QUANTITATIVE ASSESSMENT OF CURRENT STATUS AND BIOMASS OF *BERGENIA CILIATA* AND *BERGENIA STRACHEYI* FROM KUMAUN HIMALAYA

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ABSTRACT : Studies on production of biomass in the underground and above ground parts of *Bergenia ciliata* and *Bergenia stracheyi*, comparing seven sites along the altitudinal gradients to determine the best harvesting site. It also provides quantitative details through assessment of density and biomass of *Bergenia* species. This study reveals that due to difference in climatic conditions which coupled with the wide altitudinal range provides a wide diversity. It also reveals the best habitat for obtaining the maximum biomass.

Keywords: *Bergenia ciliate*, *Bergenia stracheyi*, Biomass, Density, Kumaun Himalaya

INTRODUCTION

Since long time, *B. ciliata and B. stracheyi* of the family Saxifragaceae identified as a medicinal plant. *Bergenia* species distributed in South and East Asia and European countries. In India these plants grow at high altitudes in the Himalayas usually in rocky areas and on cliffs (Singh et al., 2007). Various inhabitants of Himalaya region use the plant for curing a number of ailments (Chowdhary et al., 2009). The rhizome have been used for centuries in herbal formulation for dissolving of kidney and bladder stones and for treatment of leucorrhea, piles and pulmonary infections (Asollar et al., 1992). Its trade name is Pashanbhed. In traditional system of medicine, the rhizome is used fresh or in dried powdered form. It is reportedly used against fever, cough and pulmonary affections (Rai and Sharma, 1994; Biawas, 1955; Chowdhary et al., 2009). The juice of the rhizome of *Bergenia ciliata* is used as an anti-tussive for cold and cough by the local people of the Sikkim and Darjeeling districts of West Bengal (Sinha et al., 2001). There are various ethnobotanical reports on *Bergenia* species as, for treatment of boils and blisters (Singh, 1997), for treatment of urinary calculi and other urinary diseases; as anti-diabetic drugs; for treatment of heart diseases, haemorrhoids, stomach disorders and ophthalmic (Kapur, 1993), and for dissolving kidney stones (Singh and Aswal, 1992). Chopra et al. (1958) reported analgesic, antipyretic, anti-inflammatory, diuretic, antilithic activities of rhizomes. Rhizome is used orally, simply chewed if fresh, for curing diarrhea and during vomiting (Sinha et al., 2001). In addition they have been applied externally for healing wounds, eye-sores and boils.

These plants are in demand in market for commercial purpose. Plants collected from wild and sold to the middlemen or contractors in terms of weight and not in terms of numbers. Therefore, an estimate of the available biomass of traded plant or plant part is important. The available biomass from various sites also varied. Beside this more emphasis needs to be placed on quantitative studies so that the current status of *Bergenia* species is known along the altitudinal gradients, especially from interior areas that contribute heavily to the trade market. Previous literature reveals that informations on quantitative assessment of *B. ciliata* are not available and very few studies have been done on *B. stracheyi* (Uniyal et al., 2002 and Kala, 2000) and biomass is the primary requisite for the further studies of physio and phytochemical studies of the plant. All active ingredients are present in the biomass. So it is important to know the best habitat for obtaining the maximum biomass. Therefore, the objectives of this work was 1) to study the production of biomass in the underground and above ground parts of *B. ciliata* and *B. stracheyi*, comparing seven sites along the altitudinal gradients to determine the best harvesting site; 2) provide quantitative details through assessment of density and biomass of *Bergenia* species.

MATERIALS AND METHODS

Six sites for *B. ciliata* (Khatyari, Kasardevi, Binsar, Bhowali, Mukteshwar and Khati) and one site of *B. stracheyi* (Pindari) were selected and identified in different parts of Kumaun Himalaya. In each site, five 5 x 5 m plot size was selected. The number of plants of *B. ciliata and B. stracheyi were* recorded at all sites. This information was used to analyze density of *B. ciliate* and *B. stracheyi* per $100m^2$ area (Mishra, 1964). All the selected sites were visited during the active vegetative growth season (August to September) in the year 2007 for biomass estimation. Five randomly selected plants from each plot were carefully dug out. They were properly washed with tape water and water on the surface of the plants was removed by pressing it on the blotting paper. The plants were separated into above ground part and below ground part. Then the fresh weight of each plant part (above and below ground) was taken and total fresh weight was noted. After this the samples were oven dried at 65^0C temperature or sometimes shade dried till constant weight was not obtained. Dried weight of the samples was recorded. Above ground and below ground biomass were calculated by multiplying above ground and below ground dry weight biomass with stand density of *B. ciliata* and *B. stracheyi* at different sites.

RESULTS AND DISCUSSION

The density of *B. ciliata* varied between 83.2 plants/$100m^2$ (Mukteshwar site) to 183.2 plants/$100m^2$ (Khati site). Density of *B. stracheyi* at Pindari site was 163.2 plants/$100m^2$ at an altitude of 3630m (Table 1). Considerable variation was shown in density/$100m^2$ at various altitudes (Table 1). Gradual increase in density of *B. ciliata* was observed from lower altitude (Khatyari site – 1200m to Bhowali site – 1600m with some exceptions. However, this figure also revealed that density of *B. ciliata* was also minimum at Muketeshwar site (2286m) – 83.2 plants/$100m^2$. The density of the plant was found to be maximum at Khati site (2590m). However, *B. stracheyi* was observed at higher altitude of Pindari site (3627m) with a density of being 163.2 plants/$100m^2$. Uniyal et al. (2002) reported density of being 11162.5 plants/ha for *B. stracheyi* from Upper Gori Valley, whereas Kala (2000) reported 98500 plants/ha for *B. stracheyi* from Indian-trans Himalaya and Kala et al. (1998) have also reported 8500 plants/ha for *B. stracheyi* from Valley of flowers.

Table 1. Density (plants/100m^2) of *B. ciliata* and *B. stracheyi* at different sites in Kumaun Himalaya.

Sites	Altitude (m)	Density (plants/100m^2)	Density (D/ha)
Khatyari (*B. ciliata)*	1200	121.6	12160
Kasar Devi (*B. ciliata*)	1638	91.2	9120
Binsar (*B. ciliata*)	2058	90.4	9040
Bhowali (*B. ciliata*)	1600	180	18000
Mukteshwar (*B. ciliata*)	2286	83.2	8320
Khati (*B. ciliata*)	2590	183.2	18320
Pindari (*B. stracheyi*)	3630	163.2	16320

Highest density being 16320/ha was observed for *B. stracheyi* from Pindari glacier site, whereas highest density being 18,320/ha for *B. ciliata* at Khati site. The present observation shows higher densities than those of Uniyal *et al*. (2002) and Kala (1998 and 2000). This may be assigned due to different habitats and virgin sites in Nainital, Almora and Bageshwar districts. However, density data for *B. ciliata* are not available in the literature. Hence, present data could not be compared with any other density data for *B. ciliata*.

The moisture content was highest in *B. ciliata* biomass collected from Kasar Devi (50.61%) followed by Khatyari site (50.08%); Mukteshwar site (47.29%); Binsar site (46.00%); Bhowali site (45.92%) and least at Khati site (43-35%) (Table 2). High moisture content proved the availablity of low biomass at Kasar Devi and Khatyari sites in comparison to other study sites. *B .stracheyi* revealed 28.69% moisture content which is lowest among all studied sites.

The maximum total fresh weight of *B. ciliata* was 183.6g/plant from Mukteshwar site (Table 2). The belowground and aboveground fresh weight was also maximum (134.4g and 49.2g respectively) from Mukteshwar site. Likewise, Mukteshwar site continued to exhibit the maximum total dry weight (86.82g) followed by Bhowali site (52.53g) and Khati site (44.30g) (Table 2).

Table 2. Total fresh, dry weight (g/plant) and moisture content (%) in *B. ciliata* and *B. stracheyi* at different sites in Kumaun Himalaya.

Sites	Fresh weight (g)	Dry weight (g)	Moisture content (%)
Khatyari (*B. ciliata)*	84.00	42.07	50.08
Kasar Devi (*B. ciliata*)	68.60	34.72	50.61
Binsar (*B. ciliata*)	76.80	35.33	46.00
Bhowali (*B. ciliata*)	114.40	52.53	45.92
Mukteshwar (*B. ciliata*)	183.60	86.82	47.29
Khati (*B. ciliata*)	102.20	44.30	43.35
Pindari (*B. stracheyi*)	42.00	12.05	28.69

The above ground biomass and below ground biomass for *B. ciliata* varied from 8.22 g/plant (Khati site) to 14.34 g/plant (Mukteshwar site) and 26.41 g/plant (Kasar Devi site) to 72.48 g/plant (Mukteshwar site) respectively (Table 3). The aboveground and belowground biomass for *B. stracheyi* was 3.27 g/plant and 8.78 g/plant respectively. Total biomass of *B. stracheyi* for Upper Gori Valley in Kumaun Himalaya was reported being 1462.29 kg/ha by Uniyal et al. (2002). The total biomass of *B. ciliata* was highest (9.455 kg/100m^2) at Bhowali site followed by 8.115 kg/100m^2 at Khati site and 7.223 kg/100m^2 at Mukteshwar site. Lowest total biomass of *B. ciliata* was calculated for Kasar Devi site (3.166 kg/100m^2) followed by 3.193 kg/100m^2 at Binsar site and 5.115 kg/100m^2 at Khatyari site. The total biomass of *B. stracheyi* was reported to be 1.966 kg/100m^2 for Pindari site (Table 3).

Table 3. Biomass variations in *B. ciliate* and *B. stracheyi* at different sites in Kumaun Himalaya.

Sites	Above ground biomass (g/plant)	Below ground biomass (g/plant)	Total biomass (g/plant)	Total biomass (kg/100m²)	Total biomass (kg/ha)
Khatyari (*B. ciliate*)	9.25	32.82	42.07	5.115	511.5
Kasar Devi (*B. ciliate*)	8.31	26.41	34.72	3.166	316.6
Binsar (*B. ciliate*)	8.60	26.72	35.33	3.193	319.3
Bhowali (*B. ciliate*)	10.39	42.14	52.53	9.455	945.5
Mukteshwar (*B. ciliate*)	14.34	72.48	86.82	7.223	722.3
Khati (*B. ciliate*)	8.22	36.08	44.30	8.115	811.5
Pindari (*B. stracheyi*)	3.27	8.78	12.05	1.966	196.6

Therefore, above studies revealed that due to difference in climatic conditions which coupled with a wide altitudinal range (1200 to 3627m) provide a wide diversity that has resulted in diverse density and biomass of *B. ciliate* and *B. stracheyi*. According to the results the best harvesting site for *B. ciliate* is Bhowali followed by Khati and Mukteshwar. Sustainable collection of *B. ciliate* should be done from aforesaid sites for trade that will directly or indirectly make some difference in the economical conditions of localities and habitat conditions to be less disturbed.

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