

A TAXONOMIC REVISION OF INDIAN *TRIGONOTIS* STEV. (BORAGINACEAE)

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ABSTRACT

Trigonotis Stev. (Boraginaceae—Eritrichieae), occurring in Asia and temperate Melanesia has about 35 species. The area taken up for revision is India, including Sikkim and Bhutan. C.B. Clarke (1883) described 5 species from this area. Since then one species and a variety have been added to the list of Indian *Trigonotis*, by nomenclatural transfers (Johnston, 1925), and *T. gracilipes* Johnst., a Chinese plant, has also been reported from Sikkim (Johnston, 1937). The author now adds two more species, *T. caespitosa* Banerjee, *T. smithii* Banerjee and one variety, *T. multicaulis* Benth. ex Clarke var. *cavei* Banerjee, which are new to science. These new taxa are described here.

Efforts have been made to give full descriptions and synonymy of the other taxa taken up for revision, along with a workable key. Nomenclature has been checked and revised wherever necessary.

INTRODUCTION

Trigonotis Stev. is a genus with thirty-five species distributed in Asia and temperate Melanesia. Johnston (1937) recorded 16 species from S. W. China. Later with the merging of *Zoelleria* Warb. (1892) and *Havilandia* Stapf (1894) in *Trigonotis*, Johnston (1940) made nomenclatural transfers of eight Malaysian species belonging to the genera *Zoelleria* and *Havilandia*. Brand (1925) erected the genus *Pedinogyne* based on *Trigonotis tibetica* (Clarke) Johnst. But later he (1931) treated this genus as synonymous with *Trigonotis*. Clarke (1883) described 5 species from the area under study here—India, including Sikkim and Bhutan. With the transference of *Eritrichium tibeticum* Clarke var. *tibeticum* and *E. tibeticum* var. *minor* Clarke under the genus *Trigonotis* by Johnston (1925), 6 species and 1 variety are described from India. *T. tibetica* (Clarke) Johnston, is a Tibetan plant which crosses to India, first reported from Sikkim Himalaya by Smith and Cave (1911). I have described 9 species and 2 varieties from India, of which 2 species and 1 variety are new. *T. gracilipes* Johnst., a Chinese plant has been recorded from Sikkim by Johnston (1937).

This genus ranks among the more difficult in the family Boraginaceae. Brand (1931) in his treatment eritrichioid Boraginoideae substituted the name Cryptanthaeae for the well-established tribal name, Eritrichieae, arguing that the latter is inappropriate since the genus *Eritrichium* Schrad., is now considered a small genus and since it is not characteristic of the tribe. Johnston (1937) argues that the old tribal name Eritrichieae should be maintained as it has wide use. Apart from wide use, it is to be maintained according to the code, the nomenclatural type of a taxon between family and genus is the genus on whose present or former name that

of the taxon concerned is based. As long it is extant, it automatically fixes the application of the name concerned.

The specific and infraspecific delimitations are often based on minute details that demand careful examination. So to differentiate between taxa is at times rather difficult.

The genus *Trigonotis* has close affinities with *Eritrichium*. As in other genera of the Subfamily Boraginoideae, the nutlet character is very important in determining the identity of different taxa under it. The decidedly tetrahedral nutlet in most of the species under this genus is very characteristic. But all the species of *Trigonotis* do not have tetrahedral nutlets. In some species from S. W. China Johnston has observed bifacial nutlets which are similar in gross aspects to those found in the genus *Myosotis*. In *T. ovalifolia* Benth. ex Clarke, *T. hookeri* Benth. ex Clarke, and *T. microcarpa* Benth. ex Clarke the nutlets are truly tetrahedral. The inferior face of truly tetrahedral nutlets is morphologically equivalent to the lower half or third of the dorsal face in the bifacial nutlets. The dorsal face of the truly tetrahedral nutlets has been set off from the lower face by the formation of a mediotransverse angle across the back of an erect bifacial nutlet (Johnston, 1937), which is quite evident in the nutlets of *T. ovalifolia*. The trigonal nutlets of *T. multicaulis* Benth. ex Clarke, have developed due to suppression or poor development of basal inferior face of truly tetrahedral nutlets. In *T. rotundifolia* Benth. ex Clarke, nutlets are trigonal due to suppression or very poor development of the dorsal outer face, the three inner faces subequal, developed into 3 wing-like outgrowths. In most species the nutlets are stipitate, the stipe either straight or abruptly bent to one side. The small attachment of nutlets is at

the basal end of the ventral keel. Morphologically the attachment is medially and laterally to a very depressed gynobase (Johnston, 1924). Earlier workers (Clarke, 1883 etc.) placed this genus under the Lithospermeae with the idea that the attachment is at the broad base of the nutlet-body. The observations of the present author are mostly based on type materials available in Herb. CAL.

TRIGONOTIS Stev.

Trigonotis Stev. in Bull. Soc. Nat. Mosc. 24(1) : 603, 1851; Benth. et Hook. f. Gen. Pl. 2:858, 1876; C. B. Clarke in Hook. f. Fl. Brit. Ind. 4: 171, 1883; Gurke in Engl. et Prantl, Naturl. Pfl. Fam. IV. 3: 121, 1897. Type species: *T. clavata* Stev. *Eritrichium* Sect. *Endogonia*, et Sect. *Oreocharis* quoad species *brevifloras*, A. DC. in DC. Prodr. 10: 128, 1846. *Endogonia* Lindl. Veg. Kingd. ed. 2, 656, 1847. *Zoelleria* Warb. in Bot. Jahrb. 14: 123, 1892. Type species: *Z. procumbens* Warb. *Havilandia* Stapf in Trans. Linn. Soc. Ser. II, 4: 209, 1894. Types species: *H. borneensis* Stapf, *Pedinogyne* Brand in Fedde, Repert. 21: 251, 1925. Type species: *P. tibetica* (Clarke) Brand.

Perennial herbs, weak or diffuse, more or less hairy, often caespitose. Stems slender, cylindrical, usually sparsely strigose. Leaves simple, alternate, ovate-elliptic or lanceolate, exstipulate, mostly petiolate, lower ones usually with much larger petioles, petioles of upper cauline leaves gradually smaller, strigose. Inflorescence long, elongate, often short and dense, ebracteate or the lower pedicels bracteate. Flowers small, gamopetalous, corolla lobes distinct, often rotate, hypogynous. Calyx gamosepalous, 5-fid or 5-partite, strigose, in fruit not or slightly enlarged. Corolla small, blue or white, gamopetalous, tube short, shorter than calyx, throat with 5 small, obtuse scales, lobes 5, orbicular, imbricate in bud, obtuse, spreading. Stamens 5; epipetalous, included, usually inserted at the middle of the short corolla tube, filaments short, anthers ovate or oblong, obtuse. Ovary superior, deeply 4-lobed; style short; stigma capitate. Nutlets 4, usually tetrahedral, with 4 acute or rounded or winged marginate edges, or trigonal due to the suppression of basal inferior face of tetrahedral nutlets, hardly longer than broad, brown or shining black, smooth, glabrate, usually non-muriculate but muriculate in a few non-Indian species (nutlets of *T. microcarpa* Benth. ex Clarke also minutely muriculate on the outer dorsal face only visible under high magnifications); attachment scar of nutlets small, at the basal end of the ventral keel, sub-

sessile or stipitate, stipe straight or abruptly bent on one side.

KEY TO THE SPECIES AND VARIETIES OF *TRIGONOTIS*

- A₁ Nutlets glabrous
 - B₁ Corolla 2-3 mm long
 - C₁ Cauline leaves lanceolate, narrowed or acute at both ends
 - D₁ Nutlets tetrahedral, outer face triangular, flat ... 1. *T. microcarpa*
 - D₂ Nutlets trigonal, outer face ovate, rounded
 - E₁ Inflorescence axes long, elongate ... 2. *T. multicaulis* var. *multicaulis*
 - E₂ Inflorescence axes short, dense ... 2a. *T. multicaulis* var. *cavei*
 - C₂ Cauline leaves ovate-oblong, rounded or obtuse at both ends
 - D₁ Habit caespitose; nutlet-stipe straight ... 3. *T. caespitosa*
 - D₂ Habit diffuse; nutlet-stipe abruptly bent to inner side
 - E₁ Stems 15-25 cm long; lamina 5-15 mm long ... 4. *T. tibetica* var. *tibetica*
 - E₂ Stems 5-8 cm long; lamina 2-4 mm long ... 4a. *T. tibetica* var. *minor*
 - B₂ Corolla 5-7 mm long
 - C₁ Nutlets trigonal, sub-sessile ... 5. *T. rotundifolia*
 - C₁ Nutlets tetrahedral, distinctly stipitate ... 6. *T. smithii*
- A₂ Nutlets minutely patently hairy on all sides or at angles and ridges only
 - B₁ Leaves orbicular or elliptic, lamina 2-3 cm long; nutlets distinctly stipitate
 - C₁ Diffuse herbs; flowers never extra-axillary nor solitary ... 7. *T. ovalifolia*
 - C₂ Caespitose herbs; flowers extra-axillary often solitary ... 8. *T. gracilipes*
 - B₂ Leaves lanceolate, lamina 5-8 cm long ... 9. *T. hookeri*

ENUMERATION

1. **Trigonotis microcarpa** (DC.) Benth. ex Clarke in Hook. f. Fl. Brit. Ind. 4: 172, 1883; Smith & Cave in Rec. bot. Surv. India 4: 226, 1911 & Smith l. c. 4: 398, 1913; Johnston in Journ. Arnold Arbor. 18: 7, 1937. Type: From Nepal, Wallich 928; Isotype in Herb. CAL. *Eritrichium microcarpum* DC. Prodr. 10: 123, 1846. *T. peduncularis* var. *microcarpa* (DC.) Brand in Engl. Pflanzenr. 97: 198, 1931.

Weak herb, more or less hairy, slender, perennial, 15-35 cm long. Stem slender, cylindrical, hairy, divided, often more or less procumbent. Leaves simple, mostly cauline, alternate, entire, acute to sub-mucronate, petiolate, exstipulate, minutely appressed-strigose on both surfaces, obtuse or rounded at base, mature leaves 1-4.5 cm broad, basal leaves rather larger than the upper cauline ones and also larger-petioled, ovate-elliptic to lanceolate. Flowers small, white to bluish-white, bisexual, hypogynous,

pedicellate, pedicels upto 0.5 cm long, in terminal, diffuse and lax, ebracteate racemes, terminal portions of inflorescence-axes helicoid, lower flowers sometimes in the axils of leaves. Calyx gamosepalous, sepals 5, ovate-acute, strigose, persistent, slightly enlarged in the fruit, 2 mm long. Corolla gamopetalous, petals 5, imbricate, spreading, throat with 5 small scales, 2.5-3 mm long. Stamens 5, epipetalous, adnate to the middle of the corolla tube, included, anthers bilobed, oblong-obtuse, filament short. Ovary superior deeply 4-lobed; style short, stigma capitate. Nutlets 4, subequal, tetrahedral with 3 ventral and 1 dorsal faces, submarginate, margins acute, 1 mm long, faces triangulate, outer dorsal face minutely-muriculate; inner ventral faces glabrous, sub-stipulate, stipe formed by the prolongation of the ventral keel, attachment-scar basal, stipe slightly bent to one side.

Flowering and Fruiting: June-July, often extending upto September-October.

Indian Specimens Examined: NEFA: Rupa to Bomdila, 2266 m, Kameng F.D., Rolla S. Rao 7313 (ASSAM). NAGALAND: Zhakhama, Naga Hills, N. L. Bor 4416 (CAL); Kegurima, 1676 m, Naga Hills, C. B. Clarke 41908A (CAL); Dzulasace Valley, Naga Hills, 2438 m, N. L. Bor's Collector, Acc. no. 90839 (DD); Naga Hills, Assam, N. L. Bor 4416 (DD); Deulake Valley, Naga Hills, 2438 m, Sept. 1939, N. L. Bor's Collector, Acc. no. 90837 (DD); Phikrokedzema, 1524 m, N. L. Bor 16234 (DD). SIKKIM: Cheungtong, Zemu Valley, 2134 m, Sikkim, W. W. Smith 3348 (CAL); Cheungtong, 1829 m, Smith & Cave 893 (CAL); Sikkim, 1829-2743 m, J. D. Hooker Acc. no. 308535 (CAL); Lachung Valley, Sikkim, 2134 m, G. A. Gamble 1186 (CAL); Tong, 1524 m, F. E. Younghusband 1552 (CAL); Singhik, 1365 m, Himalaya, K. Biswas 6795 (CAL).

Distribution: Nepal, Sikkim, Nagaland, NEFA and S. W. China.

2. *T. multicaulis* (DC.) Benth. ex Clarke in Hook. f. Fl. Brit. Ind. 4: 172, 1883; Smith & Cave in Rec. bot. Surv. India 4: 226, 1911. Typus ex Nepal, Wallich 7020, Isotypus in Herb. CAL. var. *multicaulis*. *Ertrichium multicaule* DC. Prodr. 10: 123, 1846.

Minutely strigose, weak perennial herb with a cluster of stems arising from slender root-stock. Stems arising from above the basal portion, slender, cylindrical, minutely sparsely strigose, upto 25 cm long. Leaves simple, alternate, exstipulate, entire, midrib only impressed, minutely strigose on both surfaces, basal leaves long-petioled, petioles upto 4 cm long. Lamina elliptic-lanceolate, acute,

upto 2 cm long and 1 cm broad, upper cauline leaves subsessile, smaller, elliptic-lanceolate, acute, narrowed at both ends, apex acute, 2 cm long, 1 cm broad. Flowers small, ebracteate, in terminal cincinni when young, lax-elongate in fruit, hypogynous, pedicellate. Calyx gamosepalous, sepals 5, ovate-acute, entire, strigose, 1 mm long, slightly larger in fruit. Corolla gamopetalous, regular, 2-3 mm long, petals 5, entire, orbicular-obtuse, imbricate in bud, tube short, throat of corolla covered by 5 obtuse scales. Stamens 5, epipetalous, adnate to the corolla tube, anthers bilobed, oblong-obtuse. Ovary superior, deeply 4-lobed, style short, filiform, gynobasic, stigma capitate. Nutlets 4, 1-1.5 mm long, glabrate, trigonal due to suppression or poor development of basal inferior face of tetrahedral nutlets, margins acute, brown, sub-stipitate, stipe formed by the prolongation of the ventral keel, straight or slightly decurved, attachment scar broad, basal.

Flowering and Fruiting: July-August.

Indian Specimens Examined: SIKKIM: Sikkim Himalaya, King's Collector, Acc. no. 308560 (CAL); Zemu Valley, Sikkim, 3810 m, Smith & Cave 1181 (CAL); Temurchenchu, Sikkim, 3962 m, Smith & Cave 1686 (CAL); Changu to Laghep, Sikkim, 3353 m, W. W. Smith 3367, 3368, 3072 (CAL); Zemu Valley, Sikkim, Smith & Cave 1354, 1158 (CAL).

Distribution: Central and Eastern Himalaya, Nepal, Sikkim, 3048-4267 m.

2a. *T. multicaulis* var. *cavei* Ban. var. nov. (Plate I)

Varietas habitu *T. multicauli* Benth. ex Clarke affinis at foliis acuminatis, costis primariis et secundariis infra impressis, pedunculo brevior corollaque majore differens.

Herba debilis, perennis, basi suffrutescente veterum foliorum basibus operta. Rami pauci, tenues, simplices e basi suffrutescente emergentes usque 30 cm longi, paulisper pilosi, longis internodiis. Folia simplicia, alterna, estipulata; inferiora e basi suffrutescente, radicalia et longiora, petiolis 6-8 cm longis, tenuibus, paulo basin amplexantibus, gradatim versus apicem minuentibus; lamina 3-4 cm longa, integra, ad utrumque apicem angustatis. Folia superiora subsessilia, lanceolata, ad utrumque apicem angustata, paulum acuminata, strigose adpressa, costis infra laeviter impressis. Flores pauci in breves densas cymas fasciculatas dispositi. Calyx gamosepalus, profunde 5-partitus, 1.5 mm longus; sepala 5 lanceolata, acuta, ciliata, extus strigosa. Corolla gamopetala, rotata, 4-4.5 mm longa, lobis 5 orbiculatis fauceque 5 squamis obtusis operta.

Stamina 5, epipetala; filamenta brevissima, paulo supra medium tubo corollae adnata; antherae bilobae, usque 1 mm longae. Stylus brevis e basi ovarii originem ducens. Receptaculum planum. Nucelli 4, substipitati, trigoni.

Typus ad Eumtso La, Sikkim, die 17 julii 1909 a Smith & Cave lectus sub numero *Smith & Cave* 1607A. Typus, et isotypus 1607B, in CAL positi sunt.

Perennial weak herb, a few slender, simple branches arising from suffrutescent base, base covered with older leaf-bases, branches slender, upto 30 cm long, sparsely hairy, internodes long. Leaves simple, alternate, exstipulate, lower radical leaves from the suffrutescent base longer, lamina 3-4 cm long,

narrowed at both ends, slightly acuminate, appressed strigose, with nerves (veins) slightly impressed below. Flowers few, clustered in terminal, short, dense cymes. Calyx gamosepalous, deeply 5-partite, slightly united below, 1.5 mm long, sepals 5, lanceolate, acute, ciliate, strigose on the outer side. Corolla gamopetalous, rotate, 4-4.5 mm long, lobes 5, orbicular, throat of corolla covered with 5 obtuse scales. Stamens 5, epipetalous, adnate to just above the middle of the corolla tube, anthers bilobed, upto 1 mm long, filament very short. Style short, gynobasic receptacle flat. Nutlets 4, substipitate, trigonal.

Indian Specimens Examined: SIKKIM: Eumtso La (Yumchhola), Sikkim, 4267 m, 17 July, 1909, *Smith & Cave* 1607A, Holotype (CAL), *Smith & Cave* 1607B, Isotype (CAL).

3. *T. caespitosa* Ban. sp. nov. (Plate II)

T. rotundifoliae Benth. ex Clarke affinis, tamen differt habitu caespitoso nucellisque trigonis, stipitatis.

Herba perennis, debilis, strigosa, pluribus longis fibrosis que radicibus praedita, et formans compactam fere 10 cm in diam. tegetem. Caules plures, tenues, debiles, cylindrici, densis strigosisque operti; rami 5-6 cm longi, dense caespitosi. Folia simplicia, alterna, estipulata, integra, obtusa, costis tantum medianis impressis, forma variabilia; inferiora petiolis usque 1.5 cm longis, basibus caulem laeviter amplexantibus; superiora praesertim prope inflorescentiam subsessilia. Lamina ovato-oblonga vel lanceolata, utraque facie minute strigosa, 10-15 mm longa, 5-7 mm lata. Flores pusilli, ebracteati, regulares, racemis terminalibus, pedicellis tenuibus usque 2 mm longis. Calyces gamosepali, infra paullisper connati, 5 lobis, 1.5 mm longis, lanceolatis, integris, acutis, capillis hispidis extra intusque coopertis; fructiferi parum accrescentes, usque 3 mm longi. Corollae gamopetalae, tubulato-rotatae, 3-3.5 mm longae, tubis cylindricis 1-1.5 mm longis, lobis 5, ovato-obtusis, 1.5-2 mm longis, extra glabratis, intus minute pilosis, fauce obtusis 5 squamis operti. Stamina 5, epipetala, inclusa; filamenta brevissima, medio tubi adnata; antherae ovatae, bilobae, dorsifixae, 0.5 mm longae. Ovarium superius, profunde 4-lobatum; stylus tenuis, 1.5 mm longus e basi ovarii originem ducens, stigma capitatum; receptaculum planum. Nucelli 4, trigoni, anguste alati, fusco-nitide stipitibus rectis, cicatricibus ad basim ornati, 1.5 mm longi.

Typus: *Smith & Cave* 2220 apud Goraphu Chu, Llonakh, Sikkim, die 6a aug. 1909 lectus et in CAL positus.

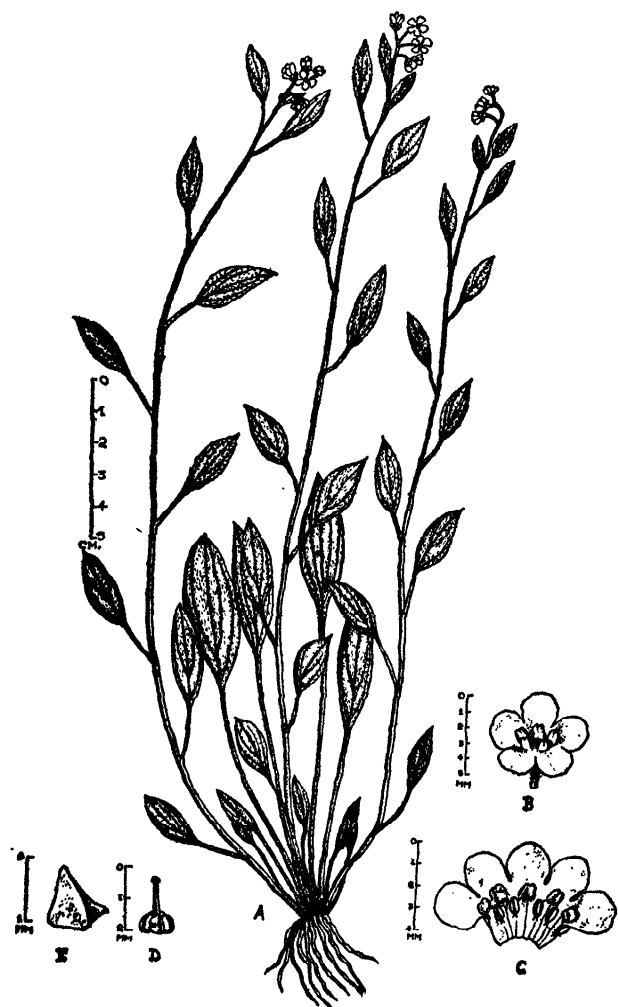


Plate I. *T. multicaulis* (DC.) Benth. ex Clarke var. *cavei* Ban.
Figs. A-E: A. Habit. B. Flower. C. Corolla split open.
D. Gynoecium. E. Nutlet.

entire, narrowed at both ends, shortly acuminate, petioles 6-8 cm long, slender slightly sheathing at the base, becomes gradually smaller in the upper cauline leaves which are sessile, lanceolate,

Perennial, weak, strigose herb, forming a compact rosette nearly 10 cm in diameter with a cluster of numerous long, fibrous roots. Stems many, slender, weak, cylindrical, covered with dense strigose hairs, branches 5-6 cm long, densely caespitose. Leaves simple, alternate, exstipulate, entire,

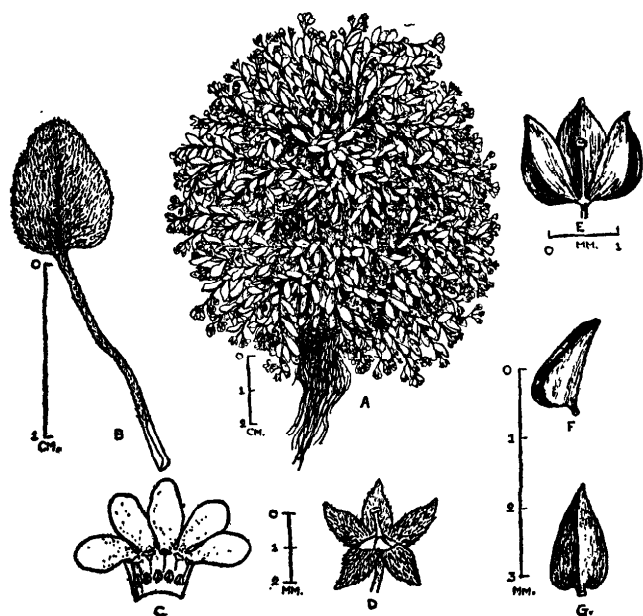


Plate II. *Trigonotis caespitosa* Ban.

Figs. A-G : A. An entire plant. B. An enlarged basal leaf. C. Corolla split open. D. Calyx and gynoecium. E. Fruit with one of the nutlets removed to show their attachment. F. Lateral view of a nutlet with stipe, produced by the prolongation of the ventral keel. G. Ventral view of a nutlet.

obtuse, midrib only impressed, variable in shape, lamina ovate-oblong to lanceolate, 10-15 mm long, 5-7 mm broad, minutely strigose on both surfaces, lower leaves long-petiolate, petioles upto 1.5 cm long, leaf-base slightly sheathing, uppermost near the inflorescence subsessile. Flowers small, ebracteate, regular, hypogynous, pedicellate, pedicels upto 2 mm long, slender, in terminal, few-flowered racemes. Calyx gamosepalous, slightly united below, sepals 5, lanceolate, entire, acute, 1.5 mm long, with long, straight, hispid hairs on both inner and outer sides, slightly enlarging in fruit, fruiting calyx upto 3 mm long. Corolla gamopetalous, tubular-rotate, 3-3.5 mm long, tube cylindrical, 1-1.5 mm long, lobes 5, ovate-obtuse, 1.5-2 mm long, outer face glabrate, inner side minutely hairy, throat of corolla covered with 5 obtuse scales. Stamens 5, epipetalous, included, adnate to the middle of the corolla-tube, filaments very short, anthers ovate, 0.5 mm long, bilobed, dorsifixed. Ovary superior, deeply 4-lobed; style slender, short, 1.5 mm long gynobasic, stigma capitate, receptacle flat. Nutlets 4, trigonal, narrowly winged, shining-

brown, stipitate, stipe straight, attachment scar basal, nutlets 1.5 mm long.

Flowering and Fruiting : July-August.

Indian Specimens Examined : SIKKIM : Goraphu Chu, Llonakh, Sikkim, 4785 m, 6th August, 1909, Smith & Cave 2220, Acc. no. 308558, Holotype (CAL).

Distribution : Sikkim Himalayas.

Notes : Smith and Cave, in *Rec. bot. Surv. India* 4 : 226 (1911), described this species as "Perhaps only a variety of the above (i.e. *T. rotundifolia*); forms a compact rosette nearly 10 cm in diameter; the inflorescences very short and with smaller flowers than the type."

I have thoroughly examined the sheet and compared it with all the available materials, including type materials, of the Indian species at Herb. CAL. *T. caespitosa* has little affinity with *T. rotundifolia*, differing from it by its nutlet characters and caespitose habit. The nutlets in *T. caespitosa* are stipitate, with 2 ventral and 1 broad dorsal faces, with acute edges, whereas in *T. rotundifolia* the nutlets are sessile, trigonal and 3-winged. On the other hand, *T. caespitosa* is allied to *T. multicaulis* by its nutlet characters, but differs from it by its habit, which is compact, dense and clustered, with shorter branches, leaves which are obtuse or rounded at the apices, and shorter inflorescence axes. For the above differences, I have treated this plant as a new species.

4. *T. tibetica* (Clarke) Johnst. in Contr. Gray Herb. Harv. 75 : 48, 1925; Brand in Engl. Pflanzenr. 97 : 20, 200, 1931; Hao in Bot. Jahrb. 68 : 632, 1938. Type : From Tibet, Hook. f. & Thoms., *Eritrichium* sp. n. 17, Isotype in Herb. CAL., Acc. no. 307586. var. *tibetica* (Plate III). *Eritrichium tibeticum* Clarke in Hook. f. Fl. Brit. Ind. 4 : 165, 1883; Smith & Cave in Rec. bot. Surv. India 4 : 226, 1911 and Smith l. c. 4(7) : 398, 1913. *Pedinogyne tibetica* (Clarke) Brand in Fedde, Rept. 21 : 251, 1925.

Lax, weak, diffuse, more or less hairy, perennial herb with slender root-stock. Stems many, 15-25 cm long, slender, covered with short appressed hairs. Leaves simple, alternate, petiolate, elliptic ovate to lanceolate, scabrous, appressed hairy, midrib only impressed, apex obtuse, upto 2 cm long and 8 mm broad. Flowers small, ebracteate, or lower pedicels bracteate, pedicellate, regular, pentamerous, in lax, diffuse terminal racemes, tips helicoid. Calyx gamosepalous, deeply 5-partite, lobes entire, acute, strigose, upto 1.5 mm long, persistent. Corolla gamopetalous, petals 5, obovate,

imbricate, entire, upto 2 mm long, throat of corolla with 5 small obtuse scales. Stamens 5, epipetalous, attached to the middle of the corolla tube, included, anthers bilobed, oblong, obtuse, filaments short.

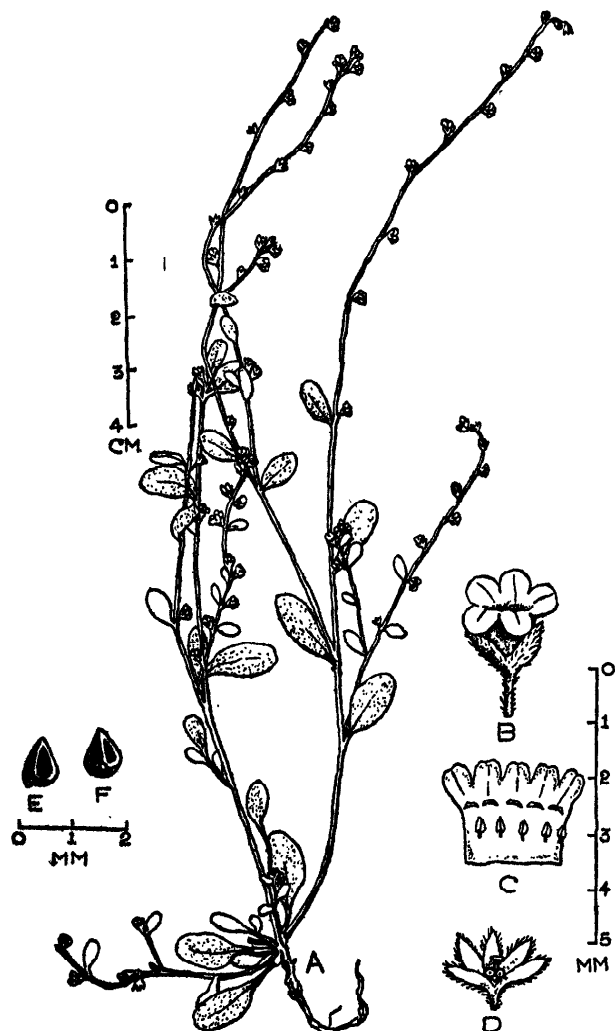


Plate III. *Trigonotis tibetica* (Clarke) Johnston var. *tibetica*
Figs. A-F : A. Habit. B. Flower. C. Corolla split open.
D. Calyx and gynoecium. E. & F. Nutlets.

Ovary 4-lobed, style short, gynobasic, stigma small, capitate. Fruit of 5 nutlets, nutlets 1 mm long, tetrahedral, with 4 acute or submarginate edges, stipitate, stipe abruptly bent to one side, brown, glabrous, shining, attachment scar small, basal.

Flowering and Fruiting : July-September.

Indian Specimens Examined : SIKKIM: Naku La, 4876 m, Sikkim, *Smith & Cave* 2787 (CAL); Nache-goh, Sikkim, 4419 m, *Smith & Cave* 1708 (CAL).

Distribution : Western Tibet, Ladak and Alpine Sikkim upto 5000 m.

Notes : *T. tibetica* was first reported from Sikkim Himalaya by W. W. Smith and G. H. Cave in *Rec. bot. Surv. India* 4 : 226, 1911. They have also mentioned the following specimens, nos. 1354,

3367, 1686, 1158 and 3368 under *E. tibeticum* but these sheets cannot be matched with the type materials of this species. In the leaf and nutlet characters these sheets agree fairly closely with *T. multicaulis*; so I have transferred and mentioned these sheets under *T. multicaulis*.

4a. *T. tibetica* var. *minor* (Clarke) Johnston. in *Contr. Gray Herb. Harv.* 75 : 48, 1925. Type : From Sikkim, *Hook. f. & Thoms.*, *Eritrichium* sp. n. 15, Isotype in Herb. CAL., Acc. no. 307585. *Eritrichium tibeticum* var. *minor* Clarke in *Hook. f. Fl. Brit. Ind.* 4 : 165, 1883; Smith and Cave in *Rec. bot. Surv. India* 4 : 226, 1911. *Pedinogyne tibetica* (Clarke) Brand var. *minor* (Clarke) Brand in *Fedde, Repert.* 21 : 251, 1925.

Small, lax, weak, diffuse, strigose herb. Stems slender, covered with small appressed hairs, 3-8 cm. long. Leaves simple, alternate, exstipulate, shortly petiolate or sessile, entire, obtuse, strigose, mid-rib only impressed, 5-10 mm long, 2-4 mm broad. Flowers small, ebracteate, or the lower ones bracteate, axillary, pedicellate, hypogynous, in short, lax, terminal racemes. Calyx gamosepalous, 1 mm long, sepals 5, small ovate-lanceolate, entire, strigose. Corolla gamopetalous, petals 5, obovate, imbricate, 1-1.5 mm long, throat of corolla with 5 small obtuse scales. Stamens 5, epipetalous, adnate to the middle of the corolla tube, included, anthers bilobed, ovate, filaments very short. Ovary deeply 4-lobed, superior, style short, gynobasic, stigma small, capitate. Fruit of 4 tetrahedral nutlets, nutlets with 4 acute or submarginate edges, glabrous, stipitate, stipe bent to one side, attachment scar small, basal.

Flowering and Fruiting : July-September.

Indian Specimens Examined : SIKKIM: Alpine Sikkim, 4572 m, *Hook. f. & Thoms.* *Eritrichium* sp. n. 15, Acc. no. 307585 (CAL), Isotype; Thango Sikkim, *Prain*, Acc. nos. 307596, 307597 & 307598 (CAL); Llonok, 4785 m, Sikkim, *Smith & Cave* 1938 (CAL). BHUTAN: Pu-Uo, Bhutan Himalaya, *Dunghoo* 237 (CAL).

Distribution : Alpine Sikkim and Bhutan, upto 5500 m.

5. *T. rotundifolia* Benth. ex Clarke in *Hook. f. Fl. Brit. Ind.* 4 : 172, 1883; Smith and Cave in *Rec. bot. Surv. India* 4(5) : 226, 1911 and Smith l. c. 4(7) : 398, 1913. Type: From Kumaon, *Wallich* 930, Isotype in Herb. CAL. *Myosotis rotundifolia* Benth. in *Royle, Ill. Bot. Him.* 395, 1836. *Eritrichium rotundifolium* (Benth.) DC. *Prodr.* 10 : 123, 1846.

Perennial, weak, strigose herb. Stem slender, weak, cylindrical, covered with sparse, appressed hairs. Leaves simple, alternate, exstipulate, petiolate, upper cauline ones subsessile, entire, cauline leaves upto 2.5 cm long and 1 cm broad, obtuse or mucronate, base obtuse, midrib only slightly impressed, appressed-strigose on both surfaces, radical leaves larger, larger petioled, petiole upto 6 cm long, base sheathing, lamina ovate to elliptic upto 3 cm long, 1.5 cm broad, base obtuse. Flowers in terminal ebracteate racemes, more elongate in fruit, in condensed cincinni when young, hypogynous, regular, pedicellate, pedicels upto 8 mm long, slender, appressed-strigose. Calyx gamosepalous, sepals 5, elliptic-acute, entire, appressed-strigose, 2 mm long, spreading. Corolla gamopetalous, tube shorter than the calyx, petals 5, glabrous, white, spreading, imbricate in bud, obtuse, throat with 5 small scales, corolla upto 5 mm long, more than twice the length of the calyx tube. Stamens 5, included, epipetalous, adnate to the middle of the corolla tube, anthers bilobed, oblong-obtuse. Ovary superior, deeply 4-lobed, style short, filiform, stigma, capitate. Nutlets 4, often one poorly developed, 1.5 mm long, 1 mm broad, glabrate, shining brown, trigonal with 3 narrow wings, the three inner faces evidently developed and subequal, the outer face nearly plain, subsessile, attachment scar basal, small.

Flowering and Fruiting: July-August.

Indian Specimens Examined: SIKKIM: Chamnago, Ningbil, 3657-4419 m, S. E. Sikkim, *Smith* 3774, 4073 (CAI); Sikkim, 3048 m. *J. D. Hooker*, Acc. no. 308545 (CAL); Kang La, Sikkim Himalaya, *King's Collector*, Acc. nos. 308546, 308547, 308548 (CAL); Kanhtha, 4572 m, Sikkim, *King's Collector*, Acc. no. 308550 (CAL); Neygola, Jongri, *King's Collector*, Acc. no. 308551 (CAL). NAGALAND: Delei Valley, Kaso, 3650-4000 m, *Ward* 8418 (CAL). WESTERN HIMALAYAS: Pather Kori, Garhwal, 3355 m, *Strachey & Winterbottom* 2 (CAL); under rocks, 4270-4575 m, Tehri Garhwal, N. W. India, *J. F. Duthie* 349 (DD); Jamna Bhagirathi Water Shed, 3965-4270 m, A. C. *Joshi* s. n. (DD); Thinigaon, Muktinath, 4270 m, open hill side, petals red-mauve, filaments green, anthers brown, *Stainton, Sykes & Williams* 1265 (DD); Chenpul under Jamnotri, 3965-4270 m, *J. F. Duthie* 349 (DD).

Distribution: Subalpine and alpine Himalayas, 1829-4419 m, fairly common in Nepal (*Stainton, Sykes & Williams* 3592; *J. F. Duthie* 3204, 5821, 5822).

6. *T. smithii* Ban. sp. nov. (Plate IV)

Herba perennis, debilis, strigosa, fibrosis caespit-

osisque radicibus. Caules tenues, debiles, 6-12 cm longi. Folia simplicia, alterna, integra, strigose appressa, exstipulata; petioli foliorum radicalium 2-5 cm longi, tenues, laeviter strigosi, basibus partem aculis inferiorem plus minusve amplectentes, lamina 1-1.5 cm longa, 6-8 mm lata, elliptice oblonga, apicibus obtusis vel rotundatis, basibus obtusis plus minusve petiolum decurrentibus. Folia superiora minora, elliptica, sub-sessilia vel breviter petiolata, lamina integra, basi acute vel sub-obtuse attenuate apice obtusa vel rotundata, costis tantum medianis impressis, 5-8 mm longa 3-4 mm lata. Inflorescentia helicoiditer cymosa, conferta, terminalis. Flores bisexuales, regulares, ebracteati; pedicelli breves, tenues, breviter strigosi, 1 mm longi, fructiferi vero 2-3 mm longi. Calyx gamosepalus, profunde 5-partitus, lobis 5, imbricatis, dense strigoso ciliatis, ovatis vel lanceolatis, obtusis, 1.5-2 mm longis, vix accrescentibus. Corolla gamopetala, rotata, 7-8 mm in diam., usque 7 mm longa, tube 1-1.5 mm longo, lobis 5, imbricatis, distinctis, orbiculatis, 4 mm longis, 3-4 mm latis, fauce 5 squamis 0.5 longis occlusa. Stamina 5, epipetala; filamenta brevissima, medio tubi adnata; antherae bilobae, dorsifixae 0.5-1 mm longae. Stylus 1 mm longus capitatus, originem ducens. Nucelli 4, fusco-nitidi, saepe unus effectus debiliter, tetradricus, tres ventrales und una dorsalis et latissima, carinis ventralibus in brevem stipitem prolongatis receptaculo plano affixi.

Typus a *Smith & Cave* apud Llonok, Sikkim die 31a julii, 1909 lectus et in Central National Herbarium (CAL) sub numero *Smith & Cave* 1811A Iso-typi (1811 B-D) ibidem positi.

Perennial weak, strigose herb, with a cluster of fibrous roots. Stems slender, weak, 6-12 cm long. Leaves simple, alternate, entire appressed-strigose, exstipulate, radical leaves very long-petioled, petioles 2-5 cm long, slender, sparsely strigose, with $\pm$ sheathing leaf-bases covering the lower portion of the stem, lamina 1-1.5 cm long, 6-8 mm broad, elliptic-oblong, obtuse or rounded at apex, base obtuse, more or less attenuate to the petiole; upper leaves smaller, elliptic, subsessile or shortly petiolate, lamina attenuate at base, entire, obtuse, or rounded at apex, acute or sub-obtuse at base, midrib only impressed, 5-8 mm broad. Flowers in terminal, dense, ebracteate, helicoid clusters; pedicels short, 1 mm long, 2-3 mm in fruit, slender, shortly strigose. Calyx gamosepalous, deeply 5-partite, sepals 5, imbricate, densely strigose, ciliate, lanceolate or elliptic-obtuse, 1.5-2 mm long, 1 mm broad, slightly or not enlarged in fruit, ovate or lanceolate, obtuse. Corolla gamopetalous, rotate, 7-8 mm in diameter upto 7 mm long, tube 1-1.5 mm long, shorter than

calyx, lobes 5, imbricate distinct, orbicular 4 mm long, 3-4 mm broad, throat of corolla closed with 5 thick, obtuse scales, scales 0.5 mm long. Stamens

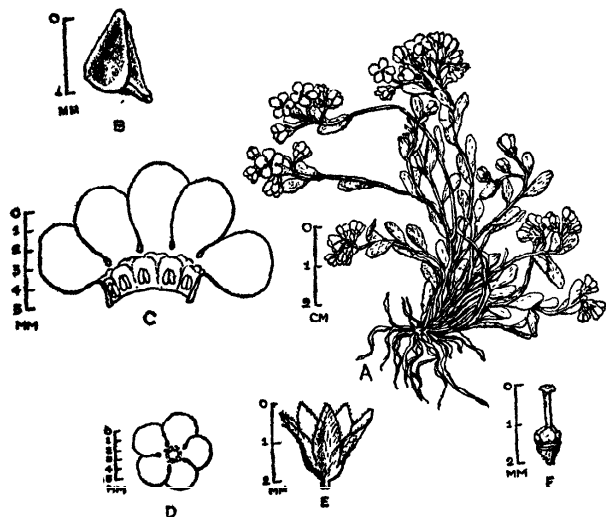


Plate IV. *Trigonotis smithii* Ban.

Figs. A-F : A. Plant. B. Nutlet. C. Corolla split open. D. Top view of corolla. E. Calyx. F. Gynoecium.

5, epipetalous, filaments very short, anthers 0.5-1 mm long, bilobed, dorsifixed, adnate to the middle of the corolla tube. Ovary deeply 4-lobed; style 1 mm long, capitate, gynobasic. Nutlets 4, often one of the nutlets poorly developed, 1 mm long, shining brown, tetrahedral with 3 ventral and one dorsal faces, outer face broadest, ventral-keel prolonged into a short stipe, attached to a flat receptacle, scar small, basal.

Flowering and Fruiting: July-August.

Indian Specimens Examined: SIKKIM: Llonok, Sikkim, 4419 m, 31st July, 1909, *Smith & Cave* 1811 A, Acc. no. 308538, Holotype (CAL), *Smith & Cave* 1811 B-D, Acc. nos. 308553, 308554, 308557, Isotypes (CAL); Llonok, Sikkim, *Smith & Cave* 1921 (CAL); Near Nakula, Sikkim, *F. E. Younghusband* 176 (CAL).

Distribution: Sikkim Himalayas.

Notes: *T. smithii* shows affinity with *T. multicaulis* in its cluster of stems, and with *T. rotundifolia* in the shape of its cauline leaves, but is readily distinguishable from both of them by its conspicuously larger flowers.

Smith & Cave (*Rec. bot. Surv. India* 4: 226, 1911), however, referred their above-mentioned sheets under *T. multicaulis* with a note "not quite the type." The grounds on which these are removed and treated separately under *T. smithii* are on the characters in the leaf and flower.

7. *T. ovalifolia* (Wall.) Benth. ex Clarke in Hook. f. *Fl. Brit. Ind.* 4: 172, 1883; *Smith et Cave* in *Rec. bot. Surv. India* 4: 226, 1911. Type: From Gossain-Than, Nepal, *Wallich* 927, Isotype in Herb. CAL. *Myosotis ovalifolia* Wall. in *Roxb. Fl. Ind.* ed Carey & Wall. 2: 9, 1824. *Eritrichium ovalifolium* (Wall.) A. DC. in *DC. Prodr.* 10: 123, 1846.

Weak, more or less hairy, diffuse herb. Stems slender, often prostrate, older portions sparsely but younger portions densely covered with brown strigose hairs, branches 20-40 cm long. Leaves simple, alternate, exstipulate, entire, obtuse or sub-mucronate, unicostate, petiolate, elliptic-ovate to orbicular, base often cordate, petiole 0.2-1 cm long, hairy lamina of cauline leaves 2.5 cm long, 1.5 cm broad, minutely strigose on both surfaces. Flowers small, hypogynous, ebracteate, in lax terminal racemes, apices helicoid. Calyx gamosepalous, sepals 5, entire, lanceolate-acute, strigose, 2 mm long, persistent, slightly accrescent, 3 mm in fruit, fruiting sepals elliptic acuminate. Corolla gamopetalous, petals 5, entire, ovate-obtuse, imbricate, throat of corolla with 5 obtuse scales. Stamens 5, epipetalous, adnate to the middle of the corolla tube, anthers bilobed, ovate-obtuse. Ovary superior, 4-lobed, style gynobasic, short, slender, stigma capitate. Nutlets 4, upto 2 mm long, 1.5-2 mm broad, sub-stipitate, stipe short, confluent with the ventral keel, tetrahedral with 4 dorso-ventral faces, minutely patently hairy on all faces.

Flowering and Fruiting: July-August.

Indian Specimens Examined: SIKKIM: Tista Valley, Lachen to Thango, 2134 m, *Smith & Cave* 2035, 2806 (CAL); Sikkim, 3048 m, *J. S. Gamble* 10390 (CAL); Sikkim Himalaya, 3658 m, *King's Collector* 173 (CAL); Kalipookri, Sikkim Himalaya, *King's Collector* 171 (CAL); Sikkim Himalaya, *G. A. Gammie* 57 (CAL); Kalipookri, Sikkim Himalaya, *King's Collector* s. n. (DD); Sikkim Himalaya, 3658 m, *King's Collector* s. n. (DD); Tongloo, Sikkim, 3048 m, *J. S. Gamble* 10390 (DD).

Distribution: Central and Eastern Himalayas: Nepal and Sikkim, 2134-3962 m.

8. *T. gracilipes* Johnst. in *Journ. Arnold Arbor.* 18: 9, 1937. Type: From Muli, S. W. China, *Rock* 17867 (GH).

Plant perennial, caespitose. Stem slender, green, erect or decumbent 10-40 cm tall, usually with few slender branches, covered with strigose hairs. Leaves many, sparsely strigose, lamina elliptic or oblong-lanceolate, often 1-4 cm long, 0.5-2 cm broad, lower leaves with 2-4 cm long petiole, upper ones gradu-

ally shorter petioled and subsessile. Flowers extra-axillary, long pedicelled, solitary among the leaves on the middle and lower portions of the stem or frequently aggregated into an ebracteate raceme towards the apical portion of the stem; pedicels slender, 1.5 mm long in flower, 5-25 mm long in fruit, ascending, erect or bent. Calyx at anthesis 1-1.5 mm long, strigose, 2-3 mm long in fruit; lobes ovate-acute, 1.5-2 mm long. Corolla 4-5 mm in diameter. Nutlets 4, about 1 mm long, tetrahedral, angles or ridges frequently sparsely pubescent, stipitate with the evident stipe abruptly bent to one side.

Indian Specimens Examined: SIKKIM: Phenop, Eastern Himalaya, 4050 m, *Ribu & Rhomoo* 6372; Jongri, 4200 m, *Ribu & Rhomoo* 6555 and *Lepcha* 942 (E), not seen.

Distribution: Sikkim, Tibet and South Western China.

9. *T. hookeri* Benth. ex Clarke in Hook. f. Fl. Brit. Ind. 4: 173, 1883. Type: From Khasia Mount., 1829 m, *J. D. Hooker & T. Thoms. s. n.*, Isotype in Herb. CAL., Acc. no. 307884.

An erect perennial, branched herb, with coarse, stiff hairs arising from white bulbous bases, hairs on the stem upto 1 mm long. Leaves simple, ovate-lanceolate, sub-dentate-ciliate, rounded or subcordate at base, hirsute on both surfaces, hairs arising from white bulbous bases, leaves 7-10 cm long, 2.5-3.2 cm broad (lamina 5-8 cm long), petioles 1-2 cm long. Racemes axillary, ebracteate, 8-16 cm long, tips helicoid, peduncle hirsute. Flowers 6-9 mm in diameter, pedicels 5-7 mm long, hypogynous. Calyx gamosepalous, campanulate, persistent in fruit, hardly more enlarged, deeply 5-partite nearly to the base; lobes lanceolate or elliptic, acute or shortly acuminate, covered with long whitish hairs on the dorsal surface, about 3 mm long, 1.5 mm broad. Corolla gamopetalous, campanulate, tube broad, short, lobes 5, imbricate in bud, orbicular, spreading, 3-4 mm in diameter, throat with 5 broad quadrate scales, scales slightly notched at the apex. Stamens 5, epipetalous, oblong, inserted just beneath the scales, filaments short or nil; receptacle flat. Ovary superior, deeply 4-lobed, lobes globose, very small; style gynobasic, stout, stigma capitate, obscurely bilobed. Nutlets 4, tetrahedral, 2-1.5 mm in diameter, minutely patently hairy on all sides, subsessile with a minute basal, attachment scar.

Flowering and Fruiting: July-September.

Indian Specimens Examined: ASSAM: Mount

Khasia, 1829 m, *J. D. Hooker & T. Thomson*, Acc. no. 307884 (CAL), Isotype. NAGALAND: Nago Hills, Kohima, *G. K. Deka* 16458, 19795 (ASSAM).

Distribution: Khasia Mounts., Naga Hills 1524-1829 m.

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