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A review on traditional zootherapeutic uses of vertebrate species in Assam, India

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Abstract
The present review addresses the available knowledge on the traditional uses of vertebrate species and their products in folk medicine by different communities and in parts of Assam. Different body parts of the vertebrate species have been used as medicine to heal many ailments and diseases by the people of Assam. For this review, data were collected from 15 published papers available on internet about the practice of zootherapy among different ethnic communities and also in different regions of the state. In Assam, total 112 species of vertebrates were found to be used as zootherapeutic means. Out of these, Mammals with 48 species constitute the highest number of species to be used as medicine followed by Fishes with 24 species, Birds with 18 species, Reptiles with 16 species and Amphibia being the least with 6 species. The conservation status of the species indicated that 1 species was under the category of Critically Endangered (CR), 11 species were Vulnerable (VU), 6 species under Endangered (EN), 5 species were Near Threatened (NT), 63 species were Least Concerned (LC),1 species was under Not Applicable (NA) category and 11 species were not evaluated (NE).

Keywords: zootherapy, animal product, ailments, diseases, ethnozoology

Introduction
Animals have not only acted as a source of food for humans but have also been commonly used in applications such as medicine, clothes, and other related services (Hussain & Tynsong, 2020). Animals and their parts/byproducts form important ingredients in the preparation of curative, protective and preventive medicine (Adeola, 1992) [1]. Use of plants and animals by the indigenous people from generation to generation in their own ways for the health care is known as traditional or folk medicine (Borah & Prasad, 2016) [2]. Use of animals and animal products to cure ailments is popularly known as 'zootherapy' and has been passed down generations through cultural transmission in several ethnic communities around the globe (Daolagupu *et al*, 2021) [10]. Since ancient times animals, their parts, and their products have constituted part of the inventory of medicinal substances used in various cultures (Lev, 2006). Animals as therapeutic agents have undoubtedly made a major contribution to the treatment and prevention of health problems all over the world (Ishaq & Adil, 2021). Zootherapy is an integral part of traditional health care practice among the ethnic communities in India but there is a dearth of reports in this regard (Prakash S & Prakash S, 2021) [24].

Methodology
Study Area
Assam, the gateway of Northeast India is a homeland of ethnic diversity. Covering an area of 78,438 km^2, this state is bordered by Bhutan and Arunachal Pradesh to the north; Nagaland and Manipur to the east; Meghalaya, Tripura, Mizoram and Bangladesh to the south; and West Bengal to the west. With 35 districts Assam is a land of different tribes and their rich cultures and traditions. The indigenous communities of Assam possess a wide range of knowledge on traditional medicines. It is crucial to record such an information structure before it gets lost forever inside the rapid push of modernization and globalization (Hussain *et al*, 2021) [14].

Data Sources
This review work was assembled by collecting data from published research work and review papers available online of various authors on zoo-therapeutic studies. Most of the literature has been cited/ downloaded from journals and online sources such as Research Gate, PubMed, Google Scholar, Academia.edu, and the respective journals' official websites (Hussain *et al*., 2021) [14]. Data published between 2005 to till date in English language were only included. Data of total 15 research articles were taken to prepare this compilation. The vertebrate animals were only taken into consideration leaving the invertebrates which also constitute a big part of zootherapy.

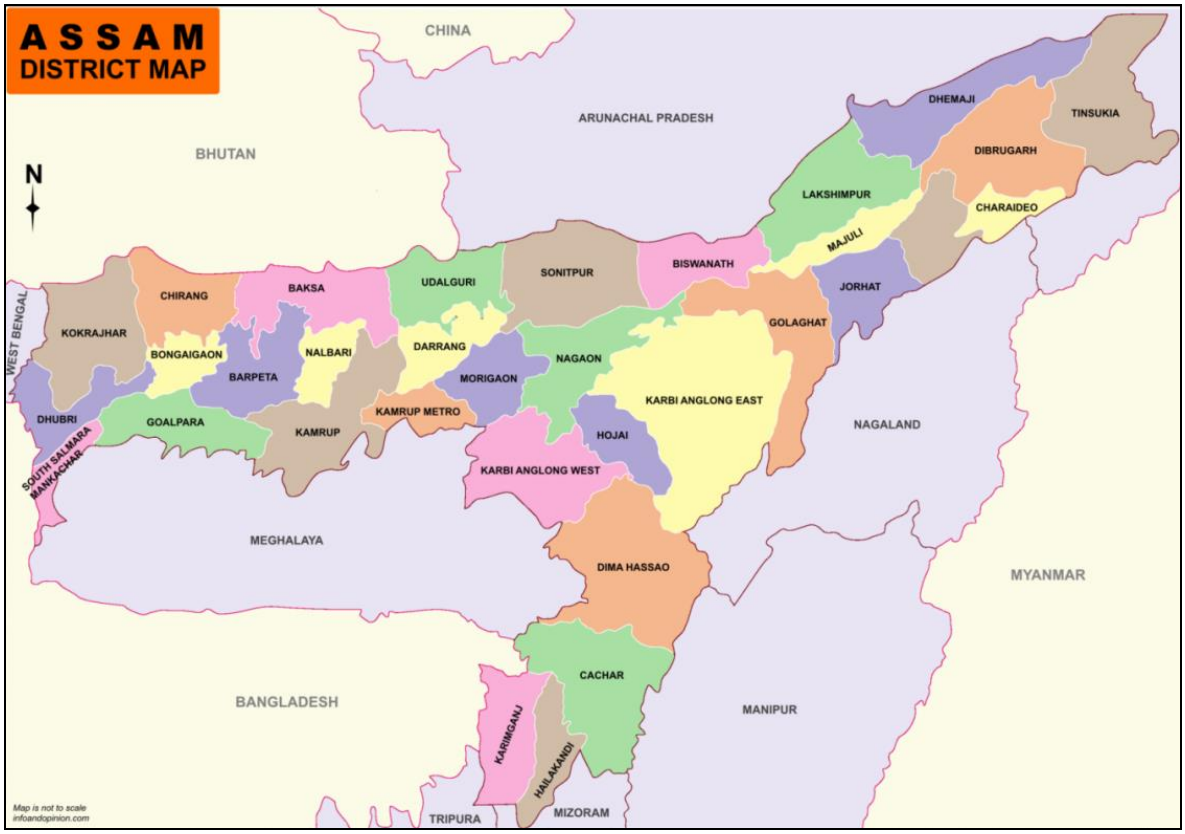

Fig 1: Map of Assam.

Result

The animal based folk medicine from Dibrugarh was investigated by Kalita *et al*, 2005. They recorded 4 fish species *Channa punctatus, Mastacembalus aramatus, Monopterus cuschia* and *Labeo gonius* which were used for body pain, carbuncle, diabetes and obesity respectively. They documented that fish curry is prepared with other medicinal plants to cure the ailments and in case of *Monopterus cuchia* to cure diabetes, fresh blood is taken orally empty stomach in the morning.

Teronpi *et al*, 2012 investigated the use of ichthyofauna in tradional healthcare practices of Karbis, Dimasa and Thadou of Assam and recorded 14 species in the treatment of 25 disease conditions like anemia, kala-azar, night blindness, small pox, common cold, Rheumatoid-arthritis, malaria etc. They found that different parts of a single species of fish were used for curing separate illness. Raw fish and blood of *Monopterus cuchia* were used to cure Kala-azar and anemia or to remove leech from anus respectively. Raw brain of *Heteropneustes fossilis* was used by Karbis when stung by the fish, as analgesic. Bile of *Labeo pangusia* was taken orally to relieve stomach pain and that of *Channa punctatus* was taken to recover from Malaria. Other species recorded were used as whole or body parts were eaten by boiling or cooking to cure many disease conditions. There were also application of fish matter recorded such as fats of *Anguilla bengalensis* applied and massage to relieve pain of Rheumatoid - arthritis; bile of *Channa gachua* species was applied to remove thorn when pricked and heads of the *Channa punctatus* were tapped on the swelled up testicles to control the swelling.

Betlu ALS, 2013 documented the use of zootherapy in the traditional healthcare system of Biate tribe of Dima Hasao district and he recorded total 29 species of vertebrate animals. Out of these, there were 5 reptiles, 7 aves, and 17 mammals. No amphibian and fishes were recorded. Maximum number of species has been reported for the treatment of diabetes. In several cases, medicine is prepared singly or in combination with herbs and very often cooked with vegetables to enhance the taste. While some are prepared fresh, some are prepared after it is sun dried or smoked dried.

Zootherapeutic practices in traditional healing by the major ethnic group of Karbi Anglong district were investigated by Verma *et al*, 2014 [30]. They found 4 reptiles, 8 aves, 1 fish and 19 mammals adding to 32 species used as medicine to cure several ailments. In the present study it was recorded that vertebrate resources are maximally used by the Karbi tribe in different medications for the treatment of different ailments including body pain, rheumatism, asthma, eczema, tuberculosis, paralysis, skin disease, stomach disorder, jaundice, night blindness, bone fracture, malaria, dysentery, kidney trouble, breathing problem, stammering, piles and general weakness etc. (Verma *et al*, 2014) [30]. The flesh is cooked or boiled or burnt or fried or eaten raw. Milk, urine, bile and blood of some animals are taken raw.

Narzary & Bordoloi, 2014 documented the ethnozoological practices of frogs of Bodo tribe from Kokrajhar District and found the use of skin of *Duttaphrynus melanostictus* as medicine in skin diseases as it contains antimicrobial and anticancer peptides. Flesh of *Hoplobatracus tigerinus* was used in stomach problems and blood pressure.

Rahman *et al*, 2014 [26] investigated the use of all Eel ichthyofauna in folkfore medicine of Assam and found that two spineless eel species *Monopterus cuchia* and *Anguilla bengalensis* had traditional use in therapeutic treatments. *Monopterus cuchia* had uses in weakness, anaemia, loss of voice, paralysis, stomach disorders, asthma and piles. The mucous of *Anguilla bengalensis* was reported to be used as skin ointment and its saliva in burn injury treatments.

Zootherapeutic knowledge of Tai-Ahom people of Upper Brahmaputra Valley was studied by Bhuyan, 2016 [7] and 13 vertebrate species were recorded to be used by the community. They comprised 4 fishes, 1 reptile, 3 birds and 5 mammals. Wholw body or parts like flesh, bile, fat, milk, urine etc were taken after cooking or applied locally to treat many diseases like anemia, pox, asthma, snake bite, dysenter, typhoid, malaria etc. Mongoose (*Herpestes Javanicus)*, fruit bat (Cynopterus) and crow (*Corvus splendens*) were used in Malaria.

Borah & Prasad, 2016 [2] studied the ethnozoological remedial used by indigenous inhabitants in adjoining areas of Pobitora Wildlife Sanctuary. They recorded 22 species of vertebrates constituting the zootherapeutic practice in the area. While fat/oil of some animals particularly pig, the dolphin is warmed up and externally applied for massage to relief pain, but most of the other parts of animals is cooked, dried and crushed into powder or boiled and eaten (Borah & Prasad, 2016) [2]. Milk, urine, raw blood of some species were taken fresh or mixed with other ingredients as medicine. They recorded 8 fish species, 1 reptile, 4 birds and 9 mammals to be used in traditional therapy to treat Diarrho, polio, piles, blood cancer, tuberculosis, dysmenorrhoea, asthma, chicken pox, leucorrhea etc.

Borah & Prasad, 2017 [3] did a ethnozoological study of animals based medicine used by traditional healers and indigenous inhabitants in the adjoining areas of Gibbon Wildlife Sanctuary. They found 25 vertebrate species having medicinal value. Three of these were amphibians, seven fishes, 5 reptiles and 10 mammals. Whole body or different body parts like meat, blood, urine, bile, milk, horn, elementary canal and gall bladder were used as medicine. Human urine was prescribed to treat senseless and also used as antiseptic in wound. Horn of Buffalo (*Bubalus bubalis*) and Deer (*Rucervus duvaucelii*) were used to cure premenstrual pain and piles respectively. To stop vomiting, blood of Indian fruit bat was prescribed to drink.

Gupta & Dey, 2017 [13] documented the use of fishes as medicine by ethnic Karbi people and recorded 16 species being used for near about 30 ailments. These fishes are used as whole or body parts for the treatment of different kinds of ailments like Kala-azar, malaria, small pox, night blindness, common cold, rheumatoid arthritis etc (Gupta & Dey, 2017) [13]. Bile of *Labeo pangusia* was reported to be taken orally to relieve, stomach ache. Raw fish of *Monopterus cuchia* was had uses to treat Kala-azar, its fresh raw blood was consumed to remove leech entered into anus. To treat Anemia, raw blood of *Amphipnous cuchia* was taken. For curing small pox, cooked Mystus sp. was consumed.

Hazarika and Sharma, 2018 [15] investigated on the conservation status of *Mabuya multifasciata* on the basis of ethnozoological survey in Kokrajhar district and found that 60% of the tribal population believes and takes *Mabuya* sp. as medicine for skin disease.

Paul S, 2018 [23] investigated on the ethnozoological knowledge among Mising tribes of Dhemaji, Assam and found 15 vertebrates being used to treat asthma, body pain, tuberculosis, jaundice, paralysis, piles, skin disease, allergy, weakness, asthma and piles. Out of these, there were eight mammals, two bird, one reptile and four fish species. Goat urine was taken to cure Asthma, bile of Porcupine (*Hystrix* sp.) was taken orally to treat Dysentery and Monkey (*Maccaca* sp.) blood was taken for tuberculosis. Body oil of River Dolphin was used to treat body pain. He also reported the use of ash of the flesh of *Chiloni*a sp. in affected area to relieve from Piles. The airbladder of *Wallago auto* had uses to treat Asthma trouble.

Narzary *et al*., 2019 [20] documented certain ethnomedicinal fishes of Bodo tribe of Kokrajhar District. They recorded total 12 species of fishes having medicinal values. Most dried fishes are used by the Bodo people by cooking with some local vegetable leaves and spices as soup for common cold and sick. They reported that *Clarias batrachus*, *Heteropneustes fossilis*, *Monopterus cuchia*, *Anabas testudineus*, *Colisa faciatus* and fishes of genus *Channa* are known to all as medicinal fishes for sick, mostly for physically weak or anaemia.

Zootherapeutic practices were recorded among the Deori tribes of Dhemaji district by Gogoi & Bora, 2020 [11] and they recorded 12 numbers of vertebrate species. Out of these, 3 species were fishes, 1 amphibian, 2 birds and 6 mammals. They reported that whole body parts or by products like milk, urine, intestine, blood are used. Some body parts are sundried and kept for future treatments (Gogoi & Bora, 2020) [11]. Raw blood of *Amphipnous cuchia* was found to be used by this community also to treat anemia. Porcupine (*Hystrix indica)* flesh was used to treat Pneumonia and flesh of Fox was used to treat paralysis and high pressure. Urine of cow was applied over affected area to treat skin problems on hands and fats of pigs in rheumatic and skin problem. Tongue of Goat was cooked and consumed to cure speech problem in childhood and its feet bones were boiled and taken orally in hand and leg cramp.

Gogoi & Bora, 2021 [12] studied the uses of animals and its products in zootherapy by the Boro tribe of Dhemaji district. They found that 16 vertebrate species comprising 7 Mammals, 3 birds, 2 reptiles, 3 amphibians and 1 fish were used for different diseases like Anaemia, high blood pressure, skin disease, small pox, chicken pox, cold, tumour, joint paint, tuberculosis, asthma, cough, fever and different wounds. Raw flesh of bat (*Eoncyteris spelaea*) was consumed to treat Asthma, raw blood of Monkey to treat tuberculosis and raw blood of Eel (*Amphipnous cuchia*) was taken for weakness. Blood of Tortoise was applied on infected area by pox, blood of Asian common toad (*Duttaphrynus melanostictus*) was applied on affected area to cure skin disease and blood of

Dove (*Spilopelia senegalensis*) was applied on wounds in eyes, nose, skin. Flesh of the animals were fried or boiled and consumed to treat different diseases.

Table 1: Vertebrate species reported to have medicinal value or zootherapeutic uses in Assam, India

Sl. No.	Common Name	Scientific Name	References	IUCN
	Fishes			
1	Spotted snakehead	*Channa punctatus*	Kalita *et al*, 2005; Narzary *et al*., 2019; Teronpi *et al*, 2012; Borah & Prasad, 2016; Gupta & Dey,2017	LC
2	Zig-zag eel	*Mastacembalus aramatus*	Kalita *et al*, 2005	LC
3	Swamp Eel	*Monopterus cuschia*	Kalita *et al*, 2005; Narzary *et al*., 2019; Gogoi & Bora, 2020; Rahman *et al*, 2014; Teronpi *et al*, 2012; Gupta & Dey,2017	NE
4	Gangetic mud Eel	*Amphipnous cuchia*	Borah & Prasad,2017; Verma *et al*,2014; Borah & Prasad, 2016; Gupta & Dey, 2017; Gogoi & Bora, 2021	LC
5	Indian Mottled Eel	*Anguilla bengalensis*	Rahman *et al*, 2014; Teronpi *et al*, 2012; Gupta & Dey,2017; Paul S,2018	NT
6	Kuria labeo	*Labeo gonius*	Kalita *et al*, 2005; Paul S,2018	LC
7	Climbing perch	*Anabus testudineus*	Bhuyan DD, 2016; Narzary *et al*., 2019; Borah & Prasad, 2016; Gupta & Dey,2017	LC
8	Magur/Walking catfish	*Clarius batracus*	Bhuyan DD, 2016; Narzary *et al*., 2019; Borah & Prasad,2017; Teronpi *et al*, 2012; Gupta & Dey,2017	LC
9	Rohu	*Labeo rohita*	Bhuyan DD, 2016; Borah & Prasad, 2017	LC
10		*Labeo pangusia*	Teronpi *et al*, 2012; Gupta & Dey,2017	NT
11	Puthi	*Puntius spp*	Bhuyan DD, 2016; Gogoi & Bora, 2020; Teronpi *et al*, 2012; Gupta & Dey,2017	
12	Dwarf Snakehaed	*Channa gachua*	Narzary *et al*., 2019; Teronpi *et al*, 2012; Gogoi & Bora, 2020; Borah & Prasad, 2016; Gupta & Dey,2017	LC
13	Assamese snake head	*Channa stewartii*	Narzary *et al*., 2019; Borah & Prasad, 2017	LC
14	Mole/Indian carplet	*Amblypharyngodon mola*	Narzary *et al*, 2019; Borah & Prasad, 2017; Borah & Prasad, 2016; Gupta & Dey,2017	LC
15	Freshwater gar fish	*Xenentodon cancila*	Narzary *et al*, 2019; Borah & Prasad, 2016; Gupta & Dey,2017	LC
16	Stinging cat/ Singee	*Heteropneustes fossilis*	Narzary *et al*, 2019; Borah & Prasad,2017; Teronpi *et al*, 2012; Gupta & Dey,2017	LC
17	Barred spiny Eel	*Macrognathus pancalus*	Narzary *et al*, 2019	LC
18	Tengara catfish	*Mystus tengara*	Narzary *et al*, 2019; Teronpi *et al*, 2012; Gupta & Dey,2017	LC
19	Giant gourami	*Colisa faciatus*	Narzary *et al*, 2019	NE
20	Devil fish	*Chaca Chaca*	Borah & Prasad, 2017; Borah & Prasad, 2016; Gupta & Dey,2017	LC
21	Giant Danio	*Danio aequipinnatus*	Teronpi *et al*, 2012	LC
22	Helicopter catfish	*Wallago attu*	Teronpi *et al*, 2012; Gupta & Dey,2017; Paul S,2018	VU
23	Feather back	*Notopterus notopterus*	Borah & Prasad, 2016; Gupta & Dey,2017	LC
24		Glossogobius gutum	Paul S,2018	NE
	Reptiles			
1	Cobra	*Naja spp*	Bhuyan DD, 2016	
2	King Cobra	*Ophiophagus hannah*	Betlu ALS, 2013; Borah & Prasad, 2017	VU
3	Indian Rock Python	*Python molurus*	Betlu ALS, 2013	NT
4	Monitor Lizard/ Bengal Monitor	*Varanus bengalensis*	Betlu ALS, 2013; Borah & Prasad, 2017; Borah & Prasad, 2016	NT
5	Tokay Gecko	*Gekko gecko*	Betlu ALS, 2013	LC
6	Indian Black turtle	*Melanochelys trijuga*	Betlu ALS, 2013	LC
7	Indian rat snake	*Ptyas mucosa*	Borah & Prasad, 2017	LC
8	Coomon Indian skink	*Eutropis carinata*	Borah & Prasad, 2017	LC
9	Indian Wall Lizard	*Hemidactylus flaviviridis*	Borah & Prasad, 2017 Gogoi & Bora, 2021	LC
10	Lizard	*Tropidurus torquatus*	Verma *et al*,2014	LC
11	Neotropical rattlesnake	*Crotalus durissus*	Verma *et al*,2014	LC

12	Tortoise	*Testudo sp.*	Verma *et al*,2014	
13	Viper	*Echis coloratus*	Verma *et al*,2014	LC
14	Common Golden skink	*Mabuya multifasciata*	Hazarika and Sharma, 2018	LC
15	Assam roofed turtle	Pangshura sylhetensis	Gogoi & Bora, 2021	CR
16	Turtle	Chilonia sp.	Paul S, 2018	
	Amphibia			
1	Asian common toad	*Duttaphrynus melanostictus*	Gogoi & Bora, 2020; Gogoi & Bora, 2021	LC
2	Common tree frog	*Polypedates leucomystax*	Borah & Prasad,2017	LC
3	Common toad	*Bufo spp.*	Borah & Prasad,2017; Verma *et al*,2014	
4	Frog	*Ranna spp*	Borah & Prasad,2017; Verma *et al*,2014	
5	Indian bullfrog	*Hoplobatrachus tigerinus*	Gogoi & Bora, 2021	LC
6	Indian Skipper Frog	*Euphlyctis cyanophlyctis*	Gogoi & Bora, 2021	LC
	Aves			
1	House Crow	*Corvus splendens*	Bhuyan DD, 2016; Verma *et al*,2014; Paul S, 2018	LC
2	Jungle Crow	*Corvus macrorhynchos*	Betlu ALS, 2013	LC
3	Common Myana or Indian Myna	*Acridotheres tristis*	Borah & Prasad, 2016	LC
4	Wreathed Hornbill	*Rhyticeros undulatus*	Betlu ALS, 2013	VU
5	Duck	*Anas platyrhynchos*	Bhuyan DD, 2016	LC
6	Red Jungle fowl	*Gallus gallus*	Bhuyan DD, 2016; Gogoi & Bora, 2020; Gogoi & Bora, 2021; Betlu ALS, 2013	LC
7	Grey Jungle fowl	*Gallus sonnerati*	Verma *et al*,2014	LC
8	Chicken	*Gallus domestica*	Verma *et al*,2014 Borah & Prasad, 2016	LC
9	House Sparrow	*Passer domesticus*	Betlu ALS, 2013 Verma *et al*,2014	LC
10	Blue whistling Thrush	*Myophonus caeruleus*	Betlu ALS, 2013	LC
11	Great Hornbill	*Buceros bicornis*	Betlu ALS, 2013	VU
12	Hoopoe	*Upupa epops*	Betlu ALS, 2013	LC
13	Ground-dove	*Streptopelia chinesis*	Verma *et al*,2014	LC
14	Peacock	*Pavo cristatus*	Verma *et al*,2014	LC
15	Common Ostrich	*Struthio camelus*	Verma *et al*,2014	LC
16	Pigeon	*Columba livia*	Verma *et al*,2014;Paul S,2018;Gogoi & Bora, 2021	LC
17	Dove	*Spilopelia senegalensis*	Verma *et al*,2014; Borah & Prasad, 2016	LC
18	Brown Owl	*Tyto alba*	Borah & Prasad, 2016	LC
	Mammals			
1	Malayan Porcupine	*Hystrix brachyura*	Bhuyan DD, 2016; Verma *et al*,2014	LC
2	Indian crested Porcupine	*Hystrix indica*	Gogoi & Bora, 2020; Borah & Prasad, 2017; Borah & Prasad, 2016; Paul S, 2018; Betlu ALS, 2013	LC
3	Pig	*Sus scrofa domesticus*	Bhuyan DD, 2016; Verma *et al*,2014; Gogoi & Bora, 2020; Borah & Prasad, 2016; Gogoi & Bora, 2021; Paul S, 2018	LC
4	Goat	*Capra aegagrus hircus*	Bhuyan DD, 2016; Gogoi & Bora, 2020; Borah & Prasad, 2016; Gogoi & Bora, 2021; Paul S, 2018	NA
5	River Dolphin	*Platanista gangetica*	Paul S, 2018; Borah & Prasad, 2016	EN
6	Cow	*Bos indicus*	Gogoi & Bora, 2020; Borah & Prasad, 2017; Verma *et al*,2014; Borah & Prasad, 2016 Gogoi & Bora, 2021	NE
7	House mouse	*Mus musculus*	Verma *et al*,2014; Gogoi & Bora, 2021;	LC
8	Cape hare	*Lepus capensis*	Verma *et al*,2014	LC
9	Golden jackel	*Canis aureus*	Gogoi & Bora, 2020; Borah & Prasad, 2016	LC
10	Bengal Fox	*Vulpes bengalensis*	Borah & Prasad, 2017	LC
11	Fox	*Dusicyon sp.*	Verma *et al*,2014	
12	Crab-eating Fox	*Cerdocyon thous*	Verma *et al*,2014	LC
13	Rat	*Ratus sp.*	Gogoi & Bora, 2020	
14	fruit bat	*Cynopterus sp.*	Bhuyan DD, 2016	
15	Indian fruit bat (vesper bat)	*Pipistrellus coromandra*	Borah & Prasad, 2017	LC

16	Indian flying fox	*Pteropus giganteus*	Borah & Prasad, 2017	LC
17	Bat	*Rhinolophus spp.*	Verma *et al*,2014; Borah & Prasad, 2017; Paul S, 2018	
18	Cave nectar Bat	*Eoncyteris spelaea*	Borah & Prasad, 2016; Gogoi & Bora, 2021	LC
19	Javan Mongoose	*Herpestes javanicus*	Bhuyan DD, 2016	LC
20	Indian Grey Mongoose	*Herpestes edwardsii*	Borah & Prasad, 2017	LC
21	Indian Pangolin	*Manis crassicaudata*	Betlu ALS, 2013	EN
22	Golden Jackal	*Canis aureus*	Betlu ALS, 2013	LC
23	Barking Deer	*Muntiacus muntjak*	Betlu ALS, 2013	LC
24	Deer/Swamp deer	*Rucervus duvaucelii or Cervus duvaucelii*	Borah & Prasad, 2017	VU
25	Dawn Bat	*Eonycteris spelaea*	Betlu ALS, 2013	LC
26	Sloth Bear	*Melursus ursinus*	Betlu ALS, 2013	VU
27	Himalayan Black Bear	*Ursus thibetanus*	Betlu ALS, 2013	VU
28	Bear	*Selenarctos sp.*	Verma *et al*,2014	
29	Hoolock Gibbon	*Hoolock hoolock*	Betlu ALS, 2013	EN
30	Mainland Serow	*Capricornis sumatraensis*	Betlu ALS, 2013	VU
31	Slow Loris	*Nycticebus coucang*	Betlu ALS, 2013	EN
32	Dog	*Canis lupus familiaris*	Betlu ALS, 2013	
33	The Assamese Macaque	*Macaca assamensis*	Betlu ALS, 2013; Verma *et al*,2014; Gogoi & Bora, 2021; Paul S, 2018	NT
34	Asian Elephant	*Elephas maximus*	Betlu ALS, 2013	EN
35	Smooth coated otter	*Lutrogale perspicillata*	Betlu ALS, 2013	VU
36	Capped langur	*Trachypithecus pileatus*	Betlu ALS, 2013	EN
37	Wild Boar	*Sus scrofa*	Betlu ALS, 2013	LC
38	Camel	*Camelus dromedarius*	Verma *et al*,2014	NE
39	Silvered Leaf Monkey	*Trachypithecus cristatus*	Betlu ALS, 2013	VU
40	Mole	*Talpa sp.*	Verma *et al*,2014	
41	Eastern Grey Squirrel	*Sciurus carolinensis*	Borah & Prasad, 2017; Verma *et al*,2014; Gogoi & Bora, 2021	LC
42	Domestic water Buffalo	*Bubalus bubalis*	Borah & Prasad, 2017; Verma *et al*,2014; Paul S, 2018	NE
43	Mithun	*Bos frontalis*	Verma *et al*,2014	NE
44	Cattle	*Bos taurus*	Verma *et al*,2014; Borah & Prasad, 2016	NE
45	Donkey	*Equus asinus*	Verma *et al*,2014	NE
46	Sheep	*Ovis aries*	Verma *et al*,2014	NE
47	Rhino	*Rhinoceros unicornis*	Borah & Prasad, 2016	VU
48	Human	*Homo sapiens*	Borah & Prasad, 2017; Verma *et al*,2014	NE

Discussion

Out of the total 112 vertebrate species recorded for zootherapeutic uses in Assam, mammals comprised the largest part and amphibian the least. Domesticated species were seen to be used as a source of traditional medicine which included goats, cows, pig, sheep, dog, pigeon, chicken etc. The other species were either hunted or bought from the market. The use of animals and its products for therapeutic practices had been a common practice among the people of Assam as most of it were easily available and had less side effects. A large section of the tribal society believes that the use of traditional medicine is more effective than the modern medicine and no side effect (Pegu *et al*, 2019). The traditional knowledge, skill, and practices that were used in folk medicine to cure, improve or prevent mental and physical ailments and diseases were mainly based on experiences, beliefs, and ideas which were indigenous to various cultures. However, studies are needed to establish their appropriate medicinal component.

Assam is a state rich in biodiversity. Rich diversity of flora and fauna gives an ample source to practice folk medicine. It is probable that many more zootherapeutic remedies are still practiced (or were used in recent years), but were simply not reported by informants in these particular field studies (Quave *et al*, 2010) [25].

Threats to these Medicinal fauna

Eleven of the vertebrate species documented in these published works are included on the IUCN Red List of Vulnerable Species. The One-horned Rhino which improved from endangered to vulnerable is still under threat from poaching for its horn and due to habitat loss and degradation. Most of the vulnerable species recorded were mammals. One species-Assam roofed turtle (*Pangshura sylhetensis*) is critically endangered. 6 species are under endangered category which are all mammals and 5 species under near threatened category. Most of these species are decreasing in number due to a combination of hunting, poaching, loss of genetic viability and habitat loss. Although 63 species were under least concerned category, the number of most of the species were found to be

decreasing at a rapid rate. It is seen that inspite of extremely precise ecological knowledge and strong tradition of conservation and sustainable use, certain animals become rare due to substances hunting for food and other uses and only preserved parts of those animals have been used as raw materials for treatment of diseases (Paul S, 2018) [23].

Conclusion

Despite the worldwide utilization of ethno-zoology in the form of traditional medicines based on animals, a thorough study of zootherapy in comparison to plant-based medicinal research is still ignored (Hussain & Tynsong, 2020). Ethno-zoological knowledge blended with latest technology can help in sustainable development of the biodiversity as well as the environment (Bhuyan DD, 2017) [6]. This review was an effort to document the traditional zootherapeutic practices among the people of Assam. It summarised all the information in one place which will be helpful for the scientists and researchers working in the field of ethnomedicine to study and develop new potential drugs.

Conflict of Interest

The authors declare that there is no conflict of interest.

Abbreviations

CR- Critically Endangered; EN- Endangered; VU- Vulnerable; NA- Not Applicable; NE- Not Evaluated, LC- Least Concern; NT- Near Threatened.

Reference

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