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Plant adaptations in alpine ecosystems of Kashmir Himalaya

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Abstract: An attempt has been made to identify and analyze various facets of alpine ecosystem in Kashmir Himalaya. Despite harsh and hostile environmental conditions alpine floristic wealth is quite significant both in terms of its richness as well as range restiction. These peculiarities imply their efficient adaptational potential in utilising the resources for survival and sustenance. An appraisal of such alpine adaptations is appended in this communication.

Key words: Alpine ecosystem; adaptation; indicator species; Kashmir Himalaya.

Kashmir Himalaya represents an integral part of the main Himalayan range and its geologic and biological history constitute a part of the Himalayan legacy. Situated between 33°-36° N latitude and 72°-80° E longitude besides spanning over an approximate area of 2,22,800 Km^2; the area is endowed with a remarkable array of geo-edaphic, topographic and climatic peculiarities. The latter not only enrich the varied habitat systems (undulating meadows, rocky cliffs, scree slopes, deep ravines and gorges (Fig. 1), lakes and glaciers, etc) but also offer ample opportunities for speciation as well. The rich representation of angiospermic wealth in the study area (3054 taxa under 151 families) together with a higher incidence of range restriction (31.66%) lends adequate support to this assertion (Vir Jee et al., 1989). The alpine wealth is equally well marked both in terms of richness as well as range restriction. Dhar and Kachroo (1983) recorded 1601 alpine-subalpine taxa under 64 families (excluding Poaceae) with 36.5% endemics in this sutdy area. The over all vegetation spectrum of Kashmir Himalaya discerns a typical blend of subtropical-temperate-cold-arid desert type. Some notable contribution attempted earlier on this aspect include: Troll (1967); Meusel (1971); Meusel and Schubert (1971); Stewart (1916, 1972); Kachroo et al. (1977); Hartmann (1984, 1987); Schweinfurth (1983,1984) and Seybold and Kull (1985) etc.

The alpines and alpine eco-systems

The word 'alpine' literally relates to high mountain Alps and is often used to denote a mountainous region above timber line lacking tree habitation but supporting low herbs and a few shrubby thickets. Basically this high altitude environment in characterised by low atmospheric pressure and density which increases air transparency and thus modifies the conditions of insulation, absorption and radiation besides evaporation (Billings, 1974). The well known '*greenhouse effect*' experienced in low land regions is nearly absent in alpine ecosystems (Mani, 1978).

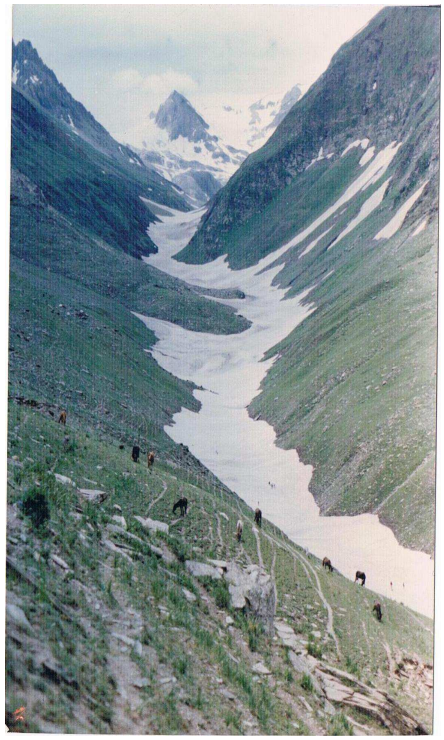

Figure 1. A Typical Alpine gorge at Gumri (3,380 m)

The alpines of Kashmir, as elsewhere in the northern hemisphere, are generally characterised by harsh and hazardous conditions like ultraviolet radiations, short and cold growing season, glaciers and snow avalanches, winds and blizzards, frost and freezing temperatures, etc which render the inhabitant taxa quite difficult to flourish and reproduce. Mani (1978), however, held that atmospheric cold by itself is not an absolute limiting factor for plants. Infact

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many plants (phanerogams) flourish in extremely low temperature even above the permanent snow line. Thus various environmental factors play an important role in determining the vegetation of an alpine ecosystem. These factors are intricately intertwined forming a complex, and not a single factor is decisive. Notwithstanding the environmental extremes the general vegetation which largely comprises of dwarf perennial herbs appears suitably adapted to different habitats in such regions and presents spectactular colour splashes during the flowering season. The peculiar adaptability of alpines has been attributed to over production of sugars which get metabolised in efficient pigment sysnthesis and speedy development of underground perennating organs for their stiff anchorage (Dhar and Kachroo, 1983). The bright and fascinating flower colour dominance of alpines prompted Kashyap (1934) to devise a scheme of classification of such taxa, though it does not hold true in most of the alpine regions.

Alpine indicators

Essentially a host of environmental factors characterize the demarcation of an alpine zone within an ecological subunit. However, irrespective of local variations, an altitude of 3,200m may be considered as the starting point of this zone in Kashmir Himalaya provided it is corroborated well by the indicator species like *Adonis chrysocyathus* (Fig. 2), *Trollius acaulis, Fritillaria roylei*, *Bergenia stracheyi*, *Senecio jacquemontianus*, *Rheum webbianum*, etc. along with

Figure 2. *Adnis chrysocyathus* Hk.f. and T. A common alpine indicator at Apharwat in Kashmir Himalaya (3,600m)

dwarf and carpetting scrubs of *Juniperus* and *Rhododendron*. Above 4000m, the nubmer of plant species decrease with an increase in altitude owing to prolonged snow cover. The common species encountered here include: *Primula elliptica*, *P. macrophylla*, *Saxifraga flagellaris*, *Corydalis crassissima*, *Allium thomsoni*, etc. In Ladakh the alpines may ascend upto 6000m or more and are represented by *Waldhemia nivea*, *Potentilla bifurca*, *Lactuca tatarica*, *Swertia thomsonii*, *Saussurea sacra*, *Lyodia serotina*, *Sedum tibeticum*, *Astragalus tibetanus* etc. along with *Caragana pygmaea* and *Artemisia* steppe.

Alpine adaptations

To cope up with the extreme environmental conditions of alpine ecosystems, plants have undergone various adaptations. Some characteristic examples of these adaptational features encountered in Kashmir Himalaya are presented below:

1. Perennial habit

Perennial herbs constitute the most common element of an alpine ecosystem and dominate the vegetation. They are more hardy than annual plants and do well under short growing season. However, annual herbs are also present either with perennial parts as in *Valeriana dioica*, *Iris lactea* etc. or as pure typical annuals like *Silene vulgaris*, *Gentiana leucomeleana* etc. but their frequency is very low.

2. Dwarf size

It is also an important characteristic of an alpine adaptation. The total lack of stalk in *Primula minutissima* makes it to look as if the plant has sprouted from the ground. *Callianthemun alatavicum* in another such example. In true alpine zone, dwarf and carpetting shrubs replace the trees. These cushion or tuft forming shrubs are highly adapted to with stand cold dry winds and blizzards; for example *Caragana pygmaea*, *Thylacospermum rupifragum*, *Berberis ulicina*, *Hippophae rhamnoides*, *Acantholimon lycopoides*, *Astragalus candolleanus*, *Juniperus spp*. Another remarkable instance of adaptability of a woody alpine to a dwarf prostrate habit is manifested by *Salix flabellaris*.

3. Long and massive root stock

The tufted alpine vegetation especially in Ladakh usually possesses a long and massive root stock which is capable of penetrating into the deeper layers of the soil. This adaptation not only ensures plant perennation under cold spells of low temperature (which may fall to -35 °C as there is no insulating humus layer or snow cover in this region) but also affords them a rich mineral absorption and stiff anchorage e.g. *Saussurea schultzia*, *Tanacetum nanum*, *Inula rhizocephala* var. *rhizocephaloides*, *Bergenia stracheyi*, *Sedum crassipes* etc.

4. Internode suppression

By this adaptation the plant assumes a short, whorlled or rosette condition as tall and weak stemed plants receive no protection against the wind and sun. The

shortening of internodes makes the leaves to become largely radical while cauline leaves remain a few e.g., *Aster tibeticus*, *Lactuca lassertiana* etc. A typical rosette arrangement is met in *Jurinea ceratocarpa* var. *depressa*, *J. himalaica* (Fig. 3), *Rosularia alpestris*, *Waldheimia nivea*, *W. vestita* etc. Similarly typical whorlled habit is seen in *Pediculars spp*., *Polygonatum verticillatum*, *Trillium govanianum* etc.

Figure 3. *Jurinea himalaica* R R S-A characteristic alpine growing in dense rosettes at Rhazdhani Pass (4,300m).

5. Dense pubescence

The growth of dense hair on the leaves and stems of many high altitude plants prevents them from excessive evapotranspiration besides offering protection and insulation. An outstanding example is provided by a bluish-purple flowered alpine lark spur - *Delphinium brunonianum* (Fig. 4).

Figure 4. *Delphinium brunonianum* Royle- A highly pubescent alpine larkspur growing at Khardung La pass (5,600m)

6. High Reflectance

The presence of waxy, hairy, silky, cottony, woolly and lime encrusted leaves and stems in alpines reflect most the sunlight and thus save the plant from excessive water loss. Examples include: *Tanacetum fruticulosum*, *Leontopodium leontopodinum*, *Oxytropis tatarica*, *Androsace villosa*, *Scutellaria heydei*, *Saussurea sacra*, *Psychrogeton andryloides*, *Gnaphalium luteoalbum*, *Echinops niveus* etc.

In addition to these adaptations succulents, spinescent composits and hardy graminoids, sedges and rushes are also best suited for an alpine environment and comprise a sizeable proportion in the constituent vegetational wealth.

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