

Notes on two lesser known *Codonopsis* (Campanulaceae) from eastern Himalaya, India

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Abstract: Two lesser known species of *Codonopsis* Wall. (Campanulaceae), viz. *C. benthamii* Hook.f. & Thomson and *C. subsimplex* Hook.f. & Thomson were collected after a lapse of more than a century from Sikkim Himalaya, India. The authors evaluated the phenology of the above species in the last hundred years which shows a significance alteration. In this paper, information about the taxonomy, habitat, distribution and phenology are discussed along with photographic images.

Keywords: *Codonopsis benthamii*, *C. subsimplex*, Phenology, Rediscovery, Sikkim, Taxonomy.

Introduction

The genus *Codonopsis* Wall. (Campanulaceae) is widely distributed in temperate to alpine region of Asia and Europe and includes about 64 species (Hong, 2015b). The genus includes perennial erect herbs or herbaceous twiners characterized by solitary and large campanulate flowers, generally with a peculiar foul odour (Haridasan & Mukherjee, 1996; Hong, 2015a; Mabberley, 2017). Clarke (1881) reported 10 species of *Codonopsis* from the then British India under two sections: *Campanumoea* Blume and *Cyclocodon* Griff. Recent field studies in Himalayas (Dash, 2018), revealed the occurrence of 15 species in India, of which *C. ovata* Benth., *C. clematidea* (Schrenk) C.B. Clarke and *C. rotundifolia* Benth. show an extended distribution in Western Himalaya, while the rest 12 species are restricted to eastern Himalaya.

During field explorations in the East district of Sikkim, two species of *Codonopsis* were came across in Kyongnosla Alpine Sanctuary. After consulting the relevant literature (Hooker & Thomson, 1858; Clarke, 1881; Komarov, 1908; Hong *et al.*, 2011; Hong, 2015a), type specimens, protologue and other specimens housed in different herbaria (A, ARUN, ASSAM, BSHC, CAL, DD, E, GH, K, LWG, PE), they were identified as *C. benthamii* Hook.f. & Thomson and *C. subsimplex* Hook.f. & Thomson. *C. benthamii* is rediscovered after 110 years while *C. subsimplex* after a gap of 50 years after their last collection in India.

Material and Methods

Flowering specimens were collected from Kyongnosla Alpine Sanctuary (East district, Sikkim, India) and voucher specimens were prepared as per standard procedure (Jain & Rao, 1977). Photographs were taken in field with a Sony HX 400V camera. The micromorphological characters of flowers were studied using stereo-zoom microscope (Olympus SZ61, Japan). Detailed description was based on field observations and herbarium specimens (A, ARUN, ASSAM, BSHC, CAL, DD, E, GH, K and LWG; acronyms as per Thiers, 2020 continuously updated). To evaluate the change in flowering time of these two species in the last hundred years, Primack *et al.* (2004) was followed.

Taxonomic treatment

Codonopsis benthamii Hook.f. & Thomson, J. Proc. Linn. Soc., Bot. 2: 14. 1857. *Lectotype*

(designated by Hong, 2010): INDIA, **Sikkim**, Lachen, 2740 m, 31.07.1849, *J.D. Hooker s.n.* (K [K000814213 digital image!]). **Fig. 1**

Erect foetid herbs. Stems 18–90 cm long, ascending, scandent, branched, sparsely hairy. Leaves alternate or nearly opposite; petioles 6–35 mm long, sparsely villous; lamina broadly ovate or ovate-lanceolate, 3–8 × 1.5–5.5 cm, acute or acuminate at apex, cuneate at base, irregularly lobed along the margins, crenate, deep green and sparsely puberulous adaxially, pale green and densely hirsute abaxially, with a prominent midrib, 4–5-nerved. Flowers solitary, terminal; pedicels 3.5–5 cm long, villous. Calyx tube obconic, 14–20 mm long, adnate to half of the hypanthium, 10-ribbed; lobes ovate, 10–13 × 4–7 mm, acute at apex, glabrous, rarely sparsely hispidulous, denticulate towards apex, ciliate. Corolla tubular, narrowly campanulate, somewhat constricted in the middle, 17–30 × 13–20 mm, yellow-green with dull purplish veins, glabrous outside, brown spotted inside; lobes five, triangular, 2.5–4 mm long, acute at apex. Stamens 5; filaments 5–9 mm long, wholly villous and narrowly dilated at base; anthers dorsally setose, 4.5–5.5 mm long, monotheical, dorsifixed. Ovary semi-inferior; style c. 7 mm long, densely ciliate; stigma 3-lobed, creamy white, recurved, glabrous. Capsules globose, with persistent calyx.

Flowering & fruiting: Flowering and fruiting from July to September.

Habitat: It grows in the alpine scrub forest, on soil surface, usually associated with *Cynoglossum wallichii* G. Don (Boraginaceae), *Gypsophila cerastoides* D. Don (Caryophyllaceae), *Meconopsis paniculata* (D. Don) Prain (Papaveraceae), *Strobilanthes wallichii* Nees (Acanthaceae), etc.

Distribution: India, Bhutan, China, N. Myanmar and Nepal.

Specimens examined: INDIA, **Sikkim**, East district, Kyongnosla Alpine Sanctuary, N 27° 22' 30.69", E 88° 43' 28.35", 3336 m, 03.07.2018, *S. Lahiri & S.S. Dash* 86684; *s.loc.*, 2740–3350 m, 1861, *J.D. Hooker s.n.*; Yakla, 3050 m, 20.10.1869, *C.B. Clarke*

10224; *Ibid.*, 15.10.1869, *C.B. Clarke* 9879; Gangtok, 09.08.1877, *G. King* 4439; *Ibid.*, 08.08.1877, *G. King's Collector* 4440; Chola Range–Nathu La, 4270, 29.09.1892, *G.A. Gammie* 1322; Lachen, 2440 m, Sept–October 1909, *Ribu & Rhomoo* 3016; Selu Valley, 3050 m, 03.09.1892, *G.A. Gammie s.n.* (CAL).

Notes: *Codonopsis benthamii* closely resembles *C. tubulosa* Kom. and *C. vadsea* S.S. Dash & A.A. Mao, but differentiated by its foetid smell and larger leaves (Dash & Mao, 2011). Lidén and Adhikari (2019) mentioned the occurrence of *C. benthamii* from east of Anini in Upper Dibang valley of Arunachal Pradesh, but without giving any collection details.

Codonopsis subsimplex Hook.f. & Thomson, *J. Proc. Linn. Soc., Bot.* 2: 16. 1857. *Lectotype* (designated by Hong, 2010): INDIA, **Sikkim**, Lachen, 4270 m, 15.07.1849, *J.D. Hooker s.n.* (K [K000814205 digital image!]). **Fig. 2**

Erect foetid herbs. Stems 16–40 cm long, ascending, almost glabrous or sparsely white-villous, red. Leaves alternate or almost opposite on branches; petioles 0.4–4.2 cm long, glabrous or sparsely white villous; lamina broadly ovate, 2.5–10 × 2–5 cm, acute or slightly obtuse at apex, cuneate or rounded at base, crenate or dentate along margin, deep green and hispidulous adaxially, pale green and hispidulous abaxially, midrib prominent, hirsute along veins. Cymes terminal, 2–4-flowered; pedicels 3.5–5 cm long, villous. Calyx tube adnate to whole hypanthium; lobes ovate, almost as long as corolla, 12–15 × 5.5–8 mm, hirsute abaxially, margin denticulate, ciliate, acute at apex. Corolla campanulate, 10–22 × 11–18 mm, inflated at base and narrowed from middle, slightly revolute at apex, greenish-yellow, glabrous and lustrous outside; lobes ovate-deltoid, 2–3 mm long, obtuse at apex. Stamens 5; filaments 3–4.5 mm long, glabrous, slightly dilated at base; anthers 5–6 mm long, linear-oblong, glabrous, yellow. Ovary semi-inferior; style erect, c. 6 mm long, sparsely ciliate; stigma lobe ovoid, recurved. Capsules obovoid, gradually narrowed towards base, with persistent calyx.

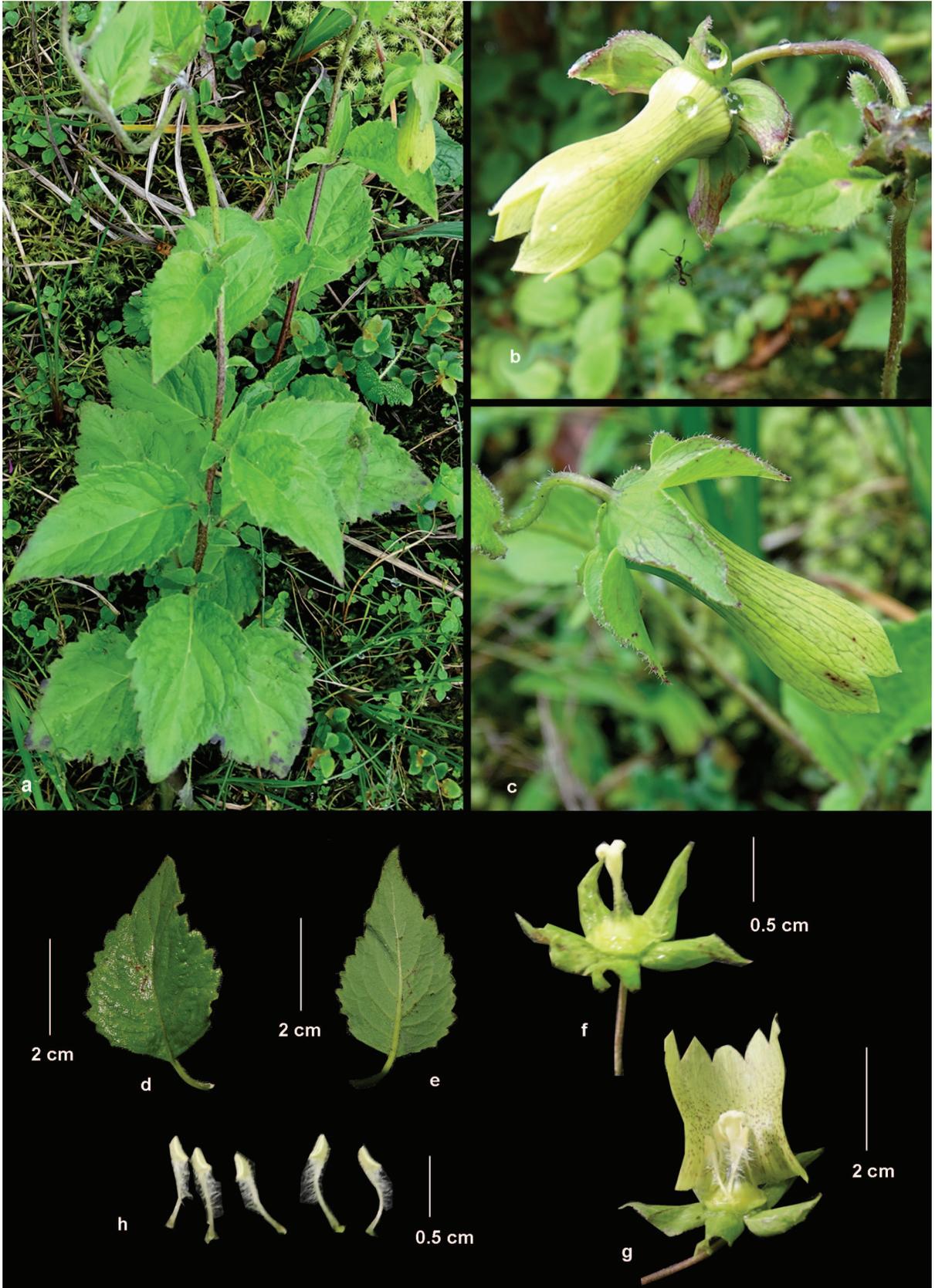


Fig. 1. *Codonopsis benthamii* Hook.f. & Thomson: **a.** Habitat; **b** & **c.** Flowering twig; **d.** Leaves—adaxial surface; **e.** Leaves—abaxial surface; **f.** Gynoecium with calyx; **g.** Corolla—split open; **h.** Stamens (from *S. Lahiri & S.S. Dash* 86684; photos by Subhojit Lahiri).

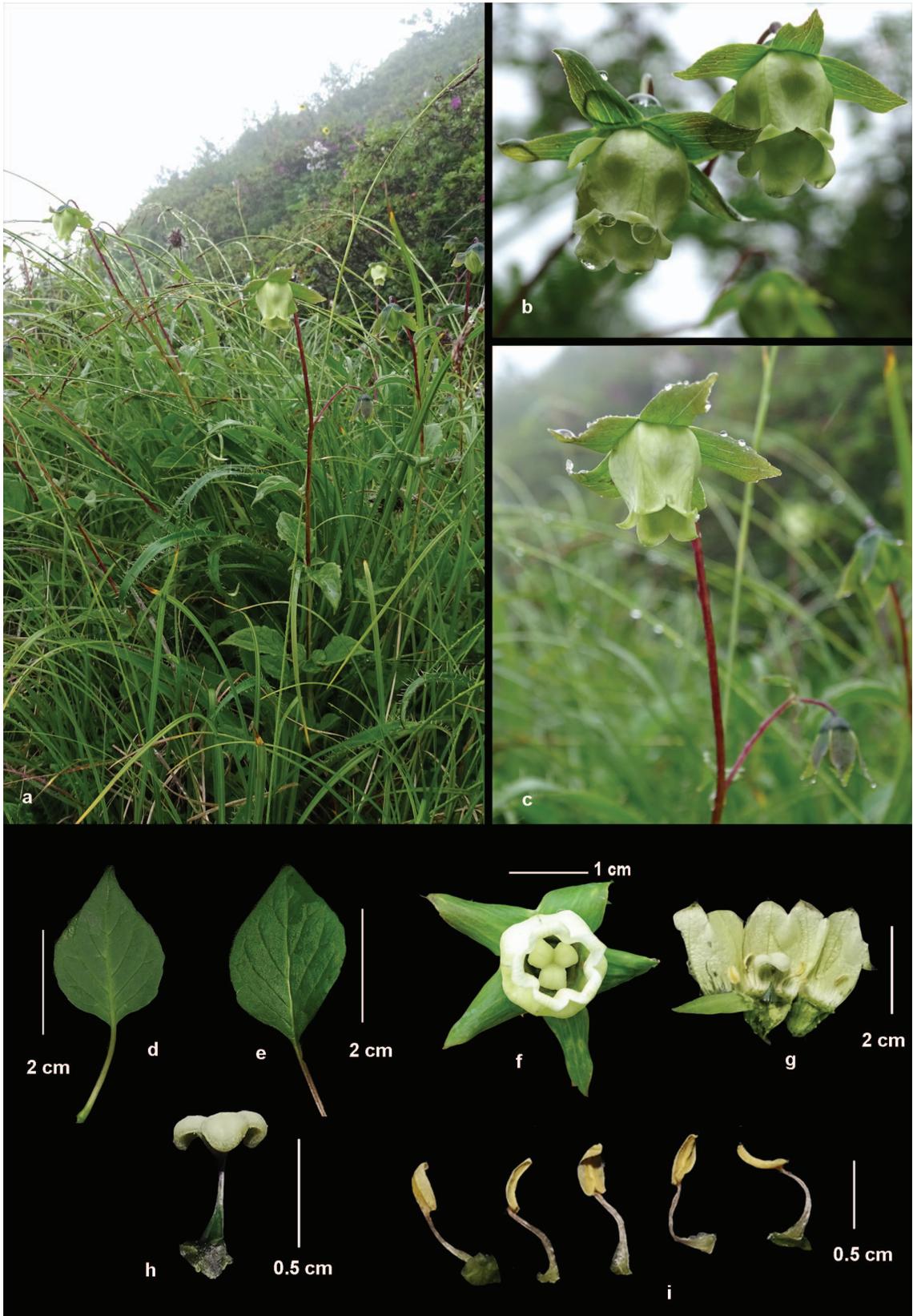


Fig. 2. *Codonopsis subsimplex* Hook.f. & Thomson: **a.** Habitat; **b & c.** Flowering twig; **d.** Leaves—abaxial surface; **e.** Leaves—adaxial surface; **f.** Flower—front view; **g.** Corolla (spilt open); **h.** Gynoecium; **i.** Stamens (from *S. Lahiri* & *S.S. Dash* 85743; photos by Subhojit Lahiri).

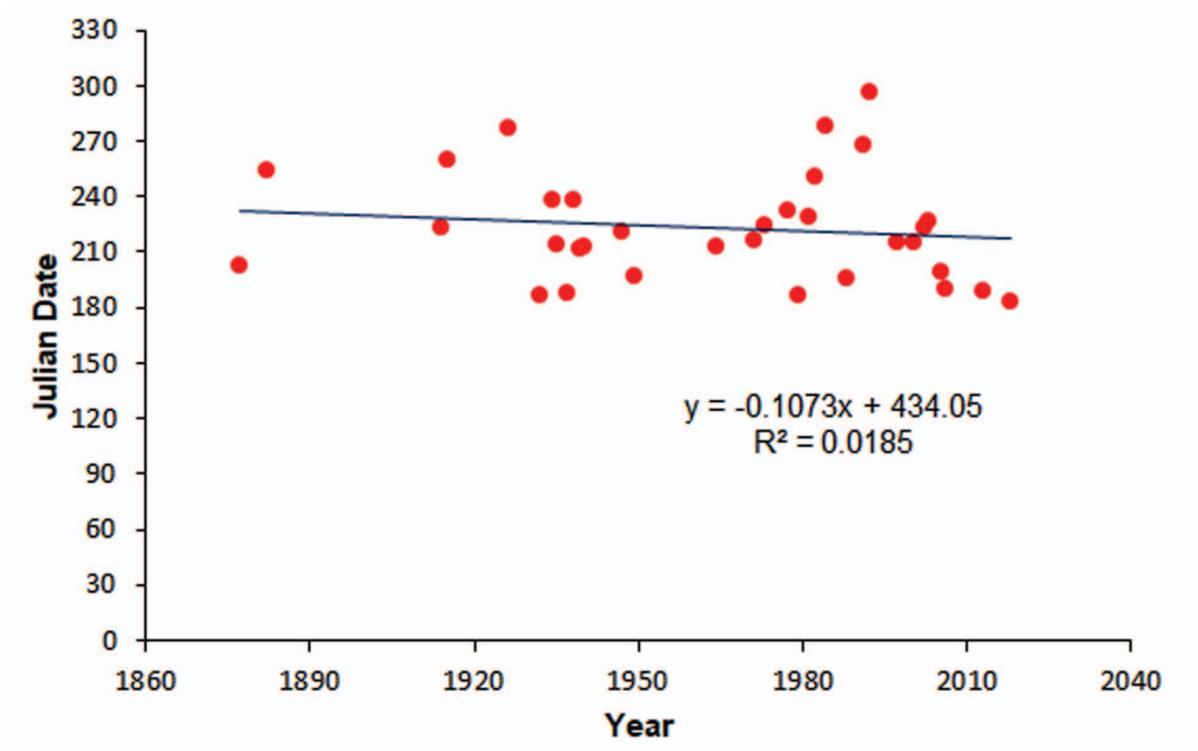


Fig. 3. Flowering phenology time of *Codonopsis benthamii* Hook.f. & Thomson over 100 years (Smoothed best fit line with 95% confidence interval).

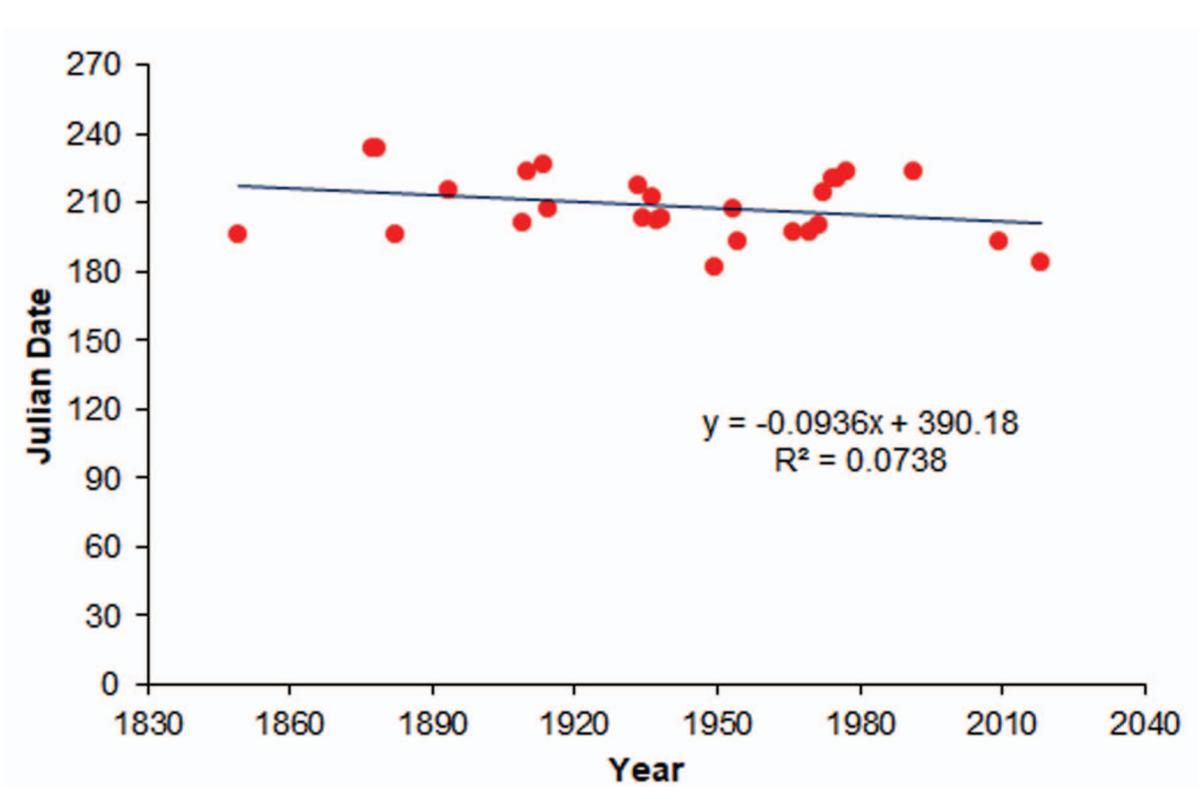


Fig. 4. Flowering phenology time of *Codonopsis subsimplex* Hook.f. & Thomson over 100 year (Smoothed best fit line with 95% confidence interval).

Flowering & fruiting: Flowering and fruiting from July to September.

Habitat: It grows in the alpine scrub forest, in association with *Corydalis juncea* Wall. (Fumariaceae), *Ligularia amplexicaulis* DC. (Asteraceae), *Gentiana stylophora* C.B. Clarke (Gentianaceae), *Morina nepalensis* D. Don (Dipsacaceae), *Rhododendron setosum* D. Don (Ericaceae), etc.

Distribution: Bhutan, China, North India and Nepal.

Specimens examined: INDIA, Sikkim, East district, Kyangnosla Alpine Sanctuary, N 27°23'37.59", E 88°45'23.19", 3965 m, 03.07.2018, S. Lahiri & S.S. Dash 85743; *Ibid.*, 3350 m, 07.10.1870, C.B. Clarke 12542; *Ibid.*, 3350 m, 08.10.1870, C.B. Clarke 13450; *s.loc.*, 4750 m, 04.08.1893, Cummins *s.n.*; *Ibid.*, 08.12.1903, Prain's Collector 267; Sherabthang, 3960 m, 13.08.1910, W.W. Smith 4298; *s.loc.*, 12.08.1910, W.W. Smith 4250; Zemu Valley, 3960 m, 20.07.1909, W.W. Smith & G.H. Cave 1653 (CAL).

Notes: *Codonopsis subsimplex* is close to *C. gongshanica* Q. Wang & D.Y. Hong but differentiated by much smaller leaf, shorter petiole and with a solitary flower, smaller calyx lobes and pale purple corolla which has dark purple ring just below the throat.

Observation on phenology

Alteration of flowering time is considered the most sensitive indicator in the herbaceous species (Tilman & Haddi, 1992; Walker *et al.*, 1999) and has the potential to predict the effects of patterns of climatic change (Kittel, 1998; Parmesan & Yohe, 2003; Root *et al.*, 2003) of a region. The authors have attempted to infer the change in flowering time of *C. subsimplex* and *C. benthamii* over a period of 100 years by analysing the herbarium specimen data of the last century collected from alpine regions with the recent field observations and collections. On comparison with current flowering dates with herbarium information (1849–2018), simple linear regression analysis of predicted and observed values of flowering time revealed significant deviation in

these two species (Figs. 3 & 4) during the last 100 years. In both of the species Julian dates of the collected material showed negative correlation with years. The value for correlation coefficient for *C. benthamii* and *C. subsimplex* is $r = 0.13$ and $r = 0.27$, respectively, which indicates a significantly negative correlation between the year and days of flowering at the level $P < 0.05$. The scrutiny of herbarium data shows the mean flowering period of *C. benthamii* is advanced by 43.05 ± 4.31 days while the mean flowering period of *C. subsimplex* is advanced by 25.78 ± 2.91 days from its usual time of flowering of late July to August. The early flowering of *C. benthamii* and *C. subsimplex* may be attributed to the change in temperature in last 100 years and can be considered as indicator of climate change.

Acknowledgements

Authors are thankful to Director, Botanical Survey of India, Kolkata for facility; Department of Forest, Government of Sikkim for giving permission and logistic support and The Ministry of Environment, Forest & Climate Change (MoEF & CC), New Delhi for the financial Assistance (Project no. NMHS/2015-16/LG-05) under "National Mission on Himalayan Studies" (NMHS) Scheme.

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