

## Stylar movement avoids self-pollination and promotes cross-pollination in *Eremurus himalaicus*

The advantages of selfing notwithstanding, only 20–25% plant taxa are predominantly selfed<sup>1</sup>. Majority practice outcrossing with the help of various contrivances they have evolved during the evolutionary history<sup>2–6</sup>. Avoidance of self pollen by the stigma is a known strategy which gets expressed as dichogamy, herkogamy<sup>7,8</sup>, etc. Stylar movement as means to avoid self-pollination is little known.

The authors observed this mechanism in *Eremurus himalaicus* Baker (Liliaceae) a bulbous angiosperm of family Liliaceae, whose foliage and young scapes are used as vegetable in the hills. This threatened temperate plant is distributed in dry, cold regions of Central Asia, Afghanistan and Pakistan<sup>9</sup>. In India, the species grows

from Kashmir to Himachal Pradesh at an altitude of 3700 m. On account of its excessive exploitation for edible foliage, the

species is living under stress<sup>10</sup> and has therefore been listed in the *Red Data Book of Indian Plants* as a 'rare' species<sup>11</sup>.



**Figure 1.** A dense raceme of *E. himalaicus* bearing creamish-white flowers.



**Figure 2 a–g.** Flowers of *E. himalaicus* showing different stylar curvatures: Just opened flower with stamens and pistil clustered together (a); curvatures of style after 2, 4 (b, c), 6 (d), 8 (e), 12 (f) and 24 h of anthesis (g) and diagrammatic representations thereof (2 a–g).

The plant is herbaceous with perennial rootstock, long leaves and creamish flowers held in long, dense racemes which resemble the tail of a fox and therefore the common English name, fox-tail lily (Figure 1). The number of racemes per plant varies between 1 and 10 ( $4.4 \pm 2.9$ ) and the number of flowers per raceme varies between 127 and 1889 ( $397.8 \pm 268.3$ ). The flower has six tepals held in two whorls of three each. Male reproductive apparatus comprises six free stamens, three each with long and short filaments. The monocarpellary pistil consists of trilocular ovary and a long style that terminates into wet, papillate stigma.

In Srinagar (Kashmir), the species commences flowering in mid-April when the day temperature fluctuates between 20 and 25°C. In a raceme the flowers bloom acropetally starting at 0630–0700 h and continue throughout the day till 2000 h. However, the maximum number of flowers open between 0800 and 1000 h. Anthesis of an individual flower is completed within half-an-hour; the entire raceme takes 11–20 days to bloom fully.

Anther dehiscence, which is synchronous in all six stamens, starts immediately after anthesis. An anther takes 2–5 h to empty its contents. With the opening of the flowers, a large number of bees (*Apis indica*) start visiting them to forage pollen, which they collect quickly.

The stigma turns receptive 24 h after anthesis. As such the flowers are protandrous. Soon after anthesis, the style undergoes several curvatures (Figure 2 a–g). As

the flower opens, the style appears weak and fragile and is surrounded by six stamens (Figure 2 a). Within 2–4 h of anthesis, it bends making an angle of 45° (Figure 2 b and c) and within 6–8 h it makes a right angle with the ovary (Figure 2 d). It continues to bend further for another 3–4 h (Figure 2 e). Finally, after 12 h, it curves back, becomes upright and makes an angle of 180° with the ovary (Figure 2 g). As a consequence, the stigma moves away from the dehiscing anthers. By so doing, it avoids receiving any leftover self pollen. The structurally unspecialized flowers of the fox-tail lily avoid selfing through protandry and stylar movements, whereby the stigma gets pushed out of the way of the dehiscing anthers.

This dual strategy keeps the stigma safe from any self-pollen intrusion. The species is self-compatible, but selfing is avoided by protandry and stylar movement. Manual self-pollination results in fruit and seed set, but the yield is drastically reduced, i.e. 2% against 12% in manual crossing ( $t_{0.001[9]} = 25.32$ ; highly significant). Protandry and stylar movement which promote cross-pollination are used by the species to maximize the reward of sexual reproduction.

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