

A revision of *Trigonostemon* Bl. (Euphorbiaceae) for Indian Subcontinent

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A revision of *Trigonostemon* Bl. (Euphorbiaceae) for Indian Subcontinent

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RÉSUMÉ

BALAKRISHNAN, N. P. & T. CHAKRABARTY (1991). Une révision de *Trigonostemon* Bl. (Euphorbiaceae) pour le subcontinent indien. *Candollea* 46: 601-637. En anglais, résumés français et anglais.

Une révision pour le subcontinent indien du genre *Trigonostemon* Bl. (Euphorbiacées) et de ses 13 espèces est présentée. *T. nicobaricus* T. Chakrab. est ramené au rang de variété de *T. villosus* Hook., alors que *T. sunirmalii* T. Chakrab. & Balakr. est fusionné avec *T. hetrophyllus* Merr. L'aire de répartition de ces deux taxa est ainsi étendue à l'Inde et à Myanmar (Birmanie) respectivement. Tous les taxa, sauf un, sont illustrés.

ABSTRACT

BALAKRISHNAN, N. P. & T. CHAKRABARTY (1991). A revision of *Trigonostemon* Bl. (Euphorbiaceae) for Indian Subcontinent. *Candollea* 46: 601-637. In English, French and English abstracts.

A taxonomic revision of the genus *Trigonostemon* Bl. (Euphorbiaceae) is presented for the Indian subcontinent with 13 species. *T. nicobaricus* T. Chakrab. is reduced to a variety of *T. villosus* Hook. f. while *T. sunirmalii* T. Chakrab. & Balakr. is merged with *T. hetrophyllus* Merr. and thus the range of distribution of these two taxa gets extended to India and Myanmar (Burma) respectively. All taxa, except for one species, are illustrated.

Introduction

The genus *Trigonostemon* was established by Blume in 1825 for a plant collected by him in Java, "in fructicetis insulae Nusae Kambangae". The generic name (originally chosen as "Trigostemon" and corrected after three years to "Trigonostemon") refers to the "3-angled stamens", i.e. column of stamens. The type species, *T. serratus* Bl. (originally treated as "serratum") is of limited distribution, occurring in Java and Bali only. The genus is now known to be represented by about 60 Indo-Malesian species. The generic name is conserved against *Enchidium* Jack, which antedates *Trigonostemon* by three years.

The first species of the genus to be discovered from the Indian subcontinent was *T. semperflorens*, originally described as a *Cluytia* by ROXBURGH in 1832 from a cultivated plant in Calcutta Botanic Garden, and originating from Sylhet in Bangladesh. Subsequently Robert WIGHT described *T. heteranthus* from Myanmar (Burma) in 1852, followed by the discovery of *T. laetus* and *T. longifolius*, both from Myanmar (Burma) by BAILLON (1858). However, the last two species had already been included by WALLICH as *Croton laetus* and *C. longifolius* in his Catalogue

(1847). Subsequently THWAITES (1861) added two species, viz. *T. diplopetalus* and *T. nemoralis* from Sri Lanka (Ceylon) and BEDDOME (1873-1874) attributed the latter to peninsular India. KURZ had also described two species of *Trigonostemon* under different generic names, viz. *Baliospermum reidioides* (1875, 1877) from Thailand, near Burma border and *Sabia viridissima* (1872, 1877) of Sabiaceae from the Andamans. CRAIB (1911) referred the former to *Trigonostemon*. BALAKRISHNAN (1966) found the latter to be an Euphorbiaceae and erected a new genus called *Kurziodendron* to accommodate it. However, later AIRY SHAW (1971) found that this species fit well into the broad generic delimitation of *Trigonostemon* and transferred *Sabia viridissima* to *Trigonostemon*.

In recent years, DEB & DEKA (1965) described a species, *T. chatterjii* from NE. India. AIRY SHAW (1982) brought to light an overlooked species, *T. praetervisus* from Bangladesh. Again in 1972 & 1975, AIRY SHAW reported the Malesian *T. laevigatus* from Andamans and attributed *T. reidioides* to Myanmar (Burma) with a question mark. Further, BALAKRISHNAN & NAIR (1983) proposed a new variety, *T. viridissimus* var. *confertifolius* from Andamans. In 1984, BALAKRISHNAN & CHAKRABARTY reduced *T. chatterjii* to a variety of *T. viridissimus*. In the same year, i.e. 1984, another four new species were described from the Indian subcontinent, viz. *T. birmanicus* T. Chakrab. & Balakr. and *T. sunirmalii* T. Chakrab. & Balakr. from Myanmar (Burma), *T. nicobaricus* T. Chakrab. from Nicobars and *T. nigrifolius* Balakr. & T. Chakrab. from Burma.

In the present revision, altogether 13 species and 2 varieties of *T. viridissimus* are recognised from the Indian subcontinent. *T. aurantiacus* var. *rubriflorus* of the Andamans and Nicobars is merged with the species. In addition, *T. sunirmalii* is shown to be conspecific with *T. heterophyllus* Merr. of Hainan and *T. nicobaricus* is also reduced to a variety of the Malesian *T. villosus* Hook. f. The occurrence of *T. heterophyllus* is thus reported for Myanmar and of *T. villosus* for India.

It may be noticed from the long tail of generic synonymy that the genus was described many times separately. The reason for this situation is evidently the wide range of morphological variability exhibited by the species, particularly with regard to the characters of the foliage, inflorescences, and to a lesser extent, the male flowers.

Phytogeography and ecology

The genus *Trigonostemon*, with about 60 species, is Indo-Malesian, distributed in Sri Lanka, S. India, NE. India to SE. Asia, China and Malesia. Of the 13 species so far known to occur in Indian subcontinent, most of the species are of restricted distribution, except for *T. viridissimus*, the most widespread species, followed by *T. aurantiacus*. The former occurs in NE. India (var. *chatterjii*), Andamans, Myanmar, Malaysia, Indonesia, Sumbawa, Timor and Lesser Sunda Island, while the latter is found in the Andaman-Nicobar Islands, Thailand, Malaya, Java and Sumatra.

T. longifolius, first discovered from Myanmar is since known from Thailand, Malaya, Sumatra and Borneo also. *T. villosus*, hitherto known from Malaya, Sumatra and Borneo, is now reported from Great Nicobar Island (var. *nicobaricus*). *T. birmanicus*, *T. heteranthus*, *T. laetus* and *T. nigrifolius* are endemic to Myanmar; while *T. praetervisus* is endemic to Bangladesh. *T. heterophyllus*, originally described from Hainan, is reported herein from Myanmar. The remaining two species, *T. nemoralis* and *T. diplopetalus* are restricted to Sri Lanka; the former, however, also extending to peninsular India.

Species of *Trigonostemon* grow mainly in evergreen primary forests. However, they may also occur in mixed forests or even coastal forests (*T. viridissimus*). Several species were found growing along the riverbanks. The plants grow mainly on clayey or sandy soil or on limestone or rocky loam from sea level up to about 900 m in peninsular India, 600 m in Sri Lanka, 1550 m in NE. India, 700 m in the Andamans and Nicobars and up to about 400 m altitude in Myanmar.

Portrait of the genus

Habit

Plants of *Trigonostemon* are shrubs or small trees, mostly up to 6 m tall or sometimes attaining a height of 10 m (*T. aurantiacus*). The indumentum is simple and never stellate.

Leaves

The leaves are simple and alternate, sometimes crowded towards ends of branches and then subopposite (e.g. *T. nemoralis*) or even pseudo-verticillate (*T. heterophyllus*, *T. semperflorens*) and in the last case, often separated by bare internodes. In general, the leaves tend to be narrowed downwards towards the base and thus conforming to obovate to oblanceolate or panduriform shape but sometimes are also elliptic to oblong. The leaf-size amongst species of Indian subcontinent varies from 2.5-55 cm in length and 1-14 cm in width. They are cuneate or attenuate or shortly cordate or acute, obtuse or rounded at base, glandular-denticulate or -serrulate to entire (*T. praetervisus*, *T. viridissimus* var. *confertifolius*) at margins and mostly caudate to acuminate or rarely acute (*T. nemoralis*, *T. viridissimus* var. *confertifolius*) to obtuse (*T. nemoralis*) or subacuminate (*T. diplopetalus*) at the apex. The texture varies from membranous to chartaceous or sometimes coriaceous (*T. aurantiacus*, *T. birmanicus*). The indumentum on leaves, if present, is mostly sparse and thin, particularly present on the lower surface on the major nerves. Rarely, as in *T. heterophyllus* and *T. reidioides*, the foliar indumentum is strong. With regard to the major venation patterns, the leaves can be grouped into two types, viz. pinnate and trinerved. The midrib is mostly flat, or slightly raised (*T. aurantiacus*, *T. diplopetalus*) on the upper surface. The lateral primary nerves in case of the trinerved leaves are weaker than the midrib but stronger than the secondary nerves, opposite, basal or slightly suprabasal, and ascending up to about halfway up the lamina, giving rise to secondary veins only exmedially, which are, however, not much stronger than the nearby tertiaries. The lateral primaries ultimately behave in the same way as the secondaries (as mentioned below). The secondary veins (lateral nerves) are 3-26 per side of the midvein, prominent or sometimes faint to obscure on the upper surface, and distinct (rarely faint as in *T. aurantiacus*) on the undersurface, ascending, more or less arcuate or often somewhat straight in their course. They finally upturn a little away from the margins and usually give rise to anastomoses (rarely vanishing, as in *T. aurantiacus*) and also form weak loops with the superadjacent secondaries. The tertiary nerves are inconspicuous to prominent on the upper surface, distinct to faint or rarely indistinct (*T. aurantiacus*) on the undersurface and scalariform (unbranched or forked) or reticulate, or may rarely tend to branch into veins of higher order (*T. heteranthus*).

The leaf margins are usually beset with small sessile glands at the serrations (not noticeable in *T. semperflorens*, *T. villosus*, *T. viridissimus*, etc. In addition, a pair of acropetiolar glands are also present on the upper side of the petioles at their junctions with lamina. Such glands or glandular appendages are setiform (*T. aurantiacus*, *T. heteranthus*), pointed (*T. diplopetalus*), subulate (*T. nemoralis*, *T. nigrifolius*), triangular or circular (*T. nigrifolius*), and up to 2 mm in length (or diameter).

The petioles are 1 mm to 15.5 cm long and 1-4 mm thick, terete or quadrangular and sulcate or channelled above in various species and sparsely pubescent (strongly so in *T. heterophyllus*) to glabrous.

The stipules are minute or obsolete (e.g. *T. aurantiacus*) or subulate (*T. heteranthus*, *T. nemoralis*, *T. nigrifolius*) or linear (*T. heterophyllus*) or triangular-acuminate (*T. villosus*) in shape and usually 1-2 mm in length, or 3-4 mm in *T. nemoralis* and 5-7 mm in *T. heterophyllus*.

Inflorescences

The inflorescences are terminal or axillary (also arising from the axils of fallen leaves) or rarely cauli- or ramiflorous (*T. aurantiacus*, *T. semperflorens*), very varied, ranging from the pseudo-racemose or racemiform type to variously cymose or thyriform or abbreviated and somewhat fasciculate or glomerate or even reduced to a solitary flower. These are often conspicuously peduncled, and unisexual or bisexual, occasionally unisexual as well as mixed within a single species (*T. laetus*).

The bracts are usually inconspicuous and lanceolate to subulate or linear to triangular or ovate-lanceolate or oblong-lanceolate in shape. Rarely, these are conspicuous and foliaceous (*T. aurantiacus*). The bracts subtending the male flowers are usually 0.5-4 mm in length, but 4-8 mm in *T. villosus* and 5-8 mm in *T. heterophyllus*. On the other hand, the bracts under the female flowers are 0.5-5 mm long, but 3-10 mm in *T. heteranthus*, up to 17 cm in *T. heterophyllus*, 3-13 mm in *T. semperflorens* and 2.5-5 mm in *T. villosus*.

Male flowers

The male flowers have slender, hairy to glabrous, 1-7 mm long pedicels, or these may be 6-12 mm in *T. aurantiacus*, 2-7 mm in *T. heteranthum*, and 5-18 mm in *T. viridissimus*.

Sepals. — The sepals are 5 in number, very shortly connate, imbricate, and orbicular, ovate, elliptic, oblong or triangular in shape and 0.8-3 mm in length, 0.6-2 mm in breadth, acute, obtuse to rounded at apex, or rarely fimbriate (*T. diplopetalus*), thinly hairy outside, glabrous inside and sometimes dorsally gibbous (*T. aurantiacus*, *T. birmanicus*, *T. nemoralis*, *T. nigrifolius*).

Petals. — The petals are also 5 in number, free, subflabellate (*T. aurantiacus*) or orbicular-obovate or spatulate or oblong-elliptic, occasionally shallowly to deeply bilobed (*T. diplopetalus*), 2-7 mm long, 1.3-4 mm broad, mostly glabrous (except in *T. villosus*) and mostly brightly coloured (yellow, orange, red, blackish-crimson, purple, black, etc.).

Disk. — The disk is shortly cupular and crenate or lobed or entire (*T. birmanicus*, *T. longifolius*, *T. nemoralis*, *T. nigrifolius*) or annular (*T. praetervisus*). However, in some species in the area the disk consists of 5 distinct glands (squarish, rectangular, obovate, oblong, etc.). In *T. nemoralis*, the disk may be shortly cupular to free while in *T. nigrifolius* the disk glands are distinct or partially to entirely connate and rounded to lobed at apex.

Stamens. — The stamens are 3 in most species in the region, while 5 in *T. praetervisus* only. The filaments are usually united, forming a column, 1-2.6 mm in length, and mostly shortly trifid at the apex (except *T. heteranthus* and *T. nigrifolius*, having the anthers directly attached to column). The filaments of *T. praetervisus* and *T. viridissimus* var. *chatterjii* are however almost free. A specialized condition is noticeable in *T. diplopetalus* and *T. nemoralis*, having sessile anthers. The anthers, as a rule, are extrorse. These are of various shapes, viz. ovoid or widely oblong to ellipsoid, squarish or orbicular, 2-celled, 0.4-1 mm in length, and they initially remain vertical or gradually become horizontal to the axis. The connectives are lobed, often shortly produced (*T. aurantiacus*, *T. laetus*, *T. longifolius*, *T. nigrifolius*) and horn-like, often emarginate at apex. The connective often splits longitudinally into two lateral halves from apex almost to base, separating the thecae (*T. heterophyllus*, *T. laetus*, *T. longifolius*, *T. nigrifolius*). In *T. diplopetalus* and *T. nemoralis*, however, the cells of anthers are free from one another from the beginning and they remain partially embedded on fleshy connectives (lacking the filaments). The connectives in these species are more or less triquetrous and bilobed, coherent towards apex and connate towards base forming a short stalk (0.4-0.5 mm in length). Together, these connectives and anthers look like a globose mass surmounted on the receptacle.

Female flowers

Like the male flowers, the female flowers are also pedicellate but the pedicels are longer, being 1-30 mm in length. These are usually hairy or occasionally glabrous and usually elongating gradually (e.g. 2.5-4.5 cm in *T. aurantiacus*, 1.5-3 cm long in *T. viridissimus*, 8-15 mm in *T. laetus* etc.) which are generally thickened towards apex and gradually tapering downwards.

Sepals. — The sepals are 5, shortly connate, imbricate in bud and of various shapes, e.g. ovate, elliptic, orbicular, oblong, triangular, lanceolate etc., 0.7-11 mm in length, 0.7-5 mm in breadth, hairy outside, glabrous inside, acute, obtuse to rounded at apex, occasionally fringed with conspicuous capitate glands (*T. heteranthus*), sometimes dorsally gibbous (*T. aurantiacus*, *T. nemoralis*), occasionally somewhat accrescent in fruit (*T. heteranthus*, *T. villosus* var. *nicobaricus*). The dorsal gibbosity is sometimes very conspicuous (e.g. *T. nemoralis*) and shortly produced towards apex and becomes horn-like.

Petals. — The petals are 5, free, elliptic, oblong-elliptic, obovate, spatulate or orbicular in shape, 1-5 mm in length, 0.5-3.5 mm in breadth, bilobed in *T. diplopetalus*, brightly coloured like the male flowers, and deciduous.

Disk. — The disk is cupular-annular in *T. longifolius*, cupular and crenate in *T. viridissimus*, while it consists of 5 distinct glands in all the other species studied (female flowers still unknown in a few species). In *T. nemoralis*, however, the disk glands are often also connate in a ring and deeply lobed.

Ovary. — The ovary is trilocular (locules 1-ovuled), trigonous or ovoid or subglobose, often depressed, 1-3 mm in diameter, glabrous (*T. aurantiacus*, *T. heteranthus*, *T. viridissimus*) or densely pubescent. The styles are 3, short (0.3-3 mm long), erect or spreading or recurved, often shortly connate below, mostly bifid or often simple (*T. aurantiacus*, *T. nemoralis*, *T. viridissimus*). The stigmas are simple or often capitate or reniform (*T. aurantiacus*, *T. longifolius*, *T. viridissimus*).

Fruits

The fruits are capsular, tricocous, subglobose or depressed, smooth or verruculose (*T. nemoralis*), 7-14 mm long, 10-15 mm in diameter, glabrous or evanescently pubescent, brown or blackish when dry. The seeds are trigonous and orbicular or ovoid, 6-8 mm long, 5-9 mm in diameter. The albumen is reported to be fleshy and the cotyledons flat and broad.

Pollen grains

The pollen grains of six species, viz. *T. verrucosus* J. J. Sm., *T. kingii* Merr., *T. reidioides* (Kurz) Craib, *T. longifolius* Baill., *T. gagnepainianus* Airy Shaw (= *Prosartema gaudichaudii* Gagnep.) and *T. aurantiacus* (Kurz ex Teijm. & Binnend.) Boerl. (= *Actephilopsis malayana* Ridley) were studied and reported by PUNT (1962). As per his report, the grains are sphaeroid or ellipsoid and inaperturate. While the first two of the above species have tectate and gemmate grains, the remaining four species have intectate and reticulate grains. The grains lack the "Croton-pattern" and thus WEBSTER's (1975) inclusion of *Trigonostemon* under a separate tribe seems to be justified on palynological grounds. Further studies in this line may be helpful in indicating the affinities of different species.

Chromosomes

There is no report so far on the chromosomes in this genus.

Discussion

The characters of the foliage in *Trigonostemon* are so diverse that a little acquaintance enables one to determine the species in most cases with fair accuracy simply by looking at the leaves. The leaves of *T. heterophyllus* and its close relative, *T. semperflorens* are often crowded at the nodes and separated by long bare internodes, a feature not to be found in any other species occurring in the region. However, the strong ochraceous or golden harsh hairs on the leaves (and on other parts) of *T. heterophyllus* clearly distinguish it from *T. semperflorens* and others (excluding *T. reidioides* which has softer but equally strong indumentum but otherwise of a different circle of affinity). As regards the size of the leaves, *T. birmanicus* and *T. longifolius* are recognizable at once by their large leaves (the size being ca. 40 by 10.5 cm in the former and 32-55 by 8-14 cm in the latter). The leaves of *T. heteranthus* are often also large, i.e. 13-42 by 3.5-8.5 cm, but in this species, in fact, the lamina is of average size, being up to about 28 by 8.5 cm, and the elongate petiole actually accounts for such length of leaves. The leaves of *T. diplopetalus*, *T. longifolius* and *T. nemoralis* are also easily recognizable by their cuneate-attenuate base which are adaxially decurrent into petioles in the last two plants. *T. praetervisus* and *T. viridissimus* var. *confertifolius* are characterized by their entire leaves rather than the shallowly serrate or denticulate types of the remaining species. The leaf apices are more or less uniform amongst the species in the region, except in *T. nemoralis* which often bears leaves with acute-mucronate or subacuminate or even obtuse apex and in *T. viridissimus* var. *confertifolius*, having an acute apex. The coriaceous texture of the leaves of *T. birmanicus* is sufficient to reveal its identity since only one more species in the area, i.e. *T. aurantiacus*, sometimes bear thinly coriaceous leaves. In *T. nigrifolius*, the leaves become black and glossy on the upper surface while dry unlike all other species. Further, the leaves of *T. diplopetalus* turn to a dark brown colour on drying, whereas in the closely allied *T. nemoralis*, they remain much yellow or greenish-brown.

The types of major venation pattern are also helpful in dividing the species into two groups. Of the 13 species occurring in Indian subcontinent, *T. birmanicus*, *T. praetervisus* and *T. viridissimus* are characterized by their trinerved leaf bases, though these species appear to be otherwise unrelated to each other. The number of secondary nerves on the lamina in *T. longifolius* is relatively

greater (19-26 pairs) than the other species. The secondary veins in *T. aurantiacus* are rather obscure on the upper surface, not as in the other species. As regards the tertiary veins, these may also be grouped into two types in respect of their orientation, viz. scalariform and reticulate.

The leaves are either long- or short-petioled. While the petioles of *T. birmanicus* (ca. 7.5 cm long), *T. laetus* (1-6.5 cm long) and *T. heteranthus* (1-15.5 cm) are usually long and variable in length, those of the other species are usually much smaller, i.e. between 1-30 mm in length, except in *T. aurantiacus* and *T. viridissimus* in which the petioles attain a length up to 4.5 cm.

The stipules do not offer any help in identifying the species, as these are either deciduous or minute and obsolete.

The inflorescences exhibit diverse characters, much helpful in delimitation. The pyramidal-thyrsoid, bisexual inflorescence of *T. viridissimus* is unique in the area and this species would perhaps deserve a distinct sectional status on this character. In this variable species the pyramidal inflorescence exhibits tendency towards reduction, as noticed in var. *confertifolius* in which the inflorescence becomes almost racemiform. On the other hand, plants of var. *viridissimus* also exhibit tendency towards dichasial branching. The inflorescences in *T. birmanicus* and *T. nigrifolius* are also thyrsoid but are unisexual (only the males are known in this species). In addition to *T. viridissimus*, bisexual inflorescences also occur in *T. longifolius* but they are elongate and pseudo-racemose. All other species studied have unisexual inflorescences (may be mixed occasionally, as in *T. laetus*). Apart from *T. longifolius*, pseudo-racemose inflorescences also occur in *T. heteranthus* (female), *T. laetus* (male), *T. nemoralis* (male) and *T. villosus* (male). The corresponding male and female flowers in these plants arise on racemiform inflorescences, except in *T. heteranthus*, having very narrowly thyrsoid male inflorescences. The female inflorescences of *T. aurantiacus* are usually elongate, long-peduncled, few-flowered and very narrowly thyrsoform or pseudo-racemose and thus unmistakable. Further variation in the inflorescence types are towards their reduction. In *T. praetervisus*, the inflorescences are diffusely cymose and abbreviated, without any main axis (only the males are known in this plant). The male inflorescences of *T. aurantiacus* and both males and females in *T. heterophyllus* and *T. semperflorens* are also much reduced. The male flowers of *T. aurantiacus* are cauli- or ramiflorous (occasionally axillary), delicate, and occurring in fascicles (sect. *Tylosepalum*). In *T. heterophyllus*, the male inflorescences are short, narrowly thyrsoform or the flowers are crowded at the apices of short peduncles. The female inflorescence of this species is also somewhat fasciculate and subtended by 5-15 mm long peduncle. *T. semperflorens*, which is closely related to *T. heterophyllus*, possesses more or less glomerulate axillary (also cauliflorous?) male inflorescences and fasciculate to solitary or even shortly racemiform, often shortly pedunculate female inflorescences.

The bracts in *Trigonostemon* also appear to have some diagnostic value. For example, *T. villosus* var. *nicobaricus* differs from var. *villosus* in its much sparser pubescence and shorter linear bracts. *T. aurantiacus* is also readily distinguishable from the remaining species by its conspicuous large foliaceous bracts under the female inflorescences. In *T. heteranthus*, the bracts are 3-10 mm long and in addition, 1-1.8 mm long bracteoles are also present. The bracts subtending the flowers, particularly the females, in *T. heterophyllus* and *T. semperflorens* are larger on the average than those of the remaining species.

Speciation in *Trigonostemon* has probably occurred through the differentiation and specialization of the male reproductive organs also, in addition to the leaves and inflorescences. Some species such as *T. aurantiacus*, *T. birmanicus*, *T. nemoralis* and *T. nigrifolius* are characterized by dorsally gibbous sepals. They, however, appear to be otherwise quite unrelated to each other. In *T. diplopetalus*, a close relative of *T. nemoralis*, such dorsal gibbosity does not occur regularly and only one or two sepals of a flower may be found to be gibbous. The petals of *T. diplopetalus* are bilobed, not as in *T. nemoralis* or any other species. The various colours that the petals assume (while fresh or on drying) also provide reliable distinctions quite often. For example, the petals are deep purple in *T. semperflorens*, while dark reddish in the allied *T. heterophyllus*. Presence of distinct disk glands as well as connate and cupular disk in *T. nemoralis* and *T. nigrifolius* is puzzling and raises doubt as to their diagnostic value. The unique sessile anthers of *T. diplopetalus* and *T. nemoralis* with fleshy connectives are distinctive and indicates their close alliance, and that they are justifiably

placed under a separate section, *Pycnanthera*. The five stamens of *T. praetervisus* together with free filaments are also distinctive. Free stamens otherwise occur only in *T. viridissimus* var. *chatterjii*. The connectives in some species are produced and may also provide character for distinction.

So far as the female flowers are concerned, these are also of some value for taxonomic demarcation in the genus, particularly the dorsal gibbosity of the sepals, colour of petals, presence or absence of hairs on ovary and the features of the styles. The dorsal gibbosity of the sepals and the colour of petals mainly are the same as in the respective male flowers. Field observation in the Andamans revealed that the female petals in *T. aurantiacus* are orange outside and deep red inside which turn dark reddish on drying. However the male sepals are completely red. The capitate glands on the female sepals of *T. heteranthus* are distinctive. The sepals in this plant and in *T. villosus* are somewhat accrescent in fruit. As already mentioned, the ovary of some of the species studied were densely pubescent and glabrous in others which thus provide reliable distinctions. The quad-rifid styles of *T. diplopetalus* readily distinguish it from the simple to bifid styles of the allied *T. nemoralis*. The stigmas are capitate in *T. aurantiacus*, *T. viridissimus* and *T. longifolius* but the styles are simple in the first two, whereas bifid in the last.

The characters of the fruits and seeds of the species studied appear to be rather uniform and therefore having limited diagnostic value. The capsules of *T. diplopetalus*, *T. laetus*, *T. longifolius* and *T. viridissimus* seem to be more depressed than the remaining species, where the fruits are known.

Affinities

The genus *Trigonostemon*, as circumscribed here is evidently a natural one, well characterized by the 3-5 (or very rarely 13) stamens with the filaments united into a column. In addition, the genus can be readily recognised and distinguished from the other taxa of the *Crotonoideae* by the bright colour of the petals. The pollen grains also exhibit departure from the typical "Croton type", to be found amongst many members of the *Crotonoideae*. WEBSTER (1975) treats the genus under a new tribe *Trigonostemonae*, along with another two Indo-chinese genera, *Oligoceras* Gagnep. and *Poilaniella* Gagnep. However, AIRY SHAW (1978) had already treated *Poilaniella*, as well as *Prosartema* Gagnep., another Indo-chinese genus, as congeneric with *Trigonostemon*, although GAGNEPAIN (1924, 1925) distinguished them by various characters of disk, stamens, style, fruit, etc. Considering the diverse characters possessed by *Trigonostemon*, we agree with AIRY SHAW (l.c.) on the above point that there are not enough grounds in treating *Prosartema* and *Poilaniella* as distinct entities. As regards *Oligoceras*, GAGNEPAIN (in Bull. Soc. Bot. France 71: 872. 1924) mentioned that this plant (i.e. *O. eberhardtii*, the type species) bears pistillode in the male flowers but according to WEBSTER (1975), the tribe *Trigonostemonae* has "ovarium rudimentum nullum". This discrepancy calls for a closer look and it will have to be ascertained by studying material whether *Oligoceras* really possesses the pistillode as indicated in the protologue. In such case, *Oligoceras* is to be excluded from *Trigonostemonae* since *Trigonostemon* differs by the absence of the pistillode in particular. In addition, the broad "ovate-deltoid" leaves of *Oligoceras* are also not known in *Trigonostemon*.

The genus is evidently close to *Dimorphocalyx* Thw., differing in the monoecism, very varied inflorescences (often as short as in *Dimorphocalyx*), the variously coloured (rather than white) petals, the single whorl of united (rather than the outer whorl of free and inner whorl of connate) stamens and the non-acrescent fruiting calyx. The leaves are most often also glandular-denticulate and sometimes triplinerved at the base. The dorsal gibbosity of sepals in some species is reminiscent of *Paracroton* Miq. (= *Fahrenheitia* Reichb. f. & Zoll.) which differs from *Trigonostemon* mainly in the stellate indumentum and biseriate stamens.

As already mentioned, *Trigonostemon* contains a wide assortment of species exhibiting very diverse characters. But our present state of knowledge of the genus is unsatisfactory, a number of species being poorly or incompletely known. Under such situation, it does not seem appropriate and convenient to assign the species occurring in Indian subcontinent under different available sections of the genus or to propose any new sections, as possibly required for *T. viridissimus*, *T. praetervisus*, etc. AIRY SHAW (1978) has rightly pointed out that a definitive world-wide revision of the

genus is in urgent need, and when such a revision is eventually undertaken, it would be possible to establish a certain number of fairly distinct sections. For the available infrageneric classification, the work of PAX & HOFFMANN (1931), may be referred.

Systematic treatment

Trigonostemon Blume, nom. cons.

- Trigonostemon** Blume, Bijdr.: 600 (1825) (as "Trigonostemon") corr. Blume, Fl. Javae Praef.: vii (1828); Endl., Gen. Pl.: 1118 (1836-1840); Baill., Et. Gen. Euphorb.: 340 (1858); Miq., Fl. Ind. Bat 1(2): 379 (1859); Muell.-Arg. in Linnaea 34: 212 (1865) & in DC., Prodr. 15(2): 1105 (1866); Bedd., For. Man. 212: (1873); Kurz, For. Fl. Brit. Burma 2: 406 (1877); Benth. & Hook. f., Gen. Pl. 3: 298 (1880); Hook. f., Fl. Brit. India 5: 395 (1887); Trimen, Handb. Fl. Ceylon 4: 51 (1898); Brandis, Indian Trees: 579 (1906); Bourd., For. Fl. Travancore: 503: 1908); Pax & Hoffm. in Engler, Pflanzenr. IV. 147(iii): 85 (1911) & in Engler & Harms, Pflanzenfam. ed. 2, 19c: 169 (1931); Ridley, Fl. Malay Penins. 3: 263 (1924); Gamble, Fl. Pres. Madras: 1341 (1924); Kanjilal & al., Fl. Assam 4: 196 (1940); Backer & Bakh. f., Fl. Java 1: 495 (1963); Jabl. in Brittonia 15: 151 (1963); Whitmore, Tree Fl. Malaya 2: 134 (1973); Airy Shaw in Kew Bull. 32: 361, 415-418 (1978) & 36: 352 (1981). **Type:** *T. serratus* Blume.
- = *Enchidium* Jack in Malay Misc. 2: 89 (1822); Muell.-Arg. in DC., Prodr. 15(2): 1256 (1866), nom. rejicienda. **Type:** *E. verticillatum* Jack.
 - = *Silvaea* Hook. & Arn., Bot. Beechy's Voy.: 211 (1836). **Type:** *S. semperflorens* (Roxb.) Hook. & Arn.
 - = *Athroisma* Griff., Notulae 4: 477 (1854) & Icon. Pl. Asiat.: 534 (1854). **Type:** *A. serratum* Griff.
 - = *Tritaxis* Baill., Et. Gen. Euphorb.: 342 (1858); Benth. in J. Linn. Soc. Bot. 17: 226 (1878); Pax in Engler, Pflanzenr. IV. 147(i): 113 (1910). **Type:** *T. gaudichaudii* Baill.
 - = *Telogyne* Baill., Et. Gen. Euphorb.: 327 (1858). **Type:** *T. indica* Baill.
 - = *Tylosepalum* Kurz ex Teijsm. & Binnend. in Natuurk. Tijdschr. Nederl. Ind. 27: 50 (1864). **Type:** *T. aurantiacum* Kurz ex Teijsm. & Binnend.
 - = *Actephilopsis* Ridley in Bull. Misc. Inf. Kew: 360 (1923) & Fl. Malay Penins. 3: 252 (1924); Pax & Hoffm. in Engler & Harms, Pflanzenfam. ed. 2, 19c: 170 (1931). **Type:** *A. malayanus* Ridley
 - = *Prosartema* Gagnep. in Bull. Soc. Bot. France 71: 875 (1924) & in Lecomte, Fl. Gen. Indoch. 5: 304 (1925); Pax & Hoffm. in Engler & Harms, Pflanzenfam. ed. 2, 19c: 170 (1931). **Type:** *P. stellare (-is)* Gagnep.
 - = *Poiloniella* Gagnep. in Bull. Soc. Bot. France 72: 467 (1925) & in Lecomte, Fl. Gen. Indoch. 5: 303 (1925); Pax & Hoffm. in Engler & Harms, Pflanzenfam. ed. 2, 19c: 170 (1931). **Type:** *P. fragilis* Gagnep.
 - = *Neotrigonostemon* Pax & Hoffm. in Notizbl. Bot. Gart. Berlin 10: 385 (1928) & in Engler & Harms, Pflanzenfam. ed. 2, 19c: 169 (1931). **Type:** *N. diversifolius* Pax & Hoffm.
 - = *Kurziodendron* Balakr. in Bull. Bot. Surv. India 8: 68 (1966). **Type:** *K. viridissimus* (Kurz) Balakr.

Monoecious shrubs or small trees, with simple hairs. Leaves alternate, often crowded towards apices of branches or falsely whorled (*T. heterophyllus*, *T. semperflorens*) and then often separated by bare internodes; lamina obovate to oblanceolate or panduriform or elliptic to oblong, glandular-denticulate or -serrulate or rarely entire at margins, membranaceous to coriaceous, penninerved or sometimes prominently triplinerved at the base, long- or short-petioled; stipules subulate, short or obsolete. Inflorescences axillary or terminal, occasionally cauli- or ramiflorous (*T. aurantiacus*), unisexual or bisexual, variously cymose (often abbreviated and even reduced to a solitary flower), thyriform, racemiform or pseudo-racemose, rarely with conspicuous foliaceous bracts (*T. aurantiacus*). *Male:* flowers shortly pedicelled; sepals 5, very shortly connate, imbricate, sometimes dorsally gibbous; petals 5, free, exceeding the sepals, rarely bilobed (*T. diplopetalus*), mostly brightly coloured (yellow, orange, red, blackish-crimson, purple, etc.); disk glands 5, often connate; stamens

3(-4) or 5 (*T. praetervisus*) or very rarely 13; filaments connate or rarely somewhat free or occasionally lacking (sect. *Pycnanthera*); anthers 2-celled, extrorse, vertical to horizontal; connectives broad, often produced and horn-like, often splitting longitudinally from apex into 2 lateral halves almost up to base, occasionally fleshy and somewhat triquetrous and coherent towards apex and connate towards base forming a globose mass on the receptacle and then anther cells being partially embedded on them, separated from one another; pistillode absent. *Female*: pedicels initially short, gradually elongating; sepals 5, shortly connate, imbricate, rarely fringed with capitate glands (*T. heteranthus*), often dorsally gibbous, occasionally slightly accrescent in fruit (*T. heteranthus*, *T. villosus*); petals 5, free, coloured as in males (occasionally differently), deciduous; disk glands free or united; ovary 3-locular (locules 1-ovuled), glabrous or pubescent; styles 3, short, bifid or occasionally simple or quadrifid, erect or spreading. Capsules tricocous, often depressed, smooth or verruculose; seeds trigonous, orbicular or ovoid; albumen fleshy; cotyledons flat, broad.

Distribution. — Sri Lanka, NE. India to China and Malesia, about 60 species, 13 in Indian subcontinent.

Key to the species

- | | |
|--|--|
| 1a. Leaves clearly trinerved at base..... | 2 |
| 1b. Leaves solely penninerved | 5 |
| 2a. Leaves entire..... | 3 |
| 2b. Leaves shallowly denticulate or serrulate..... | 4 |
| 3a. Leaves large (8-16 × 1.5-4.5 cm), acuminate at apex; petioles 5-15 mm long; inflorescences unisexual; male inflorescence diffusely cymose; stamens 5, filaments almost free | |
| | 10. <i>T. praetervisus</i> |
| 3b. Leaves small (2.5-6.5 × 1-3 cm), acute at apex; petioles 2-6 mm long; inflorescences bisexual, almost racemiform; stamens 3, filaments connate | |
| | 13. <i>T. viridissimus</i> var. <i>confertifolius</i> |
| 4a. Leaves large (ca. 40 cm long), coriaceous; inflorescences unisexual; sepals dorsally gibbous | 2. <i>T. birmanicus</i> |
| 4b. Leaves small (up to 29 cm long), membranous to chartaceous; inflorescences bisexual; sepals not gibbous | 13. <i>T. viridissimus</i> |
| 5a. Female inflorescences with a few conspicuous foliaceous bracts; male inflorescences cauli- or ramiflorous, somewhat fasciculate; sepals dorsally gibbous; petals deep red or orange; secondary and tertiary nerves rather inconspicuous on upper surface of leaves | |
| | 1. <i>T. aurantiacus</i> |
| 5b. Female inflorescences without such foliaceous bracts | 6 |
| 6a. Inflorescences reduced, short (up to 3.5 cm long) | 7 |
| 6b. Inflorescences not reduced, much longer | 8 |
| 7a. Plants ochraceous or golden hirsute; petals dark reddish or black; styles 1.6-1.8 mm long; ovary (and capsule) glabrous..... | 5. <i>T. heterophyllus</i> |
| 7b. Plants weakly pubescent or glabrescent; petals deep purple; styles 1-1.5 mm long; ovary and capsules pubescent | 11. <i>T. semperflorens</i> |
| 8a. Lamina of leaves large (31-52 × 8-14 cm); lateral nerves 19-26 pairs; inflorescences bisexual, pseudoracemose, up to ca. 40 cm long..... | 7. <i>T. longifolius</i> |
| 8b. Lamina of leaves (excluding petiole) small (8-28 × 2.5-8.5 cm); lateral nerves 8-20 pairs; inflorescences mostly unisexual (often bisexual in <i>T. laetus</i>) | 9 |

- 9a. Leaves black and shiny above when dry; inflorescences (only males known) pyramidal-thyrsoïd; sepals dorsally gibbous; petals black-crimson **9. T. nigrifolius**
- 9b. Leaves not black and shiny above when dry; inflorescences (male or female) pseudo-racemose or racemiform or very narrowly thyrsoïd 10
- 10a. Female sepals fringed with conspicuous capitate glands **4. T. heteranthus**
- 10b. Female sepals without such capitate glands 11
- 11a. Leaves cuneate-attenuate at base; anthers sessile, with the cells separated from one another and partially embedded on somewhat triquetrous fleshy coherent connectives, forming a globose mass as a whole on the receptacle; sepals often conspicuously dorsally gibbous 12
- 11b. Leaves not attenuate at base; anthers not as above but subtended by a connate column of filaments; sepals not gibbous 13
- 12a. Leaves adaxially decurrent into petioles at base, green, greenish-yellow or greenish-brown above when dry; lateral nerves faint and tertiary nerves obscure on the upper surface; all sepals of a flower dorsally gibbous; petals unlobed; styles bifid or simple; fruiting pedicels up to 6 mm long **8. T. nemoralis**
- 12b. Leaves not decurrent into petioles at base, dark brown above when dry; lateral nerves prominent and tertiary nerves faint to prominent on the upper surface; 1-2 sepals (not all) of a flower dorsally gibbous; petals shallowly to deeply bilobed at apex; styles quad-rifid; fruiting pedicels 12-16 mm long **3. T. diplopetalus**
- 13a. Leaves acute to obtuse at base; tertiary nerves scalariform; petioles 1-6.5 cm long, gla-brous; female sepals 1.8-3.5 mm long, not accrescent in fruit **6. T. laetus**
- 13b. Leaves cuneate at base and narrowly rounded at extreme base; tertiary nerves reticulate; petioles (3-)5-20 mm long, sparsely pubescent; female sepals 4-6 mm long, somewhat accrescent in fruit **12. T. villosus var. nicobaricus**

1. Trigonostemon aurantiacus (Kurz ex Teijsm. & Binnend.) Boerl., Handl. Fl. Nederl. Ind. 1(2): 284 (1900); Pax & Hoffm. in Engler, Pflanzenr. IV. 147(iii): 93 (1911) & in Engler & Harms, Pflanzenfam. ed. 2, 19c: 170 (1931); Jablonsky in Brittonia 15: 164 (1963) in obs.; Airy Shaw in Kew Bull. 23: 126 (1969), 26: 345 (1972), 36: 352 (1981) & in Hook., Ic. Pl. 38: t. 3721 (1974); Whitmore, Tree Fl. Malaya 2: 136 (1973).

= *Tylosepalum aurantiacum* Kurz ex Teijsm. & Binnend. in Natuurk. Tijdschr. Nederl. Ind. 27: 50 (1964). **Type:** Malaya, from Bantam (? Banka), Cult. in hort. bot. Bogor., ante 1864, *Kurz 466* (HK), Acc. No. 411845 (CAL).

= *Codiaeum aurantiacum* (Kurz ex Teijsm. & Binnend.) Muell.-Arg. in DC., Prodr. 15(2): 1118 (1866).

= *Actephila aurantiaca* Ridley (pro sp. nov.) in Bull. Misc. Inf. Kew: 360 (1923) & Fl. Malay Penins. 3: 197 (1924). **Type:** Malaya, Kelantan, on the Kelantan river at Chaning, in woods on sandy soil, 5 Feb. 1917, *Ridley* s.n. (K).

= *Actephilopsis malayana* Ridley in Il.cc.: 361 (1924), 252 (1924). **Syntypes:** Malaya: Pa-hang, Kwala Tembeling, in Woods, 1891, *Ridley 2300* (K), Perak, Gunong Kerbau, 1909, Haniff (in Ridley) 16311 (? 1611) (K); Penang, Ayer Etan, at foot of hills, Feb. 1886, *Curtis 674* (K).

= *Trigonostemon malayanus* (Ridley) Airy Shaw in Kew Bull. 20: 413 (1966).

= *Trigonostemon aurantiacus* var. *rubriflorus* Balakr. & T. Chakrab. in J. Econ. Tax. Bot. 5: 169 (1984); T. Chakrab. in J. Econ. Tax. Bot. 6: 408 (1985). **Types:** India: Middle Andaman Is., Claudius range, 6.4.1916, *Parkinson 1171* (DD-Paratype). Havelock Is., 15.5.1974, *R. Ansari 1361A* (CAL-Holotype); *ibid.*, *R. Ansari 1361B-1361F* (PBL-Isotypes). South Andaman Is., Miletalak, 14.8.1976, *N. G. Nair 4285* (CAL, PBL-Paratypes).

Shurbs or trees, 1-10 m tall; branchlets greyish to dark brownish, 2-8 mm thick, terete, with numerous minute warts, angled and sparsely adpressed ochraceous-puberulous when young. Leaves elliptic, oblong-elliptic to obovate (often narrowly so) or crenate-oblongate, 7-32 cm long, 3-9 cm broad (often smaller on the flowering branchlets, being 4-12 × 1.5-5 cm), cuneate-attenuate or often acute, obtuse to rounded at base, repand-serrulate or -denticulate to subentire at margins, caudate or bluntly acuminate (cauda or acumen 5-30 mm long) or sometimes subacuminate at apex, firmly chartaceous to thinly coriaceous, pale brown to blackish-brown or blackish-grey or chocolate coloured above when dry, paler beneath, glabrous above, glabrous or often sparsely adpressed puberulous towards base beneath, penninerved; midrib flat or slightly raised above, raised beneath; lateral nerves slender, 7-14 pairs (first 2-3 pairs obscure) obscure to somewhat prominent above, faint to distinct beneath, arcuate or often somewhat straight, anastomosing or vanishing near margins, tertiary nerves obscure above, inconspicuous to faint beneath, laxly reticulate; petioles 2-3(-4) cm long, 1-4 mm thick, sparsely puberulous to glabrous, channelled above, with 2 setiform glandular appendages at apex on upper side (0.8-1.3 mm long); stipules minute or obsolete. *Male*: inflorescences cauli- or ramiflorous or often axillary (in the axils of fallen leaves), fasciculate, few-flowered, subtended by minute hairy bracts; pedicels slender, 6-12 mm long; sepals 5, orbicular, rounded at apex, 0.8-1.3 mm across, orange (when fresh), sparsely adpressed ochraceous-strigose to glabrous outside, dorsally gibbous; petals 5, subflabellate or spathulate-obovate, ca. 2 mm long, 1.3-2 mm broad, deep red or occasionally orange-red (when fresh), blackish-crimson when dry, often fimbriate at margins; disk glands 5, subreniform or obcordate or oblong, 0.4-0.6 mm long; stamens 3; column 1-1.5 mm long, very shortly trifid at apex; anthers ovoid or triangular-ovoid, 0.4-0.5 mm long, initially vertical, gradually becoming subhorizontal; connectives shortly produced. *Female*: inflorescences terminal, pseudo-racemose or very narrowly thyrsoid, few-flowered, (2-)9-60 cm long, 1-2.5 mm thick at base, angled or flattened, sparsely adpressed ochraceous-puberulous to glabrous; peduncles (0.5-)1.5-40 cm long; bracts foliaceous, sessile to subsessile, ovate, elliptic to oblong or narrowly so, 1-15 cm long, 0.2-6 cm broad, the upper bracts subulate, 4-7 mm long; pedicels 6-20 mm long, thickened upwards (1-1.5 mm thick at apex, 0.4-0.6 mm thick at base), sparsely puberulous to glabrous; sepals 5, broadly ovate, elliptic to orbicular 0.7-1 × 0.7-2 mm, sparsely adpressed ochraceous-puberulous to glabrous outside, dorsally gibbous; petals 5, elliptic to obovate-spathulate, 3.5-4 mm long, 2-2.5 mm broad, deep red inside, orange outside (when fresh), blackish-crimson when dry; disk glands 5, squarish or oblong, ca. 0.5 mm long, 0.4-0.8 mm diam.; ovary trigonous-globose, ca. 1 mm diam., glabrous; styles 3, 0.3-0.6 mm long, stout, slightly spreading; stigmas capitate. Capsules subglobose, tricocous, 10-12 mm diam., glabrous, smooth, blackish when dry; pedicels 2.5-4.5 cm long; seeds suborbicular, ca. 8 mm long, ca. 7 mm diam., blackish to brownish (Fig. 1).

Flowering and fruiting. — Mar.-Aug.

Specimens examined. — **India:** Andaman-Nicobar Is. South Andaman Is.: Dhanikhari, 5.3.1978, *P. Basu* 6651 (PBL); Miletalak, 14.8.1976, *N. G. Nair* 4282 (PBL). Little Andaman Is.: Hut Bay, 13.3.1975, *N. Bhargava* 2432 (PBL); deforestation site near village No. 2, 10.6.1976, *N. Bhargava* 3372 (PBL). Katchal Is.: Jula, 6.4.1979, *M. K. V. Rao* 7529 (PBL).

Distribution. — Andaman-Nicobar Is., ? Myanmar, Thailand, Malaya, Java, Sumatra.

Ecology. — Fairly common (rare in some localities) in inland primary forests (as second storey) or mixed forests or in scrubs on sandy, clayey or rocky loam or on hill slopes up to about 200 m altitude.

A variable species but unmistakable by the much abbreviated cauli- or ramiflorous, more or less fasciculate male inflorescences and the elongate, long-peduncled, few-flowered, pseudo-racemiform or narrowly thyrsoform female inflorescences with a few foliaceous bracts. AIRY SHAW (1969) has already pointed out that "the nearest affinity of *T. aurantiacus* within the genus is probably to be found with some other shallowly denticulate-leaved species, such as *T. serratus* Bl. (Java & Bali) and *T. moluccanus* Muell.-Arg. (S. Malaya and Anamba Is.). In neither of these, however, is the male inflorescence so reduced. In fact, only two more species in Indian subcontinent, *T. semperflorens* and *T. heterophyllus* have such equally reduced male inflorescences but the female

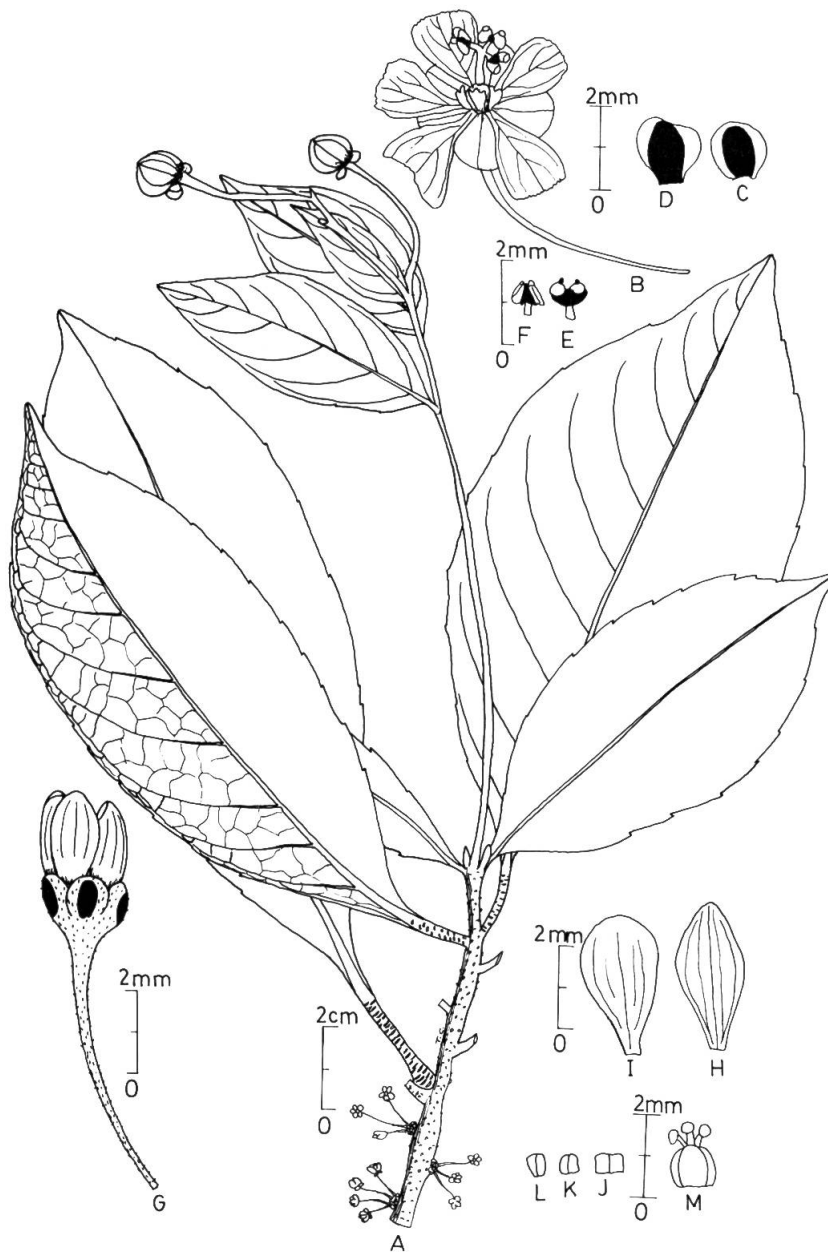


Fig. 1. — *Trigonostemon aurantiacus* (Kurz ex Teijsm. & Binnend.) Boerl.
A, twig with fruits and male inflorescences; **B**, male flower; **C-D**, male sepals; **E-F**, anthers; **G**, female flower; **H-I**, female petals;
J-L, disk glands; **M**, ovary [**A-F**: Ansari 1361 (PBL); **G-M**: Parkinson 1171 (DD)].

inflorescences in these species are also abbreviated, unlike *T. aurantiacus*. In addition, their leaves are entirely different and the sepals lack the dorsal gibbosity. The female inflorescences of *T. aurantiacus* may sometimes exhibit tendency towards reduction, being only about 2-9 cm long or even being fascicled on a very short (ca. 0.5 cm) peduncle and in such cases giving a superficial resemblance to *Actephila* Bl.

Examination of wider samples of the plant from the Andamans and Nicobars suggests that the supposed distinctions of var. *rubriflorus* Balakr. & T. Chakrab., i.e. the obscurely penninerved leaf-base, the red petals and the longer fruiting pedicels do not hold good.

A collector (*M. K. V. Rao 7529*) reports that the bark yields a red sap when cut.

2. *Trigonostemon birmanicus* T. Chakrab. & Balakr. in *J. Econ. Tax. Bot.* 5: 175 (1984). **Type:** Myanmar (Burma), Upper Chindwin dist. Numpakom drainage, 29.4.1911, collector's name uncertain (? Chin) 5849 (CAL-Holotype).

Evergreen trees, ca. 4.5 m tall; branchlets greyish, 4-7 mm thick, angled, glabrous. Leaves elliptic, ca. 40 cm long, ca. 10 cm broad, acute at base, distantly denticulate at margins, acuminate at apex, thinly coriaceous, glabrous, greenish when dry, trinerved at base; midrib flat above, raised beneath; lateral nerves (including basal pair) 7-8 pairs, prominent, arcuate, anastomosing near margins; tertiary nerves prominent, more or less at right angles to midrib, scalariform, simple or forked; nervules prominent; petioles ca. 7.5 cm long, 3-4 mm thick, quadrangular, glabrous; stipules not seen. *Male:* inflorescences (only fragments seen) in the axils of fallen leaves, thyrsoid, presumably elongate (lowermost branch ca. 11 cm long), dense-flowered, densely ochraceous-puberulous; bracts ovate-lanceolate to lanceolate, 1-2.5 mm long; pedicels 2-3 mm long, ca. 0.2 mm thick, glabrous to subglabrous; sepals 5, obovate to orbicular or oblong-elliptic, 1-2 mm long, 0.8-1.5 mm broad, scattered ochraceous-hirtellous outside, dorsally gibbous; petals 5, orange, orbicular-obovate to spatulate-obovate, 3.5-4 mm long, 2-3 mm broad; disk cupular, crenate, 0.6-0.8 mm long, 0.8-1 mm diam., often spreading towards apex; stamens 3; column ca. 2 mm long, ca. 0.2 mm thick, trifid at apex; anthers broadly oblong, 0.5-0.7 mm long, horizontal. Female inflorescences, flowers and fruits not seen (Fig. 2).

Flowering. — Apr.-May.

Specimens examined. — Type only.

Distribution. — Myanmar — Endemic.

Ecology. — In riverine evergreen forests on loamy soil, at about 400 m altitude.

The species was described on the basis of incomplete material consisting of a single leaf and a large fragment of detached male inflorescence. From this limited material, it appears that *T. birmanicus* is close to *T. quocensis* Gagnep. (Indo-China, Thailand) but distinct in the much stiffer texture of the leaves and orange male petals. As pointed out by CHAKRABARTY & BALAKRISHNAN (l.c.), a more accurate affinity could be suggested only when the female flowers and fruits are eventually discovered.

3. *Trigonostemon diplopetalus* Thw., *Enum. Pl. Zeyl.*: 277 (1861), 428 (1864); Muell.-Arg. in DC., *Prodr.* 15(2): 1108 (1866); Bedd., *For. Man.*: 212 (1873); Hook. f., *Fl. Brit. India* 5: 398 (1887); Trimen, *Handb. Fl. Ceylon* 4: 51, t. 83 (1898); Pax & Hoffm. in Engler, *Pflanzenr.* IV. 147(iii): 93, fig. 39 (1911). **Types:** Sri Lanka, Central Prov. Palahattoo, in the Reigam Corle, Sept. 1856, *Thwaites* CP 578, Acc. No. 411828 (CAL-Lectotype, here designated); *ibid.*, *Thwaites* CP 578 (CAL, K: photo!, G-DC: microfiche! Isolectotypes).

Shrubs or small trees, stature unknown; young shoots ochraceous-tomentellous; branchlets terete, 4-5 mm thick, glabrous. Leaves narrowly elliptic to elliptic-lanceolate or narrowly oblong-elliptic to oblong-lanceolate or oblanceolate, 10-25 cm long, 2-6 cm broad, cuneate-attenuate at base, glandular-serrulate at margins, acuminate (acumen 10-18 mm long, obtuse or acute) to subacuminate at apex, thinly chartaceous to membranaceous, glabrous, dark brown above when dry, pale to dark brown beneath, penninerved; midrib slightly raised above, prominently raised

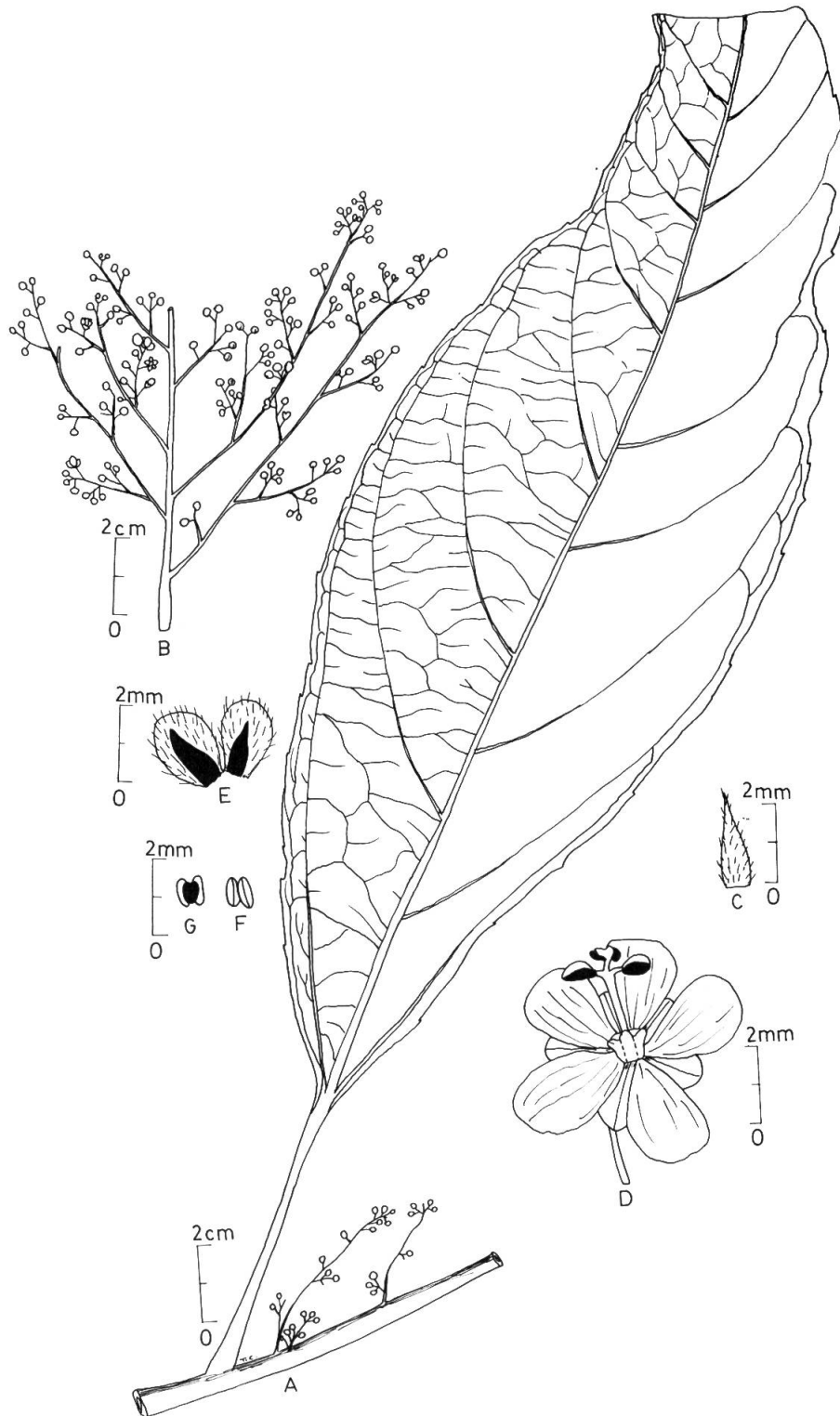


Fig. 2. — *Trigonostemon birmanicus* T. Chakrab. & Balakr.
A, twig; B, part of male inflorescence; C, bract; D, male flower; E, sepals; F-G, anthers (all from type).

beneath; lateral nerves 13-20 pairs, prominent, ascending, more or less straight, turning upwards and anastomosing near margins; tertiary nerves faint to prominent (on both surfaces), reticulate; petioles 5-15 mm long, 1.5-2 mm thick, glabrous or almost so, channelled above, bistipellate at apex (appendages glandular, setiform, pointed, up to 1 mm long). *Male*: inflorescences terminal, pseudo-racemose, up to about 17 cm long, ca. 2 mm thick at base, scattered ochraceous-puberulous, glabrescent towards base; bracts triangular, ca. 0.5 mm long; pedicels ca. 3 mm long, ca. 0.5 mm thick towards apex, ca. 0.2 mm thick towards base, scattered puberulous; sepals 5, unequal, suborbicular to orbicular-obovate or oblong, 1-3 mm long, 0.8-2 mm broad, often fimbriate towards apex, scattered adpressed ochraceous-puberulous outside; petals 5, obcordate, shallowly to deeply bilobed at apex, ca. 3 mm long, ca. 2 mm broad, fimbriate at margins, appearing black; disk glands 5, squarish, ca. 0.2 mm long, ca. 0.3 mm broad, coherent, forming a false cup; anthers 3, sessile, 2-celled; thecae separated from one another; connectives fleshy, somewhat triquetrous, coherent, connate towards base forming a short ca. 0.5 mm long stalk. *Female*: inflorescences racemiform, up to 10 cm long, scattered ochraceous-puberulous, becoming glabrescent; bracts triangular, ca. 0.5 mm long; pedicels 12-16 mm long, ca. 3.5 mm thick towards apex, ca. 1.5 mm thick towards base, sparsely puberulous; sepals 5, oblong, 5-5.5 mm long, 1.8-2.2 mm broad, scattered adpressed ochraceous-puberulous outside, often dorsally gibbous (gibbosity produced towards apex and horn-like); petals not seen (said to be as in male but larger and reflexed — vide Trimen, l.c.); ovary obovoid-globose, ca. 2.5 mm diam., 3-lobed, scattered adpressed ochraceous-puberulous; styles 3, ca. 1 mm long, stout, very shortly connate at base, quadrifid towards apex. Capsules slightly depressed, tricoccus, ca. 9 mm long, ca. 14 mm diam., scattered pubescent (Fig. 3).

Flowering and fruiting. — Sept., Mar.-May (teste Trimen, l.c.).

Specimens examined. — Sri Lanka, *Beddome* s.n. (MH).

Distribution. — Sri Lanka: endemic.

Ecology. — In forests of moist regions, up to about 300 m altitude.

Closely related to *T. nemoralis* but the leaves are not adaxially decurrent into petioles, dark brown when dry and the secondary and tertiary nerves more prominent on the upper surface, petals bilobed, styles quadrifid and the fruiting pedicels longer. The species is evidently rare and has apparently never been collected during the present century. The colour of petals is ascribed to be red or purple in literature. On the type material in herb. CAL however, the dried petals appear blackish. Trimen (l.c.) remarked that the flowers are often mixed, i.e. the inflorescences being sometimes bisexual, a feature to be observed also in *T. laetus*. The female sepals are sometimes dorsally gibbous (not all but 1-2 of a flower) while the male sepals lack the gibbosity, unlike *T. nemoralis*.

4. *Trigonostemon heteranthus* Wight, Ic. Pl. Ind. Or.: 24, t. 1890 (1852); Miq., Fl. Ind. Bat. 1(2): 379 (1859); Muell.-Arg. in DC., Prodr. 15(2): 1109 (1866); Kurz, For. Fl. Brit. Burma 2: 406 (1877); Hook. f., Fl. Brit. India 5: 396 (1887); Brandis, Indian Trees: 580 (1906); Pax & Hoffm. in Engler, Pflanzenr. IV. 147(iii): 91 (1911). **Types**: Burma, Mergui, no date, *Griffith K. D. 4796* (CAL: photo!).

Shrubs or trees, 1.5-5 m tall; young shoots densely adpressed ochraceous-puberulous; branchlets brownish, somewhat angled to terete, often striate, 3-4 mm thick, glabrous. Leaves elliptic, oblong-elliptic to oblong-lanceolate, 13-42 cm long, 3.5-8.5 cm broad, acute, obtuse to rounded at base, distantly glandular-crenulate or -serrulate to subentire at margins, caudate-acuminate (acumen 10-40 mm long) at apex, membranaceous, glabrous above, glabrous or often sparsely adpressed puberulous on major nerves beneath, chocolate-coloured or blackish-brown or dark reddish-brown above when dry, black-brown or pale brown beneath, penninerved; midrib flat above, raised beneath; lateral nerves 9-14 pairs, prominent, arcuate or sometimes somewhat straight, anastomosing near margins and forming loops with the superadjacents; tertiary nerves obscure to faint above, distinct beneath, reticulate or scalariform (mostly forked), often tending to branch into nerves of higher order; petioles 1-15.5 cm long, 1-3 mm thick, sparsely puberulous to glabrous, biglandular at apex; glands (or appendages) setiform, 1-2 mm long; stipules subulate, 1.5-2.5 mm long. *Male*: inflorescences subterminal, very narrowly thyriform, lax, up to ca. 17 cm long, 1-1.5 mm thick

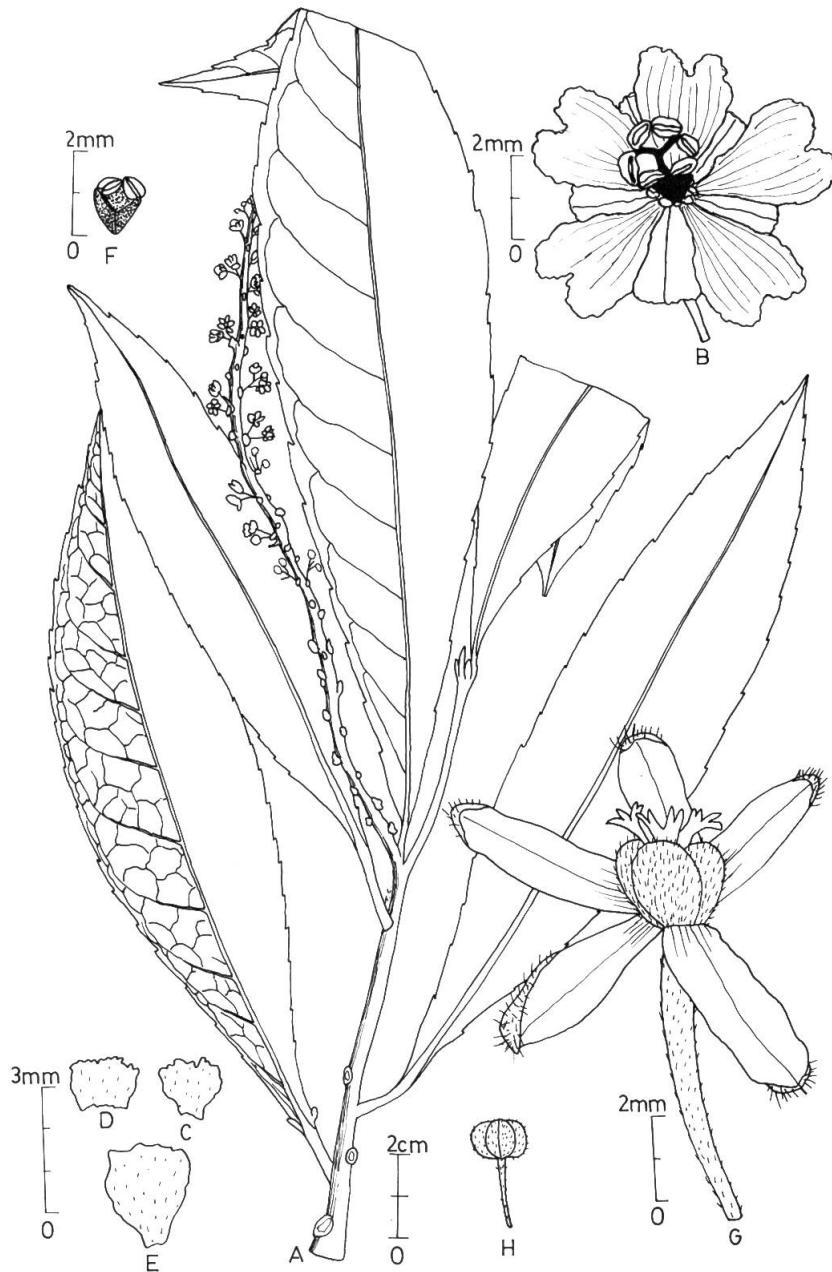


Fig. 3. — *Trigonostemon diplopetalus* Thw.
A, twig with male inflorescence; **B**, male flower; **C-E**, sepals; **F**, anther; **G**, female flower; **H**, fruit (all from type).

towards base, thinly yellowish- or whitish-pilose; bracts lanceolate to subulate, 1-3 mm long; pedicels 2-7 mm long, 0.2-0.5 mm thick, scattered strigose or pilose; sepals 5, unequal, ovate, elliptic, oblong or obovate, 1.2-2 mm long, 0.6-1.2 mm broad, scattered adpressed yellow strigose outside; petals 5, orbicular-obovate, ca. 2.6 × 2.5 mm, brownish-yellow or reddish-brown; disk glands 5, squarish or oblong, 0.5-1 × 0.5-0.8 mm; stamens 3; column ca. 1 mm long, stout (ca. 0.4 mm thick), not trifid at apex; anthers oblong to ellipsoid, 0.8-0.9 mm long, vertical to horizontal, dorsifixed. *Female*: inflorescences axillary or subterminal, pseudo-racemose, up to ca. 20 cm long, often pedunculate (3.5-5 cm long), thinly adpressed yellowish-pilose towards apex, glabrous towards base; bracts oblong-lanceolate, 3-10 mm long; bracteoles subulate, 1-1.8 mm long; pedicels 10-15 mm long, 1-3 mm thick towards apex, 0.5-1 mm thick towards base, minutely adpressed yellow-pubescent to glabrous; sepals 5, unequal, erect or spreading, suboblong to subelliptic or triangular-ovate to oblanceolate, 2-11 mm long, 1-5 mm broad, fringed with capitate glands, somewhat accrescent; marginal glands up to 2 mm long; petals 5, orbicular-obovate, ca. 2 mm long, 1.5-2 mm broad, brownish-yellow; disk glands 5, squarish or elliptic or obovate, ca. 0.5 mm long, 0.5-0.8 mm broad; ovary subglobose, 1-2.7 mm long, 1.2-3.7 mm diam., shallowly to deeply 3-lobed, glabrous; styles 3, 1-1.3 mm long, more or less free, bifid, spreading. Capsules not seen (said to be tricocous, ca. 12 mm long, crustaceous) (Fig. 4).

Flowering. — Jan.-Mar.

Specimens examined. — **Myanmar**. Mergui dist.: Sandawut reserve, Bondaung, 23.1.1919, C. G. Rogers 403 M (CAL, DD); Yanngwa range, 2.3.1927, R. N. Parker 2739 (DD). Tavoy distr.: Valley of Kyong Pyu Chaung, 29.1.1919, A. T. Gage 106 (19) (CAL).

Distribution. — Myanmar: endemic.

Ecology. — In forest undergrowths, from sea level up to about 400 m altitude; fairly common in Tavoy and Myanmar.

The thin, dark, long-petioled leaves and the conspicuous capitate glands of the female sepals are characteristic. The female sepals of *T. serratus* Bl. have marginal glandular teeth which are however not so much conspicuous. A collector (*Gage 106*) notes that the petals are pink coloured.

5. *Trigonostemon heterophyllus* Merr. in Lingnan Sci. J. 9: 38 (1930). **Types**: China Hainan, Taam Chan dist., Sha Po Sham, 30 May-June 1928, *Tsang, Wai-Tak 594* (? 17343) (CAL!, NY-n.v.). = *Trigonostemon sunirmalii* T. Chakrab. & Balakr. in J. Econ. Tax. Bot. 5: 179 (1984), syn. nov. **Types**: Myanmar: Tenasserim, Nimchaungm, 31.3.1930, *Biswas 22A* (CAL-Holotype); id., *Biswas 22B* (CAL-Isotype); Lepokechung, 11.2.1931, *Biswas 842* (CAL); Mergui, Cinchona camp, 21.3.1924, C. C. Calder s.n., Acc. No. 411835 (CAL).

Shrubs, stature unknown; all parts strongly ochraceous or golden hirsute; branchlets terete, 2.5-4 mm thick, glabrescent in age. Leaves alternate to pseudo-verticillate, often separated by bare internodes, cuneate-oblanceolate to subpanduriform or sometimes narrowly oblong-obovate to oblong-elliptic, 13-24 cm long, 2.5-7 cm broad, shortly cordate or often subtruncate at extreme base, subserrulate to subentire at margins, caudate at apex (cauda 5-20 mm long, acute), membranaceous, brown or blackish above when dry, paler beneath, penninerved, shortly and weakly trinerved at base; midrib flat above, raised beneath; lateral nerves slender, 9-13 pairs, prominent, usually arcuate, often almost straight, anastomosing near margins; tertiary nerves obscure to faint above, prominent beneath, scalariform; petioles 5-8 mm long, 1.5-2 mm thick; stipules linear, 5-7 mm long. *Male*: inflorescences axillary, also in the axils of fallen leaves, abbreviated, narrowly thyrsoid or the flowers crowded at the apex of a short peduncle (ca. 2 cm long); bracts oblong-lanceolate, 5-8 mm long, 1-1.5 mm broad; pedicels 2.5-3 mm long, ca. 0.2 mm thick; sepals 5, unequal, narrowly to broadly oblong, elliptic to ovate, 1.5-2 mm long, 0.6-1.5 mm broad, glabrous inside; petals 5, obovate to orbicular-obovate, 3-3.5 mm long, 2-2.5 mm broad, dark reddish; disk glands 5, linear with the apex bent outwards, 0.6-0.8 mm long; stamens 3; column 1.2-1.5 mm long, 0.2-0.3 mm thick, trifid at apex; anthers broadly oblong-ellipsoid, 0.6-0.9 mm long, initially vertical, finally horizontal; connectives splitting from apex into two lateral halves. *Female*: inflorescences axillary, also in the axils of fallen leaves, abbreviated, few-flowered with the flowers crowded on 3-5 mm long rachis

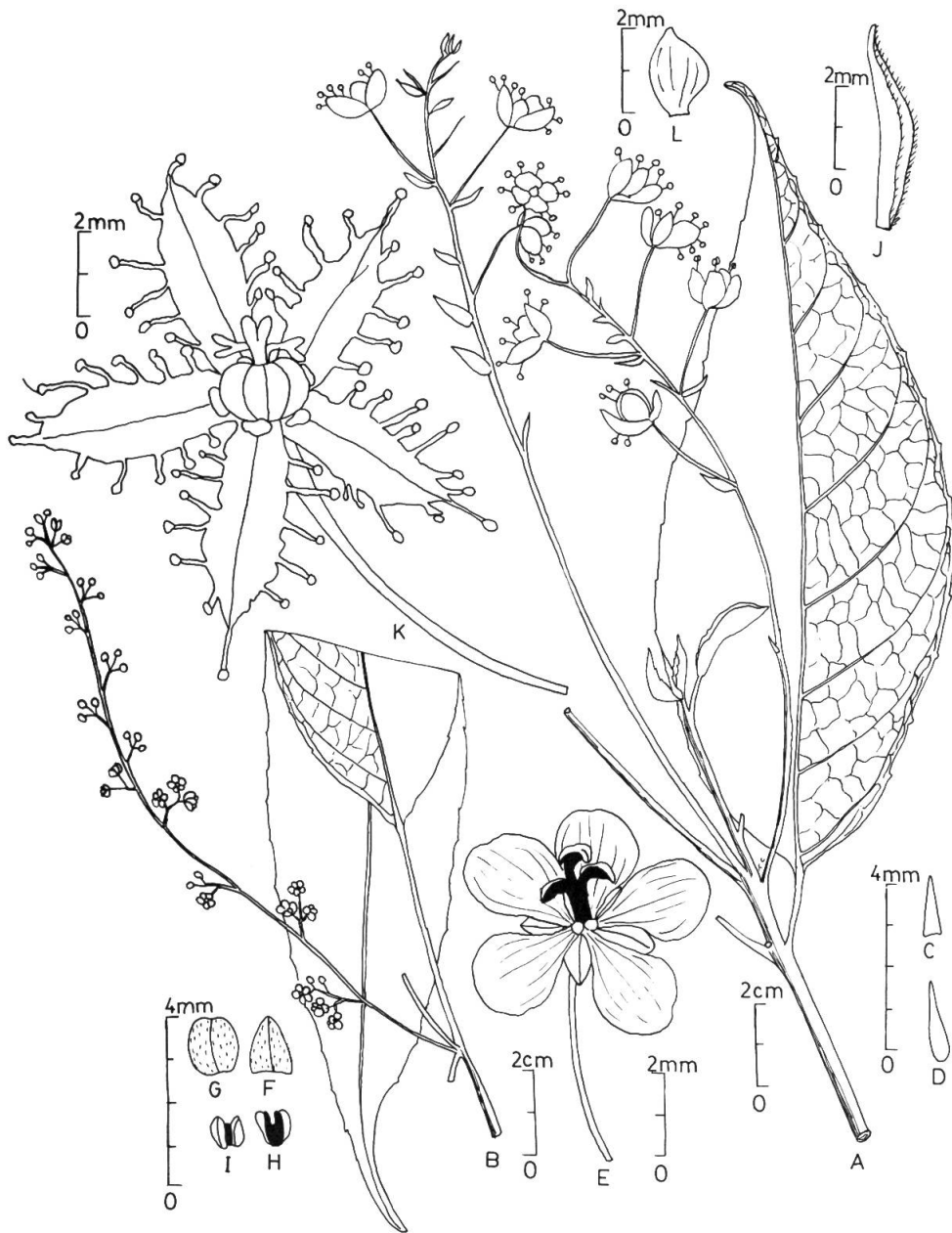


Fig. 4. — *Trigonostemon heteranthus* Wight

A, twig with female inflorescences; B, male inflorescence; C, stipule; D, male bract; E, male flower; F-G, sepals; H-I, anthers; J, female bract; K, female flower; L, petal [A, J-L: Parker 2739 (DD); B, C-I: Rogers 403 M (DD)].

at the apices of slender 5-15 mm long peduncles; bracts oblong-lanceolate to lanceolate, up to 17 mm long; pedicels 1-2 mm long, ca. 0.7 mm thick at apex, 0.2-0.3 mm thick at base; sepals 5, oblong, ovate, suborbicular or lanceolate, 1.5-2 mm long, 0.8-1.5 mm broad; petals 5 (only immature ones seen), orbicular-obovate, 1-1.3 mm long and broad, black or dark reddish; disk glands 5, squarish, coherent and forming a false cup, ca. 0.7 × 0.5-0.7 mm; ovary subglobose, ca. 0.8 mm long, 1-1.2 mm diam., deeply 3-lobed, glabrous; styles 3, 1.6-1.8 mm long, erect, connate below into a column (ca. 0.6 mm long), bifid above. Capsules not seen (Fig. 5).

Flowering. — Feb.-Mar.

Specimens examined. — Types only.

Distribution. — Myanmar and China (Hainan).

Ecology. — At about 60 m altitude; no further data available.

Related to *T. semperflorens* but with much stronger and denser pubescence, thyrsoid rather than fasciculate male inflorescences, dark reddish or blackish rather than purple petals, smaller female flowers and glabrous ovary and fruits.

Examination of type of *T. heterophyllus* in CAL (designated as isotype), though devoid of flowers, indicates that *T. sunirmalii* may represent a form of *T. heterophyllus* with more persistent and stronger indumentum, but does not seem to be a distinct species.

6. *Trigonostemon laetus* Baill., Et. Gen. Euphorb.: 341 (1858), excl. syn.; Muell.-Arg. in DC., Prodr. 15(2): 1109 (1866); Kurz, For. Fl. Brit. Burma 2: 407 (1877); Hook. f., Fl. Brit. India 5: 397 (1887); Brandis, Indian Trees: 580 (1906); Pax & Hoffm. in Engler, Pflanzenr. IV. 147(iii): 90 (1911). **Types:** Myanmar, Amherst, *Wallich 7740B* (CAL, K-WALL: microfiche! G-DC: microfiche!).

= *Croton laetus* Wall., Cat.: 7740B (1847), nom nud.

Shrubs or small trees, stature unknown; young shoots densely ochraceous-strigose; branchlets reddish-brown, terete, 2-5 mm thick, glabrous. Leaves narrowly elliptic to oblong-elliptic to oblong, 11-30 cm long, 2.5-7 cm broad, acute or often obtuse at base, distantly serrulate or often denticulate to subentire at margins, caudate (rarely acute) at apex (cauda 15-50 mm long), membranaceous to thinly chartaceous or occasionally thinly coriaceous, glabrous above, glabrous or sparsely adpressed-puberulous on major nerves beneath, remaining green or turning blackish-brown or dark reddish above when dry, pale greenish-brown beneath, penninerved; midrib flat above, raised beneath; lateral nerves 9-19 pairs, faint to prominent above, distinct beneath, somewhat arcuate, anastomosing near margins; tertiary nerves inconspicuous or faint above, distinct beneath, scalariform (simple or forked); petioles 1-6.5 cm long, 1-2 mm thick, glabrous, biglandular at apex. *Male:* inflorescences axillary, also in the axils of fallen leaves, pseudo-racemose, up to about 12 cm long, 1-1.5 mm thick towards base, scattered adpressed ochraceous-puberulous; bracts lanceolate, 1.8-3.5 mm long, puberulous; pedicels 1.8-2 mm long, ca. 0.5 mm thick, sparsely and minutely ochraceous-pubescent; sepals 5, obovate, orbicular to widely oblong, 1.2-2 mm long, 1-1.5 mm broad, sparsely and minutely ochraceous-pilose outside, shortly ciliate at margins, sometimes dorsally slightly gibbous; petals 5, orbicular-obovate or rhombate or spatulate, 2.5-2.8 mm long, 1.8-2.5 mm broad, blackish-crimson; disk glands 5, coherent and forming a false cup, obcordate to squarish, 0.4-0.6 × 0.5-0.7 mm; stamens 3, 2.5-3 mm long; column 2-2.5 mm long, very shortly trifid at apex; anthers oblong to ellipsoid, 0.8-1 mm long, vertical; connectives shortly produced, splitting from apex into two lateral halves. *Female:* inflorescences (often mixed) axillary, also in the axils of fallen leaves, racemiform, 10-16 cm long, 1.4-1.6 mm thick towards base, scattered ochraceous-puberulous to glabrescent; bracts lanceolate, 2-4 mm long, puberulous; flowers solitary at each node or often with another male flower; pedicels 3-10 mm long, 1.5-2 mm thick towards apex, 0.8-1 mm thick towards base, sparsely pilose; sepals 5, broadly ovate to triangular or oblong, 1.8-3.5 mm long, 1-2.5 mm broad, obtuse to rounded, sparsely adpressed ochraceous-pilose to glabrous outside, shortly ciliate at margins; petals 5, orbicular-spatulate to obovate, 3-3.5 mm long, 2.2-3.5 mm broad, blackish-crimson; disk glands 5, transversely oblong or obcordate, often bilobed, 0.5-0.8 × 0.6-1.2 mm;

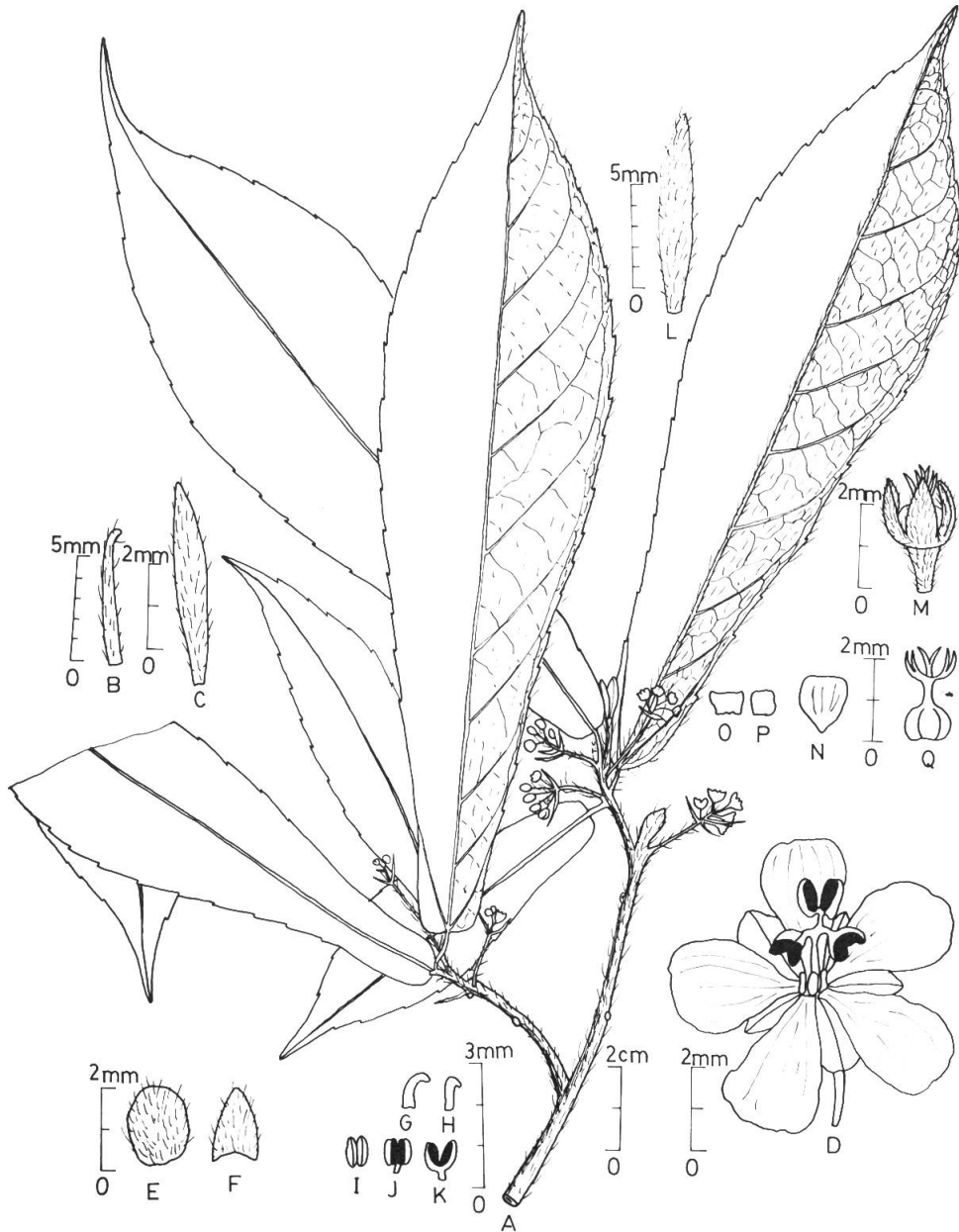


Fig. 5. — *Trigonostemon heterophyllus* Merr.

A, twig with male inflorescences; + B, stipule; C, male bract; D, male flower; E-F, sepals; G-H, disk glands; I-K, anthers; L, female bract; M, female flower; N, petal; O-P, disk glands; Q, ovary [A, L-Q: *Biswas 22* (CAL); B-K: *Calder s.n.* (CAL)].

ovary subglobose, 1.2-2 mm diam., densely (and evanescently) adpressed yellow- or whitish-pubescent; styles 3, erect, 1.2-1.5 mm long, bifid. Capsules not seen intact (said to be tricocous, depressed, 7-8 mm long, 10-12 mm diam., glabrous; seeds said to be subglobose, ca. 6 mm diam., marbled); persistent column 5-6 mm long; pedicels 8-15 mm long, 2-3 mm thick towards apex, 0.8-1.2 mm thick towards base, sparsely puberulous (Fig. 6).

Flowering and fruiting. — Feb.-April.

Specimens examined. — **Myanmar.** South Pegu dist., Sa Lw Res., 6.3.1926, *Ba Pe 2526* (DD). Amherst, 1.4.1849, *Falconer 841* (CAL).

Distribution. — Myanmar: endemic.

Ecology. — No data available.

Perhaps allied to *T. villosus* var. *nicobaricus* but leaves are acute to obtuse at base, tertiary nerves scalariform rather than reticulate, petioles relatively longer and glabrous and female sepals not accrescent in fruit.

7. ***Trigonostemon longifolius*** Baill., Et. Gen. Euphorb.: 341 (1858); Muell.-Arg. in DC., Prodr. 15(2): 1108 (1866); Kurz, For. Fl. Brit. Burma 2: 406 (1877); Hook. f., Fl. Brit. India 5: 396 (1877); Brandis, Indian Trees: 580 (1906); Pax & Hoffm. in Engler, Pflanzenr. IV. 147(iii): 88, fig. 28 (1911); Ridley, Fl. Malay Penins. 3: 264 (1924); Jablonsky in Brittonia 15: 162 (1963); Airy Shaw in Kew Bull. 26: 347 (1972) & 36: 355 (1981); Whitmore, Tree Fl. Malaya 2: 136 (1973). **Types:** Myanmar, *Wallich 7717* (G-DC: microfiche!, K-WALL: microfiche!).
- = *Croton longifolius* Wall., Cat.: 7717 (1847), nom. nud.
 - = ?*Athroisma serratum* Griff., Notulae 4: 477 (1854) & Icon. Pl. Asiat.: t. 535, fig. 9 (1854) (N.B. certe non *A. dentatum* Griff., l.c.: 478, t. 535, fig. 4, ut voluit Hook. f., non *Trigonostemon serratus* Bl. 1825-vide Airy Shaw, l.c.).
 - = *Pseudotrewia cuneifolia* Miq., Fl. Ind. Bat. Suppl. 183: 462 (1861). **Type:** Malaya, Palembang, near Batu-radja, n.v.
 - = *Trigonostemon sanguineus* Ridley in Bull. Misc. Inf. Kew: 80 (1926), non Gagnep., 1925. **Type:** Sumatra, Sipora Is., *C. Boden Kloss 14697* (SING), n.v.
 - = *Trigonostemon ridleyi* Merr. ex Jablonsky. in l.c.: 165 (1963), pro nom. nov. **Type:** same as *T. sanguineus*.

Shrubs or trees, 3-4 m tall; bark greyish-red; young shoots densely ochraceous-hirsute; branchlets angled to compressed, 5-7 mm thick, scattered ochraceous-pubescent, or hirsute. Leaves spatulate-oblongate, 32-55 cm long, 8-14 cm broad, cuneate-attenuate at base (decurent into petiole), subentire or obscurely glandular-serrulate at margins, acutely acuminate (acumen 10-25 mm long) at apex, rigidly membranaceous to firmly chartaceous, glabrous above (sometimes sparsely ochraceous-strigose on midrib), thinly pubescent (hirsute or pilose) beneath (particularly on nerves), sometimes sparsely hispid at margins, greenish-yellow or yellow when dry, penninerved; midrib flat above, raised beneath; lateral nerves slender, 19-26 pairs (first 4-5 pairs often obscure), prominent, more or less straight, turning upwards abruptly and anastomosing near margins; tertiary nerves faint above, faint to prominent beneath, scalariform; petioles 5-30 mm long, ca. 3 mm thick, ochraceous-hirsute. Inflorescences axillary or often extra-axillary, also borne in the axils of fallen leaves, bisexual, pseudo-racemose, up to ca. 40 cm long, 1.2-2 mm thick at base, ochraceous-tomentellous or -hirtellous; bracts subulate, 1-2 mm long, strongly puberulous. *Male:* pedicels 2-2.5 mm long, ca. 0.2 mm thick, sparsely yellow-pilose; sepals 5, ovate, broadly oblong-elliptic to orbicular, 1.5-2 mm long, 0.5-2 mm broad, yellow-hirtellous outside; petals 5, orbicular-obovate to spatulate, unguiculate, 4-5 mm long, 2-3.5 mm broad, often shallowly bilobed at apex, blackish-crimson; disk shortly cupular, 0.4-0.6 mm long, ca. 0.8 mm diam., entire to crenate, often bent outwards at apex; stamens 3; column ca. 1 mm long, very shortly trifid at apex; anthers orbicular to squarish, 0.6-1 mm long, initially vertical, finally horizontal; connectives shortly produced, horn-like and emarginate at apex, splitting from apex into two lateral halves. *Female:* pedicels ca. 1.5 mm long, ca. 1 mm thick, ochraceous-tomentellous to sparsely hirtellous; sepals 5, ovate or triangular, 1.8-2 mm long, 0.8-1 mm broad, acute or subobtuse, ochraceous-hirtellous outside; petals

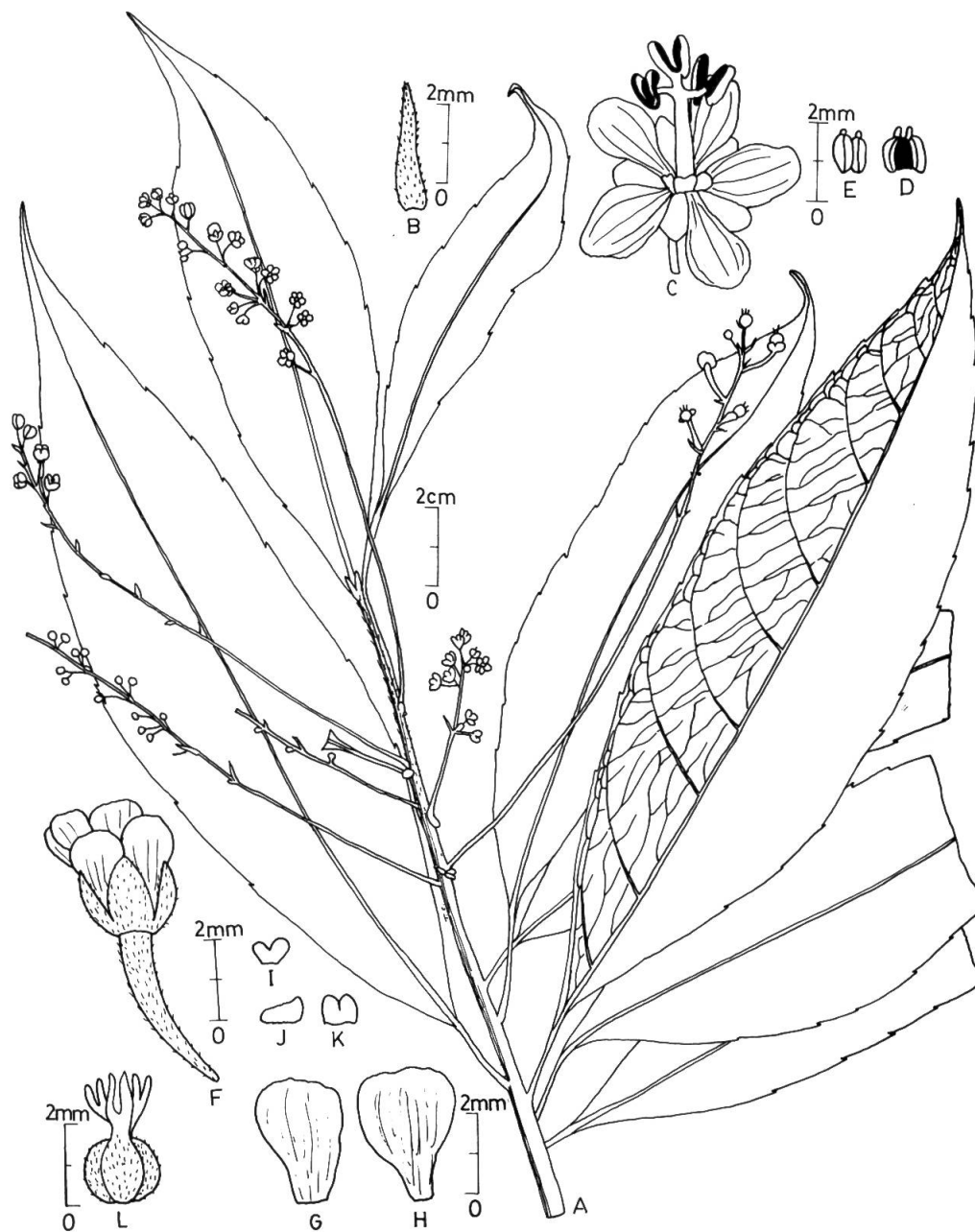


Fig. 6. — *Trigonostemon laetus* Baill.

A, twig with male and female inflorescences; B, bract; C, male flower; D-E, anther; F, female flower; G-H, petals; I-K, disk glands; L, ovary [all from Ba Pe 2526 (DD)].

deciduous, not seen; disk cupular-annular, ca. 0.5 mm high, crenate; ovary somewhat depressed, ca. 1 mm long, ca. 1.8 mm diam., strongly 3-lobed, densely ochraceous-hirsute; styles 3, 0.8-1.5 mm long, bifid; stigmas capitate. Capsules not seen (said to be depressed-globose, tricocous, 9-12 mm diam., ochraceous-tomentellous) (Fig. 7).

Flowering. — Dec.-Apr.

Specimens examined. — **Myanmar:** Tenasserim, sine loc. exact., no date, *Helper 4798* (CAL); Bawtrilaw, Salween, 26.3.1929, *Chin 6827* (DD). **Thailand:** Kapoh-Ban Kiap, 11.12.1917, *Md. Haniff 2717* (CAL).

Distribution. — Myanmar, Thailand, Malaya, Sumatra, Borneo.

Ecology. — In evergreen hill forests under shade on loamy soil, at about 600 m altitude.

Recognizable by the elongate, spathulate-oblongate penninerved leaves with cuneate-attenuate base, yellow or greenish-yellow when dry and the elongate, bisexual, pseudo-racemose inflorescences. *T. birmanicus* is the only other species in the area which has such big leaves but these are elliptic, coriaceous, trinerved and acute at base and with much fewer lateral nerves and the inflorescences are unisexual and thyrsoid (males).

8. *Trigonostemon nemoralis* Thw., Enum. Pl. Zeyl.: 277 (1861); Muell.-Arg. in DC., Prodr. 15(2): 1108 (1866); Bedd., For. Man.: 213 (1873) & Icon. Pl. Ind. Or.: 41, t. 182 (1874); Hook. f., Fl. Brit. India 5: 398 (1887); Trimen, Handb. Fl. Ceylon 4: 51 (1898); Brandis, Indian Trees: 580 (1906); Bourd., For. Trees Travancore: 504 (1908); Pax & Hoffm. in Engler, Pflanzenr. IV. 147(iii): 92 (1911); Gamble, Fl. Pres. Madras: 1341 (1925). **Types:** Sri Lanka, Central Prov., Madamahanewera, *Thwaites C. P. 3570*, Acc. No. 411830 (CAL-Lectotype, here designated); *ibid.*, *Thwaites C. P. 3570* (CAL-2 sheets, K: photo!-2 sheets, G-DC: microfiche!-2 sheets, NY-n.v.-Isolectotypes).

Shrubs or small trees, stature unknown; bark yellowish-grey, smooth (testibus Trimen, l.c.); young shoots ochraceous-sericeous; branchlets pale brownish, 2-4.5 mm thick, subterete, glabrous. Leaves crowded towards the apices of branches (alternate to subopposite or appearing verticillate), elliptic to oblong-elliptic or narrowly so or obovate-elliptic to narrowly cuneate-obovate, (5-)8-16(-20) cm long, (2-)3-5(-6) cm broad, cuneate-attenuate at base and adaxially decurrent into petioles, minutely glandular-denticulate or glandular-serrulate or often somewhat wavy at margins, acute-mucronate to acuminate (acumen acute or obtuse, 5-10 mm long) or obtuse (often rounded or subtruncate) at apex, membranaceous to subchartaceous, glabrous, remaining green or turning greenish-yellow to greenish-brown above when dry, pale brown or ochraceous beneath, penninerved; lateral nerves slender, 8-16 pairs, faint above, distinct beneath, arcuate or nearly straight, curving upwards and anastomosing near margins; tertiary nerves inconspicuous above, prominent beneath, reticulate; petioles (2-)4-10 mm long, 1.2-3 mm thick, channelled above, glabrous, bistipellate at apex (appendages glandular, subulate, up to 1 mm long); stipules subulate, 3-4 mm long, subpersistent. *Male:* inflorescences apparently unisexual and pseudo-racemose, up to ca. 18 cm long, scattered ochraceous-pubescent to glabrous; bracts triangular to lanceolate, 1-4 mm long, rigid, subpersistent; pedicels ca. 2 mm long, ca. 1 mm thick towards apex, 0.3-0.5 mm thick towards base, densely ochraceous-strigose; sepals 5, shortly connate, suborbicular to orbicular-obovate or oblong-elliptic, 1.5-2 mm long, 0.8-1.5 mm broad, rounded to obtuse, sparsely ochraceous-strigose outside, dorsally gibbous (gibbosity produced towards apex and horn-like); petals 5, ovate to oblong, 2-3 mm long, 1-1.5 mm broad, red, appearing black in dried condition; disk shortly cupular or of 5 distinct glands; anthers 3, 2-celled; cells partially embedded on the connectives and separated from one another; connectives fleshy, bilobed, somewhat triquetrous, coherent (forming a globose head as a whole), connate towards base forming a short stalk (ca. 0.5 mm long). *Female:* inflorescences terminal and axillary, racemiform (often reduced to a solitary flower?), up to ca. 9 cm long, scattered ochraceous-pubescent; bracts as in male; pedicels 2-6 mm long, 1.5-2.5 mm thick towards apex, 1-1.6 mm thick towards base, densely strigose or hirsute; sepals 5, unequal, ovate to oblong or narrowly so, 3-4 mm long, 1.8-3 mm broad, obtuse, scattered adpressed ochraceous-strigose outside, dorsally gibbous (gibbosity produced towards apex and horn-like); petals not seen; disk glands

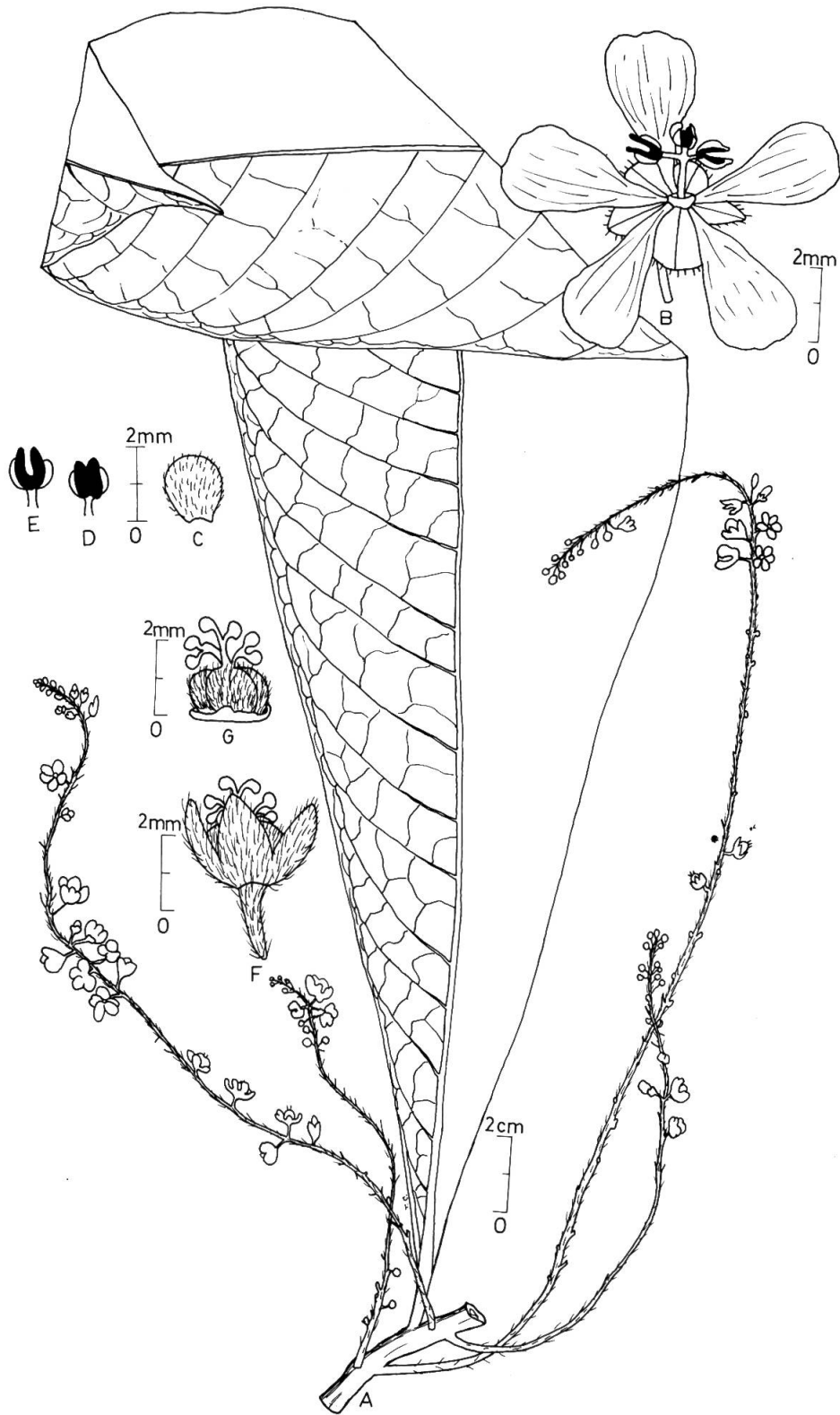


Fig. 7. — *Trigonostemon longifolius* Baill.
A, twig with inflorescences; B, male flower; C, sepal, D-E, anthers; F, female flower; G, ovary [all from *Chin 6827* (DD)].

5, free or connate in a ring and lobed; ovary subglobose, ca. 2 mm long, ca. 3 mm diam., 3-lobed, densely ochraceous-hirsute; styles 3, ca. 2 mm long, stout, simple or often shortly bifid, notched at apex, spreading or recurved. Capsules tricoccos, ca. 10 mm long, ca. 12 mm diam., verruculose, puberulous; seeds orbicular (subglobose), 6-7 × 6-7 mm (Fig. 8).

Flowering and fruiting. — Sept. (Feb.-June, vide Trimen, l.c.).

Specimens examined. — **India:** Tamil Nadu. Tirunelveli distr.: Tinnevely hills, Sept. 1874, *Beddome* s.n., Acc. No. 41183 (CAL); *ibid.*, *Beddome* s.n. (K: photo!); Ayencoil hills, Tinnevely, *Beddome* s.n. (MH). Kerala. Wynaad, *Beddome* s.n. (MH).

Distribution. — Endemic to Sri Lanka, S. Tamil Nadu and Kerala.

Ecology. — Sri Lanka: at about 600 m altitude. Tamil Nadu: in evergreen forests or often along riverbanks between 600-900 m altitude.

This extremely rare species with no recent collections is evidently close to *T. diplopetalus*, differing in the leaves being adaxially decurrent into petioles, remaining green or turning greenish-yellow or greyish-brown (rather than dark brown) when dry, the less prominent secondary and tertiary nerves on the upper surface of lamina, the unlobed petals, the simple or bifid styles and the relatively shorter fruiting pedicels.

9. *Trigonostemon nigrifolius* Balakr. & T. Chakrab. in J. Econ. Tax. Bot. 5: 173 (1984). **Types:** Myanmar, Mandalay, Maymyo dist., Gokteik viaduct, 16.5.1929, *Po Khaut 12434* (DD-Holotype).

Trees, ca. 6 m tall; branchlets deep reddish, angled, 4-5 mm thick, glabrous, sparsely adpressed ochraceous-puberulous when young. Leaves obovate-elliptic to elliptic or oblong-elliptic, 10-25 cm long, 3.5-8.5 cm broad, rounded, obtuse or subacute at base, very shallowly serrate at margins, acuminate at apex (acumen 10-15 mm long, acute), membranaceous-chartaceous, glabrous, glossy and black above (when dry), pale brown beneath, penninerved; lateral nerves slender, 9-11 pairs, somewhat prominent above, distinct beneath, more or less arcuate, anastomosing near margins, tertiary nerves inconspicuous above, faint beneath, scalariform, mostly branched; petioles 2-6 mm long, 1.5-2 mm thick, glabrous, biglandular at apex on upper side; glands circular, triangular or subulate (1-2 mm); stipules subulate, 1.5-2 mm long. *Male:* inflorescences terminal and axillary, pyramidal-thyrsoid, up to 30 cm long, dense-flowered, scattered adpressed ochraceous-puberulous; bracts subulate, 1.5-2 mm long; pedicels 2-4 mm long, 0.4-0.7 mm thick at apex, 0.2-0.3 mm thick at base, sparsely puberulous; sepals 5, orbicular-spathulate, obovate to obovate-oblong, 1.5-2 mm long, 1-2 mm broad, rounded at apex, sparsely adpressed ochraceous-puberulous to glabrous outside, dorsally gibbous; petals 5, obovate to orbicular-obovate, 3-3.5 mm long, 2-2.5 mm broad, blackish-crimson; disk glands 5, free or partially to entirely connate forming a cup; stamens 3; column 1-1.5 mm long, ca. 0.5 mm thick, stout; anthers broadly oblong to squarish, ca. 0.5 mm long, vertical, attached laterally (dorsifixed) to the tip of column; connectives shortly produced and horn-like with emarginate to rounded apex, gradually splitting into two lateral halves. Female inflorescences, flowers and fruits not seen (Fig. 9).

Flowering. — May.

Specimen examined. — Type only.

Distribution. — Myanmar: endemic.

Ecology. — No data available.

10. *Trigonostemon praetervisus* Airy Shaw in Kew Bull. 37: 121 (1982). **Types:** Bangladesh. Sylhet, no date, *Wallich 8001* (K-WALL: photo! Holotypus, specimenibus *Crotonis* in parte sinistra plagulae exclusis).

Shrubs or trees, stature unknown; branches terete, 2-4 mm thick; bark sulcate, grey; young parts pilose. Leaves oblong-elliptic, 8-16 × 1.5-4.5 cm, narrowly rounded and trinerved at base, acuminate with subacute tip at apex, entire and narrowly reflexed at margins, chartaceous, glabrous, smooth, greenish when dry; midrib slender, prominent on both sides; primary nerves (including

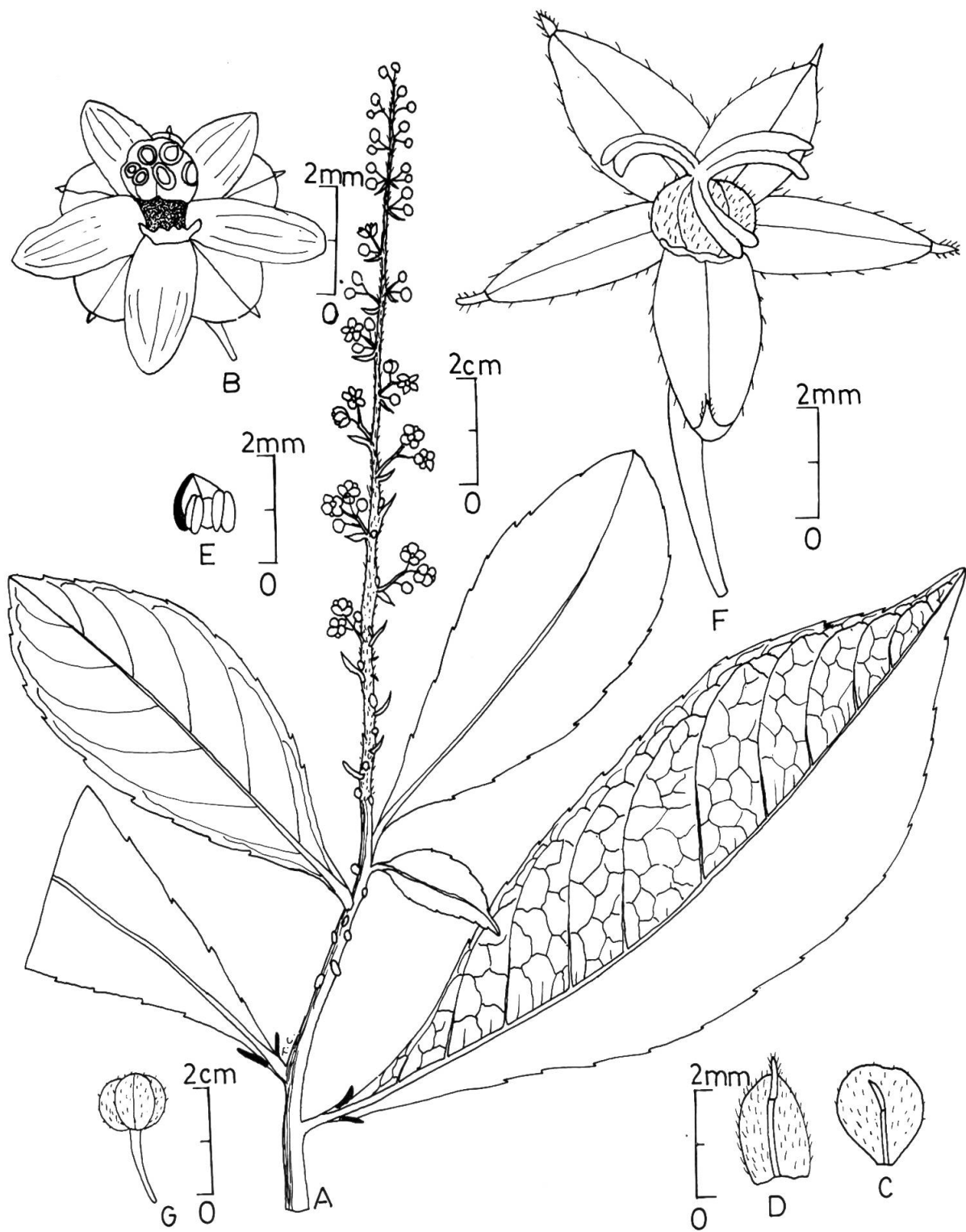


Fig. 8. — *Trigonosemon nemoralis* Thw.

A, twig with male inflorescence; B, male flower; C-D, sepals; E, anther; F, female flower; G, fruit [A, B-D: *Thwaites CP 3570* (CAL); F-G: *Beddome s.n.* (CAL)].

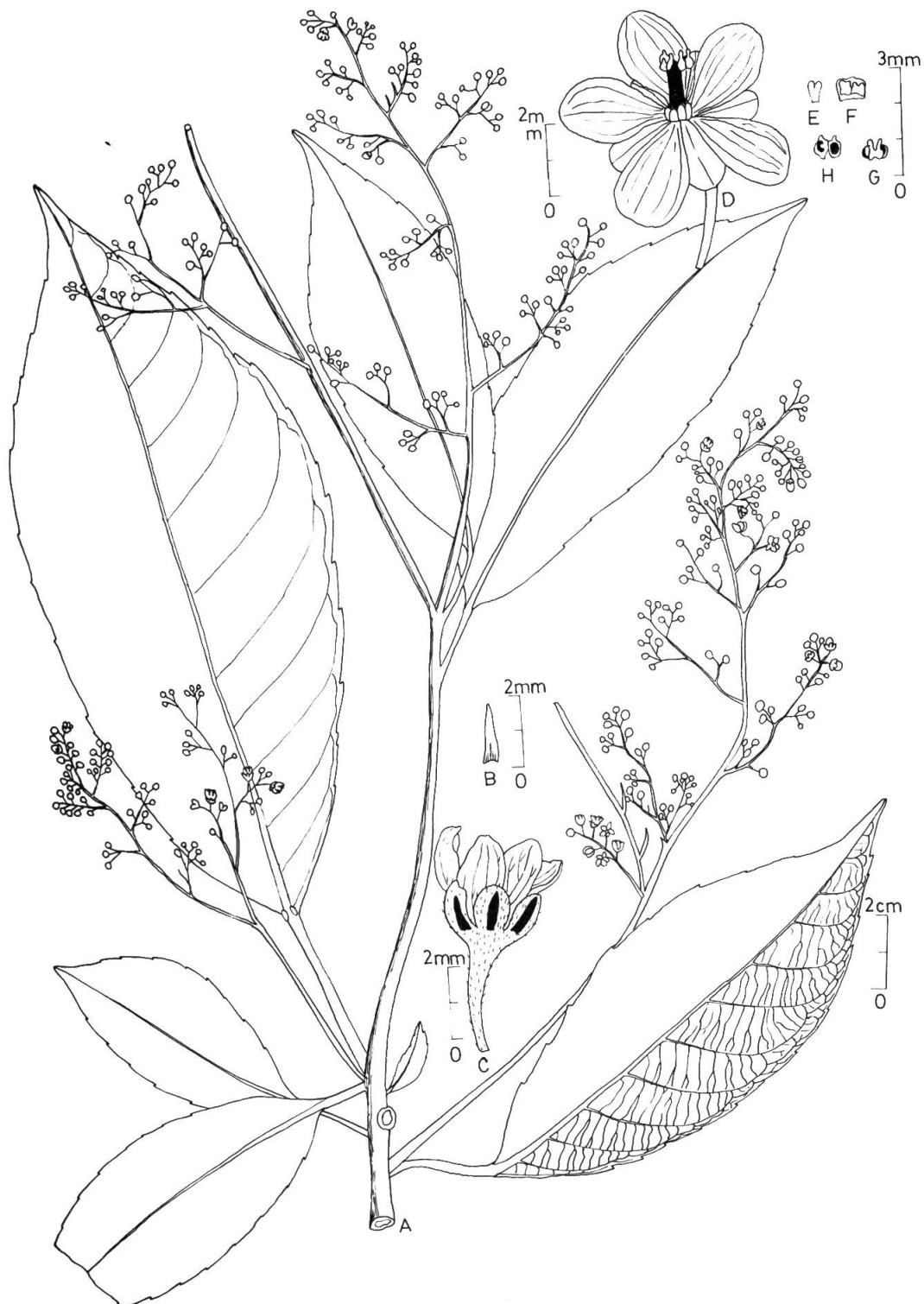


Fig. 9. — *Trigonostemon nigrifolius* Balakr. & T. Chakrab.
 A, twig with male inflorescences; B, stipule; C-D, male flowers; E-F, disk glands; G-H, anthers (all from type).

basal ascending ones) 6-7 pairs, slender, arcuate-patent; minor nerves inconspicuous, subtransverse; petioles 5-15 mm long, 1-2 mm thick, glabrous; stipules not seen. Inflorescence (only male ones seen) subtended by 2-4 leaves, with slender closely arranged divaricate branches; branchlets broadly spreading from each branch, each subtended by a linear-acute 2-3 mm long bract. Male flowers many, only buds seen, small, not yet opened, 1-2 mm long; pedicels 1-2 mm long, slender; sepals minute, ovate, scarcely 0.5 mm long, hyaline, pale, long pilose outside; petals ovate, 1-1.5 mm long, hyaline, pale, faded, contorted and hence bud apices subacute; disk annular, short; stamens 5, filaments short, nearly free. Female flowers and fruits not seen.

Flowering. — Period not known.

Specimen examined. — Photograph of type only.

Distribution. — Bangladesh and also NE. India (?) — Endemic.

As the type of this rare and extremely localized plant could not be examined, the above description is translated from the latin protologue. The type sheet, *Wallich 8001* is a mixed assemblage, containing another material, isolectotype of *Croton chlorocalyx* Muell.-Arg. (with denticulate penninerved leaves and bisexual racemose inflorescences). As already stated by AIRY SHAW (l.c.), *T. praetervisus* is perhaps somewhat isolated taxonomically, without any close relative and moreover in the absence of the female flowers "it is scarcely possible to give a satisfactory indication of the affinity of this plant". The short, diffusely cymose male inflorescence is unique while the basally trinerved leaves are to be found in *T. laevigatus* Muell.-Arg., *T. viridissimus* and *T. birmanicus*, none of which, however are close to *T. praetervisus*.

11. *Trigonostemon semperflorens* (Roxb.) Muell.-Arg. in DC., Prodr. 15(2): 1110 (1866); Hook. f., Fl. Brit. India 5: 397 (1887); Brandis, Indian Trees: 580 (1906); Pax & Hoffm. in Engler, Pflanzenr. IV. 147(iii): 90 (1911); Kanjilal & al., Fl. Assam 4: 196 (1940); Balakr., Fl. Jowai 2: 427 (1983).

- = *Cluytia semperflorens* Roxb., Fl. Ind. ed. 2, 3: 730 (1832); Voigt, Hort. Suburb. Calcutt.: 155 (1845). **Type:** "A native of Silhet", Roxburgh, Icon. No. 2401 (CAL-Iconotype).
- = *Silvaea semperflorens* (Roxb.) Hook. & Arnott, Bot. Beechy's Voy.: 211 (1836), in obs.
- = *Cluytia longifolia* Wall., Cat.: 7886 (1847), nom. nud.
- = *Agyneia tetrandra* Buch.-Ham. in Wall., Cat.: 7951 (1847), nom. nud.
- = *Agyneia ciliata* Buch.-Ham. in Wall., Cat.: 7951A (1847), nom. nud.
- = *Silvaea hookeriana* Baill., Et. Gen. Euphorb.: 342 (1858). **Syntypes:** Roxburgh, Icon. No. 2401 (CAL-Iconotype); India, Assam, "Dongtola et Birjura", no date, Hamilton (in Wallich) 7951 (CAL, K-WALL: microfiche!).
- = *Trigonostemon hookerianus* (Baill.) Muell.-Arg. l.c.: 1109 (1866).

Shrubs (often bushy) or trees, 1.5-5 m tall; bark greyish-brown, thin, splitting vertically; young shoots densely ochraceous-hirsute; branchlets brown or blackish, 2-4 mm thick, initially angled and straight, finally terete, scattered ochraceous-pilose or hirsute, glabrous in age. Leaves crowded towards tips of branches, alternate and very often pseudo-verticillate and separated by bare internodes, narrowly obovate to cuneate-oblongate or panduriform or sometimes elliptic, (6-)10-30 cm long, (2-)3-8 cm broad, narrowly cordate (often rounded) at extreme base, shallowly serrulate to subentire at margins, caudate-acuminate at apex (acumen 10-30 mm long, acute), membranaceous to chartaceous, glabrous (often with a few harsh hairs on midrib) above, sparsely ochraceous-hirsute or -pilose (on major nerves) to glabrous beneath, sometimes ciliate at margins, dark reddish or blackish-brown above when dry, coppery or pale brown beneath, penninerved; midrib flat above, raised beneath; lateral nerves slender, 9-20 pairs, faint to prominent above, distinct beneath, arcuate, anastomosing near the margins, forming loops with the superadjacents; tertiary nerves inconspicuous to faint above, faint to prominent beneath, mostly forked; petioles 1-8 mm long, 1.5-3 mm thick, scattered ochraceous-hirsute to glabrous. *Male:* Inflorescences axillary (mostly in the axils of fallen leaves) or cauliflorous (!), glomerate-fasciculate; flowers not seen (said to have short pedicels, 5 sepals, 5 deep purple petals, 5 free disk glands and 3 stamens with connate filaments). *Female:* Inflorescences axillary, also in the axils of fallen leaves, abbreviated, subfasciculate to solitary or

racemiform cymes (up to 3.5 cm long, rachis up to 12 mm long), pedunculate (peduncle up to 2 cm long) or sessile; bracts narrowly oblong or subulate or lanceolate, 3-13 mm long, 0.5-3 mm broad; pedicels 2-5 mm long, 1-3 mm thick towards apex, 0.5-1.3 mm thick towards base, sparsely yellow-pilose or -hirsute; sepals 5, often unequal, elliptic, oblong, ovate or triangular, 3.5-8 mm long, 1-3 mm broad, acute to obtuse, sparsely adpressed puberulous to glabrous outside, often ciliate at margins; petals 5, spatulate-obovate to spatulate-elliptic, 3-4 mm long, 1.8-3 mm broad, deep purple; disk glands 5, squarish, 0.5-0.7 × 0.4-0.5 mm; ovary subglobose, depressed, 1.5-2 mm long, 2-3 mm diam., fulvous- or ochraceous-tomentose or densely hirsute, styles 3, 1-1.5 mm long, erect, bifid to base. Capsules subglobose, tricocous, 9-12 mm long, 13-15 mm diam., softly adpressed pilose or ochraceous-hirsute; seeds suborbicular, ca. 7 mm long, ca. 6.3 mm diam., trigonous, marbled (Fig. 10).

Flowering and fruiting. — Apr.-May; Nov.-Jan. (perhaps round the year).

Local names. — Khasi: Dieng-soh-pyda, Diang-soh-kot.

Specimens examined. — Hort. Bot. Calcuttensi, no date, *Wallich 7886* (CAL, K-WALL: Microfiche!); *ibid.*, no date, *Griffith s.n.*, Acc. No. 411789 — lower specimen (CAL). **India.** Assam. dist. not known: Dongtola et Birjuga, no date, *Hamilton* (in Wallich) 7951 (CAL, K-Wall: Microfiche!). Cachar dist.: Sonai reserve, 4 Dec. 1914, *U.N. Kanjilal 4820* (DD). Goalpara dist.: Goalpara, *Hamilton* (in Wallich) 7952A (CAL, K-Wall: Microfiche!). Meghalaya. Khasi hills dist.: Isamati, 21 Nov. 1915, *U. N. Kanjilal 6248* (DD); Cherrapunji, Oct. 1878, *Geo. Gallatly 686* (CAL). Garo hills dist.: Tura top, 1 May 1961, *Panigraphi 24131* (CAL). **Bangladesh.** Sylhet, no date, *Wallich 8004* (G-DC: Microfiche!, K-Wall: Microfiche!); *ibid.*, no date, *J. D. Hooker s.n.*, Acc. No. 411788 (CAL).

Distribution. — NE. India and Bangladesh (Sylhet) — Endemic.

Ecology. — In primary forests between 150-1550 m altitude.

- 12. *Trigonostemon villosus*** Hook. f., *Fl. Brit. India* 5: 397 (1887); Airy Shaw in *Kew Bull. Add. Ser. IV*: 205 (1975), var. ***nicobaricus*** (T. Chakrab.) Balakr. & T. Chakrab., **comb. & stat nov.** = *Trigonostemon nicobaricus* T. Chakrab. in *J. Econ. Tax. Bot.* 5: 203 (1984). **Types:** India, Great Nicobar Island, 9 km on east-west road, 6 May 1981, *R. P. Dwivedi 8521A* (CAL-Holotype); *ibid.*, *R. P. Dwivedi 8521B-E* (PBL-Isotypes).

Trees, 5-7 m tall; branchlets brownish, terete, 2-5 m thick, glabrous, scattered yellowish-puberulous when young, becoming glabrescent. Leaves cuneate-oblongate or sometimes narrowly oblong-obovate to elliptic, 12-30 cm long, 3-7 cm broad, narrowly rounded at base, serrulate at margins, caudate-acuminate (acumen 10-25 mm long, acute) at apex, thinly chartaceous, glabrous above, scattered yellowish-puberulous on major nerves beneath, dark brown or black-brown above when dry, penninerved; lateral nerves slender, 10-16 pairs, faint above, distinct beneath, more or less arcuate, anastomosing near margins; tertiary nerves indistinct above, prominent beneath, reticulate; petioles (3-)5-20 mm long, 2-3 mm thick, channelled above, sparsely yellowish-puberulous; stipules triangular-acuminate, ca. 1 mm long. *Male:* Inflorescences axillary, slender, pseudo-racemose, 5-13 cm long, scattered yellowish-puberulous; pedicels 2-5 mm long, 0.4-0.7 mm thick at apex, 0.1-0.3 mm thick at base, softly scattered yellowish-puberulous; sepals 5, narrowly to broadly oblong or often triangular, 1-1.5 mm long, 0.7-1.2 mm broad, acute, obtuse to rounded at apex, scattered yellowish-puberulous outside, shortly ciliate at margins; petals 5, spatulate-obovate, ca. 2.5 mm long, 1.2-1.5 mm broad, blackish-crimson, sparsely pilose to glabrous outside, minutely whitish-pilose at margins; disk glands 5, obcordate or deltoid or obovate-oblong, ca. 0.5 × 0.4-0.5 mm, coherent, forming a false cup; stamens 3; column 1-1.3 mm long, very shortly trifid at apex; anthers ellipsoid to orbicular, 0.6-0.7 mm long, initially vertical, finally horizontal. *Female:* Inflorescences axillary, slender, racemiform, 6-10 cm long, scattered and adpressed yellowish-puberulous; rachis 0.5-0.7 mm thick at base; bracts linear, 2.5-5 mm long, 0.5-1 mm broad; pedicels 3.5-4 mm long, ca. 1 mm thick at apex, ca. 0.5 mm thick at base, yellowish-tomentellous; sepals 5, unequal, ovate-lanceolate to lanceolate or ovate-elliptic, 4-6 mm long, 1.5-2 mm broad, acute to shortly acuminate, softly scattered yellow-puberulous outside, often subdenticulate at margins,

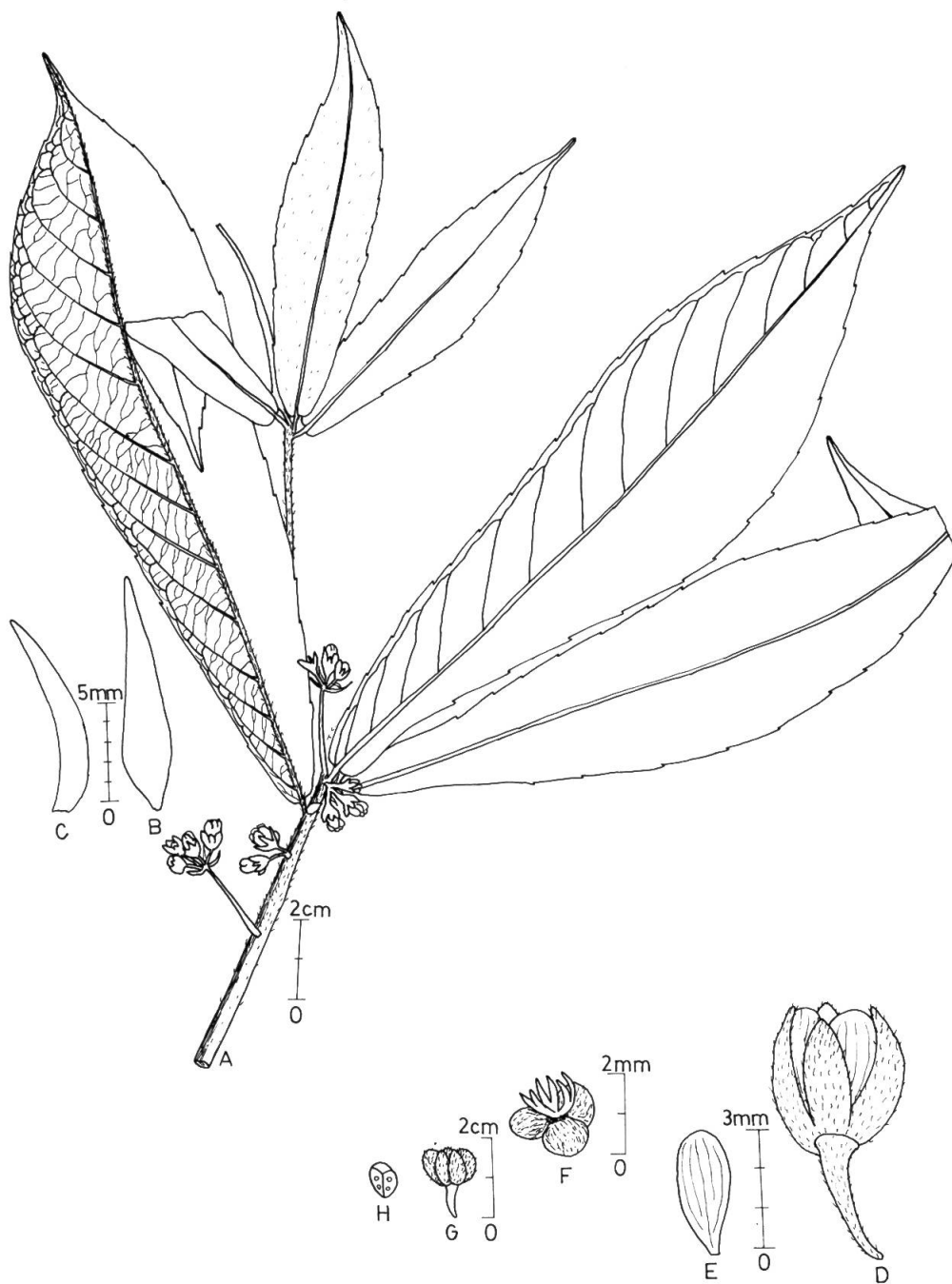


Fig. 10. — *Trigonostemon semperflorens* (Roxb.) Muell.-Arg.
 A, twig with female inflorescences; B-C, bracts; D, female flower; E, petal; F, ovary; G, fruit; H, seed [A-F: Panigrahi 24131 (CAL); G-H: Kanjilal 6248 (CAL)].

accrescent (presumably); petals 5, oblong-elliptic, ca. 2 mm long, 1-1.2 mm broad (immature), blackish-crimson, sparsely and shortly pilose outside; disk glands 5, squarish, ca. 0.5 × 0.5 mm; ovary globose, 3-lobed, ca. 1 mm diam., coarsely and densely yellow-villous; styles 3, ca. 0.8 mm long (immature), bifid, erect. Capsules not seen (Fig. 11).

Flowering. — Apr.-May.

Specimens examined. — Types only.

Distribution. — Great Nicobar Island — Endemic.

Ecology. — Rare in primary hill forests at low altitudes.

Examination of the material of typical *T. villosus* shows that *T. nicobaricus* differs from it only in the much sparser pubescence and smaller linear bracts. These differences are obviously not sufficient for recognizing *T. nicobaricus* as a distinct species and therefore reduced herein to a variety of *T. villosus*, which is a moderately variable species, hitherto known to occur in Malaya, Sumatra and Borneo.

13. **Trigonostemon viridissimus** (Kurz) Airy Shaw in Kew Bull. 25: 545 (1971) and 36: 358 (1981), 37: 36 (1982) and in Kew Bull. Add. Ser. IV: 205 (1975); Whitmore, Tree Fl. Malaya 2: 135 (1973).
- = *Sabia viridissima* Kurz in J. As. Soc. Bengal 41: 304 (1872) and For. Fl. Brit. Burma 1: 341 (1877); Hook. f., Fl. Brit. India 2: 3 (1876). **Types:** India, South Andaman Islands: Port Blair, no date, *Kurz s.n.*, Acc. No. 97543 (CAL-Lectotype); Port Mout, no date, *Kurz s.n.* (CAL, K: photo! - Syntypes).
 - = *Blachia viridissima* (Kurz) King in J. As. Soc. Bengal 65: 455 (1896), in obs.
 - = *Trigonostemon ovalifolius* J. J. Sm. in Koord. & Valet. Bijdr. No. 12. Booms. Java, in Meded. Dep. Landb. 10: 583 (1910); Pax & Hoffm. in Engler, Pflanzenr. IV. 147(v): 286 (1912); Backer & Bakh. f., Fl. Java 1: 495 (1963). **Type:** n.v.
 - = *T. membranaceous* Pax & Hoffm. in Engler, Pflanzenr. IV. 147(iii): 91 (1911) et ibid. v: 286 (1912). **Type:** Java, Djapara, *Koorders 32989B* — n.v.
 - = *T. macgregorii* Merr. in Philipp. J. Sci. 16: 566 (1920) et Enum. Philipp. Fl. Pl. 2: 452 (1923). **Types:** Philippines: Antique Prov., Panay, Culasi, 300 m, 3 June 1918, *Mac Gregor 32424* — n.v. (Holotype). Laguna Prov., Luzon, vicinity of Paeta, June 1915, *Mac Gregor 26228* — n.v. (Paratype).
 - = *Neotrigonostemon diversifolius* Pax & Hoffm. in Notizbl. Bot. Gart. Berlin 10: 385 (1928) et in Engler & Harms, Pflanzenfam. ed. 2, 19c: 169 (1931). **Types:** Myanmar (Burma), Mergui, Ngawan reserve, 13 Feb. 1927, *R. N. Parker 2593* (K: photo!).
 - = *Trigonostemon sumatranus* Pax & Hoffm. in Engler, Pflanzenr. IV. 147(iii): 90 (1911); Jabl. in Brittonia 15: 163 (1963); Stern in Amer. J. Bot. 54: 671 (1967); Whitmore, Tree Fl. Malaya 2: 135 (1973); Airy Shaw in Kew Bull. Add. Ser. IV: 204 (1975). **Type:** Sumatra, *Forbes 2647* — n.v.
 - = *Kurziodendron viridissimus* (Kurz) Balakr. in Bull. Bot. Surv. India 8: 68, figs. 1-7 (1966).

Key to the varieties

- 1a. Leaves small, on the average 2.5-6.5 × 1-3 cm, entire, acute to obtuse at apex; petioles short, 2-6 mm long; inflorescence short, 0.5-1 cm long, racemiform
13.3 var. **confertifolius**
- 1b. Leaves larger, on the average up to 29 cm long, serrulate or denticulate, caudate or acuminate at apex; petioles longer; inflorescence longer, mostly thyrsoid 2
- 2a. Filaments almost free 13.2 var. **chatterjii**
- 2b. Filaments connate 13.1 var. **viridissimus**

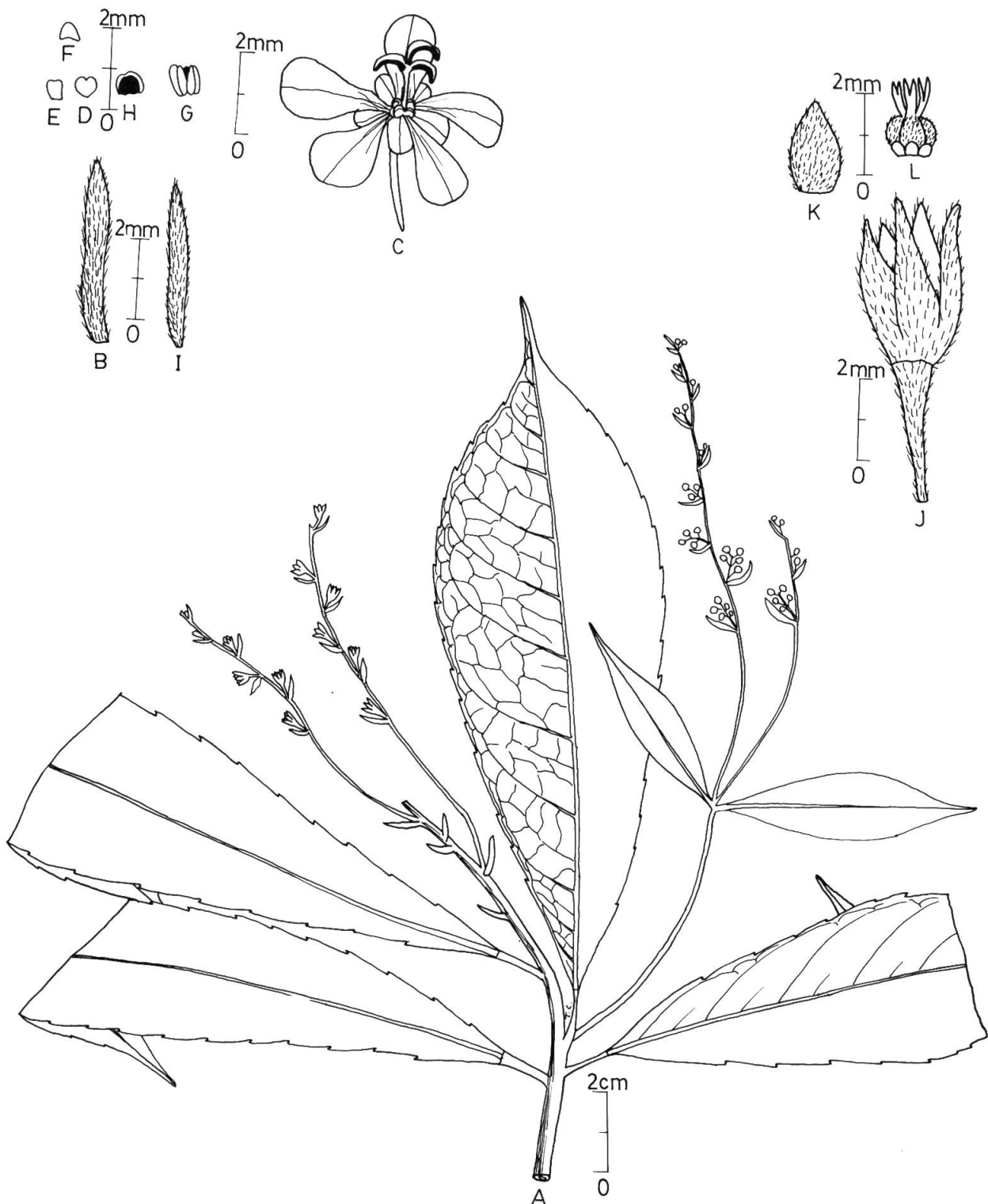


Fig. 11. — *Trigonostemon villosus* Hook. f. var. *nicobaricus* (T. Chakrab.) Balakr. & T. Chakrab.
 A, twig with inflorescences; B, male bract; C, male flower; D-F, disk glands; G-H, anthers; I, female bract; J, female flower;
 K, petal; L, ovary (all from type).

13.1 var. viridissimus

Shrubs or small trees, 1-4 m tall; young shoots densely and coarsely ochraceous-puberulous; branchlets dark brown to greyish, 1.2-6 mm thick, terete, glabrous, striate when young. Leaves crowded towards ends of branches, elliptic (or elliptic-lanceolate) to oblong, obovate to oblanceolate, (4-)10-29 cm long, 1.5-9 cm broad, acute or cuneate or obtuse to rounded at base, distantly serrulate or shallowly denticulate to subentire at margins, acuminate to caudate at apex (acumen or cauda 5-40 mm long, acute), membranaceous to thinly chartaceous or occasionally firmly chartaceous, glabrous above, glabrous or sometimes sparsely ochraceous-puberulous beneath, green or yellow or ochraceous above when dry, pinkish-brown or greenish or ochraceous beneath, trinerved at base; midrib flat above, raised beneath; lateral primary nerves opposite, ascending for about halfway up the lamina; lateral nerves 3-10 pairs, prominent, arcuate, joining the superadjacents forming a series of loops; tertiary nerves obscure to prominent above, faint to distinct beneath, scalariform; petioles 0.3-4.5 cm long, 1-2.5 mm thick, shallowly channelled or sulcate above, often sparsely puberulous; stipules subulate, ca. 1 mm long, caducous. Inflorescences terminal and axillary, bisexual, usually laxly pyramidal-thyrsoid or sometimes tending towards dichasial branching or even almost racemiform (pseudo-racemose), 2.5-12 cm long, often pedunculate, sparsely ochraceous-puberulous to glabrous; male flowers numerous, female flowers fewer and terminating the branches; bracts subulate to ovate, 0.5-1.5 mm long. *Male*: Pedicels 5-18 mm long, filiform, scattered adpressed fulvous-puberulous to glabrous; sepals 5, elliptic, oblong, ovate to suborbicular, 0.8-2 mm long, 0.6-1.2 mm broad, rounded or notched at apex, glabrous or often densely ochraceous-puberulous; petals 5, orbicular-obovate to spatulate or sometimes elliptic-oblong, 3-7 mm long, 1.5-4 mm broad, rounded or emarginate or slightly bilobed at apex, yellow or orange-yellow; disk cupular or often campanulate, crenate, 0.5-0.9 × 0.5-1.2 mm; stamens 3(-4); column 1-2.6 mm long, trifid at apex; anthers widely ellipsoid to oblong, 0.5-0.8 mm long, initially vertical, finally horizontal. *Female*: Pedicels 6-30 mm long, tapering downwards (1-2 mm thick at apex, 0.4-1 mm thick at base), sparsely puberulous to glabrous; sepals 5, free, ovate to suborbicular or triangular-oblong, 1-2.5 mm long, 0.8-2 mm broad, acute or rounded or notched at apex, sparsely ochraceous-puberulous outside; petals 5, obovate, orbicular-obovate or spatulate, 4-5 mm long, 3-3.5 mm broad, rounded or emarginate at apex, yellow; disk shortly cupular, crenate, orange-brown, 0.6-1 × 1.5-1.8 mm; ovary globose or ovoid, 1-2 mm diam., glabrous; styles 3, 1-2 mm long, often shortly connate below (column 0.4-1 mm long); stigmas capitate or reniform. Capsules slightly depressed, 7-8 mm long, 10-13 mm diam., shallowly 3-lobed, glabrous, brown or orange-brown when dry; pedicels 15-30 mm long; seeds trigonous-orbicular, 5-9 mm diam. (Fig. 12).

Flowering and fruiting. — Jan.-Dec.

Specimens examined. — **India.** Andaman Islands. North Andaman Is.: Austin Is, 23 April 1964, *Ellis & Ramamurthy 18913* (MH); Tugapur, 24 April 1964, *Ellis & Ramamurthy 18921* (MH); Lakhimpur, 22 Nov. 1976, *N. G. Nair 4872* (PBL); *ibid.*, 6 Apr. 1977, *Balakrishnan 5486* (PBL); *ibid.*, 6 Apr. 1977, *Balakrishnan 5486* (PBL); Durgapur, 20 Nov. 1976, *N. G. Nair 4837* (PBL). Middle Andaman Is.: Bakultala, 6 Nov. 1977, *Bhargava 6393* (PBL); High Land, 29 May 1886, *King's coll. 282* (CAL). Havelock Is.: Kalapathar, 2 Sept. 1977, *Premanath 6132* (PBL); sine loc. exact., 15 May 1974, *R. Ansari 1364* (PBL). Baratang Is.: On way to Bishnunala, South Creek, 28 Jan. 1978, *P. Basu 6849* (PBL); sine loc. exact., 16 Jan. 1904, *Prain's coll. 31* (CAL). Rutland Is.: 8 May 1904, *Rogers 252* (CAL); Near Bamboonala, 9 Apr. 1978, *N. G. Nair 6950* (PBL). South Andaman Is.: Dhanikhari forest, 22 Apr. 1985, *T. Chakrabarty 10395* (PBL); *ibid.*, 8 June 1974, *Thothathri 1281* (PBL); Nayasahar, 12 Sept. 1973, *Balakrishnan 348* (PBL); Chiriatapu, 29 May 1974, *Thothathri & N. G. Nair 1073* (CAL, PBL); Mount Harriet, 15 Feb. 1975, *Bhargava & N. G. Nair 2241* (CAL, PBL); 10 km towards north from Poonanala, 26 July 1976, *Bhargava 4244* (CAL, PBL); Port Mout, 15 Apr. 1893, *King's coll. s.n.* (CAL); Cadellgunj, 26 Aug. 1892, *King's coll. s.n.* (CAL); Tusonabad, 11 June 1892, *King's coll. s.n.* (CAL); Salt factory, east coast, 20 Sept. 1890, *King s.n.* (CAL); Dundas point, 18 Apr. 1895, *King's coll. s.n.* (CAL); Chouldhari, 3 Nov. 1894, *King's coll. s.n.* (CAL); Anikhet, 13 June 1891, *King s.n.* (CAL); Hobdaypur, 4 July 1891, *King s.n.* (CAL); Protherapur, Apr. 1891, *D. Prain, s.n.* (CAL); near Port Blair, 9 Sept. 1884, *King's coll. 433* (CAL).

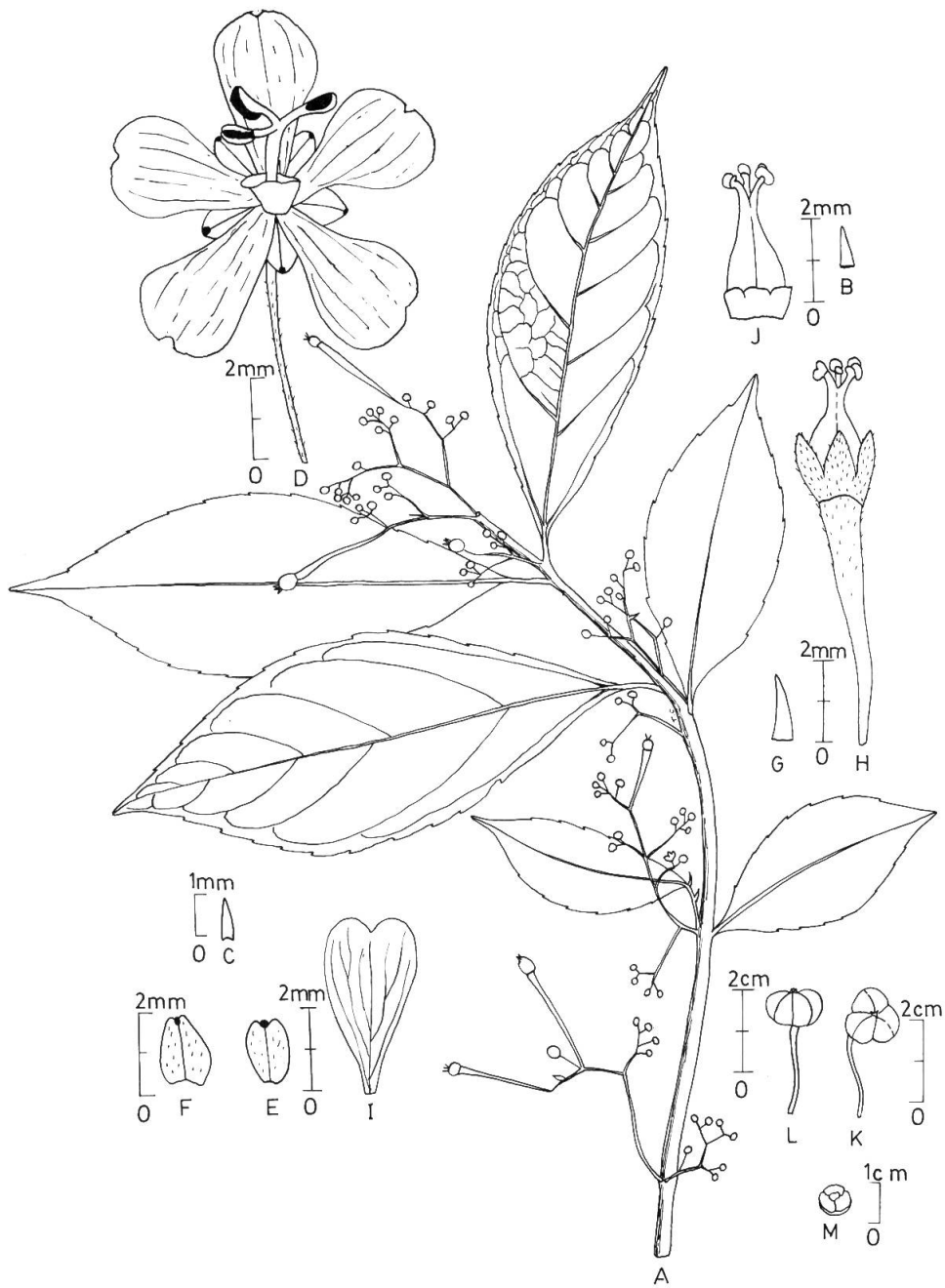


Fig. 12. — *Trigonostemon viridissimus* (Kurz) Airy Shaw var. *viridissimus*.
 A, twig; B, stipule; C, male bract; D, male flower; E-F, sepals; G, female bract; H, female flower; I, petal; J, ovary; K-L, fruits;
 M, seed (all from types).

Distribution. — Andaman Islands, Myanmar, Malaysia, Indonesia, Philippines, Timor, Lesser Sunda Is.

Ecology. — Common in coastal forests or thickets of mixed forests or inland forests on sandy, clayey or rocky loam up to about 200 m altitude.

13.2 var. chatterjii (Deb & Deka) Balakr. & T. Chakrab. in J. Econ. Tax. Bot. 5: 967 (1984).
= *Trigonostemon chatterjii* Deb & Deka in Indian For. 91: 577 (1965); Balakr., Fl. Jowai 2: 427 (1983). **Types:** India, Meghalaya, Jowai dist., Dawki, 4 May 1943, *G. K. Deka 19A* (CAL-Holotype); *ibid.*, *G. K. Deka 19B-19E* (ASSAM-Isotypes).

Shrubs of unknown stature, differing from var. *viridissimus* in its almost free filaments of stamens.

Flowering and fruiting. — Apr.-May.

Specimen examined. — **India.** Meghalaya. Jowai dist.: Dawki, 4 May 1943, *G. K. Deka 24* (DD).

Distribution. — Meghalaya in NE. India — Endemic.

Ecology. — Rare, on rocky slopes of tropical evergreen forests, up to 500 m altitude.

13.3 var. confertifolius Balakr. & N. G. Nair in Bull. Bot. Surv. India 24: 36 [1982] (1983). **Types:** India, North Andaman Island, Saddle Peak, 1 Dec. 1976, *Balakrishnan & N. G. Nair 4773A* (CAL-Holotype); *ibid.*, *Balakrishnan & N. G. Nair 4773B* (L-Isotype); *ibid.*, *4773C-4773E* (PBL-Isotypes).

Shrubs, ca. 1 m tall.

Flowering. — Nov.-Dec.

Specimens examined. — Types only.

Distribution. — North Andaman Is. (Saddle Peak) — Endemic.

Ecology. — In subtropical forests at 500-700 m altitude.

T. viridissimus is an extremely variable species, recognizable by the trinerved leaf-bases, drying yellow or green, and the bisexual thyrsoid inflorescences with a female flower terminating each branch. In Indian subcontinent, only two other species, viz. *T. birmanicus* and *T. nigrifolius* have such broadly thyrsoid inflorescences which are however unisexual (only males known in both species) and their leaves are also of very different kind, though trinerved at base in *T. birmanicus*. There are several other differences and therefore *T. viridissimus* does not appear to be related to these species. Its nearest relative appears to be *T. laevigatus* Muell.-Arg. of SE. Asia, W. Malaysia and Philippines which apparently differs mainly in having rather shorter, condensed unisexual inflorescences. Other differences (e.g. colour of petals and characters of leaves) often tend to intergrade. In any case, both *T. viridissimus* and *T. laevigatus* are highly variable species.

Var. *confertifolius* represents a form with stunted growth, characteristic of the plants growing on the Saddle Peak range in the North Andamans. The most obvious difference of this variety from the others is in its reduced, almost racemiform inflorescence. In addition, the leaves tend to be smaller, together with entire margins, acute to obtuse apices and much shorter petioles. Var. *chatterjii* differs from var. *viridissimus* only in its almost free or very shortly connate filaments of stamens.

Excluded species

1. *Trigonostemon laevigatus* Muell.-Arg. in Flora 47: 538 (1864) and in DC., Prodr. 15(2): 1111 (1886); Pax & Hoffm. in Engler, Pflanzenr. IV. 147(iii): 94 (1911); Ridley, Fl. Malay Penins.

3: 265 (1924); Jabl. in Brittonia 15: 167-168 (1963); Airy Shaw in Kew Bull. 26: 346 (1972), 32: 417 (1978) and in Kew Bull. Add. Ser. IV: 203 (1975); Whitmore, Tree Fl. Malaya 2: 135 (1973).

= *Trigonostemon anomalus* Merr. in Philipp. J. Sci. 16: 569 (1920) and Enum. Philipp. Fl. Pl. 2: 451 (1923).

AIRY SHAW (1972, 1975) included "Andamans" while citing the distribution of this SE. Asiatic and Malaysian species. During the course of the present study, we could locate no material of the species from the Andamans nor any other area covered in this work. Hence we requested (late) Mr. Airy Shaw to kindly enlighten us about his above record of the plant from the Andamans. In a letter (Kew, dated 17 June 1983), Mr. Airy Shaw replied: "the basis of my records of *Trigonostemon laevigatus* from the Andamans is a couple of sheets in the Kew Herbarium (Helfer 160 and 186, Kew Disrib. No. 5010, St. Matthew, 1 Oct. 1839), but I now feel some doubt about the identification. Could they perhaps be referable to *T. viridissimus* (Kurz) Airy Shaw? These two species are sometimes not easy to distinguish (we have isotype of *T. viridissimus* from Port Mout)". These lines suggest that the occurrence of the species in the Andamans requires confirmation through collections.

2. *Trigonostemon reidioides* (Kurz) Craib in Bull. Misc. Inf. Kew 1911: 464 and Aberdeen Univ. Stud. No. 57: 191 (1912); Pax & Hoffm. in Engler, Pflanzenr. IV. 147(vi): 28 (1912); Gagnep. in Lecomte, Fl. Gen. Indoch. 5: 316 (1925); Airy Shaw in Kew Bull. 26: 348 (1972).

= *Baliospermum reidioides* Kurz in Flora 58: 32 (1875) and For. Fl. Brit. Burma 2: 411 (1877); Hook. f., Fl. Brit. India 5: 461 (1887), in obs.; Pax & Hoffm., l.c. iv: 29 (1912).

Type: Thailand, in bosscher (!), Kaunbocrie, no date, *Teysmann s.n.*, Acc. No. 418027 (CAL).

AIRY SHAW (l.c.) cited "Burma" with a question mark while indicating distribution of *T. reidioides*, since it is known to occur in the adjoining areas of Indochina and Thailand. Although excluded from the present treatment, the species may eventually be found in Myanmar (Burma). It is recognizable by its dense tomentellum (except upper surface of leaves), short (4-13 cm) oblong entire trinerved leaves and the branched long-peduncled paniculate inflorescences.

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