Strategies adopted by the alpine genus *Pedicularis* L. (Scrophulariaceae) to overcome environmental stress

We had earlier highlighted the botanically curious nature of the then under-investigated genus *Pedicularis* L., family Scrophulariaceae[1]. This genus has now been thoroughly investigated by us. Several complexities have been solved[2], new species discovered[3,4] and the sanctity of one species, *P. bicornuta* has been brought to light[5]. The genus, however, continues to enjoy the pedestal of being a botanically-curious entity, attracting the attention of many scientists. The very existence, survival and sustenance of these plants in the tough alpine Himalayan zones, inaccessible to most other angiospermous flowering species raises curiosity. We therefore ventured to explore the strategies adopted by the *Pedicularis* plants to endure and overcome the negative environmental stochastic perturbations. Our genesis is not based on tests or assumptions but on actual field observation and experiences in the tough natural dwellings of *Pedicularis* during different seasons.

Surveys were made in all the alpine and sub-alpine zones from Kumaon in Uttaranchal to Lahaul-Spiti in Himachal Pradesh, and finally to the cold deserts of Ladakh. These alpine zones are bestowed with an array of climatic fluctuations. The climate is very cold with ice-cold, fast-blowing turbulent winds all through the year. The weather is dry, and often stormy during summer, accompanied with frequent showers during the monsoon. During winter, the entire hill slope is covered with a heavy blanket of snow. The drag impact of the windy storms is often so strong, that it becomes difficult even for human beings to resist the force of being carried away.

The functional significance of structural modifications in the flowers of *Pedicularis* was oriented in a manner so as to counteract the environmental stochastic perturbations which are mostly in the form of drag force caused by strong wind currents, which in turn minimize the chances of desiccation of the reproductive plant parts often exposed to strong winds. These damages may otherwise become so severe that the entire stem may be broken, even resulting in uprooting of the plant on the whole, causing an imbalance in the demographic behaviour. The positive adaptive compromise exhibited by the floral morphology therefore acts as a shield against mechanical damage. The hemi-parasitic nature of the plants also helps in these adaptations, as it fixes the delicate herbs firmly to the boggy soil with the help of its host plant.

The erect floral spikes of *Pedicularis*, which are generally exposed directly to the fastest winds, are appropriately adaptated for survival in such an adverse condition. Bending in flexible objects is a mechanism to reduce drag force of winds[6]. The stems of *Pedicularis* are quite flexible and suited for bending sharply sometimes even touching the ground. This reduces damage by breaking. The leaves are finely dissected, pinnate-bipinnately lobed, bracts foliaceous. These adaptations help the plants to reconfigure from the impact of strong winds (Figure 1). The extent of floral modifications has a high degree of correlation between bionomics of the plants and the environment. The zygomorphic corolla has a streamlined, aerodynamic, hooded, incurved (sometimes only the tip may be outcurved) and quite flexible or sometimes rigid upper limb, the galea, with smooth outer surface and pointed or emarginate tip, which is so designed as to offer maximum free flow of winds and negligible water retention. The lower lip or the labium offers minimum resistance to the drag force of winds as it is thin, three-lobed, spreading and flexible (Fig-

Figure 1. Spikes of *Pedicularis pyramidata* Royle in natural habitat (exposed to direct wind).

Figure 2. Flowers of *Pedicularis punctata* Decne showing incurved, flexible galea and lobed, flexible labium.

Figure 3. *Pedicularis bicornuta* Klotzsch ex Klotzsch & Garcke. Spikes with ball-like flowers.

ure 2). Variations in these basic, morphological characters are of taxonomic significance and hence beyond the scope of our present analysis.

The culminating point of these modifications is encountered in the flowers of *Pedicularis bicornuta* Klotzsch ex Klotzsch & Garcke, inhabiting the Losar area of Spiti Valley in the cold deserts of the Himalaya. The floral appendages in this species exhibit rolling up of the corolla, to the extent that the flowers become ball-like in appearance (Figure 3), an adaptation most suited to minimize mechanical damage by the pressure of high-velocity winds. Such a phenomenon was earlier observed in tree-leaves[7] and in free-flowing bodies[8] but not in flowers.

The land surface of regions where *Pedicularis* occurs is covered with snow for most part (October–May) of the year. This leaves no chance for survival of annuals, especially those with a prolonged growth and reproductive period. *Pedicularis* adapts and sustains itself by having a short life cycle and a rhizomatous root which remains dormant under snow and sprouts up at the advent of autumn when the snow melts. Within a short growth phase of about 15 days buds appear and blooming commences soon after, attracting pollinators, primarily bumble bees[9]. The spikes continue to bloom for about 40–45 days. The entire lifecycle is completed in a short span of two to two and a half months after which the *Pedicularis* vanishes under a thick blanket of snow, giving an impression that the region is devoid of vegetation. When in full blossom, *Pedicularis*, in all its glory, projects the region as a beautiful haven of flowers, often read in fairy tales.

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Council of Scientific and Industrial Research

Dr Sir S. S. Bhatnagar has made over a sum of approximately Rs 13,000, which he has personally earned as royalties this year, to the Council of Scientific and Industrial Research for the purpose of financing research workers engaged on schemes of research in operation under the Board of Scientific and Industrial Research irrespective of whether the work is carried out under his direction at Delhi, or under the direction of any other recognised director of research, elsewhere in India. The help will be given to those workers who have earned no royalties, as their work had to be given in the interest of the war effort or development of industry. A part of this donation will be utilised for preparing an oil painting of the Hon'ble Dewan Bahadur Sir A. Ramaswamy Mudaliar, whose name is so intimately associated with the promotion of industrial research in this country. A sum of Rs 1000 will be donated to the Delhi University for encouraging scientific and industrial researches and a further sum of Rs 2880 has been earmarked for granting two scholarships of Rs 60 each for two years in the Punjab University.

Messrs Tata Sons have made a munificent grant of Rs 8,30,000 to the Council of Scientific and Industrial Research for the construction and equipment of a National Chemical Laboratory. The Laboratory will be located at Poona and will be associated with the name of Tatas.

A donation of Rs 1,00,000 to the Council of Scientific and Industrial Research has been made by Messrs Indian Wire and Steel Products Ltd, for carrying out such work as may be agreed upon between the donors and the Council.

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