

Anoectangium thomsonii Mitt. (Pottiaceae, Bryophyta) from Uttarakhand, India

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ABSTRACT

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The moss *Anoectangium thomsonii* Mitt. is widely distributed in almost all the bryo-geographical regions of the Kumaon and Garhwal regions of Uttarakhand state of India, where it grows luxuriantly especially on calcareous rocks and dry and arid places. Although this species has earlier been listed from this region, the present study is first attempt for a GPS-based distribution and regional taxonomic description of the species.

Key-words: *Anoectangium thomsonii* Mitt., Pottiaceae, moss, taxonomy, GPS based distribution, Uttarakhand, India.

INTRODUCTION

The large area and variety of phyto-climatic conditions within different biogeographical zones contribute to the great and rich diversity of the Indian flora. Bryophytes, like other plant groups, are an important component of any forest ecosystem (Carleton & Maycock 1981, Glime & Saxena 1991, Rose 1992, Selva 1994). The north-western Himalayan region is known for the luxuriant bryophyte growth, both in frequency as well as in diversity (Gangulee 1969, 1970, Pant & Tewari 2002).

Uttarakhand (Lat. 28°43'N to 31°27'N; Long. 77°34'E to 81°02'E) is located at the foothills of the north-western Himalaya. This region is rich in natural resources especially water, glaciers, rivers, dense forests and snow-clad mountain peaks. It exhibits all major climatic zones; making

it amenable to rich plant diversity. The moss was collected from calcareous, rocky, dry and arid places. Plants were carefully separated out, and gametophytes appeared to be *Anoectangium thomsonii* Mitt. of the family Pottiaceae. Only scattered information is available for *Anoectangium thomsonii* in floristic lists (Barukial 2011). Family Pottiaceae is the largest known moss family, containing nearly 1500 species or more than 10% of the 10000 to 15000 moss species known (Buck & Goffinet 2000). The family is widely distributed in a great diversity of environments, mainly in temperate and mountainous regions. Many of them are especially adapted to dry climates and they are often the dominant mosses in arid regions. Aziz and Vohra (2008) provided an account of 29 genera with 130 species from India and Nath et al. (2011) described Pottiaceae from central India.

Anoetangium belongs to the family Pottiaceae. The taxonomy of the genus is difficult because of the obscure areolation, small size of the plants, and apparent phenotypic variation. A generic-level treatment by Zander (1993) pulled together the scattered literature and de-emphasized sporophytic characters, allowing easier identification of sterile plants. The genus is sporadically distributed almost throughout the world, including North and Central America, S.E. Europe (Sabovljević et al. 2008), Africa (Ros et al. 1999), New Zealand (Zander & Eckel 2007), Europe (Hill et al. 2006), Eurasia (Ignatov et al. 2006) and Southwest Asia (Kürschner & Frey 2011). The first report of *Anoetangium* in India was by Mitten (1859) who recognised several specimens, including syntypes. These species were mainly collected from Sikkim, NW Himalaya. All these specimens were collected from rocks or cliffs (Li & Iwatsuki 1997).

Dandotiya et al. (2011) listed *Anoetangium thomsonii* Mitt. from Darjeeling, Kangra, Chakrata, Sikkim, Garhwal, Kumaon, Uttar Pradesh, Mussoorie, W. Himalaya, Kanyakumari district, Western Ghats and Maramalai. Earlier, it was briefly described by Gangulee (1969).

MATERIAL AND METHOD

Extensive surveys were made in the winter (November to February), summer (March to June) and rainy seasons (July to October) of 2009 and repeated in 2010 using GPS to map the actual localities of the moss growing in these regions (Table 1).

Plants of this species were collected, for the first time, mostly from basic soil as ephemeral tufts, and along the roadside rocks in different seasons representing winter, summer and rainy, during 2009 and 2010 from different regions (Text-figure 1) of the Kumaon hills (Mukteshwar, Nainital, Ranikhet, Chaubatia, Almora, Artola, Jageshwar and Pithoragarh) as well as from the Garhwal hills (Campty Fall, Bhatta and Buransh Khand). Meteorological data were recorded at each study-site, and measurements of the temperature,

light, and relative humidity were made using digital infrared thermometer and a thermo-hygrometer (Table 1). Samples were collected and brought to the laboratory for identification using available floras (Gangulee 1969, Chopra 1975, Smith 1978). Line drawing illustrations were made with the help of a Camera Lucida (Olympus, Tokyo). Voucher specimens were prepared and deposited in the 'Bryophyte Experimental Bank' of the Botany Department,



Text-figure. 1. Map of Uttarakhand showing sites surveyed. ★ Study Sites

Bareilly College, Bareilly, numbered as 200911000268 (a) – 200911000268 (d), 200911002168 (a) – 200911002168 (d), 200911002468 (a) – 200911002468 (d), 200912003668 (a) – 200912003668 (d), 201007014668 (a) – 201007014668 (d), 201007014768 (a) – 201007014768 (d), 201007015368 (a) – 201007015368 (d), 201007015468 (a) – 201007015468 (d). Collected voucher specimens were also submitted to Missouri Botanical Garden, St. Louis, USA.

RESULTS

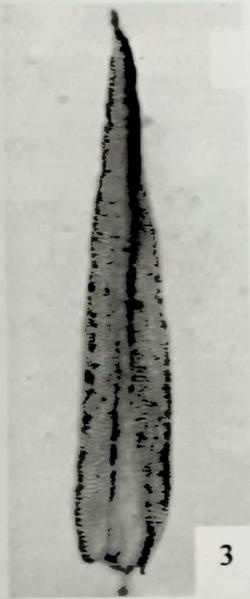
Moss specimens collected from the field were turf-forming (Plate 1, figures 1, 5), green distally and brown proximally, and paroicous. Stems



1



2



3

1, 2, 5 —————
10 x 5 mm
3 —————
1.05 x 0.138 mm
4 ———
0.11 mm
6 ———
0.11 mm



4



5



6

Plate 1

1-6. *Anoctangium thomsonii* Mitt. 1, 2, 5. Whole plant. 3. Leaves. 4. Mid-leaf cells. 6. Basal cells.

Table 1. GPS based data of native sample sites in Uttarakhand for *Anoetangium thomsonii* Mitt., collected during summer, rainy and winter seasons of 2009–2010.

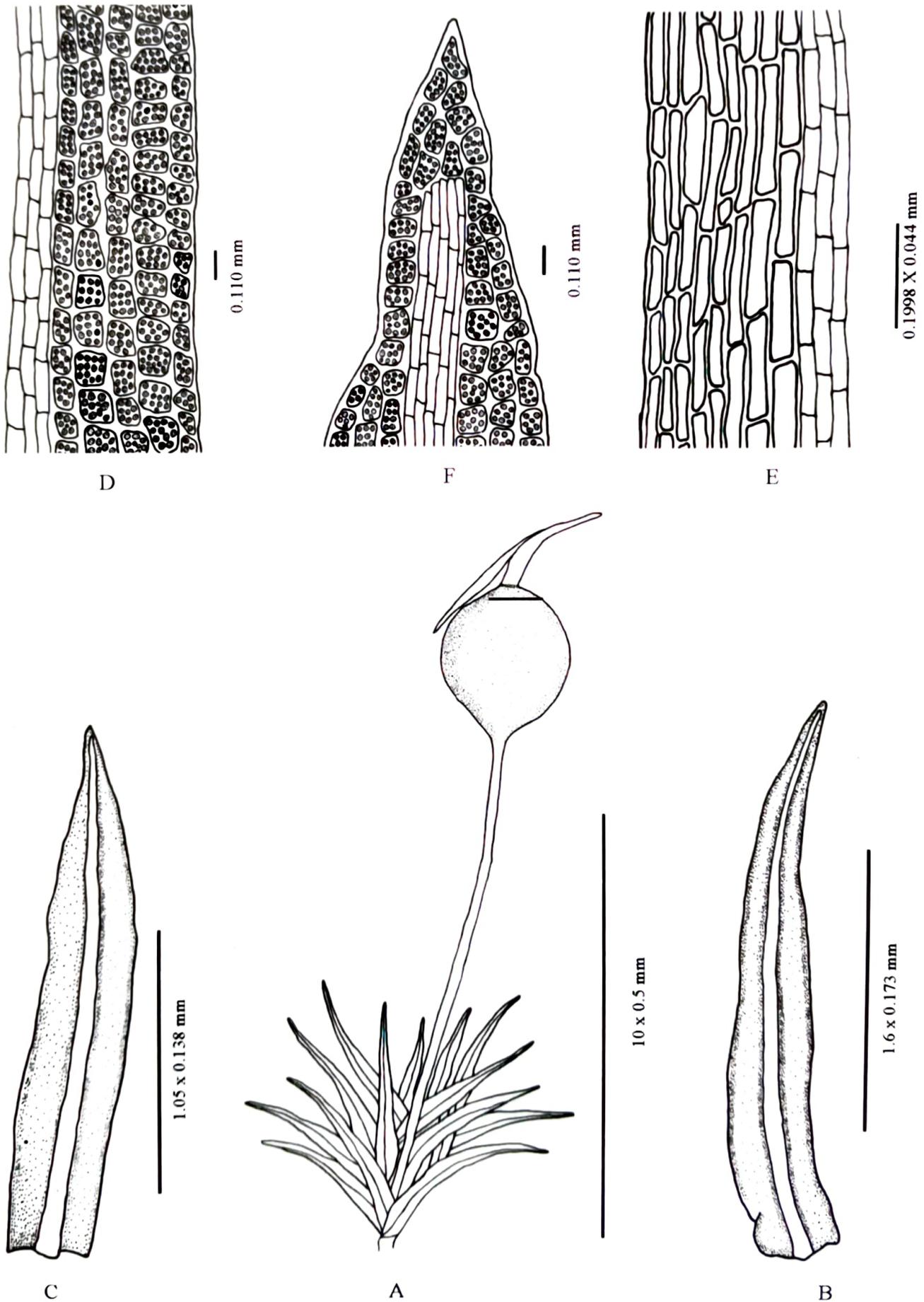
Stations/Season	Geographic coordinates		Meta data			
	Latitude N	Longitude E	Average Temp°C	Soil pH	Humidity %	Light (Foot Candle)
Mukteshwar						
Summer	29°28.638'	79°39.198'	18.1	7.9	51	1000
Winter	29°29.111'	79°42.200'	7.0	8.0	45	500
Rainy	29°30.985'	79°45.365'	8.5	7.5	76	8
Satkhol						
Summer	29°30.092'	79°32.152'	23.5	7.9	51	1000
Winter	29°31.195'	79°33.269'	13.3	7.8	59	500
Rainy	29°29.117'	79°31.335'	19.2	7.2	72	16
Artola						
Summer	29°37.023	79°51.870'	20.0	7.1	40	2000
Winter	29°37.603'	79°50.267'	10.0	7.7	29	1000
Rainy	29°37.515'	79°50.022'	13.0	7.9	81	32
Nainital						
Summer	29°23.211'	79°28.400'	23.1	7.8	34	2000
Winter	29°23.111'	79°27.432'	8.0	8.1	55	1000
Rainy	29°24.102'	79°26.263'	10.1	8.1	74	65
Pithoragarh						
Summer	29°34.620'	80°12.640'	29.4	7.9	40	2000
Winter	29°34.525'	80°12.666'	16.0	7.6	45	500
Rainy	29°34.648'	80°12.702'	12.0	7.9	79	16
Campy Fall						
Summer	30°25.375'	78°12.262'	32.2	8.2	25	1000
Winter	30°25.702'	78°04.606'	12.8	8.1	51	65
Rainy	30°27.334'	78°10.599'	8.0	8.4	80	16
Bhatta						
Summer	30°26.300'	78°10.265'	36.4	7.9	37	2000
Winter	30°25.375'	78°04.773'	20.0	8.0	42	500
Rainy	30°25.375'	78°04.773'	9.0	8.1	79	32
BuranshKhand						
Summer	30°26.335'	78°12.262'	34.7	Rock	29	2000
Winter	30°25.985'	78°04.426'	25.0	7.8	65	500
Rainy	30°25.385'	78°04.426'	12.0	8.1	77	8

measured 1–1.5 cm, Leaves are appressed and often contorted when dry, spreading when wet, ovoid to lanceolate or lingulate (Text-figure 2B, C, Plate 1, figures 3, 4, 6), often channelled or keeled. Leaves are 2–3 times longer than wide; upper cells quadrate (Text-figure 2C, Plate 1, figure 3), 0.11–0.15 μm wide, 1.5–3.5 μm in length, and strongly papillose (Text-figure 2D, Plate 1, figures 4, 5). Setae are solitary, lateral on the stem, elongate, 0.6–0.9 cm long; capsule, gymnostomous, reddish brown in colour with rough calyptras, ovate, 0.6–1.0 mm in diameter (Text-figure 2A, Plate 1, figure 2). Peristome absent. Annulus of two rows of deep

coloured, incrassate, horizontal cells ($\pm 32 \times 8.2 \mu\text{m}$). (Plate 1, figure 2). The aforesaid characters and habitat are in agreement with the characters of the species (Chen 1941, Saito 1972).

DISCUSSION

The cauline leaves that are typically lanceolate to spatulate and papillose suggest that moss belongs to family Pottiaceae. The family is also characterized by leaves stiff and erect when dry, with longer leaves generally scarcely wider at mid leaf to sometimes twice as wide. Laminal cells arranged in rows are a characteristic of family



Text-figure 2. *Anoectangium thomsonii* Mitt. A. Whole plant. B-C. Leaves. D. Mid-leaf cells. E. Basal cells. F. Leaf apex.

according to Norris & Koponen (1989). Some genera may have some species with bistratose laminae and some species with unistratose laminae. Basal laminal cells are called hyalocysts which, when much enlarged, become devoid of chlorophyll and are epapillose. The basal cells may be wide or little wider than the upper cells, and are generally smooth and elongated. Leaves, habitat and morphological structure suggest that specimens examined are of Pottiaceae and the genus *Anoetangium*. Thus present finding is in agreement with the report of Zander (2006) that *Anoetangium thomsonii* appears to be the dominant terrestrial, erect moss growing on calcareous rock in the region, in terms of distribution.

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REFERENCES

- Aziz M. N. & Vohra J. N. 2008. Pottiaceae (Musci) of India. Bishen Singh Mahendra Pal Singh, Dehradun, India.
- Barukial J. 2011. A bryofloristic ecological assessment of Assam, India. *Indian J. Fundamental Appl. Life Sci.* 1(3): 98-106 (An Online International Journal Available at <http://www.cibtech.org/jls.htm> 2011).
- Buck W. R. & Goffinet B. 2000. Morphology and classification of mosses. In: Shaw A. J. & Goffinet B. (Editors) - *Bryophyte Biology*. Cambridge Univ. Press 71, 119 pp.
- Carleton T. J. & Maycock P. F. 1981. Understory-canopy affinities in boreal forest vegetation. *Canadian J. Bot.* 59: 1709-1716.
- Chen P. C. 1941. Studienuber die ostasiatischen Arten der Pottiaceae, I-II. *Hedwigia* 80: 1-76, 141-322.
- Chopra R. S. 1975. *Taxonomy of Indian mosses*. Publication & Information Directorate (CSIR), New Delhi 114.
- Dandotiya, D., Govindaparyi H., Shantanu Suman & Uniyal P. L. 2011. Checklist of the bryophytes of India. *Archive for Bryology* 88: 1-126.
- Gangulee H. C. 1969. *Mosses of eastern India and adjacent regions*. Books and Allied Pvt. Ltd, Calcutta, 635 pp.
- Gangulee H. C. 1970. Addition to the mosses of eastern India and adjacent regions. III. *Bull. Bot. Soc. Bengal* 23: 131-134.
- Glime J. M. & Saxena D. K. 1991. *Uses of Bryophytes. Today and Tomorrow's Printers & Publishers, New Delhi*, pp. 100.
- Hill M. O., Bell N., Bruggeman-Nannenga M. A., Brugges Cano M. & Enroth J. 2006. An annotated checklist of the mosses of Europe and Macaronesia. *J. Bryol.* 28: 198-267.
- Ignatov M. S., Afonina O. M. & Ignatova E. A. 2006. Check-list of mosses of East Europe and North Asia. *Arctoa* 15: 1-130.
- Kürschner H. & Frey W. 2011. *Liverworts, mosses and hornworts of southwest Asia (Marchantiophyta, Bryophyta, Anthocerotophyta)*. Nova Hedwigia Suppl. J. Cramer, Stuttgart.
- Li X.-J. & Iwatsuki Z. 1997. Revision of the genus *Anoetangium* from China. *Acta Botanica Yunnanica* 19(3): 243-250.
- Mitten W. 1859. *Musci Indiae Orientalis; an Enumeration of the Mosses of the East Indies*. *J. Proc. Linnean Soc., Suppl. Bot.* 1: 1-171.
- Nath V., Asthana A. K. & Gupta R. 2011. An overview of family Pottiaceae (Bryopsida) in central India with special reference to Pachmarhi Biosphere Reserve (PBR). *Lindbergia* 34: 30-39.
- Norris D. H. & Koponen T. 1989. Bryophyte flora of the Huon Peninsula, Papua New Guinea. XXVIII. Pottiaceae (Musci). *Acta Bot. Fennica* 137: 81-138.
- Pant G. B. & Tewari S. D. 2002. *Bryophytes of Kumaon Himalaya*. Bishen Singh Mahendra Pal Singh, Dehradun, India, 188 pp.
- Ros R. M., Jimenez M. N. & Guerra J. 1999. Bryophyte checklist of northern Africa. *J. Bryol.* 21: 207-244.
- Rose F. 1992. Temperate forest management: Its effects on bryophyte and lichen floras and habitats. In: Bates J. W. & Farmer A. M. (Editors), *Bryophytes and lichens in a changing environment*. Oxford, Clarendon Press, 284-313 pp.
- Sabovljević M., Natcheva R., Dihoru G., Tsakiri E., Dragičević S., Erdag A. & Papp B. 2008. Check-list of the mosses of Southeast Europe. *Phytologia Balcanica* 14(2): 159-196.
- Saito K. 1972. Taxonomic and phytogeographic studies of specimens previously reported as *Molendia sendtneriana*. *J. Hattori Bot. Lab.* 36: 163-170.
- Selva S. B. 1994. Lichen diversity and stand continuity in the northern hardwoods and spruce-fir forests of northern New England. *Bryologist* 97: 424-429.
- Smith A. J. E. 1978. *The moss flora of Britain and Ireland*. Cambridge & al., Cambridge Univ. Press. 271 pp.
- Zander R. H. 1993. Genera of the Pottiaceae: mosses of harsh environments. *Bull. Buffalo Soc. Nat. Sci.* 32: 1-378.
- Zander R. H. 2006. The Pottiaceae s. str. as evolutionary Lazarus taxon. *J. Hattori Bot. Lab.* 100: 581-602.
- Zander R. H. & Eckel P. M. 2007. *Anoetangium*. In: *Flora of North America Committee, eds. Flora of North America Vol. 27. Bryophytes: Mosses, Part I* New York: Oxford University Press. pp. 520-523.