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Short Communication (Open Access)

INTRA-INFLORESCENCE VARIATIONS IN *ALLIUM TUBEROSUM* ROTTLER EX-SPRENGEL OF COLD DESERT OF SPITI VALLEY

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ABSTRACT
The medicinal properties of *Allium tuberosum* Rottler ex-Sprengel have cultural cuisine significance in the Spiti Valley, Himachal Pradesh, India. This perennial bulbous species, commonly known as garlic chives or leeks, is recognised by a white umbel-type inflorescence. Each bracteate umbel inflorescence typically bears 25 to 40 asynchronous emerging flowers of two whorls with six tepals as epitepalous and gamophyllous. The green soft scapes are called *'chau-tse'* or '*skot-che'* and are preferred in local cuisine in the Spiti Valley. The current short communication expresses the variation noticed in flower tepal count within the inflorescence and subsequently in the reproductive organs of *Allium tuberosum* where flowers with five, seven, eight, nine, ten tepals observed within umbel inflorescence. The sexual organ of variant flowers is affected in such a way that the androecium count varies as per tepals present, and the gynoecium is affected more when the number of tepals exceeds seven.

***Keywords*:** *Allium tuberosum, Inflorescence, Tepals, Variation, Tricarpellary ovary*

INTRODUCTION

Case presentation

Observed species*: Allium tuberosum* Rottler ex-Sprengel; sub genera Butomissa (Salisb.) N. Friesen Sec. Butomissa; family Alliaceae (Purseglove, 1972)- Wild species in clusters, where more than 100 inflorescences were observed. The studied natural morphotype is with pink mid-vein in white tepals on the abaxial surface different from its common type (Pandey *et al.,* 2019).

Observation Site: The observation recorded at geographic coordinates of 32°05'32.5"N 78°23'04.6"E; at an altitude of 3350 amsl; Tabo village, Lahual & Spiti, Himachal Pradesh, India.

Observation time*:* The information depicted in this short communication was gathered straight from the natural phenomena that has been observed in both wild and transplanted population during 2024 and 2025. At observation site the blooming months of *Allium tuberosum* are June, July and August have been observed. Specifically early blooming in the month of June and July for transplanted population of *Allium tuberosum* have been noticed, later wild population bloomed frequently during months of July and late August. The blooming pattern of this species is asynchronous with loose inflorescence. This has made easier to observe the single flower with naked eye meticulously. After the spontaneous observation on variation in flowers, a simple counting approach based on the number of flowers per umbel, number of tepals per flower, count and growth of reproductive organs attached to same pedicel followed for this study.

Observed Pollinators: The plant exhibits entomophilous pollination. It has variety of visiting pollinators such *Apis mellifera, Aps cerana, Bombus sp., Musca domestica*, *Lasius niger* (Common black ant), *Northora spp,* Ant-Alates, syrphids/Hoverflies, *Pieris spp*. (White butterfly), and white crab spider.

Contradiction in karyotypic analysis*: Allium tuberosum* possess the tetraploid (Do *et al.,* 2000; Mukherjee and Roy 2012; Mahbub *et al.*, 2014) , but earlier investigations have found polyploidy as diploid 2n = 16 (Ohno, 1964; Yang *et al*., 1998), triploid 2n=3x=24 (Ruifu *et al.,* 1985), tetraploid 2n=4x=30 (Talukder and Sen 2000; Sharma and Gohil 2013b), hexaploidy 2n=6x=48 (Sharma and Gohil, 2013a); aneuploids (32 ±

2–3 chromosomes) and an octaploid (2n = 61-64 chromosomes) by the previous workers (Gohil and Kaul, 1979; Kojima *et al.,* 1991). This paper corroborate with morphological variation have been observed and studied justify the previous confusion on its ploidy level and evidence of variation due to the ongoing evolution on higher altitude cold desert of Spiti valley.

OBSERVATION DETAILS

Variation in Tepals count

The flowers with six tepal (6T) is the significant characteristic of Allium family. In this study, approximately 87±1% of perianth of *Allium tuberosum* of umbel inflorescence exhibited this typical form. The remaining plants displayed the variation of 0.02 – 0.03 % intra-inflorescence variation having variant flowers with tepal (T) count varies from five (5T), seven (7T), eight (8T), nine (9T) and ten (10T) respectively (Fig. 1). The flower with 7T and 8T were maximum among the all observed variant flowers. The tepal count variation percentage varies from 0.002 %, 0.08 %, 0.08 %, 0.002 %, 0.03 %, for 5T, 7T, 8T, 9T and 10T flowers respectively. The fractional percentage variant flowers within inflorescence making them not only incredibly unusual but showed the imperfection in natural phenomena. Flowers with more than six tepals are rare but evidently this study shows the variation which may be genetic variation, stochastic variations or any effect of factors of local environment in cold desert region. As reported variation followed the uneven pattern of 7T, 8T, 9T and 10T after normal 6 tepals (6T) flowers, assume the development of discontinuous variation with external influences strongly.

Figure 1: Intra-inflorescence variation in wild *Allium tuberosum* Rottler ex Spreng. with a) Five Tepals (5T), b) Seven Tepals (7T), c) Eight Tepals (8T) d) Nine (9T) and e) Ten Tepals (10T) flower in respective single inflorescences

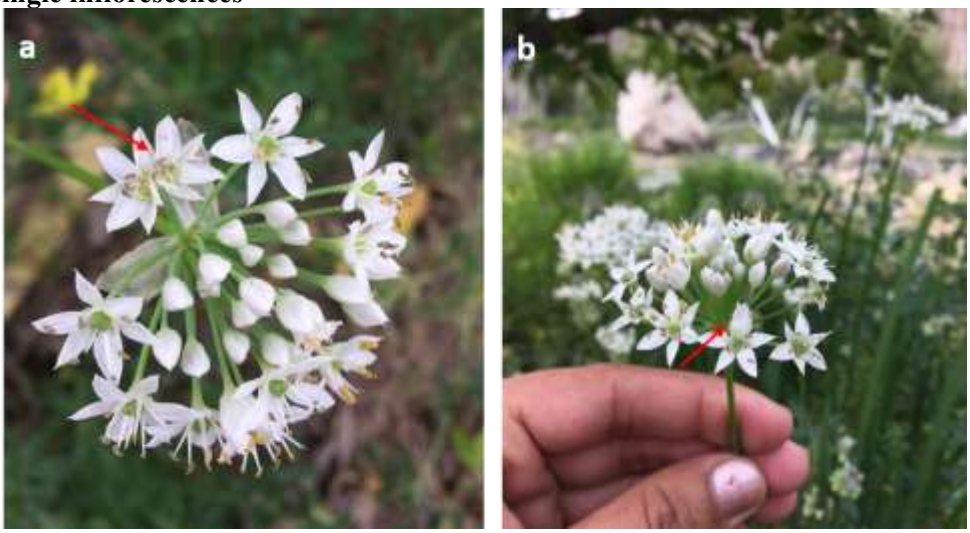

Figure 2: Unusual tepal sharing a) Two adjacent flowers, b) Fused tepals in 5T flower of *Allium tuberosum* Rottler ex Spreng. within inflorescence

The only single flower with five tepal 5T was noticed. In which four tepals were free and fifth formed from two fused tepal. Both fused one have free tips along with adjacent two filaments. Second the rare case of fusion of two different flowers with common tepal has been observed during July, 2025. The two fused flowers were with sixth common tepal only. It means a rare phenomenal variation where adjacent flowers count with five tepals along with sixth tepal acts as common for both. These two conditions observed with five tepals (5T) among observed inflorescences of *Allium tuberosum* Rottler ex Spreng. (Fig. 2). In the developed single petal for two flowers within a perianth, on anthesis the anther -filament were seen getting darken and drying consequently.

Similarly, four (4T) to Seven (7T) tepal variation along with 6T have been investigation on cytological analysis and reported hypotetraploid progeny (2n = 4x = 31) inherited from tetraploid (2n = 4x = 32) open pollinated seedlings growing in Jammu University Botanical Garden (Sharma and Gohil, 2013a).

Variation in Reproductive organs

The androecium is polyandrous exhibits epiphyllous condition in variant flowers similar as in normal flower. Epitepalous stamen with biseriate perianth condition in both normal and variant flowers were observed. The male organ stamens (anther and filament), counted same number as per tepal surrounds the ovary of hypogynous flower. Nevertheless, the difference was peculiar among carpel (ovary, style and stigma) of variant flowers. The normal gynoecium *i.e.,* superior tricarpellary ovary with axile placentation, single simple style-3 lobed stigma observed in normal as well as in 5T and 7T, rudimentary or underdeveloped in 8T and 9T variant flowers, whereas 10T variant flower exhibited with two styles-stigmas with disturbed axile placentation. Under cross sectional bud microscopy, the imperfection shape in placentation of tricarpellary ovary was observed in 8T variant flower and syncarpous gynoecium observed with peta-carpellary ovary (2 rudimentary fused carpel growth with tri-carpels) in 9T and10 T conditions (Fig. 3). The dithecous anther and trifid stigma were noticed in both conditions. Floral deviation with equations representing the flower structures for normal to variant flowers are given in Table 1.

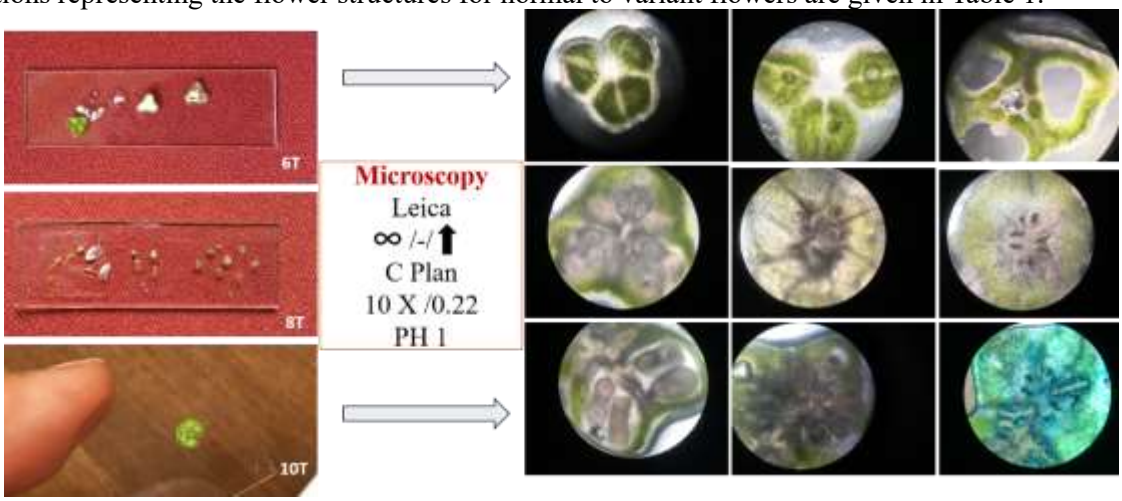

Figure 3: Microscopy of flower bud cross-section, a) perfect tricarpellary ovary in six tepals (6T) flowers, b) imperfection in tricarpellary ovary in eight tepals (8T) flowers, c) disturbed ovary carpels and placentation arrangement in ten tepals (10T) flowers of *Allium tuberosum* Rottler ex Spreng.

The studied morphological variation in both wild and transplanted population indicates substantial genetic diversity and high degree of phenotypic plasticity. Such adaptive plasticity facilitates the potential domestication of species; however, it is always important to understand the whole biology of species before the development and optimization of agro-techniques (Dhiman *et al.,* 2023). *Allium tuberosum* exhibit a semi-domesticated status, as local communities harvest/collect from wild and subsequently propagate the bulbs in kitchen garden culinary use as have been recognized with ethnomedicine applications (Singha *et*

al., 2024). Due to its huge potential in modern therapeutics, the species warrants phytochemical characterization and clinical trials to validate its therapeutic efficacy (Rana *et al.,* 2024).

Table1: Floral formula Deviation

Type of Flowers	Floral equation	Number of Tepals
Normal flower	Br ⊕ ♂ P(3+3) A(3+3) G(3)	Six tepals (6T)
Variant flowers	Br ⊕ ♂ P(3+2) A(3+2) G(3)	Five tepals (5T)
	Br ⊕ ♂ P(3+4) A(3+4) G(3)	Seven tepals (7T)
	Br ⊕ ♂ P(4+4) A(4+4) G(3+ Rud.)	Eight tepals (8T)
	Br ⊕ ♂ P(4+4) A(4+4) G(3+ 1Rud.+1UD)	Nine tepals (9T)
	Br ⊕ ♂ P(5+5) A(5+5) G(3+2 Rud.)	Ten tepals (10T)

Br-Bracteate; P-Perianth; A-Androecium; G-Gynoecium; Rud.-Rudimentary: UD-underdeveloped

HYPOTHETICAL INFERENCES BEHIND INTRA-INFLORESCENCE VARIATION

The preliminary findings and examination on variations in *Allium tuberosum* Rottler ex Spreng. could have a variety of reason and consequence in future. The variation within the inflorescence represents its flexible adaptations due to the influences of micro-climate, fusion of reproductive organ, double self-fertilization etc. As per Wyatt (1982), floral heterogeneity is common phenomenon in species of Liliaceae family due to floral variation. To respond temporarily to the changing micro-environment of cold desert area, it is kind strategy in *Allium tuberosum* Rottler ex Spreng. as resilience technique for more population and survival. Additionally, if there is succession of ovary toward multi-carpellary fashion, this can lead to convert superior ovary to inferior in future.

These findings may support the idea that intra-inflorescence variations in hermaphrodite flowers are expression for dominance toward attracting pollinators. This is like sibling flowers competition, where reproductive strategies to enhance pollinator attraction with developing more tepal and yellow anthers subsequently. The yellow bright anthers enhance visibility to more pollinator and less efforts for self-fertilization. The increase in tepals number may also serve to make perianth much compact in loosely arranged inflorescence of *Allium tuberosum* Rottler ex Spreng., potentially favouring out-crossing over self-pollination. The association of flower size, tepal numbers with visiting pollinators have been mentioned by Conner and Rush (1996) and Pal (2019), especially when perianth colour is unattractive. Mostly, the monoecy species tend to have intra-inflorescence variation as per recorded studies, there is more noticeable variation within an inflorescence even in hermaphrodite flowers (Ashman & Hitchens, 2000) in changing conditions. This has break down the preoccupied rules with respect to reproductive function of monoecy species.

Way Forward

Further studies, including detail microscopy, QTL analysis (Quantitative trait locus) are required to determine the kind of variation or mutation. To assess the relationship between the flowers' tepal counts and biological/genetic/environmental factors for adaptive significance, further research is indeed. The previous documented karyotypic and cytological analysis mostly using leave parts or on seedling stages showed the polyploidy. It is further important to understand the genetic polymorphisms at different stages of variant plants both for wild and transplanted population.

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