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RESEARCH ARTICLE

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A new species of *Rubus* (*Rosaceae*) from Arunachal Pradesh, India

C. Gupta[1], S.S. Dash[2]

Key words

India
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subgenus *Malachobatus*

Abstract A new species, *Rubus ramachandrae*, from Upper Subansiri district of Arunachal Pradesh, India is described and illustrated. It is closely similar to *R. stipulosus* and *R. fuscifolius* but differs by densely bristly or hirsute branches; narrowly ovate or oblong-lanceolate leaves with caudate-acuminate apex and adaxially hirsutulous vesture; abaxially grey tomentose intermixed with hirsutulous hairs; larger size of stipules and bracts with distinct margin and vesture; smaller size of floral structure. The distinct foliar as well as floral morphology of *R. ramachandrae* differs from all previously described species of *Rubus.* Differences in key morphological characters of *R. ramachandrae*, *R. stipulosus* and *R. fuscifolius* are also tabulated. In addition, pollen morphology is described based on light (LM) and scanning electron (SEM) microscopy. Based on the presence of straggling shrubby habit, free stipules, simple leaves, reflexed and strong needle shaped prickles, the new taxon is assigned to *Rubus* subg. *Malachobatus*. An image of the type specimen; digital images of habit, stipule, inflorescence and flower, a detailed illustration and scanned electron microscope images of pollens are provided.

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INTRODUCTION

Rubus L. (1753: 492) (*Rosaceae*) is represented in India by about 75 species (Gupta & Dash 2015) distributed principally in dense primary to secondary tropical forests to temperate regions at altitudes between 300 and 3500 m. In India the greatest diversity of the genus is in the eastern Himalayan states of Arunachal Pradesh and Sikkim (Gupta et al. 2016). *Rubus* exhibits great morphological variation in its habit, foliar and floral structure (Naruhashi 1980, Kalkman 1993).

During field exploration in Arunachal Pradesh, India we came across interesting individuals of *Rubus* in a subtropical forest in Upper Subansiri district. Critical examination of the specimen and comparison with specimens of *Rubus* in all major herbaria (APFH, ARUN, ASSAM, BLATTER, BSD, BSHC, BSI, CAL, DD, MH, NBU and PBL) of India revealed no possible match with any other species. We also compared the specimen against images of *Rubus* from multiple international herbaria (A, BM, K, L, LINN, MO, NY, P and PE) and concluded that the plants from Upper Subansiri are morphologically different from all known species of *Rubus*. We here name these plants *Rubus ramachandrae* S.S.Dash & Chand.Gupta.

MATERIALS & METHODS

The description of *R. ramachandrae* is based on living specimens collected during our field survey in Upper Subansiri district of Arunachal Pradesh, India and subsequent observations on herbarium specimens. Based on previous revisionary and systematic works (Focke 1910, 1911, 1914, Smith 1819, Roxburgh 1832, Hooker 1878, Kuntze 1879, Kanjilal et al. 1922, Long 1987, Kalkman 1993, Lu & Boufford 2003, Boufford et al. 2011) and regional floristic works (Sharma & Kachroo 1981, Chowdhery & Wadhwa 1984, Chowdhery et al. 1996), it was compared with the most morphologically similar species, *Rubus stipulosus* T.T.Yu & L.T.Lu and *R. fuscifolius* T.T.Yu & L.T.Lu . Micro-morphological characters of the pollen of *R. ramachandrae* was examined using a scanning electron microscope (SEM, model FEI Quanta 200) at HV 20.0 EV and under oil objective (100×) using an Olympus CX41 light microscope at the Central National Herbarium, Howrah. Pollen characters were described following Erdtman (1943, 1952) and Punt et al. (2007). The morphological characters of *R. ramachandrae* were compared with the digital images of *R. stipulosus* and *R. fuscifolius* (both at PE) in combination with the respective protologues and literature (Yu & Lu 1982, Lu & Boufford 2003). Details are provided in Table 1. An image of the type specimen (Fig. 1); digital images of the habitat, stipule, inflorescence and flower (Fig. 3), an illustration (Fig. 2) and scanned electron microscope images of the pollen (Fig. 4) are provided. Extensive field trips were undertaken in various localities of the eastern Himalaya during the present revisionary study of Indian *Rubus*.

[1] Central National Herbarium, Botanical Survey of India, Howrah – 711 103, West Bengal, India.
[2] Botanical Survey of India, CGO Complex, Salt Lake City, Kolkata – 700 064, West Bengal, India;
corresponding author e-mail: ssdash2002@gmail.com.

Rubus ramachandrae S.S.Dash & Chand.Gupta, *sp. nov.* — Fig. 1–4; Map 1

Rubus ramachandrae is similar to *Rubus stipulosus and R. fuscifolius*, but differs by having densely bristly or hirsute branches; narrowly ovate to oblong-lanceolate leaves with caudate-acuminate apex; adaxially hirsutulous vesture of leaves; broadly ovate to suborbicular, foliaceous, persistent stipules with irregularly and deeply biserrate margin; hirsutulous and fulvous-tomentose floral bracts and obovate petals. — Type: *S.S.Dash & Chandani Gupta* 65482 (holo CAL; iso CAL, ARUN, ASSAM), India, Arunachal Pradesh, Upper Subansiri district, between Daporijo and Raga village, E94°11'42.5 N27°49'23.4, 1270 m alt., 15 Aug. 2015. – Paratype: *S.S. Dash & Chandani Gupta* 67403 (BSD, CUH), near La village, 35 km from Daporizo, E94°13'32.3 N27°51'42.7, 1260 m alt., 9 Aug. 2016.

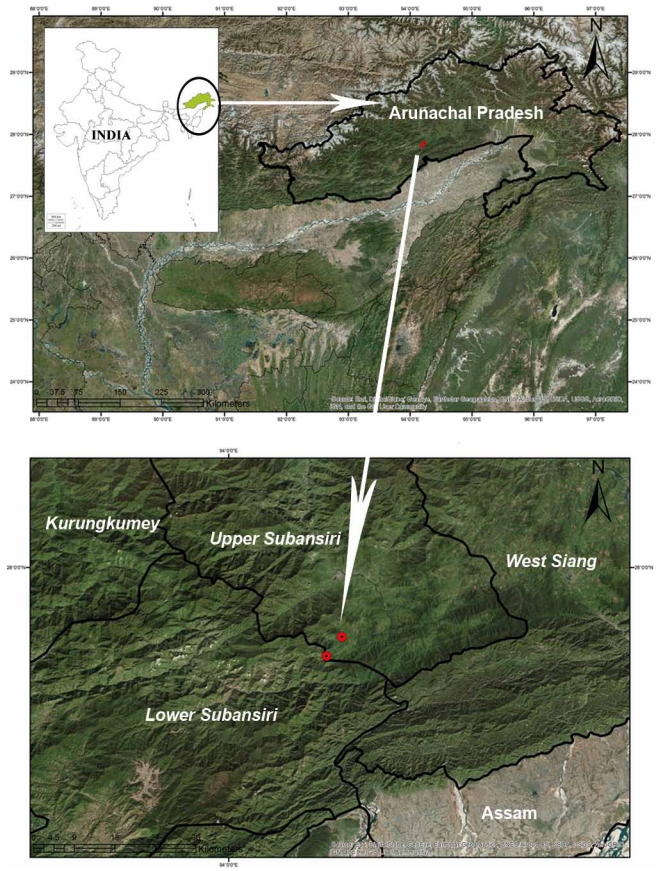
Etymology. The species is named in loving memory and reverent regards of Sri Rama Chandra Dash, father of corresponding author, who was a constant source of encouragement and motivation during all field work in the difficult terrain in Arunachal Pradesh.

Table 1 Morphological comparison between *Rubus ramachandrae* and its allied species.

Differentiating characters		*Rubus stipulosus*	*Rubus fuscifolius*	*Rubus ramachandrae*
Habit		climbing shrubs	shrubs, procumbent	straggling shrubs
Branchlets		dark brown	yellowish to dark brown	younger stems green, older stems brown
Indumentum		pubescent	densely tomentose	densely bristly or hirsute
Prickles		minute, sparse	minute, sparse	stout and scattered
Stipules		free, leaf like, persistent	free, not leaf like, persistent	free, leaf like, persistent
	shape &size	broadly or narrowly ovate, 1.5–2 by 1–1.5 cm, palmately 5–7-veined	oblong-lanceolate, c. 1.5 by 1 cm, palmately 5–7-veined	broadly ovate or suborbicular, 1.5–3 by 2–2.5 cm, palmately 10–12-veined
	margins	lobed or serrate, not laciniate	pinnately laciniate; lobes linear or linear-lanceolate	irregularly deeply biserrate
	indumentum	abaxially pubescent, light brown	abaxially densely yellowish brown tomentose	abaxially hirsutulous or densely pilose, greyish brown to light brown
Leaves	petioles	4.8 cm, pubescent, with minute reflexed prickles	4.6–5 cm, densely tomentose, with sparse, minute reflexed prickles	3–4 cm long, densely hirsute, with scattered short stout reflexed prickles
	shape	suborbicular or broadly ovate, 5–7-lobed; lobes triangular, terminal one largest, lateral veins 3–5 pairs at base	broadly ovate, 5–7-lobed, lobes oblong; lateral veins 4 or 5 pairs, at base	narrowly ovate or oblong-lanceolate shallowly 3–5 (or 7)-lobed, lobes scarcely differentiated, 3–5-veined at base, principle vein with 5 or 6 pairs of lateral veins
	size	14–16 × 12–16 cm	12–20 × 8–16 cm	12–15 × 6–9 cm
	indumentum	abaxially densely yellowish brown tomentose and pubescent along veins, adaxially glabrous or pubescent only along veins	abaxially rust-brown tomentose, adaxially similar along veins, light brown when dry	adaxially hirsutullous, more densely so along veins, green, dark brown when dry; abaxially grey tomentose, becoming fulvous-tomentose when dry
	base, margin and apex	basecordate, margin irregularly shallowly serrate, teeth abruptly pointed, apex acute	basecordate, margin unevenly sharply doubly serrate, apex short acuminate	base deeply cordate; margin irregularly bi-serrate; apex narrowly acuminate to caudate-acuminate, acumen 1.5–2 cm long
Inflores-cences	position	terminal subracemes, few flowered or flowers in clusters in leaf axils	terminal or axillary, cymose-sub-paniculate, compact, many-flowered, terminal ones 5–10 cm, axillary ones 4–6 cm	terminal thyrse and axillary thyrse, subracemes or corymbose, laxly flowered; terminal ones up to 20 cm long; axillary racemes shortened, up 12 cm long
	rachis	rachis and pedicels densely villous	rachis, pedicels, densely rust-brown tomentose	densely hirsute with minute needle-like prickles, green
	bract	bracts brown, broadly ovate or narrowly ovate, 1–1.8 × 0.9–1.6 cm, soft hairy, margin lobed or serrate above middle	bracts brown, narrowly ovate, 1.3–1.5 cm, tomentose, margin laciniate or undivided	bracts brown, broadly ovate, foliar, 1.5–2 × 0.8–1.2 cm, margin entire or serrate only near apex, adaxially glabrous, abaxially hirsutullous; sparsely strigose near base
Flowers	pedicels	pedicels 5–7 mm; flowers 1–1.5 cm diam	pedicels 0.8–1 cm; flowers 7–10 mm diam	pedicels slender, 3–12 mm long; flowers 8–13 mm diam
	calyx	calyx to 2 cm long, abaxially densely villous, calyx lobes ovate-lanceolate, apex acuminate, outer sepals laciniate apically	calyx 5–8 mm long, abaxially densely rust-brown tomentose; calyx lobes erect after anthesis, ovate to ovate-lanceolate, apex acute to acuminate; outer sepals usually divided apically, inner sepals entire	calyx 10–12 mm long, more or less campanulate, united to 1–3 mm long; calyx lobes ovate to ovate-lanceolate, green abaxially densely tomentose, adaxially sericeous from middle to apex; apex caudate acuminate, outer sepals 3-fid or laciniate apically, inner lobes entire
	corolla	petals broadly ovate or suborbicular, glabrous, base shortly clawed, margin undulate or erose, apex abruptly pointed	petals broadly obovate or suborbicular, shorter than sepals, glabrous, base shortly clawed, apex premorse	petals white, 5, obovate, 6 × 4 mm, base clawed, claw 1–1.5 mm long, margin entire, erose only near apex, apex abruptly pointed, sparsely hairy on outer surface, inner surface glabrous
	stamens	stamens many, much shorter than petals; filaments slightly broadened basally	stamens often short, rarely nearly as long as petals; filaments linear	stamens numerous, almost equal in size, in several series, shorter than petals and pistils; filaments round or flattened, c. 3 mm long, glabrous, pale white, anthers 2-celled, c. 0.5 mm long dorsifixed, sparsely hairy, yellow, dehiscence longitudinally introrse
Distribution	up to 1200 m	between 1300–2000 m	between 1100–1300 m	between 1100–1300 m

Shrubs, straggling, to 3 m tall. *Stems* terete, erect or procumbent, woody, densely bristly or hirsute mixed with reflexed strong prickles, green, bristles white becoming brown in age, internodes 4.5–6 cm long. *Stipules* foliar, broadly ovate to suborbicular, 1.5–3 by 2–2.5 cm, apex acute, margin irregularly deeply biserrate, glabrous adaxially hirsutulous or densely pilose abaxially, brown, palmately 10–12-veined, persistent or rarely late caducous. *Petioles* slender, 3–4 cm long, densely hirsute, with short stout reflexed prickles, green. *Leaves* alternate, simple, narrowly ovate or oblong-lanceolate, shallowly 3- or 5- (or 7-)lobed, lowest two lobes often differentiated, upper lobes scarcely differentiated,12–15 by 6–9 cm, apex narrowly acuminate to caudate-acuminate, acumen 1.5–2 cm long; apex of lobes acute, margin irregularly biserrate, constricted at lobes; base deeply cordate, 3–5-veined at base, principle vein with 5 or 6 pairs of lateral veins; adaxially hirsutulous, more densely so along veins, green, dark brown when dry; abaxially grey tomentose, becoming fulvous-tomentose when dry. *Inflorescences* terminal thyrse and axillary thyrse, subracemose or corymbose, terminal inflorescences up to 18 cm long, more than 20-flowered, axillary inflorescences shortened, 5–12 cm long, laxly flowered; rachis hirsute, mixed with minute needle shaped prickles; involucral bracts 2, foliar, 1.3–1.8 by 0.8–1.2 cm, broadly ovate, apex acute, margin serrate or serrate only near apex, adaxially glabrous, abaxially hirsutulous; sparsely strigose near base, brown; pedicels slender, 3–12 mm long, subtended by 2 floral bracts, hirsute; ovate or ovate-oblong, 4–10 by 1–8 mm, almost covering the buds, apex acute, margin entire or with very few serrations apically, abaxially densely pubescent to hirsutulous, mixed strigose at base, adaxially glabrous, green, brown at maturity. *Flowers* bisexual, actinomorphic, 0.8–13 mm across; hypanthium perigynous; calyx green, more or less bell-shaped or narrowly campanulate, united at base to 1–3 mm long, lobes 5, ovate to ovate-lanceolate, 10–12

Fig. 1 Image of holotype of *Rubus ramachandrae* S.S.Dash & Chand.Gupta.



Map 1 Map showing place of collection of *Rubus ramachandrae* from Upper Subansiri district, Arunachal Pradesh, India.

by 3–4 mm, apex caudate-acuminate, outer lobes 2- or 3-fid or laciniate, inner lobes entire, abaxially densely tomentose, adaxially sericeous from middle to apex, margin of outer lobes with white hairs; petals white, 5, obovate, 6 by 4 mm, base clawed, claw 1–1.5 mm long, margin entire, erose only near apex, apex abruptly pointed, sparsely hairy on outer surface, inner surface glabrous; stamens numerous, almost equal in size, in several series, shorter than petals and pistils; filaments round or flattened, c. 3 mm long, glabrous, pale white, anthers 2-celled, c. 0.5 mm long, dorsifixed, sparsely hairy, yellow, dehiscence longitudinally introrse; carpels many, ovary lunate, c. 1 mm long, glabrous, short stalked, style subterminal, c. 1 cm long, glabrous, white, stigma capitate, torus convex, to 2 mm long, with few stiff hairs basally.

Pollen morphology — Pollen grains 3-colporate, prolate-spheroidal (P/E ratio: 1.04) 24–25 µm in polar length with rounded, often emarginate ends, colpus narrow, distinctly uniform along the poles, extending over 90 % of the polar axis, equatorial bridge distinct, margins constricted at equator and elevated. The colpus membrane is covered with rugged granulations and undulate. The endoaperature is smooth, indistinct and usually hidden under the rugged exine or equatorial bridge. The exine layer is thick and finely ornamented. The surface ornamentation is finely verrucose-foveolate. The punctum consists of more or less rounded depressions and narrow and often anastomosing elongated verrucae, more often creating a perforated suprarugulate tectum (Fig. 4).

Distribution — India, Arunachal Pradesh; known only from the type and its adjacent locality (Map 1).

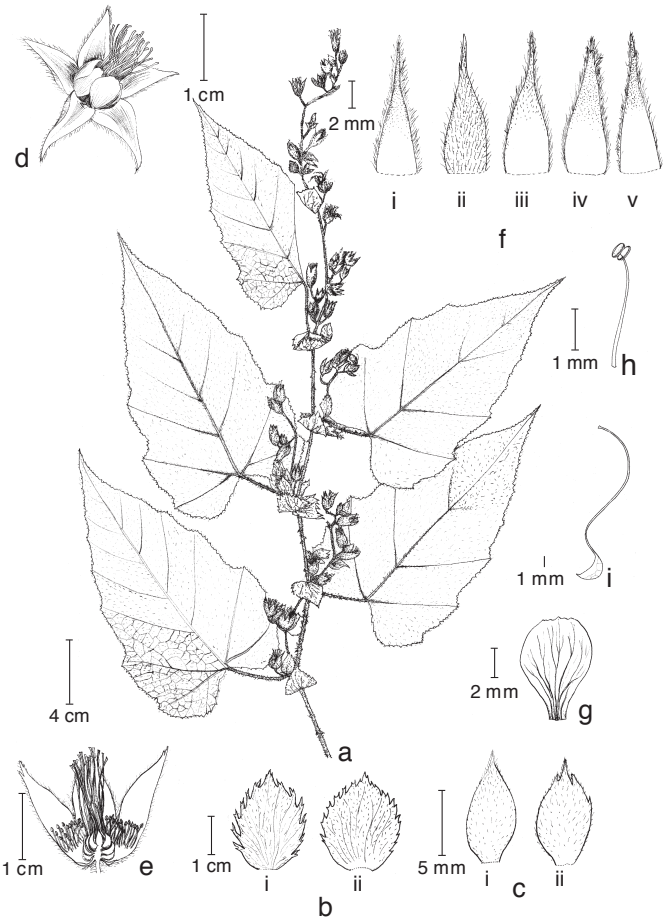


Fig. 2 *Rubus ramachandrae* S.S.Dash & Chand.Gupta. a. Flowering twig; b. abaxial surface of stipules; c. abaxial surface of bracts (i: margin serrated near apex, ii: margin entire); d. flower; e. longitudinal section of flower; f. free lobes of calyx (i–iv. adaxial surface; v. abaxial surface); g. petal; h. stamen; i. pistil. — Drawn by Chandani Gupta.

Fig. 3 Field photographs of *Rubus ramachandrae* S.S.Dash & Chand.Gupta. a. Habit; b. inflorescences; c. stipules (inset: juvenile stipule); d. closer view of flower. — Photos by S.S. Dash.

Habitat & Ecology — *Rubus ramachandrae* grows in open subtropical forests between 1 100 and 1 300 m.

Flowering & Fruiting — July to September.

Provisional IUCN conservation assessment — *Rubus ramachandrae* is known only from two localities in Upper Subansiri in Arunachal Pradesh, India. During our study, we located only two gregarious patches 5 km apart with 4 or 5 mature plants each. The species has not been collected elsewhere, hence, its provisional conservation status may be considered Data Deficient (IUCN 2017).

Note — Due to the presence of straggling shrubby habit, free stipule, simple leaves, with both needle shaped and reflexed prickles, various forms of panicled axillary and terminal inflorescences and the more or less bell-shaped or campanulate calyx, it is proposed here that *R. ramachandrae* be placed in *Rubus* subg. *Malachobatus* Focke (Focke 1910: 41), a subgenus of about 115 species (Focke 1910, 1911, 1914, Kalkman 1993, Lu & Boufford 2003) mainly concentrated in tropical and subtropical regions of the Asian continent.

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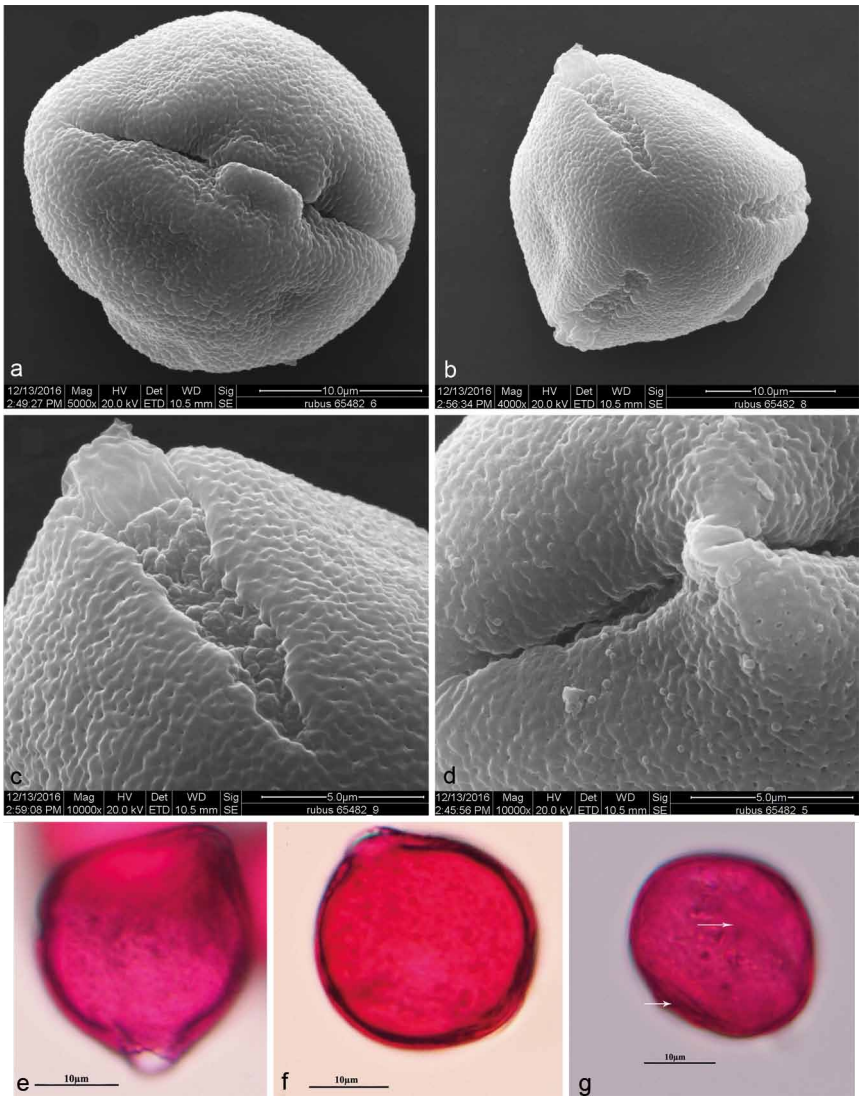

Fig. 4 Pollen morphology of *Rubus ramachandrae* S.S.Dash & Chand.Gupta. a–d: SEM images; e–g: LM images. a. Equatorial view of pollen; b. polar view of pollen showing tricolporate aperture; c. closer view of aperture showing endoaperture and the surface ornamentation; d. closer view of aperture with bridge; e, f. subpolar view showing endoaperture with bridge; g. subequatorial view (arrow showing colporate aperture).

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