

Full Length Research Paper

Conservation status of threatened medicinal plants of Mankial Valley Hindukush Range, Pakistan

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Conservation studies of 45 threatened medicinal plants were carried out for assessment of their conservation status, threats and recommendations growing in Mankial valley Hindukush Range Pakistan. Phytogeographically, the valley is present in the Sino Japanese floristic region and is a hot spot of endemism. A total of 45 taxa belonging to 35 families and 43 genera were collected and evaluated which include 13 (28.88%) vulnerable, 21 (46.66%) endangered and 11 (24.44%) critically endangered species. The number of plants scored with reference to its ecological amplitude and calculated historical distribution were compared with the IUCN criteria for threatened categories Version 3.1. The information regarding 'conservation status', threats and recommendations of the species were collected from the entire valley at different localities by filling questionnaire form 300 respondents including 260 male and 40 female. Mankial valley being naturally gifted with tremendous biodiversity, altitudinal and topographic variations is exposed to increasing human pressure, social injustice and low literacy rate that are destabilizing the biodiversity status especially species survival, habitat and ecosystem. According to the present studies, various parameters are contributing to make the important medicinal plants threatened including over exploitation (75.55%), fuel wood usage (35.55%), habitat loss (35.55%), over grazing (28.88%), deforestation (15.55%), use as timber (4.44%), bark usage (4.44%) and use as furniture (4.44%). Moreover, unsustainable utilization of plant natural resources and unscientific agricultural practices are the main threats to the 'plant biodiversity' growing in the valley. Therefore, studies regarding conservation status, threats and recommendations of threatened medicinal plants of Mankial Valley were proposed.

Key words: Conservation, deforestation, ecosystem, Hindukush Range, Mankial valley, over grazing.

INTRODUCTION

Biodiversity is the variability among living organisms from all sources including inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems (CBD, 2010). There are more than 270,000 vascular plant species supporting diverse kinds of ecosystem (Walter and Gillet, 1998). Due to severe anthropogenic activities, the natural flora is under stress and in many areas it is decreasing. Pakistan is presenting diverse climatic, topographic, altitudinal and phytogeographical variation

supporting more than 6000 species with 428 endemics (Ali and Qaiser, 2010). There is a little work carried out on the conservation studies and the available data is deficient. More than 580 plants are reported by Nasir (1991) as threatened. In another study, it has been reported that 709 plants species are threatened and endangered in Pakistan (Chaudhri and Qureshi, 1991). While according to Walter and Gillet (1998), 14 flowering plants are threatened in Pakistan. It has been reported by IUCN (1994) that 20 species are considered to be target species in Pakistan (Shah

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and Baig, 1999). According to the IUCN Red list (2008), 19 plants are threatened in Pakistan. While according to Ali and Qaiser (2010), it has been reported that 21 species are threatened. Intensive studies for the determination of the conservation status, threats and recommendations for various species and fluctuation in its population has never been carried out.

The total flora of District Swat is consisting of 1550 species. It has been estimated that flora of Swat contains 87 threatened plants. According to previous studies, it has been reported that 6.3% taxa in Swat are threatened, in which 1.7% is endangered, 2.7% is vulnerable and 1.6% is rare (Shinwari et al., 2003). Pakistan has nine ecological and five phytogeographical zones and has diverse microhabitat presenting more than 428 endemics. Therefore, species with narrow area of distribution needs more attention. During studies of the tropical and sub tropical sub humid forests up to alpine pastures, 380 species are reported. The area under study is a hot spot in representing some highly medicinal and endemic species to Swat including *Indigofera heterantha* and *Ligeticum stewartii*. The inhabitants are totally dependent upon the plant natural resources growing in the valley for themselves and their cattles. They are interacting directly or indirectly with various plants for keeping their livelihood living. Therefore, studies regarding conservation status of important medicinal plants were carried out by considering various parameters including over exploitation, fuel wood, habitat loss, over grazing, fodder collection, deforestation, timber, bark use and furniture. The present studies show that the current situation in the valley regarding conservation status of some important medicinal plants is not encouraging. Among the total 45 taxa, 13 are vulnerable, 21 are endangered and 11 are critically endangered. Similarly, various parameters have adversely contributed to make certain species vulnerable, endangered and critically endangered. It is observed that over exploitation of medicinal plants is the contributing 75.55%, due to unavailability of alternative energy sources, fuel wood is contributing 35.55%, and thus due to deforestation the habitat loss is contributing 35.55%, while the over grazing is contributing 28.88%.

It is noted during the present study that anthropogenic activities are the main contributor in the unsustainable utilization of the plant natural resources growing in the area. Therefore, studies regarding the conservation status, threats and recommendations for some threatened medicinal plants were planned.

Study area

Mankial Valley is one of the deepest Valleys of the Hindukush Range lies on 35°, 12' 24" North latitudes and 72°, 32' 15" East longitudes. It occurs 17 km short of Kalam on east side of the Kalam-Bahrain road. On

revenue index map, the area can be traced on Moza's (settlements units) bearing S. No. 18 and 19 (Badai and Mankial) with the land holdings of 20620 and 11658 acres. It is surrounded on the East by Kandya and Duber, on the West by Arayanai and Balakot, on the North by Boyoun and Shahoo and on the South by Ramet and Goornai. Altitude ranges from 1430 m at Mankial to 5726 m at Koohe Shaheen. The area is a mountainous terrain of high glaciated peaks, perennial snowfields, glaciers, falls, pastures, rivers, streams and intact forest. The percentage share by area of mountains, valleys/pastures and rivers is estimated to be 95, 45 and 0.5%, respectively. Pastures are at elevation of above 3000 m and come under alpine regions with severe long winters starting from September to end of March and a very mild summer from June till August. Floral diversity is very rich and economic potential are there. The area represents variety of micro habitats supporting a diversified biodiversity. The research area is present in northern Swat and the vegetation of Northern Swat is classified into cool temperate coniferous (1400 to 2000 m), cold temperate coniferous (2000 to 3000 m), sub alpine (3000 to 4000 m) and alpine zones (>4000 m). Mostly, these zones are away from the monsoon rains; therefore, usual rainfall is very low ranging from 160.6 to 660.4 mm and snowfall from 1.82 to 4.50 m. Sometimes more than 4.50 m snowfall has occasionally been reported.

Maximum temperature is about 10°C or less for 5 to 6 months. When the snow melts during June to August, ephemerals sprout. The temperature is below or 0°C during the period of December to March. Maximum temperature does not exceed beyond 15.9°C during winter recess. Due to short growing season, thick snow cover, intense solar radiation, high wind velocity and low temperature result in the prevalence of a xerophytic habitat for plants in the alpiners, turning them dwarf, stunted, hairy and rosette leaves. The crooked and uneven appearance of the plants is resulted due to heavy snowfall in the area.

MATERIALS AND METHODS

Field study trips were arranged to the study area during 2010 to 2012. The information regarding 'conservation status', threats and recommendations was collected from 300 respondents including 260 male 40 female. Semi structured questionnaires and oral interviews methods were adopted after Croom (1983) and Lipp (1989). The informants were asked various questions for obtaining information regarding over exploitation, use as fuel wood, reasons for habitat loss, over grazing, fodder collection, deforestation, use as timber, use of specific bark and use as furniture species. Various areas of the Mankial valley including Mankial, Bhadai, Mianshkon, Ghund Patai, Baik, Jabba, Narra, Kamar Khwah, Chokial Banda, Kafar Banda, Kakora, Char Banda, Tapra, Serai and Mehnain. During the studies observation, GPS data, altitude, locality, and data regarding rate of consumption, uses, preference of use and major threats to the reduction in population size were obtained. The species were evaluated in the field for their distribution, historical background in the valley, use pattern, present frequency and they

were compared with the existing extent and its normal ecological habitat and nich. The information were collected from the local people regarding decline in the population size of these species, factors such as decline in the area of occupancy, extent of occurrence, loss of habitat, actual or potential level of exploitation, effects of introduced taxa and attack of pathogens. Each species was taxonomically described. The distribution and number of plants scored with reference to its ecological amplitude and calculated historical distribution were compared with the IUCN criteria for threatened categories Version 3.1 (IUCN, 2001) for evaluation of the conservation status of each species. The nine categories of IUCN (2001) were reduced to 3 categories. The plant species were then categorized into vulnerable, endangered and critically endangered species (IUCN, 2001).

The plant specimens were collected, documented, preserved and identified with the help of available literature (Nasir and Ali, 1970 to 1989; Ali and Nasir, 1989 to 1991; Ali and Qaiser, 1993 to 2012); and comparing with preserved herbarium specimens. The classification was carried out according to the most recent phylogenetic system of classification (APG) Angiosperm Phylogeny Group (Judd et al., 2002). The voucher specimens were deposited in the Herbarium Centre of Plant Biodiversity (CPB) University of Peshawar.

RESULTS

IUCN criteria for threatened categories Version 3.1 (IUCN, 2001) were used and category A of vulnerable, Categories A of endangered and Category A of critically endangered species was used for evaluation. A taxon is vulnerable when the best available evidence indicates that it meets any of criteria A, and it is therefore considered to be facing a high risk of extinction in the wild. Category-A reduction in population size based on, 1) An observed, estimated, inferred or suspected population size reduction of $\geq 50\%$ over the last 10 years or three generations, whichever is the longer, where the causes of the reduction are: clearly reversible and understood and ceased, based on (and specifying) any of the following; (a) direct observation, (b) an index of abundance appropriate to the taxon, (c) a decline in area of occupancy, extent of occurrence and/or quality of habitat, (d) actual or potential levels of exploitation and (e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites. A taxon is endangered when the best available evidence indicates that it meets any of criteria A, and it is therefore considered to be facing a very high risk of extinction in the wild. Category-A reduction in population size based on, 1) An observed, estimated, inferred or suspected population size reduction of $\geq 70\%$ over the last 10 years or three generations, whichever is the longer, where the causes of the reduction are clearly reversible and understood and ceased, based on (and specifying) any of the criteria a to e shown under vulnerable category.

A taxon is 'critically endangered' when the best available evidence indicates that it meets any of the criteria A, and it is therefore considered to be facing an extremely high risk of extinction in the wild. Category-A reduction in population size based on, 1) An observed,

estimated, inferred or suspected population size reduction of $\geq 90\%$ over the last 10 years or three generations, whichever is the longer, where the causes of the reduction are clearly reversible and understood and ceased, based on (and specifying) any of the criteria a to e shown under vulnerable category of IUCN (2001). A total of 45 taxa belonging to 35 families and 43 genera were collected and evaluated which include 13 vulnerable, 21 endangered and 11 critically endangered species. The gymnosperms were represented by 4 families, 4 genera and 4 species. The monocots were also represented by 4 families, 4 genera and 4 species. The dicots were represented by 27 families, 35 genera and 37 species. Family Plantaginaceae was the leading family among the dicot represented by 3 species each. While 8 families were presented by 2 species each and 18 families were presented by 1 species each. Based on the present studies and information given by the inhabitants of the area, the decline in population size and extent of occupancy of these species is a continuous practice. It is concluded that 34 (75.55%) species are suffering due to over exploitation, 16 (35.55%) species each are suffering due to fuel wood and habitat loss, 13 (28.88%) species are suffering from over grazing problems, 11 (24.44%) species are suffering due to fodder collection, 7 (15.55%) species are suffering from the deforestation and 2 (4.44%) species each are suffering due to their bark usage, furniture and timber species.

The detail of 'conservation status', threats and recommendations regarding each species has been given as follows:

Family: Cupressaceae

Scientific name: *Juniperus communis* L.

Vernacular name: Gugur

Voucher specimen: Mankial (Chokail Banda-I)

35° 21' N and 72° 39' E, 3088 m

Asad and Rashid 648 and 1574 (PUP and PMNH).

Conservation status, threats and recommendations

It is found at higher altitude after tree line in the valley distributed from 2100 to 3000 m. The main threats are its use as fuel wood and over grazing during the summer season by the pastoralists at higher altitude. The use as fuel wood and grazing may be controlled to insure the sustainable utilization and proper exploitation. The population is reduced by more than 30% over the last 10 years and it is falling under the category A (a and c) of vulnerable species.

Family: Ephedraceae

Scientific name: *Ephedra gerardiana* Wall.

ex Stapf

Vernacular name: Asmania

Voucher specimen: Mankial (Gaider Jabba-I)
35° 18' N and 72° 41' E, 2810 m
Asad and Rashid 1842 (PUP and PMNH).

Conservation status, threats and recommendations

It is found in the valley at an altitude of 2810 m. The main threat is over exploitation due to its high medicinal value, also used as fuel wood. The over exploitation and use as fuel wood must be controlled to insure the sustainable utilization and proper exploitation. The population size is considerably reduced by more than 70% over the last 10 years/three generations. It is falling under the category A (a and c) of endangered species.

Family: Pinaceae
Scientific name: *Cedrus deodara* Roxb. ex Lamb.
Vernacular name: Diyar
Voucher specimen: Mankial (Bhadai Patti-III)
35° 20' N and 72° 38' E, 2058 m
Asad and Rashid 1880 (PUP and PMNH).

Conservation status, threats and recommendations

It is distributed in the valley from 1764 to 3000 m within the wild. The main threats are its use as a commercial timber, fuel wood and furniture. Its use as timber, fuel wood and furniture must be banned to insure the sustainable utilization and proper exploitation. The decline in area of occupancy has been occurred and ≥ 50% of the population has been reduced over the last 10 years/three generations. It is falling under category A (a and c) of vulnerable species.

Family: Taxaceae
Scientific name: *Taxus wallichiana* Zucc.
Vernacular name: Banya
Voucher specimen: Mankial (Takki Gaider-I)
35° 18' N and 72° 39' E, 2641 m
Asad and Rashid 1876 (PUP and PMNH).

Conservation status, threats and recommendations

It is found in the valley at an altitude of 2641 m. The main threats are its use for fuel wood, medicinal and timber purposes. Its use as fuel wood must be banned, while medicinal and timber use must be strictly checked. It has been observed by the local inhabitants that 80% of population has been reduced over the last 10 years and now it is very rarely distributed in the valley. It is falling under the category A (a and c) of critically endangered species.

Family: Colchicaceae

Scientific name: *Colchicum luteum* Baker
Vernacular name: Zairgulay
Voucher specimen: Mankial (Chokial Banda-II)
35° 22' N and 72° 40' E, 3275 m
Asad and Rashid 1891 (PUP and PMNH).

Conservation status, threats and recommendations

Important chemical colchicine is obtained from the underground corm of this species and it is also used as a medicinal plant. The main threat to this plant is over exploitation for medicinal purposes. Its' over exploitation as a high value medicinal plant must be stopped to insure its conservation. It is found in the valley at 3275 m. According to the local inhabitants, the population has decreased up to 75% due to its unique life form and unsustainable collection. It is falling under the category A (a, c and d) of the endangered species.

Family: Convallariaceae
Scientific name: *Polygonatum verticillatum* All.
Vernacular name: Nooryalam
Voucher specimen: Mankial (Gaider Jabba-III)
35° 18' N and 72° 40' E, 2820 m
Asad and Rashid 1720 (PUP and PMNH).

Conservation status, threats and recommendations

The underground rhizome of this species has been used for medicinal purposes. The main threat to this plant is its' over exploitation. Its' over exploitation as a high value medicinal plant must be stopped to insure its conservation. More than 70% of the population has been decreased due to its commercial utilization and market value therefore; it is falling under the category A (a, c and d) of the endangered species.

Family: Dioscoreaceae
Scientific name: *Dioscorea deltoidea* Wall. ex Kunth.
Vernacular name: Ratalu/kanees
Voucher specimen: Mankial (Bhadai-III)
35° 19' N and 72° 38' E, 1894 m
Asad and Rashid 526 and 1420 (PUP and PMNH).

Conservation status, threats and recommendations

This plant is an indicator of moist temperate forest collected at an altitude of 1894 m. The main threat is over exploitation due to its high medicinal value of tubers and deforestation. The over exploitation must be stopped and deforestation must be banned to control its further population loss. The population has been decreased up to 80%. It is falling under the category A (a, c and d) of the endangered species.

Family: Orchidaceae
 Scientific name: *Dactylorhiza hatagirea* (D. Don) Soo.
 Vernacular name: Sala
 Voucher specimen: Mankial (Jabba-I)
 35° 17' N and 72° 40' E, 2563 m
 Asad and Rashid 446 (PUP and PMNH).

Conservation status, threats and recommendations

This species was collected from very few localities in the valley at an altitude of 3563 m. The main threats are over grazing and habitat loss. Over grazing must be banned to control habitat loss. The population has been decreased by more than 70% and decline in area of occupancy has also occurred. It is falling under the category A (a and c) of the endangered species.

Family: Adoxaceae
 Scientific name: *Sambucus wightiana* Wall. ex Wight & Am.
 Vernacular name: Mushkiara
 Voucher specimen: Mankial (Bhadai-II)
 35° 19' N and 72° 38' E, 1890 m
 Asad and Rashid 6 (PUP and PMNH)

Conservation status, threats and recommendations

This species has been distributed in the valleys beds and collected at an altitude of 1890 m. The main threats are its use as over exploitation, fodder species, over grazing and gradual habitat loss. The over exploitation must be stopped, over grazing and use as a fodder must be banned and habitat loss must be controlled. The decline in area of occupancy has occurred and 50% of population loss has occurred. It is falling under the category A (a, c and d) of the vulnerable species.

Family: Adoxaceae
 Scientific name: *Viburnum cotinifolium* D. Don
 Vernacular name: Guch
 Voucher specimen: Mankial (Mankial village)
 35° 19' N and 72° 37' E, 1764 m
 Asad and Rashid 340 (PUP and PMNH)

Conservation status, threats and recommendations

The fruits of this species are edible and it is also used as fodder and fuel wood. The main threats are its use as fodder and fuel wood. Its' use must be banned to reduce further decrease of its population. Distributed in the valley bottom and mountains slopes and collected from an altitude of 1764 m. The population has decreased by more than 75% and it is falling under the category A (a and c) of the endangered species.

Family: Amaranthaceae
 Scientific name: *Chenopodium foliosum* Asch.
 Vernacular name: Angooray
 Voucher specimen: Mankial (Bhadai-III)
 35° 19' N and 72° 38' E, 1894 m
 Asad and Rashid 741 (PUP and PMNH).

Conservation status, threats and recommendations

This species has been collected at an altitude of 1894 m from very few localities and the decrease in population has been occurred. The main threats are deforestation, habitat loss and over grazing. The deforestation and over grazing must be banned to overcome the habitat loss. About 80% of the population has been decreased. It is falling under the category A (a and c) of the endangered species.

Family: Apiaceae
 Scientific name: *Bupleurum nigrescens* E. Nasir
 Vernacular name: Not known
 Voucher specimen: Mankial (Ghund Patai)
 35° 19' N and 72° 37' E, 1766 m
 Asad and Rashid 559 (PUP and PMNH).

Conservation status, threats and recommendations

This species has been collected from an altitude of 1766 m and it has been observed that the population has been reduced by more than 60%. The main threats are over grazing, habitat loss and deforestation. The deforestation and over grazing must be banned. It is falling under the category A (a and c) of the vulnerable species.

Family: Apiaceae
 Scientific name: *Ligusticum stewartii* (Hiroe) E. Nasir
 Vernacular name: Not known
 Voucher specimen: Mankial (Bhadai-II)
 35° 19' N and 72° 38' E, 1890 m
 Asad and Rashid 688 (PUP and PMNH).

Conservation status, threats and recommendations

This species is endemic to Swat and found in the valley from 1800 to 3000 m having a narrow geographic distribution due to its endemism. The main threats are over grazing, deforestation and habitat loss. The deforestation and over grazing must be banned to control the habitat loss. It is observed that about 85% of the population has been lost. It is falling under the category A (a, c and d) of the critically endangered species.

Family: Asteraceae
 Scientific name: *Achillea millefolium* L.

Vernacular name: Jasifa/Jarai
 Voucher specimen: Mankial (Serai-III)
 35° 21' N and 72° 40' E, 2400 m
 Asad and Rashid 661 (PUP and PMNH)

Conservation status, threats and recommendations

It is a very important medicinal and honey bee species. The main threat is its' over exploitation as a high value medicinal plant. Its collection and over exploitation must be banned. It has been observed that more than 60% of population has been reduced and decline in area of occupancy has been occurred. It is falling under the category A (a, c and d) of the vulnerable species.

Family: Asteraceae
 Scientific name: *Saussurea albescens* (DC.) Sch.
 Vernacular name: Azghakay
 Voucher specimen: Mankial (Kafar Banda)
 35° 18' N and 72° 39' E, 2835 m
 Asad and Rashid 488 (PUP and PMNH).

Conservation status, threats and recommendations

It is distributed in the valley at higher altitudes and collected at an altitude of 2835 m. It has been observed that 75% of the population of this species has been decreased. The main threats are over grazing, deforestation and habitat loss. Deforestation and over grazing must be banned to control the habitat loss. It is falling under the category A (a, c and d) of the endangered species.

Family: Berberidaceae
 Scientific name: *Berberis lycium* Royle
 Vernacular name: Zairlargay/korai
 Voucher specimen: Mankial (Bhadai Patti-II)
 35° 20' N and 72° 38' E, 2054 m
 Asad and Rashid 1825 (PUP and PMNH).

Conservation status, threats and recommendations

It is distributed scarcely in this Valley and the rhizome has a great medicinal value. It has been observed that more than 80% of the population has been decreased. The main threat is its' over exploitation as a medicinal plant, grazing, use as fuel wood, habitat loss and deforestation. Its' over exploitation must be controlled, its use as a fuel wood and grazing species must be banned. It is falling under the category A (a, c and d) of the endangered species.

Family: Berberidaceae
 Scientific name: *Podophyllum hexandrum* Royle.

Vernacular name: Kakora
 Voucher specimen: Mankial (Kafar Banda)
 35° 18' N and 72° 39' E, 2835 m
 Asad and Rashid 1873 (PUP and PMNH)

Conservation status, threats and recommendations

It is found in the Valley under the canopy of thick forest, collected at an altitude of 2835 m and the rhizome is highly medicinal. Due to its medicinal value, 85% of population has been decreased and now it is available from very few localities in the Valley. The main threat is over exploitation as a high value medicinal plant. Its' over exploitation must be banned. It is falling under the category A (a and c) of the endangered species.

Family: Betulaceae
 Scientific name: *Betula utilis* D. Don
 Vernacular name: Birich
 Voucher specimen: Mankial (Char Banda)
 35° 18' N and 72° 41' E, 3200 m
 Asad and Rashid 1680 (PUP and PMNH)

Conservation status, threats and recommendations

It is found at the tree line in higher altitude and collected from 3200 m. The main threats are its usage as fuel wood at higher altitude and the bark is used as paper for spiritual curing. This plant is seen at very few places and the population size is reduced by 95%. Its use as fuel wood and paper bark species must be banned. It is falling under the category A (a, c and d) of the critically endangered species.

Family: Caprifoliaceae
 Scientific name: *Valeriana jatamansi* Jones
 Vernacular name: Mushke bala
 Voucher specimen: Mankial (Serai-II)
 35° 21' N and 72° 41' E, 2620 m
 Asad and Rashid 1466 (PUP and PMNH).

Conservation status, threats and recommendations

It is distributed in the fertile beds of the forests and collected at an altitude of 2620 m in the Valley. The main threats are unsustainable collection and over exploitation as a medicinal species. The population has been reduced by 65% and decline in area of occupancy has occurred. Its collection and over exploitation must be banned. It is falling under the category A (a and c) of the vulnerable species.

Family: Elaeagnaceae
 Scientific name: *Elaeagnus umbellata* Thunb.

Vernacular name: Ghanumranga
 Voucher specimen: Mankial (Ghund Patti)
 35° 19' N and 72° 37' E, 1766 m
 Asad and Rashid 46 (PUP and PMNH).

Conservation status, threats and recommendations

It is found in the valley at lower altitude, found at only three localities in the valley and collected at an altitude of 1766 m. The main threats are its over exploitation as a medicinal species, fuel wood and fodder. The population has been reduced by 97% in the valley. Its' over exploitation as a medicinal species, fuel wood and fodder must be banned. It is falling under the category A (a, c and d) of the critically endangered species.

Family: Euphorbiaceae
 Scientific name: *Euphorbia wallichii* Hook.
 Vernacular name: Mandano
 Voucher specimen: Mankial (Kamar Khwa Banda-I)
 35° 22' N and 72° 46' E, 3088 m
 Asad and Rashid 1038 (PUP and PMNH).

Conservation status, threats and recommendations

It is found sporadically in the Valley at higher altitude and collected from 3088 m. The main threats are its' over exploitation, habitat loss and deforestation. The deforestation and its over exploitation must be banned to control the habitat loss. The population size has been considerably reduced by more than 60%. It is falling under the category A (a and c) of the endangered species.

Family: Fabaceae
 Scientific name: *Astragalus candolleanus* Royle ex Benth.
 Vernacular name: Ghorjakay
 Voucher specimen: Mankial (Bhadai-III)
 35° 20' N and 72° 38' E, 2058 m
 Asad and Rashid 1845 (PUP and PMNH).

Conservation status, threats and recommendations

It is found in the Valley at lower altitude, found at only four localities in the valley and collected at an altitude of 2058 m. The main threats are over exploitation, habitat loss and over grazing. Its collection must be banned, over grazing must be banned to control habitat loss. The population has been reduced by 90% and the area of occupancy is also reduced considerably. It is falling under the category A (a, c and d) of the critically endangered species locally in the valley.

Family: Fabaceae

Scientific name: *Indigofera heterantha* Wall. ex Brandis
 Vernacular name: Ghoreja
 Voucher specimen: Mankial (Mehnain-II)
 35° 19' N and 72° 38' E, 1764 m
 Asad and Rashid 874 (PUP and PMNH).

Conservation status, threats and recommendations

This species is endemic to Pakistan and distributed in the Valley at lower altitude and collected from 1764 m. The main threats are over exploitation, fodder value and extensive usage as fuel wood. Its collection and usage must be banned. The population size has been considerably reduced by more than 85%. It is falling under the category A (a, c and d) of the endangered species.

Family: Geraniaceae
 Scientific name: *Geranium wallichianum* D. Don ex Sweet
 Vernacular name: Sra zeela
 Voucher specimen: Mankial (Bhadai Patti-III)
 35° 20' N and 72° 38' E, 2058 m
 Asad and Rashid 766 (PUP and PMNH).

Conservation status, threats and recommendations

A high value medicinal plant distributed scarcely in the Valley and collected from an altitude of 2058 m. The population has been reduced by more than 75%. The main threats are its' over exploitation and unsustainable collection of the rhizome. Its' over exploitation and unsustainable collection must be banned. It is falling under the category A (a and c) of the endangered species.

Family: Hamamelidaceae
 Scientific name: *Parrotiopsis jacquemontiana* (Dcne.) Rehder
 Vernacular name: Pastaoonay
 Voucher specimen: Mankial (Mehnain-I) 35° 19' N and 72° 37' E, 1764 m
 Asad and Rashid 1874 (PUP and PMNH).

Conservation status, threats and recommendations

It is distributed at lower altitude along the river banks of north facing slope collected at an altitude of 1764 m. The main threats are its use as fodder and fuel wood species. Its use must be banned. The population has been reduced by more than 80% in the Valley due to over exploitation. It is falling under the category A (a and c) of the endangered species.

Family: Juglandaceae
 Scientific name: *Juglans regia* L.

Vernacular name: Ghuzz
 Voucher specimen: Mankial (Bhadai-I)
 35° 19' N and 72° 38' E, 1886 m
 Asad and Rashid 2270 (PUP and PMNH)

Conservation status, threats and recommendations

This is sporadically distributed in the Valley and collected at an altitude of 1886 m. The main threats are its use for making furniture and the bark is used locally used as "Dandasa". Its use for making furniture must be banned. It has been observed that more than 60% population has been reduced. It is falling under the category A (a and c) of the vulnerable species.

Family: Lamiaceae
 Scientific name: *Thymus linearis* Benth.
 Vernacular name: Speerkay
 Voucher specimen: Mankial (Serai-II)
 35° 21' N and 72° 41' E, 2620 m
 Asad and Rashid 810 (PUP and PMNH).

Conservation status, threats and recommendations

A high value medicinal and aromatic herb collected in the valley at 2620 m altitude. The main threat is its over exploitation as a high value medicinal herb. Its' over exploitation must be banned. The population has been decreased considerably up to more than 80%. It is falling under the category A (a and c) of the vulnerable species.

Family: Papaveraceae
 Scientific name: *Corydalis diphylla* Wall.
 Vernacular name: Bhutkis
 Voucher specimen: Mankial (Mankial village)
 35° 19' N and 72° 36' E, 1764 m
 Asad and Rashid 353 (PUP and PMNH).

Conservation status, threats and recommendations

It is distributed at very few localities in the valley and collected at an altitude of 1764 m. The main threats are over exploitation as a medicinal plant, over grazing and habitat loss in the valley. Its' over exploitation must be banned and the over grazing must be banned to control the habitat loss. The population has been reduced up to more than 80%. It is falling under the category A (a and c) of the endangered species.

Family: Paeoniaceae
 Scientific name: *Paeonia emodi* Wall. ex Royle
 Vernacular name: Mamekh
 Voucher specimen: Mankial (Kakora)
 35° 17' N and 72° 40' E, 3035 m

Asad and Rashid 1072 (PUP and PMNH).

Conservation status, threats and recommendations

A high value medicinal plant present at only 8 localities in the valley collected at an altitude of 3035 m on north facing slope. The main threats are its unsustainable collection and over exploitation. Its unsustainable collection and over exploitation must be banned. More than 80% population and area of occupancy has been reduced. It is falling under the category A (a, c and d) of the critically endangered species.

Family: Plantaginaceae
 Scientific name: *Plantago depressa* Willd.
 Vernacular name: Isphaghool
 Voucher specimen: Mankial (Jabba)
 35° 17' N and 72° 40' E, 2563 m
 Asad and Rashid 240 (PUP and PMNH).

Conservation status, threats and recommendations

This plant is distributed at the open places in the valley especially at south facing slope and collected from 2563 m altitude. The main threats are over grazing, over exploitation and habitat loss. Its' over exploitation must be banned and deforestation must be stopped to control the habitat loss. The population has been decreased by more than 60%. It is falling under the category A (a and c) of the vulnerable species.

Family: Plantaginaceae
 Scientific name: *Plantago lanceolata* L.
 Vernacular name: Warokay isphaghool
 Voucher specimen: Mankial (Ghund Patai)
 35° 19' N and 72° 37' E, 1766 m
 Asad and Rashid 58 (PUP and PMNH).

Conservation status, threats and recommendations

It is found at lower altitude in the valley, collected at 1766 m. Found on south facing slopes at open places. The main threats are its' over exploitation, fodder value and habitat loss. Its' over exploitation and use must be banned; measures should be taken to minimize habitat loss. More than 55% of population has been decreased. It is falling under the category A (a and c) of the vulnerable species.

Family: Plantaginaceae
 Scientific name: *Plantago major* Willd.
 Vernacular name: Ghat isphaghool
 Voucher specimen: Mankial (Mehnain-I)
 35° 19' N and 72° 37' E, 1764 m

Asad and Rashid 175 (PUP and PMNH).

Conservation status, threats and recommendations

It is collected from lower altitude at 1764 m and found at open places on south facing slope. The main threat is its' over exploitation as high value medicinal and fodder value. Its' over exploitation must be banned. More than 70% of the population has been reduced. It is falling under the category A (a and c) of the vulnerable species.

Family: Polygonaceae

Scientific name: *Bistorta amplexicaulis* (D. Don) Green

Vernacular name: Masloon

Voucher specimen: Mankial (Baik-II)

35° 21' N and 72° 39' E, 2606 m

Asad and Rashid 787 (PUP and PMNH).

Conservation status, threats and recommendations

This plant is distributed in the valley at few localities and collected at an altitude of 2606 m. The main threats are its' over exploitation, over grazing and habitat loss. Its' over exploitation must be banned and the over grazing must be controlled to overcome the habitat loss. More than 60% population has been reduced. It is falling under the category A (a and c) of the endangered species.

Family: Ranunculaceae

Scientific name: *Aconitum heterophyllum* Wall. ex Royle

Vernacular name: Sarbawalay

Voucher specimen: Mankial (Chokial Banda-II)

35° 22' N and 72° 40' E, 3275 m

Asad and Rashid 189 (PUP and PMNH).

Conservation status, threats and recommendations

A very popular medicinal plant, collected at 3275 m, the rhizome is extensively collected for various medicinal purposes. The main threats are its unsustainable utilization and over exploitation. To conserve this species, the unsustainable utilization and over exploitation must be banned. The population has been reduced by more than 85% in the valley. It is falling under the category A (a, c and d) of the critically endangered species.

Family: Ranunculaceae

Scientific name: *Caltha alba* Camb.

Vernacular name: Baringu

Voucher specimen: Mankial (Gaidar Jabba-III)

35° 18' N and 72° 40' E, 2820 m

Asad and Rashid 64 (PUP and PMNH).

Conservation status, threats and recommendations

Distributed at higher altitude and collected from 2820 m. The main threats are its over exploitation as a medicinal plant and habitat loss. The over exploitation must be banned and habitat loss must be controlled. The population is reduced by 65% in the valley. It is falling under the category A (a and c) of the vulnerable species.

Family: Rhamnaceae

Scientific name: *Ziziphus jujuba* Mill.

Vernacular name: Markhanaray

Voucher specimen: Mankial (Mankial bazar)

35° 19' N and 72° 36' E, 1764 m

Asad and Rashid 789 (PUP and PMNH).

Conservation status, threats and recommendations

This plant is collected from only form one locality Mankial Bazar at 1764 m. The main threats are over exploitation as a medicinal species and fuel wood. Its' over exploitation as medicinal and fuel wood species must be banned. About 98% population has been eliminated due to its medicinal, fodder and fuel wood use. It is falling under the category A (a, c and d) of the critically endangered species.

Family: Rosaceae

Scientific name: *Cotoneaster affinis* (Lindl) Schneider

Vernacular name: Mamanra

Voucher specimen: Mankial (Nara-II)

35° 22' N and 72° 40' E, 2768 m

Asad and Rashid 557 (PUP and PMNH).

Conservation status, threats and recommendations

It is collected from only 4 localities in the valley at 2768 m; it is observed that 90% population has been decreased and the area of occupancy has been shrunk. The main threats are its exploitation as a medicinal and fuel wood species. Its' over exploitation as medicinal and fuel wood species must be banned. It is falling under the category A (a, c and d) of the critically endangered species.

Family: Rosaceae

Scientific name: *Crataegus songarica* C. Koch

Vernacular name: Gony

Voucher specimen: Mankial (Tapra)

35° 20' N and 72° 41' E, 2060 m

Asad and Rashid 562 (PUP and PMNH).

Conservation status, threats and recommendations

It is collected from only two localities in the entire valley

at 2060 m; the main threats includes its over exploitation as a highly medicinal plant, fuel wood and fodder species. The over exploitation as a medicinal, fuel wood and fodder species must be banned. The population has been reduced by 98% and the area of occupancy has considerably decreased. It is falling under the category A (a, c and d) of the critically endangered species.

Family: Salicaceae
 Scientific name: *Pouplus alba* L.
 Vernacular name: Speerdad
 Voucher specimen: Mankial (Bhadai-II)
 35° 19' N and 72° 38' E, 1890 m
 Asad and Rashid 1845 (PUP and PMNH).

Conservation status, threats and recommendations

It is collected from only one locality in Bhadai at 1890 m. The main threats are its over exploitation as medicinal, fuel wood and fodder value. Its' over exploitation must be banned. The area of occupancy has decreased and the population has been reduced by 98% in the valley. It is falling under the category A (a, c and d) of the critically endangered species.

Family: Sapindaceae
 Scientific name: *Acer caesium* Wall. ex Brandis
 Vernacular name: Chinaray
 Voucher specimen: Mankial (Kafar Banda)
 35° 18' N and 72° 39' E, 2835 m
 Asad and Rashid 732 (PUP and PMNH)

Conservation status, threats and recommendations

It is only found at 2 localities on north facing slope and collected at an altitude of 2835 m. The main threats are its over exploitation as medicinal, fodder and fuel wood species. The over exploitation must be banned. The population has been decreased by 97% and the area of occupancy is considerably decreased. It is falling under the category A (a, c and d) of the critically endangered species.

Family: Sapindaceae
 Scientific name: *Aesculus indica* (Wall. ex Camb.) Hook.
 Vernacular name: Binkhor
 Voucher specimen: Mankial (Jabba-I)
 35° 17' N and 72° 40' E, 2563 m
 Asad and Rashid 340 and 540 (PUP and PMNH).

Conservation status, threats and recommendations

The species has been reported from only six localities in the valley and collected from 2563 m. The main threats

are over exploitation, fodder and fuel wood species. The over exploitation as a medicinal, fodder and fuel wood species must be banned. The area of occupancy is decreased and the population has been reduced up to 95% in the valley. It is falling under the category A (a, c and d) of the critically endangered species.

Family: Saxifragaceae
 Scientific name: *Bergenia ciliata* (Haw.) Sternb.
 Vernacular name: Zakhame Hayat
 Voucher specimen: Mankial (Serai-II)
 35° 21' N and 72° 41' E, 2620 m
 Asad and Rashid 581 (PUP and PMNH).

Conservation status, threats and recommendations

It is collected at 2620 m from the valley and it is distributed on moist rocky habitat. The main threats are its over exploitation as a medicinal species and habitat loss. The over exploitation must be banned and habitat loss must be controlled. The population has been decreased by 60%. It is falling under the category A (a and c) of the vulnerable species.

Family: Solanaceae
 Scientific name: *Solanum nigrum* L.
 Vernacular name: Tambako
 Voucher specimen: Mankial (Gaider Jabba-I)
 35° 18' N and 72° 41' E, 2810 m
 Asad and Rashid 299 (PUP and PMNH).

Conservation status, threats and recommendations

It is collected from the valley at 2810 m altitude. The main threats are over exploitation, unsustainable collection, habitat loss and over grazing. The over exploitation and unsustainable collection must be banned and habitat loss and over grazing must be controlled. The plant is highly medicinal and 80% population has been reduced. It is falling under the category A (a and c) of the endangered species.

Family: Thymeleaceae
 Scientific name: *Daphne mucronata* Royle
 Vernacular name: Leughonay
 Voucher specimen: Mankial (Mehnain-I)
 35° 19' N and 72° 37' E, 1764 m
 Asad and Rashid 1350 (PUP and PMNH).

Conservation status, threats and recommendations

It is collected from 1764 m in the valley. The main threat is over exploitation as medicinal species. The over exploitation must be banned. About 80% of the

population has been decreased in the valley. It is falling under the category A (a and c) of the endangered species.

Family: Violaceae

Scientific name: *Viola biflora* L.

Vernacular name: Benausha

Voucher specimen: Mankial (Serai-IV)

35° 21' N and 72° 40' E, 2405 m

Asad and Rashid 400 (PUP and PMNH).

Conservation status, threats and recommendations

Found in the valley at 2405 m altitude. The main threat is over exploitation as a medicinal species. Its' over exploitation must be banned. About 75% population has been reduced and the area of occupancy is decreased. It is falling under the category A (a and c) of the endangered species.

DISCUSSION

The Mankial valley is naturally gifted with tremendous floral diversity and medicinal plants, therefore, conservation and sustainable utilization of the threatened medicinal flora is mandatory. Certain factors are severely affecting plant natural resources and traditional knowledge associated with them. Haq (2011) carried out conservation studies of 37 critically endangered and endangered species and concluded that 14 species were critically endangered and 23 species are endangered. He opined that over exploitation, loss of habitat, pathogens attack, invasive species and climate change are the main reasons of threatening these species. According to some other workers, extensive grazing, deforestation, forest fragmentation and habitat loss are causing species extinction in the wild. Conservation of threatened medicinal plants in the higher altitude is important because people living in isolated and far flung areas are mainly depended on plants and this may lead to extinction of many medicinally important species. Along with that timber use for mafia, fuel wood, fodder, medicinal uses, cutting, overgrazing, habitat loss and deforestation are the main reasons for elimination of important medicinal plants. The present study was designed to evaluate the threatened medicinal plants in the valley and among the total of 45 species evaluated against IUCN criteria Version 3.1 (2001). It is concluded that 13 (28.88%) species were vulnerable, 21 (46.66%) were endangered and 11 (24.44%) were critically endangered. These studies were based on category A (a to e) as mentioned in Version 3.1 for vulnerable (VU), endangered (EN) and critically threatened (CR) species.

It has been concluded that the main reasons for reduction of population of these important medicinal plants are over exploitation (75.55%), fuel wood

(35.55%), habitat loss (35.55%), grazing (28.88%), fodder (24.44%), deforestation (15.55%), timber (4.44%), bark use (4.44%) and furniture (4.44%). Similarly, the unsustainable utilization of plant natural resources, unscientific agricultural practices and terrace farming; these medicinally important species are turning into threatened flora. The people in the valley are completely dependent upon plants and rely upon plants and plants products for their livelihood and curing different ailments. Conservation of these precious plants and the local knowledge associated with them are extremely important for the future planning, sustainable utilization and exploitation of these species. It is important to carry out concrete steps for the conservation of this natural wealth and to protect the genetic erosion of the threatened medicinal plants growing in the valley. Therefore, proper documentation, training of local inhabitants, controlling over exploitation, overgrazing, habitat loss and deforestation will be helping in conserving these resources. Further, *in-situ* conservation in the wild and *ex-situ* conservation in botanical gardens will help in conserving these threatened medicinal plants. For sustainability of such activities, legislation and monitoring will be of immense importance to conserve the threatened medicinal plants growing in the valley.

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