



RESEARCH PAPER

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Studies on zoopharmacological behaviour of wildlife and ethno-veterinarian practices among traditional communities in the Karakoram Range with a special reference to *Berberis* spp.

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Article published on August 11, 2014

Key words: Berberis, wildlife, zoopharmacology, Karakoram, epigenetics, medicinal plants, critically endangered, CKNP, wild-herbal-clinic.

Abstract

Present study documents distinctive service-beneficiary complex relationship which exists between Berberis and mountain wildlife. The synergized co-evolved epigenetic relationship observed in high mountain areas is reported for the first time. Ethno-veterinarian and zoopharmacological practices from the area have also been discussed. It is a common observation of local communities that when wildlife (especially avian and ungulates) gets physically hurt, they rush towards Berberis and eat berries and/or chew leaves or bark. Various stakeholders including hunters (57.77±5.47%), shepherds (70.74±4.20%) and local population (29.52±4.19%) have either personally observed or believe in Berberis-wildpharma interactive phenomenon. Similarly traditional communities use Berberis spp. to treat various veterinarian ailments including fracture of limbs (42.23±1.73%), back bone injury (10.42±1.04%), external injury (7.76±1.06), internal wounds (22.10±1.27%) and delivery incisions (7.23±1.48%). During present investigations, no observation was recorded regarding utilization of Berberis by herpetofauna and carnivores animals.

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Introduction

Through 'trial and error' human race over centuries has grown inclusive experience and knowledge of zoopharmacology (Rodriguesa *et al.*, 2003) and wildpharma. Standing on the giant shoulders and critical observations, traditional communities are able to recognize plants and their uses for a variety of human and animals' ailments. In case of wildlife, transmission of learning to next generations is not a common phenomenon and therefore, every generation and individual rely on a complex intelligent but supra-instinct-lead behaviour to deal with abnormal situations like accidents, wounds, illness etc. (Chakraborty *et al.*, 2013; Gradé *et al.*, 2009). Dealing with such unusual situations, animals graze specific plants (Gradé *et al.*, 2009). According to Brunfels (1532), the leaves of *Laurus nobilis* are used by pigeons and chickens to cure constipation. Noordhuis (2005) reported that Erasmus observed a toad, who, after he was bitten by a spider, took instantly a leave of plantago. Wildlife is specific in choosing fruit of a plant for their food and welfare (Dersal *et al.*, 1938).

Besides, food-web interplay, animals have been a source of learning for humanity on how to cure several bodily disorders with plants. Shepherds notice that sheep tend to eat dandelion flowers, plantago or burdock leaves when they were weak (Krief, 2012; Asseldonk, 2006). In the foothills of the Himalaya near Mt. Everest the use of the roots of 'chota-chand' as a potent antidote for a snake bite is said to have been learned by observing mongooses feeding on the plant before fighting with cobra (Balick and Cox, 1996). *Berberis lyceum* with active components viz; flavonoids, alkaloids including Berberine, tannins, saponins and triterpenoids has found effective for skin affections and wound healing in animals (Chakraborty *et al.*, 2013; Mittal *et al.*, 2013; Asif *et al.*, 2007).

A growing body of literature in the behavioral, ecological and pharmacological sciences suggests that animals use certain plants for the control of parasite

infection and related illnesses (Cousins *et al.*, 2002). There are evidences of animal self-medication (Engel, 2002; Huffman, 2006, 2003, 1997; Plotkin, 2000; Janzen, 1978; Burritt and Provenza, 2000; Villalba and Provenza, 2001, 2002; Phy and Provenza, 1998; Villalba *et al.*, 2010, 2006; Krief, 2012). However, we have little knowledge about the abilities of animals to self-medicate, and many of the observations are anecdotal and equivocal (Clayton and Wolfe, 1993; Lozano, 1998; Houston *et al.*, 2001). Contrary to the observations of Lozano (1998) recorded here from hunters, shepherds and local mountain communities establish cause and effect to a greater extend that wildlife rely upon *Berberis* and other medicinal plants for certain hurts, injuries and other illnesses.

These unlearned adaptability and accidental behaviour patterns in animals are neither learned nor simple instinct, even beyond Mendelian genetics (Jaenisch and Bird, 2003). Such a phenomenon is discussed in epigenetics domain. In the study area, traditional communities are familiar with several such behaviour of wildlife however it is not yet known to what extent domestic species retain the ability to self-medicate (Engel and Reece, 2002). Mountain wildlife when get sudden hurt, rush to *Berberis* plants for either eating berries, sucking leaves or bark, which is totally uncommon is their daily lives. Such observations reveal that dynamic nature of epigenome is more responsive to environmental stimuli (Aguilera *et al.*, 2010; Foley *et al.*, 2009; Skinner, 2011).

The growing problem of antibiotic and anthelmintic resistance is an increasingly serious problem in human health care and livestock husbandry. The study of animal self-medication, zoopharmacological practices and ethno medicinal experiences of traditional communities may provide important leads to future sources of medicine (Ansari *et al.*, 2013; Katiyar *et al.*, 2012; Brander, 1931; Riesenber, 1948; Huffman, 2003). Study is reported for the first time about unique pharmacological interaction of wildlife (avifauna and mountain wild angulates) with *Berberis*

which is a multi-potent medicinal plant. Moreover it helps to understand epigenetic behaviour of wildlife which is important from conservational perspective.

Present study was aimed at documentation of exceptionally idiosyncratic service-beneficiary complex epigenetic relationship which exists between *Berberis* and mountain wildlife. Such an exceptionally synergized co-evolved relationship and zoopharmacological practices of traditional communities from high mountainous region of Karakorum Range is reported for the first time.

Material and methods

Study area

Study was carried out in the North-Western part of CKNP which is the largest Protected Area in Pakistan (Fig. 1). It stretches over an area of 10,000 km² along the Karakoram mountain ranges and extends from 35°N to 36.5°N Latitude and from 74°E to 77°E Longitude. Park holds world's greatest glacial mass outside poles and harbors complex floro-faunal diversity. Anthro-po-climatic changes have lead species to greater vulnerability even critical endangered including *Berberis* ssp. (Hussain *et al.*, 2012; Alam and Ali, 2010; WWF Pakistan, 2009). Study area represents 21% (20.99%) of the total population.



Fig. 1. Map of study area within Central Karakoram National Park (constructed using ArcMap 10.1).

Sample frame and size

Sample frame consists upon 27 buffer zone villages grouped into three major valleys of CKNP viz; Bagrot, Rahimabad-Goro and Rakaposhi. Using a standard sampling formula (Research, 2014), a sample size of

381 was drawn from a sample frame of 52045 (GoP, 2014).

$$ss = Z^2 \times (p) \times (1-p) / c^2$$

Where: **ss** = sample size; **p** = percentage picking a choice, expressed as decimal (0.5 used for sample size needed); **c** = confidence interval, expressed as decimal (e.g., 0.04=±4). Population was categorized into three age brackets i.e. below 30, in between 31 and 60, above 60. In each age bracket, gender balance was ensured.

Data collection and statistical analysis

A random sample field survey was conducted during 2011-2013. Data was collected using structured instrument from various age groups and a semi structured interview was conducted from hunters, shepherds and concerned personal from local conservation organizations. Statistical Package for the Social Sciences (SPSS ver. 16.0) and Microsoft Excel 2010 for analysis of data gathered.

Results and discussion

Plant-animal interaction

Berberis pseudumbellata subsp. *gilgitica* and *Berberis pseudumbellata* subsp. *pseudumbellata* are found in the area (Khan *et al.* 2014a). *Berberis pseudumbellata* subsp. *gilgitica* is an endemic plant of Gilgit-Baltistan which has become critically endangered (Alam and Ali, 2010). In the study area *Berberis* plants grow in river beds to as high as 3,000 m (~10,000 ft.) above sea level. Wildlife except house sparrow, lives above 2000 m (6600 ft.) in summer (May-September) and steps down around 1500 m (~5000 ft.) in winter (October-April). During summer and winter, catchment area of wildlife living and presence of *Berberis* continuously overlap each other. Local mountain communities in general and hunters and shepherds in particular observe unique events of *Berberis*-wildlife interactions infrequently.

Personal observation and believe matrix show that 57.77% hunters, 70.74% shepherds and 29.52% local population firmly stand with the opinion that wildlife

has a close epigenetic interaction and relationship with *Berberis* for pharmacological needs particularly when they get any hurt (table 1). Moreover, 41.85% (SD±17.81) of total respondents agree that wildlife are

able to identify and recognize their natural medicine for certain injury or illness (Grandint and Deesing, 2007; Ho and Tang, 2007; Tang and Ho, 2007).

Table 1. Berberis-wildlife interaction percentages (a community perspective).

Categories	Hunters (%)	Shepherds (%)	Local Population (%)
Observed personally	36.51	58.23	17.11
Believe to happen	79.03	83.24	41.92
Mean	57.77	70.74	29.52
SE	5.47	4.20	4.19

Berberis is one of the most pharmacologically interacted medicinal plants for various ailments. When wildlife gets physical hurts, it rushes towards Berberis plants and eat berries, chew leaves or bark. Berberis species at higher altitudes (1400 m and above) seem to serve as ‘Wild-herbal-clinic’ (term “Wild-herbal-clinic” has been first time used by the first author of this paper; Tika Khan, Khan *et al.*, 2014b).

Epigenetic behavior of avian and ungulates

Respondents believe that mountain wildlife, both avifauna viz; 57.84% Chukor (*Alectoris chukar*),

72.17% House Sparrow (*Passer domesticus*), 33.31% Ram Chakor-Himalayan Snow Cock (*Ttragalus himalayensis*) and angulates viz; 25.39% Himalayan Ibex (*Capra ibex sibirica*) and the 33.13% Flare-horned Markhor (*Capra falconeri falconeri*) are differentially (Fig. 2) interact with Berberis species for their medicinal needs. Flare-horned Markhor is a subspecies of the endangered Markhor (IUCN, 2013). Taxonomic information about wildlife was collected from Ghulam Mustafa, ex-wildlife conservation expert, IUCN Gilgit (personal communication).

Table 2. Traditional use of Berberis for veterinary Pharmacognosy by local population (data obtained from surveys conducted during present studies).

Animal	Fracture		Injury		
	Limbs	Back bone	External	Internal	Delivery
Sheep	93.67	37.04	18.24	34.98	22.32
Goat	82.73	11.43	8.95	27.77	16.85
Donkey	13.65	3.68	2.54	12.32	0.00
Horse	11.17	2.62	4.33	17.55	0.00
Cow	35.64	5.44	7.81	21.87	4.22
Ox	16.52	2.33	4.68	18.1	-
Minimum	11.17	2.33	2.54	12.32	0.00
Maximum	93.63	37.04	18.24	34.98	22.32
Mean	42.23	10.42	7.76	22.10	7.23
Std. Error	1.73	1.04	1.06	1.27	1.40

Utilization of folk wisdom for treatment of domesticated animals

Present research reveals that mountain communities use Berberis spp for treatments of various diseases in sheep, goat, donkey, horse, cow and ox (table 2). Traditionally it is used for bone healing of limbs

(93.67%), other bone fracture and injury (90.91%), other internal injuries (85.53%), external injuries (73.33%), delivery of sheep (38.12%), goat (17.36%) and cow (19.87%). It was observed during present research that for delivery related treatment in horse and donkeys, use of Berberis is not practiced.

Similarly no such observation (utilization of Berberis spp) was recorded with respect to herpetofauna and carnivores. During such ailments, traditionally people either use to feed domesticated animals with Berberis or if animals are unable to reach Berberis, they bring Berberis cuttings/fodder to home. In most cases they collect roots of Berberis spp. from a drier place and boil with water for half an hour and use decoction twice a day (2 tea spoons morning and 2 at evening) for almost 7-14 days regularly.

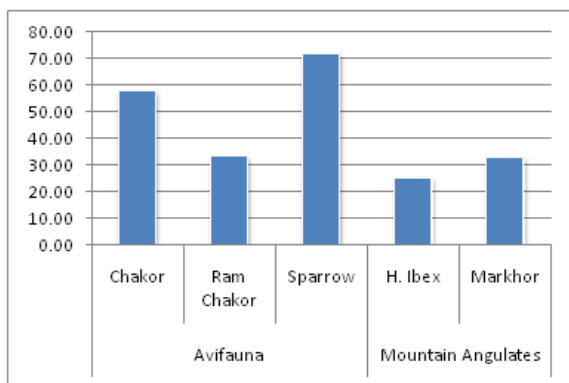


Fig. 2. Interactive data of Berberis-Wildlife (based on survey conducted during present research).

Based on the reports, we are convinced that wildlife are pre-programmed, epigenetically dictated and directed for certain ways, means and tools to use Berberis when faced any challenge of hurt. Further detailed integrated comprehensive research shall prove or disprove that this kind of expression are not individuals specific but are common to all individuals in a population. From this we draw certain results that this kind of specific expression, behaviour and phenomenon are not completely irrelevant to DNA mechanisms nor completely controlled by the DNA. Wildlife with such expressions from rest of the world has not been reported.

Acknowledgement and Conflict of interest

Authors have no conflict of interest. Research is part of PhD study generously funded by the EvK2CNR through its SEED project in collaboration of Karakoram International University.

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