

# Morpho-structural anomalies in leaves of some Himalayan mosses

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## ABSTRACT

While analyzing bryophyte collections made from the Gairsain and Mukteshwar region of Uttarakhand in Western Himalayas (India), we observed unfamiliar, morpho-structural and developmental anomalies in some moss leaves. On the whole, six species of mosses belonging to six different families were fortuitously observed to present abnormalities in their leaves. The present paper elucidates the teratology of deformed leaf structures of some mosses, which are being reported for the first time. The exact cause of foliar deformities in mosses is not yet known however, it could be caused by changes in regional physicochemical substrate conditions, as well as rapid climate change. These preliminary observations will pave the way for more future investigations. We came across some unfamiliar moss leaf structures.

Keywords- Anomalous, Bryophyte, Morpho-structural, Moss Leaves, Western Himalayas

## 1. INTRODUCTION

Plant anomalies, either in structure or function are well known in many of the plants including Angiosperms, Gymnosperms, and Pteridophytes (Shull 1901; Chrysler 1926; Rudall et al. 2011). Literature survey reveals that few cases of abnormality are reported in thalloid liverworts. Pande et al. (1953) found anomalous female receptacles of *Asterella khasiana*; Udar and Chandra (1964) reported Polyembryony in *Mannia foreau*; Sharma and Langer (2017) reported Anomalies in male receptacles of *Plagiochasma appendiculatum*. In mosses, abnormal sporophyte and embryonic structures are also known. Coker (1903) reported occurrence of two eggs in the archegonium of *Mnium*. Holferty (1904) explained the abnormal archegonium of *Mnium cuspidatum*. Lyon (1905) observed Polyembryony in *Sphagnum*. Emig (1924) reported twin eggs in *Bryum caespiticium*. Shull (1925) described abnormal archegonium of *Funaria hygrometrica*. In the *Polytrichum commune*. Andrews (1939) observed a double sporophyte. Egunyomi (1978) reported Polysety in *Octoblepharum albidum* and *Calymperus subdecolorans*. However, deformities in moss gametophyte, particularly in leaf structures, have not been delineated earlier. As in mosses, a leaf is the primary diagnostic tool for their identification showing a great degree of structural specialization between

different species. Bowden et al. (2007) categorically mentioned that in mosses, the leaf shape, texture, and color are the typical bases for identification. The considerable variation that occurs in the arrangement and structure of moss leaves provides some of the most valuable characters for species determination (Stotler & Began, 2007; Bhandari et al., 2020). Usually, moss leaves show significant variations in shape and size, but some uncommon peculiar abnormal leaf structures are rarely noticed on close microscopic observations. During the bryo-floristic survey of Kumaun and Garhwal regions in Uttarakhand, Western Himalayas (India), some uncommon anomalous structures of moss gametophyte, particularly leaves, were noticed. The deformed leaf structures in some mosses that attracted our attention are being described.

## 2. MATERIAL AND METHODS

Bryophytes were collected from different localities of Uttarakhand. Details on the habit, habitat, and elevation were recorded. Relevant literature was consulted for the confirmed identity of the taxa. While performing identification work of the bryophyte samples, morpho-structural, unforeseen abnormalities were observed under the microscope. Permanent slides of both normal and deformed leaves were prepared in gum chloral mounting medium (Watson, 1955), and photomicrographs were taken.

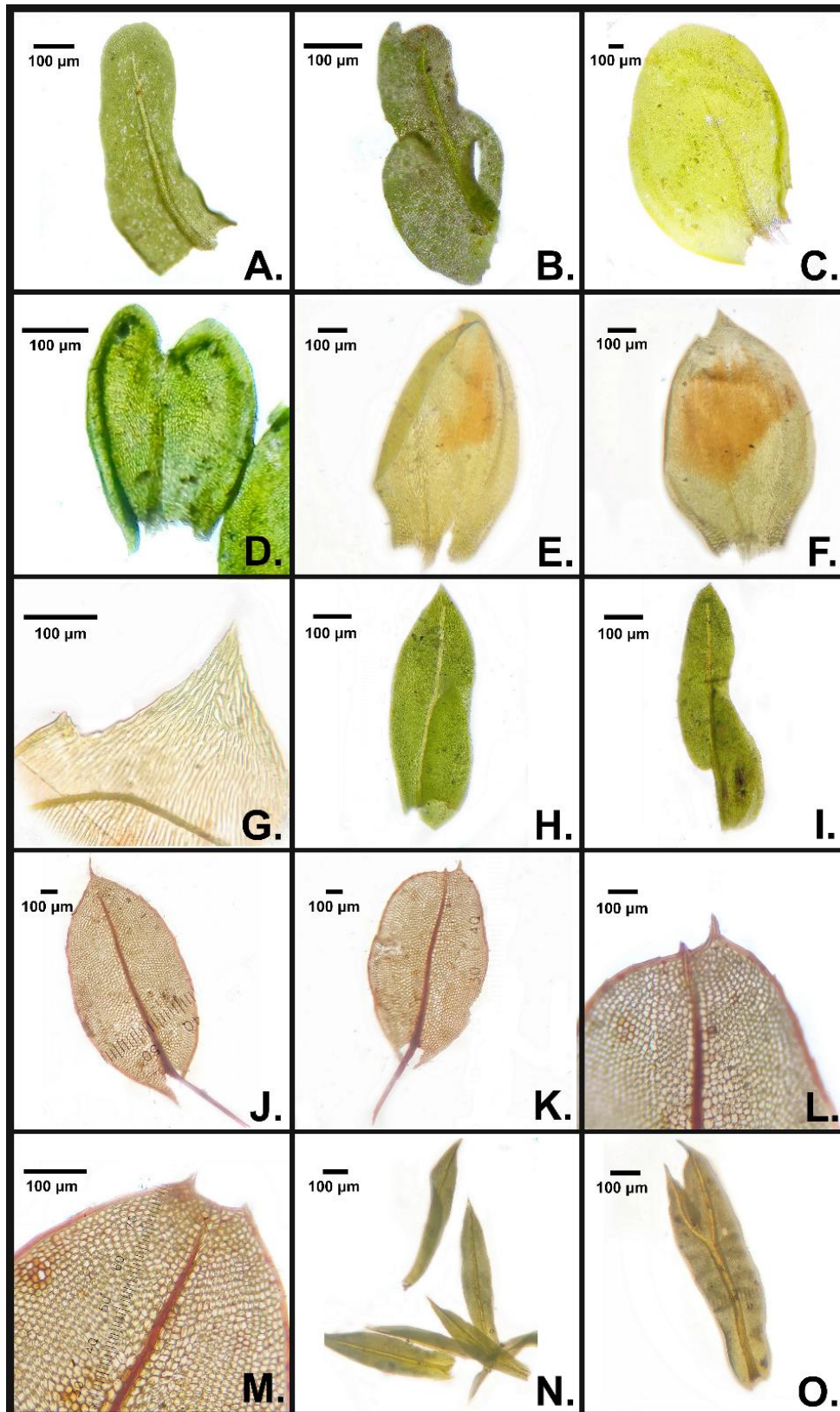
## 3. RESULTS AND DISCUSSIONS

During bryo-exploratory studies in the Kumaun region of Western Himalayas, deformed, aberrant moss leaf forms were discovered. In some mosses, noticeable morpho-structural and developmental anomalies in leaf shape, position of the costa and structure of the leaf tip are being explained separately.

1. Chick embryo-like abnormal leaf of *Anomodon minor* (Hedw.) Lindb. Epiphytic on Oak tree trunk at Gairsain (1800 m), specimen number NG- 17. *A. minor* is a dark green, non-glossy, stiff, and robust Thuidiaceae moss. Usually, the leaf is ovate to lanceolate, broadly ligulate, but due to disfigurement of the leaf, it seems like a chick embryo. (Fig. 1 A, B).
2. Cordate leaf of *Cryptolepodon flexuosus* (Harv.) Renauld & Cardot. Epiphytic on Oak tree trunk and branches at Mukteshwar (2170 m), specimen number SP- 3. An interesting, abnormal leaf shape is encountered in a Pterobryaceae, pendant moss *C. flexuosus*. Usually this moss has an ovate leaf with an obtuse apex, but the deformed leaf gives a heart-shaped (cordate) appearance. (Fig. 1 C, D).
3. Pseudo-dual tips of *Entodon rubicundus* (Mitt.) Jaeg. On a soil-covered rock at Gairsain (2290m), specimen number NG- 138. *E. rubicundus*, a glossy moss of family Entodontaceae, shows a unique morphological anomaly where the Leaf margin near the apex with incomplete growth reflects an abnormal pseudo dual leaf tip-like appearance. (Fig. 1 E, F, G)
4. Disproportionate distichous leaf of *Fissidens laxitextus* Broth. ex Gangulee. Epiphytic on an oak tree base at Gairsain (1720 m), specimen no. NG- 18. *F. laxitextus*, a minute Fissidentaceae moss showing unique abnormality, where the sheathing lamina seems to be slide down from its actual position. The moss leaf appears to be disproportionately distichous. (Fig. 1 H, I).
5. Misdirected costa of *Mnium marginatum* (Dicks. ex with.) P. Beauv. On wet slopy soil at Gairsain (1730 m), specimen no. NG- 24A. A unique type of abnormality was observed in a Mniaceae moss, *M. marginatum*, where leaf costa gives misdirected structure as false leaf tips. (Fig. 1 J, K, L & M).
6. Commingled bifurcating abnormal leaf tip of *Zygodon viridissimus* (Dicks.) Brid. On a soil-covered rock at Gairsain (1620 m), specimen no. NG- 2A. A remarkable case of fasciation was observed in an Orthotricaceae moss, *Z. viridissimus*, where the leaf shape appears as conjugated twins in which the basal portion of the leaf seems normal with the upper commingled leaf tips and bifurcating Y-shaped costa. (Fig. 1 N, O).

## 4. CONCLUSION

The present study highlights the morpho-structural and developmental deformities noticed in leaves of some mosses collected from diverse habitats and localities of Uttarakhand. Maximum moss species have shown abnormal features are from the collection site Gairsain followed by the Mukteshwar region (Western Himalayas). Although the exact cause of the abnormality is unknown, it may be presumed that the deformities in leaf structures may be due to the influence of changing regional physicochemical nature of the underlying substrate conditions coupled with rapid climate change regulating the developmental activity of the moss leaves. In the future more careful monitoring and attention will be required to spot any gametophytic abnormalities in other moss species.



**Figure 1.** — A, Normal leaf of *Anomodon minor*; B, Chick embryo-like deformed leaf of *A. minor*; C, Normal leaf of *Cryptoleptodon flexuosus*; D, Deformed, cordate leaf of *C. Flexuosus*; E, Normal leaf of *Entodon rubicundus*; F, G, Pseudo dual tips of *E. rubicundus*; H, Normal leaf of *Fissidens laxitextus*; I, Disproportionate abnormal distichous leaf of *F. laxitextus*. J, Normal leaf of *Mnium marginatum*. K, L, M, Misdirected costa with abnormal leaf tip of *M. marginatum*; N, Normal leaf of *Zygodon viridissimus*; O, Abnormal bifurcating leaf tip with Y-shaped costa of *Z. viridissimus*.

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**Ethical approval**

Bryophyte were collected from Mukteshwar region of Uttarakhand in Western Himalayas (India). The ethical guidelines for plants & plant materials are followed in the study for sample collection & identification.

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**Conflicts of interests**

The authors declare that there are no conflicts of interests.

**Data and materials availability**

All data associated with this study are present in the paper.

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