Effect of habitat diversification and temperature on *Valeriana jatamansi*

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Abstract: *Valeriana jatamansi* is commonly known as Indian valerian, is critically endangered medicinal plant of N. W. Himalaya. The species is highly adaptable to prevailing environmental conditions and diverse habitat. The varying developmental changes under different environments are reflected in the leaf shape and flower dynamics. The species avoids the fatal effects of temperature by the development of unique floral characteristics for its successful pollination It seems to be adaptation to a basic climate of a particular population. During the present investigation we have assessed the various eco -adaphic factors in different habitats that may influence the reproductive aspects and flower dynamics.
[Aabid M. Rather, Irshad A.Nawchoo, Aijaz A. Wani , Aijaz H.Ganie, Economic Botany and Reproductive Biology Research Laboratory Department of Botany, University of Kashmir, Srinagar-190 006. J & K. India. New York Science Journal 2011;4(12):57-60]. (ISSN: 1554-0200). http://www.sciencepub.net/newyork

Key words: adaptation; environmental conditions; flower dynamics; successful pollination

1. Introduction

Valeriana is distributed through temperate and cold regions of Northern Hemisphere, Bell (2004). Morphology in Valerianaceae is of great interest for its impressive diversity of forms, mainly resulting in adaptation to wide range of ecological conditions, concerning both vegetative and reproductive forms. This diversity has been well studied from the inflorescence structural perspective, with different forms and levels of complexity by Weberling (1989); Hidalgo (2004) . The unique character of family is the pattern of four different stamen numbers in a series wherein mainly four are found in *Patrinia* and *Nardostachys*, three in *Plectritis*, *Valerianella* and *Valeriana*, two in *Fedia* while in *Centranthus* have only one stamen, Donoghue (2003) . Valerianaceae exhibits a considerable diversity in flower and fruit morphology, Erickson (1989). This implicitly assumes particularly habitat diversification as well as prevailing climatic conditions have prominent effect on plant morphological characters especially reproductive parts to successfully establish its progeny in response to altered environmental conditions. The species *Valariana jatamansi* inhabit diverse habitats of Kashmir Himalaya, so it was thought worthwhile to undertake detailed reproductive traits that enable the species to survive in these varied habitats.

2. Materials and Methods

In Kashmir valley *Valeriana jatamansi* was sampled from its natural habitats and all the prerequisite parameters were assessed for three years and were compared with plants growing at Kashmir University Botanical Garden (*ex situ* conditions). Morphological characters, breeding behavior and pollination mechanisms were analyzed under *ex situ* (KUBG) conditions with a mean temperature of 30 ± 2^0C and an altitude of 1590m amsl. These characters were compared with natural populations of Ferozpura (mean temperature of 20 ± 2^0C and an altitude of 2150m amsl) and Gulmarg (mean a temperature of 15 ± 2^0C and an of altitude 2500m amsl). From these respective populations 20-50 individuals were tagged at each study site and were examined. Flower structure from all study areas were analyzed under zoom stereo-microscope. The stigma receptivity and flower anthesis was also analyzed in all the studied sites. Stigma receptivity was analyzed by using lactophenol and cotton blue. Stigmas with germinated pollen grains were labeled as receptive. Flower anthesis was checked out with respect to altitude and temperature. Number of flowers with unique adaptability (with piercing stamens) in each population was analyzed with respect to temperature.

3. Results

Valeriana jatamansi is highly adaptable to environmental conditions and occurs in pockets with 8-12 individuals per pocket. From these studied populations 17-20 hermaphrodite flowers pierce their stamens through petals in closed floral buds in KUBG with mean temperature of 30 ± 2^0C (Fig. II), at Ferozpura where temperature was 20 ± 2^0C only 8-10 individuals pierce their stamens through the petals (Fig III). However, in Gulmarg, where temperature recorded was 15 ± 2^0C, only one plant showed this unique mechanism (Fig IV). In KUBG it was also observed that out of 50 female individuals, 15-20% anthesize earlier than hermaphrodite ones, while at

Ferozpura out of 50 female individuals only 8-10% female individuals show prior anthesis and at Gulmarg population 0-1% female individuals anthesize earlier. The anthesis of female flowers prior to hermaphrodites in three different sites seems to be temperature dependent. The individuals growing at (KUBG) depicted stigma receptivity of female individuals on 4th-5th day of anthesis, which usually anthesize 8-10 days earlier than hermaphrodite flowers. At Ferozpura the female flowers anthesize 4-5days earlier and were observed receptive on 2nd and 3rd days after anthesis. However, at Gulmarg usually both hermaphrodite and female flowers anthesize at same time (Table 1). Present study revealed that temperature has a prominent effect on anthesis and breeding behavior in the species. Floral length was more in female individuals than female (Fig.I). Flower colour variation was observed under shade and sunny conditions, white large under shade and pink smaller under open sunny conditions.

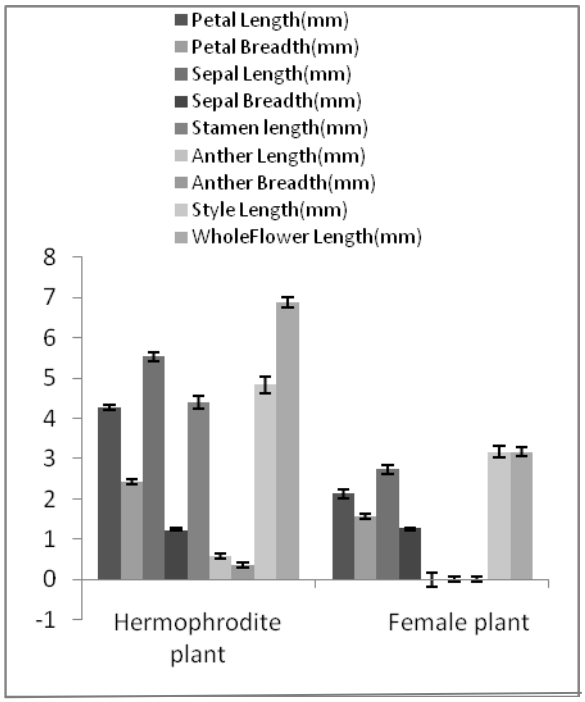

Fig. 1: Comparison of quantitative flower characters of hermaphrodite and female plant.

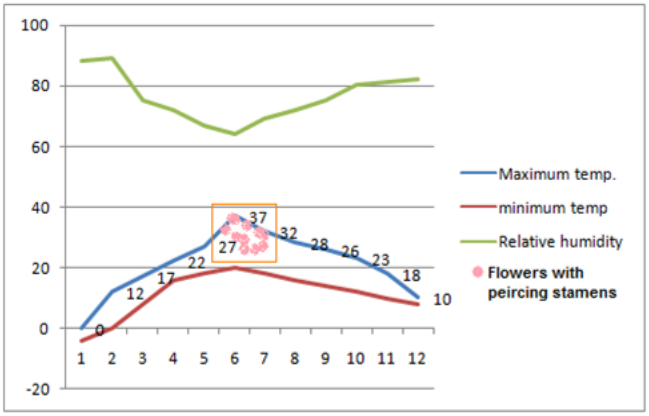

Fig II. Effect of temperature on anthesis and piercing of stamens

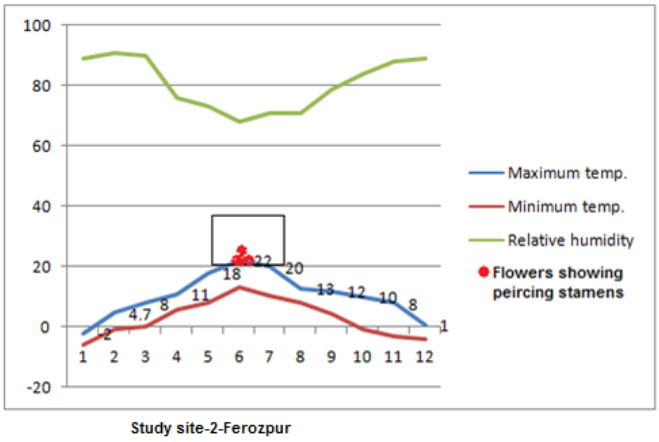

Fig.III. Effect of temperature on anthesis and piercing of stamens

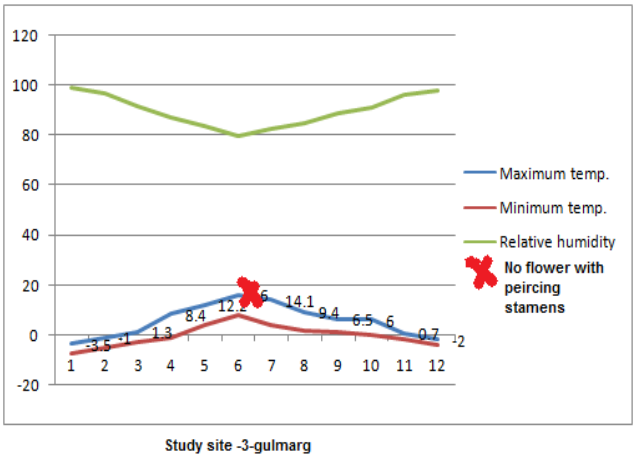

Fig.IV. Effect of temperature on anthesis and piercing of stamens

Table I. Comparative features of *Valeriana jatamansi* at three studied sites.

S.No	Plant characters	KUBG	Ferozpura	Gulmarg
1	Flowering period	15th March-15th June	15th April – 10th August	3rd May-15th September
2	Flower anthesis	Female flowers anthesize 8-10 days earlier than hermaphrodite flowers	Female flowers anthesize 4-5 days earlier than hermaphrodite.	Usually female and hermaphrodite flowers open at same times
3	Mean temperature	30^0C	20^0C	15^0C
4	Altitude	1490m amsl	2150m amsl	2500m amsl
5	Stigma receptivity	4-5 days earlier	3-4 days earlier	1 day or few hours earlier
6	Flower morphotypes	Much prevalent	Less prevalent	Least prevalent

4. Discussion:

As successful pollination is a prerequisite for survival of plant communities and is dependent on many biotic and abiotic factors is given by Kaul and Bhatnagar (2007). Thus in order to successfully pollinate the opposite sex and avoid any environmental restriction, *Valeriana jatamansi* pierces their stamens to accomplish successful sexual cycle. Adaptation of plants to the local climate is an important factor that determines the variation in the phenological timing and flower structure by Krammer (1995); Franks *et al*., (2007). It is predicted that the adaptation of plants to the local climate is an important factor that determines regional variation in plant phenology and flower structure, Manzal and Sparks (2006). The female flowers anthese before hermaphrodite ones, and anthers of hermaphrodite flowers pierce through close petals to ensure pollination of flowers of female individuals. This piercing of stamens is adaptation to local climate in order to avoid any fatal effects of high temperatures on pollination mechanism. This indicates that temperature has not only effect on phenological events but had prominent role to change flower dynamics according to the habitat in which the plant grows. Bisexual flowers were always longer in comparison to the female flowers in *Valeriana jatamansi*. Although all the floral variations noticed during investigation like gynodioecism, larger bisexual flowers in comparison to female flowers, colour or size morphotypes in female flowered plants can be used benchmarks for evaluating potentiality of *Valeriana jatamansi* under varied habitats. Difference between plants and pollinators in responsiveness to changing to increased temperatures cause early flowering plants to flower too early in warm conditions before pollinators are active. However, pollinators co-evolve with plants and do change over the season with likely consequences for selection on floral morphology. This decoupling between plants and pollinators seems most possible but unlikely to be catastrophic, since many taxa posses adaptation to temporally variable environments. Nevertheless, for many species, adaptation to novel climates will entail evolutionary change, and species interactions can influence evolutionary trajectories Forrest and Thompson (2010). This makes *Valeriana jatamansi* to pierce their stamens through closed flower buds in order to attract and maintain loyal pollinators throughout the flowering period or it might function simply to ensure the earliest possible development for the bulk of a plant's ovule. This study is in harmony with the study of Thompson (1989); Makino and Sakai (2007). This piercing of stamens through closed hermaphrodite flowers is advantage of female individuals because being anthesized earlier, as earliest fertilized ovules may take precedence in within plant competition for resources given by Hamphries and Addicot (2004) and have advantage in greater number of seed set.

Acknowledgements:

Authors are grateful to the Department of Botany, University of Kashmir Srinagar, India for their necessary support to carry out this work.

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11/22/2011