

Diversity and distribution of Buttercups (*Ranunculus* Linnaeus) in Kashmir valley of J&K, India

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Abstract

Eleven species of buttercups (viz., *Ranunculus arvensis* Linnaeus, *R. hirtellus* Royle, *R. laetus* Wallich ex D. Don, *R. lingua* Linnaeus, *R. munroanus* J.R. Drummond, *R. muricatus* Linnaeus, *R. palmatifidus* H. Riedl, *R. rubrocalyx* Regel ex Komarov, *R. sceleratus* Linnaeus, *R. trichophyllus* Chaix and *R. trilobus* Desfontaines) are, so far, recorded growing in Kashmir valley at different altitudes in diverse habitats ranging from terrestrial to aquatic. Of these *R. arvensis*, *R. laetus*, *R. muricatus* and *R. sceleratus* are the most common. *R. lingua*, a threatened emergent helophyte, is found growing only at a few places in Kashmir valley. *R. munroanus*, growing in subalpine to alpine areas under the shade of rocks or in rock crevices, has very restricted distribution and the species is facing threat due to habitat loss caused by avalanches and landslides. Of these, *R. palmatifidus* is endemic to N.W. Himalaya grows in subalpine and alpine regions of Kashmir valley. *R. hirtellus*, with diploid and tetraploid cytotypes, is the most diverse buttercup with high phenotypic variability. Cytologically, species of *Ranunculus* growing in Kashmir valley are ranging from diploid to 16-ploid having base number of $x = 8$ with the exception of *R. laetus* which has a base number of $x = 7$.

Key words: *Ranunculus*, Buttercups, Diversity, Cytotypes, Distribution, Kashmir valley

INTRODUCTION

'Buttercup' is the common and most popular name for the species of the genus *Ranunculus* Linnaeus (Ranunculaceae), although names like 'spearworts', 'water crowfoots' and 'lesser celandine' are also used for some of the species of the genus. It is a genus of herbaceous annuals and perennials comprising ca.600 species (Tamura 1995; Wencai & Gilbert 2001; Hörandl *et al.* 2005; Mabberly 2008; Srivastava 2010). The genus is distributed on all continents except Antarctica and the largest number of species occurs in temperate zones of Europe, Asia, North and South America, Australia, New Zealand, and in the alpine regions of New Guinea (Johansson 1998). In Asia the genus is distributed in Japan, Korea, China, India, Nepal, Bhutan, Thailand, Pakistan, Afghanistan, Iran, Mongolia, Egypt and Syria. In India it is almost restricted to Eastern and Northwestern Himalayas with only a few species (e.g., *R. muricatus*, *R. reniformis*, *R. subpinnatus*, and *R. wallichianus*) growing towards the peninsular India (Rau 1993).

The Kashmir Himalaya, constituting a part of the Great Himalayan range represents a repository of buttercups but there is considerable disagreement amongst the authors regarding

the number of species growing in this region. Likewise, the number of *Ranunculus* species reported from time to time growing in Kashmir valley also varies from author to author. While Hooker & Thomson (1872) have reported 14, the number of species reported by Stewart (1972), Uniyal (2002) and Srivastava (2010) are 13, 11, and 15, respectively. However, during present investigation eleven species of *Ranunculus* (viz., *R. arvensis*, *R. hirtellus*, *R. laetus*, *R. lingua*, *R. munroanus*, *R. muricatus*, *R. palmatifidus*, *R. rubrocalyx*, *R. sceleratus*, *R. trichophyllus* and *R. trilobus*) were found growing in Kashmir valley.

Study area

Kashmir valley ($33^{\circ}54' - 34^{\circ}65' \text{ N}$ and $73^{\circ}86' - 75^{\circ}35' \text{ E}$) is situated in the northwestern part of Jammu & Kashmir, India (Fig. 1) covering a total area of 15,984 km² (official website of J&K Government www.jkforest.gov.in). About 65 % of the area is covered by mountains with predominantly coniferous vegetation comprising mostly *Cedrus deodara* (Roxburgh) D. Don., *Pinus wallichiana* A.B. Jackson, and *Abies pindrow* Royle. Lofty mountains of

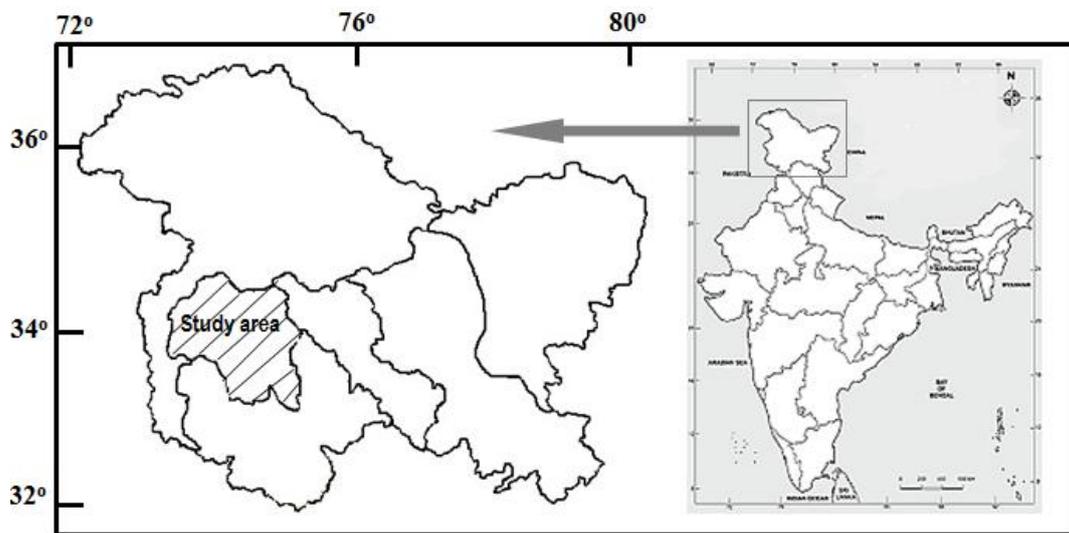


Figure 1. Map of Kashmir Himalaya showing Kashmir valley (study area)

the Pir Panjal Range in the south and southwest and Greater Himalayan Range in the north and the east enclose the deep elliptical bowl-shaped valley. The valley is an asymmetrical fertile basin stretching from Southeast to Northwesterly direction, measuring 187 km while as the breadth varies considerably being 115.6 km along the latitude of Srinagar (Kaul 1977). The altitude ranges between 1600 m amsl at Srinagar (summer capital of Jammu & Kashmir) to 5420 m at the highest peak Kolahoi. Based on topography and altitude, the Kashmir region comprises the main valley floor, the side valleys and valley facing slopes of Pir Panjal and the Greater Himalayan ranges. Valley floor is rich in alluvium, deposited by the river Jehlum and its tributaries, and has earned the name 'Rice Bowl of Kashmir'. Side valleys are carved out by the major tributaries of river Jehlum. Pir Panjal range (200 km) separates the study area from Chenab valley and Jammu region while Greater Himalayan Range (330 km) separates it from valley of Indus and Kishenganga. Razdan Pas (3650 m amsl) connects the valley with Guraiz in the north, Zojila Pas (3600 m amsl) connects it with Ladakh in northeast, Jawahar Tunnel in the southeast connects it with Chenab valley while Sadhana Pas (3100 m amsl) connects it with Karnah in the northwest. Climate of the valley displays a marked

seasonality akin to continental parts of the temperate latitudes. The temperature ranges from an average daily maximum of 31° C and minimum of 15° C in July to an average daily maximum of 4° C and minimum of -4° C in January. The average rain fall at Srinagar is 659 mm per annum and most of the precipitation occurs in the form of snow during winter and early spring, however, the precipitation is considerably more at higher slopes/altitudes. In fact, the uplift of the Pir Panjal acts as a barrier for the southwest monsoon to penetrate the valley.

MATERIALS AND METHODS

Field survey

The field data were collected from 2006 to 2008 and in 2013 during peak of vegetation season, which lasts from mid-June to mid-August.

Processing and documentation

Collected specimens were recorded in the field note book with all relevant field-data and then processed into mounted herbarium sheets following Jain and Rao (1977). The specimens were identified using available suitable literature (Stewart 1972; Polunin & Stainton 1984; Riedel & Nasir 1991; Wencai & Gilbert 2001) and were matched and deposited in KASH, DD and CAL.

Morphology

Specimens from different localities were examined minutely using magnifying glass and stereomicroscope. All measurements were taken in metric system. The leaf blades in the genus *Ranunculus* vary from entire to ternately compound. The terminology, as used by Wencai and Gilbert (2001), has been adopted: 3-sect (lamina divided almost to petiole), 3-partite (lamina divided to half or more), 3-fid (lamina divided to less than half), and 3-lobed (lamina shallowly divided). Degree of pubescence on leaves or on any part has been categorized into three types: scattered or sparse (trichomes very few, continuous (trichomes present in a regular pattern), and dense (trichomes forming a more or less fleecy pattern on the surface). For recognizing aestivation, the method given by Cunnell (1958) and terminology used by Riley (1923) were followed.

Cytology

Male meiotic studies were carried out by fixing the floral buds of proper stage in 1:3 acetic alcohol for 24 hours and later preserving the material in 70 % ethanol. Squashing of anthers was done in 2 % propionocarmine. Somatic studies were done by pretreating the young root tips in 0.1 % aqueous colchicine for 4 hours, followed by fixation in 1:3 acetic alcohol for 24 hours and preserved in 70 % ethanol in refrigerator at 4°C. The material was squashed by following standard procedure of hydrolysis and staining.

TAXONOMIC TREATMENTS

The present study is the first comprehensive taxonomic revision of genus *Ranunculus* (Ranunculaceae) from the study area. During investigation eleven species of *Ranunculus*, growing in different habitats at varying altitudes, were recorded. All the recorded species, enumerated below along with an artificial dichotomous key to the species, nomenclatural citations, synonyms, description, phenology and distribution, are presented below:

ENUMERATION

Key to the species

- | | | |
|------|---|-------------------------|
| 1a. | Leaves ternately divided, suborbicular, orbicular, broadly obovate or reniform, petiolate | 2 |
| 1b. | Leaves entire, linear lanceolate, sessile with sheathing base, sessile | <i>R. lingua</i> |
| 2a. | Flowers yellow; leaves broadly dissected | 3 |
| 2b. | Flowers white; leaves finely dissected into thread-like structures | <i>R. trichophyllus</i> |
| 3a. | Sepals patent | 4 |
| 3b. | Sepals reflexed | 5 |
| 4a. | Leaves 3-sect, segments divided into narrow linear lobes, apices acute apices; achenes spiny along the ridge or rarely smooth, 6-8 per head | <i>R. arvensis</i> |
| 4b. | Leaves 3-sect, 3-partite or 3-fid, segments divided into broader lobes; achenes smooth, more than 10 per head | 6 |
| 5a. | Achenes 10-20 per head, spiny or smooth, beak prominent, 3-5mm long | <i>R. muricatus</i> |
| 5b. | Achenes 25-45 per head, papillate, beak inconspicuous, less than 1mm long ... | <i>R. trilobus</i> |
| 6a. | Rhizome long, creeping, pubescent; stem up to 100cm or more | <i>R. laetus</i> |
| 6b. | Rhizome short, erect, glabrous; stem up to 35 cm | 7 |
| 7a. | Sepals carminish | <i>R. rubrocalyx</i> |
| 7b. | Sepals yellowish green | 8 |
| 8a. | Corolla aestivation valvate | 9 |
| 8b. | Corolla aestivation imbricate | 10 |
| 9a. | Stem caespitose or subcaespitose, 3-8cm high, achenes 25-35 on a club-shaped, glabrous torus | <i>R. munroanus</i> |
| 9b. | Stem erect, 10-80cm high, achenes 150-500 per head | <i>R. sceleratus</i> |
| 10a. | Leaf blade palmatisect, middle segment lanceolate, without lobation | <i>R. palmatifidus</i> |
| 10b. | Leaf blade 3-sect, middle segment obovate or cuneate, mostly 3-lobed or sometimes less or more | <i>R. hirtellus</i> |

Ranunculus arvensis Linnaeus, Sp. Pl. 1: 555. 1753; Hooker f. & Thomson in Hooker f., Fl. Brit. Ind. 1: 20. 1872; Blatter, Beut. Flows. Kash.1: 16. 1928; Stewart, Ann. Cat. Vas. Pl. W. Pak & Kash. 269. 1972; Polunin & Stainton, Flows. Himal. 9. 1984; Riedl & Nasir in Ali & Nasir Fl. Pak. 193: 131. 1991; Rau in Sharma *et al.*, Fl. Ind. 1: 115. 1993; Wencai & Gilbert in Wu, Raven & Hong, Fl. China 6: 430. 2001; Srivastava, Taiwanica 55(3): 275. 2010; *R. echinatissima* Blatter in Jr. Ind. Bot. Soc. 9: 200. 1930; *R. fernandezii* Blatter, l.c. 200; *R. arvensis* var. *echinatissimus* (Blatter) Qureshi & Chaudhri in Pak. Syst. 4(1-2): 184. 1988. [Figure 2A]

Terrestrial, annual herbs. Stem 10 - 40 cm, branched, hollow, terete, 3 - 4.5 mm in diameter, glabrous or sparsely puberulent with transparent, appressed hairs. Basal leaves 3 - 5, petiolate; petiole 1.5 - 3.5 cm; blade obovate-spathulate or broadly rhombic, glabrous, 3 - 5 dentate; cauline leaves petiolate or sessile, glabrous on dorsal surface and sparsely pubescent on ventral surface, 3-sect; each segment further deeply divided into narrow linear lobes, lobe apices acute. Flowers yellow, 0.9 - 1.2 cm across, pedicellate; pedicel 1 - 4.5 cm, continuously or densely pubescent with transparent, appressed trichomes of 200 - 300 µm length. Sepals 5, patent, narrowly elliptic, navicular, yellowish, continuously villous on the lower surface. Petals 5, imbricate, obovate, 5 - 8 × 4 - 6 mm, apex rounded, claw inconspicuous, nectary pit covered with nectary scale. Achenes 6 - 8 per head, 7.5 - 8.5 × 3.5 - 4.0 mm, obliquely obovate, compressed, spiny along the margin, sometimes smooth; spines straight or slightly curved, up to 3 mm long; beak straight, flattened, 2 - 4 mm long. Torus globose, 1.5 - 2.0 ×

0.75 - 1.5 mm, glabrous with mesh of transparent, spreading trichomes at the top, or all over the surface.

Flowers & fruits: March – May.

Ploidy level: Tetraploid ($2n = 4x = 32$).

Specimens examined: Chak Jagar, Jammu, 17.02.1970, *B.M. Sharma* 4693 (KASH); University Campus Hazratbal, 26.03.1971, *A.R. Naqshi* 067B (KASH); Khalmullah, 12.04.1981, *G.H. Dar* 0826 (KASH); Boniyar, Uri, 25.03.2006, *Fayaz, Dar & Wafai* 025 (KASH); Bategam, Kupwara, 15.04.2006, *Fayaz, Dar & Wafai* 031, 032 (KASH).

Habitat: Crop fields with mustard, wheat etc. and in orchards; 1600 – 1900 m amsl.

Distribution: Native to west Asia and Europe. Widely distributed from Central and South Europe through southern Siberia, western and southwest Asia to India and the Himalaya. In Kashmir, it grows as a weed in crop fields and orchards and along roadsides.

Note: *R. arvensis*, the corn buttercup, hitherto known for having spiny achenes (Riedl & Nasir 1991; Rau 1993; Whittemore 1997; Wencai & Gilbert 2001; Uniyal 2002; Srivastava 2010), during the present study, has been collected having smooth achenes instead of spiny. This variation in achenes is discontinuous with no intermediate forms. The two forms (spiny-achened and smooth-achened) grow sympatrically and breed true for their achene characters.

Ranunculus hirtellus Royle, *Illustr. Bot. Himal. Mount.* 53. 1834; Hooker *f.* & Thomson in Hooker *f.*, *Fl. Brit. Ind.* 1: 18. 1872; Blatter, *Beaut. Flows. Kash.* 1: 15.1928; Stewart, *Ann. Cat. Vas. Pl. W. Pak and Kash.* 270. 1972; Hara & Williams, *Enum. Flow. Pl. Nepal* 2: 19. 1979; Polunin & Stainton, *Flows. Himal.* 10.1984; Riedl & Nasir in Ali & Nasir, *Fl. Pak.* 193: 145.1991; Rau in Sharma *et al.*, *Fl. Ind.* 1: 121. 1993; Wencai & Gilbert in Wu, Raven & Hong, *Fl. China* 6: 404. 2001; Uniyal in Singh *et al.*, *Fl. J&K* 420-421. 2002. Srivastava, *Taiwania* 55(3): 280. 2010; *R. glabellus* Royle, *Illus. Bot. Himal.* 53. 1834; *R. nervosum* D. Don in Royle, *Illus. Bot. Himal.* 53. 1834; *R. attenuates* Royle *ex* D. Don in Royle, *Illus. Bot. Himal.* 53. 1834; *R. choorensis* D. Don in Royle, *Illus. Bot. Himal.* 53. 1834. [Figure 2B]

Terrestrial, perennial herb, with fibrous roots. Stem erect, single or 2 - 3, 10 - 30 cm, simple or branched, hollow or solid, 1 - 2 mm in diameter, terete or slightly angular, sparsely to densely puberulent with appressed trichomes. Radical leaves 3 - 5, petiolate; petiole 1.5 - 16 cm, glabrous or sparsely pubescent with appressed hairs; blade reniform or broadly obovate with a cordate base, 1.5 - 4 × 1.8 - 6.0 cm, 3-sect, middle segment obovate, 3 - 5 lobed, rarely entire, lateral segments obliquely flabellate, unequally 2-cleft, many-lobed, lobule apices acute, blade glabrous on the ventral surface and sparsely pubescent on the dorsal surface particularly along the mid rib region and margins; cauline leaves similar to basal ones except for petioles, which are shorter or absent. Flowers yellow, 0.9 - 2.0 cm across, solitary or several, pedicellate; pedicel pubescent with continuous, appressed hairs. Sepals 5, yellow, ovate or elliptic, densely villous on the lower surface, navicular, patent. Petals 5 (rarely more), imbricate, obovate or broadly obovate, 5.0 - 9.5 × 5.5 - 9.0 mm, apex rounded or plane, claw inconspicuous (0.5 mm), nectary pit small, pocket-like without nectary scale. Carpels pubescent with continuous or dense, transparent, spreading trichomes or rarely glabrous. Achenes obliquely obovoid, 30 - 50 per head, 2.5 - 3.25 × 1.5 - 1.75 mm, glabrous or continuously to densely pubescent, trichomes 70 - 325 µm long, beak straight or curved, 0.75 - 1.25 mm. Torus cylindrical to club-shaped, 2.5 - 4.5 × 1 - 1.5 mm, sparsely to densely hairy.

Flowers & fruits: May – July, rarely in August.

Ploidy level: Diploid ($2n = 2x = 16$) and tetraploid ($2n = 4x = 32$) cytotypes.



Figure 2: **A.** *Ranunculus arvensis*; **B.** *R. hirtellus*; **C.** *R. laetus*; **D.** *R. lingua*; **E.** *R. munroanus*; **F.** *R. muricatus*; **G.** *R. palmatifidus*; **H.** *R. rubrocalyx*; **I.** *R. sceleratus*; **J.** *R. trichophyllus*; **K.** *R. trilobus*

Specimens examined: Gulmarg, 29.05.1892, *J. F. Duthie* 11269 (CAL); Singola, Ladakh, 22.07.1973, *U. C. Bhattacharya* 52150 (CAL); Dachigam, 03.08.1970, *Gurcharan Singh* 2340 (KASH); Gulmarg, 19.06.1973, *A.R. Naqshi* 6697 (KASH); Gagangir, 24.05.1983, *G.H. Dar* 5150 (KASH); Thajwas, 18.06.2006, *Fayaz, Dar & Wafai* 075 (KASH); Gulmarg, 22.08.2006, *Fayaz, Dar & Wafai* 096, 097 (KASH); Panikhar, 05.06.2007, *Fayaz, Dar & Wafai* 112 (KASH); Sankoo, 08.07.2008, *Fayaz, Dar & Wafai* 143 (KASH).

Habitat: Open moist meadows and pine forests; 2600 – 3650 m amsl.

Distribution: Afghanistan, Pakistan, North India, Kashmir Himalaya, China. In Kashmir it grows in subalpine and alpine meadows.

Note: It is the most variable species amongst Kashmir Himalayan buttercups varying in leaf shape, petal shape and degree of pubescence on carpels and achenes. The middle segment of the leaf is commonly 3-lobed, however, in some forms it is either multi-lobed or with less than three lobes. The carpels and the achenes are mostly pubescent bearing trichomes either all over the body except beak or towards the basal portion only but one particular form, growing commonly in Gulmarg, has glabrous carpels and achenes. Further, the flowers bear petals with rounded or flat apices, but specimens, commonly growing in alpinines, bearing petals with deeply notched apices have been collected.

Ranunculus laetus Wallich ex D. Don in Royle, *Illus. Bot. Himal.* 53. 1834; Hooker f. & Thomson in Hooker f., *Fl. Brit. Ind.* 1: 19. 1872; Blatter, *Beaut. Flows. Kash.* 1: 16. 1928; Stewart, *Ann. Cat. Vas. Pl. W. Pak. and Kash.* 271: 1972; Hara & Williams, *Enum. Flow. Pl. Nepal* 2: 19. 1979; Polunin & Stainton, *Flows. Himal.* 9. 1984; Riedl & Nasir in Ali & Nasir, *Fl. Pak.* 193: 141. 1991; Rau in Sharma *et al.*, *Fl. Ind.* 1: 122. 1993; Uniyal in Singh *et al.*, *Fl. J&K* 421. 2002. Srivastava, *Taiwania* 55(3): 282. 2010; *R. distans* D. Don in Royle, III. 53. 1834; *R. pseudolaetus* Tamura, *Acta Phytotax. Geobot.* 19: 109. 1963; *R. laetus* var. *kashmiricus* Qureshi & Chaudri in *Pak. Syst.* 3(1): 14. 1987; *R. laetus* subsp. *chitralicus* Qureshi & Chaudri in *Pak. Syst.* 3(1): 14. 1987. [**Figure 2C**]

Terrestrial, perennial herb with a creeping, woody, densely pubescent rootstock producing numerous fibrous roots and flowering stems. Stems erect, 20 - 100 cm high, branched, hollow, 3 - 8 mm in diameter, terete, continuously or densely puberulent with appressed or spreading, 0.5 - 2.5 mm long transparent hairs. Radical leaves long-petioled; petiole 10 - 18 cm long, sulcate along dorsal side, densely villous with patent hairs, blade orbicular or suborbicular, 3.5 - 12.0 x 4.0 - 15 cm, 3-sect or 3-partite, segments with or without petiolule, petiolule 1 - 8 cm, middle segment again 3-partite or 3-fid forming three lobes, middle lobe again 3-fid forming lobules, lateral segments unequally cleft more than once forming lobules, lobules cuneate with acute apices, both surfaces of the blade densely puberulent with transparent, appressed or spreading hairs, hairs 0.5 - 2.5 mm long; cauline leaves similar to radical ones except for their shorter (2 - 5 cm) petioles, and petiolules which are more common and longer. Flowers yellow, 1.8 - 2.5 cm across, pedicellate; pedicels 1.5 - 3.0 cm, densely puberulent with appressed or spreading hairs. Sepals 5, ovate, yellowish, patent, densely villous on the lower surface, hairs transparent, spreading, 1 - 2 mm long. Petals 5 (6 - 7), imbricate, obovate, 0.95 - 1.5 x 0.7 - 0.95 cm, apex rounded, claw inconspicuous, nectary pit covered with scale. Achenes obliquely obovoid or suborbicular, smooth with a distinct margin, 3.0 - 4.25 x 2.0 - 3.75 mm, beak 0.75 - 1.0 mm, straight or slightly curved with a broad base. Torus globose or subglobose, glabrous or with a few trichomes at the top, 2.5 - 3.5 x 1.0 - 1.5 mm.

Flowers & fruits: May – August

Ploidy level: Tetraploid (2n = 4x = 28).

Specimens examined: Sakran Pur, Jammu 03.04.1970, *B.M. Sharma* 4692 (KASH); Karnah, 09.07.1988, *G.H. Dar* 935 (KASH); Chorwan, Gurez 11.08.1989, *A.R. Naqshi* 10939 (KASH); Ganderbal, 12.07.1983, *G.H. Dar* 1129 (KASH); Pahalgam, 20.06.2004, *G.H. Dar* 1120 (KASH); Bategam, Kupwara 29.06.2006, *Fayaz, Dar & Wafai* 083, 084 (KASH); Amar Singh College, Srinagar 01.07.2006 *Fayaz, Dar & Wafai* 085 (KASH); Omarabad, Srinagar 01.07.2006, *Fayaz, Dar & Wafai* 086 (KASH); Dawar, Gurez 28.06.2008 *Fayaz, Dar & Wafai* 139 (KASH); Thrungus, Dras 09.06.2007, *Fayaz, Dar & Wafai* 088, 089 (KASH).

Habitat: Roadsides, banks of streams, meadows, fields, moist places, abandoned areas at an altitude of 1600 – 2800m.

Distribution: Pamir, Western Tien-Shan, Afghanistan, Pakistan, India, Kashmir Himalaya.

Ranunculus lingua Linnaeus, Sp. Pl. 1: 549.1753; Hooker f. & Thomson in Hooker f., Fl. Brit. Ind. 1: 16. 1872; Stewart, Ann. Cat. Vas. Pl. W. Pak. & Kash. 271. 1972; Polunin & Stainton, Flows. Himal. 9. 1984; Rau in Sharma *et al.*, Fl. Ind. 1: 122. 1993; Wencai & Gilbert in Wu, Raven & Hong, Fl. China 6: 420. 2001; Srivastava, Taiwania 55(3): 283. 2010. **[Figure 2D]**

Aquatic or semiaquatic perennial macrophyte, rooting at proximal nodes. Stem erect with distinct nodes and internodes, 50 - 160 cm, hollow, glabrous, 1.0 - 2.0 cm in diameter, branched at a few nodes, preferably in the upper half. Leaves sessile with a sheathing base, blade linear-lanceolate, 17 - 30 × 2.3 - 3.1 cm, entire, base amplexicaul, apex acute or acuminate, venation parallel, glabrous dorsally and sparsely pubescent ventrally, trichomes appressed, 550 - 800 µm long. Flowers yellow, 2.6 - 3.5 cm across, pedicellate; pedicels 5.0 - 7.5 cm, appressed with scattered or continuous trichomes. Sepals 5, patent, navicular, villous on the lower surface with long, appressed, colourless hairs. Petals 5, imbricate, flabellate-obovate, 1.6 - 2.0 × 1.4 - 1.7 cm, apex rounded or rarely notched, claw inconspicuous, nectary pocket-like, naked. Achenes 1 - 20 (rarely more), obliquely obovoid, 3.0 - 3.75 × 2.0 - 2.25 mm, glabrous, keeled towards the ridge facing the torus, beak inconspicuous. Torus globose, 4.0 - 5.5 × 4.0 - 5.25 mm, glabrous all around except the top that bears a bunch of 4 - 6 trichomes.

Flowers & fruits: June – October

Ploidy level: 16-ploid (2n = 16x = 128).

Specimens examined: Srinagar, 20.06.1959, *T.A. Rao* 9579 (CAL); Dal Lake, 31.07.1967, *G.N. Javeid* 224 (KASH); Lawaypora, Srinagar 14.07.2006, *Fayaz, Dar & Wafai* 088 (KASH); Hokersar 14.07.2006, *Fayaz, Dar & Wafai* 091 (KASH); Anchar Lake, 28.07.2007, *Fayaz, Dar & Wafai* 130 (KASH); Foreshore Road, Hazratbal, 14.08.2009, *Fayaz, Dar & Wafai* 177 (KASH).

Habitat: Bogs, marshy water bodies; 1600m amsl.

Distribution: Kazakhstan, Siberia, Europe, Asia. In India it is distributed in Western Himalaya - Himachal Pradesh and Jammu & Kashmir.

Ranunculus munroanus J.R. Drummond ex Dunn, in Bull. Misc. Inform. Kew 1925: 279. 1925; Stewart, Ann. Cat. Vasc. Pl. W. Pak. and Kash. 271. 1972; Hara & Williams, Enum. Flow. Pl. Nepal 2: 19. 1979; Riedl & Nasir in Ali & Nasir, Fl. Pak. 193: 150. 1991; Rau in Sharma *et al.*, Fl. Ind. 1: 123. 1993; Wencai & Gilbert in Wu, Raven & Hong, Fl. China 6: 402. 2001. Srivastava, Taiwania 55(3): 284. 2010; *R. munroanus* var. *minor* Tamura in Kitamura, Pl. W. Pak. & Afghan. 63. 1964. **[Figure 2E]**

Terrestrial, perennial herb with fibrous roots. Stems 1 - 3, caespitose or subcaespitose, branched in upper part, slender, flaccid, 3 - 8 cm high, hollow, 1.0 - 1.5 mm in diameter,

sparsely pubescent with appressed, transparent trichomes. Radical leaves petiolate; petiole flaccid, 4 - 10 cm, glabrous proximally and continuously pubescent towards the blade, blade orbicular or suborbicular, papery, 2.0 - 3.3 × 2.2 - 3.5 cm, 3-partite, middle segment incised 3-lobed, lobe apices obtuse, lateral segments flabellate with shallow lobes, glabrous abaxially and sparsely pubescent on the adaxial surface, trichomes transparent, 500 - 700 µm long; cauline leaves with shorter petioles. Flowers yellow, 1 - 3 per peduncle, 0.5 - 1.0 cm across, pedicellate; pedicels with dense, appressed or spreading trichomes. Sepals 5, greenish with yellowish margins, patent, navicular, elliptic, glabrous. Petals 5 (6), valvate, elliptic or lanceolate, 3 - 4 × 1.75 - 2.5 mm, apex obtuse, claw 0.75 - 1.0 mm; nectary pocket-like, naked. Achenes 25 - 35, obliquely obovoid, slightly compressed laterally, 1.0 - 1.5 × 0.5 - 1.0 mm, glabrous, slightly ridged and making its surface feel rough; beak short, curved, with a broad base. Fruit head globose, 2.5 - 2.75 × 2.5 - 2.75 mm. Torus club-shaped, glabrous, 1.5 - 2.0 × 0.75 - 1.25 mm.

Flowers & fruits: May – July

Specimens examined: Gulmarg, 3000 – 3400 m, 31.05.1892, *J.F. Duthie* 11309 (DD); Khilanmarg, 27.06.1976, *A.R. Naqshi* 6897 (KASH); Sangam, 23.06.1983, *G.H. Dar* 5766 (KASH); Apharwat, 27.06.2006 *Fayaz, Dar & Wafai* 081, 082 (KASH).

Habitat: Shade of rocks on loose soils rich in mosses; in rock crevices; 3000 – 3200m amsl.

Distribution: China (W. Tibet), Nepal, Pakistan and India. In India, distributed in the alpine regions of Kashmir Himalaya and Himachal Pradesh.

Ranunculus muricatus Linnaeus, Sp. Pl. 1: 555. 1753; Hooker f. & Thomson in Hooker f., Fl. Brit. Ind. 1: 20. 1872; Blatter, Beaut. Flows. Kash.1: 16. 1928; Stewart, Ann. Cat. Vas. Pl. W. Pak. & Kash. 271. 1972; Riedl & Nasir in Ali & Nasir, Fl. Pak. 193: 129. 1991; Rau in Sharma *et al.*, Fl. Ind. 1: 124. 1993; Wencai & Gilbert in Wu, Raven & Hong, Fl. China 6: 430. 2001; Srivastava, Taiwania 55(3): 285. 2010; FNA vol. 3 @ www.efloras.org; *R. pseudomuricatus* Blatter, Hallb. & Mac Cann, Jr. Ind. Bot. Soc 1: 54. 1919; *R. emuricatus* Majeed Kak, Biol. Bull. Ind. 3: 146. 1981. [**Figure 2F**]

Terrestrial, annual herb. Stems solitary or several, 2 - 75 cm high, erect or caespitose, branched, hollow, terete, 3 - 16 mm in diameter, glabrous or sparsely pubescent. Radical leaves 6 - 9, forming a rosette, petiolate; petiole 1.5 - 27 cm, glabrous or sparsely pubescent; blade suborbicular or reniform, 1.8 - 9.0 × 1.4 - 9.2 cm, glabrous on abaxial surface and sparsely or continuously pubescent with spreading or appressed hairs on adaxial surface, base truncate to cordate, 3-sect, 3-partite or 3-fid, middle segment rhombic-obtrapeziform or obovate, without or with 5 - 12 mm long petiolule, 3-partite, 3-fid or 3-lobed, lateral segments obliquely ovate, unequally 2-cleft, incised dentate to crenate; cauline leaves with shorter petioles of 1.4 - 3.5 cm length. Flowers yellow, 0.9 - 1.5 cm across, pedicellate; pedicels 1.0 - 2.5 cm. Sepals 5, narrowly ovate, reflexed, membranous, nearly as long as petals or slightly shorter, continuously pubescent on the lower side. Petals 2 - 5, oblong-obovate, 0.5 - 0.9 × 0.25 - 0.5 cm, apex rounded, rarely notched, claw 0.5 mm, nectary pit covered with nectary scale, aestivation imbricate or mixed. Achenes complanate, elliptic or obovate 15 - 20 per head, 6 - 9 × 3 - 4.5 mm, glabrous, face smooth or spiny, margin smooth, spines 0.5 - 1.5 mm, beak straight, 3 - 5 mm long, with a broad base, glabrous. Torus 3.0 - 3.75 × 2.5 - 3.75 mm, densely pubescent, with spreading trichomes.

Flowers & fruits: March – May

Ploidy level: Hexaploid (2n = 6x = 48).

Specimens examined: Baramulla, 04.06.1954, *S.N. Singh* 11359 (CAL); Anantnag, 27.05.1962, *Abdul Rashid* 96630 (CAL); Srinagar, 11.05.1968, *G.N. Javeid* 554 (KASH);

Nagrota, 01.03.1969, *B.M. Sharma* 0042 (KASH); Doda, 02.06.1970, *B.A. Wafai* 0209 (KASH); Bategam, Kupwara, 15.04.2005, *Fayaz, Dar & Wafai* 001, 002 (KASH); University Campus, Hazratbal, 16.04.2005, *Fayaz, Dar & Wafai* 003,004 (KASH).

Habitat: Moist fields, orchards, gardens and lawns, stream banks; 1580 – 2000m amsl.

Distribution: Atlantic and South Europe, West and Southwest Asia, Crimea, Caucasus, South Siberia, Pakistan, India (native to West Asia and Europe). In the Kashmir Himalaya it is found all over the plains of Kashmir valley.

Note: The species grows in two distinct forms – one having spiny achenes and another having smooth achenes. The petioles and the adaxial surface of leaves in the former are continuously pubescent while in latter they are glabrous or sparsely pubescent. The two forms grow sympatrically and the variations are discontinuous without any intermediate forms.

Ranunculus palmatifidus H. Riedl in Kew Bull. 34: 362. 1979; Riedl & Nasir in Ali & Nasir, Fl. Pak. 193: 153. 1991; Rau in Sharma *et al.*, Fl. Ind. 1: 125. 1993. Srivastava, Taiwania 55(3): 286. 2010. [Figure 2G]

Terrestrial, perennial herb, with fibrous roots. Stems 1 - 2, erect, 15 - 30 cm, branched, terete or angular, hollow, 1 - 2 mm in diameter, puberulent with continuous, appressed trichomes. Radical leaves 3 - 5, petiolate; petiole 4.5 - 9.0 cm, sparsely puberulent; blade reniform, 3.0 - 5.5 × 4.5 - 7.0 cm, glabrous on ventral surface and sparsely or continuously pubescent on dorsal surface, 3-sect, middle segment lanceolate without any further lobation or dentation, lateral segments 2-sect to 2-partite forming lanceolate lobes; cauline leaves sessile or subsessile, palmatisect. Flowers yellow, 1.8 - 2.1 cm across, pedicellate; pedicel with dense, appressed, transparent trichomes. Sepals 5, navicular, patent, ovate to elliptic, densely villous on the lower surface. Petals 5, imbricate, obovate, 8.0 - 9.5 × 7 - 8 mm, apex rounded or truncate (plane), claw 0.5 – 1.0 mm; nectary pit pocket-like without nectary scale. Carpels densely pubescent in the ovary region. Achenes 15 - 30 per head, obliquely obovoid, 2.5 - 3.25 × 1.5 - 1.75 mm, lower half of achene bear spreading, transparent trichomes; beak 0.75 - 1.0 mm long, curved,. Torus club-shaped or cylindrical, 3 - 4 × 1.0 - 1.5 mm, sparsely covered with transparent trichomes.

Flowers & fruits: May – July

Ploidy level: Tetraploid (2n = 4x = 32).

Specimens examined: Tangmarg, 20.08.1973, *A.R. Naqshi* 6596 (KASH); Sonamarg, 28.05.1983, *G.H. Dar* 5286 (KASH); Achoor, Gurez, 11.08.1989, *A.R. Naqshi* 10577 (KASH); Gulmarg, 10.05.2006, *Fayaz, Dar & Wafai* 047 (KASH); Zojila, 09.06.2007, *Fayaz, Dar & Wafai* 126 (KASH); Tilael, Gurez, 27.06.2008, *Fayaz, Dar & Wafai* 136 (KASH).

Habitat: Subalpine and alpine moist open and shady slopes of *Abies pindrow*; 2600 – 3600 m amsl.

Distribution: Pakistan, Kashmir Himalaya, Himachal Pradesh and Uttarakhand.

Ranunculus rubrocalyx Regel ex Komarov, Trav. Soc. Naturalistes St. Petersbourg, Sect. Bot. 26: 62. 1896; Ovczinnikov in Komarov, Fl. URSS. 7: 404. 1937; Tamura in Kitamura, Pl. W. Pak and Afghan. 65. 1964; Stewart, Ann. Cat. Vas. Pl. W. Pak and Kash. 272. 1972; Riedl & Nasir in Ali & Nasir, Fl. Pak. 193: 150. 1991; Wencai & Gilbert in Wu, Raven & Hong, Fl. China 6: 404. 2001. Srivastava, Taiwania 55(3): 289. 2010; [Figure 2H]

Terrestrial, perennial herb with fibrous roots. Stems 1 - 2, erect, 4 - 10 cm high, unbranched, hollow, angular, 1.0 - 1.5 mm in diameter, reddish or greenish, pubescent with transparent,

appressed trichomes. Radical leaves 2 - 3, petiolate; petiole 1.5 - 3.5 cm, blade orbicular, suborbicular or reniform, 1.4 - 2.2 × 1.7 - 2.5 cm, 3-partite, middle segment obovate, mostly 3-lobed, lateral segments with 4 - 6 lobed, lobes shallow with obtuse or rounded apices, rarely tending to become acute, base cordate, blade glabrous from both the surfaces or bears scattered trichomes on the dorsal surface, trichome 350 - 680 µm long. Flowers yellow, 1.2 - 1.5 cm across, solitary or sometimes 2 - 3, pedicellate; pedicel with continuous, transparent, appressed trichomes. Sepals 5, reddish or rarely yellowish-green, navicular, patent, ovate, villous on the lower surface with continuous and appressed trichomes. Petals 5, imbricate, obovate, 6 - 8 × 5.5 - 7.0 mm, apex rounded or shallowly notched, claw inconspicuous; nectary pit small, pocket-like without nectary scale. Achenes 15 - 30, obliquely obovoid, glabrous, 2.25 - 2.75 × 1.25 - 1.5 mm; beak narrow, straight, 1 mm long. Torus club-shaped to globose, 2.5 - 3.0 × 1.5 - 2.0 mm, covered with spreading, scattered trichomes.

Flowers & fruits: May – June

Ploidy level: Diploid (2n = 2x = 16).

Specimens examined: Lahaul-Spiti, July-August, 1864, *D. Brandis* (DD); Zojila, 28.07.1983, *G.H. Dar* 7183 (KASH); Kangdori, Gulmarg 22.05.2006, *Fayaz, Dar & Wafai* 059 (KASH); Apharwat 22.05.2006, *Fayaz, Dar & Wafai* 062 (KASH).

Habitat: Alpine meadows, slopes; 2800 – 3000 m amsl.

Distribution: Pamir-Alai, Tien-Shan, Pakistan, Afghanistan, Kashmir

Ranunculus sceleratus Linnaeus, Sp. Pl. 1: 551. 1753; Hooker f. & Thomson in Hooker f., Fl. Brit. Ind. 1: 19. 1872; Blatter, Beaut. Flows. Kash.1: 15. 1928; Stewart, Ann. Cat. Vas. Pl. W. Pak. & Kash. 273. 1972; Hara & Williams, Enum. Flow. Pl. Nepal 2: 20. 1979; Polunin & Stainton, Flows. Himal. 10. 1984; Riedl & Nasir in Ali & Nasir, Fl. Pak. 1993: 132. 1991; Rau in Sharma *et al.*, Fl. Ind. 1: 128. 1993; Wencai & Gilbert in Wu, Raven & Hong, Fl. China 6: 421. 2001; Srivastava, Taiwania 55(3): 290. 2010; FNA vol. 3 @ www.efloras.org. *R. indicus* Roxb. Fl. Ind. 2: 671. 1820. **[Figure 2I]**

Terrestrial or aquatic, annual herb. Stems solitary or several, 10 - 80 cm high, sulcate, 0.3 - 2.6 cm in diameter, branched, glabrous. Radical leaves 7 - 8, forming a rosette, petiolate; petiole 2 - 25 cm, glabrous; blade 3-sect to 3-partite, papery, suborbicular or reniform, 1.25 - 8.8 × 1.7 - 11.5 cm, glabrous, base truncate to cordate, middle segment cuneate, 3-fid or 3-lobed, lobe apices rounded, lateral segments equally or unequally 2-partite or 2-fid, margins incised-lobate; lower cauline leaves similar to radical ones except for their shorter petioles which are glabrous or sparsely pubescent with transparent, spreading or appressed trichomes. Flowers yellow, 0.9 - 1.2 cm across. Sepals 5, ovate-elliptic, patent, navicular, densely villous on lower surface with colourless trichomes. Petals 5, obovate, 4 - 6 × 2.5 - 4.0 mm, apex rounded, claw 0.5 mm; nectary pits 1 - 3 at the base, naked, surrounded by a circular or crescent-shaped ridge. Achenes obovoid, glabrous, slightly compressed, 1.25 - 1.75 × 0.75 - 1.0 mm, beak inconspicuous. Torus club-shaped, obovoid or cylindrical, 6.5 - 9.0 × 3 - 6 mm, glabrous or sparsely hairy, trichome 500 - 600 µm long.

Flowers & fruits: March-May in post-winter populations, and October-November in pre-winter populations.

Ploidy level: Tetraploid (2n = 4x = 32).

Specimens examined: Miran Sahab, 01.02.1970, *B.M. Sharma* 0342 (KASH); Rajouri, 05.03.1988, *G.H. Dar* 9651(KASH); Langate, 20.08.2002, *Anzar Khuroo* 0603 (KASH); Saida Kadal, Srinagar 15.03.2006, *Fayaz, Dar & Wafai* 010, 011 (KASH); Bategam, Kupwara 29.3.2006 *Fayaz, Dar & Wafai* 029, (KASH).

Habitat: Marshes, wet places, stagnant waters, shallow waters of lakes, banks of streams and sewage channels, moist unploughed paddy fields; 1580 – 2000m amsl.

Distribution: All parts of Europe, Asia, North America and North Africa. In India, it occurs in plains in the north, Himalaya and in warm valleys.

Ranunculus trichophyllus Chaix in Villars, Hist. Pl. Dauph. 1: 335. 1786; Stewart, Ann. Cat. Vas. Pl. W. Pak. & Kash. 273. 1972; Hara & Williams, Enum. Flow. Pl. Nepal 2: 20. 1979; Polunin & Stainton, Flows. Himal. 11. 1984; Qureshi & Chaudhri, Pak. Syst. 4(1-2): 190. 1988; Rau in Sharma *et al.*, Fl. Ind. 1: 130. 1993 ; Srivastava, Taiwania 55(3): 292. 2010; *R. aquatilis* L. subsp. *trichophyllus* (Chaix) Moore & Moore, Cybcl. Hibernica 5. 1866; *R. aquatilis* var. *trichophyllus* Hooker f. & Thomson in Hooker f., Fl. Brit. Ind. 1: 16. 1872; *Batrachium trichophyllum* (Chaix) Van der Bosche, Prodr. Fl. Bat. 17. 1850; *Batrachium trichophyllum* Riedl & Nasir in Ali & Nasir, Fl. Pak. 1993: 124. 1991. [Figure 2J]

Aquatic (or semiaquatic*) annual or perennial herb. Stem flaccid, hollow, 1.5 - 2.0 mm in diameter, glabrous, branched or unbranched, rooting at nodes, partly erect and partly spreading under stagnant water, horizontally spreading in the direction of flowing water. Leaves petiolate, petiole 5 - 1 mm with a sheathing base, submerged, ternately divided into many capillary or threadlike segments, 2 - 3 cm long; laminate leaves absent. Flowers white, 6 - 8 mm across, pedicellate; pedicels arising singly in leaf axils, 2.5 - 4.0 cm long, raising the flowers above the surface of water. Sepals 5, elliptic, patent, glabrous. Petals 5, imbricate, ovate to obovate, 3.5 - 4.5 × 2.5 - 3 mm, apex rounded, claw 0.5 - 0.75 mm; nectary pit semilunar, naked, nectary area of petal yellow. Carpels glabrous or pubescent towards the outer ridge. Achene head globose, 3.0 - 3.5 × 3.5 - 4.0 mm; achenes 20 - 30, obovoid, 1.5 - 2.0 × 1.0 - 1.25 mm; beak small, inconspicuous, glabrous or the outer ridge bearing scattered, transparent trichomes. Torus globose, 1.0 - 2.0 × 1.0 - 1.25 mm, densely pubescent with 400 - 600 µm long trichomes.

Flowers & fruits: April – June in annuals, May – October in perennials.

Ploidy level: Tetraploid (2n = 4x = 32).

Specimens examined: Kulgam, 04.06.1959, T.A. Rao 9213 (CAL); Kashmir, 03.09.1940, R.R. Stewart 21361 (CAL); Sum, Jammu, 19.02.1969, B.M. Sharma 0195 (KASH); Batpora, 20.04.1984, G.H. Dar 08931 (KASH); Kokernag 10.09.2005, Fayaz, Dar & Wafai 005, 006 (KASH); Kunzer 04.08.2006, Fayaz, Dar & Wafai 094 (KASH); Dawar, Gurez 26.06.2008, Fayaz, Dar & Wafai 133 (KASH); Lasjan, Bypass 20.03.2009, Fayaz, Dar & Wafai 163 (KASH); Drugmulla, Kupwara 22.03.2006, Fayaz, Dar & Wafai 020 (KASH).

Habitat: Ponds, streams, flooded or waterlogged paddy fields; 1580 – 2800 m amsl.

Distribution: Europe, Asia, North Africa, Central and North America. In India it is distributed throughout temperate and subalpine regions of the Himalaya, Jammu and Kashmir, Himachal Pradesh, Uttar Pradesh and Punjab.

Note: *R. trichophyllus* shows a high degree of variability in growth form and size ranging from long ascending and/or floating perennial macrophytes to smaller creeping annual ones. The latter has been described as *Batrachium rionii* or *R. rionii* by some authors. *B. rionii* (or *R. rionii*), as the authors have noted, has leaves quite similar to that of *R. trichophyllus*, except petiole length which is 3 – 4 cm in the former and just 5mm in the latter. The number of achenes per head in *R. rionii* is 60 – 90 whereas it is 25 – 30 in *R. trichophyllus*. During present investigation, however, both annual and perennial forms were collected having leaves with petioles of almost equal length (0.4 – 1.0cm) and fruit heads with almost equal number (25 - 40) of achenes. Hence, the two forms, annual and perennial, were described under *R. trichophyllus* during present study.

Ranunculus trilobus Desfontaines, Fl. Atlant. 1: 437. 1798; Deva & Naithani, Ind. J. Forest. 7; 337. 1984; Srivastava, Taiwania 55: 293. 2010; FNA vol. 3 @ www.efloras.org *R. sardous* subsp. *trilobus* (Desfontaines) Rouy & Foucaud, Fl. France 1: 109. 1893; Lone *et al.*, Pleione 8(1): 171 – 177. 2014. [Figure 2K]

Terrestrial, annual herb. Stem erect, solitary or 2 - 3, 10 - 49 cm high, branched, hollow, terete, 2.0 - 3.5 mm in diameter, continuously pubescent with 200 - 320 µm long appressed or spreading trichomes. Radical leaves petiolate; petiole 3.5 - 14 cm, continuously hairy with appressed trichomes, sulcate along the upper side; blade cordate-ovate, 4.5 - 9.5 × 4.0 - 9.0 cm, 3-sect, middle segment 3 partite or occasionally unequally 2-partite with 5 - 10 mm long petiolule, lateral segments 3-partite or irregularly lobed, lobe margins incised dentate, both surfaces pubescent, upper surface with scattered and lower with continuous trichomes, trichomes transparent, appressed, 150 - 200 µm long. Cauline leaves similar to basal ones, petioles shorter, 2 - 3 cm. Flowers yellow, 0.9 - 1.4 cm across, pedicellate, pedicel 1 - 2 cm, pubescent with appressed hair. Sepals 5, ovate to obovate, reflexed, sparsely hairy on the lower surface. Petals 5, imbricate, ovate with rounded apex, 5 - 6 × 3 - 4 mm, nectary pit covered with scale, claw 0.5 - 1.0 mm. Achenes 25 - 40 per head, complanate, arborescent-obovate, 2.5 - 3.0 × 1.75 - 2.25 mm, faces papillate or verrucose, distinctly marginate, margin smooth; beak small, 0.5 - 1.0 mm. Torus club-shaped, 4.0 - 5.5 × 1.5 - 2.0 mm sparsely hairy, trichomes 0.5 - 1.0 mm.

Flowers & fruits: April – June

Ploidy level: Hexaploid (2n = 6x = 48).

Specimens examined: Baijnath, Kumaon, 07.06.1983, *Soma Deva* 10582 (DD); Batergam, Kupwara 20.05.2006, *Fayaz, Dar & Wafai* 056, 057 (KASH); Bemina, Srinagar 26.05.2006, *Fayaz, Dar & Wafai* 070 (KASH).

Habitat: Orchards, along the sides of ditches; 1580 – 1650 m amsl.

Distribution: Europe, Shanghai, India. In India the species grows in West Bengal, W. Himalaya, Uttarakhand. During present study, it has been collected from a few places in the Kashmir valley.

Note: The species was reported first time from Kashmir Himalaya by the authors (Lone *et al.* 2014).

DISCUSSION

Kashmir valley is a repository of buttercups comprising eleven species of the genus *Ranunculus*, growing at different altitudes ranging from <1600 m to 3000 m. While most of those are terrestrial (*R. arvensis*, *R. hirtellus*, *R. laetus*, *R. munroanus*, *R. muricatus*, *R. palmatifidus*, *R. rubrocalyx*, and *R. trilobus*), a few are aquatic or semiaquatic (*R. lingua*, *R. sceleratus* and *R. trichophyllus*). Buttercups growing at high altitude (>2500 m) include *R. hirtellus*, *R. munroanus*, *R. palmatifidus* and *R. rubrocalyx*. Only *R. laetus* with its high ecological amplitude grows at places situated below 1600 m as well as at places at around 2800 m. The most common buttercups growing in the study area include *R. arvensis*, *R. muricatus*, *R. laetus*, and *R. sceleratus*. The first two species, growing in apple orchards and open fields, commonly called as ‘Choorim’ and ‘Thulla Hakh’ in local Kashmiri language, serve as poor man’s vegetable during spring before they flower while the last two are not even eaten by animals for their toxicity. Of these eleven species of buttercups growing in the study area, six (*R. arvensis*, *R. lingua*, *R. muricatus*, *R. sceleratus*, *R. trichophyllus*, *R. trilobus*) have worldwide distribution while five (*R. hirtellus*, *R. laetus*, *R. munroanus*,

R. palmatifidus, *R. rubrocalyx*) are restricted to the Asian continent (Riedl & Nasir 1991; Whittemore 1997; Wencai & Gilbert 2001; Uniyal 2002; Srivastava 2010). Among the Asian buttercups *R. palmatifidus* is confined to Northwest Himalaya (Riedl & Nasir 1991) while others have comparatively broader range of distribution. At regional level Kashmir valley shares four species (*R. arvensis*, *R. muricatus*, *R. sceleratus*, *R. trichophyllus*) with Jammu region, one (*R. hirtellus*) with Ladakh region and one (*R. laetus*) with both Jammu and Ladakh regions (Fig. 3), although *R. laetus* is represented by a single small population near Thrungus, Dras, the gateway to Ladakh while travelling from Sonamarg to Kargil. Srivastava (2010) has reported 15 species of *Ranunculus* from Kashmir valley after studying the specimens in DD and CAL Herbaria. Amongst these, the presence of *R. hyperboreus* and *R. natans* in Kashmir valley is doubtful because the two species are restricted to Ladakh region while *R. adoxifolius* and *R. diffusus* could not be traced despite thorough field survey.

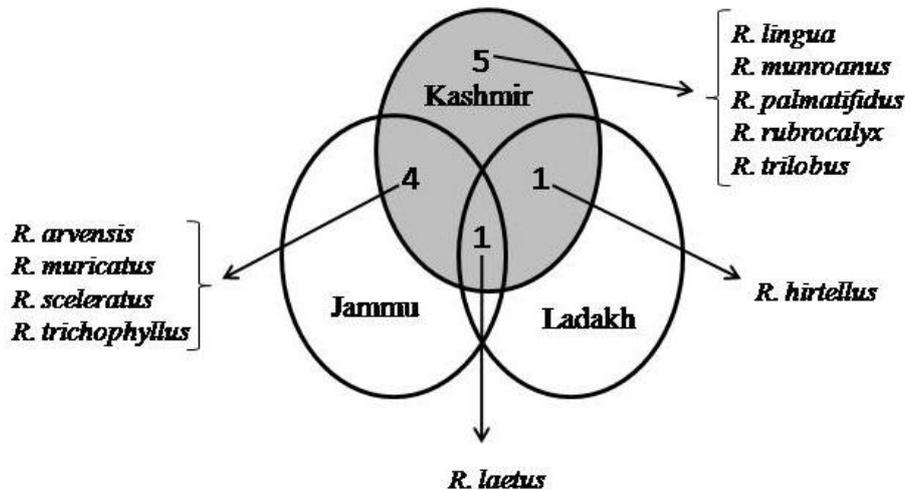


Figure 3: Venn diagram showing (i) diversity of buttercups in Kashmir valley (ii) buttercups in valley that are not found in Jammu and Ladakh regions and (iii) buttercups that are common with those growing in Jammu and Ladakh regions.

R. arvensis, the corn buttercup, hitherto known for having spiny achenes, is now collected with exclusively smooth achenes from a few populations in the study area. The variation in the two forms (spiny-achened and smooth-achened) is discontinuous without having any intermediates. The two forms grow sympatrically and breed true when seeds are separately sown in pots and allowed to grow under controlled conditions. In *R. muricatus*, the spiny-fruit buttercup, spiny ached and smooth ached forms grow quite commonly in the study area. Many authors (Rau 1993; Whittemore 1997; Wencai & Gilbert 2001) have reported *R. muricatus* bearing only spiny achenes but Blatter *et al* (1919) and Kak (1981) have reported smooth-achened forms within the species. The former segregated the smooth ached form as a separate species (viz., *R. pseudomuricatus*), while the latter named such forms as *R. emuricatus* Majeed. Riedl and Nasir (1991) and Uniyal (2002) have also reported the occurrence of smooth-achened forms in *R. muricatus* from Himalayas and Peninsular India but without proposing any new combination. Srivastava (2010), while examining *R. muricatus* specimens available in many herbaria, noted that most of the individuals had these overlapping characters, as such merged the two forms, and treated *R.*

emuricatus Majeed as synonym of *R. muricatus* Linnaeus. However, during the present study, no such merging of such characters has been observed and the two forms have been found growing together discontinuously. *R. munroanus*, growing under the shade of rocks on alpine slopes and meadows is facing threat due to loss of habitat due to landslides and avalanches that roll down such rocks. Similarly, *R. lingua*, an emergent helophyte, is also facing threat in Kashmir valley. The species is growing in small populations towards the banks and the shallow areas of Dal Lake, Hokersar and Anchar wetlands, and a few isolated puddles and ponds near Srinagar. Due to widening of roads and other construction works the species is losing its habitat at an alarming rate. *R. trichophyllus*, the only species in the study area belonging to subgenus *Batrachium*, is very interesting with regard to its life-form. The species is found as a perennial horizontally growing large macrophyte (>30 cm long) in slow moving streams. The upper branches, which are nearer to the surface of water, produce white flowers towards their distal ends, one at a node opposite to the finely dissected leaves. The flowers open only after pushed out of water by their 2 – 3 cm long pedicels. The deeper branches, however, remain vegetative or produce flowers that remain small and closed. Such flowers are visible as white pin-head like structures. In latter case the reason for remaining small and closed could be the slow growth at constantly low temperatures (<6°C). The species also grows as annual in water logged un-ploughed paddy fields and shallow ponds and puddles that dry up during summer. Such plants are comparatively of smaller size (<30 cm) with leaves having spreading capillary segments instead of being slightly clumped but the floral size and the number of achenes per head is quite matching with those of perennial forms.

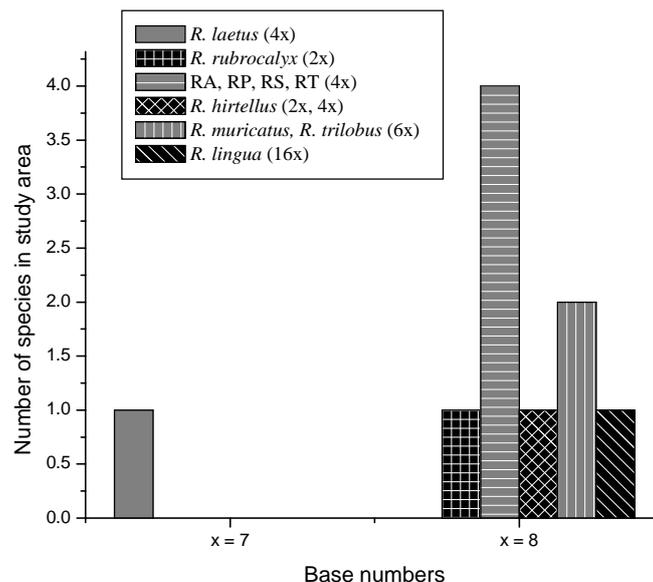


Figure 4: Buttercups in Kashmir valley grouped on the basis of their base numbers and ploidy levels. [RA = *R. arvensis*, RP = *R. palmatifidus*, RS = *R. sceleratus*, RT = *R. trichophyllus*]

Both, meiosis from PMC and karyological studies revealed that all the species of buttercups (*Ranunculus* Linnaeus) growing in the study area are with chromosome numbers based on $x = 7$ and $x = 8$. The former being represented by *R. laetus* only, having $2n = 4x =$

28 (Fig. 4). The species with $x = 8$ can be grouped into five categories, (i) diploid (*R. rubrocalyx*, having $2n = 2x = 16$), (ii) tetraploid (*R. arvensis*, *R. palmatifidus*, *R. sceleratus*, *R. trichophyllus*, having $2n = 4x = 32$), (iii) both diploid and tetraploid cytotypes (*R. hirtellus* having $2n = 2x = 16$ and $2n = 4x = 32$), (iv) hexaploid (*R. muricatus*, *R. trilobus*, having $2n = 6x = 48$) and (v) 16-ploid (*R. lingua*, having $2n = 16x = 128$).

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