Pak. J. Bot., 47(SI): 1-5, 2015.

CONSERVATION STATUS ASSESSMENT OF *MECONOPSIS ACULEATA* ROYLE; A THREATENED ENDEMIC OF PAKISTAN AND KASHMIR

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Abstract

Aim of the present study was to determine the conservation status of *Meconopsis aculeata* Royle (Papaveraceae), a threatened endemic, confined to the Himalayan ranges of Pakistan and Kashmir. Detailed studies were conducted following IUCN Categories and Criteria covering an area of 92,000Km^2. Census were performed by counting potentially reproductive individuals. A single sub populations could be found with an average of 39 mature individuals per year, while no individual could be recorded from the other previously reported locality. Estimated Extent of Occurrence was calculated to be less than 100km^2 (23Km^2) and Area of Occupancy as 20km^2 only. Collection for medicinal purposes, overgrazing and snow avalanches were among the more severe threats. Based on limited population size, small geographic range, habitat quality and anthropogenic activities, species is assigned Critically Endangered (CR) category at regional level. Establishment of reserves in the core habitat of species along with *ex-situ* conservation is recommended for conservation.

Key words: *Meconopsis aculeata*, Papaveraceae, endemic, IUCN, Critically Endangered

Fig. 1. *Meconopsis aculeata* Royle, A. habit; B. flowering and fruiting.

Introduction

Species extinction at alarming rate is one of the most severe ecological problems throughout the world (Stokstad, 2010; Barnosky *et al*., 2011; Rahbek & Colwell, 2011; Tedesco *et al*., 2014). The situation is more worsening in developing countries (Khan *et al.,* 2009) as efforts for conservation are negligible (Myers *et al*., 2000; Lenzen *et al*., 2012; Khan *et al.,* 2013). The main hurdle in effective conservation planning is lack of data regarding the conservation status of species in focus. The assessment of the species conservation status is thus, a basic need, for that the accepted standard is IUCN category and Criteria (Margules & Pressey, 2000; Rodrigues, 2007; Vié *et al*., 2009; Turnhout *et al*., 2012). Endemic plants being more prone to extinction, merit conservation assessment at top priority and can then be used as flagship species in ecosystem restoration programs (Caro & O'Doherty, 1999; Caro *et al*., 2004; Khan *et al.,* 2014). At current, many of the developing countries lack the basic assessment data meeting international standards (Hamilton & Schmitt, 2000; Kanongdate *et al*., 2012). Even at global level, the red list data covers a small fraction of the total species. From among 307,674 plant species, 9,390 (c. 3%) could have been evaluated according to relist category and criteria (Caro & O'Doherty, 1999). For Pakistan, from among the 6000 vascular plant species only 52 (0.09%) could be assigned threat categories (Alam, 2010; Ali, 2010; Abbas, 2010).

Himalaya is one of the few hot spots of the world having considerable diversity with many endemic plant species. The natural flora particularly endemics had reported to be threatened because of anthropogenic activities including commercial utilization of plants. The areas declared as natural reserve in the region are very few and are unable to play effective role in conservation (Ghimire *et al*., 2004; Kumar *et al*., 2011; Kandari *et al*., 2012).

Meconopsis is a small genus having 40-45 species with high ornamental value, and is confined to Himalaya. The *Meconopsis aculeata,* commonly known as Himalayan Blue Poppy was reported to be endemic to Kashmir according to Flora of Pakistan (Jafri & Qaiser, 1974) (Fig. 1), however recent review by Flora of China reported the species from Pakistan, Kashmir and Tibetan region of China. The IUCN red list of 1997 enlists the species in endangered category but after that no evaluation has been made (Walter & Gillett, 1998). Plant is confined to Himalayan ranges only. Evaluating species at regional level is considered integral part in producing red lists at national level (Miller *et al*., 2007). In Pakistan, the species was reported from Palas valley in 1992 and from Kaghan valley area adjoining Kashmir in 2010. Current work is aiming at assigning threat category according to IUCN Red List Categories and Criteria version 3.1. (Anon., 2001).

Materials and Methods

Northern Pakistan and the parts of Kashmir being potential occurrence sites of the species were chosen as study area covering approximately 92,000 Km^2 of the area (Fig. 2). For assessing the conservation status, comprehensive field studies were planned keeping in view the previously reported localities and potential sites based on the ecological characteristics of the reported localities. Field visits were arranged in growing season of the plant. Where a population was found, the locality was georeferenced using Global Positioning System (Garmin, E Trex Vista H). The population census was performed by counting individual plants with reproductive capability however non reproductive individuals were also counted separately. Associated species and various kinds of threats were recorded. Locals were interviewed about the plants distribution sites and uses. GPS data was transferred to GIS software ArcGIS 9.3 for further process. Extent of Occurrence (EOO) was measured through drawing Convex Hull by joining all the outer points as per IUCN criteria, while Area of Occupancy (AOO) was calculated by placing a grid polygon with each cell of $4km^2$ area. The species was assigned threat category (regional level) following IUCN Category and Criteria and guidelines for regional level assessments.

Fig. 2. Map of the surveyed area covering almost whole potential region within country's boundary.

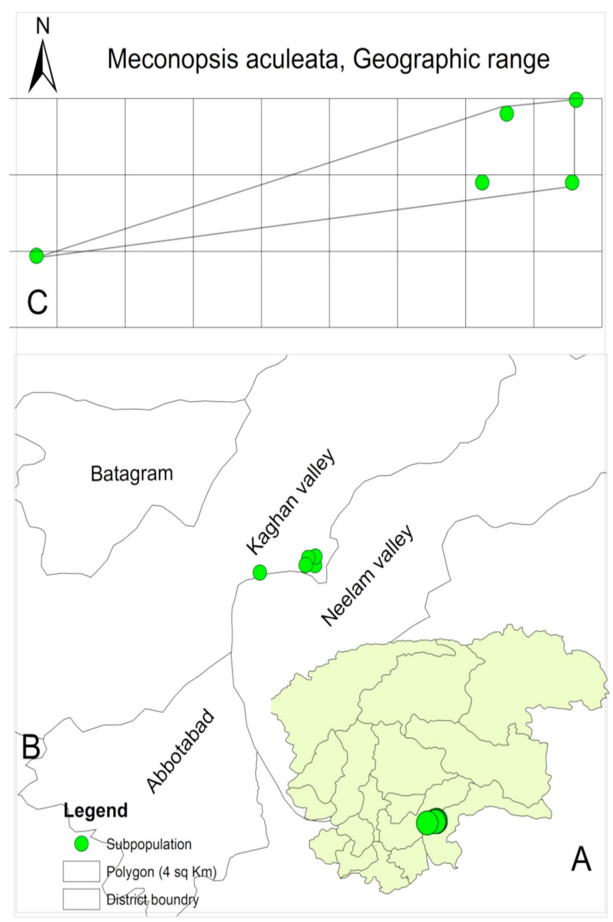

Fig. 3. A. Surveyed area, B. range of the species extent and subpopulation location C. Convex hull indicating EOO while square polygons indicate AOO.

Results and Discussion

Past and present distribution: According to Flora of Pakistan, the species was reported from Tulian, Jeoni and Phalgam areas of Kashmir (now in Indian Kashmir) where the species was reported to be threatened (Kala, 2000; Kala, 2005). In 1995, Rafiq reported the species from Palas valley at an altitude of 2400m on a rock scree along Khabkot river (Rafiq, 1996). However despite of through field visits to the area, species could not be collected. Collections from areas of Kashmir mentioned the distribution of plant at an altitude of 3000-3800 meter. In 2010, a subpopulation was found in Makra range of Kaghan valley. From 2011-2013, four other sites near to previous one were found. Except that, no other population was found in spite of through surveys in past ten years by authors in Gilgit, Chitral, Dir, Swat and Hazara region.

Population Size and habitat specificity: Five localities each with few individuals (6-11) were found. On average, 39 individuals could be collected each year (Table 1). In all cases plants were confined to broken rocks scree, in stony gravel soil at moist shady places. No plant was found growing in opens soil. The species had a small altitudinal range from 3572-3753.4 meters. The other reports from altitude below this range in previous years may be an indication of upward shift of the species (Lenoir *et al*., 2008; Fordham *et al*., 2012).

Geographic range: Extent of Occurrence (EOO) was calculated to be 23Km^2, while Area of Occupancy (AOO) as 20 Km^2 (Fig. 3) .This shows very small geographic range. This may be due to the marginal population found at this extreme of range where species remain susceptible to climatic and other adaphic factors. A reason for rarity may be the narrow ecological niche, where climatic change severely affects plant survival (Woodward & Williams, 1987; Peterson, 2001; Evans *et al*., 2009). Absence of the species from previously reported site at Palas valley indicates continuous decline in species geographic range (Lenoir *et al*., 2008; Chen *et al*., 2011).

Associated species: Plant grow singly and very few associated species like *Potentilla curviseta* and *Cortusa* sp and some lichens adopted to special conditions were found as associates. However, important species to be mentioned, indicating overall habitat were *Aconitum heterophyllum*, *Codonopsis rotundifolia*, *Potentilla pteropoda*, *Rhododendron lepidotum*, *Gaultheria trichophylla*, *Poa alpina*, *Festuca hartmannii*, *Primula hazarica* etc. Indicator species may be helpful in identifying conservation area for reintroduction (Peterken, 1974; Ludwig *et al*., 2004).

Threats

Medicinal plant collection: One of the important threat (though indirect) is the collection of medicinal herbs from the core habitat of the species. *Aconitum chasmanthum*, *Jurinea himalaica*, *Aconitum heterophyllum*, *Swertia speciosa, Sassurea* sp etc. are the important medicinal plants growing in *Meconopsis aculeata* habitat. They are highly demanded and over collected. Uprooting causes soil erosion followed by land sliding along snow avalanches. The threat has also been reported in many other cases (Smith & Larsen, 2003; Shinwari & Qaisar, 2011). Another threat is organized field visits by herbalists and chemists in search of new plants with active ingredients. Although the plant has no medicinal use by local community, it has been reported as highly medicinal being used in rheumatism in some other areas of Himalaya. In this regard species has potential threat for commercial collection. In Himalayas, one of the major reasons of declining plants populations is their market demand (Kala *et al*., 2004; Kala, 2005; Larsen & Olsen, 2007). Also the plant is reported to be threatened in Indian Kashmir mainly because of over exploitation for medicinal use (Badola & Aitken, 2003; Rana & Samant, 2011).

Overgrazing: About 1500 goats and sheep and 300 cattle were grazing in the area which is another threat. Plant is however grazed at early stage. Overgrazing makes the soil eroded. Proper management of grazing practices is necessary in order to protect grazing sensitive species (Todd & Hoffman, 1999; Mekuria *et al*., 2007; Adnan *et al.,* 2015).

Avalanches: Snow avalanches significantly disturb the plant population and habitat. All the populations were found under or alongside strong and heavy rocks resistant to such danger. Populations were found to be more susceptible where the land was exploited for uprooting medicinal plants. The barren soil causes land slide. This is one of the major problems responsible for deforestation as well (Kräuchi *et al*., 2000; Bebi *et al*., 2009). Sustainable land use may be helpful in the conservation.

Table 1. Localities, GPS coordinates, altitude and population size.

Locality Number	Locality	GPS Coordinate	Altitude (m)	2011	2012	2013
1	Below Makra Top	73.625, 34.605	3753.4	8	7	8
2	Above Nila	73.617, 34.607	3530.9	7	8	7
3	Above Tambu Naka	73.605, 34.605	3868.7	6	9	7
4	Dandan Baik	73.625, 34.620	3680.13	8	7	8
5	Shingar	73.632, 34.623	3572.77	9	8	11
Subtotal				**38**	**39**	**41**

Conservation status: As Extent of Occurrence (EOO) is less than $100Km^2$ ($23Km^2$) with only one subpopulation having continuous decline in extent of occurrence, area of occupancy, quality of habitat and number of subpopulations, species qualify for Critically Endangered (CR) category with IUCN alphanumeric classification as CR B 1 a (i), (ii), (iii), (iv). More over after three year survey, only 39 mature individuals were found in the whole subpopulation qualifying Critically Endangered category as per IUCN classification as CR D (Anon, 2001; Gärdenfors *et al*., 2001).

Conclusion

Meconopsis aculeata is a Critically Endangered species at regional scale based on IUCN alphanumeric classification CR B1(i), (ii), (iii), (iv) and CR D. Establishment of natural reserve in habitat of species and ex situ conservation of species is recommended for rescuing the plant from extinction.

Acknowledgements

Authors are highly thankful to local communities for hospitality during survey. We thank Amir Hamza and M. Waheed of wildlife Department of KP and Mian Farooq of Microbiology Department of Hazara University for field assistance.

References

Abbas, H. 2010. Ex-situ Conservation of some Threatened Endemic and Rare Plants of Southern Pakistan through Tissue Culture. PhD Thesis. University of Karachi, Karachi, Pakistan.

Adnan, M., A. Tariq and Z. K. Shinwari, 2015. Effects of human proximity and nomadic grazing on the diversity of medicinal plants in temperate Hindukush. *Pak. J. Bot.,* 47(1): 149-157.

Alam, J. 2010. Endemic flora of Gilgit and Baltistan and Conservation Strategies for Threatened Endemic Taxa. PhD Thesis. University of Karachi, Karachi, Pakistan.

Ali, H. 2010. *Floristic studies of Chitral: threatened plants and conservation strategies.* PhD Thesis. University of Karachi, Karachi, Pakistan.

Anonymous. 2001. *IUCN Red List Categories and Criteria*: IUCN Species Survival Commission.

Badola, H.K. and S. Aitken. 2003. The Himalayas of India: A treasury of medicinal plants under siege. *Biodiversity,* 4(3): 3-13.

Barnosky, A.D., N. Matzke, S. Tomiya, G.O. Wogan, B. Swartz, T.B. Quental, C. Marshall, J.L. McGuire, E.L. Lindsey and K.C. Maguire. 2011. Has the Earth's sixth mass extinction already arrived? *Nature,* 471(7336): 51-57.

Bebi, P., D. Kulakowski and C. Rixen. 2009. Snow avalanche disturbances in forest ecosystems-State of research and implications for management. *Forest Ecology and Management,* 257(9): 1883-1892.

Caro, T., A. Engilis, E. Fitzherbert and T. Gardner. 2004. Preliminary assessment of the flagship species concept at a small scale. *Animal Conservation,* 7(1): 63-70.

Caro, T.M. and G. O'Doherty. 1999. On the use of surrogate species in conservation biology. *Conservation Biology,* 13(4): 805-814.

Chen, I.C., J.K. Hill, R. Ohlemüller, D.B. Roy and C.D. Thomas. 2011. Rapid range shifts of species associated with high levels of climate warming. *Science,* 333(6045): 1024-1026.

Evans, M.E., S.A. Smith, R.S. Flynn and M.J. Donoghue. 2009. Climate, Niche Evolution, and Diversification of the “Bird-Cage” Evening Primroses (Oenothera, Sections Anogra and Kleinia). *The American Naturalist,* 173(2): 225-240.

Fordham, D.A., H.R. Akçakaya, M.B. Araújo, J. Elith, D.A. Keith, R. Pearson, T.D. Auld, C. Mellin, J.W. Morgan and T.J. Regan. 2012. Plant extinction risk under climate change: are forecast range shifts alone a good indicator of species vulnerability to global warming? *Global change biology,* 18(4): 1357-1371.

Gärdenfors, U., C.H. Taylor, G.M. Mace and J.P. Rodríguez. 2001. The application of IUCN Red List criteria at regional levels. *Conservation Biology,* 15(5): 1206-1212.

Ghimire, S.K., D. McKey and Y.A. Thomas. 2004. Heterogeneity in ethnoecological knowledge and management of medicinal plants in the Himalayas of Nepal: implications for conservation. *Ecol. & Soc.,* 9(3): 6.

Hamilton, A. and S. Schmitt. 2000. Plant conservation and WWF: Current work and recommendations for the future: WWF Project 9Z1234. Duplicated document. WWF-UK, Godalming, UK.

Jafri, S.H. and M. Qaiser. 1974. Papaveraceae No. 61 In: *Flora of Pakistan.* (Eds.): Nasir and Ali. Islamabad and Karachi.

Kala, C.P. 2000. Status and conservation of rare and endangered medicinal plants in the Indian trans-Himalaya. *Biological Conservation,* 93(3): 371-379.

Kala, C.P. 2005. Indigenous uses, population density, and conservation of threatened medicinal plants in protected areas of the Indian Himalayas. *Conservation Biology,* 19(2): 368-378.

Kala, C.P., N.A. Farooquee and U. Dhar. 2004. Prioritization of medicinal plants on the basis of available knowledge, existing practices and use value status in Uttaranchal, India. *Biodiversity* & *Conservation,* 13(2): 453-469.

Kandari, L., P. Phondani, K. Payal, K. Rao and R. Maikhuri. 2012. Ethnobotanical study towards conservation of medicinal and aromatic plants in upper catchments of Dhauli Ganga in the central Himalaya. *J. Mount. Sci.,* 9(2): 286-296.

Kanongdate, K., M. Schmidt, R. Krawczynski and G. Wiegleb. 2012. Has implementation of the precautionary principle failed to prevent biodiversity loss at the national level? *Biodiversity and conservation,* 21(13): 3307-3322.

Khan, M.A., R.E. Blackshaw and K.B. Marwat. 2009. Biology of Milk thistle and management options for growers in northwest Pakistan. *Weed Bio. & Manag.,* 9(2): 99-105.

Khan, S.M., S. Page, H. Ahmad and D.M. Harper. 2013. Sustainable utilization and conservation of plant biodiversity in montane ecosystems; using the Western Himalayas as a case study. *Ann. Bot.,* 112(3): 479-501.

Khan, S.M., S. Page, H. Ahmad and D.M. Harper. 2014. Ethno-ecological importance of plant biodiversity in mountain ecosystems with special emphasis on indicator species; a case study of the Naran Valley in the Northern Pakistan. *J. Eco. Ind*., 37(Part A): 175-185.

Kräuchi, N., P. Brang and W. Schönenberger. 2000. Forests of mountainous regions: gaps in knowledge and research needs. *For. Eco. & Manag.,* 132(1): 73-82.

Kumar, G.P., R. Kumar and O. Chaurasia. 2011. Conservation Status of Medicinal Plants in Ladakh: Cold Arid Zone of Trans-Himalayas. *Res. J. Med. Plants.,* 5(6): 685-694.

Larsen, H.O. and C.S. Olsen. 2007. Unsustainable collection and unfair trade? Uncovering and assessing assumptions regarding central Himalayan medicinal plant conservation. In: *Plant Conservation and Biodiversity*, Springer, 105-123.

Lenoir, J., J. Gegout, P. Marquet, P. De Ruffray and H. Brisse. 2008. A significant upward shift in plant species optimum elevation during the 20th century. *Science,* 320(5884): 1768-1771.

Lenzen, M., D. Moran, K. Kanemoto, B. Foran, L. Lobefaro and A. Geschke. 2012. International trade drives biodiversity threats in developing nations. *Nature,* 486(7401): 109-112.

Ludwig, J.A., D.J. Tongway, G.N. Bastin and C.D. James. 2004. Monitoring ecological indicators of rangeland functional integrity and their relation to biodiversity at local to regional scales. *Aust. Eco.,* 29(1): 108-120.

Margules, C.R. and R.L. Pressey. 2000. Systematic conservation planning. *Nature,* 405(6783): 243-253.

Mekuria, W., E. Veldkamp, M. Haile, J. Nyssen, B. Muys and K. Gebrehiwot. 2007. Effectiveness of exclosures to restore degraded soils as a result of overgrazing in Tigray, Ethiopia. *J. Arid Environ.,* 69(2): 270-284.

Miller, R.M., J.P. Rodríguez, T.A. Fowler, C. Bambaradeniya, R. Boles, M.A. Eaton, U. Gärdenfors, V. Keller, S. Molur and S. Walker. 2007. National threatened species listing based on IUCN criteria and regional guidelines: current status and future perspectives. *Conservation Biology,* 21(3): 684-696.

Myers, N., R.A. Mittermeier, C.G. Mittermeier, G.A. Da Fonseca and J. Kent. 2000. Biodiversity hotspots for conservation priorities. *Nature,* 403(6772): 853-858.

Peterken, G. 1974. A method for assessing woodland flora for conservation using indicator species. *Biological Conservation,* 6(4): 239-245.

Peterson, A.T. 2001. Predicting speciesGeographic Distributions based on Ecological Niche Modeling. *The Condor*., 103(3): 599-605.

Rafiq, R.A. 1996. *Taxonomical, chorological and phytosociological studies on the vegetation of Palas Valley*. PhD Dissertation, Botany Department, National History Museum, Vienna, Austria.

Rahbek, C. and R.K. Colwell. 2011. Biodiversity: Species loss revisited. *Nature,* 473(7347): 288-289.

Rana, M.S. and S. Samant. 2011. Diversity, indigenous uses and conservation status of medicinal plants in Manali wildlife sanctuary, North western Himalaya. *J. Trad. Know.,* 10(3): 439-459.

Rodrigues, A.S. 2007. Effective global conservation strategies. *Nature,* 450(7171): E19-E19.

Shinwari, Z.K. and M. Qaisar. 2011. Efforts on conservation and sustainable use of medicinal plants of Pakistan. *Pak. J. Bot.,* 43(1): 5-10.

Smith, O.C. and H.O. Larsen. 2003. Alpine medicinal plant trade and Himalayan mountain livelihood strategies. *The Geograph. J.,* 169(3): 243-254.

Stokstad, E. 2010. Despite progress, biodiversity declines. *Science,* 329(5997): 1272-1273.

Tedesco, P., R. Bigorne, A. Bogan, X. Giam, C. Jézéquel and B. Hugueny. 2014. Estimating how many undescribed species have gone extinct. *Conservation Biology,* 28(5): 1360-1370.

Todd, S. and M. Hoffman. 1999. A fence-line contrast reveals effects of heavy grazing on plant diversity and community composition in Namaqualand, South Africa. *Plant Ecol.,* 142(1-2): 169-178.

Turnhout, E., B. Bloomfield, M. Hulme, J. Vogel and B. Wynne. 2012. Conservation policy: Listen to the voices of experience. *Nature,* 488(7412): 454-455.

Vié, J.C., C.H. Taylor, C. Pollock, J. Ragle, J. Smart, S.N. Stuart and R. Tong. 2009. The IUCN Red List: a key conservation tool. *Wildlife in a changing world–An analysis of the 2008 IUCN Red List of Threatened Species*:1.

Walter, K.S. and H.J. Gillett. 1998. *1997 IUCN Red List of threatened plants*: IUCN.

Woodward, F. and B. Williams. 1987. Climate and plant distribution at global and local scales. In *Theory and models in vegetation science*: Springer, pp. 189-197.

(Received for publication 26 August 2014)