

**A NEW SPECIES OF *ROSCOEA* SM.
(*ZINGIBERACEAE*) FROM BHUTAN AND
SOUTHERN TIBET**

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A new species of *Roscoea* from Bhutan and southern Tibet, *R. bhutanica* Ngamriab., formerly included in *R. tibetica* Batalin, is described and a new key to all species of *Roscoea* is provided. While studying the phylogeny of *Roscoea*, we discovered that there is a correspondence between phylogeny and biogeography (Ngamriabsakul *et al.*, 2000). There are two distinct areas of distribution in *Roscoea*, namely the Himalaya and China. Only *R. tibetica* has been recorded in both areas. Cowley (1982) indicated that this species was very variable and suggested that it might be divided. We now propose to name a new species, *R. bhutanica*, based on observation of living and herbarium material at the Royal Botanic Garden Edinburgh (RBGE) and a molecular systematic study. A morphological table comparing *R. tibetica* with *R. bhutanica* is given, along with the ITS sequences of *R. tibetica*, *R. bhutanica* and *R. auriculata*. The identification key to *Roscoea* species largely follows our phylogenetic tree (Ngamriabsakul *et al.*, 2000).

Keywords. Himalaya, ITS, key, *Roscoea bhutanica*, *Roscoea tibetica*.

INTRODUCTION

Variation in material previously identified as *Roscoea tibetica*: evidence for separation of eastern and western populations.

It is evident that *R. tibetica* is very variable. Cowley (1982) wrote ‘there is also a very wide range of variation within this species which needs further study and may reveal the need to divide the taxon into subspecies’. A later study of *Roscoea* (Ngamriabsakul *et al.*, 2000) noted the significant disjunct distribution of material identified as *R. tibetica* across the ‘Brahmaputra gap’ (Fig. 1), and the morphological differences between eastern and western populations. There is one living population from Bhutan identified as *R. tibetica* in the Royal Botanic Garden Edinburgh. This Bhutanese plant was grown from seed collected by Ian Sinclair and David Long on their expedition to Bhutan in 1984 (accession number RBGE 19841747). Molecular phylogenetic analysis of ITS sequences of *Roscoea* (Ngamriabsakul *et al.*, 2000), revealed two clades, the Himalayan clade and the Chinese clade. *Roscoea tibetica* from China was placed within the Chinese clade, but *R. tibetica* from Bhutan was not sequenced. The Bhutanese material has now been sequenced and when this is added to the previous phylogenetic analysis, it is found to be nested in the Himalayan

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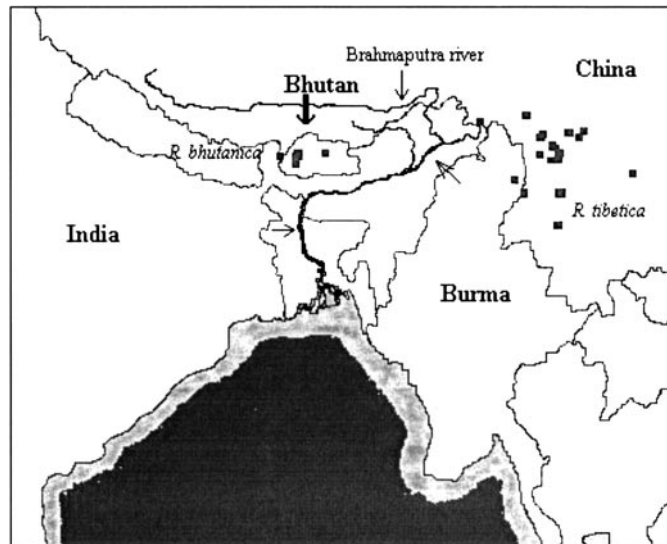


FIG. 1. Distribution map of *R. bhutanica* and *R. tibetica* showing the separation in ranges of these two species over the 'Brahmaputra gap'.

clade. All this evidence taken together (ITS sequence, distribution range and morphology) persuades us that this plant from Bhutan is a new taxon. The ITS sequence of the Bhutanese material, now called *R. bhutanica*, which is more similar to sequences from species in the Himalayan clade than to those from species in the Chinese clade, is shown in Fig. 2 along with *R. tibetica* (Chinese clade) and *R. auriculata* (Himalayan clade) for comparison.

NEW SPECIES

***Roscoea bhutanica* Ngamriab., sp. nov. Fig. 3.**

R. tibeticae Batalini affinis sed floribus generaliter majoribus, tubo corollae vix exserto, staminodiis spatulatis et appendicibus acutis ab thecis antherarum angulo recto divergentibus.

Type: Bhutan: Bumthang Dist., Bumtang Chu, Byakar, wooded valley above Lami Gompa, 27°33'N, 90°42'E, alt. 3050m, 12 vi 1979, *Grierson & Long* 1826 (holo. E).

Plants 8–14cm tall. Roots tuberous, oblong-fusiform. *Sheathing leaves* 2–4, apex obtuse. *Leaf blades* usually 2–4(–6) at flowering time, lanceolate-ovate to oblong, slightly auriculate, 4–21 × 1–4.5cm, glabrous, crowded together at the base. *Inflorescence* enclosed in leaf sheaths. *Flowers* opening just above leaves tuft, purple, one open at a time. *Bracts* 4.5–8 × 1–1.6cm, oblong to spatulate, acute. *Calyx* 5–6.5cm, apex more or less equal to bract, bidentate, teeth 1–3(–9)mm long, split by 1–1.5cm. *Corolla tube* 5–6.5cm long, usually longer than calyx by up to 1cm,

alignment	ITS1	10	20	30	40	50	60	70	80	90	
		
<i>R. tibetica</i>		TTGTTGAGAGAGCATAGAATGACGGATGGT* [*] TGTGTATGTGTGAATGTGCCCTTTCCTTCCCCATCTCGGTGGGCGATTGACCGTATCTC	[90]								
<i>R. auriculata</i>		TTGTTGAGAGAGCATAGAATGACGGATGGT* [*] TGTGAATGTGTGAATGTGCCCTTTCCTTCCCCATCTCGGTGGGCGATTGACCGTAGCTC	[90]								
<i>R. bhutanica</i>		TTGTTGAGAGAGCATAGAATGACGGATGGT* [*] TGTGAATGTGTGAATGTGCCCTTTCCTTCCCCATCTCGGTGGGCGATTGACCGTAGCTC	[90]								
			*						*		
		100	110	120	130	140	150	160	170	180	
		
<i>R. tibetica</i>		AGTGCATCGGCCTAAGGAACAATGAACTCGGAAGCAGAGGGCCCC* [*] TGCCGTGCGCGGGGAGCCCGATGCGTCCGAGATATCTCGAAA	[180]								
<i>R. auriculata</i>		AGTGCATCGGCCTAAGGAACAATGAACTCGGAAGCAGAGGGCCCC* [*] TGCCGTGCGCGGGGAGCCCAATGCGTCCGAGATTCTCGAAA	[180]								
<i>R. bhutanica</i>		AGTGCATCGGCCTAAGGAACAATGAACTCGGAAGCAGAGGGCCCC* [*] TGCCGTGCGCGGGGAGCCCAATGCGTCCGAGATTCTCGAAA	[180]								
			*			*		*	*		
		190	200	210	220	230	240	250	260	270	
	ITS2	
<i>R. tibetica</i>		TCAAATGAATCGTCGCTTTTGCTCCATGCGTTGCTGGTGTCAAGCGCGGAAATTGGCCTCGTGTCTCGGGCACAGTCCGGTTGAAGAG	[270]								
<i>R. auriculata</i>		TCAAATGAATCGTCGCTTTTGCTCCATGCGTTGCTGGTGTCAAGCGCGGAAATTGGCCTCGTGTCTCGGGCACAGTCCGGTTGAAGAG	[270]								
<i>R. bhutanica</i>		TCAAATGAATCGTCGCTTTTGCTCCATGCGTTGCTGGTGTCAAGCGCGGAAATTGGCCTCGTGTCTCGGGCACAGTCCGGTTGAAGAG	[270]								
			*		*				*		
		280	290	300	310	320	330	340	350	360	
		
<i>R. tibetica</i>		TGGGCAGTCCGCAGTCGTCGGGCACGATGGGTGTTGGTTCGCCGTGAGCGAGAACAAGACGTCGTCGCCGTCGTTT* [*] TAGGATTGTCTCAA	[360]								
<i>R. auriculata</i>		TGGGTAGTCCGAAGTCGTCGGGCACGACGGGTGTTGGTTCGCCGTGAGCGAGAACAAGACGTCGTCGCCGTCGTTT* [*] TAGGATT-TCTCAA	[359]								
<i>R. bhutanica</i>		CGGTAGTCCGAAGTCGTCGGGCACGACGGGTGTTGGTTCGCCGTGAGCGAGAACAAGACGTCGTCGCCGTCGTTT* [*] TAGGATT-TCTCAA	[359]								
		*	*	*	*	*	*	*	*	*	
		370	380	390	400	410					
						
<i>R. tibetica</i>		GAGACCCGTTGATCGTGTGATGTTGGTGCAGAAAGTCCCGTGTCCATCAAATTGT	[413]								
<i>R. auriculata</i>		GAGACCCGTTGATCGTGTGATGCGGTGTGAAAGCCCGTGTCCATCAAATTGT	[412]								
<i>R. bhutanica</i>		GAGACCCGTTGATCGTGTGATGTTGGTGTGAAAGTCCCGTGTCCATCAAATTGT	[412]								
		*	*	*	**	*			*		

FIG. 2. ITS sequences of *R. bhutanica* compared with *R. tibetica* (Chinese Clade) and *R. auriculata* (Himalayan clade). Asterisks mark variable bases. The similarity between *R. bhutanica* and *R. auriculata* can be seen.

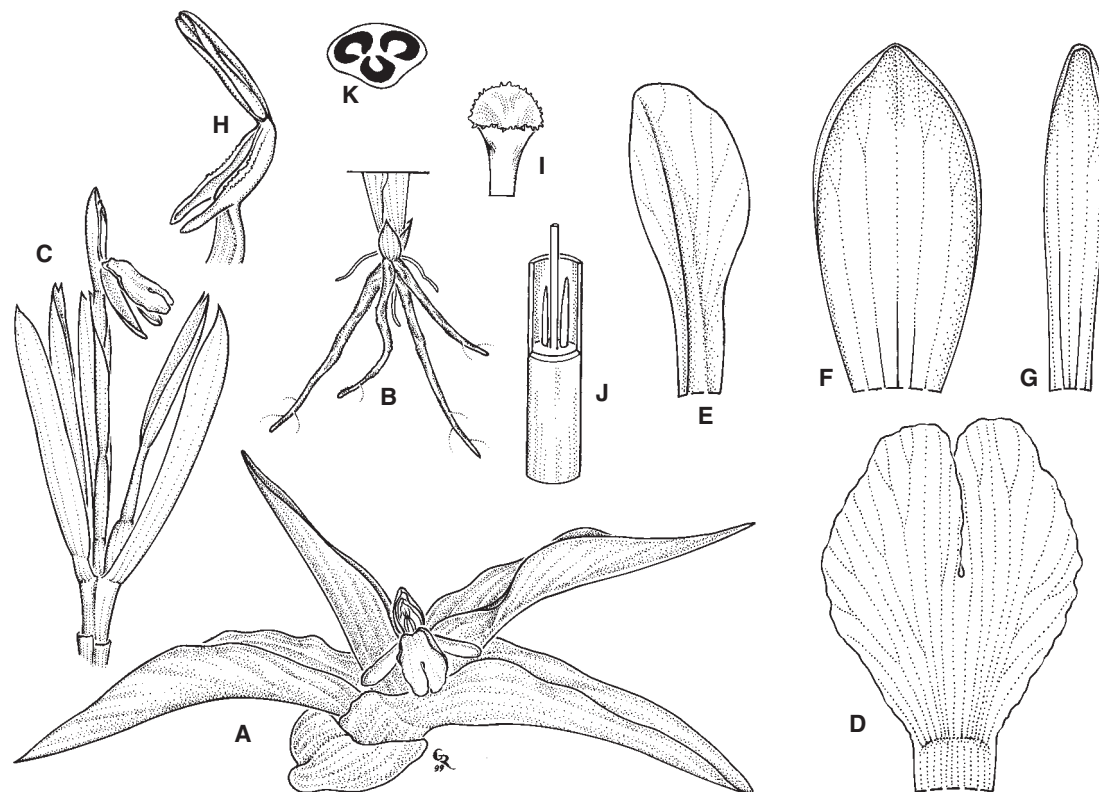


FIG. 3. *Roscoea bhutanica* Ngamriab. A, habit ($\times\frac{1}{3}$); B, roots ($\times\frac{1}{3}$); C, inflorescence ($\times\frac{2}{3}$); D, labellum ($\times 2$); E, staminode ($\times 2$); F, dorsal petal ($\times 2$); G, lateral petal ($\times 2$); H, stamen ($\times 3$); I, stigma ($\times 10$); J, ovary and base of style with epigynous glands ($\times 3$); K, ovary, transverse section ($\times 6$); drawn from plant in cult. RBGE 19841747 by Glenn Rodrigues.

rarely equal to or shorter than it. *Dorsal petal* narrowly oblanceolate, 2.3–2.6 × 1.1–1.3cm, apiculate. *Lateral petals* linear-oblong, 2.4–2.8 × 0.4–0.6cm, obtuse. *Labellum* slightly deflexed, 2.5–3.2 × 1.6–2cm, obovate, lobed less than ½ its length, without white lines at claw. *Lateral staminodes* obliquely spatulate, 1.6–1.9 × 0.5–0.6cm. *Anther* white, thecae 6–7mm long, at right angles to connective elongation and pointed appendages. *Ovary* 1–1.7 × 0.3cm. *Epigynous glands* 4–5mm. *Style* pinkish white. *Stigma* white. *Seed aril* shallowly lacerate.

Other specimens seen. BHUTAN, cultivated material: RBGE accession number 19841747, originating from Bhutan, Thimphu Dist., Dechhenphu, N of Thimphu. 27°32'N, 89°38'E. In cleared *Pinus wallichiana* forest amongst *Artemisia*, alt. 2480m, 5 ix 1984, *Sinclair & Long* 4829.

BHUTAN. Herbarium specimens: Ha Dist.: Damthang, Ha Valley, alt. c.3050m, 2 vi 1933, *Ludlow, Sherriff* 50 (BM). Thimphu Dist.: 6km N of Thimphu Dzong, alt. 2450m, 9 vii 1975, *Grierson & Long* 116 (E); Dotena Chu, alt. c.3050m, 27v 1949, *Ludlow, Sherriff & Hicks* 16377 (E, BM); Pumo La, alt. c.3350m, 8 vii 1938, *Gould* 925 (K); Tsalimaphe, alt. c.2440m, 8 vii 1938, *Gould* 912 (K); Tsalimaphe, alt. c.2440m, 28v 1938, *Gould* 251 (K); Phajudin, alt. c.2740m, 13 viii 1914, *Cooper* 2526 (E, BM); Zado La, alt. c.2740m, 29 vii 1914, *Cooper* 3252 (E, BM); Tashichu, alt. c.2380m, 12 vii 1914, *Cooper* 1512 (E); Chapcha, alt. c.2130m, 6 vii 1914, *Cooper* 1300 (E, BM). Punakha Dist.: Kotaka, Wangdi Phodrang, alt. c.2590m, 24v 1966, *Bowes-Lyon* 3244 (BM); Mara Chu Valley, alt. c.2440–3050m, 28v 1937, *Ludlow, Sherriff* 3123 (BM). Tongsa Dist.: Chendebi, alt. c.2290m, 2 vi 1938, *Gould* 356 (K); Bumthang Dist.: Takhung, Bumthang Tang, alt. c.3050m, 20v 1949, *Ludlow, Sherriff & Hicks* 18911 (BM).

S TIBET, herbarium specimens: Kyimpu (Chayul to Charwe), alt. c.3510m, 3 vii 1936, *Ludlow, Sherriff* 2275 (BM); Chumbi, Ta-ssi-cheu-doow, 16 vi 1884, *King's collector* 454 (K); Chumbi, 26 vi 1878, *Dungboo* 56 (K); Chumbi, 21 vii 1877, *Dungboo* 4244 (K).

This new species resembles both *R. purpurea* and *R. auriculata* (Himalayan clade) in floral characters. *Roscoea purpurea* and *R. auriculata* are bigger plants with a well-developed stem, usually more than 25cm in length, thus the leaves are not crowded together. *Roscoea bhutanica*'s staminodes are intermediate in colour and shape between those of *R. auriculata*, which are white and rather asymmetrically obovate, and those of *R. purpurea*, which are purple and spatulate. They are purple with a long claw, thus the proportion of staminode length to width is greater, closer to that of *R. purpurea* than to that of *R. auriculata* which has a short claw. *Roscoea bhutanica* generally has smaller flowers than *R. purpurea* or *R. auriculata*. The confusion with *R. tibetica* (Chinese clade) in the past resulted from their superficial similarities; they are both small plants with crowded leaves at the base. In most of the herbarium specimens, *R. tibetica* shows only one or two small leaves (some with no leaf at all) while *R. bhutanica* usually shows two or three leaves at flowering time and can have up to six leaves. Young plants of both species with very few leaves are not easily distinguished, especially when they are pressed on herbarium sheets. Nevertheless, at a later stage of growth *R. bhutanica* clearly shows a distichous leaf arrangement whereas *R. tibetica* remains a rosette. From observations in herbaria and of living plants at RBGE, it seems that *R. tibetica* flowers slightly earlier and usually

precociously while *R. bhutanica* generally starts to flower after producing several leaves. In addition, *R. bhutanica* can be distinguished by its bracts being equal to or longer than the calyx, shortly exserted corolla tube, narrowly elliptic dorsal petal, the labellum being large compared with the rest of the flower, usually divided for less than half its length and lacking white lines at the throat, the pointed appendages, and anther thecae at right angles to the connective elongation and appendages. Table 1 shows the morphological comparisons between *R. tibetica* and *R. bhutanica*.

TABLE 1. The distinguishing characters of *Roscoea tibetica* and *R. bhutanica*

<i>Roscoea tibetica</i>	<i>Roscoea bhutanica</i>
1. Calyx longer than bract	Calyx equal to or shorter than bract
2. Corolla tube long, exserted from calyx	Corolla tube short, usually within calyx
3. Labellum shorter than lateral petals	Labellum longer than lateral petals
4. Lateral petal tip acute	Lateral petal tip obtuse
5. Appendage tip obtuse	Appendage tip pointed

Key to species of Roscoea

- 1a. Labellum longer than dorsal petal; anther appendages pointed or tapering toward tips; staminodes obliquely spatulate or circular to elliptic; thecae at right angles or in line with appendages; flowers purple, red, white never yellow; the Himalaya _____ 2
- 1b. Labellum mostly shorter than dorsal petal; anther appendages obtuse or globular, never really pointed; staminodes asymmetrically obovate, rhombic or elliptic; thecae at obtuse angles with appendages; flowers purple, yellow or white; southcentral China or Burma _____ 10
- 2a. Leaves usually 2–3(–6) at flowering time, forming a tuft; plant usually less than 20cm high _____ 3
- 2b. Leaves usually more than 3 at flowering time, well spread; plant usually more than 20cm high _____ 5
- 3a. Staminodes circular to elliptic _____ 4
- 3b. Staminodes obliquely spatulate _____ **R. bhutanica**
- 4a. Leaves linear, first leaf slightly auriculate; bracts obtuse _____ **R. alpina**
- 4b. Leaves obovate, all leaves slightly petiolate; bracts acute _____ **R. nepalensis**
- 5a. Leaves auriculate throughout; bracts equal to or shorter than calyx _____ 6
- 5b. Leaves generally not auriculate, rarely lower leaves auriculate; bracts equal to or longer than calyx _____ 7

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- 6a. Bracts exserted, equal to or slightly shorter than calyx; staminodes white _____ **R. auriculata**
 6b. Bracts hidden, much shorter than calyx; staminodes purple _____ **R. tumjensis**
- 7a. First bract tubular, soon splitting or not, bracts ciliate; calyces ciliate _____ 8
 7b. First bract not tubular, bracts glabrous; calyces glabrous _____ 9
- 8a. Inflorescence on exserted peduncle, capitulate; thecae at right angles to
 appendages; lateral petal linear to oblong _____ **R. capitata**
 8b. Inflorescence hidden; thecae \pm in line with appendages; lateral petal elliptic –
 _____ **R. ganeshensis**
- 9a. Leaves lanceolate to oblong-ovate; dorsal petal narrowly elliptic,
 length > 3cm _____ **R. purpurea**
 9b. Leaves linear to narrowly lanceolate; dorsal petal elliptic to broadly elliptic,
 length < 3cm _____ **R. brandisii**
- 10a. Leaf bases petiolate or slightly auriculate _____ 11
 10b. Leaf bases decurrent _____ 13
- 11a. Leaves petiolate; bracts equalling calyces _____ **R. debilis**
 11b. Leaves auriculate; bracts shorter than calyces _____ 12
- 12a. Bracts acute; dorsal petal elliptic; lowest bract not tubular _____ **R. tibetica**
 12b. Bracts obtuse; dorsal petal obovate; lowest bract tubular _____ **R. australis**
- 13a. Bracts longer than calyces _____ 14
 13b. Bracts shorter than or equal to calyces _____ 15
- 14a. Leaves crowded together in a fan shape; inflorescence not capitulate,
 peduncle hidden in leaf sheaths _____ **R. schneideriana**
 14b. Leaves rather evenly spaced up the stem; inflorescence capitulate, peduncle
 visible _____ **R. scillifolia**
- 15a. Leaf blade abaxially glaucous; flowers deep purple _____ **R. wardii**
 15b. Leaf not as above; flowers purple, yellow or white _____ 16
- 16a. Bracts obtuse; lowest bract not tubular _____ 17
 16b. Bracts acute; lowest bract tubular _____ 18
- 17a. Dorsal petal obovate to obcordate; bracts much shorter than calyces _____
 _____ **R. humeana**

- 17b. Dorsal petal broadly elliptic; bracts shorter than or equal to calyces _____
_____ **R. forrestii**
- 18a. Peduncle hidden; dorsal petal elliptic to narrowly elliptic _____ **R. praecox**
- 18b. Peduncle visible; dorsal petal obovate to obcordate _____ **R. cautleoides**

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