

The Bewildering Taxonomy of Genus *Ranunculus* with Particular Reference to Kashmir Himalaya

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ABSTRACT

Belonging to family Ranunculaceae the genus *Ranunculus* comprises ca. 600 species with a worldwide distribution. The generic delimitation and infrageneric classification of *Ranunculus* have always proved a “Pandora Box” for taxonomists due to its large number of species and high phenotypic plasticity and, therefore, continue to be under discussion. The Kashmir Himalaya, constituting a part of the Northwest Himalaya, represents a repository of the *Ranunculus* species. During the course of present study 25 taxa of *Ranunculus*, belonging to 18 species were recorded from the study area in diverse habitats. The paper highlights the position of the genus at world level in general and at the regional level in particular. In order to remove certain taxonomic confusions some new combinations have been proposed.

Keywords: *Ranunculus*, Kashmir Himalaya, species

INTRODUCTION

The genus *Ranunculus* was first described by Carl Linnaeus in 1753. The Latin name meaning 'little frog' points to the wet habitats in which most of the species grow. It comprises plants commonly known as 'buttercups' for their bowl-shaped flowers with petals having glossy proximal and mat distal portions (Kadota, 1991), although epithets such as 'spearworts', 'water crowfoots' and 'lesser celandine' are also used for other species of the genus. Many of the species are poisonous to cattle and other

livestock when eaten fresh, while some of them are popular ornamentals (e.g. *R. asiaticus*) with cultivars having large and bright-coloured flowers.

Ranunculus L. is a genus of herbaceous annuals and perennials belonging to family Ranunculaceae. It is the largest genus within the family, comprising ca.600 species (Tamura, 1993, 1995; Mabberly, 2008; Srivastava, 2010) and numerous microspecies and apomictic races (Hörandl *et al.*, 2005). Its distribution is almost worldwide 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, 1993, 1995).

Ranunculus species may be found in a variety of habitats such as forests, dry and damp meadows, marshes, puddles and streams, shallow and marshy banks of rivers and lakes, and alpine heaths. Most of the species appear to have great ecological amplitude; however, habitat-specific species are not uncommon.

Plant architecture is relatively constant within the genus. Many of the species form rosettes or a cluster of basal leaves, from which one or more erect stem axes or runners/stolons emerge. Leaves may be entire, compound or highly dissected. Flowers are single or aggregated into cyme, and are hermaphrodite, usually bright-, dull-, or greenish-yellow. A few species have white (e.g. *R. trichophyllus*, *R. glacialis*) or reddish (*R. asiaticus*) flowers. The calyx consists of (3-)5(-7) sepals and the corolla of (0-)5(-12 or more) petals. The nectary gland, located near the base of the petal, may be naked or covered by a scale. Aestivation of petals may be valvate, imbricate or mixed. Achenes vary from few to many, being smooth, hairy, winged, or with tubercles or hooked spines. The beak may be conspicuous (straight or curved) or inconspicuous.

The remarkable success of *Ranunculus* with respect to species diversity and

distribution is believed to be multifactorial, being mainly attributable to varied permutations and combinations of: (1) high morphological plasticity, including genetic flexibility for rapid adaptation to new habitats, thus permitting development of various eco- and phenotypes; (2) hybridization and polyploidy for diversification, and (3) a broad range of reproductive systems, including vegetative growth, autogamy, allogamy, apomixis and combinations thereof, enabling species to colonize various habitats, especially in regions with colder climates.

Besides hybridization and polyploidy, chromosome repatterning seems to have played a significant role in the formation of new species, as the phenotypic expression of a given gene is often affected by its spatial relations with neighbouring genes in the chromosomes (Goldschmidt, 1940, 1955). The author believes that the formation of new species starts with a large scale mutational event in the chromosomes, a “systemic mutation” which scrambles and rearranges the segments.

The generic delimitation and infrageneric classification of *Ranunculus* have always proved a “Pandora Box” for taxonomists and continue to be under discussion. Previous classifications are based mainly on achene characters (shape of the body and beak, pericarp structure and indumentum), shape of the receptacle, floral morphology (number of sepals and petals, gloss and colour of petals and shape of nectary), life form, and the root system (either uniform or dimorphic with fibrous and tuberous roots). Leaf characters vary considerably within sections (from undivided peltate to strongly dissected), and are often obvious adaptations to habitats, e.g. strongly dissected leaves in water-buttercups (Cook, 1966), and thus of limited value for infrageneric classifications (Hörandl *et al.*, 2005). Infrageneric taxa rarely have exclusive diagnostic morphological characters, but are rather characterized by a combination of features (Hörandl *et al.*, 2005).

In the first worldwide classification system by de Candolle (1818, 1824), based on 159

species, the genus *Ranunculus* L. was classified within tribe *Ranunculeae* and subdivided into five sections, viz. *Batrachium*, *Ranunculastrum*, *Thora*, *Hecatonia* and *Echinella* using features of achenes, roots and flowers. Later worldwide classifications differ considerably among authors. Tamura's surveys (1993, 1995) are the only modern worldwide classifications of family Ranunculaceae based mainly on achene characters. He excluded several small "satellite" genera, viz. *Aphanostemma*, *Arcteranthis*, *Callianthemoides*, *Ceratocephala*, *Cyrtorhyncha*, *Halerpestes*, *Kumlienia*, *Oxygraphis* and *Peltocalathos* (all classified in subtribe *Ranunculinae*; Table 1) previously described under *Ranunculus*. The author subdivided *Ranunculus* s.s. into seven subgenera, viz. *Pallasiantha*, *Coptidium*, *Ficaria*, *Batrachium*, *Crymodes*, *Gampsoceras* and *Ranunculus*; the subgenus *Ranunculus* is divided into 20 sections. Tamura's (1995) classification differs considerably from regional treatments, such as that of Ovczinnikov (1937) for the Flora of USSR, Whittmore (1997) for the Flora of North America, and Tutin and Cook (1993) for the Flora Europaea (Table 1) which reflects the uncertainty about relationships within the genus (Hörandl *et al.*, 2005).

Molecular phylogenies of *Ranunculus* s.l., using Cp DNA restriction site analysis of 78 species (Johansson, 1998), mat K-trn K analysis of 133, mainly European species (Paun *et al.*, 2005), and sequences of the nrITS of ca. 200 species (Hörandl *et al.*, 2005) show a high level of congruence but strongly contradict with previous classifications. The reason for incongruence of molecular data and morphology-based classifications may be the parallel evolution of morphological characters in adaptation to climatic conditions (Hörandl *et al.*, 2005).

Table 1: Position of *Ranunculus* L. and other allied genera in Tamura's survey (1995) and its comparison with some regional treatments (compiled from Hörandl et al., 2005, Lehnebach, 2008).

| Tamura (1995) [Worldwide] | Ovczinnikov (1937) [USSR] | Whittemore (1997) [North America] | Tutin and Cook (1993) [Europe] |
|----------------------------------|--|--|---|
| <i>Tribus Ranunculae</i> | | | |
| Subtrib. <i>Trautvetteriinae</i> | | | |
| <i>Trautvetteria</i> | <i>Trautvetteria</i> | <i>Trautvetteria</i> | |
| <i>Myosurus</i> | <i>Myosurus</i> | <i>Myosurus</i> | |
| Subtrib. <i>Ranunculinae</i> | | | |
| <i>Kumlienia</i> * | | <i>Ranunculus</i> subg. <i>Ranunculus</i> sect. <i>Pseudaphanostemma</i> | |
| <i>Krapfia</i> * | | | |
| <i>Arcteranthis</i> * | | <i>R. subg. R. sect.</i> <i>Arcteranthis</i> | |
| <i>Laccopetalum</i> * | | | |
| <i>Halerpestes</i> * | <i>Halerpestes</i> * | <i>R. subg. R. sect.</i> <i>Halodes</i> | <i>R. subg. R. sect.</i> <i>Halodes</i> |
| <i>Callianthemoides</i> * | | | |
| <i>Oxygraphis</i> | <i>Oxygraphis</i> * subg. <i>Euoxygraphis</i> | <i>R. subg. Oxygraphis</i> | |
| <i>Peltocatathrs</i> * | | | |
| <i>Cyrtorhyncha</i> * | <i>Ceratocephala</i> * | <i>R. subg. R. sect.</i> <i>Cyrtorhyncha</i> | |
| <i>Ranunculus</i> * | <i>Ranunculus</i> | <i>R. subg.</i> <i>Ceratocephala</i> | <i>Ceratocephala</i> * |
| 1. subg. <i>Coptidium</i> * | <i>R. subg. Auricomus</i> sect. <i>Coptidium</i> | <i>R. subg. Coptidium</i> | |
| 2. subg. <i>Pallasiantha</i> * | <i>R. subg. Auricomus</i> sect. <i>Coptidium</i> | <i>R. subg. Pallasiantha</i> | <i>R. subg. R. sect.</i> <i>Pallasiantha</i> |
| 3. subg. <i>Ficaria</i> * | <i>Ficaria</i> | <i>R. subg. Ficaria</i> | <i>R. subg. R. sect.</i> <i>Ficaria</i> |
| 4. subg. <i>Batrachium</i> * | <i>Batrachium</i> | <i>R. subg. Batrachium</i> | <i>R. subg.</i> <i>Batrachium</i> |
| 5. subg. <i>Crymodes</i> * | <i>Oxygraphis</i> subg. <i>Crymodes</i> | <i>R. subg. Crymodes</i> | <i>R. subg. R. sect.</i> <i>Crymodes</i> |
| 6. subg. <i>Gampsoceras</i> | | | |
| 7. subg. <i>Ranunculus</i> | | | <i>R. subg.</i> <i>Ranunculus</i> |
| sect. <i>Ranunculus</i> | <i>R. subg. Auricomus</i> sect. <i>Euauricomus</i> | -sect. <i>Epriotes</i> | -sect. <i>Auricomus</i> , sect. <i>Insulares</i> |
| sect. <i>Flammula</i> | <i>R. subg. Auricomus</i> sect. <i>Flammula</i> | -sect. <i>Flammula</i> | -sect. <i>Flammula</i> |
| sect. <i>Hecatonia</i> * | <i>R. subg. Hecatonia</i> | -sect. <i>Hecatonia</i> | -sect. <i>Hecatonia</i> |
| sect. <i>Xanthobatrachium</i> | <i>R. subg. Auricomus</i> sect. <i>Xanthobatrachium</i> | -sect. <i>Hecatonia</i> | -sect. <i>Xanthobatrachium</i> |
| sect. <i>Thora</i> | <i>R. subg. Thora</i> | | -sect. <i>Thora</i> |
| sect. <i>Aconitifolii</i> | | | -sect. <i>Aconitifolii</i> |
| sect. <i>Ranuncella</i> | | | -sect. <i>Ranuncella</i> |
| sect. <i>Leucoranunculus</i> | | | -sect. <i>Leucoranunculus</i> |
| sect. <i>Physophyllum</i> | | | -sect. <i>Physophyllum</i> |
| sect. <i>Acetosellifolii</i> | | | sect. <i>Acetosellifolii</i> |
| sect. <i>Chloeranunculus</i> | | | sect. <i>Ranuncella</i> |
| sect. <i>Ficatifolius</i> | | | |
| sect. <i>Casalea</i> * | | | |
| sect. <i>Tuberifer</i> | | | |
| sect. <i>Pseudadonis</i> | | | |
| sect. <i>Acris</i> | <i>R. subg.</i> <i>Chrysanthe</i> | -sect. <i>Ranunculus</i> | -sect <i>Ranunculus</i> |
| sect. <i>Echinella</i> * | <i>R. subg. Pachyloma</i> | -sect. <i>Echinella</i> | -sect. <i>Echinella</i> |
| sect. <i>Micranthus</i> * | <i>R. subg. Micranthus</i> | | -sect. <i>Micranthus</i> |
| sect. <i>Leptocaulis</i> | | | |
| sect. <i>Ranunculastrum</i> * | <i>R. subg.</i> <i>Ranunculastrum</i> | | sect. <i>Ranunculastrum</i> |

* Genera that have been treated as *Ranunculus* by various authors.

+ Sections or subgenera of *Ranunculus* that have been treated as genera by various

authors Hooker f. and Thomson (1872), in a regional treatment, segregated 21 species of *Ranunculus* into four sections, viz. *Batrachium*, *Ceratocephala*, *Hecatonia* and *Echinella*. In this flora, *R. trichophyllus* is treated as *R. aquatilis* var. *trichophyllus*, and *R. natans* as *R. hyperboreus* var. *natans*. The authors have segregated *R. pulchellus* into three varieties, viz. *typicus*, *sericeus* and *longicaulis*, and *R. hyperboreus* into four varieties, viz. *typicus*, *natans*, *radicans* and *multifidus*. Srivastava (2010) has segregated *R. pulchellus* into three varieties, viz. *pulchellus*, *longicaulis* and *stracheyanum* on the basis of leaf shape, leaf indumentum and stylar beak. In regional Floras, Riedl and Nasir (1993) and Wang and Gilbert (2001) excluded *R.* subg. *Batrachium* and raised it to the level of genus *Batrachium* by following Ovczinnikov (1937), Rostrup (1958) and Löve (1961) and segregated it into two (*B. rionii* and *B. trichophyllum*), and eight (*B. perkense*, *B. kauffmanii*, *B. rionii*, *B. bunget*, *B. foeniculaceum*, *B. eradicatum*, *B. diviaricatum* and *B. trichophyllum*) species, respectively. It is pertinent to mention that *Batrachium* was given generic status by S. Gray (1821) and A. Gray (1886), while Ascherson and Graebner (1935), Benson (1948) and Clapham (1952) recognized it as a subgenus.

Study area

The Kashmir Himalaya, constituting a part of the Northwest Himalaya, represents a unique biospheric unit (Rodgers and Panwar, 1988). It is situated in the northern fringe of the Indian subcontinent between coordinates of 33° and 37° N latitudes and 72° 30' and 80° 30' E longitudes (Fig. 1). The region consists of a deep elliptical bowl-shaped valley of Kashmir and the cold desert of Ladakh. Zojila (3,529 m) forms the lowest pass on the Greater Himalaya, connecting Kashmir Valley with Ladakh. The Pir Panjal Range bounds the Valley in the south and southwest, while the Korakoram Range guards the Ladakh in the north. The climate of the picturesque Kashmir valley, often called the paradise on earth, is like that of mountains and continental parts of the temperate latitudes.

The temperature ranges from an average daily maximum of 31°C and a minimum of 15°C during summer to an average daily maximum of 4°C and a minimum of -4°C during winter months.



Fig. 1: Map of Jammu and Kashmir

RESULTS AND DISCUSSION

During the course of present study 25 taxa of *Ranunculus*, belonging to 18 species (Table 2; Fig 2), were recorded from the study area in diverse habitats. The specimens were identified using the available literature on floristics such as Hooker's "Flora of British India" (1872), Stewart's "An annotated catalogue of the vascular plants of West Pakistan and Kashmir" (1972), Kachroo, Sapru and Dhar's, "Flora of Ladakh" (1978), Sharma and Kachroo's "Flora of Jammu" vol. 1 (1981), Polunin and Stanton's "Flowers of the Himalaya" (1984), Riedl and Nasir's "Ranunculaceae" In : Flora of Pakistan (1991), Rau's "Ranunculaceae" In : BSI Flora of India (1993); Whittemore's *Ranunculus* In : Flora of North America (1997), Wang and Gilbert's *Ranunculus* In : Flora of China vol. 6 (2001) and Srivastava (2010). The identifications were confirmed by matching the specimens with those deposited in the Kashmir University Herbarium (KASH). The specimens were also sent to Dr. Elvira Hörandl, Department of Systematic and Evolutionary Botany, University of Vienna, Austria, for confirmation of identification.

Table 2: List of the presently studied taxa of *Ranunculus* with population designations and collection numbers of herbarium material.

| S. No | Species | Population | Collection No. | Locality |
|-------|--|------------|----------------|--|
| 1. | <i>R. arvensis</i> var. <i>arvensis</i> | BGK | 031 | Batergam, Kupwara: apple orchards on the left side of Kupwara – Chowkibal National Highway, 1618 m. |
| | | URB | 025 | Boniyar, Uri: corn fields along Baramulla - Uri Highway |
| 2. | <i>R. arvensis</i> var. <i>inermis</i> var. <i>nov.</i> * | BGK | 036 | Batergam, Kupwara: apple orchards on the left side of Kupwara – Chowkibal National Highway, 1618 m. |
| 3. | <i>R. brotherusii</i> | DRK | 121 | Dras, Kargil: open grassy slopes on the left side of Srinagar Kargil National Highway, 2890 m. |
| | | SKK | 170 | Sankoo, Kargil: corn fields on the right side of Kargil – Panikhar road, 3290 m. |
| 4. | <i>R. chaerophyllos</i> | TCK | 173 | Tingochey, Panikhar: open mountainous slope, 3430 m. |
| 5. | <i>R. hirtellus</i> var. <i>hirtellus</i> | GMB | 096 | Guimarg : under the shade of <i>Abies</i> and <i>Cedrus</i> on the slopes on the west of Gandola project, 2600 m. |
| | | PKK | 112 | Panikhar, Kargil: on either side of the Kargil – Panikhar road on moist places under the shade of willow plants, 3250 m. |
| | | RPB | 4001 | Razdan Pass: open top and slopes on either side of Bandipora-Gurez road, 3650 m. |
| | | TWS | 075 | Thajwas, Sonamarg : open, bare and moist slopes, 3200m. |
| 6. | <i>R. hirtellus</i> var. <i>gulmargicus</i> var. | GMB | 040, 041 | Guimarg : open, moist and damp places of golf course, 2600 m. |
| 7. | <i>R. hirtellus</i> var. <i>emarginatus</i> var. <i>nov.</i> | KDG | 045 | Kangdori, Gulmarg : open slopes along Kangdori –Apharwat track, 3000 m. |
| | <i>nov.</i> | TWS | 078 | Thajwas, Sonamarg : open sandy slopes and moist stream banks, 3200m. |
| 8. | <i>R. hirtellus</i> var. <i>multilobulus</i> var. <i>nov.</i> | GMB | 042 | Guimarg: under the shade of <i>Abies</i> along the track leading to high altitude herbal garden of Kashmir University, 2600 m. |
| 9. | <i>R. laetus</i> | ACS | 085 | Amar Singh College Campus Srinagar: roadsides and unattended land, 1600 m. |
| | | BGK | 083 | Batergam, Kupwara: along the fence and drains of apple orchards, 1618 m. |
| | | DGB | 139 | Dawar, Gurez: along Dawar-Tulael and Dawar-Bandipora road, 2800 m. |
| | | OCS | 086 | Omar Colony, Lawaypora Srinagar: along Srinagar-Baramulla National Highway, 1600 m. |
| 10. | <i>R. lingua</i> | LPS | 088 | Lawaypora, Srinagar: damps, ditches and puddles on either side of the Srinagar – Baramulla National Highway that remain waterlogged for most part of the year but dry up on the approach of autumn season, 1580 m. |
| | | HSL | 090 | Hokersar, Srinagar : along the northern and western marshy areas of the lake, 1580 m. |
| | | FSR | 177 | Hazratbal: on the left side of Hazratbal-Nishat foreshore road about ½ km ahead of Nishat Garden |
| 11. | <i>R. membranaceus</i> | CPL | 151 | Changla Pas, Leh: moist banks of small streams and channels on the slope facing Leh, 5183 m. |
| 12. | <i>R. munroanus</i> | KDG | 081 | Kangdori, Gulmarg: under the shade of rocks and in rock crevices along Kangdori – Apharwat track, below gondola ropeway, 3100 m. |
| 13. | <i>R. muricatus</i> var. <i>muricatus</i> | UCS | 003 | Kashmir University Campus, Hazratbal, Srinagar: on the southern side of GKRS, Hostel, 1580 m. |
| | | BGK | 001 | Batergam, Kupwara: apple orchards on the left side of Kupwara – Chowkibal National Highway and the nearby paddy fields, 1620 m. |
| 14. | <i>R. muricatus</i> var. <i>emuricatus</i> var. <i>nov.</i> | UCS | 050 | Kashmir University Campus, Hazratbal, Srinagar: on the southern side of GKRS, Hostel, 1580 m. |
| | | BGK | 053 | Batergam, Kupwara : apple orchards on the left side of Kupwara – Chowkibal National Highway and the nearby paddy fields, 1618m. |
| 15. | <i>R. natans</i> | PCK | 110 | Pankachik, Panikhar : water ditch/small pond on the rich side of Panikhar – Padam road, 3220 m. |
| | | PGL | 159 | Pangong, Leh: a big area of water ditches/puddles giving a marshy appearance, about 10 km ahead of Pangong Lake on the left side of Leh – Pangong road, 4280 m. |
| 16. | <i>R. palmatifidus</i> | GMB | 047 | Guimarg: under the shade of <i>Abies</i> along the track leading to high altitude Herbal Garden of Kashmir University, 2600 m. |
| | | ZPS | 126 | Zojila Pass, Sonamarg: open mountainous slope on the left side of Sonamarg – Kargil Highway, 3600 m. |
| | | TLG | 136 | Tulael, Gurez: open slopes along Tulael – Masjid Gali road, 2900 m. |
| 17. | <i>R. pulchellus</i> var. <i>pulchellus</i> | PDK | 117 | Padam, Zanskar, Kargil: marshes, meadows, ditches/puddles on either side of road leading to Padam. |
| 18. | <i>R. pulchellus</i> var. <i>longicaulis</i> | TDK | 106 | Thrunus, Dras: marshy/water logged land near army camp on either side of Dras – Kargil highway. |
| | | SKK | 166 | Sankoo, Kargil: along the banks of water channels flowing through corn fields on the right side of Sankoo – Panikhar road, 3290 m. |
| 19. | <i>R. rubrocalyx</i> var. <i>rubrocalyx</i> | KDG | 059 | Kangdori: on the open slopes along Gulmarg – Kangdori and Kangdori – Apharwat tracks, 2900m. |
| 20. | <i>R. rubrocalyx</i> var. <i>viridiflavus</i> var. <i>nov.</i> | KDG | 066 | Kangdori: on the open slopes along Gulmarg – Kangdori and Kangdori – Apharwat tracks, 2900m. |

| | | | | |
|-----|---|-----|-----|---|
| 21. | <i>R. hyperboreus</i> | SKK | 141 | Sankoo, Kargil: ditches, puddles and along the banks of shallow and narrow water channels, ahead of Sankoo market on the left side of Kargil – Sankoo road. |
| | | CSL | 146 | Choglamsar, Leh: ditches, puddles and along the banks of a shallow and narrow water channel on the west of Leh – Manali road, 3200 m. |
| 22. | <i>R. sceleratus</i> | SKS | 010 | Saidakadal, Srinagar : water ditches on either side of road leading to Hazratbal, 1580 m. |
| | | BGK | 029 | Batergam, Kupwara: unploughed paddy fields on either side of Batergam – Gushi road, 1618 m. |
| 23. | <i>R. tricuspis</i> var. <i>lancifolius</i> | PGL | 153 | Pangong: puddles and moist silty banks of ditches about 10 km ahead of Pangong Lake on the left side of Leh – Pongong road, 4280 m. |
| | | CSL | 147 | Choglamsar: portions of Choglamsar river that remains flooded with water for only a small part of the year but for most part of the year retains little water in puddles and ditches, 3200 m. |
| 24. | <i>R. trichophyllus</i> | KZT | 094 | Kunzer, Tangmarg : small water stream on the left side of Kunzer – Tangmarg road, 1900 m. |
| | | DGB | 133 | Dawar, Gurez : small water stream on the right side of Bandipora – Dawar road, about 2 km ahead of Dawar, 2800 m. |
| | | LBS | 163 | Lasjan Bypass, Srinagar: puddles ditches on the left side of Srinagar – Anantnag National Highway that contain water for most part of the year. |
| | | DMK | 020 | Drugmulla, Kupwara: unploughed water logged paddy fields on the left side of Kupwara – Baramulla National Highway near army camp, 1618 m. |
| 25. | <i>R. trilobus</i> | BGK | 056 | Batergam, Kupwara: Lone apple orchard on the left side of Kupwara – Chowkibal National Highway, 1620 m. |
| | | BCS | 070 | Bemina, Srinagar : along the inner link roads of Bemina Housing Colony near puddles, 1580 m. |

* Altitude a.m.s.l.; + Author citation for all new combinations in the table is Fayaz, Dar & Wafai

The taxa recorded from the study area were classified into two subgenera (*Batrachium* and *Ranunculus*) and seven sections (*Acris*, *Echinella*, *Flammula*, *Hecatonia*, *Ranunculus*, *Xanthobatrachium* and *Halodes* (Table 3). Of the 18 species, one (*R. trichophyllus*) belongs to subgenus *Batrachium*, while the rest belong to the subgenus *Ranunculus*. Stewart (1972) has reported 36 species from N.W. Himalaya, but during the present investigation some of the species (Table 4) could not be located in the study area. The reasons for not sighting these species could be many. Either the species have shifted/migrated/extirpated due to loss of specific habitats and/or due to overgrazing by cattle, or else they have been misidentified in the said area.

Table 3: Classification of the *Ranunculus* taxa recorded in the present study.

| Genus | Subgenus | Section | Species |
|-------------------|-------------------|-------------------------|---|
| <i>Ranunculus</i> | <i>Batrachium</i> | <i>Batrachium</i> | <i>R. trichophyllus</i> Chaix |
| | <i>Ranunculus</i> | <i>Acris</i> | <i>R. laetus</i> Wall ex D. Don |
| | | <i>Echinella</i> | <i>R. arvensis</i> L. var. <i>arvensis</i> |
| | | | <i>R. arvensis</i> L. var. <i>inermis</i> var. nov. |
| | | | <i>R. muricatus</i> L. var. <i>muricatus</i> |
| | | | <i>R. muricatus</i> L. var. <i>emuricatus</i> var. nov. |
| | | | <i>R. trilobus</i> Desf. |
| | | <i>Flammula</i> | <i>R. lingua</i> L. |
| | | | <i>R. pulchellus</i> C.A. Mey. var. <i>longicaulis</i> (C. A. Mey.) Hook. f. & Thoms. |
| | | | <i>R. pulchellus</i> C. A. Mey. var. <i>pulchellus</i> |
| | | <i>Hecatonia</i> | <i>R. sceleratus</i> L. |
| | | <i>Ranunculus</i> | <i>R. brotherusii</i> Freyn. |
| | | | <i>R. chaerophyllos</i> L. |
| | | | <i>R. hirtellus</i> Royle var. <i>hirtellus</i> |
| | | | <i>R. hirtellus</i> Royle var. <i>gulgargicus</i> var. nov. |
| | | | <i>R. hirtellus</i> Royle var. <i>emarginatus</i> var. nov. |
| | | | <i>R. hirtellus</i> Royle var. <i>multilobulus</i> var. nov. |
| | | | <i>R. membranaceus</i> Royle |
| | | | <i>R. munroanus</i> Drum. Ex Dunn |
| | | | <i>R. palmatifidus</i> H. Riedl |
| | | | <i>R. rubrocalyx</i> Regel ex Komarov var. <i>rubrocalyx</i> |
| | | | <i>R. rubrocalyx</i> Regel ex Komarov var. <i>viridiflavus</i> var. nov. |
| | | <i>Xanthobatrachium</i> | <i>R. natans</i> C.A. Mey. |
| | | | <i>R. hyperboreus</i> |
| | | <i>Halodes</i> | <i>R. tricuspis</i> (Maxim.) var. <i>lancifolius</i> (Bertol.) H. Hara |

Table 4: Species of the genus *Ranunculus* L. reported by R. R. Stewart (1972) from N.W. Himalaya that could not be located from the Kashmir Himalaya

| S. No. | Name of the species | Stewart's (1972) collection site |
|--------|-----------------------|--|
| 1. | <i>R. aucheri</i> | Dras (Ladakh) |
| 2. | <i>R. diffusus</i> | Naoshera (Kashmir), Uri |
| 4. | <i>R. kamchaticus</i> | Dras, Tilel, Sonamarg |
| 5. | <i>R. lobatus</i> | Kargi (Zanskar), Pansi la, Mt. Kolahoi (Kashmir) |
| 6. | <i>R. polypetalus</i> | Rangdum (Zanskar), Masjid Gali (Tilel), Sonamarg, Baltal |

Further, a few sites are presently inaccessible to civilians due to security reasons. Stewart (1972) has himself recorded, “*Ranunculus* is another large genus which needs study and revision”. Kadota (1991) is also of the opinion that the systematics of the genus is still unsatisfactory. Of the 18 species presently investigated five are of special taxonomic interest as detailed below:

R. arvensis L. hitherto known for having only spiny achenes has, during the present study, been collected with forms having exclusively smooth achenes. The two forms (spiny-achened and smooth-achened) are discrete (Fig 2a), growing sympatrically in BGK population and breed true when seeds are separately sown in pots. In the present study, therefore, the species has been segregated into two varieties, viz. var. *arvensis* (bearing spiny achenes) and var. *inermis* (bearing smooth achenes). In none of the plant both the types of achenes are borne together.

- 1) *R. muricatus* is known for its spiny achenes (Rau, 1993; Whittemore, 1997; Wang and Gilbert, 2001). Blatter and Hallberg (1919) reported for the first time smooth-achened forms within the species and segregated them as a separate species, *R. pseudomuricatus*; while Kak (1981) named such forms as *R. emuricatus*. Riedl and Nasir (1991), Uniyal (2002), Srivastava (2010) have also reported the occurrence of smooth-achened forms in *R. muricatus* from Himalaya and Peninsular India but, without proposing a separate species/subspecies/variatal status, retained them in *R. muricatus*. However, during the course of present investigation it was found that the two forms (spiny and smooth achened) co-exist throughout their distributional range in Kashmir Himalaya (Fig 2f), and in some of the populations the smooth-achened forms even outnumber the spiny-achened ones and the two discrete forms breed true from generation to generation without forming

intermediates in natural populations. Apart from achenes, the two forms differ from each other in foliar indumentum. While in spiny-achened forms the leaves bear continuous/scattered trichomes on both the surfaces, they are glabrous in smooth-achened forms. Neglecting the existence of two discrete forms and clubbing into one species (*R. muricatus*) or segregating the smooth ached forms as a separate species (*R. pseudomuricatus* Blatter and Hallb. or *R. emuricatus* Majeed Kak) seem unjustified; hence during the present study *R. muricatus* was segregated into two varieties viz., var. *muricatus* (spiny-achened) and var. *emuricatus* (smooth-achened).

- 2) *R. hirtellus* is the most variable species amongst Kashmir Himalayan buttercups. The species shows marked variability in both vegetative and reproductive characters. On the basis of these varying characters the species has been segregated into four varieties viz., var. *hirtellus*, var. *emarginatus*, var. *gulmargicus* and var. *multilobulus* (Table 5, Fig 2b-e). Of these, only the type variety (*R. hirtellus* var. *hirtellus*) matches one of the three varieties recognized by Wang & Gilbert 2001, (Table 6); the other three varieties do not match with previously recognized ones and are described as new in this study. Amongst these varieties, var. *gulmargicus* var. *nov.* has the longest flowering period (April-September) *R. rubrocalyx* owes its name to the reddish sepals found in the species. During the course of the present study, however, plants having yellowish-green sepals were found growing sympatrically with those having reddish sepals. These plants have all other characters (vegetative and reproductive) similar to those having reddish sepals. Therefore, the species was segregated into two varieties (var. *rubrocalyx*, having reddish sepals and var. *viridiflavus*, having yellowish-green sepals).

- 3) *R. pulchellus*, which has been segregated into different varieties (*viz. typicus, sericeus, longicaulis and stracheyanum*) by Hook f. & Thomson (1872) and Handel- Mazetti (1939), needs to be studied in detail by making extensive field studies and carrying out molecular characterization, as the species shows tremendous interpopulational variability. The segregation of var. *stracheyanum* on the basis of leaf indumentum seems unjustified as the presence of hairs on the petiole and leaf margins is not a discontinuous character. During the present investigation plants with both the types of leaves (glabrous- and pubescent-petioled) have been observed. Only vars. *longicaulis and pulchellus* are distinctly growing varieties of the species in the entire region of Ladakh, the former having narrow elliptic/lanceolate leaves with entire margins while the latter having elliptic leaves with both entire and 2 - 3 lobed margins.
- 4) *R. trichophyllus* grows in two life forms annual and perennial. The former occurs in paddy fields and puddles where water remains available for a few months only during spring season whereas the latter occurs in streams where water flows for the whole year. The two forms differ only in the size of plants. In the former the plants are larger in size with longer internodes while in the latter the plants are smaller with shorter internodes. Some authors (Stewart, 1972 in Flora of West Pakistan; Rau, 1993 in Flora of India; Uniyal, 2002 in Flora of Jammu & Kashmir) have described *R. rionii* from Kashmir Himalaya differing from *R. trichophyllus* mainly in the number of achenes (60-90 in the former and 20-40 in the latter) per achene head. However, during present investigation it was observed that only *R. trichophyllus* grows in Kashmir Himalaya (Fig 2g). Besides, segregating a species, which otherwise could demand at the most a

varietal status, merely on the basis of one character (no. of achenes per head) seems unjustified.

R. trilobus hitherto reported in India from Uttarakhand and Sikkim only, is reported first time during the present investigation growing at a few places in Kashmir valley (Fig 2h).

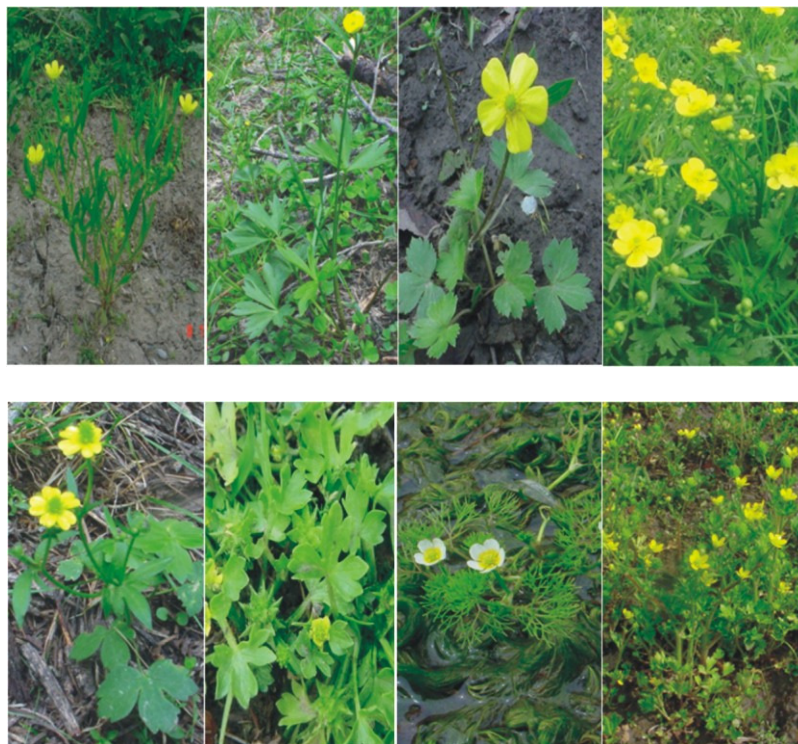


Figure 2. a: *Ranunculus arvensis* with magnified views of spiny and smooth achene heads superimposed; b: *R. hirtellus* var. *hirtellus* with magnified view of achene superimposed; c: *R. hirtellus* var. *multilobulus* var. *nov.* with magnified views of achene and leaf superimposed; d: *R. hirtellus* var. *gulgargicus* var. *nov.* with magnified view of achene superimposed; e: *R. hirtellus* var. *emarginatus* var. *nov.* with magnified view of flower superimposed; f: *R. muricatus* with magnified views of spiny and smooth achene heads superimposed; g: *R. trichophyllus* with magnified view of achene head superimposed; h: *R. trilobus* with magnified view of achene superimposed.

Table 5: Morphological and other features of the varieties of *R. hirtellus* from Kashmir Himalaya.

| Attribute | <i>R. hirtellus</i> var. <i>hirtellus</i> | <i>R. hirtellus</i> var. <i>emarginatus</i> var. <i>nov.</i> | <i>R. hirtellus</i> var. <i>gulmargicus</i> var. <i>nov.</i> | <i>R. hirtellus</i> var. <i>multilobulus</i> var. <i>nov.</i> |
|--------------------|---|---|--|--|
| Stem | 15 - 30 cm, branched, pubescent | 10 - 15 cm, branched or simple, pubescent | 15 - 25 cm, branched, glabrous, | 15 - 30 cm, branched, pubescent |
| Radical leaves | Blade 2.4-6.0 x 3.0-9 cm, 3-sect, middle segment 3-5 lobed, pubescent | Blade 1.3-2.6 x 1.7-3.7 cm, 3-sect, middle segment 3-lobed or rarely without lobes, pubescent | Blade 2.6-3.6 x 4.5 cm, 3-sect, middle segment 3-5 lobed, glabrous | Blade 3.0 x 6.5-3.8 x 8.5 cm, 3-partite to 3-sect, middle segment with more than 10 lobes, pubescent |
| Floral diameter | 1.4 - 2.0 cm | 0.9 - 1.4 cm | 1.2 - 1.8 cm | 1.6 - 2.2 cm |
| Petal apex | Rounded or flat | Cleft * | Rounded or flat | Rounded or flat |
| Torus | Pubescent | Pubescent | Pubescent | Pubescent |
| Carpels/achenes | Pubescent | Pubescent | Glabrous | Pubescent |
| Flowering/fruiting | May-July | May-July | April-September | May-July |
| Collection site | <u>Ruzgan, Pas Gulmarg, Panikhar, Gulmarg</u> | Kangdori | Gulmarg | Gulmarg |

Table 6: Morphological features of the varieties of *R. hirtellus* (after Wang and Gilbert, 2001).

| Attribute | <i>R. hirtellus</i> var. <i>hirtellus</i> | <i>R. hirtellus</i> var. <i>humilis</i> | <i>R. hirtellus</i> var. <i>orientalis</i> |
|--------------------|--|---|---|
| Stem | 15-27 cm, pubescent, branched or simple | 7-14 cm, pubescent, branched or simple | 4.5-15 cm, pubescent, branched or simple |
| Radical leaves | Petiolate, petiole 1-9.5 cm, blade 1.3-3.5 x 1.6-4.2 cm, 3-sect. | Petiolate, petiole 1-5 cm, blade 3-sect or 3-partite, sometimes 3-fid, 0.5-1.5 x 0.7-2.0 cm | Petiolate, petiole 1-5 cm, blade 3 sect or 3-partite, sometimes 3-fid, 0.5-1.4 x 0.8-2.0 cm |
| Floral diameter | 1.2 - 1.5 cm | 0.9 - 1.1 cm | 0.9-1.2 cm |
| Torus (receptacle) | Pubescent | Pubescent | Glabrous, rarely with a few hairs |
| Achene | Pubescent | Pubescent or glabrous | Glabrous |
| Flowering/fruiting | May-June | July-September | June-August |
| Distribution | China, Kashmir (3000 - 4000 m) | China (alpine meadows rocks) (4000 - 4800 m) | China (alpine meadows) (3000 - 5000 m) |

From the aforesaid account, it is amply clear that the genus *Ranunculus* L. lacks a commonly accepted infrageneric and/or infraspecific classification, both at the world and at regional levels. In the present work an attempt has been made to remove the confusions at regional level by proposing certain new combinations.

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