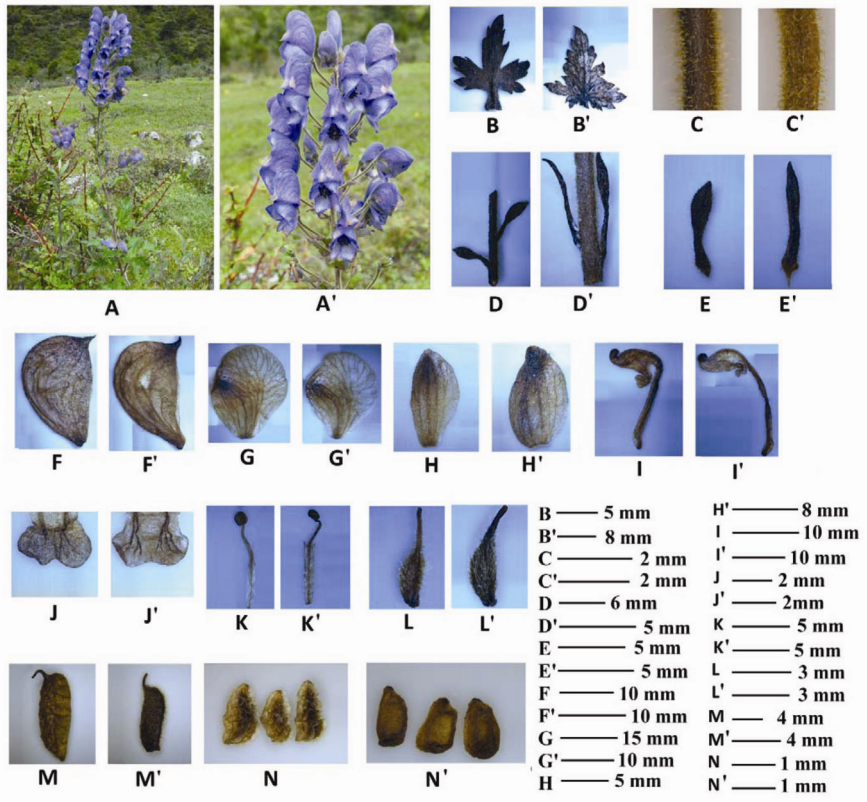


**Figure 1.** *Aconitum arunii*. (**A**) Habit and (**A'**) inflorescence. (**B–N**) *A. spicatum* from T. Husain & P. Agnihotri 257631 LWG. (**B'–N'**), *A. arunii* from T. Husain & P. Agnihotri 257637 LWG. **B** and **B'**, Bract; **C**, **C'**, Pedicel; **D** and **D'**, Attachment of bracteoles on pedicel. **E**, **E'**, Bracteole; **F**, **F'**, Upper sepal; **G**, **G'**, Lateral sepal; **H**, **H'**, Lower sepal; **I**, **I'**, Petal; **J**, **J'**, Lobes of petal lip; **K**, **K'**, Stamen; **L**, **L'**, Carpel; **M**, **M'**, Fruit and **N**, **N'**, Seed.

half of pedicel, linear ca. 7 mm, hairy. Sepals five, upper sepal helmet-shaped, 2.5 cm long, 2.2 cm high, 14–15 mm wide, erect, indistinctly clawed, helmet obliquely semiorbicular, shallowly depressed near beak; beak minute, directed upward; lateral sepal orbicular, 15.8–16.2 × 20 cm, not clawed, yellow tinged on one side, turning dark when dry, pubescent; lower sepal broadly elliptic 7–7.5 × 12–13 mm, densely so at apex on outer surface. Petals two, pubescent; claw 2.1–2.2 cm long, leaning forward, hood oblique to almost horizontal, gibbous at apex on the back, ca. 1.2 mm diameter, black when dry; lip ca. 3 mm long from a broad base, scarcely bilobed. Stamens numerous, ca. 9 mm long; filaments ca. 8 mm long, upper part hairy, distally membranous, staminal teeth prominent; anthers ca. 0.8 × 1 mm, glabrous. Carpels five, 5–5.8 mm long; ovary 3–3.6 mm long, densely hairy on one side, hairs on anterior side curled or twisted; style ca. 2 mm, lower part hairy; stigma indistinct. Follicles five, obliquely oblong, truncate at base, 6–7.2 × 1.8–2 mm, densely hairy; seeds ovate, 0.6–0.7 × 1.2–1.3 mm.

Flowering and fruiting: September–October.

Distribution and habitat: Grows on moist soils in Kupup, East Sikkim at 3943 m altitude.

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PRIYANKA AGNIHOTRI
DANISH HUSAIN
TARIQ HUSAIN*

*Plant Diversity,*
*Systematics and Herbarium Division,*
*CSIR-National Botanical Research Institute,*
*Rana Pratap Marg,*
*Lucknow 226 001, India*
**For correspondence.*
*e-mail: hustar_2000@yahoo.co.uk*

# *Caragana versicolor* Benth. (Fabaceae), a keystone species of high conservation concern in the Hindu Kush Himalayan region

Situated in the highly elevated areas well above 3000 m, where alpine shrubs and grasses are the dominant vegetation, rangelands provide diverse ecosystem services[1] to local and downstream communities. Spread over more than a third of the globe[2] and about 54% of the Hindu Kush Himalayan (HKH) region[3], these serve as the main feed resource for traditional livestock rearing systems in many parts of the world and include about 70% of the feed for domestic ruminants[1]. The HKH region is one of the largest and most assorted mountain settings in the world inhabited by more than 210 million people representing diverse ethnic and socio-cultural groups[4]. The alpine arid rangelands (AAR) in HKH are usually located at elevations above 4000 m with a unique characteristic ecology and biogeography. In Himalaya, these rangelands are positioned in the rain shadow zone and north of the Greater Himalaya. It is estimated that as many as ten million people currently reside in and depend on mountain rangelands in the Himalaya[5]. In the Trans-Himalayan region of India, the AAR are spread across two biogeographic provinces, viz. Ladakh mountains in the

north-west and Tibetan Plateau that includes Eastern Ladakh, adjacent parts of Spiti, small pockets of Uttarakhand along northern frontiers and Sikkim Plateau[6]. Wild mammals such as Snow leopard (*Panthera uncia*), Himalayan marmot (*Marmota himalayana*), Tibetan woolly hare (*Lepus oiostolus*) and Himalayan wild ungulates, viz. blue sheep (*Pseudois nayaur*), Himalayan musk deer (*Moschus chrysogaster*), Tibetan argali (*Ovis ammon hodgsoni*), Tibetan gazelle (*Procapra picticaudata*), kiang (*Equus kiang polyodon*) and ibex (*Capra ibex*) inhabit and utilize AAR for food and shelter. Dominated by alpine dry scrub (scrub steppe) vegetation comprising major shrub species such as *Caragana*, *Devendraea*, *Kraschenninikovia*, *Juniperus*, *Ephedra*, *Hippophae*, *Lonicera* and *Potentilla* and alpine dry pastures (desert steppe), the AAR in HKH have been used by a large number of indigenous communities and local and migratory pastoralists for livestock grazing (domestic sheep, goat, cow, yak, horse and mule) as well as for their social and cultural causes. Thus, human dependence is a characteristic feature as nomadic and semi-nomadic pastoral communities such as *Changpas* (nomadic community that rears famous Pashmina goat) of Changthang, Ladakh, *Gaddis*, *Gujjars*, *Bakarwals*, *Kinnauras*, *Kaulis* and *Kanets* of the north-west Indian Himalaya, *Bhotias* of Garhwal and Kumaon Himalaya, *Bhotias* and *Sherpas* of Khumbu valley of Nepal, *Kirats* of eastern Nepal, *Monpa* yak breeders of Arunachal Pradesh and *Bhutias* of Lachen and Lachung in Sikkim make efficient use of the seasonally abundant natural resources in these regions[7].

One such phyto-resource, viz. *Caragana* derived from the Mongolian name *Charachana*, for ornamental shrub, are drought-resistant leguminous species distributed widely in Eurasia. It is endemic to temperate Asia, with most species distributed on the Qinghai-Tibetan Plateau and in north-western China[8]. In China, it is mainly found in the arid and semi-arid regions of the northern part of the Yellow River catchment, and the Tibetan Plateau. There are more than 100 species in the genus of which 66 are recorded from China. Their global distribution range is from the Caucasus and Central Asia going east towards Russian Siberia, Korea and Japan, southwards to Nepal, Bhutan, Sikkim and northern India. They are mostly deciduous xerophytic shrubs and a dominant life form of cold arid regions[9]. Some of the common species found in the HKH region include *Caragana brevispina* Benth., *C. conferta* Baker, *C. crassicaulis* Benth. (now *Spongiocarpella nubigena* (D. Don) Yakovlev), *C. cuneata* (Benth.) Baker (now *Chesneya cuneata* (Benth.) Ali), *C. gerardiana* Benth., *C. nubigena* (D. Don) Bunge (now *Spongiocarpella nubigena* (D.Don) Yakovlev), *C. versicolor* Benth. and *C. polyacantha* Royle[10]. This legume is chiefly found in open dry slopes forming pure patches and also majorly associates with other xeric species, viz. *Devendraea*, *Artemisia*, *Juniperus*, *Potentilla* and at places with *Kraschenninikovia ceratoides*[11–16]. The mosaics of *Caragana* scrub on gelifluction lobes give a peculiar appearance to the Trans-Himalayan landscape[13]. Interestingly, *Caragana nubigena* (syn. *Chesneya nubigena* (D. Don) Ali), *Spongiocarpella nubigena* (D. Don) Yakovlev), have been reported to moderate the physical environment by forming soil, increasing organic matter composition and by raising soil temperatures, thus providing a micro-habitat suitable for colonization by grasses and forbs[17].

Amongst reported species of *Caragana*, *Caragana versicolor* Benth. is the dominant shrub species in AAR of the Tibetan plateau and the Trans-Himalayan Grasslands[13,15,18,19] (Figure 1). This thorny shrub species is confined to West and North-West Himalaya, China, Nepal, Afghanistan and Pakistan. The dense bushy nature, thick root stock and stunted growth with cushion-like appearance are its adaptations to the cold arid conditions. Locally known as *Trama* (Western Ladakh) and *Dam* or *Dama* (Uttarakhand), *C. versicolor* is among most important and highly preferred fodder and fuel wood above 4000 m in the Trans-Himalayan regions[13,14,19,20]. Additionally, this species has been reported to cure food poisoning, fever and throat infection in Western Ladakh[21]. It usually occurs in well drained and loose sandy soils and can be found growing between 3800 and 5400 m altitudes. Due to its adaptability to withstand harsh conditions, the growing period of this species is believed to be long when compared to other shrub species. *C. versicolor* along with few graminoids species (*Elymus*, *Carex* and *Kobresia*) is one of the few important species grazed by wild ungulates as well as livestock during onset and outward passage of the growing seasons and especially during winter season when the resources are scarce. Owing to short growing period of graminoids and other herbaceous species, this legume species along with *Devendraea spinosa* and *Kraschenninikovia ceratoides* are the alternatives left as fodder species.

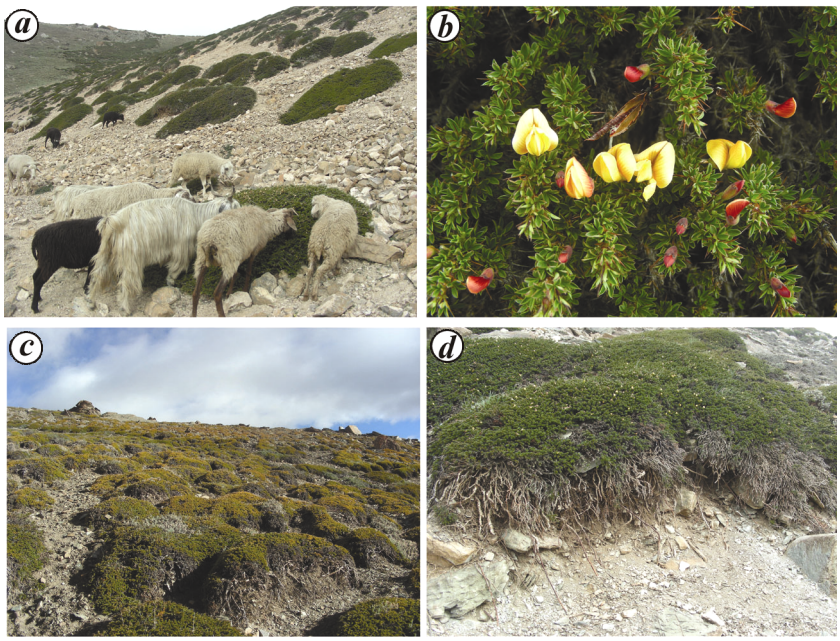


**Figure 1.** *Caragana versicolor*: ***a***, browsing by domestic livestock; ***b***, in flowering; ***c***, mosaics of *Caragana* scrub; ***d***, dry and thick root system usually used as fuel wood.

Moreover, it also provides the chief source of food during the peak growing season, viz. snow free period (June–September) every year[13,14]. Keeping its unique and crucial significance to the wild and domestic ungulates in view, an attempt to highlight *C. versicolor* as a key-stone species in Changthang, Ladakh has been done[13]. Apart from animal fodder and its role in soil stabilization, the whole plant is extracted by local inhabitants[18] and transhumant pastoralists for fuel primarily because of the lack of other energy sources in the region. In the present scenario, its wide and common distribution may not be a cause of concern. *C. versicolor* is under tremendous pressure due to loss of parts aboveground owing to grazing of leaves and tender shoots by sheep, goats and extraction for fuel by the herders. The depletion in its growth, population and regeneration might be crucial for sustenance of the wild as well as domestic ungulates and for local inhabitants and pastoral communities. Considering the role of *Caragana versicolor* in maintaining ecological stability of the fragile trans-Himalayan ecosystem, it would be prudent to map its distribution and area of occurrence within Hindu Kush Himalaya. Conservation awareness about the species and taking steps to provide alternate fuelwood and non-conventional energy sources such as solar cookers and fuel efficient portable ovens to the pastoral communities at subsidized rates could reduce the pressure on the species. Additionally, restoration of heavily degraded sites reseeding *Caragana* and participatory monitoring with the help of herders would be the most practical way forward.

*Conflict of interest statement:* The authors declare that they have no competing interests.


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AMIT KUMAR*
B. S. ADHIKARI
G. S. RAWAT

*Wildlife Institute of India,*
*Chandrabani,*
*Dehradun 248 001, India*
**For correspondence.*
*e-mail: amit_ndbr@wii.gov.in*