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Cover: Green Sea Turtle *Chelonia mydas* watercolour by Elakshi Mahika Molur.



The genus *Holigarna* Buch.-Ham. ex Roxb. (Anacardiaceae) in the central Western Ghats, Karnataka, India

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Abstract: The article deals with the taxonomy of the genus *Holigarna* found in the Western Ghats of Karnataka. Five species of *Holigarna* have been reported from the Western Ghats of Karnataka. The study includes—field surveys, herbarium examinations, and literature references provided the information on endemism, correct names, a short description, flowering & fruiting period, distribution, and illustrations & photographs of all the five species of the genus *Holigarna*. This information will be helpful in the identification of *Holigarna* species in the field.

Keywords: Field survey, herbarium examinations, *Holigarna arnottiana*, *H. beddomei*, *H. ferruginea*, *H. grahamii*, *H. nigra*, morphology, taxonomy.

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INTRODUCTION

The Anacardiaceae family encompasses approximately 950 species spread across 82 genera worldwide (Mabberley 2017). In India, this family is represented by 67 species, two subspecies, and two varieties, alongside four cultivated species within 23 genera (Chandra & Mukherjee 2000; Pramanick et al. 2020). Due to the extensive diversity and complexity of identifying species, the taxonomy of Anacardiaceae is not well understood. *Holigarna*, a polygamous evergreen genus, characterized by tall trees with acrid juice has seven species (*H. arnottiana* Hook.f., *H. beddomei* Hook.f., *H. ferruginea* Marchand, *H. grahamii* (Wight) Kurz, *H. kurzii* King, *H. longifolia* Buch.-Ham. ex Roxb., and *H. nigra* Bourd.) in India. Of these, *H. kurzii* and *H. longifolia* are the only ones not endemic to the country (Chandra & Mukherjee 2000). Five species (*H. arnottiana*, *H. beddomei*, *H. ferruginea*, *H. grahamii*, and *H. nigra*) are reported from the central Western Ghats of Karnataka (Gamble 1918; Saldanha 1984; Chandra & Mukherjee 2000).

In Karnataka, these *Holigarna* species are primarily found in evergreen and semi-evergreen forests, with only a few in moist deciduous forests. The polygamous nature of *Holigarna* poses challenges in collecting and identifying species, notably due to insufficient information on flowering and fruiting seasons and the limited availability of detailed morphological characters in the literature. Consequently, the present study aims to comprehensively document the taxonomy and morphological features of the *Holigarna* genus in the central Western Ghats, Karnataka.

MATERIALS AND METHODS

Study area

The study was conducted in Uttara Kannada, Shivamogga, Chikkamagaluru, Hassan, and Kodagu districts (Figure 1), known for their rich variety of plant and animal species. Field surveys took place from 2019 to 2022, covering moist deciduous, semi-evergreen, and evergreen forests across the central Western Ghats. The surveys included all altitudinal ranges to investigate the genus *Holigarna*.

This was supported by an extensive literature review and an examination of herbarium specimens deposited at the herbarium JCB Centre for Ecological Sciences, Indian Institute of Science, Bengaluru. The identity of collected specimens of *Holigarna* species was determined by

referring to regional Floras (Gamble 1918; Saldanha 1996) and also cross-referenced with the images of type specimens available online at the Kew Herbarium Catalogue (<http://apps.kew.org/herbcat/navigator.do>). Leaves of five species of *Holigarna* have been dried, mounted on the herbarium sheets, and deposited in the herbarium of the Department of Applied Botany at Kuvempu University, Karnataka.

RESULTS AND DISCUSSION

Structural account of genus *Holigarna*.

In certain parts of the central Western Ghats, 10 sampling sites were explored to study the distribution and morphology of *Holigarna* species. The study identified five different species—*H. arnottiana* Wall. ex Hook.f., *H. beddomei* ex Hook.f., *H. ferruginea* Marchand, *H. grahamii* (Wight) Kurz, and *H. nigra* Bourd.—across these sites. Among them, *H. arnottiana*, *H. grahamii*, and *H. ferruginea* are widespread, while *H. nigra* and *H. beddomei* are less common in the central Western Ghats. The research highlighted that *H. arnottiana* and *H. grahamii* dominate in Shivamogga, Chikkamagaluru, Hassan, Kodagu, and Uttara Kannada districts, followed by *H. ferruginea*. Of the seven *Holigarna* species in India, five are found in the Western Ghats of Karnataka (Image 1). Leaf herbarium specimens were prepared and deposited at the Department of Applied Botany, Kuvempu University, for future reference (Table 1, Image 2).

Color and texture of bark

The bark in *Holigarna* species is usually greenish-grey to brown, and the inner bark is white and occasionally light pink. The stems and twigs produce a white or cream-coloured exudate which turns black after drying. The bark is rough in *H. arnottiana* and *H. grahamii*, whereas *H. beddomei*, *H. ferruginea* and *H. nigra* have smooth bark (Image 3).

Taxonomy of the genus *Holigarna*

Lofty trees, polygamous. Leaves are simple and alternate, usually in clusters near the branch apex, entire; petioles with spur-like deciduous or persistent appendages near leaf bases. Inflorescences panicles, axillary and terminal. Flowers both bisexual and male, bracteate, perigynous. Calyx cupular, 5-lobed; lobes imbricate. Petals 5, valvate, villous on the inner surface. Stamens 5. Disk cupular, 5-lobed. Carpels 3–5, syncarpous; ovary inferior, 1-loculed; ovule 1; styles

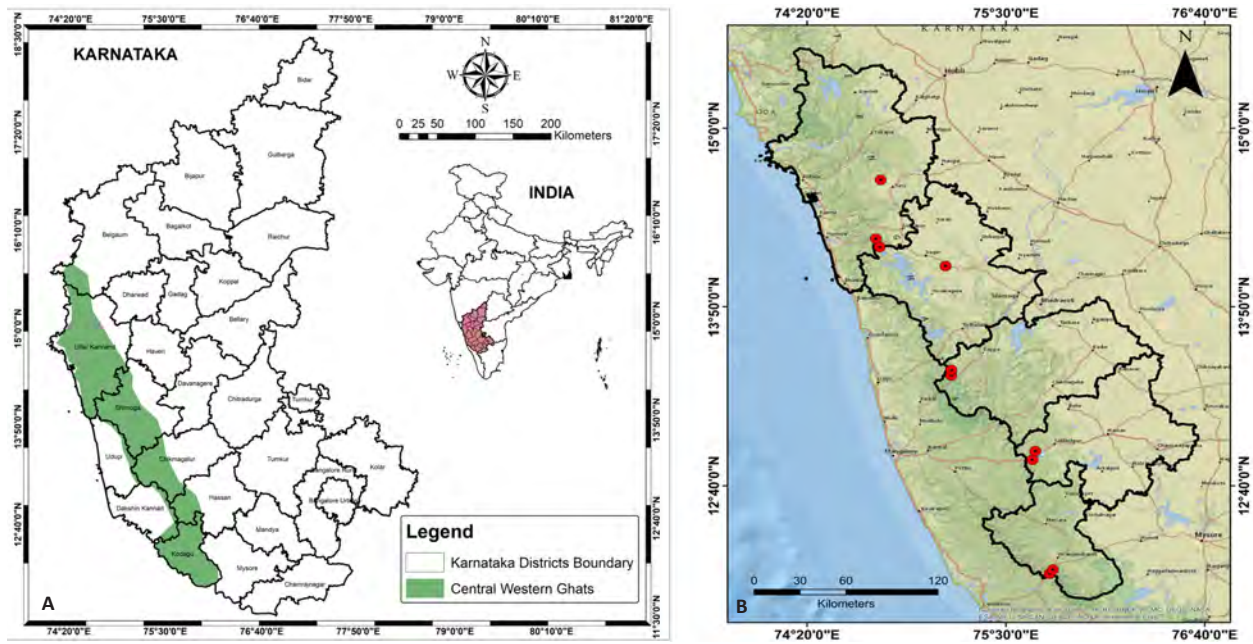


Figure 1. The GIS Map showing sampling locations of *Holigarna* species in the central Western Ghats: A—Outline map of Karnataka showing the central Western Ghats (in green) | B—The study sites of *Holigarna* species in central Western Ghats, Karnataka.

Table 1. Five species of *Holigarna* were collected from Karnataka with collection ID and herbarium accession numbers.

| Name of the species | Collection ID | Herbarium accession no. |
|--|---------------|-------------------------|
| <i>Holigarna arnottiana</i> Wall. ex Hook.f. | HAKU-01 | KUAB478 |
| <i>Holigarna beddomei</i> Hook.f. | HBKU-05 | KUAB482 |
| <i>Holigarna ferruginea</i> Marchand | HFKU-02 | KUAB479 |
| <i>Holigarna grahamii</i> (Wight) Kurz | HGKU-03 | KUAB480 |
| <i>Holigarna nigra</i> Bourd. | HNKU-04 | KUAB481 |

terminal, 3–5; stigma clavate. Drupes wholly or partly enclosed within obconic and turbinate hypocarp, resinous, acrid.

Habitat and Distribution: Moist deciduous, semi-evergreen, and evergreen forests of the Western Ghats (Shivamogga, Chikkamagaluru, Uttara Kannada, Hassan, and Kodagu districts)

Vernacular names: English: Junglemarking Nut, Black Varnish Tree, Kannada: Sanna Hologara, Holigeru, Tamil: Kattu-cheru, Karuncheru, Malayalam: Cheru, Naicheru.

Flowering: November–December; Fruiting: January–June.

Some important diagnostic characteristics features of documented *Holigarna* species were tabulated in Table 2.

Morphology of Flowers and Fruits

The basic inflorescence type is a panicle (Image 4), sometimes racemes. Flowers are small, polygamous, pentamerous, and perigynous, with a cup-shaped accrescent calyx and five valvate petals, inserted on the edges of the disk. Stamens 5, inserted on the edges of the disk, densely villous inside the disk along the calyx tube. Ovary inferior, 1-celled; ovule 1, subapical; styles 3, divergent; stigma capitate. Female flowers show self-incompatibility (Figure 2). Fruits of resinous, pungent, compressed ovoid drupes, partially or entirely hypocarpic (Image 5).

TAXONOMIC TREATMENT OF GENUS *HOLIGARNA*

1. *Holigarna arnottiana* Wall. ex Hook.f.

Fl. Brit. India 2: 36. 1876; T. Cooke, Fl. Bombay 1: 279. 1902; Gamble, Fl. Madras: 268. 1918; C.J. Saldanha, Fl. Karnataka 2: 204. 1996; Sasidh., Biodivers. Doc. Kerala 6: Fl. Pl.: 111. 2004; K.G. Bhat, Fl. South Kanara: 514. 2014. *H. longifolia* Wight & Arn., Prodr. Fl. Ind. Orient.: 169. 1834; Bedd., Fl. Sylv. S. India: t. 107. 1871.

A large tree with black caustic juice; branches glabrous. Leaves obovate to oblanceolate, acute at apex, glabrous beneath, c. 23 × 9 cm; lateral veins 14–20 pairs; petioles up to 1.5 cm long with a pair of spurs. Panicles with golden brown pubescence, 12–18 cm long. Flowers are yellowish-green, pentamerous, perigynous, and densely villous inside the disk. Corolla green; anthers red. Drupes are



Image 1. The field photographs of different *Holigarna* species: A—*H. arnottiana* | B—*H. beddomei* | C—*H. ferruginea* | D—*H. grahamii* | E—*H. nigra* | F—Phyllotaxy | G—Close-up of the lower portion of leaves showing the spurs on the petioles.

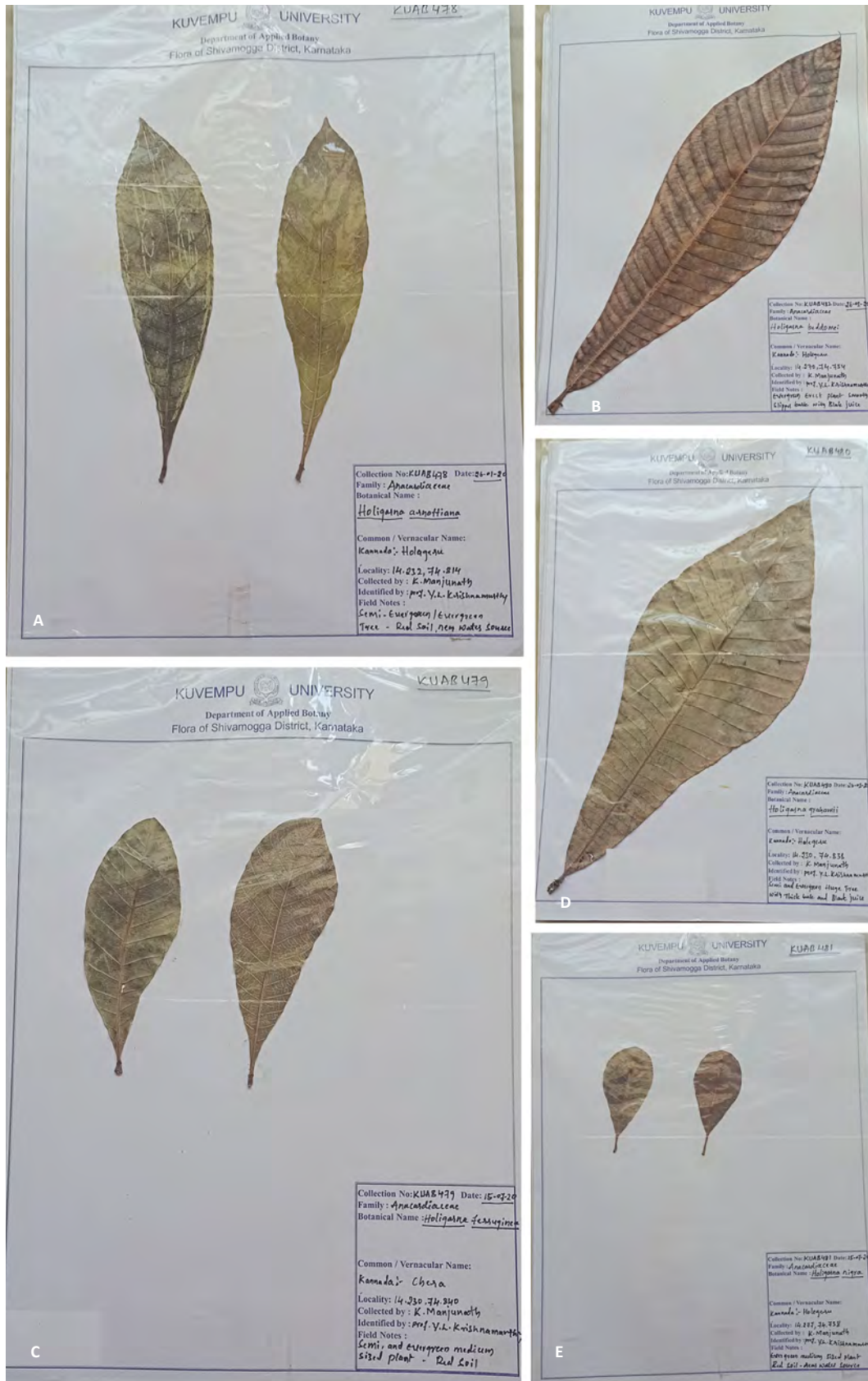


Image 2. Herbarium specimens (leaves) of different *Holigarna* species: A—*arnottiana* (KUAB478) | B—*beddomei* (KUAB482) | C—*ferruginea* (KUAB479) | D—*grahamii* (KUAB480) | F—*nigra* (KUAB481).



Image 3. Bark of different *Holigarna* species: A—*H. arnottiana* | B—*H. beddomei* | C—*H. ferruginea* | D—*H. grahamii* | E—*H. nigra*.

obliquely ovoid, c. 2.5 cm long, light brownish, completely enclosed in the hypocarp, and black when ripe.

Habitat and Distribution: Endemic to the Western Ghats. Frequent in the semi-evergreen forests (Shivamogga, Chikkamagaluru, Uttara Kannada, Hassan,

and Kodagu districts).

Vernacular names: English: Jungle Marking Nut, Black Varnish Tree; Kannada: Sanna Holegara, Holigeru; Malayalam: Cheru, Naicheru; Tamil: Kattu-cheru, Karuncheru.



Image 4. Polygamous nature of flowers in *Holigarna* of the central Western Ghats: A & B—Panicle of male flowers | C—Male flower and stamens arrangement | D—Panicle of Female flower | E—Female flower | F—Pistil | G—Staminode of the female plant.

Table 2. Important diagnostic characteristics and features of the genus *Holigarna*.

| Characters | <i>Holigarna arnotiana</i> | <i>Holigarna ferruginea</i> | <i>Holigarna nigra</i> | <i>Holigarna grahamii</i> | <i>Holigarna beddomei</i> |
|----------------|---|---|---|--------------------------------------|---|
| Habit | Medium-sized, multiple branching | Large-sized, multiple branching | Medium-sized, multiple branching | Large-sized, simple branching | Large-sized, simple branching |
| Leaf shape | Obovate to Oblanceolate | Obovate | Spathulate | Obovate to Oblanceolate | Oblanceolate, immediately widened just above the middle |
| Leaf tip | Acute | Acuminate | Obtuse | Acute | Acuminate |
| Leaf base | Cuneate or Attenuate | Cuneate | Cuneate | Cuneate | Cuneate |
| Lateral Nerves | 14–20 pairs | 10–14 pairs | 6–10 pairs | 22–30 pairs | 20–30 pairs |
| Spurs | Single pair, deciduous | Single pair, deciduous | Single pair, deciduous | Two pairs, of stout | Single pair, slender, hirsute |
| Panicle | 12–18 cm long, with golden-brown pubescence | 16–20 cm long, with dark brown pubescence | 8–10 cm long, dark purple-brown-tomentose | 20–35 cm long, with brown pubescence | 20–35 cm long, with golden-brown pubescence |
| Flower | Yellowish-green | White | Greenish-white | White | White |

Photographs: Image 6; Illustration: Figure 3.

Flowering: November–December; Fruiting: January–May.

2. *Holigarna beddomei* Hook.f.

Fl. Brit. India 2: 38. 1876; Gamble, Fl. Madras: 269. 1918; Sasidh., Biodivers. Doc. Kerala 6: Fl. Pl.: 111. 2004.

Large tree with acrid juice. Leaves simple, alternate, clustered at the tip of branches, oblanceolate,



Image 5. Fruits of different species of *Holigarna*: A—*H. grahamii* | B—*H. arnottiana* | C—*H. ferruginea* | D—*H. beddomei* | E—*H. nigra*.

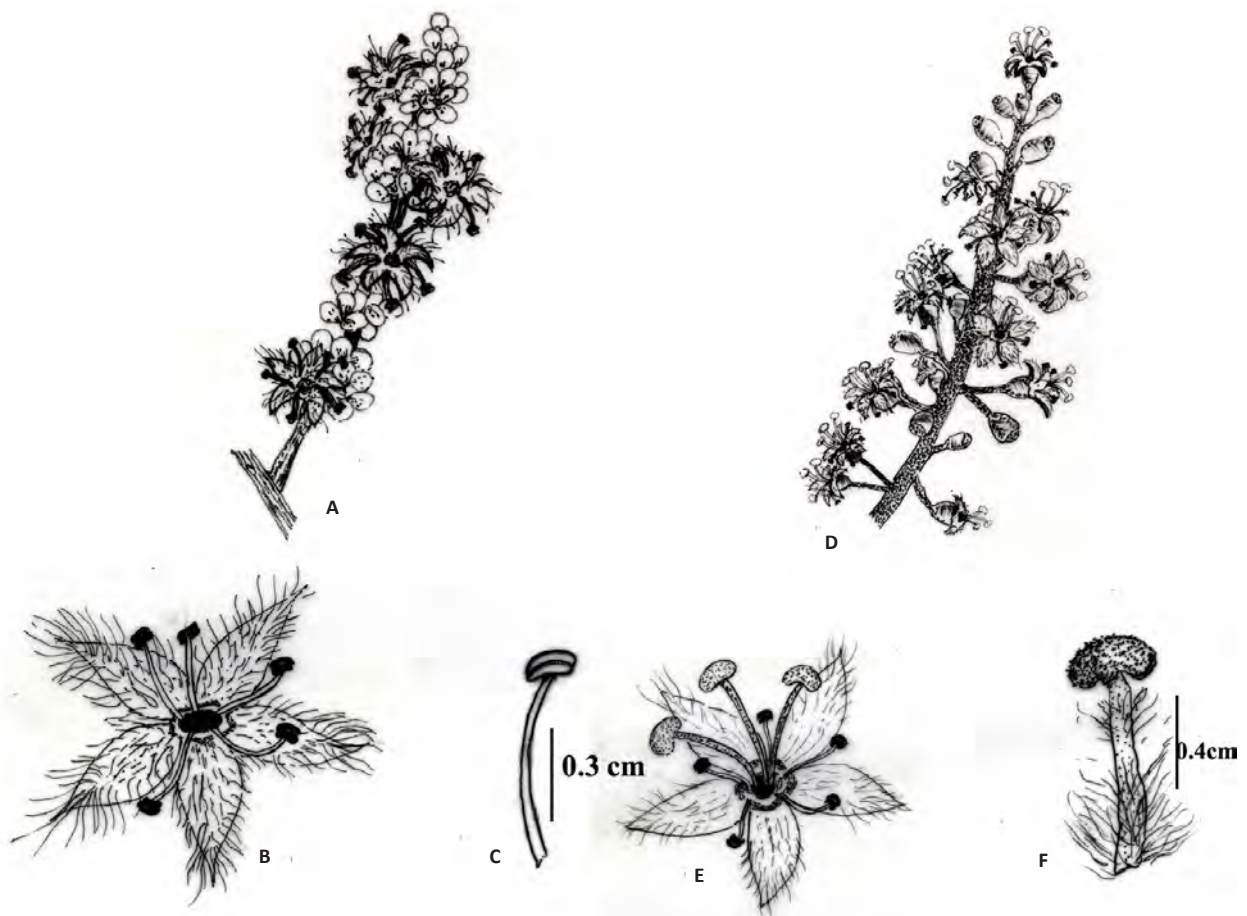


Figure 2. Illustrations of the male and female flowers in *Holigarna*: A—Panicle of the male flowers | B—Male flower | C—Stamen | D—Panicle of the female flowers | E—Female flower | F—Stigma.

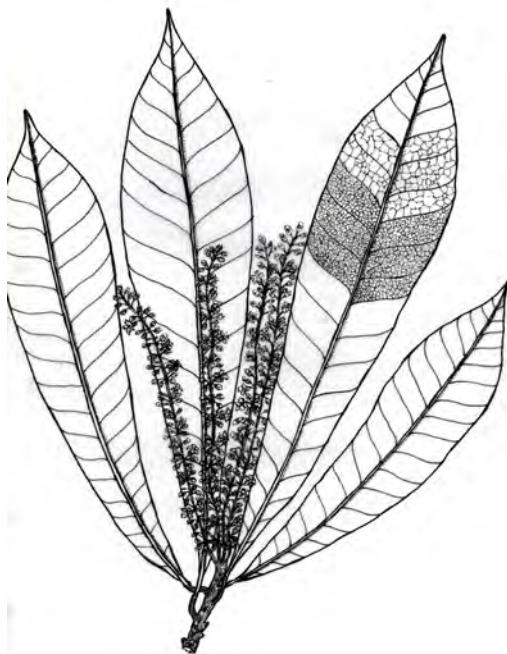


Figure 3. *Holigarna arnottiana* Wall. ex Hook.f.

immediately widened just above the middle, apex acuminate, base cuneate, margins entire, ciliate pubescent, up to 35 × 18 cm, pubescent beneath; petioles 1–2 cm long, villous, with a pair of slender, hirsute, and prominent spurs; midvein ciliate on the upper surface; lateral veins 20–30 pairs, parallel, prominent. Flowers polygamous, pentamerous. Petals 5, united at their bases, villous inside, white; a disk lines the tube of the calyx. Stamens 5, inserted outside the disk; anthers oblong-cordiform, versatile. Ovary inferior, 1-celled; styles 3, divergent; stigma capitate. Drupes are obliquely ovoid and 2–3 cm long.

Distribution: Endemic to the Western Ghats. Frequent in evergreen forests (Chikkamagaluru, Uttara Kannada, and Kodagu districts).

Vernacular Names: Kannada: Chere; Tamil: Pal vadinjan, Pal vidinyan.

Photographs: Image 7; Illustration: Figure 4.

Flowering: February–March; Fruiting: April–June.



Image 6. *Holigarna arnottiana*: A & B—Habit | C—Male inflorescence | D—Female inflorescence | E—Male flower with stamens | F—Female flower with staminodes and pistil showing self-incompatibility | G—Fruits.



Image 7. *Holigarna beddomei*: A & B—habit | C—Male inflorescence | D—Female inflorescence | E—Pistils | G—Fruits.

3. *Holigarna ferruginea* Marchand

Rev. Anacardiaceae: 171. 1869; Bedd., Fl. Sylv. S. India: t. 107. 1871; Hook.f., Fl. Brit. India 2: 36. 1876; Gamble, Fl. Madras: 268. 1918; C.J. Saldanha, Fl. Karnataka 2: 205. 1996; Sasidh., Biodivers. Doc. Kerala 6: Fl. Pl.: 111. 2004;

K.G. Bhat, Fl. South Kanara: 514. 2014.

A medium-sized tree with black caustic juice; branches glabrous. Leaves up to 18 × 9 cm, obovate, subacute at apex, glabrous beneath; lateral veins 10–14 pairs; petioles c. 1.5 cm long, with a pair of deciduous

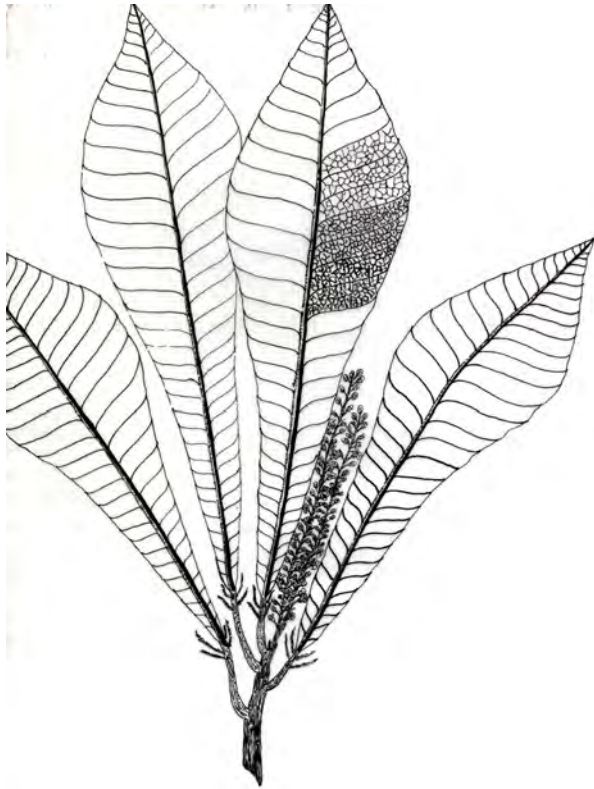


Figure 4. *Holigarna beddomei* Hook.f.

spurs. Panicles are 16–20 cm long, with dark brown pubescence. Flowers whitish. Calyx ferruginous-tomentose outside. Petals 5, cohering at the base and with the edges of the disk, are thickly villous inside. Stamens 5. Ovary inferior, 1-celled; styles 3, divergent; stigma capitate. Drupes ellipsoid, dark brown, turning black when ripe.

Distribution: Endemic to the Western Ghats. Frequently in the semi-evergreen forests (Hassan, Kodagu, Shivamogga, and Uttara Kannada districts).

Vernacular Names: Kannada: Chara; Tamil: Charei.

Photographs: Image 8; Illustration: Figure 5.

Flowering: January–February; Fruiting: March–May.

4. *Holigarna grahamii* (Wight) Kurz

Hook.f., Fl. Brit. India 2: 36. 1876; T. Cooke, Fl. Bombay 1: 282. 1902; Gamble, Fl. Madras: 268. 1918; C.J. Saldanha, Fl. Karnataka 2: 205. 1996; Sasidh., Biodivers. Doc. Kerala 6: Fl. Pl.: 112. 2004; K.G. Bhat, Fl. South Kanara: 514. 2014. *Semecarpus grahamii* Wight, Icon. Pl. Ind. Orient. 1(12): t. 235. 1839; Bedd., Fl. Sylv. S. India: t. 107. 1871.

A big tree with tomentose juvenile branches. Leaves simple, alternate, clustered at the tips of branchlets, stipulate, obovate to oblanceolate, base cuneate, apex acute; lateral veins 22–30 pairs, parallel, prominent;

intercostae reticulate, prominent; petioles stout, 2–4 cm long, with 2 pairs of typical persistent spurs, brown-tomentose. Panicles 20–35 cm long, brown-pubescent. Petals 5, white, placed outside the disk and adhering to base and margins, villous inside. Ovary inferior, 1-celled; styles often divergent; stigma capitate. Drupes ovoid, 2–3 cm long, yellowish or reddish-purple.

Distribution: Endemic to the Western Ghats. Frequent in the moist deciduous and evergreen forests of Western Ghats (Shivamogga, Chikkamagaluru, Dakshina Kannada, Hassan, Kodagu, Udipi, and Uttara Kannada districts).

Vernacular Names: Kannada: Doddele Holagara; Malayalam: Anacheru, Valia cheru; Marathi: Balwuli, Bipte.

Photographs: Image 9; Illustration: Figure 6.

Flowering: November–December; Fruiting: January–March.

5. *Holigarna nigra* Bourd.

Indian Forester 30: 95. 1904; Gamble, Fl. Madras: 268. 1918; C.J. Saldanha, Fl. Karnataka 2: 205. 1996; Sasidh., Biodivers. Doc. Kerala 6: Fl. Pl.: 112. 2004.

A large tree with black caustic exudate; branches glabrous. Leaves simple, alternate, spatulate, base cuneate, margins entire, apex obtuse, sometimes retuse, glabrous; lateral veins 6–10 pairs, parallel, prominent, intercostae reticulate; petioles 1.5–2.5 cm long, with pair of deciduous spurs. Inflorescences racemose panicles, 8–10 cm long, terminal and axillary, dark purple-brown tomentose. Flowers are polygamous and white. Calyx is cupular and villous. Petals 5. Stamens 5; filaments white. Ovary inferior, 1-celled; styles 3; stigma capitate. Drupes obovoid, 1–2 cm long.

Distribution: Endemic to the Western Ghats. Frequent in the evergreen forests (Uttara Kannada and Kodagu districts).

Vernacular Names: Kannada: Cheru geru; Malayalam: Cheru.

Photographs: Image 10; Illustration: Figure 7.

Flowering: February–March; Fruiting: April–June.

CONCLUSION

The present study reports the distribution of five species of *Holigarna* in the central Western Ghats, Karnataka along with distinguished morphological features of every species with illustrations, photographs, significant key characters, and flowering and fruiting season, which will be helpful in the identification of *Holigarna* species in the field.



Image 8. *Holigarna ferruginea*: A—Habit | B—A flowering-twig | C—Male inflorescence | D—Female inflorescence | E—Female flower with stamens and pistils, showing self-incompatibility | F—Fruits.



Image 9. *Holigarna grahamii*: A & B—Habit | C—Male inflorescence | D—Female inflorescence | E—Female flower with stamens and pistils showing self-incompatibility | F—Fruits.



Image 10. *Holigarna nigra*: A—Habit | B—A twig | C—Female flowers with stamens and pistils showing self-incompatibility | D—Female inflorescence | E—Fruits.



Figure 5. *Holigarna ferruginea* Marchand.



Figure 6. *Holigarna grahamii* (Wight) Kurz.

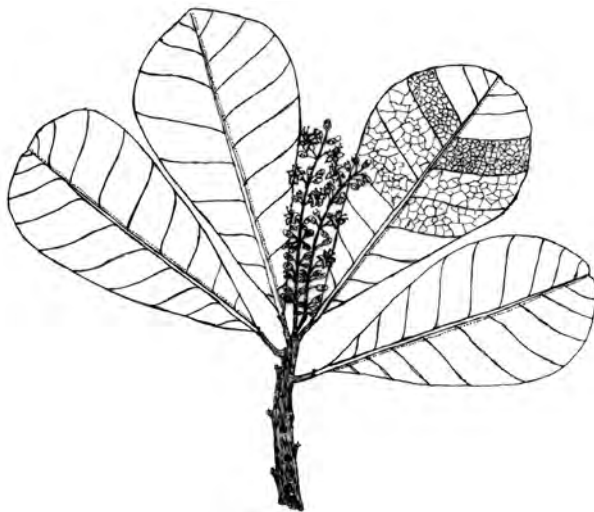


Figure 7. *Holigarna nigra* Bourd.

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