Zoopharmacognosy and epigenetic behavior of mountain wildlife towards Berberis species

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Abstract *Berberis*, a member of family Berberidaceae serves as 'wildlife-clinic' in nature. *Berberis pseudumbellata* subsp. *gilgitica* is endemic to the area and has become critically endangered. For the first time research documented unique epigenetic behaviour of different mountain wildlife and zoopharmacological practices of traditional communities from CKNP. When wildlife gets physical hurts, it rushes towards Berberis plants and eat berries, chew leaves or bark, which is found significant ($p<0.001$). Such behaviour is untaught, not learned, and automatic but seems pre-programmed instinctively triggered reflexed. This is observed in avifauna (House Sparrow, Chakor, Ram Chakor) and angulates (Flare horned Markhor, Himalayan Ibex) only. 79.03%, 36.51% hunters (SD±30.02), 83.24%, 58.23% shepherds (SD±17.68) and 41.92%, 17.11% local population (SD±17.54) believe and have personal observations respectively for Berberis-wildpharma interaction. Traditionally it is used zoopharmacologically 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%). No such observation was recorded with respect to herpetofauna and carnivores.
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Introduction

Over thousands of years and generations after generations through 'trial and error' human race has gained 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; Riesenberg, 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 multipotent medicinal plant. Moreover it helps to understand epigenetic behaviour of wildlife which is important from conservational perspective.

Material and Methods

Study area: Study was carried out in the North-Western part of Central Karakorum National Park (CKNP) which is the largest Protected Area in Pakistan (Fig. 1). It stretches over an area of 10,000 km^2 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. Anthropo-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.

Sample frame and size: Sample frame consists upon 27 buffer zone villages grouped into three major valleys of CKNP viz; Bagrote, 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).

$\mathbf{ss} = Z^2 x\ (p)x(1-p)/c^2$

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: 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.

Analysis: Statistical Package for the Social Sciences (SPSS ver. 16.0) and Microsoft Excel 2010 for analysis of data gathered. ANOVA was used to test variance and '*p'* value was taken significant at $p<0.05$.

Results and Discussion

Berberis-Wildlife interaction: *Berberis pseudumbellata* subsp. *gilgitica* and *Berberis brandisiana* are found in the area. *Berberis pseudumbellata* subsp. *gilgitica* is endemic to the area and has become critically endangered (Alam and Ali, 2010). 79.03%, 36.51% hunters (SD±30.02), 83.24%, 58.23% shepherds (SD±17.68) and 41.92%, 17.11% local population (SD±17.54) believe and observed respectively that wildlife has close *Berberis*-wildlife pharmacological interaction. Moreover, 41.85% (SD±17.81) of total respondents agree that wildlife are able to identify and recognize medicine for certain injury or illness (Grandint and Deesing, 2007; Ho and Tang, 2007; Tang and Ho, 2007). Berberis is one of the most pharmacologically interacted medicinal plants for various ailments. Berberis species at higher altitudes (1400 m and above) seem to serve as 'herbal clinics for wildlife'. When wildlife gets physical hurts, it rushes towards Berberis plants and eat berries, chew leaves or bark.

Zoopharmacology: Research reveals that mountain communities use Berberis for various treatments of sheep, goat, donkey, horse, cow and ox (Fig. 2 & 3). 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%). No such observation 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.

Wildlife scope: 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. 4) 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).

Based on the reports, we are convinced that wildlife are pre-programmed, dictated and directed for certain ways, means and tools to use Berberis when faced any challenge. 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.

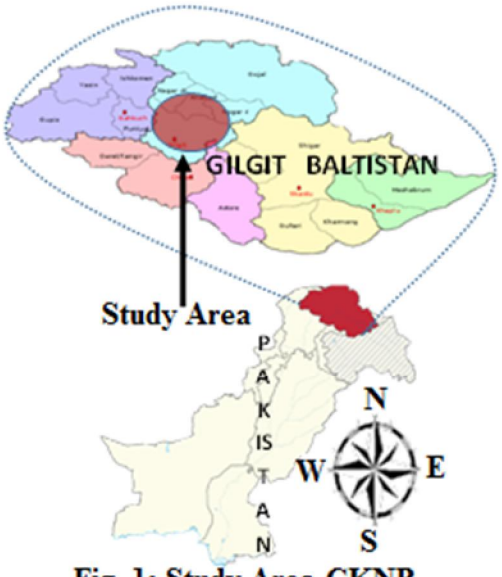
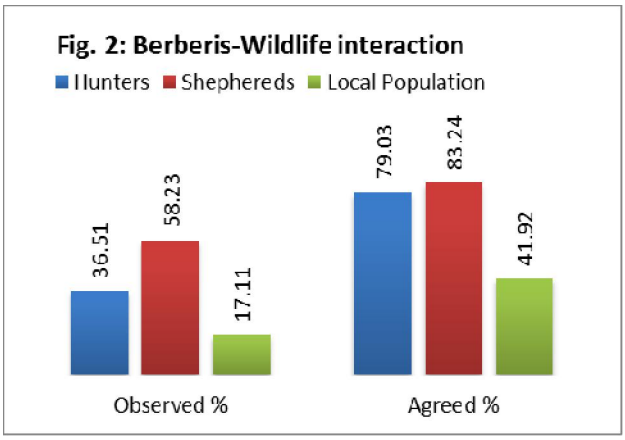
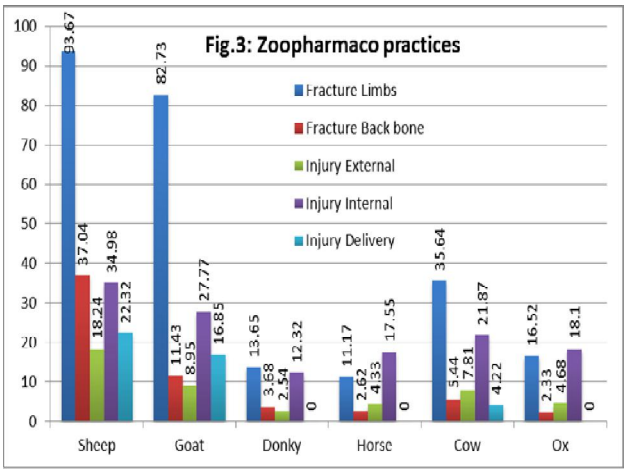
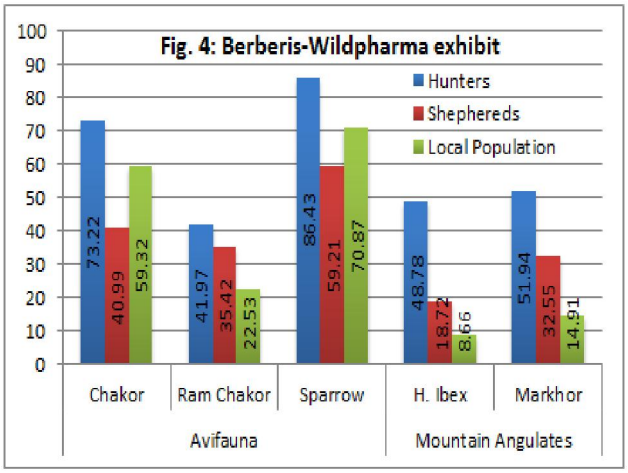


Fig. 1: Study Area-CKNP







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