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Notes on the ornamental potential of the genus *Ophiorrhiza* L. in the Western Ghats of India

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Abstract

Ornamental potential of fifteen species and five varieties of the genus Ophiorrhiza in the Western Ghats of India were evaluated here.

Keywords: *Ophiorrhiza*, Rubiaceae, Western Ghats, India

Introduction

Ophiorrhzia L. is one of the largest genera in the family Rubiaceae comprising about 382 species around the world, which is mainly distributed in the wet tropical and subtropical forests of South-East Asia (POWO, 2020). In India, the genus is represented by 52 species and mainly recorded from the Western Ghats and North Eastern states (Nayar *et al*., 2014).

Ophiorrhiza species are therapeutically important due to the presence of a pentacyclic tryptophan derived quinoline alkaloid called camptothecin (CPT). CPT is a naturally occurring anti-cancerous compound due to its ability to inhibit the topoisomerase I (TopI) enzyme (Krishnan *et al*., 2018).

India is one among the twelve mega biodiversity countries in the world is well known for its rich biodiversity and native ornamental plants whose commercial potential has been unexplored. In the modern garden landscape, native plants have an important role due to their low maintenance cost and also for conserving biological diversity in urban gardens thus providing habitat and resources for the local fauna (Buckstrup & Bassuk 2015, Heiden *et al*. 2006). Unexplored ornamental value of native wild species of India can be overcome by documenting and evaluating families and genera's known to have ornamental potential and by making such plants known to the community. Cultivation of non-native ornamental plants can adversely affect both natural environment and other native crops of that region, hence the use of native species may favour the preservation of local flora and highlight regional identities (Heiden *et al*., 2006).

Native plants play an important role in modern landscaping due the low maintenance need, regionalism, biological diversity and habitat for local wildlife (Buckstrup and Bassuk, 1997). While considering the present scenario of devastation of native environment, the need for scientific investigation on the ornamental application of native plant species is important. Hence the appropriate utilization of native wild ornamental plant can help in the conservation of biodiversity (Stumpf *et al*., 2009a).

Ophiorrhiza have a set of desirable ornamental characteristics such as shape and size of foliage, shape and colour of flowers and nature of inflorescence. But there is no published data about its ornamental potentiality. According to Tombolata (2008), any plant can have ornamental value if it fits the environment to be decorated and that meets the purpose of use, either in internal or external gardens. According to the scenario, the present work was developed with the objective to evaluate the ornamental potential of various species of the genus *Ophiorrhiza* in the Western Ghats of India.

Materials and Methods

Literature survey

An extensive survey of the literature was carried out in order to obtain the available information about the taxa under study. Information's regarding the genus were collected from various sources like Institution libraries, literature retrieval system of biodiversity heritage library of New York Botanic Garden (http://www.biodiversitylibrary.org) and botanical literature from the Missouri Botanical Garden Library (http://botanicus.org).

Plant collection

Several plant collection trips were carried out to collect different species of the genus *Ophiorrhiza* across different regions of the Western Ghats. Plant samples (both vegetative and reproductive parts) were collected for identification, macro, and microscopical investigation, and herbarium preparation. Photographs of habit, inflorescence, flowers, and fruits were taken using a digital camera.

Plant identification

The collected plants were identified with the help of published literature, including protologues and in consultation with different herbarium specimens housed at different herbaria. Floras, monographs, and expert opinions were also taken to confirm the species identity under study. Herbaria like Kew digital herbarium catalogue (K), Nationaal Herbarium Nederland, Leiden University branch (L), Central National Herbarium (CAL), Royal Botanic Garden Edinburgh Herbarium (E), TBGT (Herbarium, Jawaharlal Nehru Tropical Botanic Garden and Research Institute, Palode), KUBH (Kerala University Botany Herbarium) and Calicut University Herbarium (CALI) were consulted.

Ornamental potential characterization

The plants were evaluated for the ornamental value according to pre-established criteria, analyzing vegetative and reproductive characteristics, as well as other ornamental aspects. Different variables used for evaluating ornamental potential of the genus *Ophiorrhiza* is as follows:

- Plant height: determined with a tape measure, from the ground to the end of the highest leaf in its original position. When the plant ends in an inflorescence, the height of this structure was also considered.
- Habit: herbs, sub-shrubs, decumbent, prostrate, creeping etc
- Condition of luminosity in which the plant is found: full sun, half shade or shade
- Shape, size, texture and colour of foliage
- Position of the inflorescence: terminal or lateral
- Type of inflorescence: scorpioid cyme, corymbose cyme, sub corymbose cyme and capitate cyme
- Colour, size, shape of flowers
- Shape and size of bract
- Textures of structures of ornamental value (leaves, flowers, inflorescence, fruits): hairy or glabrous
- Presence or absence of aroma: when present, in which structures: leaves, flowers/inflorescence or fruits; the sensation caused: pleasant or unpleasant; and the aroma intensity: weak, medium or strong
- Ornamental potential of fruits and the type of fruit
- Flowering and fruiting season

The variables chosen were determined individually and sensorially (mostly visually) except for biometric variables. The plants were sorted according to their ornamental value and categorized in to three classes: low ornamental potential, medium ornamental potential and high ornamental potential (Stumpf *et al*., 2007).

Results and Discussion

Fifteen species and five varieties of Ophiorrhiza were analysed for their ornamental value. All the species have beautiful flowers and possesses ornamental value and can be used for popularization and domestication and thereby ensuring their effective conservation (Fig 1, Table 1).

1. *Ophiorrhiza barberi* Gamble, Bull. Misc. Inform. Kew 1919: 406 (1919)

Herbs 35–50 cm tall, grows in half-shade; stems erect, branching, glabrous. Leaves 9–18 × 2–5 cm, elliptic-lanceolate, glabrous, dark green to yellow green, shining. Inflorescence terminal or axillary scorpioid cyme, 3–6 cm across; branches spreading, glabrous. Flowers heterostylous, 9–12 mm long, white to cream-white colour, without any aroma. Corolla tube infundibuliform, glabrous outside; lobes ovate. Fruit is a capsule, glabrous, green to red colour.

Flowering and fruiting: April to January

Distribution: India, Kerala and Tamilnadu

2. *Ophiorrhiza barnesii* C.E.C.Fisch., Bull. Misc. Inform. Kew 1939: 248 (1939)

Herbs 20 – 50 cm tall, grows in half-shade; stems erect, glabrous below, slightly puberulous above. Leaves 8.5–14.6 × 2.8–3.9 cm, ovate-lanceolate, glabrous, dark green, shining. Inflorescence terminal or axillary, corymbose cymes, 1–2 cm across; branches short, glabrous. Flowers heterostylous, 8.02–9 mm long, lilac-white in colour, with a pleasant weak aroma. Corolla tube infundibuliform, glabrous outside; lobes ovate. Fruit is a capsule, glabrous, green to red colour.

Flowering and fruiting: March to October

Distribution: India, Kerala

3. *Ophiorrhiza brunonis* Wight & Arn. **var. *brunonis*** Hook. f., Fl. Brit. India 3: 79 (1880)

Herbs 16 – 50 cm tall, grows in half-shade; stems erect, branched, glabrous. Leaves 3–15 × 1.5–6 cm, ovate to elliptic-ovate, glabrous, dark green. Inflorescence terminal or axillary, subcorymbose cymes, 1–4 cm across, puberulous. Flowers 6.5–12 mm long, white to lilac in colour. Corolla tube infundibuliform, glabrous outside; lobes ovate. Fruit is a capsule, glabrous, green in colour.

Flowering and fruiting: February to August

Distribution: India- Kerala, Tamilnadu, Karnataka

4. *Ophiorrhiza brunonis* Wight & Arn. **var. *Johnsonii*** Hook.f., Fl. Brit. Ind. 3:80. 1880; Deb & Mondal, Bull. Bot. Surv. India 39 (1-4):34.1997.

Herbs 10–25 cm tall, grows in half-shade; stems erect, branched, puberulous. Leaves 7–12 × 2.5–4 cm, ovate-lanceolate, glabrous, olive green. Inflorescence terminal, subcorymbose cymes, 2.5–3 cm across, puberulous. Flowers 13–20 mm long, lilac to light pink to white in colour, with a pleasant weak aroma. Corolla tube infundibuliform, slightly puberulous outside; lobes ovate-lanceolate. Fruit is a capsule, slightly puberulous, olive green in colour with red puberulous hairs.

Flowering & fruiting: March to December

Distribution: India, Kerala-Southern Western Ghats

5. *Ophiorrhiza caudata* C.E.C.Fisch., Bull. Misc. Inform. Kew 1938: 125 (1938)

Herbs 38–78 cm tall, grows in half-shade; stems erect, glabrous. Leaves 5–12 × 1.5–3.5 cm, narrowly elliptic-lanceolate, glabrous, light green. Inflorescence terminal, capitate cymes, 1–2 cm across, glabrous. Flowers 9–13.3 mm long, white in colour with pink striations, with a pleasant weak aroma. Corolla tube infundibuliform, glabrous outside; lobes subacute to acute. Fruit is a capsule, glabrous, green in colour.

Flowering & fruiting: May - September

Distribution: India, Kerala

6. *Ophiorrhiza codyensis* Gamble, Bull. Misc. Inform. Kew 1919: 406 (1919)

Herbs 15–40 cm tall, grows in half-shade; stems erect, glabrous and puberulous above. Leaves 6–16 × 2–4 cm, ovate-lanceolate to lanceolate, glabrous, dark green. Inflorescence axillary or terminal, corymbose cymes, 1–2 cm across, glabrous. Flowers 7–9 mm long, white in colour. Corolla tube infundibuliform, glabrous outside; lobes ovate to acute. Fruit is a capsule, glabrous, light green in colour.

Flowering & fruiting: September - October

Distribution: India, Karnataka, Kerala

7. *Ophiorrhiza eriantha* Wight, Icon. Pl. Ind. Orient. 3: t. 1067 (1846)

Herbs 30-100 cm tall, grows in half-shade to full sun; stems erect, suffruticose, branched, pubescent when tender, gradually glabrous with age. Leaves 10–18 × 2.4–5.3 cm, elliptic-lanceolate, glabrous above, puberulous on the nerves beneath, light to dark green. Inflorescence terminal, corymbose cymes, 3–5 cm across, pubescent. Flowers 13–18 mm long, red to red-pink, with a pleasant weak aroma. Corolla tube infundibuliform, highly pubescent outside on the upper part of corolla tube; lobes broadly ovate. Fruit is a capsule, pubescent, green in colour.

Flowering and fruiting: March to October

Distribution: India – Kerala, Tamilnadu

8. *Ophiorrhiza grandiflora* Wight, Icon. Pl. Ind. Orient. 3: t. 1069 (1846)

Herbs 10-40 cm tall, grows in half-shade; stems erect, branched, glabrous. Leaves 6–17.5 × 2–6 cm, elliptic-lanceolate, glabrous, light green. Inflorescence terminal, corymbose cymes, 1.5–7 cm across, glabrous. Flowers 20–40 mm long, white, with a pleasant weak aroma. Corolla tube infundibuliform, tube slender, pubescent outside on the lower part of corolla tube along the veins; lobes broadly ovate. Fruit is a capsule, pubescent, light green in colour.

Flowering and fruiting: May to December

Distribution: India – Kerala, Tamilnadu

9. *Ophiorrhiza hirsutula* Wight ex Hook.f., Fl. Brit. India 3: 81 (1880)

Herbs 15-45 cm tall, grows in half-shade; stems prostrate and then becoming erect, branched or unbranched, rusty pubescent. Leaves 3–17.5 × 2–6 cm, ovate to ovate-lanceolate, pubescent, light green. Inflorescence terminal or axillary, subcorymbose cymes, 1–2.5 cm across, rusty pubescent. Flowers 14–16 mm long, white to pinkish white, with a pleasant weak aroma. Corolla tube infundibuliform, pubescent outside; lobes lanceolate. Fruit is a capsule, pubescent, light green in colour.

Flowering and fruiting: April to December

Distribution: India – Kerala, Tamilnadu, Karnataka; Burma

10. *Ophiorrhiza mungos* L., Sp. Pl.: 150 (1753)

Herbs to undershrubs, 8–100 cm tall, grows in half-shade to full sun; erect, branching, somewhat fleshy, glabrous. Leaves 5.50–22.50 × 2.0–8.3 cm, ovate-elliptic, glabrous, light green. Inflorescence terminal or axillary, corymbose cymes, 1–7.5 cm across, glabrous. Flowers 4.98–5.98 mm long, white, without any aroma. Corolla tube infundibuliform, glabrous; lobes ovate. Fruit is a capsule, glabrous, light green in colour.

Flowering and fruiting: Throughout the year

Distribution: India, Nepal, Malay, Sumatra and Java

11. *Ophiorrhiza nairii* Ramam. & Rajan, J. Bombay Nat. Hist. Soc. 82: 174 (1985)

Herbs to undershrubs, 25–100 cm tall, grows in half-shade; erect, branching, densely hairy. Leaves 11–15.60 × 3.20–4.90 cm, elliptic-lanceolate, hairy, light green. Inflorescence terminal, corymbose cymes, 3–5 cm across, densely hairy. Flowers 24.12–26.32 mm long, white-pink, with a pleasant weak aroma. Corolla tube infundibuliform, densely hairy; lobes broad ovate. Fruit is a capsule, hairy, yellow green in colour with pink-white hairs.

Flowering and fruiting: March to October

Distribution: India, Kerala–Southern Western Ghats

12. *Ophiorrhiza pectinata* Arn., Nova Acta Acad. Caes. Leop.-Carol. German. Nat. Cur. 18: 338 (1836)

Herbs, 15–50 cm tall, grows in half-shade; erect, branching, glabrous, rarely puberulous upwards. Leaves 10.70–18.50 × 2.80–5.40 cm, elliptic-lanceolate, sparsely scabrous above, greenish yellow. Inflorescence usually terminal, sometimes axillary, capitate cymes, 0.8–3.75 cm across, glabrous. Flowers 8.77–11.59 mm long, heterostylous, pink-white, with a pleasant weak aroma. Corolla tube infundibuliform, glabrous; lobes ovate. Fruit is a capsule, glabrous, green in colour with red patches.

Flowering and fruiting: May to December

Distribution: India- Tamilnadu, Kerala; Sri Lanka.

13. *Ophiorrhiza radicans* Gardner ex Thwaites, Enum. Pl. Zeyl.: 139 (1859)

Herbs, 20–30 cm tall, grows in half-shade; stems creeping, rooting at the nodes, branching, pubescent. Leaves 1.60–5.30 × 0.75–2.50 cm, ovate-orbicular, sparsely scabrous above, light green. Inflorescence terminal, corymbose cymes, 0.5–1.5 cm across, glabrous. Flowers 7.66–9.27 mm long, heterostylous, white with pink striations, without any aroma. Corolla tube infundibuliform, glabrous; lobes ovate. Fruit is a capsule, glabrous, green in colour.

Flowering and fruiting: April to November

Distribution: India- Kerala; Sri Lanka

14. *Ophiorrhiza roxburghiana* Wight, Icon. Pl. Ind. Orient. 3: t. 1068 (1846)

Herbs to undershrub, 40–100 cm tall; stems erect, suffruticose, branched, young shoots densely pubescent. Leaves 7.8–17.2 × 2.9–5.6 cm, elliptic-lanceolate, glabrous above, slightly pubescent on the nerves beneath, dark green. Inflorescence terminal, corymbose cyme, 2–5 cm across, pubescent. Flowers 19.31–24.98 mm long, white, with a pleasant weak aroma. Corolla tube infundibuliform, pubescent; lobes broadly ovate. Fruit is a capsule, pubescent, green in colour with red hairs.

Flowering and fruiting: June to November

Distribution: India- Kerala, Tamilnadu

15. *Ophiorrhiza rugosa* var. *angustifolia* (Thwaites) Ridsdale, Blumea 41: 461 (1996)

Herbs, 20–30 cm tall, grows in half-shade; stems erect, somewhat suffruticose, branched, puberulous above, glabrous below. Leaves 8.7–14.4 × 2.6–3.9 cm, linear to lanceolate, scabrous above, dark green. Inflorescence terminal or axillary, corymbose cymes, 1–2 cm across, puberulous. Flowers 5.41–6.77 mm long, white with pink striations, without any aroma. Corolla tube infundibuliform, glabrous; lobes ovate. Fruit is a capsule, glabrous, green in colour with red patches.

Flowering and fruiting: April to November

Distribution: India- Kerala; Sri Lanka

16. *Ophiorrhiza rugosa* var. *decumbens* (Gardner ex Thwaites) Deb & Mondal, Bull. Bot. Surv. India 24: 228 (1982 publ. 1983)

Herbs, 10–30 cm tall, grows in half-shade; stems decumbent, branched, glabrous. Leaves 5.30–12.5 × 2.6–4.6 cm, elliptic-lanceolate, glabrous, dark green. Inflorescence terminal, corymbose cymes, 1–2 cm across, glabrous. Flowers 10.32–10.46 mm long, white, with a pleasant weak aroma. Corolla tube infundibuliform, glabrous; lobes triangular. Fruit is a capsule, glabrous, light green in colour.

Flowering and fruiting: April to September

Distribution: India- Kerala; Sri Lanka

17. *Ophiorrhiza rugosa* var. *prostrata* (D.Don) Deb & Mondal, Bull. Bot. Surv. India 24: 228 (1982 publ. 1983)

Herbs, 7–46 cm tall, grows in half-shade; stems prostrate, simple, glabrous. Leaves 1.5–5 × 1–2 cm, ovate to narrowly ovate, glabrous, dark green. Inflorescence terminal, corymbose cyme, 1–2 cm across, glabrous. Flowers 8–10 mm long, white, with a pleasant weak aroma. Corolla tube infundibuliform, glabrous; lobes ovate. Fruit is a capsule, glabrous, light green in colour.

Flowering and fruiting: April to November

Distribution: India, Nepal, Bhutan, Burma

18. *Ophiorrhiza sahyadriensis* Hareesh, V.B.Sreek. & K.M.P.Kumar, Phytotaxa 202: 220 (2015)

Herbs, 15–60 cm tall; stems erect, branched. Leaves 3–16 × 1.5–6.5 cm, ovate to elliptic-lanceolate, glabrous above, dark green. Inflorescence axillary, subcorymbose cyme, 1.5–3 cm across, pubescent. Flowers 8–11 mm long, white. Corolla tube infundibuliform, pubescent; lobes ovate-lanceolate. Fruit is a capsule, glabrous, green in colour.

Flowering and fruiting: November to July

Distribution: India- Kerala

19. *Ophiorrhiza shendurunii* A.E.S.Khan, E.S.S.Kumar & Pushp., J. Bombay Nat. Hist. Soc. 95: 317 (1998)

Herbs to undershrub, 30–80 cm tall; stems erect, suffruticose, branched, glabrous. Leaves 10–14.2 × 3.7–4.8 cm, elliptic-lanceolate, glabrous, dark green. Inflorescence terminal, corymbose cyme, 1.5–4.5 cm across, pubescent. Flowers 19.78–20.12 mm long, white, with a pleasant weak aroma. Corolla tube infundibuliform, pubescent; lobes ovate. Fruit is a capsule, pubescent, green in colour with red hairs.

Flowering and fruiting: July to December

Distribution: India- Kerala, Kollam

20. *Ophiorrhiza trichocarpos* Blume, Bijdr. Fl. Ned. Ind.: 977 (1826)

Herbs, 10–15 cm tall; stem erect, branched, densely pubescent. Leaves 5.5–10.5 × 2.1–3.5 cm, elliptic, glabrous above, pubescent on the nerves beneath, dark green. Inflorescence terminal or axillary, corymbose cyme, 1–3 cm across, densely pubescent. Flowers 4.87–6.32 mm long, white, without any aroma. Corolla tube infundibuliform, pubescent; lobes ovate. Fruit is a capsule, pubescent, green.

Flowering and fruiting: May to October

Distribution: India, Bangladesh, Burma, Thailand, Malaya, Java

Table 1
List of species of Ophiorrhiza categorized according to their ornamental potential

Low ornamental potential	Medium ornamental potential	High ornamental potential
O. brunonis var. *brunonis*	*O. barberi*	*O. brunonis* var. *johnsonii*
O. mungos	*O. barnesii*	*O. codyensis*
O. rugosa var. *angustifolia*	*O. caudata*	*O. eriantha*
O. sahyadriensis	*O. hirsutula*	*O. grandiflora*
O. trichocarpos	*O. pectinata*	*O. nairii*
	O. radicans	*O. roxburghiana*
	O. rugosa var. *decumbens*	*O. shendurunii*
	O. rugosa var. *prostrata*	

Figure 1: 1 - *O. barberi*, **2** - *O. barnesii*, **3** - *O. brunonis* var. *johnsonii*, **4** - *O. caudata*, **5** - *O. eriantha*, **6** - *O. mungos*

Figure 1 (cont.): 7 - *O. nairii*, **8** - *O. pectinata*, **9** - *O. radicans*, **10** - *O. roxburghiana*, **11** - *O. rugosa* var. *angustifolia*, **12** - *O. rugosa* var. *decumbens*

Figure 1 (cont.): 13 - *O. rugosa* var. *prostrata*, **14 -** *O. shendurunii*, **15 -** *O. trichocarpos*

Conclusion

Genus *Ophiorrhiza* possess several desirable ornamental characters, especially the inflorescence and flower morphology which can be effectively utilized as a native wild ornamental plant and can be used for popularization and domestication and thereby ensuring their effective conservation.

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