

**A TAXONOMIC REVISION OF *AMORPHOPHALLUS* BLUME EX DECNE.
SECT. *CONOPHALLUS* (SCHOTT) ENGL. (ARACEAE) IN INDIA**

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Abstract

The diagnostic characters of *Amorphophallus* Blume ex Decne. sect. *Conophallus* (Schott) Engl. is amended based on detailed studies of characteristics of the constituent species. In India the section is represented by six species, viz. *A. bognerianus* Sivad. et Jaleel, *A. bulbifer* (Sims) Blume, *A. carnosus* Engl., *A. commutatus* (Schott) Engl., *A. nicolsonianus* Sivad. and *A. oncophyllus* Prain ex Hook. f. The species *A. commutatus* forms a complex with three varieties, viz. var. *commutatus*, var. *anmodensis* Sivad. et Jaleel, and var. *wayanadensis* Sivad. et Jaleel. Keys to the species and varieties have been provided to facilitate easy identification. *Amorphophallus carnosus* has been rediscovered after more than 100 years of its first discovery and collection. *Amorphophallus bulbifer* has comparatively wider distribution in India with extended distribution in Bangladesh and Myanmar. The species *A. bognerianus*, *A. carnosus*, *A. commutatus*, *A. nicolsonianus* and *A. oncophyllus* are exclusive endemics of India.

Introduction

The genus *Amorphophallus* Blume ex Decne. is represented by more than 200 species (Mayo *et al.*, 1997; Jaleel *et al.*, 2011). Engler (1911) recognized 11 sections under the genus based on 78 species, and additional 12 species were treated as doubtful or not at all known. Many new species have been discovered and recognized since then. The sectional classification of Engler (1911) has several drawbacks as per the present taxonomic standards. A brief account on the taxonomic history of Indian species of *Amorphophallus* has very recently been provided by Jaleel *et al.* (2011) and it contained reference to earlier relevant works of Hooker (1894), Bogner *et al.* (1985), Sivadasan (1986, 1989), Sivadasan *et al.* (1994), Hettterscheid *et al.* (1994), Bogner (1995), Mayo *et al.* (1997), Sivadasan and Jaleel (1998a, b, 2000a, b, 2001, 2009) and Yadav *et al.* (2009). The genus is reported to be under revision and is supposed to include pollen morphology, odour biochemistry and pollination biology, and molecular data (Van der Ham *et al.*, 2005).

In India the genus is represented by 3 sections (*sensu* Engler, 1911), and revision of one of the three sections, viz. *Amorphophallus* sect. *Rhaphiophallus* which is the largest in India has been published recently (Jaleel *et al.*, 2011). The present paper deals with revision of *Amorphophallus* sect. *Conophallus* (Schott) Engl. which is the second largest in India. As the present revisionary study deals with the species confined only to India and a worldwide revision of the genus is expected to ensue, any attempt on sectional re-classification based on Indian taxa would be inappropriate, and hence the sectional name as used by Engler is retained here for convenience with amendments to the diagnostic characters of the section under study.

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Materials and Methods

Exhaustive field explorations were made all over India including the Andaman and Nicobar Islands at different seasons for collection of specimens in vegetative and reproductive phases; and all relevant data have been recorded, and photographs taken. The present taxonomic revision was based on both the specimens collected during the study and those available in major Indian and international herbaria. The methodology as mentioned by Jaleel *et al.* (2011) has been followed. Specimens of Indian species available at various major Indian and International herbaria, viz. ASSAM, BSA, BSD, BSHC, BSI, CAL, CALI, DD, GH, JCB, K, KFRI, L, M, MH, PBL, TBGT and US were examined; but citations were limited to few representative specimens to restrict the length of the article.

Taxonomic treatment

Amorphophallus Blume *ex* Decne., *Nouv. Ann. Mus. Hist. Nat.* 3: 366 (1834), *nom. cons.* [Taxon 31: 310 (1982)].

Type: Amorphophallus campanulatus Decne. [= *A. paeoniifolius* (Dennst.) Nicolson].

Amorphophallus Blume *ex* Decne. sect. **Conophallus** (Schott) Engl., *Pflanzenr.* IV. 23C (Heft 48): 79 (1911), *emend. Sivad. mut. char.* (*Conophallus* Schott, *Syn. Aroid.* 34 (1856) = *Proteinophallus* Masters, *Gard. Chron.* 610 (1873); *Tapeinophallus* Baill., *Dict. Bot.* 1. (fasc. V), *Ic. sine desc.* (1877); *Hydrosme* Engl., *Bot. Jahrb.* XV: 456 (1892), *p.p.*)

Tuberous herbs; tubers subglobose, globose, depressed-globose, cylindrical or obconoid. Leaves solitary; lamina with leaflets sessile or rarely petioluled, base usually unequal and decurrent on rachis or not; venation reticulate with secondary lateral veins united below margin forming sub-marginal collective vein. Flowering without leaves; inflorescence with peduncle short or long, usually identical with petiole in colour and pattern of mottling, basally surrounded by 3-7 cataphylls; spathe with a basal convolute tube and erect or bent limb. Spadix long or shorter than spathe, usually non-stipitate or stipitate, with a basal female zone, a continuous middle male zone, and a terminal sterile appendix. Female flowers crowded, spirally or sub-spirally arranged, ovary 1-3-locular, stigma sessile, or very short styled, entire or lobed; ovule 1 per locule. Male flowers free, dense; dehiscence by apical slit or pore. Spadix-appendix erect, elongate-ovoid, ellipsoid, fusiform or cylindrical with tapering tip.

Key to the Indian species of *Amorphophallus* sect. *Conophallus*

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|---|-----------------------|
| 1. Leaves bulbiferous, epiphyllar bulbils produced at junction of petiole with rachises and at axils of branches of rachises; spadix ovoid, or elongate obpyriform, cream-coloured. | 2 |
| - Leaves not bulbiferous. | 5 |
| 2. Peduncle short, usually 11-15 cm long; spathe-limb apically fornicate. | <i>A. bognerianus</i> |
| - Peduncle long, usually 38-68 cm long, spathe-limb apically erect, not fornicate. | 3 |
| 3. Spathe without a constriction between basal tube and limb, c. 39.5 cm long, with indistinct blotches outside; spadix sessile. | <i>A. carnosus</i> |
| - Spathe with or without a constriction between basal tube and limb, c. 14-25 cm long with distinct blotches outside; spadix stipitate. | 4 |
| 4. Petiole and peduncle dark green with light greenish blotches and minute greenish white mottles in between blotches; leaflet-margin green; spathe with distinct constriction between tube and limb. | <i>A. oncophyllus</i> |
| - Petiole and peduncle pinkish green to brownish green with cream to white irregular vertical linear stripes; leaflet-margins light pinkish; spathe without constriction between tube and limb. | <i>A. bulbifer</i> |

5. Tuber cylindrical in reproductive phase, small and obconic in vegetative phase; petiole and peduncle turgid and brittle; peduncle 21-31 cm long; spathe 10.6-12.0 cm long, greenish brown to greenish purple with light green mottles and dark purple spots outside; greenish yellow and smooth within, sometimes very light pinkish green tinged with purple spots at base within.
- Tuber subglobose in reproductive and vegetative phases; petiole and peduncle not brittle; peduncle 38-56 cm long; spathe 15-32 cm long, dark brownish or purplish green outside, dark purplish inside with short rounded bumps.

*A. nicolsonianus**A. commutatus****Amorphophallus bognerianus*** Sivad. *et* Jaleel, *Aroideana* 32: 136 (2009).**(Fig. 1)**

Type: India, Arunachal Pradesh, Bhalukpong, alt. 217 m, 8.6.1999, *Abdul Jaleel* RIA 371 (*Holotype* - K).

Tubers depressed globose, 7.0-14.5 cm in diam. and 4.5-10.5 cm thick in vegetative phase, c. 9 cm in diam. and c. 4.5 cm thick in reproductive phase. Petiole 77-105 cm long, dark greenish with pale green irregular ovoid to oblong, horizontal mottles and minute pale green lines also within mottles. Leaflets oblong to elliptic, acuminate at apex, leaflets 6-26 x 3-8 cm. Bulbils c. 0.6-3.5 cm in diam., 0.5-1.5 cm thick. Peduncle c. 11.0-15.5 cm long. Spathe broadly lanceolate, 13-25 cm long, with a basal convolute tube and an upper expanded limb without constriction in between, convolute basal tube apically dilated, funnel-shaped, 2.0-2.6 cm in diam. at base, 3.5-4.0 cm in diam. at top, limb 8.5-13.0 cm broad at centre, tip acute and fornicate, pale pinkish outside with narrow horizontal brownish green patches at basal convolute part, patches vertical on the limb portion, brownish green mottles towards tip, pinkish inside, minutely muricate at base within, smooth and paler above. Spadix sessile, shorter than spathe, 9.5-13.0 cm long; stipe 0.2-0.3 cm long, pale pinkish; female zone 2.5-2.9 cm long; male zone 2.1-2.5 cm long; appendix 4.5-7.5 cm long. Female flowers dense, each c. 2.5-3.0 mm high, ovary c. 1 mm high, dark reddish, 1 or 2-loculed; style very short, c. 1 mm long; stigma discoid, 2 or 4-lobed. Male flowers dense, each c. 3 mm high, cream-coloured. Spadix-appendix fusiform or ellipsoid, cream or yellow with slight brownish minute spinescent projections at maturity, especially towards tip. Fruits elongate-ellipsoid, 1.5-1.7 cm long. Seeds 1.1-1.2 cm long.

Phenology: Flowering: May-June; Fruiting: August-September.

Specimens examined: **Arunachal Pradesh:** Balukpong, alt. 217 m, 2.10.1997, *Abdul Jaleel* RIA 199 (CALI); *Ibid.*, 2.10.1997, *Abdul Jaleel* RIA 200 (CALI); [Kerala State, Calicut University Botanical Garden, 13.5.1999, *Abdul Jaleel* RIA 370 (CALI); *Ibid.*, 8.6.1999, *Abdul Jaleel* RIA 371 (CALI) (originally collected from Balukpong, Arunachal Pradesh and introduced in the Calicut University Botanical Garden)].

Notes: *Amorphophallus bognerianus* is related to *A. bulbifer* (Sims) Blume, but differs in having the inflorescence with short peduncle and erect fornicate spathe-limb. It also differs from *A. bulbifer* in having a different mottling of petiole and peduncle, and spadix shorter than spathe and spadix-appendix, more or less equals to the length of fertile portion of spadix in contrast to the condition in *A. bulbifer* where the spadix-appendix is longer than the length of the fertile portion of spadix.

Distribution: Hitherto known only from the type locality in Arunachal Pradesh.

Amorphophallus bulbifer (Sims) Blume, *Rumphia* 1: 148 (1837); Kunth, *Enum. Pl.* 3: 34 (1841); Engl. in DC., *Monogr. Phan.* 2: 317 (1879); Hook. f., *Fl. Brit. India* 6: 515 (1893); Prain, *Bengal Pl.* 2: 1110 (1903); Cooke, *Fl. Pres. Bombay* 2: 825 (1908); Engl. in Engl., *Pflanzenr.* IV. 23C(48): 98 (1911); Haines, *Bot. Bihar and Orissa* 3: 903 (1924); C.E.C. Fisch. in Gamble, *Fl. Pres. Madras*: 1587 (1931); Nicolson in Saldanha & Nicolson, *Fl. Hassan Dist.*: 783 (1976);

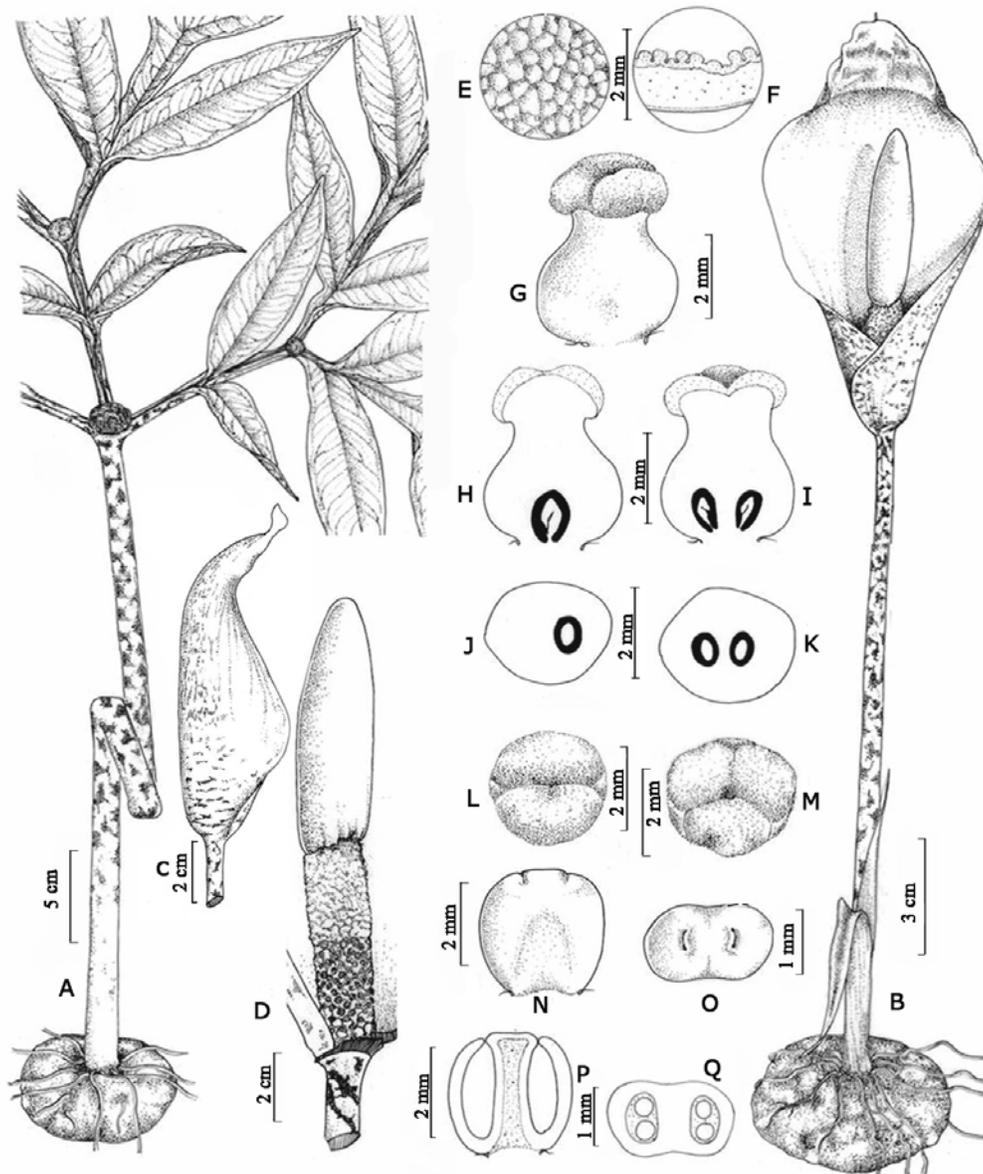


Fig. 1. *Amorphophallus bognerianus* Sivad. *et* Jaleel. A. Tuber with leaf; B. Tuber with inflorescence; C. Inflorescence - side view; D. Spadix; E. A small basal inside portion of spathe; F. A small basal portion of spathe - c.s.; G. Female flower; H. One-loculed female flower - l.s.; I. Two-loculed female flower -l.s.; J. One-loculed ovary - c.s.; K. Two-loculed ovary - c.s.; L. Stigma of one-loculed flower; M. Stigma of two-loculed flower; N. Male flower - view from broad side; O. Male flower - view from top; P. Male flower - l.s.; Q. Male flower - c.s.

Karth., Jain, Nayar & Sanjappa, Fl. Ind. Enum. Monocot.: 6 (1989). *Arum bulbiferum* Roxb. [Hort. Beng. 65 (1814), *nom. nud.*] ex Sims, Curtis's Bot. Mag. 46: t. 2072 (1819), *Ibid.* 51: t. 2508 (1824); Roxb., Fl. Ind. 3: 510 (1832); Wight, Icon. Pl. Ind. Or. 3: 783 (1844). *Pythonium bulbiferum* (Sims) Schott in Schott & Endl., Melet. Bot.: 18 (1832). *Conophallus bulbifer* (Sims) Schott, Syn. Aroid.: 34 (1856). *Conophallus tuberculiger* Schott, Bonplandia 7: 28 (1856). *Amorphophallus tuberculiger* (Schott) Engl. in DC., Monogr. Phan. 2: 317 (1879); Hook. f., Fl. Brit. India 6: 517 (1893). *Amorphophallus bulbifer* var. *marmoratus* Engl., Pflanzenr. IV. 23C (48): 99 (1911). *Amorphophallus bulbifer* var. *atroviridimaculatus* Engl., Pflanzenr. IV. 23C (48): 99 (1911); Karth., Jain, Nayar & Sanjappa, Fl. Ind. Enum. Monocot.: 6 (1989). *Amorphophallus bulbifer* var. *tuberculiger* (Schott) Engl., Pflanzenr. IV. 23C (48): 99 (1911); Karth., Jain, Nayar & Sanjappa, Fl. Ind. Enum. Monocot.: 6 (1989). **(Fig. 2)**

Type: Illustration of *Arum bulbiferum*, t. 2072, published by Sims in Bot. Mag. Vol. 46 (1819).

Tubers sub-globose, c. 6 cm in diam. and 3.0 cm thick in vegetative phase, 9-16 cm in diam. and 6-9 cm thick in reproductive phase. Petiole 60-82 cm long, pinkish green to brownish green with cream to white irregular vertical linear patches. Leaflets 4-18 x 2.0 - 4.5 cm sessile, ovate-oblong lanceolate, apex acuminate; greenish above and paler below, extreme margin pale pinkish. Bulbils 0.7-0.9 cm in diam., 0.3-0.5 cm thick. Peduncle 60-68 cm long. Spathe ovate-obtuse, erect, 18-22 cm long, basal convolute tube 5.5-6.0 cm in diam., pale green to greenish yellow outside with white to cream rounded blotches, pinkish at base and paler at top within. Spadix longer than spathe, 20-24 cm long, with a stipe of c. 0.5 cm long; female zone 2.5-3.0 cm long; male zone 4.0-4.5 cm long; appendix 12-14 cm long. Female flowers dense, each with ovary c. 1.5 mm high, pale purplish, 1-2-locular; style 1.0-1.5 mm long, pale yellowish; stigma c. 2.5 mm in diam., yellowish green. Male flowers dense, pale pinkish, each 2.0-2.5 cm high. Spadix-appendix elongate-ovoid, buff-coloured, smooth. Fruits broadly ovoid, 1.0-1.4 cm long. Seeds 1-3, 0.8-0.9 cm long.

Phenology: Flowering: May-June; Fruiting: July-November.

Specimens examined: **Kerala:** Malappuram Dist.: Nilambur ghat, July 1937, *Barnes* s.n. (DD); Palghat Dist.: Manthampotti, 8.6.1979, *Sivadasan* CU 21463 (CALI); Nelliampathy, Karappara, 15.8.1997, *Abdul Jaleel & Bobby Thomas* RIA 125 (CALI). **Goa:** Anveldem (Malem), 18.9.1970, *Mudaliar*, Acc. No. 124346 (CAL); Dodamarg, 5.6.1997, *Abdul Jaleel & Bobby Thomas* RIA 71 (CALI). **Maharashtra:** Poona, Ambowne, 6.9.1964, *Venkata Reddi*, Acc. No. 99013 (CAL); Tungar Hill, Mandi range, 22.7.1968, *Billore* Acc. No. 116331 (CAL); Amboli Ghat, 8.6.1997, *Abdul Jaleel & Bobby Thomas* RIA 75 (CALI). **Madhya Pradesh:** Bilaspur, Paranta Pendra, 14.7.1973, *Murti*, Acc. No. 19128 (BSA). **Orissa:** Koraput Dist., Jeypore Circle, Papadahandi, (?)9.1966, *Das* 40 (DD). **West Bengal:** Lower Bengal, 21.5.1896, *Davies* s.n. (DD); Lower Bengal, 4. 6.1896, *Prain*, Acc. No. 496661 (CAL). **Sikkim:** 'Sikkim', (Specific loc.?), 7.1894, *Pantling*, Acc. No. 496648 (CAL); Munghoo, (?), 7.1894, *Pantling* s.n. (DD). **Assam:** 'Assam', 6.5.1897, *Prain*, Acc. No. 496735 (CAL); N. Kanrup Dist.: *s.d.*, *Panigrahi*, Acc. No. 9491 (CAL); Dermukh Reserve forest, 16.5.1966, *Verma* 46372 (ASSAM). **Manipur:** Manipur, 4.1.1994, *Sinha* 10772 (BSHC). **Tripura:** Tripura, Shipaijak, 4.6.(19)59, *S. Coll.* 1792 (infl.) (CAL).

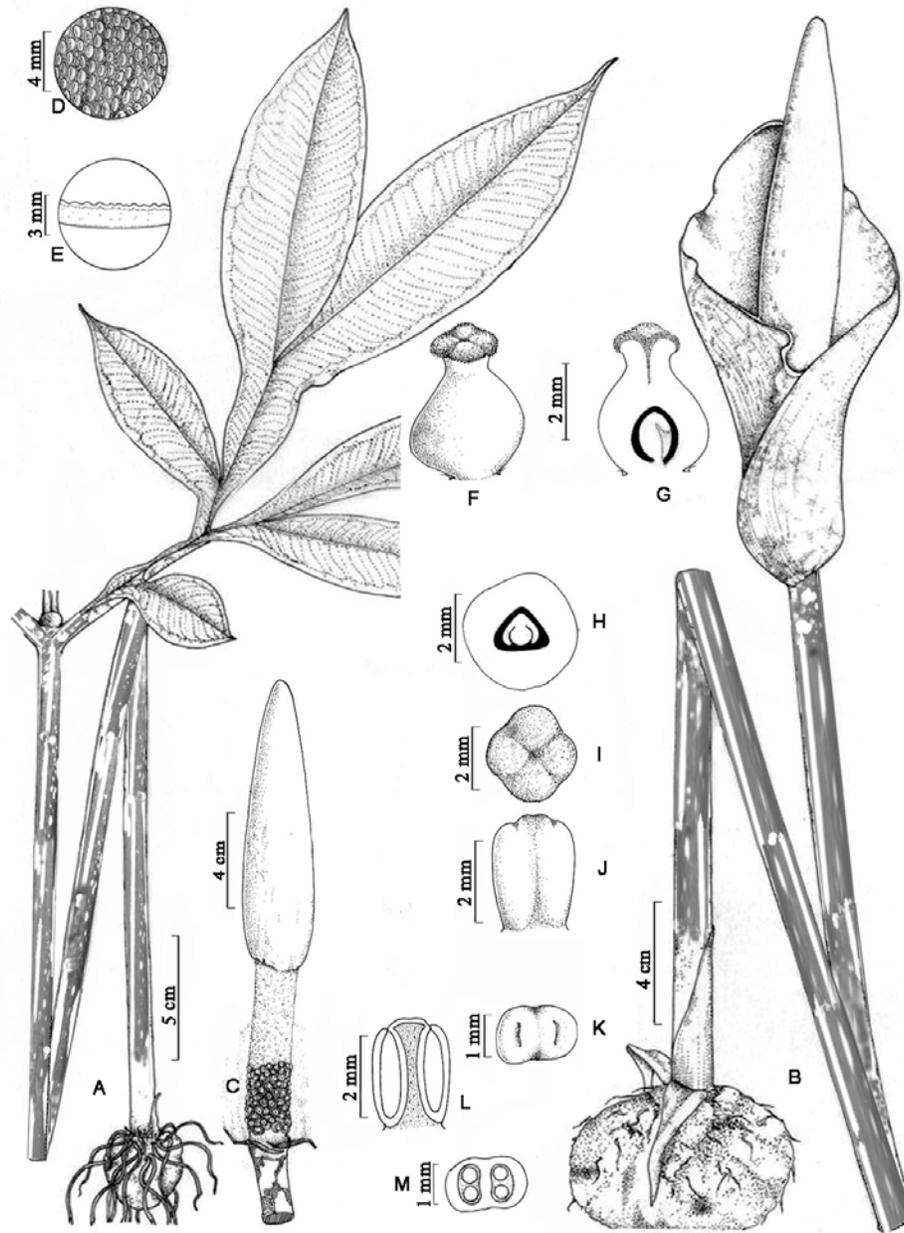


Fig. 2. *Amorphophallus bulbifer* (Sims) Blume. A. Tuber with leaf; B. Tuber with inflorescence; C. Spadix; D. A small basal inside portion of spathe; E. A small basal portion of spathe - c.s.; F. Female flower; G. Female flower - l.s.; H. Ovary - c.s.; I. Stigma; J. Male flower - view from broad side; K. Male flower - view from top; L. Male flower - l.s.; M. Male flower - c.s.

Notes: *A. bulbifer* closely resembles *A. bognerianus* but the latter differs by having the inflorescence with short peduncle, erect fornicate spathe limb and spadix shorter than spathe. It resembles *A. oncophyllus*, but differs in having different colour and pattern of mottling of petiole and peduncle, and erect limb of spathe without any constriction between the basal convolute tubular portion and the upper expanded limb. In *A. oncophyllus* the mature inflorescence is with a deflexed spathe-limb in contrast to the erect limb of *A. bulbifer*.

Distribution: India, Bangladesh and Myanmar. In India it is found in Kerala, Karnataka, Andhra Pradesh, Goa, Maharashtra, Madhya Pradesh, Orissa, Bihar, West Bengal, Sikkim, Assam, Arunachal Pradesh, Manipur, Meghalaya and Tripura.

Amorphophallus carnosus Engl., Pflanz. IV 23C (48): 93 (1911); Srivast. & Rao in Higher Pl. Ind. Subcont. IV: 32 (1993); Sivad. & Jaleel, Rheedeia 10(1): 63 (2000). **(Fig. 3)**

Type: India, Andamans, March 1899, *Prain's Collector*, s.n. (*Holotype* - CAL).

Tubers subglobose, 2.5-7.5 cm in diam. and 2-6 cm thick in vegetative phase, c. 20 cm in diam. and 14 cm thick in reproductive phase. Petiole 70-108 cm long, dark greenish brown with few minute pale green mottling. Leaflets sessile, 5-23 x 2.6-8.0 cm, ovate to elliptic lanceolate, tip long-acuminate, twisted in mature leaflets, margin undulate, green above and paler below; veins depressed above and projected below, secondary laterals close. Bulbils pale greenish, c. 0.5 cm in diam. and 0.1 cm thick. Peduncle c. 68 cm long. Spathe c. 39.5 cm long, ovate-oblong with basal convolute tube and an upper expanded erect limb, pale green outside with few minute white mottling, and dark green minute mottling towards margin, basal portion with dark green dense mottling; spathe-tube c. 15.5 cm long and 7.5 cm in diam., rough within with irregular verrucogranulate protuberances; limb margin undulate, tip obtuse, purplish orange inside, reddish pink above with small ovate yellow mottling, mottling sparse towards margin, closely oriented vertical veins prominent on outer surface of spathe. Spadix slightly longer than spathe, sessile, c. 41 cm long; female zone c. 9 cm long; male zone about half the length of female zone, c. 5.5 cm long; appendix c. 28 cm long. Female flowers dense, sub-spirally arranged, irregular towards base; each flower c. 4 mm high, ovary sub-globose, c. 1.5 mm high, reddish, 2-locular; style very short, c. 1.0 mm long, pale red; stigma inconspicuously 2 or 4-lobed, yellowish. Male flowers dense, sessile, each c. 2 mm high, inconspicuously 2-lobed, yellowish. Spadix-appendix obpyriform with narrowed tip, cream-coloured, slightly rough with minute depressions at base, and smooth towards the top. Fruits ovoid, or ellipsoid, 1.2-1.5 cm long. Seeds 1-2, 0.9-1.1 cm long.

Phenology: Flowering: May-June; Fruiting: September-October.

Specimens examined: **South Andaman:** Ograbraj, 9.5.1999, *Abdul Jaleel* RIA 335 (CALI); *Ibid.*, 9.5.1999, *Abdul Jaleel* RIA 336 (CALI); *Ibid.*, 31.5.1999, *Abdul Jaleel* RIA 369 (CALI).

Notes: *Amorphophallus carnosus*, a little known rare and endemic species, has been rediscovered from Andaman after it was first collected by Prain's collector in the year 1899 and no later collections were available from the islands (Srivastava and Rao, 1993). After over 100 years, during May 1999 the species was rediscovered and collected both in flowering and vegetative stages from its type locality – Andaman islands and the rediscovery was reported by Sivadasan and Jaleel (2000a). *A. carnosus* is quite remarkable in having large-sized plants and inflorescence with erect spathe of about 39.5 cm long with prominent pale green colour outside and purplish orange at base, and reddish pink above within. It resembles *A. oncophyllus*, but differs in its large size, erect spathe, male zone about half the length of the female zone and an elongate obpyriform spadix-appendix with narrow tapered tip.

Distribution: So far known to occur only in Andaman Islands, India.

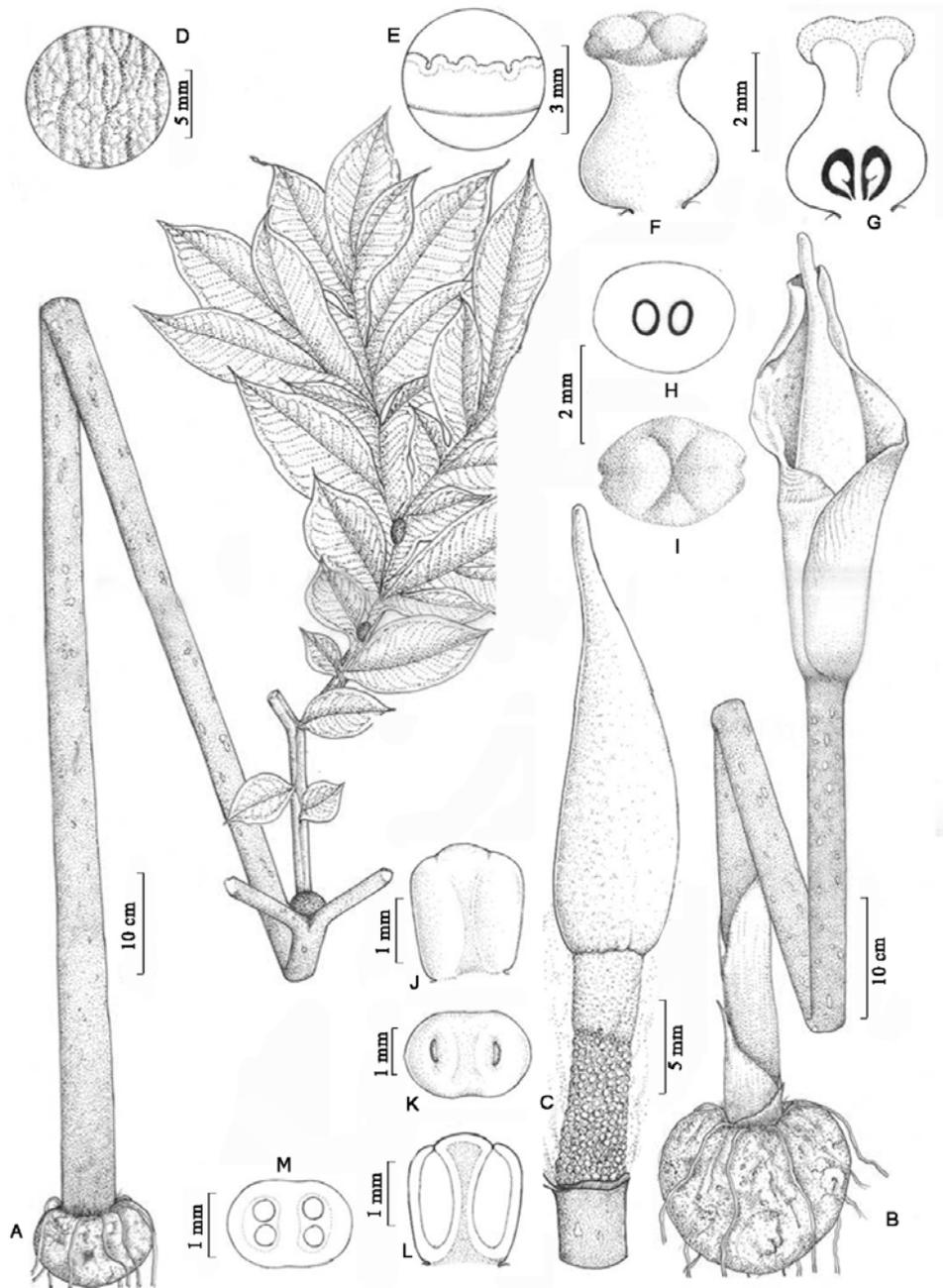


Fig. 3. *Amorphophallus carnosus* Engl. A. Tuber with leaf; B. Tuber with inflorescence; C. Spadix; D. A small basal inside portion of spathe; E. A small basal portion of spathe - c.s.; F. Female flower; G. Female flower - l.s.; H. Ovary - c.s.; I. Stigma; J. Male flower - view from broad side; K. Male flower - view from top; L. Male flower - l.s.; M. Male flower - c.s.

Amorphophallus commutatus (Schott) Engl. in DC., Monogr. Phan. 2: 319 (1879); Hook. f., Fl. Brit. India 6: 515 (1893); Engl., Pflanzenr. IV. 23C (48): 95 (1911); Cooke, Fl. Pres. Bombay 2: 826 (1908); Karth., Jain, Nayar & Sanjappa, Fl. Ind. Enum. Monocot.: 6 (1989); Shetty & Singh, Fl. Rajasthan 3: 69 (1993). *Conophallus commutatus* Schott, Bonplandia 7: 28 (1859). *Dracontium polyphyllum* Graham, Cat. Bombay Pl.: 229 (1839), non L. (1753). *Pythonium wallichianum* Kirt., J. Bombay Nat. Hist. Soc. 7: 312 (1893), non Schott (1832). *Amorphophallus sylvaticus* Dalz. & Gibs., Bombay Fl.: 289 (1861), non Kunth (1850).

Type: Bombay (no date), *Anonymous* (Dalzell?), s.n. (K).

Tubers sub-spherical, smooth, often produce short cylindrical offsets, skin smooth. Petiole pale green to pale brownish with numerous elongate to irregular brown to dark brown spots; basal portion of rachises naked without decurrent bases of leaflets. Leaflets elliptic, elongate-elliptic or more or less oblong, upper leaflets with base long decurrent on rachis, apex acuminate. Inflorescence long or short peduncled; peduncle resembles petiole in colour and pattern of mottling. Spathe erect, ovate-oblong or narrowly elongate-triangular, acute or acuminate, with or without a shallow constriction between tube and limb, purplish or brownish green or pale yellowish brown outside, inner side verrucose or with rounded bumps and with or without unicellular silvery hairs at base. Spadix usually longer than spathe, sessile or stipitate.

Distribution: Kerala, Karnataka, Tamil Nadu, Goa, Maharashtra, Gujarat, Madhya Pradesh and Rajasthan.

Key to the varieties of *Amorphophallus commutatus*

1. Peduncle 8-10 cm long; tubular portion slightly compressed obovoid, inner side slightly purplish and pale yellow towards base, verrucose with unicellular silvery hairs at base; male zone of spadix cylindrical. var. *anmodensis*
- Peduncle 20-95 cm long; tubular portion slightly obovoid or cylindrical, with or without unicellular silvery hairs at base within; male zone of spadix fusiform or obconic. 2
2. Spathe without constriction between tube and limb; tube cylindrical, inner side at base dark purplish brown, verrucose with short unicellular silvery hairs. var. *commutatus*
- Spathe with constriction between tube and limb; tube slightly compressed obovoid, inner side purplish at top and pale yellowish to light purplish with blunt-bumps at base without unicellular silvery hairs. var. *wayanadensis*

Amorphophallus commutatus (Schott) Engl. var. ***anmodensis*** Sivad. *et* Jaleel, Rheede 12(2): 159 (2002). (Fig. 4)

Type: India, Goa, Anmod Ghat, 4.6.1997, *Abdul Jaleel & Bobby Thomas* RIA 67 (*Holotype* - K).

Tubers 8-10 cm in diam. and 5-7 cm thick, offsets 2-3, each c. 4-5 cm long. Petiole 50.0-52.5 cm long, blackish brown with white mottling. Leaflets ovate acuminate to oblong acuminate, 5.0-16.5 x 3.0-6.5 cm, dark green above and paler below. Peduncle 8-10 cm long, pale yellowish. Spathe ovate-acute, 17-18 x 4-5 cm, basal tube slightly compressed obovoid, 2.5-3.0 cm long, limb expanded, erect, pale yellowish brown outside and pale brownish towards margin, inner side slightly purplish and pale yellowish towards base, verrucose with unicellular silvery hairs at base. Spadix sessile, 23-25 cm long; female zone c. 1.5 cm long; male zone cylindrical, c. 3 cm long; appendix 18-20 cm long. Female flowers c. 2.5 mm long, ovary sub-globose, c. 1.5 mm high, pale greenish, unilocular; style very short or absent; stigma yellowish orange, inconspicuously 3-lobed

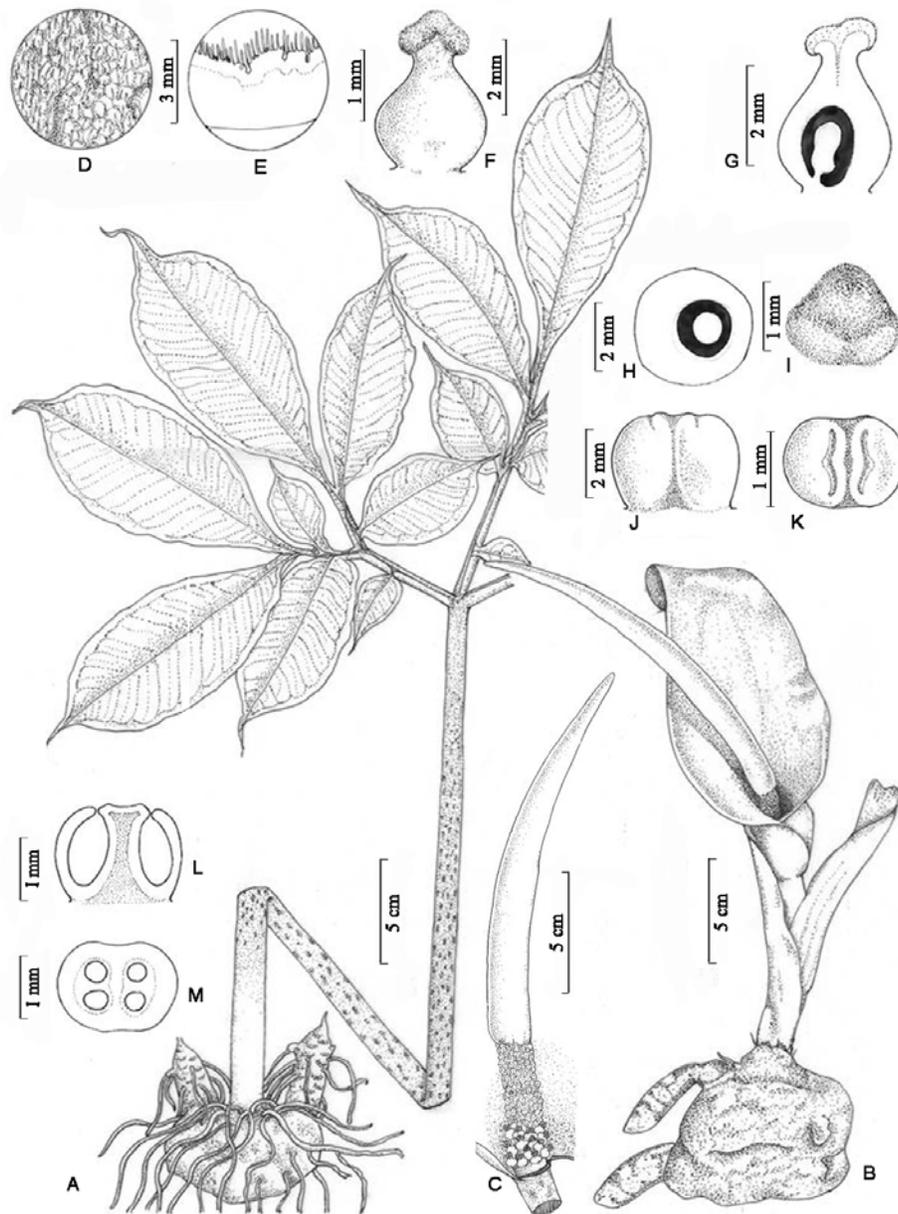


Fig. 4. *Amorphophallus commutatus* (Schott) Engl. var. *anmodensis* Sivad. et Jaleel. A. Tuber with leaf; B. Tuber with inflorescence; C. Spadix; D. A small basal inside portion of spathe; E. A small basal portion of spathe - c.s.; F. Female flower; G. Female flower - l.s.; H. Ovary - c.s.; I. Stigma; J. Male flower - view from broad side; K. Male flower - view from top; L. Male flower - l.s.; M. Male flower - c.s.

with a bigger median lobe, c. 1.5 mm in diam., narrower than the ovary, obliquely oriented towards axis and with a notch at abaxial side. Male flowers pale yellowish, dense, sessile, each c. 1.2 mm high and 1.2 mm broad, inconspicuously 2-lobed. Spadix-appendix cylindrical, tapering towards tip, apex rounded, pale-yellowish brown to dark purplish brown. Infructescence not observed.

Phenology: Flowering: June; Fruiting: Not observed.

Specimens examined: **Goa**: Anmod Ghat, 4.6.1997, *Abdul Jaleel* RIA 68 (CALI); *Ibid.*, 25.8.1998, *Abdul Jaleel* RIA 322 (CALI).

Notes: *Amorphophallus commutatus* var. *anmodensis* resembles var. *wayanadensis* in general appearance of spathe and spadix, but differs by having a short peduncle of c. 8-10 cm long, male zone cylindrical and less than twice the length of the female zone, and the spathe-tube slightly purplish and verrucose with unicellular hairs at base within.

Distribution: A narrow endemic known to occur only in Anmod Ghat, Goa in India.

***Amorphophallus commutatus* (Schott) Engl. var. *commutatus* (Fig. 5)**

Type: Same as that of the species. Bombay, (no date), *Anonymous* (*Dalzell?*), s. n. (K).

Tubers 6-14 cm in diam. and 4.5-5.5 cm thick, offsets 4-5; each offset c. 5-10 cm long. Petiole 40-65 cm long, greenish yellow with dark green patches. Leaflets ovate-acuminate, 8-13 x 3.5-5.0 cm, upper side dark green, lower side pale green. Peduncle 20-40 cm long. Spathe erect, ovate acuminate, 10-23 x 3.5-5.6 cm, basal portion convolute forming a tube of 2.5-5.0 cm long, limb expanded, erect, greenish brown with white mottles and dark pinkish towards margin, inside tube dark purplish brown at base, verrucose with short unicellular silvery hairs. Spadix shortly stipitate, 8-20 cm long, stipe c. 0.5 cm long; female zone 1.8-2.0 cm long; male zone c. 2.8-3.0 cm long; appendix c. 10-12 cm long. Female flowers sub-spirally arranged, each with ovary c. 1.5 mm high, pale green and purplish at top, unilocular; style absent or very short, c. 0.2 mm long, purplish; stigma disciform, pale orange. Male flowers dense, each c. 2 mm high, pale pinkish. Spadix-appendix cylindrical, tapering to apex, smooth or with inconspicuous rhomboidal projections at base, pale yellowish or rarely light reddish-brown. Fruits sub-globose to ellipsoid, reddish, c. 0.8-0.9 cm long. Seeds 0.7-0.8 cm long.

Phenology: Flowering: May-June; Fruiting: July-August.

Specimens examined: **Karnataka**: Uduppi, 24.5.1997, *Abdul Jaleel* RIA 56 (CALI); *Ibid.*, 3.7.1999, *Abdul Jaleel* RIA 372 (CALI). **Goa**: Anmod Ghat, 4.6.1997, *Abdul Jaleel* RIA 67 (CALI). **Maharashtra**: Poona, Ambauni Taluk, near Forest Rest House, 6.9.1964, *Venkata Reddi* 99014 (CAL); Khurvada R.F., Bodhi Range, 11.1.1968, *Billore*, Acc. No. 113449 (CAL); Kolhapur, Amba Ghat, 7.6.1997, *Abdul Jaleel* RIA 74 (CALI).

Notes: *Amorphophallus commutatus* var. *commutatus* resembles the other two varieties, viz. *A. commutatus* var. *anmodensis* and var. *wayanadensis* in general appearance of the spathe and spadix. But it differs from the above two in having a cylindrical basal tube of spathe without constriction between tube and limb, spadix with male zone obconical, more than twice or more or less thrice the length of female zone, and female flowers with purplish colour at upper portion of ovary.

Distribution: Karnataka, Goa and Maharashtra.

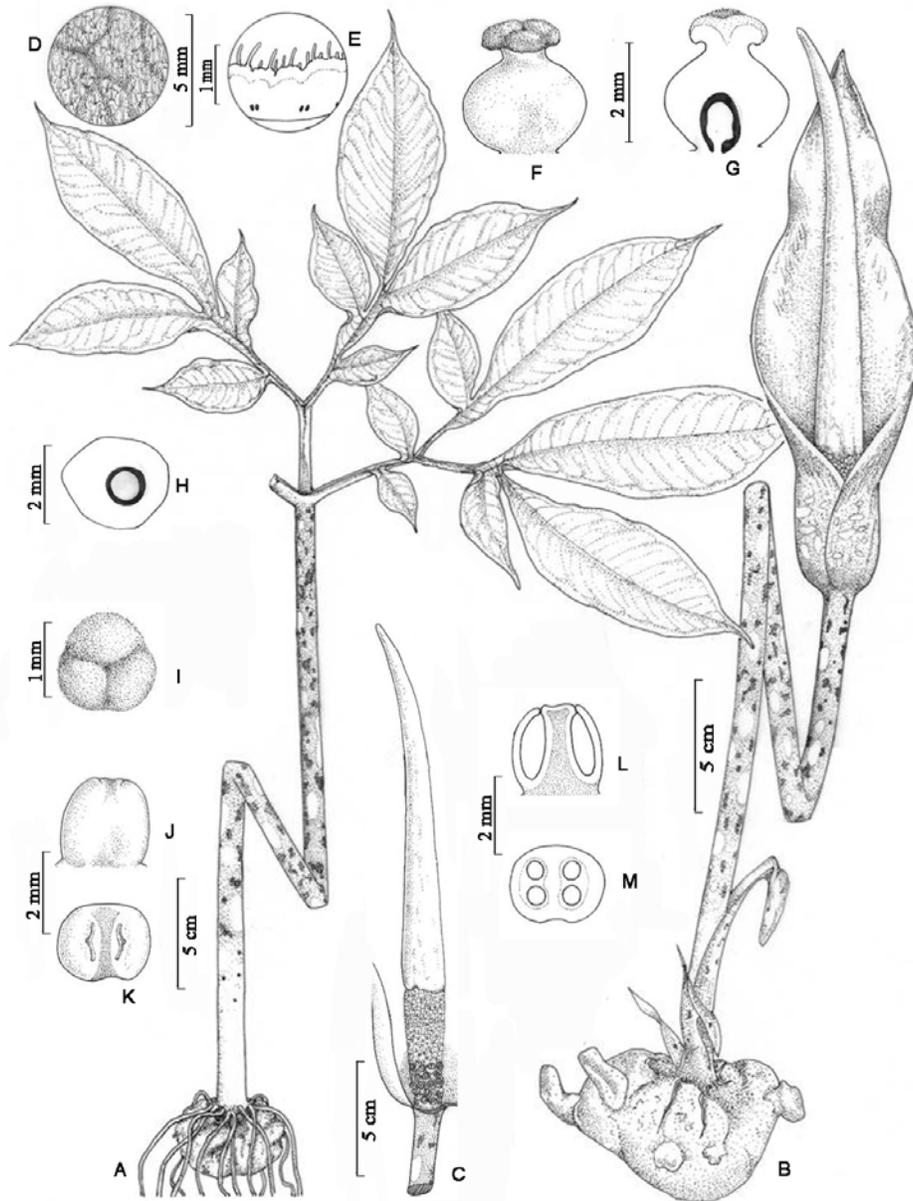


Fig. 5. *Amorphophallus commutatus* (Schott) Engl. var. *commutatus*. A. Tuber with leaf; B. Tuber with inflorescence; C. Inflorescence - spathe partially removed showing spadix; D. A small basal inside portion of spathe; E. A small basal portion of spathe - c.s.; F. Female flower; G. Female flower - l.s.; H. Ovary - c.s.; I. Stigma; J. Male flower - view from broad side; K. Male flower - view from top; L. Male flower - l.s.; M. Male flower - c.s.

Amorphophallus commutatus (Schott) Engl. var. ***wayanadensis*** Sivad. *et* Jaleel, *Rheedea* 12(2):163 (2002). **(Fig. 6)**

Type: India, Kerala, Wayanad Ghat, 29.4.1997, *Abdul Jaleel & Bobby Thomas* RIA 62 (*Holotype* - K).

Tubers 10-16 cm in diam. and 4.5-6.5 cm thick. Petiole 85-100 cm long, light greenish with whitish mottles and dark green dots, extreme base bluish green. Leaflets ovate-oblong, 4.5-18.0 x 2.2-5.5 cm, acuminate, base cuneate; upper surface dark green and lower surface light green, margin entire. Peduncle c. 75-95 cm long. Spathe ovate-oblong, equaling the length of spadix, c. 26-32 x 9-12 cm, basal portion convolute forming a slightly compressed obovoid tube of c. 5-7 cm long, slightly constricted at the mouth, limb expanded, erect, apex acute, margin incurved, purplish at the top, greenish purplish at base with white mottles; inside tube purplish at top, pale yellowish to light purplish with short rounded bumps at base. Spadix sessile, c. 27-30 cm long; female zone c. 2.3-2.5 cm long; male zone c. 3.7-4.0 cm long, appendix c. 20.5-23.0 cm long. Female flowers with ovary sub-globose, 1.5-1.8 mm high and c. 0.2 mm in diam., green, unilocular; style very short or absent, light purplish; stigma discoid, orange-coloured. Male flowers sessile, loosely arranged, each flower c. 2 mm high, inconspicuously 2-lobed, pale yellowish with connectives purplish or completely purplish. Spadix-appendix cylindrical, tapering to tip with rounded apex, smooth, reddish brown, base with inconspicuous, irregularly elongate rhomboid projections. Fruits broadly ovate, red-coloured berries, c. 1.2 cm long. Seeds c. 0.8 cm long.

Phenology: Flowering: May-June; Fruiting: July-August.

Specimens examined: **Kerala:** Palghat Dist.: Makkali, 29.5.1966, *Vajravelu* 27711 (MH); Manthampotti, 16.5.1977, *Sivadasan* CU 19174 (CALI); Dhoni Hills, 26.1.1978, *Sivadasan* CU21434 (CALI); Wayanad Dist.: Vaithiri, 13.9.1975, *Sivadasan* CU 7815 (CALI); Wayanad Ghat, 29.4.1997, *Abdul Jaleel & Bobby Thomas* RIA 62 (CALI).

Notes: *Amorphophallus commutatus* var. *wayanadensis* resembles var. *anmodensis* in its general appearance of the spathe and spadix. But it is distinct in having a long peduncle of about 75-95 cm, tube of spathe yellowish with slight purplish colour at base with warts or verrucae and absence of unicellular silvery hairs within.

Distribution: So far known only from Kerala.

Amorphophallus nicolsonianus Sivad., *Pl. Syst. Evol.* 153: 165 (1986); Manilal, *Fl. Silent Valley:* 330 (1988); Sasi. & Sivar., *Fl. Pl. Thrissur For.:* 483 (1996); Sivad. in Manoharan, Biju, Nayar & Easa, *Silent Valley-Whisp. Reas.:* 230 (1999). **(Fig. 7)**

Types: Kerala State, Palghat Dist., Silent Valley Dam site, alt. ca. 1000 m, 3.1.1983, *Sivadasan* CU 21516-A (*Holotype* - K), *Sivadasan* CU 21516-B (*Isotype* - K), *Sivadasan* CU 21516-C, *Sivadasan* CU 21516-D (*Isotypes* - US), *Sivadasan* CU 21516-E (*Isotype* - CAL), *Sivadasan* CU 21516-F (*Isotype* - M).

Tubers more or less obconical to napiform or sub-cylindrical, c. 3.0-5.5 cm long and 1.5-3.5 cm in diam. in vegetative phase; cylindrical, 10-17 cm long and 1.5-4.0 cm in diam. in reproductive phase; skin smooth. Petiole 18-50 cm long, 0.5-1.2 cm in diam. at base, green with pale green mottles and small dark purplish spots, extreme base white; rachises without decurrent leaflet-bases; petiole and rachises very turgid, breaking easily when bent without becoming crushed. Leaflets 4.0-16.5 x 1.6-5.0 cm, margin undulate, upper surface dark green and glossy, lower surface pale green; basal leaflets with distinct petiolules or rarely sessile. Peduncle c. 21-31 cm long. Spathe erect, ovate-lanceolate, acuminate, c. 10.6-12.0 x c. 5 cm, basally convolute, tubular;

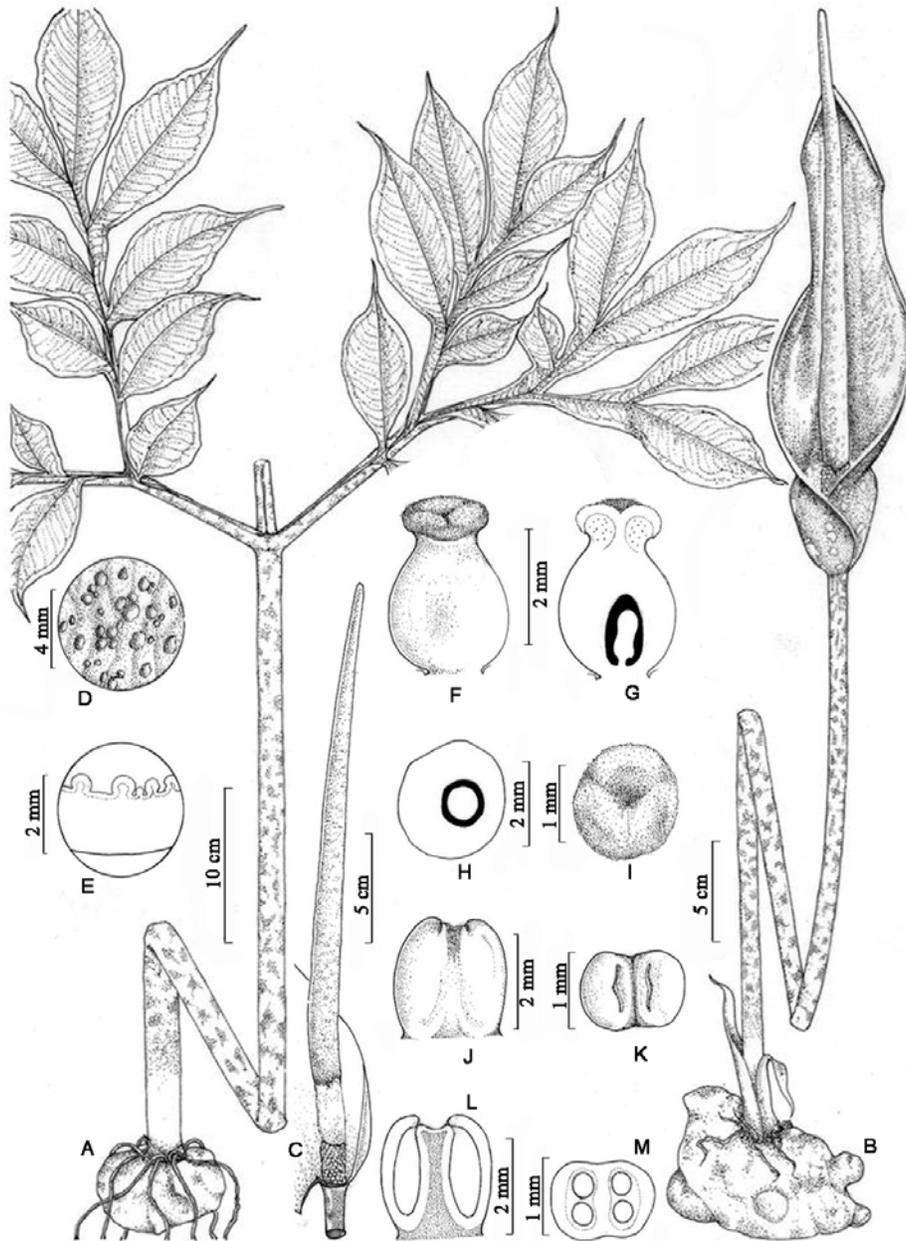


Fig. 6. *Amorphophallus commutatus* (Schott) Engl. var. *wayanadensis* Sivad. et Jaleel. A. Tuber with leaf; B. Tuber with inflorescence; C. Inflorescence - spathe partially removed showing spadix; D. A small basal inside portion of spathe; E. A small basal portion of spathe - c.s.; F. Female flower; G. Female flower - l.s.; H. Ovary - c.s.; I. Stigma; J. Male flower - view from broad side; K. Male flower - view from top; L. Male flower - l.s.; M. Male flower - c.s.

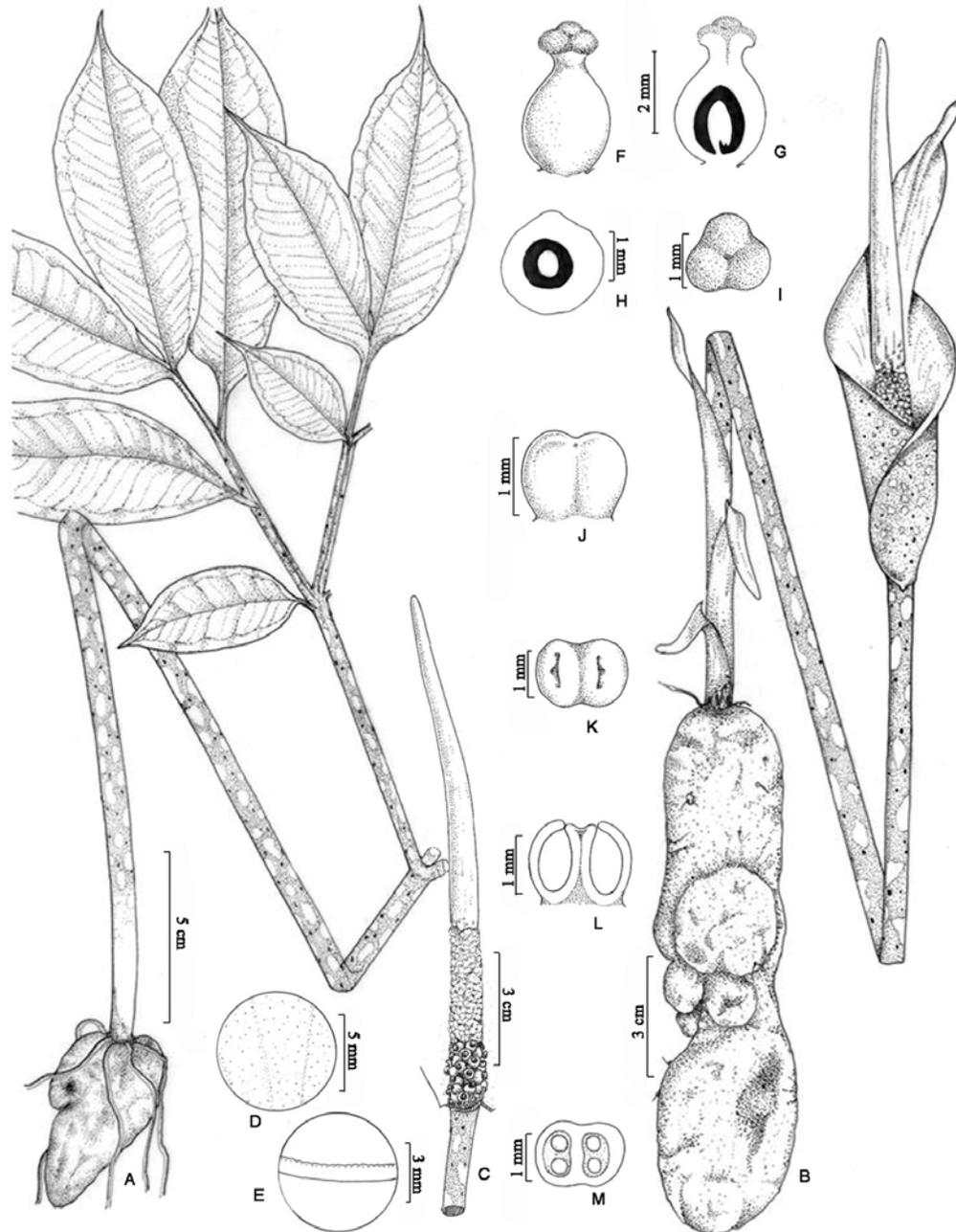


Fig. 7. *Amorphophallus nicolsonianus* Sivad. A. Tuber with leaf; B. Tuber with inflorescence; C. Spadix; D. A small basal inside portion of spathe; E. A small basal portion of spathe - c.s.; F. Female flower; G. Female flower - l.s.; H. Ovary - c.s.; I. Stigma; J. Male flower - view from broad side; K. Male flower - view from top; L. Male flower - l.s.; M. Male flower - c.s.

limb expanded, erect, usually two halves of the limb longitudinally reflexed at maturity, greenish brown to greenish purple with light green mottling and dark purple spots outside, greenish yellow and smooth within, sometimes very light pinkish-green tinged and with purple spots at base within. Spadix sessile, c. 11-12.5 cm long, slightly longer than spathe; female zone c. 1.2-1.4 cm long; male zone c. 2.0-2.5 cm long; appendix c. 7.2-8.5 cm long. Female flowers loose or dense in sub-spirals, each with ovary sub-globose, c. 2 mm high, pale yellowish, unilocular; style very short, c. 0.5 mm long, greenish; stigma capitate, more or less discoid, 1.5 mm in diam., greenish. Male flowers dense, sessile, each c. 1.2 mm high, cream-coloured, inconspicuously 2-lobed. Spadix-appendix sessile, terete, tapering to the tip, pale yellowish green, blunt-spinescent or with irregular-shaped vestiges of staminate flowers and irregular longitudinal furrows at base, becoming completely corrugated, creamy or light yellowish on ageing. Fruits ellipsoid, dark red at maturity, 1.0-1.3 cm long. Seeds ellipsoid, c. 1 cm long.

Phenology: Flowering: December-February; Fruiting: February-April.

Specimens examined: **Kerala:** Thiruvananthapuram Dist., Bonaccord, 16.2.1991, Mohanan 10333 (TBGT). Palghat Dist.: Silent Valley, 1.1.1977, *Sivadasan* CU 19184 (CAL); Silent Valley, Walakkad, 1700 m, 28.2.1983, *Sathish Kumar* SV 10797C (CALI); Silent Valley, 6.2.1998, *Abdul Jaleel* RIA 251 (CALI). Kozhikode Dist.: Thenpara forest, 26.12. 1997, *Abdul Jaleel* RIA 241 (CALI). Wayanad Dist.: Meppadi, 27.12.1997, *Abdul Jaleel*, RIA 243 (CALI). Kannur Dist.: Walathode, Kannavam forest, 24.12.1984, *Sabu & Sivadasan* CU 36578 (CALI).

Notes: *Amorphophallus nicolsonianus* differs from all other Indian species by having a cylindrical tuber in reproductive phase, turgid and brittle petiole and peduncle, and the two halves of the limb of the spathe longitudinally reflexed at maturity.

Distribution: So far known to occur only in Kerala state in India.

Amorphophallus oncophyllus Prain *ex* Hook. f., Fl. Brit. Ind. 6: 516 (1893); Hook. f., Curtis's Bot. Mag. 119 (Ser. 3, v. 49): t. 7327 (1893); Srivast. & Rao in Higher Pl. Ind. Subcont. IV: 32 (1993). **(Fig. 8)**

Types: 'Birma, Great Cocos Island', 1889/1890, *Prain* s.n. (*Holotype* - CAL; *Isotypes* - CAL, K).

Tubers sub-globose, c. 2.5-4.5 cm in diam. and 2-3 cm thick in vegetative phase; c. 7.5-9.0 cm in diam. and 4.5-6.5 cm thickness in reproductive phase; root scars annuliform. Petiole c. 52.5-96.0 cm long, dark green blotched with elongated greenish white and minute greenish white mottles in between blotches, extreme base pale purplish. Leaflets ovate-elliptic to lanceolate, 4.2-22.5 x 2.2-7.2 cm, acuminate, secondary lateral veins close; upper surface glossy green, lower surface pale green. Bulbils c. 0.6-1.5 cm in diam. Peduncle smooth, 38-56 cm long. Spathe broader than long, broadly ovate-obtuse, c. 14-26 x 18-22 cm; basal convolute tube c. 6-7 cm long and 3.2-4.0 cm in diam., limb expanded, orbicular-ovate, c. 10 cm long with a slight constriction between tube and limb, initially erect, reflexed and horizontal at maturity, tip obtuse or broadly acute; pale greenish brown with irregular elongate greenish white blotches and dark minute spots in-between outside; inside extreme base pale pinkish, muricate, middle purplish with oblong to ovoid blotches, pale green with small green blotches at apical portion. Spadix slightly longer than spathe, exserted, c. 16.5-20.0 cm long, stipitate; stipe pale greenish, c. 0.5-1.0 cm long; female zone c. 3.5-4.0 cm long; male zone c. 4.0-4.5 cm long; appendix c. 8.0-10.5 cm long. Female flowers loosely arranged in sub-spirals, each c. 4 mm high; ovary c. 2 mm high, sub-globose, much broader than stigma, reddish, 2-locular, rarely 3-locular; style very short, c. 1.2 mm long; stigma 2-lobed, rarely 3-lobed, yellowish, c. 2.2 mm in diam. Male flowers dense, each c. 2 mm long, yellowish. Spadix-appendix fusiform or elongate-ellipsoid, pale yellowish, basal most part with slight rhomboid projections. Fruits ellipsoid, c. 1.5-1.8 cm long. Seeds 1-3, ellipsoid, c. 1.1-1.3 cm long.

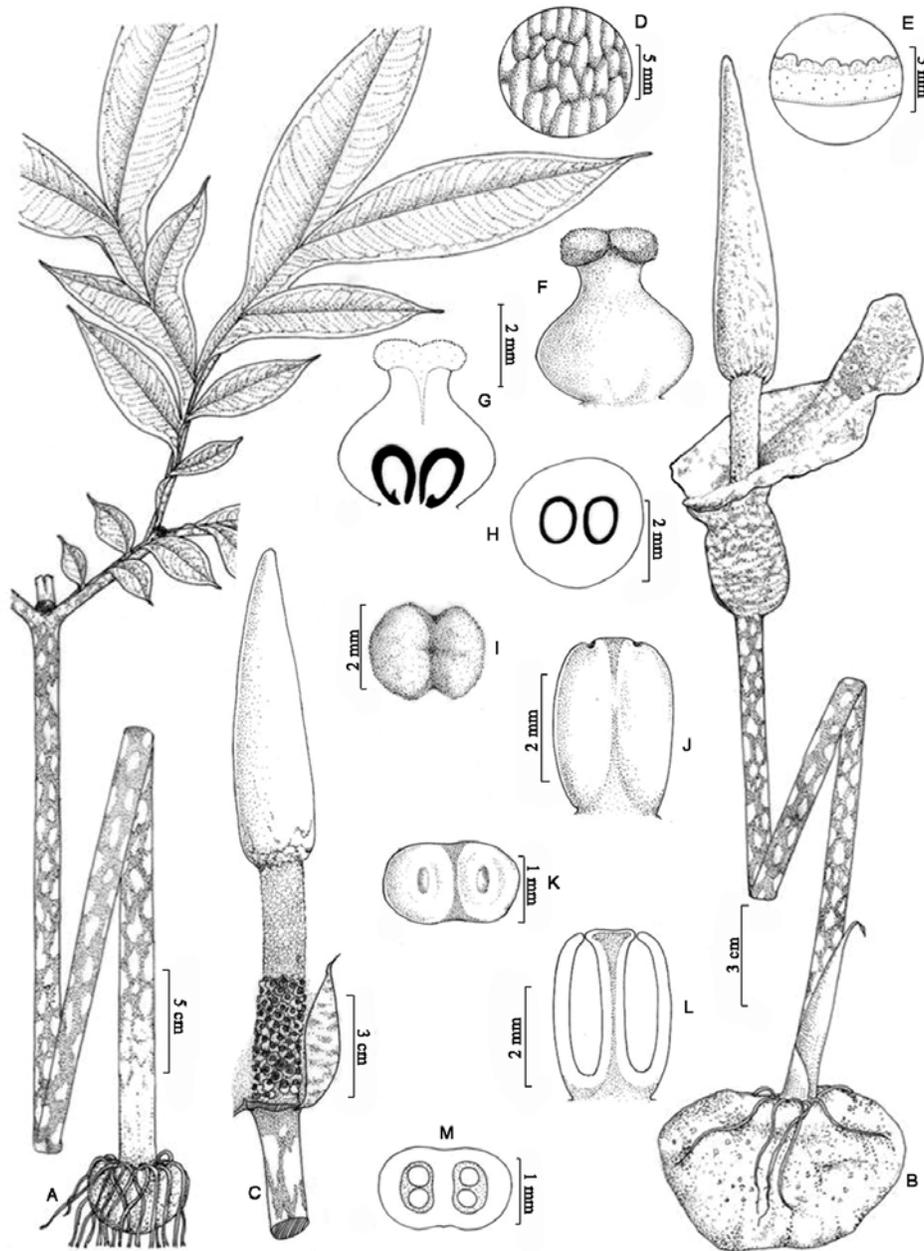


Fig. 8. *Amorphophallus oncophyllus* Prain ex Hook. f. A. Tuber with leaf; B. Tuber with inflorescence; C. Inflorescence - spathe partially removed showing spadix; D. A small basal inside portion of spathe; E. A small basal portion of spathe - c.s.; F. Female flower; G. Female flower - l.s.; H. Ovary - c.s.; I. Stigma; J. Male flower - view from broad side; K. Male flower - view from top; L. Male flower - l.s.; M. Male flower - c.s.

Phenology: Flowering: April-June; Fruiting: July-December.

Specimens examined: **Andaman and Nicobar Islands**: South Andaman: Port Mount, Hill jungle, 2.6.1893, *Dr. King's Collector*, Acc. No. 496692 (CAL); Calcutta, Botanical Garden Div. nursery (cultivated) (Originally collected from Andaman islands), 16.4.1894, *S. Coll.*, Acc. No. 496695 (CAL); Guptapara, 28.11.1997, *Abdul Jaleel & Bobby Thomas* RIA 216 (CALI); Gunnihat, 29.11.1997, *Abdul Jaleel & Bobby Thomas* RIA 217 (CALI); Dandras point, 29.11.1997, *Abdul Jaleel & Bobby Thomas* RIA 218 (CALI); Ograbraj, 9.5.1999, *Abdul Jaleel* RIA 334 (CALI). Middle Andaman: Baratang, 30.4.1999, *Abdul Jaleel* RIA 332 (CALI); North Andaman: Lamia Bay, 13.12.1997, *Abdul Jaleel & Bobby Thomas* RIA 235 (CALI).

Notes: *Amorphophallus oncophyllus* more or less resembles *A. bulbifer*, but the colour and pattern of mottling of petiole and peduncle are quite different. The spathe limb in the latter is erect and lack a constriction between tube and limb whereas in *A. oncophyllus* the spathe-limb is reflexed at maturity.

Distribution: Endemic to the Andaman and Nicobar islands

Taxonomic analysis

Hooker (1894) in his *Flora of British India* recognized 17 species under four genera, viz. *Amorphophallus*, *Synantherias*, *Thomsonia* and *Plesmonium* which according to the present generic delimitation belong to one genus - *Amorphophallus*; and out of those, only eight species were recorded as occurring in India. Out of the eight species, three, viz. *A. bulbifer*, *A. commutatus* and *A. oncophyllus* and one species described as new by Engler (1911), viz. *A. carnosus* were the Indian species included under the sect. *Conophallus* by Engler (1911) in his treatment of *Amorphophallus* under the subfamily Lasioideae as part of his monographic work of Araceae. *Amorphophallus bognerianus*, *A. commutatus* var. *anmodensis*, *A. commutatus* var. *wayanadensis*, and *A. nicolsonianus* are the other taxa now included under the section which are described after Engler's treatment.

Hettterscheid and Ittenbach (1996) listed fourteen Indian species of *Amorphophallus* in their treatment of the genus and treated *A. carnosus* and *A. oncophyllus* as synonymous with *A. muelleri* Blume, a Javanese species; but detailed studies during the present investigation do not corroborate their view, and treat them as distinct species. *A. bulbifer* is the only widely distributed species in India with extended distribution in Bangladesh and Myanmar. This species was reported to have four varieties (Engler, 1911) viz., var. *bulbifer*, var. *atroviridimaculatus* Engl., var. *marmoratus* Engl. and var. *tuberculiger* (Schott) Engl., and in the present investigation those varieties are considered as representing variations of a single species.

The present investigation shows that the maximum species diversity of the section is in Kerala belonging to the Western Ghats area which is one of the world's ten "Hottest biodiversity hotspots" (Myers *et al.*, 2000). There are four species, viz. *A. bognerianus* (Arunachal Pradesh), *A. carnosus* (Andaman Islands), *A. oncophyllus* (Andaman islands) and *A. nicolsonianus* (Kerala state), endemic to India and they are considered to be endangered. The indiscriminate habitat destruction poses threat to the existence of the endemic species.

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