Inflorescence architecture and staminal movement as contrivance measures in reproductive assurance and survival of *Valeriana jatamansi* Jones (=*Valeriana wallichii* DC)

Dramatic movements of floral structures, including the pistil (style), stamen (filament, anther) and corolla have been observed in many angiosperms to affect successful pollination and mating. Various hypotheses have been proposed to explain the adaptive significance of floral movements. These include reduction in intrafloral male–female interference[1–4], avoidance of self-pollination and promotion of outcrossing[5–7], delayed autonomous pollination[8–10] and tolerance of harsh environments[11,12]. Floral movements have previously been viewed as a mechanism to avoid self-pollination[13], but increasing evidence[4,14] suggests that it may also act as a mechanism to reduce interference between the reproductive functions of female and male organs. However, it is difficult to distinguish the reduction in intrafloral male–female interference from the avoidance of self-pollination. Additional studies also corroborate that floral movements have more than one adaptive significance[15,16].

Valeriana jatamansi Jones (= *Valeriana wallichii* DC) is a perennial herb with a terminal flat-topped cluster of small, white or pink-tinged flowers borne on erect, nearly leafless stem, belonging to the family Valerianaceae, now in Caprifoliacae[17]. The species was found sporadically distributed in the mountain ranges of Kashmir Himalaya, confined to sub-temperate and temperate regions, thriving best in moist, shady slopes, landslide areas ranging in altitude from 1200 to 3000 m amsl. During the present study, the species was collected from Gulmarg, Ferozpora, Yusmarg, Duksum, Sonamarg, Phalgam, Naranag and Dara, Jammu and Kashmir. It was transplanted and now grows successfully in Kashmir University Botanical Garden (KUBG), Srinagar. *V. jatamansi* is reported as gynodioecious, with coexistence of female and hermaphrodite plants separately[18], which do not differ much in vegetative characters but show variation in floral characters. The flowers are actinomorphic, arranged in terminal corymbs exhibiting dimorphism in colour – white (under shade) and tinged with pink (under open Sun) in both hermaphrodite and female plants. The female flowers are markedly smaller, wherein the flowers are coloured as well as the whole plants are relatively bright in colour (pinkish) than the hermaphrodite plants.

The present study revealed that sterile flower is produced at each branching point (dichotomy) of inflorescence and reduction in the length of peduncles in acropetal manner results in reduction of the angle of branches from its dichotomy to top of inflorescence (Table 1). The reduction in peduncle length and branch angle is positively correlated (Figure 1). The reduction of angle from base (60°–150°) to top (100°–110°) and decrease in length of peduncles facilitate all the inflorescences to lie in the same plane to give it head-like appearance (Figure 2). The crowding effect of flowers is easily visualized by pollinators necessary to pollinate female flowers (cross-pollination). This crowding effect of flowers also resulted in successful pollination by means of staminal movement in hermaphrodite flowers either by physical contact of anthers and stigmas of two different flowers (bending of stamens towards straight styles), or the stamens are positioned in such a way that wind or insect visitation (ambophilly) results in certainty of geitenogamy (Figure 3).

Staminal movement and production of sterile flowers (at dichotomy) were observed across all individuals of the studied populations. The study was carried out on 50 plants in each population. The angle was measured with respect to main axis of the inflorescence. The branch angle and peduncle length do not vary significantly ($P \leq 0.001$) in all the plants across the studied populations.

The architecture of inflorescences and staminal movement are important in

Table 1. Decrease in branch angle and peduncle length from bottom to top of ramet

Stage of branching in acropetal manner	Branch angle (°) with respect to main axis	Branch angle (°) (mean ± SE)	Peduncle length (each; cm)
I	60–150	89.80 ± 0.88	6–7
II	70–150	79.80 ± 0.84	3.5–4
III	90–140	50.06 ± 0.86	1.5–2
IV	100–130	29.53 ± 0.79	0.5–0.7
V	110–130	19.80 ± 0.62	0.4–0.6
VI	100–110	9.86 ± 0.55	0.3–0.5

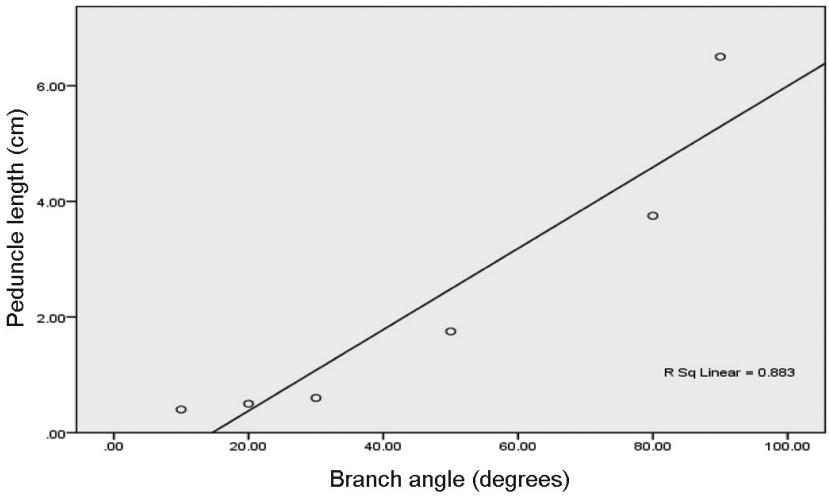

Figure 1. Correlation of branch angle with peduncle length.

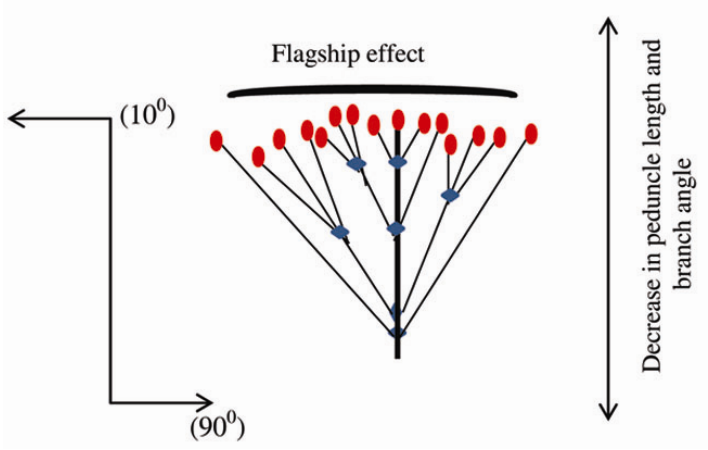

Figure 2. Production of sterile flowers and reduction in peduncle length and branch angle to give flagship effect for successful pollination.

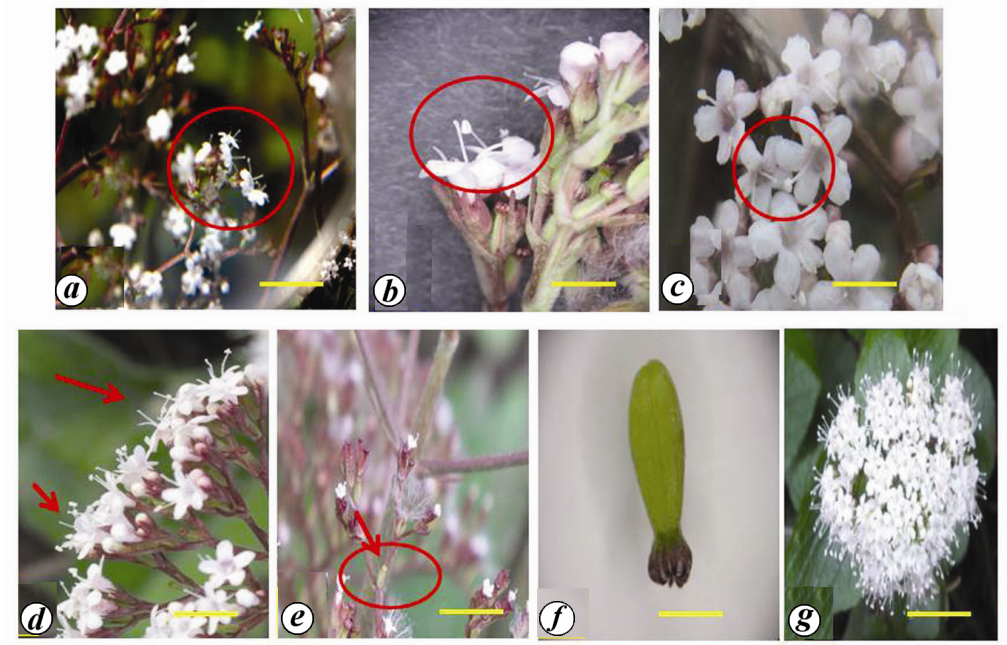

Figure 3. Inflorescence architecture and staminal movement in *Valeriana jatamansi*. ***a***, ***c***, Bending of stamens (scale = 1 and 2 cm); ***b***, Contact of bending stamen of one flower with straight style of another (scale = 1.6 cm); ***d***, Straight styles (scale = 1.5 cm); ***e***, Sterile flower in axil (scale = 1.8 cm); ***f***, Sterile flower (scale = 3 cm); ***g***, Crowded flowers (scale = 1 cm).

successful mating in the species. Our results are not in conformity with those of Khajuria *et al.*[19], who reported that in *V. wallichii*, the styles of flowers show movements by either forming a sharp bend above half of their length or by assuming a bow shape or by slightly tilting towards one of the anthers of the same or the adjacent flower in a complex biparous cyme, to affect pollination and thus assure fruit and seed set.

It was also observed that hermaphrodite and female flowers show asynchrony in anthesis and anther dehiscence from flower to flower in a ramet or in different flowers of a genet in a population. This protracted asynchronous pollen presentation assures pollen availability for long periods to ensure effective pollination and also ensures survival of female plants. The inflorescence architecture and staminal movement in the plant species avoid inbreeding in hermaphrodites and thus favour ecological xenogamy. However, females only set seeds under obligate outcrossing.

The present study has revealed that knowledge of reproduction in *V. jatamansi*, a threatened medicinal species, may contribute to improve our understanding of the phenomenon of its adaptation and its mating success and at the same time assist conservation strategies.

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Recurrent outbreaks of hypoglycaemic encephalopathy in Muzaffarpur, Bihar

Earlier we had reported that the recurring annual seasonal outbreaks in Muzaffarpur district, Bihar, of what used to be considered viral encephalitis and called 'acute encephalitis syndrome' since no virus could be detected, is acute encephalopathy[1]. Our report was based on a limited study and retrospective analysis of case records. The outbreaks are restricted to April–July with a peak in June[2–5]. In 2014, the outbreak started in the first week of June and we conducted a prospective data cumulation effort during June, as reported here. Clearly, the disease is a form of 'hypoglycaemic encephalopathy' as described below.

One of us (A.S.) is attending pediatrician in a local private hospital that creates a special ward every year as soon as the outbreak begins and treats children with acute central nervous system (CNS) disease without any user-fee charges. We planned data collection from children who conformed to a case definition designed for simplicity and reasonable specificity and sensitivity. The case definition was any child with acute onset of severe CNS disease with loss of consciousness and seizures. All cases hospitalized under A.S. during the first two weeks of June 2014 are included for this analysis.

Children were examined and minimum essential laboratory tests were conducted. We had a treatment protocol in the case of children for whom the laboratory results excluded bacterial meningitis, cerebral malaria and encephalitis (characterized by more than 10 cells/cumm in the cerebrospinal fluid, CSF). However, during the two weeks no child with meningitis, encephalitis or malaria was hospitalized. This year we tested blood glucose level immediately after hospitalization and infused 10% dextrose (volume according to body size) irrespective of the glucose concentration.

There were 26 children conforming to the case definition in the first two weeks of June, while there was none during the preceding four weeks in May. Among them, 24 (92%) were between 2 and 10 years of age. All children had been well (according to their parents) the evening before, but were found early in the morning with seizures and loss of consciousness, with or without vomiting and/or fever. In all children CSF was under increased pressure (judged by the speed of flow), but without inflammatory cell response: all cell counts were below 5/cumm. Twenty-two (84.6%) children had hypoglycaemia (less than 70 mg/dl); 20 (77%) had moderate to severe hypoglycaemia (7 with 31–40 mg/dl and 13 below 30 mg/dl).

Acute encephalitis usually begins with a prodromal phase with fever and systemic, non-CNS-specific, symptoms lasting a few days before convulsions and/or loss of consciousness occurs. The CSF will contain more than 10 cells/cumm. In the absence of prodromal phase before onset and of any inflammatory cell response in CSF, we confirm the diagnosis of acute encephalopathy in all the cases, confirming our earlier report[1].

All case-children were given 10% dextrose infusion in addition to per-protocol anticonvulsants and supportive nursing care. The response to dextrose was encouraging. We are unable to compare it with any control children; A.S. has treated children with this disease over the past several years but has not seen such rapid response with any other treatment. Thus, 15 children (58%) recovered so fast that they could be discharged home within two days. Two more children could be sent home well after 3–4 days of hospitalization. The parents removed three children from the hospital during the course of illness. Among the remaining 23, six died, with case fatality rate of 26%. This is the lowest fatality rate in our experience of the attending pediatrician.