

The genus *Trigonostemon* (Euphorbiaceae) in Thailand

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ABSTRACT. A taxonomic revision of *Trigonostemon* in Thailand is presented. The following 14 species are recognised: *T. albiflorus*, *T. aurantiacus*, *T. capillipes*, *T. heterophyllus*, *T. kerrii*, *T. laevigatus*, *T. longifolius*, *T. murtonii*, *T. pachyphyllus*, *T. phyllocalyx*, *T. quocensis*, *T. reidiodes*, *T. thyrsoides* and *T. verticillatus*. *T. leucanthus* from China is placed in synonymy of *T. albiflorus*. *T. heterophylla* is recorded from Thailand for the first time. A key to the species, ecological data and geographical distributions are provided. Lectotypes for *T. kerrii* and *T. quocensis* are selected.

Trigonostemon is a crotonoid genus of Euphorbiaceae *sensu stricto*. The genus comprises some 50 species and is distributed from India to northern Australia and mainly restricted to Southeast Asia. The first and last complete revision of the genus in Thailand was made by Airy Shaw in 1972 with 13 recorded species. He also pointed out that *B. Sangkhachand* 531, a specimen from Chanthaburi province might be a new species. *Trigonostemon capillipes* was thought to have unisexual inflorescence. In fact, the inflorescence always bears both staminate and pistillate flowers, with the female ones always developing before the males.

During the preparation of the treatment of *Trigonostemon* for the Flora of Thailand, 14 species are enumerated, including *T. heterophylla*, a species previously known only from Yunnan, China and Laos. *T. leucanthus* from China is reduced to a synonym of *T. albiflorus*.

Trigonostemon is a difficult genus to recognise because of its highly variable inflorescences and wide range of morphological variation in leaf shape and size. It is also extremely difficult to distinguish the species of *Trigonostemon* without inflorescence, flower and fruit, as the leaves are variable within each species. In general appearance the genus is similar to *Dimorphocalyx* from which it differs in having fewer stamens (3–5 versus 10–15) and being monoecious. Müller (1866) and Airy Shaw (1972) accepted the genus in tribe *Jatrophaeae*. Pax and Hoffmann (1911) placed it in *Cluytieae* whereas Webster (1975) described a new tribe *Trigonostemoneae*, containing only one genus. I believe *Trigonostemoneae* should be placed under tribe *Codiaeae* as Radcliffe-Smith's (2001) view. They are extremely similar in simple indumentum, pollen type, copious endosperm, thin cotyledons and having petals. Recent molecular work (Wurdack *et al.* 2005) placed *Trigonostemon* at the base of the clade consisting of mainly Old World crotonoid taxa (including most *Codiaeae*) with inaperturate pollen.

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TAXONOMIC TREATMENT

TRIGONOSTEMON

Blume, Bijdr.: 600. 1826 & Fl. Javae: viii. 1828, nom. cons.; Baill., Étude Euphorb.: 340. 1858; Müll.Arg. in DC., Prodr. 15(2): 1105. 1866; Benth., Gen. Pl. 3: 298. 1880; Hook.f., Fl. Brit. Ind. 5: 395. 1887; Pax & K.Hoffm. in Engl., Pflanzenr. IV.147.iii: 85. 1911; Gagnep. in Lecomte, Fl. Indo-Chine 5: 309. 1925; Pax & K.Hoffm. in Engl. & Harms, Nat. Pflanzenfam. ed. 2, 19C: 169. 1931; Backer & Bakh.f., Fl. Java 1: 495. 1963; Airy Shaw, Kew Bull. 20: 47. 1966, 21: 407. 1968, 23: 126. 1969, 25: 545. 1971 & 26: 344. 1972; Whitmore, Tree Fl. Malaya 2: 134. 1973; Airy Shaw in Hooker's Icon. Pl. 38: t. 3721. 1974; G.L.Webster, Ann. Missouri Bot. Gard. 81: 108. 1994; Philcox in Dassan., Fl. Ceyl. 11: 110. 1997. — *Enchidium* Jack, Malayan Misc. 2(7): 89. 1822, nom. rej.; Baill., Étude Euphorb.: 652: 1858. — *Telogyne* Baill., Étude Euphorb.: 652: 1858. — *Tylosepalum* Kurz ex Teijsm. & Binn., Natuurk. Tijdschr. Ned.-Indië 27: 50. 1864. — *Actephilopsis* Ridl., Bull. Misc. Inform. Kew 1923: 360. 1923.

Shrub or small tree, monoecious. Leaves spirally arranged at the ends of the branches rarely subopposite; usually trinerved at base. Inflorescence a raceme-like spike or panicle, rarely a cyme, axillary or terminal, bisexual. Flower dark purplish, orange-yellow or white; disc usually entire, annular or cupular, or of 5 free glands. Staminate flowers with 5 sepals; petals 3 or 5; stamens 3 or 5, united into a column with free, spreading filament tips, pistillode absent. Pistillate flowers with 5 sepals; petals 3 or 5, ovary 3-locular, 3-lobed; one ovule per locule; style bifid or twice bifid. Fruit a capsule, 3-lobed, smooth or pubescent, splitting into 3 bivalved parts, calyx persistent, sometimes enlarged in fruit. Seed ovoid or globose.

KEY TO THE SPECIES

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|---|-----------------------------|
| 1. Leaves (at least on lower surface) densely hairy | |
| 2. Inflorescences shorter than 5 cm | 4. T. heterophyllus |
| 2. Inflorescences longer than 5 cm | 12. T. reidioides |
| 1. Leaves glabrous or sparsely hairy | |
| 3. Inflorescence a spike or narrowly spike-like cymose | |
| 4. Leaves oblanceolate. Petioles 1–1.5 cm long. Stamens 3 | 7. T. longifolius |
| 4. Leaves ovate-elliptic or narrowly elliptic. Petioles 1.5–20 cm long. Stamens 5 | 14. T. verticillatus |
| 3. Inflorescence paniculate or not spike-like cymose | |
| 5. Inflorescences longer than 5 cm | |
| 6. Petals orange-yellow | |
| 7. Leaves penninerved, rarely trinerved at base. Pistillate inflorescences with a few leafy bracts, bracts 3.5 by 1.5 cm, ovate or elliptic, sparsely hairy | 2. T. aurantiacus |
| 7. Leaves trinerved at base. Pistillate inflorescences slender, with scale-like bracts, bracts 5–9 by 0.5–1 mm, narrowly oblong, pubescent | |
| 8. Stamens 3. Capsule 10 mm in diam., thinly adpressed pubescent | 11. T. quocensis |
| 8. Stamens 5. Capsule 12–15 mm in diam., sparsely and very shortly aculeate | 13. T. thyrsoides |
| 6. Petals white | 1. T. albiflorus |
| 5. Inflorescences shorter than 5 cm | |
| 9. Leaves penninerved | |
| 10. Stamens 3 | |
| 11. Ovary glabrous. Pistillate sepals fringed with elongate capitate glands | 5. T. kerrii |
| 11. Ovary pubescent. Pistillate sepals entire | 8. T. murtonii |

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| 10. Stamens 5 | 9. <i>T. pachyphyllus</i> |
| 9. Leaves trinerved at base | |
| 12. Petioles variable in length on a single specimen, 0.5–10 cm long | 10. <i>T. phyllocalyx</i> |
| 12. Petioles all of about equal length, 0.3–2 cm long | |
| 13. Petals yellowish | 6. <i>T. laevigatus</i> |
| 13. Petals purplish red or red | 3. <i>T. capillipes</i> |

1. *Trigonostemon albiflorus* Airy Shaw, Kew Bull. 25: 547. 1971. Type: Thailand. Lampang, Wang Nua, Mae Ping, 19 June 1926, *Winit* 1704 (holotype K!; isotypes BKF!, BM!).— *T. leucanthus* Airy Shaw, Kew. Bull. 25: 548. 1971, **synon.nov.** Type: China, Kwangsi, Lungchow, *Morse* 668 (holotype K!).

Thailand.— NORTHERN: Chiang Mai (Doi Chiang Dao), Nan, Lampang (Wang Nua); SOUTH-EASTERN: Chanthaburi (Khao Soi Dao).

Distribution.— China (Kwangsi).

Ecology.— In evergreen forest, 110–1,800 m.

Specimens examined.— *H.-J. Esser* 2001-2 (BKF); *K. Larsen, S.S. Larsen, C. Niyomdham, P. Siriruga, D.D. Tirvengadam, C.N. Nørgaard* 43569 (AAU); *J.F. Maxwell* 97-960 (BKF, L, 2 sheets); *T. Shimizu et al.* T-20939 (BKF); *T. Smitinand* 8133 (BKF); *Winit* 1704 (BKF, BM, K).

Note.— *Trigonostemon albiflorus* is distinctive on account of its loose inflorescence and white flowers. On examination of plant material (*Morse* 681 at K which is the isotype of *T. leucanthus* from China), I have concluded that *T. leucanthus* should be regarded as conspecific with *T. albiflorus*. The species is distributed from northern Thailand towards southern China.

2. *Trigonostemon aurantiacus* (Kurz ex Teijsm. & Binn.) Boerl., Handl. Fl. Ned. Ind. 3 (1): 284. 1900; Pax & K. Hoffm. in Engl., Pflanzenr. IV.147.iii: 93. 1911; Airy Shaw, Kew Bull. 28: 126. 1969.— *Tylosepalum aurantiacum* Kurz ex Teijsm. & Binn. in Natuurk. Tijdschr. Ned. Ind. 27: 50. 1864. Type: Banka, ante 1864, *Kurz* s.n. (not located).— *Codiaeum aurantiacum* (Kurz ex Teijsm. & Binn.) Müll. Arg. in DC., Prodr. 15(2): 1118. 1866.— *Actephila aurantiaca* Ridl., Bull. Misc. Inform. Kew 1923: 360. 1923 & Fl. Malay Penins. 3: 197. 1924. Type: Malaysia, Kelantan, *Ridley* s.n. (holotype K!).— *Actephilopsis malayana* Ridl., Bull. Misc. Inform. Kew 1923: 361. 1923 & Fl. Malay Penins. 3: 252. 1924; Henderson, J. Malay. Br. Roy. As. Soc. 17: 68. 1939.— *Trigonostemon malayanus* (Ridl.) Airy Shaw, Kew Bull. 20: 413. 1966. Type: Malaysia, Pahang, Kwala Tembeling, in 1891, *Ridley* 2300 (not located); Perak, Gunong Kerbau in 1909, *Haniff* 1611 (not located); Ayer Hitam, February 1866, *Curtis* 674 (not located).

Thailand.— PENINSULAR: Surat Thani (Ko Samui), Phuket (Thalang), Satun (Tarutao), Songkhla (Padang Besar, Saba Yoi), Pattani (Khao Kala Khiri), Yala (Banang Sta), Narathiwat (Bacho).

Distribution.— India (Andaman Is.), Malaysia, Indonesia.

Ecology.— In evergreen forest or on limestone hills, 0–200 m.

Specimens examined.— *C. Charoenphol*, K. Larsen & E. Warncke 3938 (AAU); *C. Chermisrivathana* & Kasem 1474 (AAU, BK, K), 1475 (BK); *G. Congdon* 1253 (AAU); *R. Geesink* & *T. Santisuk* 4961 (K, P); *B. Hansen* & *T. Smitinand* 11987 (K), 12153 (BKF, K, L); *A.F.G. Kerr* 7151 (BK, BM, K), 7410 (BK, BM, K), 12534 (BK, BM, K), 13046 (K), 13617 (BK, BM, K), 15047 (BK, K), 17454 (BK, BM, K, L); *M.C. Lakshanakara* 349 (BK, K, L); *K. Larsen* & *S.S. Larsen* 33164 (AAU, BKF, L, P); *K. Larsen*, *S.S. Larsen*, *C. Niyomdham*, *W. Ueachirakan* & *P. Sirirugsa* 42444 (AAU); *K. Larsen*, *S.S. Larsen*, *S.S. Renner*, *C. Niyomdham*, *W. Ueachirakan* & *P. Sirirugsa* 42480 (AAU, BKF); *J.F. Maxwell* 84-99 (PSU), 84-351 (PSU), 85-312 (AAU, BKF, L, PSU), 85-896 (L), 87-566 (BKF, L, PSU); *R. Pooma*, *V. Chamcumroon* & *K. Phattarahirankanok* 2058 (BKF, 2 sheets); *Put* 706 (BK, BM, K); *P. Sangkhachand* 1614 (BK); *T. Shimizu*, *H. Toyokuni*, *H. Koyama*, *T. Yahara* & *C. Niyomdham* T-27197 (BKF); *P. Suvanakes* 540 (BKF), 1674 (BKF); *C.F. van Beusekom* & *C. Phengkai* 610 (L), 610a (BKF, L).

Note.— *T. aurantiacus* is distinct from all other *Trigonostemon* species by virtue of its cauline fascicles of small orange-yellow staminate flowers while the pistillate flowers are solitary in the axils of leaf-like bracts in a terminal raceme. This species is common in peninsular Thailand.

3. *Trigonostemon capillipes* (Hook.f.) Airy Shaw, Kew Bull. 20: 413. 1966 & 26: 145. 1972; Whitmore, Tree Fl. Malaya 2: 134. 1973; Milne, Kew Bull. 50(1): 45. 1995. — *Dimorphocalyx capillipes* Hook.f., Fl. Brit. Ind. 5: 404. 1888; Pax & K. Hoffm. in Engl., Pflanzenr. IV.147.iii: 33. 1911; Ridl., Fl. Malay Penins. 3: 266. 1924. Type: Singapore, *Lobb* s.n. (holotype K!).

Thailand.— SOUTH-EASTERN: Chanthaburi (Khao Soi Dao); SOUTH-WESTERN: Uthai Thani (Katatak); PENINSULAR: Ranong (Khao Pota Chong Dong, Khao Pota Luang Khaeo), Nakhon Si Thammarat.

Distribution.— Peninsular Malaysia, Borneo.

Ecology.— In evergreen forest, 10–900 m.

Specimens examined.— *C. Chermisrivathana* & *Kasem* 1669 (BK, 2 sheets); *R. Geesink* & *T. Santisuk* 4961 (K); *Haniff* & *Nur* 3811 (K); *B. Hansen* & *T. Smitinand* 11987 (K); *A.F.G. Kerr* 13905 (BM, K), 16809 (BK, BM, K), 16929A (BK), 17515 (K), 19429 (K), 19443 (K); *K. Larsen* & *S.S. Larsen* 33233 (AAU, BKF, E, K, P); *J.F. Maxwell* 85-518 (AAU, BKF, PSU); *S. Sutheesorn* 4008 (BK).

Note.— *T. capillipes* is distinguished by its black leaves on the upper surface when dry.

4. *Trigonostemon heterophyllus* Merr., Lingnan. Sc. 9: 38. 1930. Type: China, Hainan, Sha Po Shan, 30 May 1928, *Tsang Wai Tak* 17343 (holotype UC; isotypes A, L!, P!).

Thailand.— NORTH-EASTERN: Nong Khai (Phu Wua).

Distribution.— China, Laos.

Ecology.— In light evergreen forest, ca. 200–400 m.

Specimens examined.— *H.-J. Esser* 98-154 (BKF).

Note.— *T. heterophyllus* differs from the Malayan species, *T. rufescens* Jabl. in having shorter petioles (ca. 0.5 cm vs 3–9 cm). This species was hitherto known from Yunnan, China and Laos, but is now seen to have a much wider range.

5. *Trigonostemon kerrii* Craib, Bull. Misc. Inform. Kew 1924: 97. 1924; Gagnep. in Lecomte, Fl. Indo-Chine 5: 321. 1925. Type: Thailand, Phitsanulok, Nakhon Thai, 17 April 1922, *A.F.G. Kerr* 5871 (lectotype BK!; isolectotypes BM!, K! selected here).

Thailand.— NORTHERN: Tak, Phitsanulok (Nakhon Thai).

Distribution.— Endemic.

Ecology.— In evergreen or mixed forest, ca. 200 m.

Specimens examined.— *A.F.G. Kerr* 5871 (BK, BM, E, K, P, TCD), 5871A (BK, K), 6006 (BK, BM, E, K), 20367 (BK, BM, K, L).

Note.— *T. kerrii* has a distinctive fringe of elongate capitate glands on its pistillate sepals. Three collections, *Kerr* 5871, *Kerr* 5871A and *Kerr* 6006, are mentioned in the original description. *Kerr* 5871 at BK is chosen as the lectotype because it is the best preserved with various duplicates.

6. *Trigonostemon laevigatus* Müll.Arg., Flora 47: 538. 1864 & in DC., Prodr. 15(2): 1111. 1866; Pax & K.Hoffm. in Engl., Pflanzenr. IV.147.iii: 94. 1911; Ridl., Fl. Malay Penins. 3: 265. 1924. Type: Borneo, Kalimantan, Bangarmassing, *Motley* 686 (type K!).— *T. anomalus* Merr., Philipp. J. Sci. 16: 569. 1920 & Enum. Philip. 2: 451. 1923. Type: Philippines, Mindanao, Zamboanga district, Naganaga, *For. Bur.* 22018 *Vilamil*, 2 June 1914 (not located). — *T. petelotii* Merr., Univ. Calif. Publ. Bot. 10: 425. 1924. Type: Vietnam, Cho-ganh, *A. Petelot* 795, June 1921 (isotypes P!, 2 sheets).— *T. laevigatus* var. *petiolaris* Airy Shaw, Kew Bull. 32: 417. 1978. Type: Malaysia, Sarawak, Fourth Division, Simpang Tiga, Ulu Mayeng, 4 October 1963, *Chai* S19224 (holotype K!).

Thailand.— PENINSULAR: Ranong (Khao Pota Luang Khaeo), Nakhon Si Thammarat (Khiriwong), Satun (Tarutao), Narathiwat (Sungei Kolok).

Distribution.— Myanmar, Indo-China, Peninsular Malaysia, Borneo, Philippines.

Ecology.— In evergreen forest, 50–1,300 m.

Specimens examined.— *K. Chayamarit*, *R. Pooma*, *V. Chamchumroon*, *K. Phattarahirankanok* & *D.J. Middleton* 2659 (BKF, 2 sheets); *C. Chermisrivathana* 1435 (AAU, K); *R. Geesink* & *T. Santisuk* 5128 (AAU, BKF, K); *R. Geesink*, *P. Phengkklai* 7647 (BKF, L), *B. Hansen* & *T. Smitinand* 12508 (L); *A.F.G. Kerr* 12021 (K), 16929 (BM, K, L, P), 16929A (K); *H. Koyama*, *H. Terao* & *T. Wongprasert* T-33854 (BKF); *K. Larsen* & *S.S. Larsen* 32761 (AAU, BKF, K, P); *K. Larsen*, *S.S. Larsen*, *I. Nielsen* & *T. Santisuk* 31128 (AAU, BKF, K, L, P); *C. Niyomdham* 1273 (AAU, BKF, 2 sheets, K, L); *C. Niyomdham*, *R. Kubat* & *W. Aajchomphoo* 1415 (BKF, 2 sheets, K); *S.P. et al.* 29 (BKF); *T. Shimizu*, *H. Toyokuni*, *H. Koyama*, *T. Yahara* & *C. Niyomdham* T-26681 (BKF); *T. Smitinand* & *P. Suvanakoses* 253 (BKF); *P. Suvanakoses* 181 (BKF).

Note.— *T. laevigatus* is distinct from all other Thai *Trigonostemon* species by virtue of its short cymose inflorescences and yellowish petals.

7. *Trigonostemon longifolius* Baill., Étude Euphorb.: 341. 1858; Müll.Arg. in DC., Prodr. 15(2): 1108. 1866; Hook.f., Fl. Brit. Ind. 5: 396. 1887; Pax & K. Hoffm. in Engl., Pflanzenr. IV.147.iii: 88, f. 28. 1911; Ridl., Fl. Malay Penins. 3: 264. 1924; P.H. Hò, Câyco Vietnam 2(1): 341. 1992. Type: not located.

Thailand.— SOUTH-EASTERN: Chanthaburi; PENINSULAR: Ranong (Khao Pota Chong Dong, Khlong Nakha), Krabi (Nong Chik), Nakhon Si Thammarat (Khao Luang, Tasala), Phuket, Phatthalung (See Bahn Pote), Satun (Kuan Kalong, Kuan Po), Yala (Banang Sta), Narathiwat (Waeng).

Distribution.— Myanmar, Malaysia, Indonesia (Sumatra).

Ecology.— In evergreen forest, 50–1,600 m.

Vernacular. — Thao yai mom pa (เตาชายมอมปา), ai bao (ไอบาว) (Pattani).

Specimens examined.— *R. Geesink* & *T. Smitinand* 5091 (L), *R. Geesink* & *T. Santisuk* 5330 (AAU, BKF, K, L, P); *Haniff* & *Nur* 2717 (K); *A.F.G. Kerr* 7344 (BK, BM, L), 7344A (K), 16743 (BK, BM, L), 18617 (BK, BM, K, L); *Kiah* 24271 (BM, K); *C.B. Kloss* 6565 (K, 2 sheets); *H. Koyama*, *H. Terao* & *Th. Wongprasert* T-33908 (BKF); *K. Larsen* & *S.S. Larsen* 33351 (AAU); *J.F. Maxwell* 85-660 (AAU, BKF, L, PSU), 85-898 (BKF, E, L, PSU), 86-265 (AAU, BKF, E, L, PSU), 86-322 (BKF, L, PSU), 86-378 (BKF, L, PSU), 86-501 (BKF, L, PSU); *R. Pooma*, *V. Chamchumroon* & *K. Phattarahirankanok* 1988 (BKF, 2 sheets); *B. Sangkhachand*, *S. Phusomsaeng* & *B. Nimanong* 1019 (BKF, L); *T. Santisuk* 770 (BKF, PSU); *T. Smitinand* 2339 (BKF, K, TCD), 3019 (BKF, L); *Vanpruk* 692 (BKF, K); *S.N.* 361 (BKF s.n. 25293).

Note.— *T. longifolius* is characterised by having a long spike and the leaves turning yellowish when dry. Radcliffe-Smith (2001) placed *T. longifolius* under *T. heteranthus* Wight. The former differs from the latter by the long-attenuate based leaves (vs leaves with obtuse bases) and shorter petiole (c. 1 cm long vs at least 3 cm long).

8. *Trigonostemon murtonii* [*murtoni*] Craib, Bull. Misc. Inform. Kew 1911: 464. 1911; Pax & K. Hoffm. in Engl., Pflanzenr. IV. 147.vi: 128. 1912; P.H. Hò, Câyco Vietnam 2(1): 342. 1992. Type: Thailand, Trat, Klong Yai, Ko Klon, *Murton* 18 (holotype K!).— *T. pinnatus* Gagnep., Bull. Soc. Bot. France 64: 752. 1922 (publ. 1923) & in Lecomte, Fl. Indo-Chine 5: 318. 1925. Type: Vietnam, Lap-Vo, *Pierre* s.n. (holotype P!).

Thailand.— SOUTH-EASTERN: Trat (Klong Yai, Ko Klon, *Murton* 18, holotype K!).

Distribution.— Vietnam (Cochinchina).

Ecology.— In shaded and rocky areas.

Specimens examined.— *C. Phengkklai et al.* 3282 (PSU); *Murton* 18 (K).

Note.— The vegetative part of *T. murtonii* is superficially similar to *T. kerrii* but the species differs in its pubescent ovary and entire pistillate sepals.

9. *Trigonostemon pachyphyllus* Airy Shaw, Kew Bull. 25: 546. 1971. Type: Thailand, Chanthaburi, Khao Soi Dao, 28 April 1930, *A.F.G. Kerr* 19429 (holotype K!).

Thailand.— SOUTH-EASTERN: Chanthaburi (Khao Soi Dao); PENINSULAR: Narathiwat (Waeng).

Distribution.— Endemic.

Ecology.— In evergreen forest, 300–700 m.

Specimens examined.— *A.F.G. Kerr* 19429 (K); *J.F. Maxwell* 85-518 (AAU, BKF, L, PSU); *P. Sangkhachand* 1271 (L).

Note.— Milne (1995) placed *T. pachyphyllus* under *T. capilipes*. I consider *T. pachyphyllus* to be a distinct species. The characters distinguishing the species from *T. capillipes* are the larger leaves which are not trinerved at the leaf base.

10. *Trigonostemon phyllocalyx* Gagnep., Bull. Soc. Bot. France 69: 753. 1922 (publ. 1923) & in Lecomte, Fl. Indo-Chine 5: 312. 1925; P.H. Hô, CÂYCO VIỆT NAM 2(1): 341. 1992. Type: Vietnam, Annam, Nahtrang, 5 March 1922, *Poilane* 2700 (holotype P!; isotype P!).

Thailand.— SOUTH-EASTERN: Chanthaburi (Khao Sabap, Phlio waterfall).

Distribution.— Vietnam.

Ecology.— In evergreen forest, ca. 200 m.

Specimens examined.— *N. Fukuoka & M. Ito* T-34960 (BKF); *A.F.G. Kerr* 18014 (BK, BKF, BM, K, P); *J.F. Maxwell* 71-260 (BK), 72-143 (AAU, BK).

Note.— *T. phyllocalyx* is characterised by its striking accrescent pistillate calyx in fruit and the varying petiole length.

11. *Trigonostemon quocensis* Gagnep., Bull. Soc. Bot. France 69: 753. 1922 & in Lecomte, Fl. Indo-Chine 5: 316. 1925; P.H. Hô, CÂYCO VIỆT NAM 2(1): 343. 1992. Type: Cambodia, Phu-quoc, *Pierre* s.n. (lectotype P!; selected here).

Thailand.— EASTERN: Nakhon Ratchasima (Katok, Pak Thongchai, Si Khio); SOUTH-WESTERN: Prachuap Khiri Khan; SOUTH-EASTERN: Chanthaburi (Khao Soi Dao Nua); PENINSULAR: Ranong (Khao Pota Chong Dong), Surat Thani (Khao Wong, Khiriratnikhom), Phangnga (Khao Nang Hong, Tap Put), Nakhon Si Thammarat, Phatthalung (Klong Huai Kao).

Distribution.— Myanmar, Indo-China.

Ecology.— In evergreen forest, 50–630 m.

Specimens examined.— *C. Chai-anan* 412 (BKF); *C. Charoenphol, K. Larsen & E. Warncke* 4511 (AAU, BKF, K, L); *C. Chermisirivathana & Kasem* 1487 (AAU, BK, K); *Damrongsak* 42 (BKF); *N. Fukuoka & M. Ito* T-34748 (BKF); *C. Hambananda* 366 (BKF), 412 (BKF); *A.F.G. Kerr* 8174 (BK, BM, K, L, P), 8766 (BM, K, L), 12410 (BK, BM, K, L), 15295 (BK, BM, K, L, P), 16735 (BK, L), 16813 (BK, BM, K, L), 18259 (BK, BM, K, L); *H. Koyama, H. Terao & T. Wongprasert* T-33077 (BKF), 33854 (BKF), 33991 (BKF);

J.F. Maxwell 75-467 (AAU, 2 sheets, BK, L), 75-920 (AAU-2 sheets, BK, L-2 sheets), 76-334 (AAU, BK, L); *D. Middleton, L. Lindsay & R. Pooma* 2117 (L); *D. Middleton, S. Suddee & C. Hemrat* 1251 (L); *Put* 4334 (BK, BM, K, L, P); *B. Sangkhachand* 531 (BKF, K); *Sanoh* 714 (BKF); *T. Shimizu, N. Fukuoka & A. Nalampoon* T-7975 (BKF, K); *T. Smitinand* 8391 (BKF); *T. Smitinand & H. Sleumer et al* 1241 (BKF, K, L, P, 2 sheets); *S. Suthesorn* 3387 (BK); *C.F. van Beusekom, Chan Wid, R. Geesink* 3292 (BKF, L); *C.F. van Beusekom & C. Charoenphol* 1851 (BKF, L), 1869 (AAU, BKF, E, L-2 sheets); *C.F. van Beusekom & T. Smitinand* 2174 (AAU, BKF, E, K, L, 2 sheets, P).

Note.— *B. Sangkhachand* 531 at K has been annotated as *Trigonostemon* sp. nov. by Airy Shaw (1972). He suggested that the specimen was evidently related to *T. albiflorus* and *T. leucanthus*. I have examined the specimen and have no doubt that it belongs to *T. quocensis*. Five collections, *Pierre* s.n. from Phu-quoc, Cambodia and the rest from Vietnam, *Pierre* s.n., *Harmand* 632 and *Godefroy* 739 & 740, housed at P, are all mentioned in the original description. *Pierre* s.n. from Phu-quoc is chosen as the lectotype because it is the best preserved.

12. *Trigonostemon reidioides* (Kurz) Craib, Bull. Misc. Inform. Kew 1911: 464. 1911; Pax & K. Hoffm. in Engl., Pflanzenr. IV.147.vi: 128. 1912; Gagnep. in Lecomte, Fl. Indo-Chine 5: 316. 1925; P.H. Hô, Cây cỏ Việt Nam 2(1): 343. 1992. — *Baliospermum reidioides* Kurz, Flora 58: 32. 1875 & For. Fl. Brit. Burma 2: 411. 1877; Hook. f., Fl. Brit. Ind. 5: 461. 1887; Williams, Bull. Herb. Boiss. Ser. 2, 5: 32. 1905; Pax & K. Hoffm. in Engl., Pflanzenr. IV.147.vi: 29. 1912. Type: Thailand, Kanchanaburi, Khao Thong, Wang Kanai, *Teysmann* 5981 (isotype K!).

Thailand.— NORTHERN: Tak (Ban Na, Doi Musoe), Sukhothai (Khao Luang), Phitsanulok (Thung Salang Luang); NORTH-EASTERN: Phetchabun, Loei (Wang Sapung), Udon Thani, Nong Khai (Bung Khla, Dong Sichompu, Phon Phisai, Seka), Sakon Nakhon (Phu Phan, Wa Nawn), Nakhon Phanom (Phu Langka), Kalasin, Maha Sarakham (Kosumpisai), Khon Kaen (Tha Phra); EASTERN: Chaiyaphum, Nakhon Ratchasima (Bua Yai, Khao Yai), Buri Rum (Nang Rong), Surin (Sangka), Si Sa Ket (Kantharom), Ubon Ratchathani; SOUTH-WESTERN: Uthai Thani (Huai Kha Khaeng), Kanchanaburi (Khao Thong, Wang Kanai), Phetchaburi (Cha-am), Prachuap Khiri Khan (Nong Kae); SOUTH-EASTERN: Sa Kaeo (Aranya Prathet), Prachin Buri, Chon Buri (Siracha), Chanthaburi (Makham), Trat (Klong Yai, Takam).

Distribution.— Indo-China.

Ecology.— In open dry dipterocarp forest, 0–1,100 m.

Vernacular.— Khao yen noen (ข้าวเย็นเนิน), du bia (ดูเบีย), du tia (ดูเตี้ย), thanong, rak thanong (รักทอง), thanong daeng (ทองแดง), nang saeng (นางแซง), lot thanong (โลดทอง), lot thanong daeng (โลดทองแดง), nat kham (หนาดคำ), hua ya khao yen noen (ห้วยข้าวเย็นเนิน).

Uses.— Roots applied as emetic, anti-asthmatic and laxative.

Specimens examined.— *Adisai* 537 (BK); *K. Aekumphon* s.n. (AAU); *D. Bourcke* s.n. (AAU, BK s.n. 239876, K); *K. Bunchuai* 1583 (AAU, BKF, L); *D. Bunpheng* 14 (BKF), 809 (BKF, K); *P. Chantaranonthai, D. Middleton, J. Parnell & D. Simpson* 874 (K); *P.*

Chantaranothai, *J. Parnell* & *D. Simpson* 90-498 (K, KKU, 2 sheets, TCD); *C. Chermersirivathana* s.n. (BK s.n. 239840); *D.J. Collins* 1596 (BK, K), 1670 (BK, K); *N. Fukuoka* T-36190 (BKF); *R. Geesink*, *T. Hattink*, *C. Phengklai* 6514 (AAU, BKF, K, L); *M. Greijmans* 82 (BKF); *S. Homchurn* s.n. (BCU); *A.F.G. Kerr* 2305 (AAU, BM, E, K, P), 2549 (AAU, BM, E, K), 2967 (BM, E, K), 5690 (BK, BM, K), 8254 (BK, BM, K, L), 8480 (BK, BM, K), 8486 (L), 10622 (BK, BM, K, TCD), 12833 (BK, BM, K, L), 17871 (BK, BM, K), 19288 (BK, K, TCD), 19626 (BK, BM, K), 19769 (BK, BM, K, L, P), 19888 (BK, BM, E, K, L, TCD), 19956 (BK, BM, K), 20491 (BK, BM, K, L), 20585 (BK, BM, K), 21539 (BK, BM, K, L), s.n. (BK s.n. 239839, BM), s.n. (BM), *Kosum et al.* 42 (BCU), 153 (BCU); *H. Koyama*, *H. Terao* & *Th. Wongprasert* T-30630 (BKF); *M.C. Lakshanakara* 401 (BK, K), 479 (BK, BM, K); *K. Larsen*, *S.S. Larsen*, *I. Nielson* & *T. Santisuk* 32347 (AAU, BKF, K, L, P); *A. Marcan* 374 (BM, 2 sheets, K), 1742 (BM); *J.F. Maxwell* 71-728 (BK), 72-112 (BK), 75-439 (AAU, BK, L), 76-86 (AAU, BK, L), 76-271 (AAU, BK), s.n. (AAU); *G. Murata* & *C. Phengklai* T-50368 (BKF); *G. Murata*, *N. Fukuoka* & *C. Phengklai* T-17668 (AAU, BKF, L), T-17669 (BKF, L, 2 sheets); *C. Nilaviset* 13 (BKF, K); *Patrikan* & *Prayad* 84 (BK), 164 (BK); *C. Phengklai* 159 (AAU, BKF, E, L, P); *C. Phengklai et al.* 3586 (BKF, 3 sheets, PSU); *Ploenchit* 409 (BCU, BK); *R. Pooma* 401 (BKF); *R. Pooma*, *V. Chamchumroon*, *N. Kaonkhunthod* & *P. Chantaboon* 3453 (BKF); *R. Pooma*, *W.J.J.O. de Wilde*, *B.E.E. Duyffes*, *V. Chamchumroon* & *K. Phattarahirankanok* 2893 (BKF); *Pradit* 692 (BK), 873 (BK); *Pradit* & *Adisai* 393 (BK); *Put* 10 (BKF), 4225 (AAU, BK, BM, E, K); *T. Smitinand* 10412 (BKF, K, L, P); *T. Smitinand* & *Ploenchit* 595 (BKF); *S. Sooksawat* s.n. (BKF, s.n. 252784, 4 sheets); *S. Sutheesorn* 440 (BK), 3009 (BK); *P. Suvanakes* 1322 (K), 1449 (BKF, 2 sheets, K); *S. Sutheesorn* & *J. Sadakorn* 2111 (BK); *O. Thaihong et al.* 10 (BCU); *P. Trisarasm* 351 (BCU); *Umpai* 359 (BK), 368 (BK); *Vacharee* & *Santi* 1018 (BK); *C.F. van Beusekom* & *C. Phengklai* 1069 (AAU, 2 sheets, BKF, E, L); *Winit* 284 (BM, K), 285 (BM, K), 556 (K); *Th. Wongprasert et al.* s.n. (BKF s.n. 122317); *S.N.* 10 (BKF).

Note.— *T. reidioides* is the most common species in Thailand except in the Peninsular. The plant has either reddish or white flowers.

13. *Trigonostemon thyrsoideus* [thyrsoideum] Stapf, Bull. Misc. Inform., Kew 1909: 264. 1909; P.H.Hô, *Câyco* Vietnam 2(1): 344. 1992. Type: China, Yunnan, *Henry* 11947 (holotype K!).

Thailand.— NORTHERN: Mae Hong Son, Chiang Mai (Doi Chiang Dao, Doi Inthanon), Chiang Rai (Khunkon waterfall), Phrae (between Pha Tuem and Ban Phra).

Distribution.— Myanmar, China (Yunnan), Vietnam, Laos.

Ecology.— In evergreen or pine-dipterocarp forest, 600–1,500 m.

Specimens examined.— *T. Boonkird et al.* 830 (BCU); *H. Koyama*, *H. Terao* & *Th. Wongprasert* T-32586 (BKF), T-39239 (BKF), T-39411 (BKF); *K. Larsen*, *T. Santisuk* & *E. Warncke* 2697 (AAU, BKF, E, K); *Martriss van de Bult* 343 (BKF); *J.F. Maxwell* 97-615 (BKF, L), 97-900 (BKF, L, 2 sheets); *C. Phengklai et al.* 7123 (BKF, 2 sheets); *J. Sadakorn* 578 (BK, 2 sheets); *T. Smitinand* & *A.S. Cheke* 10827 (BKF, K, L, P).

Note.— *T. thyrsoideus* is distinguishable from *T. quocensis* by its five stamens and longer capsule.

14. *Trigonostemon verticillatus* (Jack) Pax & K. Hoffm. in Engl., Pflanzenr. IV.147.iii: 87. 1910.— *Enchidium verticillatum* Jack in Malayan Misc. 2(7): 90. 1822 & in Comp. Bot. Mag. 1: 257. 1836 (excl. syn. Rumphl.); Müll. Arg. in DC., Prodr. 15(2): 1256. 1866; Merr., J. Arn. Arb. 33: 224. 1952. Type: Indonesia, Sumatra (not located).— *Telogyne indica* Baill., Étude Euphorb.: 238. 1858. Type: (not located).— *Trigonostemon indicus* (Baill.) Müll. Arg., Linnaea 34: 214. 1865 & in DC., Prodr. 15(2): 1107. 1866; Hook.f., Fl. Brit. Ind. 5: 398. 1887; Ridl., Fl. Malay Penins. 3: 264. 1924.

Thailand.— SOUTH-EASTERN: Chanthaburi (Phlio waterfall, Khao Sabap); PENINSULAR: Ranong (Kam Puan, Klong Naka), Phangnga (Ko Yao Yai, Takuapa), Narathiwat (Sukhirin).

Distribution.— Malaysia, Indonesia (Sumatra).

Ecology.— In evergreen forest, 0–300 m.

Specimens examined.— V. Chamchumroon, C. Puff & N. Koonkhunthod 1291 (BKF, 2 sheets); N. Fukuoka & M. Ito T-34941 (BKF, L); R. Geesink, P. Hiepko & C. Charoenphol 7529 (AAU, BKF, K, L); R. Geesink & T. Santisuk 4961 (AAU, E); Haniff & Nur 2745 (K); A.F.G. Kerr 16822 (L), 16862 (BK, BM, K), 17328 (BK, BM, K); K. Larsen & S.S. Larsen 32956 (AAU, BKF, K), 33402 (AAU); T. Santisuk 616 (BKF, 4 sheets); T. Shimizu, H. Toyokuni, H. Koyama, T. Yahara & C. Niyomdham T-26537 (BKF); P. Sirirugsa 521 (PSU); Th. Sørensen, K. Larsen & B. Hansen 668 (K); C. F. van Beusekom & C. Phengklai 726 (L); Vidal 5766 (K).

Note.— *T. verticillatus* is closely related to *T. malaccanus* Müll. Arg. from the Malesian region but differs in its pistillate and staminate flowers on the same spike.

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REFERENCES

- Airy Shaw, H.K. 1972. The Euphorbiaceae of Siam. Kew Bulletin 26: 191–363.
 Milne, R. 1995. Notes on Bornean and other West Malesian *Trigonostemon* (Euphorbiaceae). Kew Bulletin 50(1): 25–49.

- Müller, J. 1866. Euphorbiaceae (excluding Euphorbieae). In: De Candolle, A. *Prodromus Systematis naturalis Regni Vegetabilis* 15(2): 189–1260. V. Masson et fils, Paris.
- Pax, F. & Hoffmann, K. 1911. Euphorbiaceae-Cluytieae. In: Engler, A., *Das Pflanzenfamilien*, Heft 47: 1–124. Wilhelm Engelmann, Berlin.
- Radcliffe-Smith, A. 2001. *Genera Euphorbiacearum*, Royal Botanic Gardens, Kew. Webster, G.L. 1975. Conspectus of a new Classification of the Euphorbiaceae. *Taxon*. 24(5/6): 593–601.
- Wurdack, K.J., Hoffmann, P., and Chase, M.W. 2005. Molecular phylogenetic analysis of uniovulate Euphorbiaceae (Euphorbiaceae sensu stricto) using plastid *rbcL* and *trnL-F* DNA sequences. *American Journal of Botany* 92: 1397–1420.