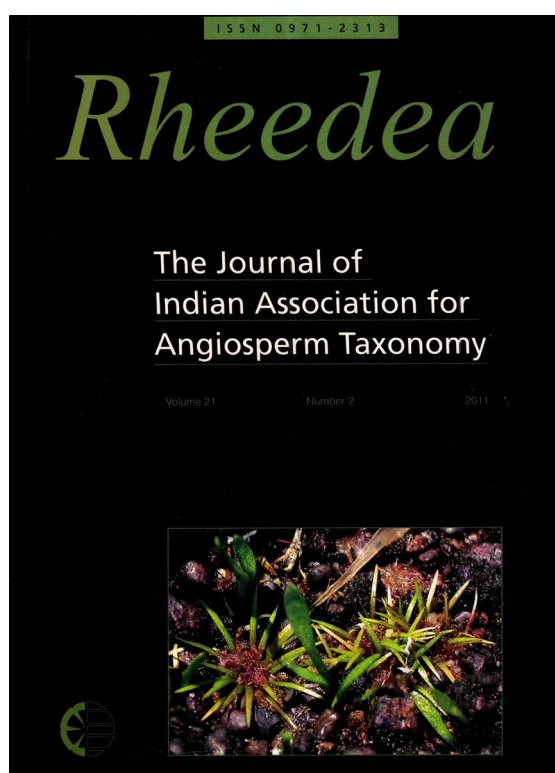




## Taxonomic significance of fruit and seed morphology in identification of South Indian *Rauvolfia* (Apocynaceae)

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# Taxonomic significance of fruit and seed morphology in identification of South Indian *Rauvolfia* (Apocynaceae)

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## Abstract

Morphological characters of fruits and seeds of all the five *Rauvolfia* species, viz., *R. hookeri*, *R. micrantha*, *R. serpentina*, *R. tetraphylla* and *R. verticillata*, occurring in South India were analysed. Comparative study revealed that the species can be delimited based on fruit/seed characters and an artificial key is provided for the same.

**Keywords:** Fruit Morphology, *Rauvolfia*, Seed Morphology

## Introduction

The genus *Rauvolfia* L. (Apocynaceae) comprises of c. 80 species distributed in tropics of the world (Mabberley, 2008). Five species of *Rauvolfia*, viz., *R. serpentina* (L.) Benth. ex Kurz, *R. hookeri* Sriniv. & Chithra, *R. micrantha* Hook.f., *R. verticillata* (Lour.) Baill. and *R. tetraphylla* L. occur in Kerala (Nayar *et al.*, 2006) of which *R. hookeri* and *R. micrantha* are endemic to South India. *Rauvolfia tetraphylla* is a native of the West Indies but naturalised in South India. *Rauvolfia serpentina* is the source of indole alkaloids, including the therapeutically useful compound 'reserpine'. Export of this species is banned by the Government of India in order to prevent over exploitation of this species from the wild. In this context, the identification at seed level may be useful to legitimize conservancy of commercially important species. Thus a complementary method based on fruit/seed morphology for the identification of *Rauvolfia* species of the region is essential and is provided.

## Materials and Methods

Mature fruits of the five *Rauvolfia* species were collected from the Kerala region of southern Western Ghats and Field Gene Bank of Tropical Botanic Garden & Research Institute. Voucher specimens of all the five species were deposited in the Herbarium (TBGT). The seeds were accessioned and documented as part of reference collections of the Seed Bank. Morphological characters such as shape, size, colour and surface features of both the

fruits and the seeds were simultaneously recorded, described and presented in a comparative basis. Seeds were observed under both Light Microscope (LM) and Scanning Electron Microscope (SEM) (Hitachi S-24000). The descriptive terminologies are used following Das & Saha (2006). Photographs of all these five studied specimens are provided.

## Results and Discussion

Morphological characters of both fruits and seeds facilitate identification of many species. (Hooker, 1882; Kumar & Singh, 1990; Das *et al.*, 1995; Basak & Maiti, 2000; Bernard, 2000; Munoz-Centeno *et al.*, 2006). The described morphological characteristics of fruits including the weight of the five *Rauvolfia* species are presented in Table 1. Fruits of *R. verticillata* are distinct in having ellipsoid fruits (Fig. 1). Syncarpus fruits are found only in *R. tetraphylla*. The fruit of *R. verticillata* is apocarpus and therefore invariably single-seeded. *Rauvolfia hookeri*, *R. micrantha* and *R. serpentina* possess semi-apocarpus fruits which are both single and double-seeded. The fruits of *R. micrantha* showed maximum weight among all other species. Though the ripened fruits of all species are dark purple, the colour of the unripe fruits are different as cream-yellow, yellowish green, dark green and red. *Rauvolfia tetraphylla* has the fruits with pubescent surface.

Details of the characters of seeds of the five *Rauvolfia* species are given in the Table 2. The seeds

**Table 1.** Comparative description of the characters of fruits of five species of *Rauvolfia*

Character	<i>R. hookeri</i>	<i>R. micrantha</i>	<i>R. serpentina</i>	<i>R. tetraphylla</i>	<i>R. verticillata</i>
Fruit type	Semiapocarpus	Semiapocarpus	Semiapocarpus	Syncarpus	Apocarpus
Fruit shape	Ovoid	Ovoid	Dumbbell-shaped	Globose	Ellipsoid
Fruit size (cm)	Single-seeded: 1.02 ± 0.02 × 0.78 ± 0.02	Single-seeded: 0.78 ± 0.008 × 0.7 ± 0.01	Single-seeded: 0.73 ± 0.012 × 0.69 ± 0.012	0.78 ± 0.01 × 0.87 ± 0.012	1.13 ± 0.03 × 0.812 ± 0.03
	Double-seeded: 0.71 ± 0.05 × 0.69 ± 0.1	Double-seeded: 0.74 ± 0.009 × 1.18 ± 0.02	Double-seeded: 0.66 ± 0.012 × 0.88 ± 0.09		
Fruit weight (g)	Single-seeded: 0.28 ± 0.02	Single-seeded: 0.296 ± 0.01	Single-seeded: 0.189 ± 0.012	0.36 ± 0.011	0.186 ± 0.02
	Double-seeded: 0.43 ± 0.09	Double-seeded: 0.499 ± 0.023	Double-seeded: 0.263 ± 0.013		
Fruit colour (Young)	Cream-yellow	Yellowish green	Dark green	Reddish	Dark green
Fruit colour (Ripen)	Dark purple	Dark purple	Dark purple	Dark purple	Dark purple
Fruit texture	Glabours	Glabrous	Glabrous	Pubescent	Glabrous

Values as mean of 50 replicates ± standard error

of *R. verticillata* are flat and two-sided. Seed size is maximum in *R. hookeri* and minimum in *R. serpentina* (Fig. 1). Morphology of micropylar region provides key features for identification of species (Fig. 2). The shape of micropylar pore in different species is also significant.

Seeds of the five different species of *Rauvolfia* showed variations with respect to hilar groove and presence or absence of wax (Fig. 2). Hilum characters are species specific (Gopinathan & Babu, 1985 and Barua *et al.*, 2007). Three of the species show specific hilum features except *R. hookeri* and *R. micrantha*.

Details of SEM studies on seed morphology (Fig. 3) are provided in Table 2. The secondary testa structures such as alveolate, pitted and tuberculate are the consistent seed characters to delimit taxa (Murthy & Sanjappa, 2002). The primary structure of seed-testa of all the species is reticulate except that of the *R. verticillata* which is ruminant. In *R. verticillata*, secondary seed surface structure is tuberculate while that of *R. hookeri*, *R. serpentina* and *R. tetraphylla* are alveolate. Pitted character of seed testa in *R. micrantha* demarcates it from the rest of the species (Fig. 3c).

The present study has also revealed that all the five species of *Rauvolfia* can be segregated based on the characters of fruits and seeds. A key based on salient characters of fruits and seeds of the five studied species of *Rauvolfia* is provided to facilitate identification of the species.

### Key to species

1. Fruits ovoid; seeds black ..... 2
1. Fruits other than ovoid; seeds pale yellow .... 3
2. Seed apex acute; micropyle triangular; texture pitted-granulate ..... **R. micrantha**
2. Seed apex acuminate; micropyle circular; texture alveolate ..... **R. hookeri**
3. Fruits pubescent ..... **R. tetraphylla**
3. Fruits glabrous ..... 4
4. Seeds ovoid; hilar groove present ..... **R. serpentina**
4. Seeds oblong; hilar groove absent ..... **R. verticillata**



Fig. 1. Fruits and seeds of five species of *Rauvolfia*: a & b. Fruits and seeds of *R. hookeri*; c & d. *R. micrantha*; e & f. *R. serpentina*; g & h. *R. tetraphylla*; i & j. *R. verticillata*.

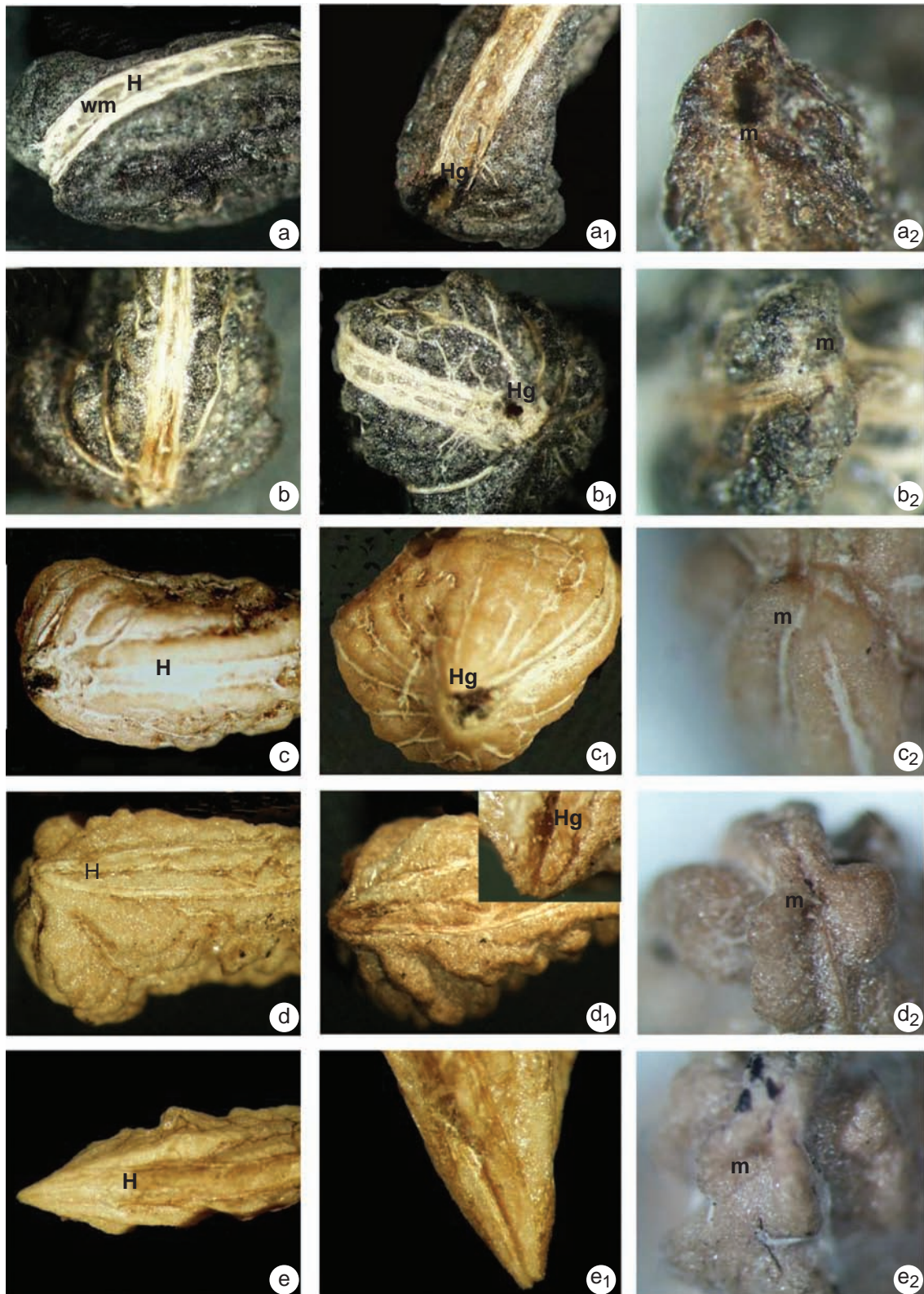


Fig. 2. Light microscopic (LM) photographs of five *Rauvolfia* species showing structural details of its seeds. a. *Rauvolfia hookeri*: hilum with waxy covering; a<sub>1</sub>. Circular hilar groove on dewaxing; a<sub>2</sub>. Micropyle; b. *R. micrantha*: hilum with waxy substance; b<sub>1</sub>. Circular hilar groove; b<sub>2</sub>. Micropyle; c. *R. serpentina*: with waxy material; c<sub>1</sub>. Oval-shaped hilar groove; c<sub>2</sub>. Micropyle; d. *R. tetraphylla*: with waxy material; d<sub>1</sub>. Very minute groove; d<sub>2</sub>. Micropyle; e. *R. verticillata* without waxy material: e<sub>1</sub>. Not showing any groove in the hilum; e<sub>2</sub>. Micropyle. (H – Hilum; Hg – Hilar groove; wm – Waxy material covering the hilum; m – Micropyle).

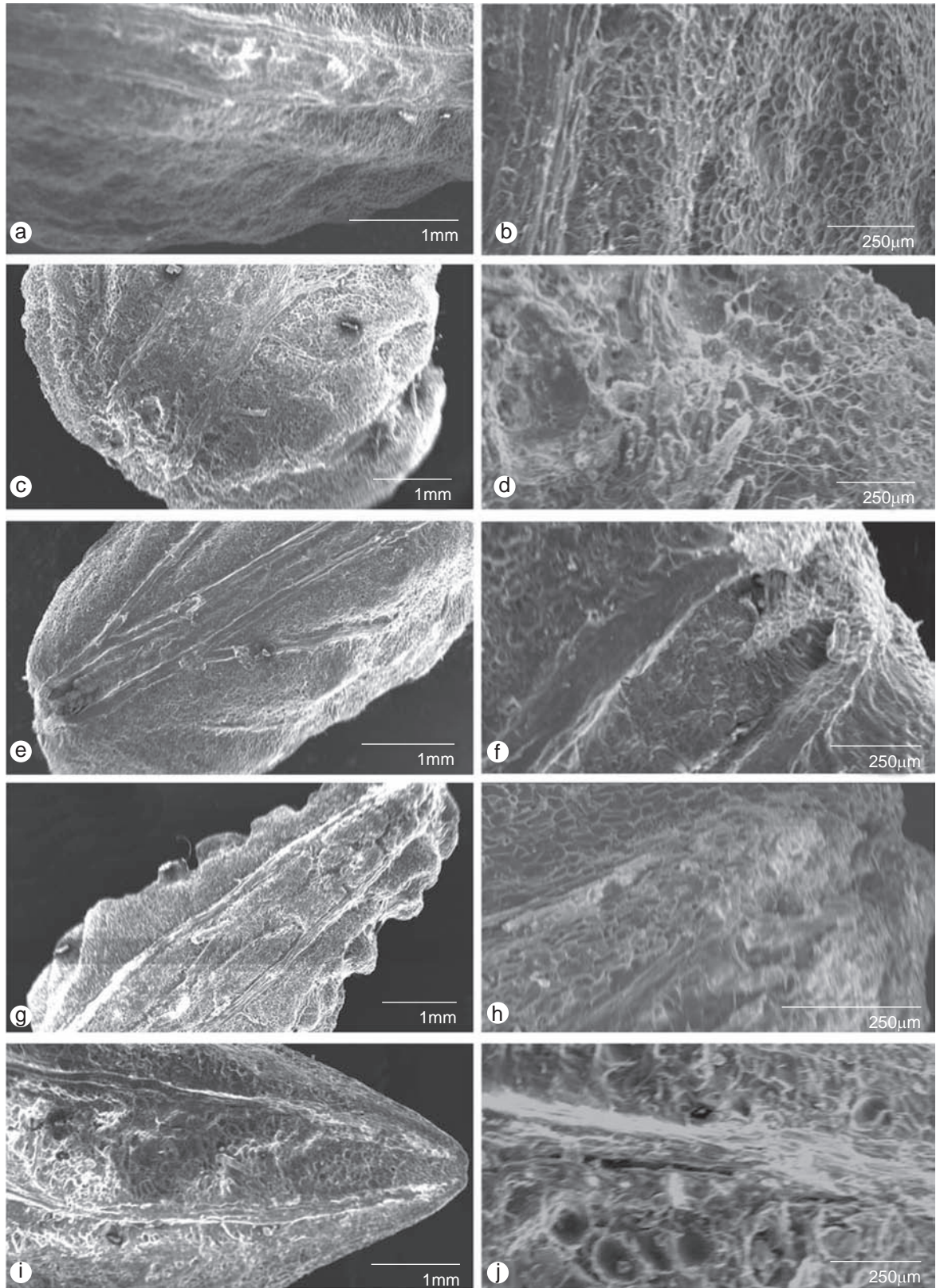


Fig. 3. Scanning Electron Micrographs (SEM) of the five *Rauvolfia* showing detailed features of seed surface. a & b. *R. hookeri*, reticulate-alveolate; c & d. *R. micrantha*, reticulate-pitted-granulate; e & f. *R. serpentina*, reticulate-alveolate; g & h. *R. tetraphylla*, reticulate-alveolate; i & j. *R. verticillata*, ruminant-tuberculate.

**Table 2.** Comparative description of the characters of seeds of five species of *Rauvolfia*

Character	<i>R. hookeri</i>	<i>R. micrantha</i>	<i>R. serpentina</i>	<i>R. tetraphylla</i>	<i>R. verticillata</i>
Shape	Ovoid, compressed one side, the other side bullate	Ovoid, compressed one side, the other side bullate	Suboblongoid, one side flat and the other bullate	Obliquely ovoid, 3-sided	Ellipsoid, 2-sided
Colour	Black	Black	Cream-yellow	Cream-yellow	Cream-yellow
Texture	Rugose, reticulate, alveolate	Rugose, reticulate, pitted-granulate	Rugose, reticulate, alveolate	Rugose, reticulate, alveolate	Rugose, ruminate, tuberculate
Size (cm)	$0.88 \pm 0.004 \times 0.51 \pm 0.004$	$0.56 \pm 0.02 \times 0.49 \pm 0.006$	$0.42 \pm 0.003 \times 0.29 \pm 0.004$	$0.603 \pm 0.006 \times 0.333 \pm 0.003$	$0.99 \pm 0.036 \times 0.457 \pm 0.037$
Weight (g)	$0.043 \pm 0.002$	$0.037 \pm 0.003$	$0.04 \pm 0.008$	$0.035 \pm 0.0007$	$0.053 \pm 0.004$
Hilar groove (shape and size in mm)	Circular; 0.05	Circular; 0.05	Oval to oblong; 0.1 – 0.15 x 0.03 – 0.06	Minute	Nil
Micropylar region	Beak like	Pointed	Rounded	Rounded	Pointed
Shape of micropyle	Circular	Triangular	Constricted	Oval	Circular
Embryo	Straight	Spathulate with curved cotyledons at chalazal end	Straight	Spathulate with curved cotyledons at chalazal end	Straight

Values as mean of 50 replicates  $\pm$  standard error

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