TAXONOMY AND DISTRIBUTION STATUS OF MOSS RACOMITRIUM CRISPULUM IN KUMAON HILLS OF WESTERN HIMALAYA, INDIA

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Received 05.05.2009. Accepted for publication 19.08.2009

Saxena, Dinesh K. & Saiful-Arfeen Md. 2009 12 30: Taxonomy and distribution status of moss *Racomitrium crispulum* in Kumaon hills of Western Himalaya, India. *–Iran. J. Bot. 15 (2): 248-256.* Tehran.

Present study is focused on the distribution and taxonomy of moss *Racomitrium crispulum* from Kumaon hills. *R. crispulum* have wide range of distribution both attitudinally as well as under microclimate. Distribution of plant with references to density, abundance and frequency implicit their availability for biomonitoring. It is also observed that seasonal environmental changes do not influence distribution and showed their presence also under xeric condition.

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Key words: R. crispulum, systematic, density, abundance, frequency, distribution, India.

تاکسونومي و انتشار خزه **Racomitrium crispulum** در بلندي‌هاي غرب هيماليا، هندوستان

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انتشار و تاکسونومی خزه *Racomitrium crispulum* از بلندی های غربی کوه های هیمالا مورد بررسی قرار گرفته است. این گونه انتشار وسیعی از نظر ارتفاع و میکروکلیما دارد. انتشار گیاه از نظر تراکم، غلبه و فراوانی میتواند به عنوان شاخص در پایش های زیستی مورد استفاده قرار گیرد. همچنین تغییرات زیست محیطی تأثیری بر انتشار گیاه ندارد و حضور آن در شرایط خشک نشان داده می شود.

INTRODUCTION

India exhibits a variety of phytoclimatic conditions within its different biogeographical zone favorable to its great diversity of bryoflora. Despite rich vegetation of bryophytes in forest cover (22.6%) (Banerjee, 1978), there is fragmentary knowledge on the distribution of mosses from Kumaon hills (Saxena et al., 2006). Our knowledge of bryophytic flora of Kumaon hills, is still in neglected state of infancy. Survey conducted by International Association of Bryologists (IAB) for endangered bryophytes revealed that preservation of them is in urgent need before they will extinct (William et al., 2006; Ah-Peng and Bardat, 2005; Saxena and Saxena, 2005; Hallingback, 1992).

Present study is based on exhaustive and periodic seasonal survey in year 2003 on microclimate distribution and on the morpho-taxonomic study of moss *Racomitrium crispulum* (Hook. f. et Wils.) Hook. f. et Wils. The genus is large and complicated and represented by 77 terrestrial and saxicolous species. Taxonomic status of this species is still under doubts. The present state of this species shows that, there are several species merged in *Racomitrium crispulum* including *R. javanicum* & *R. fuscens* Wils.

It is noteworthy that *Racomitrium crispulum* was reported earlier only from Nainital of Kumaon hill of western Himalaya.

MATERIALS AND METHODS

Racomitrium crispulum was collected from Almora, Nainital, Ranikhet, Pithoragarh and Mukteswar of Kumaon hills of western Himalaya during the periodic seasonal survey (Fig. 1). Moss samples were collected during different seasons (i.e. winter, summer and monsoon) in year 2003. The collection were carried out from a uniform area, of at least 50 cm^2 to avoid intraspecific variability caused by ecological factors such as light intensity, temperature, moisture etc.

The humidity of the moss colleting spots was recorded by Psychrometer (AWSPERRY, Taiwan, model no. SLM-110), soil moisture was measured by moisture meter (Korean) and soil pH of the moss collection point was taken by soil pH meter (EW system, USA, model no. O. S. K. Pat 193478). Besides, this the detailed meteorological data were collected from field stations of Vivekanand Parvatiya Avam Krishi Anusandhan Sansthan, Almora; Chaubatia

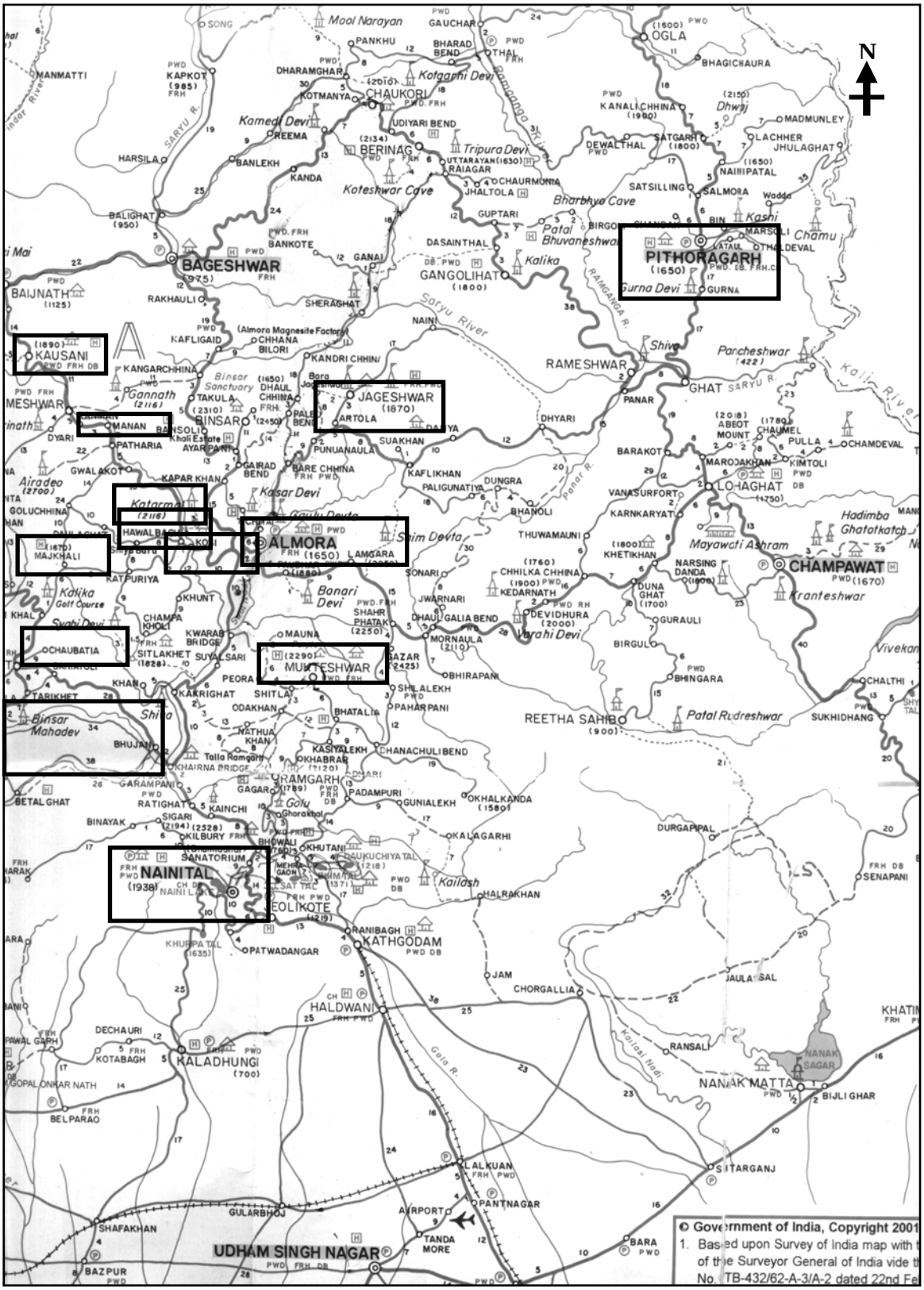

Fig. 1. Map of the study area of Kumaon hill showing the district undertaken for bryoflora collection.

Research Center, Ranikhet and Defense Agricultural Research Institute, Pithoragarh.

The number of individuals of species in each sampling unit was counted for frequency and distribution of that species. The moss *R. crispulum* frequency was calculated by method of Showman (1986) and depicted cartographically using program package Surfer (Golden Software Inc., U. S. A.). (Fig. 2). In order to study the population of species, area was divided into distinct, non-overlapping sampling units. Quadrat sampling method was used for random sampling of bryophytes. The sampling units were 25 cm^2 area of diameter 10 X 10 cm for frequency and distribution of that species (Pandey & Joshi, 2004). Total 54 quadrats were plotted at each site of Almora, Nainital, Ranikhet, Pithoragarh and Mukteswar at every season during year 2003. The bryophytes density and abundance were calculated by the method of Skorepa & Vitt (1976) and Showman (1985) respectively.

$$\text{Frequency } (\%) = \frac{\text{Total number of quadrats in which species occurred}}{\text{Total number of quadrats studied}}$$

$$\text{Density} = \frac{\text{Total number of individuals of the species}}{\text{Total number of quadrats studied}}$$

$$\text{Abundance} = \frac{\text{Total number of individuals of the species}}{\text{Total number of quadrats in which species occurred}}$$

The collected bryophytes were processed and deposited in the "*Bryophyte Environmental Bank*", of Bryology division, Botany Department, Bareilly College, Bareilly, INDIA and are sent to Prof. Tamas Poćs, Bryology Lab, Eger Univerisity, Eger, HUNGARY.

The collected bryoflora were identified from various floras cited in literatures (Smith, 2004; Chopra & Kumar, 1990; Gangulee, 1969) and were tallied with the specimens borrowed on loan from Eger Univerisity, Eger, HUNGARY and of the Herbarium of University of Michigan (MICH), Ann Arbor, Michigan, USA.

OBSERVATIONS

Racomitrium crispulum (Hook. f. et Wils.) Hook. f. et Wils. in Fl. Nov. Zel., **2**:75 (1854).

Plant cladocarpous, dioecious; stem erect and elongated; 4-5 cm long and prostrate with short branchlets on main stem (Figs. 3 & 4). Leaves olive green, uniformly unistratose and falcatosecund near tips. Leaves 2.2-2.8 mm long and 0.5-1 mm wide when moist. Leaf cells thick walled, incrassate and strongly sinuose, linear and elongated near the base (Fig. 3). The middle wall is narrow sinuose and highly incrassate side walls. Orange coloured alar cells are rounded to 4-6 sided and have about 3 rows wide at leaf base with smooth cells. Seta orange, straight and twisted 0.8-1.2 cm long.

DISTRIBUTION AND ECOLOGY

The Kumaon region is spread over 21,073 Km^2 and had extensive tracts of natural forests until a few centuries back. *Racomitrium crispulum* is distributed on mountain ranges between 640 to 2290 meters. Western Himalayas i.e. latitude 29˚5′- 31˚25′N and longitude 79˚43′-81˚E located in district Almora, Nainital, Ranikhet, Chaubatia and Pithoragarh of Kumaon hills.

It has been also found growing luxuriantly at high altitude of 2290 meters at Mukteswar which was never reported earlier. During field survey it was found at different gradient starting from 1219 to 2290 meters (Table. 1). It grows epiphytically on tree bark, trees, dominantly on rocks and rarely on soil. Predominantly on north facing mountains, the vegetation was rich owing to the low temperature range from 0 to 10 °C (Table. 1). The macroclimatic factor (Figs. 5 & 6) is justifying for their presence.

DESCRIPTION OF LOAN SPECIMENS EXAMINED

1. Musci Australasiae Exsiccati

Edited by H.Streimann

194. *Racomitrium crispulum* (Hook. f. & Wils) Hook. f. & Wils., Fl. Nov. Zel. 2: 75 (1854).

Syn.: *Dryptodon crispulus* Hook. f. &Wils., London J. Bot. 3: 544, 1844.

Collection site: NEW ZEALAND. South Island: Mt. Rochefort, Denniston Plateau, 11 Km ESE of Westport. 41º46'S- 171º 45'E, alt. 990m. Semi-exposed moist shrubby area on gentle southerly slope. On rock; 2nd Feb 1993.

2. Flora Novae- Zelandiae

Edited by Schäfer- verwimp

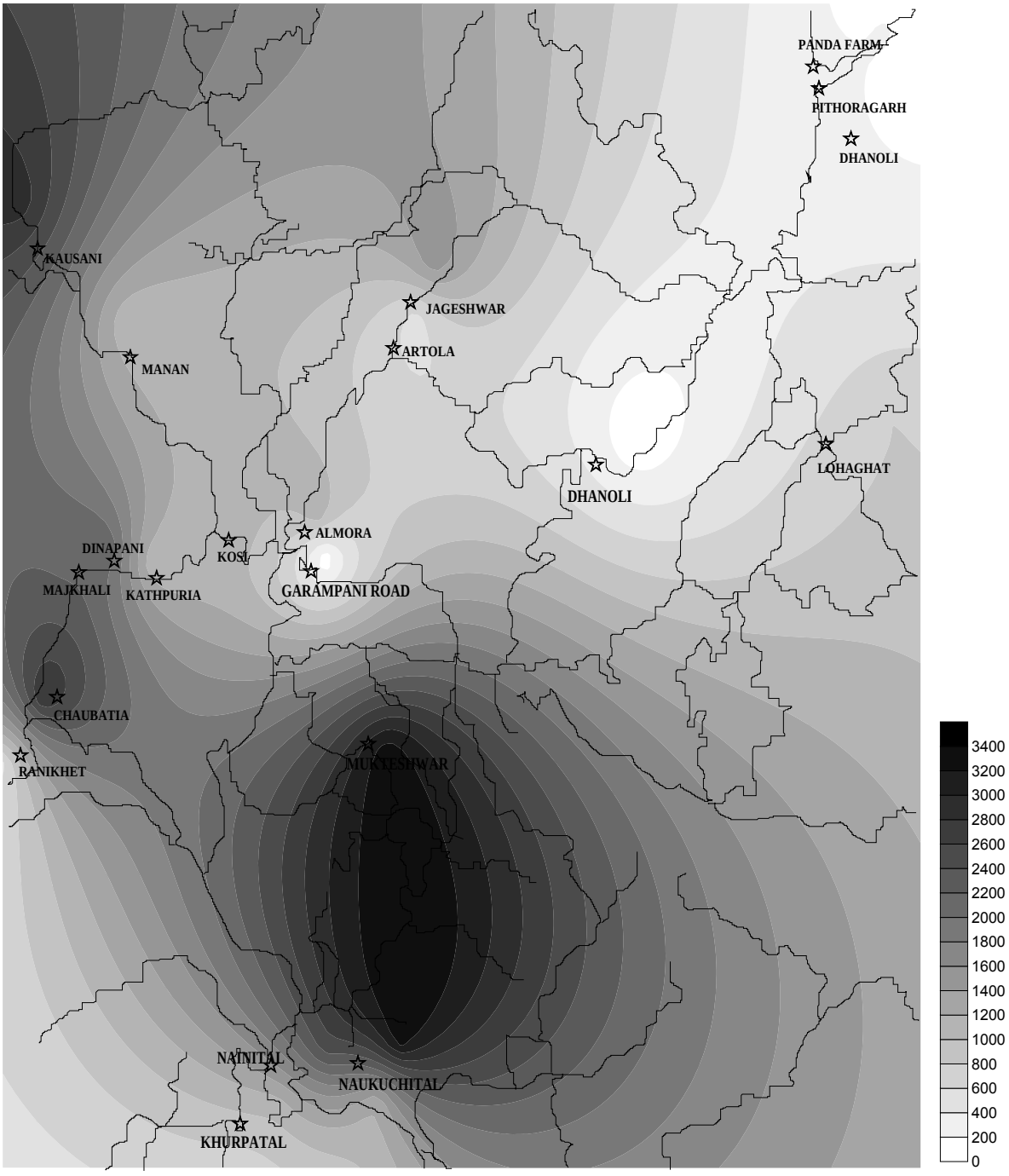

Fig. 2. Cartographic representation of abundance of moss *Racomitrium crispulum* throughout the Kumaon hills of Western Himalaya (INDIA).

Fig.3. *Racomitrium crispulum* (Hook. f. et Wils.) Hook. f. et Wils. 1, 5, 6, 11 & 12 Leaf folding (440X), 2, 3 &10 Leaf (100X), 8 Leaf basal with alar cell (440X), 7 Leaf upper lamina cells (440X), 4 & 9 Whole Plant (20X).

Fig. 4. Collected specimen *Racomitrium crispulum* from Ranikhet site during winter season in year 2003.

Racomitrium crispulum (Hook. f. & Wils) Hook. f. & Wils. Collection site:
SOUTH ISLAND. Fjordland National Park Zwischen Te Anau und Milford Sound, Subalpine Vegetation mit Blockhalden buderseits des Homer Tunnels, auf exponiertem Fels; 820m NN
Leg.- Schäfer- verwimp & Verwimp 29. Jan 1991.
Det.- Schäfer- verwimp & Verwimp (1997).

ACKNOWLEDGEMENT

The present study is supported by financial assistance of Department of Biotechnology, Ministry of Science and Technology (Grant no. BT/PR3 108/BCE/08/235/2002). Special gratitude to Prof. Tamas Poćs, Eager University and Prof. Zoltan Tuba, Szent Istvan University, HUNGARY for taxonomic discussion. Thanks extended to MICH, Ann Arbor, Michigan, USA for loan specimen. Special gratitude to the Head of the Institute. For meteorological data Directors of field stations of VPKAS (Almora), CRC (Ranikhet) and DARI (Pithoragarh) are duly acknowledged.

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Table. 1. Distribution and position of moss *Racomitrium crispulum* (Hook. f. et. Wils.) Hook. f. et. Wils. in Kumaon hill during year 2003. Data representing mean of three observations in periodic survey after every four months (seasonal basis).

	PLACE	ALTITUDE (Meter)	AREA	OCCURANCE/ SUBSTRATUM	MOUNTAIN POSITION	pH
1	Almora	1650	close to city	soil	N	6.9
2	Kausani	1890	forest	On bark &land (North facing)	NW	6.9
3	Manan	1762	forest	North West rock	NW	6.8
4	Garampani road	640	close to village	rock	N	7.0
5	Dinapani	1980	close to village	pine tree trunk	NE	7.1
6	Majkali	1670	rural area	rock	N	7.1
7	Artola	1868	forest	tree bark, rock	N	7.0
8	Jageswar	1870	Deodar forest	tree bark	N	6.9
9	Kosi-Katarmal	2116	agricultural area	soil, artificial substrate	NW	6.8
10	Kathpuria	1835	forest	Land (Yellowish red soil)	NW	6.8
11	Nainital	2100	pine forest	Cave area & University road on wall	NE	68
12	Khurpatal	1650	tourist place	Both side with tickling water (NALA)	E	6.8
13	Dhobighat	2270	Lake	rock	-	6.8
14	Naukuchital	1219	Lake	rock	-	6.8
15	Cheena peak	2500	forest	rock, Deodar tree trunk	NW	6.8
16	Mukteswar	2290	dense forest	on land (yellowish red soil)	NE	7.0
17	Pithoragarh	1650	close to city	soil, rock	NE	7.1
18	Lohaghat	1750	forest	tree, tree bark	N + E	7.1
19	Dhanoli	1123	close to village	soil, artificial substrate	-	6.9
20	Panda farm	1602	agricultural area	Near Nala (trickling water)	W	6.9
21	Chadar Deol	1592	tourist temple	trickling water	-	6.9
22	Ranikhet	1790	close to city	soil, artificial substrate	-	7.0
23	Chaubatia	1820	forest	Road side in forest	NE	7.0

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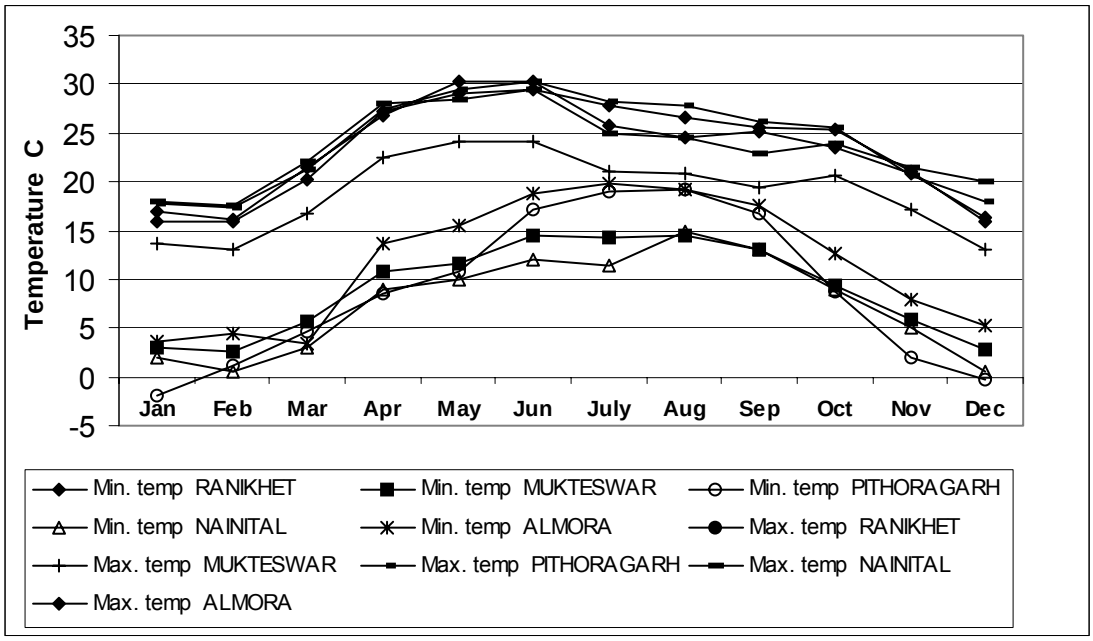

Fig. 5. Average mean temperature (max & min) difference on monthly basis in year 2003.

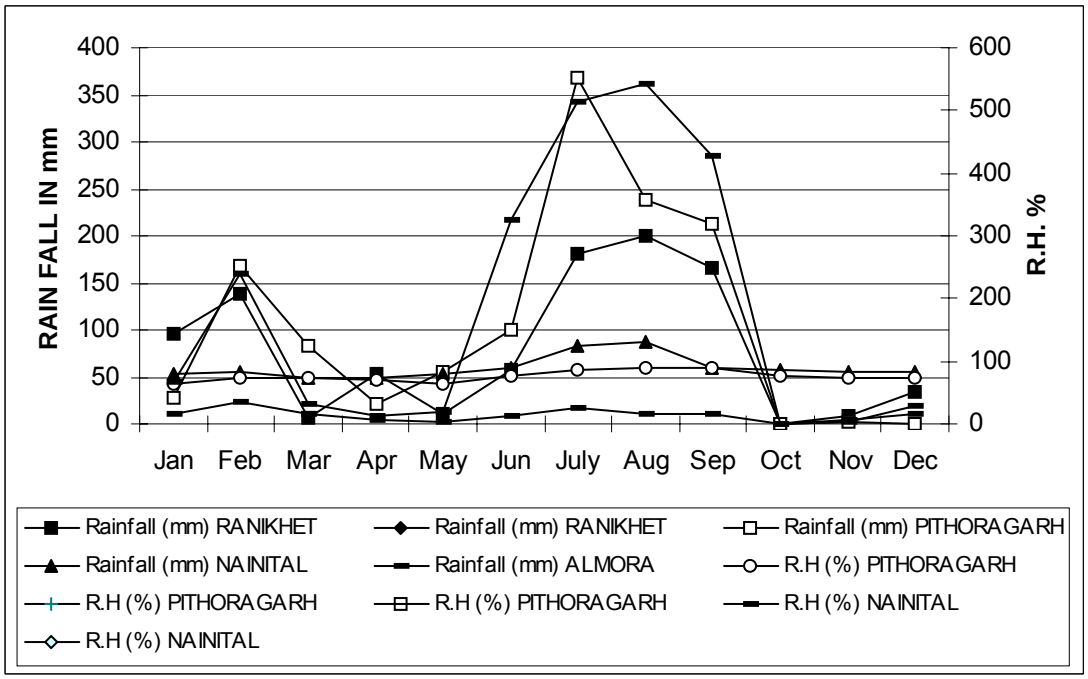

Fig. 6. Average mean rain fall and relative humidity difference on monthly basis in year 2003.

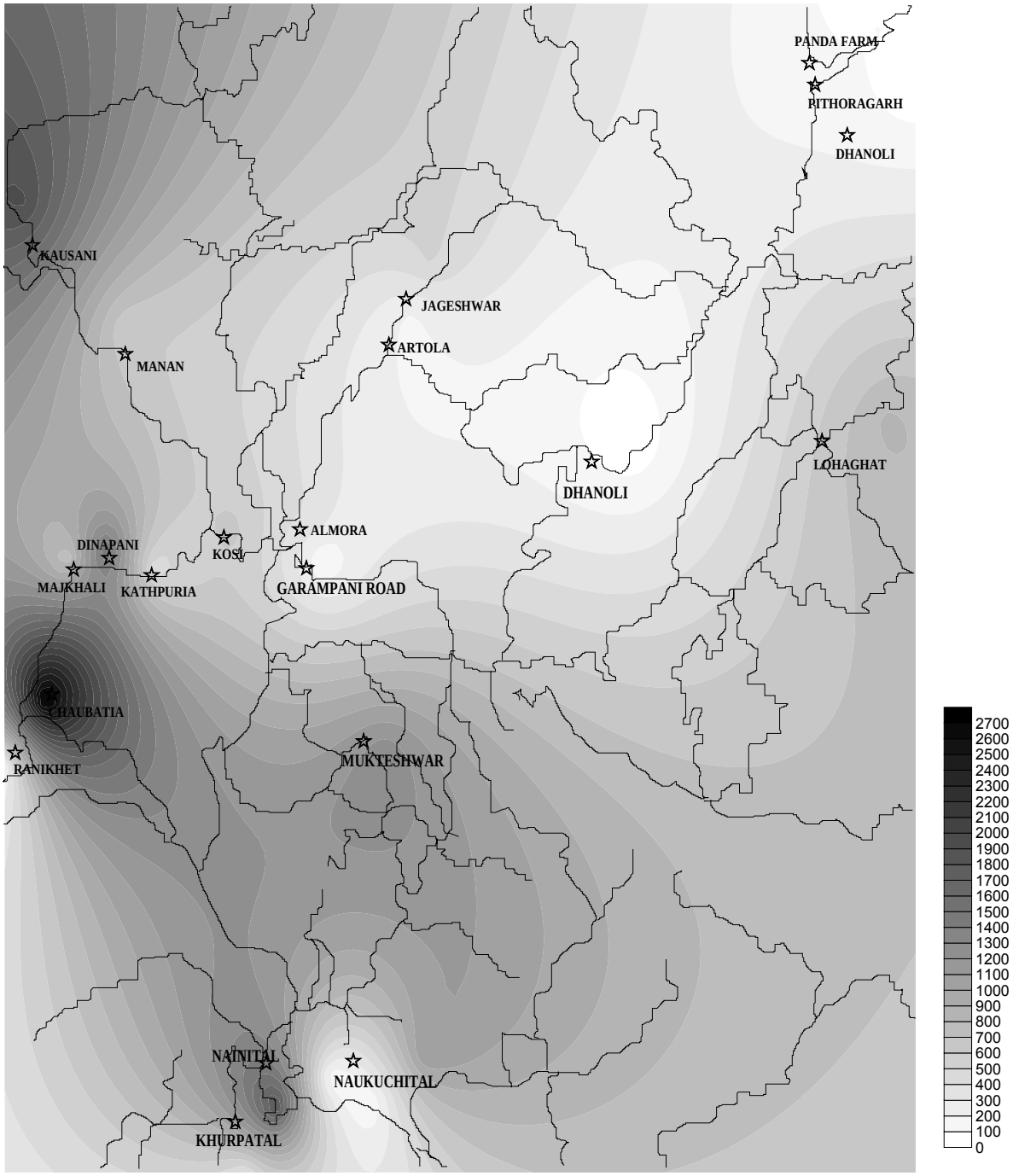

Fig. 7. Cartographic representation of density of moss *Racomitrium crispulum* throughout the Kumaon hills of Western Himalaya (INDIA).