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Dwindling Numbers of *Eremostachys superba* Royle ex Benth. in its Type Locality: Mohand (Dehradun)

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Abstract

An assessment of *Eremostachys superba* (Lamiaceae) was done in the type locality of Mohand (Dehradun) for its gradual decrease in the number from 100 to 25 in the last decades and only 7-9 plants at present. A regular visit has revealed that no flowering has been observed in the area from past two years and due to this no breeding has taken place which could result in further decrease in the number of the plants. The plant mainly breeds through cross pollination and no other population exists in the nearby area. But as no flowering has been observed in the area, the chances of self fertilization is also nil and it means that no propagation is taking place in the area. Further trampling of the plant by cattle grazing in the area has caused deterioration of the existing plants. The experiments carried out in the laboratory indicate that the seeds produced by the selfing have very poor germination percentage. As there is no other nearby population in the area, all the seeds that were produced in the earlier decades might have been the result of selfing and hence could not germinate under natural conditions. This strongly indicated occurrence of inbreeding depression and loss of fitness of the offspring right from the stage of germination, which is harmful for the perpetuation of the species and thereby leading to its rarity and making its conservation a challenge.

1. Introduction

The threatened status of *Eremostachys superba* was first reported by Botanical Survey of India in Indian Plant Red Data Book (Jain and Sastry, 1984) which reported the number of plants to be only 100. Prior to this Babu (1977) reported this species from Mohand and adjacent Rajaji National Park. This report may have gone ignored if Rao and Garg (1994) had not raised an alarm regarding the further deteriorating status of the species at Mohand (Dehradun), its Type locality in 1994 which highlighted the need of its conservation measures. They found that the population of 100 was drastically reduced to 25 in the Type locality and no population was observed at Rajaji National Park. As a follow up of Rao and Garg's report, Verma *et al.* (2003) initiated extensive explorations of Jammu Shivaliks in 1996 as the species was also reported from those areas. Upto 2001, they located five populations of the species containing about 1300 individuals. After this, various populations have been located in different areas of Jammu and Kashmir.

Garg (2004) studied the reproductive behavior and inbreeding depression in endangered *Eremostachys superba* Royle ex Benth. (Labiatae) in Dehra Dun population. The author conducted various types of breeding experiments and results revealed failure of self-fertilization and a strong tendency towards out-breeding as seed set by xenogamy was highest (44.4%). The study revealed that the plant mainly favours cross-pollination since the seed set was six times higher (44.4% vs 6.9%) but still these seeds showed loss of vigor and germinability. Author concluded that the miniature ramet population of *E. superba* in its Type locality is sustained by clonal propagation of rhizomatous root stock, hence comprises of homozygous individuals. This suggests that any out-crossing within these homozygous individuals also amounted to inbreeding that selfing in restricted populations increases homozygosity and homozygous genotypes are more susceptible to the integrated stochastic effect detrimental to their existence. The studies done by the author established that *Eremostachys superba* is certainly adapted for out-crossing, but the reduced and isolated nature of the population never permits out-breeding. Even when this is made to effect the genetic exchange is only between close relatives which are less different from inbreeding. This resulted in acute inbreeding depression and the resultant seeds reared by various inbreeding methods had a reduced viability, vigour and germinability and hence they succumb to environmental pressures. This augments the rate of elimination responsible for species extinction. Thus, the entire demography of the population got adversely affected. The study was carried out with the objective of studying the various

Mohand, Dehradun, Uttarakhand
Location: 30°13.475′ N, 77°56.389′ E (Elevation: 2074 ft.)

Fig. 1: Few plants in the Type locality

populations of the species and also its propagation and introduction in its areas of occurrence.

2. Materials and Methods

Morphological studies were carried out in different localities and different phases were observed. An assessment of *Eremostachys superba* (Lamiaceae) in its Type locality of Mohand (Dehradun) revealed that at present the site is left with only 7-9 plants which are present in very poor conditions (Fig. 1 and 2).

New leaf emerges from the dormant tubers in last week of August (Fig. 3A). The first inflorescence appears from the last week of February (Fig. 3B). The first flower of the season blooms in the beginning of March and lasts till the end of April. Fruit maturation is completed by the first week May. After the maturation of fruit the leaves start drying and the tuber enters into

Source: Google Maps

Fig. 2: Exact locality of *Eremostachys superba* in its Type locality

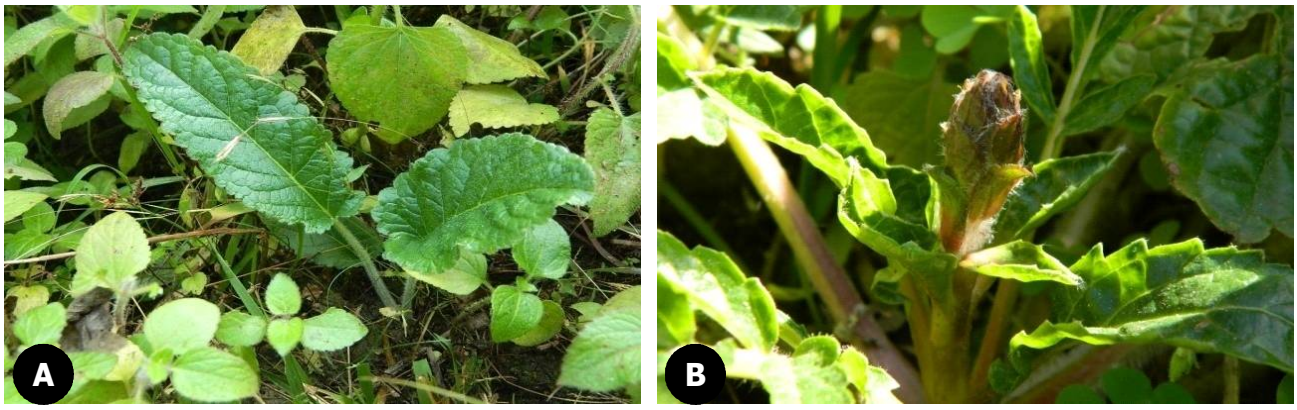

Fig. 3: A. Emergence of new leaves of *E. superba*, B. Initiation of flowering spike of *E. superba*

Table 1: Phenop hases of *E. superba* during various months of the year

Phenophase	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Vegetative growth												
Flowering												
Seed dispersal												
Dormant												
Germination												

dormant stage which last till next August (Table 1).

The site has been regularly visited for two years (2012-2014) in both vegetative and flowering stage. No flowering has been observed in any of the existing plants and due this no breeding has taken place which could result in an increase in the number of the plants (Fig. 4A-F).

The population of Mohand is the only population existing in Uttarakhand and the other populations are disjunct in nature (in Jammu and Kashmir state) and far from reach of insect pollinators. This pollinator scarcity adds on to inbreeding results in low seed set. Inbreeding in normally out-breeding species brings about a reduction in fitness and loss of alleles which prevents the reversal of inbreeding depression. This renders the population almost devoid of variation and prone to demographic perturbations and thrust the species towards extinction.

The various causes for the decrease in the population size of the type locality Mohand are as follows Rao and Garg (1994):

1. Plucking of aerial spikes by Gujjars dwelling in the area, removes the fertile parts, wiping out chances of sexual reproduction and seed set (Rao and Garg, 1994).
2. Digging out of root stock for medicinal values dampens the chances of asexual propagation to a great extent (Verma *et al.*, 2003).
3. Scanty pollinator visits in its Type locality has negative effect on xenogamy success in this normally out-breeding species (Garg and Rao, 1996).
4. Strong pollen competition on stigma surface for good quality pollen (Garg and Rao, 1997).
5. Discrete and sparse populations for successful out crossing. The other reported disjunct populations are from Jammu & Kashmir (Verma *et al*., 2003), a geographically distant area, which is out of reach of natural pollinators of this species namely *Nomia rustica* and *Ceratina heiroglyphica* (Garg and Rao, 1996) and is also too far for normal dispersal of the plant.

A good population of *Eremostachys superba* was found in Balshama (Fig. 5A-B) and Tarah (Fig. 6) of Jammu and Kashmir and in Botanical Garden of BSI,

Fig. 4(A-F): *Eremostachys superba* in both vegetative and flowering seasons

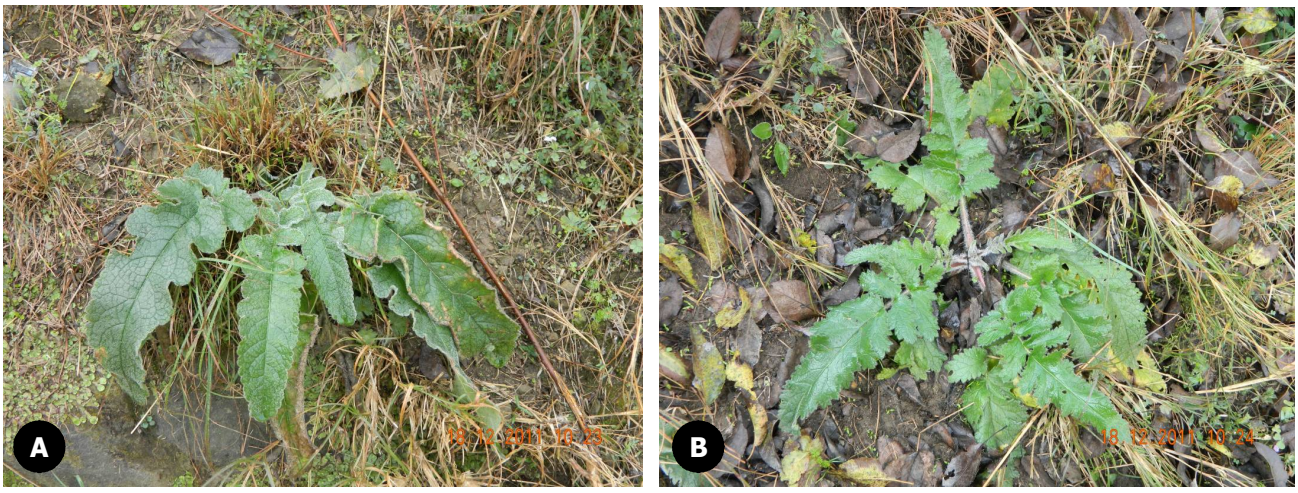

Fig. 5 (A-B): Plants in Balshama, Jammu and Kashmir

Fig. 6: Healthy population of *E. superba* in Tarah, Jammu and Kashmir

Dehradun and conducted several experiments.

3. Results and Discussion

An experiment conducted in the garden of Botanical Survey of India, Dehradun and also from the literature available revealed that the plant mainly breeds through cross pollination. The data was analyzed based on the experiments carried out in the Botanical garden and in the laboratory (Fig. 7A-B, Fig. 8 and Table 2).

Seeds were collected from those experiments. The experiments carried out in the laboratory indicated that the seeds produced by the selfing have very poor germination percentage. Thus, it is evident that in the earlier years when the population in the Type locality

Fig. 7 (A-B): Experiments conducted in the garden of Botanical Survey of India, Dehradun

Table 2 : Pollination patterns and fruit setting in *E. superba*

Type of pollination	Number of flower pollinated	Number of fruit (Seeds)	% Fruit set
Forced selfing	50	3	6
Natural selfing	50	12	24
Xenogamy	50	46	92
Geitonogamy	50	34	68

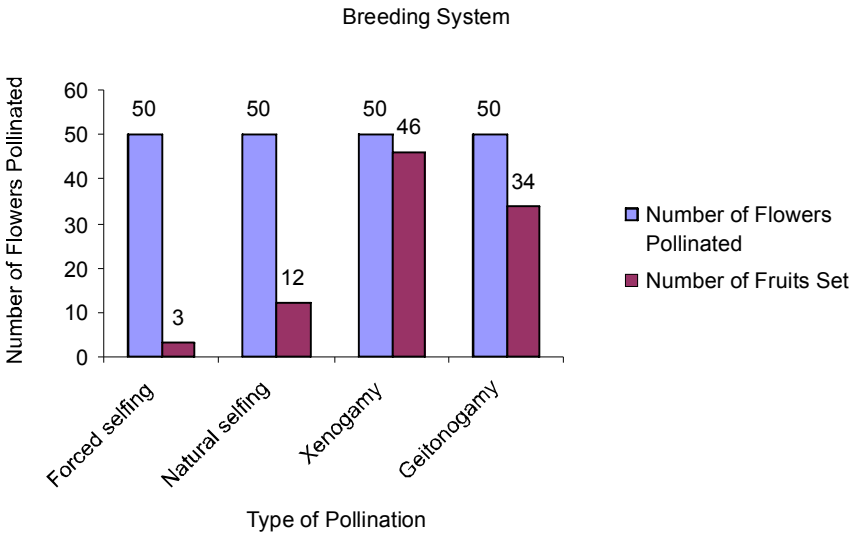

Fig. 8: Bar diagram showing the results of different breeding types in the species

(Mohand) was flowering, due to lack of any other population in the nearby areas inbreeding depression might have occurred which was exemplified by the loss of competitive ability, and the loss of fitness of seeds and seedlings of the offspring of the population in Mohand right from the stage of germination, which is harmful for the perpetuation of the species. Also, as there is no other nearby population in the area, all the seeds that were produced in the earlier decades might have been the result of selfing and hence could not germinate under natural conditions. At present as no flowering has been observed in the area, the chances of self fertilization is also nil and it means that no propagation is taking place in the area. Further trampling of the plant by cattles grazing in the area is causing deterioration of the existing plants (Fig. 9). This has gradually led to the decrease in the population thereby leading to its rarity and making its conservation a challenge.

Based on the studies carried out in the field and laboratory it is concluded that since the population size consists of only 5-6 plants in one locality in Mohund and no flowering for a couple of years and absence of any other population in the study area has resulted in the decrease in number of plants over a period of time.

Fig. 9: Local disturbance by cattle

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