



A new species of *Isodon* (Lamiaceae) from Indian Eastern Himalaya

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ABSTRACT: *Isodon neorensis*, a new species from Eastern Himalaya of India has been described and illustrated here based on its morphology. A weak, short lived herbaceous species was collected from Neora Valley National Park, Darjeeling, India. Inflorescence, dark red colour flower, calyx without septate-villose hairs at base, stamens glabrous at base, and not exerted filaments are some important diagnostic features besides substantial morphological differences with allied species. The identification key to Indian Eastern Himalayan species of *Isodon*, distribution map, photo plate, illustration is also provided.

KEY WORDS: Darjeeling, Eastern Himalaya, India, *Isodon atroruber*, *I. neorensis*, *I. lophanthoides*, Neora Valley National Park.

INTRODUCTION

The genus *Isodon* (Schrad. ex Benth.) Spach (Lamiaceae: Nepetoideae: Ocimeae: Isodoninae) comprises around 100 species globally and members of the genus are mainly confined to tropical and subtropical Asia (Wu and Li, 1977; Li and Hedge, 1994; Harley *et al.*, 2004; Mabberley, 2008; Chen *et al.*, 2014a, b, 2017, 2019, 2021), except two disjunct endemic African species (Li, 1988) that likely formed through allopolyploidy and their migration might have happened from Asia to Africa through Arabia during the early Miocene (Yu *et al.*, 2014). The genus consists of 21 taxa (19 species & 2 varieties) in India and most of these species are restricted in eastern and peninsular India (Mukerjee, 1940; Hara, 1971; Li, 1988; Clement, 1999; Sasidharan, 2013; Naveen *et al.*, 2016; Anonymous, 2020) and among them six species are endemic to India (Anonymous, 2020). In India, the genus is used by different tribal communities in western Himalayan regions and northeast Indian states for various ailments, like acidity, cough, dyspepsia, stomach-ache, small pox, insect bite and skin diseases (Khan *et al.*, 2004; Singh and Chauhan, 2005; Khomdram *et al.*, 2011; Ningthoujam *et al.*, 2013; Dutt *et al.*, 2015; Kumar *et al.*, 2015). And is also used as broom, rosary and cultural rituals (Singh and Singh, 2005; Singh *et al.*, 2008; Khomdram *et al.*, 2011).

Bentham (1832-36, 1876) treated *Isodon* as a section under genus *Plectranthus* L'Herit and the same treatment was followed by Hooker (1885) in *Flora of British India* and described 21 species in then British India under this section. Later, section *Isodon* was raised to generic rank (Kudo, 1929; Farr *et al.*, 1979) and is now recognised as the only genus in the subtribe Isodoninae (Zhong *et al.*, 2010) and it can be delimited from other genera of tribe Ocimeae by pedunculate and bracteolate cymes, actinomorphic or two-lipped (3/2) calyx, strongly two-lipped (4/1) corolla, and stamens with free filaments

inserted at the base of the corolla tube (Li, 1988; Paton and Ryding, 1998; Harley *et al.*, 2004a,b; Chen *et al.*, 2019). The genus is further divided into four sections based on the morphology of inflorescence, fruiting calyx and corolla tube (Wu and Li, 1977; Li, 1988). Recent molecular studies also support that Isodoninae (Maki *et al.*, 2010; Zhong *et al.*, 2010; Yu *et al.*, 2014) and tribe Ocimeae (Paton *et al.*, 2004) are monophyletic.

During plant exploration of Neora Valley National Park, in Darjeeling-Sikkim Himalaya in 2016, a species of *Isodon* was collected which was quite interesting in flower's colour and very lax terminal and axillary inflorescences. Thorough morphological study of the above specimens and their comparison with *Isodon* species of eastern Himalaya of India and the adjoining countries (Nepal, Bhutan, China) and together with comprehensive literature consultation (Hooker, 1885; Mukerjee, 1940; Hara, 1971; Li, 1988; Clement, 1993, 1999; Li and Hedge, 1994; Suddee *et al.*, 2004; Xiang and Liu, 2012; Chen *et al.*, 2014a,b, 2017a,b, 2019, 2021) and comparison with specimens housed at ARUN, ASSAM, BSHC, CAL, and Himalayan and South-East Asian specimens of the genus deposited at BM, E, K, P, concluded that materials appears to be close to *Isodon atroruber* R. A. Clement and *Isodon lophanthoides* (Buch.-Ham. ex D. Don) H. Hara and its variety *graciliflorus* (Benth.) H. Hara but exhibits major differences with allied taxa like inflorescence, shape of flower buds and flowers, corolla and filaments colour, indumentum in whole plant, calyces and filaments etc. Therefore, after critical study, authors concluded that this material shows new novelty which is worthy to recognize as a new species and hence, here is described and illustrated as *Isodon neorensis*. Comparison of morphological features of the new species and its allied taxa is provided in table 1, along with dichotomous identification key of Eastern Himalayan species of *Isodon* is given here for delimitation of eastern Himalayan taxa.

**Table 1.** Comparison of *Isodon neorensis*, *I. lophanthoides* var. *lophanthoides*, *I. lophanthoides* var. *graciliflorus* and *I. atroruber*.

Characters	<i>Isodon neorensis</i>	<i>I. lophanthoides</i> var. <i>lophanthoides</i>	<i>I. lophanthoides</i> var. <i>graciliflorus</i>	<i>I. atroruber</i>
Stem	softly scabrous	glabrous to pubescent	glabrous to pubescent	glandular-pubescent and with some villous hairs
Inflorescence	terminal lax racemose composed of dichasial cymes, scabrid, lax and spreading	composed of several lax narrow racemose branches, forming a large panicle, glabrous to pubescent, lax or dense	Same as type variety	narrow and dense panicle
Bracteoles	up to 0.5 mm long, scabrid	up to 2 mm long, pubescent	Same as type variety	ca. 1 mm long
Calyx	glabrous, 10 veined, lobes subacute	glabrous to densely pubescent, dense at tube base, 10 veined, lobes subacute	glabrous or hairy, 10 veined, lobes subacute	puberulent intermixed with numerous orange-brown sessile glands, 15 veined, lobes obtuse
Corolla colour	dark red, white and hairy at throat with few red spots	white with purple spots at throat or rosy	Same as type variety	deep wine red to deep reddish-purple
Stamens	not exerted beyond the anterior corolla lip	exserted beyond the anterior corolla lip	Same as type variety	much exerted beyond the anterior corolla lip
Filaments	dark red except extreme tip, glabrous at base	white, villous at base	Same as type variety	deep wine red to deep reddish-purple
Style colour	dark red	white	Same as type variety	deep wine red to deep reddish-purple
Nutlets	yellowish, obovoid	brown, ovoid or oblong	Same as type variety	pale brown, ellipsoid

MATERIALS AND METHODS

During the assessment of flora of Neora Valley National Park, Darjeeling-Sikkim Himalaya in September, 2016, plant materials were collected and processed as per the standard procedure for botanical specimens. Morphological characterization and microscopic dissection of materials were done and detailed illustrations were prepared. The morphological characters of stems, leaves, inflorescence, bracts, bracteoles, flower buds, calyx, corolla, stamens, style and nutlets were used for comparing among the allied species. Plant materials were also matched with the herbarium specimens of *Isodon* deposited at different Indian herbaria (ARUN, ASSAM, BSHC, CAL) as well as digital images of herbarium specimens deposited at BM, E, K, P. In addition, protologues and type specimens of all allied species were critically examined.

TAXONOMIC TREATMENT

Isodon neorensis Ranjan, G. Krishna & Anant Kumar, *sp. nov.* **Figs. 1-2**

Type: INDIA. West Bengal, Darjeeling, Neora Valley National Park, Lava to Kolbong, 27°04'59.1"N 88°40'01.2"E, 2025.4m elev., 28th September 2016, *Vinay Ranjan, Gopal Krishna, Anant Kumar* 77032 (holotype, CAL0000033994, CAL!; isotype, CAL0000033993, CAL!).

Diagnosis: A species is morphologically allied to *Isodon lophanthoides* and its variety *graciliflorus* but distinctly differs in having obovoid flower buds, absence of long septate-villose hairs and presence of sessile glands at base of calyx, dark red corolla with white and hairy throat having reddish spots, anterior lip obovate, stamens glabrous at base, filaments dark red except

extreme tip, style dark red, nutlets yellowish, obovoid, minutely granulate. The new species is also allied to *Isodon atroruber* but differs in stem softly scabrous, leaf apex acute to acuminate, inflorescence lax and spreading, calyx 10 nerved with subacute apex, corolla dark red, white and hairy at throat with few red spots, stamens and style not exerted beyond the anterior lip of corolla.

Description: Erect or ascending annual herb, up to 1 m tall. Stems quadrangular, not branched, softly scabrous, sometimes rooting from lower nodes. Leaves opposite, well-spaced on the stem, chartaceous, ovate, 3.5–8.5 × 2.5–5.5 cm, apex acute to acuminate, base broadly cuneate, margins bluntly dentate or crenate, sparsely hairy above, dotted with minute sessile glands beneath, greenish, yellowish-brown when dry; veins prominent both sides; mid vein impressed above, raised below, glabrous; lateral veins 5–7 pairs, same as mid vein; petioles up to 3.3 cm long in mid and lower leaves, gradually reduced in length and becoming sessile to on upper leaves, scabrid. Inflorescences terminal racemose, composed of lax dichasial cymes, with axis scabrid; cymes with peduncle up to 3.5 cm long, lax with 6–8 flowers; flower buds obovoid, sessile glands present; bracts foliaceous to elliptic or oblanceolate, up to 1.3 cm long, sessile, scabrid, with sessile glands, persistent; bracteoles linear or linear-oblong, up to 0.5 mm long, scabrid, caducous or persistent; pedicels up to 1cm long in flower and fruit, scabrid, glandular at apical part. Calyx campanulate, ca. 1.5 mm long at anthesis, with sessile glands, tubular-campanulate, up to 3 mm long in fruit, inconspicuously 2-lipped; posterior lip 3-toothed, subequal, triangular ovate, ca. 0.5 mm long, subacute at apex, mid tooth smaller; anterior lip 2-toothed, equal, ovate-oblong, ca. 0.8 mm long, usually subacute at apex; tube declinate, 10-nerved, twice as long as posterior teeth,



Fig. 1. *Isodon neorensis* Ranjan, G. Krishna & Anant Kumar *sp. nov.*: A. Inflorescence axis with flowers, B. Close view of flower, C. Portion of inflorescence of *Isodon lophanthoides* (Buch.-Ham. ex D. Don) H. Hara

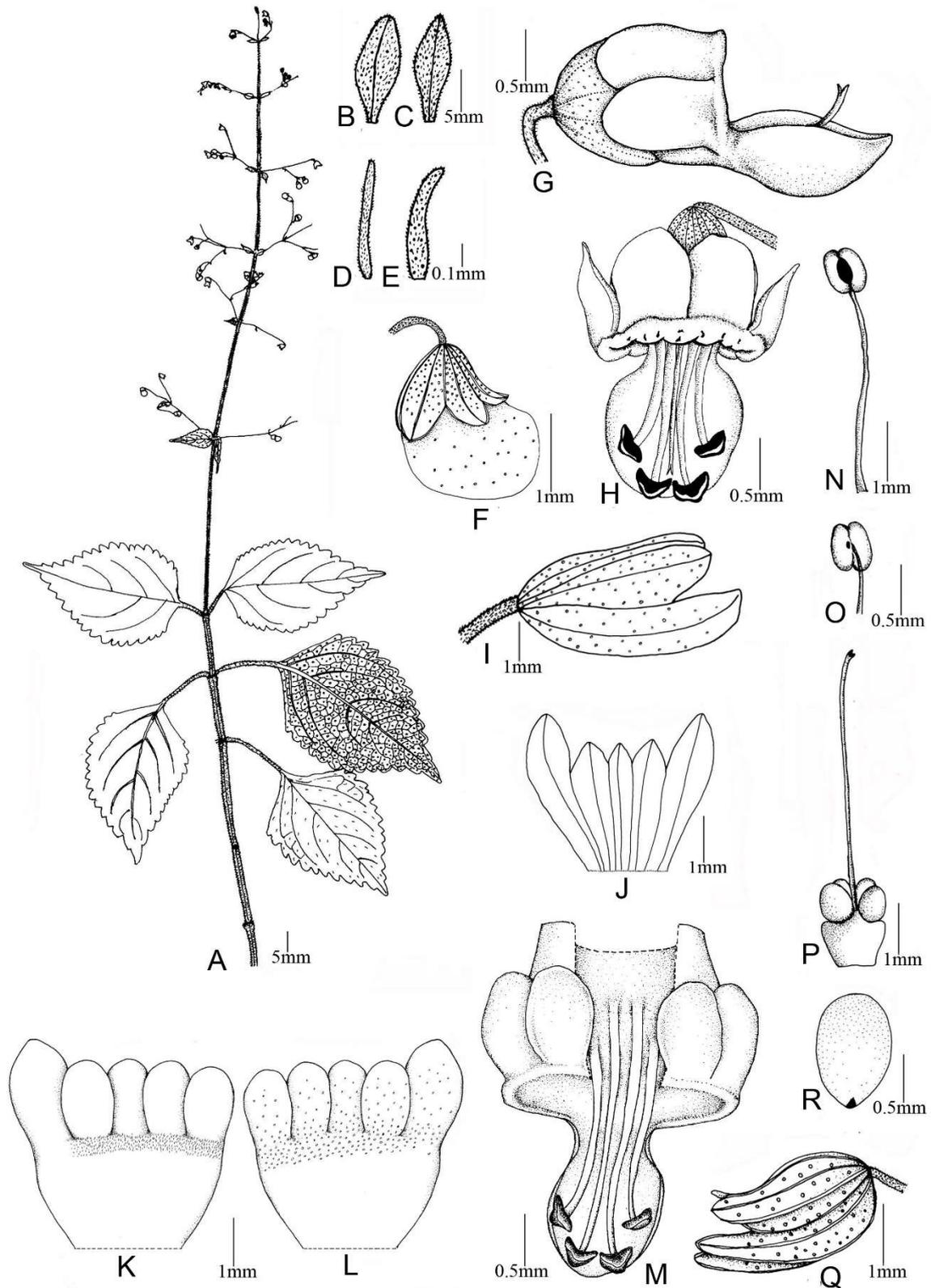


Fig. 2. *Isodon neorensis* Ranjan, G. Krishna & Anant Kumar *sp. nov.*: **A.** Habit, **B-C.** inflorescence bracts, **D-E.** bracteoles, **F.** flower bud, **G.** Lateral view of flower, **H.** Front view of flower, **I.** Calyx at anthesis, **J.** Calyx split open showing inner surface, **K.** Corolla split open showing inner surface, **L.** Corolla split open showing outer surface, **M.** Corolla showing stamens, **N.** Stamen, **O.** Ventral surface of anther showing a gland, **P.** Gynoecium with disc, **Q.** Fruiting calyx, **R.** Nutlet.

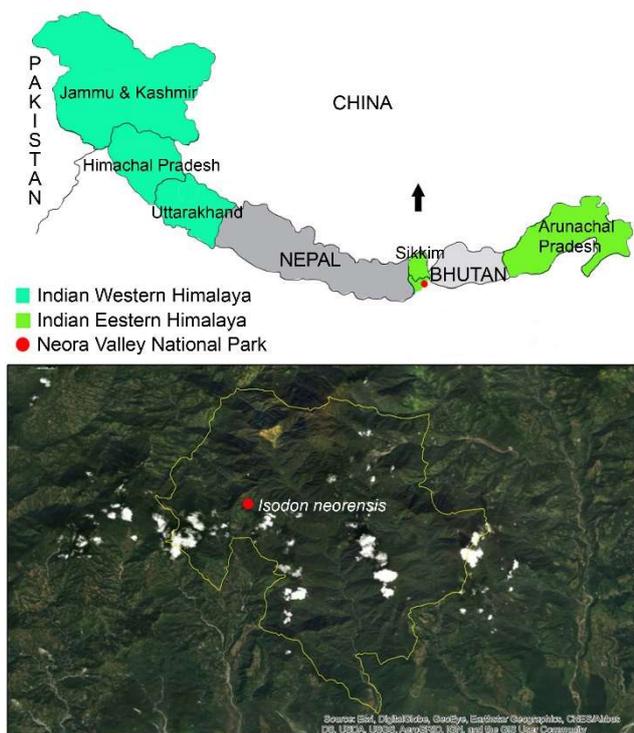


Fig. 3. Distribution map of *Isodon neorensis* Ranjan, G. Krishna & Anant Kumar sp. nov.

with sessile glands outside. Corolla dark red, white at throat with few red spots, straight, ca. 3.5 mm long; tube campanulate, ca. 2 mm long, glabrous, without sessile glands; posterior lip strongly reflexed, 4-lobed, rounded at apex, hairy inside at throat, sessile glands outside; lateral lobes elliptic-ovate, ca. 1.5 mm long; mid lobes obovate, ca. 1.5 mm long; anterior lip obovate, ca. 1.7 mm long, slightly longer to posterior, flattened or concave, sessile glands outside, otherwise glabrous. Stamens 4, didynamous, dark red in colour, exerted, glabrous at base, inserted at the middle or below the middle of corolla tube; filaments slender, 2–3 mm long; anthers black, elliptic, ca. 0.5 mm long, versatile, a dark gland like body near insertion of filament, glabrous. Style dark red in colour, slender, gynobasic, exerted, ca. 4 mm long, glabrous. Disc annular with equal lobes or with anterior side well developed but not exceeding ovary. Nutlets 4, yellowish, obovoid, 1–1.2 mm long, minutely granulate.

Distribution, habitat and Associated species: This species is presently known only from the type locality (Fig. 3). About five patches of its population with 1–2 individuals have been observed among scrub, path sides and dry hillsides area of national park at 2000–2740m elevation. But, since the locality comes under protected forest of Neora Valley National Park in Eastern Himalaya stretch and due to implementation of Convention on Biological Diversity directive in West Bengal Forest department, there is prohibition of collection more than three samples. However, we have taken geospatial data of

other population growing in the area. The species was growing in association with *Ageratina adenophora* (Spreng.) R. M. King & H. Rob.; *Begonia xanthina* Hook.; *Impatiens cathcartii* Hook. f.; *Strobilanthes multidentens* C. B. Clarke, etc.

Phenology: Flowering and fruiting: September–November.

Etymology: The epithet ‘neorensis’ refers to main river ‘Neora’ of Neora Valley National Park.

Conservation status: Collection was made inside protected forest area. Although, it has been collected from type locality only, yet it has been present in other localities of protected forest also. Habitat destruction, surge of invasive species, and clearing of forest for making path are the possible threats for this species. Apart from type locality, there are no data on the population of the species available in other states of India. Therefore, the new species is assessed here as “Data Deficient” based on the IUCN categories and criteria (IUCN, 2015).

In addition, the identification key for the 12 taxa including newly described species of *Isodon* distributed in Indian Eastern Himalaya is provided below.

Key to the species of *Isodon* in Indian Eastern Himalaya

- 1a. Leaves in whorls of 3–4, sometimes opposite at basal part *I. ternifolius*
- 1b. Leaves opposite only 2
- 2a. Nutlets triquetrous 3
- 2b. Nutlets not triquetrous 4
- 3a. Stems sparsely spreading strigose or hirsute, densely puberulous; leaves deeply or shallowly cordate at base, occasionally subtruncate, chartaceous, floccose-pilose above, whitish-villose and dotted with small, yellow glands beneath; corolla yellow with purple spots on upper lip inside, rarely reddish *I. sculponaeatus*
- 3b. Stems densely stellate-tomentose; leaves cuneate, rounded or subtruncate at base, often decurrent, rugose, densely stellate-tomentose above, grey-tomentose beneath; corolla white, tinged with purple or lilac *I. rugosus*
- 4a. Fruiting calyx 5-toothed or inconspicuously 2-lipped 5
- 4b. Fruiting calyx conspicuously 2-lipped 7
- 5a. Calyx densely septate-villose over entire surface, teeth acuminate at apex in fruiting calyx *I. hispidus*
- 5b. Calyx densely septate-villose at junction of pedicel or without, teeth obtuse at apex in fruiting calyx 6
- 6a. Flower buds clavate; calyx densely septate-villose at junction of pedicel; corolla white or rosy, with or without purple spots; stamens hairy at base; filaments and style white *I. lophanthoides*
- 6b. Flower buds obovoid; calyx not septate-villose at junction of pedicel; corolla dark red, white at throat with few red spots; stamens glabrous at base; filaments and style dark red *I. neorensis*
- 7a. Cymes loosely many-flowered, often arranged in panicles, rarely in dense verticillasters 8
- 7b. Cymes few-flowered, arranged in remote verticillasters or a terminal spike like panicles 11
- 8a. Calyx tube more than half of their length; stamens exerted *I. scrophularoides*
- 8b. Calyx tube equal or less than half of their length; stamens included .. 9
- 9a. Plant dwarf; stems creeping and ascendent at base *I. repens*
- 9b. Plant tall; stems erect, not creeping at base 10
- 10a. Leaves broadly orbicular, rarely broadly ovate, cuneate and slightly narrowed to attenuate at base, margins deeply serrate or toothed almost from middle, obtuse at apex, densely strigose at midrib and nerves on upper surface, otherwise sparsely strigose, glabrous beneath; bracts foliaceous; calyx subglabrous outside; corolla



- glabrous outside; lower lip of corolla 3–5 mm long *I. kurzii*
- 10b. Leaves ovate or ovate-elliptic, sometimes broadly elliptic to suborbicular, obtuse or shortly cuneate at base, often decurrent on petiole, margins crenate-serrate from base, occasionally dentate, acuminate at apex, rarely acute, subglabrous to pubescent on upper surface, puberulous to sparsely pilose or strigose beneath; bracts ovate or ovate-lanceolate; calyx pubescent and glandular outside; corolla pubescent outside; lower lip of corolla ca. 2.5 mm long *I. coetsa*
- 11a. Stems densely pubescent and papillose strigose; leaves ovate to broadly so, ovate-triangular, broadly cuneate-decurrent at base, crenate-serrate at margins, acute or shortly acuminate at apex, hispidulous on both sides; cymes arranged into many remote verticillasters; corolla sparsely pubescent outside; stamens subequal, included; filaments slightly winged at base; nutlets broadly ovoid to suborbicular *I. melissoides*
- 11b. Stems minutely adpressedly hairy; leaves broadly ovate, rounded at base, margins serrate from middle to above, entire towards base, acuminate at apex, sparsely hairy, glandular punctate; cymes of long slender racemes, erect; cymes arranged in terminal, spike-like panicles; corolla glabrous; stamens unequal, upper pair longer and exerted; filaments not as above; nutlets subglobose *I. assamicus*

Affinities: *Isodon neorensis* sp. nov. is very unique species and exhibits quite differences from allied species by having dark red corolla which is a very infrequent character in *Isodon* while *Isodon atroruber* R. A. Clement, having deep reddish-purple corolla as an exception. Besides, corolla colour, there are substantial differences with allied species which are compared in table 1.

The new species is differed from *Isodon lophanthoides* var. *lophanthoides* in stem being softly scabrous, leaves ovate, 3.5–8.5 × 2.5–5.5 cm, apex acute to acuminate, sparsely hairy above, greenish, yellowish-brown when dry, petioles up to 3.3 cm long, peduncle up to 3.5 cm long, bracts elliptic or oblanceolate, bracteoles up to 0.5 mm long, scabrid, corolla dark red, white and hairy at throat with few red spots, filaments dark red in colour, nutlets yellowish, obovoid.

The new species is differed from *Isodon lophanthoides* var. *graciliflorus* (Benth.) H. Hara, from its larger size (undershrub), glabrous to pubescent stems, leaves broadly ovate, ovate-oblong to ovate-lanceolate, (2.5–) 4–17 × (1.5–) 3–8 cm, attenuate at base, scaberulous or scabrid above and vary from green to yellowish-brown beneath when dry and disjunct distribution range within India.

The new species is differed from *Isodon atroruber* in stem being softly scabrous, leaves 3.5–8.5 × 2.5–5.5 cm, apex acute to acuminate, sparsely hairy above, greenish, yellowish-brown when dry, petioles up to 3.3 cm long, inflorescence lax and spreading, peduncle up to 3.5 cm long, bracts elliptic or oblanceolate, bracteoles up to 0.5 mm long, calyx 10 veined and lobes subacute, corolla dark red, white and hairy at throat with few red spots, corolla tube ca. 1 mm long, stamens and style not exerted beyond the anterior lip of corolla, nutlets yellowish, obovoid.

Additional specimens examined:

Isodon lophanthoides (Buch.-Ham. ex D. Don) H. Hara: **INDIA**, Arunachal Pradesh, Subansari FD (NEFA), Palin to Nyapin, 16 November 1964, Sastry 40670; Siang FD (NEFA), Geling, 08 November 1958, Rao 17449 (CAL); Upper Siang District, Jido, 02

October 2005, Choudhary 16675 (ARUN); **Himachal Pradesh**, Dalhousie, 6000ft, 22 September 1874, Clarke 22926; Dalhousie, 7000ft, 11 September 1874, Clarke 22161 (CAL); **Maharashtra**, Concan, s.d., Stocks s.n. (K001067867!); Concan, s.d., Stocks s.n. (K001067866!); **Meghalaya**, Shillong, Nongthmai Road, 08 November 1956, Panigrahi 3770; Sohra, 5000ft, 15 October 1872, Clarke 17559C (CAL); **Mizoram**, Aijal, Lushai hills, 20 October 1953, Godfrey 499 (CAL); **Sikkim**, Mungpoo, 3000ft, 03 October 1908, Smith 375; Labdah, 2000ft, 20 October 1908, Smith 606 (CAL); Gadi Central Pandam, 20 September 2016, Pradhan 39654 (BSHC); **Uttarakhand**, Almora, Dwarahat, 4500ft, 07 October 1912, Hooper 38943; Western Himalaya, Kumaon, 10 August 1900, Inayat 24883; Garhwal, 1300m, 22 September 1958, Rau 6482 (CAL); Kumaon, 1829, Wallich 2742B (Neotype, K001067858!); NW Himalaya, Simla, 8000ft, October 1907, Meebold 4907 (CAL); **West Bengal**, Darjeeling, Rishap, 4000ft, 05 November 1870, Clarke 13590C, 13590D; Darjeeling, Singalila NP, 13 October 2003, Debta 33201 (CAL); Darjeeling, Phullolong, 8000ft, 05 October 1870, Clarke 12678A (K001067864!); East Bengal, s.d., Griffith 3954/I (P007207851, P00720786!); L.c., s.d., 1869, Falconer 13 (P00720787!); **CHINA**, Loh Ch'ang District, Chong Uen Shan near Kau Fung, 2ft, 02 November 1932, Tsang 20657 (P00720783!); **MYANMAR**, Maquinjo, 3600ft, 28 November 1909, Luce 5006 (E00910095!); **INDO-CHINA**, Siamenses, 15 January 1905, Hosseus 326 (E00036604!); Siamenses, 15 January 1905, Hosseus 326 (BM000503469!); **NEPAL** (Napal), 1821, Wallich cat. No. 2742a (BM000950308!).

Isodon lophanthoides var. *graciliflorus* (Benth.) H. Hara: **INDIA**, Assam, Notrong forest, 5000ft, 28 October 1938, Biswas 4171 (CAL); **Himachal Pradesh**, Dalhousie, 7000ft, 13 September 1874, Clarke 22245 (CAL); **Nagaland**, Kohima, Naga hills, 1886, Prain s.n., acc. no. 352764 (CAL); **Meghalaya**, Khasia, Sohra, 5000ft, 16 October 1872, Clarke 17557C; Khasia, Sohra, 4000ft, 22 October 1871, Clarke 15709; Khasia, Sohra, 4000ft, 12 October 1872, Clarke 17455E (CAL); Khasia, s.d., Griffith & Lemann 214 (K001067857!); Khasia, 4-5000ft, 01 November 1850, Hooker & Thomson s.n. (K001067860!); Khasia, 5-6000ft, 01 November 1850, Hooker & Thomson s.n. (K001067863!); **Sikkim**, Selim, 2500ft, 18 October 1884, Clarke 36826D; Rishu, 3500ft, 04 October 1875, Clarke 24973; Youmtham, 1901, Prain's collector 363; Siltong, 5300ft, 19 October 1908, Smith 568; Lachung valley, 7000ft, 14 September 1892, Gammie 1189; Yoksum, 05 October 1862, Anderson 1079 (CAL); **West Bengal**, Khursiong, 3500ft, 25 September 1884, Clarke 35844B (BM000950311!); Darjeeling, 7300ft, 27 September 1875, Clarke 24833A (CAL).

Isodon atroruber R.A. Clement: **BHUTAN**, Thimpu District, Dotena, Thimpu Chu, 27° 35' N, 89° 38' E, 2550m, 05 September 1984, Ian W.J. Sinclair & David G. Long 4843 (E00273726!).

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