

Diversity and distribution of genus *Ranunculus* Linnaeus (Ranunculaceae) in the trans-Himalayan (Ladakh) region in J&K, India

Fayaz A. Lone^{1,5}, Shazia Lone², Malik Asif³, G. H. Dar⁴ and B. A. Wafai⁴

¹Department of Botany, Govt. Degree College Handwara, 193221, J&K, India

²Govt. Higher Secondary School Karihama (Kupwara), 193222, J&K, India

³Krishi Vighyan Kendra (Kargil), SKUAST (K) Shalimar, J&K, India

⁴Centre for Biodiversity Studies, Baba Gulam Shah Badshah University, Rajouri, J&K, India

⁵Corresponding author: E-mail: falonebotany@gmail.com

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Abstract

Of the many number of species of genus *Ranunculus* growing in Kashmir Himalaya in diverse habitats ranging from terrestrial to aquatic at different altitudes, nine species (viz., *R. brotherusii*, *R. chaerophyllos*, *R. hirtellus*, *R. hyperboreus*, *R. laetus*, *R. membranaceus*, *R. natans*, *R. pulchellus* and *R. tricuspis* var. *lancifolius*) are found growing in the trans-Himalayan region. Two of the species (*R. laetus* and *R. hirtellus*) are found in other parts of the Kashmir Himalaya also, while seven species (*R. brotherusii*, *R. chaerophyllos*, *R. hyperboreus*, *R. membranaceus*, *R. natans*, *R. pulchellus* and *R. tricuspis* var. *lancifolius*) are restricted to the trans-Himalayan region.

Key words: *Ranunculus*, diversity, distribution, Kashmir Himalaya, trans-Himalaya, Ladakh,

INTRODUCTION

The genus *Ranunculus* Linnaeus (Ranunculaceae) was first described by Carolus Linnaeus in 1753. It comprises plants commonly known as 'buttercups' for their bowl-shaped flowers, although epithets such as 'spearworts', 'water crowfoots' and 'lesser celandine' are also used for other species of the genus. It is a genus of herbaceous annuals and perennials comprising ca.600 species (Tamura 1993, 1995; Wang & Gilbert 2001; Mabberly 2008; Srivastava 2010) and numerous microspecies and apomictic races (Hörandl *et al.* 2005). 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). A small number of species occurs in tropical regions where they are restricted to high mountain areas (Tamura 1995). The Arctic region harbours 42 – 48 species/subspecies of *Ranunculus* (Tolmachev 1971; Elven 2007). 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 Northwest Himalayas with only a few species (e.g., *R. muricatus*, *R. reniformis*, *R. subpinnatus*, *R. wallichianus*) growing towards peninsular India.

The Kashmir Himalaya, constituting a part of the Great Himalayan range represents a repository of *Ranunculus* but there is considerable disagreement amongst the authors as for as the number of species of the genus growing in this region. Likewise, the number of

Ranunculus species reported from time to time growing in the trans-Himalayan region also varies from author to author. While Hooker & Thomson (1872) have reported only 5, the number of species reported by Stewart (1972), Uniyal (2002), Kachroo *et al.* (1977), and Srivastava (2010) is 14, 5, 6, and 27 respectively. During present investigation nine species of *Ranunculus* (viz., *R. brotherusii*, *R. chaerophyllos*, *R. hirtellus*, *R. laetus*, *R. membranaceus*, *R. natans*, *R. pulchellus*, *R. hyperboreus* and *R. tricuspis* var. *lancifolius*) were found growing in the trans-Himalayan (Ladakh) region. Three of these species (*R. chaerophyllos*, *R. hyperboreus*, *R. tricuspis* var. *lancifolius*) have worldwide distribution while the rest are confined to Asia only.

The species-poor desert and high altitude flora of Ladakh region have attracted the attention of botanists since the second half of the 19th century (Moorcraft & Trebeck 1841; Thomson 1852; Klimeš & Dickoré 2005). Presently sandwiched between the borders of Pakistan and China, the region has remained difficult to access, both on account of its physical geography and on strategic and political grounds. Floristic knowledge of this region is accordingly still very patchy. The present paper focuses on the diversity and distribution of genus *Ranunculus* growing in this region in aquatic and moist terrestrial habitats.

Study area

Ladakh or 'Little Tibet' (32°50' – 34°75' N, 75°45' – 79°70' E) is situated in the eastern part of Jammu & Kashmir, India (Fig 1). It covers a total area of 59,146 km² (official website of J&K Govt. Forest Department), excluding the areas under Pakistan and China, delimited by the eastern Karakoram Range in the north and the Great Himalayan Range in the south forming the western most extension of the Tibetan Plateau (Dvorský *et al.* 2010). Physiographically, the cold arid zone of Ladakh can be divided into six valleys – Leh, Nubra, Changthang, Zaskar, Suru and Dras (Ballabh & Chaurasia 2007). The area comprises a large tract of high mountains, barren landscapes, beautiful meadows, vast pasturelands, colourful moraines, marshes and screes. The study area lies in the rain shadow region of the Himalaya which poses a barrier to seasonal monsoon precipitations from reaching the trans-Himalayan region. The climate is, therefore, generally arid with mean annual precipitation as

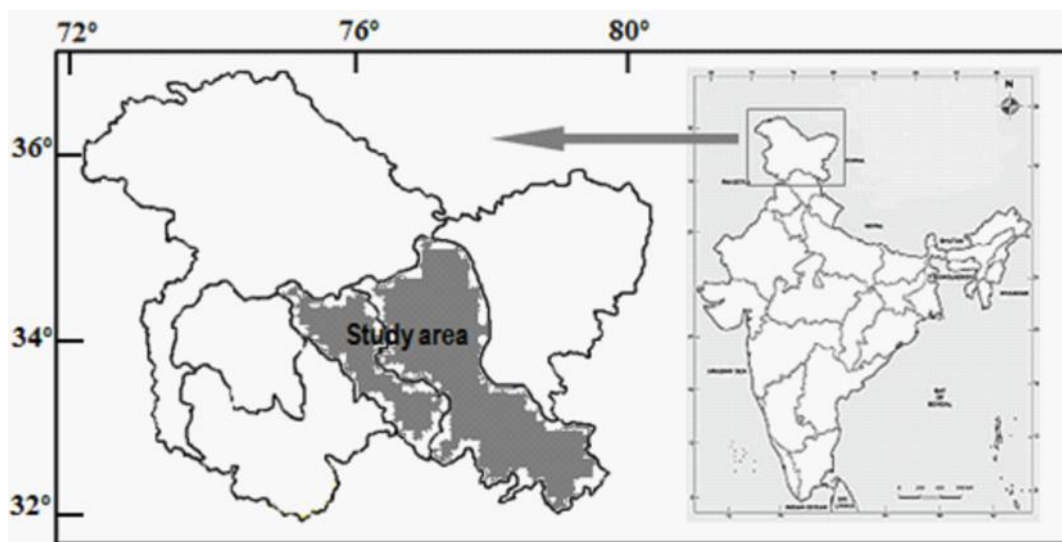


Figure 1. Map of Kashmir Himalaya showing trans-Himalayan (Ladakh) region.

low as 50 – 100 mm (Hartmann 1983; Wang 1988) thus forming a high altitude cold desert (Stewart 1916-17; Negi 1995) with most often sparse vegetation. Evaporation exceeds precipitation at lower and middle elevations. The Zaskar valley, however, which lies immediately to the north of the Himalayan range, has a relatively higher rainfall; richer flora and thicker forest cover (Polunin & Stanton 1984). The mean monthly temperature rises above 0°C during June to August only and winter temperatures generally drop below -30°C (Klimeš & Doležal 2010). The whole area is characterized by snow clad ranges with altitudes of ca. 6000 m and high altitude valleys lying between 2700 and 4500 m.

MATERIAL 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

A random sample of 4 to 5 healthy specimens of each taxon from each population was collected and assigned a specific collection number. Complete field notes recording the details of the locality, altitude, habitat, habit, and diagnostic characters were made for each specimen. The specimens were identified using the available suitable literature. The identifications were confirmed by matching the specimens with those deposited in KASH, DD and CAL.

RESULTS AND DISCUSSION

The present study is the first taxonomic revision of genus *Ranunculus* Linnaeus (Ranunculaceae) from the trans-Himalayan (Ladakh) region. During investigation nine species of *Ranunculus*, growing in different habitats, were recorded. The taxonomic treatment of all the recorded species, key to the species, nomenclatural citations, synonyms, taxonomic descriptions, phenology and distribution is presented as follows:

Key to the species of *Ranunculus*

- | | | |
|---|---|-------------------------|
| 1 | Plants terrestrial | 2 |
| 1 | Plants aquatic or semi-aquatic* | 5 |
| 2 | Rhizome horizontal, long, branched, and pubescent | <i>R. laetus</i> |
| 2 | Rhizome erect and short, glabrous | 3 |
| 3 | Petals persistent and enclosing the fruit head till the achenes mature; nectary covered with scale | <i>R. chaerophyllos</i> |
| 3 | Petals wither, nectary naked | 4 |
| 4 | Stem 3- 7 cm tall, caespitose; lamina rhomboid; sepals and achenes carminish, | <i>R. membranaceus</i> |
| 4 | Stem 10-30cm tall, non-caespitose; lamina reniform or broadly obovate; sepals and achenes yellowish green | 5 |
| 5 | Middle segment of lamina obovate, 3-5 lobed or sometimes entire, lobes wider at the base; flowers 1.2 – 2 cm across, imbricate; achenes mostly pubescent with curved or straight beak, 30 – 50 per head | <i>R. hirtellus</i> |
| 5 | Middle segment of lamina cuneate, 3-4 partite, lobes narrow; flower 0.8 – 1.1cm across valvate; achenes glabrous with beak straight, 50 – 70 per head | <i>R. brotherusii</i> |

*Semiaquatic – a plant that thrives in water puddles during spring but matures in terrestrial conditions when the puddles dry up during summer.

6	Stem erect; lamina elliptic or lanceolate, entire or 2 – 3 lobed	<i>R. pulchellus</i>
6	Stem creeping; lamina pentagonal, suborbicular, oblong or linear or reniform, 3-fid or 3- partite	7
7	Stem >5mm in diameter, nectary cup-shaped,	<i>R. natans</i>
7	Stem up to 1mm in diameter, nectary small ridge like	8
8	Leaves pentagonal, suborbicular, 3-partite or 3-fid, base truncate or cordate	<i>R. hyperboreus</i>
8	Leaves narrow linear or oblong, 3-fid at the tip, base cuneate	<i>R. tricuspis</i>

Taxonomic treatment:

Ranunculus brotherusii Freyn in Bull. Herb. Boissier 6: 885. 1898; Stewart, Ann. Cat. Vas. Pl. W. Pak & Kash. 270. 1972; Kachroo *et al.*, Fl. Ladakh 46. 1977; Polunin & Stainton, Flow. Himal. 10. 1984; M. A. Rau in B.D. Sharma *et al.* Fl. Ind. 1: 116. 1993; Wang & Gilbert in Wu, Raven & Hong, Fl. China 6: 409. 2001; Uniyal in Singh *et al.*, Fl. J&K 417 - 418. 2002. *R. affinis* Hooker f. & Thomson in Fl. Brit. Ind. 1: 18. 1872; *R. brotherusii* Freyn var. *latisectus* H. Riedl in Kew Bull. 34: 362. 1979. **Figure 2a**

Terrestrial, perennial herb with both fibrous and fleshy roots. Stem solitary or caespitose, erect, up to 35cm, simple or branched, densely pubescent. Radical leaves 5-7, petiolate, blade orbicular, suborbicular or reniform, 1.5 - 2.5 x 1.7 - 2.7cm, 3-sect, middle segment cuneate, 3-4 partite, lobules narrow, apices acute, lateral segments equally or unequally 2-partite, both surfaces continuously pubescent. Flowers solitary or sometimes 2-3, 0.8 - 1.1cm across. Sepals 5, patent, membranous. Petals 5, valvate, narrowly obovate or ovate, apex rounded, claw 0.5 - 0.75mm, nectary pit pocket-like, naked. Carpels many, glabrous. Achenes 50 - 75 per head, obovoid, 1.5 - 2.0 x 0.75 - 1.0mm, glabrous; beak straight.

Distribution: China, Nepal, India [Himachal Pradesh, Uttar Pradesh, Sikkim, Arunachal Pradesh and Zaskar-Ladakh region of Kashmir Himalaya and Kishtwar area of Jammu region], and Russia.

Habitat: Meadows and grassy slopes, banks of streams. 2890 – 3300m.

Flowering and fruiting: June – July

Specimens examined: Upshi, Chushul, Leh, 06.08.1976, *U. Dhar* 7559 (KASH); Khardung, 23.07.1980, *A.R. Naqshi* 7332 (KASH); Zaskar, Kargil 06.06.2007, *Fayaz, Dar & Wafai* 114 (KASH); Dras, Kargil 09.06.2007, *Fayaz, Dar & Wafai* 121 (KASH); Sankoo, Kargil 19.06.2009, *Fayaz, Dar & Wafai* 170 (KASH).

Ranunculus chaerophyllos Linnaeus, Sp. Pl. 1: 555. 1753; Boiss., Fl. Or. 1: 31. 1867; Stewart, Ann. Cat. Vas. Pl. W. Pak & Kash. 270. 1972; Riedl & Nasir in Ali & Y. Nasir, Fl. Pak. 193: 144. 1991; Wang & Gilbert in Wu, Raven & Hong, Fl. China 6: 409. 2001. **Figure 2b**

Terrestrial, perennial herb with thin fibrous and thick fleshy roots. Stem erect, 8 - 15cm, terete, unbranched, carmine red, densely pubescent with spreading transparent trichomes. Radical leaves 2-3, petiolate; blade thicker in texture, glabrous on both surfaces, reniform or suborbicular with a cordate base, 2.1 - 2.8 x 2.6 - 3.4cm, 3-sect, middle segment obovate with or without petiolule, 3-partite to 3-fid, central lobe of middle segment 2 - 3 dentate, lobule apices subacute or acute, lateral segments flabellate, unequally 2-cleft; cauline leaves sessile, tripartite with narrow, linear, subacute segments. Flowers 1.8 - 2.5cm across, solitary or sometimes two, Sepals 5, patent, navicular, yellowish, villous on lower surface. Petals 5 (- 6 or 7), imbricate, persistent, obovate, apex subacute or dome-shaped, nectary pit covered

with scale, claw inconspicuous. Carpels many, glabrous or sparsely pubescent. Achenes obovoid with a curved beak.

Distribution: Mediterranean region of Europe, Asia and North Africa. In India, in a small area of Kargil only.

Habitat: Moist slopes of sandy mountains. 3400 – 3470m.

Flowering and Fruiting: June – July

Specimens examined: Ladakh, July 1905, *A. Meebold* 3315 (CAL); Tingochey, Tingole, Panikhar 20.06.2009, *Fayaz, Dar & Wafai* 173, 174 (KASH).

Ranunculus hirtellus Royle, *Illustr. Bot. Himal. Mount.* 53. 1834; Hooker f. & Thomson in *Fl. Brit. Ind.* 1: 18. 1872; Blatter, *Beaut. Fl. Kashmir.* 1:5. 1928; Stewart, *Ann. Cat. Vas. Pl. W. Pak & Kash.* 270. 1972; Polunin & Stainton, *Flow. Himal.* 10. 1984; Riedl & Nasir in Ali & Y. Nasir, *Fl. Pak.* 193: 145. 1991; M.A. Rau in B. D. Sharma *et al.*, *Fl. Ind.* 1: 121. 1993; Wang & Gilbert in Wu, Raven & Hong, *Fl. China* 6: 404. 2001; Uniyal in Singh *et al.*, *Fl. J&K* 420 – 421. 2002. *R. glabellus* Royle *ex* D. Don, in Royle, *Illus. Bot. Himal.* 53. 1834; *Ranunculus attenuatus* Royle *ex* D. Don, in Royle, *Illus. Bot. Himal.* 53 (1834); *Ranunculus choorensis* Royle *ex* D. Don in Royle, *Ill. Bot. Himal.* 53 (1834). **Figure 2c**

Terrestrial, perennial herb, with fibrous roots. Stem erect, single or 2 - 3, 10 - 30cm, simple or branched, hollow or solid, 1 - 2mm in diameter, terete or slightly angular, sparsely to densely pubescent with appressed trichomes. Radical leaves 3 - 5, petiolate; petiole 1.5 - 16cm, glabrous or sparsely pubescent with appressed hairs; blade reniform or broadly obovate with a cordate base, 1.5 - 4 x 1.8 - 6.0cm, 3-sect, middle segment obovate, 3 - 5 lobuled, rarely entire or many lobuled, lateral segments obliquely flabellate, unequally 2-cleft, many-lobuled, 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 0.9 - 2.0cm across, solitary or several, Sepals 5, navicular, patent. Petals 5 (6 - 13), imbricate, obovate or broadly obovate, apex rounded, plane or notched, nectary pit small, pocket-like, naked. Carpels many, pubescent, Achenes obliquely obovoid, 30 - 50 per head, 2.5 - 3.25 x 1.5 - 1.75mm, pubescent, beak straight or curved.

Distribution: Afghanistan, Pakistan, North India, Kashmir Himalaya, China

Habitat: Moist meadows and pine forests. 2600 – 3250m.

Flowering and fruiting: May – July, rarely August.

Specimens examined: 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); Panikhar, 05.06.2007, *Fayaz, Dar & Wafai* 112 (KASH); Sankoo, 08.07.2008, *Fayaz, Dar & Wafai* 143 (KASH).

Notes: The species is extremely variable in leaf-shape, petal shape and degree of pubescence on carpel and achene. In other parts of Kashmir Himalaya (e.g., Gulmarg, Thajwas, Bungus valley) specimens, with leaves having glabrous lamina and glabrous carpels and achenes or with leaves having broader middle segment with more than 10 incisions or with petals having notched apex, have been collected.

Ranunculus hyperboreus Rottbøll, *Skrift. Kjoeb. Selesk. Laerd. Elsk.* 10: 458. 1770; Hooker f. & Thomson in *Fl. Brit. India* 1: 18. 1872; Kachroo *et al.*, *Fl. Ladakh* 46. 1977; Riedl in *Fl. Pak* 193: 141. 1991; M.A. Rau in B.D. Sharma *et al.*, *Fl. India* 1: 128. 1993; Whittemore in

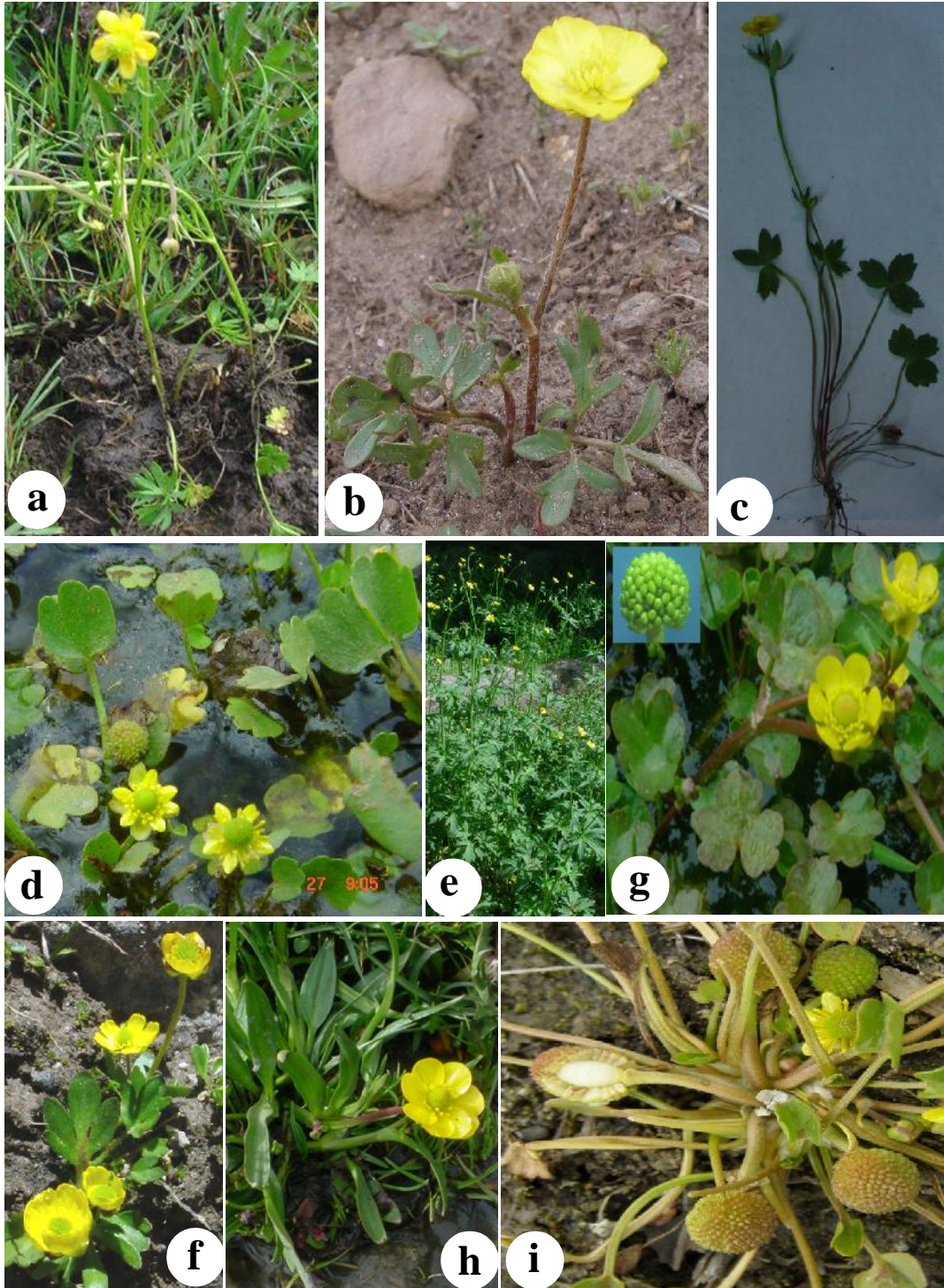


Figure 2: a. *Ranunculus brotherusii*; b. *R. chaerophyllos*; c. *R. hirtellus*; d. *R. hyperboreus*; e. *R. laetus*; f. *R. membranaceus*; g. *R. natans*; h. *R. pulchellus*; i. *R. tricuspis* var. *lancifolius*

Fl. N. Amer. 1997; Uniyal in Singh *et al.*, Fl. J&K 421. 2002; *R. hyperboreus* Rottb. var. *typicus* Hooker f. & Thomson in Fl. Brit. India 1: 18. 1872; *R. hyperboreus* Rottb. var. *multifidus* (Regel) Hooker f. & Thomson, in Fl. Brit. India 1: 18. 1872; *R. natans* C.A. Meyer var. *intertextus* (Greene) L.D. Benson. Amer. Mid. Nat. 40(1): 202. 1948; Stewart, Ann. Cat. Vas. Pl. W. Pak. & Kash. 270. 1972. **Figure 2d**

Aquatic or sub-aquatic, rosette, perennial herb, producing 1-4 stoloniferous stems. Stem creeping, floating or submerged, slender, up to 70cm long, 0.75 - 1.0mm in diameter, hollow, terete, glabrous, rooting at the nodes. Leaves petiolate; petiole 4 - 15cm; blade pentagonal, suborbicular or oblong, 1.0 - 2.0 x 0.5 - 2.3cm, glabrous, 3-sect, 3-partite or 3-fid, lateral segments entire or bilobed, middle segment entire, base truncate to cordate or cuneate. Flowers solitary axillary, borne in the rosette as well as on the nodes of stoloniferous stems, 0.75 - 1.1cm across. Sepals 5, yellowish-green, navicular, patent, glabrous. Petals 5 (6 - 7), ovate, claw prominent, 1.25 - 1.5mm, apex rounded, nectary pit small ridge-like, naked. Stamens 20-30, in two whorls, outer whorl longer (2.75 - 3.5mm) than the inner whorl (1.5 - 2.0mm). Carpels 40 - 60, 0.75 - 1.5mm long, glabrous. Achenes obovoid, 2.0 - 3.0 x 1.25 - 2.0mm, forming a globose head, head 5.0 - 6.0 x 4 - 5.0mm, glabrous; beak straight or slightly curved, greenish-yellow.

Distribution: Nepal, Pakistan, Russia, Canada, Alaska, Denmark, and India. In India it occurs in Jammu & Kashmir (Ladakh), Himachal Pradesh, Uttarakhand, Sikkim and Manipur.

Flowering and Fruiting: May – July.

Habitat: Stagnant small water bodies and slowly-flowing shallow streams, irrigation canals. 3200 – 3290 m.

Specimens examined: Taltal Nallah, Kajnag range, 19.05.1892, *J.F.Duthie 11101* (CAL); Leh, 03.09.2003, *Z.S. Khan 24681* (KASH); Dras 09.06.2007, *Fayaz, Dar & Wafai 102* (KASH); Sankoo 08.07.2008, *Fayaz, Dar & Wafai 141* (KASH); Choglamsar, Leh, 09.07.2008, *Fayaz, Dar & Wafai 146* (KASH); Pangong, 31.08.2008, *A.H. Malik 820* (KASH).

Notes: The species is cold-loving as for its distribution pattern at world and local levels is concerned. It grows profusely in the arctic region; however, scattered populations occur at high altitudes in non-arctic cold regions (Hoffmann *et al.*, 2010). *R. hyperboreus* along with *R. trichophyllus* are two species that grow in arctic region as well as in Kashmir Himalaya, the former being restricted to high altitude trans-Himalaya.

Ranunculus laetus Wallich *ex* D. Don in Royle, Illus. Bot. Himal. 53. 1834; Hooker f. & Thomson, Fl. Ind. 36. 1855; Hooker f. & Thomson in Hooker f., Fl. Brit. Ind. 1: 19. 1872; Blatter, Beaut. Fl. Kashm. 1: 16. 1928; Stewart, Ann. Cat. Vas. Pl. W. Pak. & Kash. 271: 1972; Polunin & Stainton, Flows. Himal. 9. 1984; Riedl & Nasir in Ali & Y. Nasir, Fl. Pak. 193: 141. 1991; M.A. Rau in B.D. Sharma *et al.*, Fl. Ind. 1: 122. 1993; Uniyal in Singh *et al.*, Fl. J&K 421. 2002. *R. distans* D. Don in Royle, III. 53. 1834; *R. pseudolaetus* Tamura Acta Phytotax. Geobot. 19: 109. 1963; **Figure 2e**

Terrestrial, perennial herb with a creeping, woody, densely pubescent rootstock producing numerous fibrous roots and flowering stems. Stems erect, 20 - 100cm high, branched, hollow, 3 - 8mm in diameter, terete, continuously or densely pubescent with appressed or spreading, transparent hairs. Radical leaves long-petioled; petiole 10 - 18cm long, sulcate along dorsal side, densely villous with patent hairs, blade orbicular or suborbicular, 3.5 - 12.0 x 4.0-15cm, 3-sect or 3-partite, segments with or without petiolule, petiolule 1 - 8cm, 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 pubescent with transparent, appressed or spreading hairs; cauline leaves similar to radical ones except for their shorter (2 - 5cm) petioles, and petiolules which are more common and longer. Flowers yellow, 1.8 - 2.5cm across. Sepals 5, ovate, yellowish, patent, densely villous on the lower surface. Petals 5(6 - 7), imbricate, obovate, apex rounded, claw inconspicuous, nectary pit covered with 1.0 - 1.25 x 1.0 - 1.25mm scale. Carpels many, glabrous. Achenes 35 - 50, obliquely obovoid or suborbicular, smooth with a distinct margin, 3.0 - 4.25 x 2.0 - 3.75mm, beak straight or slightly curved with a broad base.

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

Habitat: Roadsides, banks of streams, meadows, fields, moist places, abandoned areas. 1600 - 2800m.

Flowering and fruiting: May - August

Specimens examined: Sakran Pur, Jammu 3.4.1970, *B.M. Sharma 4692* (KASH); Karnah, 09.07.1988, *G.H. Dar 935* (KASH); Chorwan, Gurez 11.08.1989, *A.R. Naqshi 10939* (KASH); Pahalgam, 20.06.2004, *G.H. Dar 1120* (KASH); Amar Singh College, Srinagar 01.07.2006, *Fayaz, Dar & Wafai 085* (KASH); Dawar, Gurez 28.06.2008, *Fayaz, Dar & Wafai 139* (KASH); Thrungus, Dras 09.06.2007, *Fayaz, Dar & Wafai 088, 089* (KASH);

Ranunculus membranaceus Royle, *Illustr. Bot. Himal. Mount.* 53: 1834; Riedl & Nasir in Ali & Y. Nasir, *Fl. Pak.* 193: 136.1991; Wang & Gilbert in Wu, Raven & Hong, *Fl. China* 6: 412. 2001. *R. pulchellus* C.A. Meyer, var. *sericeus* Hooker f. & Thomson in Hooker f., *Fl. Brit. Ind.* 1: 17. 1872; **Figure 2f**

Terrestrial, perennial herb, with fibrous roots. Stem 3 - 7cm tall, caespitose, simple or with 1 - 2 branches, hollow, terete, 1 - 2mm in diameter, densely or continuously pubescent, hairs transparent spreading or appressed, 250 - 450µm long. Radical leaves petiolate; petiole 2.0 - 3.5cm long, densely covered with hairs; blade rhomboid, 1.1 - 1.5 x 1.2 - 1.6cm, pubescent on the dorsal surface and glabrous on ventral surface, thicker in texture, 3-lobed, 3-fid or 3-partite, lateral segments unequally lobed, middle segment usually entire or 2-lobed, base cuneate, apices acute, cauline leaves 3 to 5-sect. Flowers 1.0 - 1.2cm across. Sepals 5, carminish, navicular, patent, densely velutinous on lower surface. Petals 5, imbricate, obovate, apex rounded, claw 1.0 - 1.5mm, nectary pit pocket-like, naked. Achenes 80 - 150, glabrous, obliquely obovoid with a straight or recurved beak, 2.0 - 2.5 x 1.5 - 2.0mm, glabrous,

Distribution: China, Pakistan, Nepal and India. In India it is restricted to Ladakh in the Kashmir Himalaya, Himachal Pradesh, Uttarakhand and Sikkim.

Habitat: Open, moist and cold mountain slopes. 5000 - 5200m.

Flowering and Fruiting: June - August

Specimens examined: Himachal Pradesh: Kunawar, *Lippa 1831* (DD); Uttarakhand: Tehri, Rudra Prayag, 20.07.1953, *J. F. Duthie 758* (DD); Changla Pass, Leh 11.07.2008, *Fayaz, Dar & Wafai 151, 152* (KASH).

Ranunculus natans C.A. Meyer in Ledeb., *Fl. Altaic.* 2: 315. 1830; Riedl & Nasir in Ali & Y. Nasir, *Fl. Pak.* 1993: 135. 1991; M.A. Rau in B.D. Sharma *et al.*, *Fl. India* 1: 124. 1993; Wang & Gilbert in Wu, Raven & Hong, *Fl. China* 6: 420. 2001. Uniyal in Singh *et al.*, *Fl. J&K* 424-425. 2002; *R. hyperboreus* Rottbøll var. *natans* (C.A. Meyer) Regel in Bull. Sci. Nat. Mosc. 34: 43. 1861; Hooker f. & Thomson in Hooker f., *Fl. Brit. India* 1: 18. 1872. **Figure 2g**

Aquatic, floating, perennial herb. Stems long, 3 - 5mm in diameter, terete, hollow, glabrous, branched, rooting at nodes. Leaves petiolate; petiole 7 - 14cm; blade reniform to rounded reniform, 1.9 - 4.6 x 2.5 - 4.6cm, glabrous, base cordate, 3-partite, middle segment 3-lobed, lateral segments larger, unequally 2-lobuled, lobule apices rounded or crenate. Flowers 8 - 14mm across. Sepals 5, ovate or roundish-ovate, patent, navicular, glabrous,. Petals 5 (6), valvate. rounded obovate to rounded ovate, nectary pit cup-shaped, naked; claw 0.5 - 1.0mm. Achenes 120 - 150, 1.25 - 1.75 x 0.75 - 1.0mm, slightly inflated, glabrous; beak inconspicuous. Achene head globose or club-shaped.

Distribution: Central Asia, Afghanistan, Pakistan, Nepal, China, Mongolia, Siberia and India. In India, it is distributed in Ladakh region of the Kashmir Himalaya, Himachal Pradesh and Uttarakhand.

Habitat: Stagnant waters up to a depth of 40 cm. 3220 – 4280m.

Flowering and fruiting: June – August

Specimens examined: Liddarwart, Sangam valley, 12.08.1893, *J.F. Duthie 13333* (DD); Khilanmarg, 03.07.1893, *J.F. Duthie 13056* (DD); Parkachik, Kargil, 05.06.2007, *Fayaz, Dar & Wafai 110* (KASH); Pangong, Leh, 12.07.2008, *Fayaz, Dar & Wafai 159* (KASH).

Ranunculus pulchellus C.A. Meyer in Ledebour, Fl. Altaic. 2: 333. 1830; Hooker *f.* & Thomson in Fl. Brit. Ind. 1: 17. 1872; Stewart, Ann. Cat. Vas. Pl. W. Pak. & Kash. 272. 1972; Polunin & Stainton, Flows. Himal. 10. 1984; Riedl & Nasir in Ali & Y. Nasir, Fl. Pak. 193: 138. 1991; M.A. Rau in B.D. Sharma *et al.*, Fl. Ind. 1: 125. 1993; Wang & Gilbert in Wu, Raven & Hong, Fl. China 6: 411. 2001. Uniyal in Singh *et al*, Fl. J&K 425. 2002. *R. flammula* D. Don in Royle, Illustr. Bot. Himal. Mount. 53. 1835. **Figure 2h**

Terrestrial, aquatic or subaquatic, perennial herb with fibrous roots. Stem erect or decumbent, 5 - 25cm high, simple or with a few one-flowered branches, hollow, 1.5 - 2.5mm in diameter, angular, glabrous to sparsely hairy, hairs appressed. Radical leaves 5 - 7, petiolate; petiole 0.5 - 4.0cm; blade elliptic to elongate-elliptic, 1.5 - 4.2 x 0.6 - 1.2cm, entire, base cuneate, apex acute, glabrous, venation parallel. Peduncles densely pubescent in uppermost part; hairs appressed, transparent, 450 - 800µm. Flowers solitary or 2 -3 per peduncle, 1.0 - 1.5cm across. Sepals 5, ovate-lanceolate, patent with long spreading hairs on the outer side. Petals 5 (6 - 9), imbricate, obovate, apex rounded, claw 0.5 - 1.0mm, nectary pit pocket like without scaly appendage. Fruit head 5 x 4 mm; achenes 60 - 120, obliquely obovoid, glabrous, beak straight.

Distribution: From Altai mountain and a few locations in eastern Siberia, Tien-shan, Mongolia and China to Afghanistan, Pakistan, India, Iran, Nepal. In India distributed in Ladakh region of Kashmir Himalaya, Himachal Pradesh and Sikkim.

Flowering and fruiting: May – August

Habitat: Moist meadows, stream banks, shallow water ditches and puddles. 2800 – 4300 m.

Specimens examined: Chandanwari to Sheshnag, 26.09.1961, *B.M. Wadhwa & J.N. Vohra 237* (CAL); Hemis N.P., Leh 23.08.1985, *I.A. Nawchoo 0109* (KASH); Thrungus, Drass, 04.06.2007, *Fayaz, Dar & Wafai 106* (KASH); Pangong, 12.07.2008, *Fayaz, Dar & Wafai 156* (KASH); Sankoo, 19.06.2009, *Fayaz, Dar & Wafai 166, 167* (KASH); Padam, 06.06.2007, *Fayaz, Dar & Wafai 117* (KASH).

Ranunculus tricuspis var. *lancifolius* (Bertoloni) H. Hara., Fl. E. Him. 3: 39, in *adnota*, 1975; *R. lancifolius* Bertoloni in Mem. Accad. Sci. Inst. Bologna, Ser. 2, 3: 423. 1862; Qureshi & Chaudhri in Pak. Syst. 4(1-2): 180. 1988; *R. tricuspis* Maximowicz, Fl. Tangut.

12. 1889; Stewart, Ann. Cat. Vas. Pl. W. Pak. And Kash. 274. 1972; Polunin & Stainton, Flows. Himal. 11. 1984; *Halerpestes lancifolia* (Bertoloni) Handel.-Mazzetti Acta Horti Gothob. 13: 136. 1939. **Figure 2i**

Terrestrial or aquatic, rosette, perennial herb, with 1 - 4 stoloniferous stems. Stems creeping or submerged, slender, 0.75 - 1.0cm in diameter, hollow, terete, glabrous, rooting at nodes. Leaves petiolate; petiole 4 - 10mm; blade narrow, linear, oblong, 1.0 - 1.5 x 0.4 - 0.7cm, base cuneate or truncate, margin 3-dentate near the apex. Scapes 1.5 - 2.5cm, glabrous, leafless with a linear bract below flower. Flowers solitary, 8 - 10mm across. Sepals 5, ovate, glabrous navicular, patent. Petals 5, ovate or oblong, claw prominent, 1.25 - 1.5mm, apex rounded; nectar pit small, with a proximal horizontal ridge, naked. Achene head globose, 5 - 6mm in diameter; achenes obovoid, 2 - 3 x 1.25 - 2.0mm, glabrous, carminish when mature; beak straight or slightly curved.

Distribution: Pamir, Himalaya, Tibet, Nepal, Bhutan, North China, Kashmir Himalaya (Ladakh): prominent along the Indus at Leh and along the silty banks of marshes and puddles ahead of Pangong Lake.

Flowering and fruiting: June – August

Habitat: Stagnant and shallow ditches found along the sandy / silty banks of rivers and marshes and in puddles which remain flooded with water during early summer. 3200 – 4300m.

Specimens examined: Tagar, Leh, 19.07.1986, *I.A. Nawchoo 0201* (KASH); Leh, 03.09.2003, *Z.S. Khan 01454* (KASH); Choglamsar, Leh, 10.07.2008, *Fayaz, Dar & Wafai 147, 148* (KASH); Pangong, Leh, 12.07.2008, *Fayaz, Dar & Wafai 153* (KASH).

DISCUSSION

Being present in the rain shadow areas of the Himalayas, the trans-Himalaya experience an arid climate, as a result harbour quite sparse vegetation. The genus *Ranunculus* Linnaeus is represented in the area by 9 species only. Amongst these, *R. laetus*, *R. chaerophyllos* and *R. membranaceus* have restricted distribution pattern in trans-Himalaya while others are found growing widely throughout the study area. *R. laetus* was seen growing only as a small population in Thrungus, Dras along the National Highway. Interestingly, the species is one of the most profusely growing weeds in Kashmir valley and Jammu region (up to 2800m amsl), probably because of its high seed output (>3000 per ramet) and high seed viability (>80%). It seems that the species has invaded this newer area recently by anthropogenic or some other biotic means. *R. chaerophyllos* has a very restricted distribution pattern, growing on the moist patches of sand/silt rich slopes in Tangole, Panikhar only. This is the only *Ranunculus* species having persistent petals enclosing the achene head, perhaps a natural strategy to save its maturing seeds from winds and spring showers. *R. membranaceus* is restricted to Changla Pass (>5100m amsl), Leh. Srivastava (2010) has reported *R. lingua*, *R. trichophyllus* and *R. rionii*, all aquatic/semiaquatic, from Ladakh, but the authors during present study, despite thorough survey, could not locate any of these three species. *R. hyperboreus* flowers more profusely in shallow (up to 10cm) water bodies as compared to deep (>10cm) ones and is distributed throughout the trans-Himalayan range. The species is different from other aquatic species in having flowers with distinctly two types of stamens – longer and shorter.

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