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Perception and application of zootherapy for the management of cattle diseases occurred in northern laterite region of West Bengal, India

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Abstract. *Mandal SK, Rahaman CH. 2022. Perception and application of zootherapy for the management of cattle diseases occurred in the northern laterite region of West Bengal, India. Asian J Ethnobiol 5: 12-19.* The present study aims to invent the glory of traditional knowledge about zootherapy for livestock diseases in the northern laterite region of West Bengal, India. Semi-structured and open interviews were taken for data collection. Data were analyzed with statistical indices like use mention factor (UM) and use value index (UV). A total of 21 zoological specimens have been recorded. Mammals are the most common species (8) used in this region for livestock health care. In 57% of cases, endo & exoskeletal structures like bone, feather, horn, scale, shell, beak, teeth, etc., are used as ethnoveterinary medicine. Four species have been identified as the most frequently used species in the region *Coracias benghalensis* (Linnaeus, 1758) (UM=16; UV=0.12), *Herpestes javanicus palustris* (Ghose, 1965) (UM=12; UV=0.09), *Varanus bengalensis* (Daudin, 1802) (UM=11; UV=0.08) and *Lamellidens marginalis* (Lamarck, 1819) (UM=11; UV=0.08). Among the recorded species, more than 50% are enlisted in the IUCN Red List. The present study provides baseline information regarding the depth of ethnozoological knowledge and its current status in the studied area. It will further help frame conservation strategies for the medicinally important and threatened animal species.

Keywords: Conservation facets, livestock disease, new observations, quantitative ethnozoology, zootherapy

INTRODUCTION

The uses of animals as alternative therapeutic agents are ancient practices and have been considered an important constituent of traditional medicine (Alves and Souto 2015). In searching for alternative therapeutic resources, studies on ethnozoology contribute a lot worldwide. It also helps in decision-making regarding the exploitation and management of the local fauna. Numbers of wild and domesticated animals, their different body parts, and byproducts have been used as effective ingredients in another system of traditional medicine and Ethnomedicine (Still 2003; Mahawar and Jaroli 2008; Khan 2012). Indigenous tribes reside in different parts of the world with enormous knowledge about edible and medicinal animals (Alves et al. 2007; Lohani 2011; Martinez 2013; Belay 2015; Hussain and Tynsong 2020). For the treatment of veterinary diseases, the use of zootherapy has been chiefly recorded from Brazil (South America) and a few from Nigeria (Africa), Spain, and Italy (Europe) (Antoine-Moussiaux et al. 2007; Barboza et al. 2007; Confessor et al. 2009; Souto et al. 2011a; Souto et al. 2012; Piluzza et al. 2015; González et al. 2016).

Ethnozoological studies in India were first initiated in 1982 with the formation of AICRPE (All India Coordinated Research Project on Ethnobiology). Later on, many ethnobiologist showed interest in documenting the zootherapeutic knowledge of different ethnic groups in India (Jaroli et al. 2010; Chakravorty et al. 2011; Chellappandian et al. 2014; Chaudhury et al. 2016; Pongener et al. 2019).

Most of the ethnoveterinary survey in India focuses on the documentation of medicinal plants, and zootherapy remains neglected except in a few where animal-derived ethnomedicines are also documented along with the plant remedies (Galav et al. 2013; Mandal and Rahaman 2014).

As per our knowledge, from India, no such publication has been made exclusively on zootherapy for livestock diseases. In this context, the present study has been designed to invent the glory of traditional knowledge about zootherapy for livestock diseases practiced in India.

MATERIALS AND METHODS

Data collection

Regular field surveys were conducted from 2014-2018 in 21 blocks of the Birbhum and Burdwan districts which mainly constitute the northern laterite region of West Bengal, one of the culturally enriched states in eastern India (Figure 1).

A total of 132 informants were interviewed for data collection after visiting the remote and tribal-dominated villages. Before collecting the data, Prior Informed Consent (PIC) was taken verbally from each informant as the PIC safeguards the knowledge providers' Intellectual Property Rights (IPR). Then, interviews of the informants were performed with the help of semi-structured and open-ended questionnaires (Martin 1995; Thomas et al. 2007). Information on the animals' local and/or tribal names, their parts used, mode of remedy preparation, administration, etc., was recorded in detail.

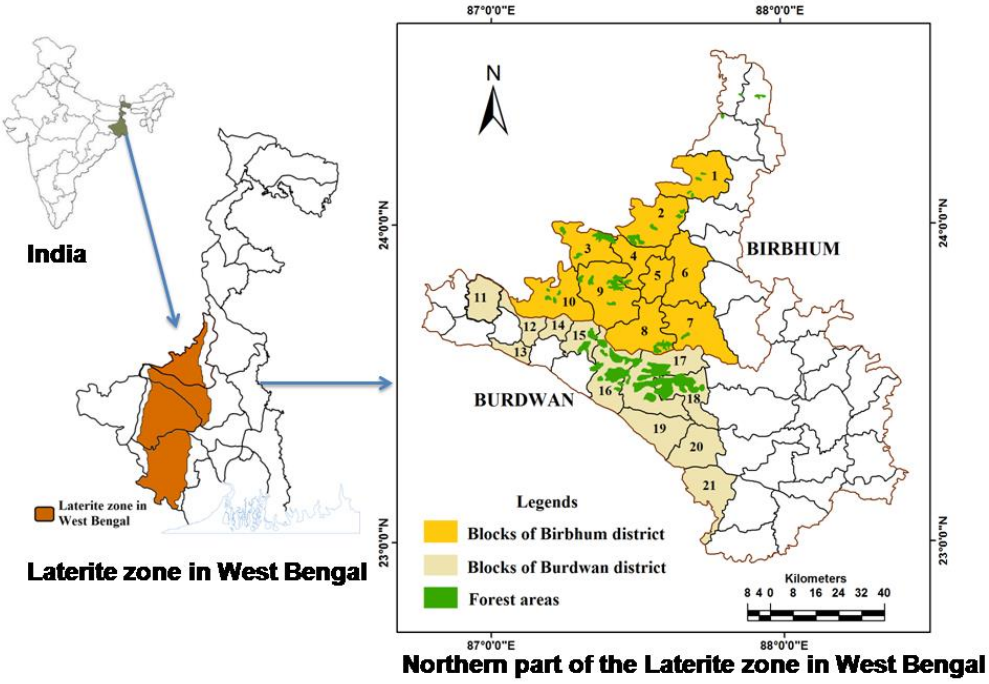

Figure 1. The study area covers 21 blocks of the northern laterite zone (West Bengal, India)

Identification of the zoological specimen

Collected zoological specimens were identified with the help of standard literature and specialists through examination of voucher specimens and photographs of the animal species or their parts taken during interviews (Tikader 1983; Ali 1996; Prater 1996). Whenever necessary, these procedures were supplemented by checking vernacular names provided by the healers against the scientific names.

Data analysis

Qualitative analysis

Recorded information on the local/ tribal name of the animals, updated scientific name and family, their parts used, mode of preparation of the remedies, and administration were tabulated scientifically.

Quantitative analysis

Two suitable statistical indices were employed to quantify the recorded zootherapeutic knowledge regarding their value, reliability, and importance to the ethnic communities in the study area.

Use value (UV). This index is a popular quantitative tool that helps measure a species' usefulness. The formula is -UV= ΣU/n**,** where U is the number of use-reports cited by each informant for a given species and n refers to the total number of informants. Use values are high when there are many useful reports for a species, implying that the animal is important. Conversely, the value approaches zero when there are few reports of uses of a particular species (Phillips et al. 1994).

The use mentions factor (UM). The UM is defined as the number of mentions for one species given by all informants for a specific health condition (Andrade-Cetto and Heinrich 2011).

RESULTS AND DISCUSSION

In the present investigation, 21 zoological specimens have been recorded as ethnoveterinary medicine in West Bengal, India's northern part of the laterite zone. That is the first report from West Bengal in India exclusively on zootherapy employed for livestock disease management. All the recorded species are listed alphabetically, providing their scientific name, common English name, local/tribal name, parts used, disease treated, and status in the International Union for Conservation of Nature (IUCN) Red List (Table 1).

In 21 cases, local people of the study area use recorded species singly or in combination with medicinal herbs as therapeutic agents (Table 2). So, using animal species along with medicinal plants is a good example of combined therapy for livestock diseases (Bullitta et al. 2018). Such knowledge in the studied area highlights the richness of knowledge diversity regarding using local flora and fauna, which may substitute one ingredient with another when certain medicinal resources are unavailable.

Most of the 21 recorded animal species belong to the vertebrate group (17 species). Only four species are of the invertebrate group (Figure 2). Mammals are the most common species (8) used in this region for livestock health care. In some other ethnozoological explorations in India, it has been found that mammals are the most commonly used species (Kakati et al. 2006; Mahawar and Jaroli 2008).

In most cases, it has been found that remedies are applied topically (9 times) in the form of poultice, massage oil, etc. In 5 cases, an oral application has been recorded. Moreover, quite a large number of animals (7 cases) are attached to magico-religious beliefs.

Generally, to prepare animal-based medicine, animal use as a whole, its parts, metabolic byproducts, and sometimes ingredients like building materials of nests, the soil of burrowing animals' holes, etc., are very common (Costa-Neto 2005). Here it has been found that in 57% of cases, endo- & exoskeletal structures like bone, feather, horn, scale, shell, beak, teeth, etc., are used as ethnoveterinary medicine followed by body fat (19%), fecal matter (5%), honey (5%), naval chord (5%) and whole-body (5%) (Figures 3 and 4).

Table 1. Ethnomedicinally import animal species recorded from the laterite region of West Bengal, India (n=21)

Common English name, (local name)	Scientific name of the recorded animal species	Parts used	Disease/illness treated	UM & (UV)	IUCN status
Indian hive bee (*Mou-machhi, Dumur*)	*Apis cerana indica* (Fabricius, 1798)	Honey	Foot and mouth disease (FMD)	4 (0.03)	-
Spotted deer (*Harin, Jil*)	*Axis axis* (Erxleben, 1777)	Horn/ Antlers	Headache	5 (0.04)	LC
Cow (*Garu, Dangra*)	*Bos Taurus indicus* (Linnaeus, 1758)	Fecal matter	Body sore due to poisoning	2 (0.02)	-
Crab (*Behula Kankra, Dhiri Katkom*)	*Cancer pagurus* (Linnaeus, 1758)	Front appendage	Sore between hooves	3 (0.02)	-
Dog (*Kukur, Sita*)	*Canis familiaris* (Linnaeus, 1758)	Skull	Retention of milk due to evil effect	4 (0.03)	LC
Goat (*Chhagol, Merom*)	*Capra hircus* (Linnaeus, 1758)	Fecal matter	Rheumatic pain	3 (0.02)	-
Clown knife fish (*Chital haku*)	*Chitala chitala* (Hamilton, 1822)	Scale	Loosened teeth	2 (0.02)	NT
Blue jay (*Nilkantha*)	*Coracias benghalensis* (Linnaeus, 1758)	Feather	Diarrhoea	16 (0.12)	LC
Short-nosed fruit bat (*Chamchiki, Bhaulo*)	*Cynopterus sphinx* (Vahl, 1797)	Skull & wing bone	Illness due to evil effect	7 (0.05)	LC
Russell's viper (*Chandrabora, Bing*)	*Daboia russelii* (Shaw and Nodder, 1797)	Body fat	Stiffness of shoulder	9 (0.07)	-
Indian green frog (*Jar-Baang, Badhe*)	*Euphlyctis hexadactylus* (Lesson, 1834)	Body fat	Stiffness of vein	9 (0.07)	LC
Vulture (*Shakun, Gidi*)	*Gyps bengalensis* (Gmelin, 1788)	Bone	Fever	6 (0.05)	CR
White-breasted kingfisher (*Machh-ranga, Kikir*)	*Halcyon smyrnensis* (Linnaeus, 1758)	Skull & beak	Breathing trouble	5 (0.04)	LC
Bengal mongoose (*Beji, Chemench*)	*Herpestes javanicus palustris* (Ghose, 1965)	Naval chord	Spleen enlargement	12 (0.09)	LC
Freshwater mussel (*Jhinuk*)	*Lamellidens marginalis* (Lamarck, 1819)	Shell	Fresh wound	11 (0.08)	LC
Turtle (*Kachhop, Kachhim, Hara*)	*Lissemys punctata punctata* (Bonnaterre, 1789)	Shell	To combat evil spirit	4 (0.03)	-
Bear (*Bhaluk, Bana*)	*Melursus ursinus* (Shaw, 1791)	Teeth	Fever	4 (0.03)	VU
Indian earth-worm (*Kencho, Lendet*)	*Metaphire posthuma* (Vaillant, 1868)	Whole body	Fever	5 (0.04)	-
Long-whiskered catfish (*Aar machh*)	*Sperata aor* (Hamilton, 1822)	Parietal bone	Body ache	2 (0.02)	LC
Pig (*Shukar, Shukri*)	*Sus scrofa domesticus* (Erxleben, 1777)	Body fat	Stiffness of shoulder	9 (0.07)	-
Bengal monitor (*Gosap, Sonagoda*)	*Varanus bengalensis* (Daudin, 1802)	Body fat	Rheumatic pain	11 (0.08)	LC

Note: UM & (UV): Use Mention & (Use Value), LC: Least Concern, NT: Near Threatened, VU: Vulnerable, CR: Critically Endangered

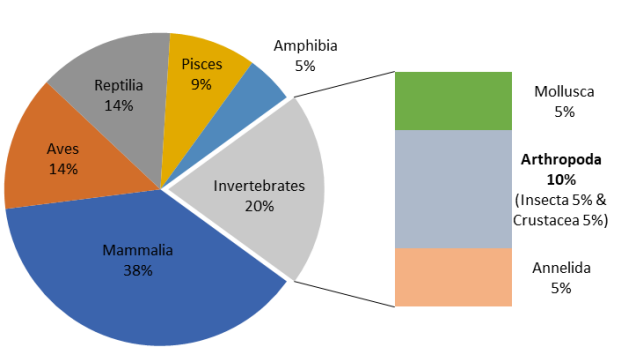

Figure 2. Distribution proportion of the recorded specie in the different animal classes

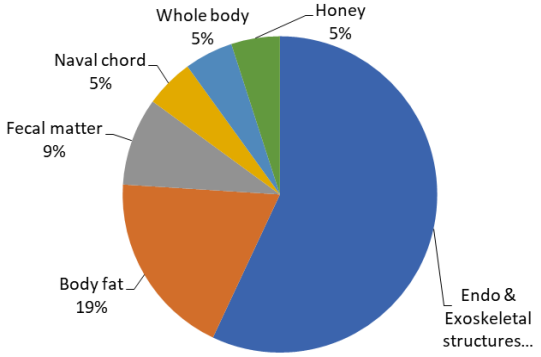

Figure 3. Percentage composition of animal body parts used in zootherapy

Figure 4. The zoological specimen used in/as ethnoveterinary medicine: A. Hunted Blue jay (*Coracias bengalensis*), B. Skull & beak of Kingfisher (*Halcyon smyrnensis*), C. Bone of vulture (*Gyps bengalensis*), D. Skull & wing bone of Fruit bat (*Cynopterus sphinx*), E. Antler of Spotted deer (*Axis axis*), F. Indian green frog (*Euphlyctis hexadactylus*), G. Nail of Fruit bat, H. Parietal bone of Long-whiskered catfish (*Sperata aor*), I. Naval chord of Bengal mongoose (*Herpestes javanicus palustris*), J. Teeth of Bear (*Melursus ursinus*), K. Front appendage of Crab (*Cancer pagurus*), L. Body fat of Bengal monitor (*Varanus bengalensis*), M. Body fat of Pig (*Sus scrofa domesticus*), N. Body fat of Russell's viper (*Daboia russelii*), O. Honey

Moreover, using the body fat of 4 animals like *Euphlyctis hexadactylus* (Lesson, 1834), *Daboia russelii* (Shaw and Nodder, 1797), *Sus scrofa domesticus* (Erxleben, 1777) and *Varanus bengalensis* (Daudin, 1802) were recorded from the study area. Those methods are administered to treat skeleton-muscular disorders such as stiffness of the shoulder, lameness of hind leg, rheumatoid arthritis, and body ache. Here, the fat of the same therapeutic value is derived from four animals, indicating its alternative sources. Thus, therapeutic practices associated with it would not be hampered when any of those four animals are unavailable. Using animal fat for various therapeutic purposes is a very common practice in ethnic communities worldwide (Souto et al. 2011b). The therapeutic use of animal fat for skeleton-muscular disorders has been scientifically proven through several studies for its anti-inflammatory potentiality (Yoganathan et al. 2003; Falodun et al. 2008; Ferreira et al. 2010; Buthelezi et al. 2012; Ferreira et al. 2014). In a recent study, Green-anaconda fat (*Eunectes murinus* Linnaeus, 1758) showed significant anti-inflammatory efficacy (Abrão et al. 2021). So, folk use of body fat of four animal species recorded here for the skeleton-muscular problems is very much justified as most of the disorders related to the skeleton-muscular system of veterinary animals are the pathophysiological manifestations of different inflammatory conditions. Animal fats sourced from the four species need further research for their chemical and biological activity studies.

Foot and mouth disease (FMD) is a contagious viral disease that seriously affects livestock health throughout the country. Here for the treatment of FMD, at least ten years old honey is given along with a medicinal herb *Andrographis paniculata* (Burm.fil.) Nees. The earlier investigations show that both components have antiviral potential (Pongtuluran and Rofaani 2015; Shahzad and Cohrs 2012). In addition, the traditional use of honey in medicine provides extra benefits as it acts as '*Yogavahi*' or helps absorb active molecules in the body system (Singh et al. 2016).

Multiple uses of antlers of deer have already proved their effectiveness. Here in this study, the use of deer antlers in the severe headache of bullock supports the earlier report of using it in case of the dizzy head (Kawtikwar et al. 2010).

There is a long tradition of using the fecal matter of domesticated animals to treat arthritis, which supports the use of cow and black goat fecal matter in treating rheumatoid arthritis or paralyzed leg in the studied area (Hatfield 2004).

Here scale ash of Chital fish is used to treat loosened teeth. The pharmacological relevance of using the fish scale in tissue formation has already been understood after observing the efficacy of gelatin extracted from the fish scale, which enhanced cell adhesion, cell growth, and wound healing (Huang et al. 2018).

For treating cattle fever use of earthworms is a fact now a day. The earthworm is popular in treating fever throughout the world (Cooper et al. 2012; Grdisa 2013). That is because earthworms' antipyretic and anti-inflammatory activity has been scientifically established (Balamurugan et al. 2009). Furthermore, powdered mollusk shells' wound-healing properties have recently been examined (Andrade et al. 2015). So the use of shell ash for treating the wound is very much acceptable.

Some new findings

Uses of two animal species like *E. hexadactylus* and *Sperata aor* (Hamilton, 1822) in ethnoveterinary medicine are exclusively new reports from India as they were not recorded in the earlier literature published so far (Gupta et al. 2003; Kakati et al. 2006; Mahawar and Jaroli 2008; Galav et al. 2013; Pushpangadan et al. 2014).

Colorful feathers of *Coracias bengalensis* (Linnaeus, 1758) were reported earlier for its ornamental uses (Altaf et al. 2017) and body fat as medicine (Pushpangadan et al. 2014). Still, there is no report on its medicinal efficacy against the loose motion of cattle. So this is a new report regarding the use of feathers of *C. bengalensis* in loose motion, which should be pharmacologically validated in the future.

Feathers of kingfisher have been globally used for ornamental purposes (Altaf et al. 2017), but there is no report on its beak and skull bone for breathing trouble of large ruminants.

Magico-religious belief

Indigenous people of the study area strongly believe in the magical power of certain animal species employed for healing certain diseases of their domesticated animals, which are supposed to be caused by the bad effects of some evil spirits. Different parts of the animals are first made sacred by holy chanting and then activate their magical healing power through certain religious rituals. Traditional people, in many cases, believe in the existence of supernatural power and evil spirit. Attachment of 7 out of 21 species (Table 3) with magico-religious cures reflects their strong belief in the magical healing power of the animal parts as found in many other traditional societies worldwide (Moazami 2005; Alves et al. 2012).

Quantitative ethnozoology

To estimate the relative importance of the recorded animal species, the data related to zootherapy are analyzed with the help of statistical indices like use mention factor (UM) and use value index (UV) and provided their value in Table 1.

The value of UM varies from 2 to 16, and UV values range from 0.02 to 0.12. The highest UM value assigned to *C. bengalensis* (UM=16), followed by *Herpestes javanicus palustris* (Ghose, 1965) (UM=12), *Lamellidens marginalis* (Lamarck, 1819) (UM=11) and *V. bengalensis* (UM=11) which indicate their wide acceptance regarding disease curing ability. Animals mentioned maximum numbers of times (UM) obtained greater UV values, reflecting their linear correlation. For example, the informants have mentioned the feathers of C. bengalensis a maximum number of times (UM- 16) for the treatment of cattle diarrhea and thus produce the highest UV score of 0.12 among all the documented taxa. Similarly, for treating body aches, the parietal bone of *S. aor* has been mentioned only

two times (UM=2), and a very minimum UV value has been calculated for that species (UV=0.02). So, all four ethnoveterinary medicinally important animals with higher UV and UM values can be considered promising sources of bioprospection, and an attempt should be prioritized for their conservation.

Table 2. Zootherapeutic remedies used for various ill-health conditions of cattle in the northern laterite region of West Bengal, India

Disease/ illness treated	Mode of remedy preparation and its applications
Foot and mouth disease (FMD)	Dried aerial part of *Andrographis paniculata* is made into a paste with honey (produced by *Apis cerana indica*) and given orally once a day for seven days.
Severe headache of a bullock	Mature root of *Datura stramonium* is made into a paste along with the roots of *Chrysopogon zizanioides* and *Cyperus rotundus* (2:1:1); a small amount of horn dust of spotted deer (*Axis axis*) is added to this preparation and applied as a poultice on the head twice a day for 2-3 days.
Rheumatoid arthritis /Paralyzed leg	• 14-15 pieces of mature leaves of *Calotropis gigantea* are made into a paste and mixed with 5 gm powder of Ammonium chloride ("*Nishadal"*), fecal matter (500 gm) of a heifer (*Bos Taurus indicus*), and the required amount of soil from the mouth of crab-hole. All the ingredients are taken into an earthen pot, heated for a few minutes, and applied to the paralyzed leg twice a day until the cure. • Lukewarm body fat of Bengal monitor (*Varanus bengalensis*) is applied to the affected body parts as a massage
Rheumatic pain	The whole plant of *Cleome gynandra* is made into a paste with common salt and fecal matter of black goat (*Capra hircus*) in a 4:1:2 ratio; applied topically to the affected area once a day for 9-10 days
Loosened teeth	Freshly collected rhizome of *Curcuma longa* is made into a paste and mixed with scale-ash of the "Chital machh" (*Chitala chitala*) and rock salt in a 2:2:1 ratio. The mixture is stirred well in mustard oil and applied at the base of the loosened teeth, wrapped with a piece of cotton, and then a red hot Ion rod is put on it for a few seconds. This practice is done once a day for three successive days
Diarrhoea	A mixture is prepared from the small amount of feather of the "*Nilkantha*" bird (*Coracias bengalensis*), 4-5 pieces of *Abrus precatorius* seeds, and 100 gm of bamboo leaves; given orally once a day for three days.
Stiffness of shoulder	• Body fat of Russell's viper (*Daboia russelii*) is slightly heated and applied to the affected area twice a day till the cure. • Body fat of the pig (*Sus scrofa domesticus*) is melted by slight heating and applied on the shoulder twice a day for at least 5-7 days.
Lameness in the hind leg	Body fat of an Indian green frog (*Euphlyctis hexadactylus*) is used as an effective massage.
Breathing trouble	A very small amount of paste is prepared by rubbing the beak and skull bone of a kingfisher (*Halcyon smyrnensis*) against a rough stone surface and given orally once on Tuesday and Saturday mornings for three consecutive weeks.
Spleen enlargement	A hot extract is prepared from 5 gm dust of Bengal mongoose spleen (*Herpestes javanicus palustris*) and given orally in the early morning, once a day, for 15 days.
Fresh wound	Shell ash powder of freshwater mussel (*Lamellidens marginalis*) is applied on the fresh cut to stop bleeding.
Fever	One piece of earthworm (*Metaphire posthuma*) is made into a paste, fed, and wrapped with bamboo leaves once a day for 3-5 days.

Table 3. Magico-religious myths attached to the healing of livestock diseases in the northern laterite region of West Bengal, India

Disease/ illness cured	Magico-religious practices/myths
Sore between the hooves	Sometimes, a piece of the front appendage of a crab (*Cancer pagurus*) is tied to the neck of the affected animal to protect it from evil spirits.
Poor lactation due to evil effect	If more than one animal shows the same symptom, a dog's skull (*Canis familiaris*) is hung from the southeastern roof corner of a cowshed.
Weakness due to evil effect	A talisman is prepared with the dust of the skull and wing bone of a short-nosed fruit bat (*Cynopterus sphinx*) and tied around the neck of an affected cow with a piece of black thread to combat the evil spirit.
Fever due to evil effect	Black magic is performed with the bone of a vulture (*Gyps bengalensis*) to relieve the situation.
Drowsiness due to evil effect	A dried shell of a freshwater turtle (*Lissemys punctata punctata*) is hung just above the front door of a cowshed.
Fever due to evil effect	One tooth of a Bear (*Melursus ursinus*) is used to protect against the evil spirit.
Body aches due to evil effect	Black magic is performed with the parietal bone of Long-whiskered catfish (*Sperata aor*) to eliminate the evil effect.

Conservation facets of threatened species

Among the recorded 21 species, more than 50% of species are already enlisted in the IUCN Red List of Threatened species (IUCN Red List 2021). Furthermore, it has been found that species like *Gyps bengalensis* (Gmelin, 1788) as 'Critically Endangered,' *Melursus ursinus* (Shaw, 1791) as 'Vulnerable' *Chitala chitala* (Hamilton, 1822) has been recorded as 'Near Threatened,' and eight other species as 'Least Concern.' In the global scenario, species categorized under the 'Least Concern' are not the focus of species conservation. In the studied area, the status of *V. bengalensis, S. aor, H. javanicus palustris, E. hexadactylus,* and *C. bengalensis* is gradually declining due to habitat destruction and other anthropogenic pressure.

An interesting observation has been made that there is a tendency to frequently use the 'locally rare' and 'Least Concern' recorded species like *C. bengalensis* (UM=16) and *H. javanicus palustris* (UM=12). This utilization pattern may indicate the anthropogenic Allee effect, which predicts the increasing tendency to exploit the gradually becoming rarer species. That can force a species to annihilate (Holden and McDonald-Madden 2017).

The local people have many superstitions and folklore associated with the local fauna. Sometimes it might help protect the local fauna from overexploitation or might cause harm to animal life due to their inadequate knowledge (Alves et al. 2012). So it is high time to make people aware of the rare and threatened animal species and their value as a component of biodiversity. Furthermore, to protect them, local inhabitants should be encouraged to use the available substitutes instead of rare and endangered species (Luo et al. 2011). Funds from Government and Non-Government organizations should be raised to investigate the local faunal resources thoroughly, evaluate their economic value, estimate their current status, and identify the needed threats. An arrangement should be provided for captive breeding and reintroduction of the endangered species. Concurrently, the socio-ecological conditions must be reinforced through sustainable utilization and conservation of the local biodiversity.

In conclusion, using 21 zoological specimens in ethnoveterinary medicine preparation highlights local zoo resources' exploitation as therapeutic agents, a wide knowledge base in zoo therapy in the surveyed area. All those 21 animal species used as medicine were found first time recorded from the state of West Bengal for ethnoveterinary medicinal purposes. This finding also indicates exploring more new recipes of zoo therapy practiced in the northern portion of the state laterite region and West Bengal as a whole. Some of the recorded species' medicinal effects have already been pharmacologically validated. There is a scope for further investigation to confirm the newer uses reported and the statistically justified information provided here. In addition, this study offers new mitigation and conservation strategies for restoring and preserving wildlife in the lateritic belt of West Bengal.

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REFERENCES

Abrão CF, de Oliveira DR, Passos P, Freitas CVRP, Santana AF, da Rocha ML, da Silva AJR, Tinoco LW. 2021. Zootherapeutic practices in the Amazon Region: Chemical and pharmacological studies of Green-anaconda fat (*Eunectes murinus*) and alternatives for species conservation. Ethnobiol Conserv 10:1-27. DOI: 10.15451/ec2021-02-10.15-1-27.

Ali S. 1996. The Book of Indian Birds. Bombay Natural History Society, Bombay, India.

Altaf M, Javid A, Umair M, Iqbal KJ, Rasheed Z, Abbasi AM. 2017. Ethnomedicinal and cultural practices of mammals and birds in the vicinity of River Chenab, Punjab-Pakistan. J Ethnobiol Ethnomed 13: 1-24. DOI: 10.1186/s13002-017-0168-5.

Alves RRN, Rosa IL, Léo Neto NA, Voeks R. 2012. Animals for the Gods: Magical and religious faunal use and trade in Brazil. Hum Ecol 40: 751-780. DOI: 10.1007/s10745-012-9516-1.

Alves RRN, Rosa IL, Santana GG. 2007. The role of animal-derived remedies as complementary medicine in Brazil. BioScience 57: 949-955. DOI: 10.1641/B571107.

Alves RRN, Souto WMS. 2015. Ethnozoology: A brief introduction. Ethnobiol Conserv 4: 1-13. DOI: 10.15451/ec2015-1-4.1-1-13.

Andrade PH, Schmidt RE, Carollo CA, Rodrigues MML, Viana LH, Schiaveto SA, Turatti OC, Cepa Matos MDF. 2015. Effect of powdered shells of the snail *Megalobulimus lopesi* on secondary-intention wound healing in an animal model. Evid-Based Complement Altern Med 2015: 120785. DOI: 10.1155/2015/120785.

Andrade-Cetto A, Heinrich M. 2011. From the field into the lab: Useful approaches to selecting species based on local knowledge. Front Pharmacol 2: 1-5. DOI: 10.3389/fphar.2011.00020.

Antoine-Moussiaux N, Faye B, Vias GF. 2007. Tuareg ethnoveterinary treatments of camel diseases in Agadez Area (Niger). Trop Anim Health Prod 39: 83-89. DOI: 10.1007/s11250-007-4404-1.

Balamurugan M, Parthasarathi K, Cooper EL, Ranganathan LS. 2009. Anti- inflammatory and antipyretic activities of earthworm extract-*Lampito mauritii* (Kinberg). J Ethnopharmacol 121: 330-332. DOI: 10.1016/j.jep.2008.10.021.

Barboza RR, Souto WMS, Mourão JS. 2007. The use of zootherapeutics in folk veterinary medicine in the district of Cubati, Paraíba State, Brazil J Ethnobiol Ethnomed 3: 1-14. DOI: 10.1186/1746-4269-3-32.

Belay M. 2015. Medicinal use of fauna in the indigenous medicine system of Gendewuha and Kumeraaftit *Kebeles* of Metema *Woreda*, North West Ethiopia. Intl J Innov Res Dev 4: 459-464.

Bullitta S, Re GA, Manunta MD, Piluzza G. 2018.Traditional knowledge about plant, animal, and mineral-based remedies to treat cattle, pigs, horses, and other domestic animals in the Mediterranean island of Sardinia. J Ethnobiol Ethnomed 14: 1-26. DOI: 10.1186/s13002-018-0250-7.

Buthelezi S, Southway C, Govinden U, Bodenstein J, du Toit K. 2012. An investigation of the antimicrobial and anti-inflammatory activities of crocodile oil. J Ethnopharmacol 143: 325-330. DOI: 10.1016/j.jep.2012.06.040.

Chakravorty J, Meyer-Rochow VB, Ghosh S. 2011. Vertebrates used for medicinal purposes by members of the *Nyishi* and *Galo* tribes in Arunachal Pradesh (North-East India). J Ethnobiol Ethnomed 7: 1-14. DOI: 10.1186/1746-4269-7-13.

Chaudhury S, Rahaman CH, Singh H. 2016. Some ethnozoological uses of Birhor tribe of West Bengal, India. J Tradit Folk Pract 2,3&4: 33-42.

Chellappandian M, Pandikumar P, Mutheeswaran S, Paulraj MG, Prabakaran S, Duraipandiyan V, Ignacimuthu S, Al-Dhabi NA. 2014. Documentation and quantitative analysis of local ethnozoological knowledge among traditional healers of Theni District, Tamil Nadu, India. J Ethnopharmacol 154: 116-130. DOI: 10.1016/j.jep.2014.03.028.

Confessor MV, Mendonça LE, Mourão JS, Alves RRN. 2009. Animals to heal animals: Ethnoveterinary practices in semiarid region, Northeastern Brazil. J Ethnobiol Ethnomed 5: 1-9. DOI: 10.1186/1746-4269-5-37.

Cooper EL, Balamurugan M, Huang CY, Tsao CR, Heredia J, Tommaseo-Ponzetta M, Paoletti MG. 2012. Earthworms dilong: Ancient, inexpensive, noncontroversial models may help clarify approaches to integrated medicine emphasizing neuroimmune systems. Evid-Based Complement Altern Med 2012: 164152. DOI: 10.1155/2012/164152.

Costa-Neto E. 2005. Animal-based medicines: Biological prospection and the sustainable use of zootherapeutic resources. An Acad Bras Cienc 77: 33-43. DOI: 10.1590/s0001-37652005000100004.

Falodun A, Owolabi OJ, Osahon O. 2008. Physicochemical, antimicrobial and anti-inflammatory evaluation of fixed oil from *Boa constrictor*. Acta Pol Pharm 65: 477-480.

Ferreira FS, Brito SV, Sales DL, Menezes IRA, Coutinho HDM, Souza EP, Almeida WO, Alves RRN. 2014. Anti-inflammatory potential of zootherapeutics derived from animals used in Brazilian traditional medicine. Pharm Biol 52: 1403-1410. DOI: 10.3109/13880209.2014.894091.

Ferreira FS, Brito SV, Saraiva RA, Araruna MKA, Menezes IRA, Costa JGM, Coutinho HDM, Almeida WO, Alves RRN. 2010. Topical anti-inflammatory activity of body fat from the lizard *Tupinambis merianae*. J Ethnopharmacol 130: 514-520. DOI: 10.1016/j.jep.2010.05.041.

Galav P, Jain A, Katewa SS. 2013. Traditional veterinary medicines used by livestock owners of Rajasthan, India. Indian J Tradit Knowl 12: 47-55.

González JA, Amich F, Postigo-Mota S, Vallejo JR. 2016. Therapeutic and prophylactic uses of invertebrates in contemporary Spanish ethnoveterinary medicine. J Ethnobiol Ethnomed 12: 1-19. DOI: 10.1186/s13002-016-0111-1.

Grdisa M. 2013. Therapeutic properties of the earthworms. Bioremed Biodivers Bioavailabil 7: 1-5.

Gupta L, Silori CS, Mistry N, Dixit AM. 2003. Use of animals and animal products in traditional health care systems in District Kachchh, Gujarat. Indian J Tradit Knowl 2: 346-356.

Hatfield G. 2004. Encyclopedia of Folk Medicine: Old World and New World Traditions. ABC-CLIO Inc., Santa Barbara, California.

Holden MH, McDonald-Madden E. 2017. High prices for rare species can drive large populations extinct: The anthropogenic Allee effect revisited. J Theor Biol 429: 170-180. DOI: 10.1016/j.jtbi.2017.06.019.

Huang CY, Wu TC, Hong YH, Hsieh SL, Guo HR, Huang RH. 2018. Enhancement of cell adhesion, cell growth, wound healing, and oxidative protection by gelatins extracted from extrusion-pretreated tilapia (*Oreochromis* sp.) fish scale. Molecules 23: 1-16. DOI: 10.3390/molecules23102406.

Hussain JF, Tynsong H. 2020. Review: Ethno-zoological study of animals-based medicine used by traditional healers of Northeast India. Asian J Ethnobiol 4: 1-22.

International Union for Conservation of Nature (IUCN) Red List. 2021. Red List of Threatened Species. [https://www.iucnredlist.org] Accessed 26 April 2021

Jaroli DP, Mahawar MM, Vyas N. 2010. An ethnozoological study in the adjoining areas of Mount Abu Wildlife Sanctuary, India. J Ethnobiol Ethnomed 6: 1-8. DOI: 10.1186/1746-4269-6-6.

Kakati LN, Ao B, Doulo V. 2006. Indigenous knowledge of zootherapeutic use of vertebrate origin by the Ao Tribe of Nagaland. J Hum Ecol 19: 163-167. DOI: 10.1080/09709274.2006.11905874.

Kawtikwar PS, Bhagwat DA, Sakarkar DM. 2010. Deer antlers-traditional use and future perspectives. Indian J Tradit Knowl 9: 245-251.

Khan KA. 2012. A survey on the drugs of animal origin used in Unani medicine as possible alternative for the cure of sizable human ailments. Hamdard Medicus 55: 5-9.

Lohani U. 2011. Traditional uses of animals among *Jirels* of Central Nepal. Stud Ethnomed 5: 115-124. DOI: 10.1080/09735070.2011.11886398.

Luo J, Yan D, Zhang D, Feng X, Yan Y, Dong X, Xiao X. 2011. Substitutes for endangered medicinal animal horns and shells exposed by antithrombotic and anticoagulation effects. J Ethnopharmacol 136: 210-216. DOI: 10.1016/j.jep.2011.04.053.

Mahawar MM, Jaroli DP. 2008. Traditional zootherapeutic studies in India: A review. J Ethnobiol Ethnomed 4: 1-12. DOI: 10.1186/1746-4269-4-17.

Mandal SK, Rahaman CH. 2014. Determination of informants' consensus and documentation of ethnoveterinary practices from Birbhum District of West Bengal, India. Indian J Tradit Knowl 13 (4): 742-751.

Martin GJ. 1995. Ethnobotany: A Methods Manual. Chapman & Hall, New York. DOI: 10.1007/978-1-4615-2496-0.

Martinez GJ. 2013. Use of fauna in the traditional medicine of native Toba (qom) from the Argentine Gran Chaco region: An ethnozoological and conservationist approach. Ethnobiol Conserv 2: 1-43. DOI: 10.15451/ec2013-8-2.2-1-43.

Moazami M. 2005. Evil animals in the Zoroastrian Religion. Hist Relig 44: 300-317. DOI: 10.1086/497802.

Phillips O, Gentry AH, Reynel C, Wilkin P, Galvez-Durand B. 1994. Quantitative ethnobotany and Amazonian conservation. Biol Conserv 8: 225-248. DOI: 10.1046/j.1523-1739.1994.08010225.x.

Piluzza G, Virdis S, Serralutzu F, Bullitta S. 2015. Uses of plants, animal and mineral substances in Mediterranean ethno-veterinary practices for the care of small ruminants. J Ethnopharmacol 168: 87-99. DOI: 10.1016/j.jep.2015.03.056.

Pongener A, Ao B, Yenisetti SC, Lal P. 2019. Ethnozoology and entomophagy of Ao tribe in the district of Mokokchung, Nagaland. Indian J Tradit Know 18: 508-515.

Pongtuluran OB, Rofaani E. 2015. Antiviral and immunostimulant activities of *Andrographis paniculata*. Hayati 22: 67-72. DOI: 10.4308/hjb.22.2.67.

Prater SH. 1996. The Book of Indian Animals. Bombay Natural History Society, Bombay, India

Pushpangadan P, George V, Sreedevi P, Ijinu TP, Ninawe A. 2014. Ethnozoological knowledge of Indian scheduled tribe, scheduled caste and rural communities. Indian J Tradit Knowl 13: 735-741.

Shahzad A, Cohrs RJ. 2012. In vitro antiviral activity of honey against Varicella zoster virus (VZV): A translational medicine study for potential remedy for shingles. Transl Biomed 3 (2): 2 DOI: 10.3823/434

Singh S, Tripathi JS, Rai NP. 2016. An appraisal of the bioavailability enhancers in Ayurveda in the light of recent pharmacological advances. Ayu 37: 3-10. DOI: 10.4103/ayu.AYU_11_15.

Souto WMS, Barboza RRD, Mourão JDS, Alves RRN. 2012. Traditional knowledge of *sertanejos* about Zootherapeutic practices used in ethnoveterinary medicine of Northeastern Brazil. Indian J Tradit Knowl 11: 259-265.

Souto WMS, Mourão JDS, Barboza RRD, Alves RRN. 2011a. Parallels between zootherapeutic practices in ethnoveterinary and human complementary medicine in Northeastern Brazil. J Ethnopharmacol 134: 753-767. DOI: 10.1016/j.jep.2011.01.041.

Souto WMS, Mourao JS, Barboza RRD, Mendonca LET, Lucena RFP, Confessor MVA, Vieira WLS, Montenegro PFGP, Lopez LCS, Alves RRN. 2011b. Medicinal animals used in ethnoveterinary practices of the 'Cariri Paraibano', Northeastern Brazil. J Ethnobiol Ethnomed 7: 1-20. DOI: 10.1186/1746-4269-7-30.

Still J. 2003. Use of animal products in traditional Chinese medicine: Environmental impact and health hazards. Complement Ther Med 11: 118-122. DOI: 10.1016/s0965-2299(03)00055-4.

Thomas E, Vandebroek I, Van Damme P. 2007. What works in the field? A comparison of different interviewing methods in ethnobotany with special reference to the use of photographs. Econ Bot 61: 376-384. DOI: 10.1663/0013-0001(2007)61[376:WWITFA]2.0.CO;2.

Tikader BK. 1983. Threatened Animals of India. Zoological Survey of India, India.

Yoganathan S, Nicolosi R, Wilson T, Handelman G, Scollin P, Tao R, Binford P, Orthoefer F. 2003. Antagonism of croton oil inflammation by topical emu oil in CD-1 mice. Lipids 38: 603-607. DOI: 10.1007/s11745-003-1104-y.