SYSTEMATICS AND BIOGEOGRAPHY OF SOUTHEAST ASIAN SENECIONEAE (ASTERACEAE): REVISION OF *CISSAMPELOPSIS* AND *GYNURA* AND HYBRIDISATION IN THE INTRODUCED *CRASSOCEPHALUM*

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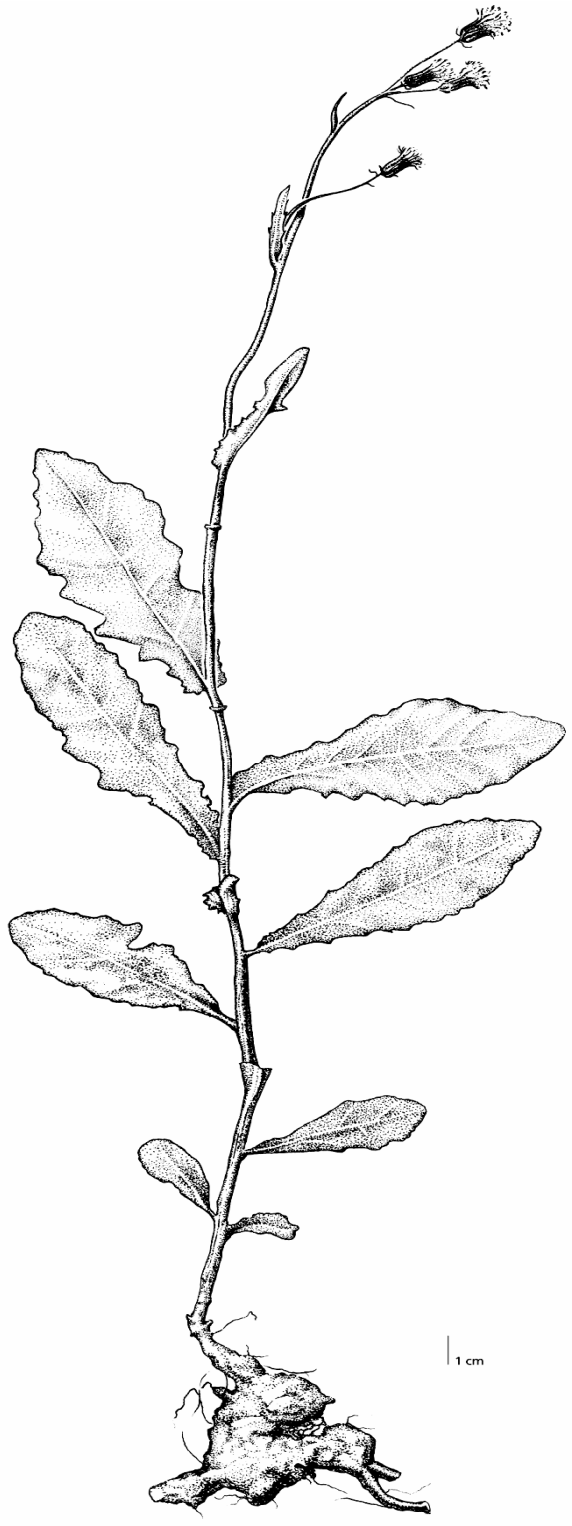

Gynura siamensis Vanijajiva & Kadereit

CONTENTS

SUMMARY

This dissertation includes two parts. The first contains an introduction to the flora of Southeast Asia and the objects of this study, Asteraceae-Senecioneae Cass. with *Cissampelopsis* (DC.) Miq., *Gynura* Cass. and *Crassocephalum* Moench (Chapter 1). The second part comprises three manuscripts based on original research (Chapter 2-4).

In chapter 2 a revision of the Asian genus *Cissampelopsis* is provided. Two sections with ten species and two varieties are recognized. These are sect. *Buimalia* C. Jeffrey & Y. L. Chen with *C. buimalia* (Buch.-Ham. ex D. Don) C. Jeffrey & Y. L. Chen, *C. erythrochaeta* C. Jeffrey & Y. L. Chen and *C. calcadensis* (Ramasw.) C. Jeffrey & Y. L. Chen and sect. *Cissampelopsis* with *C. glandulosa* C. Jeffrey & Y. L. Chen, *C. walkeri* (Arn.) C. Jeffrey & Y. L. Chen with var. *walkeri* and var. *floccosa* Vanijajiva & Kadereit (var. nov.), *C. corifolia* C. Jeffrey & Y. L. Chen, *C. volubilis* (Bl.) Miq, *C. ansteadii* (Tadul. & Jacob) C. Jeffrey & Y. L. Chen, *C. spelaeicola* (Van.) C. Jeffrey & Y. L. Chen and *C. corymbosa* (Wall. ex DC.) C. Jeffrey & Y. L. Chen. Keys, descriptions, photographs of floral characters and distribution maps are provided.

Chapter 3 is a revision of the palaeotropical genus *Gynura*. Forty-four species are recognized of which three are described as new. These are *G. davisii* Vanijajiva & Kadereit, *G. siamensis* Vanijajiva & Kadereit and *G. villosus* Vanijajiva & Kadereit. *Gynura dissecta* (F. G. Davies) Vanijajiva & Kadereit, *G. annua* (F. G. Davies) Vanijajiva & Kadereit and *G. aurantiaca* (Bl) DC. subsp. *parviflora* (F. G. Davies) Vanijajiva & Kadereit are new combinations. An identification key, descriptions and distribution maps are provided.

In chapter 4, an analysis of the genus *Crassocephalum* in Asia, introduced there from Africa, is presented. This analysis is based on extensive field work, herbarium studies, analyses of pollen and seed fertility and chromosome numbers as well as ITS and *trn*L-F sequences. We found that *Crassocephalum* in Asia comprises two species and their interspecific hybrid. The two species are *C. crepidioides* (Benth.) S. Moore and *C. rubens* (Juss. ex Jacq.) S. Moore, of which the latter is a new record for Asia. The hybrid between these two species originated from a cross *C. crepidioides* (2n=40) as female and *C. rubens* (2n=40) as male parent.

ZUSAMMENFASSUNG

Die vorgelegte Dissertation enthält zwei Teile. Der erste beinhaltet eine Einführung in die Flora Südostasiens und die Untersuchungsgruppe Asteraceae-Senecioneae Cass. mit den Gattungen *Cissampelopsis* (DC.) Miq., *Gynura* Cass. und *Crassocephalum* Moench (Kapitel 1). Der zweite Teil besteht aus drei Manuskripten, die auf originalen Forschungsergebnissen basieren (Kapitel 2-4).

In Kapitel 2 wird eine Revision der asiatischen Gattung *Cissampelopsis* vorgelegt. Die folgenden zwei Sektionen mit zehn Arten und zwei Varietäten werden anerkannt: sect. *Buimalia* C. Jeffrey & Y. L. Chen mit *C. buimalia* (Buch.-Ham. ex D. Don) C. Jeffrey & Y. L. Chen, *C. erythrochaeta* C. Jeffrey & Y. L. Chen und *C. calcadensis* (Ramasw.) C. Jeffrey & Y. L. Chen sowie sect. *Cissampelopsis* mit *C. glandulosa* C. Jeffrey & Y. L. Chen, *C. walkeri* (Arn.) C. Jeffrey & Y. L. Chen mit var. *walkeri* und var. *floccosa* Vanijajiva & Kadereit (var. nov.), *C. corifolia* C. Jeffrey & Y. L. Chen, *C. volubilis* (Bl.) Miq, *C. ansteadii* (Tadul. & Jacob) C. Jeffrey & Y. L. Chen, *C. spelaeicola* (Van.) C. Jeffrey & Y. L. Chen und *C. corymbosa* (Wall. ex DC.) C. Jeffrey & Y. L. Chen. Schlüssel, Artbeschreibungen, Fotographien von Blütenmerkmalen und Verbreitungskarten werden präsentiert.

Kapitel 3 beinhaltet die Revision der paläotropischen Gattung *Gynura*. Vierundvierzig Arten werden anerkannt, darunter die folgenden drei Neubeschreibungen: *G. davisii* Vanijajiva & Kadereit, *G. siamensis* Vanijajiva & Kadereit und *G. villosus* Vanijajiva & Kadereit. *Gynura dissecta* (F. G. Davies) Vanijajiva & Kadereit, *G. annua* (F. G. Davies) Vanijajiva & Kadereit und *G. aurantiaca* (Bl) DC. subsp. *parviflora* (F. G. Davies) Vanijajiva & Kadereit sind Neukombinationen. Ein Schlüssel, Artbeschreibungen und Verbreitungskarten werden vorgelegt.

In Kapitel 4 wird eine Analyse von *Crassocephalum* in Asien, einer aus Afrika eingeschleppten Gattung, präsentiert. Diese Untersuchung basiert auf umfangreicher Feldarbeit, Herbarstudien, Analysen der Pollen- und Samenfertilität, Chromosomenzählungen sowie ITS- und *trn*L-F-Sequenzen. Die Studie ergab, dass *Crassocephalum* in Asien mit zwei Arten und deren Hybrid vertreten ist. Die zwei Arten sind *C. crepidioides* (Benth.) S. Moore und *C. rubens* (Juss. ex Jacq.) S. Moore, wobei letztere einen Neufund für Asien darstellt. Der Hybrid aus diesen beiden Arten resultiert aus einer Kreuzung von *C. crepidioides* (*2n*=40) als weiblichem und *C. rubens* (*2n*=40) als männlichem Elter.

1. GENERAL INTRODUCTION

1.1 The Flora of Southeast Asia

Southeast Asia (Fig. 1) consists of two geographic regions: the Asian mainland and island arcs and archipelagoes to the east and southeast. The mainland part consists of Cambodia, Laos, Myanmar, Vietnam and Thailand. The maritime part consists of Singapore, Brunei, East Timor, Indonesia, Malaysia and the Philippines. The area extends more than 3,300 km from north to south and 5,600 km from east to west, stretching from 30° northern to 11° southern latitude and from 92° to 142° eastern longitude (Holloway & Hall, 1998).

The climate of Southeast Asia is essentially hot-tropical all year round. Precipitation is high, but the region has a wet and a dry season caused by seasonal shift in winds and by the monsoon. The tropical rain belt leads to additional rainfall during the monsoon season. Exception to this type of climate are the mountain areas in the northern parts of Southeast Asia, where high altitudes lead to milder temperatures and drier landscapes (Manton et al., 2001).

Southeast Asia currently contains more than 25,000 species of flowering plants, equivalent to about 10% of the flora of the world. Myers et al. (2000) identified 25 global 'biodiversity hotspots' (Fig. 1), defined as areas containing high numbers of endemic species. Four of these hotspots can be found in Southeast Asia. This region also holds a key geographical position for research on Asian and Australian biogeography by containing the continental margins and offshore archipelagos of Asia between the south of China and the east of India as well as about 20,000 islands located between Asia and Australia.

According to current fossil evidence, Southeast Asia is not the area of the initial radiation of the angiosperms (Morley, 1998). Van Steenis (1979) suggested that the origin and genesis of the Southeast Asian flora probably is closely linked to the Asian continent in the north and north-west and to Australasia in the east. He postulated that the flora of Southeast Asia became enriched by the dispersal of taxa from other continental regions. For example, high altitude taxa dispersed into the region from the Himalayan region, East Asia and Australia, and lowland taxa, especially those requiring a strong dry season, probably immigrated from mainland Asia and Australia. In order to better understand the origin, migration and evolution of the Southeast

Asian flora, it is necessary to study the historical biogeography of taxa on the basis of their phylogenies. A good summary of the geological and climatic background of the region as indispensable background knowledge for any biogeographical interpretation can be found in Whitmore (1987). Historical biogeography also requires a sound taxonomic framework. It is the major aim of this thesis to provide such framework for some genera of Asteraceae-Senecioneae.

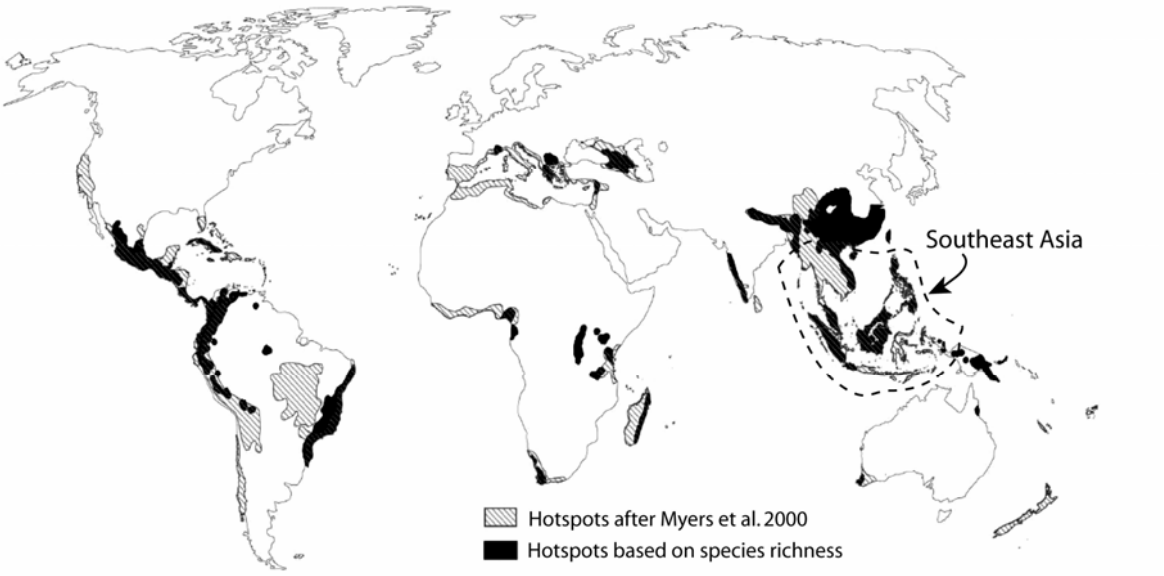

Figure 1. Global biodiversity hotspots (modified from Mutke & Barthlott 2005)

1.2 Tribe Senecioneae Cass.

The Asteraceae (Compositae; Sunflower family) is the largest family of flowering plants with c. 23,000 species and 1,600 genera. Asteraceae thus make up ca. 10% of total flowering plant specific diversity. The family apparently originated already in the Cretaceous, and started to become abundant in the Miocene (Bremer, 1994; Kadereit, 2007). Species of Asteraceae today are found throughout the world from the Arctic to alpine meadows and from arid regions to rainforest.

Senecioneae is the largest tribe of Asteraceae with approximately 150 genera and 3,000 species, and includes one of the largest genera in the family, *Senecio* L., with more than 1,250 species (Nordenstam, 2007). The tribe shows a wide range of growth forms by including annuals, minute creeping alpines and perennial herbs, shrubs, climbers, leaf, stem and root succulents, trees and semi-aquatic herbs (Nordenstam, 1977; Pelser et al., 2004). Its species can be easily recognized primarily by the involucres which usually consists of one series of involucral bracts. Frequently the

single-rowed involucre is subtended by a smaller outer calyculus (Nordenstam, 1978; Bremer, 1994). Other characters of the tribe are the presence of pyrrolizidine alkaloids of the macrocyclic senecionine type and sesquiterpenes of the furanoeremophilane type. Polyacetylenes common in other tribes of the family are rare or absent (Pelser et al, 2005).

Traditionally, Senecioneae have often been divided into three subtribes, Blennospermatinae, Senecioninae and Tussilagininae, on the basis of morphological characters (Bremer, 1994, Kadereit & Jeffrey, 1996; Panero et al., 1999, Bain & Golden, 2000; Pelser et al., 2002). Some authors have recognized additional subtribes such as Abrotanellinae, Adenostylinae (e.g. Robinson et al., 1997), Othonninae (e.g. Hoffmann 1890; Ornduff et al., 1963) and Tephroseridinae (Jeffrey & Chen 1984). Recent molecular phylogenetic studies in Senecioneae have shown that the subtribal classification needs to be revised (Pelser et al., 2007). In this study, based on ITS and plastid DNA sequence data from a large taxon sample, it was suggested that subtribes Adenostylinae, Blennospermatinae and Tephroseridinae should be abandoned, and that subtribes Abrotanellinae, Othonninae, Tussilagininae and Senecioninae should be recognised. Tussilagininae may need to be split into three additional subtribes: Brachyglottidinae, Chersodominae, Tussilagininae and perhaps Doronicinae. The study also showed a strong African influence throughout the evolutionary history of Senecioneae, particularly in subtribes Senecioninae and Othonninae.

Senecioneae are distributed all over the world with prominent centres of diversity in South America (c. 1,300 species) and southeastern Africa (c. 700 species) (Nordenstam, 2007; Pelser et al., 2007). The tribe is less common in Mediterranean type areas of Europe, Africa, the Americas and Australia where numerous representatives of other tribes, such as Lactuceae, Cardueae, Heliantheae, Gnaphalieae and Astereae can be found (Nordenstam, 1977; Bremer, 1994).

In Southeast Asia, Senecioneae is represented by eight genera. These are *Cissampelopsis* (DC.) Miq., *Crassocephalum* Moench., *Emilia* (Cass.) Cass., *Erechtites* Raf., *Gynura* Cass., *Senecio* L., *Sinosenecio* B. Nord. and *Synotis* (C. B. Clarke) Jeffrey & Chen (Ridley, 1923; Gagnepain, 1924; Backer & Bakhuizen, 1965; Koyama, 1986, 1988; Kress et al., 2003). Senecioneae in Southeast Asia have been little studied, and the diversity and phylogeny of the tribe in the region is poorly known. For the purpose of improving our knowledge of Southeast Asian Senecioneae,

the Asian endemic *Cissampelopsis*, the widespread palaeotropical *Gynura* and the introduced *Crassocephalum* were selected for taxonomic and evolutionary studies.

1.3 *Cissampelopsis* (DC.) Miq.

Cissampelopsis is one of only few endemic genera of tropical Asian Senecioneae with a comparatively small number of species distributed mainly from South Asia eastwards through China and Southeast Asia (Jeffery, 1986, Nordenstam 2007). The genus can easily be recognized by its perennial scandent habit, climbing on shrubs or small trees, and its usually palmately-veined cordate leaves (Fig. 2A). The capitula are either radiate (sect. *Buimalia*) or discoid (sect. *Cissampelopsis*).

The taxonomy of *Cissampelopsis* requires further investigation because the genus has never been revised in its entirety. The revision by Jeffery & Chen (1984) covered only the species distributed in China. Apart from Jeffery & Chen's revision, no taxonomic treatment of the genus has been published. In addition, several species have been noted to be very variable and difficult to delimit (Grierson 1974). The genus is regarded as critically endangered particularly in South and Southeast Asia (Koyama, 1986; Gopalan & Henry, 2000).

1.4 *Gynura* Cass.

Gynura is one of the most species-rich genera of Senecioneae occurring in tropical Asia with its highest diversity in Southeast Asia. A few species also occur in Africa and Australia (Davies, 1981, Nordenstam, 2007). The genus has homogamous disciform capitula, corollas which are distinctly longer than the involucre, and long and exserted style-arms (Fig. 2B-2H). Its species have a long history of use in local traditional medicine. For example, in China roots of *G. japonica* have been used for promoting microcirculation and relieving pain (Dai et al., 2007).

After the revision of *Gynura* by Davies (1978, 1979, 1980a, 1980b), several new species have been described (Jeffrey, 1986; Koyama, 1988; Belcher, 1988; Foster & Thonpukdee, 1988, Zhu, 2006). In addition, as several of Davies' taxa were known from only few collections, she noted that most species particularly in Southeast Asia are in great need of further study.

1.5 *Crassocephalum* Moench.

Crassocephalum is a palaeotropical herbaceous genus of Senecioneae which is distributed in Africa, Madagascar and the Mascarene Islands. Several species are grown as leaf vegetables and used for medicine (Jeffrey & Beentje, 2005, Nordenstam, 2007). Its species are usually characterized by their mesophytic habit, cylindrical and calyculate involucres, narrow phyllaries and strongly spirally thickened achenial duplex hairs (Jeffrey, 1984).

In Asia, *Crassocephalum* has only been reported with a single species, *C. crepidioides* (Benth.) S. Moore (Fig. 2I), which grows as a weed in disturbed habitats on a wide variety of soil types (van Steenis, 1932; Baker, 1939; Nair & Srinivasan; 1982; Koyama, 1986; Sinha & Rama, 1991; Ohtsuka *et al*., 1993). This species is assumed to have been introduced to Asia as early as 1923 (van Steenis, 1967) or 1925 (Belcher 1955). During field work in Southeast Asia, mostly in Thailand, a species new to Asia, *C. rubens* (Juss. ex Jacq.) S. Moore, as well as intermediates between these two species were observed. The diversity of *Crassocephalum* in Asia aroused our curiosity with respect to hybridisation in the genus.

1.6 Statement of research

This PhD. thesis has two main aims. First, the study aims to provide a complete taxonomic treatment of *Cissampelopsis* and *Gynura*. This is a contribution to a better understanding of biodiversity in the tropics, particularly in Southeast Asia but also in Africa in case of *Gynura*, and provides the basis for future phylogenetic and biogeographical studies. In the second part hybridisation of the African genus *Crassocephalum* in Asia will be analysed using morphological and molecular data. This contributes to the understanding of evolutionary processes in *Crassocephalum*, but also to hybridisation between introduced plant taxa in general.

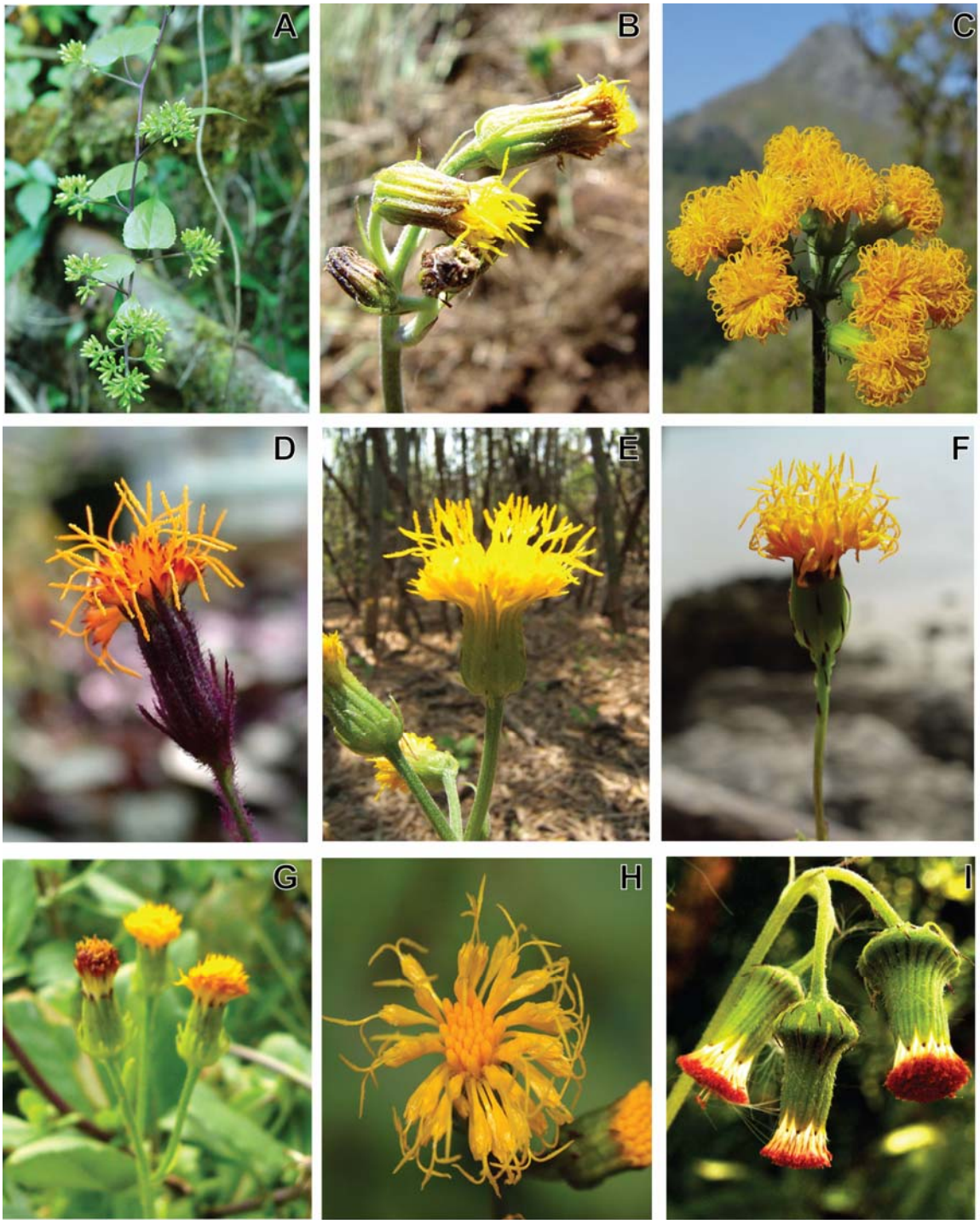

Figure 2. A *Cissampelopsis corifolia* **B** *Gynura pseudochina* **C** *G. cusimbua* D. *G. aurantiaca* E *G. dissecta* **F** *G. calciphila* **G** *G. divaricata* **H** *G. japonica* **I** *Crassocephalum crepidioides*

2. A REVISION OF *CISSAMPELOPSIS* (ASTERACEAE: SENECIONEAE)

2.1 Introduction

Cissampelopsis (DC.) Miq. is a perennial scandent genus of Asteraceae-Senecioneae. It comprises ten species distributed mainly in tropical Asia from India and Sri Lanka eastwards through the Himalayas, Myanmar, China, Vietnam and Thailand to Indonesia (Nordenstam 2007). Its members usually are found climbing on shrubs or small trees on the margin of mixed deciduous and evergreen montane forests at altitudes of (700-) 1000 - 2500 m.

Although the genus contains a relatively small number of species, its taxonomy is not straightforward because several species are very variable and difficult to delimit (Grierson 1974). No complete revision of the genus has been published after Jeffrey and Chen (1984) presented a thorough treatment of the species found in China. The present study contains a revision of all known species of *Cissampelopsis*.

2.1.1 Taxonomic history

The name *Cissampelopsis* was first used by de Candolle (1838) to name a section of *Cacalia* L. and was applied to specimens collected by Ecklon and Blume in Africa and Java as *Cacalia? cissampelina* and *Cacalia? volubilis*, respectively. The recognition of these taxa as a section was based on their unique scandent habit with prehensile petioles, the number of florets per capitulum, the long anther tails, and stigmatic areas with short papillate hairs.

In 1856, Miquel segregated *Cacalia? volubilis* from *Cacalia* and established the new monotypic genus *Cissampelopsis* based on Blume's specimen from Java as well as on additional specimens from Sumatra and the Celebes Islands. This enlarged sample provided an improved basis for identifying diagnostic characters of the genus. Miquel (1856) noticed that the characters he employed to delimit *Cissampelopsis* were very similar to those found in three scandent species of *Senecio* L., *S. corymbosus* Wall., *S. araneosus* DC. and *S. walkeri* Arn., from India and Sri Lanka. He did not, however, include them in his *Cissampelopsis*.

These three species, however, plus *S. buimalia* Buch.-Ham. ex D. Don, were placed by Bentham (1873) in his *Senecio* sect. *Synotios* Benth. & Hook. f. His reason for the establishment of this section was to accommodate some exceptional taxa including endemic Asian species with a relatively long-tailed anther base. Bentham (1873) also considered *Cissampelopsis volubilis* (as *Senecio araneosus*) a possible candidate for sect. *Synotios*.

Indian Compositae specimens collected by various botanists in the service of the British East India Company were studied by Clarke (1876) who raised sect. *Synotios* to subgeneric rank. His subg. *Synotis* contained three sections: sect. *Scandentes* C. B. Clarke, sect. *Semiscandentes* C. B. Clarke and sect. *Erectae* C. B. Clarke, and almost all scandent species of Indian *Senecio* were included in sect. *Scandentes*. Later, Koyama (1969) lowered the rank of this section to series.

In their treatment of East Asian Senecioneae, Jeffrey and Chen (1984) transferred several scandent species of *Senecio* with conspicuously tailed anthers to *Cissampelopsis* and provided the first conspectus and key of this genus. Their account, however, did not cover the material from India and Sri Lanka which was considered to be very variable and difficult by Grierson (1974).

In Jeffrey and Chen's (1984) treatment, *Cissampelopsis* was divided into two sections: sect. *Buimalia* and sect. *Cissampelopsis*. The definition of these two sections was based on capitulum type (radiate vs. discoid) and structure of the style arm apex (without vs. with tuft of hairs). We here accept this subdivision of *Cissampelopsis* although phylogenetic relationships among species are unknown.

2.1.2 The relationships of *Cissampelopsis*

Following Jeffrey (1986, 1992) and Bremer (1994), *Cissampelopsis* belongs to the Synotoid group of subtribe Senecioninae. This group, a monophyletic assemblage according to Drury (1967) and Jeffrey & Chen (1984), includes eleven genera and is characterized by its tailed anthers with always sterile basal auricles, and its mostly shrubby or scandent habitat (Jeffrey 1992). The Synotoid group is distributed in the Old World, mostly in tropical climates. Most genera are distributed in Africa and Madagascar and only *Synotis* (C. B. Clarke) C. Jeffrey & Y. L. Chen and *Cissampelopsis* are endemic to Asia. Of the genera first considered by Jeffrey (1986) to form the synotoid group (*Austrosynotis* C. Jeffrey, *Cissampelopsis*, *Delairea* Lem., *Mikaniopsis* Milne-Redh., *Synotis*, *Cissampelopsis* is more similar to the Afro-

Madagascan scandent genera than to the Asian *Synotis* which is only weakly scandent and lacks prehensile petioles. *Mikaniopsis* has been postulated (Jeffrey 1986) to be more closely related to *Cissampelopsis* than *Synotis* because the two genera share the scandent habit and have exauriculate leaves with a basally cordate blade and prehensile petioles. Interestingly, one of the two specimens used by Candolle (1838) to establish *Cacalia* sect. *Cissampelopsis*, Ecklon's African *Cacalia? cissampelina*, was transferred by Milne-Redhead (1956) into his *Mikaniopsis* (Jeffrey 1986). *Mikaniopsis* differs from *Cissampelopsis* by having almost always heterogamous disciform capitula whereas *Cissampelopsis* has either heterogamous radiate or homogamous discoid capitula (Nordenstam 2006). Nordenstam (1977) noted that these two genera probably evolved independently. Jeffrey (1986) also observed that *Cissampelopsis* may be closely related to other African scandent genera of Senecioneae such as *Austrosynotis*. The monotypic *Austrosynotis* can be distinguished from *Cissampelopsis* and *Mikaniopsis* by having auriculate leaves. However, like part of *Cissampelopsis* it has radiate capitula. The monotypic scandent African *Delairea* also has been postulated (Jeffrey 1986) to belong to the *Cissampelopsis*-*Mikaniopsis*-*Austrosynotis* assemblage. However, this genus is succulent and lacks prehensile petioles.

In an ITS phylogeny of a large sample of Senecioneae (Pelser et al., 2007), *Cissampelopsis* is well-supported as sister to *Synotis*. Of the genera listed above, *Austrosynotis* is located in a different part of the phylogenetic tree, and *Delairea* was not included in the analysis. A very preliminary analysis of ITS sequences of *Mikaniopsis* places this genus together with *Cissampelopsis* and *Synotis* (Pelser et al., 2007). Of the genera later added to the Synotoid group by Jeffrey (1992; *Eriotrix* Cass., *Faujasia* Cass., *Faujasiopsis* C. Jeffrey, *Hubertia* Bory, *Humbertacalia* C. Jeffrey, *Parafaujasia* C. Jeffrey), *Eriotrix*, *Faujasia* and *Hubertia* were included in the above ITS analysis but grouped in a different part of the tree. In summary, the closest relative of *Cissampelopsis* has not yet been conclusively identified, but *Synotis* appears to be a likely candidate.

2.2 Material and methods

This study is based mainly on herbarium material from AAU, BK, BKF, BRIT, CMU, E, K, KEP, KKU, KYO, L, MJG, PSU, QBG, SING and W (abbreviations according to Holmgren & Holmgren 1998). Anther and style samples were obtained

from florets removed from capitula softened in boiling water. Samples were mounted in glycerin jelly and all permanent slides were deposited in the herbarium of Johannes Gutenberg-Universität Mainz (MJG). Field observations in continental Southeast Asia, mostly Thailand, were made from September to December 2004 and from January to February 2005.

2.3 Results and Discussion

Taxonomic treatment

Cissampelopsis *(DC.) Miq.*, Fl. Ind. Bat. 2 (1856) 102.

Cacalia L. sect. *Cissampelopsis* DC. in Prodr. 6: 331 (1838). Lectotype (selected by Pfeiffer, 1873: 763): *Cacalia? volubilis* Bl. = *Cissampelopsis volubilis* (Bl.) Miq.

Senecio L. sect. *Synotios* Benth. & Hook. f., Gen. Pl. 2 (1873) 448 *nom. illegit.*

Senecio L. subg. *Synotis* C. B. Clarke sect. *Scandentes* C. B. Clarke in Comp. Ind. (1876) 177.-Type: *Senecio araneosus* DC.

Senecio L. sect. *Synotis* Benth. & Hook. f. ser. *Scandentes* (C. B. Clarke) Koyama in Mem. Fac. Sc. Kyoto Univ. Ser. Biol. 2 (1969) 144.

Perennial lianas, 3-5 m high or more, sometimes shrub-like when old. *Stems* climbing dextrorsely with prehensile petioles, much-branched, becoming woody when old. *Leaves* simple, alternate, petiolate, exauriculate, decreasing in size towards the apex and in the inflorescence; blade ovate to deltoid or most commonly cordate, minutely to coarsely dentate, apiculate to acuminate, palmately 3-7-veined from near the base, central vein with 1-2 pairs of ascending laterals, pale to dark green or purplish, herbaceous, coriaceous, papyraceous or membranous, almost glabrous to more or less densely arachnoid-tomentose particularly on lower surface or glandular. *Inflorescence* paniculate, usually exceeding the leaves, axes commonly glandular-pubescent, with 1-5 linear-subulate bracts. *Capitula* few to numerous in terminal and axillary panicles. Capitula heterogamous and radiate or homogamous and discoid, pendunculate; involucres cylindrical or narrowly campanulate, calyculate, calycular bracts linear-subulate, pubescent to almost glabrous; phyllaries usually 8, rarely 5, 6, 10 or 13, free, herbaceous with broad to narrow scarious margins, almost glabrous, sparsely to densely arachnoid-tomentose or glandular; receptacle flat, glabrous, epaleate. *Ray florets* 0, 5, 6 or 8, female, yellow, 4-5-veined, oblong-linear, apex entire or 3-dentate. *Disc florets* 8 - 20, hermaphrodite, white, pinkish or yellow, 5-lobed, lobes oblong-

lanceolate, acute. *Anthers* linear or linear-oblong; anther base distinctly tailed, tails ½ to 2 times as long as filament collar; collar subcylindrical or somewhat balusterform, hardly to slightly dilated towards the base; apical anther appendage usually oblong-lanceolate. *Style* branched, style arms truncate or convex, with short to rather long marginal papillae and with or without prominent central tuft of much longer papillae. *Cypselas* narrowly oblong to cylindrical, ribbed, glabrous; carpopodium cylindrical to hemispherical, yellowish to whitish, slightly larger in diameter than the cypsela base; pappus of numerous capillary bristles, bristles barbellate, uniform, white, yellowish or reddish.

Flowering Sept. to Feb., rarely to April.

Distributed from India and Sri Lanka eastwards through the Himalaya, Myanmar, China, Vietnam and Thailand to Indonesia. Several species have a restricted distribution range and are critically endangered, e.g., *C. ansteadii* (Gopalan & Henry 2000). Almost all species of the genus are found climbing on shrubs or small trees on the edge of or in tropical wet or semi-evergreen montane forests. They preferably occur in habitats with high moisture such as along rivers. A few species, e.g., *C. erythrochaeta*, can also be found in mixed deciduous forests on bamboos.

Cissampelopsis can be divided into two sections:

Cissampelopsis sect. *Buimalia* C. Jeffrey & Y. L. Chen in Kew Bull. 39: 348 (1984). Type: *C. buimalia* (Buch.-Ham. ex D. Don) C. Jeffrey & Y. L. Chen.

Capitula heterogamous, radiate; style arms penicillate without a central tuft of longer, more or less fused papillae (Fig. 3A).

Cissampelopsis (DC.) Miq. sect. *Cissampelopsis*; C. Jeffrey & Y. L. Chen in Kew Bull. 39: 342 (1984).

Capitula homogamous, discoid; style-arms penicillate with a central tuft of longer, more or less fused papillae (Fig. 3B).

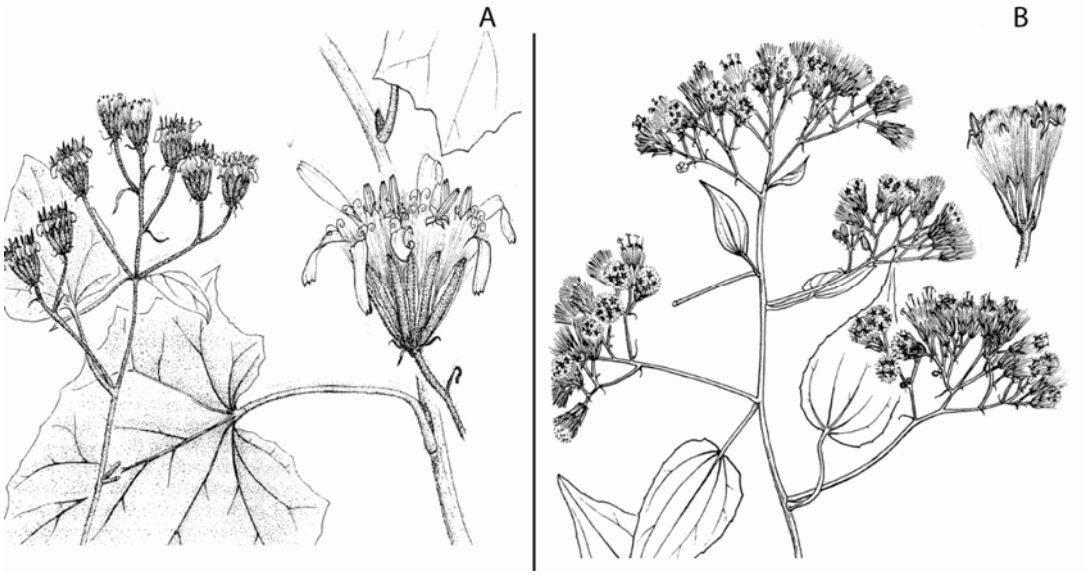

Figure 3. A *Cissampelopsis erythrochaeta* (sect. *Buimalia*) **B** *C. corifolia* (sect. *Cissampelopsis*) (modified from Jeffrey & Chen 1984)

Key to the species of *Cissampelopsis*

1a. Capitula radiate; ray and disc corollas truly yellow; style arm penicillate, apices without central tuft of longer papillae (sect. *Buimalia*)……..……..…2

b. Capitula discoid; corolla pale yellow or pinkish to white; style arm penicillate, apices with central tuft of longer papillae (sect. *Cissampelopsis*)…….....…....4

2a. Capitula with 5-6 ray florets and about 10-15 disc florets; phyllaries 8……..……..1. *C. buimalia*

b.Capitula with 8-13 ray florets and about 20 disc florets; phyllaries 13…….…..3

3a. Leaf apex apiculate, apex about 2-3 mm long; pappus reddish…….…..2. *C. erythrochaeta*

b. Leaf apex acuminate, apex about 5-10(20) mm long; pappus yellowish……...……..……..3. *C. calcadensis*

4a. Capitula with 5-10 disc florets; leaves sparsely arachnoid-tomentose or fulvous-glandular to glabrous beneath……..…….....….5

b. Capitula with 15-20 disc florets; leaves densely and persistently arachnoid-tomentose beneath……..…….…….…….9

5a. Stem and leaves densely fulvous-glandular; panicle shorter than leaves.……...…...……..……4. *C. glandulosa*

b. Stem and leaves sparsely to densely arachnoid-tomentose to floccose or almost glabrous; panicle longer than leaves…….……..…….…….....……6

6a. Leaf margin callose-denticulate with minute teeth;
phyllaries glabrous or almost so……...…..…7
b. Leaf margin sinuate-denticulate with mucronulate teeth;
phyllaries sparsely arachnoid-tomentose ……..……....8
7a. Leaf blade papyraceous to herbaceous with shortly apiculate apex about 2-5 mm long; stem and leaves sparsely arachnoid-tomentose to subglabrous……..5. *C. walkeri*
b. Leaf blade coriaceous with acuminate apex about 5-10 (20) mm long; stems and leaves glabrous……...…….....6. *C. corifolia*
8a. Phyllaries 8; disc florets 8-10...…….……..….……7. *C. volubilis*
b. Phyllaries 5-6; disc florets 5-6.....…….....……...…..…8. *C. ansteadii*
9a. Capitula about 5-8 in terminal and axillary panicles;
leaf blade papyraceous…….....……..…9. *C. spelaeicola*
b. Capitula more than 8 in terminal and axillary panicles;
leaf blade coriaceous to subcoriaceous…….....……....10. *C. corymbosa*

Sect. *Buimalia*

1. Cissampelopsis buimalia (Buch.-Ham. ex D. Don) C. Jeffrey & Y. L. Chen (Fig. 7A)

Cissampelopsis buimalia (Buch.-Ham. ex D. Don) C. Jeffrey & Y. L. Chen in Kew Bull. 47 (1986) 937.-*Senecio buimalia* Buch.-Ham. ex D. Don in Prodr. Fl. Nepal. (1825) 178.-Syntype: *Wallich* Cat. n. 3120 (BM; iso E!, K photo!), Nepal.

Plants 3-7 m high, stems sparsely white arachnoid-tomentose. *Petioles* 3-5 cm long, densely to sparsely white-arachnoid, sometimes also with fulvous hairs. *Blade* ovate to ovate-triangular, 5-12 x 3-8 cm, thinly papyraceous, acuminate-apiculate, sinuate-denticulate with mucronulate teeth, sparsely arachnoid when young, glabrescent above, greyish-white-arachnoid below. *Panicle* narrow, slightly longer than leaves**.** *Capitula* 8-12 mm wide, 3-10 per panicle; peduncles slender, 10-15 mm long, densely grey-tomentose, with 1-2 bracts; involucres 8-12 mm long, 4-6 mm broad; calycular bracts 3 - 7, 1 - 3 mm long, unequal, pubescent; phyllaries 8, 2.5-3 mm broad, densely to sparsely arachnoid-tomentose. *Ray florets* 5-6, ray 3-6 x 1-1.5 mm, yellow. *Disc florets* 10-15, yellow. *Anthers* 3.5-4 mm long, anther tails shorter than filament collar (Fig. 10A). *Style arms* 2.5 mm long (Fig. 11A). *Cypselas* 5.5 mm long; carpopodium hemispherical, whitish; pappus 11-12 mm long, white or dirty white, yellowish at base.

Flowering from Dec. to Feb. Climbing on shrubs or trees in mixed forests, 1100-2500 m. North India, Nepal, Bhutan, south China (Fig. 4).

Specimens examined. **India**: Sikkim, *J. D. Hooker.* (E, K). **Nepal**: S of Kathmandu, 20 Dec. 1965, *Schilling 709* (K); Yektin-Akasay-Batasay, 30 Sept. 1963, *Hara et al. 6306345* (K, KYO); Mul Pokhari-Gorzu, 30 Oct. 1963, *Hara et al. 6306346, 6306347* (KYO); without locality, *Wallich 3120* (E, K). **China**: Yunan Ma-chung-kui valley, Feb. 1913, *Forrest 9521* (E).

2. Cissampelopsis erythrochaeta C. Jeffrey & Y. L. Chen, *nom. nov*. (Fig. 7B)

Cissampelopsis erythrochaeta C. Jeffrey & Y. L. Chen in Kew Bull. 39 (1984) 348.-

Senecio buimalia Buch.-Ham. ex D. Don var. *bambusetorum* Hand.-Mazz. in Anzeig. Akad. Wiss. Wien Math.-Naturw. Kl. 62 (1925) 147 & Symb. Syn. 7 (1936) 1124.-Type: *Handel-Mazzetti 12435* (holo W! photo), China, Hunan.

Plants up to 3 m high, stems white-arachnoid-tomentose to glabrescent. *Petioles* 3-7 cm long, sparsely arachnoid to subglabrous. *Blade* ovate-triangular, 7-13 x 4-12 cm, papyraceous or submembraneous, shortly apiculate, repand or sinuate-denticulate with mucronulate teeth. *Panicle* broad, pyramidical, longer than leaves. *Capitula* 2.5-3 cm wide, usually 5-10 per panicle; peduncles stout, 1-2 cm long, sparsely arachnoid, with 1-2 bracts; involucres 8-10 mm long, 6-8 mm broad; calycular bracts 7-8, 4-6 mm long, pubescent; phyllaries 13, 1-2 mm broad, sparsely arachnoid. *Ray florets* 8, ray 10 x 2 - 2.5 mm, yellow. *Disc florets* c. 20, yellow. *Anthers* 4.5 mm long, anther tails about as long as filament collar (Fig. 10B). *Style arms* about 4 mm long (Fig. 11B). *Cypselas* 4 mm long; carpopodium hemispherical, whitish; pappus 9-10 mm long, reddish.

Flowering from Sept. to Oct. Climbing on bamboos and shrubs in mixed forest, 950 - 1180 m. Endemic to south China (Hunan) (Fig. 4).

Note. Apart from the measurement of floral characters, this description is mainly based on Jeffrey & Chen (1984).

Specimens examined. **China**: Hunan near Wukang Yun-schan, 13 Sept. 1918, *Handel-Mazzetti & Paul* in *Handel-Mazzetti 12435* (W photo).

3. Cissampelopsis calcadensis (Ramasw.) C. Jeffrey & Y .L. Chen (Fig. 7C)

Cissampelopsis calcadensis (Ramasw.) C. Jeffrey & Y .L. Chen in Kew Bull. 39 (1984) 341.-*Senecio calcadensis* Ramasw. in Rec. Bot. Surv. India 6 (1914) 138. Type: *Hooper & Ramaswami 39250* (holo CAL), India, Madras.

Plants about 3 m high, stems sparsely white- to yellowish-arachnoid-tomentose. *Petioles* stout, 3-5 cm long, densely white-arachnoid-tomentose. *Blade* ovate-triangular, 6-8 x 4-7 cm, membranous, acuminate with acumen 5-10(-20) mm long, blade sinuate-denticulate with mucronulate teeth, sparsely arachnoid or glabrescent above, densely greyish-white-arachnoid-tomentose below. *Panicle* broad, longer than leaves. *Capitula* 2 cm wide, 3-5 in terminal and 1-3 in axillary panicles; peduncles stout, 10-20 mm long, densely white-tomentose, with 1-2 bracts. involucres 8-10 mm long, 5-8 mm broad; calycular bracts 10-13, 2-4 mm long, densely white- arachnoid-tomentose; phyllaries c. 13, 2.5-3 mm broad, densely arachnoid-tomentose. *Ray florets* 10-13, rays 5-6 x 1.5-2 mm, yellow. *Disc florets* c. 20, yellow. *Anthers* 3.5 cm long, anther tails about ½ as long as filament-collar (Fig. 10C). *Style arms* 2.5 mm long (Fig. 11C). *Cypselas* 5.5 mm long; carpopodium cylindrical, yellowish; pappus 8-10 mm long, yellowish.

Flowering in Feb. Endemic to south India (Fig. 4).

Specimens examined. **India**: Tinnevelli Kalaka Hill, 11 Feb. 1916, *Frichen 3879* (K).

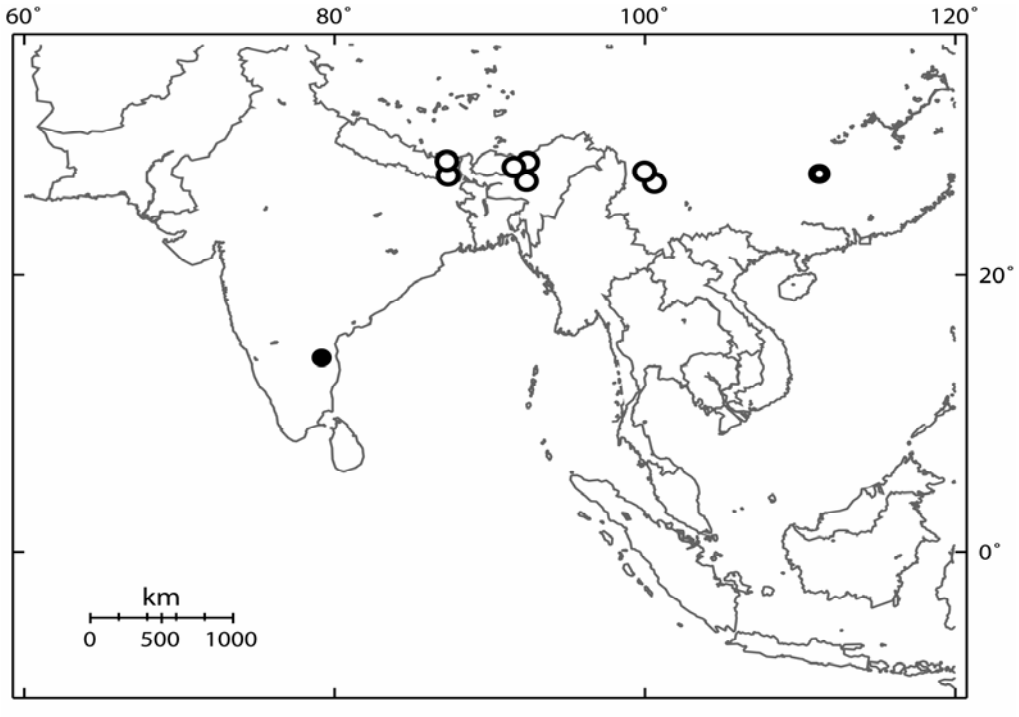

Figure 4. Distribution of *Cissampelopsis buimalia*○, *C. erythrochaeta*◘, *C. calcadensis*●.

Sect. *Cissampelopsis*

4. Cissampelopsis glandulosa C. Jeffrey & Y. L. Chen (Fig. 8A)

Cissampelopsis glandulosa C. Jeffrey & Y. L. Chen in Kew Bull. 39: 345 (1984).-
Type: *Forrest* 9593 (holo K!; iso E!, GH), China, Yunnan,.

Plants 3-7 m high or more, stems distinctly glandular-pubescent. *Petioles* stout, 3-9 cm long, glandular-fulvous-pubescent. *Blade* ovate to broadly ovate, 7-14 x 5-10 cm, papyraceous, acuminate with acumen 10-20 mm, blade coarsely repand-denticulate or dentate with apiculate teeth, sparsely arachnoid-tomentose to glabrescent above, densely glandular- fulvous-pubescent below. *Panicle* narrow, shorter than leaves**.** *Capitula* numerous in dense panicles, axillary panicles mostly shorter than leaves, peduncles 4-10 mm long, bracts 2-3, 2-3 mm long; involucres 7-8 mm long, 2.5-3.5 mm broad; calycular bracts 3-5, 2 mm long, glandular; phyllaries 8, 1.5-2 mm broad, glandular-pubescent. *Florets* about 10, white or pale yellow. *Anthers* c. 4.5 mm long, anther tails shorter than filament collar (Fig. 10D). *Style arms* 3 mm long, apical tuft much longer than marginal papillae(Fig. 11D). *Cypselas* 4.5-5 mm long; carpopodium cylindrical to hemispherical, whitish; pappus 11 mm long, white or dirty white.

Flowering from Dec to Feb. Climbing on shrubs or trees on the edge of evergreen forests in open and sunny places, 2300 - 2500 m. South China, north Myanmar (Fig. 5).

Specimens examined. **China**: Yunnan, Feb. 1913, *Forrest 9593* (K, E)**. Myanmar**: Myitkyina Bawahkow, 16 Dec. 1938, *Naw Mu Pa 17491*(K).

5. Cissampelopsis walkeri (Arn.) C. Jeffrey & Y. L. Chen (Fig. 8B & 8C)

Cissampelopsis walkeri (Arn.) C. Jeffrey & Y. L. Chen in Kew Bull. 39 (1984) 341.

Senecio walkeri Arn. in Pug. Pl. Ind. Or. (1836) 31. Lectotype: *Walker* 421 (K! & iso K!, chosen here), Sri Lanka.

Plants 5-8 m high or more, stems sparsely arachnoid-tomentose or brownish-floccose especially in upper part, more or less subglabrous at base. *Petioles* 3-6 cm long, sparsely white-arachnoid or brownish-floccose. *Blade* ovate to broadly ovate, 4-7 x 3-6 cm, papyraceous to herbaceous, apiculate, with minutely denticulate teeth, sparsely white- or brownish-arachnoid-tomentose to subglabrous above, sparsely white- to brownish- arachnoid-tomentose or almost glabrous with prominent veins below. *Panicle* broad, longer than leaves. *Capitula* numerous per panicle, peduncle slender, 6-15 mm long, bracts 4-5, 1-2 mm long; involucres 6-9 mm long, 2-3 mm broad; calycular bracts 3-5, 1-1.5 mm long, pubescent to subglabrous; phyllaries 8, 1-2 mm broad, almost glabrous. *Florets* c. 10, pale yellow or white. *Anthers* c. 3 mm long; anther tails slightly longer than filament collar (Fig. 8E & 8F). *Style arms* c. 3 mm long, apical tuft much longer than marginal papillae (Fig 9E & 9F). *Cypselas* c. 2 - 2.5 mm long; carpopodium cylindrical to hemispherical, whitish to yellowish; pappus 7 - 9 mm long, white or dirty white.

In Sri Lanka, material of this widespread species Grierson (1974) had observed specimens which he regarded as being intermediate between *C. walkeri* and *C. corymbosa*. Two of the four collections cited by Grierson (1974) as intermediate were examined by us. These collections are not distinctively different from *C. walkeri*, and in our opinion should be treated as a new variety of *C. walkeri* which differs from the type variety in having a brownish-floccose indumentum on the stems and a dense

brownish arachnoid-tomentose indumentum on the lower surface of the leaves, making them appear brownish-powdered, and blades which are relatively thickly papyraceous.

Key to the varieties of *C. walkeri*

1a. Leaves papyraceous to herbaceous, more or less thin with transparent veins, stems sparsely white-arachnoid-tomentose……..…….....…..a. var. *walkeri*

b. Leaves thickly papyraceous, densely brownish-arachnoid-tomentose beneath, stems brownish-floccose…….…….....…..b. var. *floccosa*

5a var. *walkeri*

Senecio araneosus DC. var. *walkeri* (Arn.) C. B. Clarke in Comp. Ind. (1876) 182.

Senecio corymbosus Wall. ex DC. var. *walkeri* (Arn.) Grierson in Ceylon J. Sci. (Biol. Sci) 11 (1974) 22.

Flowering from Jan. to April. Climbing on trees on the edge of mixed forests, 1500-2500 m. South India, Sri Lanka (Fig. 5).

Specimens examined. **India**: Madras, 1867, *Wight 1651* (K), 9 Feb. 1985, *K. M. Matthew 40962* (AAU, K), 2 March 1990, *K. M. Matthew 54134* (K). **Sri Lanka**: Nuwara Eliya, 28 Jan. 1974, *Jazasuriza et al. 1485* (K), 9 March 1969, *Grierson 1081* (E); without locality, 1838, *Walker 412* (K), *253* (E).

5b var. *floccosa* Vanijajiva & Kadereit var. nova.

Differt a var. *walkeri* foliis crassis papyraceis, caulibus infuscentis floccosis.

Typus: Sri Lanka (Ceylon) *F. R. Fosberg & D. Mueller-Dombois* 50009 (holotype K, isotype E).

Flowering from Jan. to April. Climbing on trees in moist mixed forest, 2000 - 2100 m. Endemic to Sri Lanka (Fig. 5).

Specimens examined. **Sri Lanka**: Nuwara Eliya Horton Plains, 28 March 1968, *F. R. Fosberg & D. Mueller-Dombois 50009* (K, E), 10 April 1969, *Kostermans 23118* (K); Pidurutalaga, 8 March 1969, *Grierson 1071* (E).

6. Cissampelopsis corifolia C. Jeffrey & Y. L. Chen (Fig. 8D)

Cissampelopsis corifolia C. Jeffrey & Y. L. Chen in Kew Bull. 39 (1984) 339.-Type: China; Yunnan, *Henry 9178B* (holo K!, iso E!).

Senecio araneosus sensu Koyama in Mem. Fac. Sc. Kyoto Univ. Ser. Biol. 2 (1969) 146, non Wall. ex DC.

Plants 3-7 m high or more, stems glabrous. *Petioles* 3-6 cm long, glabrous. *Blade* ovate to broadly ovate, 8-14 x 4-11 cm, distinctly coriaceous or subcoriaceous, distinctly acuminate with acumen 5-10(-20) mm, blade dentate with minutely to coarsely callose-denticulate teeth, glabrous. *Panicle* broad, longer than leaves**.** *Capitula* numerous per panicle, panicles densely glandular-pubescent; peduncle slender, (3-)5-15 mm long, bracts 2-3, 1-2 mm long; involucres 5-6 mm long, 2-3 mm broad; calycular bracts 4-5, 1-2 mm long, glabrescent; phyllaries 8, rarely 6-7, 1-2 mm broad, almost glabrous. *Florets* c. 8-10, pale yellow, cream or pinkish-white to white. *Anthers* c. 3.5 mm long; anther tails as long as to twice as long as filament collar (Fig. 10G)**.** *Style arms* c. 2.5 mm long, apical tuft slightly to much longer than marginal papillae (Fig. 11G). *Cypselas* c. 2.5-3 mm long; carpopodium cylindrical, whitish; pappus 8-9 mm long, white, sometimes brownish at base.

Flowering and fruiting Sept. to March. Climbing on trees and shrubs in evergreen forests or on the edge of evergreen or mixed forests, 1300-2800 m. North India, Bhutan, south China, Vietnam, Myanmar, north Thailand (Fig. 5).

Specimens examined. **India**: Sikkim, Nov. 1881, *J. S. Gamble 10024* (K), *25269* (K); without locality, *Forrest 16029* (K). **Myanmar**: Seingkhu valley, 22 Oct. Darjeeling, *J. S. Gamble 9891, 2531A* (K), 5 Oct. 1902, *Lace 2389* (E), Chongtan, *J. D. Hooker* (K); Sureil, 25 Feb. 1920, *Cave* (E), *Ribu & Rhomoo* (E); Assam, 19 Nov. 1976, *J. S. Gamble 2022A* (K); Myrang, *Hooker & Thomson* (K); Nunklow, *Hooker & Thomson 2523* (K), *Griffith 1056* (K); Ascaty Seriphari, *Watt 5976* (K); Khasiya, *Griffth* (K); without locality, *J. D. Hooker* (K), 1862, *Griffith 3247* (K). **Bhutan**: Tongsa, 2 April 1982, *Grierson & D. G. Long 4226* (E). **China**: Yunnan; Shang-pa Hsien, 17 Sept. 1933, *H. T. Tsai 54303, 54905* (K); Mengtze, 1898, *Henry 9178A* (K, E); Sheweli, Dec. 1918, *Forrest 17530* (E), Oct. 1924, *Forrest* 1926, *Ward 7465, 7604* (K), *3880* (E); Kachin, Tama Burn, *Ward 21507* (E). **Vietnam**: Bach ma town, 31 Jan. 1990,

Newman 180 (E). **Thailand**: Chiang Mai; Doi Chiang Dao, 25 Dec. 2004, *Vanijajiva* 005 (MJG), *Smitinand & Anderson 7282* (KYO), 8 Feb. 1983, *Koyama et al T-33259* (KYO); Doi Inthanon, 8 Dec. 1984, *Koyama et al T-40000* (KYO), 7 Jan. 1998, *Srisanga et al. 10415* (QBG).

Koyama (1986) reported this species also from Afghanistan. We have not, however, seen the specimens from there cited by him.

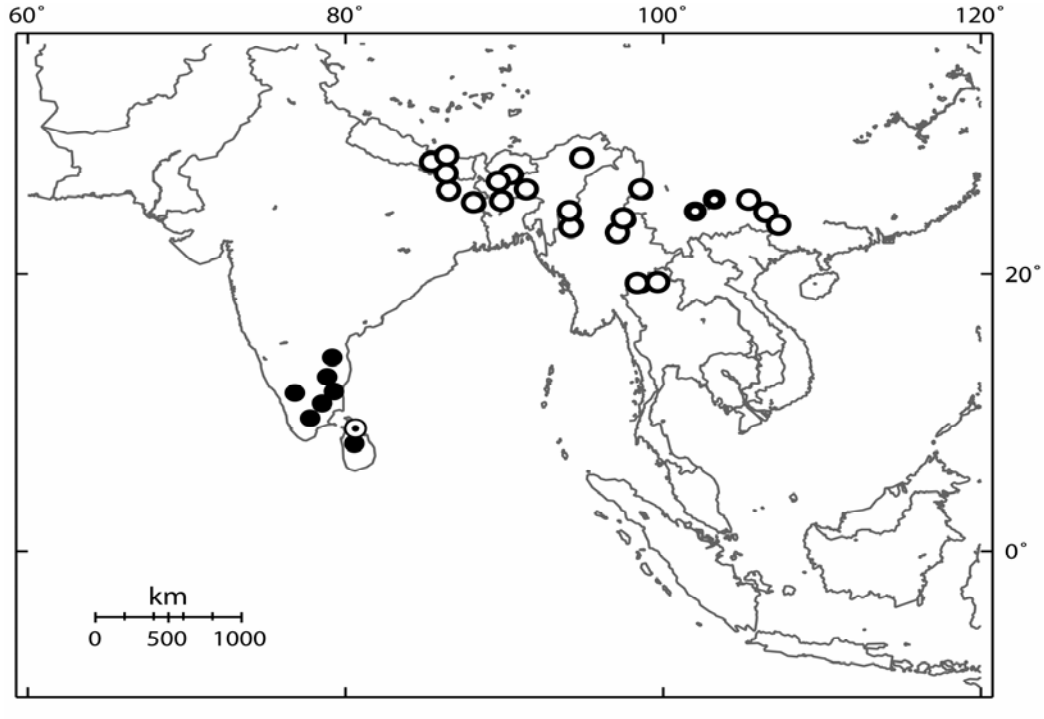

Figure 5. Distribution of *Cissampelopsis glandulosa*❶, *C. corifolia*○, *C. walkeri* var. *walkeri*, *C. walkeri* var. *floccosa*⊙.

7. Cissampelopsis volubilis (Bl.) Miq. (Fig. 9A)

Cissampelopsis volubilis (Bl.) Miq. in Fl. Ind. Bat. 2 (1856) 102-103.-*Cacalia? volubilis* Bl., Bijdr. Fl. Ned. Ind. (1826) 903.-Type: *Blume s. n.* (holo L! photo, iso K! photo), Indonesia, Java.

Senecio blumei DC., Prodr. 6 (1838) 334.

S. araneosus DC., Prodr. 6 (1838) 364.-Type: *De Silva* (holo G-DC, iso K-W *3136*), Bangladesh, Sylhet.

Vernonia esquirolii Van., Feddes Rep. 4 (1907) 331.-Type: *Esquirol 781* (holo E!), China, Guizhou.

Senecio hoi Dunn in Bot. J. Linn. Soc. 35 (1968) 506.-Syntype: *Henry 10392* (K!, iso

G, PE), China, Yunnan.

Senecio walkeri sensu S.Y. Hu in Quart. Taiwan Mus. 21: 150 (1968), quoad syn. *S. araneosus* DC., *S. blumei* DC. & *Vernonia esquirolii* Van., non Arn.

Plants up to 3 m high, stems more or less sparsely brown-setulose, white-arachnoid-tomentose or glabrescent. *Petioles* stout, 3-6 cm long, more or less tomentose and sometimes sparsely brown-setulose. *Blade* ovate to broadly ovate or ovate-triangular, 10-15 x 8-12 cm, papyraceous or membranous, acuminate-apiculate, sometimes hastate, remotely and minutely to coarsely repand-dentate with mucronulate teeth, sparsely arachnoid, glabrescent and sometimes shortly scabrous-setulose above, greyish with dense to sparse arachnoid floccose indumentum or brownish-setulose below. *Panicle* narrow, longer than leaves. *Capitula* numerous per panicle, panicles sparsely to densely white-tomentose or with brownish glandular hairs; peduncles slender, 5-15 mm long, arachnoid-tomentose, with 3-5 bracts, 3-4 mm long, pubescent; involucres 7-8 mm long, 2-3 mm broad; calycular bracts 4-5, 1-2 mm long, pubescent; phyllaries c. 8, 1.5-2 mm, sparsely arachnoid or puberulous or glabrous. *Florets* 8 -10, white or pale yellow. *Anthers* c. 3.5 mm long; anther tails shorter than or as long as filament collar (Fig 10H). *Style arms* 3 mm long, apical tuft much longer than marginal papillae (Fig. 11H). *Cypselas* c. 4 mm long; carpopodium cylindrical, whitish; pappus 8-9 mm long, white.

Flowering Oct. to Feb. Climbing on trees and shrubs in forests and thickets, 780 - 2000 m. North India, south China, Myanmar, Thailand, Indonesia (Fig. 6).

Specimens examined. **China**: Guizhou, Dec. 1906, *Esquirol 781* (E); Yunnan Mengtze, 1981, *Henry 10392A* (K), 7 Jan. 1934, *H. T. Tsai 54596* (E). **Myanmar**: Kachin, 15 Jan. 1962, *J. Kanan 3430, 3972* (K), *3744* (E). **Thailand**: Kao Laem Nakronratsima, 11 Sept. 1925, *Kerr 9922* (K, BK), *3543* (BK). **Indonesia**: Celebes, 1905, *A. J. Whitten* (L).

8. Cissampelopsis ansteadii (Tadul. & Jacob) C. Jeffrey & Y. L. Chen (Fig. 9B)

Cissampelopsis ansteadii (Tadul. & Jacob) C. Jeffrey & Y. L. Chen in Kew Bull. 39 (1984) 341.-*Senecio ansteadii* Tadul. & Jacob in Ind. Bot. Soc. 9 (1930) 40.- Type: *Jacob 13712* (holo MH), India, Madras.

Plants slender, 3-5 m high, stems sparsely white- or brownish-arachnoid-tomentose in upper part, more or less glabrous at the base. *Petioles* slender, 2-5 cm long, white-arachnoid-tomentose to glabrous. *Blade* ovate-triangular, 4-10 x 2-8 cm, membranous, apiculate-acuminate, sometimes hastate, denticulate with remote, shallow mucronulate teeth, arachnoid and glabrescent above, sparsely white- or brownish-arachnoid-tomentose below. *Panicle* narrow, longer than leaves. *Capitula* slender, 5 - 8 in narrow panicles; inflorescence-branches slender, white-arachnoid-tomentose, sometimes also with brownish glandular hairs; peduncles slender, 5-8 mm long, arachnoid-tomentose, bracts 2-5, 3-5 mm long, pubescent; involucres 6-7 mm long, 2 - 2.5 mm broad; calycular bracts 2-3, 1-3 mm long, glabrescent; phyllaries 5-6, 1-2 mm broad. *Florets* 5-6, pale yellow or white. *Anthers* c. 2.5 mm long; anther tails shorter than filament collar (Fig. 10I). *Style arms* 3 mm long, apical tuft much longer than marginal papillae (Fig. 11I). *Cypselas* about 2 mm long; carpopodium cylindrical, whitish; pappus 5 - 10 mm long, white.

Flowering and fruiting Jan. to Aug. Climbing on the edges of clearings in primary evergreen forests, 1200 - 1300 m. Endemic to South India (Tamil Nadu) (Fig. 6).

Specimens examined. **India**: Tamil Nadu, Tirunelveli Kalakkadu forest, 1975, *J. F. Oates 24* (K), Aug. 1976, *J. L. Mason 24* (K).

9. Cissampelopsis spelaeicola (Van.) C. Jeffrey & Y. L. Chen (Fig. 9C)

Cissampelopsis spelaeicola (Van.) C. Jeffrey & Y. L. Chen in Kew Bull. 39 (1984) 346.- *Senecio spelaeicola* (Van.) Gagnep., Bull. Soc. Bot. Fr. 67 (1920) 364.-*Vernonia spelaeicola* Van, Bull. Acad. Géogr. Bot. 12 (1903) 123.- Type: *Martin & Bodinier 2570* (holo E!, iso P), China, Guizhou.

Senecio buimalia sensu Dunn in Journ. Linn. Soc. Bot. 39 (1911) 493. & sensu S. Y. Hu in Quart. Journ. Taiwan Mus. 21 (1968) 36, non Buch.-Ham. ex D. Don.

Senecio yalungensis Hand.-Mazz. in Anzeig, Akad. Wiss. Wien Math. Naturw. Kl. 62 (1925) 148 & Symb. Sin. 7 (1936) 1124, tab. 18, fig. 2. Type: China; Sichuan, *Handel-Mazzetti 2073* (holo W).

Senecio walkeri sensu Rehd. in Journ. Arn. Arb. 18 (1937) 253 & sensu S. Y. Hu in Quart. Journ. Taiwan Mus. 21 (1968) 150 pro parte, non Arn.

Plants up to 5 m high, stems sparsely white-arachnoid or glabrescent. *Petioles* stout, up to 6 cm long, densely tomentose. *Blade* ovate to broadly ovate or ovate-triangular, 7 - 9 x 8 - 11 cm, papyraceous, acuminate-apiculate, repand-denticulate with shallow mucronulate teeth, sparsely arachnoid above, densely yellowish- to white-arachnoid-tomentose below. *Panicle* broad, longer than leaves. *Capitula* large, 5 - 8 per panicle, panicles densely tomentose; peduncles short, 3-5 mm long, densely tomentose, bracts 2–3; involucres 6-7 mm long, 2.5-4 mm broad; calycular bracts 6-8, 2-3 mm long, unequal, densely tomentose; phyllaries 8, 1.5-2 mm broad, densely arachnoid-tomentose. *Florets* 15 - 20, white. *Anthers* c. 4 mm long; anther tails slightly shorter than to about twice as long as filament collar (Fig. 10J). *Style arms* 3 - 3.5 mm long, apical tuft stout, much longer than marginal papillae (Fig. 11J). *Cypselas* 5 mm long; carpopodium cylindrical to hemispherical, whitish; pappus c. 9 mm long, white or dirty white.

Flowering from Nov. to Dec. Climbing on trees and shrubs in mixed forests, 1000-2500 m. North India to south China (Fig. 6).

Specimens examined. **China**: Yunnan, Mengtze, 1898, *Henry 9274* (K); Yuanchang, 1986, *Henry 9274B* (K, E), 1922, *Cavalerie 1833* (K).

10. Cissampelopsis corymbosa (Wall. ex DC.) C. Jeffrey & Y. L. Chen (Fig. 9D)

Cissampelopsis corymbosa (Wall. ex DC.) C. Jeffrey & Y. L. Chen in Kew Bull. 39 (1984) 341.-*Senecio corymbosus* Wall. ex DC., Prodr. 6 (1838) 364. Type: *Wight 1648*; *Wallich Cat. n. 3121* (holo G-DC; iso K!), India, Madras.

Plants 3-5 m high or more, stems sparsely to densely white- or yellowish-arachnoid-tomentose. *Petioles* 3-8 cm long, sparsely white-tomentose. *Blade* ovate, 6-9 x 4-7 cm, coriaceous to subcoriaceous, apiculate-acuminate, base sometimes round or hastate, minutely denticulate, sparsely white-arachnoid to glabrescent above, persistently and densely yellowish- to brownish- or white-arachnoid-tomentose below. *Panicle* broad, longer than leaves**.** *Capitula* large, numerous in usually dense panicles, panicles sparsely to densely white-arachnoid-tomentose; peduncles 5-10 mm long, white-arachnoid-tomentose, bracts 3-5, 3-4 mm long, pubescent; involucres 6-8 mm long, 3-4 mm broad; calycular bracts 4-5, 2-4 mm long, densely tomentose; phyllaries

8, 1.5-2 mm broad, densely to sparsely arachnoid or subglabrous. *Florets* 15-20, white to pale yellow. *Anthers* c. 3 mm long; anther tails about twice as long as filament collar (Fig. 10K). *Style arms* 2.5 mm long, apical tuft rather short but longer than marginal papillae (Fig. 11K). *Cypselas* c. 4 mm long; carpopodium cylindrical to hemispherical, whitish to yellowish; pappus 8-10 mm long, white or dirty white.

Flowering Dec. to Feb. Climbing on shrubs or trees on the edge of or in moist mixed forests, 1500- 2500 m. Sri Lanka to India (Fig. 6).

Specimens examined. **Sri Lanka**: Kandy, Kotagala Hill, 7 Feb. 1973, *B. L. Burtt & C. C. Townsend* (K). **India**: Madras, Nilgiri Hill, *Wight 1648* (K)*, 11013 (*E), Jun. 1884, *J. S. Gamble 14104* (K), 1 March 1917. *J. S. Gamble 13712*, 30 Dec. 1948, *E. K. Janaki 1809, 13712* (K), *L. J. G. Maesen 3394* (K), 16 Feb. 1937, *Koelz 11013* (E), 23 May 1987, *K. M. Matthew & M. Charles 49708* (AAU); Bombay, 14 June 1898, *Borne 1118* (K); Kalahandi, 3 Feb. 1938, *H. F. Mooney 737* (K), *3214* (K); Aber Hill, 12 Feb. 1928, *Ward 7845* (K).

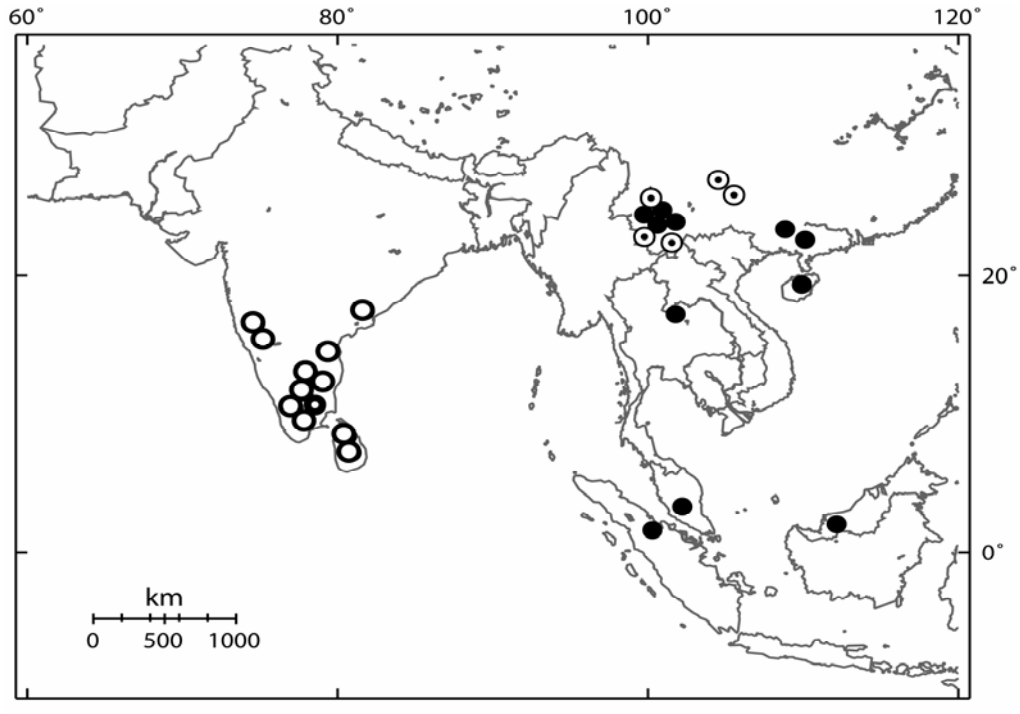

Figure 6. Distribution of *Cissampelopsis volubilis*●, *C. ansteadii*⊙, *C. spelaeicola*◉, *C. corymbosa*○.

Figure 7. A *Cissampelopsis buimalia*, **B** *C. erythrochaeta*, **C** *C. calcadensis*.

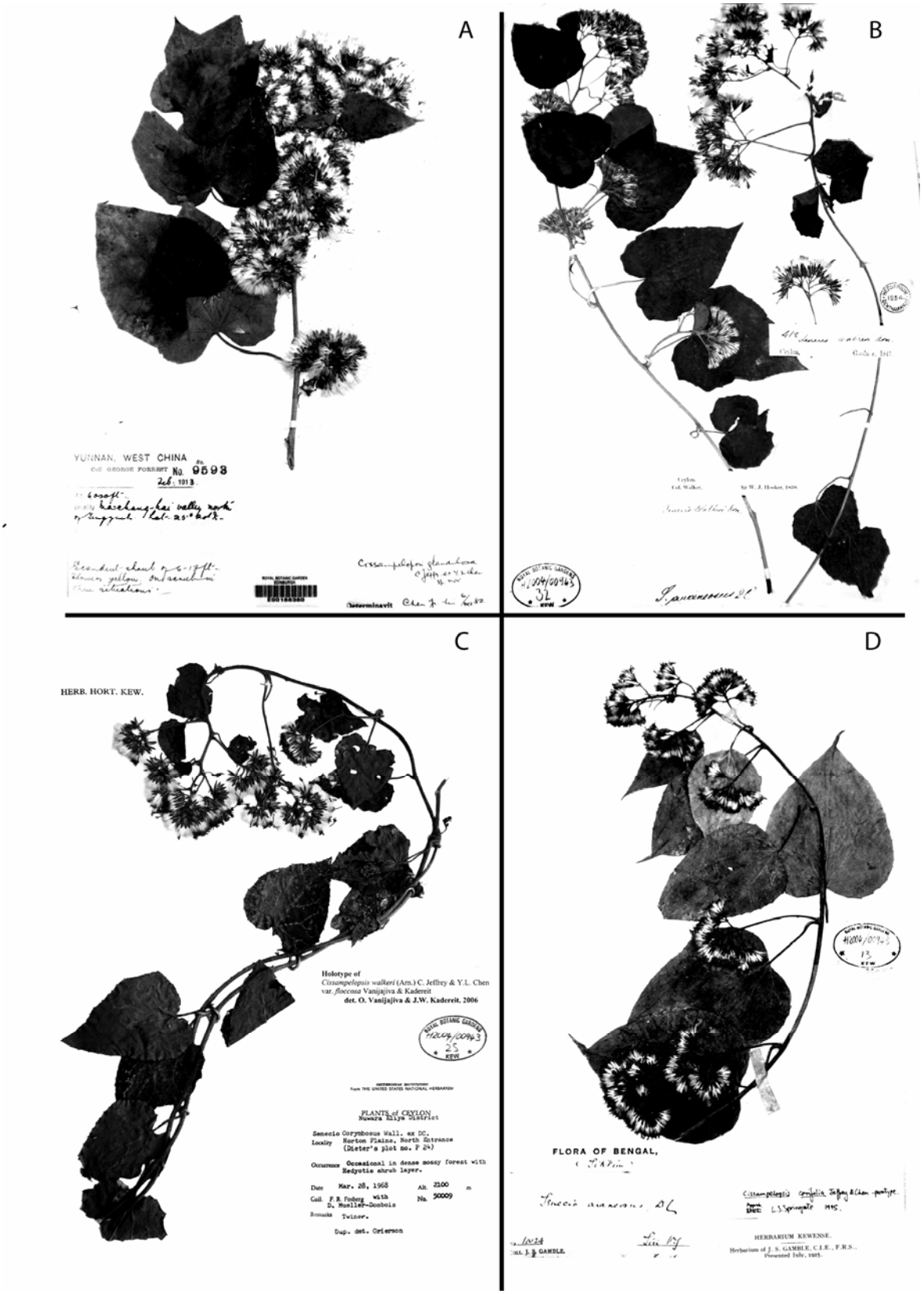

Figure 8. **A** *Cissampelopsis glandulosa*, **B** *C. walkeri* var. *walkeri*, **C** *C. walkeri* var. *floccosa*, **D** *C. corifolia*.

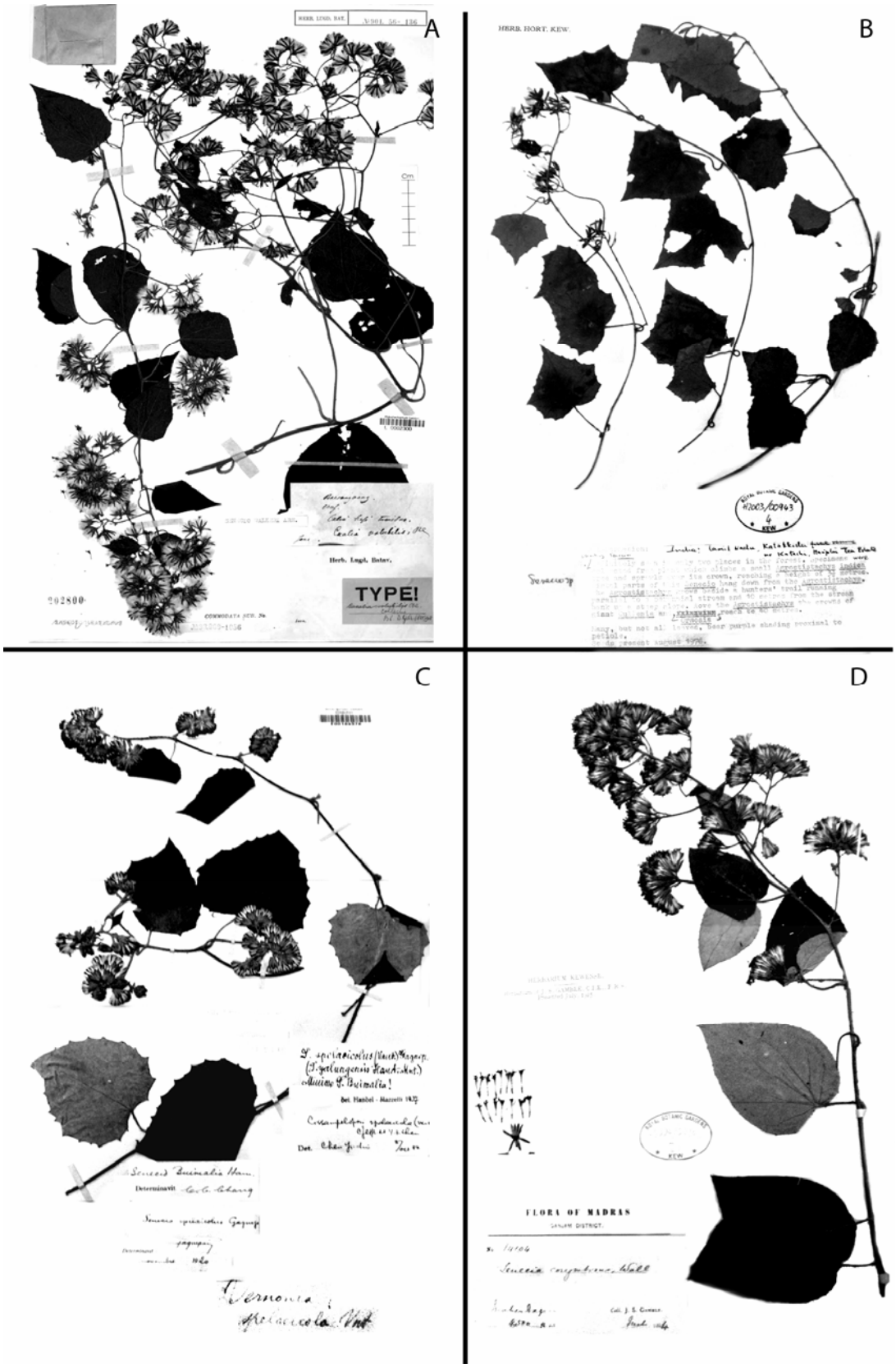

Figure 9. A *Cissampelopsis volubilis*, **B** *C. ansteadii*, **C** *C. spelaeicola*, **D** *C. corymbosa*.

Figure 10. Anther base and filament collar **A** *C. buimalia* (from *Wallich* 3120, E); **B** *C. erythrochaeta* (from *Handel-Mazzetti* 12435, W); **C** *C. calcadensis* (from *Frichen* 3879, K) ; **D** *C. glandulosa* (from *Forrest* 9593, E); **E** *C. walkeri* var. *walkeri* (from *Wight* 1651, K); **F** *C. walkeri* var. *floccosa* (from *F. R. Fosberg & D. Mueller-Dombois* 50009, K); **G** *C. corifolia* (from *Henry* 9178B, E); **H** *C. volubilis* (from *Henry* 10392A, K); **I** *C. ansteadii* (from *J.F. Oates* 24, K); **J** *C. spelaeicola* (*Martin & Bodinier* 2570); **K** *C. corymbosa* (from *Wight* 1648, K). Scale bar = 0.5 mm.

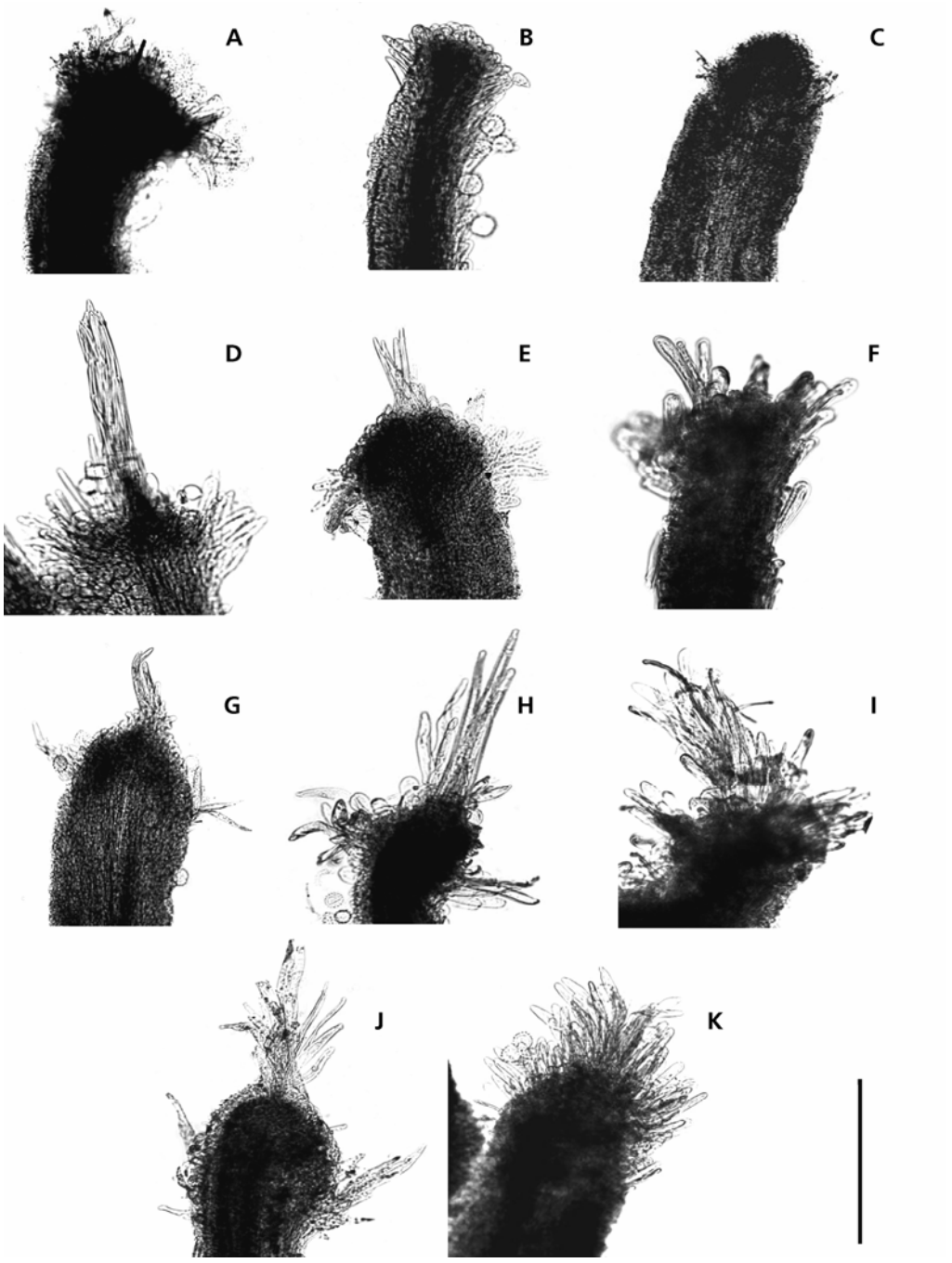

Figure 11. Style arm apices **A** *C. buimalia* (from *Wallich* 3120, E); **B** *C. erythrochaeta* (from *Handel-Mazzetti* 12435, W); **C** *C. calcadensis* (from *Frichen* 3879, K) ; **D** *C. glandulosa* (from *Forrest* 9593, K); **E** *C. walkeri* var. *walkeri* (from *Wight* 1651, K); **F** *C. walkeri* var. *floccosa* (from *F. R. Fosberg & D. Mueller-Dombois* 50009, K); **G** *C. corifolia* (from *Henry* 9178B, E); **H** *C. volubilis* (from *Henry* 10392A, K); **I** *C. ansteadii* (from *J. F. Oates* 24, K); **J** *C. spelaeicola* (*Martin & Bodinier* 2570, E); **K** *C. corymbosa* (from *Wight* 1648, K). Scale bar = 0.5 mm.

3. A REVISION OF *GYNURA* (ASTERACEAE: SENECIONEAE)

3.1 Introduction

Gynura Cass. is a perennial herbaceous genus of Asteraceae-Senecioneae characterized by homogamous disciform capitula, yellow corollas and mostly long and exserted style-arms (Nordenstam 2007). It is distributed from tropical Africa to South and East Asia and Australasia with one species in tropical Australia. The highest specific diversity is found in Southeast Asia. Species of *Gynura* grow either in open places in primary vegetation, such as tree fall gaps or along river margins, or in disturbed and secondary vegetation such as roadsides. They can be found from sea level to up to 3,000 m altitude.

Several studies of the genus have been published by Davies (1978, 1979, 1980a, 1980b). Since then, several new taxa have been described (Jeffrey, 1986; Koyama, 1988; Belcher, 1988; Foster & Thonpukdee, 1988; Zhu, 2006). Apart from that, species delimitation partly has been unsatisfactory, particularly in widespread species such as *G. pseudochina* (L.) DC., but also in local taxa such as *G. aurantiaca* (Bl.) DC (Jeffrey, 1986; Davies, 1981). The present study is a revision of all known species of *Gynura*.

3.1.1 Taxonomic history

Gynura was first described by Cassini (1825) on the basis of *Senecio pseudochina* Jussieu from India. Cassini noted that this species, known only from a single specimen, has several characters intermediate between *Crassocephalum* Moench and *Emilia* Cass. He therefore erected the new monotypic genus *Gynura* and renamed Jussieu's species as *G. dubia* Cass. After that, De Candolle (1838) transferred several species previously included in *Cacalia* L. and *Senecio* L. into *Gynura*. De Candolle (1838) also divided *Gynura* into two groups on the basis of the absence or presence of outer involucral bracts. In his 'involucro ecalyculato' group he recognized only *G. ecalyculata* DC, a species later transferred to *Emilia* as *E. sonchifolia* (L) DC. In his 'involucro calyculato' group, De Candolle included 22 species and noted that all species were known only from Asia.

As the palaeotropics became better known botanically, several new species were added to the genus. However, the very brief generic description resulted in substantial

taxonomic confusion particularly with respect to the African species. In Africa the genus was confused with *Crassocephalum*, and Bentham (1849) suggested that the two genera might be synonymous. As a result, *Gynura* was conserved over *Crassocephalum* during the Vienna Congress in 1905.

In 1939, Backer published a treatment of *Gynura* in Asia in which he recognized four native and one cultivated species in Java. In his treatment he also provided a more detailed generic description of *Gynura* and pointed out the differences to the African *Crassocephalum*. The differences between these two genera were described more clearly by Belcher (1955) when typifying *Crassocephalum* and *Gynura*. He pointed out that *Gynura* has an involucre which is much shorter than the florets, and especially exserted style-arms with prominent apical tuft of papillae.

The first treatment of *Gynura* in Africa was published by Davies (1978) who recognized seven species, including one new species. Later, she (Davies 1979) also studied the genus in East Asia and the Himalayas and recognized nine species including two varieties of *G. calciphila* from Thailand as well as three subspecies of *G. divaricata* from China. Davies subsequently reviewed the genus in India, Sri Lanka and the Seychelles (Davies 1980a) and recognized seven species including two subspecies of *G. lycopersicifolia* DC. She finally completed her treatment of *Gynura* by studying the material from Malesia and Australia (Davies 1980b) where she recognized 18 species including seven new species, most of these endemic to Southeast Asia. As several of her taxa were known from only few collections, she noted that most species particularly in Southeast Asia are in great need of further study. After Davies' work in Asia, Belcher (1988) described *G. malaccensis* Belcher from Malaysia and typified the Australian *G. drymophila* (F. Muell) F.G Davies. This species was later divided into two varieties by Foster & Thonpukdee (1988). Koyama (1988) described a new species endemic to Thailand, *G. hmopaengensis* H. Koyama. Zhu (2006) recently reported two new species of *Gynura* from Mountain Emei, Sichuan, China, *G. panershenia* Z.Y. Zhu and *G.emeiensis* Z.Y. Zhu. Jeffrey, in his treatment of Senecioneae for Flora of Tropical East Africa (1986), newly described *G. campanulate* C. Jeffrey and suggested that *G. fischeri* O. Hoffm and *G. meyeri-johannis* O. Hoffm from Tanzania probably are synonymous with *Solanecio angulatus* (Vahl) C. Jeffrey and *Senecio syringifolii* O. Hoffm., respectively.

3.1.2 The relationships of *Gynura*

According to Jeffrey (1986, 1992), *Gynura* belongs to the Gynuroid group of subtribe Senecioninae. This group, including *Kleinia* Mill. (incl. *Notonia* DC. and *Notoniopsis* B. Nord.), *Gynura* Cass and *Solanecio* (Sch. Bip.) Walp., is characterized by the presence of prominent drusiform crystals in the ovary wall, always discoid capitula and a mostly subsucculent to succulent habit (Jeffrey 1979). The Gynuroid group is distributed in the Old World, mostly in tropical climates. *Kleinia* is distinguished by its succulent habit and appendaged style-arms, *Gynura* by its herbaceous habit and its long, erect, subulate and papillose style-arm appendages, and *Solanecio* by its truncate style-arms with or without an apical tuft of longer, more or less fused papillae (Jeffrey 1986).

A recent molecular phylogenetic study of a large sample of Senecioneae (Pelser et al. 2007) has provided new insights into the relationships of the Gynuroid complex within Senecioneae. This analysis of ITS sequences showed that the Gynuroid group as understood by Jeffrey (1986, 1992) is well-supported as a monophyletic group with *Gynura* as (unsupported) sister to *Solanecio*. This '*Solanecio-Kleinia* clade' is nested within succulent species of *Senecio* and together with these forms the 'Gynuroid clade' (Pelser et al. 2007). Only two species of *Gynura* were included in the study by Pelser et al. (2007).

3.2 Material and Methods

This study is based mainly on herbarium material from AAU, BK, BKF, BM, CMU, E, G, K, KEP, KKU, KYO, KUN, L, MJG, P, PSU, QBG, S, SING and TEX (abbreviations according to Holmgren & Holmgren 1998). Field observations in continental Southeast Asia, mostly Thailand, were made from September to December 2004, from January to February 2005 and from March to April 2006

3.3 Results and Discussion

Taxonomic treatment

Gynura *Cass.* in F. Cuvier, Dict. Sci. Nat. 34 (1825) 391 *nom. cons.*-Lectotype (designated by Davies 1978: 335): *Gynura divaricata* (L.) DC. = *Gynura auriculata* Cass.

Gynaecura Hassk., Cat. Hort. Bog. Alt. (1844) 103.

Senecio sect. *Gynura* (Cass.) Baill., Histoire des Plantes. 8 (1882) 260.

Perennial herbs or subshrubs or plants scandent, roots fibrous or tuberous. *Stems* erect, decumbent or scrambling to climbing, fleshy to subsucculent, somewhat woody when old, variously pubescent to glabrous. *Leaves* simple, alternate, cauline or in basal rosette, sessile or petiolate, with or without auricles, papyraceous, fleshy to succulent, pale to dark green, sometimes purplish beneath, variously densely to sparsely pubescent to glabrous; blade linear-lanceolate, oblong, ovate to deltoid, entire, crenate, minutely denticulate to coarsely dentate or lyrate to pinnatifidly lobed, apex apiculate to acuminate, base cuneate, truncate or obtusely rounded, rarely unequal. *Capitula* solitary to numerous in lax to dense terminal and/or axillary corymbose panicles; capitula homogamous, discoid, pendunculate; involucres cylindrical or narrowly campanulate, calyculate, calycular bracts linear-subulate, pubescent to almost glabrous; phyllaries arranged in a single row, 8-18, free, herbaceous with broad to narrow scarious margins, almost glabrous or sparsely to densely pubescent; receptacle flat, glabrous, epaleate. *Florets* numerous, hermaphrodite, orange to yellow, sometimes red or purple, 5-lobed, lobes oblong-lanceolate, acute. *Anthers* five, linear or linear-oblong; anther collar subcylindrical or somewhat balusterform, short to elongated, slightly dilated towards the base; apical anther appendages usually oblong-lanceolate. *Styles* 2-branched, style arms long, exserted, gradually tapered, with prominent apical tuft of papillae, sometimes coloured. *Cypselas* oblong to cylindrical, usually brown, ribbed, pilose to glabrous; carpopodium annular, cylindrical to hemispherical, usually yellowish, slightly larger in diameter than cypsela base; pappus of numerous capillary bristles, bristles barbellate, uniform, white, dirty-white or yellowish.

Chromosome numbers in *Gynura* range from 2n = 20 to 2n = 52 (Chidambaram, 2005).

Flowering throughout the year, commonly from December to May

Distributed from tropical Africa to South Asia eastward through southern China, Japan, Southeast Asia and New Guinea into northern Australia. Many species have been cultivated for medicinal (*G. psudochina*, *G. japonica* and *G. malaccensis*; Davies, 1981) or for horticultural purposes (*G. procumbens* and *G. aurantiaca*).

Key to the species of *Gynura*

1a. Plants climbing or scrambling.....…….....…….2

b. Plants erect or decumbent……..…….....……...4

2a. Leaves ovate to triangular, prominently auriculate…….....…1. *G. scandens*

b. Leaves elliptical to rhomboid, usually exauriculate…….....……...3.

3a. Plants slender; capitula 1-3 per corymb……...……...….2. *G. elbertii*

b. Plants robust; capitula 3-10 (20) per corymb…..….....……3. *G. procumbens*

4a. Plants usually with tuberous roots…….....5.

b. Plants with fibrous roots……..…….…….……...…..……13.

5a. Leaves lanceolate to narrowly linear-lanceolate …….....6.

b. Leaves elliptical, ovate, lyrate or pinnatifid…….....7.

6a. Leaves glabrous, petioles 0.5-2 cm long…….…..……. 4. *G. integrifolia*

b. Leaves with sparsely glandular indumentum, sessile ……..…5. *G. micheliana*

7a. Roots forming tapering tubers, diameter 1-2 cm …….....8.

b. Roots forming rounded tubers, diameter 1-6 cm …….....9.

8a. Leaves sessile……...…...6. *G. amplexicaulis*

b. Leaves petiolate, petiole 2-5 cm long…….……..….10.

9a. Plants smaller than 20-60 cm high; leaves simple……...…..…7. *G. calciphila*

b. Plant usually 60-120cm high; leaves usually pinnatifid……...…8. *G. dissecta*

10a. Plants about 1-2 m high or more, stems usually with leaves ……....…….....11.

b. Plants smaller than 10-50 cm, leaves in basal rosette …….....…....12.

11a. Leaves simple, sessile ……..……..……..…..……9. *G. siamensis*

b. Leaves pinnatifid, petioles 0.5-3 cm ……..……10.*G. japonica*

12a. Capitula 4-20 (-30) in dense corymbs; involucres 7-9 mm long .....11. *G. colorata*

b. Capitula 1-3 (6) per corymb; involucres about 13 mm long …..12. *G. pseudochina*

13a. Leaves exauriculate; stems usually erect…….....…….…….….14.

b. Leaves auriculate; stems erect, decumbent or procumbent…….....…….…27.

14a. Plants glabrous……..……..……...……...15.

b. Plants sparsely to densely pubescent…….....…17.

15a. Leaf base attenuate or semi-amplexicaulous; leaves sessile ..... 13. *G. annua*

b. Leaf base obtuse or cuneate, petioles 0.3-1.2 cm …….…….…..16.

16a. Leaf margin usually minutely denticulate; capitula 2-4 in lax corymbs…….……...…….....14. *G. alblicaulis*

b. Leaf margin entire; capitula 4-11 in dense corymbs…….…….15. *G. abbreviata*

17a. Leaf margin dentate; involucres 6-8 cm long…….…….16. *G. steenisii*

b. Leaf margin entire to minutely denticulate, involucres 8-13 cm long…..…….…18.

18a. Leaves clustered in upper part of stem ……19

b. Leaves in lower part of stem or along the stem…….20

19a. Phyllaries 7-8; cypselas 3-4 mm long.....17. *G. sechellensis*

b. Phyllaries 12; cypselas about 4.5 mm long…….……...18 *G. sundaniaca*

20a. Plants sparsely glandular, hispid or pubescent to glabrescent, leaves usually glabrescent below…….…….……....….21.

b. Plants and leaves densely tomemtose, pilose or pubescent ……..……...24.

21a. Leaves petiolate, petioles 1-4 cm long……..…….....……22.

b. Leaves sessile……..…...……...23.

22a. Leaves lanceolate; margin dentate……..……...……19. *G. malaccensis*

b. Leaves elliptical to ovate; margin entire or minutely denticulate…….…… 20. *G. carnosula*

23a. Plants sparsely glandular; phyllaries 12-14; capitula 3-7 per corymb…….…….21. *G. nitida*

b. Plants sparsely hispid to glabrescent; phyllaries 14-16; capitula 2-3 per corymb…….…….……..22. *G. travancorica*

24a. Leaves elliptical, rhomboid or lyrate; phyllaries 13-14……..…...25.

b. Leaves ovate; phyllaries 8-12…….....……26.

25a. Plants densely tomentose; cypselas 4-6 cm long……..23. *G. nepalensis*

b. Plants densely pilose; cypselas 2-3 cm long…….....…24. *G. hmopaengensis*

26a. Leaf blades about 8-12 x 5-8 cm, base cordate……..…25. *G. rubiginosa*

b. Leaf blades 3-12 x 2-4 cm, base cuneate…….....26. *G. villosus*

27a. Plants scapose, about 10-120 cm high, leaves in lower part of stem……....28

b. Plants robust about 1-2 m high or higher, leaves along the stem ……....30.

28a. Peduncles glandular pubescent…….....27. *G. campanulate*

b. Peduncles hispid or pubescent to glabrous…….....29

29a. Plant tomentose or glabrous……...28. *G. drymophila.*

b. Plants densely hispid.....29. *G. hispida*

30a. Leaves sessile or petioles 0.5-1 cm long 31

b. Leaves petiolate, petioles 1-8 (15) cm long.....32.

31a. Leaves glabrous……..……....……. 30. *G. cusimbua*

b. Leaves brownish scabrous ……..……..…31. *G. ajakensis*

32a Plants about 1 m high……...…...……33.

b. Plants 1-2 m high or higher…….……...…….39.

33a. Leaves entire, elliptical.....32. *G. elliptica*

b. Leaves serrate-dentate, ovate to lanceolate or lyrate…….....34.

34a. Stems sparsely pubescent……..……..…….33. *G. divaricata*

b. Stems densely pubescent or vilose……....…….……35

35a. Phyllaries 8-10; involucre 6-8 mm long.....34. *G. batorensis*

b. Phyllaries 12-14; involucre 8-12 mm long.....36.

36a. Petioles 1-2 cm long……..…….……...…35. *G. brassi*

b. Petioles 3-7 cm long……...……..…….37.

37a. Leaves simple lanceolate……..…….....……36. *G. fulva*

b. Leaves lyrate or pinnatifid ……..……..….38.

38a. Plants sparsely or densely scabrous; peduncles 2-6 cm long……...37. *G. lycopersicifolia*

b. Plants densely whitish-tomentose; peduncles 0.5-2 cm long…..…38. *G. zeylanica*

39a. Leaves sessile.....40.

b. Leaves petiolate, petioles 1-8 cm long.....41.

40a. Plants glabrous.....39. *G. daviesii*

b. Plants sparsely to densely pubescent.....40. *G. vidaliana*

41a. Leaves lyrate or pinnatifid.....41. *G. valeriana*

b. Leaves not lyrate or pinnatifid 42

42a. Plants sparsely pubescent; leaves lanceolate to elliptical.....42. *G. bicolor*

b. Plants densely pubescent; leaves ovate or lyrate.....43.

43a. Plants densely white-appressed pubescent; cypsela pilose; florets 25-30.....43. *G. grandifolia*

b. Plants scabrous; cypsela glabrous; florets 30-45.....44. *G. aurantiaca*

1. Gynura scandens O. Hoffm. (Fig. 23A)

Gynura scandens O. Hoffm. in Engl., Pflanzenw. Ost-Afr. C (1895) 416.- *Crassocephalum scandens* (O. Hoffm.) Hiern, Cat. Welw. Pl. (1898) 595- Lectotype: *Holst 3315* [K!, iso BM, W designated by Davies (1977)], Tanzania, Usambara, Lutindi.

Gynura ruwenzoriensis (S. Moore) S. Moore in Op. Cit. 50 (1912) 213.- *Crassocephalum ruwenzoriensis* S. Moore in J. Linn. Soc. Bot. 35 (1902) 352.- Type: *Scott-Elliot 7777* (holo BM!; iso K!), Ruwenzori.

Gynura auriformis (S. Moore) S. Moore in J. Bot. 50 (1912) 212-*Crassocephalum auriformis* S. Moore in Op. Cit. 37 (1904) 171.- Type: *Bagshawe 657* (holo BM!), Uganda, Lake Victoria.

Gynura taylorii S. Moore in J. Bot. 43 (1906) 23.-Type: *Taylor s.n*. (holo BM!) Tanzania, Rabai.

Senecio seretii de Wild. in Ann. Mus. Congo. V. 3 (1910) 315.-Type: *Scaetta 666* (holo BR!),Congo, Fendula, Nyakolonge.

Gynura brownie S. Moore in Op. Cit. 54 (1916) 281.-Type: *E. Brown* as *Dummer 2723* (holo BM!), Uganda, Kampala.

Senecio rutshuruensis de Wild., Pl. Bequart. 5 (1929) 130.-Type: *Bequaert 6054* (holo BR!). Congo, Rutshuru,

Senecio variostipellatus de Wild., Op Cit. (1929) 135.-Type: *Bequaert 2980* (holo BR!), Congo, between Mboga & Lesse.

Plants 1.5-6 m high or more, stems climbing, pubescent. *Petioles* 2-8 cm long, usually auriculate, auricles 2-7 x 3-9 mm, sparsely pubescent. *Blades* ovate to triangular, rarely lyrate, 1.5-9 x 2-12 cm, sparsely pubescent, base cuneate, truncate or cordate, apex obtuse or acute, margin coarsely dentate. *Capitula* numerous in dense corymbs; peduncles stout, 3-8 cm long, pubescent, bracts 1-4, 1-3 mm long; involucres 8-12 mm long, 3-7 mm in diameter; calycular bracts 3-7, 3-6 mm long, pubescent; phyllaries 13-14, 1-2 mm broad, sparsely pubescent. *Florets* 60-80, yellow or orange-red, 10-13 mm long, exserted part 2-3.5 mm long. *Anthers* 2.5-3 mm long, anther collars elongated. *Style arms* 2-3.5 mm long. *Cypselas* 4-5 mm, brown, pilose; carpopodium annular or cylindrical, brownish; pappus 10-12 mm long, white or dirty white.

Flowering and fruiting throughout the year. Climbing on trees in wooded ravines, at the edge of mixed to moist forests, also in secondary vegetation, 0-3000 m. Tropical Africa (Fig. 12).

Note. Gynura scandens is easy to recognize on accout of its scandent habit and its distinct leaf shape. The lower leaves mostly are triangular and usually auriculate. Jeffrey & Beentje (2005) noted that in tropical East Africa the species is similar to *Solanecio nandensis* (S. Moore) C. Jeffery from which it differs by having white or pale yellow florets and a longer pappus, which is 5-8 mm long in *S. nandensis*.

Specimens examined. **Congo**: Bukeye, 1926, *Robynes 2319* (K); Rutshuree, 1937, *Ghesquiere 4331* (K); Djugu, 1931, *Lebrun 3909* (K); Katara, 2 Feb. 1953, *Kinet 242* (K); Muguga, Dec. 1937, *Lebrun 8837* (K). **Burudi**: Teza, Muramya, 14 June 1981, *Reekmans 10692* (K), 19 June 1980, *Reekmans 9380* (K), 12 Jan. 1966, *Lewalle* 240 (K); Cibitoki, 4 May 1969, *3526* (K), **Rwanda**: Biumba, 12 July 1958, *Troupin 8007* (K); Gihindamuyaga, 8 June 1978, *Raynal 20353* (K); Nyungwe, 13 March 1971, *Bouxin 462* (K); Kibuye, 10 June 1981, *Troupin 16296* (K). **Uganda**: Ankole, Buhwejo, Rugongo, 7 Jan 1917, *Rwanburindore 510* (K); Kigeze, Kachwekano Farm, July 1949, *Purseglove P2978* (K), Feb. 1950, *Purseglove P3239* (K), Kinkizi, 16 May 1951, *Dawkins 737* (K); Busoga, Bukizibu, 15 June 1953, *Wood 765* (K); Mengo, Nakiza Forest, 24 Jan. 1951, *Dawkins 707* (K), Wabusana-Luwero, July 1956, *Langdale-Brown 2253* (K); Kabarole, Kibale, 17 June 1997, *Eilu 130* (K); Ichuya Forest, 28 Dec. 1995, *Freidberg & Yarom 21* (K); Bunjenje, Budongo Forest, 26 May 1971, *Synnott 608* (K); Nkose, Lake Victoria, 22 Jan 1956, *Dawkins 882* (K). **Kenya**: Kamasia, Katimok Forest, Oct. 1930, *Dale 2444* (K); Elburgon Forest, Feb. 1952, *Souereu s.n.* (K); Webuye, 10 Oct 1981, *Gilberg & Tadossa 6578* (K); Nakuru, 26 April 1979, *Gillett 21826* (K), N lake of Nakuru, 5 Aug. 1967, *Mwangangi* 86 (K); Sotik, 12 Sept 1949, *Balley 7455* (K), Masai, Migori, June 1961, *Glover et al 1807* (K); Mangea Hill, Mar. 1989, *Luke & Robertson 1789* (K); Cheymen, 19 Sept 1992, *Freidberg 54* (K). **Tanzania**: Tanga, Muheza, Usambara Mts, 12 Nov. 1986, *Iversen & Steiner 86662* (K); Moshi, Kilimandjaro, 19 Jan. 1938, *Schlieben 4591* (K); Lushoto, Kwamkoro, May 1987, *Lversen 87/372* (K); Ufipa, Nsanga, Aug. 1960, *Richards 13009* (K); Nguru, Maskati, March 1988, *Bidgood et al. 476* (K); Zanaki, Musoma, 21 June 1959, *Tanner 4390* (K); Bukoha, Minziro Forest, 3 July 2000,

Bidgood et al. 4821 (K). **Malawi**: Nkhata Bay, Chikangawa, 21 Aug. 1978, *Phillips 3807* (K); Mzimba, 23 Sept 1939, *Pawek 2742* (K). **Zambia**: Penza Village, 19 Oct 1968, *Sanane 334* (K).

2. Gynura elbertii Koster (Fig. 23B)

Gynura elbertii Koster in Fedde, Rep. Spec. Nov. 34 (1933) 25.-Type: *Elbert 1251* (holo L!), Lesser Sunda Islands, Lombok, Segare Anak.

Plants 1-2 m high or more, stems prostrate, scrambling, glabrous. *Petioles* slender, 3-7 cm long, exauriculate, glabrous. *Blades* elliptical or sometimes cordate, 6-11 x 3-5 cm, glabrous, base cuneate, apex acute, margin entire to dentate. *Capitula* 2-4 in lax corymbs; peduncles slender, 1.5-6 cm long, glabrescent, bracts 1-3, 1-3 mm long, glabrescent; involucres 6-8 mm long, 2-4 mm in diameter; calycular bracts 8-15, 1-3 mm long, glabrescent; phyllaries 8, 1-1.5 mm broad, glabrescent. *Florets* 12-15, yellow, 9-11 mm long, exserted part 1-3 mm. *Anthers* 2.5 mm long, anther collars elongated. *Style arms* 3.5 mm long. *Cypselas* 2-2.5 mm long, brown, glabrous; carpopodium cylindrical, yellowish; pappus 7-9 mm long, white.

Flowering from May to June. Climbing on trees in disturbed areas, on limestone, 700-1000 m. Endemic to Indonesia (Lesser Sunda Islands) (Fig 12).

Note. Gynura elbertii is recognizable by its slender scrambling habit and its narrow capitula arranged in lax corymbs.

Specimens examined. **Indonesia**: Lesser Sunda; Lombok, Segare Anak, 11 May 1909, *Elbert 1251* (L), 19 June 1909, *Elbert 2271* (L); Sumbawa, Batulanteh Mts, 17 April 1961, *Kostermans 18272* (A, K); Bali, 30 March-14 April 1950, *Holstvoogd* (A, L).

3. Gynura procumbens (Lour.) Merr. (Fig. 23C)

Gynura procumbens (Lour.) Merr., Enum. Philipp. Fl. Pl. 3 (1923) 618.-*Cacalia procumbens* Lour., Fl. Cochin. (1790) 485.-Type: *Loureiro s.n.* (holo P!), Cochinchina.

Gynura sarmentosa (Blume) DC., Prodr. 6 (1838) 298.- *Cacalia reclinata* Wall *Cat. n. 3151* (1830), *nom. nud*.-*Cacalia sarmentosa* Blume, Bijdr. (1826) 907.-Type: *Blume 1041* (holo & iso L!), Indonesia, Java.

Cacalia cylindriflora Wall. Cat. n. 3150 (1830), *nom. nud*.

Cacalia finlaysoniana Wall. Cat. n. 3162 (1830), *nom. nud*.

Cacalia sarracenia Blanco, Fl. Filip. (1837) 618, non Linn.-*Senecio cacaliaster* Blanco op. cit. ed. 2: 441 (1845).- Type: not found.

Gynura affinis Turcz., Bull. Soc. Nat. Mosc. 24 (1851) 201.-Type: *Cumming 926* (holo & iso K!), Philippine, Luzon, Albay.

Gynura lobbiana Turcz., Bull. Soc. Nat. Mosc. 24 (1851) 202.-Type: *Lobb 239* (holo K!, iso BM!, L!), Indoneisa, Java.

Gynura scabra Turch., Bull. Soc. Nat. 24 (1851) 201.-Type: *Cumming 1638* (holo K!), Philippine, Panay.

Gynura latifolia (S. Moore) Elmer, Leaflets Philipp. Bot. 1 (1906) 145.- *Crassocephalum latifolium* S. Moore in J. Bot. 43 (1905) 141.-Type: *Whitehead s.n.* (holo BM!), Philippines, Negros.

Gynura clementis Merr., Philipp. J. Sci. 1 Suppl. (1906) 244.-Type: *Clemens 49* (holo PNH), Philippines, Mindanao, Lake Lanao, Camp Keithy.

Gynura piperi Merr., Philipp. J. Sci. Bot. 7 (1912) 355.-Type: *Piper 384* (holo K) Philippines, Siquijor.

Gynura cavaleriei H.Lév., Bull. Geogr. Bot. 24 (1914) 284.-Type: *Esquirol 3572* (holo E!), China.

Gynura agusanensis Elmer, Leaflets Philipps. Bot. 7 (1915) 2585.-Type: *Elmer 13864* (holo K!), Phillippine, Mindanao, Mt Urdaneta, Agusan.

Gynura pubigera Boldingh, Zakflora Landbouwstr. Java (1916) 58. *non rite publ.*

Gynura buntingii S. Moore, J. Bot. 54 (1916) 287.-Lectotype: *Bunting 110* [BM, designated by Davies (1977)], Liberia.

Gynura emeiensis Z. Y. Zhu, Bull. Bot. Res. 26 (2006) 645. synon. nov. - Type: *Z. Y. Zhu s.n.* (holo EMA photo), China, Sichuan, Emeishan.

Plants 2-5 m high or more, stems scrambling to climbing, sparsely pubescent to glabrescent. *Petioles* 1-10 cm, usually exauriculate, glabrescent. *Blades* elliptical to rhomboid, 1-11 x 0.5-6 cm, sparsely pubescent or glabrous, base cuneate or narrowed into petiole, apex acute, margin subentire to denticulate. *Capitula* 3-10 (20) per

corymb; peduncles stout, 2-7 cm long, subglabrous, bracts 1-4, 1-3 mm long; involucres 12-20 mm long, 3-7 mm in diameter; calycular bracts 7-8, 3-6 mm long, sparsely pubescent to glabrescent; phyllaries 8-12, 1-2 mm broad, glabrous. *Florets* c 20-35, yellow or orange-red or purple, 9-20 mm long, exserted part 2-3.5 mm long. *Anthers* 2.5-3 mm long, anther collars elongated. *Style arms* 2-3.5 mm long. *Cypselas* 4-6 mm, brown, pilose to glabrous; carpopodium annular or cylindrical, yellowish; pappus 10-20 mm long, white or dirty-white. 2n = 20 (Jose & Mathew, 1990), 52 (Chidambaram, 2005).

Flowering and fruiting throughout the year. Climbing on trees in wooded ravines, at the edge of mixed to moist forests, along open areas on limestone, in oil palm plantations, 0-4000 m. Tropical West Africa and tropical Asia from India, China, Myanmar, Thailand, Malaysia, Philippines, Indonesia to Papua New Guinea (Fig. 12).

Note. Davies (1980b) already noted that the species is very variable in the dentation of the leaf margin, the shape of the leaf base, the length and number of involucral bracts and the degree of branching of the inflorescence. This variation, however, is continuous, and does not warrant the subdivision of the species.

Specimens examined. **Ghana**: Gold Coast, Volta River, Nov. 1951, *Morton 6071* (K), Aburi, 27 Nov. 1953, *Adam 1914* (K), Ajema, 29 Nov. 1955, *Morton 9456* (K). **Liberia**: Webo, Diebla, 2 July 1947, *Baldwin 6368* (K), Kolahun, Gondalahun, 2 Nov. 1987, Bladwin *10117* (K). **Guinea**: Sierra Leone, Picket Hill, 16 Oct. 1965, *Morton s.n*. (K)**. Nigeria**: Abeokuta, Olokemeji, 22 July 1948, *Keay 22414* (K). **India**: without locality, *Wallich 3150* (K)*, 3151* (K). **China**: Hainan, Taam Chau-Lam Ko, 4 May 1928, *Tsang 237* (G), 2 Nov. 1933, *Liang 63584* (A, G), Po-Ting, April 1935, *How 71601* (BM, G); Yunnan, Pin Fa, April 1908, *Cavalerie 7381* (K). **Laos**: Weing Chan, Mnang Hnang, 29 March 1932, *Kerr 20794* (BM). **Thailand**: Chumpawn, Ban Mak Amarit, 14 Jan. 1977, *Kerr 11429* (BM); Surathani, Samui, 14 May 1920, *Kerr 15713* (BM), Ban Kanth Kep 16 Feb. 1927, *Kerr 13364* (BM); Pattani, Ban Sai Kao, 18 March 1918, *Kerr 14859* (BM), Banang Sta, 27 Jan. 1923, *Kerr* 7367 (BM); Ranong, Kao Panta Cheng dong, 10 Jan. 1929, *Kerr 16764* (BM). **Malaysia**: Perak, Gunong Kerbau, June 1913, *Robinson s.n*. (BM), 13 Sept. 1949, *Sinchair 38709* (BM); Borneo, Sabah, Tenompok, Mt Kinabalu, Dec. 1933, *Clemens*

51678 (BM), 7 April 1984, *Beaman 9265* (L) Penampang, 17 Sept. 1991, *Krispinus 131417* (L). **Singapore**: Johore, Gunong Pulai, 12 Feb.1961, *Burkill 2588* (A); Ulu Brang, Trengganu, July 1937, *Moysey & Kiah 33350* (A). **Indonesia**: Java, Mt Salak, 2 Oct. 1904, *Hochreutiner 1961* (G), Mt Wajang, 28 July 1904, *Hochreutiner 1633* (G), Malang, Dadapan Kulon, 18 July 1980, *Mogea 2531* (L); Lesser Sunda, Flores, Sita, 1 July 1963, *Verheijen 675* (TEX); Borneo, Berau, Mt Njapa, 25 Oct. 1963, *Kostermans 21508* (L); Amboyna, 15 Sept. 1840, *Barclay 4146* (BM), Mt. Kinabalu, Dec. 1933, *Clemens 51678* (BM); Sarawak, Bakelalan, 13 Aug. 1955, *Brooke 10358* (BM), Kalabit, 18 April 1970, *Nooteboom & Chai* 2127 (L), Mt Dulit, 13 Sept. 1932, *Richards 1763* (L); Sumatra, Barong, 8 June 1914, *Robinson & Kloss* 124 (BM), Kota Pinang, Saboengan, March 1933, *Toroes 3794* (A), without locality, 1880, *Forbes 1404* (BM); Celebes, Minahasa, 1854, *Hose 791* (BM). **Philippines**: Negros, Dumaguete, March 1908, *Elmer 9571* (BM, G, L); Samar, Oct. 1922, *Merrill 11597* (G); Luzon, Mt Bulusan, Dec. 1915, *Elmer 15342* (BM, G, L), Mt Banahaw 29 Feb. 1996, *Reynoso & Majaducon 21678* (TEX), San Antonio, Aug. 1910, *Ramos 10946* (BM), Benguet, Dec. 1910, *Femix 12912* (BM), Mt Juban, 23 June 1956, *Edano* 37199 (BM, L), Mt Malianao, 3 Feb. 1956, *Edano 34510* (L), Mt Urdaneta, Sept. 1912, *Elmer 13864* (BM, G), Intavas, Mt Kitanglad, 18 July 1991, *Gaerlan et al. 3286* (TEX); Poneas, Sitio Dabo, *Stone at al. 12030* (TEX). **Papua New Guinea**: Central, Mt Tafa, May 1933, *Brass* 4882 (BM), Rona, Laloki river, April 1933, *Brass 3682* (BM), Koitaki, 22 April 1935, *Carr 12003* (BM); Western, Laiagam, 1 Sept. 1960, *Hoogland & Schodde 7659* (BM), Tomba Village, 6 Sept. 1956, *Hoogland & Pullen 6151* (BM); Eastern, Goroka, Daula camp, 30 Aug. 1957, *Pullen 417* (BM), Mt Wilhelm, 14 July 1959, *Brass 30517* (L); Megang, Kaironk Village, 24 July 1997, *Weiblen et al 1031* (L).

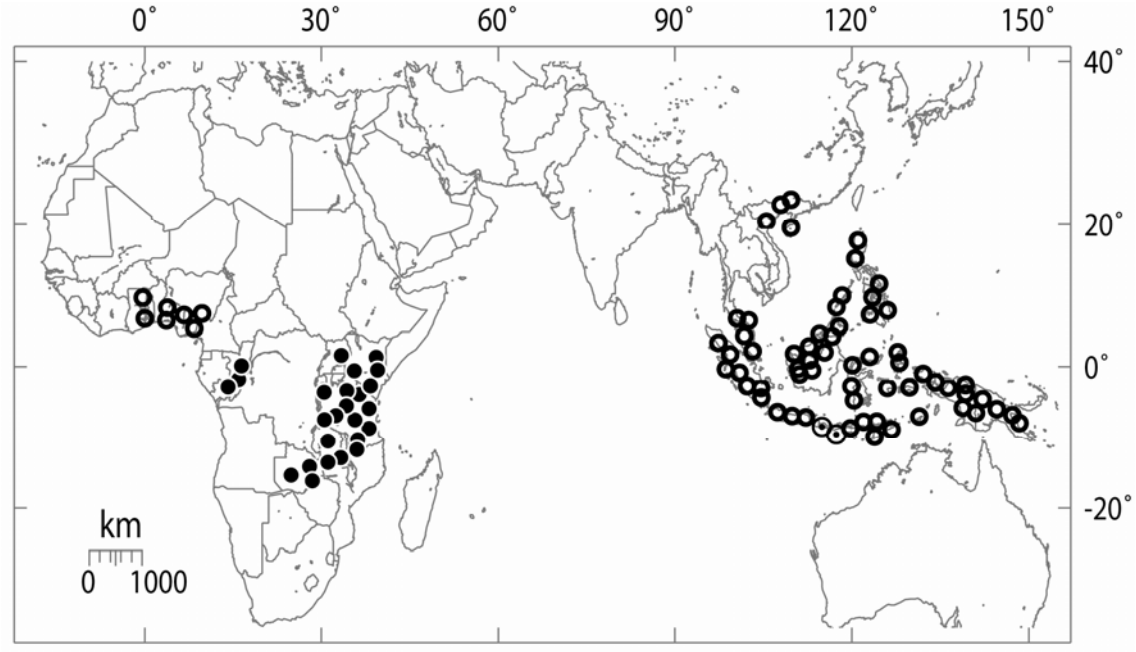

Figure 12. Distribution of *Gynura scandens* ●, *G. elbertii* ⊙, *G. procumbens* ✪.

4. Gynura integrifolia Gagnep. (Fig. 23D)

Gynura integrifolia Gagnep. in Bull. Soc. Bot. France 78 (1921) 120.-Lectotype: *Geoffray 427* [P!, designated by Davies (1980)], Cambodia, Kampot.

Gynura annamensis S. Moore, J. Nat. Hist. Soc. Siam 4 (1922) 147.-Type: *Kloss s.n.* (holo BM!), Vietnam, Lang bian.

Plants 10-40 cm high, stems erect, arising from small subglobose tubers of about 1-2 cm diameter, leaves in lower part of stems, sparsely pubescent. *Petioles* 0.5-2 cm long, exauriculate, sparsely pubescent to glabrescent. *Blades* narrowly linear-lanceolate, sometime elliptical, 4-12 x 0.3-1.5 cm, sparsely pubescent , apex obtuse to acute, base cuneate, margin entire or rarely denticulate. *Capitula* 1-3 per corymb; peduncles slender, 4-10 cm long, sparsely pubescent, bracts 2-6, 1-5 mm long; involucres 8-11 mm long, 2.5-6 mm in diameter; calycular bracts 5-8, 3-5 mm long, pubescent; phyllaries ca. 14, 1-2 mm broad, sparsely pubescent. *Florets* 20-30; orange to yellow, 8-12 mm long, exserted part 2-3 mm long. *Anthers* 2-2.5 mm long, anther collars elongated. *Style arms* 3-3.5 mm long. *Cypselas* 2-3 mm long, brown, pilose; carpopodium annular to cylindrical, yellowish; pappus 8-10 mm long, dirty-white.

Flowering and fruiting throughout the year. Growing in open grassy places in evergreen and mixed deciduous forests, 500-1500 m. Myanmar, Thailand, Laos, Vietnam and Cambodia (Fig. 13).

Note. Gynura integrifolia can be recognized by its often narrowly linear-lanceolate leaves and its small, subglobose tuberous roots.

Specimens examined. **Myanmar**: Shan, Taunggyi, 5 Aug. 1934, *Malaise 260* (S). **Thailand**: Chiang Mai, Doi Suthep, 12 July 1958, *Sorensen et al. 4026, 2289* (K); 11 July 1987, *Maxwell 87-630, 88-790* (AAU, E, L), Doi Pha Dam, 5 July 1968, *Larsen et al. 2157* (AAU); Loei, Poo Kradeng, 19 Jan. 1948, *Native 102* (S), 10 July 1959, *Floto* 7452 (K), 20 July 1964, *Bunchuai* 133 (L), 18 Dec. 1982, *Koyama* T31272 (KYO), 31 Aug. 1988, *Koyama T61478* (KYO); Chaiyaphum, Thung Kra Mang, *Geesink et al. 7061* (AAU, L), *Larsen et al*. *31622* (AAU); Khon Kaen, Nam Nao, 11 Oct., 1979, *Shimizu et al. T18304* (KYO); Nakawn Sawan, Hna Wai, 28 Aug. 1931, *Put 4059* (BM, K, L); Chonburi, Kow Kiew, 30 May 1976, *Maxwell 76-363, 75-986* (AAU, L); Chanthaburi, Khao Phra Bat, 27 Sept. 1972, *Larsen et al*. *32121* (AAU). **Laos**: Mt La Khon, *Harmand s.n*. (P). **Vietnam**. Annam, Langbian, June 1906, *Andre s.n.* (P), March 1918, *Kloss* s.n. (BM), 12 Dec. 1912, Eberhardt 1782 (P). **Cambodia**: Kampot, 25 Octorber 1904, *Geoffray 427* (P); Mt. Pursat, 18 June 1875, *Godefroy 409* (P).

5. Gynura micheliana J. G. Adam (Fig. 24A)

Gynura micheliana J. G. Adam in Bull. I.F.A.N. 35 (1975) 79.-Type: *J. G. Adam 25818* (holo P photo), Guinea, Nimba Mts.

Plants 30-80 cm high, stems erect from small subglobose tubers of about 1-2 cm diameter, plants subsucculent, with sparse glandular indumentum. *Leaves* sessile, exauriculate. *Blades* narrowly obovate to oblong, 5-15 x 1.5-4 cm, with sparse glandular indumentum, base narrowed, apex obtuse, margin entire or sinuate-dentate. *Capitula* 1-5 in lax corymbs; peduncles 2-5 cm long, sparsely glandular-pubescent, bracts 3-7, 2-4 mm long; involucres 9-12 mm long, 4-8 mm in diameter; calycular bracts 4-7, 3-5 mm long, sparsely to densely glandular-pubescent; phyllaries 13-18, 1-2 mm broad, sparsely glandular-pubescent. *Florets* c. 50-100, orange to yellow, rarely

green or white, 10-13 mm long, exserted part 3.5-4.5 mm. *Anthers* 2 mm long, anther collars elongated. *Style arms* 3 mm long. *Cypselas* 5-5.5 mm long, brown, pilose to glabrous; carpopodium cylindrical, yellowish; pappus 8-10 mm long, white.

Flowering and fruiting throughout the year. Growing on grassy mountain sides, 1500-2500 m. Only know from tropical West Africa (Fig. 13).

Note. *Gynura micheliana* is very similar to the Southeast Asian *G. integrifolia*. It differs from *G. intergrifolia* by having a glandular indumendum and sessile leaves.

Specimens examined. **Guinea**: Sierra Leone, Bintinmani, 18 July 1960, *Bakahi 279* (K), Tingi Hill, 11 April 1965, *Morton & Gledhill SL1883* (K); Lomas Mts., 19 June 1966, *Morton SL 3622* (K), without locality, June 1958, *Adam 14500* (K).

6. Gynura amplexicaulis Oliv. & Hiern (Fig. 24B)

Gynura amplexicaulis Oliv. & Hiern in Oliv. Fl. Trop. Afr. 3 (1877) 403.-*Crassocephalum amplexicaule* (Oliv. & Hiern) S. Moore in J. Bot. 50 (1912) 211.-Type: *Schwienfurth 3770* (holo K!; iso BW, W), Sudan, Niamniam Land, Bodumo.

Gynura claessenii De Wild., Pl. Bequaert 5 (1929) 91.-*Senecio claessenii* (De Wild.) Humbert & Staner in Bull. Jard. Bot. 14 (1936) 105.-Type: *J. Claessens 1295* (holo BR!) Congo, Kilo.

Plants 1 m high or more, stems erect, from irregular subglobose tubers of about 1-5 cm diameter, sparsely pubescent. *Leaves* sessile, exauriculate. *Blades* narrowly rhomboid to linear, 9-20 x 1-4 cm, sparsely to densely pubescent, base cuneate or sagittate, apex acute, margin coarsely dentate. *Capitula* 3-10 in dense corymbs; peduncles stout, 2-10 cm long, glabrescent, bracts 2-6, 1-3 mm long; involucres 15-22 mm long, 3-7 mm in diameter; calycular bracts 3-5, 3-6 mm long, glabrescent; phyllaries 13-15, 1-2 mm broad, glabrous. *Florets* (50) 80-100, yellow, orange, red or purplish, 9-15 mm long, exserted part 3.5-4.5 mm long. *Anthers* 2.5-3 mm long, anther collars elongated. *Style arms* 2-2.5 mm long. *Cypselas* 4-6 mm, dark brown, sparsely pilose to glabrous; carpopodium annular or cylindrical, yellowish; pappus 10-18 mm long, white or dirty-white.

Flowering from March to July. Growing in open places, grassland, marshy areas or as a weed of cultivated fields, 500-2000 m. Tropical Africa and Asia (only Nepal) (Fig. 13).

Note. This species is similar to the more widely distributed *Gynura pseudochina* but has amplexicaulous leaves. *Gynura amplexicaulis* has previously been thought to be endemic to tropical Africa but has now also been discovered in Nepal.

Specimens examined. **Congo**: Kasmidi, 1932, *Lebrun 4739* (K); Rutahuree, Dec. 1937, *Lebrun 8326, 8901, 9174* (K). **Zaire**: Caramba, 15 May 1951, *Saeger 1137* (K). **Uganda**: Nyakasula, 7 Jan. 1936, *Wancock 142/36* (K) Ankole, Bunyaruguru, Feb. 1939, *Purseglove 563* (K); Teso, Serere, March 1932, *Chandler 592*; May 1972, *Lye 6884* (K); Buambara, N Kigizi, Feb. 1950, *Purseglove P3276* (K). **Kenya**: Elgon, 1930, *Lugrad 240* (K); Trans Nzoia, July 1965, *Tweedie 3071* (K); Kericho, Kibajet Estate, Oct. 1948, *Bally 6477* (K); Kitale, Jan. 1957, *Knight AB 4405* (K). **Tanzania**: Bukoba, Kakindu, Oct. 1931, *Haarer 2327* (K), Minziro Forest, 23 Nov. 1999, *Festo et al 396*; Biharamulo, Lasahunga, Oct. 1960, *Tanner 5359* (K). **Nepal**: Dhaulagiri, Myagdi, Tatopani, 28 July 1996, *Hoshino et al. 9662059* (A): Gandaki, Gorkha, Macha, 22 July 1994, *Suzuki et al. 9470129* (A), Jagat, 24 July 1994, *Suzuki et al. 9460060* (A).

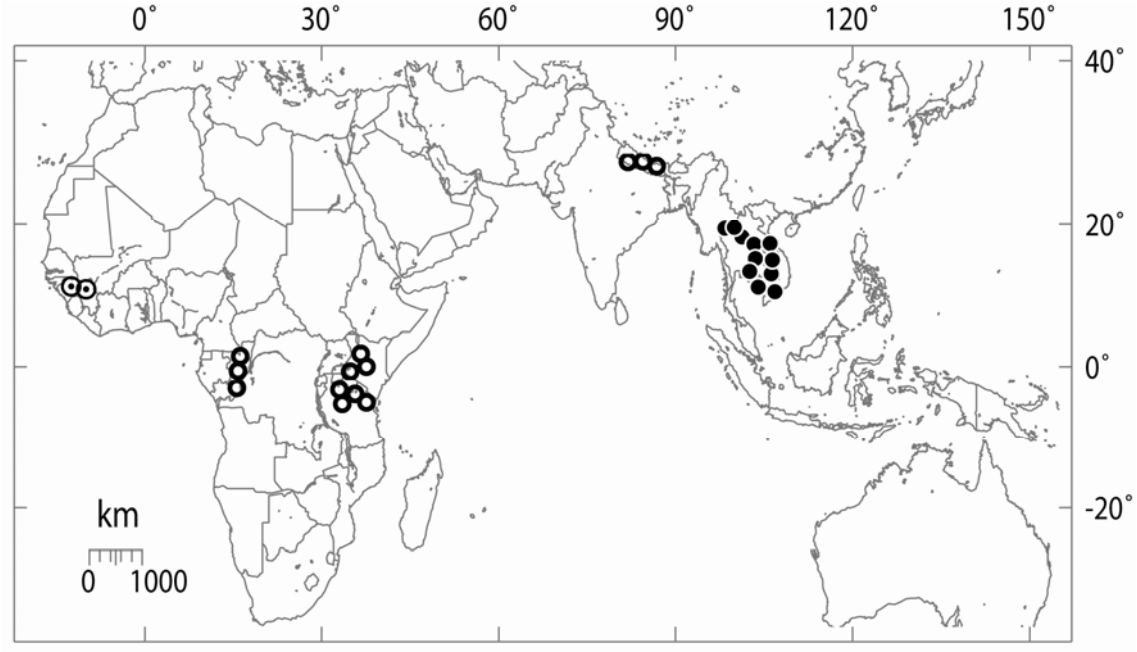

Figure 13. Distribution of *Gynura integrifolia* ●, *G. micheliana* ⊙, *G. amplexicaulis* ✪.

7. Gynura calciphila Kerr (Fig. 24C)

Gynura calciphila Kerr in Bull. Misc. Inf. Kew 1935 (1935) 330.-Type *Put* 953 (holo K!; iso BM!), Thailand, Chumpawn, Siepzuan.

Plants 20-60 cm high, stems decumbent or erect from small tapering tubers of about 1-2 cm diameter, subsucculent, sparsely pubescent. *Petioles* 3-7 cm long, with small auricles, 0.5-1 x 0.5-2 cm, or auricles absent, sparsely pubescent. *Blades* cordate, ovate or elliptical, 5-11 x 1.5-6 cm, sparsely pubescent, base cordate, apex acute, margin sinuate-dentate. *Capitula* 1-5 in lax corymbs; peduncles 4-10 cm long, sparsely pubescent, bracts 3-7, 2-4 mm long; involucres 7-10 mm long, 3-8 mm in diameter; calycular bracts 4-7, 3-5 mm long, pubescent; phyllaries 14, 1-2 mm broad, sparsely pubescent. *Florets* 15-25, orange to yellow, 10-13 mm long, exserted part 2-3 mm. *Anthers* 2 mm long, anther collars elongated. *Style arms* 3 mm long. *Cypselas* 4 mm long, brown, glabrous; carpopodium cylindrical, yellowish; pappus 7-10 mm long, white. 2n = 20 (counted here).

Flowering and fruiting throughout the year. Growing in open rocky places of limestone hills, 0-500 m. Endemic to peninsular Thailand (Fig. 14).

Note. Gynura calciphila is a subsucculent plant arising from small, tapering tubers. It often has subsucculent, ovate or elliptical leaves.

Specimens examined. **Thailand**: Chumpawn, Siepzuan, 6 Sept. 1927, *Put 953* (K, BM); Surathani, Khao Phra Rahu, 20 Sept. 1963, *Smitinand & Sleumer 1158* (K, L), Khao Sak 30 Aug. 1982, *Shimuzu et al. T28941* (KYO), Khao Lak, 21 Sept. 1963, *Smitinand & Sleumer 1194* (L); Trang, Lamphura, 16 Nov. 1990, *Larsen et al. 41457* (AAU), Nam Tai, 11 Oct. 1970, *Charoenphol et al. 3635* (AAU); Patalung, Kaw Si Kaw Ha, 12 April 1928, *Kerr 15144* (BM, E, L, K), Kao Olatalu, 21 April 1928, *Kerr 15345*; Songkla, Khao Changlon, 24 July 1928, *Kerr 15898* (BM, K); Krabi, Khao Tham Sua, 4 Sept. 1982, *Shimizu et al. T29096* (KYO), 24 Oct. 1991, *Larsen et al. 42548* (AAU), Had Nopharatara, 2 Jan. 2005, *Vanijajiva 050* (MJG); Phang Nga, Khao Ping Kan, 8 Sept. 1982, *Shimizu T29200* (KYO).

8. Gynura dissecta (F. G. Davies) Vanijajiva & Kadereit, *comb. nov.* (Fig. 24D)

Gynura calciphila Kerr var. *dissecta* F. G. Davies in Kew Bull. 33 (1979) 637.-Type:

> *Geesink & Phengkhai 6235* (holo K!; iso AAU!, E!, KYO!), Kanchanaburi, between Kritee and Huay Ban Kao.

Plants 60-120 cm high, stems fleshy, erect or somewhat decumbent, from small tapering tubers, 1-1.5 cm diameter, sparsely pubescent. *Petioles* 2-4 cm long, with prominent auricles 5-8 x 4-9 mm, sparsely pubescent. *Blades* ovate in outline, usually pinnatifid, 5-11 x 1-6 cm, sparsely pubescent, base cuneate, apex acute, margin dentate. *Capitula* 2-5 per corymb; peduncles 1-6 cm long, sparsely pubescent, bracts 5-10 , 2-7 mm long; involucres 5-8 mm long, 4-9 mm in diameter; calycular bracts 4-7, 3-5 mm long, pubescent; phyllaries 12-14, 1-2 mm broad, sparsely pubescent. *Florets* 20-30, yellow, 10-13 mm long, exserted part 2-4 mm. *Anthers* 2 mm long, anther collars elongated. *Style arms* 2.5-3 mm long. *Cypselas* 4 mm long, brown, glabrous; carpopodium cylindrical, yellowish; pappus 7-10 mm long, white.

Flowering and fruiting from July to August. Growing in open places of bamboo forests and on limestone cliffs, 500-800 m. Endemic to central Thailand (Kanchanaburi) (Fig. 14).

Note. *Gynura dissecta* was originally described as *G. calciphila* var. *dissecta* (Davies, 1978). However, the species can be distinguished from *G. calciphila* by being somewhat fleshy, by having usually pinnatifid leaves and by being restricted to central Thailand.

Specimens examined. **Thailand**: Kanchanaburi, between Kritee and Huay Ban Kao, 12 July 1973, *Geesink & Phengkhai 6235* (K, AAU, E, KYO), Khao Obuing, 16 Aug. 1971, *Pengklai et al. 2989* (K, KYO, L), Ban Tha Kradan, 8 Aug. 1982, *Shimizu et al. T28487* (KYO).

9. Gynura siamensis Vanijajiva & Kadereit, *spec. nov*. (Fig. 25A)

Species *G. pseudochina* affinis sed sessile foliis, laminis margina sinuate-dentate.- Typus: *Maxwell 91-643* (holo E, iso A, AAU, L), Thailand, Chiang Mai.

Plants 1-2 m high or more, stems erect, arising from irregularly subglobose tubers of about 1-3 cm diameter, brownish pubescent. *Leaves* sessile, exauriculate, pubescent. *Blades* ovate to elliptical, 2-9 x 3-5 cm, sparsely pubescent, base amplexicaulous, apex obtuse, margin sinuate-dentate to pinnatifid. *Capitula* 2-4 per corymb; peduncles 2-5cm long, pubescent, bracts 3-6 , 2-4 mm long; involucres 9-11 mm long, 3-6 mm in diameter; calycular bracts 5-8, 3-6 mm long, pubescent; phyllaries 14, 1-2 mm broad, sparsely pubescent. *Florets* 30-60, yellow, 12-15 mm long, exserted part 2.5-4 mm. *Anthers* 2-3 mm long, anther collars elongated. *Style arms* 3 mm long. *Cypselas* 3-4 mm long, brown, pilose; carpopodium round, whitish or yellowish; pappus 10-14 mm long, white.

Flowering in July. Growing in open places in deciduous dipterocarp forests, 500-1000 m. Only known from Thailand.

Note. *Gynura siamensis* is a distinct species on accout of its mostly subshrubby or shrubby habit, its irregularly subglobose tubers and its sessile leaves. Most of the material of this species has been treated as *Gynura pseudochina*. *Gynura siamensis* is mostly found in deciduous dipterocarp forests in northern Thailand.

Specimens examined. Thailand, Chiang Mai, 10 July 1991, *Maxwell 91-643* (A, AAU, E, L); Chiang Rai, 24 July 1967, *Bunchuai & Nimanong 1423* (K); Phitsanulok, Tung Salaeng Luang, 25 June 1973, *Murata et al. T17056* (KYO).

10. Gynura japonica (Thumb.) Juel. (Fig. 25B)

Gynura japonica (Thumb.) Juel. in Acta Horti Bergiani 1 (3) (1891) 86.-*Kleinia japonica* (Thunb.) Less. in Linnaea 6 (1836) 134.- *Porophylum japonicum* (Thunb.) DC. Prodr. 5 (1836) 650.-*Senecio japonicus* Thunb., Fl. Jap. (1784) 315

- Type: *Thunberg s.n*. as *Jacobaea japonica* (holo UPS-TH; iso BM!), Japan, Nagasaki.

Gynura pinnatifida (Lour.) DC., Prodr. 6: 301 (1837) 301. -*Gynura segetum* Lour. ex Merrill in Philip. Journ. Sci. 15 (1919) 200. - *Cacalia segetum* Lour., Fl. Cochin.(1790) 486, *in adnot*.-*Cacalia pinnatifida* Lour. Fl. Cochin.: (1790) 486 *non* L. (1771).-Type: (holo BM!), China, Canton

Gynura pinnatifida Van. in Bull. Acad. Ge'ogr. Bot. 12 (1903) 489.-*Gynura vaniottii* H. Le'v. in Bull. Acad. Ge'og. Bot. 24 (1914) 284.- Type: *Martin* in *Bodinieri 2380* (holo E!), China, Gan-pin.

Gynura aurita C. Winkl. in Act. Hort. Petrop. 14 (1895) 151.-Syntypes: *Kashkarow s.n*. (LE), China, Sikiang & *Potanin s.n*. (LE; iso K!), Tibet, Tung-go-ho valley, between Tatsienla and Lifanfu.

Gynura flava Hayata in Journ. Coll. Sci. Tokyo 25: 138 (1908).- *Gynura japonica* var. *flava* (Hay.) Kit. in Acta Phytotax. Geobot.8:202 (1939).-Syntypes: *Mori & Kawakam*i *2021, 195* (TAI) & *Nagasawa* 562 (TI), Taiwan, N. Fukuyama.

Plants 1-4 m high, stems erect, arising from subglobose tubers of about 2-6 cm diameter, sparsely pubescent. *Petioles* 0.5-3 cm long or absent, auricles 0.5-3 x 1-3 cm or absent, sparsely pubescent. *Blades* elliptical, usually pinnatetisect to bipinnatisect or pinnatipartite, 9-12 x 2-7 cm, sparsely pubescent, apex acute, margin of lobes coarsely dentate. *Capitula* (1-)3-8(-16) per corymb; peduncles slender, 1-6 cm long, bracts 2-12, 0.5-4 mm long, pubescent; involucres 8-17 mm long, 3-5 mm in diameter; calycular bracts 4-8, 1-3 mm long, pubescent; phyllaries 8-13, 1-2 mm broad, sparsely pubescent to glabrescent. *Florets* 50-100, red to yellow, 10-20 mm long, exserted part 3-5 mm. *Anthers* 2-3 mm long, anther collars elongated. *Style arms* 3.5 mm long. *Cypselas* 3-6 mm long, brown, pilose; carpopodium cylindrical, yellowish; pappus 7-12 mm long, white to dirty-white. 2n = 22 (Jose & Mathew, 1990).

Flowering and fruiting throughout the year. Growing in open places in moist areas, in rocky places in forests or as a weed in cultivated fields, 0-3000 m. Japan, China, Taiwan, Nepal and Philippines (Fig. 14).

Note. Gynura japonica, a much collected species in Japan and China, is easily recognized by being a shrub arising from subglobose tubers and by usually having pinnatisect to bipinnatisect or pinnatipartite leaves. The species is very similar to *G. valeriana* which is restricted to tropical East Africa.

Specimens examined. **Japan**: Honshu, near Mizunoo, 10 Oct. 1991, *Takahashi 2244* (A, KYO); Takao, Kizan-gun, 27 Dec. 1938, *Tagawa 1867* (KYO); Nagasaki, 1862, *Oldham 446* (S); Hondo, Mikawa, Mt. Horraijii, 28 Oct. 1957, *Furuse s.n*. (A). **China**: Kweichow, Haufeng, *She-Won-San, Teng 90456* (A); Hupeh, Changyang, *Wilson 2522* (K,W); Kwangsi, Yuan Tung Shan, Ching *s.n.* (W); Hunan, Sinning Hsien, 25 Sept. 1935, *Fan & Li 546* (A, BM, P); Szechuan, Kikiang-hsien 1200 m, *Fang 1293* (E); Tchen-Keou-tin, *Farges* 652 (P); Yunnan, 1913, *Maire 524, 539* (BM), Aug. 1906, *Forest 2721* (BM), Tengyuch, *Forest 8497* (S, E), Mt Yung-pe, *Forrest 11069* (E), Kunming, 6 Nov. 1980, *Li 801247*; Xiuning, Liangnan, 24 Oct. 1987, *Yao 11142* (A); without locality, Aug. 1910, *Forest 6433* (BM, P). **Taiwan**: Mt Arisan, Dec. 1914, *Faurie 1423* (BM); Mt Chung Yang Chien, 27 Aug. 1964, *Tamura & Koyama 23556, 23724* (A, KYO, S); Naw Tom Hsien, Hoozan, 24 Oct. 1967, *Ishizawa 27733* (KYO); Pingtung Hsien, Wutai Hsiang, 28 Sept. 1992, *Liao 624* (A).

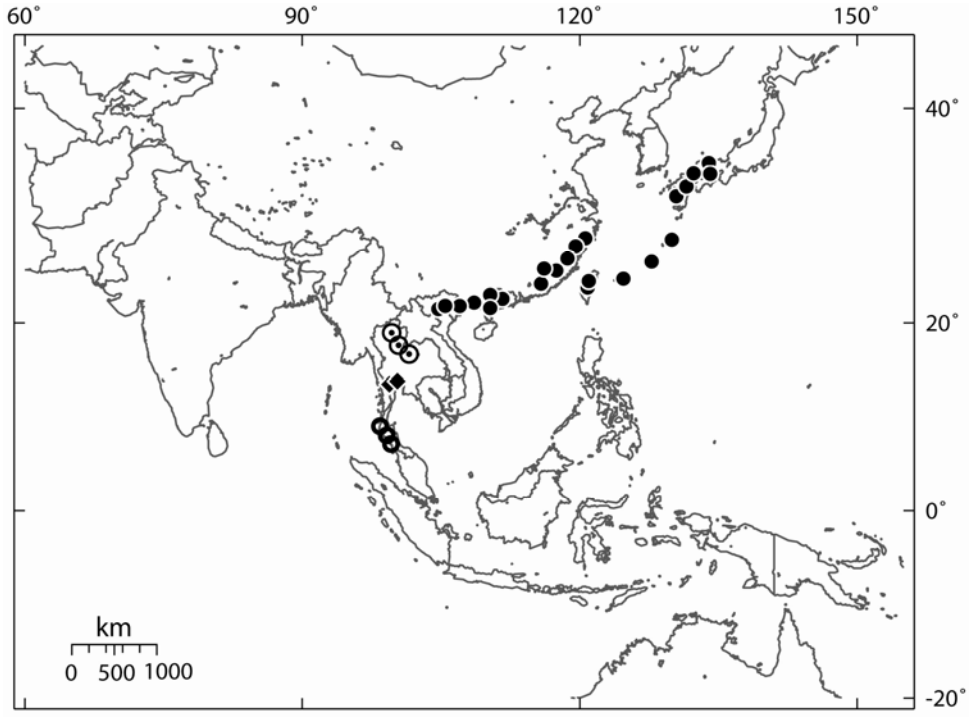

Figure 14. Distribution of *Gynura calciphila* ⭘, *G. dissecta* ◆, *G. siamensis* ⊙, *G. japonica* ●.

11. Gynura colorata F. G. Davies (Fig. 25C)

Gynura colorata F. G. Davies in Kew Bull. 33 (1978) 340.-Type: *Greenway 6063* (holo K!; iso EAH), Tanzania.

Plants 10-30 cm high, stems decumbent or erect, arising from small tapering tubers of about 1-3 cm diameter, leaves in lower part of stems, sparsely pubescent. *Petioles* 0-3(-8) cm long, auricles 1-2 x 2-4 mm or absent, sparsely pubescent. *Blades* ovate, suborbicular or sometimes pinnatipartite, 4-25 x 3-7 cm, sparsely pubescent or glabrous, base cuneate, apex acute to obtuse,margin dentate to serrate. *Capitula* numerous per corymb; peduncles 0.5-10 cm long, sparsely pubescent, bracts 3-6, 1-3 mm long; involucres 7-9 mm long, 2-4 mm in diameter; calycular bracts 3-5, 2-6 mm long, pubescent; phyllaries 12-14, 1-1.5 mm broad, glabrous. *Florets* 20-25, corolla red, orange to yellow, 7-10 mm long, exserted part 3-3.5 mm. *Anthers* 2-2.5 mm long, anther collars elongated. *Style arms* 3 mm long. *Cypselas* 3-4 mm long (immature), brown, glabrous; carpopodium round, whitish or yellowish; pappus 10-14 mm long, white to dirty-white.

Flowering and fruiting throughout the year. Growing in shady places in rocky forests, 0-1000 m. Only known from tropical East Africa (Fig. 15).

Note. Gynura colorata resembles *G. pseudochina* from which it differs by having rather small capitula in dense corymbs and suborbicular to pinnatipartite leaves.

Specimens examined. **Kenya**: Kilifi, Jaribuni, 6 June 1973, *Musyoki & Hansen 974* (K). **Tanzania**: Lushoto, Amani-Muheza road, 19 April 1968, *Renvoize & Abdallah 1614* (K), Usambaras, Sigi valley, May 1915, *Peter 53876* (K), 8 Jan. 1998, *Pakit 15348* (K), Kigogoa, 4 June, 1914, *Peter 54410* (K), Kisiwani, 6 May 1950, *Williams 20* (K); Tanga, Kange Gorge, June 1956, *Faulker 1872* (K).

12. Gynura pseudochina (L.) DC. (Fig. 25D)

Gynura pseudochina (L.) DC. in Prodr. 6 (1838) 299.-*Senecio pseudochina* L., Sp. Pl.: 867 (1753).-Syntype: *Royen 164* (L!), India.

Gynura biflora (Burm. f.) Merr., Philip. J. Sci. 19(1921) 386.-*Senecio biflora* Burm. f., Fl. Ind.:181 (1768).-Type: (not found), India.

Gynura bulbosa (Lour.) Hook. & Arn., Bot. Beech. Voy. 194 (1836) 194. -

Cacalia bulbosa Lour., Fl. Cochin. (1790) 485.-Type: (not found), Vietnam.

Gynura nudicaulis Arn., Nov. Act. Cur. 18 (1836) 351.-Type: *Wight 2333* (holo E!; iso K), south India.

Gynura purpurascens Wall. ex DC., Prodr. 6 (1838) 299.-Type: *Wall.* Cat. n. *3157* (holo K-W!), Cult. Calcutta,.

Gynura sagittaria Wall. ex DC., Prodr. 6 (1838) 301.-Type: *Wallich* Cat. n. *3159* (holo K-W!), India.

Gynura sinuata DC., Prodr. 6 (1838) 301.-Type: *Hamilton* (holo E!, isotype BM!).

Gynura miniata Welw., Apont. (1859) 586.-Type: *Welwitsch 3595* (holo BM!), Angola, Pungo Andongo, Caghuy.

Gynura miniata Welw. var. *orientalis* O. Hoffm. In P.O.A. C (1895) 416.-Type: *Stuhlmann 7776* (holo K),Tanzania, Uzaramo.

Senecio crassipes H. Lév. & Van., Fedde, Rep. Sp. Nov. 6 (1909) 331.-Type: *Cavalerie* 3305 (holo E!), China, Kweichow.

Gynura rusisiensis R.E.Fr. in Wiss. Ergebn. Schwed. Rhod.-Kongo Exped. 1 (1911) 342.-Type: *Fries 1435* (holotype UPS), Tanzania, Mpanda, Rusisi Valley between Mpanda and Mecherenge.

Gynura somalensis (Chiov.) Cuf. in Nuov. Giorn. Bot. Hal. n.a. 1 (1943) 112.-*Senecio somalensis* Chiov. Result. Sc. Miss. Stef.-Paoli Somal. Ita. 1 (1916) 106.-Type: *Paoli 1110* (holo FT photo), Somalia, Baidoa.

Gynura bodinieri H. Lév., Bull. Géogr. Bot. 24 (1914) 283. -Type: *Esquirol 3563* (holo E!), China, Kouy-Tcheou.

Gynura eximia S. Moore in J. Bot. 56 (1918) 225.-Type: *Gossweiler 3638* (iso K!), Angola, Kaconda.

Gynura variifolia De Wild., Pl. Bequaert. 5 (1929) 93.-Type: *Bequaert 5627* (holo BR!), Congo (Kinshasa), Rutshuru.

Gynura truncata Kerr., Bull. Misc. Inform. Kew. (1935) 331.- Type: *Kerr 20484* (holo K; iso E!), Thailand, Korat.

Plants 10-50 cm high, stems erect, arising from subglobose tubers of about 1-9 cm diameter, leaves mainly in lower part of stems, sparsely pubescent to glabrescent. *Petioles* 0.3-3(-8) cm long, exauriculate, sparsely pubescent. *Blades* elliptical, ovate or lyrate, (1-) 7-40 by 1-12 cm, sparsely pubescent, base truncate or cuneate, apex acute to obtuse, margin sinuate or coarsely dentate. *Capitula* 1-3 (6) in lax corymbs; peduncles 0.5-10 cm long, sparsely pubescent, bracts 3-6, 1-3 mm long; involucres about 13 mm long, 7.5-10 mm in diameter; calycular bracts 3-5, 2-6 mm long, pubescent; phyllaries 10-14 (16), 1.5-2 mm broad, somewhat purple-tinged, sparsely pubescent. *Florets* 20-30, red, orange to yellow, 10 – 13 mm long, exserted part 2.5-4 mm. *Anthers* 2-2.5 mm long, anther collars elongated. *Style arms* 3 mm long. *Cypselas* 3-4 mm long, brown, sparsely pubescent; carpopodium round, whitish or yellowish; pappus 10-14 mm long, white to dirty-white. 2n = 20 (Jose & Mathew, 1990), 40 (Chidambaram, 2005).

Flowering and fruiting throughout the year. Growing on dry steep slopes, sandy soil, meadows, 0 – 2600 m. Tropical Africa eastward to Sri Lanka, India, Nepal, Bhutan, Myanmar, China, Thailand and Indonesia (Fig. 15).

Note. Gynura pseudochina is a relatively small herb arising from large subglobose tubers. Its leaves usually are arranged in a basal rosette, and the lax corymbs often have only 1-3 capitula. The species is by far the most widespread and variable of the genus.

Specimens examined. **Ghana**: Sierra Leone, Bintumane peak, 4 Jan. 1957, *Jones 103* (K), Bamenda, 24 March 1959, *Daramora FHI41002* (K). **Nigeria**: Zaria, 7 July 1950, *Keay 25947* (K); Bamenda, 25 April 1951, *Kjiofor FHI30079* (K), Abakpa, 1 May 1951, *Ujor FHI30095* (K); Sardauna, Mayo Ndaga, 3 April 1970, *Hall 1699* (K); Ibadan, 22 Aug. 1962, *Keay FHI46322* (K). **Cameroons**: Bangola village, 30 March 1962, *Brunt 275* (K), Hosseae, 17 July 1974, *Fotius 2120* (K); Ourosnge, 23 March 1977, *Lowe 3355* (K). **Burundi**: Bubansa, 5 March 1977, *Reekmans 5801* (K); Plaine Rubizi, 16 March 1975, *Reekmans 4406* (K). **Ethiopia**: Sidamo, 22 May 1985, *Mesfin*

& *Vollesen 4184* (K), 12 May 1980, *Thulla at al 3578* (K); Bale, 2 June 1988, *Gilbert & Sebsebe 8617* (K); Neghelle, 18 May 1982, *Friis et al 3074* (K). **Kenya**: Meru, Isiolo, April 1971, *Kimani 281* (K); Masai, Loitokitok-Emali, May 1974, *Kokwaro et al 3520* (K); Kwale, Mayi ya Chumvi, March 1902, *Kassner 475* (K). **Tanzania**: Moshi, Engare Nairobi, June 1944, *Greenway 6877* (K). **Sri Lanka**: Kandy, 27 Feb. 1819, *Moon 1819* (BM). **India**: Madra, 1920, *Wight s.n*. (K), 24 July 1901, *Bourne 2405*; Kerala, Pamba, 11 Sept. 1973, *Rix & Schneller 208* (K); Sikkim, Namfok, 26 April 1876, *Clarke 27627* (BM), Peshok, 27 April 1960, *Hara et al. 2881* (KYO); Darjeeling, Peshok, 27 April 1960, *Hara et al 5510* (KYO). **Bhutan**: Lhuntse Dzong, Kuru Chu, Ludlow, *Sherriff & Hicks 20169* (E); Tongsa, 19 April 1967, *Hara et al 7136* (BM, KYO). **Nepal**: Mechi, Taplejung, 21 May 1992, *Suzuki et al. 9240224* (BM) **China**: Kwangsi, Ping Hoh village, 16 April 1933, *Tsang 22115* (A, BM, S); Kwantung, Kwai Shan, Ho-yuen, Tsing-lo-Kong village, April 1938, *Tsang 28622* (A, KYO); Hainan, Yeung Lam village, May 1935, *Lau 6380* (A, KYO), Chung Ngo Shan, 9 Feb. 1934, *Lau 3312* (S), Ku Tung village, 29 Dec. 1932, *Lei 313* (KYO), Fung Muk Shan, 3 May 1928, *Tsang 215* (G); Yunan, 28 May 1908, *Ducloux 5547* (A, P), 1935, *Wang 74433* (A). **Myanmar**: Shan, June 1909, *MacGregor 530* (E); Ragoon, April 1932, *Dickason 1902, 1124* (A); Maymyo Plateau, June 1912, *Lace 5856* (K). **Laos**: Chiang Kwang, 12 April 1932, *Kerr 20943* (BM). **Cambodia**: Chereer, *Pierre 1061* (G). **Thailand**: Chiang Mai, Doi Suthep, 23 April 1911, *Kerr 1802* (BM, K), 22 May 1992, *Maxwell 92-236* (L); Chiang Rai, Doi Luang, 25 May 1998, *Maxwell 98-580* (A, L); Loie, Pha Nok En, 1 Sept. 1988, *Koyama T61503* (A, KYO), Phu Krading, 13 March 1924, *Kerr 8687* (BM, K), 2 April 1933, *Lakshnakara 1380* (BM); Lampoon, Doi Kuhn Dahn, 3 June 1993, *Maxwell 93-532* (A, L); Lampang, Doi Khun Tan, 1 Jan. 1985, *Koyama & Phengklai T39004* (KYO); Nakron Ratchasima, Khao Yai, 20 Nov. 1982, *Koyama et al*. *T30113* (KYO), 16 March 1930, *Put* 2849 (BM); Chaiyaphum, Thung Kra Mang, 20 Dec. 1979, *Larsen* et al 31616 (AAU); Uthaithani, 12 Nov. 1979, *Shimizu et al. T22376* (KYO); Koan Keng, Pu Weing, 16 March 1932, *Kerr 20659* (BM, K); Bangkok, 25 April 1930, *Kerr* 19457 (BM); Patchaburi, 27 March 1922, *Kerr s.n*. (BM); Phachuap, Hua Hin, 7 Nov. 1927, *Kerr 13494* (BM, K); Surat, Khao Tao, 14 April 1927, *Kerr 12734* (BM, K). **Vietnam**. Si Xung, *Petelot 6410* (A). **Indonesia**: Java, 1859, *Horsfield* 51 (A); cult.Batavia, 13 Nov. 1918, *Heyne 9405* (L); Bogor, 21 Aug. 1995, *Balgooy 7089* (L).

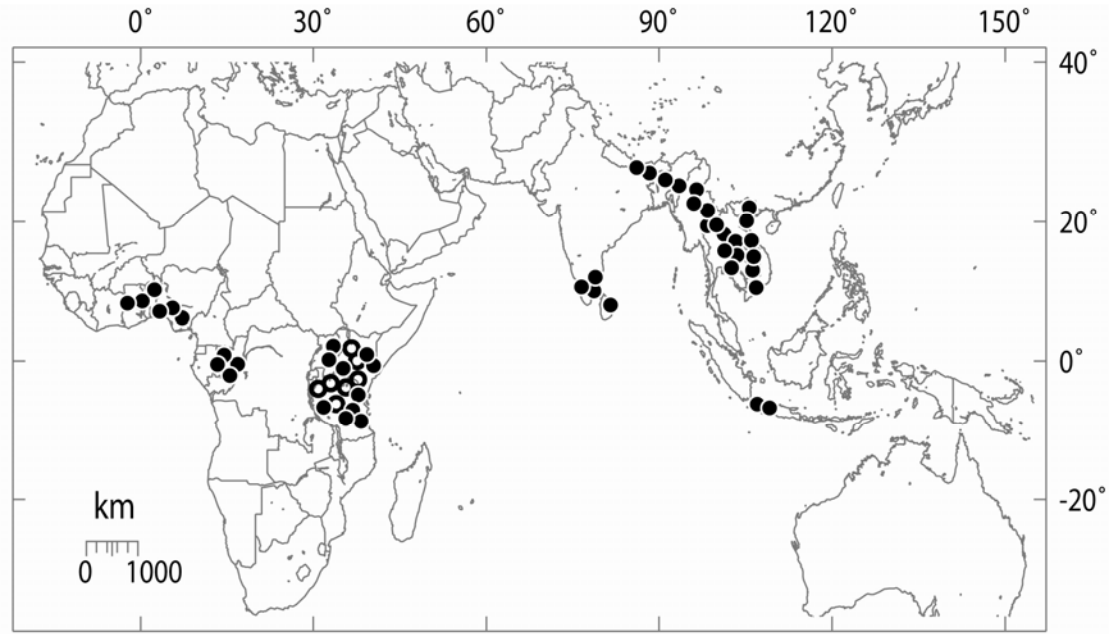

Figure 15. Distribution of *Gynura colorata* ⭘, *G. pseudochina* ●

13. Gynura annua (F. G. Davies) Vanijajiva & Kadereit, *comb. nov.* (Fig. 26A)

Gynura procumbens var. *annua* F. G. Davies in Kew Bull. 35 (1980) 718.-Type:

Eyma 3838 (holo K!; iso L), Indonesia, Celebes.

Plants 1-3 m high or more, stems erect, glabrous. *Leaves* sessile, exauriculate, glabrescent. *Blades* lanceolate to narrowly obovate, 8-12(-20) x 3-6 cm, glabrous, apex acute, base cuneate, margin denticulate. *Capitula* 3-8 in dense corymbs; peduncles stout, 2-7 cm long, subglabrous, bracts 2-6, 1-3 mm long; involucres 15-22 mm long, 3-6 mm in diameter; calycular bracts 3-5, 3-6 mm long, glabrescent; phyllaries 8, 1-2 mm broad, glabrous. *Florets* 15-35, yellow, 15-20 mm long, exserted part 2 – 3 mm long. *Anthers* 2.5-3 mm long, anther collars elongated. *Style arms* 2-2.5 mm long. *Cypselas* 4-6 mm, brown, pilose to glabrous; carpopodium annular or cylindrical, yellowish; pappus 10-20 mm long, white or dirty-white.

Flowering from March to July. Growing in open places in coastal forests, 500-1200 m. Only known from Indonesia, Sulawesi (Celebes Islands) (Fig. 16).

Note. *Gynura annua* was originally described as *Gynura procumbens* var. *annua* F. G. Davies. Although the epithet '*annua*' refers to an annual habit, all material we examined, including the material examined by Davies (1980b), clearly is perennial. In

addition, we could barely find any resemblance of this taxon with *G. procumbens* which is scandent whereas *G. annua* is an erect shrub with sessile leaves.

Specimens examined. **Indonesia**: Sulawesi (Celebes), 17 March 1917, *Kauderns* 29 (S), 4 July 1956, *Forman 384B* (K), Tonderukan, Mt Soputa, 17 July 1954, *Alston 15874* (BM), Gunung Nokila-laki, 29 June 1975, *Meijer 9750* (L); 19 March 1981, *Johansson et al 525* (K), Sapu Valley, 27 May 1979, *Hennipman 5646* (L), Balukang, 22 July 2002, *Craven et al 85* (A).

14. Gynura albicaulis W. W. Smith (Fig. 26B)

Gynura albicaulis W. W. Smith in Notes Roy. Bot. Gard. Edin. 8 (1915) 322.- Lectoype: *Haviland* 1500 [K! designated by Davies (1980)], Sarawak, Mt Staat.

Plants 1-2 m high, stems erect, whitish grey or silvery, glabrous. *Petioles* 1-2 cm long, exauriculate, glabrous. *Blade* elliptical to rhomboid, 3-12 x 2-4 cm, coriaceous when dry, glabrous, base cuneate, apex acute or obtuse, margin entire or distantly denticulate. *Capitula* 2-4 in lax corymbs; peduncles slender, 1-4 cm long, glabrous, bracts 2-3, 3-6 mm long, glabrescent; involucres 7-9 mm long, 3-5 mm in diameter; calycular bracts 3-6, 1-2 mm long, glabrescent; phyllaries 8, 1-2 mm broad, glabrous. *Florets* 10-20, yellow, turning red to dark purple, 8-10 mm long, exserted part 2 – 2.5 mm. *Anthers* c. 2.5 mm long, anther collars elongated. *Style arms* 3 mm long. *Cypselas* 2.5 – 3.5 mm long, brown, pilose; carpopodium cylindrical, yellowish; pappus 6-9 mm long, white.

Flowering and fruiting throughout the year. Growing on hillslopes on limestone, 50-500 m. Endemic to Malaysia (Borneo, Sarawak) (Fig. 16).

Note. Gynura albicaulis is unique within the genus by being glabrous and by having whitish-grey or silvery stems and coriaceous leaves.

Specimens examined. **Malaysia**: Borneo, Sarawak, Bau, 11 Feb. 1914, *Native collector* (E), 1929, *Clemens 20612* (A), 29 April 1955, *Brooke 9908* (L), 15 Aug.

1957, *Anderson 9073* (K, L), 14 July 1957, *Anderson 8374* (L), 14 Sept. 1958, *Jacobs* 5472 (G, K, L), 14 July 1963, *Chew 551* (L), 7 Oct. 1977, *Martin* S.*39279* (L), 25 Oct. 1979, *Bremer 1715* (A, K, S), 9 May 1988, *Yii et al. S50338* (K, L), 10 Jan. 1996, *Beaman 11857* (K), 25 Jan. 1996, *Beaman 11906* (K), 17 Dec. 1965, *Chai & Seng S22871* (K, L).

15. Gynura abbreviata F. G. Davies (Fig. 26C)

Gynura abbreviata F. G. Davies in Kew Bull. 35 (1980) 719.-Type: *Kjellberg 2915* (holo S!), Indonesia, Celebes.

Plants 2-4 m high or more, stems erect, glabrous. *Petioles* 0.3-1.2 cm long, exauriculate, glabrous. *Blades* elliptical, 2-7 x 1.5-3.5 cm, glabrous, base cuneate, apex obtuse and apiculate, margin entire. *Capitula* 4-11 per corymb; peduncle 3-10 mm long, glabrous, bracts 2-3, 1-2 mm long, glabrescent; involucres 7-8 mm long, 2-4 mm in diameter; calycular bracts 5-6, 1-2 mm long, glabrescent; phyllaries 8, 1-2 mm broad, glabrous. *Florets* 15-20, yellow, 9-11 mm long, exserted part 2 mm. *Anthers* c. 2.5 mm long, anther collars elongated. *Style arms* 3 mm long. *Cypselas* 4 mm long, brown, pilose; carpopodium cylindrical, yellowish; pappus 7-9 mm long, white.

Flowering from July to December. Growing in dry places on calcareous rocks in open thickets or in dry, deciduous forests, 600-1300 m. Endemic to Indonesia (Celebes Islands) (Fig. 16).

Note. Gynura abbreviata is distinct by being entirely glabrous and by having elliptical leaves with entire margins.

Specimens examined. **Indonesia**: Celebes, Makale, 19 July 1929, *Kjellberg 1674* (L, S); Rante Pao, 12 Dec. 1929, *Kjellberg 2915* (S).

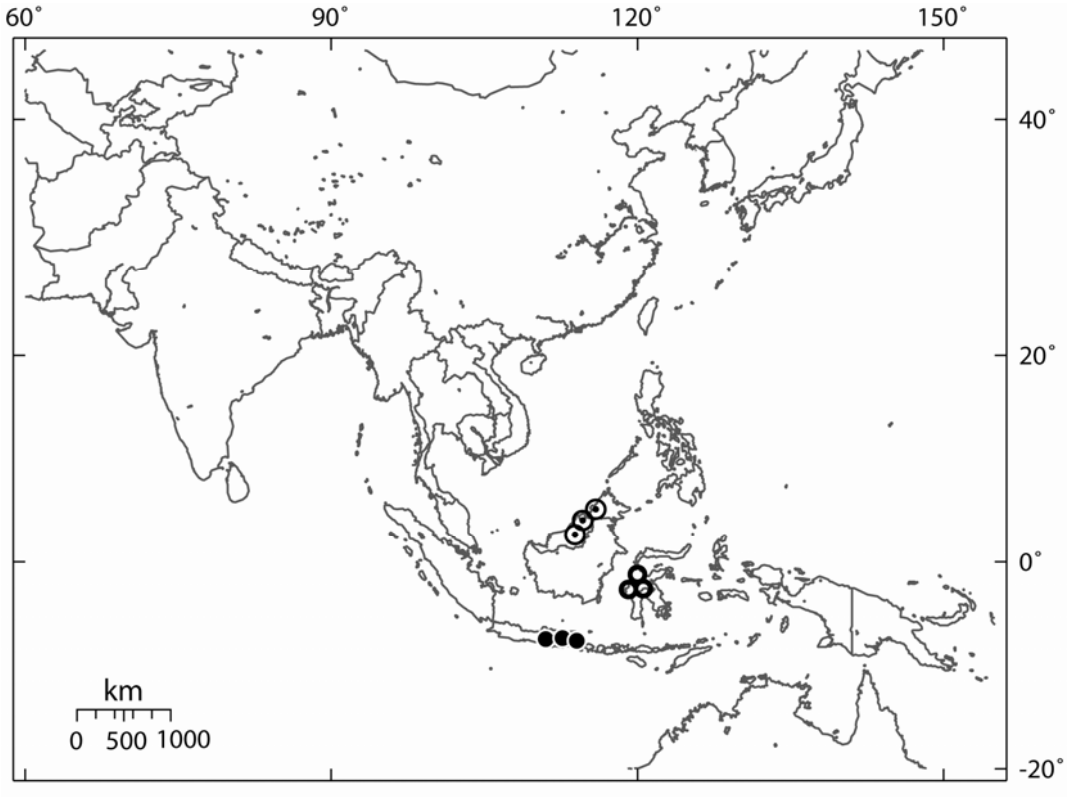

Figure 16. Distribution of *Gynura annua* ✪, *G. alblicaulis*⊙, *G. abbreviate* ●

16. Gynura steenisii F. G. Davies (Fig. 26D)

Gynura steenisii F. G. Davies in Kew Bull. 35 (1980) 724.-Type: *van Steenis 18241* (holo K!, iso A!, L!), Timor.

Plants about 2-3 m high, stems erect, glabrous. *Petioles* 4-5 cm long, exauriculate, glabrous. *Blades* ovate, 7-10 x 3-4 cm, sparsely scabrous, base cuneate, apex acute, margin coarsely dentate. *Capitula* 2-8 in dense corymbs; peduncles 0.2-1 cm long, sparsely scabrous, bracts 4-8, 3-6 mm long, sparsely scabrous; involucres 6-8 mm long, 3-6 mm in diameter; calycular bracts 3-5, 2-4 mm long, glabrescent; phyllaries 10-12 , 1-1.5 mm broad, sparsely scabrous to glabrescent. *Florets* 15-20, yellow, 6-9 mm long, exserted part 1-3 mm. *Anthers* 2 mm long, anther collars elongated. *Style arms* 3 mm long. *Cypselas* 2 mm long, brown, pilose; carpopodium cylindrical, yellowish; pappus 8 mm long, dirty-white to yellowish.

Flowering in December. Growing on limestone, 0-500 m. Endemic to Timor (Fig. 17).

Note. Gynura steenisii is unique in the genus because of its markedly small capitula.

Specimens examined. **Timor**: Central Port, Mt Perdido, 23 Dec. 1953, *van Steenis 18241* (L).

17. Gynura sechellensis (Baker) Hemsl. (Fig. 27A)

Gynura sechellensis (Baker) Hemsl. in J. Bot. 54 (1916) 21.- *Senecio sechellensis* Baker, Fl. Maurit. Seych. (1877) 178.-Lectotype: *Horne 316* (K!, designated here), Seychelles, Mahe.

Plants about 1-2 m high, stems erect, fleshy, glabrous, leaves clustered in upper part of stems. *Petioles* 0.3-4 cm long, exauriculate, glabrous. *Blades* elliptical, 9-20 x 3-6 cm, glabrous, base narrowed into petiole, apex obtuse, margin entire. *Capitula* 4-6 per corymb; peduncles slender, 2-6 cm long, glabrous, bracts 2-3, 3-6 mm long, glabrescent; involucres 8-10 mm long, 3-6.5 mm in diameter; calycular bracts 2-5, 2-4 mm long, glabrescent; phyllaries 7-8 , 1-2 mm broad, glabrous. *Florets* 20-25, yellow, 8-10 mm long, exserted part 2-3 mm. *Anthers* 2 mm long, anther collars elongated. *Style arms* 3 mm long. *Cypselas* 3-4 mm long, brown, pilose; carpopodium cylindrical, yellowish; pappus 10-12 mm long, dirty-white to yellowish.

Flowering and fruiting throughout the year. Growing in shady rocky place in mixed scrub and in mountain forests, 50-1000 m. Endemic to Seychelles Islands (Fig. 17).

Note. Gynura sechellensis is recognizable by being entirely glabrous and having entire leaf margins. The leaves usually are clustered in the upper part of the stems. The species is only known from the Seychelles Islands.

Specimens examined. **Seychelles**. Mahe, April 1908, *Thomasset s.n*. (K), Latour river, 17 Jan. 1970, *Fosberg 51985* (K), Cascade estate, 29 March 1905, *Thomasset 190* (K), central Massif, 16 Jan. 1938, *DV-FG 6139* (K), Congo Rouge, May 1970, *Procter & Mason 3922* (K), above Niole, 4 Nov 1961, *Jeffrey & Zelia 372* (K).

18. Gynura sundaiaca F. G. Davies (Fig. 27B)

Gynura sundaiaca F. G. Davies in Kew Bull. 35 (1980) 722.-Type: *van Steenis 18025* (holo K!; iso L!),Timor.

Plants about 1-2 m high, stems erect with prominent leaf scars, leaves clustered in upper part of stems, glabrous. *Petioles* 0.3-4 cm long, exauriculate, glabrous. *Blades* elliptical, 4-10 x 0.7-4 cm, glabrous, base cuneate, apex acute, margin entire or denticulate. *Capitula* 2-3 in lax corymbs; peduncles stout, 0.5-6 cm long, glabrous, bracts 2 -3, 3-6 mm long, glabrescent; involucres 8-10 mm long, 3-6.5 mm in diameter; calycular bracts 2-5, 2-4 mm long, glabrescent; phyllaries 12, 1-2 mm broad, glabrescent. *Florets* 30-40, yellow, 9-11 mm long, exserted part 2 mm. *Anthers* 2 mm long, anther collars elongated. *Style arms* 3 mm long. *Cypselas* 4.5 mm long, brown, pilose; carpopodium cylindrical, yellowish; pappus 10-12 mm long, dirty-white to yellowish.

Flowering from December to May. Growing on limestone, 5-300 m. Endemic to Indonesia in Lesser Sunda Islands.

Note. *Gynura sundaiaca* is closely similar to *G. sechellensis*. It can be recognized by the prominent leaf scars on the stems and its stout peduncles. The species is restricted to the Lesser Sunda Islands.

Specimens examined. **Indonesia**: Lesser Sunda, Alor, 5 May 1938, *Jaag 518* (BM, L); Kalabahi, 9 May 1938, *Jaag 741* (L); *Weltar*, 12 March 1910, *Elbert 4659* (L).
Timor: Baucan, 15 Dec. 1953, *van Steenis 18025* (L).

19. Gynura malaccensis Belcher (Fig. 27C)

Gynura malaccensis Belcher in Kew Bull. 44 (1988) 538.- *Gynura malasica* F. G. Davies in Kew Bull. 35 (1980) 716.-Type: Malaysia, Malacca, *Griffith 3235* (holo & iso K!).

Plants 50-100 cm high, stems erect, subsucculent, glabrous. *Petioles* 0.5-1.5 cm long, exauriculate, glabrescent. *Blades* lanceolate, 5-10 x 2-3 cm, glabrous, base cuneate, apex acute, margin coarsely and distantly dentate. *Capitula* 3-8 in lax corymbs;

peduncles slender, 5-10 cm long, pubescent, bracts 2-4, 3-6 mm long, glabrescent; involucres 11-13 mm long, 3-6 mm in diameter; calycular bracts 3-5, 3-6 mm long, glabrescent; phyllaries 12-14, 1-2 mm broad, sparsely pubescent. *Florets* 20-30, yellow, 9-11 mm long, exserted part 3.5-4 mm. *Anthers* 2 mm long, anther collars elongated. *Style arms* 3 mm long. *Cypselas* 4 mm long, brown, glabrous; carpopodium cylindrical, yellowish; pappus 10-12 mm long, dirty-white to yellowish.

Flowering in October. Growing in open sunny areas, cultivated as an ornamental. 300-400 m. Only known from Malaysia (Fig. 17).

Note. Gynura malaccensis is recognizable by its slender long peduncles and its usually lanceolate leaves with coarsely and distantly dentate margins. The leaves often are clustered in the lower part of stem. The species is only known from peninsular Malaysia.

Specimens examined. **Malaysia**: Malacca, 1861, *Griffith 3235* (K), 1871, *Wight s.n.* (K); Kalimantan, 30 Oct. 1997, *Uluk & Gollin LXG 45-97* (L).

20. Gynura carnosula Zoll. (Fig. 27D)

Gynura carnosula Zoll. in Nat. En Geneesk. Arch. Neerl. Indie 2 (1845) 265.-Type: *Zollinger 2378* (holo & iso G-DC!), Indonesia, Java, Malang, near Sri Gontjo.

Gynura densifolia Miq., Fl. Ind. Bot. 2 (1856) 99.-Lectotype: *Horsfield 50* [BM!, iso K! designated by Davies (1980)], Java, Patjittan.

Plants 1-2 m high, stems erect, pubescent or glabrescent below. *Petioles* 1-4 cm long, exauriculate, pubescent. *Blades* elliptical to ovate, 3-9 x 1.5-6 cm, sparsely to densely pubescent, base cuneate, apex acute, margin usually entire, rarely dentate. *Capitula* 2-5 in dense corymbs; peduncles slender, 1-5 cm long, densely pubescent, bracts 4-7 , 3-7 mm long, pubescent; involucres 6-9 mm long, 3-6 mm in diameter; calycular bracts 2 -4, 3-5 mm long, pubescent; phyllaries 8-12, 1-2 mm broad, pubescent. *Florets* 20-35, yellow, 7-11 mm long, exserted part 2.5-3 mm. *Anthers* 2 mm long, anther collars short. *Style arms* 3 mm long. *Cypselas* 3.5 mm long, brown, pilose; carpopodium cylindrical, yellowish; pappus 10-12 mm long, dirty-white.

Flowering from December to May. Growing on limestone rocks along the coast, 0-5 m. Endemic to Indonesia (Java) (Fig. 17).

Note. Gynura carnosula is similar to *G. elliptica* but has exauriculate petioles, often strongly pubescent leaves and pilose cypsela. *Gynura carnosula* occurs only on Java.

Specimens examined. **Indonesia**: Java, Malang, 21 Dec. 1940, *van Steenis s.n.* (A, K, L, SING), Besoeki, Batoe, *Altmann 453* (A, L, SING); Kediri, 12 April 1931, *van Slooten 2459* (L).

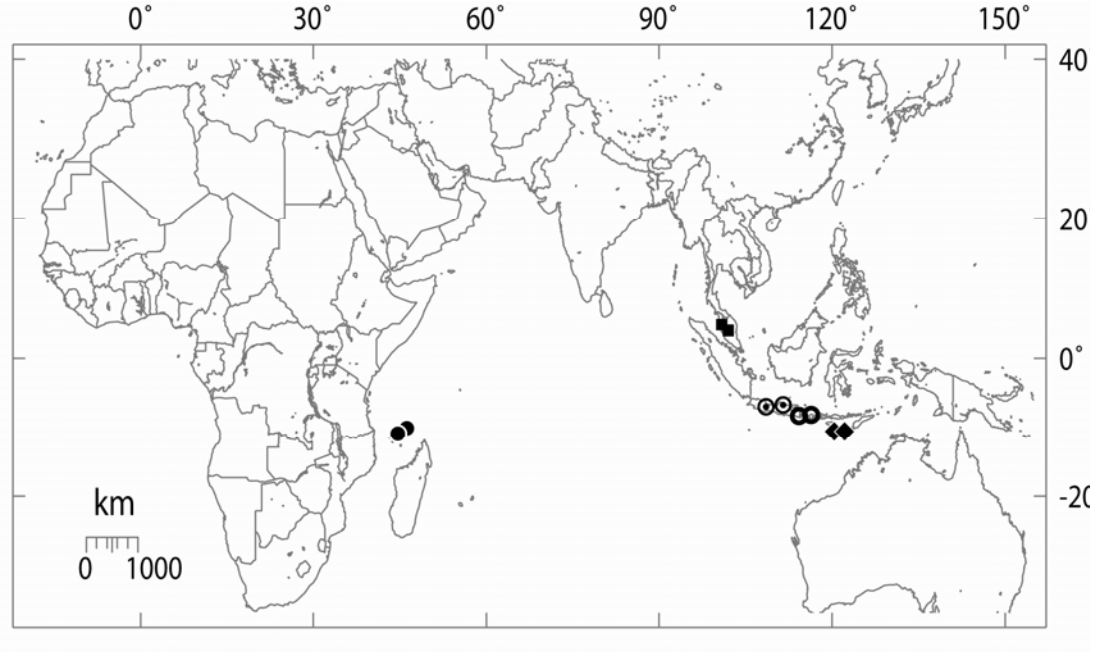

Figure 17. Distribution of *Gynura steenisii* ✪, *G. sechellensis* ●, *G. sundaniaca*◆, *G. malaccensis* ■, *G. carnosula* ⊙.

21. Gynura nitida DC. (Fig. 28A)

Gynura nitida DC. in Wight, Con. Ind. Bot. (1834) 24.-Lectotype: *Wight 1488* (E!; iso E!, K! designated here), India, Mts Dingigul.

Plants 10-70 cm high, stems erect, leaves mainly in lower part of stems, subsucculent, sparsely glandular. *Leaves* sessile, exauriculate, sparsely glandular to glabrescent. *Blades* lanceolate to linear, 7-15 x 2-5 cm, glabrous, base cuneate, apex acute, margin dentate to serrate. *Capitula* 3-7 per corymb; peduncle 1-4 cm long, pubescent, bracts 3-5, 3-6 mm long, glabrescent; involucres 10-13 mm long, 5-8 mm in diameter; calycular bracts 4-7, 3-5 mm long, pubescent; phyllaries 12-14, 1-1.5 mm broad,

glabrous. *Florets* c. 20, orange to yellow, 9 – 15 mm long, exserted part 1-2 mm. *Anthers* 2 mm long, anther collars elongated. *Style arms* 3 mm long. *Cypselas* 4-5 mm long, brown, pilose; carpopodium cylindrical, yellowish; pappus 8-10 mm long, dirty-white. n = 10 (Jose & Mathew, 1990), 20 (Chidambaram, 2005).

Flowering and fruiting throughout the year. Growing in partial shade on roadside slopes, 500-2500 m. India (Fig. 18).

Note. Gynura nitida is readily recognized by its sparsely glandular indumentum on the stem and its sessile and narrowly lanceolate levaes which usually cluster in the lower part of the plant. The species is found mainly in south India.

Specimens examined. **India**: Tamil Nadu, 3 Nov. 1982, *Klackenberg & Lundin 532* (S), Nilgiri, Coonoor, Sept. 1885, *Gamble 12135, 12136, 16922* (K), 1937, *Vine 142* (BM), Coimbatore, 1866-8, *Wight 1641* (A, K, L, S); Salem, 14 Nov. 1976, *Matthew & Arockiasamy 5047* (L); Palung, 1885, Beddome *4535* (BM); Hassan, Mysore, 24 Oct. 1970, *Jarrett & Ramamoorthy 971* (SING).

22. Gynura travancorica W.W. Smith (Fig. 28B)

Gynura travancorica W.W. Smith in Rec. Bot. Surv. Ind. 6 (1912) 29.-Type: *Meebold 13516* (holotype CAL), India, Travancore, Devicolam.

Plants 10-40 cm high or more, stems erect, ridged, with more or less prominent leaf scars, pubescent to glabrescent. *Leaves* sessile, exauriculate, pubescent to glabrescent. *Blades* elliptical to oblanceolate, 5-10 x 1.5-4 cm, hispid to glabrescent, base cuneate, apex acute or obtuse, margin dentate to serrate. *Capitula* 2-3 per corymb; peduncles 0.5-5 cm long, pubescent; involucres 8-11 mm long, 5-8 mm in diameter; calycular bracts 2-5, 5-12 mm long, pubescent; phyllaries 14-16, 10-14 mm long, 1-2 mm broad, glabrous. *Florets* 30-40, red or yellow, exserted part 3-4 mm. *Anthers* 2.5 mm long, anther collars elongated. *Style arms* 3 mm long. *Cypselas* 4 mm long, brown, glabrous; pappus 10-12 mm long, white or dirty-white to yellowish. n = 10 (Jose & Mathew, 1990).

Flowering and fruiting in June and July. Growing on rocky ground or on sunny slopes at riversides in forests, 800-2000 m. India and Nepal (Fig. 18).

Note. *Gynura travancorica* is closely allied to *G. hispida* from which it differs only in its much longer involucres. It is also similar to *G. zeylanica*, another Sri Lanka endemic, but distinguished from this species by its exauriculate leaves and the number of phyllaries (12-14 vs. 14-16).

Specimens examined. **India**: Pulney Hills, Pambar Stream, 28 Jun. 1899, Bourne *1567* (K), 4 June 1985, *Matthew 41464* (K).

23. Gynura nepalensis DC. (Fig. 28C)

Gynura nepalensis DC. in Prodr. 6 (1838) 300.-Type: *Wallich 3146* (holo K-W!; iso BM!, K!), Nepal, Noakote.

Gynura foetens Wall ex DC., Prodr. 6 (1838) 300.-Type *Wallich 3156* (holo K-W!), Nepal.

Gynura nepalensis DC. var. *thomsoni* Clarke, Comp. Ind.(1876) 171.-Syntype: *Thomson s.n.* (K!), India, Kumaon,

Gynura nudibasis (H. Lev'. & Van.) Lauener & D. K. Ferguson, Notes Roy. Bot. Gard. Edinb. 34 (1976) 359.-*Gynura dielsii* H. Le'v., Bull. Acad. Ge'og. Bot. 24(1914) 284, *nom. illegit., superfl.*-*Senecio nudibasis* H. Le'v. & Van., Fedde, Rep. Sp. Nov. 6 (1909) 331.-Type: *Cavalerie 3312* (holo E!), China, Kweichow.

Plants 2-5 m high or more, stems erect, densely white- or tawny-tomentose. *Petioles* 0.5-5 cm, exauriculate, tomentose. *Blades* elliptical, narrowly elliptical, rhomboid or lyrate, 2-20 x 1-6 cm, densely tomentose, base cuneate, apex acute, margin entire to denticulate. *Capitula* 3-7 per corymb, peduncles stout, 2-10 cm long, calycular bracts 3 -8, 3-7 mm long, densely tomentose; involucres 8-12 mm long, 7-12 mm in diameter; phyllaries 14, 8-10 mm long, 1-2 mm broad, densely tomentose or sometime glandular. *Florets* 25-40, orange to yellow, 9-15 mm long, exserted part 2.5-4 mm. *Anthers* 2.5 mm long, anther collars elongated. *Style arms* 3.5 mm long.

Cypselas 4-6 mm long, brown, pilose; carpopodium cylindrical, yellowish; pappus 10-12 mm long, white or dirty-white.

Flowering and fruiting throughout the year. Growing at the edge and in open places of mountain forests, 700-4500 m. India, Nepal, Bhutan, China, Myanmar and Thailand (Fig. 18).

Note. Gynura nepalensis resembles *G. pseudochina* as also noted by Davies (1978). It differs from this species by being a robust subshrub, having denser inflorescences and by being densely white- or tawny-tomentose.

Specimen examined. **India**: Assam, Sehit valley road, 2 March 1928, *Ward 7904* (K); Naga Hills, Tizu river, 22 March 1935, *Bor 2946* (K); Himachal Pradesh, Ranikhet, 1886, *Duthie 5699* (K); Sikkim, Teesta, 4 March 1871, *Clarke 13941D* (BM), 20 March 1913, *Cave s.n.* (A), Yankeung, 28 April 1876, *Clarke 27670B* (K). **Nepal**: Pokhara, Bakhri Kharka, 23 April 1954, *Stainton et al 5021* (E); Namuche to Rukma, 10 May 1965, *Banerjee & Baskola 3423* (G); Madi Khola, 25 March 1983, *Stainton 8620* (E); Jinglam, 14 April 1913, *Cave* s.n. (E); Taplejung, Thunglung, 13 May 1992, *Suzuki et al*. *9240059* (A); Pannchuthar, Hima Khola, 9 April 1967, *Nicolson 3202* (BM). **Bhutan**: SW Wandi, Prodrung, 27 May 1971, *Lyon 6063* (BM); Between Lobeysa & Lometsawa, 17 June 1975, *Grierson & Long 460* (E); Chenari Khola, *Grierson & Long 3471* (K); Tongsa, 4 April 1982, *Grierson & Long 4319* (A, K). **China**: Kweichow, April 1907, *Cavalerie 3312* (E); Yunan, Kouang Tiao Pa, 1922, *Cavalerie 7491* (K), Tavabed, March 1913, *Forrest 9751* (E); Tengyneh, *Forrest 7700* (E, K); Tung Chow, April 1901, *Moore 533* (K). **Myanmar**: Myitkyina, Lankhaung-Ritsaw road, 28 March 1938, *Kermode 16664* (K). **Thailand**: Chieang Mai; Doi Suthep, 15 Feb. 1959, *Sørensen et al 6928* (AAU, K), Ban Pong Yien, 2 Feb. 1913, *Kerr 2899* (E).

24. Gynura hmopaengensis H. Koyama (Fig. 28D)

Gynura hmopaengensis H. Koyama in Acta Phylotax. Geobot. 39 (1988) 152.-
Type: (holo KYO!, iso BKF!), Thailand, Mae Hong Son, Pai Hmo Paeng waterfall.

Plants 1-2 m high, stems erect, densely pilose. *Petioles* 2-5 cm long, exauriculate, pilose. *Blades* oblanceolate, 10-17 x 3-6 cm, densely pilose, base cuneate, apex acuminate, margin serrate. *Capitula* 2-5 in lax corymbs; peduncles 3-6 cm long, pilose, bracts 4-6, 6-10 mm long; involucres 10-13 mm long, 4-6 mm in diameter; calycular bracts 5-8, 3-5 mm long, pilose; phyllaries 13-14, 1-2 mm broad, densely pilose. *Florets* 30-40, orange to yellow, 9-12 mm long, exserted part 2-4 mm long. *Anthers* 2 mm long, anther collars elongated. *Style arms* 3 mm long. *Cypselas* 2-3 mm long, brown, pilose; carpopodium cylindrical, yellowish; pappus 9-10 mm long, white.

Flowering from January to March. Growing in disturbed parts of deciduous forests. 700-1000 m. Endemic to Thailand (Fig. 18).

Note. Gynura hmopaengensis is endemic to Thailand where it grows in disturbed parts of deciduous forests at high elevations. It is recognizable by its usually oblanceolate leaves which are densely pilose and have a serrate margin.

Specimens examined. **Thailand**: Mae Hong Son, Hmo Paeng waterfall, 15 Jan. 1993, *Koyama et al. T32536* (KYO, BKF); Chiang Mai, Doi Mah Geu, 6 March 1997, *Maxwell 97-214* (A).

25. Gynura rubiginosa Elmer (Fig. 29A)

Gynura rubiginosa Elmer in Leaflets Philipp. Bot. 1 (1906) 154.-Type: *Elmer 6246* (holo K!; iso PNH), Philippines.

Plants 1-2 m high, stems erect, sparsely to densely brown-scabrous. *Petioles* 2-4 cm long, exauriculate, sparsely to densely brown-scabrous . *Blades* ovate to cordate, 8-12 x 5-8 cm, sparsely to densely brown-scabrous, base cuneate to cordate, apex acute, margin crenate-dentate. *Capitula* 3-8 per corymb; peduncles stout, 0.5-2 cm long, sparsely brown-scabrous, bracts 3-6 , 2-4 mm long, sparsely to densely brown-scabrous; involucres 9-11 mm long, 4-6 mm in diameter; calycular bracts 3-5, 2-4 mm long, sparsely to densely brown-scabrous; phyllaries 8, 1-1.5 mm broad, sparsely scabrous. *Florets* 20-25, orange to yellow, exserted part 2-3 mm. *Anthers* 2.5 mm long, anther collars elongated. *Style arms* 3 mm long. *Cypselas* 4 mm long, brown,

glabrous or pilose; carpopodium cylindrical, yellowish; pappus 10-12 mm long, dirty-white.

Flowering from May to September. Growing in damp thickets, 1600-2000 m. Endemic to the Philippines (Fig. 18).

Note. Gynura rubiginosa is easily recognized by its cordate leaves and its sparse to dense brown-scabrous indumentum.

Specimens examined. **Philippines**: Luzon, Benguet, Mt Santo Thomas, May 1904, *Elmer 6246* (K), May 1911, *Merrill 897* (G); Bontoc, Mt Pukis, March 1920, *Ramos & Edano 37755* (A, K, L).

26. Gynura villosus Vanijajiva & Kaderit, *spec. nova* (Fig. 29B)

. Species *G. albicaulis* affinis, foliis caulibus & infuscentis villosus.-Typus: Malaysia, Borneo, Sarawak, *Chai S39887* (holo K, iso L).

Plants 1-2 m high, stems erect, brown-villose. *Petioles* 1-4 cm long, exauriculate, brown-villose. *Blades* elliptical to obovate, 3-15 x 1-5 cm, brown-villose, base cuneate, apex acute or obtuse, margin entire or denticulate. *Capitula* 2-6 per corymb; peduncles 1-6 cm long, densely villose, bracts 1-4, 2-8 mm long, villose; involucres 7-9 mm long, 4.5-6 mm in diameter; calycular bracts 4-6, 1-2 mm long, villose; phyllaries 8-14, 1-2 mm in diameter, glabrous. *Florets* 10-25, orange to yellow, 8-10 mm long, exserted part 2-3 mm. *Anthers* c. 2.5 mm long, anther collars elongated. *Style arms* 3 mm long. *Cypselas* 4 mm long, brown, pilose; carpopodium cylindrical, yellowish; pappus 6-9 mm long, white.

Flowering November to January. Growing on limestone cliffs, 1000-1300 m. Endemic to Malaysia (Borneo, Sarawak) (Fig. 18).

Note. This new species is morphologically similar to *G. albicaulis* but differs in being brown-villose.

Specimens examined. **Malaysia**: Borneo, Sarawak, Gunong Buda, 17 Oct. 1977, *Chai S39887* (L, K), Gunung Api, 7 Nov. 1983, *Primack s.n.*(L, K, A).

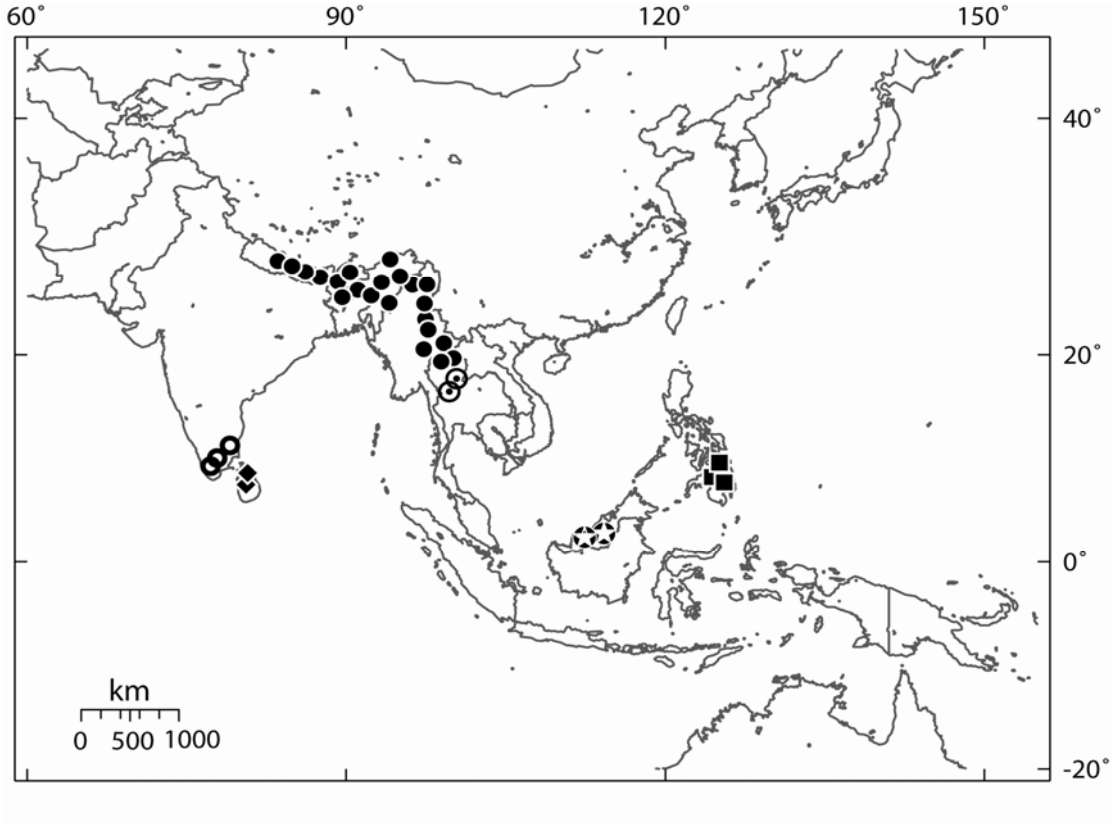

Figure 18. Distribution of *Gynura nitida* ⭘, *G. travancorica* ◆, *G. nepalensis* ●, *G. hmopaengensis* ⊙, *G. rubiginosa* ■, *G. villosus* ✪

27. Gynura campanulate C. Jeffrey (Fig. 29C)

Gynura campanulate C. Jeffrey in Kew Bull. 41 (1986) 929.-Type: *T.H. Jackson 15* (holo BM!), Kenya, Kiambu.

Plants 30-50 cm high, stems erect, subsucculent, leaves clustered in lower part of stems, glabrous. *Petioles* 1.5-3 cm long or absent, auricles 1-2 x 1-3 mm or absent, sparsely pubescent. *Blades* oblanceolate, lyrate to pinnatifid, 4-5 x 2-2.5 cm, pubescent, base cuneate or truncate, apex acute, margin dentate. *Capitula* 2-4 in lax corymbs; peduncles slender, 1.5-6 cm long, glandular pubescent, bracts 2-4, 0.5-4 mm long, glandular; involucres 12-13 mm long, 4-6 mm in diameter; calycular bracts 8-10, 1-3 mm long, pubescent; phyllaries 13, 1-2 mm broad, glabrous. *Florets* 20-25, yellow, 9-12 mm long, exserted part 2-3 mm. *Anthers* 2.5 mm long, anther collars

elongated. *Style arms* 3.5 mm long. *Cypselas* 1.5-2.5 mm long, brown, pilose; carpopodium cylindrical, yellowish; pappus 11-13 mm long, white to dirty-white.

Flowering in December. Growing in wet scrub, 1615 m. Only know from Kenya (Fig. 19).

Note. *Gynura campanulate*, only known from a single collection, is well distinguished from the other species of the genus by its leaves which usually are clustered in the lower part of the stems and its slender peduncles with a glandular indumentum.

Specimens examined. Kenya. Kiambu, Dec. 1935, *T.H. Jackson* 15 (BM)

28. Gynura drymophila (F.W. Muell)F.G. Davies (Fig. 29D)

Gynura drymophila (F.W. Muell)F.G. Davies in Kew Bull. 35 (1981) 733.- *Senecio drymophilus* F.W. Muell. in Trans. Phil. Inst. Vict. 2 (1858) 69.-Type: *Hill & Meuller* (holo & iso K!), Australia, Brisbane River.

Gynura pseudochina sensu Benth. Fl. Austral. 3 (1867) 661, non (L.) DC.*Senecio shirleyanus* Domin, Biblioth.Bot. 89 (1929) 1240.- Type: *Domin* (holo PR), South Queenland, Tambourine Mts.

Plants 50-120 cm high, stems erect, densely or sparsely pubescent to glabrous. *Petioles* 0.5-1.5 cm long or leaves sessile, auricles 1-2 x 1-2.5 cm, pubescent to glabrescent. *Blades* oblanceolate to oblong, 5-8 x 1-3 cm, pubescent, base truncate, apex obtuse, margin irregularly dentate to shallowly lobed. *Capitula* 2-3 per corymb; peduncles stout, 2-10 cm long, sparsely pubescent, with 2-5 bracts, pubescent; involucres 15-18 mm long, 6-8 mm in diameter; calycular bracts 7-14, 4-5 mm long, pubescent; phyllaries 13, 1-2 mm broad, sparsely pubescent. *Florets* c. 30-40, orange to yellow, 9-11 mm long, exserted part 2-3 mm long. *Anthers* 3.5 mm long, anther collar short. *Style arms* 2.5 mm long. *Cypselas* 5-6 mm long, dark brown, pilose; carpopodium hemispherical, yellowish; pappus 12-14 mm long, white or dirty-white.

Note. Gynura drymophila looks similar to the South Asian *G. hispida* but differs by its much larger capitula and irregularly dentate to shallowly lobed leaf margins. The

species has been divided into two varieties by Froster & Thongpukee (1988) which we agree represent distinct taxa.

Key to the varieties of *Gynura drymophila*

1a. Stems pubescent…….……..a. var. *drymophila*

b.Stems glabrous……...…….b. . var. *glabrifolia*

28a. var. *drymophila*

Flowering and fruiting throughout the year. Growing on rocks near the coast, 0-500 m. Endemic to Northern Australia (Fig. 19).

Specimens examined- Australia, New Holland (N. Australia), Banks & Solader 72 (BM); Brisbane River, Oct. 1856 *Hill & Meuller* (K)

28b. var. *glabrifolia* Froster & Thongpukee

Flowering and fruiting throughout the year. Growing in cracks or detritus of rhyolitic rock or alternatively in deep sand, 0-500 m. Endemic to Northern Australia.

Note. Our description of the morphology, distribution and habitat of *G. drymophila* var. *glabrifolia* is mainly based on Froster & Thongpukee (1988).

29. Gynura hispida Thwaites (Fig. 30A)

Gynura hispida Thwaites in Enum. Pl. Zeyl. (1860) 166.-*Gynura pseudochina* var. *hispida* (Thwaites) Hooker, Fl. Brit. Ind. 3 (1882) 335.-Type: *Thwaites 3507* (holo PDA; iso K!, L), Sri Lanka

Plants 10-70 cm high, stems erect, densely hispid. Leaves sessile, clustered in lower part of stems, auricles 1-1.5 x 2-3 cm or absent, sparsely hispid. *Blade*s elliptical or narrowly elliptical, 4-12 x 2-6 cm, densely hispid, base cuneate, apex acute, margin serrate-dentate. *Capitula* 2-5 per corymb; peduncles stout, 1-10 cm long, densely hispid, bracts 2-7, 5-8 mm long, densely hispid; involucres 9-11 mm long, 4.5-7.5 mm in diameter; calycular bracts 4-7, 5-7 mm long, densely hispid ; phyllaries 14, 1-2 mm

broad, hispid. *Florets* 25-30, orange-yellow, 9-11 mm long, exserted part 2.5-3.5 mm. *Anthers* 2 mm long, anther collars elongated. *Style arms* 3 mm long. *Cypselas* 4 mm long, brown, pilose; carpopodium cylindrical, yellowish; pappus 10-12 mm long, dirty-white.

Flowering in March. Growing in rock crevices, 1000-2000 m. Only known from Sri Lanka (Fig. 19).

Note. Gynura hispida looks similar to the widespread *G. pseudochina* but differs by its densely hispid stem indumentum and its much stouter peduncles.

Specimens examined. **Sri Lanka**: Nuwara Eliya, Hakgala Hill, 9 March 1969, *Grierson 1079* (E); without locality *Thwaites 3507* (BM, G).

30. Gynura cusimbua (D. Don) S. Moore (Fig. 30B)

Gynura cusimbua (D. Don) S. Moore in J. Bot. 50 (1912) 212. -*Porophyllum cusimbua* (D. Don) DC., Prodr. 5 (1836) 650.- *Kleinia cusimbua* (D. Don) Less., Linnaea 6 (1831) 133.-*Cacalia cusimbua* D. Don, Prodr. Nep.(1825) 179.-Type: *Hamilton s.n.* (holo E), Nepal

Gynura angulosa DC., Prodr. 6 (1838) 298, syn nov.-Syntype: *Wallich 3152* (K-W!), Nepal.

Plants 1-4 m high, stems erect to procumbent, sparsely pubescent to glabrescent. *Leaves* sessile, auricles 1-4 x 1-3 mm or absent, pubescent or glabrescent. *Blades* obovate or ovate, 4-40 x 2-15 cm, densely to sparsely pubescent, base cuneate, apex acute, margin serrate-dentate. *Capitula* 4-15 in dense corymbs; peduncles 1-8 cm long, pubescent, bracts 4-8, 2-5 mm long; involucres 10-15 mm long, 5-8 mm in diameter; calycular bracts 8-15, 1-3 mm long, pubescent; phyllaries 12-16, 1-2 mm broad, glabrescent. *Florets* 30-45, orange-yellow, 11-15 mm long, exserted part 3-4 mm. *Anthers* 2 mm long, anther collar elongated. *Style arms* 3.5 mm long. *Cypselas* 4-4.5 mm long, brown, glabrous or pilose; carpopodium cylindrical, yellowish; pappus 10-13 mm long, white. n = 20 (Jose & Mathew, 1990).

Flowering and fruiting throughout the year. Growing in open places near streams and on wet ground along the edge of mixed forests and mossy evergreen forests, 1800-2500 m. India, Bangladesh, Nepal, Bhutan, China, Myanmar and Thailand (Fig. 19).

Note. Gynura cusimbua looks somewhat similar to *G. bicolor* but clearly differs from that species by its essentially sessile leaves with often large, obovate or ovate laminas with a distinctly serrate-dentate margins.

Specimens examined. **India**: Darjeeling, 27 Oct. 1809, *Clarke 9428A* (BM), Oct. 1925, *Gamble 2522A* (K), 1885, *Beddom*e *4543* (BM), 1923, *Cowan s.n*. (K), 18 Nov. 1923, *Parker 2136* (A); Kanglatonbi, 11 Dec. 1945, *Bullock 885* (L); Assam, Khasi hills, 25 May 1952, *Chand* 5749 (L), Naga hills, 28 Feb. 1935, *Bor 6446* (*K*), Theopesini, 20 July 1942, *Bor 16165* (A); Punjab, 25 Sept. 1884, *Drummond 1806* (G, K), Kulu, Sept. 1932, *Range* s.n. (S); Ganktok, 20 Oct. 1952, *Biswas 9737* (G); Sikkim, 1867, *Hooker s.n.* (A, K); East Bengal, 1862, *Griffith 3233* (S). **Bangladesh**: Khasia, Boga Pani, 17 Nov. 1871, *Clarke 14646* (BM). **Nepal**: Kathmadu, 1 Nov. 1965, Schilling *689* (K); Landung, 9 Nov. 1969, *Flatt 155* (BM); Kascura Khola, 29 Nov. 1971, *Beer et al 12337* (BM); Wabak Khola, 18 Oct. 1975, *Beer 25610* (BM); Dhankuta-Hilay-Murhay, 23 Oct. 1963, *Hara et al. 06306281*(BM); Bhuji Khola, 15 Oct. 1954, *Stainton et al. 9033* (BM); Lalitur, Pulchoki, 12 Nov. 1966, *Nicolson 2735* (BM); Marichur, 15 July 1923, *Sakya 5902* (BM); Likhu Khola, 17 June 1964, *Stainton 4638* (BM); Mardi Khola, 26 Oct. 1967, *Stainton 6095* (BM); Myagdi, Dhawalagiri, Dhara Khola, 4 Sept. 1996, *Mikage et al*. *9681144* (BM); Chalis, 18 Aug. 1935, *Bailey 150* (BM); Duraihi, Bheri Valley, 16 July 1952, *Polunin et al. 2477* (E, G); Jubing, 28 Oct. 1954, *Zimmermann 1916* (G); Khading, 1928, *Dhevoj 181* (E). **Bhutan**: Mirichama, 20 Nov. 1914, *Cooper 3641* (BM); Pintsogong, 21 Nov. 1938, *Ludlow et a*l *6751* (BM). **China**: Yunnan, Shang-pa Hsien, 10 Sept. 1933, *Tsai 54219* (A), 31 Dec. 1966, *Henry 9381B* (A), Tali, July 1929, *Forrest 28014* (E), Lichiang, 1933, *McLaren 147A* (E), 218B (BM), Shunning, 28 June 1938, *Yu 16526* (A, E), Mekong-Salwin, Londjrela, 28 Sept. 1938, *Yu 23149* (A); Shan, 21 Oct. 1998, *Bartholomew & Zhi-ling 10769* (A); Tibet, Tali Range, July 1929, *Forrest 28014* (BM). **Myanmar**: Amhersr, 27 Jan. 1912, *Lace 5630* (K); Mandalay, 13 Nov. 1997, *Kress* 97-6-48; Myitkyina, 14 Sept. 1938, *Naw Mu Pa 17460* (K) **Thailand**: Chiang Mai, Doi Chiang Doi, 5 Nov. 1922, *Kerr 6567* (BM, E, K); Doi Inthanon, Angka, 7

Oct. 1982, *Konta et al. T29792* (A, KYO), 8 Dec. 1984, *Koyama & Phengklai T40002* (A, KYO), 8 Dec. 1969, *Beusekom & Pheng 2406* (KYO), 7 Jan. 1983, *Koyama et al. T32094* (KYO), 24 Dec. 1934, *Garrett 918* (L), 22 Dec. 1997, *Niyomdham 5267* (K).

31. Gynura ajakensis Hochr. (Fig. 30C)

Gynura ajakensis Hochr. in Candollea 5 (1934) 330. - Type: *Hochreutiner 2736* (holo G!), Java, Tengger, Mt Ajak-ajak.

Plants 1-2 m high, stems erect, sparsely brownish-scabrous to glabrescent. *Petioles* 0.5-1 cm long or leaves sessile, auricles 1-1.5 x 1-2 cm long, brownish-scabrous. *Blades* ovate to elliptical, 8-12 x 2-8 cm, brownish-scabrous, base cuneate and often asymmetrical, apex acute, margin coarsely serrate. *Capitula* numerous in dense corymbs; peduncles 0.5-3 cm long, brownish-scabrous, bracts 3-6 , 3-7 mm long, brownish-scabrous; involucres 9-12 mm long, 4.5-7.5 mm in diameter; calycular bracts 5-8, 3-8 mm long, brownish-scabrous; phyllaries 14, 1-2 mm broad, glabrescent. *Florets* c. 40, orange to yellow, 8-11 cm long, exserted part 2-2.5 mm. *Anthers* c. 2.5 mm long, anther collars elongated. *Style arms* 3 mm long. *Cypselas* 4 mm long, brown, pilose; carpopodium cylindrical, yellowish; pappus 6-9 mm long, white.

Flowering and fruiting throughout the year. Growing in clearings and dry areas at high altitudes, 2000-3000 m. Endemic to Indonesia (Java) (Fig. 19).

Note. Davies (1980b) already discussed the similarity between *G. ajakensis* and *G. aurantiaca*. She distinguished *G. ajakensis* from *G. aurantiaca* by the size of the florets and the shape of the anther collar. She also noted that *G. ajakensis* replaces *G. aurantiaca* in drier habitats at higher altitudes.

Specimens examined. **Indonesia**: Java, 20 Jan.1905, *Hochreutiner 2736* (G), Nov. 1907, *Elbert 43* (L), 12 May 1920, *Backe 36603* (L), 5 June 1926, *Backe 37327* (L) Oct. 1923, *Saranya 214* (L).

32. Gynura elliptica Yabe & Hayata (Fig. 30D)

Gynura elliptica Yabe & Hayata in J. Coll. Sci Tokyo 18 (1904) 25.-Type: *Miyake s.n.* (holo TI photo), Taiwan, Kotosho.

Plants about 50-80 cm high, stems erect or somewhat decumbent, sparsely pubescent or glabrescent. *Petioles* 1-3 cm long, auricles 1-2 x 2-3 cm, glabrous. *Blades* broadly elliptical, 3-12 x 2-6 cm, sparsely pubescent, base cuneate, apex obtuse to apiculate, margin usually entire. *Capitula* 2-5 per corymb; peduncles 1-4 cm long, sparsely pubescent, bracts 2-6, 2-5 mm long; involucres 8-11 mm long, 3.5-7 mm in diameter; calycular bracts 5-8, 3-5 mm long, pubescent; phyllaries 14, 1-2 mm broad, sparsely pubescent. *Florets* 35-50, orange to yellow, 8-12 mm long, exserted part 2-3 mm long. *Anthers* 2 mm long, anther collars elongated. *Style arms* 3 mm long. *Cypselas* 2-3 mm long, brown, glabrous or pilose; carpopodium cylindrical, yellowish; pappus 8-10 mm long, dirty-white.

Flowering and fruiting throughout the year. Growing in grassland or on rocks in coastal areas. 0 – 500 m. Taiwan and Philippines (Fig. 19).

Note. This species is well-distinguished by the shape of its leaves which are broadly elliptical and entire. Its distribution is restricted to Taiwan.

Specimens examined. **Taiwan**: Lanyu, 25 Feb. 1993, *Hu et al 1024* (A), 20 May 1992, *Leu 1372* (E), 17 March 1983, *Tamura et al. 27331* (KYO), 6 April 1983, *Chang 16705* (KYO), 4 Sept. 1976, *Liu 2003* (K). **Philippines**: Batan, Mt. Iraya, 21 March 1991, *Barbon et al. 1587* (KEP, L, TEX), April 1930, *Ramos PNH 79966* (A), 13 March 1981, *Suzuki & Sugawara* (KYO).

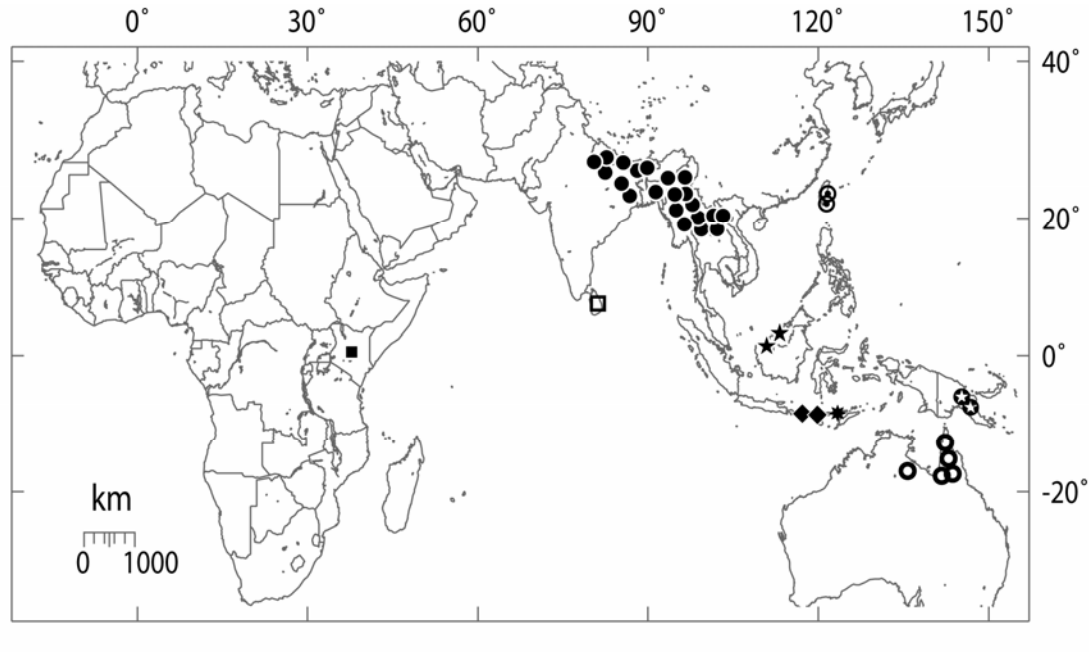

Figure 19. Distribution of *Gynura campanulate* ■, *G. drymophila* ❍, *G. hispida* □ *G. cusimbua* ●, *G. ajakensis* ◆, *G. elliptica*⊙.

33. Gynura divaricata (L.) DC. (Fig. 31A)

Gynura divaricata (L.) DC., Prodr. 6 (1838) 301.-*Senecio divaricatus* L., Sp. Pl.: (1753) 866. Type: *Osbeck s.n.* (holo LINN photo), China, Canton.

Plants 50-120 cm high, stems erect or procumbent, sparsely pubescent to glabrescent. *Petioles* 0.5-5 cm long or leaves sessile, auricles 0.3-1 x 0.4-1.5 cm, pubescent to glabrescent. *Blades* ovate, elliptical, lanceolate, oblanceolate or lyrate, 2-15 x 1.5-5 cm, sparsely to densely pubescent, base cordate or truncate, apex obtuse or acute, margin entire or distantly dentate**.** *Capitula* 1-5 per corymb; peduncles 1-15 cm long, pubescent to subglabrous, bracts 3-7, pubescent to glabrescent; involucres 8-12 mm long, 5-7.5 mm in diameter; calycular bracts 7-8, 4-5 mm long, pubescent; phyllaries 12-14, 1-2 mm broad, sparsely pubescent. *Florets* c. 30-40, orange to yellow, 9-11 mm long, exserted part 2-3 mm long. *Anthers* 3.5 mm long, anther collar short. *Style arms* 2.5 mm long. *Cypselas* 4-6 mm long, pilose; carpopodium hemispherical, yellowish; pappus 10-12 mm long, white or dirty-white. 2n = 20 (Jose & Mathew, 1990).

Note. Gynura divaricata can be recognised by being fleshy in its upper parts but woody and procumbent at the base, by having ascending scapose or leafy flowering shoots, and ribbed stems which usually are purple-tinged when dried. The species is restricted to south China and north Vietnam (Fig. 20). *Gynura divaricata* shows great variation in leaf form which is correlated with geographical distribution. We follow Davies (1979) in dividing the species into three subspecies.

Key to the subspecies of *Gynura divaricata*

1a. Leaves simple, base narrowed into petiole-South China……..a. subsp. *divaricata*

b. Leaves lyrate, base usually cordate, truncate or cuneate…….....2.

2a. Plants erect; leaf base cordate to truncate-Hainan and Vietnam

……...……..b. subsp. *barbareifolia*

b. Plants procumbent; leaf base cuneate-Taiwan……..…….c. subsp. *formosana*

33a. subsp. *divaricata*

Gynura incana (L.) Druce in Rep. Bot. Exch. Cl. Soc. Brit. Isles, 1913. 3 (1914) 418.-*Cacalia incana* L., Sp. Pl. ed. 2 (1763) 1169.-Type: *Osbeck s.n.* (holo S).

Porophyllum hieracioides (Willd.) DC., Prodr. 5 (1825) 650.-*Cacalia hieracioides* Willd, Sp. Pl. ed. 4 (1804) 1721.-Type: *Wallich 3148* (K-W!).

Cacalia ovalis Kar-Gawl in Bot. Reg. (1816) 2, t. 101.-Type: *Hammersmith 1816* (holo BM!), cult. England.

Gynura auriculata Cass., Opusc. Phyt. 3 (1834) 100.-Lectotype: *Bouton* (K), Mauritius.

Gynura bulbosa sensu Hook. & Arn., Bot. Beech. Voy. (1836) 194, non Lour.-Type: *Cavalerie 3305* (holo K!), China, Yunnan.

Gynura ovalis (Ker-Gawl.) DC., Prodr. 6 (1837) 300.-Type: *Playfair* 63 (holo K!), China.

Gynura hemesleyana H. Le'v. in Bull. Acad. Geogr. Bot. 24 (1914) 284.-*Gynura*

ovalis var. *pinnatifida* Hemsl. in Bot. J. Linn. Soc. 23 (1888) 448.-Type:

Playfair s.n. (holo K!), China.

Gynura panershenia Z. Y. Zhu, Bull. Bot. Res. 26 (2006) 644, syn. nov.-Type: *Z. Y. Zhu s.n.* (holotype EMA), China, Sichuan, Emeishan.

Flowering and fruiting throughout the year. Growing on rocks by the shore, 0-500 m. China.

Specimens examined. **China**: Kwangtung, Pak Tze Tsoi, 12 Sept. 1935, *Tsang 25802* (A); Kwangsi, Yan Wo, 16 Dec. 1928, *Pan & Hom 19173* (A), KwongTung, Lah Fau Shan, Oct. 1916, *Levine 521* (A); Hong Kong, Luk Keng, 15 April 1972, *Hu 11854* (K), Plover cove, 18 May 1970, *Hu 10098* (A, K), Shatin, 9 May 1969, *Hu 7257* (K), Lantau, Ngong Ping, 26 July 1970, *Hu 10707* (K), Port Island, 6 Oct. 1972, *Hu 12226* (K), Cape D'aguilar, 3 May 1970, *Hu 10072* (K), Green Island, 28 March 1972, *Hu 11678* (A), without locality, 1855, *Furet 139* (P), 18 July 1894, *Bodinier 757* (P).

33b. subsp. *barbareifolia* (Gagnep.) F.G. Davies

Gynura barbareifolia (as *barbareaefolia*) Gagnep. in Bull. Soc. Bot. France 68 (1921) 119. Lectotype: *Bon 2880* [E!; iso P! designated by Davies (1980)], Vietnam, Annam.

Gynura maclurei Merrill in Philip. Journ. Sci. 21 (1922) 355.-Type: *McClure 8620* (holo A!), China, Hainan.

Flowering and fruiting throughout the year. Growing in ravines, on dry, steep slopes, on sandy soils or on rock, 0-1500 m. China (Hainan) and Vietnam.

Specimens examined. **China**: Hainan, 1 Oct. 1933, *Wang 34415* (A), Bak Sa, 10 March 1936, *Lau 25659* (A), Kan-en, *Lau 3498* (A, S), Chuang Ngo Shan, 6 Feb.1934, Lau *3283* (S); Five Finger Mt., Dec. 1921, *MacLure 8626* (A); Kwangsi, Sui-Luk, March 1933, *Tsang 21861* (A). **Vietnam**: Annam, 9 April 1885, *Bon 2880* (E, P), 29 March 1922, *Poiland 2847* (P), 28 Sept. 1922, *Poiland 4779* (P), Nov. 1932, *Petelot 2058* (A), July 1935, *Petelot 5562* (A), May – July 1927, *Clemens 3694*

(G, P); Hanoi, Nov. 1922, *Petelot 1216* (BM, P); Chua-Lung, 30 April 1913, *Safran 2672* (P); Conkin, Chapa, April 1935, *Petelot 2062* (A).

33c. subsp. *formosana* (Kitam) F.G. Davies

Gynura formosana Kitam. in Acta Phytotax. Geobot. 2 (1933) 175.-Type: *Kitamura 871* (holo KYO!), Taiwan, Tamsui.

Flowering and fruiting throughout the year. Growing in sand along the sea shore, 0-500 m. Only known from Taiwan.

Specimens examined. **Taiwan**: Tamsui, 19 Jan. 1932, *Kitamura 871* (KYO), Nov. 1914, *Faurie 1439* (BM), 14 May 1922, *Ito s.n.* (BM); Taihoku-shu, 11 May 1932, *Shimada 11028* (E, G, L, P, S), Taipei, San-Tiao Chiao, 6 April 1976, *Lui 1833* (K); Taito-Cho, 3 March 1931, *Tanaka 10359* (BM), Batakan, Taroko, 31 Oct. 1931, *Suzuki 8661* (S), Dandan, Kiirun, 17 May 1930, *Suzuki 4497* (S), without locality, April 1864, *Oldham 260* (A).

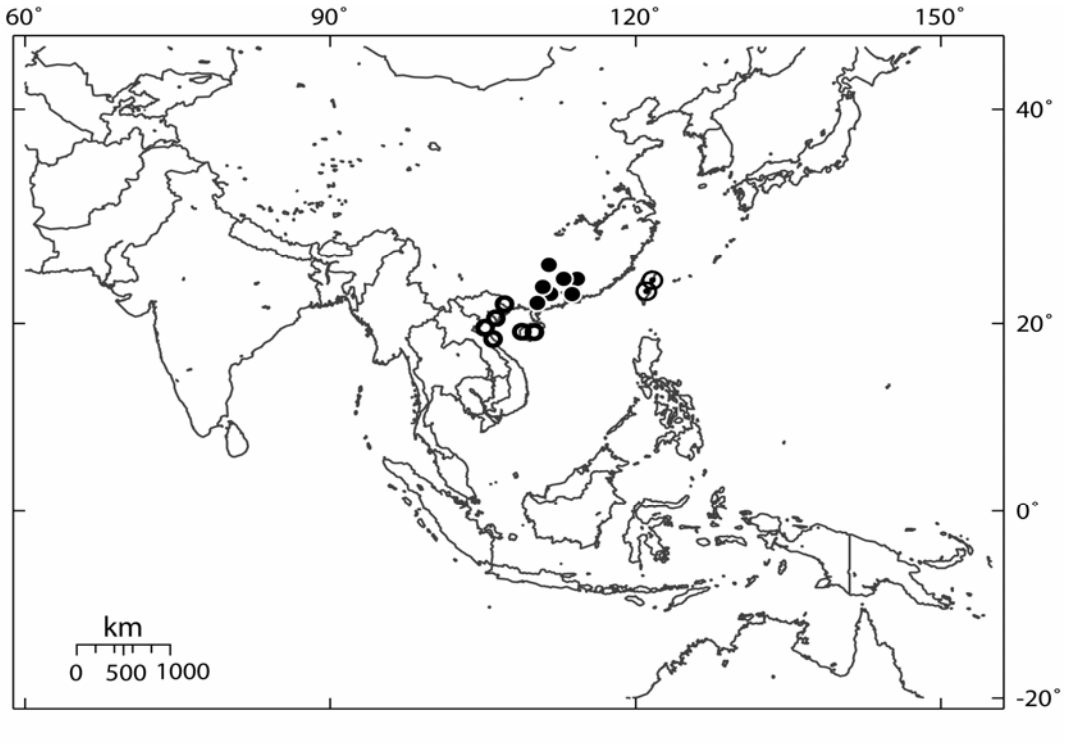

Figure 20. Distribution of *Gynura divaricata* subsp. *divaricata* ●, *G. divaricata* subsp. *barbareifolia* ❍, *G. divaricata* subsp. *formosana* ⊙

34. Gynura batorensis F. G. Davies (Fig. 31B)

Gynura batorensis F. G. Davies in Kew Bull. 35 (1980) 724.-Type: *Zollinger 3896* (holo W, iso L!), Indonesia, Bali.

Plants about 1 m high, stems erect, with prominent leaf scars, densely villose. *Petioles* 1-6 cm long, auricles 6-14 x 2-3 mm, densely villose. *Blades* ovate to elliptical, rarely lyrate, 3-8 by 2-5 cm, usually densely pubescent beneath, base truncate or cuneate, apex acute, margin sharply incised-serrate. *Capitula* 4-10 in dense corymbs; peduncles 0.5-2 cm long, densely pubescent, bracts 3-5, 3-6 mm long, glabrescent; involucres 6-8 mm long, 2.5-5 mm in diameter; calycular bracts 4-7, 2-3 mm long, villose; phyllaries 8-10, 1-2 mm broad, glabrous. *Florets* 10-12, yellow, 8-12 mm long, exserted part 2-3 mm. *Anthers* c. 2.5 mm long, anther collars short. *Style arms* 3 mm long. *Cypselas* 4 mm long, brown, pilose; carpopodium cylindrical, yellowish; pappus 8-11 mm long, dirty-white.

Flowering from May to September. Habitat unknown. Endemic to Indonesia, Bali (Mt. Bator) (Fig. 21).

Note. Gynura batorensis closely resembles *G. carnosula*, a species known only from Java, but differs by its distinctly auriculate leaves and by having prominent leaf scars on the stems.

Specimens examined. **Indonesia**: Bali, Mt Bator, 8 Sept. 1857, *Zollinger 3896* (L), 25 May 1935, *de Voogh 2022* (L), 8 April 1936, *Van Steenis 7935* (K, L, SING).

35. Gynura brassi F. G. Davies (Fig. 31C)

Gynura brassi F. G. Davies in Kew Bull. 35 (1980) 726.-Type: *Brass 27629* (holo K!; iso L!), Papua New Guinea, Misima.

Plants 30-100 cm, stems erect, densely olive-green villose. *Petioles* 0.5-1.5 cm long or leaves sessile, auricles 1-2 x 2-4 mm, olive-green villose. *Blades* elliptical or lanceolate, 8-12 x 2-4 cm, olive-green villose, base cuneate, apex acute to apiculate, margin entire or coarsely dentate to serrate. *Capitula* 2-7 per corymb; peduncles stout, 1-7 cm long, villose, bracts 2-6, 3-6 mm long, villose; involucres 8-10 mm long, 1-2

mm in diameter; calycular bracts 4-7, 3-5 mm long, villose; phyllaries 12-14 , 1-2 mm broad, densely villose. *Florets* 35-60, yellow, 9-12 mm long, exserted part 3-4 mm. *Anthers* 2 mm long, anther collars short. *Style arms* 3 mm long. *Cypselas* 4 mm long, brown, glabrous; carpopodium cylindrical, yellowish; pappus 10-12 mm long, white.

Flowering from May to December. Growing in rock crevices of limestone hills or on stony ground, 50-200 m. Endemic to Papua New Guinea.

Note. *Gynura brassi* is very distinct by its densely olive-green villose indumentum. The species is only known from Papua New Guinea (Fig. 21).

Specimens examined. **Papua New Guinea**: Fergusson, 1 June 1956, *Brass 26071* (L); Misima, 5 Aug. 1956, *Brass 27629* (L); Morobe, 28 May 1975, *Henty & Katik 49813* (L); Milne Bay, 5 Nov. 1976, *Henty 49972* (L), 7 Dec. 1977, *Benjamin 67905* (L); Ruana, 26 May 1935, *Carr 12344* (BM).

36. Gynura fulva F. G. Davies (Fig. 31D)

Gynura fulva F. G. Davies in Kew Bull. 35 (1980) 724.-Type: *Schmutz 3831* (holo L!; iso K!), Indonesia, Lesser Sunda, Flores.

Plants about 1 m high, stems erect, densely olive-brown tomentose. *Petioles* 1-1.5 cm long, auricles 3-4 mm, densely olive-brown tomentose. *Blades* narrowly elliptical or rhomboid, 5-12 x 2-4 cm, olive-brown tomentose, base cuneate, apex acute, margin coarsely dentate. *Capitula* 5-10 in dense corymbs; peduncles 0.5-1 cm long, densely tomemtose, bracts 1-5, 1-3 mm long, densely tomentose; involucres 7-8 mm long, 3-6 mm in diameter; calycular bracts 3-5, 3-6 mm long, densely tomentose; phyllaries 12-14, 1-2 mm broad, densely tomentose. *Florets* 35-40, yellow, 8-12 mm long, exserted part 2-3 mm. *Anthers* 2 mm long, anther collars elongated. *Style arms* 3 mm long. *Cypselas* 4 mm long, brown, pilose; carpopodium cylindrical, yellowish; pappus 8 mm long, dirty-white to yellowish.

Flowering from February to August. Growing on steep rocky slopes, 1500-2500 m. Endemic to Indonesia, Lesser Sunda Islands (Fig. 21).

Note. Gynura fulva can be recognized by its coriaceous, narrowly elliptical to rhomboid leaves with an olive-brown indumentum.

Specimens examined. **Indonesia**: Lesser Sunda, Flores, Mt Ranaka, 28 April 1965, *Kostermans & Wirawan 686* (AAU, K, L), 2 Aug. 1975, *Schmutz 3831* (L), 18 Feb. 1974, *Verheijen 3420* (L, TEX), Ruteng, 20 June 1964, *Verheijen 1996* (L), 16 June 1975, *Veldkamp 7009* (L, TEX), 12 July 1988, *Schmutz 6940* (L).

37. Gynura lycopersicifolia DC. (Fig. 32A)

Gynura lycopersicifolia DC., Prodr. 6: 300 (1838).-Lectotype: *Wight 1489* (K!; iso E!), India, Courtallum.

Plants 30-100 cm high, stems erect, sparsely or densely scabrous. *Petioles* 1-3 cm long, auricles 1-5 x 1-3 cm or absent, scabrous. *Blades* rhomboid to lyrate to pinnatpartite, lower pinnae smaller, terminal pinae ovate to triangular, 9-12 x 2-7 cm, sparsely or densely scabrous, base cuneate or truncate, apex acute, margin coarsely dentate-serrate. *Capitula* 2-4 in lax corymbs; peduncles slender, 1.5-6 cm long, scabrous to glabrescent, bracts 2-12, 0.5-4 mm long, scabrous; involucres 10-17 mm long, 6-8 mm in diameter; calycular bracts 4-8, 1-3 mm long, pubescent; phyllaries 14, 1-2 mm broad, scabrous to glabrescent. *Florets* 20-40, orange to yellow, 9-12 mm long, exserted part 2-3 mm. *Anthers* 2.5 mm long, anther collars elongated. *Style arms* 3.5 mm long. *Cypselas* 5 mm long, brown, pilose; carpopodium cylindrical, yellowish; pappus 7-9 mm long, white to dirty-white. 2n = 20 (Jose & Mathew, 1990), 26 (Chidambaram, 2005).

Note. Gynura lycopersicifolia is recognizable by its lyrate to pinnatipartite leaves. The species is distributed in Sri Lanka and India (Fig. 21). The division into subspecies was first proposed by Grierson (1974) and is followed here.

Key to the subspecies of *Gynura lycopersifolia*

1a. Involucre 10-14 mm long; terminal leaf lobe ovate to lanceolate...…….....…a subsp. *lycopersifolia*

b. Involucre 13-17 mm long; terminal leaf lobe broadly ovate to triangular.....b. subsp. *taprobanensis*

37a. subsp. *lycopersicifolia*

Flowering and fruiting throughout the year. Growing along forest road sides, 500-3000 m. Sri Lanka, India.

Specimens examined. **India**: Courtallum, 1910, *Wight 1489* (K, E), Wallice Cat n. 3153 (BM, G, K), *Wight 1640* (K, L); Bastar, Bailadila, 7 Oct. 1940, *Mooney 1484* (K), Canoon ghat, 7 March 1870, *Clarke 10431* (BM); Orissa, Korafut, 10 Oct. 1950, *Mooney 4072* (K). **Sri Lanka**: Central Province, Dambulla, Matale, near Rock temple, 9 Dec. 1971, *Cramer 3551* (E), 17 June 1932, *Junifusan 9778* (BM); Elkaduva, 13 Nov. 1931, *Junifuson 8965* (BM); Wilpattu, 2 Feb. 1970, *Cooray 70020246R* (E, K, KYO); Uva, Pattini Devala, 11 Jan. 1978, *Cramer 5039* (K); without locality, *Garner 424* (BM, K), *Thwaites 420, 2826,* (A, G).

37b. subsp. *taprobanensis* Grierson

Gynura subsp. *taprobanensis* Grierson in Ceylon J. Sci. 11 (1974) 20.- Type: *Gardner* s.n. (holo PDA), Sri Lanka , Kurunegala.

Flowering from January to April. Growing in open places in forests, 1500-3500 m. Endemic to Sri Lanka.

Specimens examined. **Sri Lanka**: Nuwara Eliya, between Horton Plains & Ohiya, 13 March 1969, *Grierson 1108* (E), 6 Feb.1971, *Robyns 7148* (K, L), 2 May 1972, *Jayasuriya & Robyns* 87 (L); Kandy, ascent to Admm's Peak, 2 March 1969, *Grierson 1046* (E); without locality, 17 April 1969, *Kostumam 23180* (L).

38. Gynura zeylanica Trim. (Fig. 32B)

Gynura zeylanica Trim., Fl. Ceylon 3 (1895) 44.- Type: *Thwaites s.n*. (holo PDA), Sri Lanka, Uva Province, Galagama,

G. nepalensis Thwaites, Enum. (1860) 166, non DC.

G. pseudochina Hook. f., Fl. Brit. Ind. 3 (1882) 334 pro parte (Ceylon plants), non (L.) DC.

Plants 60 cm high, stems erect, grooved, densely whitish-tomentose. *Petioles* 0.5-2 cm long, auricles 1-4 x 0.5-3 mm, tomentose. *Blades* elliptical to oblong or lyrate, 6-10 x 3-6 cm, pubescent, base cuneate or truncate, apex acute, margin serrate-dentate. *Capitula* 3-5 per corymb; peduncles stout, 0.5-2 cm long, tomentose, calycular bracts 3-5, 2-4 mm long, tomentose; involucres 10-17 mm long, 4-6 mm in diameter; phyllaries 12-14, 1 – 1.5 mm broad, tomentose. *Florets* 30-40, orange to yellow, exserted part 2-2.5 mm. *Anthers* 2 mm long, anther collars elongated. *Style arms* 3 mm long. *Cypselas* 4 mm long, brown, pilose; carpopodium cylindrical, yellowish; pappus 10-12 mm long, dirty-white.

Flowering from December to May. Growing in open places or along road sides, 500-1000 m. Only known from Madagascar and Sri Lanka (Ceylon) (Fig. 21).

Specimens examined. **Sri Lanka**: Bandarawella, 17 Sept 1931, *Simpson 8656* (BM); Sabaragamuwa, Ratnapura, 5 April 1969, *Grierson 1152* (E); Bibile, Westminster abbey, 15 Dec. 1975, *Bernardi 16027* (S); Uva, Badulla, Ettampitiya, 3 March 1978, *Cramer 5173* (K).

39. Gynura daviesii Vanijajiva & Kadereit, *spec. nov.* (Fig. 32C)

Species *G. aurantiaca* affinis sed sessile foliis, laminis glabratus.- Typus: *Kostermans s.n.* (holo K; iso L), Indonesia, Java, Pelabuhanratu.

Plants about 1 m high or more, stems erect, divaricately branched, glabrous. *Leaves* sessile, auricles 1-2 (10) x 1-3 mm or absent, glabrous. *Blades* elliptical, 18-25 x 4-6 cm, glabrous, base cuneate, apex acute, margin dentate. *Capitula* 2-4 per corymb; peduncles stout, 0.5-2 cm long, glabrous, bracts 4-7 , 3-7 mm long, scabrous; involucres 8-10 mm long, 5-7 mm in diameter; calycular bracts 4-7, 3-5 mm long, pubescent; phyllaries 13, 1-2 mm broad, pubescent. *Florets* 40-60, yellow, 8-12 mm long, exserted part 3 mm. *Anthers* 2 mm long, anther collars short. *Style arms* 3 mm long. *Cypselas* 4 mm long, brown, pilose; carpopodium cylindrical, yellowish; pappus 10-12 mm long, dirty-white.

Flowering from November to February. Growing in brushwood, 0-300 m. Only known from Indonesia (Java) (Fig. 21).

Note. This new species is named after F.G. Davies who first considered the type chosen here, *Kostermans s.n.*, to be a distinct species but did not name it because she had seen only this single collection. Since then, further collections have been made. *Gynura daviesii* is closely similar to *G. vidaliana* and *G. aurantaica*. It differs from *G. vidaliana* in the widely spreading inflorescence branches, and from *G. aurantiaca* by its glabrous and sessile leaves.

Specimens examined. **Indonesia**: Java, Pelabuhanratu, Feb. 1964, *Kostermans s.n.* (K, L), 11- 13 Nov. 1954, *Popta 2086* (L)

40. Gynura vidaliana Elmer (Fig. 32D)

Gynura vidaliana Elmer, Leaflet Philipp. Bot. 1 (1906) 144.-Type: *Merrill 3937* (holo K!), Philippines, Luzon, Pampanga, Mt Arayat.

Plants 1-2 m high, stems erect, densely to sparsely scarbrous or glabrescent**.** *Petioles* 0.3-1 cm, usually leaves sessile, auricles 0.5-1.5 x 0.5-1 cm, densely to sparsely scarbrous or glabrescent. *Blades* elliptical, often narrowly obovate, 4-30 x 2-6 cm, densely to sparsely scabrous, tomentose or glabrescent**,** base cuneate, apex acute, margin dentate. *Capitula* 2-8 per corymb; peduncles 0.5-5 cm long, densely scabrous to glabrescent; involucres 10-12 mm long, 5-9 mm in diameter; calycular bracts 3-7, 5-12 mm long, scabrous; phyllaries 13-14, 1-2 mm broad, scabrous. *Florets* c. 30-40, yellow, 12-17 mm long, exserted part 3-4 mm. *Anthers* 3 mm long, anther collars short to elongate. *Style arms* 3.5 mm long. *Cypselas* 4-6 mm long, brown, pilose or glabrous; carpopodium cylindrical, yellowish; pappus 12- 15 mm long, dirty-white.

*Note***.** *Gynura vidaliana* is distinguished by its usually sessile and narrowly obovate leaves which are densely to sparsely scabrous, tomentose or glabrescent. The species is restricted to the Philippines (Fig. 21). This species has divided into two varieties by Davies (1981) which we agree represent distinct taxa.

Key to the varities of *Gynura vidaliana*

1a. Plants sparsely scabrous to glabrous…….…..…….a. var. *vidaliana*

b. Plants densely tomentose ……..b. var. *apoensis*

40a. var. *vidaliana*

Gynura purpurascens Vidal in Rev. Pl. Vasc. Filip. (1886) 164, non DC (1837).-Type: *Vidal 1499* (iso A!), Philippines, Luzon, Benguet, Lepanto.

Gynura macgregorii Merill in Philipp. J. Sci. 5 (1910) 398.-Lectotype: *McGregor PNH 8381* (K! designated here), Philippines.

Gynura acuminatissima Merrill in Philipp. J. Sci. 12 (1917) 121. -Type: *Ramos & Edano PNH 26556* (holo K!; iso L!), Philippines, Luzon, Tayabas, Mt Dingalem.

Gynura subglabra Merrill in Philipp. J. Sci. 12 (1917) 120.-Type: *Ramos PNH 27023* (holo K!), Philippines, Luzon, Abra, Mt. Posuey.

Flowering and fruiting throughout the year. Growing in mossy forests at high altitudes, 1500-3000 m. Endemic to the Philippines.

Specimens examined. **Philippines**: Luzon Benguet, Mt Province, *Vidal 1499* (A), Mt Tonglon, Oct.-Nov. 1905, *Merrill PNH 4844* (K, L), Dec. 1908, *Ramos PNH5405* (L), Oct. 1921, *Ramos & Edano PNH 40443* (K), Mt Santo Tomas, Dec. 1922, *Merrill 11715* (BM, L), Mt Tabayoc, 16 Feb. 1968, *Jacob 7478* (L), Mt San Isidro, *Fenix PNH 29855* (BM, L), (A), Mt Quebrada, Feb.-March 1953, *Edano PNH 17877* (L), Mt Pulog, 7 Feb. 1968, *Jacob* s.n. (L), Feb.-March 1925, *Ramos & Edano PNH 44921* (BM), Mt Moises, March 1926, *Ramos & Edano PNH 47277* (BM), Mt Lusong, Oct 1921, *Ramos & Edano PNH 40443* (K), Mt Polis, Feb. 1913, *Mcgregor PNH 19678* (BM), Pauai, June 1909, *McGregor PNH 8381* (K), *Loher 3702* (K), Baguio, 28 June 1958, *Sinclair & Edano 9731* (SING), *Loher 3702* (K), Bontoc, March 1920, *Ramos & Edano PNH 38120* (A, BM), Lagum, Cagayan, March 1929, *Ramos PNH 82029* (A); Palawan, Mt Pulgar,, May 1911, *Elmer 13186* (A, BM, G, K, L); Camiguin, Babuyanes, March 1930, *Edano PNH 79161* (A); Mindanao, Davao Mt Maya, March-April 1949, *Edano PNH 11483* (A).

40b. var. *apoensis* (Elmer) F.G. Davies

Gynura apoensis Elmer, Leaflet Philipp. Bot. 7 (1915) 2587. -Type: *Elmer 11584* (hopo K; iso E!, L!), Philippines, Mindanao, Davao, Todaya (Mt Apo).

Flowering and fruiting throughout the year. Growing in rocky places along roadsides and in forests, 1800-2000 m. Endemic to the Philippines.

Specimens examined. **Philippines**: Mindanao, Davao, Mt Apo, *August* 1909, *Elmer 11584* (E, L), Bukidnon, Tanculan, July 1916, *Fenix 26048* (K); Luzon, Bontoc, 14 May 1914, *Vanoverbergh 2506* (G, K,L, S), Parang, *Loher 3701* (K), Benguet, 28 June 1958, *Sinclair 9731* (E), Mt Santo Thomas, *Merrill 11715* (K), Mt Tonglon, Oct. 1905, *Merrill 4844* (K); Palawan, Puerto Princesa, 1 Aug. 1988, *Soejarto & Reynoso 6300* (A), 30 March 1947, *Edano PNH 348* (L), Mt Pulgar, May 1911, *Elmer 13186* (BM,K), Mt Victoria, May 1950, *Sulit 14791* (A, L, SING).

41. Gynura valeriana Oliv. (Fig. 33A)

Gynura valeriana Oliv. in Hook. Icon. Pl. 16: t. 1507 (1886).-Type: *Johnston* (holo K!), Tanzania, Kilimanjaro

Plants 2-3 m high, stems procumbent to erect, sparsely pubescent. *Petioles* 3-7 cm long, auricles 3-7 x 2-5 mm, pubescent to glabrescent. *Blade*s ovate to elliptical, usually pinnatisect to pinnatipartite with 1-10 pairs of oblong to lanceolate lateral lobes, 10-25 (-50) x 8-20 cm, pubescent, base cuneate or truncate, apex acute, margin denticulate to dentate. *Capitula* 5-20 per corymb; peduncles 1-3 cm long, pubescent to glabrescent, bracts 2-12, 0.5-4 mm long, pubescent; involucres 10-17 mm long, 6-8 mm in diameter; calycular bracts 3-5, 1-3 mm long, pubescent; phyllaries 10-15, 1-2 mm broad, pubescent. *Florets* 30-55, orange to yellow, 9-12 mm long, exserted part 3-3.5 mm. *Anthers* 2.5 mm long, anther collars elongated. *Style arms* 3.5 mm long. *Cypselas* 5 mm long, brown, sparsely pilose or glabrous; carpopodium cylindrical, yellowish; pappus 7-9 mm long, white to dirty-white.

Flowering and fruiting throughout the year. Growing in mountain grassland, 500 – 1000 m. Only known from Madagascar and Sri Lanka (Ceylon) (Fig. 21).

Specimens examined. **Kenya:** Masai, Chyulu Hills, 7 June 1938, *Balley 8176* (K), 13 Dec. 1993, *Luke & Luke 3919* (K). **Tanzania**: Muhesa, Usambara, 13 Nov. 1935, *Greenway 4162* (K), 18 Aug. 1952, *Williams 500* (K), 16 Nov. 1986, *Iverson et al 86813* (K); Arusha, Meru Mts, Nov. 1969, *Richards 24612* (K); Lushoto, Kitive

Forest, 6 Sept 1966, *Semsei 4105* (K); Kilosa, Ukaguru Mts, June 1978, *Thulin & Mhoro 2880* (K); Morogoro Rural, Morogoro, 1 Aug. 2000, *Mhoro 212* (K); Tanga, Korogwe, 27 Oct. 1999, *Mwangoka 945* (K), Kitive Forests, 1 Sept. 1966, *Semsei 4098* (K).

42. Gynura bicolor (Roxb. ex Willd.) DC. (Fig. 32B)

Gynura bicolor (Roxb. ex Willd.) DC., Prodr. 6 (1838) 299. - *Cacalia bicolor* Roxb. ex Willd., Sp. Pl. 3: 1731 (1804).- Type: *Roxburgh* (holo BM!), Calcutta, cult.

Gynura angulosa var. *petiolata* Hook. *loc. cit., non* Cooke (1904).-Syntype: *J.D. Hooker* (K!), Sikkim

Gynura longifolia Kerr in Bull. Misc. Inf. Kew 1935 (1935) 331.-Type: *Kerr 3195* (holo BM!; iso E,! K!), Thailand, Doi Sutep.

Plants 1-4 m high, stems erect, fleshy to subsucculent, sparsely pubescent. *Petioles* 0.5-6 cm long, auricles 1 mm or absent, pubescent or glabrescent. *Blades* lanceolate to elliptical, 4-40 x 2-15 cm, usually dark green or purple beneath, densely to sparsely pubescent, base cuneate, apex acute, margin serrate-dentate. *Capitula* 4-15 in lax or dense corymbs; peduncles 1-8 cm long, pubescent, bracts 4-8, 2-5 mm long; involucres 10-15 mm long, 4-7 mm in diameter; calycular bracts 8-15, 1-3 mm long, pubescent; phyllaries 12-16, 1-2 mm broad, glabrescent. *Florets* c 50, dark red to orange-yellow, 11-15 mm long, exserted part 3-4 mm. *Anthers* 2 mm long, anther collars elongated. *Style arms* 3.5 mm long. *Cypselas* 4-4.5 mm long, brown, glabrous or pilose; carpopodium cylindrical, yellowish; pappus 10-13 mm long, white. 2n = 20 (Jose & Mathew, 1990).

Flowering and fruiting throughout the year. Growing at the edge of forests, widely cultivated in botanic gardens, 0-2500 m. China, Myanmar and Thailand (Fig. 21).

Note. Gynura bicolor is readily distinguished by being fleshy to subsucculent and by having often petiolate leaves with a lanceolate lamina which usually is dark green or purple below.

Specimens examined. **China**: Kwangsi, Tou Ngok Shan, 13 Nov. 1933, *Tsang 23176* (A), Shang, 24 Sept. 1934, *Tsang 24333* (A), Yao Shan, 30 Nov. 1936, *Wang 40476*

(A); Guangdong, Huaiji, 14 Oct. 1984, *Chen 15067* (A); Hainan, Po-ting, 14 April 1935, *How 71924* (A); Yunnan, Shang-pa, 31 Oct. 1934, *Tsai 59157* (A); Taiwan, Taipei, cult. Seh-ting, 4 April 1990, *Kao 10849* (A), Tsutsuhu, 22 March 1991, *Leu 893* (A); Hong Kong, Lantua, Sunset peak, 1 May 1992, *Hu & But 20562* (A). **Myanmar**: Sumpra, 16 Jan. 1953, *Kingdon-Ward 20392* (BM). **Thailand**: Chiang Mai, Doi Suthep, 4 Feb. 1991, *Maxwell 91-108* (A), 28 Feb. 1988, *Maxwell 88-253* (L), Doi Chiang Dao, 31 Jan. 1996, *Maxwell 96-157* (A, L), Maetaeng, 18 Jan. 1983, *Koyama et al T32690*(KYO), Doi Pha Hom Pok, 12 Feb. 1983, *Koyama et al. T33456* (KYO), Doi Chang, 19 Jan. 1983, *Koyama et al*. *T32781* (KYO), Jomm Tong, 9 March 1991, *Maxwell 91-246* (A); Loei, Phu Luang, 19 Feb 1983, *Koyama et al T33697* (KYO); Lopburi, 19 Nov. 1984, *Murata et al. T50984* (L); Udawn, Phu Luang, 9 Jan. 1966, *Hennipman 3517* (L).

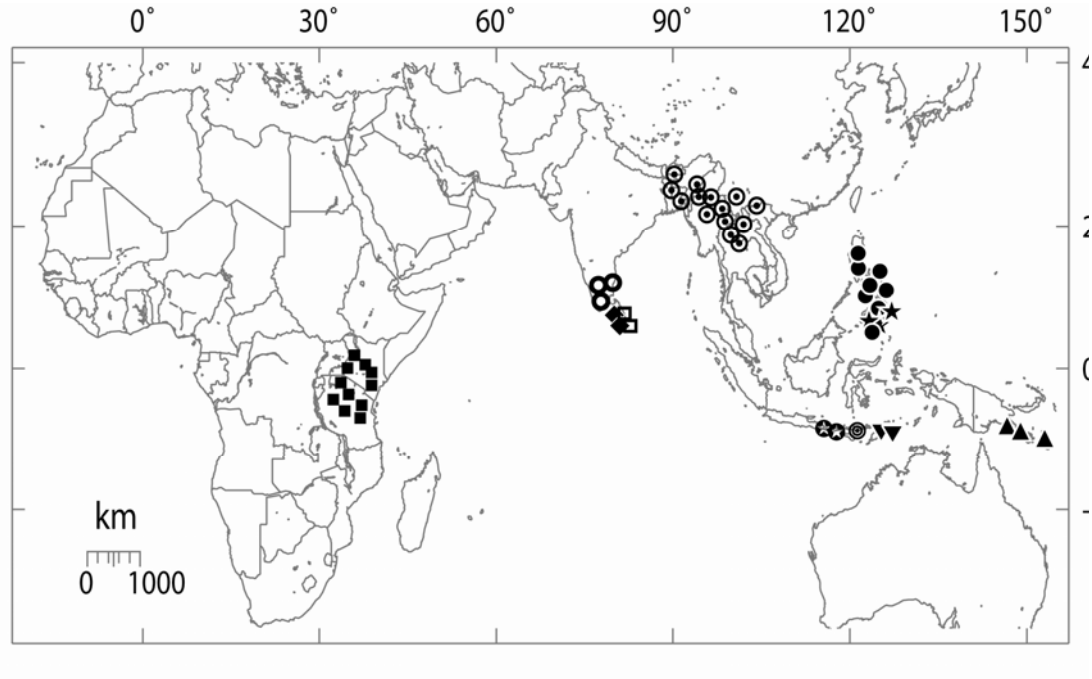

Figure 21. Distribution of *Gynura batorensis* ◎, *G. brassi* ▲**,** *G. fulva*▼**,** *G. lycopersicifolia* subsp. *lycopersicifoli*❍ *G. lycopersicifolia* subsp. *taprobanensis* ❑**,** *G. zeylanica* ◆**,** *G. daviesii* ✪, *G. vidaliana* var. *vidaliana* ● *G. vidaliana* var. *apoensis*★, *G. valeriana* ■, *G. bicolor* ⊙.

43. Gynura grandifolia F. G. Davies (Fig. 32C)

Gynura grandifolia F. G. Davies in Kew Bull. 35 (1980) 726.- Type:, *Kostermans & Wirawan* 271 (holo L!; iso K!), Indonesia, Flores.

Plants 1-2 m high, stems erect, densely white-appressed pubescent. *Petioles* 4-6 cm long, auricles 3-5 x 2-4 mm or absent, white-appressed pubescent. *Blades* broadly elliptical to ovate, 8-17 x 4-13 cm, densely white-appressed pubescent, base cuneate, apex acute, margin dentate. *Capitula* 2-7 in corymb; peduncles slender, 1-7 cm long, white-appressed pubescent, bracts 4-7, 3-7 mm long, white-appressed pubescent; involucres 8-10 mm long, 6-9 mm in diameter; calycular bracts 4 -7, 3-5 mm long, pubescent; phyllaries 12-13, 1-2 mm in diameter, sparsely pubescent to glabrescent. *Florets* 25-30, yellow, 8 -12 mm long, exserted part 2.5 mm. *Anthers* 2 mm long, anther collars short. *Style arms* 3 mm long. *Cypselas* 3.5-4 mm long, brown, pilose; carpopodium cylindrical, yellowish; pappus 10-12 mm long, dirty-white.
Flowering from December to May. Growing in open places on limestone and in savanna areas among stones, 300-1500 m. Indonesia around Lesser Sunda Islands and Timor (Fig. 22).

Note. Gynura grandifolia is very distinctive by its densely white-appressed indumentum and its usually olive green and broad leaves.

Specimens examined. **Indonesia**: Lesser Sunda, Flores, Mt Ndeki, 14 April 1965, *Kostermans & Wirawan 271* (K, L), Keo, 14 Sept. 1936, *Voogd 2818* (L, A), near Ruteng, 26 April 1965, *Kostermans & Wirawan 673*, 5 July 1974, *Verheijen 3725* (TEX), Manggarai, 18 Nov. 1971, *Schumutz 2829* (L), 5 Feb. 1979, *Schumutz 4327* (L); without locality, 10 March 1939, *Bloembergen 3422* (L, SING), 26 April 1965, *Koay 109* (L), 14 May 1934, *de Voogd 1779* (L). **Timor**: Baucan, 16 Dec. 1953, *van Steenis 18047* (A, K, L); Nusa Tenggara, 10 March 1939, *Bloembergen 3422* (A, L).

44. Gynura aurantiaca (Bl.) DC. (Fig. 32D)

Gynura aurantiaca (Bl.) DC., Prodr. 6 (1837) 300.-*Cacalia aurantiaca* Bl., Bijdr.: (1826) 908.-Type: *Blume 520* (holo & iso L!), Indonesia, Java, Gede et Burangrang.

Gynura dichotoma Turcz. in Bull. Soc. Nat. Mosc. 24 (1851) 202.-Type: *Lobb 271*

(holo K!), Indonesia, Java.

Gynura aurantiaca var. *ovata* Miq., Fl. Ned. Ind. 3 (1856) 98.-Lectotype: *Junghuhn s.n*. [L! designated by Davies (1980)], Indonesia Java,

Gynura sumatrana Miq., Fl. Ned. Ind. Suppl. 1 (1861) 536.- Type: *Diepenhorst 1340* (holo U), Indonesia, Sumatra, Priaman.

Gynura densiflora Miq., Fl. Ned. Ind. 3 (1856) 99 *nom. illeg*.- *Gynura mollis* Sch. Bip. ex Zoll. in Syst. Verz. Ind. Archip. (1854) 124 - Type: *Zollinger 2592* (holo G!), Indonesia, Java, Bandong.

Gynura lyrata Sch. Bip. ex Miquel, Fl. Ned. Ind. 3 (1856) 100.-Type: *Zollinger 442* (not found), Indonesia, Java.

Gynura teysmanniana Kuntz nomen in Sched., E. Java, 1868, leg. *Teysmann*.

Plants 1-2 m high or more, stems erect, densely to sparsely more or less purple-scabrous. *Petioles* 1-8 cm long, auricles 0.5-2 x 0.3-1 cm, densely to sparsely scabrous. *Blades* ovate or lyrate with 1-3 pairs of lobes, 5-17 x 4-10 cm, sparsely scabrous, base usually cuneate, sometimes truncate or cordate, apex acute to acuminate, margin dentate-serrate. *Capitula* 1-7 per corymb; peduncles 1-10 cm long, scabrous; involucres 10-12 mm long, 5-8 mm in diameter, calycular bracts 3-7, 3-7 mm long, scabrous; phyllaries 12-13, 10 -12 mm long, scabrous. *Florets* c 30-45, brick-red to yellow, (5) 10-15 (18) mm long, exserted part 3-4 mm. *Anthers* 2.5 mm long, anther collars elongated. *Style arms* 3 mm long. *Cypselas* 4 mm long, glabrous, brown; pappus 10-13 mm long, dirty-white. 2n = 20 (Jose & Mathew, 1990), 24 (Chidambaram, 2005).

Note. Gynura aurantiaca is dinguished by being a robust subshrub with usually auriculate and ovate to lyrate leaves with distinct lateral veins. The species has been divided into two varities by Davies (1981) which we agree represent distint taxa. However, their geographical separation and the consistent differences in leaf shape and corolla length warrant recognition of the two taxa at subspecies rank (Fig. 22).

Key to the subspecies of *Gynura aurantiaca*

1a. Leaves often lyrate, auricles 0.5-2 x 0.3-1 cm, corolla 15-18 mm long-Java and Sumatra.....……a. subsp. *aurantiaca*

b. Leaves ovate, auricles small or absent, corolla 5-10 mm long-Celebes……..b. subsp. *parviflora*

44a. subsp. *aurantiaca*

Flowering and fruiting throughout the year. Growing in open places in evergreen forests and abundant as a weed in cultivated fields, 0-2600 m. Sri Lanka, India, China and Indonesia.

Specimens examined. **Sri Lanka**: cult. Peradenniya Royal botanic Gardens, 1 Feb. 1951, Jayaweera *372* (A) **India**: Madras, cult Salem, Omallur, 21 March 1979, *Venugopal & Jayseelan 22446* (K). **China**: Hong Kong, cult 13 June 1970, *Hu 10433* (A) **Indonesia**: Java, Tjibodas, Preanger, 28 May 1917, *Koorder 26034* (L), Tji Panas, 8 July 1936, *Pijl 598* (K), Tji Koendoel, 7 May 1950, *Ooststroom 13926* (L), Tjiboeroem, 12 April 1909, *Palmer & Bryant 182* (Sing), Baturaden to Gunung Slamet, 18 Aug. 1973, *Murata et al. J751* (KYO, L), Gunung Pangrango, 12 Sept. 1971, *Murata & Iwatsuki J290* (KYO), Mt. Merapi, 9 Aug. 1974, *Yoshida 1728* (KYO), 27 Aug. 1992, *Macdonald & Ismael* 3636 (A), Preanger, 18 July 1904, *Hochreutiner 1291, 1288* (G), Bawang, 8 Nov. 1904, *Hochreutiner 2499* (G), Pasoeroean, 1935, *van Steenis 7135* (A), Poentjak-pas, 20 Oct. 1948, *Hied 3086* (L), without lacality, 5 April 1930, *Kjellberg 84* (S), *Lobb* 241 (BM, K); Sumatra, Djambi, Oct. 1925, *Posthumus 905* (SING).

44b. subsp. *parviflora* (F. G. Davies) Vanijajiva & Kadereit, *comb. nov.*

Gynura aurantiaca (Bl) DC. var. *parviflora* F. G. Davies in Kew Bull. 35 (1980) 731.- Type: *Bloembergen 4253* (holo L!), Indonesia, Celebes.

Flowering from July to September. Growing at the edge of forests near rivers or along grassy roadsides, 200-700 m. Only known from Indonesia (Celebes).

*Specimens examined***. Indonesia**: Celebes, Meneda, 13 July 1939, *Bloembergen 4253* (holotype L!), Masamba, 18 July 1937, *Eyma 1122*, *1176* (K), between Palu & Parigi, 16 April 1975, *Meijer 9267* (L).

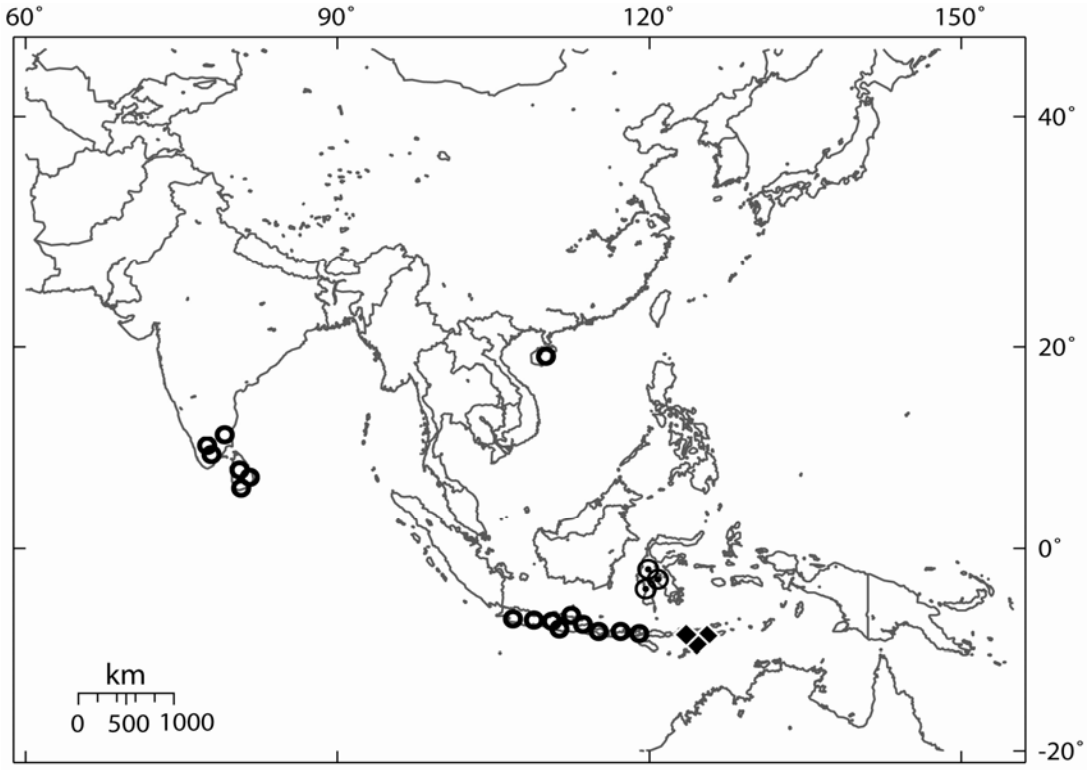

Figure 22. Distribution of *Gynura grandifolia* ◆, *G. aurantiaca* subsp. *aurantiaca* ⭘ *G. aurantiaca* sub. *parviflora* ⊙

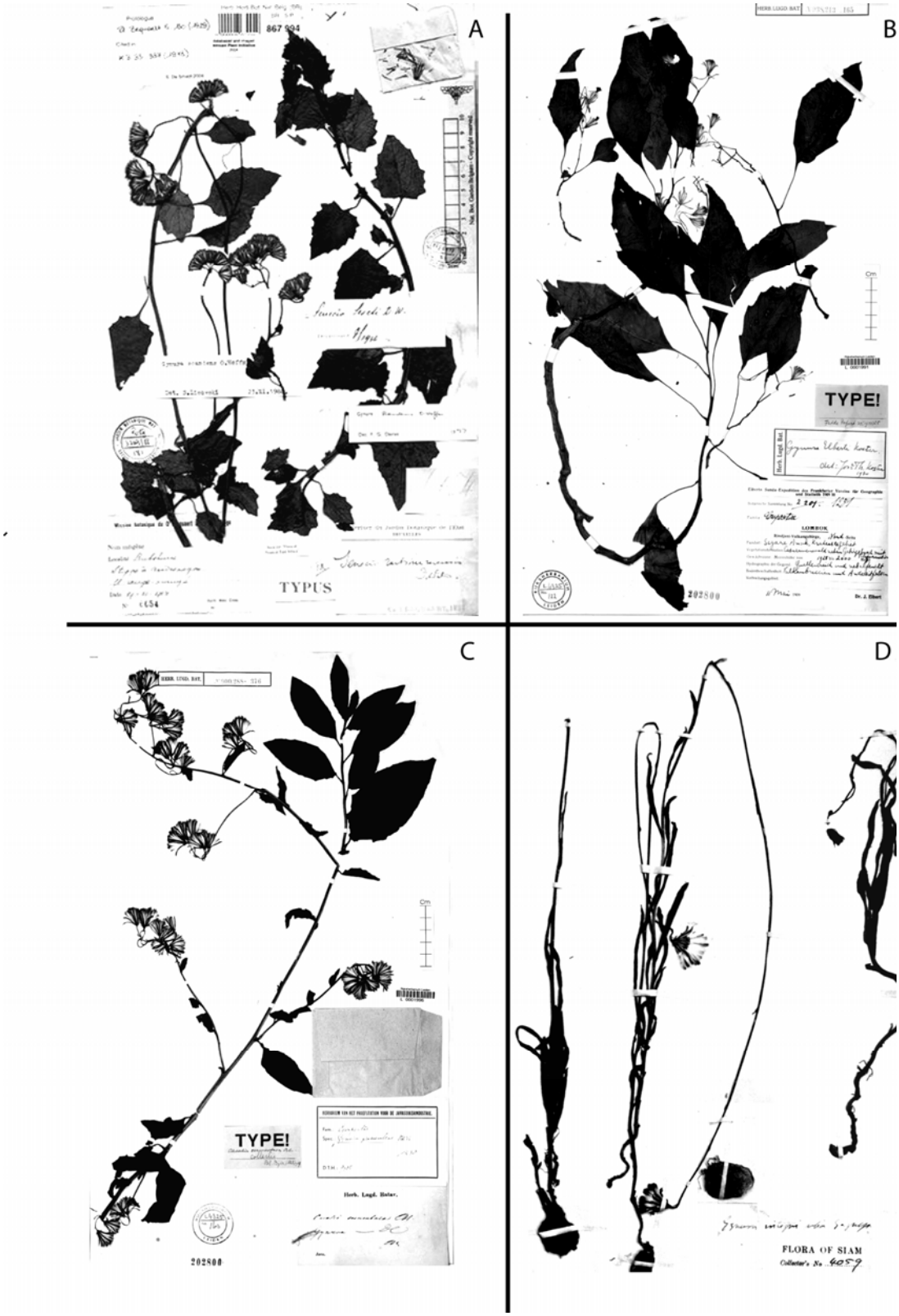

Figure 23. A *Gynura scandens*, **B** *G. elbertii*, **C** *G. procumbens*, **D** *G. intergrifolia*.

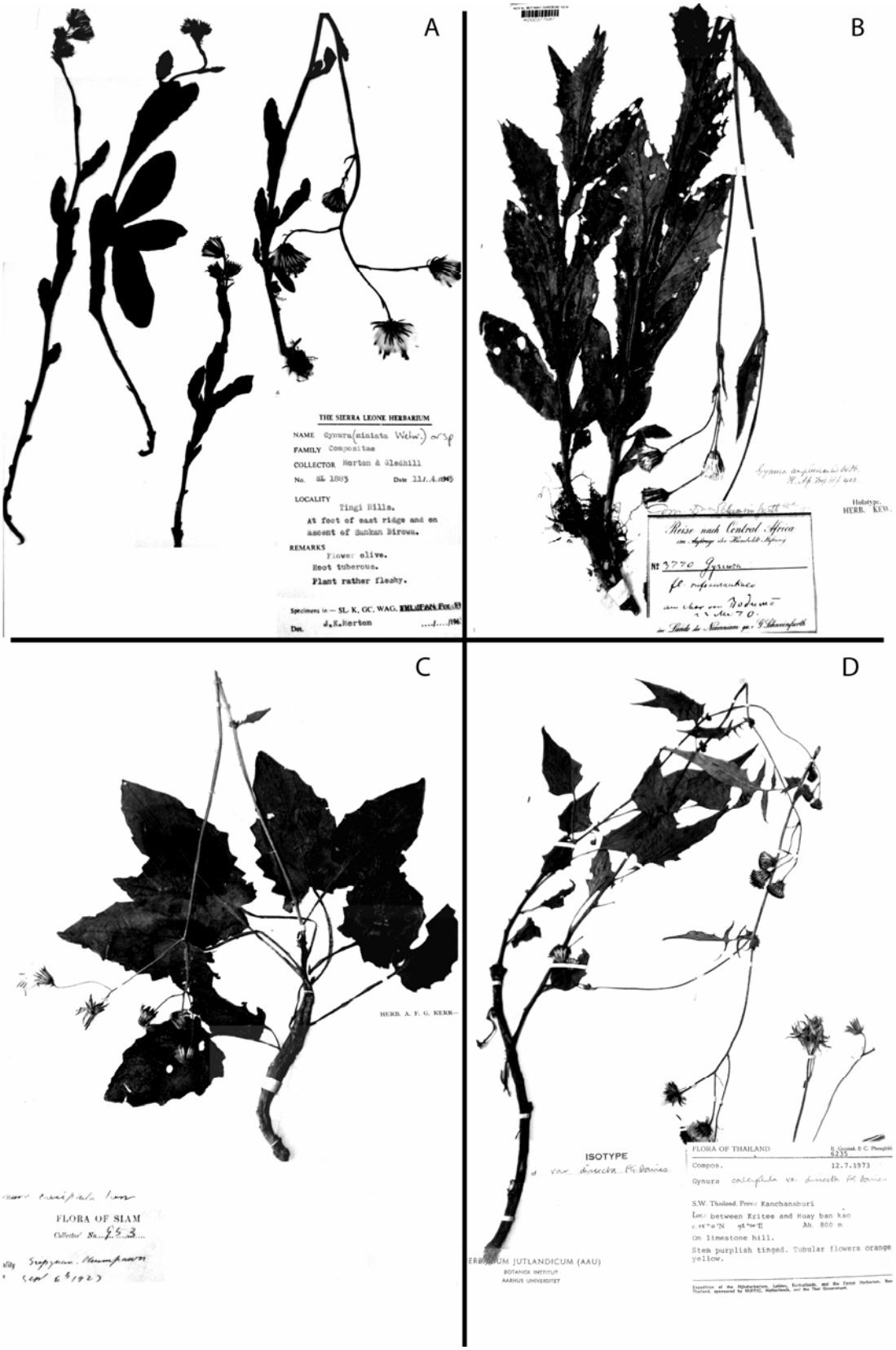

Figure 24. A *Gynura micheliana*, **B** *G. amplexicaulis*, **C** *G. calciphila*, **D** *G. dissecta.*

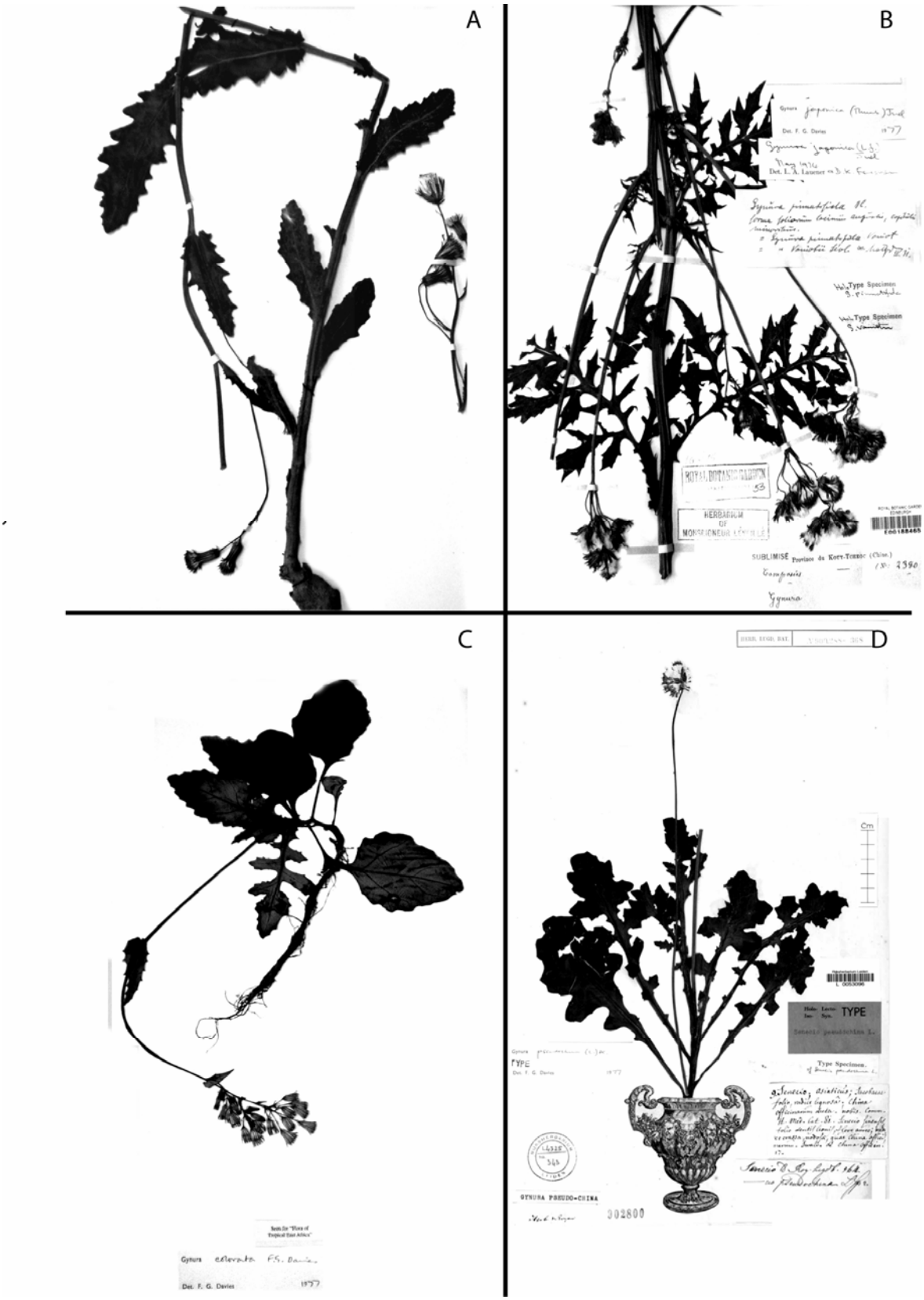

Figure 25. A *Gynura siamensis*, **B** *G. japonica*, **C** *G. colorata*, **D** *G. pseudochina*.

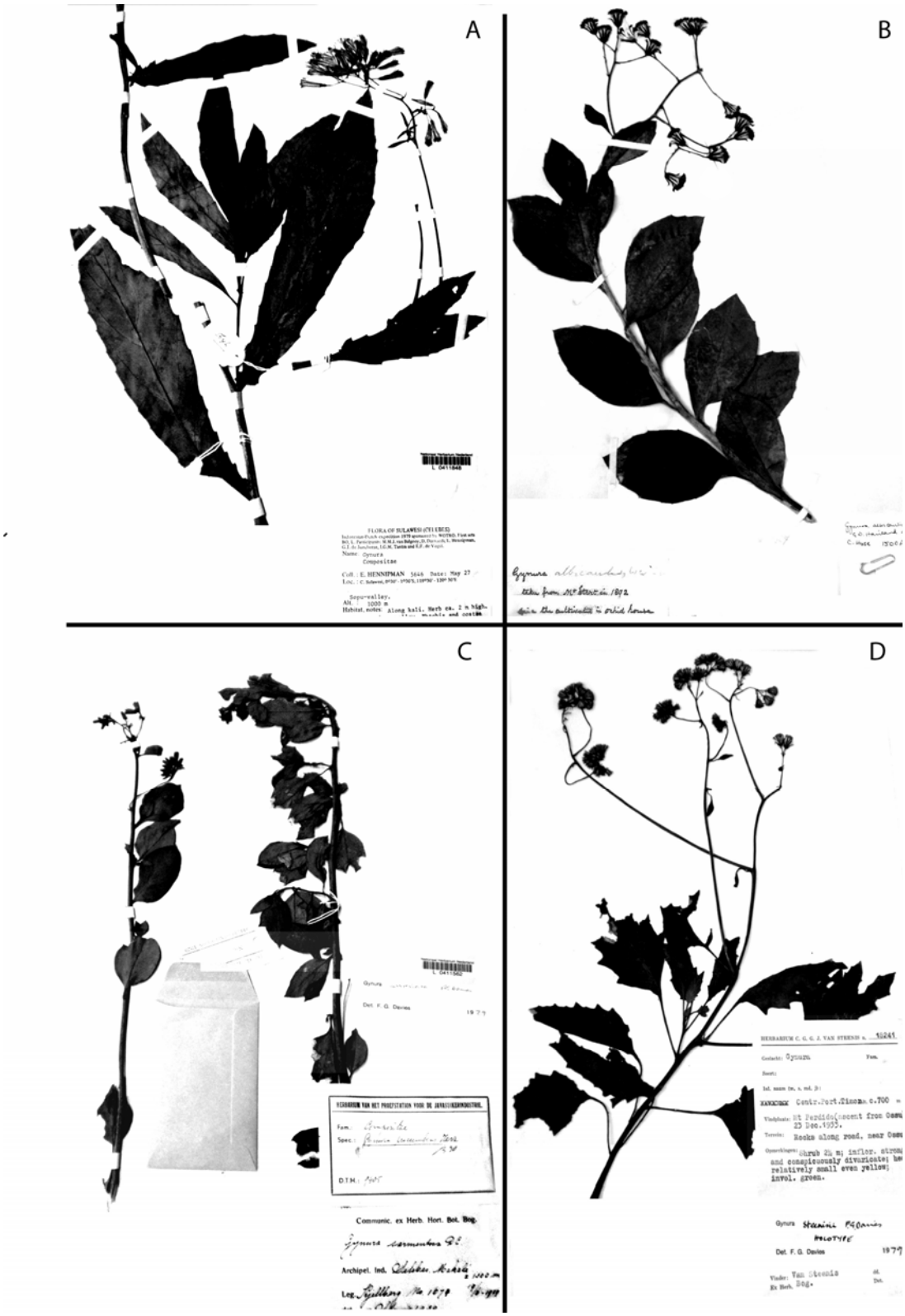

Figure 26. A *Gynura annua*, **B** *G. alblicaulis*, **C** *G. abbreviate*, **D** *G. steenisii*.

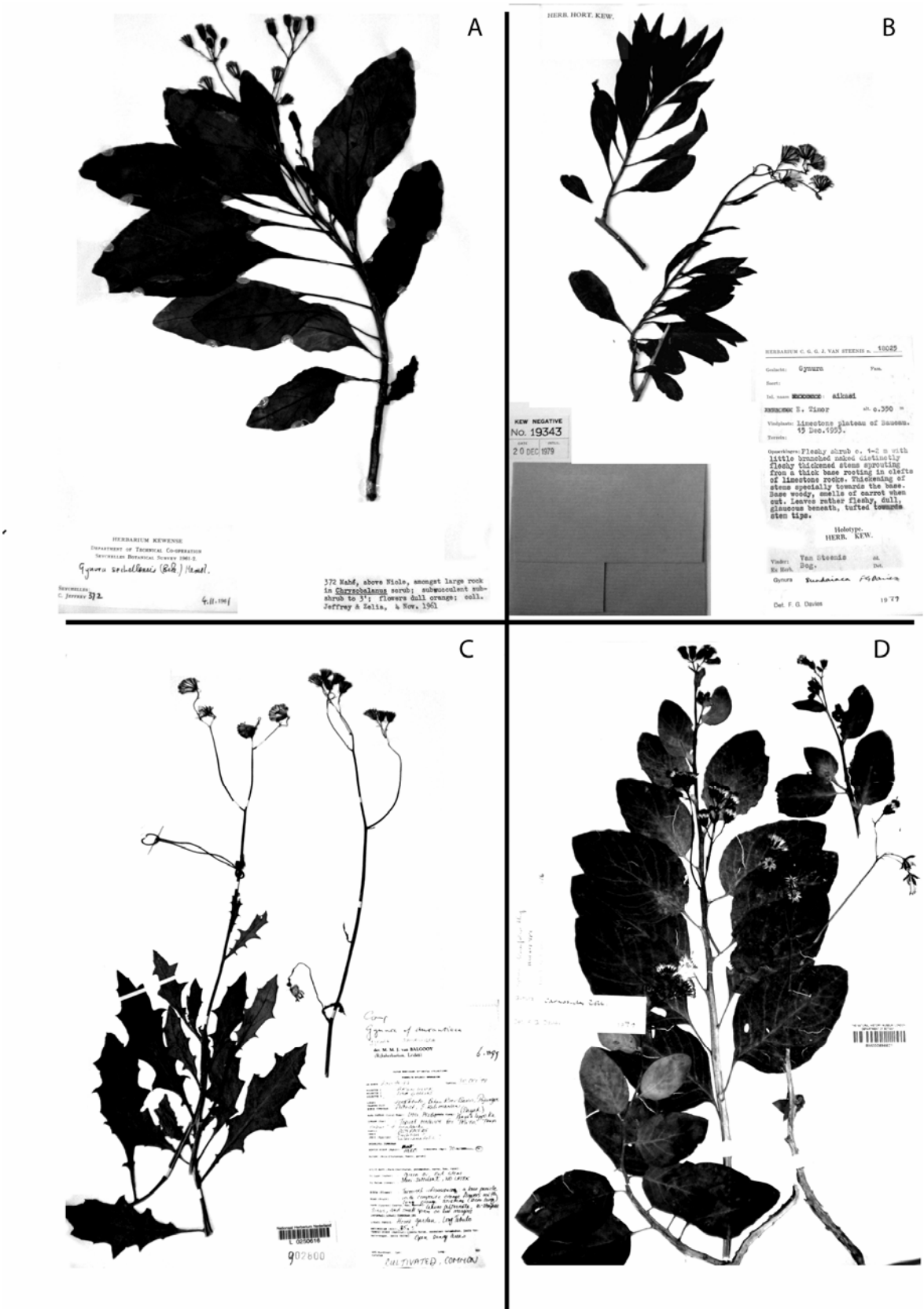

Figure 27. A *Gynura sechellensis* , **B** *G. sundaniaca*, **C** *G. malaccensis* , **D** *G. carnosula*.

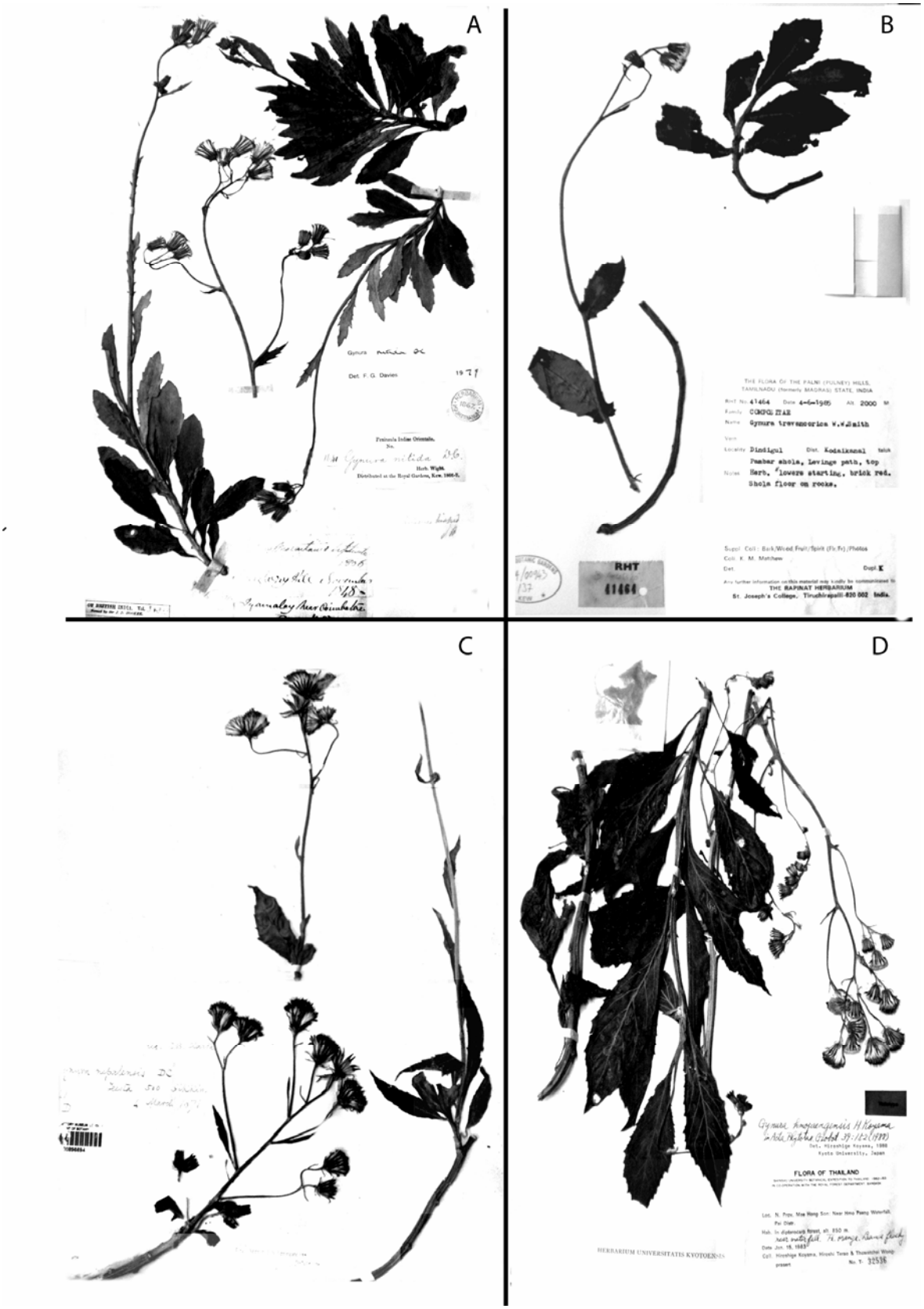

Figure 28. A *Gynura nitida*, **B** *G. travancorica*, **C** *G. nepalensis* ,
D *G. hmopaengensis*

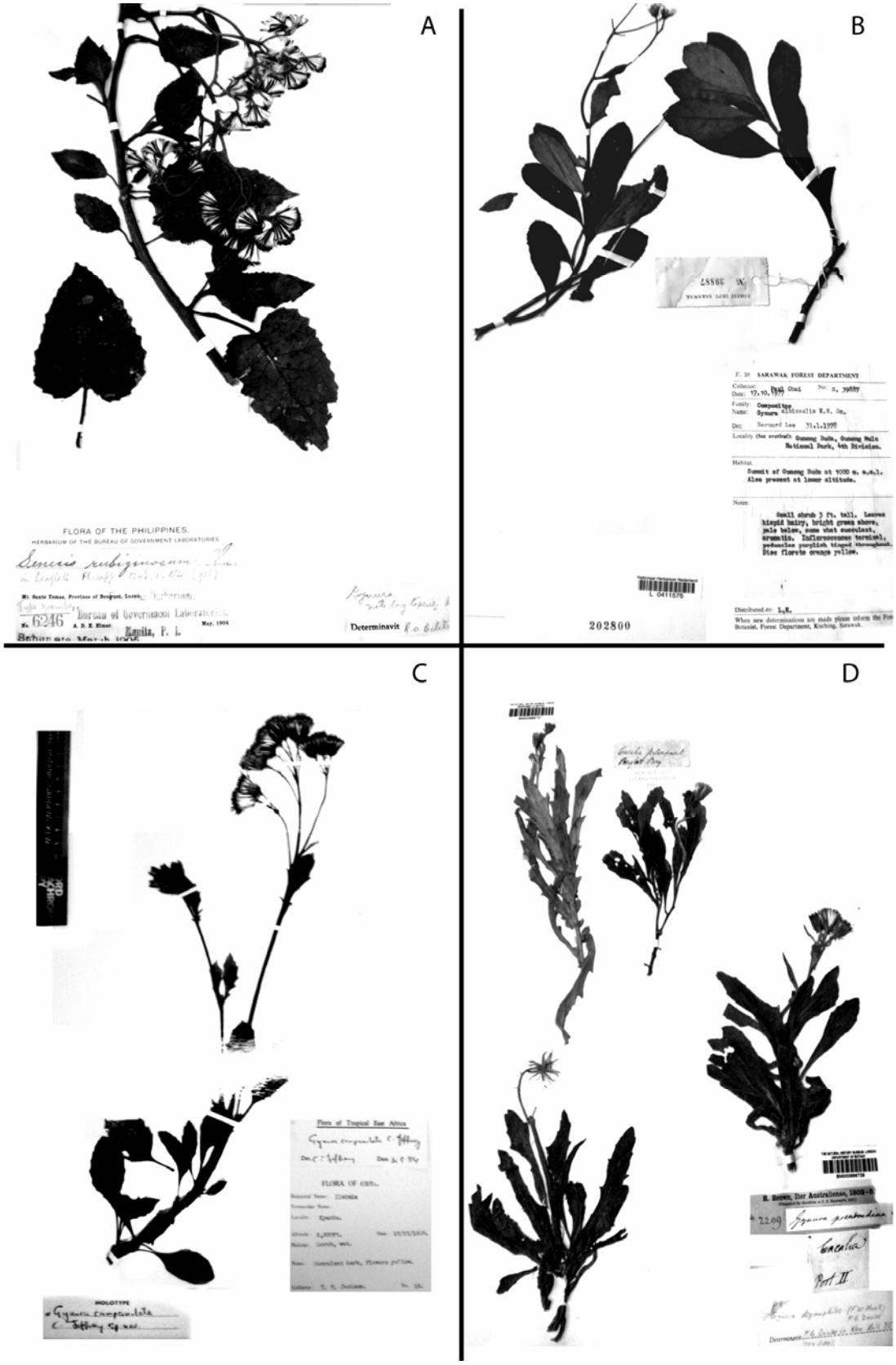

Figure 29. A *Gynura rubiginosa*, **B** *G. villosus*, **C** *G.campanulate*, **D** *G. drymophila*.

Figure 30. A *Gynura hispida*, **B** *G. cusimbua*, **C** *G. ajakensis*, **D** *G. elliptica*.

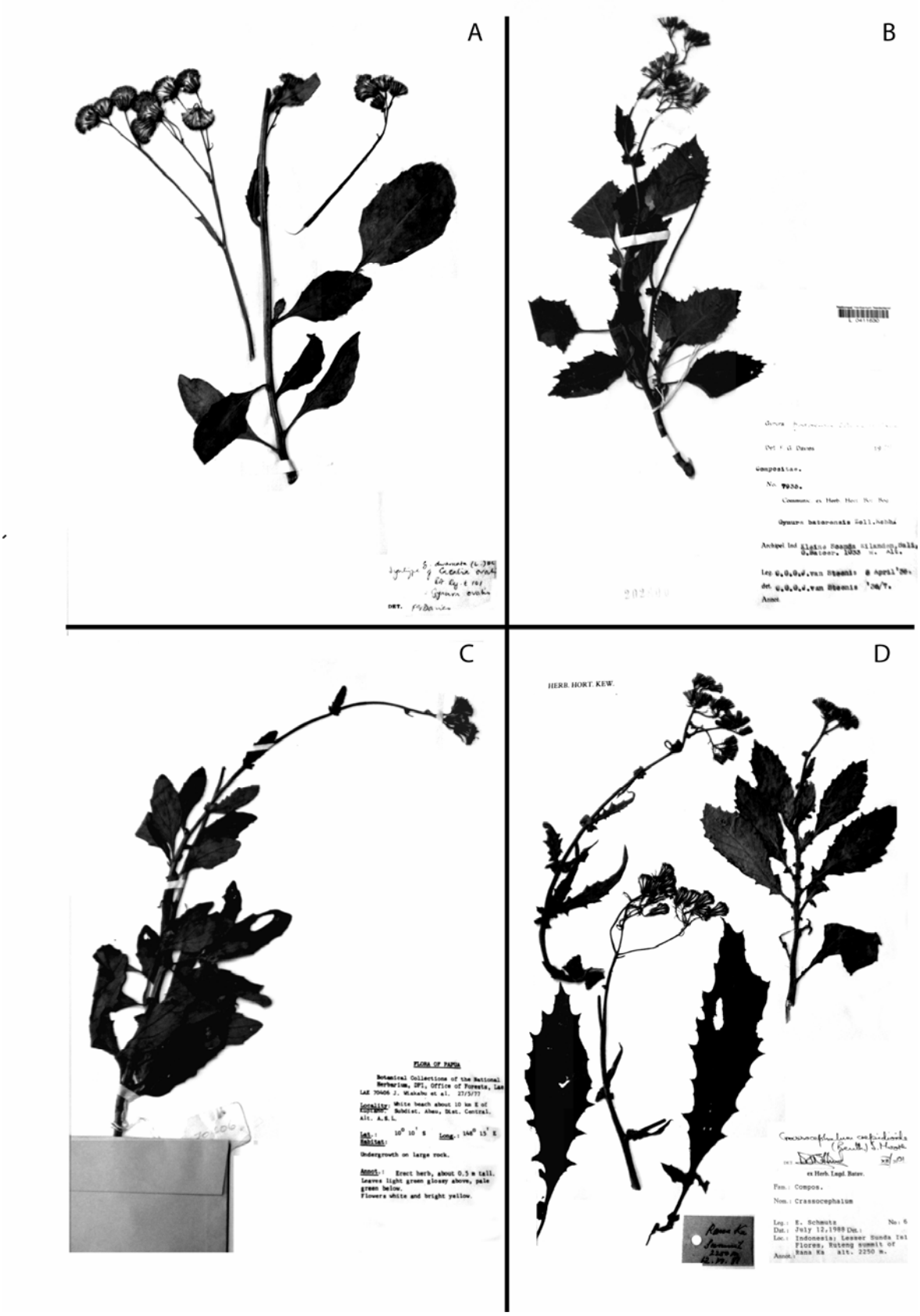

Figure 31. A *Gynura divaricata*, **B** *G. batorensis*, **C** *G. brassi*, **D** *G. fulva*.

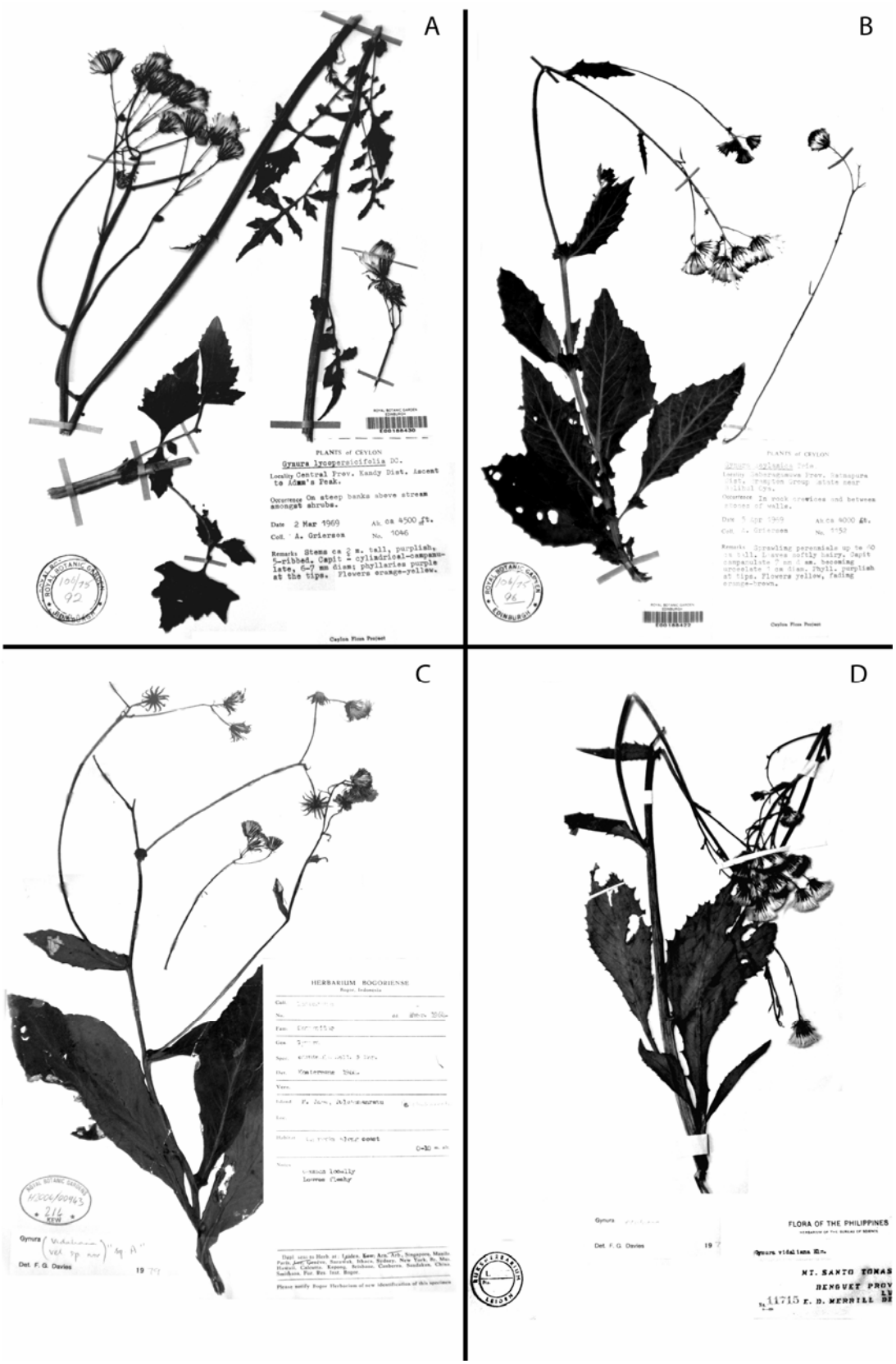

Figure 32. A *G. lycopersicifolia*, **B** *G. zeylanica*, **C** *G. daviesii*, **D** *G. vidaliana*.

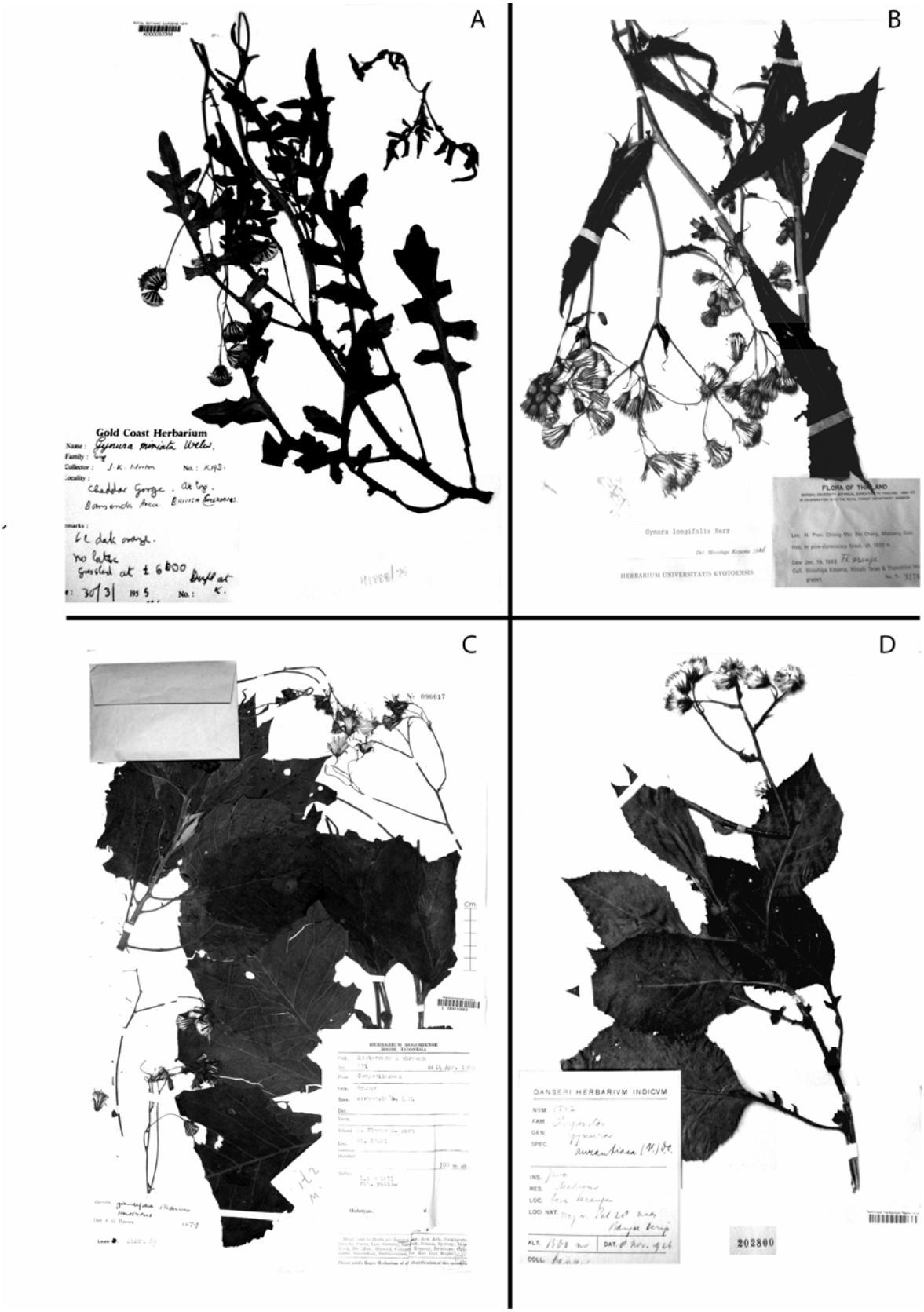

Figure 33. A *G. valeriana*, **B** *G. bicolor*, **C** *G. grandifolia*, **D** *G. aurantiaca.*

4. MORPHOLOGY AND MOLECULAR EVIDENCE FOR INTERSPECIFIC HYBRIDISATION IN THE INTRODUCED AFRICAN GENUS *CRASSOCEPHALUM* (ASTERACEAE: SENECIONEAE) IN ASIA

4.1 Introduction

Introduced species are organisms which are not indigenous to a given area but instead have been introduced there accidentally or deliberately by human activity. Some of these introductions can become invasive when they succeed to outcompete native species for resources such as nutrients or physical space (Cronk & Fuller, 1995; Richardson & Pyšek, 2006). The study of introduced species and their impact outside their native range has become a research topic of considerable importance (Meyerson & Mooney, 2007). From a review of the literature, Pyšek *et al.*, (2008) concluded that the availability of information on the geographical distribution of introduced species probably is unbalanced. In regions such as Europe, North America and Australia there is an acute awareness of such species particularly in plants. In contrast to this, introduced species are understudied and poorly known in most parts of Africa and Asia.

Interspecific hybridization between introduced or between introduced and native plant species is a frequent phenomenon and has been made responsible for part of the success of introduced species (for review see Ellstrand & Schierenbeck 2006). Well-studied examples of hybridization between introduced species in temperate regions include *Tragopogon* L. in the USA (Soltis et al., 2004) and *Senecio* L. in the British Isles (Abbott *et al.*, in press). In contrast to this, comparatively little is known about hybridization of introduced taxa in the tropics, and particularly in tropical Asia (Daehler & Carino, 2001; De Walt & Hamrick, 2004; Howarth & Baum, 2005).

We here report interspecific hybridization between two species of *Crassocephalum* Moench in its introduced range in Asia. *Crassocephalum* is a herbaceous genus of Asteraceae-Senecioneae. Its 24 species are all native to Africa, Madagascar and the Mascarene Islands (Nordenstam, 2007) and are commonly found in clearings or at the edge of moist and evergreen forests as well as in open grassland from sea level to up to 3,500 m altitude (Jeffrey, 1986). The genus is considered to be difficult taxonomically, and differences between species are small while intraspecific variation is large (Belcher, 1955, 1988; Jeffrey & Beentje, 2005). In Asia, only one

species of the genus, *C. crepidioides* (Benth.) S. Moore, has been recorded as a weed in disturbed habitats on a wide variety of soil types (van Steenis, 1932; Baker, 1939; Nair & Srinivasan; 1982; Koyama, 1986; Sinha & Rama, 1991; Ohtsuka *et al*. 1993). This species is assumed to have been introduced to Asia as early as 1925 (Belcher 1955) or 1923 (van Steenis, 1967). However, the locality of its original introduction and its spread from there are still obscure (van Steenis, 1967).

During recent field work in Southeast Asia by one of us (O.V.), mostly in Thailand, we found not only *C. crepidioides*, but also *C. rubens* (Juss. ex Jacq.) S. Moore as a new record for Asia, as well as intermediate forms between the two species.

We here will (1) revise the taxonomy of *Crassocephalum* in Asia, (2) reconstruct its introduction to Asia based on herbarium collections and (3) examine the intermediate forms found for their morphology, pollen and seed fertility, chromosome number and molecular identity using the ITS region of nuclear ribosomal DNA and the *trnL*-3′-*trnF* intergenic spacers of chloroplast DNA.

4.2 Material and Methods

4.2.1 Plant material

We examined ca. 600 herbarium specimens from Asia borrowed from A, AAU, BK, BKF, BM, CMU, E, G, K, KEP, KKU, KYO, KUN, L, MJG, P, PSU, QBG, S, SING and TEX (acronyms following Holmgren, Holmgren & Barnett, 1990) or collected by ourselves (O.V.).

Field observations in continental Southeast Asia, mostly Thailand, were made from September to December 2004, from January to February 2005 and from March to April 2006. Nine individuals of *C. crepidioides*, nine of *C. rubens* and nine putative hybrid individuals were collected in three populations in northern Thailand (Fig. 34): 1. Doi Pha Hom Pok (20° 05' N, 99 ° 10' E); 2. Doi Chiang Dao (19° 17' N, 98 ° 49' E): 3. Ruk Thai Village (19° 47' N, 98 ° 02' E). These specimens are deposited in the herbarium of Johannes Gutenberg-Universität Mainz (MJG).

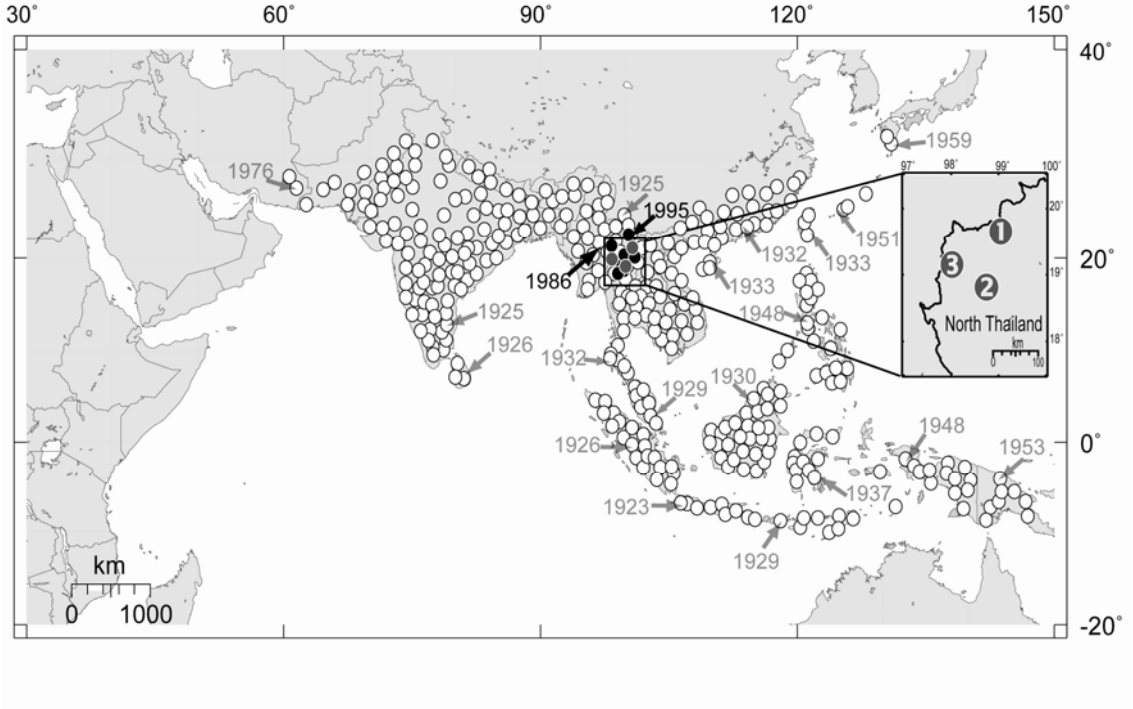

Figure 34. Geographical distribution (dots) and dates of collection (numbers) of *Crassocephalum* in Asia: grey numbers: *C. crepidioides*, black numbers: *C. rubens*. Open dots: *C. crepidioides*, black dots: *C. rubens*, grey dots: *C. crepidioides x C. rubens* (localities: 1. Doi Pha Hom Pok; 2. Doi Chiang Dao: 3. Ruk Thai Village)

4.2.2 Pollen and seed fertility

Percentage pollen fertility was estimated by examining the shape of pollen grains. Anthers were removed from flower buds and chopped on a microscope slide in a drop of glycerin jelly to release pollen grains. Regularly shaped globose pollen grains were regarded as fertile. Percentage pollen fertility was calculated by counting at least 100 pollen grains per individual. Seed fertility was assessed by examining cypselas for endosperm and embryos. Seeds collected in the field were squashed in a drop of glycerin jelly on a microscope slide. Absence of endosperm and an embryo was scored as infertility. Percentage seed fertility was calculated by examining at least 25 cypselas per individual. Pollen and seed fertility was determined for nine individuals each of *C. crepidioides*, *C. rubens* and the intermediate form. Permanent slides of anther and cypsela squashes were deposited in MJG.

4.2.3 Chromosome counts

Cypselas collected in the field were germinated on wet filter paper in Petri dishes in the experimental greenhouse of Mainz University Botanic Garden. Chromosome numbers were determined in mitotic metaphases of root tip cells. Root tips were pretreated with 0.002 M 8-hydroxy-quinoline at room temperature for 2 h and fixed in absolute ethanol and glacial acetic acid (3:1) for 24 h at room temperature and then stored at 4 ^{o}C. For analysis, root tips were hydrolyzed in 5 N HCl for 30 min at room temperature, stained in an acetic orcein solution, and squashed on a microscope slide for examination by light microscopy.

4.2.4 DNA isolation, PCR amplification and sequencing

Samples used in the sequence analysis, their origin, voucher specimens and GenBank accession numbers are listed in Table 1. Total genomic DNA was extracted from 0.5-1.0 g of silica gel dried leaf tissue of young leaves collected in the field or from herbarium specimens using the NucleoSpin-Plant ^{TM} (Macherey-Nagel GmbH, Duren, Germany) or DNeasy ^{TM} (Qiagen, Germany) extraction kits following the manufacturer's protocols. DNA concentration was measured spectrophotometrically with a GeneQuant RNA/DNA calculator (Pharmacia, Cambridge, UK) or estimated visually in ethidium bromide-stained agarose gels. Extracted DNAs were stored at −20 ^{o}C.

Amplification of the ribosomal DNA ITS1-5.8S-ITS2 region was accomplished using flanking primers ITS-A (Blattner, 1999) and ITS-4 (White *et al*., 1990). For most herbarium samples, the ITS-1+5.8 S and ITS-2+ 5.8 S regions were amplified separately using primers ITS-C and ITS-D (Blattner,1999) or combinations of ITS-A with ITS-C and ITS-4 with ITS-D, respectively. Primer sequences used for amplification and sequencing of the chloroplast *trnL*-3′-*trnF* intergenic spacer were obtained from Taberlet et al. (1991).

Polymerase chain reactions (PCR) were performed on Grant Autogene II (Grant Instruments, Cambridge, England) or Programmable Thermal Controller PTC-100 (MJ Research Inc., Watertown, Massachusetts, USA) thermocyclers. All amplification reactions were prepared in 25 µL volumes containing 1 unit *Taq* polymerase BioTherm (GeneCraft, Münster, Germany), 10 % of 10X PCR BioTherm buffer (GeneCraft, Münster, Germany), 2 mmol/L $MgCl_2$, 0.1 mmol/L dNTPs, 0.2 mmol/L of each forward and reverse primer, 4% DMSO, and approximately 5 – 10 ng of

template DNA. The cycler program was set to: initial denaturation at 94 °C for 1 min, 35 cycles of denaturation of 30 s at 94 °C, annealing of 50 s at 52 °C and 1 min extension at 72 °C followed by a final 10 min extension step at 72 °C. The reaction products were analyzed on 0.8 % agarose gels containing 0.4 µg/ml ethidium bromide.

Amplified products were purified using the NucleoSpin Extract (Macherey-Nagel) or the QIAquick (Qiagen) purification kits following the manufacturer's manuals. The ITS region was cycle-sequenced with the BigDye® Terminator Cycle Sequencing Kit v3.1 (Applied Biosystems) using the same primers as used for amplification. PCR conditions were 10 s at 96 °C, followed by 4 min at 55 °C repeated 30 times. Sequences were obtained in both directions by using ABI 373 and 377 DNA automated sequencers.

4.2.5 Sequence alignment

Sequences were edited and aligned using Sequencher Version 4.1(Gene Codes Co., Ann Arbor, MI, USA), and adjusted visually where needed. Particular attention was paid to ITS sites with peaks of two different nucleotides. To qualify for that, both nucleotides needed to show peaks that were clearly distinguishable from the background on both DNA strands. Mixed peaks were assigned standard IUPAC ambiguity codes. All sequences obtained in this study were deposited in GenBank (Table 1).

Table 1 List of taxa and source of plant material.

Taxon	Geographical origin	Voucher	GenBank accession no.	
			ITS	*trnL-F*
Crassocephalum crepidioides	Thailand	*Vanijajiva* 05-023 (MJG)		
C. crepidioides	Indonesia	*Nordenstam* 9451 (S)		
C. crepidioides	Malaysia	*Clausing* 255 (MJG)		
C. crepidioides	Guinea	*Carvalho* 2513 (S)		
C. rubens	Thailand	*Vanijajiva*05-010 (MJG)		
C. rubens	China	*Inta* 004 (MJG)		
C. rubens	Tanzania	*Lovett et al.* 3782		
C. crepidioides x *rubens*	Thailand	*Vanijajiva* 05-065 (MJG)		

4.3 Results

4.3.1 Geographical distribution and ecology, morphology, taxonomy

The geographical distribution of *C. crepidioides* and *C. rubens* in Asia is indicated in Fig. 34 which also indicates the areas in which intermediate forms were identified and collected. The oldest specimens of the two species collected in Asia are compiled in Table 2. Capitula of *C. crepidioides*, *C. rubens* and an intermediate individual as well as a mixed population of all three forms are shown in Fig. 35, and variation of leaf shape in the genus in Asia is shown in Fig. 36. A morphological comparison of the two species and the intermediate forms is contained in Table 3. *Crassocephalum crepidioides* commonly grows in disturbed areas or along roadsides on a wide variety of soil types from sea level to up to 2500 m altitude. *Crassocephalum rubens* and intermediate forms are restricted to the edge or the understorey of mountain forests at altitudes between 800 – 1500 m.

Table 2 Earliest known localities for *Crassocephalum* in Asia based on herbarium specimens.

Collection localities	Date	Specimens number
Crassocephalum crepidioides		
Southeast Asia; Indonesia, Java, 250 m.	May 1923	*Steenis* 5265 (L)
South Asia; India, Madras, 2000 m.	September 1925	*Jacob* 77051 (K)
East Asia; China, Yunnan, 2500 m.	August 1925	*Forrest* 27181 (K)
Crassocephalum rubens		
Southeast Asia, Myanmar, Shan, 1350 m.	December 1986	*Y Paisooksantiwatana* (BK)
East Asia; China, Yunnan, 1300 m.	October 1995	Wu *et al* 331 (KUN)

4.3.2 Taxonomy of *Crassocephalum* in Asia

Crassocephalum *Moench*, Meth. Pl.: (1794) 516.

For typification and synonymy see Belcher (1955: 461).

Annuals herbs, rarely short-lived perennials, with fibrous roots. *Stems* usually erect, fleshy, sparsely pubescent to glabrescent. *Leaves* alternate, petiolate, sparsely pubescent, blade lanceolate to ovate, margin serrate, variously incised or lobed to pinnatifid (Fig. 36), apex acute, base mostly attenuate. *Capitula* pedunculate, one to numerous in terminal or axillary panicles, erect or horizontal to nodding,

homogamous, discoid. *Involucres* narrowly campanulate, calyculate, calycular bracts linear-subulate, pubescent to almost glabrous; phyllaries sparsely pubescent, uniseriate, c. 18 - 23, herbaceous with narrow scarious margin, almost glabrous to pubescent; receptacle flat. *Florets* numerous, corolla brick-red, orange, orange-yellow to yellow or blue or pink to purple. *Anthers* 1 mm long, linear, minutely sagittate at base; anther collars narrow and elongated. *Style* 2-branched, 2 - 3 mm long, with apical appendages of fused papillae. *Cypselas* 2 – 2.5 mm, cylindrical to oblong, ribbed with spirally thickened duplex hairs on the ribs, dark brown to black; carpopodium cylindrical to hemispherical, yellowish to whitish, slightly larger in diameter than the cypsela base; pappus 8 -12 mm long, bristles numerous, capillary, uniform, white.

The natural distribution of the genus is tropical Africa, Madagascar and the Mascarene Islands.

Figure 35. A Population of *C. crepidioides, C. rubens* and *C. crepidioides* x *rubens*. Capitula of **B** *C. crepidioides*, **C** *C. crepidioides x rubens*, **D** *C. rubens*.

Table 3 A morphological comparisons among *Crassocephalum crepidioides*, *C. crepidioides* x *rubens* and *C. rubens*

Features	*C. crepidioides*	*C. cre* x *rub*	*C. rubens*
Height of plants when flowering (cm)	30 - 150	30 - 80	20 - 50
Length of peduncles (cm)	1 - 5	3 - 10	6 - 20
Character of capitulum	nodding	usually horizontal	erect
No. of capitulum	Numerous (4 - 12)	2 - 8	1 - 2
No. of phyllaries	18 - 21	18 - 23	21 - 23
Width of capitulum (mm)	5 - 12	7 - 12	9 - 15
Colour of florets	Orange-yellow to brick red	Magenta	Bright blue, rarely pink
Shape and colour of cypsela	Cylindrical, red brown	Cylindrical or oblong, black	Oblong, black

Key to *Crassocephalum* in Asia

1a. Florets orange-yellow to brick red; peduncle 1-5 cm long with numerous, usually nodding capitula; cypselas brown…….....……...…1. *C. crepidioides*

b. Florets bright blue, magenta or pink; peduncle 5-25 cm long with few, usually horizontal to erect capitula; cypselas black……...…….…...……..…..2.

2a. Peduncles 10-25 cm long with usually one erect capitulum; florets bright blue or pink..……..……..……....……2. *C. rubens*

b. Peduncles 5-10 cm long with 2–6, usually horizontal to nodding capitula; florets magenta……..….....……3. *C. crepidioides* x *rubens*

1. Crassocephalum crepidioides (Benth.) S. Moore, in J. Bot. 50: 211 (1912).
For typification and synonymy see Jeffrey & Beentje (2005: 610-611).

Plants 30-180 cm high when flowering. *Leaf blades* 4-18 x 1-6 cm, upper leaves usually subentire or with one pair of basal lobes (Fig. 36A–36C). *Capitula* 4–12, nodding, peduncles 0.5-5 cm long; florets brick red to orange to yellow (Fig. 35B); involucres 8-12 mm long; phyllaries 18-21, c. 1 mm broad. *Cypselas* cylindrical, brown. 2n = 40 (counted here).

Flowering and fruiting throughout the year.

Crassocephalum crepidioides is widely distributed in its synanthropic range in subtropical and tropical Asia and is found in India, Sri Lanka, Pakistan, Iran, Nepal, Bhutan, China, Taiwan, Japan, Myanmar, Laos, Cambodia, Vietnam, Thailand, Malaysia, Indonesia, the Philippines and Papua New Guinea (Fig. 34).

Specimens examined. **Sri Lanka**: Perderiza, 8 Oct. 1926, *Alston 580* (K); Kandy, 8 Feb. 1969, *Grierson 1011*; Anuradhapura, 4 May 1974, *Jayasuriya & Premadasa 1637* (L); Badulla, 19 March 1968, *Comanor 1064* (AAU, E, K, G, L), 29 Oct. 1956, *Lika 2310* (TEX). **India**: Nicobar, 16 Feb 1977, *Chakraborty 5247* (L); Assam, 17 July 1945, *Steinacker 2* (G, K); Bombay, 7 Feb. 1950, *Fernandes 932* (L); Madra, Madura, July 1926, *Auglade 1090* (K), 8 Sept. 1925, *Jacob 77051* (K), 1 April 2000, *Matthiew 71689* (AAU, K); Sikkim, 10 June 1996, *Long & Noltie 95* (E); Soembawa, Sept. 1941, *Blomberg 9405* (S); Hassan, 13 May 1969, *Saldanha 13388* (K); Dehra Dun, 12 July 1950, *Mooney 3861* (A). **Iran**: Eipomek-tal, 12 Feb. 1976, *Hiepko & Shultze-Motel 1008* (L), Baliem-Tal, 5 Feb. 1976, *Hiepko & Shultze-Motel* 642 (L). **Nepal**: Pokhara, 6 Sept. 1954, S*tainton et al. 7091* (BM, E), 8 Oct. 1965, *Schilling 673* (K), 12 Dec. 1969, *Wraber 176* (BM); Khandbari, 27 August 1972, *Wraber & Marshall 65* (BM); Rasuwa, 10 July 1992, *Takayama et al. 92* (A, E); Dumonast, 2 April 1952, *Zimmermann 141* (BM, G); Sankhuwasabha, 13 Oct. 1991, *Long et al. 746* (E); Solikhumbu, 30 Aug. 1997, *Wakabayashi et al. 9720331* (BM); Ramipawa, 3 Sept 1954, S*tainton 7658* (BM). **Bangaladesh**: Hazaniabelui, 13 March 1970, *Rulnan 14* (E); Paddy, 18 March 1976, *Alam 023* (E); Chittagong, 23 Jan. 1965, *Khan 994* (E), 19 April 1994, *Huq & Mia 10292* (A, L). **Bhutan**: Punaka, June 1985, *Bambron G466* (E); Phutsholing, 1 May 1979, *Grierson & Long 722* (E); Shamgong, 29 March 1986, *Bartholomew & Boufford 3827* (A). **China**: Yunnan, Heugyueh Hills, Aug. 1925, *Forrest 27181* (E), S Chungtien, 18 Nov. 1939, *Feng 3382* (A), Shang-pa, 20 Oct. 1934, *Tsai 58828* (A); Kwangtung, Yung-Yun, 26 Dec. 1932, *Lau 889* (G), Aug 1936, *Tsang 26626* (A, E, K); Kwangsi, 10 Oct. 1933, *Steward & Cheo 1130* (G, S), March 1933, *Tsang 21880* (G), 21981 (S), 6 Nov. 1934, *Tsang 24629* (A); Hunan, 8 Sept. 1984, *Zhen-yu et al. 909* (K), 16 Oct. 1935 *Fan & Li* 618 (G); Hubei, 1 Sept 1980, *Bartholomew et al. 489* (A); An Hui, 26 Aug. 1997, *Zhong-wen 97244* (A); Xinning, 22 July 1994, *Lin-Bo* 0063 (E); Guizhou, Jiangkou Xian, 7 Sept. 1986, *Bartholomew et al. 1001* (A), 27 Aug. 1986 *Bartholomew et al. 379* (L); Sichuan, Leshan, 13 Aug. 1981, *Reveal & Duke 5949* (A), Guan Xian, 3 Sept. 1988, *Boufford*

& Bartholomew 24491 (A, L). **Taiwan**: Miaoli Hsien, Huoyenshan, 24 June 1992, *Wang & Lin 1248*; Yang-mei, 24 June 1977, *Boufford et al. 19217* (A); Lanyu, 11 Nov. 1982, *Tateishi et al 15156* (A). **Hong Kong**: Hei Ling Chau, 27 Apr. 1969, *Hu 7142* (A); Chung Chi, 4 June 1968, *Hu 5453* (A, K); Lamma, 30 March 1969, *Hu 6826* (A). **Japan**: Honshu, Kyoto, 24 Aug. 2003, *Tsugaru et al 225* (KYO), 9 Nov. 1997, *Tsugaru & Takahashi 25937* (KYO), 18 Nov. 2001, *Masuda 546* (KYO); Kiushiu, Fukuoka, 3 Aug. 1959, *Murata 12617* (KYO), Kumamoto, 29 Aug. 1959, *Shimizu 4754*; Okinawa, 20 June 1951, *Walker et al 5724* (K), 2 March 2003, *Yasuda 1586, 3372* (KYO); Shikaku, *G. Murata 20476* (KYO); Nagasaki, *G. Murata & H Koyama 14544* (KYO); Shikoku, 23 Aug. 1964, *Murata 18735*; Tsushima, Shimoagata, 24 June 1968, *Ohashi & Sohma 10245* (A). **Vietnam**: Dalat, March-April *1932*, *Squires* 797(G, K, S); Cao Bang, 12 Nov. 1998, *Averyanov et al*. *CBL023* (AAU). **Laos**: Ta Tey Leu, 30 Jan. 1970, *Martin 1685* (P); Luang Prabang, 10 Feb. 1969, *Pedrono 88* (P), 16 June 1969, *Potter 190* (P); Viang Chan, 1 Feb. 1935, *Kerr 21270* (BM, K), 23 Dec. 1951, *Vidal 1368* (P), Nov. 1956, *Holliday* (BM), 17 April 1996, *Klackenberg 1057* (S). **Cambodia**: Ka Kong, 24 June 1966, *Martin 392* (P). **Myanmar**: Haka, 11 Nov. 1937, *Dickason* 7709 (A, L, E); Myitkyina, 20 Sept 1945, *Belcher 546* (G), 24 Sept. 1945, *Belcher 597* (S); Kachin, 1 March 1962, *Keenan et al. 3761* (E); Shan, Taunggyi, 22 Sept. 1934, *Malaise 377* (S), 7 July 1934 *Malaise 250* (S). **Thailand**: Chiang Mai, 17 Oct. 1987, *Maxwell 87-1210* (L), 14 July 1992, *Maxwell 92-379* (G, L), 15 Oct. 1979, *Shimizu et al T-18804* (KYO), 25 Dec. 2004, *Vanijajiva 05-023* (MJG); Lampang, 13 May 1996, *Panatkool 12* (A, L), 5 June 1963, *King et al. 5446* (K, L); Tak, G. *Murata et al T16637* (KYO); Phitsanulok, 25 Jul. 1973, *Murata T17096* (KYO); Nakron Ratchasima, Khao Yai, 14 March 1968, *Beusekom & Phengkhai 49* (L); 10 March 1987, *Lambion 87/84* (AAU); Chaiyaphum, Tunkamang, 29 May 1974, *Geesink et al. 7052* (AAU, L); Surin, *G. Murata et al T37676*; (KYO); Nakron Nayok, 9 Oct. 1979, *Shimizu et al. T18082* (KYO); Uthaothani, 12 Nov. 1979, *Shimizu et al*. *T22364*; Saraburi, 7 Oct. 1979, *Shimizu et al T19406* (KYO); Prachin Buri, *G. Murata et al*. *T37222*; Phetchabun, 11 Oct. 1979, *Shimizu et al. T18331* (L); Trat, 20 Nov. 1971, *Vidal 5773* (AAU); Prachinburi, 2 Oct. 1984, *Murata et al. T37222* (KYO); Kanchanaburi, 6 Aug. 1982, *Shimizu et al. T28430* (A, KYO); Chanthaburi, 28 Nov. 1979, *Shimizu et al T23879*. Prachinburi, 11 July 1966, *Larsen et al*. *297* (AAU); Pachuan Sirikran, 6 May 1932, *Kerr 21350* (K, E); Phangnga, 23 Aug. 1967, *Shimizu et al*. *T14673* (KYO); Narathiwat, 15 Nov.

1961, *Sangkhachand 243* (K). **Philippines**: Cotabato, 24 May 1950, *Santos 4827* (L); Palawan, Tarawanka, 1957, *Kondo & Edano 38798* (BM), 5 June 1948, *Edano 421* (G); Atiponpon, 13 March 1981, *Allen 150189* (L); Kajayas, April 1953, *Santos 5213, 5623* (L); Luzon, 11 June 1956, *Edano 37103* (L), 8 Dec. 1962, *Onklin & Buwaya 78606* (L); Mansalay, Nov.-Dec. 1952, *Sulit & Conklin 16776* (L); Tangao, 3 June 1961, *Mendoza 42018* (L); Mindanao, Feb.- March 1949, *Mendoza & Convocar 10298* (L), 12 Feb 1955, *Cachalian et al 33522* (L); Leyte, 14 April 1957, Gertrude & Frohne *35122* (K); Sibulan, Aug 1948, Edano 6682 (G); Samar, April 1948, Sulit 6061 (G). **Malaysia**: Kepong, 14 Sept 1929, *Hyminfan 21268* (KEP); Sarawak, 4 Aug. 1954, *Mujong 8942* (L), 24 March 1979, *Chin 2933* (L). **Singapore**: Perak, 5 Nov. 1938, *Spare 36046* (G), Palas, 28 Aug. 1956, *Burkill 721* (K). **Indonesia**: Java, Batavia, Buitenrong, 15 May 1923, *Steenis 5265* (L), July 1934, *Bakhuizen & Brink* 20 (K, L); Bogor, 1 June. 1948, *Enoh 111* (L); Celebes, Sulawesi, 14 Feb. 1980, *Grimes 1161* (K, L); Kota Mardura, 29 Sept 1993, *Sibil 288* (K); Malang, 9 March 1981, *Mogea 2429* (L); Papakelan, 25 June 2000, *Whitacre 026* (G); Tamu Darat, 27 Jan 1954, *Dareton 48* (BM); Kilimantan, 1 Jan 1979, *Murata et al 107, 591* (KYO); Kinabaru, 4 July 1961, *Chew et al. 1217* (L); Sumatra, 4 Jun. 1928, *Hamel 435* (G), 16 Jan. 1929, *Jochem 5098* (L), 1939, *Dames 10* (L), 20 Feb. 1939, *Bloembergen 3123* (L), 5 Nov. 1929, *Lörzing 15118* (K, L); Bali Mt Agung, *Meijer 10391* (L); Bogor, *S. Bloembergen 3123* (L); Gunung Panjang, *Vogel 3159* (L). **Timor**, 9 March 1968, *Kooy 462* (L), 23 Dec 1953, *Heeuis 18624* (L), 1962, *Cinatti 245* (L). **Papua New Guinea**: East Highlands, April 1966, *Wheeler ANU5724* (A, L); West Highlands, 26 June 1957, *Robbins 63* (A, BM, L), 21 July 1963, *Vink 16328* (A, K, L); Central Highlands, 10 Sept 1971, *Wace ANU 13005* (A, K, L) Normanby, 20 April 1956, *Brass 25512* (K, L, S); Star Mt, 25 August 1959, *Kalkman 4555* (A), 17 May 1975, *Veldkamp 6861* (K, KYO, L), Sepik, 8 June 1961, *Darbyshire & Hoogland 7893* (A, BM, L); Morobe, 9 Oct. 1962, *Royen 16033* (A, K, L), Jan 1957, *Wells NGF 7379* (A, L), 8 Jan 1962, *Hartley* 9674 (K, L); Wasemi, 29 Sept 1961, *Schodde 2323* (L); Milne Bay, July 1953, *Brass 24959* (A, K, L), 19 Aug 1969, *Pullen* 8076 (L); Fergusson, 19 June 1956, *Brass 27231* (L).

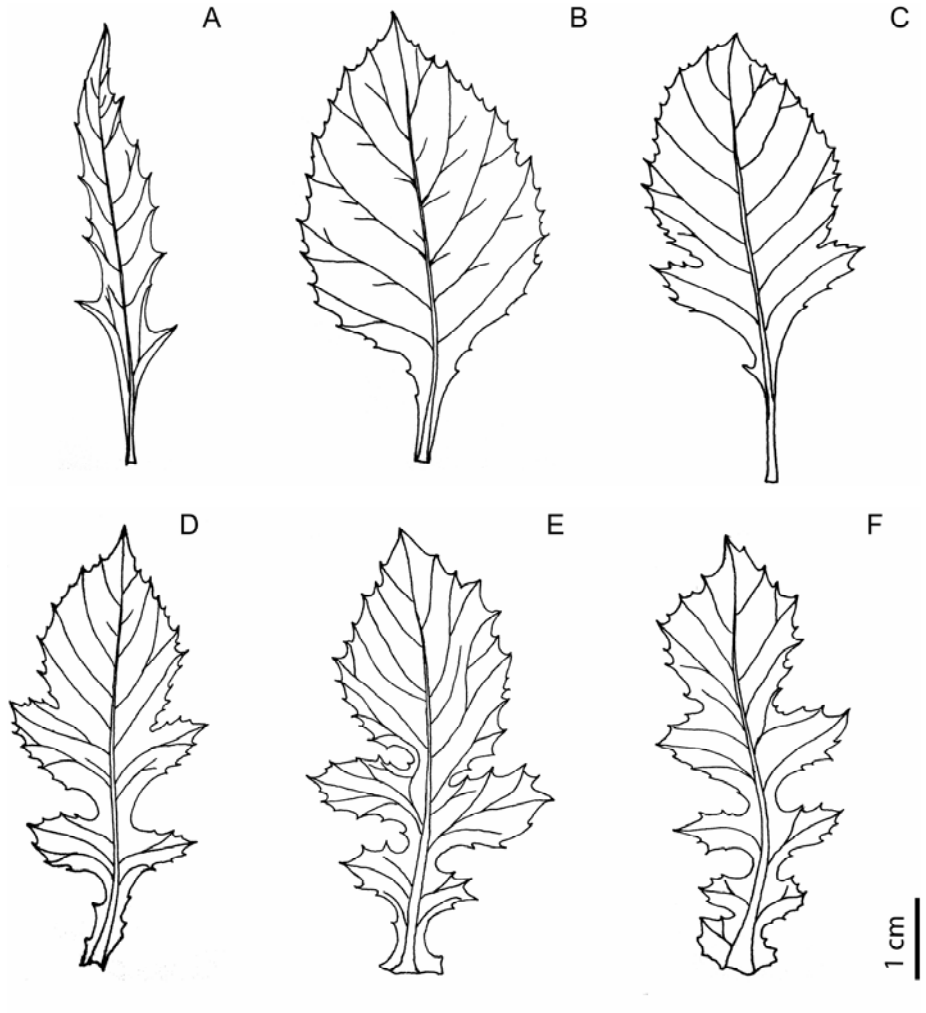

Figure 36. Leaves of **A-C**: *C. crepidioides*, **D-F**: *C. rubens*.

2. Crassocephalum rubens (Juss. ex Jacq.) S. Moore in J. Bot. 50: 212. 1912.
For typification and synonymy see Jeffrey & Beentje (2005: 608-609).

Plants 20-50 cm high when flowering. *Leaf blades* 2-10 x 0.5-6 cm, upper leaves usually with several pairs of lobes (Fig. 36D - 36F). *Capitula* usually single, erect, peduncles 6-20 cm long (Fig. 35D); florets bright blue or rarely pink; involucres 10-15 mm long, phyllaries 20–23. *Cypselas* oblong, black. 2n = 40 (counted here)

Flowering and fruiting from September to May.

In Asia, *C. rubens* is known only from a small area in north Thailand, east Myanmar and south China (Yunnan; Fig. 34).

Specimen examined. **China**: Yunnan, Oct., 1995, *Wu et al 331* (KUN). **Myanmar**: Shan state, 23 Dec. 1986, *Paisooksantiwatana 1970-86* (BK). **Thailand**: Chiang Mai, Chiang Dao, 16 Sept 1989, *Maxwell 89-1096* (E, L), 24 Nov. 1989, *Paisooksantiwatana 2576-89* (BK), 27 Sept 1994, *Nanakron & Pongamornkul* 1840 (QBG), 3 Sept. 1999, *Norsangsri 907* (QBG) 23 Dec. 2004, *Vanijajiva 05 - 018*, Ang Kang, 4 Nov. 1998, *Suksathan 1361*, 8 Sept 1999, *Suksathan 15687* (QBG); Mae Hong Son, Ruk Thai Village, 11 Nov. 2005, *Vanijajiva* 06 – 063 (MJG).

3. Crassocephalum crepidioides x rubens

Plants 30-80 cm high when flowering. *Leaf blades* 2-7 x 0.5-6 cm, upper leaves subentire or with one to several pairs of lobes, intermediate between the parents (Fig. 36). *Capitula* 2–6, horizontal or rarely erect, peduncles 7-15 cm long; florets magenta(Fig. 35C); phyllaries 18–23. *Cypselas* oblong, black. 2n = 40 (counted here).

Flowering and fruiting from September to March.

Specimens examined: Only known from our own collections. **Thailand**: Chiang Mai, Doi Pha Hom Pok, 11 Nov. 2005, *Vanijajiva 05 – 065* (MJG); Doi Chiang Dao, 12 Dec. 2005, *Vanijajiva 05 – 035* (MJG): Mae Hong Son; Ruk Thai Village, 11 Nov. 2005, *Vanijajiva 06 – 070* (MJG).

4.3.3 Pollen and seed fertility

Fertile and sterile pollen grains and cypselas are illustrated in Fig. 37. Mean pollen and seed fertilities were 93.5 % and 98% in *C. rubens*, 90.5 % and 96.7% in *C. crepidioides*, and 15 % and 18% in the intermediate forms.

4.3.4 Chromosome numbers

All individuals counted of *C. crepidioides*, *C. rubens* and the intermediate forms are uniformly tetraploid with 2*n* = 4x= 40 chromosomes. (Fig. 37G – 37I).

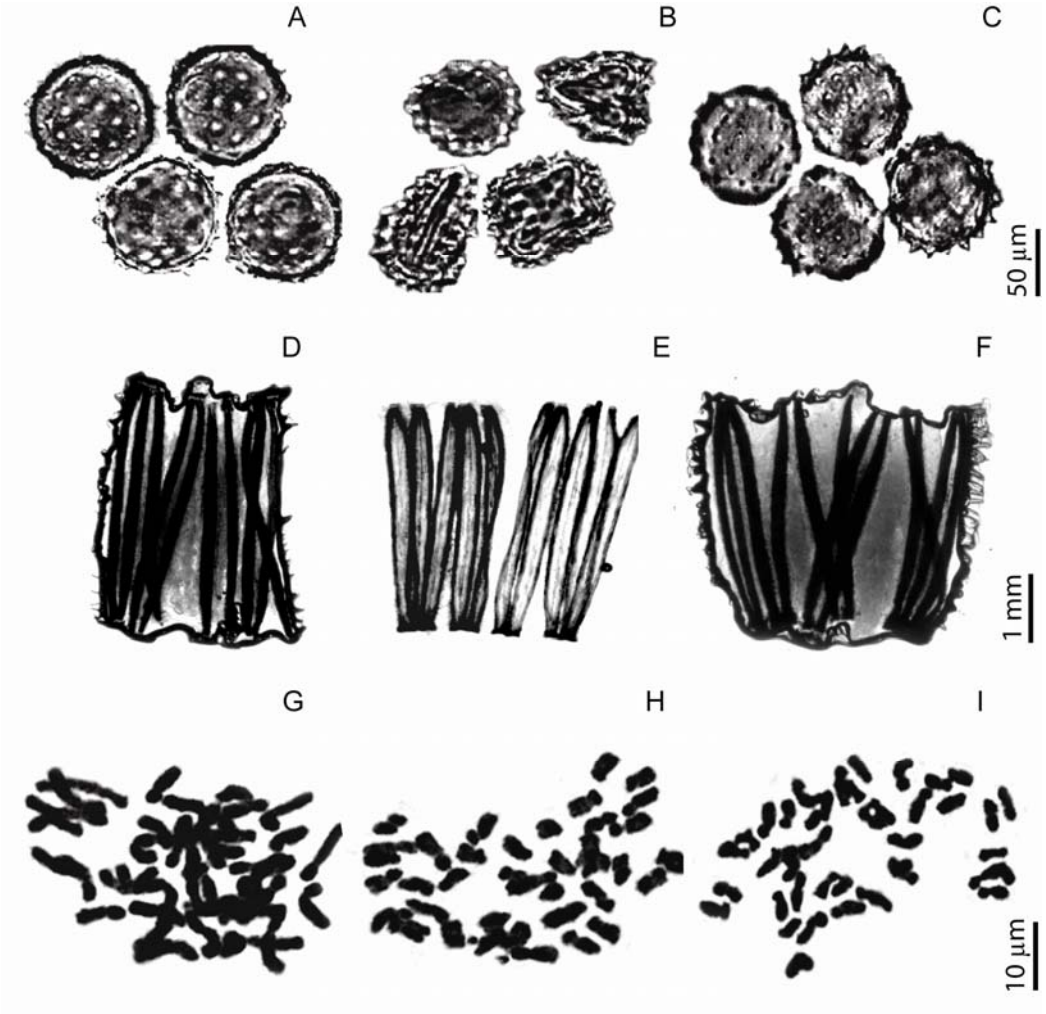

Figure 37. Pollen , cypselas and chromosomes of *C. crepidioides* (**A, D, G**), *C. crepidioides x rubens* (**B, E, H**) and *C. rubens* (**C, F, I**). In the cypsela squashes, the endosperm is recognizable as grey tissue.

4.3.5 Nuclear ribosomal DNA ITS sequences

The boundaries of the ITS region (ITS1-5.8S-ITS2) of *Crassocephalum* were determined by comparison with previously published ITS sequences of *C. crepidioides* and *C. montuosum* (Pelser *et al.* 2002; 2007). The length of the ITS sequences of all individuals sequenced was 648 bp (Fig. 38). No sequence variation was found within either *C. crepidioides*, *C. rubens* or the intermediate forms collected in Asia, and sequences were identical among individuals from Asia and Africa in *C. crepidioides* and *C. rubens*.

The ITS sequences of *C. crepidioides* and *C. rubens* differ at 47 sites (13 %; Fig. 38). At each of these 47 sites the sequence spectrum of all intermediate individuals show two overlapping peaks about half as high as peaks of neighbouring sites.

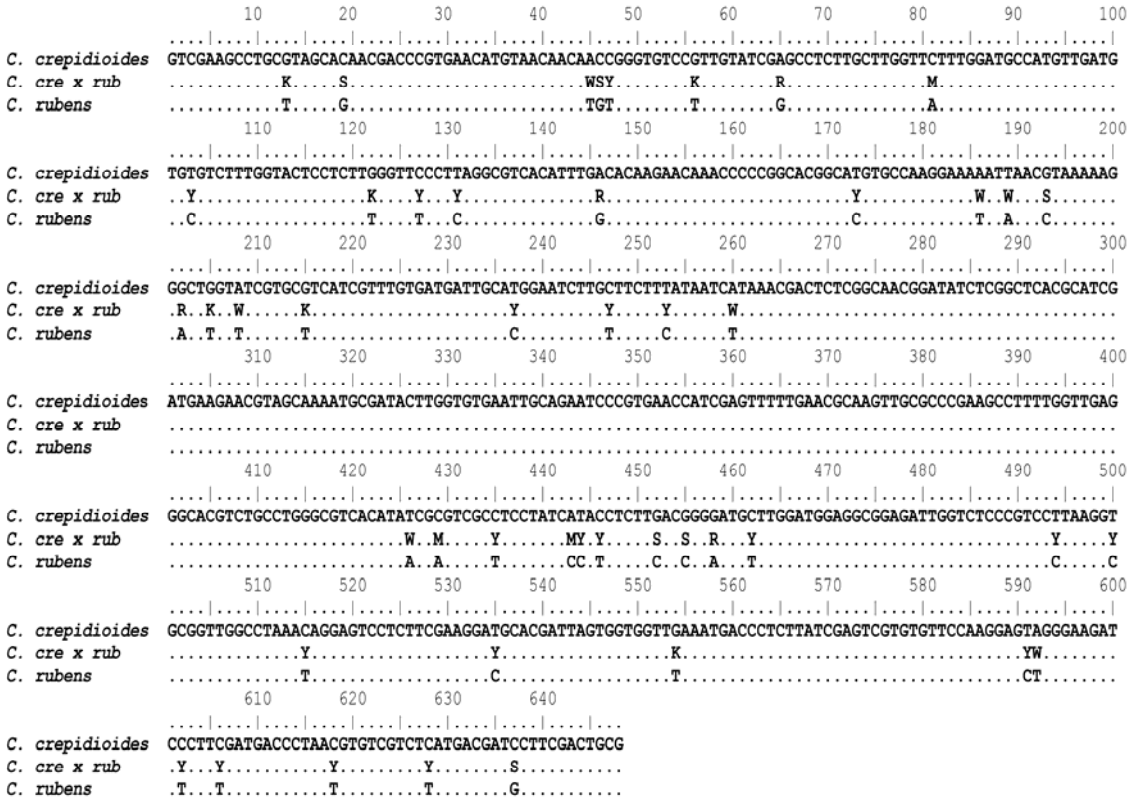

Figure 38. Alignment of ITS sequences of *C. crepidioides*, *C. crepidioides* x *rubens* and *C. rubens* from Thailand. IUPAC ambiguity symbols are used to represent polymorphisms (W = A + T, Y = C + T, R = G + A, K = G + T, M =A + C).

4.3.6 Chloroplast DNA *trnL-3′-trnF* sequences

Sequences obtained for the chloroplast *trnL-3′-trnF* intergenic spacer (IGS) were 434 bp long. In the comparison of *C. crepidioides* and *C. rubens*, six variable sites were found (Table 4). All intermediate individuals contained the haplotype of *C. crepidioides*.

Table 4 Alignment of *trnL-F* intergenic spacer sequences obtained from examined *Crassocephalum crepidioides*, *C. crepidioides x rubens* and *C. rubens*

Taxon	*trnL-F* intergenic spacer (bp)					
	27	38	87	157	178	294
Crassocephalum crepidioides	A	A	C	G	A	G
C. crepidioides x *rubens*	A	A	C	G	A	G
C. rubens	G	C	A	T	G	C

4.4 Discussion

4.4.1 Taxonomy and chromosome numbers of *Crassocephalum* in Asia

As set out in the above revision of the *Crassocephalum* in Asia, the genus is represented by two species, *C. crepidioides* and *C. rubens* as well as by intermediate forms. Whereas the presence of *C. crepidioides* in Asia had been known for a long time (Belcher, 1955, van Steenis, 1967), the occurrence of *C. rubens* and the existence of intermediate forms is here recorded for the first time. Whereas *C. crepidioides* has been reported to contain both diploid and tetraploid cytotypes in Africa (van Steenis, 1967), only tetraploid cytotypes have been reported from Asian and Australian populations (Henderson, 1973; Koyama, 1986). This finding is confirmed here (Fig. 37G). The chromosome number of 2n = 40 for *C. rubens* in Asia is here documented for the first time (Fig. 37I). This count differs from counts of African material which was found to be diploid with 2*n* = 20 chromosomes (Nwankiti & Udengwu, 1983).

4.4.2 Introduction history of *Crassocephalum* in Asia

The introduced status of both *C. crepidioides* and *C. rubens* in Asia is supported by the observation that in both species no sequence variation could be found in the comparison of Asian and African material. The oldest collection of *C. crepidioides* known to us was made on Java, Indonesia, in 1923. This confirms the information provided by van Steenis (1967) and predates the earliest collections known to Belcher (1955). Early collections of the species include specimens from India (1925) and China (1925; Fig. 34, Table 4). The more or less simultaneous collection of the species in three geographically distant areas probably implies their more or less simultaneous and independent introduction. Considering the geographical distribution of collecting dates as shown in Fig. 34, it seems possible that the three areas of original introduction, i.e., Java, southern India and southern China, served as starting points for the dispersal of the species into neighbouring areas. Increasing geographical distance from these three areas is correlated with an increasingly younger age of collections (Fig. 34). It can only be guessed that this somewhat weedy species probably was an accidental introduction and arrived in Asia as a contamination of seed or soil of some commercial plant. One possible candidate for this might be Robusta Coffee (*Coffea canephora* Pierre ex Fröhner) which was introduced from tropical Africa into Asia around the 1900s. This species was first introduced to Java followed by Sri Lanka (Puff & Chamchumroon, 2003). In comparison to *C.*

crepidioides, the introduction of *C. rubens*, here reported for the first time, was much more recent, and the earliest collection was made in 1986 in Myanmar (Table 2). *Crassocephalum rubens* is still restricted to this general area (Myanmar, north Thailand, south China).

4.4.3 The intermediate specimens

All result obtained in this study clearly indicate that the intermediate specimens of *Crassocephalum* found by us represent interspecific hybrids between *C. crepidioides* and *C. rubens*. Apart from the fact that intermediate specimens were only found in sympatry with the two parental species (Fig. 34), these intermediate specimens are intermediate morphologically (Figs. 35 – 36, Table 2), have additive ITS sequences (Fig. 38) and show reduced pollen and seed fertility (Fig. 37). The presence of the *C. crepidioides* cpDNA haplotype in the hybrid individuals suggests that this species served as female parent. Considering the simple additivity of the ITS sequences and the comparatively low fertility of the hybrid plants, it seems very likely that 1) all intermediate specimens collected represent F1-hybrids and that 2) the potential for further evolution of these hybrids by backcrossing to the parents or forming hybrid progeny seems low.

The hybrid plants from Asia are morphologically very similar to *C. rubens* var. *sarcobasis* (DC.) C. Jeffrey & Beentje (= *C. sarcobasis* (DC.) S. Moore) from tropical Africa. This taxon has smaller and more numerous capitula than *C. rubens*, and the capitula are erect, distinguishing it from *C. crepidioides* (Hutchinson & Dalziel, 1963; Jeffrey, 1986, Jeffrey & Beentje, 2005). The distribution of *C. rubens* var. *sarcobasis* only in the sympatric range of *C. crepidioides* and *C. rubens* in tropical Africa and Madagascar may imply that this taxon is a hybrid between the two species. However, examination of pollen fertility in 53 specimens deposited at Kew showed high fertility with a mean of 94.5 % normally shaped pollen grains. From this we conclude that *C. rubens* var. *sarcobasis* is not comparable to the interspecific hybrid in Asia but rather an independent taxon.

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