Indigenous knowledge of zootherapeutic use among the Biate tribe of Dima Hasao District, Assam, Northeastern India

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Abstract

**Background:** The present study addresses the use of zootherapy in the traditional healthcare system of the Biate tribe of Dima Hasao district, Assam, India. It sought to identify the different species used for zootherapeutic use with the detailed methods of usages to create awareness and contribute to the conservation and sustainable utilization of the resources.

**Method:** 15 Biate villages within the district of Dima Hasao were surveyed through semi-structured questionnaires and informal interviews. Detailed information on the uses of each animal was recorded. Species were identified using standard literature. Fidelity level (FL) was calculated to demonstrate the percentage of respondents claiming the use of a certain animal for the same major purposes.

**Result:** The study documents 34 species for the treatment of about 34 different ailments. The largest number of species reported was mammals with 17 species. Maximum number of species has been reported for the treatment of diabetes and its high fidelity levels warrants in-depth studies to establish its pharmacological activity. The usages documented herein are unique to the Biate tribe. Very often, these animals are hunted and sold openly at the local markets in the lure of quick money. A 300 gm live Gekko gecko may fetch a sum of 2,50,000 Indian Rupees (INR), and smoked meat of Hoolock hoolock cost approximately 250–300 INR per kg. Animals are also hunted for its hide. The unrestricted hunting of species like Capricornis sumatraensis has almost wiped out the population within the district. Some species are also reared as pets while some are used for display as a sign of expertise in hunting. The present study has documented the usage of at least 15 animals listed in the IUCN Red List.

**Conclusion:** The study illustrates the in-depth knowledge of the Biate tribe on zootherapy. Systematic investigation to identify the active ingredient may lead to the development of new drugs, which would prompt protection of these valuable resources.

**Keywords:** Ethnozoology, Zootherapy, Biate, Dima Hasao, North Cachar Hills

Background

Animal parts have been used as a source of medicine in the traditional healthcare system since ancient times, and have played a significant role in the healing practices. In the modern societies, zootherapy constitutes an important alternative among many other known therapies practiced worldwide [1]. The World Health Organization estimates that as many as six billion people rely primarily on medicines of animal and plant origin [2]. Although plant and plant derived materials are more commonly used in traditional medical systems than animal derived products, the latter also constitute an important element in most of the traditional healthcare systems of the world. As for example, Traditional Chinese Medicine (TCM) recorded more than 1,500 animal species to be of medicinal use [3]. A list of 60 different species of insects used to treat a wide range of disabilities and illnesses in Japan has been published [4] and 24 animal species were identified, whose byproducts were used therapeutically by the Tamang people of Nepal [5]. However, in spite of such worldwide prevalence, research on medicinal animals has often been
neglected in comparison to medicinal plants [6]. Pieroni et al. [7], for example, has pointed out that studies on drugs of animal origin are still rare in the scientific literature.

India is known for its age-old heritage of traditional medicine. It is a goldmine of well-recorded and traditionally practiced knowledge of herbal medicine such as the Ayurveda, Siddha and Unani medical system. India officially recognizes over 3,000 plants for their medicinal value and estimated that over 6,000 plants are in use in traditional, folk and herbal medicine, representing about 75% of the medicinal needs of the third world countries [8]. Nonetheless, as far as zootherapeutic uses is concerned, very few researches has been done so far, especially in the northeastern states of India. Northeastern India harbors over 130 major tribal communities. Most tribal communities still largely depend on their traditional system of medicine. Because of their scattered and far-flung settlements, and problems arising due to transportation and communication, traditional medicine has remained as the most affordable and easily accessible source of treatment [9]. Although some of the traditional medicines have already been documented, tried, tested and even incorporated in the modern systems of medicine, much larger number of these folk medicines is still undocumented and remains endemic to certain pockets of the area. Each tribe have their own unique way of traditional healthcare system that has been handed down from generation to generation orally, but with the steady development of rural areas coupled with the lure for a more profitable job, the interest of the younger generations in this tradition is declining. The traditional ecological knowledge including the healing practice is gradually being corroded from their culture. Therefore, ethnobiologist in this region have a greater responsibility not only in inventorizing the traditionally used biological resources but also in conserving and revitalizing the traditional beliefs, so that these age-old cultures are not lost [10].

Because of their rich traditional knowledge, different tribal communities of northeastern India have been a subject of several intense and eye-opening ethnozoological studies. Solanki and Chutia reported 11 species used by the Monpa tribe of Arunachal Pradesh [11], Lalrarmghinglova has reported the usage of 56 species from the state of Mizoram [12], Chakravati et al. reported the usage of 36 species from Arunachal Pradesh [13], Jamir et al. reported 26 species from Nagaland [14] while Kalita reported the usage of 4 species from Assam [15]. Kakati and Duolo reported 23 species from Nagaland [16] while Kakati reported 25 species used by the Ao Naga [17]. The district i.e. Dima Hasao of Assam, formerly North Cachar Hills district, has also been subjected to several ethnobotanical studies [18-26]. Nevertheless, till date, no comprehensive report on the ethnozoological wealth and indigenous knowledge of zootherapeutic use is available from the district. The present study area remains to be explored in this aspect. It is on this backdrop that the present research work has been taken-up for the first time to document the indigenous zootherapeutic knowledge of the Biate tribe of Dima Hasao district of Assam, northeastern India.

The study area
Dima Hasao district, covering an area of 4890 km² (92°37’ E – 93°17’E longitude and 25°3’ N – 25°27’N latitudes) is a place of immense interest and potential for ethnotaxonist, ethnozoologist as well as anthropologist (Figure 1). More than 12 ethnic tribes namely Dimasa, Zeme, Biate, Jaintia, Hrangkhol, Hmar, Kuki, Vaiphei, Khelma, Rongmei, Lushai, Karbi etc., live harmoniously together within the district with several non tribal groups like the Assamese, Bengali, Nepali, etc. who are mostly government employees, traders, living in urban and semi-urban areas. It has a total population of 213,529 and the density of population is 44 individuals per square kilometers which is the lowest in the state of Assam according to the census of India, 2011 [27]. Most of the villages are situated far from modern conveniences and inaccessible by road or rail. Thus, the tribal villagers have deep faith in their traditional healthcare system and in most cases prefer them to the modern system of medicine.

The Biate tribe
The Biate tribe (Figure 2) belonging to one of the branches of Mongoloid stock of race is among the prominent inhabitants of the district occupying the Khartong constituency spreading into the other side of the Kopili River in the Saipung constituency of Jaintia Hills of Meghalaya [28]. Shifting cultivation is the traditional means of agriculture practiced by the villagers. Besides these, they raise livestock such as cows, goats, pigs, chicken and also grow a variety of both wild and cultivated plants in their residential compounds.

In olden days, the Biate people believe in naturalism, animism and animalism. Besides them, they believed that there is the high God called Chung Pathian which means Heavenly Father. When any disease or fatal epidemic comes through the village, the priest (Pathian or Thiampu) performs the rituals calling upon the Chung Pathian to protect the village from the epidemic and the entire village is out of bounds to outsiders for five days or more [29]. However, today, with the advent of Christianity and majority of them being Christians, most of these rituals have been discarded and with it scores of traditional knowledge including ethnomedicine has been forgotten.
Methodology
The present study is based on a carefully planned, field survey on 15 Biate villages within the district of Dima Hasao. Surveys were carried out from November 2010 to March 2013 with a minimum of three visits to each village, to gather information on a maximum number of species. Surveys were conducted through semi-structured questionnaires and in cases where the respondents were uncomfortable with the questionnaires, discussion and informal interviews were employed, and in the process information on different zootherapeutic uses were noted and documented [30,31]. A total of 300 individuals were interviewed. The age of the respondents ranges between 27 years to 78 years and the number of male respondents was higher (67%) as compared to the female respondents (33%). The respondents were selected randomly and Prior Informed Consent (PIC) was obtained for all interviews conducted. Information on the uses of each animal for disease treated, method of preparation, use and dosage, side effects, spiritual aspects linked to its use, parts used as medicine, local name, whether dried or fresh, whether rare or abundant, changes in abundance of the animal for the last 10 years, food value with market rate, efficacy of the remedies and how this knowledge was acquired by the respondents themselves were recorded. The scientific name and species of animals were identified by using relevant and standard literature.

Data analysis
For the data analysis, Fidelity Level (FL) calculated that demonstrates the percentage of respondents claiming the use of a certain animal for the same major purpose, was calculated for the most frequently reported diseases or ailments as,

\[
FL (%) = \frac{N_p \times 100}{N}
\]

Where \(N_p\) is the number of respondents that claim a use of a species to treat a particular disease, and \(N\) is the number of respondents that use the animals as a medicine to treat any given disease [31].

The range of fidelity level (FL) is from 1% to 100%. High use value (close to 100%) show that this particular animal species are used by large number of people while a low value show that the respondents disagree on that species to be used in the treatment of ailments.

Results and discussion
The present study documents 34 species used for the treatment of different ailments. Table 1 summarizes the scientific names of the medicinally used species, their
vernacular names, the part(s) of the species used, the
diseases or ailments the animal derived medicines
thought to be effective for, and the ways the treatments
are carried out. Table 2 summarizes the present conser-
vation status of the species mentioned in Table 1 as
zootherapeutically important. These species are distrib-
uted among at least 31 zoological families. The taxo-
nomic Class with the largest number of species were
Mammalia (17 species), followed by Aves (7 species) and
Reptilia with five species (Figure 3). In similar studies
carried out around the world, mammals and birds also
recorded the highest use as part of local folk medicines
[32-35]. Surveys other than our own research from
northeastern India indicates the same [14,16,17]. Other
Class mentioned by the interviewees belonged to
Gastropoda (2 species), Insecta (2 species) and Malacos-
traca (1 species). Different researchers from India have
already contributed to the knowledge of 351 ethno-
medicinal uses of animal and its parts (Table 3)
[11-17,36-44]. The present study, with the usage of 34
species recorded for the first time from the district is an
addition to the above figure.

Fidelity Level (FL) demonstrates the percentage of re-
spondents claiming the use of a certain animal for the
same major purpose. The uses of animals that are com-
monly known by the respondents have higher fidelity
level than less common known. The bone of *Hoolock
hollock* used to relieve rheumatism has the highest FL
(97%) followed by *Paratelphusa sp* for the treatment of
jaundice (96%) and the gall bladder of *Melursus ursinus*
used for easy delivery of a child (93%). The use of the
fur of *Lutrogale perspicillata* to treat burns and
*Periplaneta americana* for tuberculosis has the lowest
FL of 2% each (Table 1). The FL reveals that the treat-
ment for frequently reported ailments has the highest FL
value and those with low number of reports have low FL
value. About 34 different ailments have been reported to
be treated in the present study (Figure 4). While some of
Table 1 Medicinal uses of animals and animal parts in traditional therapy by the Biate tribe of Dima Hasao district

| Scientific Name/Family | English name | Part used | Dried/Fresh | Disease treated | Method of preparation, use and dosage of medicine | Used Singly/combination with others | Side effects reported | Fidelity level (%) |
|------------------------|--------------|-----------|-------------|-----------------|-----------------------------------------------|-----------------------------------|----------------------|---------------------|
| **Class: Reptilia**    |              |           |             |                 |                                               |                                  |                      |                     |
| Ophiophagus hannah     | King Cobra   | Gall bladder | Dried      | Snake bite      | Eaten/swallowed whole. 1 whole piece once.    | Singly                           | None                 | 33                  |
| Python molurus         | Python       | Flesh      | Dried or fresh | Seizure         | Eaten cooked with vegetables. No particular dosage. | Singly or in combination with vegetables | None                 | 90                  |
| Varanus bengalensis    | Monitor Lizard | Fat     | Fermented  | Burns       | Cooked and eaten. No particular dosage. | Singly                           | None                 | 61                  |
| Gekko gecko            | Tokay Gecko  | Flesh      | Dried      | Jaundice       | Cooked and eaten. No particular dosage. | Singly                           | None                 | 54                  |
| Melanochelys trijuga   | Indian Pond Terrapin | Flesh     | Dried      | Jaundice       | Cooked and eaten. No particular dosage. | Singly                           | None                 | 38                  |
| **Class: Malacostraca**|              |           |             |                 |                                               |                                  |                      |                     |
| Paratelphusa sp.       | Fresh water crab | Whole   | Fresh     | Jaundice       | Crabs (especially small ones) are crushed to pulp. The juice extracted is mixed with a little water and boiled till it becomes half of the quantity and then taken. It is often cooked along with banana flower. No particular dosage. | Singly                           | None                 | 96                  |
| **Class: Gastropoda**  |              |           |             |                 |                                               |                                  |                      |                     |
| Cryptozona sp.         | Snail        | Whole     | Fresh      | Rheumatism and Sciatica | Inserted inside a banana for ease of ingestion and swallowed whole. 1 every day for 1 week. | Singly or in combination with edibles | None                 | 36                  |
| Lymnaea sp.            | Water snail  | Flesh     | Fresh      | Jaundice       | Cooked and eaten. No particular dosage. | Singly or in combination with vegetables | None                 | 73                  |
| **Class: Insect**      |              |           |             |                 |                                               |                                  |                      |                     |
| Cimex lectularius      | Bed bugs     | Whole     | Fresh      | Malaria        | 3 bedbugs are swallowed whole, daily for 1 week. It is often inserted in a banana for ease of ingestion. | Singly                           | None                 | 27                  |
| Periplanata americana  | Cockroach    | Whole     | Dried      | Tuberculosis   | Crushed and eaten. 3 every week for 1 month. | Singly                           | None                 | 2                   |
Table 1 Medicinal uses of animals and animal parts in traditional therapy by the Biate tribe of Dima Hasao district (Continued)

| Class: Aves | | | | |
|---|---|---|---|---|
| Gallus gallus (Linn. 1758) /Phasianidae | Jungle fowl | Fat | Fermented | Burns | Applied locally. Singly or in combination with edibles |
| Corvus macrorhynchos (Wagler, 1827) /Corvidae | Jungle crow | Flesh | Dried or fresh | Health tonic for the aged | Cooked and eaten. No particular dosage. Singly or with vegetables |
| Rhynchos undulatus (Shaw, 1811) /Bucerotidae | Wreathed Hornbill | Fat | Fermented | Burns | Applied locally. Singly |
| Passer domesticus (Linn. 1758) /Passeridae | House Sparrow | Brain | Fresh | Impotency | Cooked and eaten. No particular dosage. Singly or with vegetables |
| Myophonus caeruleus (Scopoli, 1786) /Turdidae | Blue whistling Thrush | Flesh | Dried | Meat allergy | Cooked and eaten. No particular dosage. Singly or with vegetables |
| Buceros bicormis (Linn. 1758) /Bucerotidae | Great Hornbill | Fat | Fermented | Arthritis | Applied locally. Singly |
| Upupa epops (Linn. 1758) /Upupidae | Hoopoe | Flesh | Dried | Gall bladder stone | Cooked and eaten. No particular dosage. Cooked with Marsdenia sp. |

| Class: Mammalia | | | | |
|---|---|---|---|---|
| Manis crassicaudata (E. Geoff. 1803) /Manidae | Indian Pangolin | Scales | Dried | Hook worm | 1 scale, crushed to powder and taken with water. Singly |
| Canis aureus (Linn. 1758) /Canidae | Golden Jackal | Flesh | Dried | Tuberculosis | Cooked and eaten. No particular dosage. Singly or with vegetables |
| Muntiacus muntjak (Zimm. 1780) /Cervidae | Barking Deer | Flesh | Dried or fresh | Easy conception | Cooked and eaten. No particular dosage. Singly or with vegetables |
| Eonycteris spelaea (Dobson, 1871) /Pteropodidae | Bat | Flesh | Dried | Eneuresis | Cooked and eaten. No dosage. Singly |
| Melursus ursinus (Shaw, 1791) /Ursidae | Sloth Bear | Gall bladder | Dried | Diabetes | Swallowed whole at least twice in a year. Decreases lactation which becomes normal again after 3–6 days. |
| Ursus thibetanus (Cuvier, 1823) /Ursidae | Himalayan Black Bear | Gall bladder | Dried | Easy delivery of a child | Swallowed whole before delivery. 1 whole piece once. Decreases lactation which becomes normal again after 3–6 days. |
| Ursus thibetanus (Cuvier, 1823) /Ursidae | Himalayan Black Bear | Gall bladder | Dried | Diabetes | Swallowed whole at least twice in a year. Decreases lactation which becomes normal again after 3–6 days. |
| Animal Species                                      | Body Part       | Condition                        | Preparations and Administration                                                                 | Dosage Details                                           | Notes                                                                 |
|-----------------------------------------------------|-----------------|----------------------------------|-------------------------------------------------------------------------------------------------|----------------------------------------------------------|----------------------------------------------------------------------|
| **Hoolock hoolock (Harlan, 1834)** /Hylobatidae     | Gall bladder    | Diabetes                         | Swallowed whole. 1 whole piece once. It is cooked with vegetables and taken. No dosage          | Singly                                                    | None 87                                                              |
|                                                     | Flesh           | Tonic for pregnant women         | It is cooked with vegetables and taken. No dosage                                             | In combination with different vegetables                 | None 80                                                              |
|                                                     | Brain           | Tonic for pregnant women         | Cooked and eaten. Believed to be an excellent health tonic especially for a pregnant women and her unborn child. No dosage | Singly                                                    | None 68                                                              |
|                                                     | Bone             | Rheumatism                       | A piece of bone is usually tied around the foot, leg or waist                                  | Singly                                                    | None 97                                                              |
|                                                     | Skull bone      | Dizziness                        | Piece of skull bone is tied to the head.                                                       | Singly                                                    | None 3                                                               |
|                                                     | Hand             | Hernia                           | Smoked dried hand is used to rub down the affected area.                                       | Singly                                                    | None 16                                                              |
| **Capricornis sumatraensis (Bechstein, 1799)** /Bovidae | Front foot     | Joint pains, rheumatism          | The affected area is usually hammered gently every day.                                       | Singly                                                    | None 74                                                              |
|                                                     | Urine            | Diabetes                         | ~ 5 ml once in a month.                                                                         | Singly                                                    | None 24                                                              |
|                                                     | Fur              | Cuts & wounds and bed sore       | Applied locally                                                                                | Singly                                                    | None 31                                                              |
|                                                     | Blood            | Chronic malaria                  | ~ 100 ml of fresh blood is drunk while still warm                                               | Singly                                                    | None 58                                                              |
| **Nycticebus coucang (Boddaert, 1785)** /Lorisidae  | Blood            | Epilepsy                         | ~ 50 ml fresh blood mixed with alcohol (preferably local rice beer) is taken once.             | Singly                                                    | Slight dizziness and nausea 10                                      |
|                                                     | Flesh            | Epilepsy                         | Cooked and eaten. No dosage                                                                    | Singly                                                    | None 38                                                              |
|                                                     | Flesh            | Tonic for pregnant women         | Cooked and eaten. No dosage                                                                    | In combination with different vegetables                 | None 61                                                              |
| **Macaca assamensis (McClelland, 1840)** /Cercopithecidae | Brain           | Tonic for pregnant women         | Cooked and eaten. Believed to be an excellent health tonic especially for a pregnant women and her child. No dosage | Singly                                                    | None 27                                                              |
|                                                     | Gall bladder     | Diabetes                         | Swallowed whole. 1 whole piece once.                                                            | Singly                                                    | None 77                                                              |
|                                                     | Smoked dried hand| Mumps                            | It is used to tap gently in and around the affected area.                                      | Singly                                                    | None 63                                                              |
| **Hystrix indica (Kerr, 1792)** /Hystricidae        | Flesh            | Easy delivery of a child         | Cooked and eaten. No dosage                                                                    | Singly                                                    | None 38                                                              |
|                                                     | Teeth            | Toothache                        | The thick hair on the tail is used to pick the affected tooth.                                 | Singly                                                    | None 4                                                               |
| Animal and Part | Use | Part Used | Condition | Preparation | Dosage |
|-----------------|-----|-----------|-----------|-------------|--------|
| **Lutrogale perspicillata**<br>(Geoffroy, 1826) / Mustelidae | Smooth coated otter | Flesh | Dried or fresh | Fish bone stuck in the throat | Soup prepared is taken slowly. No dosage |
| | Fur | Dried or fresh | Burns | | Cooked with lady's finger. |
| **Trachypithecus pileatus**<br>(Blyth, 1843) / Cercopithecidae | Capped langur | Tongue | Dried | Food poisoning | Cooked and eaten. No dosage |
| | | | | | In combination with different vegetables |
| **Sus scrofa**<br>(Linn. 1758) / Suidae | Wild Boar | Fat | Fresh | Hair care | Fats are fried to produce oil which is applied daily. |
| | | | | | At least 3 pieces are eaten, one per day at intervals of a few days to lower diabetes. The same applies for high blood pressure. |
| **Trachypithecus cristatus**<br>(Raffles, 1821) / Cercopithecidae | Silvered Leaf Monkey | Gall bladder | Dried | Diabetes & High Blood Pressure | Singly |
| | | | | | None | 3 |
| | | | | | None | 2 |
| | | | | | None | 8 |
| | | | | | None | 45 |
| | | | | | None | 82 |
Table 2 Table showing the food value, other uses and recent conservation status of species mentioned in Table 1 as per the IUCN Redlist

| Scientific Name/Family | English name | Vernacular name | Is the species Rare or Abundant? | Changes in abundance of the animal for the last 10 years (more Abundant/ Less Abundant/same/Rare) | Food value (Price in Indian Rupees if sold) | Uses other than food & medicine | Threat status (IUCN Red List) |
|------------------------|--------------|-----------------|---------------------------------|--------------------------------------------------------------------------------------------------|-----------------------------------------------|----------------------------------|--------------------------------|
| **Class: Reptilia**    |              |                 |                                 |                                                                                                  |                                               |                                  |                                 |
| Ophiophagus hannah     | King Cobra   | Sok ngan        | Rare                            | Less Abundant                                                                                    | None                                          | None                             | Vulnerable                      |
| (Cant. 1836) /Elapidae |              |                 |                                 |                                                                                                  |                                               |                                  |                                 |
| Python molurus         | Python       | Rulpui          | Rare                            | Rare                                                                                             | None                                          | None                             | Near Threatened                 |
| (Linn., 1758) /Pythonidae |              |                 |                                 |                                                                                                  |                                               |                                  |                                 |
| Varanus bengaleensis   | Monitor lizard | Sartang        | Rare                            | Rare                                                                                             | None                                          | None                             | Least Concern                   |
| (Daudin, 1802) /Varanidae |              |                 |                                 |                                                                                                  |                                               |                                  |                                 |
| Gekko gecko            | Tokay Gecko  | Totke           | Abundant                        | Less Abundant                                                                                    | None (Rs 2,50,000 approx for 300 gm live animal) | None                             | Not Assessed                    |
| (Linn. 1758) /Gekkonidae |              |                 |                                 |                                                                                                  |                                               |                                  |                                 |
| Melanochelys trijuga   | Indian Pond Terrapin | Sarpha | Rare | Rare                                                                                             | Yes (Rs 400 per kg)                           | Pet                              | Near Threatened                 |
| (Schw.1812) /Geoemydidae |              |                 |                                 |                                                                                                  |                                               |                                  |                                 |
| **Class: Malacostraca**|              |                 |                                 |                                                                                                  |                                               |                                  |                                 |
| Paratelphusa sp.       | Fresh water crab | Iai             | Abundant                        | Less Abundant                                                                                    | Yes (Rs 5 per crab)                          | None                             | Not Assessed                    |
| (Alcok, 1919) /Paratelphidae |              |                 |                                 |                                                                                                  |                                               |                                  |                                 |
| **Class: Gastropoda**  |              |                 |                                 |                                                                                                  |                                               |                                  |                                 |
| Cryptozona sp          | Snail        | Napkhong        | Abundant                        | Same                                                                                             | None                                          | None                             | Not Assessed                    |
| (Moerch, 1872) /Ariophantidae |              |                 |                                 |                                                                                                  |                                               |                                  |                                 |
| Lymnaea sp. (Lam. 1822) | Water snail | Rifol          | Abundant                        | Same                                                                                             | Yes (Rs 40 per kg)                           | None                             | Not Assessed                    |
| /Lymnaeidae            |              |                 |                                 |                                                                                                  |                                               |                                  |                                 |
| **Class: Insect**      |              |                 |                                 |                                                                                                  |                                               |                                  |                                 |
| Cimex lectularius      | Bed bugs     | Rifat           | Abundant                        | Same                                                                                             | None                                          | None                             | Not Assessed                    |
| (Linn.1758) /Cimicidae |              |                 |                                 |                                                                                                  |                                               |                                  |                                 |
| Periplaneta americana  | Cockroach    | Khalai          | Abundant                        | Same                                                                                             | None                                          | None                             | Not Assessed                    |
| (Linn. 1758) /Blattidae |              |                 |                                 |                                                                                                  |                                               |                                  |                                 |
| **Class: Aves**        |              |                 |                                 |                                                                                                  |                                               |                                  |                                 |
| Gallus gallus          | Jungle fowl  | Ram Ar          | Abundant                        | Less Abundant                                                                                    | Yes                                           | Pet                              | Least Concern                   |
| (Linn. 1758) /Phasianidae |              |                 |                                 |                                                                                                  |                                               |                                  |                                 |
| Corvus macrorhynchos   | Jungle crow  | Va ak           | Abundant                        | Same                                                                                             | None                                          | None                             | Least Concern                   |
| (Wagler, 1827) /Corvidae |              |                 |                                 |                                                                                                  |                                               |                                  |                                 |
| Rhyticeros undulatus   | Wreathed     | Rangkek         | Rare                            | Rare                                                                                             | Yes                                           | Used in traditional dance by the Zeme Naga Tribe | Not Assessed                    |
| (Shaw, 1811) /Bucerotidae | Hornbill    |                 |                                 |                                                                                                  |                                               |                                  |                                 |
| Passer domesticus      | House Sparrow | Vasak           | Abundant                        | Same                                                                                             | Yes                                           | None                             | Least Concern                   |
| (Linn. 1758) /Passeridae |              |                 |                                 |                                                                                                  |                                               |                                  |                                 |
| Myophonus caeruleus    | Blue whistling Thrush | Vakok | Rare | Rare                                                                                             | Yes                                           | Pet                              | Least Concern                   |
| (Scopoli, 1786) /Turdidae |              |                 |                                 |                                                                                                  |                                               |                                  |                                 |
| Scientific Name | Common Name | Status | Trade Status | Conservation Status |
|-----------------|-------------|--------|--------------|---------------------|
| *Buceros bicornis* (Linn. 1758) /Bucerotidae | Great Hornbill | Rare | Rare | Yes (Rs 1500 whole) | Skull used as decoration | Near Threatened |
| *Upupa epops* (Linn. 1758) /Upupidae | Hoopoe | Rare | Rare | Yes | Feather used as decoration | Least Concern |
| *Manis crassicaudata* (E. Geoff. 1803) /Manidae | Indian Pangolin | Rare | Rare | Yes (Rs 10,000 whole skin) | The skin is believed to posses powers to ward off black magic | Near Threatened |
| *Canis aureus* (Linn. 1758) /Canidae | Golden Jackal | Abundant | Less Abundant | Yes (Rs 250 per kg) | None | Least Concern |
| *Muntiacus muntjak* (Zimm. 1780) /Cervidae | Barking Deer | Rare | Rare | Yes (Rs 400 per kg) | None | Least Concern |
| *Eonycteris spelaea* (Dobson, 1871) /Pteropodidae | Bat | Abundant | same | None | None | Least Concern |
| *Melursus ursinus* (Shaw, 1791) /Ursidae | Sloth Bear | Rare | Rare | None | Pet | Vulnerable |
| *Ursus thibetanus* (Shaw, 1791) /Ursidae | Himalayan Black Bear | Rare | Rare | None | Pet | Vulnerable |
| *Hoolock hoolock* (Harlan, 1834) /Hylobatidae | Hoolock Gibbon | Rare | Rare (almost extinct) | Yes (Rs 250–300 per kg) | Pet | Endangered |
| *Capricornis sumatraensis* (Bechstein, 1799) /Bovidae | Mainland Serow | Rare | Rare (almost extinct) | Yes (Rs 300 per kg) | Skin is used for making drums | Vulnerable |
| *Nycticebus coucang* (Boddaert, 1785) /Lorisidae | Slow Loris | Rare | Rare | Yes | As Pet | Vulnerable |
| *Canis lupus familiaris* (Linn. 1758) /Canidae | Dog | Abundant | same | Yes (Rs 200 per kg) | Pet | Not Assessed |
| *Macaca assamensis* (McClelland, 1840) /Cercopithecidae | The Assamese Macaque | Abundant | Less Abundant | Yes (Rs 200–250 per kg) | Pet | Near Threatened |
| *Hystrix indica* (Kerr, 1792) /Hystricidae | Indian Crested Porcupine | Rare | Rare | Yes (Rs 400–600 whole) | Spine used in traditional weaving | Least Concern |
| *Elephas maximus* (Linn,1758) /Elephantidae | Asian Elephant | Rare | Rare (almost extinct) | Yes (Rs 300–500 per kg) | None | Endangered |
| *Lutrogale perspicillata* (Geoffroy, 1826) /Mustelidae | Smooth coated otter | Rare | Rare | Yes | None | Vulnerable |
| *Trachypithecus pileatus* (Blyth, 1843) /Cercopithecidae | Capped langur | Rare | Rare | Yes (Rs 250–300 per kg) | None | Vulnerable |
| *Sus scrofa* (Linn. 1758) /Suidae | Wild Boar | Abundant | Same | Yes (Rs 250–300 per kg) | None | Least Concern |
| *Trachypithecus cristatus* (Raffles, 1821) /Cercopithecidae | Silvered Leaf Monkey | Rare | Rare | Yes (Rs 200–250 per kg) | Pet | Near Threatened |
the ailments reported here are common ones such as burns, worms, hair care etc., but most of them are serious ailments such as jaundice, diabetes, malaria, impotency, hernia, epilepsy etc. Maximum number of species has been reported for the treatment of diabetes (Figure 4). The high fidelity levels for the treatment of diabetes suggest high frequency of report and thereby warrant in-depth studies to establish its pharmacological activity.

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. Fifty three percent of the animal parts are used after drying either after sun dried or smoked dried (Figure 5). Different parts of the animals are utilized for different ailments. In some cases, the sought after body parts does not always come from the same species. For example, the gall bladder from six different species has been reported as treatment for diabetes (Table 1). Maximum number of animal parts used for medicine comes from the flesh, followed by the gall bladder and fat (Figure 6). Very few side effects have been reported except for a few species.

The study has revealed that the Biate tribe possesses vast knowledge on the traditional usage of animal parts for medicine. This traditional knowledge is a guarded secret passed on from generation to generation through oral tradition. The reluctance of the traditional healers to reveal their secrets is due to the belief that revealing the properties and secrets renders the medicine ineffective. Although some of the species has already been documented elsewhere in India, the usages documented herein are unique to the Biate tribe. As for example, fats of *Buceros bicornis* is used by the Nyishi and Galo tribe of Arunachal Pradesh to treat body pain [13], while in the present study area, the fats of the same species is used in the treatment of arthritis. Flesh and fats of *Hystrix sp* are used in the treatment of body ache, rheumatic pain etc. [14] however the flesh of the same species is used to facilitate easy delivery of a child amongst the Biate tribe. Tooth of *Elephas maximus* is used for conjunctivitis and pimples [38], whereas it is used for toothache by the Biate tribe. Similarly, the use of *Python molurus* flesh for seizure, *Cimex lectularius*

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**Table 3 Ethnomedicinal uses of animals reported from different parts of India**

| Title                                | No of species | Authors                | Reference |
|---------------------------------------|---------------|------------------------|-----------|
| Sporadic study in India               | 20            | Gosh A K, Maiti P K    | [44]      |
| Bhil of Rajasthan                     | 17            | Sharma S K             | [43]      |
| Bhil, Gamit, Kokna etc. of Maharashtra| 15            | Patil S H              | [42]      |
| Chhattisgarh                          | 10            | Oudhia P               | [41]      |
| Chhattisgarh                          | 7             | Oudhia P               | [40]      |
| Kachch (Gujrat)                       | 34            | Gupta Leena et al.     | [39]      |
| Irular, Kurimba of Tamilnadu          | 26            | Solvan A et al.        | [38]      |
| Kanikar, Paliyar of Tamilnadu         | 11            | Ranjit Singh ASA       | [37]      |
| Mogya, Meena, Bawaria of Rajasthan    | 15            | Mahawar, Jaroli        | [33]      |
| Saharia of Rajasthan                  | 15            | Mahawar, Jaroli        | [36]      |
| Monpas                                | 11            | Solanki GS and Chutia P| [11]      |
| Mizoram                               | 56            | Lalramminglevlova      | [12]      |
| Chakhesang of Nagaland                | 23            | Kakati and Doulo       | [16]      |
| Naga tribe of Nagaland                | 26            | Jamir N S et al.       | [14]      |
| Dibrugarh (Assam)                     | 4             | Dilip Kalita           | [15]      |
| Ao tribe of Nagaland                  | 25            | Kakati L N et al.      | [17]      |
| Nyishi & Galo Tribe of Arunachal Pradesh | 36    | Chakravarty et al.     | [13]      |

**Biate Tribe, Dima Hasao, Assam** | 34 | Present Study |
for malaria, flesh of *Upupa epops* for gall bladder stone etc. are all unique to the Biate tribe.

It has been observed that most of the animal parts are usually procured manually which involves hunting of these animals and birds. Very often, animal-derived medicines and preserved animal body parts are sold openly at the local markets. Commercialization of animals for medicinal purposes is a widespread phenomenon; with significant implications for their conservation and sustainable use [45]. Local villagers very often hunt these animals in the lure of quick money. For example, a 300 gm live *Gekko gecko* may fetch a sum of 2,50,000 INR and scales of *Manis crassicaudata* cost approximately 10,000 INR (Table 2). Thus, the unchecked and unmonitored sale of wild animal products in the local markets has a significant impact on the population of the wild fauna.

The present study has documented the usage of at least 15 animals listed under Endangered, Vulnerable and Near Threatened category of the IUCN Red List (Table 2). While several are listed under Least Concern in the IUCN Red List, the present study observes that there has been a drastic change in the abundance of the species even within the last ten years (Table 2). Species like *Gekko gecko, Gallus gallus, Canis aureus, Macaca assamensis, Nycticebus coucang* are less abundant now as compared to the last ten years (Figure 7).

The present study has revealed that out of the 34 species documented herein, at least 24 are also hunted for its meat as much as it is hunted for its medicinal value. Smoked meat of *Sus scrofa, Trachypithecus pileatus, Hoolock hoolock* etc. are in high demand and cost approximately 250–300 INR per kg (Table 2). Wild edible plants and animals form a part of the basic source of food amongst the tribal community in the study area. Traditionally, most of the Biate villages have an age old system of sustainable utilization which involves protecting or closing a section of the village forest area for several years and then open it for several years while another section is protected. The village chief is the supreme head and owner of the entire land and it is he who ensures the protection of an area along with his council. However, presently, with the lands coming under the Autonomous District Council, the village chiefs are often appointed by the district council and doesn’t follow the clan system as earlier and although the village chief is still the head, his powers are limited and the sense of ownership is gradually declining leading to unimpeded exploitation of the forest resources by the villagers and also by outsiders. *Elephas maximus, Capricornis sumatraensis* and *Hoolock hoolock* has almost been obliterated in the study area due to its excessive hunting. This is a fact of great concern because those species directly involved in traditional medicines and food should be amongst those of the highest priority for conservation [46].

Besides its medicinal and food value, these animals are also hunted for other uses. In a Biate community, as in
most of the tribes of the Chin-Kuki-Mizo clan of the district, the traditional drum known as ‘Khuang’ plays an important role while performing rites and rituals in the early days. Even in the present day, after the advent of Christianity, the ‘Khuang’ is still an integral part of the church music. The hide of *Capricornis sumatraensis* is considered one of the best raw materials for making the ‘Khuang’, and almost every household has one. The unrestricted hunting of this particular species for its meat and hide has almost wiped out the population within the district. Species like, *Melanochelys trijuga*, *Macaca assamensis*, *Nycticebus coucang*, *Hoolock hoolock* etc. are also reared as pets while skull and feather of *Buceros bicornis*, *Upupa epops* etc. are used as decoration and as a sign of expertise in hunting. The spine of *Hystrix indica* is used in weaving (Table 2).

Thus, it is important to point out that although medicinal use of animals is one of the main cause of threats to wild populations, it cannot be considered the only threat to the conservation of the species [47]. Medicinal use of animals must be considered together with other anthropogenic pressures, such as habitat loss, hunting for food etc. In most cases, the medicinal products of animals are by products from animals hunted for other purposes; thus, these multiple uses (including medicinal) of fauna and their impact on animal populations must be properly assessed and taken into consideration when implementing recovery plans for these species, especially those that are highly exploited [48].

It was observed that most of the people prefer this traditional cure to the modern pharmaceuticals, as it is less expensive and claimed to be more effective. Thus, zootherapy is an important and integral part of the traditional healthcare system of a tribal community, however overexploitation and lack of regulation and monitoring to safeguard for sustainable utilization is a point to consider seriously from the conservation point of view. Active participation by stakeholders at various levels in any management strategies, especially youths and the younger generation could help guarantee the sustainable use of these zootherapeutic resources. Spreading awareness coupled with a holistic approach to *in situ* and *ex situ* conservation, clinical trials and multidisciplinary studies to establish the efficacy of the products could come a long way in safeguarding the traditional knowledge and the resources as well.
Conclusion

The study provides a comprehensive account of the vast wealth of traditional knowledge and healthcare system of Biate tribe inhabiting the Dima Hasao district of Assam. Careful scientific scrutiny and screening of this traditional knowledge could lead to the development of newer and safer drugs as well as spur conservation and sustainable utilization of such a unique habitat and resources. The study area warrants further studies to document the traditional knowledge of the rest of the tribes inhabiting the area, which is the most important aspect in determining practical approaches to the management and sustainable use of the local flora and fauna.

Competing interest
The author(s) declare that they have no competing interest.

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