



Short communication

Floral phenology of *Centella asiatica* (L.) Urban: a predominantly autogamous taxon of Apiaceae

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Centella asiatica (L.) Urban (Family: Apiaceae) is a small, perennial creeping herb that flourishes in wet and moist areas on sandy or clayey soil forming large clumps (Hashim 2011) or as a weed in crop fields and other waste places (Jamil *et al.* 2007). It propagates both vegetatively by runners and sexually by seed.

The herb is known to have immense medicinal potential mainly as a memory enhancer. The plant was earlier confused with *Bacopa monniera* wettst. as both were sold under same trade name *i.e.* »Brahmi' in India. However "Department of Indian system of medicine and Homeopathy" has recommended 'Brahmi' for *B.monnieri* and 'Mandookaparni' for *C. asiatica* (Kasture *et al.* 2014).

Plants of *Centella asiatica* are slender creepers (Fig. 1a) characterized by constantly growing roots and runners with wide spaced internodes, which are on an average 3.8 ± 1.3 (2.5-4.7) cm long. Flowers are aggregated in umbels (Fig. 1b), which are borne on nodes with each node bearing on an average 2.8 ± 0.41 (0-6) inflorescences (n=30). The flower of *C. asiatica* is sessile or shortly pedicillate, ebracteate, hermaphrodite, actinomorphic and pentamerous. Each flower is pinkish in colour measuring 3.53 ± 0.13 (3-4) \times 2.10 ± 0.43 (2-2.5) mm² in size (Fig. 1d). Sepals are absent. Petals are five in number, pink and ovate to acute in shape measuring 1.31 ± 0.43 (1.16-1.93) \times 1.01 ± 0.43 (0.83-1.2) mm². Five stamens are present each with pink to reddish anther and greenish filament, 0.78 ± 0.02 mm long. Anthers are dorsifixed and ditheous, introse and open longitudinally by a narrow slit. Gynoecium is bicarpellary, syncarpous with inferior, bilocular ovary. The ovary is swollen and pinkish measuring 2.2 ± 0.51 mm in length. It remains covered with minute brown hairs. Surmounting the ovary is present greenish stylopodium showing bulbous base of style. It harbors a nectary. Two styles are present each terminating in non-papillate and wet stigma at maturity.

Floral biology of the species was followed for two consecutive years *i.e.*, 2015 and 2016. In 2015, flowering got initiated in second week of April at a time when maximum and minimum temperature of the area averaged 34.2°C and 14.3°C respectively with maximum and minimum relative humidity of 43.4% and 28.0% respectively.

As observed in both these years, the central flower of an inflorescence is first to open, at this time the peripheral flowers of the same inflorescence are still in bud condition (Fig. 1c). When the flower opens, stamens and petals gets unfold. This unfolding of stamens leads to anther dehiscence; it continues for the whole day and is completed on the next day of flower opening. The anthers are in introse condition when stamens are flexed. Dehiscence of anthers is asynchronous. The staminate phase lasts for two days of anthesis. Nectar appears on the surface of stylopodium at this time, showing peak secretion when all the anthers are dehiscing. On the third day of anthesis, the stamens and petals are shed.

There is an overlap between the staminate and pistillate phase at the level of flower. At the start of anthesis, the two stigmatic lobes are closely appressed to each other; they appear dry and without any exudates on their surface. As the anther dehiscence continues, the stigma turns receptive. Stigma receptivity is marked by divergence of two lobes away from each other. Also, the two lobes show increase in length and become V-shaped at the time of peak receptivity (Fig. 1e). It happens on the first day of anthesis itself, at a time when third (3⁺) and/or fourth (4⁺) anther of flower has initiated dehiscence (11:30-12:30 pm noon). Stigma shows an average pollen load of 27.93 ± 5.8 (0-77) {n=25} on its surface at this time with 40% germination. The stigma receptivity increases progressively as the anther dehiscence approaches toward completion (Fig. 1e); peak receptivity is attained on the second day of anthesis between 12:00pm to 3:30 pm. This phase

Table 1- Temperature and relative humidity during the months of bloom.

S.No	Month	Temperature (C)		Relative humidity (%)	
		Minimum	Maximum	Minimum	Maximum
1.	April (2015)	14.3	34.2	28.0	43.4
2.	May(2015)	19.1	40.0	32.9	46.9
3.	June (2015)	23.7	45.6	39.5	43.4
4.	March (2016)	14.4	26.6	52.5	67.7

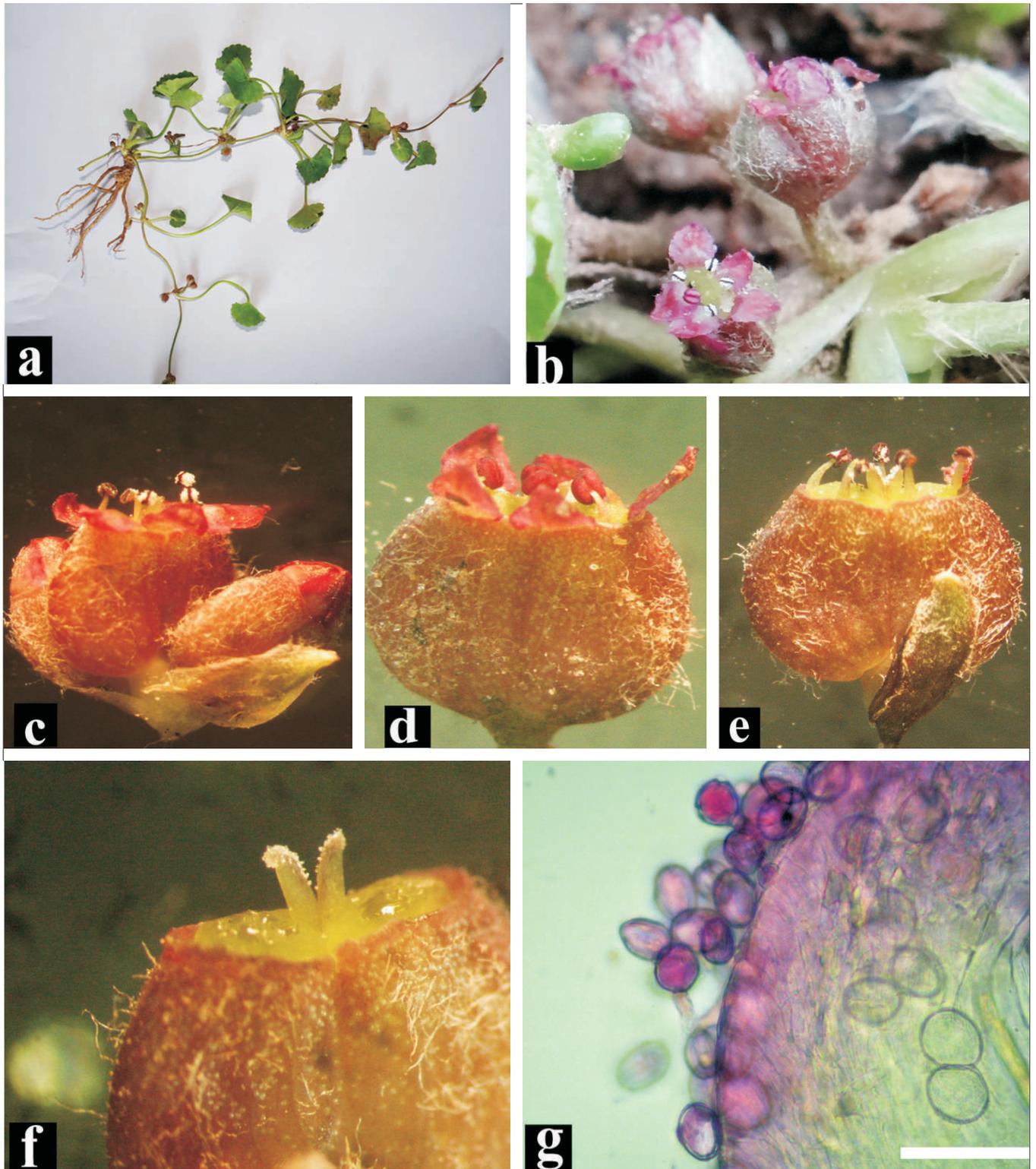


Fig. 1- *Centella asiatica* (L.) Urban. a. creeper $\times 1.5$; b. Umbels $\times 4.6$; c. An umbel with opened central flower $\times 11.9$; d. Single flower $\times 16.2$; e. Flower with dehiscent anthers $\times 14.4$; f. Stigma at peak receptivity with stylopodium secreting nectar $\times 30.9$; g. Germinating pollen on stigmatic surface Bar = $50\mu\text{m}$.

Table 4- Floral-phenological events

Day	Flower	Phenological event
1	Central Flower	Central flower opens between 8:00 am and 8:30 am. Anther dehiscence initiates between 9:30-10:30am. Stigma shows average pollen load of 27.93 ± 5.8 (0-77). The stylopodium secretes nectar.
	Lateral Flower A	Closed
	Lateral Flower B	Closed
2	Central Flower	Dehiscence continues and remaining anthers of flower also dehisce. Stigma of same flower is clogged with average of 46.39 ± 4.69 (22-130) pollen grains.
	Lateral Flower A	Closed
	Lateral Flower B	Closed
3	Central Flower	Anthers and petals start shedding.
	Lateral Flower A	Anthesis occurs and anthers start dehiscing. Pollen load is observed.
	Lateral Flower B	Closed
4	Central Flower	Petals and anthers are shed completely.
	Lateral Flower A	Dehiscence continues and pollen grains start germinating. More exudates appear on stigma and nectar is produced by stylopodium.
	Lateral Flower B	Closed
5	Central Flower	Stigma turns pinkish and shrivelled. No pollen load.
	Lateral Flower A	Petal and stamens start shedding off.
	Lateral Flower B	Anthesis occurs and anther dehiscence starts.
6	Central Flower	Swelling of ovary takes place.
	Lateral Flower A	Petals and stamens shed completely.
	Lateral Flower B	Anther dehiscence continues.

shows overlap with completion of staminate phase (complete dehiscence of all anthers of same flower). The stigma turns translucent and starts secreting exudates as it turns receptive. The stylopodium continues to secrete nectar during whole of this phase (Fig.1f). The stigma remains in this phase till the next day (3rd day of anthesis) during which time the petals and anthers are completely shed. Pollen load on stigma at this time averages 46.39 ± 4.69 (22-130) with average germination of 45.6% (Fig.1g). On the fourth (4th) or fifth (5th) day of flower opening, receptivity of stigma ends and it dries up. It turns pinkish and shrivelled.

On the third day of anthesis of central flower, one of the lateral flowers opens and repeats the above cycle. On day fifth (5th) of anthesis of central flower, second lateral flower of inflorescence also opens up. Thus, when the central flower of inflorescence is in pistillate phase, the surrounding flowers of

same inflorescence either enter in staminate phase or remain closed. An inflorescence takes five (5) days to complete its anthesis.

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