

USE OF ZOOTHERAPY IN THE TREATMENT OF MALARIA BY DIFFERENT ETHNIC GROUPS OF NORTH-EAST INDIA

Shreyasi Roy¹ and
Jaydip Sen¹

¹*Department of Anthropology, University of North Bengal, Raja Rammohunpur,
Darjeeling-734 013, West Bengal, India.*

ABSTRACT

Article History

Received : 26 October 2020

Revised : 12 November 2020

Accepted : 25 November 2020

Published : 31 December 2020

Key words

Malaria, zootherapy, ethnic
groups, north-eastern India.

Malaria is a long-standing public health issue around the world. It is estimated that India contributes 4% of the world's malaria cases and deaths. Out of this, north-east (NE) India contributes 15.2% of the country's total malaria cases. High transmission in the aforementioned region is fuelled by several factors. NE India is often contemplated as the goldmine of immense flora, fauna as well as cultural diversity with many ethnic communities who predominantly rely on the traditional medicinal system for their primary health care. The present review addresses the application of zootherapy in case of malaria among different tribes residing in the north-eastern states of India. Documentation and evaluation of this indigenous remedial knowledge may be convenient in establishing new drugs for human health.

INTRODUCTION

Northeast (NE) India (22°04'–29°31'N; 89°48'–97°25'E) is largely a mountainous territory of area of 255,128 km² with two-thirds being covered with hilly and mountainous terrain with heights ranging from 50m in Brahmaputra valley to 7000 m above mean sea level in the Himalayan borderland (Dikshit and Dikshit, 2014). The area comprises of seven administrative states viz. Assam, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland and Tripura (Figure 1). NE India is

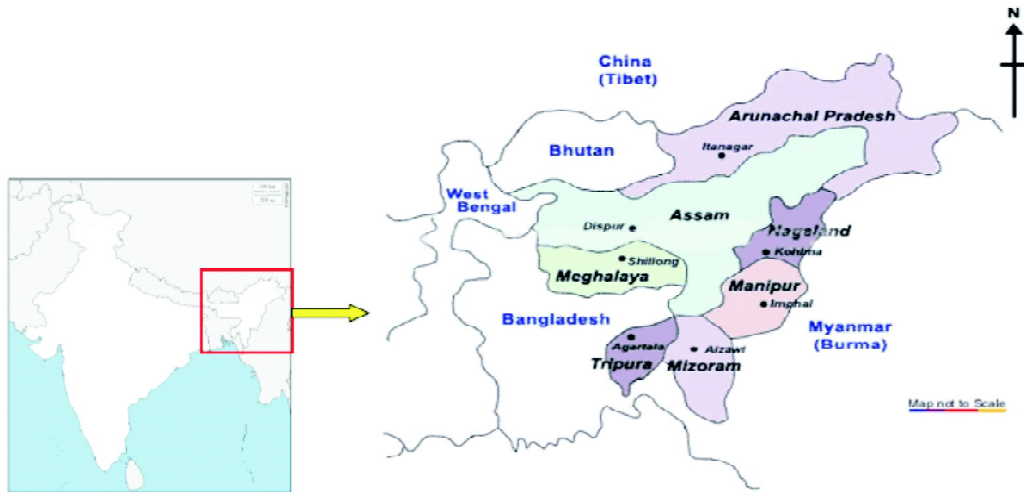


Figure 1. Map showing north-eastern states of India

acknowledged for its huge contribution (about 15.2%) of malaria cases in India (Sarma *et al.*, 2019). Intense malaria transmission in NE India is fuelled by its unique geo-ecological diversity and climatic variability, complex epidemiology, prevalence of drug-resistant strains, international borders, intense jhum cultivation and deforestation, etc.

One of the distinctive features of NE India is that this area is inhabited by a total of 427 tribal groups which have their own traditional cultural identity (as per 2011 Census). It is reported that these tribal groups are at the highest risk of malaria (Dev *et al.*, 2003). The tribal people are accustomed to heal health disorders using various traditional methods. They use plants parts, animals and/or their body parts/byproducts as a means to cure several diseases.

Zootherapy is defined as the healing of human ailments by using therapeutics based on medicines obtained from animals or ultimately derived from them (Costa-Neto, 2005). Animals and their parts/byproducts form important ingredients in the preparation of curative, protective and preventive medicine (Adeola, 1992). In modern societies, zootherapy constitutes an important alternative among many other known therapies practiced worldwide. Traditional method of healing in the form of traditional Chinese medicine, Indian Ayurveda and Arabic Unani medicine have proved their utmost best in curing several ailments. In comparison to complementary

and alternative medicine, traditional medicine is more prevalent in developing countries. Of the 252 essential chemicals that have been selected by the World Health Organization (WHO), 11.1% come from plants, and 8.7% from animals (Marques, 1997). According to WHO Traditional Medicine Strategy of 2002-2005, about 80% of African population uses traditional medicine to help meet their health care needs. In China, this accounts for around 40% of the health care needs. In India, about 65% of the population rely on traditional medicine. In India, nearly 15–20 percent of the Ayurvedic medicine is based on animal-derived substances (Unnikrishnan, 1998). Mahawar and Jaroli (2008) compiled and listed approximately 109 animal species used in the treatment of different kinds of ailments in India. In Tamil Nadu, nine tribes of four districts reported traditional therapeutic uses of sixteen different animal species, consisting of 6 species of mammals, 5 species of birds, 2 species of reptiles, 2 species of arthropods and 1 species of annelid for the treatment of over 17 kinds of diseases (Solavan *et al.*, 2004). In Chhattisgarh, Oudhia (1995) reported over 500 species of insects, mites and spiders useful to cure common and complicated ailments. A recent review by Das *et al.* (2017) portrayed lists of 77 species of mammals, 65 species of arthropods, 24 species of birds, 22 species of fishes, 18 species of reptiles, 6 species of annelids, 5 species of amphibians and 4 species of molluscs that are used by several ethnic groups of NE states in treating different ailments.

The present study attempted to list all the animal species used by the tribal/ethnic communities of NE India to treat malaria. Data was collected from 16 research papers published by different authors on zootherapeutic studies in NE India (Table 1). The present study focussed only on the application of zootherapy in curing malaria. From each and every included study, details such as scientific name, common English name and body parts of the animals used were listed. The mode of application by different tribes was also discussed in detail.

Mammals used by the ethnic groups

Mammals are one of the widely used groups of animals by the ethnic groups of NE India. Most commonly used body parts include gall bladder and bile of different mammals like Asiatic Black bear (*Ursus thibetanus*), fox (*Vulpes bengalensis*), porcupine (*Hystrix sp.*), hoolock gibbon (*Hoolock leuconedys*). Fresh warm blood of non-human primates such as slow loris (*Nycticebus coucang*), Assamese macaque (*Macaca assamensis*) were found to aid in the treatment of malaria. Flesh of clouded leopard (*Neofelis*

Table 1: List of published research works on zotherapy application (in the treatment of malaria) by different tribes of NE India

<i>Tribes/ ethnic groups/ region</i>	<i>Studied by</i>	<i>No. of animals reported for the treatment of malaria</i>
Lushais of Mizoram	Lalramnghinglova, 1999	5
Biate tribe of Dima Hasao district, Assam	Betlu, 2013	3
Karbis of Assam	Ronghang <i>et al.</i> , 2011	1
Major ethnic groups in Karbi Anglong district, Assam	Verma <i>et al.</i> , 2014	1
Meitei community of Bishnupur District of Manipur	Chanu <i>et al.</i> , 2017	1
Ao tribe of Nagaland	Kakati <i>et al.</i> , 2006	1
Chakhesang tribe of Nagaland	Kakati and Doulo, 2002	3
Tangsa tribe of eastern Arunachal Pradesh	Jugli <i>et al.</i> , 2020a	6
Wancho tribe of eastern Arunachal Pradesh	Jugli <i>et al.</i> , 2020a	2
Nyishi and Galo tribes of Arunachal Pradesh	Chakravorty <i>et al.</i> , 2011a	3
Nyishi and Galo tribes of Arunachal Pradesh	Chakravorty <i>et al.</i> , 2011b	1
Monpa of Arunachal Pradesh	Solanki and Chutia, 2004	9
Adi tribe of Arunachal Pradesh	Borang, 1999	3
Khasis of East Khasi Hill District of Meghalaya	Mihsill and Kehsan, 2017	3
Thadou tribe of Karbi Anglong, Assam	Teronpi <i>et al.</i> , 2012	1
Adi tribe of Arunachal Pradesh and local tribes of Mizoram	Chinlampianga <i>et al.</i> , 2013	12
Tribal communities of Arunachal Pradesh	Solanki and Chutia, 2009	45

nebulosa), common leopard (*Panthera pardus*) and wild cat (*Felix sp.*) are widely used in treating malaria. Musk of deer (*Moschus chrysogaster* or *M. moschiferus*) is also used for such purposes.

Aves used by the ethnic groups

Fat of crow (*Corvus splendens*) and eagle (*Spilornis cheela*) are used by the Monpa tribe of Arunachal Pradesh. Meat of different species of eagle, drongos, crow, hornbill and barbet were also found to aid in the treatment of malaria.

Reptiles used by the ethnic groups

Snakes such as *Hydrophis sp.*, *Vipera russelli* and *Python molurus* were used in treatment of malaria. Other reptiles used were Indian pond terrapin (*Melanocheilus trijuga*), tortoise (*Testudo sp.*) and monitor lizard (*Varanus bengalensis*).

Pisces used by the ethnic groups

Spiny eel (*Mastacembelus armatus*), climbing perch (*Anabas testudineus*) and *Channa punctata* were found to be used by the tribes of Arunachal Pradesh in treating malaria.

Annelids used by the ethnic groups

One of the common annelids used in treating malaria is fresh raw earthworms.

Anthropods used by the ethnic groups

Flesh of crab (*Cancer pagurus*) is used in the treatment of malaria. Eggs, larvae and adults of several ants were found to be used in treating malaria.

DETAILED STUDY ON THE MODE OF APPLICATION

According to Betlu (2013), Biate tribe of Dima Hasao district of Assam often prescribes to swallow 3 whole bedbugs (*Cimex lectularius*) daily for one week. For ease of ingestion, the bedbugs are often inserted in a banana. They are also prescribed to swallow one whole piece of (either sun- or smoke-) dried gall bladder of golden jackal (*Canis aureus*). Nearly 100 ml of fresh warm blood of slow loris (*Nycticebus coucang*) is also prescribed to drink in case of chronic malaria. Like the Biate tribe of Assam, Meitei community of Bishnupur District of Manipur were also found to treat malaria by swallowing *Cimex rotundatus* (Chanu *et al.*, 2017).

Karbi community of Assam roast a portion of smoke-dried gall bladder of sloth bear (*Melursus ursinus*) and take it directly for the treatment of malaria (Ronghang *et al.*, 2011). They are also observed to consume raw bile of bear (*Selenarctos sp.*) for treating malaria (Verma *et al.*, 2014). In contrast, the Ao tribe of Nagaland were found to boil the bile of bear in sufficient water prior to drinking (Kakati *et al.*, 2006). Teronpi *et al.* (2012) reported the use of bile of an unidentified fish by Thadou tribe of Assam. The bile is prescribed to be taken thrice a day till recovery. According to Mihsill and Kehsan (2017), the Khasis of East Khasi Hill District of Meghalaya claim that malaria can be cured by eating the hill mole after it was simply burned to cook. Some of them also reported to use bile juices of cows or bears along with some medicinal plants.

Adi tribe of Arunachal Pradesh claimed to prefer to use musk of deer, flesh of Indian rock python (*Python molurus*), bile and gut of Indian porcupine (*Hystrix hodgsoni*) for the treatment of malaria (Borang, 1999). They are also reported to use fishes such as *Channa punctata* and *Anabas testudineus* for treating malaria (Chinlapianga *et al.*, 2013). Based on the empirical study by Chinlapianga *et al.* (2013), the women of Adi tribe collect larvae of ants *Oecophylla smaragdina* to administer to a patient suffering from malaria. The adults of these ants are left on the back of a malaria patient. It is believed that these ants after coming in contact with the patient's body frequently bite and inject some acids or hormones into the body of the patient. This process eventually reduces the body heat which further aids to cure malaria. Another interesting insect scientifically known as *Aspongopus najus* is also given to malaria patients after mixing with some local leafy plants. During the treatment of malaria, the patient is asked to avoid eating bamboo shoots (in fresh or fermented form) as they believe this might cause hindrances in the curing process.

Like Adi tribe, the Mishings tribe and the Ahom Community of Assam also use *Oecophylla smaragdina* as one of the food items during the Assamese Bohag Bihu Festival in the month of April. It is presumed that consuming these ants might keep their health free from various diseases including malaria (Doley and Kalita, 2012). It was found that these ants contain very high levels of polyunsaturated fatty acids (PUFAs) that might cause a marked *in vitro* inhibition of *Plasmodium* (Ragunath *et al.*, 2017).

Chinlapianga *et al.* (2013) reported that the local tribes of Mizoram insert 3-5 whole bed bugs (*Cimex lectularis*) in an empty capsule and take it orally for the treatment

of malaria. Two or five times of such ingestion is reported to be sufficient to alleviate chronic fever. This method is also reported by Lalramnghinglova (1999) Fresh warm blood of Assamese macaque (*Macaca assamensis*) is taken orally for treating malaria. Earthworms are also prescribed in such cases. For ease of ingestion, earthworms are sometimes crushed and mixed with honey prior to drinking. Cooked meat of turtle (*Melanochelys trijuga*) and cooked bile of monitor lizard (*Varanus bengalensis*) and *Vipera russelli* were also taken by them in treating malaria. Lalramnghinglova (1999) reported that the Lushais (also known as Mizos) swallow cooked bile of Assamese macaque and monitor lizard, cooked meat of Indian pond terrapin for treating malaria. They are also reported to take 2-3 tablespoons of water of cooked stomach or intestine of porcupine twice a day till recovery.

Jugli *et al.* (2020a) reported traditional zotherapeutic application by Tangsa and Wancho tribe of eastern Arunachal Pradesh. Tangsa tribe of Arunachal Pradesh preserve freshly extracted gall bladder and bile of animals through smoke-dried or sun-dried method prior to application and/ or ingestion. They preferably rely on the gall bladder and bile of Asiatic black bear (*Ursus thibetanus*), fox (*Vulpes bengalensis*), porcupine (*Hystrix sp.*) and hoolock gibbon (*Hoolock leuconedys*). It is believed that the medicine prepared using gall bladder and bile of the bear can potentially uproot healthy teeth within a few months or 1-2 years. As a result, this medicine is consumed by putting it inside some solid eatables such as cooked rice, banana, etc. The Tangsa tribe of eastern Arunachal Pradesh treats enlarged spleen (i. e. , a major symptom of malaria) by rubbing dried/ fresh bile of hoolock gibbon onto the stomach with the aid of a leaf. It is believed that direct contact with the bile can make the spleen disappear completely which compels them to avoid direct contact of the bile with the stomach. Cooked spiny eel (*Mastacembelus armatus*) is also prescribed to consume for curing malaria. The Tangsa tribe crushes and sprinkles a small piece of sun/ smoke-dried shell or carapace of tortoise (*Testudo sp.*) on hot charcoal. The smoke emitted from this is believed to be a cure for malaria. The patient is asked to inhale the smoke by covering the head with a piece of cloth. This traditional healing method is, however, strictly prohibited for pregnant women. Like the Tangsa tribe, the Wancho tribe also consume dried gall bladder of porcupine as a treatment of malaria. They are also found to consume thin, reddish and small earthworms (*Pheretima sp.*) in raw form. The Tangsa tribe has developed a taboo against eating freshwater crabs

(*Maydelliathelphusa lugubris*) as they believe eating this in large quantity might cause malaria (Jugli *et al.*, 2020b).

Nyishi and Galo tribes of Arunachal Pradesh use gall bladder and umbilicus of deer to cure malaria (Chakravorty *et al.*, 2011a). They cook rice with fresh gall bladder and about 100-200 g of the mixture is taken once in a day till some improvement is seen. A pinch of smoke-dried umbilicus of deer is mixed in about half litre of water and fed to the patient till recovery. These tribes are also reported to use gall bladder of bear as a remedy in case of malaria. The bladder is filled with rice powder and smoke dried. A pinch of this mixture is either mixed with rice or taken directly once a day till some improvements are seen. Chakravorty *et al.* (2011b) reported that these tribes prescribe intake of crushed black ants (*Bothroponera rufipes*) along with other edibles during morning hours as a great remedy in case of malaria. Solanki and Chutia (2009) reported about 45 different species of animals that had great remedial potential in case of malaria. The study listed 26 different mammalian species, 1 reptile species and 18 avian species whose cooked meat was widely used by the tribal communities of Arunachal Pradesh for the treatment of malaria (Table 2).

CONCLUSION

In conclusion, fauna-based traditional knowledge is of utmost importance in curing malaria and other related disorders. However, this has posed a serious threat to endangered and rare animal species. As such banning such age-old traditions without giving an alternative is ought to bear its own social repercussions.

LIMITATIONS

As with the majority of studies, the design of the present review is subjected to few limitations. Firstly, the review listed small (though appropriate) list of animals and their body parts/ byproducts used in traditional healing of malaria. Secondly, the review focussed only on the research articles found in databases available online such as Pubmed. Only full papers were considered. Articles with only abstracts or no abstracts were not included in the current review. Other offline sources such as library books based on ethnobiology and ethnomedicine could have yielded more information pertaining to this issue.

Table 2: List of animals used in the treatment of malaria used by different tribes/ ethnic groups of NE India

<i>Studied by</i>	<i>Tribes/ ethnic groups</i>	<i>Common name</i>	<i>Scientific name</i>	<i>Body parts</i>	
Jugli <i>et al.</i> , 2020a	Tangsa tribe of AP	Asiatic Black bear	<i>Ursus thibetanus</i>	Gall bladder, bile	
		Fox	<i>Vulpes bengalensis</i>	Gall bladder, bile	
		Porcupine	<i>Hystrix sp.</i>	Gall bladder, bile, stomach, intestine	
		Hoolock gibbon	<i>Hoolock leuconedys</i>	Flesh, liver, blood, gall bladder, bile	
		Tortoise	<i>Testudo sp.</i>	Shell/ carapace	
		Spiny eel/ Bami fish	<i>Mastacembelus armatus</i>	Whole body, gall bladder	
		Wancho tribe of AP	Porcupine	<i>Hystrix sp.</i>	Gall bladder, bile
Chanu <i>et al.</i> , 2017	Meitei community of Bishnupur District of Manipur	Earthworm	<i>Pheretima sp.</i>	Whole	
		Bed bug	<i>Cimex rotundatus</i>	Whole	
Mihsill and Kehsan, 2017	Khasis of Meghalaya	Hill mole	-	-	
		Cow	-	Bile juice	
		Bear	-	Bile juice	
Verma <i>et al.</i> , 2014	Ethnic tribes of Karbi Anglong district, Assam	Bear	<i>Selenarctos sp.</i>	Bile	
Betlu, 2013	Biate tribe of Dima Hasao district, Assam	Golden jackal	<i>Canis aureus</i>	Gall bladder (dried)	
		Slow loris	<i>Nycticebus concang</i>	Fresh warm blood	
		Bed bug	<i>Cimex lectularis</i>	Whole	
Chinlapianga <i>et al.</i> , 2013	Local tribes of Mizoram	Indian porcupine	<i>Hystrix indica</i>	Intestine, rectum	
		Assamese macaque	<i>Macaca assamensis</i>	Fresh warm blood	
		Turtle	<i>Melanochelys trijuga</i>	Flesh	
		Monitor lizard	<i>Varanus bengalensis</i>	Bile	
		Russell's Viper	<i>Vipera russelli</i>	Bile	
		Earthworm	<i>Pheretima sp.</i>	Whole	
		Bed bug	<i>Cimex lectularis</i>	Whole	
		Adi people of AP	-	<i>Cbanna punctata</i>	-
		Climbing perch	<i>Anabas testudineus</i>	-	
		Bug	<i>Aspongopus najus</i>	-	
	Green ants	<i>Oecophylla smaragdina</i>	Larva and adults		
	Manta (red ants)	-	Eggs and adults		

Chakravorty <i>et al.</i> , 2011	Nyishi and Galo tribes of AP	Moon bear	<i>Ursus thibetanus</i>	Gall bladder
		Black bear	<i>Selenarctos thibetanus</i>	Gall bladder
		Deer	<i>Moschus chrysogaster</i> or <i>M. moschiferus</i>	Gall bladder, fresh blood, umbilicus
Chakravorty <i>et al.</i> , 2011b	Nyishi and Galo tribes of AP	Black ant	<i>Bothroponera rufipes</i>	Whole
Ronghang <i>et al.</i> , 2011	Karbi community of Assam	Sloth bear	<i>Melursus ursinus</i>	Gall bladder
Solanki and Chutia, 2009	Tribal communities of AP	Flying fox	<i>Pteropus giganteus</i>	Flesh, gut
		Bat	<i>Cynopterus sphinx</i>	Flesh, gut
		Chinese pangoline	<i>Manis pentadactyla</i>	Flesh, gut
		Leopard cat	<i>Felis bengalensis</i>	Flesh
		Marbled cat	<i>Felis marmorata</i>	Flesh
		Large Indian civet	<i>Viverra zibetha</i>	Flesh
		Himalayan palm civet	<i>Paguma larvata</i>	Flesh
		Yellow throated marten	<i>Martes flavigula</i>	Flesh
		Beech marten	<i>M. foina</i>	Flesh
		Yellow bellied weasel	<i>Mustela kathiah</i>	Flesh
		Siberian weasel	<i>M. sibirica</i>	Flesh
		Back striped weasel	<i>M. strigidorsa</i>	Flesh
		Common mongoose	<i>Herpestes edwardsii</i>	Flesh
		Small Indian mongoose	<i>H. auropunctatus</i>	Flesh
		Otter	<i>Lutra lutra</i>	Flesh
		Assamese macaque	<i>Macaca assamensis</i>	Flesh
		Rhesus macaque	<i>Macaca mulatta</i>	Flesh
		Stump tailed macaque	<i>Macaca arctoides</i>	Flesh
		Hoolock gibbon	<i>Bunopithecus hoolock</i>	Flesh
		Clouded leopard	<i>Neofelis nebulosa</i>	Flesh
		Tiger	<i>Panthera tigris</i>	Flesh
		Common leopard	<i>Panthera pardus</i>	Flesh

Use of Zotherapy in the Treatment of Malaria by Different Ethnic Groups of North-East India

		Sloth bear	<i>Ursus ursinus</i>	Flesh, gall bladder
		Himalayan Black bear	<i>Selenarctos thibetanus</i>	Flesh, gall bladder
		Eagle	<i>Nisaetus nipalensis</i>	Flesh
			<i>N. cirrhatus</i>	Flesh
			<i>Hieraetus fasciatus</i>	Flesh
			<i>Spilomis cheela</i>	Flesh
		Drongos	<i>Dicrurus adsimilis</i>	Flesh
			<i>D. paradiseus</i>	Flesh
			<i>D. aeneus</i>	Flesh
			<i>D. hottentottus</i>	Flesh
		Crow	<i>Corvus macrorhynchos</i>	Flesh
		Raven	<i>C. corax</i>	Flesh
		House crow	<i>C. splendens</i>	Flesh
		Great hornbill	<i>Buceros bicornis</i>	Flesh
		Indian pied hornbill	<i>Anthracoceros</i>	Flesh
			<i>malabaricus</i>	
		Wreathed hornbill	<i>Aceros undulates</i>	Flesh
		Rufous necked hornbill	<i>A. nipalensis</i>	Flesh
		Blue troated barbet	<i>Megalaima asiatica</i>	Flesh
		Himalayan great barbet	<i>M. virens</i>	Flesh
		Lineated barbet	<i>M. lineata</i>	Flesh
		Monitor lizard	<i>Varanus bengalensis</i>	Flesh
Kakati <i>et al.</i> , 2006	Ao tribe of Nagaland	Bear	<i>Selenarctos sp.</i>	Bile
Solanki and Chutia, 2004	Monpa of AP	Common leopard	<i>Panthera pardus</i>	Flesh
		Himalayan Black bear	<i>Selenarctos thibetanus</i>	Gall bladder
		Deer	<i>Moschus moschiferus</i>	Musk
		Hoolock gibbon	<i>Bunopithecus hoolock</i>	Flesh
		Assamese macaque	<i>Macaca assamensis</i>	Flesh
		Capped langur	<i>Trachypithecus pileatus</i>	Flesh
		Rhesus monkey	<i>Macaca mulatta</i>	Flesh
		Jungle Crow	-	Fat
		Hawk-eagle (shahinfalcon)	-	Fat

Kakati and Doulo, 2002	Chakhesang of Nagaland	Wild cat	<i>Felix sp.</i>	Flesh
		Snake	<i>Hydrophis sp.</i>	Liver
		Crab	<i>Cancer pagurus</i>	Whole body
Lalramnghinglova, 1999	Lushais of Mizoram	Indian porcupine	<i>Hystrix indica</i>	Stomach, intestine
		Assamese macaque	<i>Macaca assamensis</i>	Bile
		Indian pond terrapin	<i>Melanochelys trijuga</i>	Flesh
		Monitor lizard	<i>Varanus bengalensis</i>	Bile
		Beg bug	<i>Cimex lectularis</i>	Whole
Borang, 1999	Adi people of AP	Indian porcupine	<i>Hystrix hodgsoni</i>	Bile, gut
		Deer	<i>Moschus chrysogaster</i>	Musk
		Indian rock python	<i>Python molurus</i>	Flesh

AP= Arunachal Pradesh

References

- Adeola, M.O. (1992). Importance of wild animals and their parts in the culture, religious festivals, and traditional medicine, of Nigeria. *Environmental Conservation* 19:125–134.
- Betlu, A.L.S. (2013). Indigenous knowledge of zootherapeutic use among the Biate tribe of Dima Hasao District, Assam, Northeastern India. *Journal of Ethnobiology and Ethnomedicine* 9: 56.
- Borang A. (1999). *Studies on ceratin ethnozoological aspects of Adi tribe of Arunachal Pradesh (India)*. Ph.D. Thesis. Gauhati University.
- Chakravorty, J., Meyer-Rochow, V. B. and S. Ghosh. (2011a). Vertebrates used for medicinal purposes by members of the Nyishi and Galo tribes in Arunachal Pradesh (North-East India). *Journal of Ethnobiology and Ethnomedicine* 7:13.
- Chakravorty, J., Ghosh. S. and V. B. Meyer-Rochow. (2011b). Practices of entomophagy and entomotherapy by members of the Nyishi and Galo tribes, two ethnic groups of the state of Arunachal Pradesh (North-East India). *Journal of Ethnobiology and Ethnomedicine* 7:5.
- Chanu, T.A., Teron, R. and O.S.K. Singh. (2017). Studies on indigenous ethno-entomology of ethnic Meitei community of Bishnupur district, Manipur, NE India. *International Journal of Current Research* 9(4): 48625-48632.
- Chinlapianga, M., Singh, R.K. and A.C. Shukla. (2013). Ethno zoological diversity of Northeast India: Empirical learning with traditional knowledge holders of Mizoram and Arunachal Pradesh. *Indian Journal of Traditional Knowledge* 12:18-30.
- Costa-Neto, E. M. (2005). Animal-based medicines: biological prospection and the sustainable use of zootherapeutic resources. *Anais da Academia Brasileira de Ciências* 77(1):33-43.

- Dikshit, K. R. and Dikshit J.K. Relief Features of North-East India. In: Dikshit K.R., Dikshit J.K., eds. (2014). *North-East India: Land, People and Economy*. Dordrecht, The Netherlands: Springer Netherlands. pp. 91–125.
- Das, K. S., Choudhury, S. and K. C. L. Nonglati. (2017). Zootherapy among the ethnic groups of north eastern region of India- a Critical review. *Journal of Critical Reviews* 4(2): 1-9.
- Dev, V., Bhattacharyya, P. C. and R. Talukdar. (2003). Transmission of malaria and its control in the north-eastern region of India. *The Journal of the Association of Physicians of India* 51:1073-6.
- Doley, A. K. and J. Kalita. (2012). Traditional Uses of Insect and Insect Products in Medicine and Food by the Mishing tribe of Dhemaji District, Assam, North-East India. *Social Science Researcher* 1(2): 11-21.
- Jugli, S., Chakravorty, J. and V. B. Meyer-Rochow. (2020a). Zootherapeutic uses of animals and their parts: an important element of the traditional knowledge of the Tangsa and Wancho of eastern Arunachal Pradesh, North East India. *Environment, Development and Sustainability* 22: 4699–4734.
- Jugli, S., Chakravorty, J. and V. B. Meyer-Rochow. (2020b). Tangsa and Wancho of North-East India Use Animals not only as Food and Medicine but also as Additional Cultural Attributes. *Foods* 9(4):528.
- Kakati, L. N. and V. Doulo. (2002). Indigenous knowledge system of zootherapeutic use by Chakhesang tribe of Nagaland, India. *Journal of Human Ecology* 13:419-23.
- Kakati, L. N., Ao, B. and V. Duolo. (2006). Indigenous Knowledge of Zootherapeutic Use of Vertebrate Origin by the Ao Tribe of Nagaland. *Journal of Human Ecology* 19(3): 163-167.
- Lalramnghinglova, H. (1999). Ethnobiology in Mizoram state: Folklore Medico-zoology. *Bulletin of the Indian Institute of History of Medicine* 29: 123-148.
- Mahawar, M. M. and D. P. Jaroli. (2008). Traditional zootherapeutic studies in India: a review. *Journal of Ethnobiology and Ethnomedicine* 4: 17-29.
- Marques, J. G. W. (1997). Fauna medicinal: Recurso do ambiente ou ameaça à biodiversidade? *Mutum*. 1:4.
- Mihsill, K. R. R. and B. Keshan. (2017). Ethno-zoological Practices by Khasis, An Indigenous Tribe of Meghalaya, India. *The NEHU Journal* 15(1): 89-96.
- Oudhia, P. (1995). Traditional knowledge about medicinal insects, mites and spiders in Chhattisgarh. *Insect Environment*. 4: 57-58.
- Ragunath, G., Iyyapan, R., Senthilkumar, S. K. and V. Senthilkumar. (2017). Traditional zootherapeutic importance of the medicinal weaver ant *Oecophylla smaragdina*. *International Journal of Biological & Pharmaceutical Research* 8(1): 34-40.

- Ronghang, R., Teron, R., Tamuli, K. A. and R. Rajkhowa. (2011). Traditional zootherapy practised among the Karbis of Assam, India. *The Ecoscan* 2011, 1:161-6.
- Sarma, D. K., Mohapatra, P. K., Bhattacharyya, D. R., Chellappan, S., Karuppusamy, B., Barman, K., Kumar, N. S., Dash, A. P., Prakash A. and P.B. Nina. (2019). Malaria in North-East India: Importance and Implications in the Era of Elimination. *Microorganisms* 7(12):673.
- Solanki, G. S. and P. Chutia. (2004). Ethno Zoological and Socio-cultural Aspects of Monpas of Arunachal Pradesh. *Journal of Human Ecology* 15(4): 251-254.
- Solanki, G. S. and P. Chutia. (2009). Studies on Ethno-Medicinal Aspects and Zoo-Therapy in Tribal Communities in Arunachal Pradesh, India. *International Journal of Ecology and Environmental Sciences* 35 (1): 67-76.
- Solavan, A., Paulmurugan, R., Wilsanand, V. and A. J. A. R. Sing. (2004). Traditional therapeutic uses of animals among tribal population of Tamil Nadu. *Indian Journal of Traditional Knowledge* 3(2): 198-205.
- Teronpi, V., Singh, H. T., Tamuli, A. K. and R. Teron. (2012). Ethnozoology of the Karbis of Assam, India: Use of ichthyofauna in traditional health-care practices. *Ancient Science of Life* 32(2):99-103.
- Unnikrishnan, P. (1998). Animals in Ayurveda. *Amruth* 1(13): 1-15.
- Verma, A. K., Prasad, S. B., Rongpi, T. and J. Arjun. (2014). Traditional Healing With Animals (Zootherapy) By the Major Ethnic Group of Karbi Anglong District Of Assam, India. *International Journal of Pharmacy and Pharmaceutical Sciences* 6(8): 593-600.
- WHO. (2002). WHO Traditional Medicine Strategy of 2002-2005. WHO/EDM/TRM/2002.1.

To cite this article:

Shreyasi Roy and Jaydip Sen. Use of Zootherapy in the Treatment of Malaria by Different Ethnic Groups of North-East India. *Man, Environment and Society*, Vol. 1, No. 2, 2020, pp. 173-186