

Article

# Additions to the new taxonomic classification of Molluginaceae (Caryophyllales)

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#### Abstract

Two new combinations are published here after establishment of the new generic classification of Molluginaceae based on molecular phylogeny (Thulin *et al.*, 2016). *Mollugo pentaphylla* L. var. *rupestris* T.Cooke from Western Ghats (India) is raised to the rank of species within the genus *Trigastrotheca* F.Muell. (*T. rupestris* (T.Cooke) Sukhor.). *Mollugo pentaphylla* var. *rupestris* is lectotypified. All investigated Caribbean specimens of *Paramollugo nudicaulis* (Lam.) Thulin (previously *Mollugo nudicaulis* Lam.) differ from the Old World specimens in seed coat ornamentation, and therefore we assume that *P. nudicaulis* s.str. is absent in the Caribbean region. *Pharnaceum spathulatum* Sw., described from the West Indies and previously synonymized with *Mollugo nudicaulis* Lam. or *Paramollugo nudicaulis*, is a basionym for the new combination within *Paramollugo (P. spathulata* (Swartz) Sukhor.). A list of synonyms of *P. spathulata* including *Paramollugo navassensis* (Ekman) Thulin and *Mollugo bellidifolia* (Poir.) Ser. is provided.

**Key words:** Molluginaceae, new combinations, nomenclature, *Paramollugo*, taxonomy, *Trigastrotheca*, West Indies, Western Ghats

## Introduction

The recent concept of Molluginaceae based on molecular phylogeny has drastically improved our understanding of the taxonomy for many members, and the non-monophyly of formerly the largest core genus *Mollugo* L. has been shown (Thulin *et al.*, 2016). *Mollugo* is now divided into five genera including *Mollugo* L. s.str., *Pharnaceum* L., *Hypertelis* E.Mey. ex Fenzl (sensu Thulin *et al.*, 2016), reinstated *Trigastrotheca* F.Muell. and the newly established genus *Paramollugo* Thulin. However, there are further additions to *Paramollugo* that include two newly described endemics from Madagascar, *P. elliotii* Sukhor. and *P. simulans* Sukhor., along with a forgotten taxon *Mollugo digyna* Montrouz. from New Caledonia. Upon the transfer of the latter to *Paramollugo*, a new combination has been made: *Paramollugo digyna* (Montrouz.) Sukhor. (Sukhorukov and Kushunina, 2016). The current paper fills the gap in the

taxonomy of *Trigastrotheca* in India with the notes to *Mollugo pentaphylla* L. var. *rupestris* T.Cooke and completes our conclusions about the circumscription of the difficult genus *Paramollugo*.

#### **Material and Methods**

The revision of herbarium material was undertaken in the collections B, BM, BR, E, H, HUJ, K, LE, M, MHA, MSB, MW, P, PRA, W, and WU (acronyms follow Thiers, 2016) although it was only in K that the authors found a certain number of *Mollugo pentaphylla* var. *rupestris* specimens. The first author has searched for *Mollugo spathulata* on three islands of Grenada (Grenada, Carriacou and Petit Martinique Islands) but the species was not found.

The seed surface was examined using a scanning electron microscope (SEM; JSM–6380, JEOL Ltd., Japan) at 15 kV after sputter coating with gold-palladium. Fallen fruits (1–2) from the vouchers listed below were used for SEM, those of *Trigastrotheca* were also referred to in the article on the seed morphology and ornamentation (Sukhorukov and Kushunina, in press).

*Paramollugo spathulata* (Swartz) Sukhor.: (1) [without location, date or collector's name] herb. Jussieu *s.n.* (P-Jussieu) as *Mollugo bellidifolia* (Poir.) Ser.; (2) Cuba [without precise location and date] *Poppig s.n.* (M!); (3) Cuba, 1865, *C.Wright 25* (P04557327!); (4) US Virgin Islands, St. Thomas, XI.1880, *Eggers 169* (LE!; P04557326!); (5) [Virgin Islands] St. Croix [Island], 21.VIII.1896, *A.Ricksecker 499* (E!); (6) Dominican Republic, 1911, *Anonym s.n.* (E!); Cuba, near Santa Clara, VI.1941, *R.A.Howard 5038* (P04601424!); (7) Navassa Island, VI.1956, *R.Proctor 15462* (BM!, K!);

*Trigastrotheca molluginea* F.Muell.: (1) Australia, Nullagine, 22.V.1953, *Broadber 754* (BM); (2) Australia, Pilbara, 23.IX.1995, *Hunger and Kilian 3961* (B!);

*T. pentaphylla* (L.) Thulin: (1) Philippines, Luzon, 7.VIII.1955, *Sulit 32940* (K!); (2) Ceylon [Sri Lanka], Polonnaruwa Distr., 10.XII.1970, *Sachet and Jayasiriya 1492* (K!); (3) Cameroon, Central Prov., IV.1976, *Westphal 9054* (BR174609!); (4) [China,] Jiangxi Prov., Juijang Co., Sha-He, 11.X.1996, *Tan* s.n. (B!);

T. rupestris (T. Cooke) Sukhor.: India, Panchgani, X.1892, Anonym s.n. (K!).

#### **Taxonomy and Nomenclature**

Genus Trigastrotheca F.Muell., Hooker's J. Bot. Kew Gard. Misc. 9: 16. 1857.

This genus distributed in the Eastern Hemisphere (tropical Africa, Asia and Australia) is characterized by leafy stems (leaves arranged in false whorls), flowers of 5 free tepals, 3-5 stamens with broad-based filaments and 3-loculicidal capsule with many papillate or smooth seeds. Along with the type species, *T. molluginea*, a perennial from northern Australia, so far it has included two closely related annuals: *T. pentaphylla* and *T. stricta* (L.) Thulin. The fourth species is added here.

Trigastrotheca rupestris (T.Cooke) Sukhor., comb. nov.

(urn:lsid:ipni.org:names: 77158745-1).

Basionym: Mollugo pentaphylla L. var. rupestris T.Cooke, Fl. Bombay 1: 558. 1901.

**Type**: [India, Goa State,] wet rocks at Marmagoa [Mormugao], X.1892, [*T.Cooke*] (K-000641800!) (lectotype K-000641800! **designated here** by Sukhorukov). Fig. 1.

#### Additional specimen seen:

India, Maharashtra State, Satara District] Panchgani, X.1892, rec.[orded] 24.IV.[18]93, *Anonym* [probably *T.Cooke*] *s.n.*, (K!, BM!); India, Panchgani, 4300 ft, XI.1928, *L.J.Sedgwick* & *T.R.D. Bell* 4689 (K!).

In the protologue, Cooke (1901) mentioned two localities for the variety: Panchgani and Marmagoa [Mormugao].

**Taxonomic notes**: *T. rupestris* is a very distinct, well-recognizable taxon. It inhabits rocky places and is distinguished by a perennial life cycle, short stems up to 10 cm, linear leaves up to 1.5 mm wide and umbel-like inflorescences of densely arranged flowers. In contrast to that, both *T. pentaphylla* and *T. stricta*, which are also present on the Indian Subcontinent, are weedy annuals up to 60 cm tall, with much broader (lanceolate to ovate) leaves and spreading paniculate inflorescences. The seed morphology and ultrasculpture, the most indicative characters in Molluginaceae (Sukhorukov and Kushunina, in press; Sukhorukov *et al.*, in prep.), in *T. rupestris* are very close to both *T. pentaphylla* and *T. stricta* (Fig. 2; see also Sivarajan and Usha (1983) for the ultrasculpture of *T. stricta*) rather than *Mollugo disticha* Ser. as it was shown earlier (Manilal and Sivarajan, 1982); the latter species belongs to *Mollugo* L. s.str. as was shown by molecular studies (Thulin *et al.*, 2016) supported by carpological data (Sukhorukov and Kushunina, in press).

**Ecology and distribution**: Wet rocks at altitude of 1000–2000 m. Flowering time: August– December (Manilal and Sivarajan, 1982). Endemic to the Western Ghats. Although we have seen only two additional specimens, we include here another record of *Trigastrotheca rupestris* from Calicut, State of Kerala (Manilal and Sivarajan, 1982) due to its reliability, as it is well differentiated morphologically from *T. pentaphylla* or *T. stricta* (Fig. 3).

. rupustnis, T. Cooke an var. M. strictae? Rec. 24/4 93 5 9 5 Wet wello at managas 4 3 KEW NEGATIVE ROYAL BOTANIC GARDENS KEW No. 18713 N K000641800 DATE INTLS. MAR 1979

Figure 1. Lectotype of Mollugo pentaphylla L. var. rupestris T.Cooke (K-000641800)

**Conservation status**: *Trigastrotheca rupestris* inhabits pristine rocky areas and is considered a threatened taxon (Watve, 2013, sub *Mollugo pentaphylla* var. *rupestris*). However, *T. rupestris* 

is given a Data Deficient (DD) status IUCN 2016) due to the absence of exact data regarding the current extent of the populations.



Figure 2. Ultrasculpture of *Trigastrotheca pentaphylla* (L.) Thulin (A, B), *T. molluginea* F.Muell. (C, D) and *T. rupestris* (T.Cooke) Sukhor. (E, F). Magnification: 100 x, 500 x

## Genus Paramollugo Thulin, Taxon 65(4): 784. 2016

Despite the differences in habit (shrubby vs. herbaceous) and seed coat ornamentation, all the species included in this genus have a distinct common carpological trait: pitted cell boundaries of the testa cells (Sukhorukov and Kushunina, in press). The herbaceous taxa are also very distant from other Molluginaceae due to basally located leaves (no cauline leaves are present). After extensive herbarium revisions, the authors came to the conclusion that in the Eastern Hemisphere (tropical parts of Asia, Africa and New Caledonia), the genus includes five herbaceous and one shrubby species (Sukhorukov and Kushunina, 2016). The names accepted for the species of the Eastern Hemisphere are *P. nudicaulis* (Lam.) Thulin (the core species in

the genus), *P. angustifolia* (M.G.Gilbert) Thulin, *P. decandra* (Scott Elliot) Thulin, *P. simulans* Sukhor., *P. elliotii* Sukhor. and *P. digyna* (Montrouz.) Sukhor. The center of diversity within the Eastern Hemisphere is located in Madagascar, where four species are found (Sukhorukov and Kushunina, 2016).

Another diversity center of the genus is found on the Caribbean Islands, from where *P*. *cuneifolia* (Griseb.) Thulin, *P. deltoidea* (Léon) Thulin and *P. navassensis* (Ekman) Thulin



Figure 3. Distribution of *Trigastrotheca rupestris* (T.Cooke) Sukhor.

have been reported, together with P. nudicaulis (Thulin et al., 2016). The most distinct of these species is the endemic of Cuba, P. cuneifolia, due to its perennial life cycle and the presence of a massive caudex and succulent leaves. Thulin et al. (2016) considered Paramollugo nudicaulis to be widespread in the West Indies, while P. navassensis has been reported only from Navassa Island and the British Virgin Islands. Morphological differences between P. nudicaulis and P. navassensis mentioned in the protologue (Ekman in Urban, 1929) are insignificant (the number of leaves) or clearly overlapping (length of perianth and seeds). Our conclusion based on observations of the seed coat ultrasculpture in numerous specimens from the Caribbean Basin is that P. nudicaulis is not present in the New World. All specimens collected in the Western Hemisphere and labelled Paramollugo (previously Mollugo) nudicaulis have been misidentified. Peculiarities of the seed coat ornamentation are the major trait allowing differentiation between the Caribbean plants and P. nudicaulis, the species widely distributed in the Eastern Hemisphere (see map and voucher list in Sukhorukov and Kushunina, in press). The seed coat is papillate, with striate secondary ultrasculpture in *P. nudicaulis* and warty in all Caribbean plants. The taxon known as Mollugo nudicaulis var. navassensis (Ekman in Urban, 1929) which is a basionym of Paramollugo navassensis, a name accepted in the latest revision of Molluginaceae by Thulin et al. (2016) appears to be a later synonym of the oldest name for

West Indian plants, *Pharnaceum spathulatum* Sw. (Swartz, 1797), and other names previously synonymized with *Paramollugo nudicaulis* should be referred to *Paramollugo spathulata*. Thus we transfer here *Pharnaceum spathulatum* to the genus *Paramollugo*.

Paramollugo spathulata (Swartz) Sukhor., comb. nov.

(urn:lsid:ipni.org:names: 77158746-1).

Basionym : Pharnaceum spathulatum Swartz, Fl. Ind. Occid. 1: 568. 1797.

**Type**: Jamaica, *Swartz s.n.* (lectotype: S [S05-5804], designated by Thulin *et al.*, 2016), seen photo.

=Pharnaceum bellidifolium Poir., Encycl. (J.B.A.P.Lamark et al.) 5: 262. 1804.

Type: not designated (probably destroyed).

*≡Mollugo bellidifolia* (Poir.) Ser., Prodr. (A.P. de Candolle) 1: 391. 1824

=Mollugo nudicaulis Lam. var. navassensis Ekman, Ark. Bot. 22A (17): 14 (1929).

**Type**: Insula Navassa (inter Haiti et Jamaica sita) in savannis ad partem septentrionalioccidentalem versus, 19.X.1928, *Ekman H 10810* (lectotype: S [R-3647], designated by Thulin *et al.* 2016; isolectotypes: S, A [A00037491], B [B100248713], C [C10001454, C10001455], G [G00356430], GH [GH00037490], K!, LE [LE00006649], LL [LL00370733], MO [MO216413], NY [NY00232982], S [S13-8983]).

**Notes:** *Paramollugo spathulata* can grow as an annual or short-lived perennial. Reported by a number of authors (e.g., Liogier, 1983; Fournet, 2002), this life cycle along with the similarities in seed coat ornamentation (Fig. 4) make the species akin to the New Caledonian *P. digyna* rather than P. *nudicaulis*, even *P. spathulata* and *P. nudicaulis* often produce leaves of similar shape (obovate or oblanceolate). The short-lived perennial life cycle is observed in many specimens from different locations (Navassa Island, Cuba, U.S. Virgin Islands). *Paramollugo deltoidea* is still an enigmatic taxon known only from the type locality (n.v.) but it could, in fact, be *P. spathulatum*.

Additional specimens seen: (Fig. 5). Cuba: Cuba Orientalis, 1856-1857, C.Wright 25 (K!); Cuba, 1865, C.Wright 25 (P04557327!); valley of Rio Matamoros S of Holguin, 14.IV.1909, J.A.Shafer 1380 (BM!); Camaguey, Queen city to Riverside, 31.III.1909, J.A.Shafer 1135 (BM!); Havana, Guanabacoa, 6.VI.1914, E.L.Ekman 1278 (BM!); 10 km W of Santa Clara,VI.1941, R.A.Howard 5038 (BM!, P04601424!); in aridis montis Sabanasso, Poeppig 756 (M!); prov. Habana, 1907, Leon s.n. (P05196672!); [without precise location and date] Ramon de la Sagra s.n. (P04601607!); Havana, [without date], A.J.A.Bonpland & F.W.H.A. von Humboldt, s.n. (P00679592!); Puerto-Rico: Guanica, 2.II.1886, Anonym 3569 (BM!, K!,



Figure 4. Seed coat ornamentation of *Paramollugo spathulata* (Swartz) Sukhor. (A, B) and *P. nudicaulis* (Lam.) Thulin (C, D). Magnification: 100 x, 500 x

P04557325!); Dominican Republic: Barahona Province, Bahormo, VI.1911, M.Fuertes s.n. (BM!, K!, P04601427!); Arroyo Frances, 4 miles W of Puerto Plata, 28.X.1969, A.H.Liogier 16585 (P04601420!); Haiti: Navassa Island, near the lighthouse, alt. 250 ft, 20-23.VI.1956, G.R. Proctor 15462 (BM!); [department du Nord-Est], plaine du Nord, Terriere Rouge, 26.IV.1928, E.L.Ekman 9887 (K!); Ile La Navase [Navassa Island], in savannas towards the northwest point, common, 19.X.1928, E.L.Ekman 10810 (K!, isolectotype); Jamaica: without date and collector (S05-5804, B-W06100-010!); Martinique: [without precise locality], 1786-1787, L.C.M.Richard s.n. (B-W06100-020!) Virgin Islands [American]: St. Thomas, XI.1880, Eggers 169 (K!, P04557326!); St. Thomas, Vejen v. Smiths Bay, 6.II.1914, C.H.Ostenfeld 260 (P04601425!); Navassa Island, 19.X.1928, Ekman H10810 (B!). St. Croix, Teague bay, 11.I.1979, F.R.Fosberg 58899 (BM!);

Also reported from Guyana and French Guadeloupe (Urban, 1921, sub *Mollugo nudicaulis* Lam.), but the specimens were not present in the herbaria visited.



Ecology and distribution: Rocky grassy slopes (Swartz, 1797; Quesada, 2014), sands (Swartz, 1797; Fawcett and Rendle, 1914), or else as a weed (León and Alain, 1951; Howard, 1988). Flowering and fruiting: March – June (Urban, 1921).

Conservationstatus:P.spathulatacanoccupydisturbedhabitats(León and

Figure 5. Distribution of *Paramollugo spathulata* (Swartz) Sukhor. in West Indies (● – specimens seen, ■ – locations in the literature)

Alain, 1951; Liogier, 1983, all sub *Mollugo nudicaulis*), and is therefore unlikely to be at risk of extinction. Following the IUCN (2016) guidelines, this species should be categorized as not threatened.

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