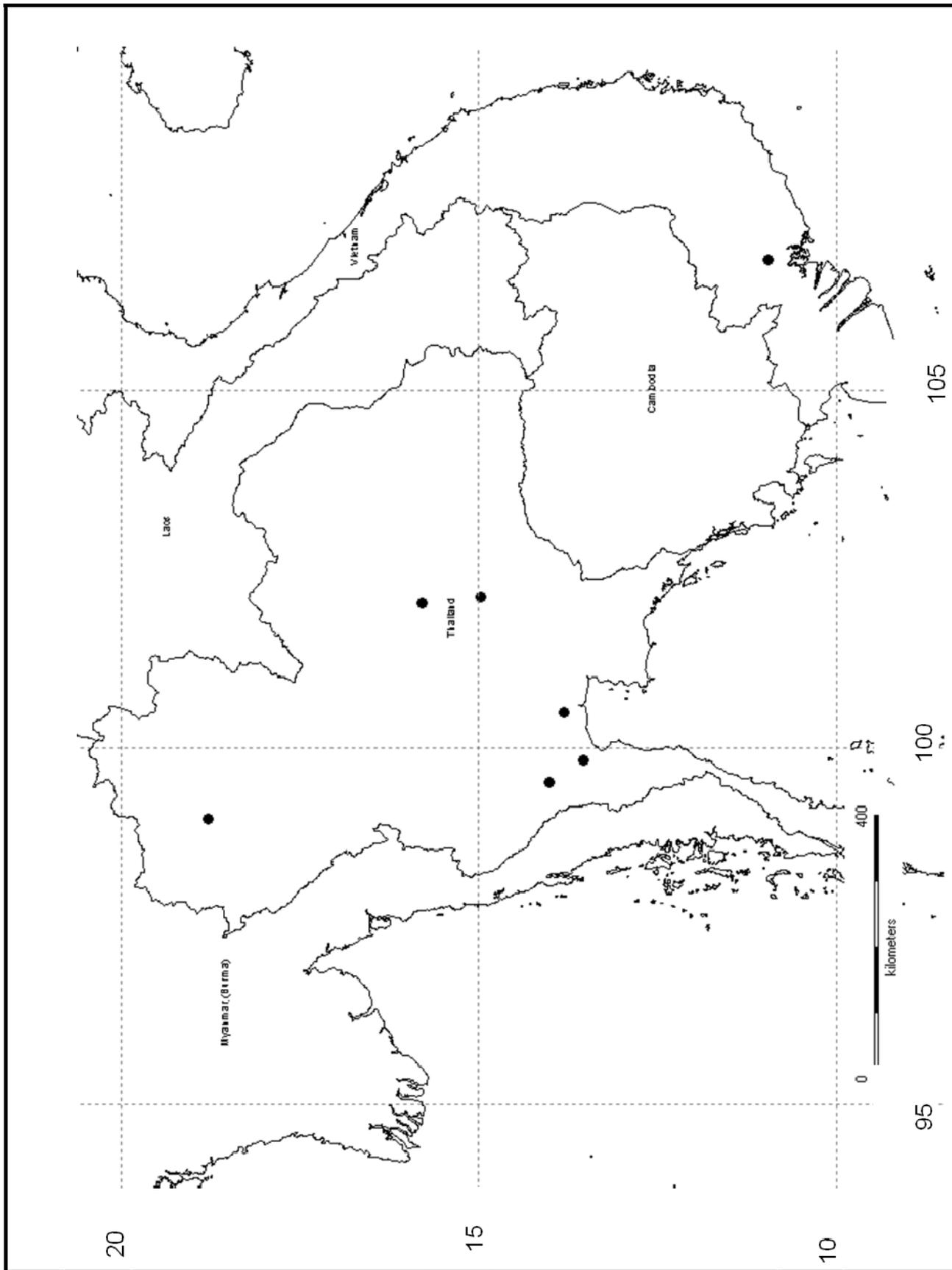


Fig. 4.2.26 Geographical distribution of *Finlaysonia pierrei*

4.2.6 *Finlaysonia puberulum* (Kerr) Venter and A.M.Venter, *comb. nov.*;

Venter & R.L.Verh. in *Annals of the Missouri Botanical Garden* 88: 565 (2001) [see *Confusing synonymy*, No. 1, p. 120].

Basionym: *Meladerma puberulum* Kerr in *Kew Bulletin* 1938: 447 (1938).

Type: Thailand, Prachuap, *Put* 285 (K!, holotype; BM!, L!, isotypes) (Fig. 4.2.27).

= *Finlaysonia insularum* (King & Gamble) Venter in Venter & R.L.Verh., *Annals of the Missouri Botanical Garden* 88: 565 (2001) [see *Confusing synonymy*, No. 1, p. 120].

Type: Malaysia, Kedah, small islands near Langkawi, *Curtis* 3684 (CAL, holotype?; K!, isotype? [see *Notes*, No. 2, p. 49]).

Macromorphology

Climbers. **Stems:** bark glossy, purplish to reddish-brown, glabrous on older stems, densely pubescent on younger stems; nodes slightly pubescent with pale copper-coloured hairs; colleters numerous. **Leaves** petiolate; petiole 9–10 x 1 mm; axil tomentose; blade broadly elliptic, 45–52 x 30–34 mm, herbaceous, adaxially sparsely villous and abaxially densely villous with adpressed white hair, apex acuminate to obtuse-mucronate, base rounded to obliquely-rounded, venation brochidodromous, 5–9 secondary veins on either side of main vein, divaricate, tertiary venation random reticulate, areole well developed with branching veinlets.

Inflorescences axillary, compact monochasia with few flowers, primary peduncles 5–6 mm long, densely puberulous with adpressed pale to copper-coloured falcate hairs, secondary and tertiary peduncles not seen; pedicels \pm 3 mm long, densely puberulous with falcate hairs; bracts alternate on primary peduncles, ovate-triangular, \pm 1.2 mm long, outer surface and margin densely puberulous with white falcate hairs; colleters not seen. **Floral buds** ovoid, 1.7–2 mm long, apex obtuse to acute-obtuse. **Sepals** broadly triangular to broadly triangular-ovate, 0.6 x 0.5–0.6 mm, densely puberulous on outer surface and margins, apices acute to obtuse: colleters not seen. **Corolla:** colour not known; tube shallowly campanulate, \pm 0.5 mm long, glabrous on both surfaces to densely puberulous on outside; lobes oblong-ovate, 3 x 1 mm, semi-succulent to herbaceous, glabrous on both surfaces to puberulous on outside with membranous



Fig. 4.2.27 Type specimen of *Finlaysonia puberulum* (Kerr) Venter & A.M.Venter (*Put* 285, holotype (K)).

margin, apex obtuse. **Corona** lobes narrowly conical and apically narrowly subulate, 1–1.8 mm long, glabrous; coronal feet ovoid, fleshy, glabrous. **Stamens**: filament linear to terete, 1 x 0.4–0.6 mm, erect, glabrous; anther glabrous, hastate; thecae oblong, with basal callosities, dehiscent with half length slits, connective glabrous, connective appendage narrowly triangular, glabrous; pollinia oblong-ovoid to narrowly elliptic. **Nectary** rim without interstaminal lobules. **Pistil**: style \pm 0.5 mm long; stylar head broadly angular-ovoid, 0.4 x 0.5 mm, apex bluntly obtuse, translator receptacle ovate to obovate, apex slightly notched to deeply split, stype linear-terete. **Follicles** brown, horizontal, narrowly ovoid, 95–106 x 4–5 mm, pericarp surface puberulous and herbaceous, apex obtuse-acute; seed unavailable. (Fig. 4.2.28).

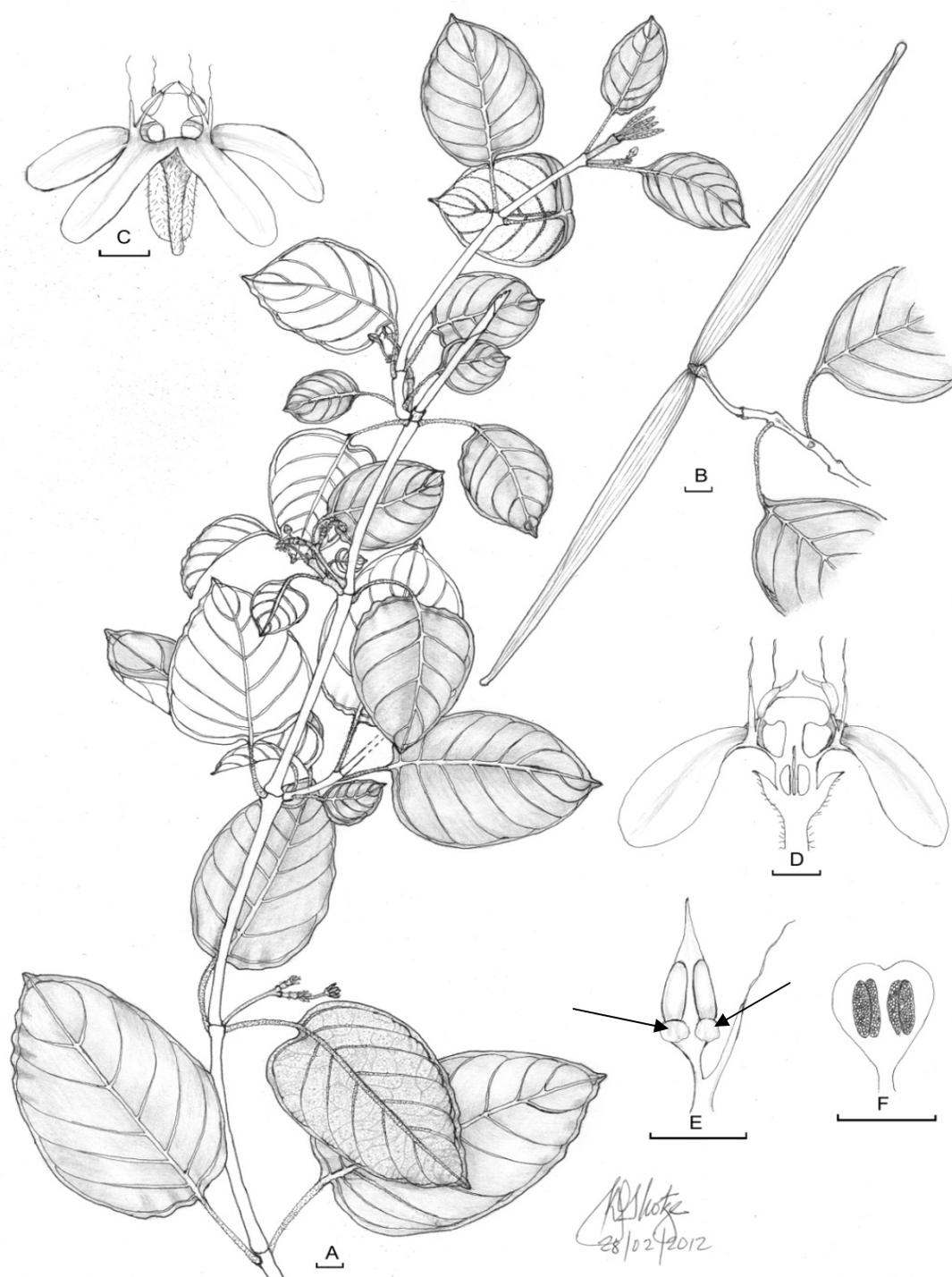


Fig. 4.2.28 *Finlaysonia puberulum*. A: stem with leaves and inflorescences; B: stem with follicles; C: external view of flower; D: longitudinal section of flower showing inverted corolla tube, corona lobes, stamens, ovaries, style and stylar head; E: stamen showing thecae with basal callosities (↓) and narrowly triangular connective appendage; F: translator with obovate receptacle carrying four pollinia. Scale bars: A, B = 5 mm; C–F = 1 mm. [A– F: Shimizu et al. 7620 (L)].

Micromorphology

Adaxial **leaf epidermal cells** are tetra- to hexagonal. Outer periclinal cell walls are tabular to convex. The adaxial epidermis is sparsely villous on lamina but densely villous on main vein (Fig. 4.2.29 A). The cuticle is striated. Striations are parallel, straight to slightly wavy and restricted to individual cells but occasionally crossing cellular boundaries. No wax is present (Fig. 4.2.29 B).

The abaxial leaf epidermal cells are tetra- to pentagonal. Outer periclinal cell walls are tabular. The abaxial epidermis is densely villous (Fig. 4.2.29 C). The cuticle is slightly striated. Striations are straight and parallel. No wax is present.

The leaves are hypostomatic. Stomata are elliptic with narrow stomatal ledges. Stomata are randomly oriented and level to the surface (Fig. 4.2.29 D).

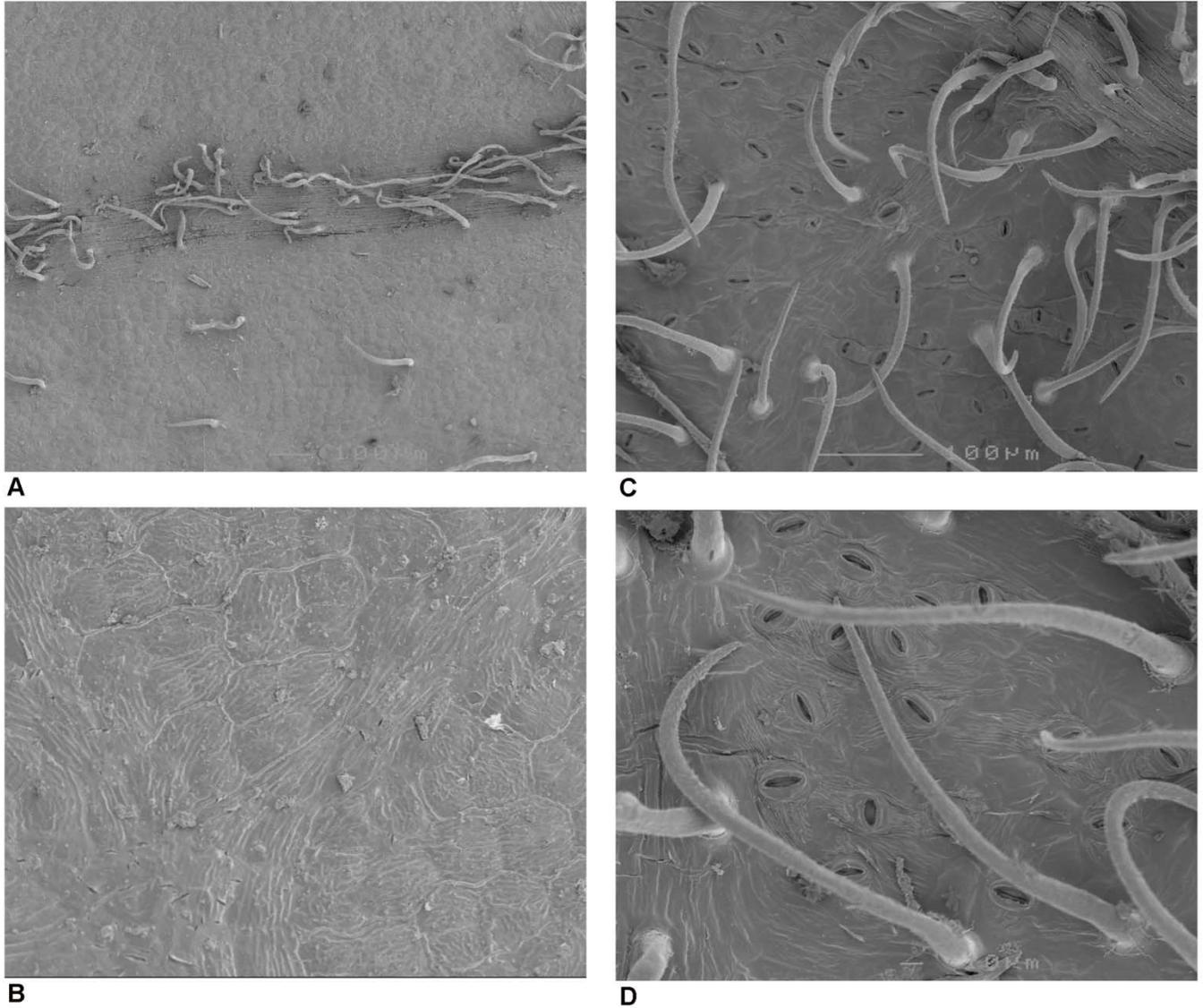


Fig. 4.2.29 *Finlaysonia puberulum*. A: adaxial epidermis showing distribution of trichomes; B: adaxial epidermis showing cuticular striations, restricted to cells or continuous over several cells; C: abaxial epidermis showing dense trichomes; D: abaxial epidermis showing stomata. Magnifications: A = x80; B, C = x200; D = x400. [A–D: Shimidzu et al. 7620 (L)].

Distribution and habitat

Finlaysonia puberulum has been collected only in Thailand where it grows on sunny, rocky limestone hills (Fig. 4.2.30). Flowering occurs between July and September.

Specimens examined

Thailand:

- 11°49'N, 99°48'E: Bangkok Region, Prachuap, *Put* 285 (K, holotype; BM, L, isotypes).
- 11°49'N, 99°48'E: Bangkok Region, Prachuap, Khiri Khan, Khao Chong Crackok, near Bang Saphan, *Shimizu T. et. al.* 7620 (L).

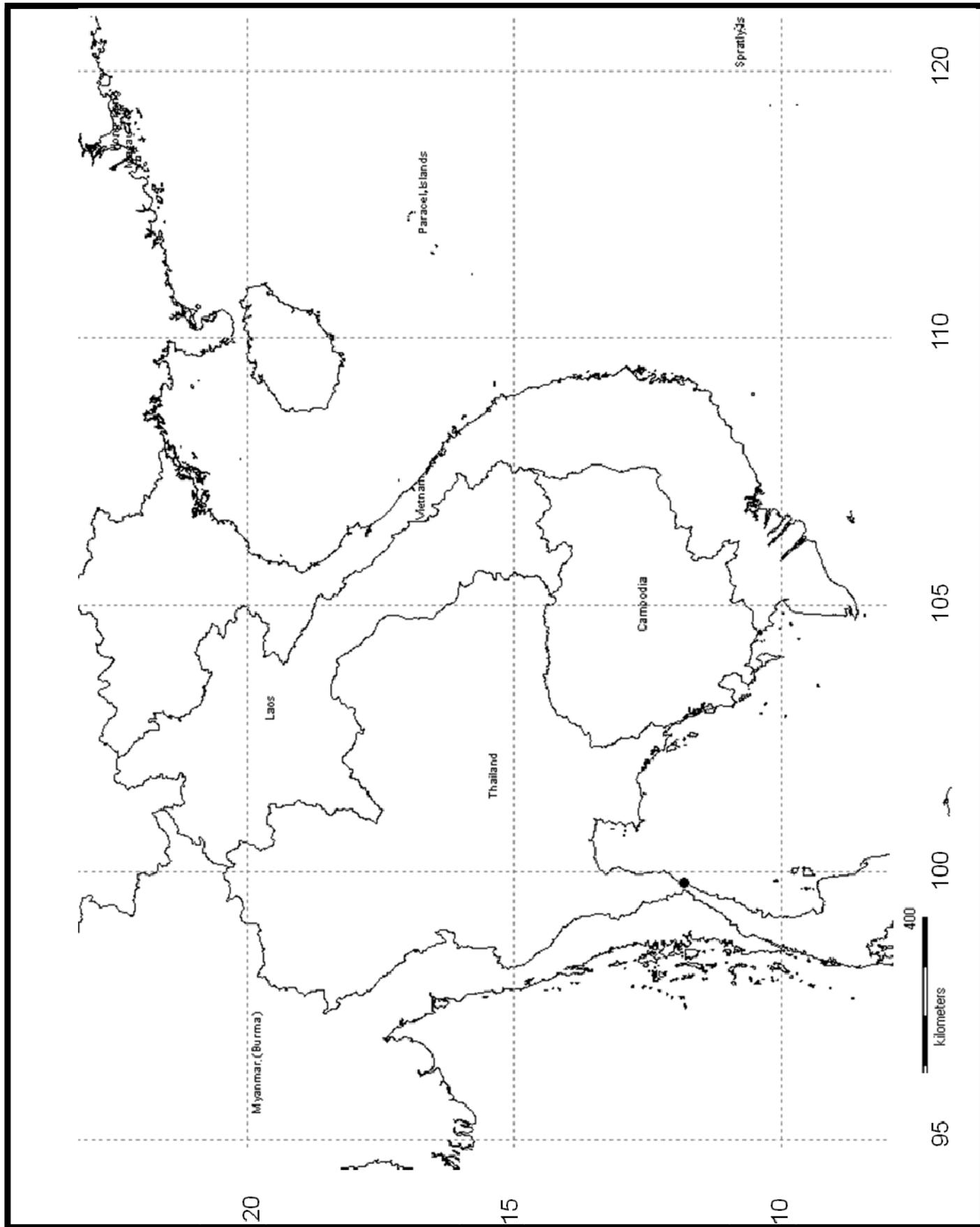


Fig. 4.2.30 Geographical distribution of *Finlaysonia puberulum*

4.2.7 *Finlaysonia venosa* (Collett & Hemsl.) Venter & A.M.Venter, *comb. nov.*

Basionym: *Atherolepis venosa* Collett & Hemsl. in Journal of the Linnean Society 28: 86 (1891).

Type: Burma, Meiktila, *Collett 844* (K!, holotype) (Fig. 4.2.31).

Macromorphology

Probably a climber. **Stems:** bark reddish-brown, puberulous; nodes puberulous, copper-coloured; colleters few. **Leaves** petiolate; petiole 2 x 1–1.5 mm, puberulous; axil puberulous; blade narrowly elliptic, 80–87 x 19–24 mm, herbaceous, glabrous on both surfaces with main vein abaxially puberulous, apex acute or obtuse-mucronate, base cuneate, margin recurved, undulate and puberulent, venation brochidodromous, 8–10 secondary veins on either side of main vein, divaricate, tertiary venation random reticulate, areoles imperfect, without veinlets.

Inflorescences axillary, compact dichasia with 3–5 flowers per terminal branch; primary peduncles 1–2 mm long, scabridulous, secondary and tertiary peduncles not seen; pedicels 0.6–0.8 mm long, scabridulous; bracts densely stacked on dichasial peduncles, naviculate ovate, 1 x 0.7 mm, outer surfaces scabridulous and margins fimbriate. **Floral buds** ovoid, ± 1 mm long, apices rounded. **Sepals** ovate to broadly ovate, 1.5 x 0.8–1.0 mm, scabridulous on the outside and margins, apices acute to round; colleters free. **Corolla** colour not known; tube shallowly campanulate, ± 0.8 mm long, glabrous on both surfaces; lobes narrowly ovate, 2–2.2 x 0.7–0.8 mm, coriaceous, outside scabridulous to papillose, inside glabrous but papillose towards base, margins membranous, apices rounded [see Notes, p. 97]. **Corona** lobes rod-shaped, ±1 mm long, glabrous, apices blunt to bifid; feet ovoid, herbaceous, glabrous. **Stamens:** filament broadly linear, ± 0.1 mm long, erect, glabrous; anther glabrous, narrowly triangular-ovate, 0.4 x 0.2 mm; thecae oblong with basal callosities, dehiscent with half length slits, connective glabrous, connective appendage dark purple, deltoid, glabrous; pollinia not seen. **Nectary** rim without interstaminal lobules. **Pistil:** styles 0.2 mm long;

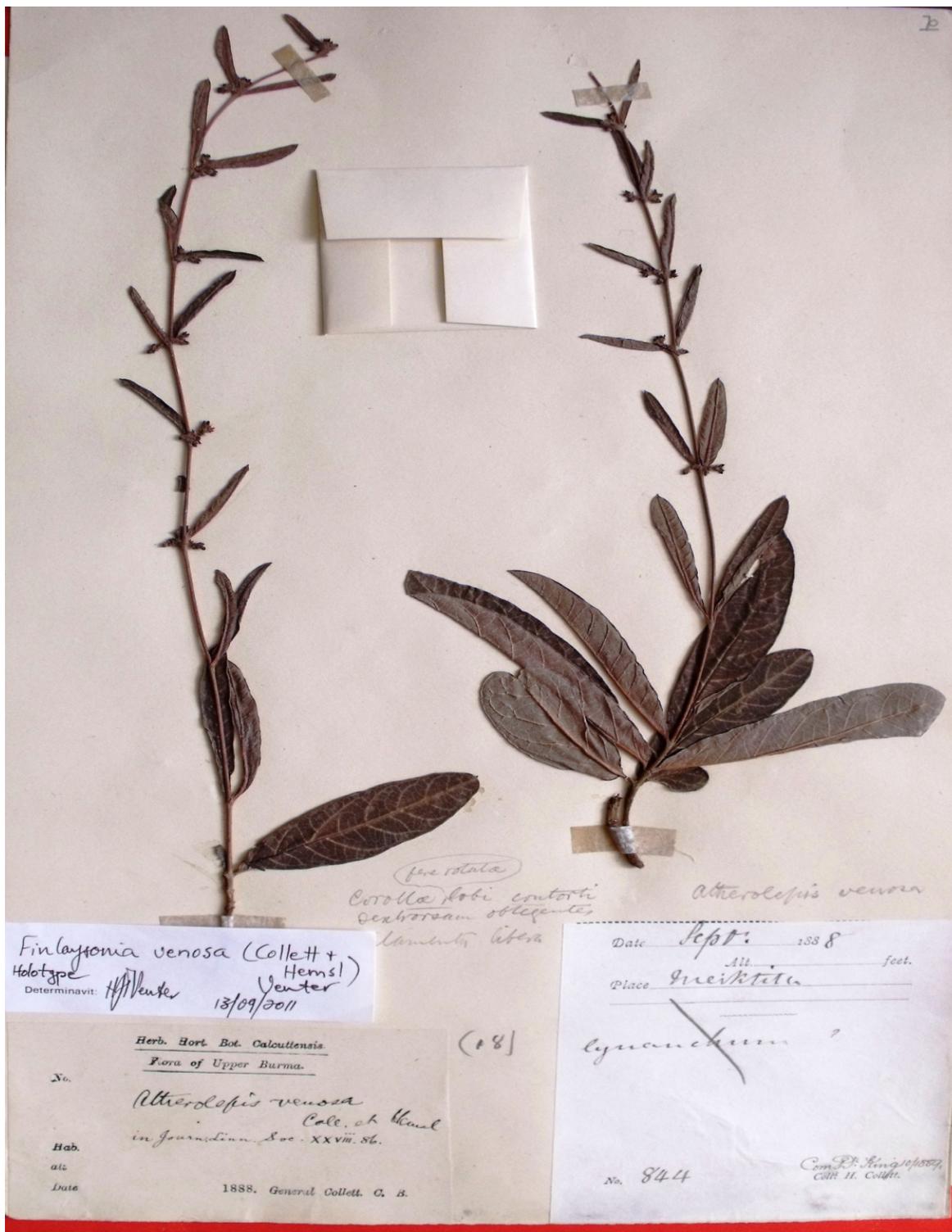


Fig. 4.2.31 Type specimen of *Finlaysonia venosa* (Collett & Hemsl.) Venter & A.M. Venter (Collett 844, holotype (K)).

stylar head very broadly angular-ovoid, 0.2 x 0.4 mm, apex bluntly obtuse; translator receptacle broadly obovate, apex emarginate, style linear-terete. **Fruit** and seed not seen. (Fig. 4.2.32).

Micromorphology

No micromorphology could be done as only the type specimen was available.



Fig. 4.2.32 *Finlaysonia venosa*. A: stem with leaves and inflorescences; B: longitudinal section of floral bud with rod-shaped corona lobes, ovaries, style and stylar head, stamens with deltoid connective appendages. Scale bars: A = 5 mm; B = 1 mm. [A–B: Collett 844 (K)].

Distribution and habitat

A single specimen, the type, of *Finlaysonia venosa* was collected in Myanmar (“Burma”) (Fig. 4.2.33), and flowered in September.

Notes

The corolla tube and lobes of *Finlaysonia venosa* may be reflexed as in the other *Finlaysonia* species, but from the type specimen’s flowers this feature could not be ascertained.

Specimen examined:

Myanmar:

- 20° 52’N, 95° 52’E: Upper Burma, Meiktila, *Collett, C.B. 844* (K, holotype).

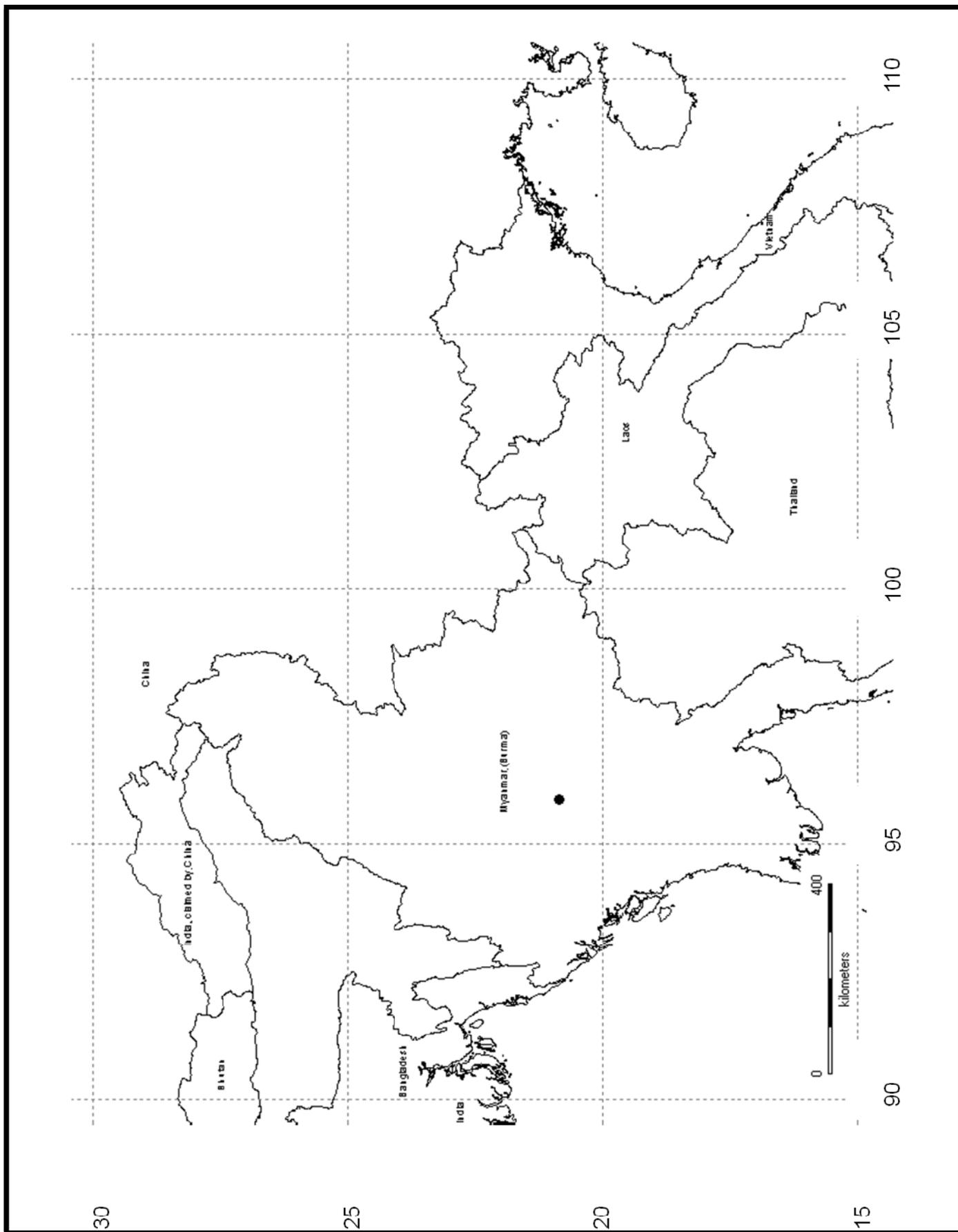


Fig. 4.2.33 Geographical distribution of *Finlaysonia venosa*

4.2.8 *Finlaysonia wallichii* (Wight) Venter in Venter & R.L. Verh., *Annals of the Missouri Botanical Garden* 88: 565 (2001). Basionym: *Hemidesmus wallichii* Wight, *Contributions to the Botany of India*: 63 (1834) [see Notes, p. 106].

Type: Myanmar, Prome, *K-W 8245* = *Wall. Asclep. no. 106* (K-W!, holotype; K!, isotype) (Fig. 4.2.34).

= *Atherolepis wallichii* (Wight) Hook.f., *Flora of British India* 4(10): 8 (Jun. 1883); Hooker's *Icon. Pl.* 5, 26, tab. 1433.

Homotypic synonym.:

= *Atherandra wallichii* (Wight) Benth., *Genera Plantarum* 2, 744 (1873).

Type: Burma, Pegu Yomah, *Kurz 2358* (K!, holotype).

Macromorphology

Climbers. **Stems:** bark pale brown to reddish-brown, puberulous; nodes glabrous; colleters numerous. **Leaves** petiolate; petiole (3–)5–10 x 3–4 mm, puberulous; axil villous; blade oblong-lanceolate to narrowly lanceolate, 96–125(–154) x 12–15(–25) mm, herbaceous, sparsely scabrid adaxially, densely villous abaxially, sometimes scabrid, apices acute to attenuate, base rounded, rarely cuneate, margin revolute and wavy, venation brochidodromous, 15–22 secondary veins on either side of main vein, divaricate, nearly patent, higher order venation not visible.

Inflorescences axillary, compact monochasia of 1–2 branches, each with 1–2 flowers, primary peduncles 0.5–1 mm long, puberulous with whitish hairs; pedicels 1–1.5 mm long, puberulous with white hairs; bracts alternate to opposite, densely stacked around monochasial branches, narrowly ovate, naviculate, outer surfaces and margins puberulous, apices acute. **Floral buds** ovoid, 3 mm long; apex acute. **Sepals** broadly ovate to broadly angular-ovate, 1–1.5 x 0.7–1.2 mm, puberulous on outside and margins, apices acuminate; colleters free. **Corolla:** colour not known; tube bowl-shaped, ± 0.7 mm long, glabrous on both surfaces to puberulous on outside, lobes ovate, 2.8–3.1 x 1.2–2 mm, glabrous on inside, puberulous on outside, margins membranous, apices acute to acuminate or attenuate. **Corona** lobes rod-shaped, 0.1–1.5 mm long, herbaceous, glabrous, coronal feet broadly triangular, glabrous.



Fig. 4.2.34 Type specimen of *Finlaysonia wallichii* (Wight) Venter (K-W 8245, holotype (K-W)).

Stamens: filament terete, 0.2–0.3 mm long, erect to curved, glabrous; anther glabrous, oblong-ovate to angular-ovate, 0.8–1 x 0.4 mm; thecae oblong, each with basal callosity, dehiscent with half length slits, connective glabrous, connective appendage narrowly triangular; pollinia glossy, \pm 0.5 mm long, oblong to elliptic. **Nectary** rim with interstaminal lobules. **Pistil:** style terete, \pm 0.3 mm long; stylar head narrowly to broadly angular-ovoid, 0.3–0.5 x 0.3–0.5 mm, apex broadly acute; translator receptacle broadly ovate and grooved, style terete, viscidium disc-shaped. **Follicles** brown, horizontal, ovoid and keel-shaped, 90 x 15 mm long, pericarp surface scabrid and herbaceous, apex attenuate; seed glossy, dark brown, 10 x 3–4 mm, oblong-obovate; coma coppery white, 25–30 mm long. (Fig. 4.2.35).



Fig. 4.4.2.35 *Finlaysonia wallichii*. A, B: stem with leaves and inflorescences; C: ovoid floral bud; D: external view of flower with rod-shaped corona lobes and gynostegium; E: internal view of corolla, stamens, nectary rim with lobules and corona lobes. Scale bars: A, B = 5 mm; C, D, E = 1 mm. [A, B: McClelland 1433 (K); C–E: McClelland s.n.(K)].

Micromorphology

Adaxial **leaf epidermal cells** are tetragonal in shape but anticlinal walls may be undulate. Outer periclinal walls are convex. The adaxial epidermis is sparsely scabrid. The cuticle is striated. Parallel striations radiate from trichome bases, spreading over the surrounding epidermal cells (Fig. 4.2.36 A). On epidermal cells not associated with trichomes, the randomly orientated striations radiate from the centres of the cells and cross intercellular boundaries (Fig. 4.2.36 B).

The abaxial leaf epidermal cells are tetra- to hexagonal in shape. Outer periclinal cell walls are tabular. The abaxial leaf epidermis is sparsely villous. The cuticle is densely striated with these slightly wavy and perpendicular to the stomata (Fig. 4.2.36 C).

The leaves are hypostomatic. The stomata are narrowly elliptic with a broad stomatal ledge, slightly raised and randomly arranged (Fig. 4.2.36 C).

The upper **seed coat** surface is finely pitted (Fig. 4.2.37 A). Epidermal cells are isodiametric, tetra- to hexagonal and are tightly packed (Fig. 4.2.37 B). Outer periclinal walls are tabular. Anticlinal walls are straight. The cuticle is smooth (Fig. 4.2.37 C).

The lower seed coat surface is concave with a narrow central longitudinal ridge and crassinate margins (Fig. 4.2.37 D). The central longitudinal ridge and margin are smooth with no distinguishable cell shape (Fig. 4.2.37 E, F). The region between the ridge and margin is not clear from the micrograph.

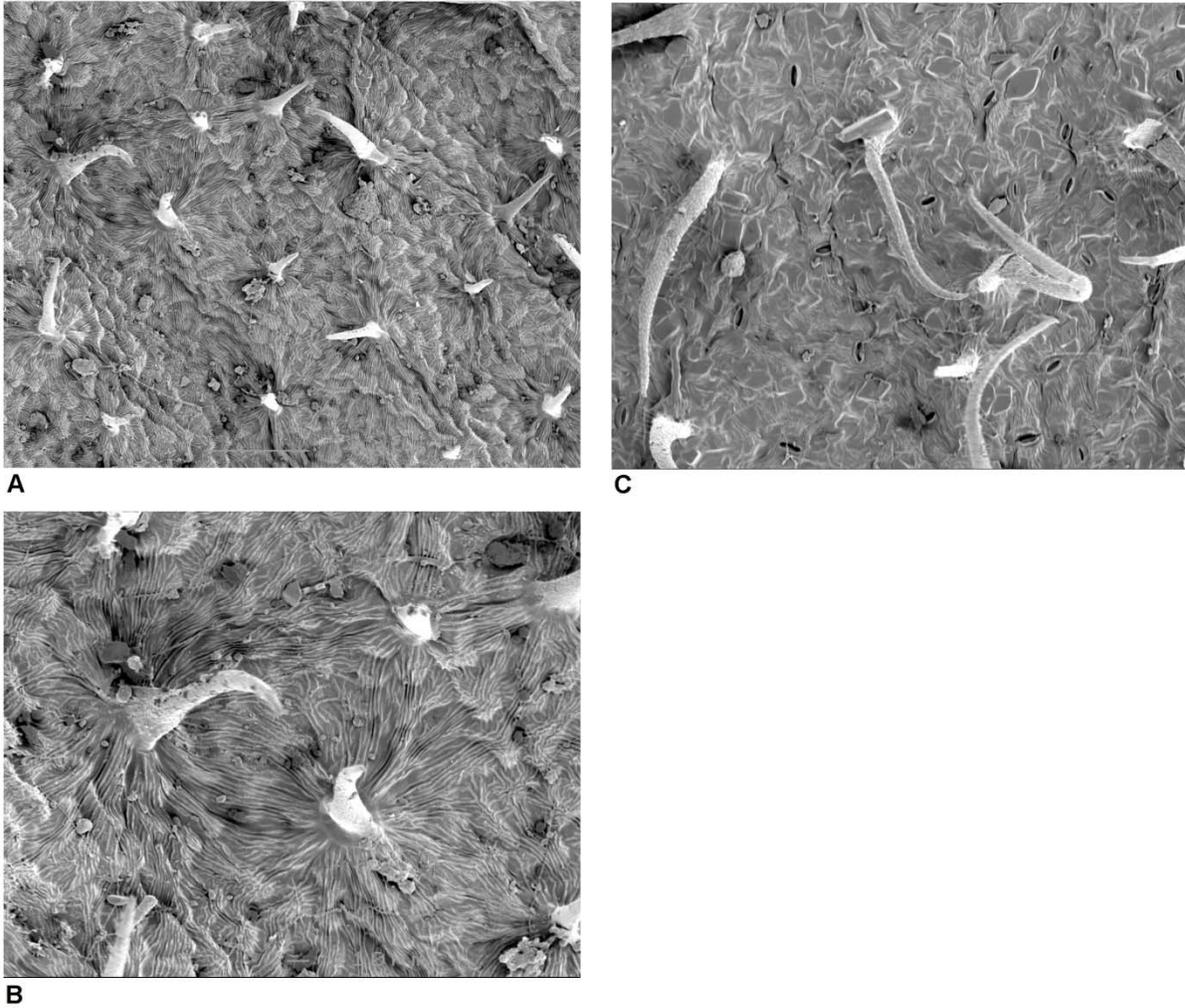


Fig. 4.2.36 *Finlaysonia wallichii*. A, B: adaxial epidermis showing tetragonal epidermal cells, dense parallel to wavy cuticular striations, radiating from trichome bases and crossing cellular boundaries; C: abaxial epidermis showing stomata. Magnification: A = x200; B, C = x400. [A– C: *Lace 2747 (K)*].

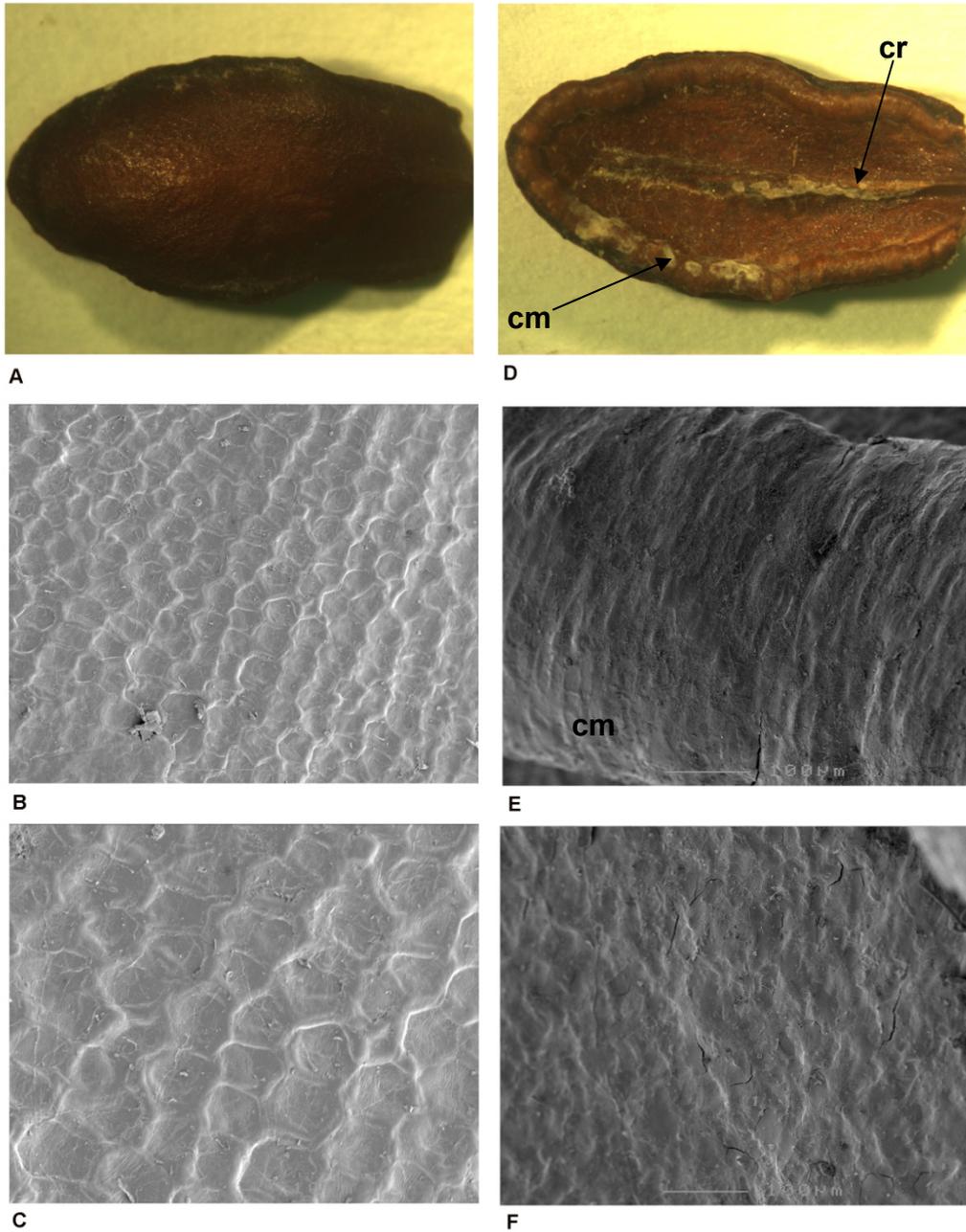


Fig. 4.2.37 *Finlaysonia wallichii*. A: upper seed coat showing finely pitted surface; B, C: upper seed coat showing tightly packed penta- to hexagonal cells; D: lower seed coat showing a narrow central longitudinal ridge and crassinate margin; E: lower seed coat showing margin with no distinguishable cell shape; F: central ridge morphologically similar to the lower seed margin; cr: central ridge; cm: crassinate margin. Magnification: B = x200; C, E, F = x400. [A–F: Kurz 2358 (K)].

Distribution and habitat

Finlaysonia wallichii occurs in Myanmar (Fig. 4.2.38). Flowering occurs during summer, peaking during December to February.

Notes

Ionta (2009) transferred this species to *Decalepis* Wight & Arn. in her unpublished thesis.

Specimens examined

Myanmar:

- 16° 47'N, 96° 10'E: Rangoon, *McClelland s.n.* (K).
- 18° 00'N, 95° 30'E: Tharrawaddy District, Kanyinngu (= Kangyi) to Bacobin, *Lace, J.H. 2747* (K).
- 18° 49'N, 95° 13'E: Prome (now Pyay), *K-W 8245* (K-W, holotype; K, isotype).
- 20° 55'N, 95° 14'E: Pegu Yomah (also known as Bogo Yoma), *Kurz 2358* (K, holotype of *Atherandra wallichii*).
- 24° 16'N, 97° 14'E: Bhamo District, Si-ngau (Xingau), *Lace, J.H. 4483* (K).
- 25° 07'N, 96° 22'E: Kachin State, Monyin Township, *Khin Win Myint 441/84* (K).

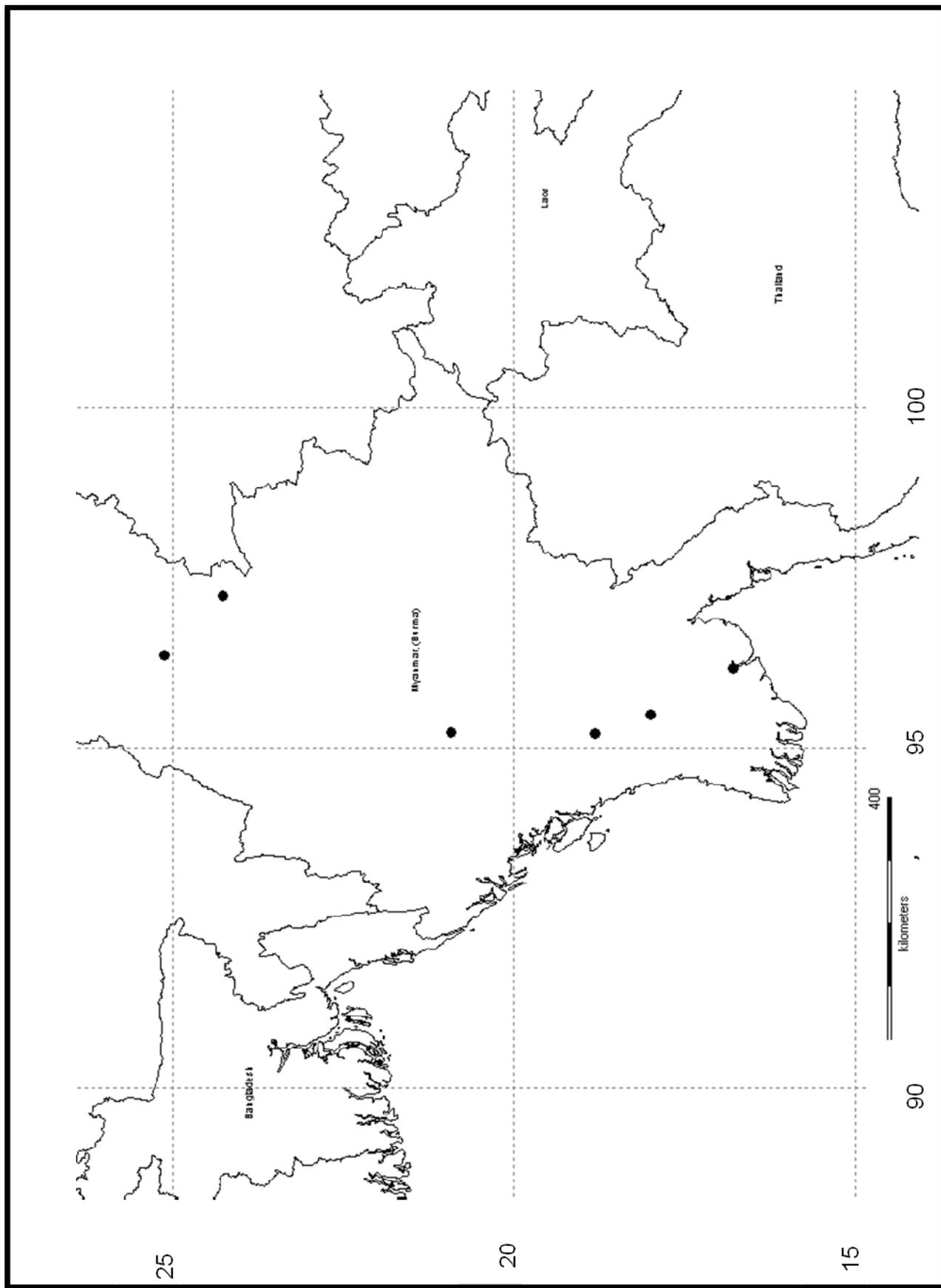


Fig. 4.3.38 Geographical distribution of *Finlaysonia wallichii*

4.3 Results and discussion

4.3.1 Distribution, habitat and vegetative characteristics

Finlaysonia is widely distributed throughout Asia with five of the eight *Finlaysonia* species found in Thailand, often on limestone hills, as well as on river banks. Two species, *F. decidua* and *F. puberulum*, seem to be endemic to Thailand, while *F. venosa* and *F. wallichii* are restricted to Myanmar. However, only one collection exist for each of the first three species. *Finlaysonia obovata* has by far the widest distribution and covers all of Asia. (Fig. 4.1.1 and Table 4.1).

All the species are climbers with twining stems. The petiolar ridges between the opposite leaves are prominent, glabrous or with pubescent to puberulent, copper-coloured or dirty white indumentum, except *F. decidua* with copper-coloured tomentose indumentum. (Table 4.1).

The leaves of all the species are petiolate, but in *F. pierrei* and *F. venosa* the petiole is short, not longer than 2 mm. The leaf shape of the majority of species is variations of elliptic, except *F. decidua* with linear leaves, *F. pierrei* with oblong to obovate leaves and *F. wallichii* where leaves can also be oblong-lanceolate. Leaf size varies considerably within species and also overlaps between species. The ratio length:width of seven species falls into the same range, but *F. wallichii* is an exception with a ratio of 7–11:1. The leaf texture of all the species is herbaceous except for *F. obovata* with coriaceous leaves. (Table 4.1).

Micromorphologically, the primary sculpture of the leaves show very little variation between the species, and only the clustered arrangement of the stomata in *F. obovata* is remarkable. Both adaxial and abaxial leaf surfaces are usually glabrous to sparsely hairy with varied vestiture types, except *F. decidua* which is densely tomentose on both surfaces. (Table 4.1).

Table 4.1: Comparison of macro- and micromorphological leaf characteristics of *Finlaysonia* species

SPECIES CHARACTERS	<i>F. decidua</i>	<i>F. insularum</i>	<i>F. khasiana</i>	<i>F. obovata</i>	<i>F. pierrei</i>	<i>F. puberulum</i>	<i>F. venosa</i>	<i>F. wallichii</i>
Distribution	Thailand	Thailand, Malaysia	China, Bangladesh, India, Laos	Brunei, Bangladesh, India, Indonesia, Malaysia, Myanmar, Papua New Guinea, Philippines, Thailand, Singapore, Vietnam.	Thailand, Vietnam	Thailand	Myanmar	Myanmar
Habitat	Limestone hills	Limestone hills	Hills	Mangrove swamps, tidal river banks	Hedgerows, river banks, in scrub jungle, thorny savanna	Limestone hills	–	–
Habit	Climber	Climber	Climber	Climber	Climber	Climber	Climber	Climber
Interpetiolar ridge indumentums	Tomentose, copper-coloured.	Glabrous to puberulent, dirty white.	Puberulent, dirty white.	Glabrous	Puberulent, dirty white	Slightly pubescent, pale copper-coloured	Puberulous, copper-coloured	Glabrous

SPECIES CHARACTERS	<i>F. decidua</i>	<i>F. insularum</i>	<i>F. khasiana</i>	<i>F. obovata</i>	<i>F. pierrei</i>	<i>F. puberulum</i>	<i>F. venosa</i>	<i>F. wallichii</i>
Cuticle abaxially	–	Slightly striated	Prominent striations	Smooth to slight. striated	Striated	Striated	–	Striated
Cuticle adaxially	–	Densely straited	Prominent straitions	Smooth to slight. straited	Straited	Slightly straited	–	Densely straited

4.3.2 Floral characteristics

The floral characteristics show little variation among the species except for a few distinctive or unique characteristics. Examples are the presence of anther callosities in all species except *F. pierrei*, hairy anther connectives with rhomboid anther connective appendages are unique to *F. khasiana*, as is the presence of a nectary rim lobule in *F. wallichii*.

The corolla is mostly uniform. The colour, as indicated by the collectors, seems to be pale green to cream to pale yellow, with brown or purple markings inside. The corolla lobe shape is similar for all species except the apex that is generally obtuse or rounded, but acute to acuminate in *F. pierrei* and *F. wallichii*. The indumentum of the corolla is distinctive. The corolla lobes of *F. decidua* are densely pubescent on the outside, puberulous in *F. puberulum* and *F. wallichii*, scabrid and papillose in *F. venosa*. On the inside both the lobes and tubes are pubescent in *F. khasiana*, puberulous in *F. pierrei* and *F. wallichii*, and villose in *F. obovata*. Only in *F. insularum* is the corolla completely glabrous.

The coronal foot is ovoid in all the species except for the broadly triangular foot of *F. wallichii*. The corona lobes are generally filiform or rod-shaped but are uniquely concave-ovate in *F. khasiana* and basally concave-ovoid to apically cylindrical-filiform in *F. pierrei*.

The anther connective in all species is glabrous but is uniquely hairy in *F. khasiana*.

The translator receptacle and stype shape vary considerably among the species. The translator receptacle shape is generally ovate to obovate with emarginate apices and linear-terete stypes in *F. decidua* and *F. venosa* but grooved in the former. In contrast, *F. insularum* has a characteristic ovate to angular-ovate translator receptacle with apices split and stypes also linear-terete. The receptacle and stype shape of *F. khasiana* is broadly ovate and apices slightly split, with terete to slender filiform stypes. *F. obovata* typically has a broadly ovate receptacle, folded funnel-like with split apex

and filiform stype. In *F. pierreii* the translator receptacle is ovate, with split apex and terete stype. *F. puberulum* translator receptacle is ovate to obovate, and apex slightly notched to deeply split, with linear-terete stype. The translator receptacle of *F. wallichii* is broadly ovate and grooved and the stype terete. (Table 4.2).

Table 4.2 Comparison of the floral characteristics of species in *Finlaysonia*

SPECIES CHARACTERS	<i>F. decidua</i>	<i>F. insularum</i>	<i>F. khasiana</i>	<i>F. obovata</i>	<i>F. pierrei</i>	<i>F. puberulum</i>	<i>F. venosa</i>	<i>F. wallichii</i>
Corolla colour	Green	Green	Pink to yellow	Pale yellow, green or cream	Cream to pale yellow	Pale green to yellow	–	–
Corolla lobe apex	Round	Obtuse	Obtuse to acute	Obtuse	Acute to acuminate	Obtuse	Round	Acute to acuminate
Corolla lobe shape	Narrow ovate to oblong-ovate	Narrow ovate to oblong-ovate	Ovate to triangular-ovate	Ovate to oblong-ovate	Ovate	Oblong-ovate	Narrow ovate	Ovate
Corolla lobe indumentum	Densely pubescent outside; glabrous inside	Glabrous on both surfaces	Glabrous outside; pubescent inside	Glabrous outside; villous inside	Glabrous outside; puberulous inside	Glabrous on both surfaces to puberulous outside	Scabrid to papillose outside; glabrous inside (papillose towards base)	puberulous outside; Glabrous inside
Corolla tube indumentum	Glabrous	Glabrous	As in lobes	As in lobes	As in lobes	As in lobes	Glabrous	As in lobes
Presence of anther callosities	Present	Present	Present	Present	Absent	Present	Present	Present
Corona foot shape	Ovoid and fleshy	Ovoid	Ovoid and fleshy	Oblong-ovoid	Ovoid	Ovoid and fleshy	Ovoid	Broadly triangular

SPECIES CHARACTERS	<i>F. decidua</i>	<i>F. insularum</i>	<i>F. khasiana</i>	<i>F. obovata</i>	<i>F. pierrei</i>	<i>F. puberulum</i>	<i>F. venosa</i>	<i>F. wallichii</i>
Corona lobe shape	Filiform	Filiform	Concave ovate	Filiform	Basally concave – ovoid, cylindrical-filiform	Narrowly conical becoming narrowly subulate	Rod-shaped	Rod-shaped
Corona lobe apex	Entire	Entire	Attenuate and entire	Entire	Entire	Entire	Blunt to bifid	Entire
Anther connective appendage	Attenuate	Deltoid	Rhomboid	Conical	Conical to deltoid	Narrowly triangular	Deltoid	Narrowly triangular
Anther connective indumentum	Glabrous	Glabrous	Hairy	Glabrous	Glabrous	Glabrous	Glabrous	Glabrous
Style indumentum	Glabrous	Glabrous	Glabrous	Glabrous	Glabrous	Glabrous	Glabrous	Glabrous
Presence/Absence of nectary rim lobule	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present
Translator receptacle	Broadly obovate and grooved	Ovate to angular-ovate, folded funnel-like	Broadly ovate	Broadly ovate folded funnel-like	Ovate	Ovate to obovate	Broadly obovate	Broadly ovate
Translator stype	Linear but folded	Terete to linear-terete	Terete	Filiform	Terete	Linear-terete	Linear-terete	Terete

4.3.3 Follicle and seed characteristics

The fruit and/or seed of *F. decidua*, *F. khasiana*, *F. puberulum* and *F. venosa* were either unavailable or only present on the type specimens.

Follicle shape and size seem to be species specific. *Finlaysonia insularum* follicles are narrowly ovoid with long attenuate apices, size ranging from 95–105 x 4–5 mm, with the pericarp puberulous and herbaceous. *Finlaysonia khasiana* and *F. pierrei* follicles are typically falcate-ovoid with acute, hooked apices but differ in size and texture. In *F. khasiana* they are on average 22 x 5 mm, the pericarp glabrous and herbaceous but in *F. pierrei*, the follicles are about 40 x 10 mm and also glabrous but coriaceous. The follicles of *F. puberulum* are narrowly ovoid with obtuse-acute apices and puberulous with herbaceous pericarp. The characteristics of *F. obovata* are the unique keel-shaped follicles with incurved attenuate apices, glabrous with coriaceous pericarp, and sizes ranging from 60–100 x 30–40 mm. Follicles of *F. wallichii* are usually ovoid-keel-shaped, with attenuate apices and 90 x 15 mm, pericarp longitudinally ribbed, scabrid and herbaceous.

Finlaysonia obovata is differentiated from other *Finlaysonia* species by its flat broad obovate seed that are marginally winged and fimbriate and lacking a coma. This is probably an adaption to hydrochonic (water) dispersal in contrast to others with coma at the micropylar end which is an indication of anemochoric (wind) dispersal. *F. pierrei* is characterized by evenly distributed warts on the margin and flat, broad ridges on the lower seed coat surface. In *F. wallichii*, the seeds are oblong-obovate, smooth on both surfaces, and the margin is crassinate (sausage-like) and patterned on the concave surface. (Table 4.3).

Table 4.3: Comparison of follicle and seed characteristics of species in *Finlaysonia*

SPECIES CHARACTERS	<i>F. decidua</i>	<i>F. insularum</i>	<i>F. khasiana</i>	<i>F. obvata</i>	<i>F. pierrei</i>	<i>F. puberulum</i>	<i>F. venosa</i>	<i>F. wallichii</i>
Follicle shape	–	Narrowly ovoid	Narrowly falcate-ovoid	Keel-shaped	Falcate-ovoid	Narrowly ovoid	–	Ovoid-keel-shape
Follicle size (mm)	–	95 – 105 x 4 – 5	22 x 5	60 – 74 x 25 – 34	40 x 10	95–106 x 4–5	–	90 x 15
Follicle apex	–	Attenuate	Acute and hooked	Incurved and attenuate	Acute and hooked	Obtuse-acute	–	Attenuate
Follicle pericarp surface	–	Puberulous and herbaceous	Glabrous and herbaceous	Glabrous and coriaceous	Glabrous and coriaceous	Puberulous and herbaceous	–	Scabid and herbaceous
Seed shape	–	Oblong-obovoid	–	Obovoid	Narrowly oblong-ovoid	–	–	Oblong-obovoid
Seed size (mm)	–	5 x 1	–	15 – 20 x 7 – 12	5 – 6 x 2	–	–	10 x 3 – 4
Lower seed margin	–	Smooth	–	Smooth and fimbriate	Warted	–	–	Patterned, crassinate (sausage-like)
Seed distribution mechanism	–	Coma, 35–40 mm	–	Winged with margin fimbriate	Coma, 25–45 mm	–	–	Coma, 25–30 mm

4.4 Key to the *Finlaysonia* species

1. Leaves oblong-lanceolate to very narrowly lanceolate, length:width ratio more than 7:1. ***F. wallichii***
 Leaves broadly to narrowly elliptic, obovate to oblong-obovate or linear, length:width ratio less than 4:1..... **2**
2. Leaves broadly elliptic, length:width approximately 1.5:1; corona lobes narrowly conical tapering to narrowly subulate apically ***F. puberulum***
 Leaves elliptic, narrowly elliptic, obovate, oblong-ovate or lanceolate; length:width ratio more than 1.7:1; corona lobes filiform, rod-shaped or ovate..... **3**
3. Leaves subsessile or petiole shorter than 2 mm..... **4**
 Leaf petioles longer than 7 mm..... **5**
4. Leaves narrowly elliptic, glabrous; corolla lobes glabrous inside, apices rounded; corona lobes rod-shaped with bifid or blunt apices..... ***F. venosa***
 Leaves oblong-ovate to narrowly obovate, puberulous at least on the veins; corolla lobes pubescent inside and apices acute, acuminate or attenuate; corona lobes with concave-ovoid bases and cylindric-filiform apices ***F. pierrei***
5. Interpetiolar ridges tomentose; juvenile leaves narrowly linear and densely tomentose; sepals outside densely tomentose..... ***F. decidua***
 Interpetiolar ridges glabrous or puberulous to puberulent; leaves elliptic, rarely obovate, sepals outside glabrous to puberulous..... **6**

6. Corona lobes ovate and fleshy, anther connective hairy on outside; follicles shorter than 30 mm..... ***F. khasiana***
- Corona lobes filiform and herbaceous, stamens glabrous; follicles longer than 60 mm..... **7**
7. Leaves coriaceous; sepals glabrous, corolla lobes villous on inside; follicles keel-shaped; seed margins winged and fimbriate, coma absent..... ***F. obovata***
- Leaves herbaceous; sepals densely puberulous, corolla lobes glabrous on both sides; follicles very narrowly ovoid, seed margins entire, seed margins entire, seed with coma ***F. insularum***

4.5 Generic synonyms of *Finlaysonia*

Atherolepis Hook. f. (= *Finlaysonia*)

Finlaysonia Wall.

Hanghomia Gagnep. & Thenint (= *Finlaysonia*)

Meladerma Kerr (= *Finlaysonia*)

Stelmacrypton Baill. (= *Finlaysonia*)

4.6 Synonyms of *Finlaysonia* species

Atherolepis pierrei Costantin (= *F. pierrei*)

Atherolepis pierrei var. *glabra* – nom. nud. (= *F. pierrei*)

Atherolepis venosa Collett & Hemsl. (= *F. venosa*)

Atherolepis wallichii (Wight) Hook. f. (= *F. wallichii*)

Atherolepis wallichii (Wight) Benth. (= *F. wallichii*)

Finlaysonia decidua (Kerr) Venter & A.M.Venter

Finlaysonia insularum (King & Gamble) Venter

Finlaysonia khasiana (Kurz) Venter & A.M. Venter

Finlaysonia obovata Wall.

Finlaysonia maritima Backer ex K. Heyne (imperfectly known, possibly synonymous with *F. obovata*)

Finlaysonia pierrei (Costantin) Venter & A.M.Venter

Finlaysonia puberulum (Kerr) Venter & A.M.Venter

Finlaysonia venosa (Collett & Hemsl.) Venter & A.M.Venter

Finlaysonia wallichii (Wight) Venter

Gymnanthera insularum King & Gamble (= *F. insularum*)

Gurua obovata (Wall.) Buch.- Ham. ex Voigt. (= *F. obovata*)

Hanghomia marseillii Gagnep & Thenint (= *F. khasiana*)

Hemisdesmus wallichi Wight (= *F. wallichii*)

Meladerma deciduum Kerr (= *F. decidua*)

Meladerma insularum (King & Gamble) Kerr (= *F. insularum*)

Meladerma puberulum Kerr (= *F. puberulum*)

Pentanura khasiana Kurz (= *F. khasiana*)

Periploca acuminata Rahman & Wilcock (= *F. khasiana*)

Stelmacrypton khasiana (Kurz) Baill. (= *F. khasiana*)

Tabernaemontana cirrhosa Blanco (= *F. obovata*)

4.7 Confusing synonymy

Venter in Venter and Verhoeven (2001) combined *Meladerma decidua*, *M. insularum* and *M. puberulum* with *Meladerma insularum* and transferred the latter to *Finlaysonia* as *F. insularum*. In this dissertation *F. insularum* has been disassembled into *F. decidua*, *F. insularum* and *F. puberulum*.

4.8 Imperfectly known species names

Finlaysonia maritima Backer ex K.Heyne in Heyne, De Nuttige Planten van Nederlandsch Indie (ed. 2) 2: 1293 (1927).

CHAPTER 5

TAXONOMY OF *STREPTOCAULON*

5.1 Generic description

STREPTOCAULON Wight & Arn. in Wight, Contributions to the Botany of India: 64 (1834); Hook.f., Flora of British India, 4: 9 (1885); Drury, Handbook of Indian Flora 2: 215 (1866); Costantin, Flora Generale de L'Indo-Chine: 30 (1912).

Type species: *Streptocaulon kleinii* Wight & Arn. [see Notes, p. 126].

= *TRIPOLEPIS* Turcz. in Bulletin de la Société Impériale des Naturalistes de Moscou 21: 251 (1848).

Type species: *Triplolepis cumingii* Turcz.

= *GONGYLOSPERMA* (King & Gamble) Venter & A.M.Venter *syn. nov.*; King & Gamble, Journal of the Asiatic Society of Bengal, Pt. 2, Natural History 74: 510 (1908); Venter & R.L.Verh., Annals of the Missouri Botanical Garden 88: 564 (2001).

Type species: *Gongylosperma curtisii* King & Gamble.

Macromorphology

Climber or shrub. **Stems** woody; branches erect or twining; bark smooth to longitudinally ridged, puberulous, scabrid to tomentose with dirty white to copper-coloured hair; interpetiolar nodes ridged with dirty white to copper-coloured hair; colleters axillary and on interpetiolar ridges, narrowly turbinate, glabrous, reddish-black to black. **Leaves** opposite, petiolate to sub-sessile; petiole adaxially grooved; blade simple, coriaceous or herbaceous, margin entire, venation pinnate, secondary veins patent or divaricate, brochidodromous, rarely eucamptodromous, tertiary veins random reticulate.

Inflorescences axillary, rarely terminal, cymose, flowers on terminal branches, few to numerous; bracts one or two per node, opposite, rarely alternate, margins fimbriate;

colleters on nodes of primary, secondary and tertiary peduncles, in association with bracts, reddish to reddish-black, narrowly turbinate. **Floral buds** with corolla lobes overlapping anti-clockwise. **Flower** bisexual, actinomorphic, pentamerous, semi-epigynous. **Sepals** free, glabrous to puberulous or scabrous outside, glabrous inside, margins entire but fimbriate; apices acute, attenuate or obtuse; colleters at inner base of sepals, two per sepal, free and narrowly turbinate or two colleters from adjacent sepals fused into an ovate or orbicular compound colleter, reddish-black. **Corolla:** glabrous on both sides; tube short, inverted at coronal annulus, shallowly campanulate or bowl-shaped; lobes longer than tube, reflexed, glabrous, margins entire. Only lower (primary) **corona** present, inserted on inversion of corolla tube, exerted from corolla tube, pentamerous; lobes consist of a broadened, glabrous foot and an upper glabrous segment. **Stamens** inserted on inversion of corolla tube and fused to inner base of coronal feet, connivent over stylar head, filamentose, glabrous; anther basally fused to stylar head, thecae whitish, without basal callosities, dehisce with full length lateral slits; connective glabrous, connective appendage prominent and connivent over stylar head, glabrous; pollinia 4 per anther, 2 per theca, ovoid to ellipsoid. **Nectaries** 5, interstaminal, below corolla tube inversion, fused laterally with coronal feet and staminal filament bases, forming vertical chutes between stamens, directly above nectaries, each nectary shelf-like with erect, thickened rim pressing against style, no interstaminal lobules present on rim. **Gynostegium** exerted. **Pistil:** ovaries 2, semi-inferior, free, placentation marginal, ovules numerous; styles 2, terete, fused towards stylar head; stylar head pentangular, glabrous, apex acute to obtuse; translators embedded in upper surface of stylar head, alternating with anthers, spatulate, divided into receptacle, style and viscidium; receptacle ovate to broadly ovate or obovate, style filiform to linear-terete; viscidium disc-shaped. **Fruit** of paired follicles, divergent to horizontal; pericarp surface tomentose, lanuginose or scabrid and herbaceous; apex obtuse to acute or attenuate. **Seed** dark brown to black, ovate to obovate; coma at micropylar end, copper-coloured.

Micromorphology

The adaxial **leaf epidermal surfaces** are usually sparsely to densely scabrid to scabridulous. Epidermal cells are tetra- to hexagonal with or without papillae. The cuticle is smooth to striated. Indumentum on abaxial leaf epidermal surface is very densely tomentose to lanuginose, rarely scabrid. The leaves are hypostomatic with the exception of *Streptocaulon sylvestre* that is amphistomatic.

The upper **seed coat surface** is smooth to finely pitted. The upper seed coat surface sculpture show little variation between species. Epidermal cells are tetragonal to elongate, linearly and tightly packed. Outer periclinal walls are tabular, concave to slightly convex. Anticlinal walls are straight to wavy. The cuticle is smooth to granular. The lower seed coat surface and margin is smooth to rarely rugose with a narrow central longitudinal ridge. Epidermal cells are morphologically similar in shape and arrangement to those on the upper seed coat. The cuticle is smooth, slightly striated to granular.

Pollen tetrads are agglutinated, forming ovoid, oblong to ellipsoid pollinia, 83–236 x 43–45 μm in size (Fig. 5.1.1 A, B). Pollinia in *Streptocaulon juvenas* and *S. lanuginosa* are ovoid; *S. cumingii*, *S. curtisii* and *S. sylvestre* have oblong-shaped pollinia while ellipsoid pollinia occur in *S. kleinii* and *S. wallichii*. Pores are present on the proximal pollen wall but may be present on the distal wall as well (Fig. 5.1.1 E). Tectum and granular stratum of adjoining tetrads may be fused where pores of adjacent tetrads are opposite to each other (Fig 5.1.1 D). Distal wall exine is smooth and consists of a compact stratum (tectum), subtended by granular stratum (Fig. 5.1.1 C). The proximal wall has the same exine stratification as the distal wall with tectum and granular stratum. The inner walls are reduced and consist only of a thin exine layer and intine with wall bridges (Fig. 5.1.1 E, F). (Venter and Verhoeven, 1998).

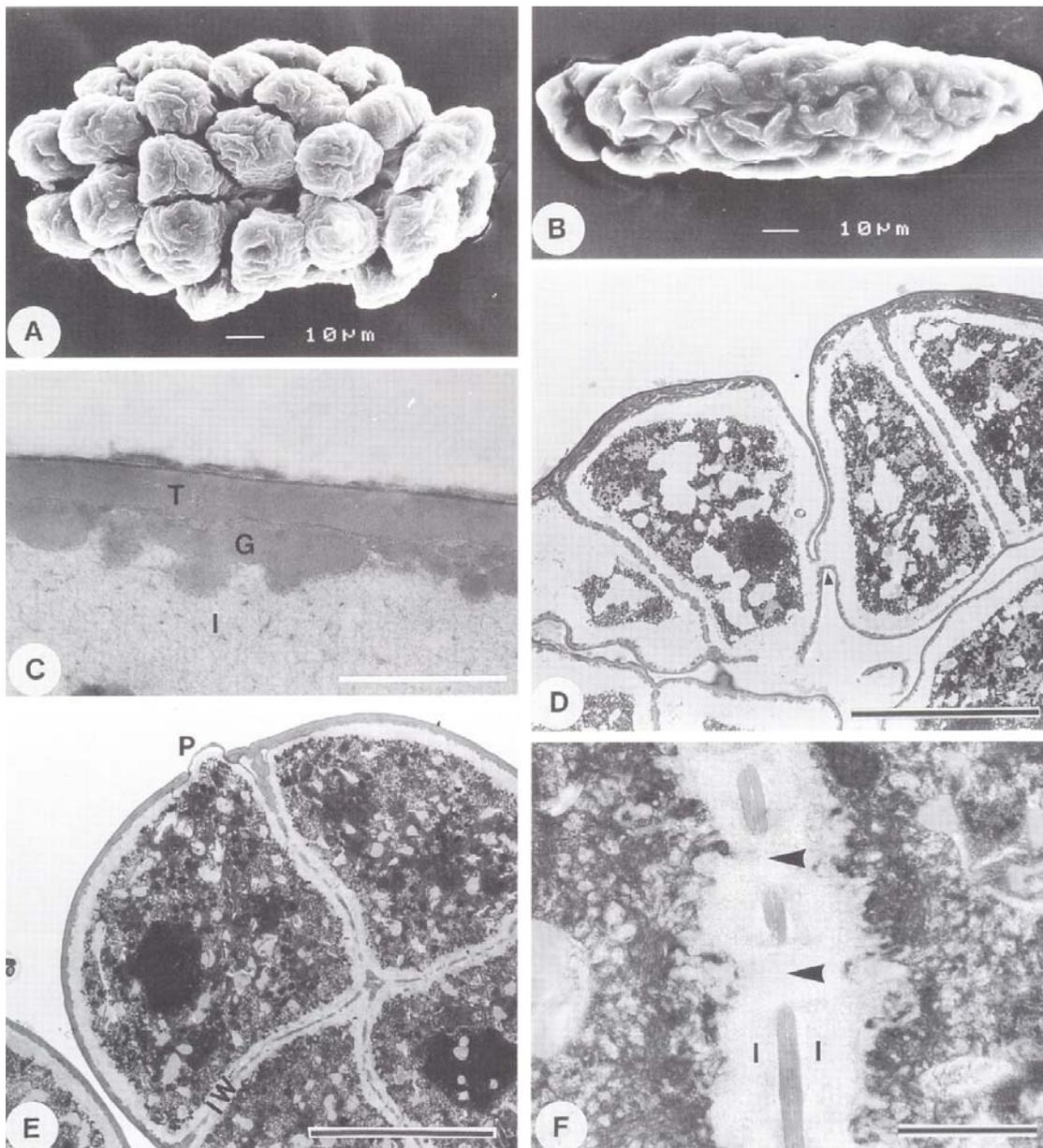


Fig. 5.1.1 Pollinia and pollen wall architecture of *Streptocaulon juvenas* (= *S. griffithi*) and *S. cumingii*. A: pollinium of *S. juvenas*; B: pollinium of *S. cumingii*; C: distal wall showing tectum (T), granular stratum (G) and intine (I); D: fusion of two tetrads (arrow head); E: tetrad showing pore (P) in distal wall and reduced inner wall (IW); F: inner wall with wall bridges (arrow heads), consisting of exine layer and intine (I). Scale bars: A, B = 0.5 μ ; C, D, E = 10 μ ; F = 1 μ . [A–F: duplicated from Verhoeven and Venter (1998)].

Distribution and habitat

Streptocaulon species are widely distributed in tropical Asia, with the highest concentration of species in Thailand (Fig. 5.1.2).

The genus occurs in a variety of habitats, on river banks, along road sides or in paddy fields, growing mostly in dry clayey soils or soils from sandstone, limestone, granite or red-basalt. *Streptocaulon* species form part of communities ranging from savannah, scrub, evergreen forest and deciduous jungle to bamboo thickets. Flowering occurs in all seasons, peaking in spring.

Notes

The first species listed by Wight and Arnot (1834) in their publication on *Streptocaulon*, was *S. tomentosa*, but as this is a synonym of *S. juvenas*, Venter and Verhoeven (2001) designated *S. kleinii* as the generic type.

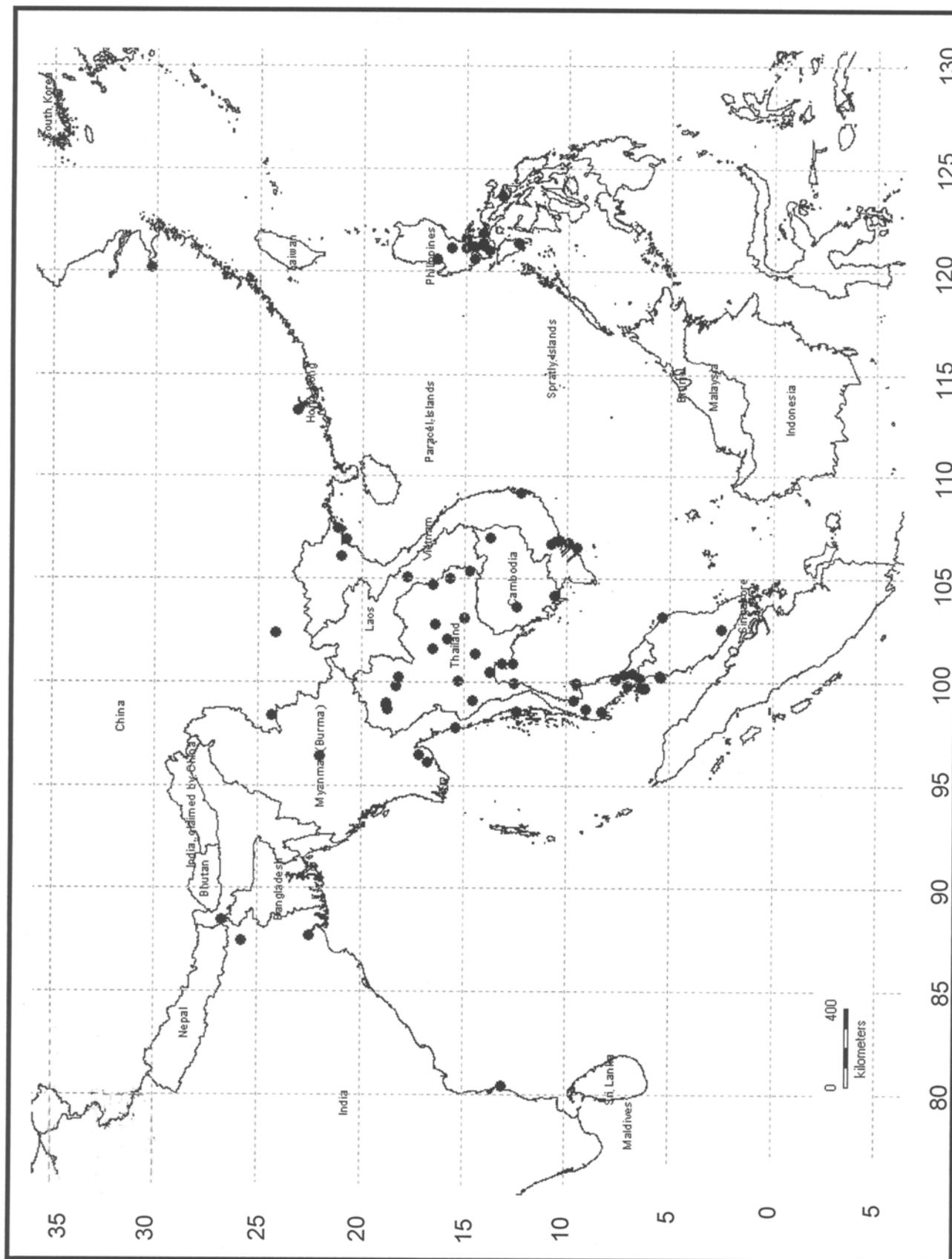


Fig. 5.1.2 Geographical distribution of the genus *Streptocaulon* in Asia

5.2 Description of *Streptocaulon* species

5.2.1 *Streptocaulon cumingii* (Turcz.)Vill. in Blanco, Flora de Filipinas (ed. 3), vol. 4(12A): 132 (1880); Merr., An enumeration of Philippine flowering plants, vol. 3 (1923). Basionym: *Triplolepis cumingii* Turcz. in Bulletin de la Société Impériale des Naturalistes de Moscou 21: 251 (1848).

Type: Philippines, Provence Pangasanan, Luzon, *Cuming 1025* (KW-scan!, holotype) Fig 5.2.1A); *Cuming 1024* (K!, BM!, MW, P! (2 sheets), isotypes) [see Notes, No. 1, p. 136] (Fig. 5.2.1B).

= *Streptocaulon corymbosum* (Elmer) Elmer in Leaflets on Philippine Botany 10: 3594 (1938). Basionym: *Anodendron corymbosum* Elmer in Leaflets on Philippine Botany 2: 512 (1908); Merr., An enumeration of Philippine flowering plants, vol. 3 (1923).

Type: Philippines, Luzon, *Elmer 8468* (K!, lectotype, here designated; G!, MO, isolectotypes) [see Notes, No. 2, p. 136].

= cf. *Streptocaulon magnum* Elmer, *in sched.*

Specimen: Philippines, Luzon, Los Banos, *Elmer 17867* (BM!, K!).

Macromorphology

Climbers. **Stems:** bark with prominent longitudinal ridges, reddish brown, young stems sparsely puberulous, older stems glabrous, slightly verrucose and lenticellate; nodes puberulous, hairs copper-coloured; colleters few. **Leaves** petiolate; petioles (3–)15–38(–42) x 2 mm, glabrous to scabridulous with dirty white hairs; axil lanuginose; blade ovate to elliptic, (89–)120–187(–195) x (38–)65–101(–146) mm, herbaceous, glabrous, puberulous to sparsely scabrid, rarely sparsely lanuginose adaxially, mostly densely tomentose abaxially, rarely sparsely scabridulous, main vein glabrous to puberulous, apex acuminate, base round to cordate, rarely obtuse, venation brochidodromous, 10–15 secondary veins on either side of main vein, divaricate, tertiary venation random reticulate, areoles well developed, veinlets branching.



Fig.5.2.1A Type specimen of *Streptocaulon cumingii* (Turcz.) Vill. (Cuming 1025, holotype (KW)).

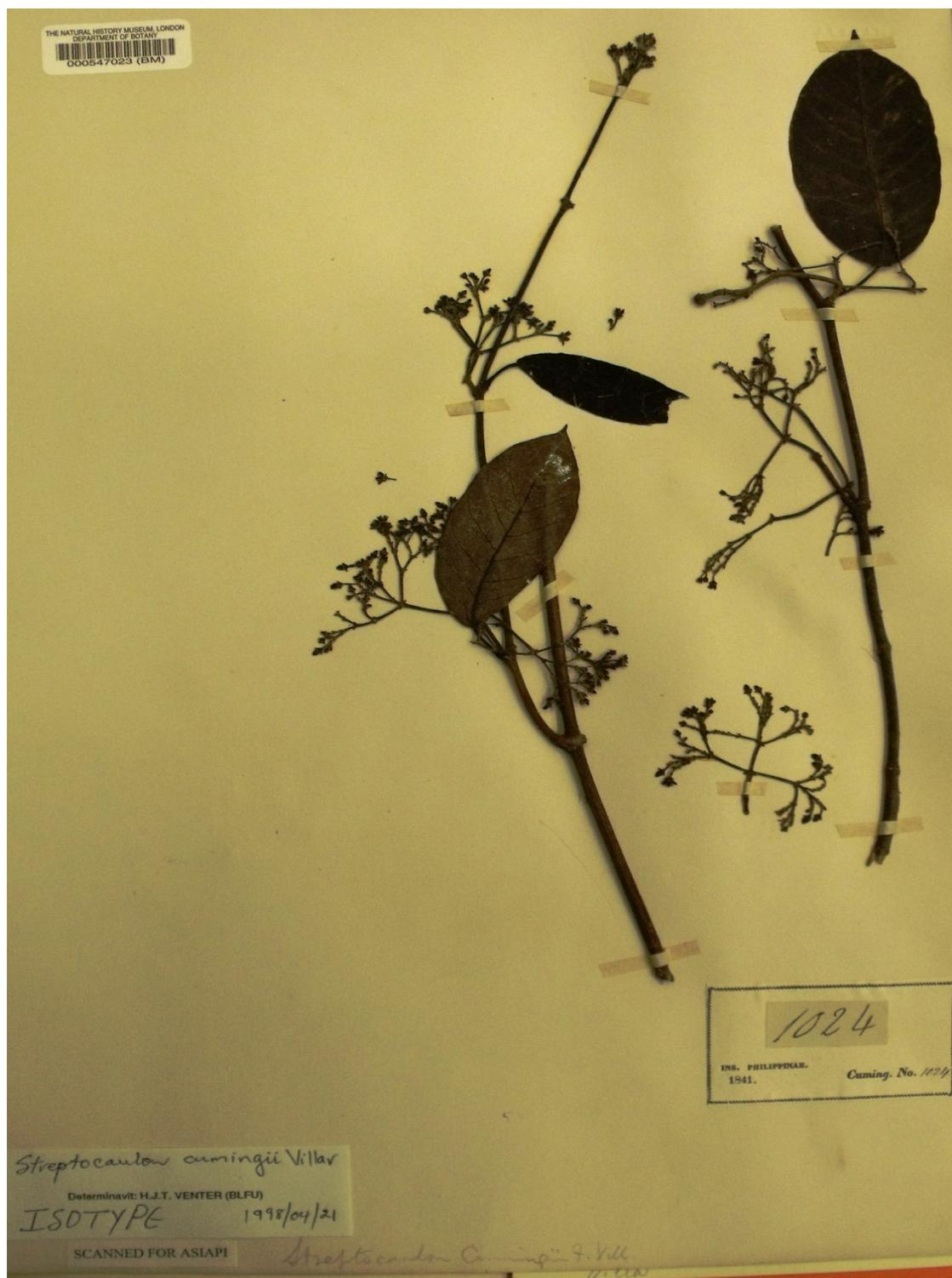


Fig.5.2.1B Specimen representing the isotype specimen of *Streptocaulon cumingii* (Turcz) Vill. but given an incorrect collecting number (*Cuming 1024*, isotype (BM)).

Inflorescences axillary, lax to slightly compact dichasia with monochasial terminal branches, sometimes only monochasia, up to 60 flowers per cyme, primary peduncles 4–12(–25) mm long, secondary peduncles (4–)15–25(–30) mm long, tertiary peduncles 5–10 mm long, puberulous with white hair; pedicels 2–6 mm long, puberulous with dirty white to copper-coloured hair; bracts opposite on dichasial peduncles, alternate on monochasial branches, broadly ovate, naviculate, 1–2 x 1–2 mm, glabrous to puberulous on main vein; margins with copper-coloured hairs. **Floral buds** ovoid, 1.3–2 mm long, apices obtuse. **Sepals** broadly ovate, 1.2–1.7 x 1–1.1 mm, glabrous, marginal hair copper-coloured; apices obtuse; colleters compound, broadly triangular. **Corolla** tube shallowly campanulate or bowl-shaped, 1 mm long, glabrous on both sides; lobes ovate to broadly ovate or oblong-ovate, 2–2.5 x 1.1–1.5 mm, coriaceous, glabrous on both surfaces, apices obtuse. **Corona** lobes falcate-cylindric, 0.8–1 mm long, glabrous, herbaceous; apices notched to truncate; coronal feet laterally broadened. **Stamens:** filament linear 0.2 – 0.5 mm long, erect to curved; anther narrowly triangular to narrowly ovate, 0.5 – 0.6 x 0.2 mm, thecae oblong, connective appendage deltoid; pollinia linear-to narrowly oblong. **Pistil:** style 0.2–0.5 mm long, glabrous; stylar head broadly ovoid, sometimes with central erect column, 0.3–0.5 x 0.4–0.6 mm, apex obtuse to truncate; translator receptacle narrowly elliptic, apex entire, style short, terete. **Fruit** unavailable; seed pale greyish-green, oblong, 4–5 x 1–2 mm; coma unavailable. (Fig.5.2.4).

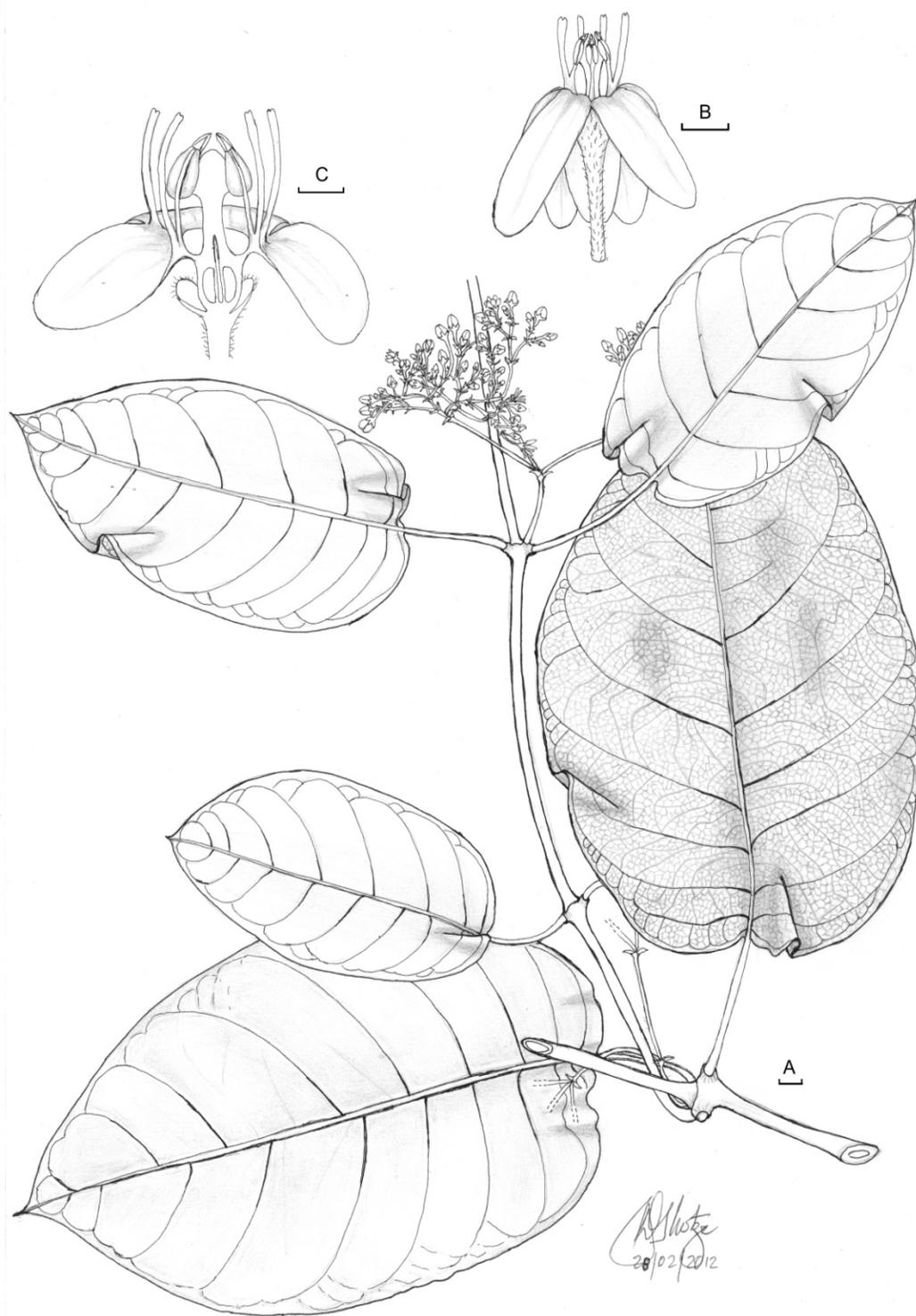


Fig. 5.2.2 *Streptocaulon cumingii*. A: stem with leaves and inflorescences; B: external view of flower; C: longitudinal section of flower with inverted corolla tube, corona lobes, stamens, ovaries, style and stylar head. Scale bars: A = 5 mm; B, C = 1 mm. [A: Ramos 41932 (K); B, C: Ramos and Edamo 45074 (P)].

Micromorphology

Adaxial **leaf epidermal cell** shape is not clearly distinguishable from the micrograph (Fig. 5.2.3 A). Outer periclinal cell walls are slightly concave without papillae. Anticlinal walls are undulating. The upper epidermis is glabrous to very sparsely scabridulous. The cuticle is striated. Striations are prominent and wavy (Fig. 5.2.3 A, B). Outer periclinal walls of abaxial leaf epidermis are tabular. Abaxial leaf epidermis is tomentose (Fig. 5.2.3 C). The cuticle is slightly striated. Striations are parallel to wavy and perpendicular to guard cells. No wax is present.

The leaves are hypostomatic. The stomata are elliptic with broad stomatal ledges and randomly arranged (Fig. 5.2.3 D).

The upper **seed coat** surface is longitudinally ribbed (Fig. 5.2.4 A). Epidermal cells are tetra- to pentagonal in shape. Outer periclinal walls are concave (Fig. 5.2.4 C). Anticlinal walls are straight to slightly wavy. The cuticle is smooth. (Fig. 5.2.4 B, C).

The lower seed coat surface is rugose and margin curved inwards which is an extension of the upper seed coat (Fig. 5.2.4 D). Epidermal cells are tetragonal in shape. Outer periclinal walls are concave (Fig. 5.2.4 F). Anticlinal walls are wavy. The cuticle is smooth (Fig. 5.2.4 E, F).

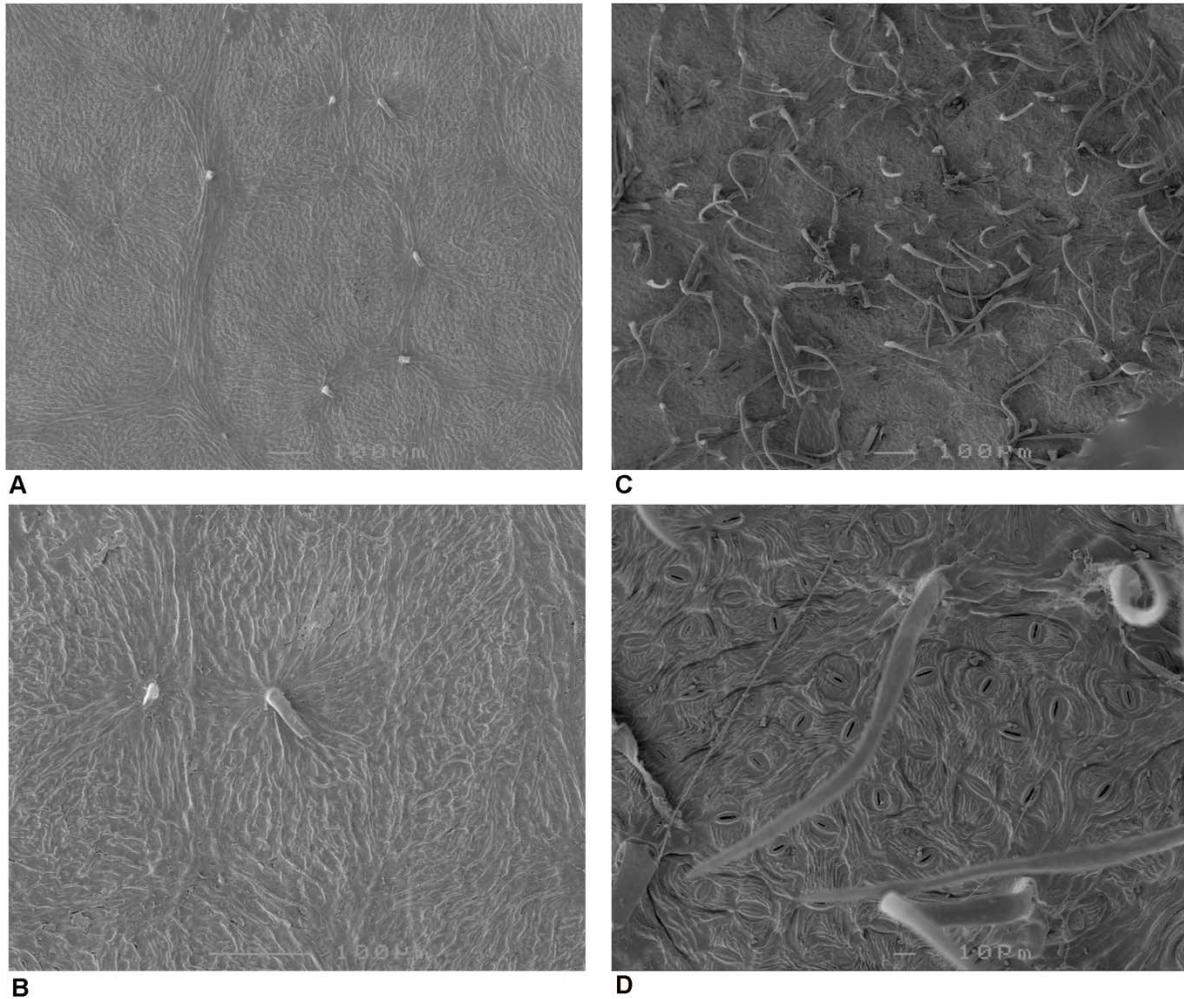


Fig. 5.2.3 *Streptocaulon cumingii*. A: adaxial epidermis showing sparsely distributed scabrid hairs; B: adaxial epidermis showing prominent cuticular striations; C: abaxial epidermis showing dense striations and tomentose indumentum; D: abaxial epidermis showing stomata, cuticular striations. Magnification: A, C = x80; B = x200; D = x400. [A–D: Merrill 1302 (K)].

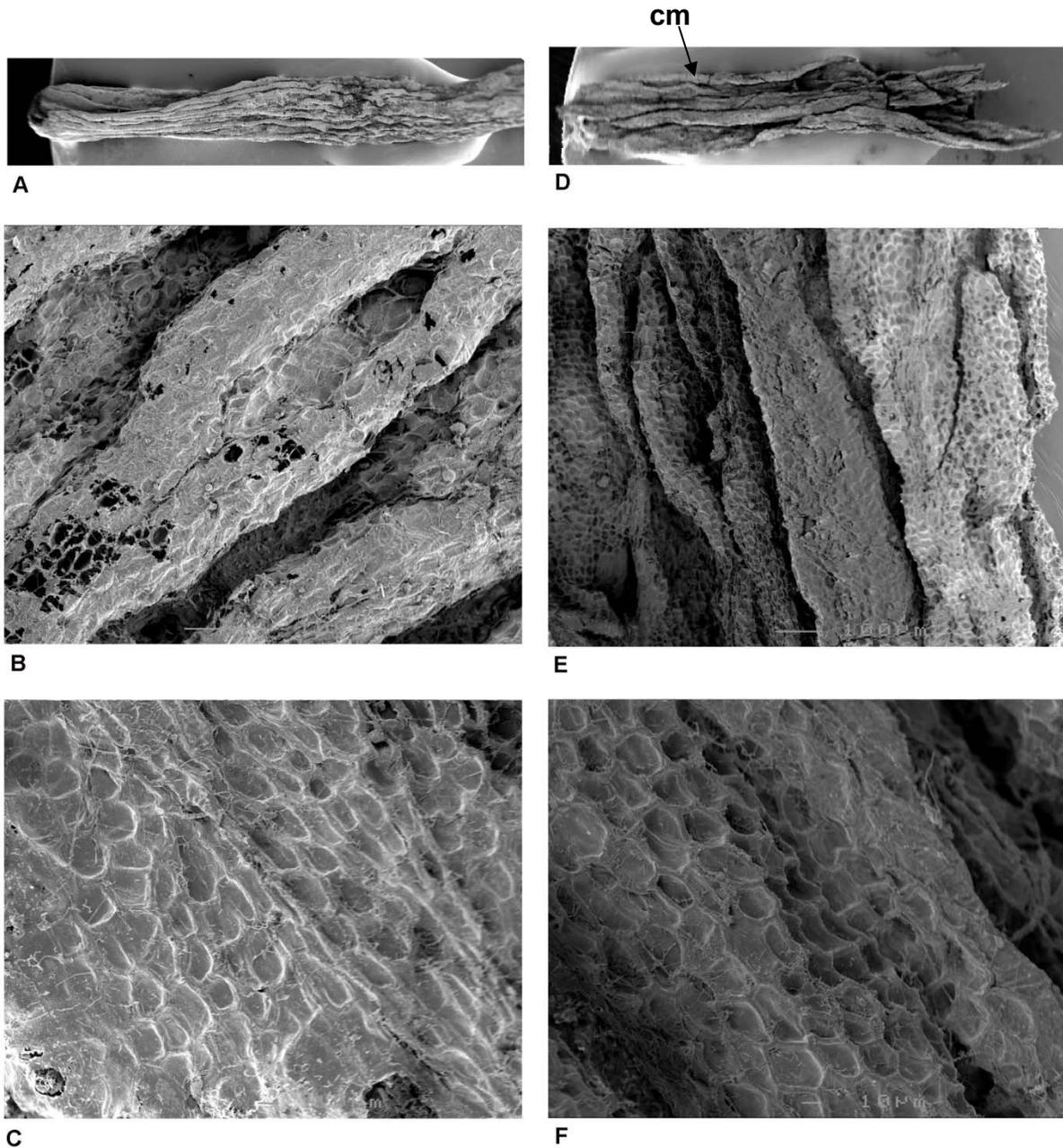


Fig. 5.2.4 *Streptocaulon cumingii*. A: upper seed coat showing longitudinally ridged surface; B: upper seed coat showing smooth cuticle; C: upper seed coat showing tetra- to pentagonal cells with concave periclinal walls; D: lower seed coat showing rugose surface and curled margin (cm); E: lower seed coat showing smooth cuticle; F: lower seed coat showing concave outer periclinal walls. Magnification: A, D = x20; B, E = x80, C, F = x200. [A–F: Merrill 1302 (K)].

Distribution and habitat

Streptocaulon cumingii is probably endemic to the northern island of Luzon in the Philippines (Fig.5.2.5), and inhabits mountainous areas. Flowering occurs from February to March.

Notes

1. Turczaninow cited *Cuming 1025* as type of *Triplolepis cumingii*. The herbaria of British Museum (BM), Kew (K), Moscow (MW) and Paris (P) have *Cuming 1024* in their type folders (Fig. 5.2.1B). Serenga (2010) alleges that Turczaninow incorrectly cited *Cuming 1025* as type of *Triplolepis cumingii* in his protologue, but that this specimen is actually that of *Gnaphalium luteo-album* and that *Cuming 1024* is the correct type specimen of *Triplolepis cumingii*. The scan supplied by the National Herbarium of Ukraine (KW) of the holotype of *Triplolepis cumingii* is clearly identified as *Cuming 1025* (Fig. 5.2.1A). The confusion regarding correct collector's number could have occurred when duplicates were sent out to various other herbaria.
2. A.D.E. Elmer, author of *Streptocaulon corymbosum*, described many of his new species in a Philippine journal and a number of the corresponding type specimens were housed in the Philippine National Herbarium (PNH) in Manila. However, in 1941 during World War II the herbarium building and the whole collection were completely destroyed (PNB web page).

Specimens examined

Philippines

- 13° 14'N, 123° 38'E: Luzon, Province Albay, *Cuming 1024*, (K, BM, P, isotypes).
- 14° 10'N, 121° 13'E: Luzon, Province Laguna, Los Banos (Mt. Maquiling), *Elmer, A.D.E. 17867* (K, BM).
- 14° 35'N, 120° 58'E: Luzon, Manila, Pena de la Cuera de Montalban "Volubulus", *Loher 4036* (K).

- 14° 36'N, 121° 11'E: Luzon, Province Rizal, Antipolo, *Merrill, E.D. 1302* (K).
- 15° 42'N, 121° 05'E: Luzon, Province Rizal, Mt Irig (= Irid), *Ramos, M. 41853* (K, L).
- 15° 42'N, 121° 05'E: Luzon, Province Rizal, Mt Irig (= Irid), *Ramos, M. HNP41853* (L).
- 16° 25'N, 120° 36'E: Luzon, Province Benguet, Baguio, *Elmer, A.D.E. 8468* (G, K, MO, isotypes of *Adenodendron corymbosum*).
- Grid reference unknown: Luzon, District Morong, *Vidal 3285* (K).

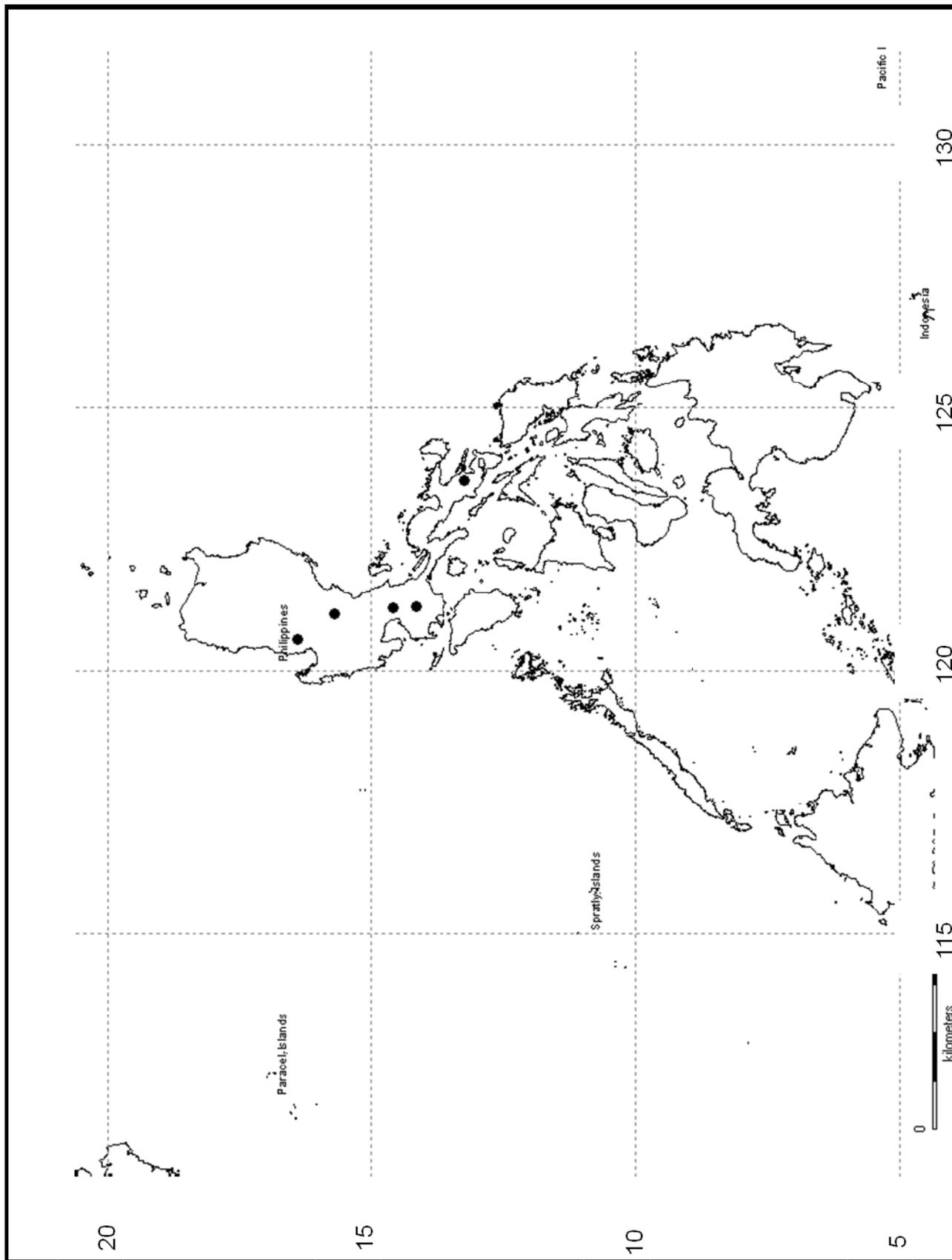


Fig 5.2.5 Geographical distribution of *Streptocaulon cumingii*

5.2.2 *Streptocaulon curtisii* (King & Gamble) Venter & A.M.Venter *comb. nov.* [see Notes, No. 1, p. 145].

Basionym: *Gongylosperma curtisii* King & Gamble in Journal of the Asiatic Society of Bengal, Pt. 2, Natural History 74: 510 (1908).

Type: Thailand, Pang-nga (Poongah), *Curtis 2951* (CAL, holotype?, K!, SING-scan!, isotypes?) [see Notes, No. 2, p. 145] (Fig. 5.2.6).

= *Finlaysonia curtisii* (King & Gamble) Venter in Venter & R.L.Verh., Annals of the Missouri Botanical Garden 88: 565 (2001). Homotypic synonym.

Macromorphology

Small shrubs. **Stems:** bark smooth, reddish-brown, puberulous, dirty white, verrucose and lenticellate; nodes puberulous, dirty white; colleters few. **Leaves** petiolate; petiole 4–5 x 1–1.5 mm, glabrous to puberulous, dirty white, adaxially grooved; axil lanuginose; blade ovate, narrowly elliptic to elliptic, 65–90 x 20–32 mm, coriaceous and rugose, adaxially sparsely scabrid and rugose, abaxially densely tomentose, main vein glabrous to tomentose, apex acute to acuminate, rarely obtuse, base cuneate, rarely rounded, venation brochidodromous, 14–23 secondary veins on either side of main vein, divaricate and patent, tertiary venation prominent and random reticulate, areoles well developed, veinlets inconspicuous because of dense hair covering leaf surface.

Inflorescences terminal and axillary, lax, dichasia or monochasia or dichasia terminating in monochasial branches with 5–10 flowers each, primary peduncles 5–10 mm long, secondary peduncles 4–7 mm long, tertiary peduncles 3–6 mm long, puberulous to densely puberulous, dirty white; pedicels 2–6 mm long, puberulous with dirty white hairs; bracts opposite on dichasial peduncles, alternate on monochasial peduncles, narrowly to broadly ovate, naviculate, 0.5–1.2 x 0.8–1 mm, outer surface puberulous, margin villous, hair white. **Floral buds** ovoid to broadly ovoid, 3 mm long; apices obtuse to obtuse-acute. **Sepals** broadly ovate to broadly triangular-ovate, 0.5–0.8 x 1 mm, puberulous to villous outside, apices acute to obtuse; colleters compound,



Fig. 5.2.6 Type specimen of *Streptocaulon curtisii* (King & Gamble) Venter & A.M.Venter (Curtis 2951, isotype (K)).

broadly ovate, 0.5 x 0.5 mm, apices bifurcate. **Corolla** purple; tube bowl-shaped, 0.3–1.5 mm long, glabrous on both sides; lobes ovate to broadly ovate or elliptic to broadly elliptic, 2–3 x 1–2 mm, semi-succulent, glabrous on both surfaces, margins hyaline (membranous); apices obtuse. **Corona** lobes filiform, 0.5–1 mm long, herbaceous, glabrous, apices bifid to entire; coronal feet conical to ovoid to broadly ovoid. **Stamens:** linear to broadly linear, filament 0.1–0.5 mm long, erect; anther oblong, oblong-ovate to broadly triangular, 0.5 x 0.2–0.5 mm, thecae oblong, connective appendage triangular to broadly triangular and dark purple; pollinia oblong to ellipsoid, 0.15–0.2 mm long. **Pistil:** style 0.1–0.2 mm, glabrous; stylar head broadly ovoid, 0.3–0.5 x 0.3–0.6 mm, apex obtuse; translator \pm 0.3 mm long, receptacle narrowly obovate to ovate to rhomboid-elliptic, apices deeply split, stipe linear to linear-terete. The **follicle** is juvenile, pale brown, ellipsoid, 17–35 x 4–5 mm, pericarp surface tomentose with whitish grey hairs, apex bluntly acute; seed unavailable. (Fig. 5.2.6).

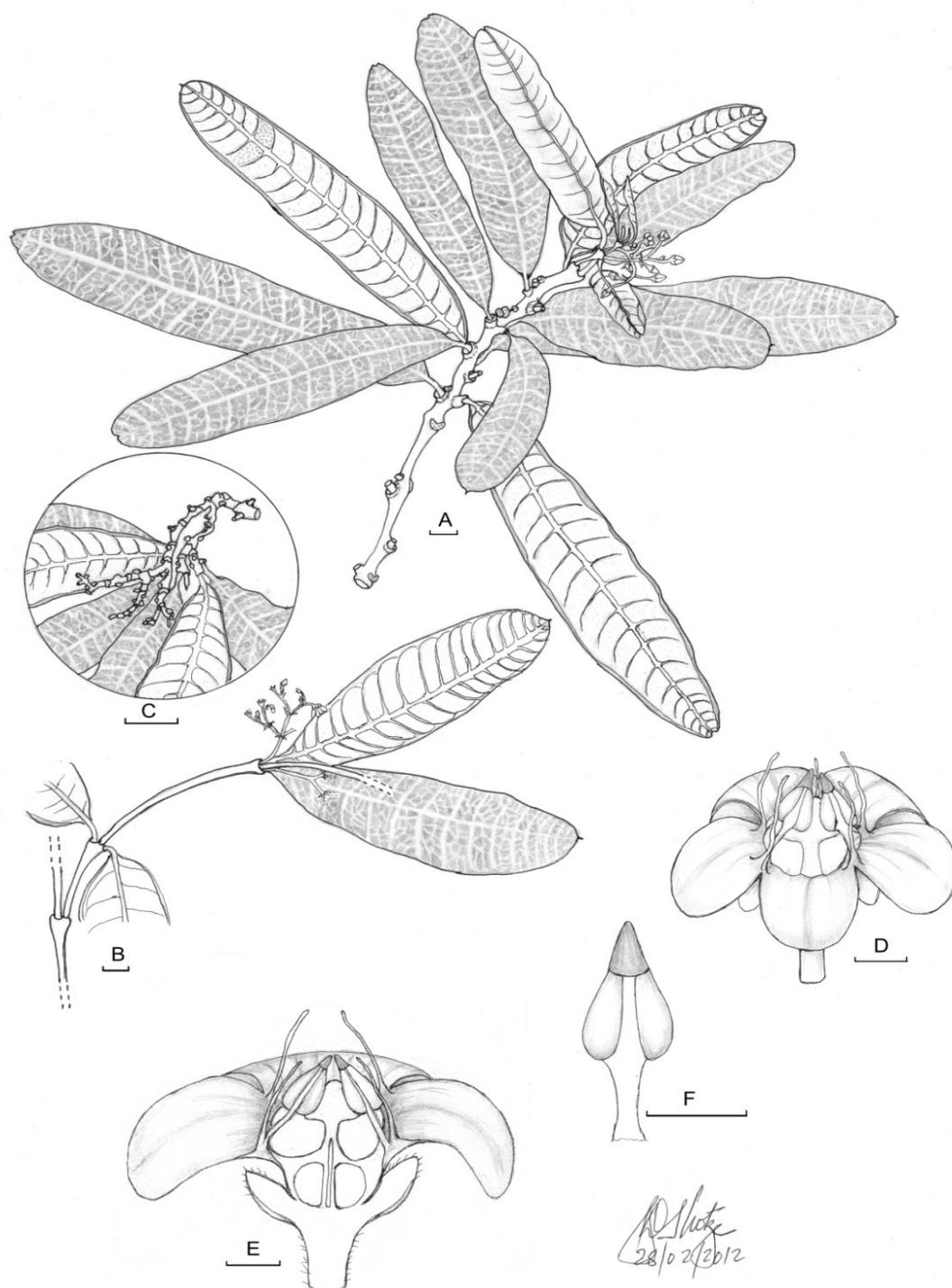


Fig. 5.2.7 *Streptocaulon curtisii*. A, B: stem with leaves and inflorescences; C: stem with inflorescence enlarged; D: external view of flower; E: longitudinal section of flower with inverted corolla, corona lobes, stamens, ovaries, style and stylar head; F: stamen with triangular connective appendage. Scale bars: A–C = 5 mm; D–F = 1 mm. [A, B, C: Kerr 17305 (K); D: Hain 12471(K); E, F: Kerr 12471 (L)].

Micromorphology

Adaxial **leaf epidermal cells** are tetragonal with convex outer periclinal cell walls without papillae. The adaxial epidermal surface is sparsely scabrid. The cuticle is smooth. No wax is present. (Fig. 5.2.8 A).

On the abaxial leaf epidermis cells are obscured by dense indumentum. The abaxial epidermis is sunken to form stomatal crypts which are densely tomentose. The cuticle and stomata are not visible because of dense indumentum. The leaf is probably hypostomatic as no stomata was observed on the adaxial leaf epidermis. (Fig. 5.2.8 B).

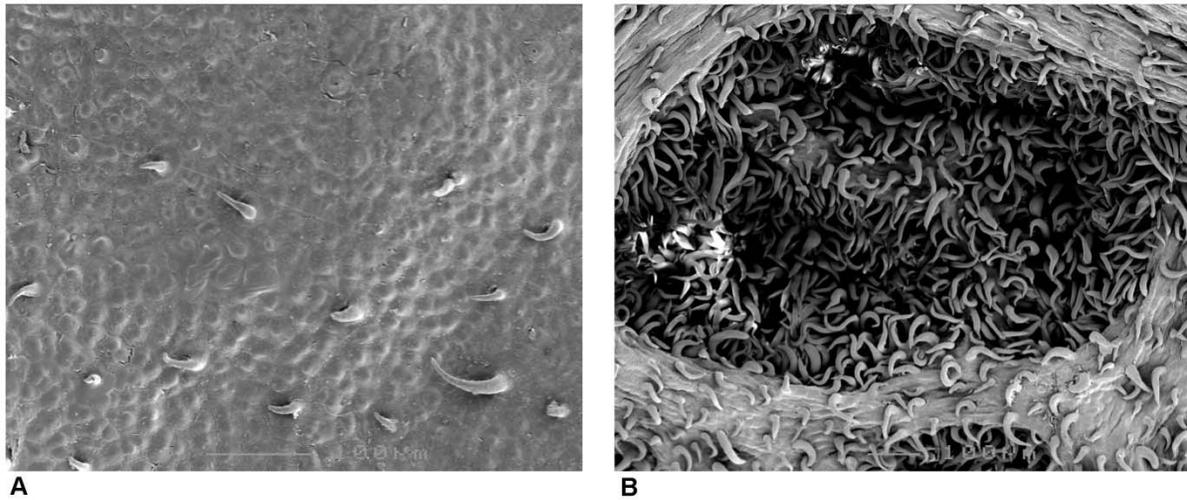


Fig. 5.2.8 *Streptocaulon curtisii*. A: adaxial epidermis showing trichomes and convex outer periclinal cell walls; B: abaxial epidermis showing stomatal crypts, densely tomentose. Magnification: A, B = x200. [A, B: Kerr 17315 (P)].

Distribution and habitat

Streptocaulon curtisii is found in Thailand (Fig. 5.2.9), and is associated with limestone rocks and crevices. Flowering occurs from March to April.

Notes

1. The phylogenetic analysis of Ionta (2009), in an unpublished thesis, supports the transfer of *Finlaysonia curtisii* to *Streptocaulon* to form the new combination *S. curtisii*.
2. As with *Finlaysonia insularum*, another species described by King and Gamble, there is doubt as to the location of the holotype. George King did not indicate where the holotype was housed but it is most probable that the holotype is housed in the Central National Herbarium, Calcutta (CAL) (Venter & Verhoeven, 2001). Attempts to verify this fact have been unsuccessful up till now.

Specimens examined

Thailand:

- 08° 17'N, 98° 36'E: Phang-nga, *Curtis, C. 2951* (K, isotype).
- 08° 17'N, 98° 36'E: Kaw Kalut, Phang-nga, *Kerr, A.F.G. 17305*, (P).
- 09° 01'N, 98° 44'E: Surat Thani, Phanom, Khoa Sok National Park, *Middleton, D.J. 4069* (K).
- 12° 37'N, 100° 54'E: Sarat, Kao Meo, *Kerr, A.F.G. 12471* (L).
- 12° 37'N, 100° 54'E: Bangkok, Surat, Kao Meo [= Kua Mio], *Hain, L. 12471* (K).

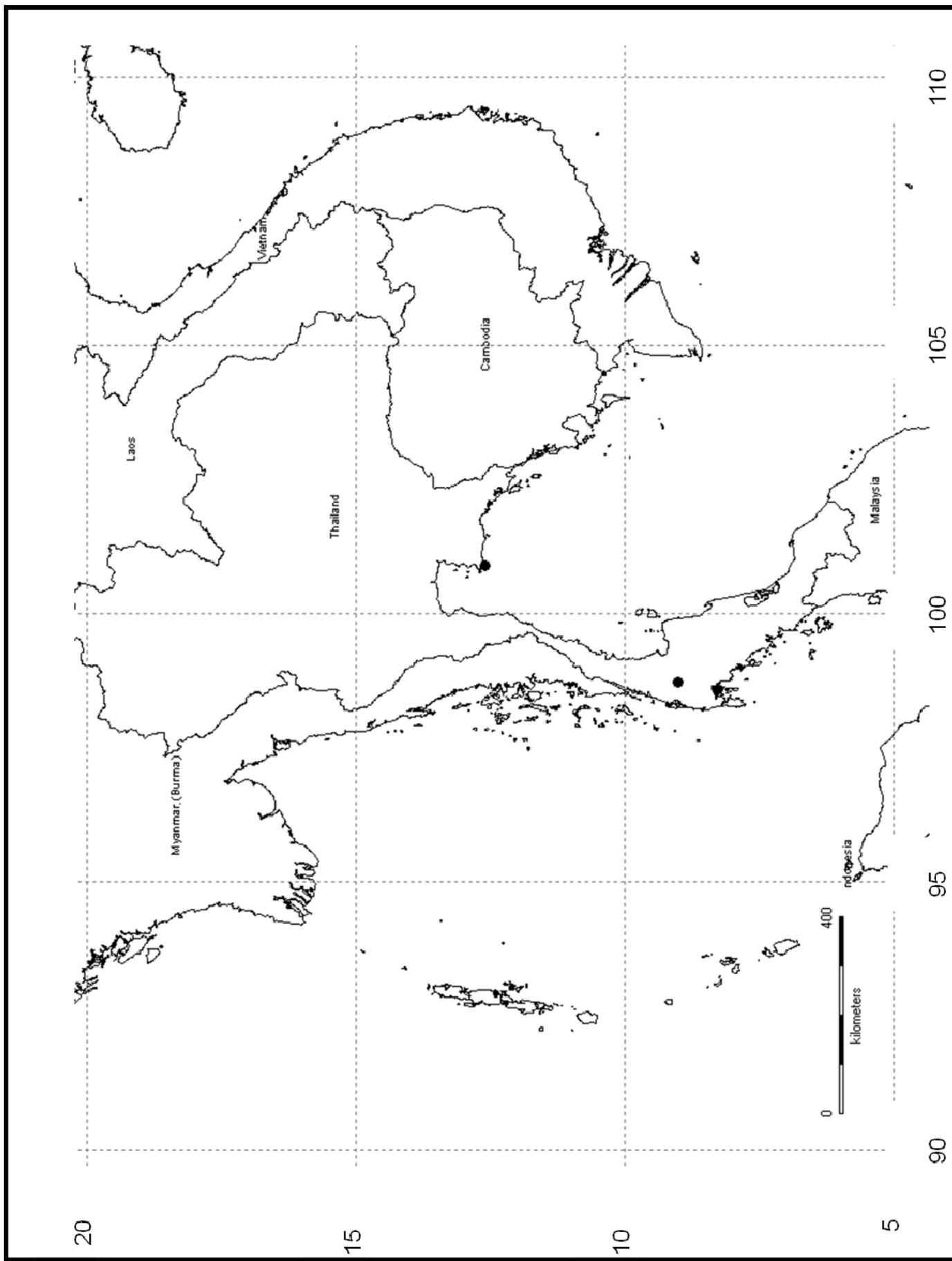


Fig. 5.2.9 Geographical distribution of *Streptocaulon curtisii*

5.2.3 *Streptocaulon juvenitas* (Lour.) Merr. in Transactions of the American Philosophical Society 24: 315 (1935).

Basionym: *Apocynum juvenitas* Lour., Flora Cochinchinensis: 167 (1790).

Type: Cochinchine (= southern Vietnam), *Loureiro s.n.* (BM-scan!, holotype) [see Notes, p. 154] (Fig. 5.2.10).

= *Streptocaulon griffithii* Hook.f. in Hooker's Icones Plantarum: tab. 406 (1842); Costantin, Flora Generale de L'Indo-Chine: 33 (1912).

Types: *Griffith 311* (K (sheet 1)!, lectotype, designated here; K, (sheet 2)!, isolectotype).

= *Streptocaulon tomentosum* Wight, Contributions to the Botany of India: 65 (1834); Hook.f., Flora of British India 4: 10 (1885); Costantin, Flora Generale de L'Indo-Chine: 31 (1912).

Types: Indonesia, Meong and Taong-Dong, *K-W 8248B* = *Wall. Asclep. no. 125a* (K-W!, lectotype, designated here); Cochinchine (now southern Vietnam), *K-W 8248A* = *Wall. Asclep. no. 125b* (K-W!, K!, syntypes (originally from Finlayson Herb.)); Myanmar, Tavoy (now Dawei) and Moolmyne (now Mawlamyine), *K-W 8248C* = *Asclep. no. 126* (K-W!, syntype).

Macromorphology

Climbers. **Stems** 8 m or more in length; bark with prominent longitudinal ridges, reddish-brown to dark reddish-brown, scabrid, hair copper-coloured, smooth; nodes with scabrid, copper-coloured hair; colleters numerous. **Leaves** petiolate; petiole 3–10(–20) x 2–3 mm, scabrid, hairs copper-coloured; axil villous; blade obovate to broadly obovate or rhomboid to broadly rhomboid, (60–)75–130(–160) x (25–)35–88(–95) mm, herbaceous, adaxially puberulous to scabrid, abaxially densely tomentose, main vein densely scabrid, apex usually acuminate, rarely obtuse-mucronate, base round to cordate, venation brochidodromous, 12–16 secondary veins on either side of main veins, divaricate, higher order venation and areoles inconspicuous because of dense indumentum.



Inflorescences axillary, lax, dichasia with distal monochasial branches, up to 25 flowers per cyme, primary peduncles 11–12 (–40) mm long, secondary peduncles 4–5 (–14) mm long, tertiary peduncles (3–)7–10 (–15) mm long, densely scabrid, hair copper-coloured; pedicels 2–6 mm long, scabrous; bracts opposite on nodes of both dichasial and monochasial peduncles, narrowly ovate to triangular, naviculate, 2.3–2.5 x 1 mm, densely hispid, hair copper-coloured; colleters numerous. **Floral buds** ovoid, 1–2 mm long, apices obtuse. **Sepals** ovate to broadly ovate, 1–1.2 x 0.5–1 mm, villous outside, glabrous inside, apices acute to attenuate; colleters compound, broadly ovate. **Corolla** pale green outside, reddish to olive-brown inside, tube shallowly campanulate, 0.5–0.9 mm long, glabrous on both sides; lobes ovate, 2–3.7 x 1–1.7 mm, herbaceous, glabrous on both surfaces, margins membranous; apices acute or obtuse. **Corona** lobes cylindrical-filiform, 0.7–2 mm long, apices entire, herbaceous; coronal feet ovoid. **Stamens:** filament linear, 0.1–0.2 mm long, erect; anther narrowly ovate to oblong-ovate, 0.5–0.7 x 0.2–0.3 mm, thecae oblong, connective appendage deltoid; pollinia ovoid. **Pistil:** style 0.1–0.2 mm long, glabrous; stylar head ovoid, 0.5 x 0.2–0.3 mm, apex acute to obtuse-acute; translator \pm 0.3 mm long, receptacle narrowly ovate to elliptic, \pm 0.2 x 0.1 mm, apex split, style very short, linear. **Follicles** pale brown, sub-horizontal to horizontal, oblong or oblong-lanceolate, 60–105 x 5–8 mm long, pericarp surface scabrid with white hairs; apex attenuate; seed dark brown, 5–9 x 1.5–2 mm, cylindrical to ovoid-cylindrical; coma silver-white, 20–45 mm long. (Fig. 5.2.10).

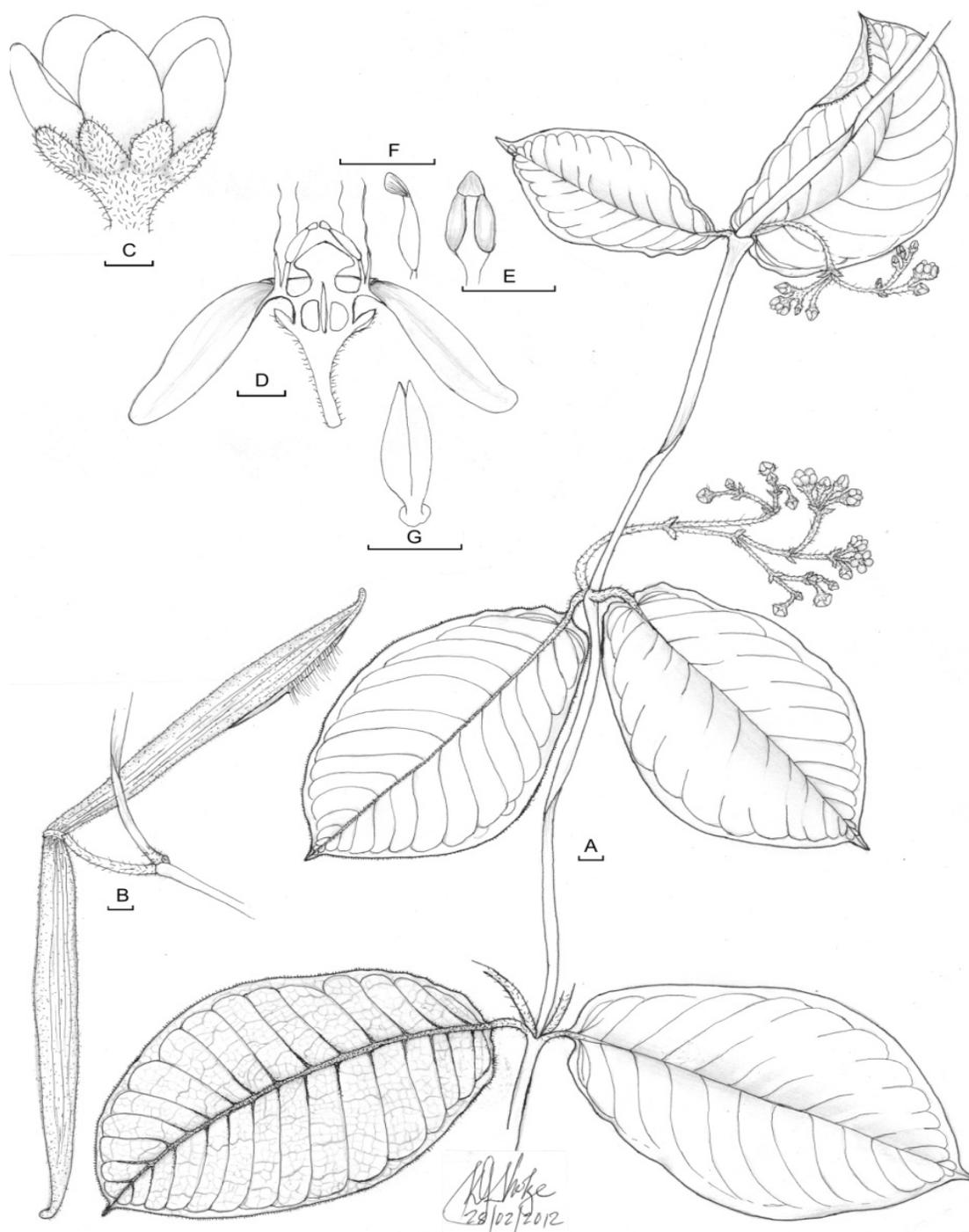


Fig. 5.2.11 *Streptocaulon juvenas*. A: stem with leaves and inflorescences; B: stem with follicles; C: external view of opening bud; D: longitudinal section of flower showing inverted corolla tube, corona lobes, stamens, ovaries, style and stylar head; E: stamen with deltoid connective appendage; F: lateral view of stamen with deltoid appendage; G: translator. Scale bars: A, B = 5 mm; C–F = 1 mm. [A, C, D, E, F: *Balansa 2107* (P); B: *Spire 22* (K)].

Micromorphology

The adaxial **leaf epidermal cells** are tetra- to hexagonal and the outer periclinal walls form small conical papillae (5.2.12 B). The adaxial leaf epidermis is densely puberulous to scabrid (Fig. 5.2.12 A). The cuticle is smooth to slightly striated. Striations are restricted to cells (Fig. 5.2.12 C). No wax is present.

The abaxial leaf epidermal surface is densely tomentose obscuring epidermal cells, stomata and cuticle (Fig. 5.2.12 D). The leaf is probably hypostomatic as no stomata were observed on the adaxial leaf epidermis.

The upper **seed coat** surface and margin is smooth (Fig. 5.2.13 A). Epidermal cells are elongate, tetragonal, and tightly packed (Fig. 5.2.13 B). Outer periclinal walls are convex. Anticlinal walls are straight and slightly sunken. The cuticle is smooth to slightly granular (Fig. 5.2.13 C).

The lower seed coat surface is smooth with a narrow central longitudinal ridge (Fig. 5.2.13 D). Epidermal cells on central longitudinal ridge are elongate and tetragonal in shape. Periclinal walls are slightly convex. Anticlinal walls are straight and sunken (Fig. 5.2.13 B). The epidermal cells towards the margin are tetragonal with similar periclinal and anticlinal walls as on the central ridge and the cuticle is smooth to slightly granular (Fig. 5.2.13 F).

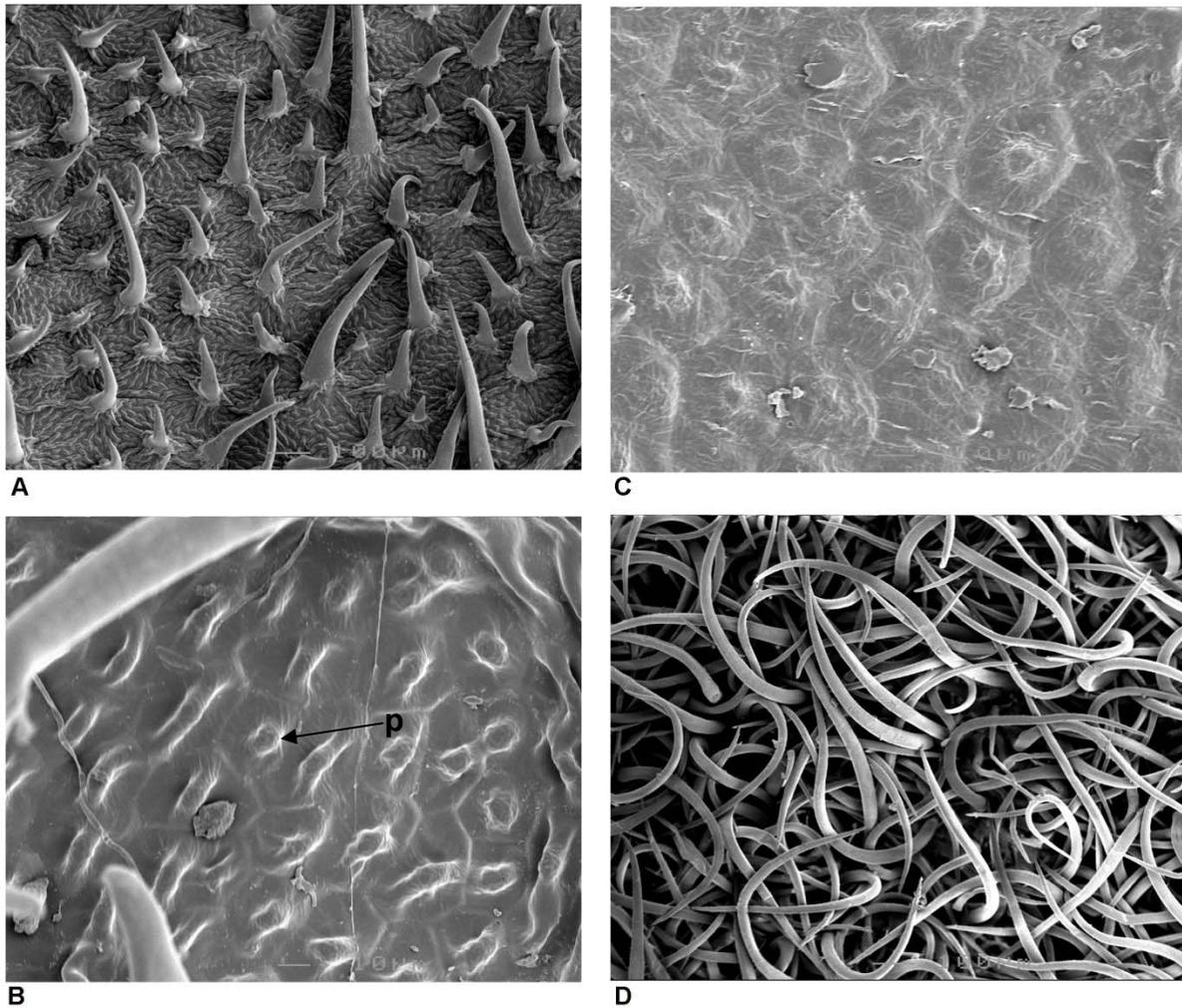


Fig. 5.2.12 *Streptocaulon juvenas*. A: adaxial epidermis showing indumentum; B: adaxial epidermis showing papillated epidermal cells; C: adaxial epidermis showing slightly striated epidermal surface; D: abaxial epidermis showing densely tomentose indumentum . p: papilla. Magnification: A, D =x200; B, C = x400. [A, B: *Henry 13439* (K); C: *Ramos 8* (K); D: *Stevens 1993* (K)].

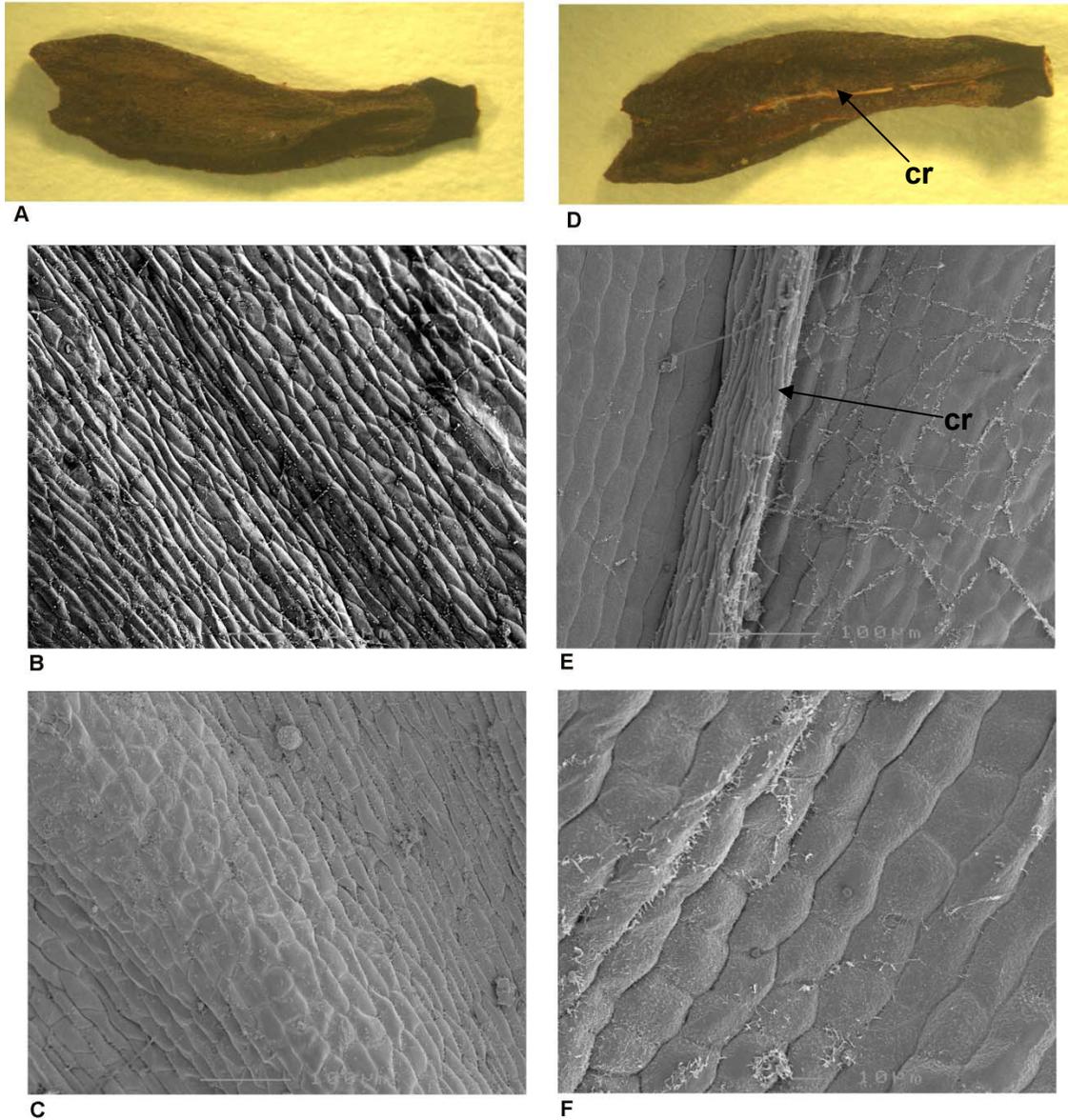


Fig. 5.2.13 *Streptocaulon juvenas*. A: upper seed coat showing smooth surface and margin; B, C: upper seed coat showing elongate and tightly packed cells with smooth to slightly granular cuticle; D: lower seed coat showing smooth surface with narrow central longitudinal ridge; E: central ridge showing elongate cells; F: lower seed coat showing smooth to slightly granular cuticle. cr: central ridge. Magnification: B = x200; C = x300; E = x400; F = x600. [A–F: Kurz 3259 (K)].

Distribution and habitat

Streptocalon juvenas is widely distributed over eastern Asia, in Cambodia, China, India, Laos, Malaysia, Myanmar, Thailand and Vietnam (Fig. 5.2.14).

Plants grow in a wide range of habitats, from dry clayey soil to soils of sandstone, red basalt and granite. This species is a component of savanna, bamboo thickets, evergreen and deciduous forests. Flowering occurs throughout the year but peaks during late summer in August and September.

Notes

Merrill (1935) stated the following: "Loureiro's specimen, which agrees with his description, is in the herbarium of the British Museum and Moore (Journ. Bot. 63: 252. 1925) has supplied a critical note regarding it, concluding that there is no reasonable doubt as to the identity of *Apocynum juvenas* Lour. with *Streptocaulon tomentosum* Wight. His note should be consulted because of the confusion that has existed between that species and *Tylophora indica* (Burm.f.) Merr. (*Apocynum reticulatum* Lour.), apparently due to a mixture of specimens and labels, or by accrediting the medicinal qualities to the wrong plant. Merrill (1935) continued: "Moore was doubtless correct in his assumption that the second specimen of *Apocynum juvenas* Lour. in the Herbarium of the British Museum, which does not agree with Loureiro's description of that species, really represents *Apocynum reticulatum* Lour. This specimen is, according to him (Journ. of Bot. 63: 253 (1925)), a small leaved form of *Tylophora asthmatica* Wight & Arn. As explained by him, Loureiro, apparently by error, affixed the wrong names to the specimens representing *Apocynum juvenas* en *A. reticulatum*; but these names stand for the species actually described by Loureiro, one a *Tylophora*, the other a *Streptocaulon*."

The Loureiro specimen in BM agreeing with *S. juvenas*, is therefore regarded as the holotype.

Specimens examined

Cambodia:

- 10°36'N, 104°10'E: Kampot, *Geoffray 40* (P).
- 12° 27'N, 103° 40'E: Pursat (= Sway Pak), *Martin, M. 252* (L).
- 13°44'N, 107°00'E: Province Ratanakiri, Ban Lung (= Ban Tun), *Martin, M. 104* (P).
- 13°44'N, 107°00'E: Province Ratanakiri, Ban Lung (= Ban Tun), *Martin, M.A. 1407* (P).

China:

- 23° 08'N, 113° 16'E: Guangdong (= Kwangtung) Province, Fang Cheng District, Guangzhou (= Canton), *Tsang, W.T. 26630* (K).
- 24° 20'N, 98° 25'E: Yunnan, Luxi (= Looksi), *Wilson 2758* (K).
- 30° 15'N, 120° 10'E: Hangchow (= Hangzhou), *Morse, H.B. 135* (K).
- Grid reference unknown: Yunnan Province, Sjemer? *Henry, A. 13439* (K).
- Grid reference unknown: Yunnan Province, Sjemer? *Henry, A. 12761* (K).

India:

- 22° 30'N, 87° 40'E: Bengalia, near Calcutta, *Helper, J.W. 59* (L).

Laos:

- 03°34'02"S, 122°16'43"E: Meong island, Sulawesi, Tenggara, *K-W 8248B* (K–W, lectotype of *S. tomentosum*).
- 14°09'N, 105°50'E: Province Champsak, Paksè, *Vidal, J.E. 1918* (P).
- 16°34'N, 104°45'E: Province Savannakhet, Ban Si Khay, *Vidal, J.E. 2762* (P).
- 17°49'N, 105°04'E: Province Luang Prabang, Ban Dong, *Pittuer 486* (P).

Malaysia:

- 02° 30'N, 102° 35' E: Selangor, Ulu Yam (= Ulu Klang), Forest Reserve, *T & P 410* (L).

Myanmar:

- 12° 26'N, 98° 34'E: Mergui, *Griffith, S. s.n.* (K).
- 14°06'21"N, 98°13'36"E: Tavoy (now Dawei), Tenasserim State, *K–W 8248C = (K–W, syntype of S. tomentosum)*.
- 15° 24'N, 97° 50'E: Myingyan District, Taungbon, *Lance, J.H. 4888* (K).
- 16°29'05"N, 97°37'33"E: Moolmyne (now Mawlamyine), *K–W 8248C* (K–W, syntype of *S. tomentosum*).
- 17° 13'N, 96° 30'E: Pegu, *Kurz 2359* (K).
- 17° 13'N, 96° 30'E: Pegu, *McLelland s.n.* (K).
- 17° 13'N, 96° 30'E: Pegu, *McLelland s.n.* (K).
- 22° 02'N, 96° 28'E: Maymyo Plateau, *Lace 5975* (K).

Thailand:

- 07°10'N, 100°23'E: Province Songkhla, Khao Kho Hong, Hat Yai, *Larsen et al. 40948* (P).
- 09°37'N, 99°07'E: Kan Tuli River (= Kantuli), Surat Thani, *Put 4180* (K).
- 12°34'N, 99°58'E: Hua Hin, *Marcan 2257* (K).
- 13°10'N, 100°56'E: Province Chon Buri, District Siricha, Kow Kleo, *Maxwell, J.F. 75-620* (L).
- 13°10'N, 100°56'E: Province Chon Buri, District Siricha, Kow Kleo, *King, R.M. 5606* (L).
- 14°26'N, 101°22'E: Eastern Province, Nakhon Ratchasima, Khao Yai National Park, *Murata et al. T16476* (L).
- 14°28'N, 99°13'E: Eastern Province, Nakhon Ratchasima, Pak Thong Chai, Wang Nam Khieo, *Phengnarem, S. & Smitinand, T. 415* (L, P).
- 14°35'N, 99°06'E: South West Province, District Kanchanaburi, Si Sawat, *Van Beusekom et al. 3444* (L).
- 14°45'N, 105°24'E: Province Borikhane, Ban Phôn Ngam, *Vidal, J.E. 4343* (P).

- 15°01'N, 103°06'E: Buri Ram Province, 40 km south of Buriram City, *Murata et al. T-37460* (L).
- 15°42'N, 105°02'E: Province Borikhane, Ban Phôn Ngam, *Vidal 4343* (P).
- 15°50'N, 102°05'E: Eastern part, 15 km NE of Chaiyaphum, *Laesen et al. 31866* (K).
- 16°26'N, 102°50'E: Khon Kaen, University campus, vicinity of the Faculty of Architecture, *Chantaranonthai et al. D90/19* (K).
- 16°32'N, 101°39'E: Eastern part, near Chulabhorn Chulapon Dam, *Laesen et al. 31471* (K).
- 18°18'N, 99°50'E: Lampang, Campus of Huay Tak Forest Station, *Shimidzu, T. 10600* (L).
- 18°47'N, 98°59'E: Chiang Mai, *Kerr, A.F.G. 564* (K).
- 18°48'N, 98°53'E: Province Chiang Mai, District Muang, Doi Sutep (Doi (mountain)), east side above Pah Ngeub, *Maxwell, D.F. 87-407* (L).
- 18°46'N, 98°41'E: Province Chiang Mai, District Sangampang, Subdistrict Sahagawn, Mae Awn village (= Muang Awn (limestone hill)), *Maxwell, J.F. 90-662* (L).
- 18°11'N, 100°15'E: Northern Province, District Phrae, *Van Beusekom et al. 3818* (L).

Vietnam:

- 09°29'N, 106°30'E: Cua Dinh An (river), *Bon, M. 5842* (P).
- 09°55'N, 106°44'E: Cua Ham Luong (river) (= Cua Hang Luong), *Bon, M. 5587* (P).
- 12°15'N, 109°11'E: Central Vietnam, Nha Trang, *De Sigaldy 382* (P).
- 20°45'N, 106°55'E: Tonkin Bay (= Bak-bo Bay) near Hanoi, *Balansa 603* (P).
- 20°45'N, 106°55'E: Tonkin Bay (= Bak-bo Bay) near Hanoi, *Balansa 2107* (P).
- 21°01'N, 106°04'E: Bac-Ninh, *Spire, D.E. s.n.*, anno 28/02/1890 (K).
- 21°10'N, 107°28'E: Ke Bua (island), *Bon, M. 5012* (P).

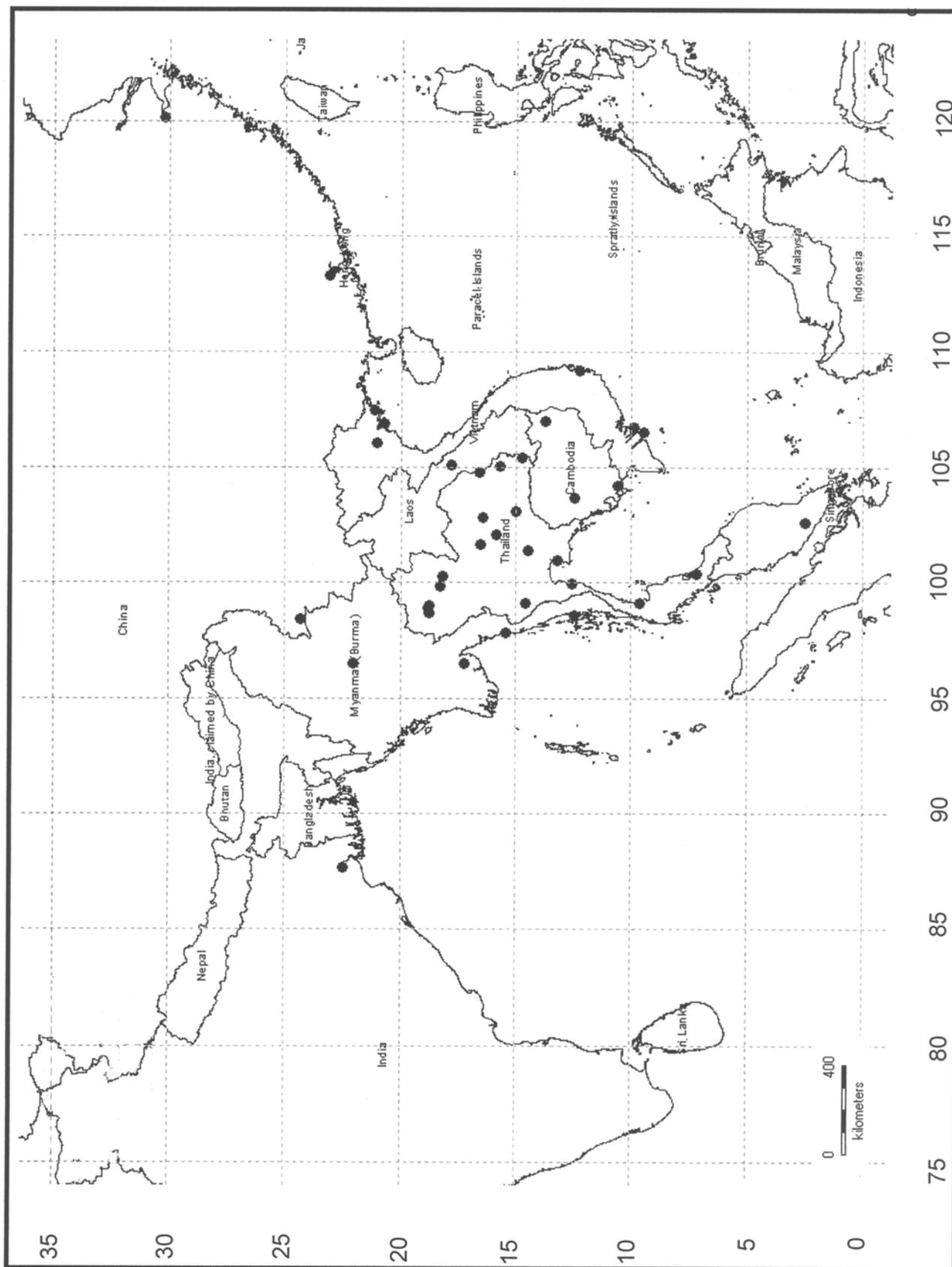


Fig. 5.2.14 Geographical distribution of *Streptocaulon juvenetas*

5.2.4 *Streptocaulon kleinii* Wight & Arn. in Wight, Contributions to the Botany of India: 65 (1834); Hook.f., Flora of British India 4: 9 (1885); Costantin, Flora Generale de L'Indo-Chine: 34 (1912).

Type: India, Madras, *Wight cat. no. 1564* = *Wallich Asclep. no. 157* (K (sheet 1)!, holotype; K (sheet 2)!, isotype?) [see Notes, p. 166] (Fig. 5.2.15).

Macromorphology

Climbers. **Stems** 4 m or more in length; bark with prominent longitudinal ridges, pale reddish-brown on young stems, reddish-brown on older stems, scabrid to puberulous with white to copper-coloured hair, verrucose and lenticellate; nodes scabrid with dirty white to copper-coloured hair; colleters few. **Leaves** petiolate; petiole 3–5(–7) x 0.5–1 mm, scabrid; axil villous; blade narrowly obovate to oblong-obovate, (55–)60–85(–92) x 20–35(–44) mm, herbaceous, adaxially glabrous to sparsely scabridulous, abaxially densely tomentose, main vein scabrid on both sides, apex acuminate to obtuse-mucronate, base round to cordate, margin entire, venation brochidodromous, 9–11 secondary veins on either side of main vein, divaricate; higher order venation inconspicuous because of dense indumentum covering lower leaf surface.

Inflorescences axillary, open dichasia with monochasial branches bearing 4–10 flowers each, primary peduncles (2–)5–12 mm long, secondary peduncles 10–20 mm long, tertiary peduncles 5–10 mm long, hispid, dirty white to copper-coloured; pedicels 1–5(–10) mm long, hispid; bracts opposite to alternate to decussate on peduncles, broadly triangular to triangular-ovate, naviculate, 1 x 0.8 mm, hispid on the outer surface and margin, copper-coloured. **Floral buds** ovoid, ± 2 mm long, apices obtuse. **Sepals** triangular-ovate, 1 x 0.7–0.8 mm, hispid on outer surface, apices acute to acuminate, rarely attenuate; colleters free. **Corolla** tube bowl-shaped, 0.5–1 mm long, glabrous on both surfaces, sometimes hispid outside; lobes ovate, oblong-ovate to ovate-elliptic, 2–3 x 1.2–1.5 mm, herbaceous, outside densely hirsute, inside glabrous, margins membranous, apices obtuse to obtuse-acute. **Corona** lobes filiform, 0.8–1 mm long, glabrous, herbaceous, apices entire and tortuous; coronal feet swollen and ovoid. **Stamens:** filament terete, 0.1–0.2 mm long, curved; anther, oblong to oblong-ovate,



Fig. 5.2.15 Type specimen of *Streptocaulon kleinii* Wight & Arn. (K-W1564, holotype (K)).

0.5–1 x 0.2–0.5 mm; thecae oblong, connective appendages rhomboid, half the length of anther, dark-coloured; pollinia narrowly elliptic. **Pistil:** style \pm 0.2 mm long, glabrous; stylar head ovoid, \pm 0.6 x \pm 0.6 mm, apex obtuse; translator 0.3 mm long, receptacle narrowly elliptic, apex split, style linear but short. **Follicles** light brown, horizontal, narrowly ovoid, 80–85 x 5 mm, pericarp tomentose, apex attenuate; seed black, 3–5 x 1–1.5 mm, narrowly oblong to oblong-obovate; coma creamy white, 20–25 mm long. (Fig. 5.2.15).

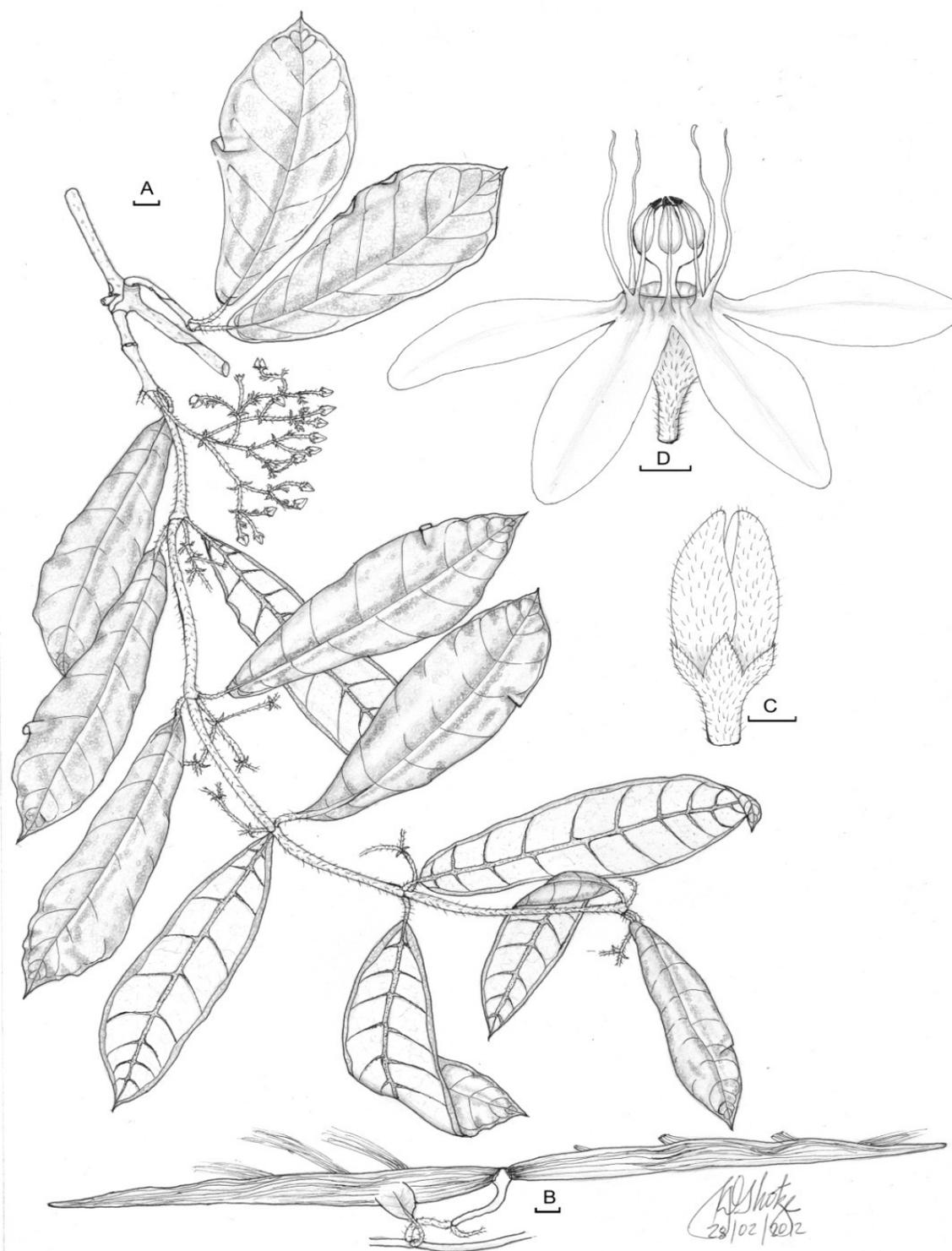


Fig. 5.2.16 *Streptocaulon kleinii*. A: stem with leaves and inflorescences; B: stem with follicles; C: floral bud; D: external view of flower with inverted corolla tube, filiform corona lobes, stamens, style and stylar head. Scale bars: A, B = 5 mm; C, D = 1 mm. [A: Pierre 4516 (K); B, C, D: Kerr 16859 (K)].

Micromorphology

Adaxial **leaf epidermis** cells are tetra- to hexagonal with convex outer periclinal walls without papillae (Fig. 5.2.17 A). The adaxial epidermis is sparsely scabridulous. The cuticle is smooth to slightly striated. Striations radiate from the cell centres, crossing cell boundaries and may be pushed up into buttressed ridges, connecting trichomes (Fig. 5.2.17 B). No wax is present.

On the abaxial leaf epidermal cells, stomata and cuticle are not visible on the micrograph as the abaxial leaf surface is densely tomentose (Fig. 5.2.17 C). Since no stomata were observed on the adaxial leaf epidermis, the leaf is probably hypostomatic.

The upper **seed coat** surface and margin is smooth (Fig. 5.2.18 A, B). Epidermal cells are tetragonal, short to elongate and tightly packed. Outer periclinal walls are convex. Anticlinal walls are straight to slightly curved. The cuticle is smooth. (Fig. 5.2.18 C).

The lower seed coat surface is smooth with a narrow central longitudinal ridge (Fig. 5.2.18 D) and margin that is recurved which is an extension of the upper seed coat (Fig. 5.2.18 E). The curled margin shows the same surface sculpture described for the upper seed coat (Fig. 5.2.18 F). Epidermal cells between the central ridge and the margin are tetra- to pentagonal and tightly packed. Outer periclinal walls are tabular and anticlinal walls are straight to wavy. The cuticle is smooth. (Fig. 5.2.18 E).

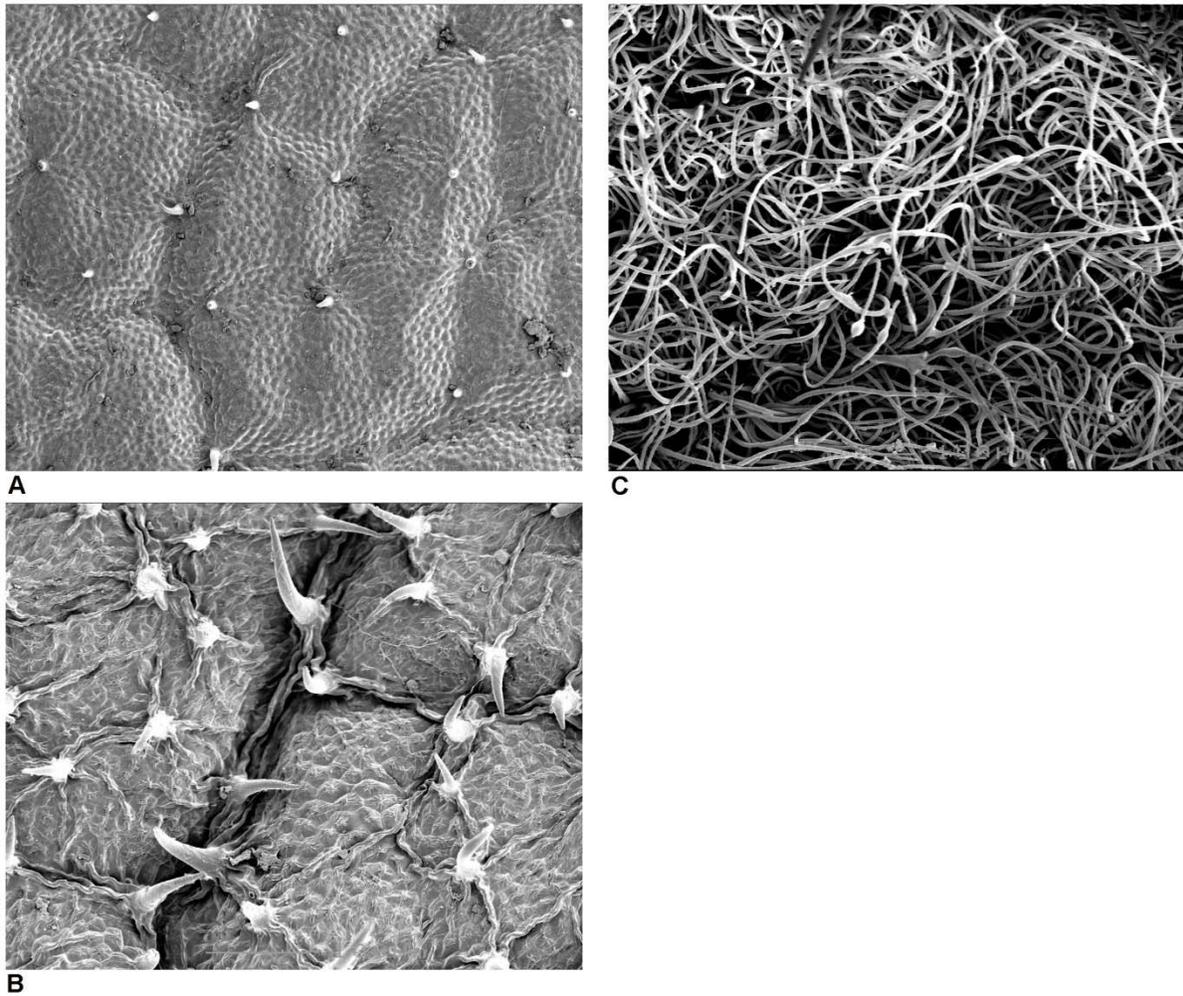


Fig. 5.2.17 *Streptocaulon kleinii*. A: adaxial epidermis showing scabridulous trichomes and smooth cuticle covering epidermal cells. B: adaxial epidermis showing scabridulous trichomes, connected by cuticular ridges; C: abaxial epidermis densely tomentose. Magnification: A, C = x80; B = x200. [A, B: *Pierre 4516* (K); C: *Marcan 1493* (K)].

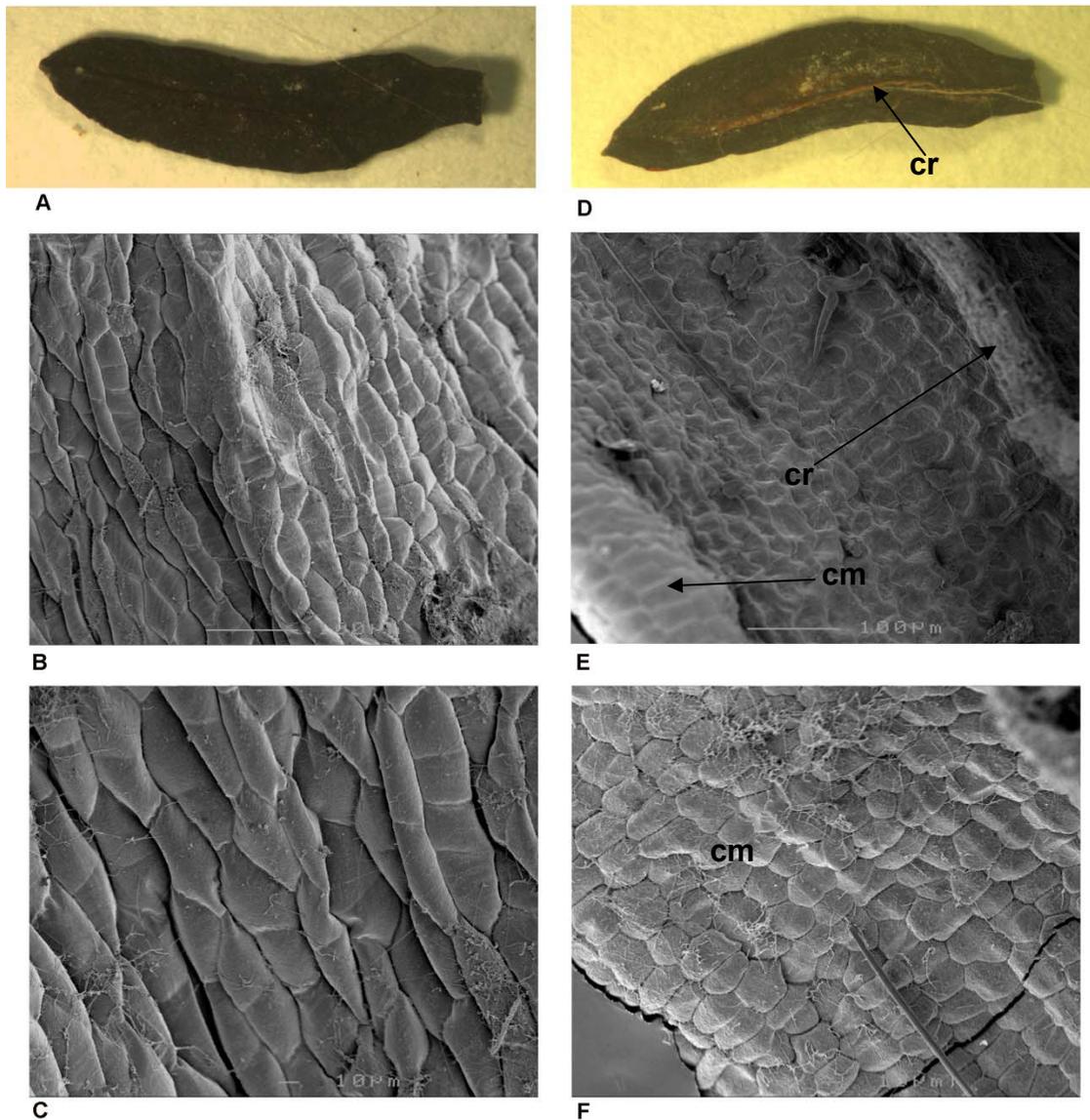


Fig. 5.2.18 *Streptocaulon kleinii*. A: upper seed coat showing smooth surface and margin; B,C: upper seed coat showing short tetragonal to elongate tightly packed cells; D: lower seed coat showing narrow central longitudinal ridge; E: lower seed coat showing smooth surface, central ridge and recurved margin; F: lower seed coat showing tetra- to pentagonal cells towards the margin. cr: narrow central ridge; cm: curved margin. Magnification: C = x600; B, F, G = x400; E = x100. [A–E: *Marcan 1493 (K)*].

Distribution and habitat

Streptocaulon kleinii was collected in India, Myanmar, Thailand and Vietnam (Fig. 5.2.19). This species grows in open scrub and open grassland. Flowering occurs from September to November.

Notes

Two specimens were found in the type file in the main collection of K. On sheet 1, donated by die WIGHT HERB. in 1871, the numbers 157 and 1564 (corresponding to the numbers Wight (1834) used and the Wallich catalogue numbers) were written and it is therefore regarded as the holotype used by Wight. No numbers appear on sheet 2, but the specimen resembles this species and is possibly an isotype. No corresponding specimen was located in K-W.

Specimens examined

India:

- 13° 05'N, 80° 16'E: Madras, *Wight 1564* (K (sheet 1), holotype; K (sheet 2) isotype).

Myanmar:

- 16° 48'N, 96° 09'E: Yangon (= Rangoon), Kanpaan, *Kerr, A.F.G. 16856* (K).

Thailand:

- 09° 01'N, 98° 44'E: Surat, Tha Khanon (= Ta Kanaan), *Kerr, A.F.G. 12347* (K).
- 13° 45'N, 100° 31'E: Bangkok, Pakret, *Marcan, A. 1493* (K).
- 15° 19'N, 100° 05'E: Manorom, Chainat, *Kerr, A.F.G. 19676* (K).

Vietnam:

- 10° 20'N, 106° 52'E: Song Nha Bè (=River Bè), *Pierre L. 3516* (P); *Pierre L. 4516* (K).
- Grid reference unknown: *Talmy 162* (P).

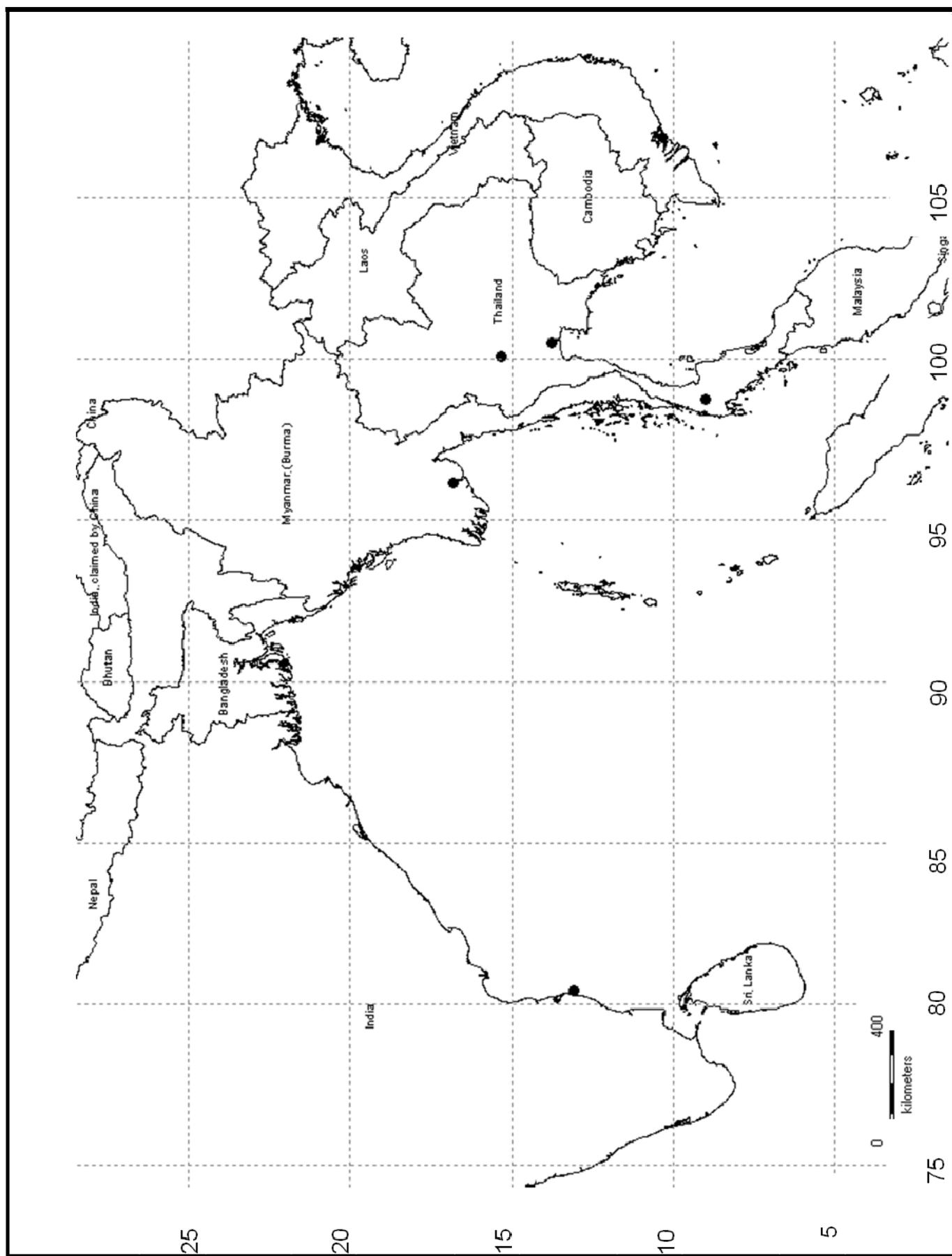


Fig. 5.2.19 Geographical distribution of *Streptocaulon kleinii*

5.2.5 *Streptocaulon lanuginosa* (Ridley) Venter & A.M.Venter, *comb. nov.*, [see Notes, No. 1, p. 175].

Basionym: *Gongylosperma lanuginosum* Ridley in Journal of the Straits Branch of the Royal Asiatic Society 59: 135 (1911), Ionta & Judd in Annals of Missouri Botanical Garden 94: 372 (2007).

Type: Malaysia, Lankawi Island, near Dayong Bunting, *Curtis C. s.n.*, anno 09/1896 (K!, lectotype designated here; BM!, isotype) [see Notes, No. 2, p. 175] (Fig. 5.2.20).

= *Finlaysonia lanuginosa* (Ridley) Venter in Venter & R.L. Verh., Annals of the Missouri Botanical Garden 88: 565 (2001). Homotypic synonym.

Macromorphology

Shrubs. **Stems** erect; bark dark reddish-purple, densely tomentose, smooth; nodes tomentose, dirty white; colleters few. **Leaves** petiolate; petiole 3–5 x 1–2.5 mm, tomentose; axil tomentose, dirty white; blade oblong-obovate, oblong-elliptic, narrowly elliptic to elliptic, 117–250 x 43–48 mm, coriaceous and rugose, adaxially sparsely lanuginose and rugose, abaxially densely lanuginose, hair dirty white, main vein lanuginose on both sides, apex acute, obtuse or notched, base round to cordate, venation brochidodromous, 22–29 secondary veins on either side of main vein, divaricate and patent; higher order venation inconspicuous because of dense indumentum covering lower epidermis.

Inflorescences terminal and axillary, compact dichasia with terminal monochasial branches bearing 4–10 flowers each, primary peduncles 15–20 mm long, secondary peduncles 5–10 mm long, tertiary peduncles 15–20 mm long, densely lanuginose, dirty white, pedicels 0.5–3 mm long, densely lanuginose, dirty white; bracts opposite on dichasial peduncles, alternate on monochasial peduncles, triangular-ovate and naviculate, 1–2 x 0.5–1 mm, outer surface and margin densely lanuginose, copper-coloured. **Floral buds** ± 2 mm long, broadly ovoid, apices obtuse. **Sepals** broadly ovate, 1 x 1 mm, lanuginose on outside and margins, apices obtuse; colleters free. **Corolla** tube bowl-shaped, 1–1.5



Fig. 5.2.20 Type specimen of *Streptocaulon lanuginosa* (Ridley) Venter & A.M.Venter (Curtis C. s.n., anno 09/1896, lectotype (K)).

mm long, both surfaces glabrous; lobes ovate, 3 x 2 mm, herbaceous, glabrous on both surfaces, apices obtuse. **Corona** lobes cylindric-filiform, 1.5–2 mm long, glabrous, herbaceous, apices entire and tortuous; coronal feet conical. **Stamens:** filament linear, ± 2 mm long, curved; anther oblong, $\pm 0.4 \times \pm 0.2$ mm; thecae oblong, connective appendage blackish-purple and apically deltoid; pollinia weakly defined globose bodies. **Pistil:** style ± 0.5 mm long, glabrous; stylar head ovoid, $\pm 0.5 \times 0.6\text{--}0.7$ mm, apex bluntly obtuse; translator receptacle ob-rhomboid, style linear. **Follicles** grey, horizontal, ovoid, 15–18(–34) x 5 mm, pericarp lanuginose with greyish-white hairs, apex attenuate; seed black, 2–2.5 x 1–1.5 mm, obovoid to ellipsoid; coma copper-brown, 5–8 mm long. (Fig. 5.2.21).

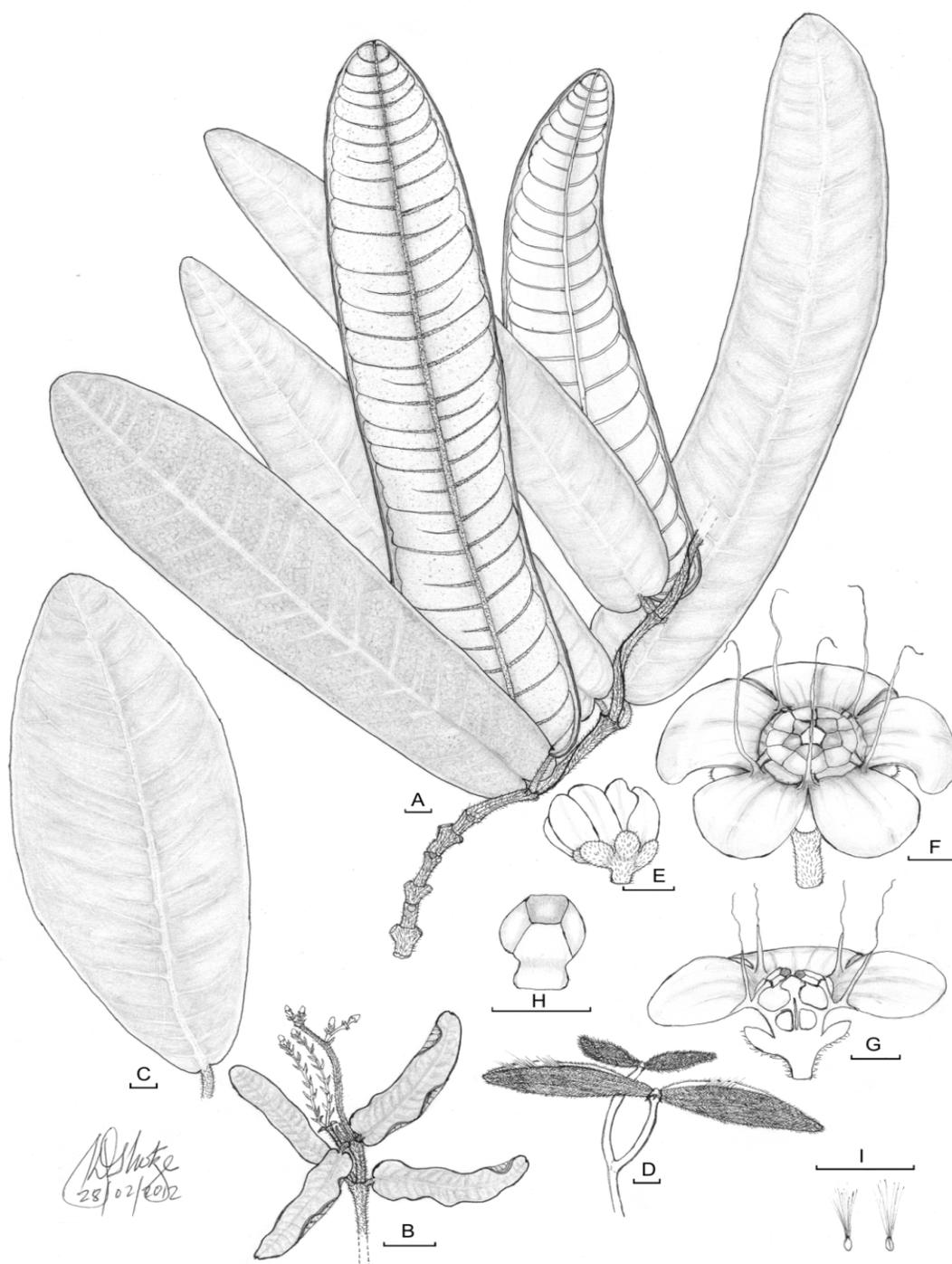


Fig. 5.2.21 *Streptocaulon lanuginosa*. A: stem with leaves; B: stem with leaves and inflorescences; C: adaxial view of single leaf; D: stem with follicles; E: external view of opening floral bud; F: external view of flower; G: longitudinal section of flower with inverted corolla tube, corona lobes, ovaries, style, and gynostegium; H: adaxial view of stamen showing deltoid connective appendage; I: seed with coma. Scale bars: A, C = 5 mm; D = 3 mm; B, E, F, G, H, I = 1 mm. [A–D: *Corner 37836* (K); E–I: *Curtis s.n.* (K)].

Micromorphology

Adaxial **leaf epidermal cells** are tetra- to hexagonal with convex outer periclinal walls without papillae. Anticlinal walls are curved. The adaxial epidermis sparsely lanuginose. The cuticle is smooth. No wax is present. (Fig. 5.2.22 A, B).

The abaxial leaf surface is densely lanuginose obscuring the abaxial epidermis, cuticle and stomata (Fig. 5.2.22 C). However, the leaf is probably hypostomatic as no stomata were observed on the adaxial leaf epidermis.

The upper **seed coat** surface is finely pitted, margin entire (Fig. 5.2.23 A). Epidermal cells are pentagonal to contorted (Fig. 5.2.23 B). Outer periclinal walls are tabular. Anticlinal walls are straight to undulating. The cuticle is smooth to slightly striated (Fig. 5.2.23 C).

The lower seed coat surface and margin is smooth with a narrow central ridge (Fig. 5.2.23 D). Epidermal cells are tetragonal in shape. Outer periclinal walls are concave. Anticlinal walls are curved. The cuticle is smooth (Fig. 5.2.23 E, F).

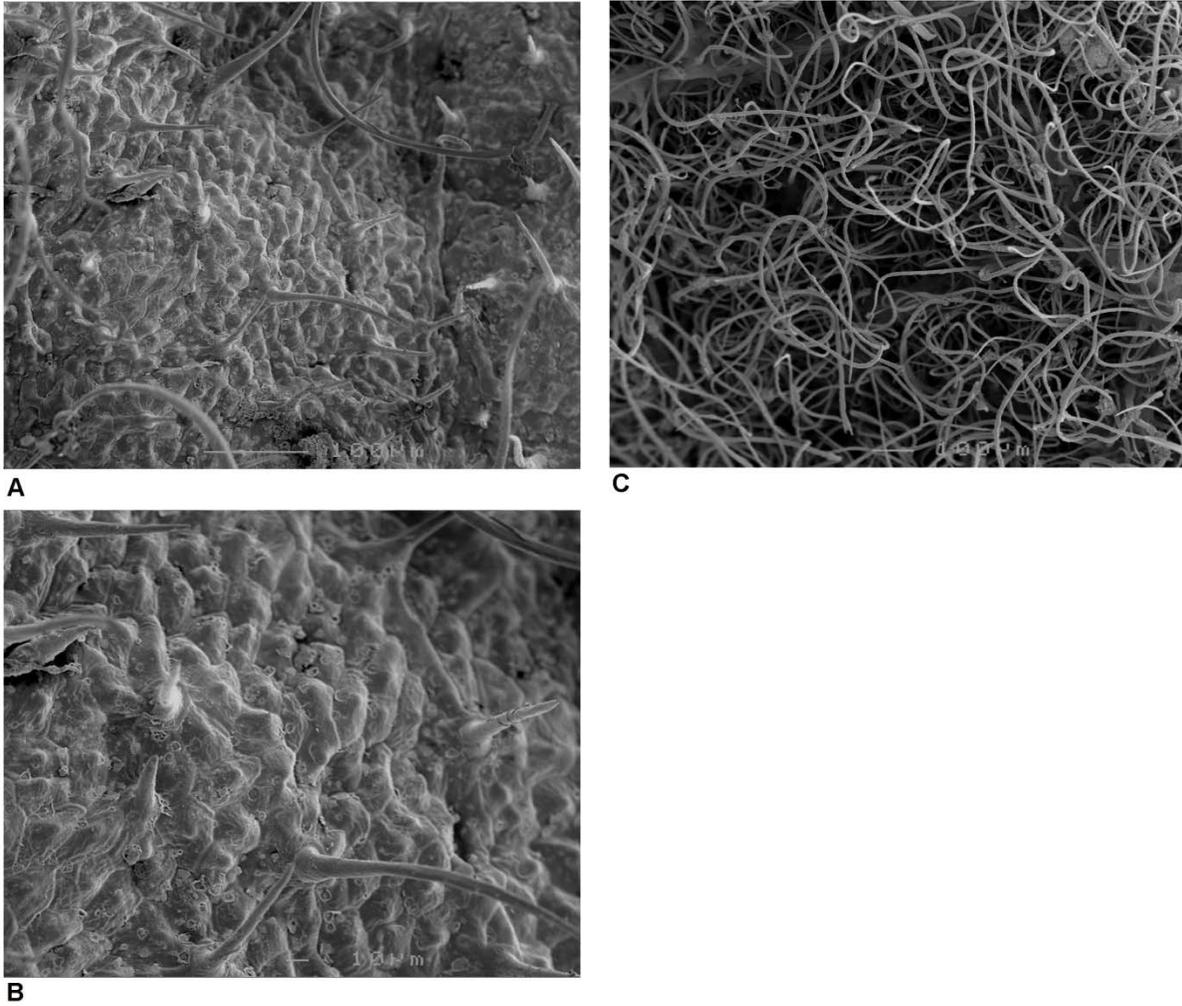


Fig. 5.2.22 *Streptocaulon lanuginosa*. A, B: adaxial epidermis showing trichomes sparsely lanuginose and epidermal cells; C: abaxial epidermis showing dense lanuginose indumentum. Magnification: A = x200; B = x400; C = x80. [A, B, C: *Corner 37836 (K)*].

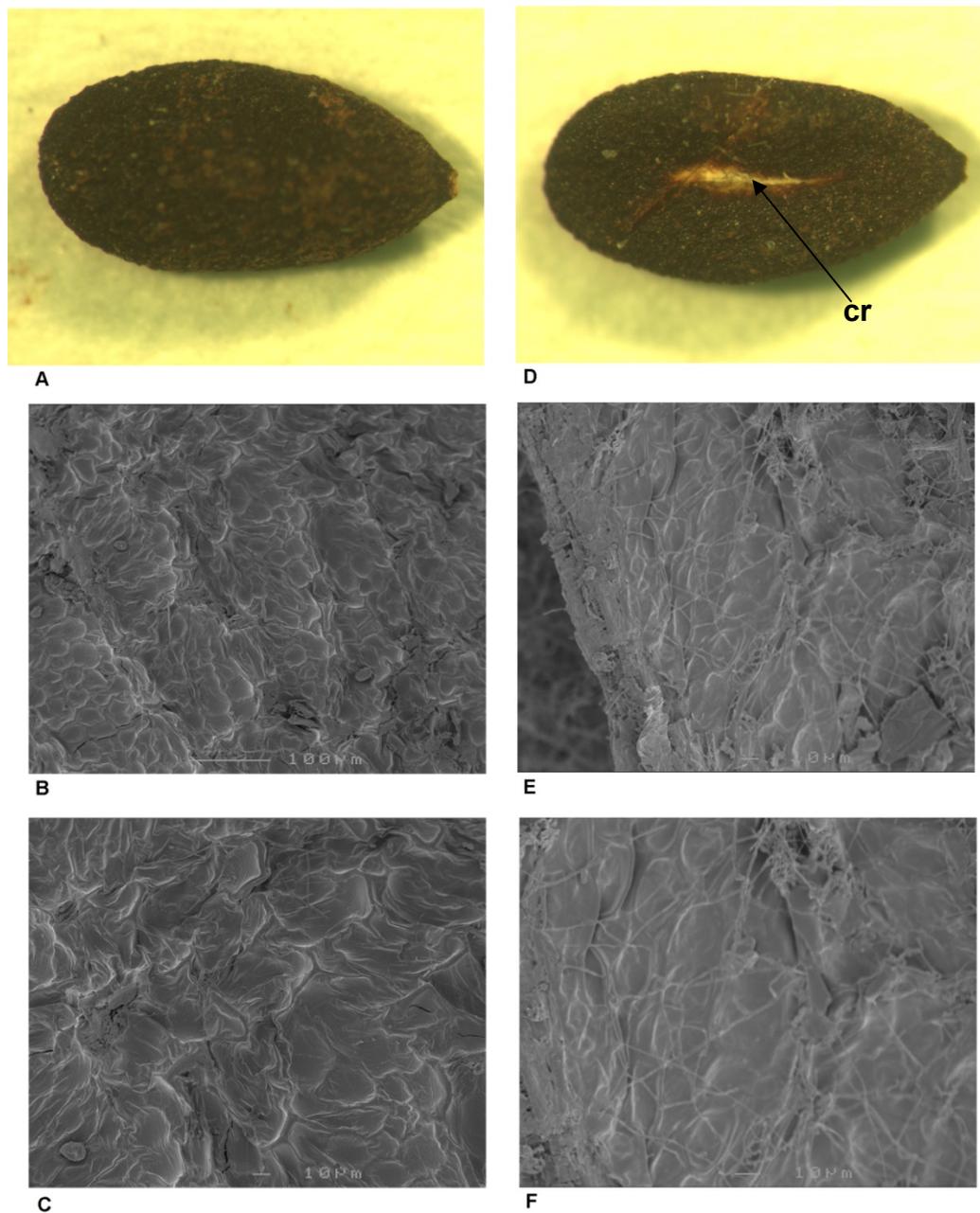


Fig. 5.2.23 *Streptocaulon lanuginosa*. A: upper seed coat with finely pitted surface and smooth margin; B, C: upper seed coat showing pentagonal to contorted cells and smooth cuticle; D: lower seed coat showing smooth surface and margin with a narrow central longitudinal ridge; E, F: lower seed coat showing epidermal cells with smooth cuticle. cr: central ridge. Magnification: B, E = x200; C, F = x400. [A, B, C, D, E: *Corner* 37836 (K)].

Distribution and habitat

Streptocaulon lanuginosa occurs in Malaysia, on the Langkawi Islands, [see Notes, No. 3, p. 175], growing mostly on limestone rocks (Fig. 5.2.24). The collected specimens flowered during autumn and winter.

Notes

1. The phylogenetic analysis of Ionta (2009), in an unpublished thesis, supports the transfer of *Finlaysonia lanuginosa* to *Streptocaulon* to form the new combination *S. lanuginosa*.
2. Ridley designated the collection, *Curtis 2663*, as the type of *Gongylosperma lanuginosa*. This specimen could not be located in either K or BM, where collections from the same locality in the type files are labeled as *Curtis s.n.* As the type specimen at K is not indicated as the holotype, and since Ridley was director of the Botanical Gardens of Singapore when he published *Gongylosperma lanuginose*, it was assumed that the holotype was housed in SING (Venter & Verhoeven, 2001). However, no type specimen could be found on the SING digitized type specimen database. Therefore the K specimen is designated here as the lectotype.
3. The name Pulau Dayong Bunting, of the second largest island of Langkawi archipelago translates to 'Isle of the Pregnant Maiden'. Rainforest covers the island.

Specimens examined

Malaysia:

- 06° 10'N, 99° 43'E: Langkawi, Pulau Chupah (= Chupa), *Corner, E.J.H. 37836* (BM, K, P).
- 06° 13'N, 99° 48'E: Lankawi, west coast of Pulau Dayong Bunting, *Henderson, M.R. 29141* (BM, K) [see notes no. 3, p. 170].
- 06° 13'N, 99° 48'E: Lankawi, Pulau Dayong Bunting, *Curtis, C. s.n. anno 09/1896* (K, lectotype; BM, isolectotype).

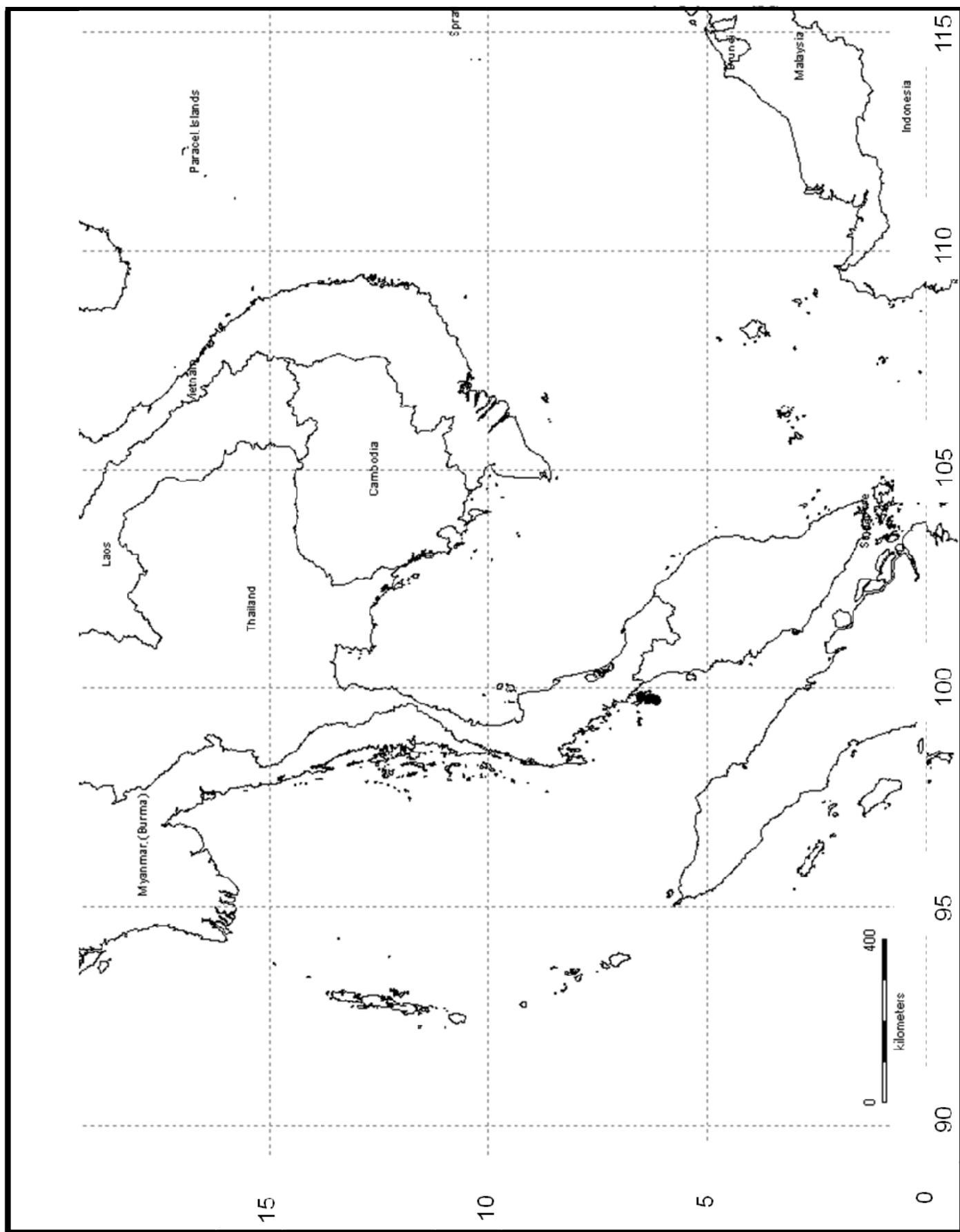


Fig. 5.2.24 Geographical distribution of *Streptocaulon lanuginosa*

5.2.6 *Streptocaulon sylvestre* Wight, Contributions to the Botany of India: 65 (1834); Hook.f., Flora of British India 4: 10 (1885).

Type: Sanashygota, *K-W 8251 = Wall. Asclep. no. 140* (K-W!, holotype; K!, isotype); *Hamilton herb. no. 763* (K!, syntype) (Fig. 5.2.25).

Macromorphology

Climbers. **Stems:** bark with prominent longitudinal ridges, light reddish-brown, scabrid with dirty white hairs, not verrucose and lenticellate; nodes scabrid, dirty white; colleters numerous. **Leaves** subsessile to petiolate; petiole 0.5–1(–2) x 1 mm, sparsely scabridulous, dirty white; axil villous; blade sub-orbicular, 20–42 x 15–35(–40) mm, herbaceous, scabridulous on both surfaces, main vein sparsely scabridulous, apex obtuse-mucronate, base rounded to cordate, margin ciliate, venation brochidodromous, 5–9 secondary veins on either side of main vein, divaricate, tertiary venation random reticulate, aerole development imperfect, veinlets absent.

Inflorescences axillary, compact, small dichasia of one or few monochasial branches with 2–3 flowers each, primary peduncles 5–10 mm long, secondary peduncles 2–4 mm long, tertiary peduncles 2–4 mm long, villous, erect to curved; pedicels 3–8 mm long, villous, dirty white; bracts opposite on dichasial peduncles, alternate on monochasial peduncles, narrowly triangular to triangular-ovate, naviculate, 1.2–1.7 x 1–1.5 mm; margin fimbriate with copper-coloured hairs; apices acuminate; colleters reddish-black.

Floral buds ovoid to broadly ovoid, 2–3 mm long, apices obtuse to obtuse-acute.

Sepals broadly ovate to broadly triangular-ovate, 1 x 1 mm, villous on outside and on margins, margins membranous, apices acute to obtuse-acute; colleters single or fused and broadly ovate. **Corolla** tube bowl-shaped, ±1 mm long, herbaceous, glabrous on both sides; lobes ovate to oblong-ovate, 3 x 1–1.2 mm, glabrous on both surfaces, apices obtuse. **Corona** cylindric-filiform, 1.5–2.5 mm long; apices entire and tortuous; coronal feet conical. **Stamens:** filament terete, 0.2–0.3 mm long, erect; anther deltoid-ovoid to narrowly elliptic, 0.8–1 x 0.3–0.5 mm; thecae oblong, connective appendage blackish, deltoid; pollinia oblong, 0.3–1.0 mm long.



Fig. 5.2.26 Type specimen of *Streptocaulon sylvestre* Wight, (K-W 8251, holotype (K-W)).

Pistil: style flattened-terete, 0.1–0.5 mm long, sometimes villous at base; stylar head conical-ovoid to broadly ovoid, 0.5–0.6 x 0.5–0.7 mm, apex bluntly acute and notched; translator receptacle broadly ovate to obovate, apex deeply split, stype short linear. **Fruit and seed** unavailable. (Fig. 5.2.26).

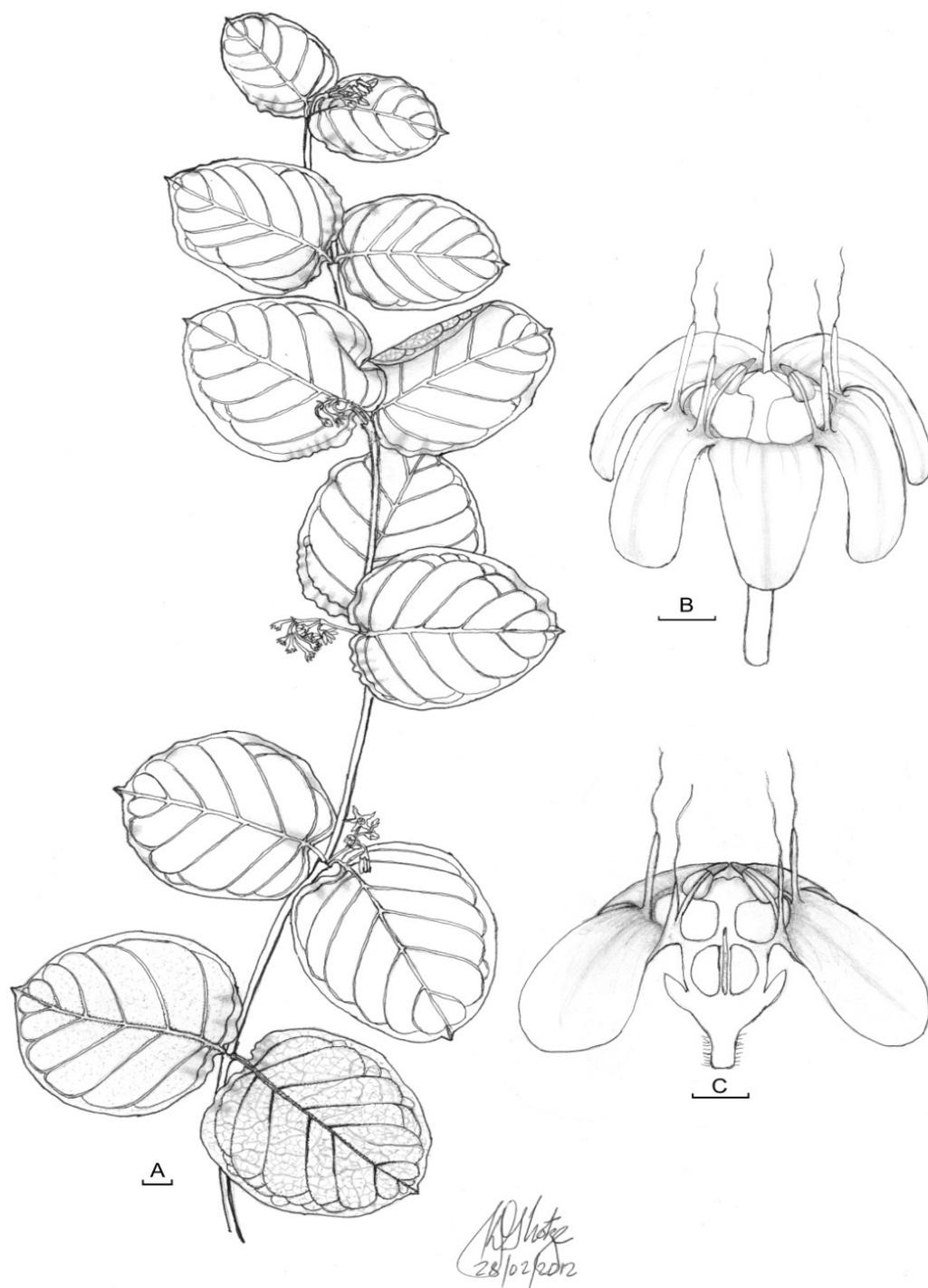


Fig. 5.2.26 *Streptocaulon sylvestre*. A: stem with leaves and inflorescences; B: external view of flower; C: longitudinal section of flower showing inverted corolla tube, corona lobes, ovaries, style and stilar head. Scale bars: A = 5 mm; B, C = 1 mm. [A, B, C: *Haines 4581* (K)].

Micromorphology

Adaxial **leaf epidermal cells** are isodiametric and tetra- to pentagonal in shape. Outer periclinal cell walls are convex without papillae. Anticlinal walls are slightly to deeply curved. The adaxial epidermis is sparsely scabridulous (Fig. 5.2.27 A, B). The hairs are conical and covered with micro-papillae. The cuticle is densely striated. Striations are parallel, continuous over cell margins and perpendicular to guard cells and trichomes. No wax is present. (Fig. 5.2.27 B).

Abaxial leaf epidermal cells are tetra- to pentagonal in shape. Outer periclinal walls are concave. Anticlinal walls are wavy. The abaxial epidermis is sparsely scabridulous. Hairs are flattened and covered with micro-papillae (Fig. 5.2.27 C, D). The cuticle is heavily striated. Striations are parallel, continuous over cell boundaries, perpendicular to guard cells or forming a ring around guard cells. No wax is present (Fig. 5.2.27 D).

The leaves are amphistomatic. Stomata are broadly ovoid to elliptic and are covered with narrow to medium stomatal ledges. Stomata are randomly arranged, level with the epidermal surface abaxially and raised above the surface adaxially. The stomata are more numerous adaxially. (Fig. 5.2.27 D).

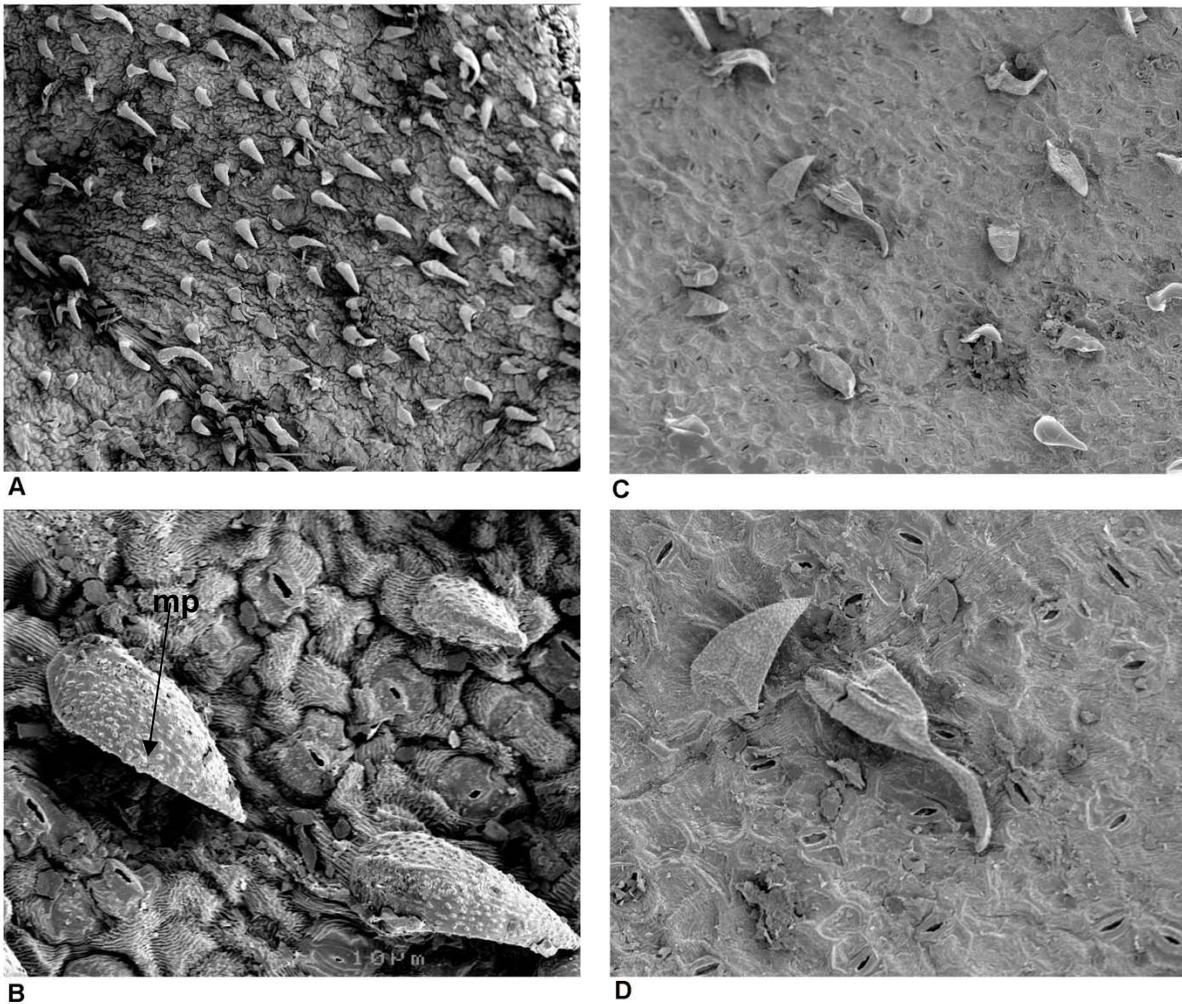


Fig. 5.2.27 *Streptocaulon sylvestre*. A: adaxial epidermis scabridulous with conical trichomes; B: adaxial epidermis showing trichomes covered with micro-papillae, stomata and dense cuticular striations; C: abaxial epidermis showing flattened trichomes; D: abaxial epidermis showing stomata; trichomes covered with micro-papillae. mp: micro-papillae. Magnification: A, C = x80; B, D = x400. [A–D: Clarke 11656 (K)].

Distribution and habitat

Streptocaulon sylvestre is found in the Bengal Province of India, growing on sandy river banks (Fig. 5.2.28). Flowering occurs from October to December.

Specimens examined

India:

- 25° 47'N, 87° 28'E: Purnesh (= Purnea), *Haines H. H. 4581* (K).
- 26° 42'N, 88° 26'E: Siliguri (= Siliguree), *Clarke 11656* (K).
- Grid reference unknown: Sanashygota, *K-W 8251 = Wall. Asclep. no. 140* (K-W, holotype).

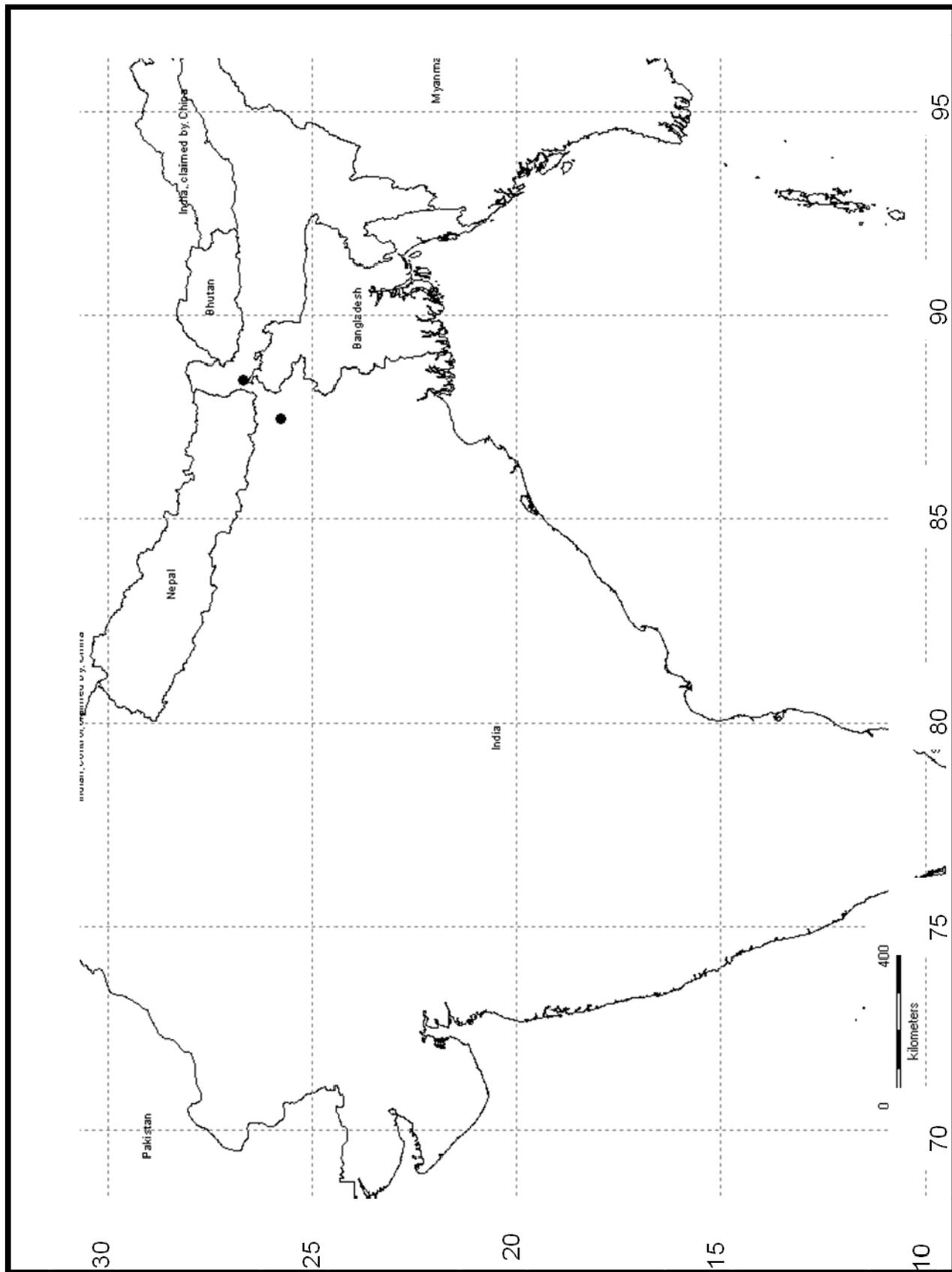


Fig. 5.2.28 Geographical distribution of *Streptocaulon sylvestre*

5.2.7 *Streptocaulon wallichii* Wight, Contributions to the Botany of India: 65 (1834); Hook.f., Flora of British India 4: 9-10 (1885); Costantin, Flora Generale de L'Indo-Chine: 31 (1912).

Type: Malaysia, Singapore, *K-W 8249B* = *Wall. Asclep. no. 124a* (K-W!, lectotype, declared here); Singapore and Penang, *K-W 8249A* = *Wall. Asclep. no. 124b* (K-W!, syntype (originally from Finlayson Herb.); *Asclep. no. 124* (K (2 sheets)!, syntypes (originally from Wight Herb.) (Fig. 5.2.29).

= *Streptocaulon baumii* Decne. in DC, Prodrômus 8: 496 (1844); Blanco, *Streptocaulon baumii* in Novissima Appendix ad Floram Philippinarum: 132 (1880); Merr., Species Blancoanae, p. 314 (1918). Merr., An enumeration of Philippine flowering plants, vol. 3 (1923).

Type: Philippines, Manilla, *Baum*, anno 1832/02/08 (P!, neotype) [see Notes, No. 1, p. 192].

= *Streptocaulon obtusum* Turcz. in Bulletin de la Société Impériale des Naturalistes de Moscou 21: 252 (1848); Merr., An enumeration of Philippine flowering plants, vol. 3 (1923). Synonymy after Merrill (1923).

Type: Philippines, *Cumings 697* (KW, holotype?; MW, isotype?) [see Notes, No. 2, p. 192].

= *Periploca calumpitensis* Llanos, Fragmentos de algunas plantas de Filipinas: 62 (1851).

Type: *Merrill 168* (L!, lectotype, designated here).

Macromorphology

Climbers. **Stems:** bark with prominent longitudinal ridges, rusty brown, young stems densely scabrid, copper-coloured, older stems glabrous, verrucose and lenticellate; nodes scabrid; colleters few. **Leaves** petiolate; petiole 5–15(–25) x 1–2 mm, densely scabrid; axil tomentose; blade lanceolate to broadly lanceolate, rarely broadly ovate or

obovate, 60–100(–110) x 20–64 mm, herbaceous, sparsely scabrid adaxially, copper-coloured, densely tomentose abaxially, copper-coloured, main vein scabrid to densely scabrid, apex acuminate to obtuse-mucronate, base cuneate to round; venation brochidodromous to eucamptodromous, 6–12 secondary veins on either side of main vein, arched and divaricate, higher order venation inconspicuous because of indumentum.

Inflorescences axillary, large lax dichasia with terminal monochasial branches, 150 x 70 mm, cyme bearing more than 60 flowers, primary peduncles (5–)20–40(–50) mm long, secondary peduncles 5–16(–55) mm long, tertiary peduncles 5–15(–25) mm long, hispid, copper-coloured; pedicels 2–5 mm long, glabrous to sparsely scabrid, copper-coloured; bracts opposite on dichasial peduncles, opposite to alternate to obliquely opposite on monochasial peduncles, triangular-ovate, naviculate, 1–1.5 x 1 mm, abaxially densely hispid on mid-rib abaxially to sparsely hispid elsewhere, margin with copper-coloured hair, colleters reddish-black. **Floral buds** ovoid to conical-ovoid, ± 1 mm long, apices obtuse. **Sepals** ovate to broadly ovate to triangular-ovate, 1 x 0.5–0.6 mm, glabrous, apices acute to obtuse; colleters free or fused, then semi-orbicular and apices bifid. **Corolla** purple to pale reddish-pink; tube bowl-shaped, ± 0.5 mm long, glabrous on both surfaces; lobes ovate, narrowly ovate to oblong-ovate to broadly triangular, 1.2–2 x 0.8–1 mm, herbaceous, glabrous on both surfaces, apices obtuse. **Corona** cylindrical-filiform, 0.8–1.3 mm long, glabrous, herbaceous, apices entire; coronal feet conical. **Stamens:** filament linear, 0.1–0.2 mm long, erect; anther narrowly ovate, 0.5–0.6 x 0.2 mm, thecae oblong, connective appendage deltoid; pollinia narrowly ellipsoid, 0.1–0.2 mm long. **Pistil:** style 0.1–0.2 mm long, glabrous; stylar head ovoid, glabrous, 0.3 x 0.6 mm, apex obtuse; translator ± 0.4 mm long, receptacle rhomboid, apex split, style linear. **Follicles** dark brown, paired or single, horizontal when paired, very narrowly ovoid, 70–75 x 5 mm, pericarp surface tomentose with whitish-grey hairs, apex attenuate; seed reddish-brown, 6–7 mm long, oblong to oblong-ovoid; coma whitish, 15–30 mm long. (Fig. 5.2.30).



Fig. 5.2.30 *Streptocaulon wallichii*. A, B: stem with leaves and inflorescences; C: stem with leaves and follicles; D: opening bud; E: adaxial view of sepals; F: longitudinal section of flower showing inverted corolla tube, corona lobes, stamens, ovaries, style and stylar head; G: embryo with 2 cotyledons; H: seed with coma. Scale bars: A, B, C = 5 mm; D, E = 1 mm; F = 0.5 mm; G, H = 2 mm. [A, B, C: *Cupen 1573* (K); D, E, G, H: drawings from *King 4910* (K); F: *King 4910* (K)].

Micromorphology

Adaxial **leaf epidermal cells** are tetra- to hexagonal and outer periclinal walls are convex, with papillae (Fig. 5.2.31 B). Anticlinal walls are wavy. The adaxial epidermis is sparsely scabrid (Fig. 5.2.31 A). The cuticle is smooth to slightly striated. Striations may be pushed up into small buttressed ridges, wavy, restricted to individual cells without crossing cellular boundaries where they radiate from the centres of the cell. No wax is present. (Fig. 5.2.31 B).

On the abaxial leaf epidermal surface, epidermal cells are irregular, tetra- to pentagonal in shape. Outer periclinal cell walls are tabular. Anticlinal walls are slightly wavy to undulate. The abaxial epidermis is densely tomentose (Fig. 5.2.31 C). The cuticle is slightly striated. Striations are either slightly wavy or parallel, perpendicular guard cells (Fig. 5.2.31 D). No wax is present.

The leaves are hypostomatic. Stomata are narrowly ovoid covered by a narrow stomatal ledge. Stomata are level with other epidermal cells and are randomly arranged (Fig. 5.2.31 D).

The upper **seed coat** surface and margin is smooth (Fig. 5.2.32 A). Epidermal cells are tetragonal and linearly arranged with concave outer periclinal walls. Anticlinal walls are straight to wavy and raised. The cuticle is smooth. (Fig. 5.2.32 B, C).

The lower seed coat surface and margin is smooth with a central narrow longitudinal ridge (Fig. 5.2.32 D). Epidermal cells on the margin are tetra- to pentagonal with convex periclinal walls and straight, sunken anticlinal walls (Fig. 5.2.32 E). Epidermal cells at the central region are tetragonal with tabular periclinal walls and straight anticlinal walls (Fig. 5.2.32 F). The cuticle is smooth.

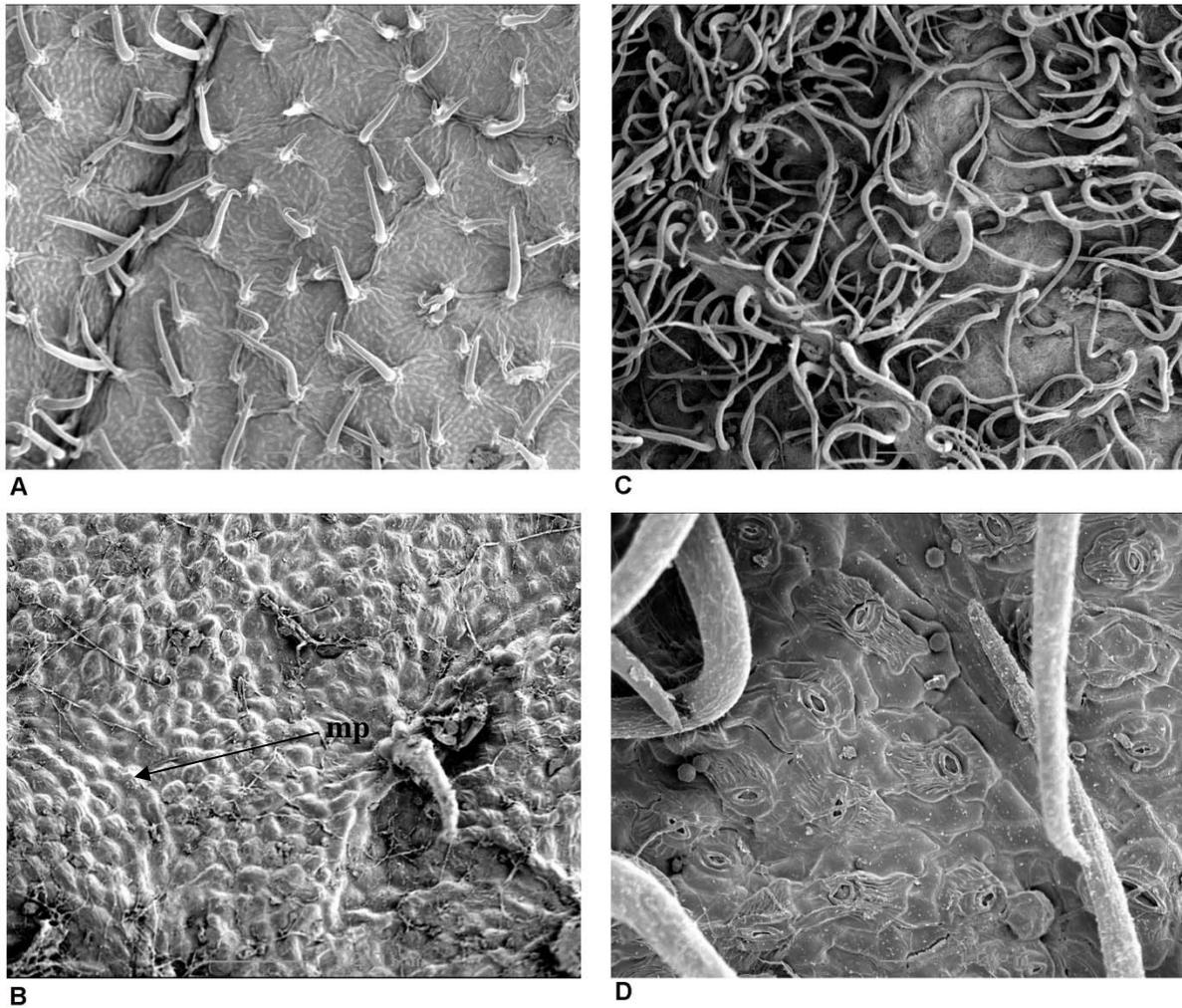


Fig. 5.2.31 *Streptocaulon wallichii*. A: adaxial epidermis showing scabrid indumentum; B: adaxial epidermis showing papillae on convex periclinal walls; C: abaxial epidermis densely tomentose; D: abaxial epidermis showing stomata; cuticular striations, perpendicular to guard cells. mp: papillae. Magnification: A, B, C = x200; D = x400. [A, B: Sinclair & Kia bin Salleh 40469 (K); C, D: Ridley 9484 (K)].

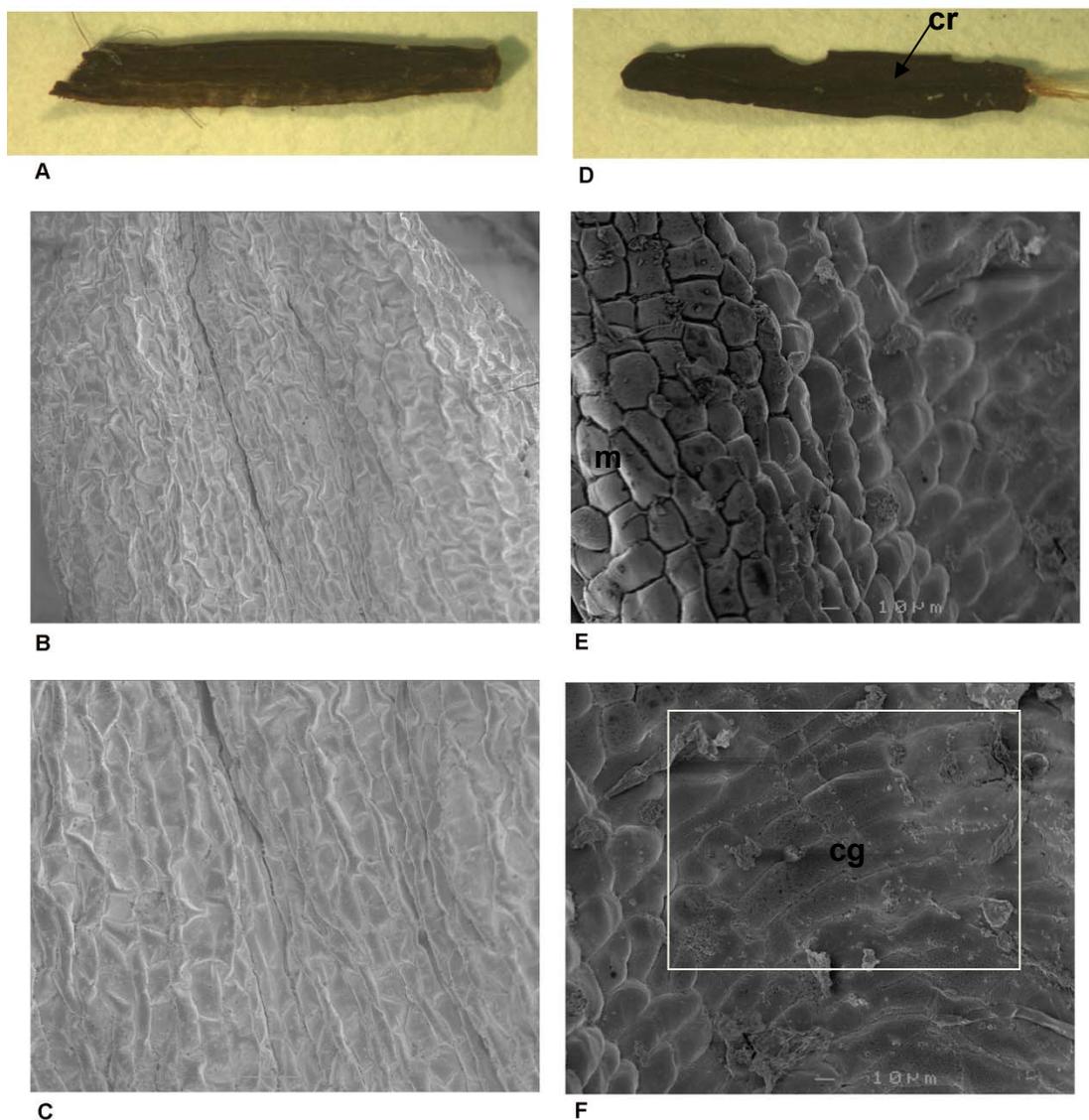


Fig. 5.2.32 *Streptocaulon wallichii*. A: upper seed coat showing smooth surface and margin; B, C: upper seed coat showing linearly arranged tetragonal cells, concave periclinal walls, straight to wavy, raised anticlinal walls and smooth cuticle; D: lower seed coat showing smooth surface and margin with a narrow central longitudinal ridge; E: lower seed coat showing margin; F: central region showing tetragonal epidermal cells. cr: central ridge; m: margin; cg: central region. Magnification: B = x80; C, E = x200; F, G = x400. [A, B, C, D, E, F: *Ridley 9484* (K)].

Distribution and habitat

Streptocaulon wallichii is common and widely distributed in central and northern Luzon and Mindoro Provinces of the Philippines, at low and medium altitudes. Its distribution range extends into Cambodia, China, Malaysia, southern Thailand and Vietnam (Fig. 5.2.33).

This species grows in a variety of habitats, mostly on rich clayey soils of abandoned paddy fields, along roadsides and river banks as well as on limestone hills. Plants are also associated with open forest and scrub. Flowering occurs from September to December.

Notes

1. Decaisne (1844) designated a collection in Paris Herbarium (P) by *Baum & Perrottet* as holotype of *S. baumii*. This specimen could not be found in P. However, in P there is a specimen Baum anno 1832/02/08, which may well be the holotype, but as uncertainty exists, it was declared a neotype by Venter (Venter & Verhoeven, 2001).
2. According to Serengin (2010) the *Cuming 697* collection in Moscow University Herbarium (MW) is an isotype. Most of Turczaninow's holotypes are probably in the National Herbarium of the Ukraine (KW), but the presence of *Cuming 679* could not be verified up till now.

Specimens examined

Cambodia:

- 10°36'N, 104°10'E: Kampot, Mount Inom Dong, *Geoffray 40* (P).

China:

- 24°10'N, 102°24'E: Yunnan, Shuangjiang (= Shaimmaghan), *Anderson, D.J. s.n.*, anno 14/01/1868 (K).

Malaysia:

- 05°20'N, 103°09'E: 11 miles along road from Kuala Trengganu to Besut, *Sinclair J, Kia bin Salleh 40469* (K, L).
- 05° 24'N, 100° 14'E: Penang, Ajer Etam, *Curtis 472* (K).
- 05° 24'N, 100° 14'E: Penang, Montagnes, *Deschamps, E. s.n.*, anno 27/12/1900 (K).
- 05° 24'N, 100° 14'E: Penang, *King 4910* (K).
- 05° 24'N, 100° 14'E: Penang, *King 5188* (K).
- 05° 24'N, 100° 14'E: Penang, *Phillips, D. s.n.*, anno 1842 (K).
- 05° 24'N, 100° 14'E: Penang, near Thomas Baths, *Maingay, A.C. 1100* (K).
- 05° 24'N, 100° 14'E: Pulau Penang, Balik Pulau, *Ridley 9484* (K).
- 05° 24'N, 100° 14'E: Penang, *K-W 8249B = Wall. Asclep. no. 124* (K-W, syntype).
- 05° 27'N, 100° 19'E: Penang, between Kampong Pulau Betong and Tanjong Mascari, *Sinclair, J. 39318* (K, L).
- 06° 18'N, 99° 42'E: Langkawi, Kedah, Kuala Kuah (= Quah), *Haupt & Nur 7068* (K).
- 06° 26'N, 100° 12'E: Perlis, Kangar (= Kangai), *Henderson 22914* (K).
- Grid reference unknown: Kedah territory, *Gutta 229* (K).

Philippines

- 12°25'N, 121°19'E: Luzon, Province Mindoro, Mount Yagaw (SE slope), *Conklin, H.C. PNH 18705* (L).
- 13° 14'N, 123° 38'E: Luzon, Province Albay, *Cuming, H. 847* (K, L).
- 13° 50'N, 121° 00'E: Luzon, Province Batangas, *Cuming, H. 1562* (K).
- 13° 50'N, 121° 00'E: Luzon, Province Batangas, *Cuming, H. 1599* (K).
- 14° 10'N, 121° 50'E: Luzon, Province Tayabas, *Cuming, H. 817* (K).
- 14° 10'N, 121° 20'E: Luzon, Province Laguna, Losbanos, *Rintz, R.E. RER1* (L).

- 14° 34'N, 120° 36'E: Luzon, Province Bataan, Limay (= Lamao), *Edano, G.E. PNH 4156* (L).
- 14° 35'N, 121° 10'E: Luzon, Province Rizal, Antipolo, *Merrill, D.E. 168* (L, lectotype of *Periploca calumpitensis*; P, isotype).
- 14° 50'N, 121° 14'E: Luzon, Province Rizal, Panintingan, Montalban, *Loher, S. 13147* (P).
- 14° 58'N, 120° 96'E: Luzon, Manilla, *Baum s.n., anno 1832/02/08* (P, neotype of *S. baumii*).
- 15° 00'N, 121° 05'E: Luzon, Province Bulacan, *Ramos, M. 1493* (L, P).

Singapore:

- 01°17'N, 103° 47'E: Singapore, *K-W 8249B = Wall. Asclep. no. 124a* (K-W, lectotype).

Thailand:

- 06° 45'N, 100° 25'E: Pattani, *Kerr, A.F.G. 7836* (K).
- 07° 01'N, 99° 52'E: Hat Yai, *Kerr, A.F.G. 13546* (K).
- 07° 37'N, 100° 09'E: Lampam, Phathalung (= Patobeng), *Annandale s.n.* (K).
- 08° 56'N, 98° 27'E: Khao Sok Mountains (= Khaw Pok Hill), *Haupt & Nur 3816* (K)
- 09° 32'N, 99° 56'E: Ko Samui Surat, *Put 1267* (K, L).

Vietnam

- 10° 45'N, 106° 40'E: Hochi Minh (= Saigon), Prey Nokor, *Ciep 955* (P).

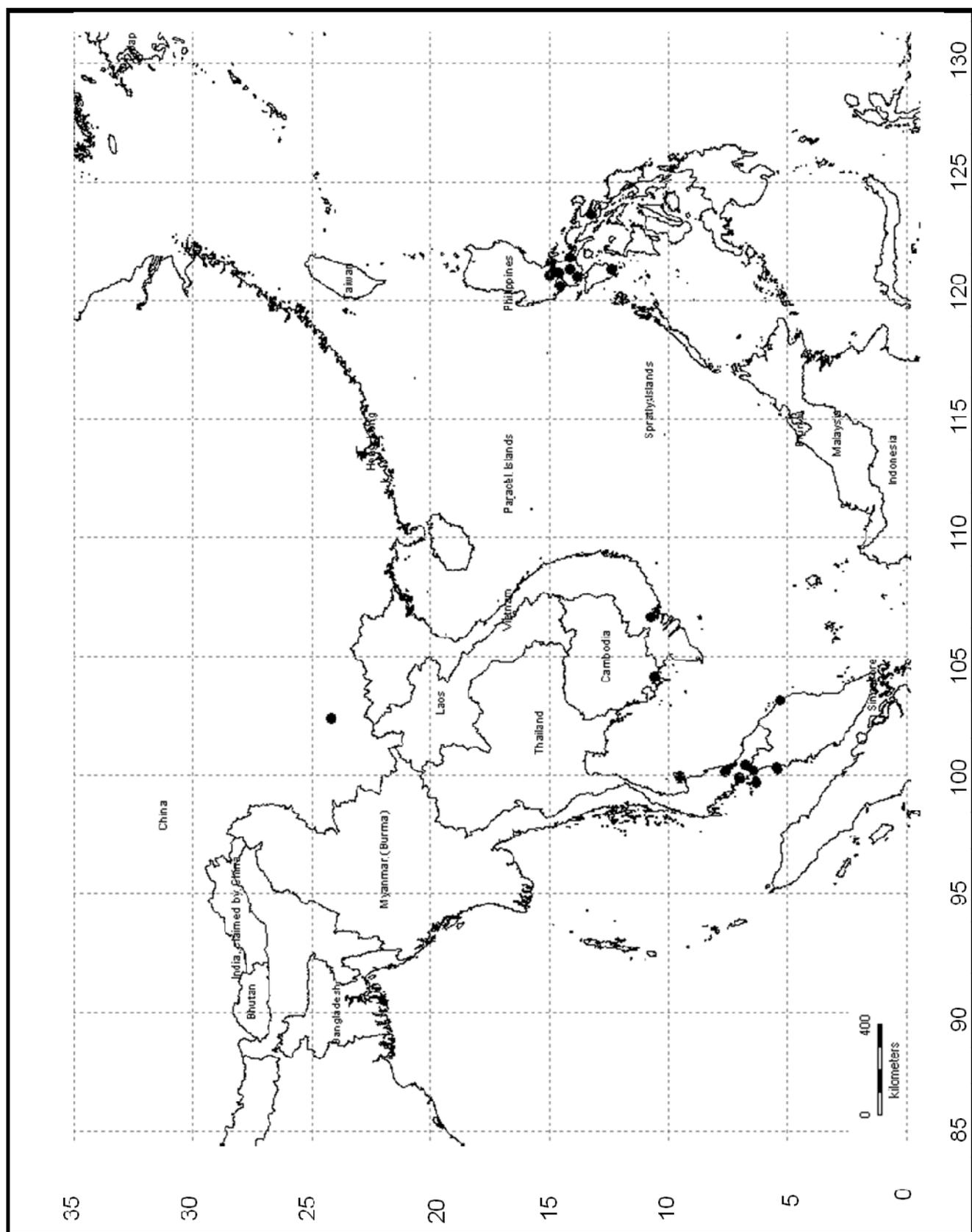


Fig. 5.2.33 Geographical distribution of *Streptocaulon wallichii*

5.3 Results and discussion

5.3.1 Distribution, habitat and vegetative characteristics

Streptocaulon is widely distributed over Asia, with *S. juvenas* and *S. wallichii* the most widely occurring species. *Streptocaulon cumingii* seems to be endemic to the mountaneous region of Luzon in the Philippines, *S. curtisii* to Thailand, *S. lanuginosa* to the Langkawi Islands of Malaysia, and *S. sylvestre* to the southern delta region of the Bengal Province of India.

Five of the species are climbers as in *Finlaysonia*, but *S. curtisii* and *S. lanuginosa* are shrubs, usually associated with limestone hills.

The indumentum on the interpetiolar nodes is generally scabid, but puberulous in *S. cumingii* and *S. curtisii*, and uniquely tomentose in *S. lanuginosa*.

The general leaf shape is ovate to elliptic to obovate but uniquely orbicular in *S. sylvestre* and lanceolate in *S. wallichii*. The leaf texture is generally herbaceous but coriaceous and rugose in *S. curtisii* and *S. lanuginosa*. The leaves of *S. sylvestre* are sessile or with a very short petiole. The petiole of *S. cumingii* is exceptionally long, up to 38 mm in length. The adaxial leaf surface is generally sparsely scabrid, scabridulous or puberulous. However, in *S. cumingii* and *S. kleinii* it could be glabrous. The abaxial leaf surface is densely tomentose or lanuginose in the majority of species but sparsely scabrid to puberulous in *S. cumingii* and *S. sylvestre*.

There is very little variation in the micromorphological characters. The outer periclinal cell wall shapes are convex with or without the presence of papillae, except *S. cumingii* with slightly concave outer periclinal cell wall. The leaves are generally hypostomatic, except *S. sylvestre* with amphistomatic leaves. The stomata where visible, are randomly orientated, but in *S. curtisii* stomatal crypts are present. (Table 5.1).

Table 5.1: Comparison of macro and micromorphological leaf characteristics of species in *Streptocaulon*.

SPECIES CHARACTERS	<i>S. cumingii</i>	<i>S. curtisii</i>	<i>S. juvenas</i>	<i>S. kleinii</i>	<i>S. lanuginosa</i>	<i>S. sylvestre</i>	<i>S. wallichii</i>
Distribution	Philippines	Thailand	Thailand, Cambodia, Myanmar, Vietnam, Malaysia, China Laos, India	Thailand, India, Myanmar, Vietnam	Malaysia (Lankawi islands)	India (Bengal)	Thailand, Philippines, Cambodia, China, Malaysia, Singapore, Vietnam
Habitat or plant communities	Mountainous areas	Limestone hills	Sandstone, basalt, granite in savanna and forest	Open scrub and savanna	Limestone hills	River banks	River banks and abandoned paddy fields, open forest and scrub
Habit	Climbers	Shrubs	Climbers	Climbers	Shrubs	Climbers	Climbers
Interpetiolar ridge indumentum	Puberulous	Puberulous	Scabrid	Scabrid to puberulous	Tomentose	Scabrid	Scabrid
Colour of indumentum	Copper-coloured	Dirty white	Copper-coloured	Dirty white copper-coloured	Dirty white	Dirty white	Copper-coloured
Leaf shape	Ovate to elliptic	Ovate to elliptic	Broadly obovate to broadly rhomboid	Narrowly obovate to oblong-obovate	Oblong-obovate to elliptic	Sub-orbicular	Lanceolate to broadly lanceolate

SPECIES CHARACTERS	<i>S. cumingii</i>	<i>S. curtisii</i>	<i>S. juvenas</i>	<i>S. kleinii</i>	<i>S. lanuginosa</i>	<i>S. sylvestre</i>	<i>S. wallichii</i>
Leaf size (l x w mm)	120 – 187 x 65 – 101	65 – 90 x 20 – 32	75 – 130 x 35 – 88	60 – 85 x 20 – 35	117 – 250 x 43 – 48	20 – 42 x 15 – 35	60 – 100 x 20 – 64
Leaf (l : w)	1.3–2.3:1	2.2–5.8:1	1.2–2.4:1	1.5–3.0:1	2.4–4.5:1	1:1	1.4–2.4:1
Leaf texture	Herbaceous	Coriaceous and rugose	Herbaceous	Herbaceous	Coriaceous and rugose	Herbaceous	Herbaceous
Number of lateral veins	10 – 15	14 – 23	12 – 16	9 – 11	22 – 29	5 – 9	6 – 12
Petiole length (mm)	15 – 38	4 – 5	3 – 10	3 – 5	3 – 5	0.5 – 1	5 – 15
Adaxial leaf indumentum	Glabrous to puberulous (sparsely scabridulous)	Sparsely scabrid	Puberulous to scabrid	Glabrous to sparsely scabridulous	Sparsely lanuginose	Sparsely scabrid	Sparsely scabrid
Abaxial leaf indumentum	Densely tomentose	Densely tomentose	Densely tomentose	Densely tomentose	Densely lanuginose	Sparsely scabridulous	Densely tomentose
Outer adaxial periclinal wall shape (primary sculpture)	Slightly concave without papillae	Convex without papillae	Convex with papillae	Convex without papillae	Convex without papillae	Convex without papillae	Convex with papillae
Stomata distribution	Random	Stomatal crypts	Obscured	Obscured	Obscured	Random	Random
Stomata orientation	Hypostomatic	Obscured, probably hypostomatic	Obscured, probably hypostomatic	Obscured, probably hypostomatic	Obscured, probably hypostomatic	Amphistomatic	Hypostomatic

5.3.2 Floral characteristics

The floral characteristics of the *Streptocaulon* species show little variation. The colour as indicated by the collectors seems to be purple, pale green to pale reddish-green on the outside and olive brown on the inside. The corolla lobes are usually ovate with obtuse apices. The corolla is glabrous both inside and outside for all the species except in *S. kleinii* with corolla lobes hirsute on the inside.

Anther callosities are absent in all of the *Streptocaulon* species and the anther connectives are also glabrous. The connective appendage is usually deltoid but triangular in *S. curtisii* and rhomboid in *S. kleinii*. The styles of the species are glabrous, but may be basally villous in *S. sylvestre*. The shape of the coronal feet are generally conical or ovoid, but laterally broadened in *S. cumingii*. The corona lobes show little variation, being filiform or cylindric-filiform, but falcate-cylindric in *S. cumingii*.

The translator receptacle shape seems to be relatively specific for most species. In *S. cumingii* and *S. kleinii* the translator receptacles are narrowly elliptic but with short terete styles and entire apices in *S. cumingii* and short linear styles and split apices in *S. kleinii*. The translator receptacles in *S. curtisii* are rhomboid-elliptic to narrow obovate, styles linear to linear-terete and apices deeply split. *Streptocaulon juvenas* has characteristically narrow ovate to elliptic translator receptacles, very short linear styles with split apices. Obtrapezoid translator receptacles with linear styles are characteristic of *S. lanuginosa*. In *S. sylvestre*, the translator receptacles are usually broadly ovate to obovate, short linear style with deeply split apices. *S. wallichii* is characterized by rhomboid translator receptacles, linear styles, with split apices. (Table 5.2).

5.3.3 Follicle and seed characteristics

The *Streptocaulon* follicles are rather uniform being longer than 60 mm, shaped narrowly ovoid or oblong-lanceolate, with apices attenuate. The exceptions with follicles

shorter than 35 mm are *S. curtisii* with ellipsoid follicles with bluntly acute apices, and *S. lanuginosa*.

The seeds are quite similar with little variation in shape. *Streptocaulon curtisii*, *S. kleinii* and *S. lanuginosa* have “small” seeds, being generally shorter than 5 mm, while the seeds of *S. juvenas* and *S. wallichii* are longer than 6 mm. Unique to *S. lanuginosa* is the coma being shorter than 8 mm. (Table 5.3).

Table 5.2: Comparison of the floral characteristics of *Streptocaulon* species.

SPECIES/CHARACTERS	<i>S. cumingii</i>	<i>S. curtisii</i>	<i>S. juvenas</i>	<i>S. kleinii</i>	<i>S. lanuginosa</i>	<i>S. sylvestre</i>	<i>S. wallichii</i>
Corolla colour	–	Purple	Pale green outside, olive brown inside	–	–	–	Purple to pale reddish-pink
Corolla lobe apex	Obtuse	Obtuse	Acute to obtuse	Obtuse to obtuse-acute	Obtuse	Obtuse	Obtuse
Corolla lobe shape	Ovate to oblong-ovate	Ovate to elliptic	Ovate	Ovate to elliptic	Ovate	Ovate to oblong-ovate	Ovate to triangular
Corolla lobe indumentum	Glabrous on both sides	Glabrous on both sides	Glabrous on both sides	Outside hirsute, glabrous inside	Glabrous on both sides	Glabrous on both sides	Glabrous on both sides
Corolla tube indumentum	Glabrous on both sides	Glabrous on both sides	Glabrous on both sides	Glabrous on both sides	Glabrous on both sides	Glabrous on both sides	Glabrous on both sides
Presence of staminal callosities	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Corona foot shape	Laterally broadened	Conical to ovoid	Ovoid	Ovoid	Conical	Conical	Conical
Corona lobe shape	Falcate-cylindric	Filiform	Cylindric-filiform	Filiform	Cylindric-filiform	Cylindric-filiform	Cylindric-filiform
Corona lobe apex	Notched to truncate	Bifid to entire	Entire	Entire and tortuous	Entire and tortuous	Entire and tortuous	Entire
Anther connective appendage	Deltoid	Triangular to broadly triangular	Deltoid	Rhomboid	Deltoid	Deltoid	Deltoid
Anther connective indumentum	Glabrous	Glabrous	Glabrous	Glabrous	Glabrous	Glabrous	Glabrous
Style indumentum	Glabrous	Glabrous	Glabrous	Glabrous	Glabrous	Base sometimes villous	Glabrous

SPECIES/CHARACTERS	<i>S. cumingii</i>	<i>S. curtisii</i>	<i>S. juvenas</i>	<i>S. kleinii</i>	<i>S. lanuginosa</i>	<i>S. sylvestre</i>	<i>S. wallichii</i>
Presence/Absence of nectary rim lobule	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Translator receptacle shape	Narrowly elliptic	Narrowly obovate, ovate, rhomboid-elliptic	Narrowly ovate to elliptic	Narrowly elliptic	Ob-rhomboid	Broadly ovate to obovate	Rhomboid
Translator stype shape	Terete	Linear to linear-terete	Linear	Linear	Linear	Linear	Linear

Table 5.3 Comparison of follicle and seed characteristics of *Streptocaulon* species

SPECIES/CHARACTERS	<i>S. cumingii</i>	<i>S. curtisii</i>	<i>S. juvenas</i>	<i>S. kleinii</i>	<i>S. lanuginosa</i>	<i>S. sylvestre</i>	<i>S. wallichii</i>
Follicle shape	–	Ellipsoid	Oblong or oblong-lanceolate	Narrowly ovoid	Ovoid	–	Narrowly ovoid
Follicle size (mm)	–	17–35 x 4–5	60 – 105 x 5 – 8	80 – 85 x 5	15 – 18 x 5	–	70 – 75 x 5
Follicle apex	–	Bluntly acute	Attenuate	Attenuate	Attenuate	–	Attenuate
Follicle pericarp surface	–	Tomentose	Scabrid	Tomentose	Lanuginose	–	Tomentose
Seed shape	–	–	Cylindric to ovoid-cylindric	Narrowly oblong to oblong-obovate	Obovoid to ellipsoid	–	Oblong to oblong-ovoid
Seed size (mm)	–	–	5 – 9 x 1.5 – 2	3 – 5 x 1 – 1.5	2 – 2.5 x 1 – 1.5	–	6 – 7
Seed lower seed margin	–	–	Smooth	Smooth	Smooth	–	Smooth
Distribution mechanism	–	–	Coma, 20–45 mm	Coma, 20–25 mm	Coma, 5–8 mm	–	Coma, 15–30 mm

5.4 Key to the *Streptocaulon* species

1. Erect shrubs, leaves coriaceous, adaxially rugose 2
 Climbers, leaves herbaceous, adaxially smooth..... 3
2. Leaves shorter than 90 mm, adaxially sparsely scabrid and abaxially densely lanuginose, stomata in stomatal crypts, corona lobes filiform, ***S. curtisii***
 Leaves longer than 100 mm, adaxially sparsely lanuginose and abaxially densely lanuginose without stomatal crypts, corona lobes cylindric-filiform.....***S. lanuginosa***
3. Leaves orbicular to sub-orbicular, not longer than 45 mm, petiole shorter than 1 mm, style base sometimes villous..... ***S. sylvestre***
 Leaves not orbicular to sub-orbicular, longer than 55 mm, petiole 3 mm or longer, style glabrous..... 4
4. Leaves broadly lanceolate to lanceolate ***S. wallichii***
 Leaves broadly obovate to narrowly obovate, broadly rhomboid to rhomboid, ovate to elliptic.....5
5. Leaves ovate to elliptic, petioles longer than 14 mm, corona lobe apices notched to truncate..... ***S. cumingii***
 Leaves obovate, oblong-obovate, rhomboid, petioles 10 mm or longer, corona lobe apices filiform..... 6
6. Leaves broadly obovate or broadly rhomboid to rhomboid, corolla lobes glabrous, corona lobes cylindric-filiform and apices erect..... ***S. juvenas***
 Leaves narrowly obovate to oblong-obovate, corolla lobes outside densely hirsute, corona lobes filiform and apices tortuous..... ***S. kleinii***

5.5 Generic synonyms of *Streptocaulon*

Gongylosperma King & Gamble (= *Streptocaulon*)

Streptocaulon Wight & Arn.

Tripolepis Turcz. (= *Streptocaulon*)

5.6 Synonyms of *Streptocaulon* species

Anodendron corymbosum Elmer (= *S. cumingii*)

Apocynum juvenas Lour. (= *S. juvenas*)

Finlaysonia curtisii (King & Gamble) Venter (= *S. curtisii*)

Finlaysonia lanuginosa (Ridley) Venter (= *S. lanuginosa*)

Gongylosperma curtisii King & Gamble (= *S. curtisii*)

Gongylosperma lanuginosa Ridley (= *S. lanuginosa*)

Periploca calumpitensis Llanos (= *S. wallichii*)

Streptocaulon baumii Decne. (= *S. wallichii*)

Streptocaulon corymbosum (Elmer) Elmer (= *S. cumingii*)

Streptocaulon curtisii (King & Gamble) Venter & A.M.Venter

Streptocaulon griffithi Hook.f. (= *S. juvenas*)

Streptocaulon juvenas (Lour.) Merr.

Streptocaulon kleinii Wight & Arn.

Streptocaulon lanuginosa (Ridley) Venter & A.M.Venter

Streptocaulon magnum Elmer (= *S. cumingii*)

Streptocaulon obtusum Turcz. (= *S. wallichii*)

Streptocaulon sylvestre Wight

Streptocaulon tomentosum Wight (= *S. juvenas*)

Streptocaulon wallichii Wight

Tripolepis cumingii Turcz. (= *S. cumingii*)

5.7 Species name excluded from *Streptocaulon*:

Streptocaulon extensum Wight (= *Myriopteron extensum* (Wight) K. Schum.)

Streptocaulon calophyllum Wight (= *Periploca calophylla* (Wight) Falc.)

CHAPTER 6

PHYLOGENY

6.1 Introduction

In the Periplocoideae the only detailed phylogenetic studies have been done by Venter and Verhoeven (2001) and Ionta and Judd (2007) based on generic relationships. Phylogenetic work at species level has only recently received attention in the revision of *Cryptolepis* by L. Joubert and the DNA analysis of *Raphionacme* by M. Pienaar which are currently under way (personal communication). The phylogenetic study in this subfamily by Ionta and Judd (2007) based on molecular, morphological and geographic data resulted in a well resolved phylogeny with good support, but in the phylogeny of the Periplocoideae based on morphological data by Venter and Verhoeven (2001), the resulting cladograms contained mostly polytomies and generic relationships were therefore, unresolved.

The aim of the present cladistic treatment, based exclusively on morphological data, was to establish the relationship between *Finlaysonia* and *Streptocaulon* as well as between the species within each genus.

Systematics is defined by Simpson (2006) as a science that includes and encompasses traditional taxonomy which deals with the description, identification, nomenclature and classification of organisms. Systematics goes beyond that and is founded in the principles of evolution which, in the broadest sense means “change”. Biological evolution is described as “descent (the transfer of genetic material from parents to offsprings over time) with modification” (Simpson, 2006). This descent results in the formation of a lineage or clade (a set of organisms interconnected through time and space by the transfer of genetic material from parents to offspring). The genetic make-up of a population changes over time, mainly by mutation, which is the direct alteration of DNA, or by genetic

recombination, whereby existing genes are reshuffled in different combinations (during meiosis, by crossing over and independent assortment) (Simpson, 2006). This leads to a change in the characteristics of a population from a pre-existing, or ancestral, character state (plesiomorphic) to a new, derived character state (apomorphic). Phylogenetic systematics is thus a methodology of inferring the pattern of evolutionary history or pattern of descent of a group of organisms, utilizing the synapomorphies (shared derived characters), the result of which is shown in the form of a cladogram, or phylogenetic tree (Simpson, 2006).

The importance of phylogenetic study cannot be over-emphasized. In addition to the above, the knowledge gained from a phylogenetic study gives insight into the possible functional, adaptive significance of hypothesized evolutionary changes. Furthermore, cladograms can also be used to classify life in a way that directly reflects evolutionary history. It could also serve as a tool for inferring biogeographic and ecological history, assessing evolutionary processes, and making decisions in the conservation of threatened or endangered species (Simpson, 2006).

Morphological and/or molecular data provides the sources on which phylogenetic study is based. Morphology has historically constituted the primary and often only source of taxonomic evidence (Judd et al., 1999). This is because morphological characters are easily observed, known/obtainable from all plant species and all parts of plants (vegetative and reproductive), including for fossils, and find practical use in keys and descriptions. Therefore, morphological characters were the first to be used in phylogenetics. The most compelling reason to continue to collect morphological data is that it allows us to address the phylogeny of fossil taxa and their relationships to living taxa.

Molecular phylogenetics cannot provide evidence for fossil taxa because molecular data cannot be readily obtained from fossils, despite impressive molecular studies of very recent fossil taxa (Wiens, 2004). Secondly, many extant taxa are known only from a limited

number of specimens. They are therefore fixed in formalin because they may never be collected again due to limited distribution, habitat destruction and other factors. Collecting molecular data from such specimens is very difficult hence, the only way that we may know anything about the relationships of these species is through phylogenetic analysis of morphology (Wiens, 2004). Thirdly, until we reach the stage where all molecular phylogenies are reconstructed without error, it is still important to have rigorous, morphology-based phylogenies as a “reality check” for molecular results. This is because there are factors that may cause reconstruction of clades using molecular data to be incorrect although statistically well-supported, such as long-branch attraction, deviations between gene and species trees and more mundane problems such as contamination and misidentification of specimens (Wiens, 2004).

Comparing molecular results to morphology-based phylogenies can help prevent us from being misled in these cases (Wiens, 2004). However, morphological characters as data source in phylogenetic studies have some serious shortcomings. Morphological features can be influenced by the environment which makes it difficult to trace a character to its ancestral form. This results in homoplasy, creating problems in ordering or even polarizing character states. As a result, high levels of autapomorphies and a lack of well defined synapomorphies occur. Scotland et al., (2003) stated that inclusion of morphological data in phylogeny reconstruction is problematic and that morphological data should merely be mapped onto phylogenies, established by molecular data to determine if they add further support to specific nodes.

The introduction of molecular data as source of characters supplemented morphological characters for use in phylogenetic studies. Molecular systematics is therefore, a relatively new source of evidence in the quest to obtain an accurate picture of evolutionary history. Molecular systematics finds its usefulness in the discreteness of its character states, the large number of characters that can potentially be obtained rather easily, and their easier interpretation. This is unlike the morphological characters where, for example, compound

leaves can form in quite different ways in different plants. Hence, the information obtained from molecular data has a higher degree of reliability (Soltis et al., 1992).

Despite the reliability of molecular systematics, it is still fraught with most of the same problems that morphological data has. The problem of homoplasy, as stated earlier, resulting from convergence and parallelism are indeed present in molecular traits (Judd et al., 1999). Furthermore, molecular data does not show the record of past changes in characters. This is a serious short-coming, as there are only four possible nucleotides for any site in the DNA molecule. If there has been changes from one nucleotide to another and back again, such 'multiple hits' can not be detected. Also, only part of the entire plant genome (example, cpDNA or mtDNA) is used for the analysis which does not give a comprehensive picture of the whole organism and in my opinion it would be incorrect to generalize and conclude that deductions from it can be used as representative of a given taxon.

Despite the many advantages of molecular data, it is absolutely critical that systematists continue to be trained in morphological systematics as well, particularly for poorly known groups (Hills and Wiens, 2000). This is also essential for quick and accurate identification of species based on morphological characters in the field and laboratory (Maddison, 1996). Analyses of molecular and morphological data in phylogenetics are quite similar. The differences are mainly a matter of degree and do not map neatly onto the division of characters into molecular versus morphological. Molecular and morphological data, when gathered carefully and analyzed in an appropriate manner, are equally useful in understanding evolutionary history (Soltis et al., 1992). In my opinion molecular and morphological data should complement each other for use in phylogenetic study.

The biggest problem when using morphological data in phylogenetic analysis, is determining informative characters and character states. According to Simpson (2006) morphological features are generally the manifestation of numerous intercoordinated

genes, and because evolution occurs by a change in one or more of those genes, the precise definition of a feature in terms of characters and character states may be problematic. Phylogenetic systematics entails the recognition of an evolutionary transformation from one state to another. An important requirement of character analysis is that character states be distinct or discontinuous from one another. Stevens (1991) clearly stated that the delimitation of character states is still, for the most part, either not explicit, or if explicit, apparently arbitrary. He further opined that characters with an obvious continuous quantitative basis often show higher homoplasy than others. Poe and Wiens (2000), on the contrary, assert that there is no justification for excluding characters because of variations within terminal taxa, continuous and quantitative variations, unknown polarity, and assumed levels of homoplasy. They argued that the so-called ambiguous characters (uninformative characters) do contain useful phylogenetic information (i.e., continuous and quantitative variation) and in fact, resolutions of relationships among taxa and bootstrap support are increased. Despite the shortcomings thereof, Wiens (2004) still supports the necessity of continued use of morphological data for phylogenetic study. He adds that more explicit methods and rigorous testing of these methods, using simulations and congruence studies, could be used to solve many problems.

6.2 Results

The statistics of the three data sets used for the phylogenetic analysis are summarized in Table 6.1. Characters eliminated from the long data-set (Appendix 1, p. 249) to produce the short data-sets (Appendix 2, p. 255), had a homoplasy index of less than 0.5

Table 6.1 Statistical results of three PAUP analyses using different data-sets and out-groups.

DATA-SET	LONG DATA-SET	SHORT DATA-SET (A)	SHORT DATA-SET (B)
Outgroups	<i>Raphionacme brownii</i>	<i>Raphionacme brownii</i>	<i>Raphionacme brownii</i> and <i>Cryptolepis buchananii</i>
No. of taxa	16	16	17
Total number of characters	59	38	38
Parsimony informative characters	51	31	31
Tree length (TL)	159	92	109
Consistency index (CI)	0.5157	0.5870	0.5396
Homoplasy index (HI)	0.4843	0.4130	0.4404
Retention index (RI)	0.4934	0.5682	0.5296

In all the strict consensus analyses nearly complete polytomies were obtained, except for a clade comprising *S. curtisii* and *S. lanuginosa*, which was well supported with a bootstrap support value (BS) of 80 (Fig. 6.1.1).

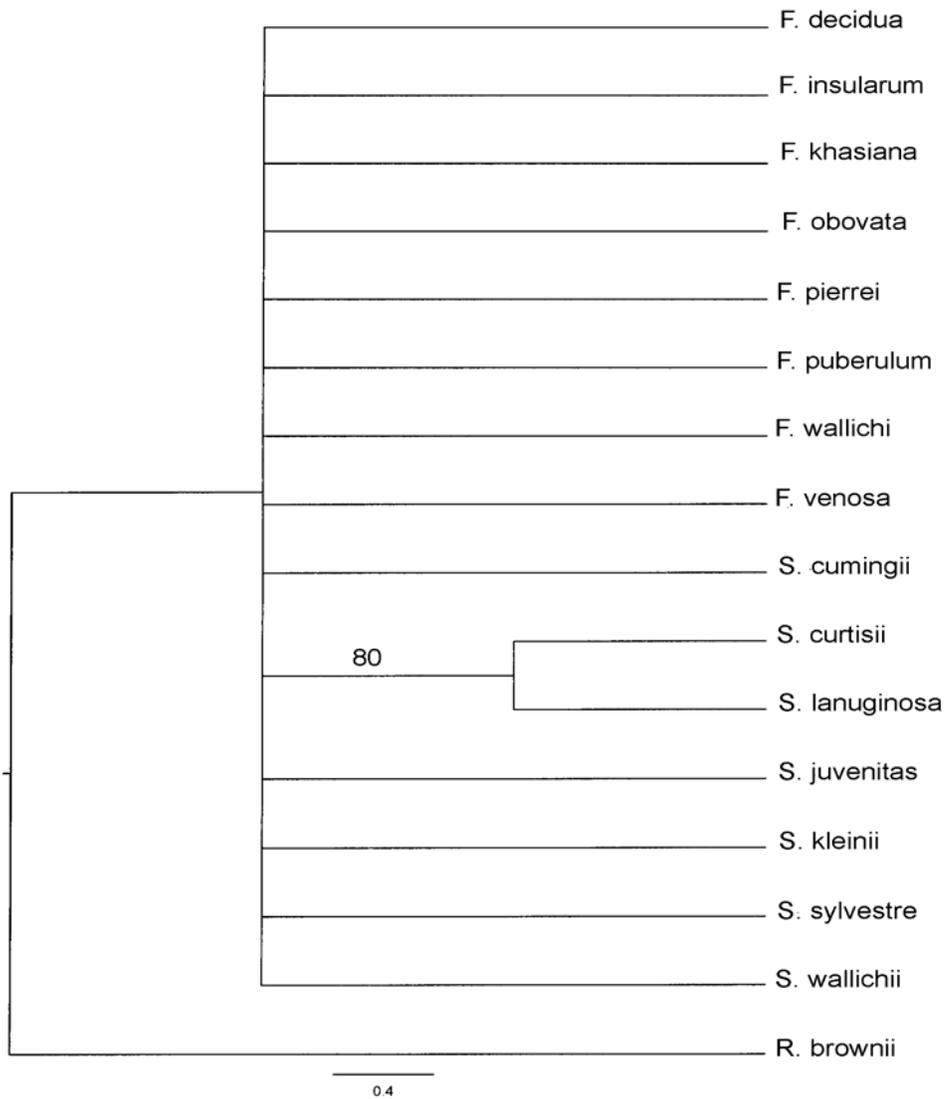


Fig. 6.1.1 Consensus tree of *Finlaysonia* and *Streptocaulon* species using PAUP based on long and short datamatrixes (Tables 6.2 (p.251) and 6.3 (p. 256)).

Initially bootstrap of values of above 60% were deemed acceptable, but this resulted in polytomies, and it was decided to set aside this restriction. When the required Bootstrap support threshold was lowered the trees in Figures 6.1.2, 6.1.3, 6.1.4 were obtained. However, most of these branches have very low support values and are therefore not reliable.

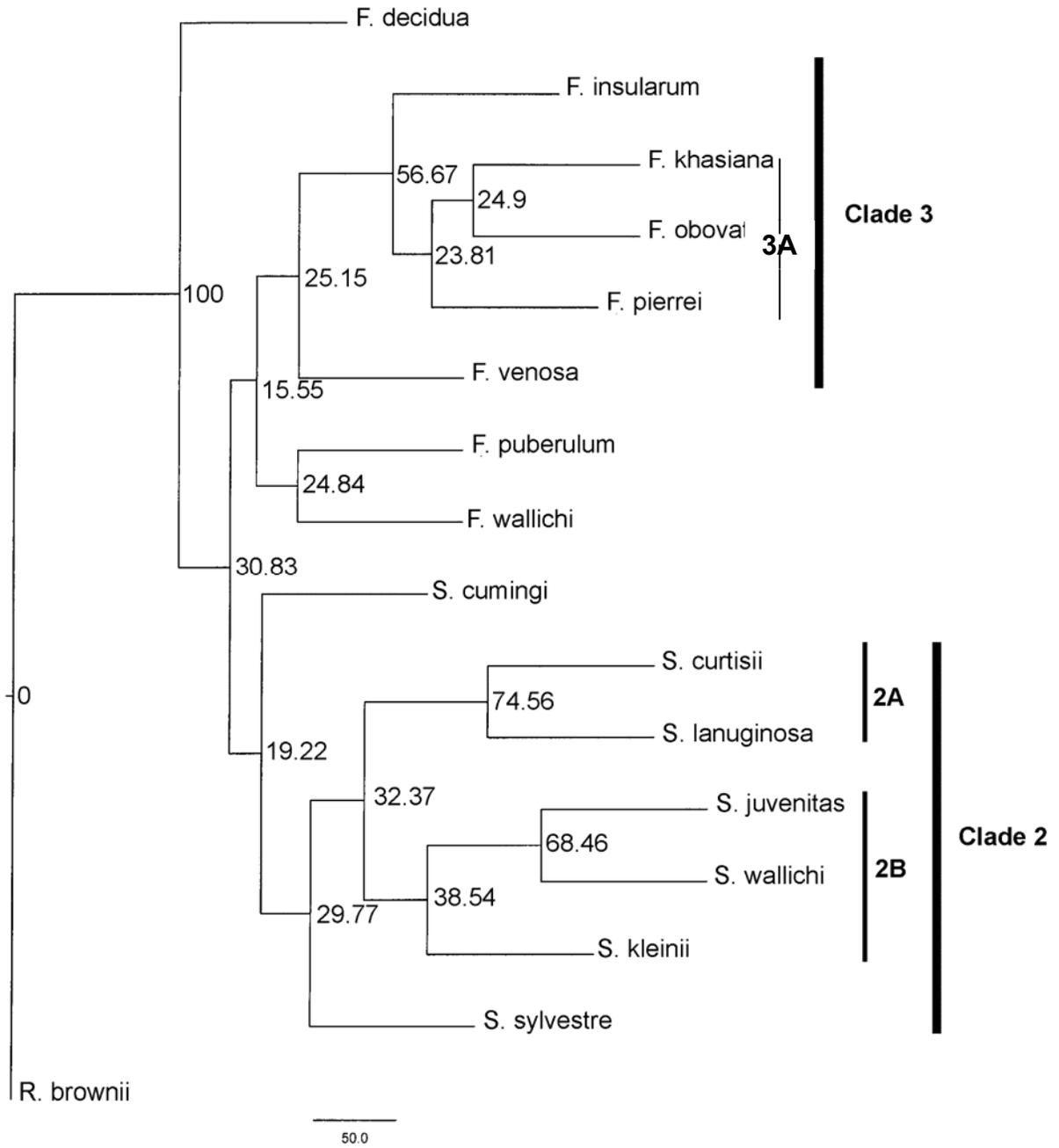


Fig. 6.1.2 Consensus tree of *Finlaysonia* and *Streptocaulon* species using PAUP, based on the long datamatrix, consisting of 16 taxa and 59 characters, Outgroup= *Raphionacme brownii* (Appendix 1, Table 6.2, (p. 251)).

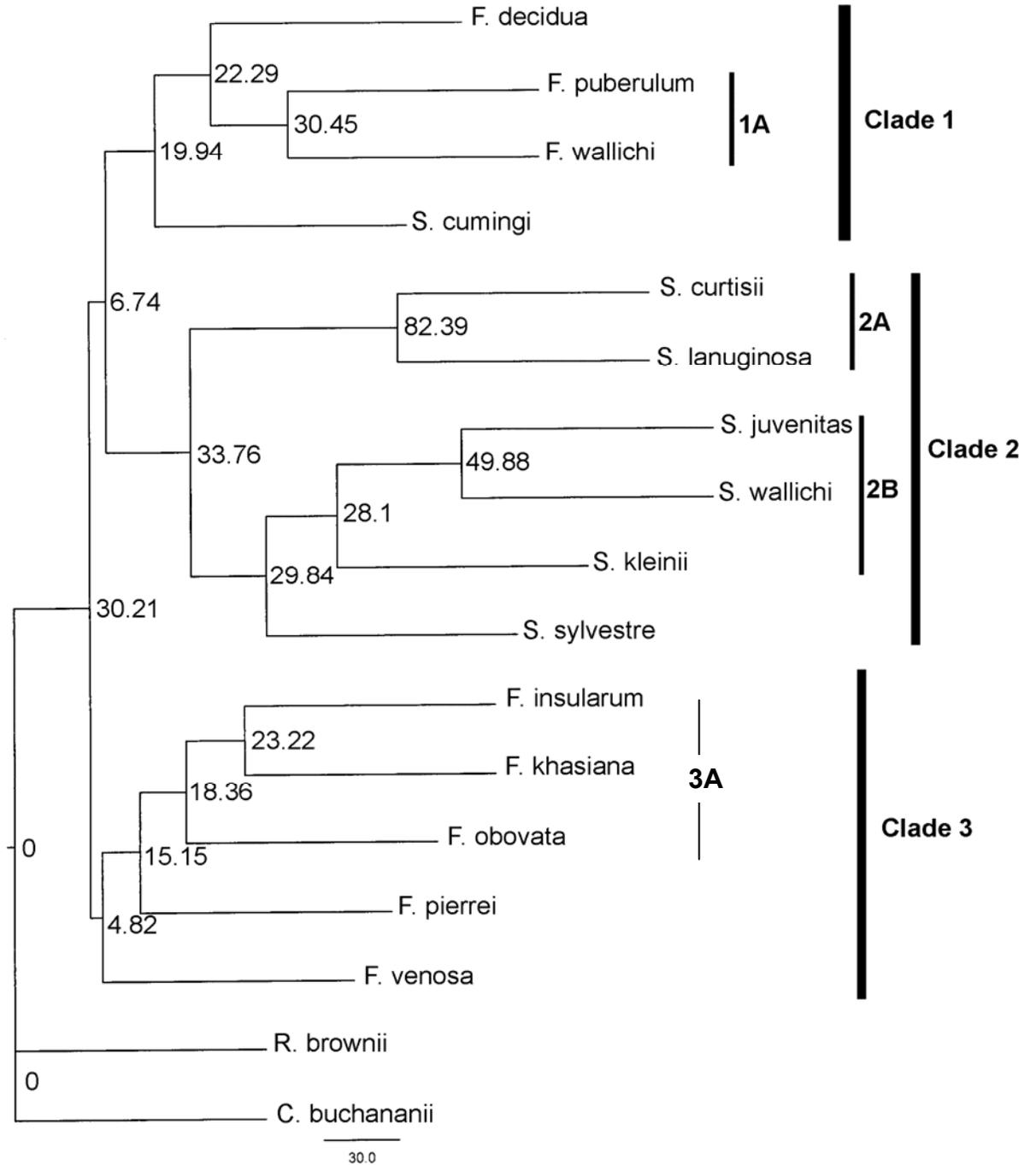


Fig. 6.1.3 Consensus tree of *Finlaysonia* and *Streptocaulon* species using PAUP, based on the short datamatrix B consisting of 17 taxa and 38 characters and two outgroups, *Raphionacme brownii* and *Cryptolepis buchananii* (Appendix 2, Table 6.3, (p. 256)).

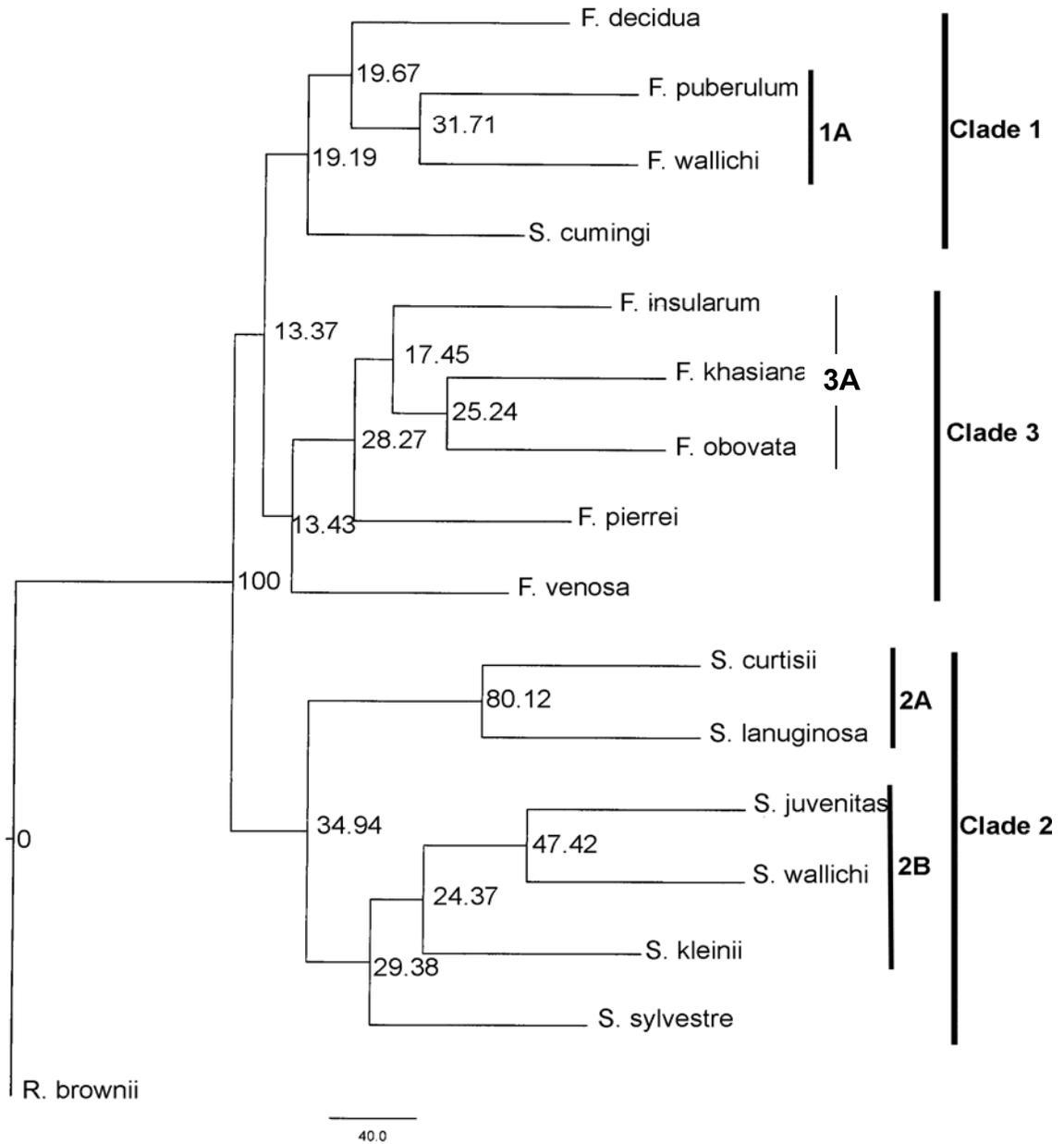


Fig. 6.1.4 Consensus tree of *Finlaysonia* and *Streptocaulon* species using PAUP, based on the short datamatrix A, consisting of 16 taxa and 38 characters. Outgroup = *Raphionacme brownii* (Appendix 2, Table 6.3 (p. 256)).

Results from the short data-sets yielded 3 consistent clades; clades 1, 2 and 3 while only clades 2 and 3 are formed in the long data-set. In all analyses relationships in clade 2 are consistent except for the position of *S. sylvestre*, but in clade 3 relationships change among the three trees.

Clade 1 is made up of *F. decidua*, *F. puberulum*, *F. wallichii* and *S. cumingii*, characterised by glabrous to sparsely arranged hairs on the upper leaf surface and dense hairs on the lower leaf surface and narrowly triangular anther connective appendage shape (Appendix 2: characters 7 and 23, Table 6.3, p. 256). In clade 1 subclade 1A consisting of *F. puberulum* and *F. wallichii* (BS 30.45, Fig. 6.1.3; BS 31.71, Fig. 6.1.4) is sister to *F. decidua* (BS 22.29, Fig. 6.1.3; BS 19.67, Fig. 6.1.4) and together these are sister to *S. cumingii* (BS 19.94, Fig. 6.1.3; BS 19.19, Fig. 6.1.4).

Clade 2 consist of *S. curtisii*, *S. lanuginosa*, *S. juvenas*, *S. wallichii*, *S. kleinii* and *S. sylvestre* which are characterized by divaricate secondary vein orientation (Appendix 2: character 6, Tables 6.3, p. 256; Appendix 1: character 16, Table 6.2, p. 251) which overlaps with *F. insularum* in clade 3; glabrous to sparsely arranged hairs on the upper leaf surface and dense indumentum on the lower leaf surface (Appendix 2: characters 7, Tables 6.3, p. 256; Appendix 1: character 17, Table 6.2, p. 251), overlapping with members of clade 1 (*F. decidua*, *F. puberulum*, *F. wallichii* and *S. cumingii*); tomentose abaxial leaf indumentum (Appendix 2: characters 8, Tables 6.3, p. 256; Appendix 1: character 18, Table 6.2, p. 251) which overlaps with *F. decidua* in clade 1. Clade 2 consists of sub-clades 2A and 2B. Sub-clade 2A consists of *S. curtisii* and *S. lanuginosa* (BS 74.56, 82.39 and 80.12) while sub-clade 2B consists of *S. juvenas*, *S. wallichii* and *S. kleinii* (BS 38.54, 28.1 and 24.37). Both sub-clades 2A and 2B are sisters which then form sister clades to *S. sylvestre* (BS 29.77, 29.84 and 29.38) (Fig 6.1.2, 6.1.3 and 6.1.4).

Clade 3 consists of *F. insularum*, *F. khasiana*, *F. obovata*, *F. pierrei* and *F. venosa* based mainly on glabrous leaf surface indumentum (Appendix 2: characters 7, Table 6.3, p. 256;

Appendix 1: character 17, Tables 6.2, p. 251). In the cladogram (Fig. 6.1.2) from the long data-set, sub-clade 3A consisting of *F. khasiana*, *F. obovata* and *F. pierrei* (BS 23.81) is sister to *F. insularum* (BS 56.67) and altogether they are sister to *F. venosa* (BS 25.15). A clade formed by *F. puberulum* and *F. wallichii* (BS 24.84) is sister to clade 3 (BS 15.55). In the short data-sets (Fig. 6.1.3 and 6.1.4) sub-clade 3A consist of *F. insularum*, *F. khasiana* and *F. obovata* and are sister to *F. pierrei* and *F. venosa* but with different Bootstrap values.

In the long data-set were *Raphionacme brownii* is used as outgroup, a clade formed by clade 3 together with *F. puberulum* and *F. wallichii* is sister to clade 2 (Fig. 6.1.2). In the short data-set (B) were *R. brownii* and *Cryptolepis buchananii* were used as outgroups (Fig. 6.1.3), clade 1 (BS 19.94) is sister to clade 2 (BS 33.76) and both of them is sister to clade 3 (BS 4.82). When only *R. brownii* is used as outgroup (short data-set A), clades 1 (BS 19.19) and 3 (BS 13.43) are sister groups and together these groups are sister to clade 2 (BS 34.94) (Fig.6.1.4).

6.3 Discussion

Generally, the phylogenetic analyses show unresolved cladograms with poor Bootstrap support. This could be due to a lack of adequate informative data as all characters used were derived from dried herbarium specimens, or the use of non-discreet characters, and possible hybridization of species. It is also possible that most taxa form polytomies due to independent divergence from a single ancestral species, thus, no synapomorphic evolutionary event links any two or most of the taxa as a monophyletic group. It is therefore not possible to make well founded suggestions for classification based on the phylogenies as most clades may not represent natural groupings.

The result from the phylogenetic analysis of Ionta and Judd (2007) with respect to *Finlaysonia* and *Streptocaulon* yielded a polyphyletic *Finlaysonia* because *Finlaysonia lanuginosa* was placed as sister to *Streptocaulon juvenas*, while *Finlaysonia insularum*

formed a clade with *Atherandra*. This result supports the transfer of *Finlaysonia lanuginosa* to *Streptocaulon* in this work, to resolve the polyphyletic *Finlaysonia*.

Clade 1 is not present in the long data-set (Fig 6.1.2) but present in the short data-set consisting of *F. decidua*, *F. puberulum*, *F. wallichii* and *S. cumingii*, although relationships among these species are poorly supported.

Clade 2 (*Streptocaulon*-clade) is consistent in all data-sets, and relationships among species are moderately supported especially for the sub-clades 2A (*S. curtisii* and *S. lanuginosa*, BS 82.39) and 2B (*S. juvenas* and *S. wallichii*, BS 68.46) (Figs. 6.1.3 and 6.1.2 respectively) supporting the clade *F. lanuginosa* (= *S. lanuginosa*) and *S. juvenas* in Ionta and Judd (2007). Clade 3 is present in all data-sets but relationships among species within these clades are poorly supported. In the long data-set, clade 3 is sister to *F. puberulum*, *F. wallichii* and *S. cumingii* which are members of clade 1 in the short data-sets. The position of these three species in the long data-set is therefore questionable. The position of *F. decidua* as sister to the rest of the ingroup taxa in the long data-set is probably as a result of missing data and insufficient sampling in the species.

When *R. brownii* is used as single outgroup in the long data-set, *Finlaysonia* (excluding *F. decidua*) forms a monophyletic clade which is sister to a monophyletic *Streptocaulon* clade (Fig. 6.1.2). A monophyletic *Finlaysonia* and *Streptocaulon*, as delimited here were not contradicted by Ionta and Judd (2007). This grouping disappears when using the short data-set for analysis (Fig. 6.1.3 and 6.1.4). In both results, *Finlaysonia* forms a paraphyletic group, while *Streptocaulon* excluding *S. cumingii* (BS 33.76) remains a monophyletic clade, nested within *Finlaysonia* in Figure 6.1.3. In Figure 6.1.4 a monophyletic *Finlaysonia*, including *S. cumingii* (BS 13.37) is sister to a monophyletic *Streptocaulon* (BS 34.94) excluding *S. cumingii*.

This data therefore provides no support for inferences on evolutionary history or proposals for classification. This is because there is no consistent character in all of the clades that could have driven evolutionary process.

The age, method of pressing and conditions under which these specimens were housed, sometimes posed a serious problem especially in extracting useful taxonomic information. These problems were further compounded by the presence of specimens without leaves, fruits and/or seeds. Insufficient sampling that resulted in missing data probably influenced the cladistical results, especially with regard to *F. decidua*. Inclusion of molecular data in the phylogenetic studies would most probably solve many of the uncertainties. However, according to Wiens (2004), using such poor quality materials for molecular studies could result in mundane problems such as contamination and misidentification of specimens as DNA for molecular sequencing are usually degraded. Recent collections or fresh material would be needed for successful DNA extraction.

However, considering that many of the specimen localities date from previous centuries, population growth and accelerated agriculture pose a serious problem to the habitat of the species, especially those with a restricted distribution. *Finlaysonia obovata*, according to Davison (2008), nearly went into extinction due to habitat destruction and only 50 mature individuals were recorded in the wild. The under collection of species in recent years may be the result of this situation and as such, species would then be known from old herbarium specimens only, and morphology the only available tool for analysis.

Despite the generally poor support values and the tenuous placement of some species in the clades, the phylogenetic analysis presented here, provides a platform upon which future studies of the phylogeny of *Finlaysonia* and *Streptocaulon* may be built, when the rest of the Asian genera have been analysed and are added to the phylogenies.

CHAPTER 7

DISCUSSION AND CONCLUSION

7.1 Distribution and habit of *Finlaysonia* and *Streptocaulon*

Finlaysonia and *Streptocaulon* species are climbers or lianas, except for *S. curtisii* and *S. lanuginosa* which are shrubs. They are geographically widely distributed in Asia, from Brunei to China, Cambodia, India, Laos, Myanmar, Malaysia, the Philippines, Papua-New Guinea, Singapore and Vietnam, with the majority of the species (8 of 15) in Thailand. Both genera occupy a wide range of similar niches, with most of the species found on limestone, forming part of scrub forest, mixed deciduous forest and savanna. *Finlaysonia obovata* also inhabits mangrove forests of coastal lagunes and tidal rivers, while two species, namely, *S. sylvestre* and *S. juvenas*, are found in forests along fresh water river banks.

7.2 Comparison between *Finlaysonia* and *Streptocaulon*

The morphological characteristics of vegetative and floral parts of *Finlaysonia* and *Streptocaulon* are similar. Therefore, no single characteristic can effectively be used to delimit either of the genera. A combination of useful characters is to be applied. A comparison of the distinguishing characters of *Finlaysonia* and *Streptocaulon* is given in Table 7.1

Table 7.1: Comparison of generic characters applicable to *Finlaysonia* and *Streptocaulon*

CHARACTERS	<i>Finlaysonia</i>	<i>Streptocaulon</i>
Abaxial leaf indumentum	Glabrous or sparsely scabrid to scabridulous	Densely tomentose or lanuginose
Corolla lobe indumentum	Hairy inside and/or outside except <i>F. insularum</i> that is glabrous on both surfaces	Glabrous on both sides, except for <i>S. kleinii</i> that is densely hirsute outside
Presence/Absence of Callosities	Present except in <i>F. pierrei</i>	Absent
Pollen wall architecture	Inner wall with granular stratum and intine	Inner wall reduced with only thin exine layer

The vegetative features provide the most effective means for identification of species in these two genera as they are available throughout the year and not seasonal like flowers and fruit. Generally the leaf shape is relatively specific for each species even if leaf size varies considerably within each species. Additional characters such as leaf blade length:width ratio, texture, number of lateral veins and petiole length, adaxial and abaxial leaf vestiture are important for identification purposes. (Tables 4.1 and 5.1).

Leaf micromorphology can also be useful for delimiting species. In this study characters like primary sculpture (periclinal wall shape), stomatal orientation and distribution proved to be taxonomically useful. (Tables 4.1 and 5.1).

Floral characteristics have been of systematic value in separating genera and species in the Periplocoideae over the years. This started with Linnaeus (1754) when he distinguished *Periploca* from the rest of the Asclepiadaceous genera by its filiform corona

lobes and hairy anthers. Subsequent taxonomists adopted the use of floral characteristics, with emphasis on relative position of the corona, presence or absence of a distinct corolla tube and relative length of the corolla tube in comparison to corolla lobes to separate genera in the Periplocoideae (Venter and Verhoeven, 1994a). Venter and Verhoeven (1997) added the exposure of the gynostegium from the corolla and the positioning of coronas and stamens in the corolla tube as taxonomically important in separating Periplocoideae genera. However, Venter and Verhoeven (2001) noted that, within the Periplocoideae, floral features such as length of the corolla tube is much more variable within a genus as the corolla tube may be distinct in some species, but indistinct in other species of the same genus. Ionta and Judd (2007) confirmed this when they noted that floral form varies among, as well as within genera. According to Ionta and Judd (2007) this is evidenced by a wide range of corolla shapes, elaborate diversification of corolline coronas, varying degrees of fusion between corona and stamens, and differences in the position of floral organs in the corolla tube. By using only the floral characteristics Venter and Verhoeven (2001) mistakenly placed two *Streptocaulon* species, namely *S. curtisii* and *S. lanuginosa*, in *Finlaysonia*. Hence, floral characteristics should be complemented with other useful taxonomic features to avoid such misconceptions.

With respect to *Finlaysonia* and *Streptocaulon* floral characteristics such as corolla lobe apex, corolla lobe indumentum, presence/absence of anther callosities, corona foot and lobe shape, anther connective indumentum and presence/ absence of nectary rim lobules proved to be taxonomically useful for distinguishing some species in *Finlaysonia* (Table 4.2) but were not very useful in *Streptocaulon* species identification as there is very little variation in their floral characters (Tables 5.2).

In *Finlaysonia* and *Streptocaulon* colleters can be observed on interpetiolar ridges, in leaf axils, on leaf petioles and blade main veins and in the axils of inflorescence bracts. Colleters are usually present at the inner bases of the floral sepals. These are usually paired and narrowly turbinate but fusion of colleters from adjacent sepals may result into a

compound ovate to broadly ovate colleters. Brush-like colletes are found in leaf-axils usually in dense fascicles. There is very little variation in the number, position and shape of colletes among species of *Finlaysonia* and *Streptocaulon*, and they are therefore of no taxonomic value.

Pollen arranged in tetrads or pollinia is characteristic of the Periplocoideae. These pollinia consist of loosely agglutinated, but not fused tetrads in contrast to pollinia in the Asclepiadoideae (Lont and Judd, 2007). The only physical connection between Periplocoideae tetrads in the pollinia is fusion of the tectum and granular layer where two pores of adjacent tetrads are opposite (Verhoeven and Venter, 1998). Although pollinia are similar in all Periplocoideae genera, Verhoeven and Venter (1998) distinguished *Finlaysonia* by its pear-shaped pollinia. However, pollinium size, shape and pollen wall architecture vary little in the different species of *Finlaysonia* and *Streptocaulon*, hence have little taxonomic value.

The basic structure of all Periplocoideae translators is the same but shape and size may vary considerably making it a useful taxonomic tool in distinguishing genera and species. However, in *Finlaysonia* and *Streptocaulon* translators are all spatulate with variations in the shape of receptacles and styles among species in each genus, thus are not taxonomically useful in distinguishing between the genera but may be taxonomically useful at species level.

Fruit characteristics proved to be taxonomically useful for distinguishing some species of *Finlaysonia* and *Streptocaulon*. Follicle shape, size and texture, are unique to some species and can effectively be used to identify such species. For example, in *Finlaysonia*, the characteristic keel-shaped and falcate-ovoid follicle with coriaceous pericarp is unique to *F. obovata* and *F. pierreii* respectively while *S. lanuginosa* and *S. kleinii* can be identified by their short ovoid and long narrowly ovoid follicles respectively. (Fig 4.3 and 5.3).

At present, very little work has been done on the morphology of seeds in the Periplocoideae. The seeds are dorsiventrally flattened with a coma at the micropylar end (Venter and Verhoeven, 1993, 1999). Seed coat characteristics in combination with other taxonomic important characters were used in distinguishing Periplocoideae genera. Venter et al. (1990a, 1990b, 1990c) delimited the genera *Petopentia* Bullock and *Tacazzea* based on their smooth seed surfaces, while *Cryptolepis decidua* (then *Curroria decidua* subsp. *decidua* Bullock) and *C. migiurtina* Chiov. (then *Curroria migiurtina* (Chiov.) Bullock) were characterized by the presence of protuberances on their seed coat surfaces. Also, the seed coat surface of *Cryptolepis yemenensis* Venter & R.L.Verh. is rough with protuberances (Venter and Verhoeven, 1999). In general, seed and seed coat characteristics in *Finlaysonia* and *Streptocaulon* vary greatly within each genus, thus, reducing the value of seed and seed coat characteristics in distinguishing the genera from one another and from other genera of the Periplocoideae.

7.3 Phylogenetic relationship between *Finlaysonia* and *Streptocaulon*

The molecular phylogenetic study on the Periplocoideae by Ionta and Judd (2007) resulted in a well resolved phylogeny with good branch support. However, only three species represented *Finlaysonia* and *Streptocaulon* in their study, making their results inconclusive with regard to the relationships of species in these two genera.

The present phylogenetic study using morphological data indicated *Finlaysonia* and *Streptocaulon* could be monophyletic and therefore sister taxa which supports the initial assumption that these genera are closely related. However, relationships among species were poorly resolved with bootstrap values below 60%, for reasons already enumerated on. Hence, the resultant strict consensus tree was a polytomy, with the only useful clade that of *S. curtisii* and *S. lanuginosa*, which is consistent in all the data analyses, with BS

values above 80 in all the trees. This confirmed the decision to transfer *F. lanuginosa* to *Streptocaulon*.

The presence of *S. cumingii* in the “*Finlaysonia*” clade (Fig. 6.1.3 and 6.1.4) might indicate that *S. cumingii* actually belong in *Finlaysonia*. Characteristics similar in both *S. cumingii* and *Finlaysonia* species but different in other *Streptocaulon* species include adaxial and abaxial leaf indumentum that is glabrous to very sparsely scabrid and sparsely scabridulous to puberulous respectively as well as the slightly concave outer periclinal cell wall shape.

The position of *F. decida* in *Finlaysonia* is also doubtful as it exhibits characters of both *Finlaysonia* and *Streptocaulon*. The dense tomentose hairs of *F. decida* are characteristic of *Streptocaulon* species while the floral characters are more similar to those of *Finlaysonia*. In the tree (Fig. 6.1.2) based on the long dataset *F. decida* does not form part of the “*Finlaysonia* clade”, supporting the assumption of this species’s doubtful position in *Finlaysonia*. The grouping of *Finlaysonia* species into different clades (Fig. 6.1.3 and 6.1.4) suggests that, as presently circumscribed, the genus might not be monophyletic. *Finlaysonia*, as currently circumscribed, consists of an amalgamation of six smaller genera recently placed in synonymy by Venter and Verhoeven (2001).

It is clear that morphology alone, especially based on, in some cases, inadequate herbarium specimens, is insufficient to resolve inter-and intra-phylogenetic relationships in *Finlaysonia* and *Streptocaulon*. Hopefully, a clearer picture of the relationships between genera and species will emerge as all the Asian genera are analyzed and compared, preferably if DNA analysis could be incorporated.

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SUMMARY

A taxonomic revision of *Finlaysonia* Wall. and *Streptocaulon* Wight and Arn. (Apocynaceae; Periplocoideae) in Asia is presented. This revision comprises an investigation of the nomenclature of the two genera and their species, macromorphology of all plant parts; micromorphology of leaf epidermal surfaces, seed coat surfaces and translators, pollen wall architecture, geographical distribution, habitat preferences and phylogenetic relationships. The investigation resulted in the identification of characteristics for effective delimitation of the two genera and their respective species, identification keys for both genera and the species within each genus, correction of nomenclature, determination of inter- and intra-phylogenetic relationships and determination of their distribution patterns.

Available type material was investigated, type literature was confirmed for all species and synonyms were declared where applicable. Lectotypes, selected from isotypes or syntypes, were declared where holotypes were not cited by authors or were not found in their collections or were destroyed or could not be located at all.

Finlaysonia and *Streptocaulon* are closely related genera and have many characters in common. This includes the presence of colleters on the interpetiolar ridges, in leaf axils, on the leaf petiole and main vein, in the axils of inflorescences and at the inner bases of sepals. The flowers in both genera are rather similar with bowl-shaped, inverted corolla tubes and reflexed lobes, presence of only the primary corona which is divided into a foot and lobe, presence of interstaminal nectaries, translators and pollinia, two semi-inferior, apocarpous many ovuled-ovaries, a compound style, a gynostegium that is the result of fusion between stylar head and anthers, paired follicles and seeds with comas at the micropylar end except in *F. obovata* where the coma is replaced by a winged, fimbriate margin.

Finlaysonia is characterized by trichomes on the outer or inner surfaces of the corolla, presence of anther callosities except in *F. pierrei*. *Streptocaulon*, in contrast, is characterized by a glabrous corolla, absence of anther callosities.

A number of characters, unique to a specific species and thus diagnostic were used in identifying of the species. Vegetative features provide the most effective means to distinguish and identify the species and combinations of leaf shape, leaf length:width ratios, texture, leaf indumentum and petiole length proved to be taxonomically the most valuable characters. Corolla lobe apex shape, corona lobe shape, anther connective indumentum, style indumentum, follicle and seed shape and size, seed margin appearance and coma length and presence/absence of coma are diagnostically useful. Micromorphological features of the leaf epidermis, such as primary sculpture, as well as stomata characteristics and distribution can also be useful. However, a single character is often insufficient to distinguish between the genera and a combination of characters should to be applied.

Finlaysonia and *Streptocaulon* are widely distributed in Asia with the largest concentration of species in Thailand. Species like *F. khasiana*, *F. obovata*, *F. pierrei*, *S. juvenas* and *S. wallichii* are common, while *F. decidua*, *F. puberulum*, *F. venosa*, *F. insularum*, *S. cumingii*, *S. curtisii*, *S. lanuginosa* and *S. sylvestre* have restricted distributions, at present only known from one or two localities. Most of the species are found on limestone and form part of scrub forest and mixed deciduous forest. *Finlaysonia obovata* typically are found in mangrove forests along coastal lagunes and tidal rivers, while *S. sylvestre* and *S. juvenas* are found in riverine forest along fresh water rivers.

The phylogenetic treatment was based on morphological characters of vegetative parts, flowers and fruits. The analyses yielded polytomies as strict consensus trees unless the Bootstrap support values were ignored. However, an exciting result from the strict consensus trees was the pairing of *S. lanuginosa* and *S. curtisii* in a clade, confirming the

finding of Ionta and Judd (2007) and justifying the transfer of these two species from *Finlaysonia* to *Streptocaulon*.

KEY WORDS: *Finlaysonia*, *Streptocaulon*, Apocynaceae, Periplocoideae, Asian flora, taxonomy.

OPSOMMING

'n Taksonomiese hersiening van *Finlaysonia* Wall. en *Streptocaulon* Wight & Arn. (Apocynaceae; Periplocoideae) in Asië word aangebied. Hierdie hersiening behels 'n ondersoek van die nomenklatuur van die twee genera en hulle spesies, makromorfologie van alle plantdele; mikromorfologie van blaarepidermis- en saadhuidoppervlakke en translators, stuifmeelwandargitektuur, geografiese verspreiding, habitatsvoorkeure en filogenetiese verwantskappe. Die ondersoek het gelei tot die aanwysing van kenmerke vir doeltreffende omgrensing van die twee genera en hulle onderskeie spesies, opstel van identifiseringsleutels vir die twee genera en hulle afsonderlike spesies, regstelling van nomenklatuur, bepaling van inter- en intrafilogenetiese verwantskappe en die vasstelling van geografiese verspreidingspatrone.

Beskikbare tipemateriaal is ondersoek, tipeliteratuur is vir al die spesies bevestig en sinonieme is, waar van toepassing, aangedui. Waar holotipes nie deur outeurs aangewys is nie, of nie in hul versamelings gevind is nie, of vernietig is, of geensins opgespoor kon word nie, is lektotipes uit isotipes of sintipes aangewys.

Finlaysonia en *Streptocaulon* is naverwant en het verskeie kenmerke in gemeen. Dit sluit in die voorkoms van kolleters op die interpetiolêre riwwe, in die blaaroksels, op die blaarsteel en hoofaar, in die oksels van bloeiwyses en by die binnebasis van kelkblare. Daar is 'n sterk ooreenkoms tussen die blomme van die twee genera, met bakvormige, omgebuigde kroonbuise en teruggebuigde kroonlobbe, teenwoordigheid van slegs die primêre bykroon wat verdeel is in 'n voet en lob, die teenwoordigheid van nektarkliere tussen die meeldrade, translators en polliniums, twee halfonderstandige, onvergroeide vrugbeginsels met baie sade, 'n saamgestelde styl, ginostegium gevorm uit die vergroeiing van stylkop en meeldrade, gepaarde kokervrugte en sade met vrugpluise aan die saadpoortjie se kant. *Finlaysonia obovata* is die uitsondering waar die saadpluis deur 'n vlerk en rand met kort haartjies vervang is.

Finlaysonia word gekenmerk deur hare aan die buite- of binnekant van die kroon, teenwoordigheid van bolvormige uitwasse of “kallosiete” aan helmknopbasisse, behalwe in *F. pierrei*. *Streptocaulon*, daarenteen, word deur ‘n haarlose kroon, afwesigheid van helmknopkallosiete.

‘n Aantal kenmerke wat uniek aan ‘n bepaalde spesies is en dus van diagnostiese waarde is, is vir uitkenning van die soorte benut. Vegetatiewe kenmerke werk die beste, en kombinasies van blaarvorm, verhouding van blaarlengte:breedte, tekstuur, blaarbeharing en blaarsteellengte is as die taksonomies waardevolste kenmerke vasgestel. Vorm van kroonlobpunte, bykroonlobvorm, helmbindselbeharing, stylbeharing, kokervrug- en saadvorm en –grootte, saadrandvoorkoms en lengte van die saadpluis of teenwoordigheid of afwesigheid daarvan besit diagnostiese waarde. Mikromorfologiese kenmerke van blaarepidermisse, soos primêre struktuur, asook huidmondjiesstruktuur en -verspreiding kan diagnosties ook nuttig gebruik word. ‘n Enkele kenmerk is nie genoegsaam om tussen die genera te onderskei nie, maar verskeie kenmerke moet saam gebruik word.

Finlaysonia en *Streptocaulon* is wyd oor Asië versprei met die grootste konsentrasie van spesies in Thailand. Spesies soos *F. khasiana*, *F. obovata*, *F. pierrei*, *S. juvenas* en *S. wallichii* kom wyd versprei voor, terwyl *F. decidua*, *F. puberulum*, *F. venosa*, *F. insularum*, *S. cumingii*, *S. curtisii*, *S. lanuginosa* en *S. sylvestre* beperkte verspreidings het en tans van slegs enkele lokaliteite bekend is. Die meerderheid spesies groei op kalksteen en maak deel uit van struikwoud of gemengde bladwisselende woud. *Finlaysonia obovata* kom tipies in manglietwoude langs kumere en getyrieviere voor, terwyl *S. sylvestre* en *S. juvenas* in oewerwoude langs varswaterriviere aangetref word.

Slegs morfologiese kenmerke van vegetatiewe dele, blomme en vrugte is in die filogenetiese studie gebruik. Daar is geen resoluë in die streng konsensus bome gevind nie, tensy die skommelskuif-ondersteuningswaardes of “bootstrap support values” weggelaat is. ‘n Belangrike resultaat is met die filogenetiese ondersoek verkry, naamlik dat

S. lanuginosa en *S. curtisii* telkens in dieselfde klade gegropeer het, wat die bevinding van Ionta en Judd (2007) bevestig en die oordrag vanaf *Finlaysonia* na *Streptocaulon* regverdig. Al die kladogramme dui aan dat die oorblywende *Finlaysonia* spesies nie saam hoort nie, maar waarskynlik in die oorspronklike drie genera, *Finlaysonia*, *Meladerma* en *Atherolepis* terug geplaas moet word.

SLEUTELWOORDE: *Finlaysonia*, *Streptocaulon*, Apocynaceae, Periplcoideae, Asiese flora/plantegroei, taksonomie.

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APPENDIX 1

LONG DATASET

LIST OF CHARACTERS AND CHARACTER STATES

1. Habitat: savanna (0); hills and mountains (1); forest, riverbanks, scrub (2)
2. Habit: shrub (0); liana or climber (1)
3. Node with/without trichomes: glabrous (0); with trichomes (1)
4. Type of node trichomes: puberulent, puberulous, pubescent, (0); lanuginose, tomentose (1), scabrous (2)
5. Colour of node trichomes: dirty white (0); copper-coloured (2)
6. Stem indumentum: glabrous (0); hairy (1)
7. Bark lenticilate: yes (0); no (1)
8. Petiole length: 0.5 – 2.0 mm (0); 3.0–15.0mm (1)
9. Leaf dimensions (ratio of length:width): 1:1 (0); 1:2-4 (1); $\geq 1:8$ (2)
10. Leaf shape: ovate, obovate oblong, elliptic (0); oblanceolate (1); linear (2)
11. Leaf apex: acute, attenuate, acuminate (0), obtuse, emarginate (1), mucronate (2)
12. Leaf base: cuneate (0); obtuse (1); cordate (2)
13. Leaf texture: herbaceous (0); coriaceous (1)
14. Main vein indumentum: glabrous (0); hairy (1)
15. Number of secondary veins: 2–9 (0); 10–17 (1); 18–24 (2)
16. Secondary vein orientation: arched (0); divaricate (1); patent (2)
17. Leaf surface indumentum: glabrous on both sides (0); upper surface glabrous or sparsely hairy, lower side densely hairy (1); equally hairy on both sides (2)
18. Abaxial leaf indumentum type: puberulent, puberulous, pubescent, villous (0); lanuginose, tomentose (1); scabrous (2)
19. Inflorescence position: Terminal and axillary (0); terminal (1); axillary (2)
20. Number of flowers per inflorescence: many, > 10 (0); few, < 10 (1)

21. Density of inflorescence: lax (0); compact (1)
22. Inflorescence indumentum: glabrous (0); hairy (1)
23. Primary peduncle length: ≤ 1 mm (0); 2–9 mm (1); ≥ 10 mm (2)
24. Pedicel length: ≤ 1 mm (0); 2–5 mm (1); ≥ 6 mm (2)
25. Floral bract length: ≤ 1.5 mm (0); >1.6 mm (1)
26. Floral bract shape: ovate to broadly ovate (0); narrowly triangular (1)
27. Floral bract margin: fimbriate (0); membranous (1)
28. Floral bud shape: ovoid, orbicular (0); conical, deltoid (1)
29. Sepal apex: acute, acuminate, attenuate (0); obtuse (1); papillate (2)
30. Corolla shape: rotate (0); inverted (1); campanulate (2)
31. Corolla indumentum outside: glabrous (0); hairy (1)
32. Corolla indumentum inside: glabrous (0); hairy (1); papilose (2)
33. Petal apex: acute, acuminate (0); obtuse (1)
34. Insertion of stamens: from the base of coronal foot (0); from the inner face of coronal foot (1)
35. Corona: absent (0); present (1)
36. Corona insertion: at base of upper corolla tube (0); against inversion annulus (1); at corolla tube mouth (2)
37. Coronal shape: filiform (0); linear (1); ovate (2); clavate (3)
38. Coronal apex: filiform and entire (0); notched to truncate (1)
39. Style-head shape: ovoid (0); broadly ovoid (1); narrowly deltoid (2)
40. Style-head apex: obtuse (0); acute (1); notched (2)
41. Anther connective appendage colour: blackish (0); pale (1); red (2)
42. Anther connective appendage shape: deltoid (0); narrowly triangular (1); lanceolate (2); long attenuate (3)
43. Anther connective indumentum: glabrous (0); hairy (1)
44. Pollen borne in: tetrads (0); pollinia (1)
45. Follicle orientation: 0 to 90 degree (0); more than 90 degrees (1)
46. Follicle size (ratio L:W): ≤ 30 mm (0); 31–60 mm (1); ≥ 61 mm (2)

47. Follicle shape: narrowly ovoid (0); keel-shaped (1); falcate-ovoid (2)
48. Follicle apex shape: attenuate, acuminate (0); acute (1); hooked (2)
49. Follicle surface: smooth (0); ribbed (1); hairy (2); verrucose (3)
50. Seed shape: obovate (0); elliptic (1); obovoid to ellipsoid (2)
51. Seed margin: smooth (0); patterned (1); fimbriate/membranous (2)
52. Seed size (ratio L:W): 2:1 – 3:1 (0); 4:1 – 5:1 (1); \geq 6:1 (2)
53. Seed surface: smooth (0); pitted (1); warty (2); longitudinally ribbed (3)
54. Coma length: shorter than 10 mm (0), longer 10 mm (1)
55. Staminal callosities: present (0); absent (1)
56. Adaxial periclinal wall: tabular (flat) (0); raised (1); sunken (2)
57. Adaxial epidermal cells: papillate (0); without papillae (1)
58. Adaxial epidermis: without wax layer (0); wax layer present (1)
59. Adaxial cuticle layer striations: dense (0); sparse (1); smooth (2)

MATRIX

Table 6.2 Datamatrix for cladistic analysis of *Finlaysonia* and *Streptocaulon*: long dataset (characters = 1–59; character states = 0–3; – = missing data; outgroup species = *Raphionacme brownii*)

	MATRIX	F. decidua	F. insularum	F. khasiana	F. obovata	F. pierrei	F. puberulum	F. wallichii	F. venosa	S. cumingii	S. curtisii	S. juventas	S. kleinii	S. lanuginosa	S. sylvestre	S. wallichii	R. brownii
1.	Habitat	1	1	1	2	2	1	1	–	1	1	2	2	1	2	2	0
2.	Habit	1	1	1	1	1	1	1	1	1	0	1	1	0	1	1	2
3.	Node glabrous or with trichomes	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	0
4.	Type of node trichomes	1	0	0	0	0	0	0	0	0	0	2	2	1	2	2	–
5.	Colour of node trichomes	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1	–
6.	Stem pubescence	1	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1
7.	Bark lenticulate	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0
8.	Petiole length	0	0	0	1	0	0	1	0	0	0	1	0	1	0	1	0
9.	Leaf dimensions	1	1	1	1	1	2	1	1	1	1	1	1	1	0	1	2
10.	Leaf shape	1	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2
11.	Leaf apex	0	0	0	1	0	0	0	0	0	0	0	0	0	2	0	0
12.	Leaf base	0	0	0	0	2	1	1	0	2	0	2	1	1	2	1	0
13.	Leaf texture	0	0	0	1	0	0	0	0	0	1	0	0	1	0	0	0
14.	Main vein indumentum	1	1	1	0	1	1	1	1	0	1	1	1	1	1	1	0
15.	No. of secondary veins	–	1	0	1	1	0	2	0	1	2	1	1	2	0	0	2
16.	Secondary vein orientation	–	1	0	0	0	0	0	0	0	1	1	1	1	1	1	0
17.	Leaf surface indumentum	1	0	0	0	0	1	1	0	1	1	1	1	1	1	1	1
18.	Type of indumentum	1	–	–	–	0	0	2	–	0	1	1	1	1	2	1	2
19.	Inflorescence position	0	0	0	2	2	2	2	2	2	1	2	2	0	2	2	1
20.	Number of flowers/ inflorescence	1	1	1	1	1	1	1	1	0	1	0	1	1	1	0	1
21.	Density of inflorescence	0	1	1	0	1	1	1	1	0	0	0	0	1	1	0	0
22.	Inflorescence indumentum	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
23.	Primary peduncle length	1	1	1	2	0	1	0	1	1	1	2	1	2	1	2	2

	MATRIX	F. decidua	F. insularum	F. khasiana	F. obovata	F. pierrei	F. puberulum	F. wallichii	F. venosa	S. cumingii	S. curtisii	S. juventas	S. kleinii	S. lanuginosa	S. sylvestre	S. wallichii	R. brownii
24.	Pedicle length	2	1	1	1	1	1	0	0	1	1	1	1	0	2	1	2
25.	Floral bract (L:W)	0	0	1	1	1	0	-	0	0	0	1	0	0	0	0	1
26.	Floral bract shape	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
27.	Floral bract margin	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
28.	Floral bud shape	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0
29.	Sepal apex	1	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0
30.	Corolla tube shape	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2
31.	Corolla indumentum outside	1	0	0	0	0	1	1	1	0	0	0	0	0	0	0	1
32.	Corolla indumentum inside	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
33.	Petal apex	1	1	1	1	0	1	0	1	1	1	1	1	1	1	1	1
34.	Insertion of stamens	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0
35.	Only primary corona present	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
36.	Corona insertion	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2
37.	Corona shape	0	0	2	0	0	0	0	0	1	0	0	0	0	0	0	0
38.	Corona apex	0	0	0	0	0	0	0	0	1	0	1	1	1	1	0	0
39.	Style- head shape	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	1
40.	Style- head apex	0	0	0	1	0	0	1	0	0	0	1	0	0	2	0	0
41.	Anther connect. appendage colour	1	1	0	0	0	1	1	0	0	0	0	0	0	0	0	-
42.	Anther connect. appendage shape	1	0	0	0	0	1	1	0	1	0	0	0	0	0	0	-
43.	Anther connective indumentum	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	-
44.	Pollen borne in	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0
45.	Follicle orientation	-	1	1	0	1	-	1	-	-	1	1	1	1	-	1	0
46.	Follicle size	-	2	0	2	1	-	2	-	-	0	2	2	0	-	2	2
47.	Follicle shape	-	0	2	1	2	-	1	-	-	3	0	0	3	-	0	0
48.	Follicle apex	-	0	1	0	1	-	2	-	-	1	0	0	0	-	0	0

	MATRIX	F. decidia	F. insularum	F. khasiana	F. obovata	F. pierrei	F. puberulum	F. wallichii	F. venosa	S. cumingii	S. curtisii	S. juvenas	S. kleinii	S. lanuginosa	S. sylvestre	S. wallichii	R. brownii
49.	Follicle surface	-	0	0	0	0	-	1	-	-	2	0	0	0	-	0	2
50.	Seed shape	-	0	-	0	0	-	0	-	0	0	0	0	2	-	0	0
51.	Seed margin	-	1	-	2	0	-	1	-	0	0	0	0	0	-	0	0
52.	Seed size (L:W)	-	1	-	0	0	-	0	-	0	1	0	0	0	-	2	2
53.	Seed surface	-	2	-	0	2	-	0	-	3	1	0	0	1	-	0	0
54.	Coma length	-	1	-	?	1	-	1	-	-	0	1	1	0	-	1	1
55.	Staminal callosities	0	0	0	0	1	0	0	0	1	1	1	1	1	1	1	-
56.	Adaxial periclinal cell wall	-	2	0	0	0	0	1	-	1	1	1	1	1	0	1	-
57.	Adaxial epidermis cells	-	1	1	1	1	1	1	-	1	0	0	0	0	1	0	-
58.	Adaxial epidermis	-	0	1	1	0	0	0	-	0	0	0	0	0	0	0	-
59.	Adaxial cuticle layer	-	1	0	1	1	1	0	-	0	2	2	2	2	0	2	-

APPENDIX 2

SHORT DATASETS A and B

LIST OF CHARACTERS AND CHARACTER STATES

1. Habit: shrub (0); liana or climber (1)
2. Node with/without trichomes: glabrous (0); with trichomes (1)
3. Type of node trichomes: puberulent, puberulous, pubescent, (0); lanuginose, tomentose (1); scabrous (2)
4. Leaf dimensions (ratio of length:width): 1:1 (0); 1:2-4 (1); $\geq 1:8$ (2)
5. Leaf texture: herbaceous (0); coriaceous (1)
6. Secondary vein orientation: arched (0); divaricate (1); patent (2)
7. Leaf surface indumentums: glabrous on both sides (0); upper surface glabrous or sparsely hairy, lower side densely hairy (1); equally hairy on both sides (2)
8. Leaf indumentum type: puberulent, puberulous, pubescent, villous (0); lanuginose, tomentose (1); scabrous (2)
9. Inflorescence position: terminal and axillary (0); terminal (1); axillary (2)
10. Number of flowers per inflorescence: numerous, > 10 (0); few, < 10 (1)
11. Density of inflorescence: lax (open) (0); compact (1)
12. Inflorescence with/without indumentum: glabrous (0); hairy (1)
13. Floral bract margin: fimbriate (0); glabrous (membranous) (1)
14. Corolla tube: not inverted (0); inverted (1)
15. Corolla indumentum outside: glabrous (0); hairy (1);
16. Corolla indumentum inside: glabrous (0); hairy (1); papillose (2)
17. Corolla apex shape: acute to acuminate (0); obtuse (1)
18. Stamen insertion: from base of coronal tube (0); from coronal inversion and fused to inner face of coronal foot (1)
19. Corona: double (0); single (1)
20. Corona insertion: at base of upper corolla tube (0); against inversion annulus (1); at corolla tube mouth (2)

21. Coronal shape: filliform (0); linear (1); ovate (2); clavate (3)
22. Style-head shape: ovoid (0); broadly ovoid (1); broadly conical (2)
23. Anther connective appendage shape: deltoid (0); narrowly triangular (1); lanceolate (2)
24. Anther connective indumentum: glabrous (0); hairy (1)
25. Pollen borne in: tetrads (0), pollinia (1)
26. Follicle size (ratio L:W): ≤ 30 mm (0); 31-60 mm (1); ≥ 61 mm (2)
27. Follicle shape: narrowly ovoid (0); keel-shaped (1); falcate-ovoid (2)
28. Follicle apex shape: attenuate, acuminate (0); acute (1); hooked (2)
29. Follicle surface: smooth (0); ribbed (1); hairy (2); varicose (3)
30. Seed margin: smooth (0); patterned (1); fimbriate/membranous (2)
31. Seed size (ratio L:W): 2:1 – 3:1 (0); 4:1 – 5:1 (1); $\geq 6:1$ (2)
32. Seed surface: smooth (0); pitted (1); warty (2); longitudinally ribbed (3)
33. Coma length: shorter 10 mm (0), longer 10 mm (1)
34. Staminal callosities: present (0); absent (1)
35. Adaxial periclinal wall: tabular (flat) (0); raised (1); sunken (2)
36. Adaxial epidermal cells: papillate (0); without papillae (1)
37. Adaxial epidermis: without wax layer (0); wax layer present (1)
38. Adaxial cuticle layer striations: densely (0); sparsely (1); smooth (2)

	MATRIX	F. decidua	F. insularum	F. khasiana	F. obovata	F. pierrei	F. puberulum	F. wallichii	F. venosa	S. cumingii	S. curtisii	S. juvenas	S. kleinii	S. lanuginosa	S. sylvestre	S. wallichii	R. brownii	C. buchananii
22.	Style-head shape	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	1	2
23.	Anther connective appendage shape	1	0	0	0	0	1	1	0	1	0	0	0	0	0	0	-	2
24.	Anther connective indumentum	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	-	1
25.	Pollen borne in	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
26.	Follicle size	-	2	0	2	1	-	2	-	-	0	2	2	0	-	2	2	2
27.	Follicle shape	-	0	2	1	2	-	1	-	-	3	0	0	3	-	0	0	0
28.	Follicle apex	-	0	1	0	1	-	2	-	-	1	0	0	0	-	0	0	1
29.	Follicle surface	-	0	0	0	0	-	1	-	-	2	0	0	0	-	0	2	2
30.	Seed margin	-	1	-	2	0	-	1	-	0	0	0	0	0	-	0	0	0
31.	Seed size (L:W)	-	1	-	0	0	-	0	-	0	1	0	0	0	-	2	2	0
32.	Seed surface	-	2	-	0	2	-	0	-	3	1	0	0	1	-	0	0	2
33.	Coma length	-	1	-	-	1	-	1	-	-	0	1	1	0	-	1	1	1
34.	Staminal callosities	0	0	0	0	1	0	0	0	1	1	1	1	1	1	1	1	1
35.	Adaxial periclinal cell wall	-	2	0	0	0	0	1	-	1	1	1	1	1	0	1	-	0
36.	Adaxial epidermis cells	-	1	1	1	1	1	1	-	1	0	0	0	0	1	0	-	1
37.	Adaxial epidermis	-	0	1	1	0	0	0	-	0	0	0	0	0	0	0	-	1
38.	Adaxial cuticle layer	-	1	0	1	1	1	0	-	0	2	2	2	2	0	2	-	1

