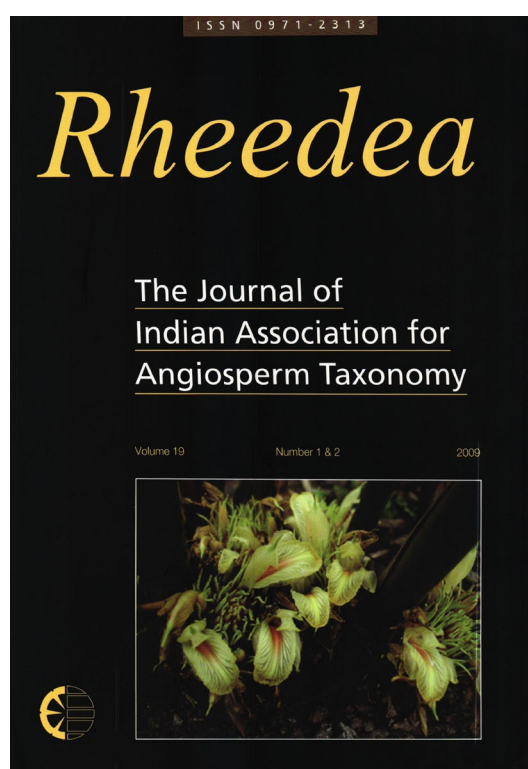




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Taxonomic studies on cultivars of *Amomum subulatum* (Zingiberaceae)

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Abstract

Amomum subulatum Roxb. (Large cardamom) is an important medicinal and spice crop of India. The specimens of *A. subulatum* from Sikkim, North Bengal and Nagaland were collected and studied in detail. Based on critical study five new cultivars viz., 'Dzongu', 'Green Golsey', 'Sawney', 'Seremna' and 'Varlangey' have been recognised. A key to the cultivars, taxonomic descriptions, illustrations, ecology, distributions, etymology and notes are provided.

Keywords: *Amomum subulatum*, Cultivars, Spice, Zingiberaceae

Introduction

The genus *Amomum* Roxb. is the second largest genus of the family Zingiberaceae with c. 150 species (Tripathi & Prakash, 1999). It is characterized by the position of radical inflorescence, absence of involucre of sterile bracts and reduced lateral staminodes. *Amomum subulatum* (Large cardamom) was described in detail with an excellent illustration for the first time by Roxburgh (1820a) in his 'Plants of the Coast of Coromandel' and in 'Flora Indica' (1820b). *A. subulatum* is indigenous to moist deciduous and semi-evergreen forests of sub-Himalayan tracts (Gupta, 2000). The crop is widely cultivated in sub-Himalayan mountains at an altitude ranging from 1000 – 2000 m.

Economic Importance

Large cardamom is one of the major cash crops of India. In India, c. 30,000 ha of land is under large cardamom cultivation with an average production of c. 150 kg/ha. The annual production of this crop is 5000 – 5500 tonnes (Anonymous, 2004). It is mainly cultivated in Sikkim, Darjeeling Hills and Northeastern states (Gupta, 1983) and neighbouring countries like Nepal and Bhutan (Gupta & Gopakumar, 2004). Large cardamom is mainly sold in the domestic markets of Northern India, small amount exported to Pakistan, Singapore, Hong Kong, Malaysia, UK and some Middle East countries. It has good markets in Gulf countries, USA and West Germany (John, 1984). It is one of

the ingredients for flavour and fragrance in food and raw material in perfumery industry.

Cardamom seeds form one of the important ingredients used in the masticatory throughout India. In both Indian and European medicines it is a frequent adjunct to other stimulants, bitters and purgatives, used in the form of tincture or powder (Dey & Badhadur, 1973).

There are a number of 'cultivars' or 'varieties' under cultivation since long, but none of them were established as per the rules and regulations of International Code of Nomenclature for Cultivated Plants (ICNCP) (Brickell *et al.*, 2004). Identification and selection of suitable cultivar is very important for the cultivation at various altitudes. Because of its economic importance, it is necessary to have an identification key and naming of cultivars according to ICNCP. It would be helpful for the trading and marketing using valid names. In the present study an attempt has been made to name and establish the cultivars based on morphological studies. These studies would be helpful for scientists working in other aspects of this species.

Materials and Methods

A. subulatum growing in Pangthang and Kabi (Sikkim) field stations of Spices Board and wild collections from Nagaland were subjected to the present study. The germplasm includes collections from

different parts of Sikkim and Darjeeling district of West Bengal. The selection of cultivars was generally made on the basis of morphological characters such as plant height, girth at base, number of productive leafy shoots per plant, leaf size and number of spike per plant, capsule per spike, weight of 100 dry capsules, shape, length, diameter and colour of capsule, number of seeds per capsule and seed – husk ratio. The germplasm conservatory located at Pangthang (East Sikkim) and Kabi (North Sikkim) has 208 accessions. The five cultivars recognized based on present study are ‘Dzongu’, ‘Green Golley’, ‘Sawney’, ‘Seremna’ and ‘Varlangey’. The rules of latest ICNCP are followed for the nomenclature of cultivars (Brickell *et al.*, 2004).

Amomum subulatum Roxb., Pl. Coromandel 3: 75, t. 277. 1820 & Fl. Ind. 1: 43. 1820; Baker in Hook.f., Fl. Brit. India 6: 240. 1892; K. Schum. in Engl., Pflanz. IV 46 (Heft 20): 253. 1904; Sealy, Kew Bull. 2: 307. 1956; J. N. Mitra, Fl. Pl. E. India 1: 253. 1958; H. Hara, Fl. E. Himalaya: 421. 1966; A. S. Rao & D. M. Verma, Bull. Bot. Sur. India 14: 135. 1972; Karth. *et al.*, Fl. Ind. Enum. Monocotyl.: 290. 1989; S. K. Jain & V. Prakash, Rheedeia 5(2): 157. 1995; Delin & K. Larsen in Zhengyi & Raven, Fl. China 24: 355. 2000; S. Kumar, Zingiberaceae Sikkim: 17. 2001.

Fig. 1, 2a, 3a

Vernacular Names: Bengali – *Bara Elachi*; English – *Large Cardamom*, *Greater Cardamom*, *Nepal Cardamom*, *Bengal Cardamom*; Hindi – *Bada Elaichi*; Malayalam – *Perelam*; Sanskrit – *Brihadaela*; Tamil – *Periyelam*; Telugu – *Pedayalakai*.

Type: Icones Roxburghianae 2157 (CAL!).

Rhizomatous perennial herb. Rhizome woody, fibrous, hard, subterranean, dark pink, nodal markings prominent, outer side dull pink, brighter towards centre; roots pink outside. Leafy shoots 100 – 285 cm high, girth 7 – 7.5 cm, robust, swollen at base, green to pink. Sheath 2.2 – 2.8 cm broad at base, glabrous, prominently ridged with parallel nerves; margins hyaline, ciliate, pink. Leaves simple, alternate, distichous, 5 – 9, sessile to petiolate, produced mainly towards the upper 2/3 of shoot, lower 1/3 covered by sheaths; lamina, oblong-lanceolate, 30 – 81 × 7.5 – 10.5 cm, thick, drooping, dark green on upper side, pale beneath, glabrous; margin entire, wavy, hyaline, slightly revolute, glabrous; apex long-acuminate, up to 4.5 cm long; base oblique, tapering, oblique ends 0.5 – 1 cm apart; midrib shallowly ridged, white, glabrous; nerves many, running parallel at an angle 25 – 30° with the midrib, originate from midrib and runs parallel with the midrib a little long, then slanting; petiole to 2.5 cm long, grooved above, shallowly ribbed with nerves. Ligule 4 – 6 mm long, deeply

emarginate, apex nearly rounded, margin ciliate, glabrous, light pink; gland usually not prominent, rarely present in the adjoining portion between petiole and ligule, dark pink, glabrous. Spike 6 – 12 × 3 – 6 cm, 1 – 3 per leafy shoot, radical, clavate, compact, 1 or 2-flowered, a little elevated above the soil, elongate during flowering; bracts, bracteoles, calyx and beak of dorsal corolla lobe with pale yellow pointed apical process; involucre of sterile bracts absent; peduncle 3.5 – 6 cm long, with 6 or 7 bracts; the uppermost bracts of peduncle often enclose the spike. Flower 4.7 – 5.1 cm long, yellow, borne singly from each bract and bracteole. Bract broadly obovate, obtuse with a horny cusp, 3 – 5 × 2 – 3 cm, imbricate, leathery at centre, membranous towards the margin, pubescent outside, glabrous inside, green to pink; margin hyaline, ciliate; beak subulate, 3 – 4 mm long, glabrous. Bracteole obovate or spathiform, 2.7 – 3.1 × 2 – 2.4 cm, opening on one side, thick at centre, membranous towards margin, pubescent outside, glabrous inside, light green, light green; margins membranous, ciliate; beak subulate, 2 – 4 mm long, glabrous. Calyx cylindrical, tubular, 2.5 – 3.5 × 0.6 – 0.9 cm, 3-clefted, longer than corolla tube, reaches ¾ of the flower, pubescent outside, glabrous inside, pale green-yellow at tip, white towards base; splitting unequal, one split is longer than others; beaks 3, 0.5 – 1 cm long, nearly equal in length, glabrous; beak base notched, apex *c.* 1 mm long. Corolla tube 1.8 – 2 cm long, *c.* 4 mm at mouth, shorter than lobes, glabrous outside, densely hairy towards mouth, glabrous towards base, downwardly directed, pale pink-yellow; dorsal lobe obovate-oblong or boat-shaped, concave, broader than laterals, 2.1 – 2.5 × 1.1 – 1.2 cm, pale yellow, glabrous, apex hooded, margin sparsely ciliate; beaks subulate, 3 – 4 mm long, some hairs below, many-nerved, 3 nerves continuous till apex; lateral lobe oblanceolate, 2.4 – 2.6 × 0.8 – 0.9 cm, glabrous, pale yellow; margin sparsely ciliate, one side of apex slightly folded, many-nerved, 1 nerve extends up to the apex. Labellum 2.4 – 2.6 × 1.2 – 1.3 cm, oblong, longer than corolla lobes, dark yellow, 9 – 12 pairs parallel nerves form mid nerve, bright yellow, all nerves nearly equidistant, laterals hyaline, close, not reaching up to the margins, unsplit; apex nearly truncate, emarginate, ends overlapping, crumpled; margin crenulate, crumpled; base cuneate, densely hairy, slightly pink-tinged. Lateral stamens subulate, 4 – 9 mm long; base slightly bulbous, hairy. Stamen 1, perfect, 2.2 – 2.6 cm long, nearly equal to the lip; filament slightly concave, 6 – 9 × 2 – 3 mm, hairy inside, glabrous outside, creamy white; connective slightly hairy, produced into a crest; crest fan-shaped, unlobed, apex inflexed, 0.8 – 1 × *c.* 2 cm, petaloid, glabrous, yellow; anther 2-celled; thecae oblong, 0.9 – 1.1 × *c.* 0.1 cm, glabrous, creamy white,

apex diverging, base sharply ending, equal, dehiscing throughout the length. Epigynous glands 2, 1–2 mm long, yellow, warted, irregularly minutely lobed, glabrous, placed above the ovary; style passes between the glands. Ovary inferior, barrel-shaped, 4–5 × 3–4 mm, pink, pale towards tip, sparsely hairy, 3-loculed; ovules many, placed a little apart from the axis, 2 or 3 in each row, 2 groups in each locule; style filiform, 3.7–3.9 cm long, sparsely hairy, white; stigma subglobose, one side slightly bulged, c. 1 mm across, minutely red-spotted, situated at the tip of the anther thecae, not exceeding the crest, opening terminal, elliptic, ciliate around the mouth. Infructescence 13–19 cm long; peduncle 6–11 cm long, elongate during fruiting. Fruit a capsule, 14–20 per spike, conical, 2.5–3 cm long, 5.5–6 cm in girth, fresh weight c. 4.39 g, dry weight c. 0.64 g, maroon-coloured; 10–13-winged, wingless towards base, irregularly lobed, glabrous; bract, bracteoles and calyx are persistent in fruit; bract c. 3.5 × 3 cm, with c. 6 mm long beak; bracteole c. 3 × 2.2 cm, with c. 5 mm long beak; calyx 3–3.7 cm long. Seeds 40–50, c. 2.5 mm, black, bold, glabrous, arillate; aril white, sweet.

Flowering: April–May.

Fruiting: June–November.

Specimens Examined: INDIA, **Nagaland**, Zunhebeto District, Lumami, Near Nagaland University Campus, 27.6.2005, *Sanoj* 92131; Near Nagaland University Campus, 26.8.2006, *Thomas & Sanoj* 105525; Way to Longhum Village, 28.8.2006, *Thomas & Sanoj* 105559 (CALI).

Distribution: Arunachal Pradesh, Assam, Meghalaya, Sikkim and West Bengal and neighbouring countries like Bhutan, China and Nepal.

Ecology: Endemic to moist deciduous and semi-evergreen forests of sub-Himalayan tracts, near streams or ponds.

Pollination: Cross pollination by bumble bees (*Bombus* sp.) and honey bees.

Chromosome Number: 2n = 48 (Venkatasubban, 1946; Sharma & Bhattacharya, 1959); 2n = 26, 34, 42, 44 (Sharma & Bhattacharya, 1959); 2n = 54 (Das et al., 1998).

Etymology: The specific epithet 'subulatum' is derived from a Latin word 'subula' means "awl", referring to the awl-shaped tips of bract and calyx projecting above the inflorescence.

Notes: The plant with glabrous leaves, green to pink bracts with beak, yellow flower, beaked calyx, dorsal corolla lobe with subulate beak, winged fruit with spicy seeds distinguish *A. subulatum* from other species. *A. subulatum* described by Roxburgh

differs from plants under cultivation in some attributes. In wild plants the lip is oblong and the apex is somewhat truncate in shape, all bands are parallel, equidistant and not branching, whereas in cultivars the apex of lip is somewhat rounded in shape, bands dividing, not parallel and equidistant.

Key to the cultivars of *A. subulatum*

1. Capsules conical, 13–20 per spike2
1. Capsules oblong or spherical, 5–10 per spike3
2. Plants 200–250 cm high; leaves 60–80 cm long; capsules 3–4 cm long; seeds 55–70 per capsule.....'Varlangey'
2. Plants 150–190 cm high; leaves 40–55 cm long; capsules 2.5–3 cm long; seeds 35–50 per capsule.....'Sawney'
3. Leafy shoot maroon-coloured towards the base 'Seremna'
3. leafy shoot green-coloured throughout.....4
4. Plants 100–145 cm high; leaf margin straight; ligule pubescent outside; capsules completely dark maroon in colour.....'Dzongu'
4. Plants 155–200 cm high; leaf margin wavy; ligule glabrous outside; capsules pink with green-coloured wings 'Green Golsey'

Amomum subulatum 'Dzongu' Fig. 2b, 3b

Standard Specimen: INDIA, **Sikkim**, North Sikkim District, Dzongu, 22.8.2006, *Thomas* 105510 (CALI).

Rhizome pale pink towards periphery, slightly dark inside. Leafy shoots 100–145 cm high, girth 3.7–4 cm, green, not robust. Sheath c. 2.3 cm broad at base, shallowly ridged with parallel nerves, puberulous; margins membranous, ciliate, pink. Leaves sessile to petiolate, 3–6 per leafy shoot; lamina elliptic-lanceolate, 22–45 × 6.5–8 cm, thin, erect, glabrous, pale green; apex slightly obtusely acuminate, up to 3.2 cm long, spirally curled; base equal, cuneate; margins straight, membranous, glabrous; midrib shallowly ridged with parallel nerves, glabrous; nerves many, running parallel at an angle 16–21° with the midrib, not prominent, puberulous; petiole to 3 mm long, puberulous. Ligule shallowly emarginate, 3–5 mm long, pink, pubescent outside, glabrous inside; margin membranous, ciliate; glands not prominent. Spikes 1 or 2 per leafy shoot, obtrullate, 6–8 × 2.5–3 cm; peduncle 1.5–2 cm long, 4–7 sheaths on stalk. Bracts broad-oblong, 3.2–5 × 1.5–2.3 cm, slightly convex, densely hairy outside, glabrous inside,

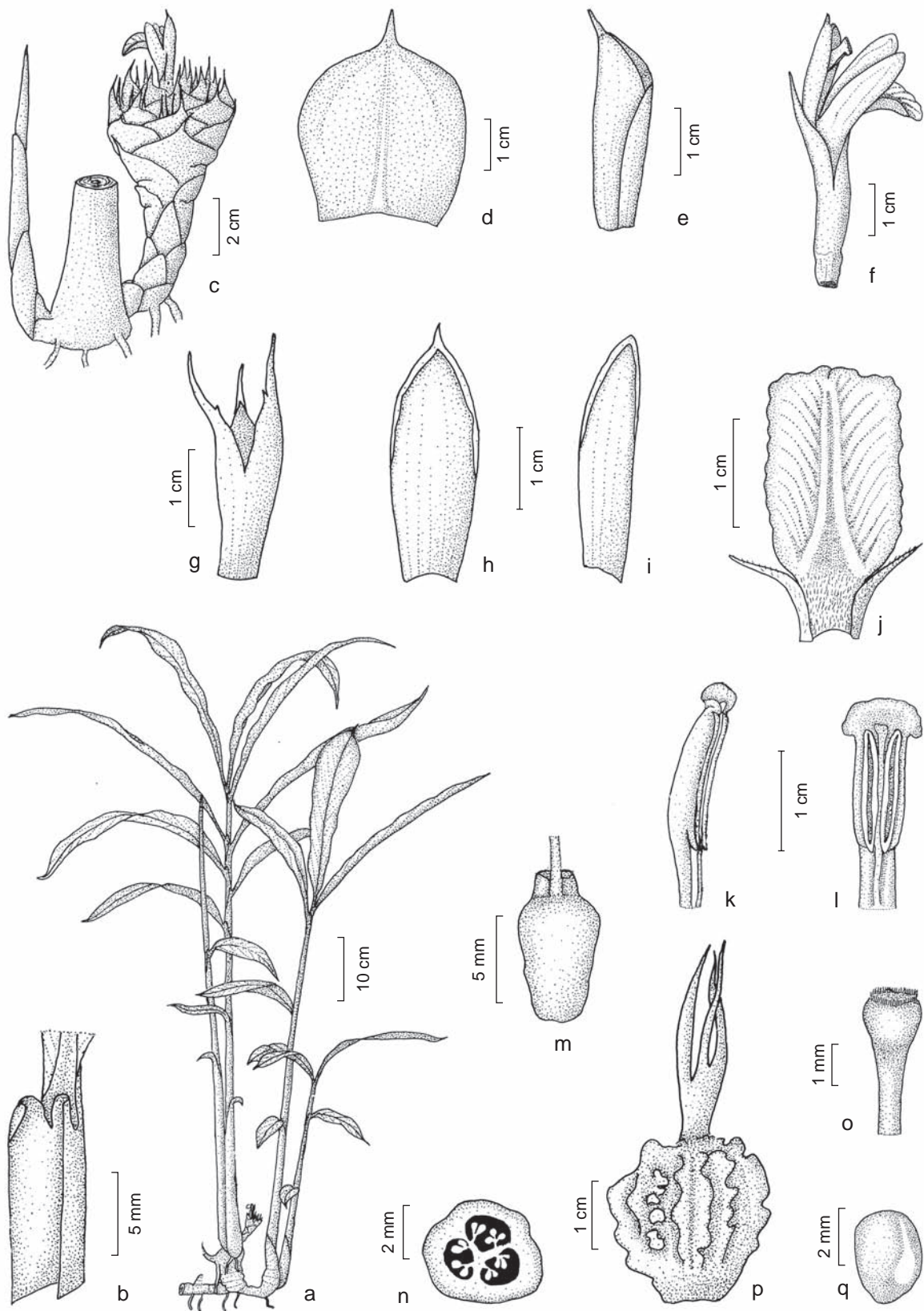


Figure 1. *Amomum subulatum* Roxb. a. Habit; b. Ligule; c. Inflorescence; d. Bract; e. Bracteole; f. Single flower; g. Calyx; h. Dorsal corolla lobe; i. Lateral corolla lobe; j. Labellum; k. Stamen - lateral view; l. Stamen- front view; m. Ovary with epigynous glands; n. C.S. of ovary; o. Stigma; p. Fruit with calyx; q. Seed.

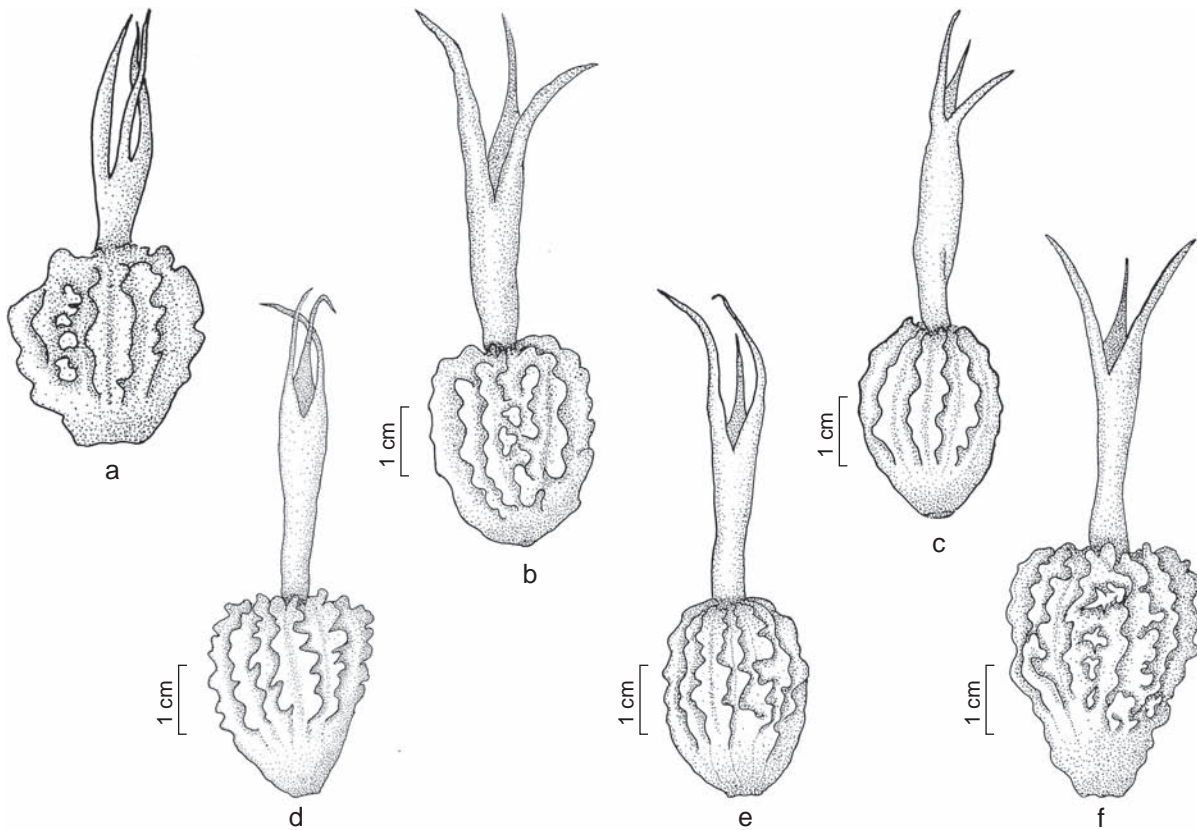


Figure 2. *Amomum subulatum* Roxb. Comparison of Fruits: a. Wild; b. 'Dzongu'; c. 'Green Golsey'; d. 'Sawney'; e. 'Seremna'; f. 'Varlangey'.

green; apex rounded; margin pink, membranous, ciliate; beak 4–8 mm long, glabrous, a notch at the base of beak. Bracteole 2.5–3.3 × 1.2–1.5 cm, obovate-oblong, membranous, pink-white, densely hairy outside, glabrous inside; margin ciliate; beak 1–3 mm long, glabrous. Flowers usually one at a time, 5–5.5 cm long, pale yellow. Calyx tubular, 3.9–4.6 × 0.6–0.7 cm, 3-clefted, hairy outside, glabrous inside, white; beak 1–1.2 cm long, slightly curled, a notch at the base of the beak, unequal, glabrous. Corolla tube 2–2.5 cm long, densely hairy inside, glabrous outside; dorsal lobe, oblong or boat-shaped, 3.6–3.7 × 1.2–1.3 cm, sparsely hairy outside, glabrous inside, many-nerved, 3 nerves continue up to apex; apex hooded; margin ciliate; beak subulate, 5–7 mm long, glabrous; lateral lobes oblanceolate, c. 3 × 0.9 cm, one side of apex slightly folded, glabrous inside; margin ciliate. Labellum oblong, 2.8–3 × 1–1.5 cm, pubescent at throat inside, light pink tinge at base, the median nerve of lip is dark yellow in colour, 7–9 pairs of nerves emerging out from the mid nerve to periphery; nerves hyaline, diverging, most of

them dividing dichotomously towards the margin; margin slightly crenulate and crumpled; apex rounded, emarginate, crumpled, reflexed, oblong, crumpled, base cuneate. Lateral staminodes 4–6 mm long, flat. Stamen 2.3–2.6 cm long; filament 6–11 × 2–3 mm, sparsely hairy, white; connective glabrous; crest obscurely 3-lobed, petaloid, 8–9 × 3–4 mm, glabrous, many-nerved; apex crenulate, recurved; thecae oblong, 1–1.1 × c. 0.1 cm, glabrous, cream-coloured; apex slightly diverging out; base sharply ending. Epigynous glands 2, 3–4 mm long, minutely lobed at apex, warted, glabrous, creamy yellow; style passes between them. Ovary c. 3 mm, sparsely hairy, pink, 3-loculed; ovules many, on axile placenta; style linear, 3.9–4.5 cm long, glabrous, white; stigma cup-shaped, c. 1 mm, red-spotted; mouth ciliate. Infructescence c. 10 cm long, girth c. 16 cm; peduncle c. 4 cm long; persistent calyx 3.2–4.1 cm long, tip drying. Capsules 7 or 8 per spike, oblong-spherical, 2.4–3 cm long, c. 2.7 cm in diameter, c. 6 cm in girth; fresh weight of a capsule c. 7 gm, dry weight c. 1.5 gm, dark maroon; wings 10–13, crenulate; fruit wall

1.5 – 3 mm in thickness. Seeds 55 – 70 in each capsule, black, arillate; aril membranous, white.

Flowering: March – May.

Fruiting: June – October.

Specimens Examined: INDIA, **Sikkim**, North Sikkim District, Dzongu, 11.4.2005, *Sanoj* 92767; Dzongu, 1.7.2005, *Sanoj* 92774 (CALI).

Distribution: Pasindang, Gnansandong, Lingdem and other areas of Dzongu in North Sikkim.

Ecology: Found in low altitudes (< 1500 m) especially along river banks.

Etymology: 'Dzongu' refers to a place in North Sikkim, where the cultivar is grown abundantly.

Notes: It is very specific to Dzongu area of North Sikkim and is relatively tolerant to Chirke but susceptible to Foorkey and leaf streak diseases. (Chirke and Foorkey are important viral diseases found in large cardamom plantations. The affected plant shows gradual decline in growth and yield and ultimately perish. This cultivar can be easily identified from others by weak green-coloured leafy shoots with oblong-spherical capsules. This cultivar is smallest among all available cultivars. Leaves are erect and not wavy.

***Amomum subulatum* 'Green Golsay'**

Fig. 2c, 3c

Standard Specimen: INDIA, **Sikkim**, East Sikkim District, Pangthang, 22.8.2006, *Thomas* 15502 (CALI).

Rhizome pale pink inside. Leafy shoot 155 – 200 cm high, girth 5 – 6 cm, robust, green. Sheath glabrous, *c.* 4 cm across, puberulous; margins membranous, ciliate, pink. Leaves sessile to petiolate, lanceolate, narrow, erect, 35 – 60 × 4.5 – 10 cm, thick, glabrous, dark green; base tapering, equal; margin wavy, glabrous; apex acuminate, up to 3.1 cm long; midrib ridged with parallel nerves, glabrous; parallel nerves many, form 20 – 28° with midrib, prominent above; petiole absent or to 5 mm long, glabrous. Ligule deeply emarginate, 4 – 5 mm long, glabrous, pink; margin ciliate; glands prominent, dark pink. Spike *c.* 2 per leafy shoot, 9 – 12 × 3 – 3.5 cm; peduncle *c.* 2.5 cm long; sheaths 4 – 6. Bract oblong, 3.8 – 4.5 × 1.2 – 2 cm, leathery, hairy outside, glabrous inside, green; margin membranous, ciliate, pink; beak 4 – 6 mm long, glabrous. Bracteole obovate, non-tubular, spathaceous, 2.5 – 3.1 × 1 – 1.9 cm, membranous, hairy outside, glabrous inside, white, green towards the apex; margin ciliate; beak 2 – 4 mm long, glabrous.

Flowers 5 – 6 cm long, yellow. Calyx tubular, 4.5 – 4.8 × 0.5 – 0.7 cm, 3-clefted, sparsely hairy outside, glabrous inside, white; beak 1 – 1.5 cm long, curled, unequal. Corolla tube 2.1 – 2.5 cm long, hairy inside, glabrous outside, pale yellow; dorsal lobe oblong or boat-shaped, 2.6 – 3.2 × 1.1 – 1.3 cm; margin ciliate; apex pouched; nerves many, 3 continue up till apex, sparsely hairy outside, glabrous inside; beak subulate, 2 – 4 mm long, glabrous; lateral lobes oblong, 2.5 – 2.8 × 0.8 – 1 cm, sparsely hairy outside, glabrous inside; nerves many; midnerve extend up to tip; margin ciliate. Labellum oblong, margin slightly crenulate and crumpled, rounded, not emarginate, 2.8 – 3.4 × 1 – 1.3 cm; midrib deep yellow; lateral bands 7 or 8 pairs, bands splitting towards the margin, usually not parallel, base with pink tinge, hairy. Lateral staminodes usually reduced, represented only by the bulbous base. Stamen 1.9 – 2 cm long; filament 0.6 – 1 × 0.2 – 0.3 cm, sparsely hairy, pale yellow; connective sparsely hairy; crest distinctly 3-lobed, petaloid, 6 – 8 × 3 – 4 cm, recurved, glabrous, many-nerved; apex crenulate; thecae oblong, 8 – 9 × *c.* 1 mm, cream-coloured; apex diverging out; base sharply ending. Epigynous glands 2, 4 – 5 cm long, minutely lobed at apex, glabrous, creamy yellow. Ovary 4 – 5 × *c.* 4 mm, hairy outside, 3-loculed; ovules many, on axile placenta; style 4 – 4.8 cm long, glabrous or very sparsely hairy; stigma cup-shaped, *c.* 1 cm long, red-spotted; mouth ciliate. Infructescence 10 – 12 cm long, girth *c.* 14 cm. Capsule *c.* 6 per spike, oblong-round, 2.5 – 3 cm long, *c.* 2 cm in diameter, light pink and upper part green; wings up to the upper half of the fruit, lobed; fresh weight of a capsule *c.* 5.05 g, dry weight *c.* 1 g; fruit wall 4 – 5 mm thick; calyx persistent, 4.5 – 5.2 cm long. Seeds 35 – 50, black, arillate; aril white, sweet.

Flowering: May – August.

Fruiting: August – November.

Other Specimen Examined: INDIA, **Sikkim**, East Sikkim District, Pangthang, 1.7.2005, *Sanoj* 92777 (CALI).

Distribution: Soreng, Hee, Barmoik, Kaluk, Dartam, Gyalshing, Ravongla, Ben daral, Kew zing and other areas of South and West Sikkim.

Ecology: Less shade is required, found at low altitude areas (below 1500 m)

Etymology: The Hindi word 'Gol' means 'round' and indicates the shape of the capsule, Bhutia word 'sey' means 'yellow', which indicates the flower colour. Green indicates the characteristic green colour of bract, leafy shoot and upper part of the fruit.

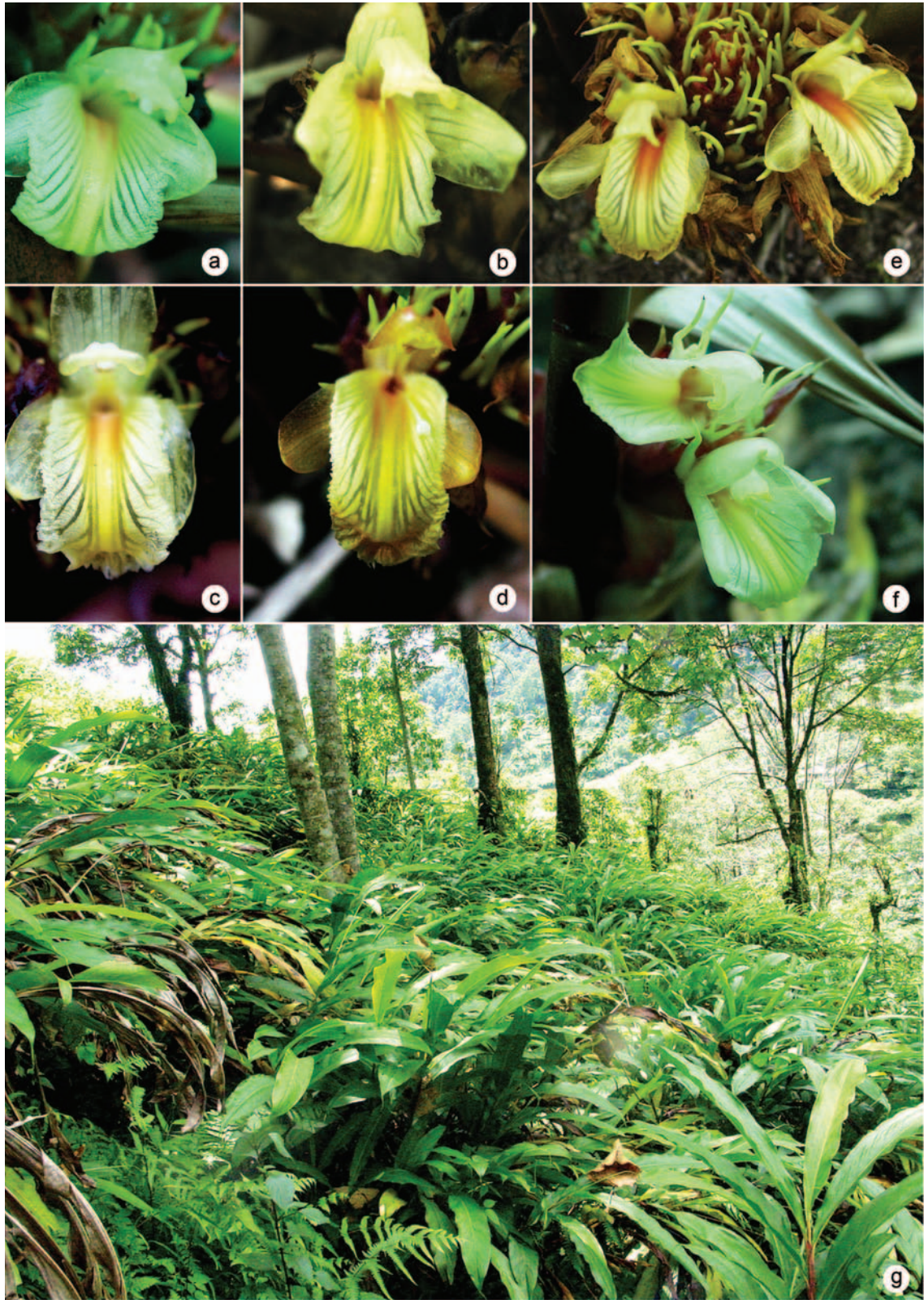


Figure 3. *Amomum subulatum* Roxb. Flowers: a. Wild; b. 'Dzongu'; c. 'Green Golshey'; d. 'Sawney'; e. 'Seremna'; f. 'Varlangey'; g. Plantation.

Notes: 'Green Golsey' is suitable to grow at low altitude areas below 1500 m and can tolerate marginally high temperature. These cultivars can be identified by erect thick and dark green leaves, fruit with upper green part. Moisture percentage is 15 (Gupta, 1996), essential oil 2.3 – 5%. The plants are tolerant to Chirky and Foorkey but susceptible to leaf spots.

***Amomum subulatum* 'Sawney' Fig. 2d, 3d**

Standard specimen: INDIA, **Sikkim**, North Sikkim District, Kabi, 8.5.2007, *Thomas & Nissar* 95515 (CALI).

Rhizome dark pink. Leafy shoots 150 – 190 cm high, girth 4.5 – 5.3 cm, robust, maroon towards base. Sheath 2.8 – 3 cm wide at base, glabrous; margin membranous. Leaves drooping, lanceolate, 40 – 55 × 6 – 10 cm, thick, glabrous; apex acuminate, up to 3.5 cm long, curled; base equal, cuneate; margin membranous, wavy, glabrous, slightly revolute; nerves many, running parallel at an angle 16 – 22° with the midrib, a little prominent above; midrib glabrous; parallel nerves prominent. Petiole absent or to 5 mm long, glabrous. Ligule deeply emarginate, 5 – 7 mm long, glabrous, pink; margin ciliate; glands prominent, glabrous. Spike 2 or 3 per leafy shoot, 7 – 11 × 3 – 3.5 cm; peduncle 2 – 2.5 cm long; sheaths 5 or 6. Bract oblong, 3 – 4 × 1.2 – 1.9 cm, leathery at centre, membranous towards margin, densely hairy outside, glabrous towards base, pink; margin ciliate; beak subulate, 2 – 6 mm long, glabrous. Bracteole lanceolate, 2.5 – 3.1 × 1.3 – 1.4 cm, spathaceous, sometime base fused, membranous, hairy outside, glabrous inside; margin ciliate, light pink; beak 2 – 3 mm long, a notch at the base of the beak. Flowers 1 or 2 at a time, 6 – 6.7 cm long, yellow. Calyx tubular, 4 – 4.5 × 0.5 – 0.7 cm, 3-clefted, sparsely hairy outside, glabrous inside, white, pale green towards apex, persistent; beak straight, unequal, 0.8 – 2 cm long, glabrous. Corolla tube 2.5 – 2.7 cm long, hairy inside, glabrous outside, pink-white; dorsal lobe obovate-oblong or boat-shaped, 3.8 – 4.4 × 1.1 – 1.2 cm, membranous, base only ciliate, minutely hairy outside, glabrous inside, pale yellow, many-nerved; beak subulate, 0.8 – 1.2 cm long, glabrous; lateral lobes oblanceolate, *c.* 3.2 × 0.9 cm, sparsely hairy outside, glabrous inside, 3 nerves continue till apex, membranous, often ciliate. Labellum oblong, margin slightly crenulate and crumpled, 2.8 – 3 × 1.2 – 1.5 cm, 8 or 9 pairs of transparent bands emerging out from the midrib; midrib colour is near to the lateral part of lip and corolla lobes, pink-tinged at base; apex emarginate, crumpled; base cuneate. Lateral staminodes 2 – 3 mm long, flat, pale yellow; base bulbous, hairy or sometimes reduced. Stamen 2.2 – 2.5 cm long; filament 0.8 – 1 × *c.* 0.3 cm, sparsely hairy outside, glabrous inside, pale yellow; connec-

tive sparsely hairy; crest petaloid, obscurely 3-lobed, 0.9 – 1.1 × 0.5 – 0.6 cm, glabrous, pale yellow; thecae oblong, 0.9 – 1.2 × 0.1 cm, cream-coloured; apex diverging out, base sharply ending. Epigynous glands 2, 3 – 4 mm long, warted, minutely lobed at apex, glabrous, creamy yellow. Ovary 4 – 6 × 4 – 5 mm, densely hairy outside, pink, 3-loculed; ovules many, on axile placenta; style filiform, 4.7 – 4.9 cm long, glabrous, white; stigma cup-shaped, situated above the thecae, minutely red-spotted; mouth ciliate. Infructescence *c.* 11.5 cm long, girth *c.* 19 cm. Capsules 13 or 14 per spike, conical, 2.5 – 3 cm long, *c.* 2.2 cm in diameter; fresh weight of a capsule *c.* 5.7 g, dry weight *c.* 1.4 g, maroon-coloured; fruit wall *c.* 1 mm in thickness; persistent calyx 4.3 – 4.5 cm long. Seeds 35 – 50 in each capsule, black, arillate; aril white.

Flowering: March – May.

Fruiting: June – October.

Other Specimens Examined: INDIA, **Sikkim**, North Sikkim District, Phodong, 11.4.2005, *Sanoj* 92763; Phodong, 11.4.2005, *Sanoj* 92764; East Sikkim District, Pangthang, 22.8.2006, *Thomas* 15502; Pangthang, 22.8.2006, *Thomas* 15503 (CALI).

Distribution: Manul, Naga, Mangan, Phodong, Phensong, Chawang, Kabi and Tingda area of North Sikkim. Soreng, Hee, Barmoik, Kaluk, Dartam, Gyalshing, Ravongla, Ben daral, Kew zing in other areas of South and West Sikkim.

Ecology: Moderate to deep shade is required for best yield and prefers high altitude areas above 1350 m.

Etymology: 'Sawan' is the name of a month in Nepali calendar, which comes in the month of August and indicates the harvesting season of the cultivar

Notes: Tall plant but not as tall as 'Varlangy'. It is a widely adjustable cultivar, which is most suited to medium and high altitude areas of *c.* 1350 m. The cultivar is susceptible to both Chirke and Foorkey diseases and can tolerate lower temperatures. It is estimated that Essential oil content is 1.8 – 2.5% and moisture is 13%. The cultivar shows affinity with 'Varlangy' and can be distinguished from it by maroon robust leafy shoots, small conical fruits with lesser number of seeds.

***Amomum subulatum* 'Seremna' Fig. 2e, 3e**

Standard Specimen: INDIA, **Sikkim**, North Sikkim District, Kabi, 8.5.2007, *Thomas & Nissar* 95516 (CALI).

Rhizome dark pink inside. Leafy shoots 150 – 200 cm high, girth 5 – 5.7 cm, robust, maroon, Sheath 2.7 – 3 cm wide at base, puberulous; margin pink,

ciliate. Leaves drooping, lanceolate to elliptic-lanceolate, 40 – 60 × 7 – 10 cm, thick, glabrous, dark green; apex acuminate, up to 4.5 cm long; base equal, cuneate; margin wavy, often revolute, membranous, glabrous; nerves many, not prominent, running parallel at an angle 17 – 20° with the midrib, glabrous; petiole usually absent; midrib shallowly ridged with parallel nerves, glabrous. Ligule deeply emarginate, 4 – 5 mm long, glabrous, pink; margin ciliate; glands prominent, glabrous. Spike 1 – 3 per leafy shoot, 6 – 10 × 2.5 – 4 cm, girth c. 15.8 cm; peduncle 2 – 2.5 cm long. Bract oblanceolate, 3.2 – 4 × 1.1 – 2.2 cm, densely hairy outside, glabrous inside, pink; margin ciliate; beak 3 – 7 cm long, glabrous. Bracteole lanceolate, 2.9 – 3.4 × 1.3 – 1.8 cm, hairy outside, glabrous inside; margin ciliate; beak 2 – 4 mm long, glabrous. Flowers 5 – 7 cm long, yellow. Calyx tubular, 4.2 – 5.1 × 0.5 – 0.6 cm, 3-clefted, sparsely hairy outside, glabrous inside, white; beak 1.2 – 1.7 cm long, unequal, glabrous. Corolla tube 2.5 – 2.8 cm long, hairy inside, glabrous outside; dorsal lobe oblong, pouched at apex, 3 – 3.8 × 0.7 – 1.1 cm, sparsely hairy outside, glabrous inside; nerves many, central one continues till apex; ciliate towards base; beak 0.6 – 1.1 cm long, subulate, glabrous; lateral lobes 2.4 – 3.1 × 0.8 – 0.9 cm, oblong, sparsely hairy outside, glabrous inside. Labellum oblong, 3.4 – 3.6 × 1.3 – 1.5 cm, apex rounded, margin slightly crenulate and crumpled, base hairy, many lateral hyaline bands arising from the midrib. Lateral staminodes 2 – 3 mm or reduced, flat, bulbous at base, yellow. Stamen 2.6 – 3 cm long; filament 0.7 – 1 × 0.25 – 0.3 cm, sparsely hairy, glabrous inside; connective glabrous; crest obscurely 3-lobed, 0.4 – 0.5 × c. 1.1 cm, petaloid, crenulate, recurved; thecae oblong, 1.1 – 1.3 × c. 0.1 cm, cream-coloured; apex diverging outside, tapering towards base. Epigynous gland 1, 0.3 – 0.5 cm long, slightly lobed, sometimes splitting, glabrous, cream-coloured. Ovary c. 4 mm across, densely hairy outside, pink, 3-loculed; ovules many, on axile placenta; style linear, c. 4.8 cm long, glabrous; stigma cup-shaped, c. 1 mm, red-spotted; mouth ciliate. Infructescence c. 10.7 cm long, girth c. 15.8 cm. Capsule 8 – 10 per spike, sub-spherical, 2.5 – 3 cm long, c. 2 cm in diameter, dark maroon; fresh weight of a capsule c. 5.15 g, dry weight c. 1.2 gm; fruit wall c. 1 mm thick; persistent calyx c. 4.2 cm long. Seeds 65 – 75, black, arillate.

Flowering: April – June.

Fruiting: July – October.

Other Specimens Examined: INDIA, **Sikkim**, West Sikkim District, Hee-Gaon, 11.4.2005, *Sanoj* 92773; East Sikkim District, Panthang, 22.8.2006, *Thomas* 105511 (CALI).

Distribution: Soreng, Hee, Barmoik, Kaluk, Dartam, Gyalshing, Ravongla, Ben daral, Kew zing and other areas of South and West Sikkim.

Ecology: Found at low altitudes.

Etymology: The Nepali word 'Seremna' means drooping, which indicates the drooping nature of leaves.

Notes: The cultivar is grown in a small area at the Hee-Gaon, West Sikkim, at low altitude and is well known for its high yielding potential i.e. the cultivar can tolerate marginally high temperatures.

Amomum subulatum 'Varlangey' **Fig. 2f, 3f**

Standard Specimen: INDIA, **Sikkim**, North Sikkim District, Kabi, 8.5.2007, *Thomas & Nissar* 95517 (CALI).

Rhizome pale pink inside. Leafy shoots robust, 200 – 250 cm high, girth 5.5 – 6.3 cm, maroon towards the base, with prominent pink spots or streaks on the upper green-coloured region. Sheath c. 5 cm wide at base, glabrous, pink-dotted or streaked. Leaves drooping, narrowly lanceolate, 60 – 80 × 6 – 10 cm, glabrous; apex acuminate, up to 5 cm long; base equal, cuneate; margin wavy, membranous, often slightly recurved; nerves run parallel at an angle 18 – 25° with the midrib; petiole absent or to 4 mm long; midrib with nerves prominent. Ligule deeply emarginate, c. 5 mm long, glabrous outside, pink; margin ciliate, apex rounded; glands prominent, glabrous. Spike 2 – 4 per leafy shoot, 8 – 12 × 3 – 4 cm; peduncle c. 2 cm long. Bract obovate-oblong, 2.2 – 4.1 × 1.5 – 2 cm, leathery, densely hairy outside, glabrous inside, pink; margin ciliate; beak 4 – 7 mm long, glabrous. Bracteole ovate, 2.3 – 3.6 × 1.5 – 2.1 cm, leathery at centre, membranous towards margin, hairy outside, glabrous inside, pale pink; margin ciliate; beak 3 – 5 mm long, glabrous. Flowers 5.5 – 6.5 cm long, yellow. Calyx tubular, 3.8 – 4.5 × 0.6 – 1.1 cm, 3-clefted, sparsely hairy outside, glabrous inside, white; beak 0.5 – 2 cm long, unequal, glabrous. Corolla tube 2.2 – 2.8 × c. 0.4 cm; mouth c. 6 mm, hairy inside; dorsal lobe 3 – 4 × 1.1 – 1.3 cm, oblong, dorsal side sparsely hairy, glabrous inside; margin sparsely ciliate; beak subulate, 0.7 – 1.3 cm long, glabrous; lateral lobes oblong, c. 2.7 × 0.7 – 1 cm, glabrous. Labellum oblong, 2.3 – 3.4 × 1.1 – 1.3 cm; margin slightly crenulate and crumpled, sometime emarginate; midrib dark yellow, 6 or 7 pairs of nerves emerging out from the centre, branching, not parallel, pink-tinged at base. Lateral staminodes 2 – 4 mm long or reduced. Stamen 1.8 – 2.3 cm long; filament 5 – 8 × 2 – 4 mm, glandular-hairy; connective slightly hairy; crest petaloid, c. 9 × 4 – 5 mm, obscurely 3-lobed; thecae

Table 1. Comparison of characters between wild *Amomum subulatum* Roxb. and its cultivars

Sl. No.	Characters	Wild	'Dzongu'	'Green Golley'	'Sawney'	'Seremna'	'Varlangey'
1	Rhizome colour	Dark pink	Pale pink	Pale pink	Dark pink	Dark pink	Pale pink
2	Leafy shoot - height (cm)	150 – 285	100 – 145	155 – 200	150 – 190	150 – 200	200 – 250
3	Leafy shoot - girth (cm)	7 – 7.5	3.7 – 4	5 – 6	4.5 – 5.3	5 – 5.7	5.5 – 6.3
4	Tiller colour	Green-pink	Green	Green	Maroon	Maroon	Maroon
5	Tiller nature	Robust	Not robust	Robust	Robust	Robust	Robust
6	Sheath width (cm)	2.2 – 2.8	c. 2.3	c. 4	2.8 – 3	2.7 – 3	c. 3.5
7	Lamina nature	Slightly drooping	Erect	Erect	Slightly drooping	Well drooping	Slightly drooping
8	Lamina length (cm)	30 – 81	22 – 45	35 – 55	40 – 60	40 – 60	60 – 80
9	Lamina width (cm)	7.5 – 10.5	6.5 – 8	4.5 – 10	6 – 10	7 – 10	6 – 10
10	Lamina shape	Oblong-lanceolate	Elliptic-lanceolate	Lanceolate	Lanceolate	Lanceolate to elliptic-lanceolate	Narrowly lanceolate
11	Lamina – length of tip (cm)	4.5	3.2	3.1	3.5	4.5	5
12	Lamina margin	Wavy	Straight	Wavy	Wavy	Wavy	Wavy
13	Lamina base	Oblique	Equal	Equal	Equal	Equal	Equal
14	Nerve-angle	25 – 30°	16 – 21°	20 – 28°	16 – 22°	17 – 20°	18 – 25°
15	Petiole length (cm)	0 – 2.5	0 – 0.3	0 – 0.5	0 – 0.5	Usually absent	0 – 0.4
16	Ligule size (mm)	4 – 6	3 – 5	4 – 5	5 – 7	4 – 5	c. 5
17	Ligule colour	Light pink	Pink	Pink	Pink	Pink	Pink
18	Ligule indumentum	Glabrous	Pubescent out	Glabrous	Glabrous	Glabrous	Glabrous
19	Ligule gland	Not prominent	Not prominent	Prominent	Prominent	Prominent	Prominent
20	Ligule apex	Deeply emarginate	Shallowly emarginate	Deeply emarginate	Deeply emarginate	Deeply emarginate	Deeply emarginate
21	No. of spikes/ Tiller	1 – 3	1 or 2	2	2 or 3	1 – 3	2 – 4
22	Spike length (cm)	6 – 12	6 – 8	9 – 12	7 – 11	6 – 10	8 – 12
23	Spike width (cm)	3 – 6	2.5 – 3	3 – 3.5	3 – 3.5	2.5 – 4	3 – 4
24	Peduncle length (cm)	3.5 – 6	1.5 – 2	c. 2.5	2 – 2.5	2 – 2.5	c. 2
25	Bract length (cm)	3 – 5	3.2 – 5	3.8 – 4.5	3 – 4	3.2 – 4	2.2 – 4.1
26	Bract width (cm)	2 – 3	1.5 – 2.3	1.2 – 2	1.2 – 1.9	1.1 – 2.2	1.5 – 2.1
27	Bracteole length (cm)	2.7 – 3.1	2.5 – 3.3	2.5 – 3.1	2.5 – 3.1	2.9 – 3.4	2.3 – 3.6
28	Bracteole width (cm)	2 – 2.4	1.2 – 1.5	1 – 1.9	1.3 – 1.4	1.3 – 1.8	1.5 – 2
29	Calyx length (cm)	2.5 – 3.5	3.9 – 4.6	4.5 – 4.8	4 – 4.5	4.2 – 5.1	3.8 – 4.5
30	Calyx beak (cm)	0.5 – 1	1 – 1.2	1 – 1.5	0.8 – 1.7	1.2 – 1.7	0.5 – 2
31	Flower length (cm)	4.7 – 5.1	5 – 5.5	5 – 6	6 – 6.7	5 – 7	5.5 – 6.5

Sl. No.	Characters	Wild	'Dzongu'	'Green Golshey'	'Sawney'	'Seremna'	'Varlangey'
32	Corolla tube length (cm)	1.8 – 2	2 – 2.5	2.1 – 2.5	2.5 – 2.7	2.5- 2.8	2.2 – 2.8
33	DCL- length (cm)	2.1 – 2.5	3.6 – 3.7	2.6 – 3.2	3.8 – 4.4	3 – 3.8	3 – 4
34	DCL beak (cm)	0.3 – 0.4	0.5 – 0.7	0.2 – 0.4	0.8 – 1.2	0.6 – 1.1	0.7 – 1.3
35	LCL length (cm)	2.4 – 2.6	c. 3	2.5 – 2.8	c. 3.2	2.4 – 3.1	2.7
36	Labellum length (cm)	2.4 – 2.6	2.8 – 3	2.8 – 3.4	2.8 – 3	3.4 – 3.6	2.3 – 3.4
37	Labellum shape (apex)	Nearly truncate	Round	Round	Round	Round	Round
38	Bands on labellum	Bands not splitting, parallel	Bands splitting, not parallel	Bands splitting, not parallel	Bands splitting, not parallel	Bands splitting, not parallel	Bands splitting, not parallel
39	No. of veins	9 – 12 pairs	7 – 9 pairs	7 or 8 pairs	8 or 9 pairs	8 or 9 pairs	6 or 7 pairs
40	Colour of midrib	Dark yellow	Dark yellow	Dark yellow	Pale yellow	Dark yellow	Dark yellow
41	Labellum tip	Emarginate	Emarginate	Not emarginate	Emarginate	Emarginate	Emarginate
42	Staminodes (mm)	4 – 9	4 – 6	reduced	2 – 3/ reduced	2 – 3/ reduced	2 – 4/ reduced
43	Stamen size (cm)	2.2 – 2.6	2.3 – 2.6	1.9 – 2	2.2 – 2.5	2.8 – 3	1.8 – 2.3
44	Filament length (cm)	0.6 – 0.9	0.6 – 1.1	0.6 – 1	0.8 – 1	0.7 – 1	0.5 – 0.8
45	Thecae length (cm)	0.9 – 1.1	1 – 1.1	0.8 – 0.9	0.9 – 1.2	1.1 – 1.3	0.8 – 1.2
46	Crest	Not lobed	Obscurely 3-lobed	Distinctly 3-lobed	Obscurely 3-lobed	Obscurely 3-lobed	Obscurely 3-lobed
47	Ovary size (mm)	4 – 5	c. 3	4 – 5	4 – 6	4	4 – 6
48	Style length (cm)	3.7 – 3.9	3.9 – 4.5	4 – 4.8	4.7 – 4.9	c. 4.8	3.4 – 3.8
49	Capsules/Spike	14 – 20	7 – 8	c. 6	13 – 14	8 – 10	c. 20
50	Capsule length (cm)	2.5 – 3.0	2.4 – 3	2.5 – 3	2.5 – 3	2.5 – 3	3 – 4
51	Capsule diameter (cm)	c. 2.5	c. 2.7	c. 2	c. 2.22	c. 2	2 – 2.75
52	Capsule colour	Maroon	Dark maroon	Light pink and upper part green	Maroon	Dark maroon	Dark maroon
53	Capsule shape	Conical	Oblong-round	Oblong-round	Conical	Spherical	Conical
54	Capsule fresh weight (g)	c. 4.39	c. 7	c. 5.05	c. 5.70	c. 5.15	c. 8
55	Capsule dry weight (g)	c. 0.64	c. 1.50	c. 1	c. 1.40	c. 1.20	c. 1.60
56	Seeds/Capsule	40 – 50	55 – 70	35 – 50	35 – 50	65 – 75	55 – 70
57	Husk thickness (mm)	1 – 4	1 – 3	4 – 5	c. 1	c. 1	2 – 3
58	Flowering period	April – May	March – May	May – August	March – May	April – June	May – July

8 – 12 × c. 1 mm, apex diverging out, base sharply ending, cream-coloured. Epigynous glands 2, lobed at apex, 3 – 4 mm long, glabrous, creamy yellow. Ovary 4 – 6 × c. 4 mm, hairy; locules 3; ovules many, on axile placenta; style 3.4 – 3.8 cm long, linear, filiform, glabrous; stigmatic mouth ciliate. Infructescence c. 12 cm long, c. 20 cm in girth. Capsule c. 20 per spike, 3 – 4 cm long, 2 – 2.75 cm in diameter, conical, large, fresh weight of capsule c. 8 g, dry weight of capsule c. 1.60 g, dark maroon, conical, wings 13 or 14; fruit wall 2 – 3 mm in thickness; persistent calyx 4.7 – 5.1 cm long. Seeds 55 – 70, black, bold, arillate.

Flowering: May – July

Fruiting: August – November

Other Specimens Examined: INDIA, **Sikkim**, East Sikkim District, Rongli, 11.4.2005, *Sanoj* 92765; Rongli, 1.7.2005, *Sanoj* 92765; Rongli, 1.7.2005, *Sanoj* 92772; Pangthang, 22.8.2006, *Thomas* 15507 (CALI).

Distribution: Pakyong, Assam Lingzey, Changuenty, Aongli, Rigu, Nazitan, Sang, Rakdong, Tumin, Tintek, Lingdok, Pangthang, Penlong and other areas of Sikkim.

Ecology: Suitable to grow in medium and high altitude areas (975 – 1600 m and above).

Etymology: The Bhutia word 'Varlangey' means 'bold' which indicates the large size of capsule.

Notes: 'Varlangey' produces the largest capsule among available cultivars. Its yield performance is very high at high altitudes and can tolerate lower temperature. Spike and productive leafy shoot ratio is relatively high in this cultivar. Flowering starts in May at medium altitudes and June – July at high altitudes. Consequently the harvesting is delayed up to the end of November at high altitudes. This cultivar is the tallest (up to 2.5 m) among all cultivars. It can be identified from others by narrow long leaves with wavy leaf margins, maroon leafy shoots, conical, big and bold capsules with maximum seeds (55 – 70).

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