




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

Salomi Jugli¹ · Jharna Chakravorty¹ · Victor Benno Meyer-Rochow^{2,3} 

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Abstract

Using animals and their products to treat patients suffering from a range of health conditions has a long history and is still common in many parts of the world. We investigated such zootherapeutic uses among two tribes who inhabit different areas of North-East India: the Tangsa and the Wancho. Overexploitation of the animals they use, however, could endanger some species' survival and create imbalances in the ecosystem that ultimately could affect humans and animals of the region. In order to find solutions how humans and animals can continue to coexist harmoniously, it is essential to know which species and their products are sought after by the local healers. We found that the Tangsa make greater use of animals than Wancho and use predominantly a variety of mammals (47%) followed by birds (16%) of the 55 species of animals considered therapeutic by them. The Wancho informed us of using 20 species, of which birds and their products account for 37%, while mammals and insects feature in 26% and 21%, respectively. In both tribes, the remainder are distributed across different animal taxa. To treat ailments and diseases like joint, bone and muscle pains, Tangsa prefer to use the body fats of tiger, civet, hornbill, eagle and python. Wancho do not use any animal fats very often and prefer animal parts and marrow to be given to a sick person in cooked or roasted form. The bile of bears is used by both Tangsa and Wancho in that it is supposed to ameliorate pain-causing conditions such as stomach, head and toothaches and to reduce labour pains. The use of leeches to remove blood clots and the consumption of earthworms to ward off malaria has been recorded only from the Wancho, while Tangsa treat malaria sufferers with tortoise carapace extracts. The use of the flesh of roasted bat wings fed to children older than 4 years of age to stop bed-wetting seems unique to the Tangsa. Being aware of such folk medicinal traditions is important not just with regard to safeguarding the animal resource, but also in connection with the introduction of possible alternative treatment methods not involving animal zootherapies.

Keywords Folk medicine · Vertebrates · Common knowledge · Treatment · Sickness

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✉ Victor Benno Meyer-Rochow
meyrow@gmail.com

Extended author information available on the last page of the article

1 Introduction

Traditional knowledge (TK), also often referred to as common knowledge or common sense (Erren et al. 2013), is a cumulative body of awareness and understanding of practices and beliefs held by local people (Turner and Berkes 2006). It involves adaptations to local environmental circumstances, has stood the test of time and is handed down through generations by way of cultural transmission (Berkes 2009; Alves and Rosa 2013). Traditional knowledge is integral to the identity of most local communities and key constituent of a community's social and physical environment, and as such, its preservation is of paramount importance. Practices using animals for varied purposes like food, medicines, entertainment, hunting, handicrafts, trade and various sociocultural practices are an important component of the body of traditional knowledge of many tribal communities around the world (Turner 2005; Singh et al. 2009; Mishra et al. 2009; Alves et al. 2017). *The bio-cultural wisdom often present among tribals has not only made them sustain their life through the ages* (e.g. Alves 2012; Singh et al. 2010) but moreover is of sociocultural significance reflecting regional preferences (Nonaka 2005).

Use of plants and animals by generations of indigenous people for health and well-being is known as traditional or folk medicine, and zootherapies have been studied, to name but a few, in several locations around the world, e.g. Latin America (Costa-Neto 2005; Alves et al. 2010; Alves and Alves 2011; Alves 2012; Castillo and Ladio 2018; Souto et al. 2018), Africa (Tchibozo 2004; Williams et al. 2016, 2017; Soewu 2008; Soewu and Sodeinde 2015; Vats and Thomas 2015), Europe (Motte-Florac 2004; Quave et al. 2010) and East Asia (Reid 1982; Still 2003; Commission 2015; Yang et al. 2018). Zotherapy practices for India as a whole were summarized by Mahawar and Jaroli (2006) and Pandey (2015), but for the North-East Region of India alone only the review by Das et al. (2017) is available. The World Health Organization stresses that a large proportion of the world's inhabitants rely primarily on animal and plant-based medicine (WHO 2013) and it is widely accepted that even today traditional medicines remain the most available and affordable form of therapy in many low-income countries.

Although plants and plant-derived materials constitute the principal sources of ingredients for traditional healing methods, identification of the animal resources began in earnest less than 20 years ago in Brazil (e.g. Costa-Neto 2005; Alves and Rosa 2005), and a few years later in India (Mahawar and Jaroli 2006), this despite the fact that in India nearly 15–20% of the age-old Ayurvedic medicine is based on animal-derived substances (Unnikrishnan 1998), involving 41 mammalian, 41 avian 21, piscine, 16 reptilian and 24 insect species (Tripathy 1995 cited in Sarkar et al. 2014). Healing of human ailments by using therapeutics based on medicines obtained from animals or derived from them is an accepted practice since time immemorial among the indigenous people of Arunachal Pradesh. Both wild and domesticated animals and their by-products (e.g. skin, bones, blood, meat, feathers, faeces, etc.) are used in protective, preventive and curative contexts as part of decoctions and potions to treat patients suffering from a variety of health conditions (Anageletti et al. 1992; Alves et al. 2007; Sarkar et al. 2014; Holenavar 2015; Pandey 2015).

Arunachal Pradesh, a global biodiversity hot spot (Myer et al. 2000) and the largest state in North-East India, lies between 26°28' and 29°30'N latitude and 90°30' and 97°30'E longitude and is blessed with massive ecological and geographic diversity. By virtue of its geographical position, climatic zones and altitudinal variations, the state's biodiversity is rich with large tracts of tropical, wet evergreen forests and subtropical, temperate and

alpine vegetation. The state is not only biologically diverse, but is furthermore home to a rich diversity of traditional communities with 26 major tribes and 110 sub-tribes, each tribe having its own socio-religio-cultural practices (Sengupta 1991; Solanki 2002; Solanki and Chutia 2004). These various communities dwelling amidst the local biological resources have an extensive understanding of nature and therefore possess deep ethno-biological knowledge.

Many of the tribes are totally dependent for their livelihood on the forests and their resources, and collecting certain plants and animals for food and other traditional purposes has been an age-old practice. Among the tribal communities of eastern Arunachal Pradesh, the Tangsa of Changlang district and the Wancho of Longding district are blessed with rich cultural heritage. The increasing global interest in ethno-biological knowledge and, on the other hand, the danger of losing important information before it can properly be documented (Alves 2012; Alves and Rosa 2013) had spurred us to embark on this study and to continue the earlier work that had already dealt with vertebrates used for medicinal purposes by Nyishi and Galo tribals (Chakravorty et al. 2011) of Arunachal Pradesh, the Biate (Betlu 2013) and Karbi (Verma et al. 2014; Borah and Prasad 2016) of Assam, the Chakhesang (Kakati and Doulo 2002) and Ao (Kakati et al. 2006) as well as other tribes (Jamir and Lal 2005) of Nagaland. We chose to examine the extent that members of the Tangsa and Wancho tribes make use of animals and their products for treatments of various common ailments and diseases, because none of the earlier studies [not even the detailed surveys of ethno-zoological diversity of North-East India by Chinlapianga et al. (2013) or that of Arunachal tribes by Solanki and Chutia (2009)] had provided information on these two remote tribes of eastern Arunachal Pradesh. Additionally, we hoped to provide a wider and more critical view on the conservation perspective and the sustainable use of the animal resource.

2 Materials and methods

Extensive field surveys were conducted from May 2015 to March 2016 to record the various uses of animals among tribal members of the Tangsa and Wancho in their respective districts, i.e. Changlang and Longding, in the North-East Indian state of Arunachal Pradesh. The two tribes were chosen, because of three reasons: firstly, there has never before been any study into their uses of animals for medicinal purposes; secondly, being neighbours it was deemed interesting to investigate how and whether they would share the resource of therapeutic species; thirdly, one of us (Salomi Jugli) hailed from that region of Arunachal Pradesh and knew the local language. The region has hardly any roads, and many villages are only reachable on foot or at certain times of the year. Ten accessible villages were visited in each of the two tribal areas. Respondents were seen and interviewed once for about 1–2 h. The number of households in the Changlang district varied from 30 to 60 per village, but it was higher with around 100–200 houses per village (one village had around 500) in the Longding district. The surveys were based on focus group discussions, and the information gathered from these discussions in the two villages was based on semi-structured interviews combined with free conversation conducted at each village headman's house (i.e. the *Gaon burha*). During the interviews, photographs of animals were shown to 20 between 45- and 70-year-old assembled members of the village (the majority being men in keeping with the local custom that they are the leaders). Additionally, at least two households inhabited by village elders (aged 80–90: local people often

do not exactly know their ages) and their families were visited in each of the two districts. Recommendations by the headman or the village elders to visit certain knowledgeable persons in other villages were sometimes followed in line with the “snow ball method” (Goodman 1961). Headmen were chosen as initial contact persons because of their status, influence and knowledge of the residents in their areas and because of their experience with medications used in their respective geographic spheres of authority.

The interviewed people were asked simple questions on whether the animals shown to them in photographs and videos were hunted for food only, or had other traditional and sociocultural roles like using animal parts and products for treating diseases, performing local rituals, decorating traditional attires, were part of local folklore and anything else considered important in connection with the animals in question. When animals or parts of animals were involved, we requested that the specimens be shown to us, and with the help of illustrated guides (Grewal and Pfister 2004; Anonymous 2006; Ahmed et al. 2009), it was usually possible to confidently identify a particular species. When this was not possible, photographs of the specimens in question were taken and later shown to an expert or compared with material held in the university collection for identification. Because of the remoteness of the study area involved and the fact that some animals represented protected species that we were not authorized to collect, voucher specimens could not be assembled. The vernacular names of the animals were noted down. As the knowledge of Hindi or English of the locals was not extensive, Assamese, as the predominant language used by the inhabitants of the eastern part of the state to communicate with outsiders, was frequently used. Moreover, village elders were usually surrounded by younger people (e.g. sons and daughters), who could easily understand and communicate with us. Our questions had to be simple and to the point. Since one of the authors (Salomi Jugli) herself belonged to the Tangsa community, questions could be asked in Tangsa dialect, which facilitated collecting reliable information from members of the Tangsa communities.

According to the locals, their knowledge of animals and their uses as a part of their tradition and customs was acquired from their forefathers and had been passed on from generation to generation. Therefore, most of the information recorded is based on verbal interpretations by the local communities. However, religious factors and modernity have had a huge impact in more recent times and have led to a decline in traditional practices. Special emphasis was given to record practices still in use, particularly the use of animal parts and products for medicines used in the treatment of disorders and illnesses of humans and livestock.

2.1 The Tangsa tribe

Members of the Tangsa tribe inhabit the Changlang district located in the south-eastern corner of Arunachal Pradesh. Known for its picturesque hills, it is bounded by the districts of Tinsukia (Assam and Arunachal Pradesh) in the north, Tirap in the west and Myanmar in the south-east. With an area of 4662 km², the district lies between 26°40'N–27°40'N latitudes and 95°11'E–97°11'E longitudes. The district has a population of 148,226 according to the most recent census data of 2011 (reported in: Census 2014) and is majorly inhabited by Tangsa. A few other tribes, including Singpho, Tutsa, Lisu (Yobin) and Deori, also call the district their home. The Tangsas are considered to have one of the highest numbers of sub-tribes, namely the Muklom, Longchang, Mossang, Jugli, Kimsing, Tikhak, Ronrang, Mungrey, Lungphi, Longri, Havi, Ponthai, Sangwal, Yungkuk, Sakieng and Thamphang. With so many sub-tribes

residing together, managing to maintain peace and harmony among themselves, they share many traditional practices. All of these sub-tribes differ slightly from each other in terms of dialect and customs. However, this study includes information from only the six sub-tribes, viz. Mossang, Muklom, Longchang, Jugli, Tikhak and Kimsing whose villages were accessible during the period of this study.

The climatic conditions in the district vary from place to place due to the mountainous nature of the terrain. The altitude varies from 200 to 4500 m with regions located at lower elevations and in the valleys experiencing hot and humid climatic conditions during the months of June–August and with settlements in the hilly areas, where the climate is moderate and more pleasant. January is the coldest month, and average minimum and maximum temperatures throughout the district then range from about 13 °C and 22 °C, respectively. August is the hottest month during which temperatures may occasionally exceed 30 °C. Rainfall is also very much influenced by the terrain, the annual precipitation being 3800–4866 mm. Maximum rainfall is received during the months of June through October. The Tangsa of Changlang district are agrarian in nature with about 80% of the population dependent on agriculture. Shifting cultivation is traditionally practiced in the district, although people have started to adopt wet cultivation as well.

2.2 The Wancho tribe

Wancho people inhabit the Longding district of Arunachal Pradesh located within 27°012' N and 27°132' N latitude and 95°16'E–95°20'E longitude. Longding district is bounded by the Tirap district of Arunachal Pradesh towards the east, Nagaland towards the west, Assam towards the north and Myanmar in the south. The district has a population of around 70,000 as per 2011 census (Districts of India 2017). The literacy rate of Longding inhabitants of 68.50% is higher than that of the state average of 65.38%. The district was economically backward with a large number of school dropouts and lack of healthcare facilities, which is why Wancho people had wanted a separate district for them, expecting such a move to facilitate their development. Their long-cherished dream was fulfilled by the Government of Arunachal Pradesh on 19 March 2012, and a separate district was created by bifurcating the erstwhile Tirap district of Arunachal Pradesh.

The district is mostly inhabited by the Wancho people, who practiced headhunting until 1991 when the practice was discontinued. Tribals including those of the Nocte and Konyak Naga (also former head hunters) occupy some areas of the district. Owing to the large and diverse geographical features of the district, the Wancho tribe has inherited rich and complex social norms, customs, beliefs and practices. In the past, Wancho were actively engaged in headhunting. Being followers of animalisms, the society was predominantly engrossed by the myths, superstitions, tattoo custom and rituals. Due to modernization, however, people have become influenced by Christian missionaries and began to shun headhunting and many rituals that used to accompany major festivals and events. The society is traditionally governed by the council of chieftains in which the King is the Head of the Council. The tradition of gun making, woodcarving and bead making is still practiced. A type of slash-and-burn cultivation known as the “jhum cultivation” is practiced in the mountainous terrains. This study explores only the ethno-zoological knowledge of the most populous tribe of the district, i.e. the Wancho tribe.

3 Results and discussion

The results of the traditional knowledge of Tangsa and Wancho tribals in relation to their uses of animals and animal parts in various treatments of diseases affecting humans and livestock are summarized in Tables 1 and 2. Table 1 provides information on the zootherapeutic uses of animals by the Tangsa, while Table 2 deals with the Wancho and their therapeutic uses of animals. The animals are listed according to their taxonomic positions.

3.1 Zootherapeutic uses of animals by Tangsa and Wancho compared with tribals elsewhere in the world

Altogether 55 (both vertebrate and invertebrate species) were identified by ethnic Tangsa as medicinal in connection with various health conditions by humans and domesticated animals and 20 (both vertebrate and invertebrate species) were revealed to us by members of the Wancho to possess therapeutic properties. Out of these 55 species in case of the Tangsa (Fig. 1), the use of mammals and their parts was highest, constituting 47%, followed by birds (16.4%), insects (15%), fishes (7.2%) and reptiles (4%). Other taxa of animals mentioned belonged to malacostracan crustaceans (5.5%), amphibians (1.8%), and gastropod molluscs (1.8%).

For India as a whole and in agreement with similar studies from around the world, e.g. Latin America (Alves et al. 2008, 2010; Alves and Alves 2011; Martinez 2013), Africa (Adeola 1992; Mbaya and Malgwi 2010; Whiting et al. 2011; Izah and Seiyaboh 2018), and China (Maciocia 1994; Commission 2015), mammals and birds as components of local folk medicines usually scored the highest and amphibians the lowest use percentages (Sharma and Khan 1995; Mahawar and Jaroli 2006; Betlu 2013). Surveys other than our own specifically focusing on North-East India indicated roughly the same (Kakati and Doulo 2002; Solanki and Chutia 2004; Jamir and Lal 2005; Kakati et al. 2006; Chakravorty et al. 2011), but some differences were nevertheless apparent. For example in South America, fishes, according to Alves et al. (2017), played a major therapeutic role, but not among North-East Indian tribals (reviewed by Das et al. 2017), and in Africa, reptile species in addition to birds and mammals tended to be more commonly used than fishes as traditional medicines (Vats and Thomas 2015; Williams et al. 2016). Among the Wancho tribe (Fig. 2) not mammals, but birds scoring 37% followed by mammals (26.3%) and insects (21.1%), annelids (10.5%) and fish (5.6%) topped the list. In the Chhindwara district of Madhya Pradesh, birds also achieved the highest uses followed by mammals (Neelima and Jain 2015), but for the inhabitants of the Kolli Hills in Tamil Nadu, mammals and insects were therapeutically considerably more important than birds (Raja et al. 2018) and the native inhabitants adjacent to the Gibbon Wildlife Sanctuary, Assam, according to the list presented by Borah and Prasad (2017), used mainly insects and mammals, in that order, but no birds at all.

Differences such as these may have a variety of reasons, and obviously availability of specific species has to be a factor, a factor that depends on climatic and geographic conditions and whether agricultural and industrial uses have affected the species' habitat. However, a host of other reasons may be involved and traditional uses, handed down from generation to generation, as well as taboos not to hurt or kill or reveal the use of certain species (Meyer-Rochow 2009), can be effective in strengthening the confidence of a group by functioning as a demonstration of the uniqueness of a particular society in the face of others.

Table 1 Zootherapy practiced by the Tangsa tribe of Arunachal Pradesh

Nr	Scientific name	Common name	Local name	Parts used	Indication	Prescription	Remarks
<i>I. Mammalia</i>							
1	<i>Ursus thibetanus</i>	Asiatic Black Bear	Chabbaang	1) Gall Bladder and bile (Smoke-dried)	Malaria, stomach ache, body pains, joint pains, coughs and colds, toothache, tuberculosis and body burns	Uncooked rice is put inside the freshly extracted gall bladder to be smoked and dried for preservation; consumed when necessary; a small piece of preserved bile is applied onto the infected tooth; in case of body and joint pains, a portion of dried gall bladder is mixed with hot water and massaged into the painful area	Considered as painkiller While consumed or used for toothache, it is to be made sure that the medicine does not come into contact with teeth as it is believed that it can potentially uproot healthy teeth within a few months to 1–2 yrs. The medicine is therefore consumed by putting it inside some solid eatables like, banana, cooked rice, etc.
2	<i>Melursus ursinus</i>	Sloth bear		2) Body fat (Fresh)	Grey hair	Fat applied to slow down greying of hair	When appropriately preserved (smoked dried), the fat can last for many years One dose/day for 3 days and then a gap of 3 weeks between the next dose. To be continued if until effect is noticed. Smoked dried gall bladders or bile are sold in the local market
3	<i>Vulpes bengalensis</i>	Fox	Makakoi	1) Flesh (Fresh/Cooked)	Body and joint pains, energy booster for weak persons and pregnant women	The whole body cooked and consumed; fed to pregnant women before and after delivery for strength and energy	

Table 1 (continued)

Nr	Scientific name	Common name	Local name	Parts used	Indication	Prescription	Remarks
4	<i>Canis lupus familiaris</i>	Dog	Heeh	2) Gall bladder and bile (Dried/cooked) Liver and gall bladder/bile	Tuberculosis, liver problem, rheumatism, malaria Antidote for dog bite	Smoke-dried and preserved, boiled and consumed in little amount whenever required The gallbladder/bile is spread over the cut pieces of liver and then roasted for consumption.	
5	<i>Panthera tigris</i>	Tiger	Chaah	Body fat (Fresh)	Burns	Fresh body fat is preserved in a bamboo jar or glass bottle and used whenever needed	Consuming flesh of the tiger is believed to cure a person who transforms to a tiger in their dreams and hunts domesticated animals
6	1) <i>Neofelis nebulosa</i> 2) <i>Panthera pardus</i>	1) Clouded leopard 2) Common leopard	Pulkhu Chaah	Flesh (Fresh/cooked) Lactating breast (Dried) Body fat (Fresh)	For strengthening bones and tendons Boils and other skin disease Burns (mostly) and other injuries	Flesh cooked and consumed The breast is cut, dried and preserved, and used when needed. The dried breast is rubbed against any hard matter or cut with a knife and made into powder that is then applied to boils, e.g. skin problems Fresh body fat is preserved in a bamboo can or glass bottle and used whenever needed	

Table 1 (continued)

Nr	Scientific name	Common name	Local name	Parts used	Indication	Prescription	Remarks
7	<i>Paguma larvata</i>	Himalayan palm civet	Sammong	Body fat (Fresh)	Foot crack, body pain	Applied on foot cracks. The fat is applied before going to bed and is covered with cloth; for body pain the fat is used as massaging oil	Consuming foot and hand of civet is believed to cause foot crack
8	<i>Viverra zibetha</i>	Large Indian civet		Tooth (Dried)	Snake anti-venom	Teeth are dried, crushed and soaked in water. The water is then applied on the snakebite as anti-venom	
9	<i>Manis pentadactyla</i>	Chinese Pangolin	Bitsai	Scales (Fresh/dried)	Piles	Fresh or dried scales (1 or 2) are tied around the waist for curing piles. Scales are worn until piles have healed	Exported illegally to nearby states like Assam, Nagaland and countries like Myanmar and China
10	<i>Rhizomys pruinosus</i>	Hoary bamboo rat	Tarau	Scales (Dried)	Skin diseases; allergies	Dried scales are pounded into powder and applied on the skin	It is believed that the scales feature different pictures (e.g. a temple, deer, maiden, etc.) on their surfaces so that scales with pictures on it are considered more effective, and thus are preferred
11	<i>Cannomys badius</i>	Lesser bamboo rat		Blood (Fresh)	For liver cirrhosis treatment and to maintain a healthy liver	The neck is cut and the fresh blood is consumed raw	Usually drunk by an alcoholic to detoxify the liver. People with high blood pressure avoid its consumption as it is believed that the warm fresh blood could increase blood pressure

Table 1 (continued)

Nr	Scientific name	Common name	Local name	Parts used	Indication	Prescription	Remarks
12	<i>Rattus</i> spp.	Common rats	Jugpi	Whole body (Fresh, cooked, roasted)	Allergies, scabies	Eating of rat meat heals body itching	
13	<i>Hystrix</i> sp.	Porcupine	Wihaang	Stomach (Dried and cooked)	Malaria, stomach ache, gallbladder stones and appendicitis, liver and heart-related problems, gastritis	The stomach is smoked, dried and preserved; consumed whenever required in small amounts by boiling with water	
				Intestine (Dried and cooked)	Malaria, jaundice, diarrhoea, dysentery	Smoked dried and preserved, consumed whenever required in small amounts by boiling with water	
14	<i>Cynopterus sphinx</i>	Bat	Phaksak	Gall bladder/bile (Dried and cooked) Flesh (Fresh/cooked)	Malaria dysentery, gastritis, diarrhoea Liver enlargement problem & pain, to improve eyesight	Smoked dried, boiled and had in small amounts whenever needed Flesh cooked and consumed	
				Whole body (Fresh/roasted)	Bed-wetting	The whole body roasted and fed to children to remedy bed-wetting	

Table 1 (continued)

Nr	Scientific name	Common name	Local name	Parts used	Indication	Prescription	Remarks
15	<i>Biswamoyopterus biswasi</i>	Namdapha flying squirrel	Loklang	Wings/appendages (Dried) Brain (Fresh/cooked) Urinary bladder (Smoke-dried)	Allergies due to insects, tooth-aches Nausea, fever Gall bladder and kidney stone pain	For allergy, the wings are dried, crushed into powder and applied; for toothache the wing/appendages (dried) are used for pricking the particular infected tooth with it Fresh or cooked and had Rice grains are stored inside the bladder which is smoked and dried. 2–3 rice grains after drying are consumed along with water whenever required Gall bladder/bile smoked and consumed in little amounts whenever required	The urine is believed to dissolve the stone particles inside gall bladder and kidney of human sufferers
16	<i>Capra hircus</i>	Goat	Kekai	Excreta (Fresh/dried)	Cuts, burns and early detachment of infant umbilical cord	Fresh excreta along with water are used on cuts and burns; fire-dried excreta are crushed, powdered and applied on the navel of the newborn infant for early detachment of the umbilical cord. Applied also after detached cord is infected	

Table 1 (continued)

Nr	Scientific name	Common name	Local name	Parts used	Indication	Prescription	Remarks
17	<i>Hemiragrus</i> sp.	Himalayan tahr	Ngakheng	Bone marrow (Fresh)	Joint pain, muscle sprain, strain and bruises	Bone marrow is extracted by crushing the thighbone and preserved in a bottle or bamboo jar for later use. Used as massage ointment.	
18	<i>Bos indicus</i> and <i>Bos bubalus</i>	Cow and buffalo	Maan, Loi	Limb bones and bone marrow (Fresh/cooked)	To treat weakness	Limb bones are made into soup and consumed as energy booster (cracked to allow marrow to come out)	
19	<i>Cervus unicolor</i>	Sambar deer	Chok/Khihoi,	Budding tender antlers (locally called <i>Rungnen'</i> (Fresh/cooked)	Energy booster for weak people. Also, as a vitamin and energy booster for elderly people for strength; fed to children to remedy late talkers and speech impairment	Tender antlers boiled as soup and consumed; also fed to children (about 2–3 years or toddlers)	The budding tender antlers are cut, and the fresh blood is drunk. A patient should be completely submerged in water (river) to lower body temperature as its consumption is believed to increase the body's temperature and could even cause death. The patient is expected to get rid of all body and joint pains
20	<i>Axis porcinus</i>	Hog deer	Nalang	Tender antlers (Fresh/cooked) 3) Blood (Fresh/raw)	Body pains, joint pains Body and joint pains	The tender antlers are boiled, prepared as soup and had Raw fresh blood from antlers is drunk	

Table 1 (continued)

Nr	Scientific name	Common name	Local name	Parts used	Indication	Prescription	Remarks
21	<i>Nycticebus</i> spp.	Slow loris	Rangchuwi	Body fat (Fresh)	Used as a massage oil for curing body pains and burns	Fresh body fat is kept in a bamboo jar or glass bottle to preserve and used whenever required by heating it	
22	1) <i>Macaca assamensis</i>	1) Assamese macaque,	1) Witi till	Brain (Fresh/raw)	Blood pressure, nausea	Cooked brain helps to maintain high blood pressure; brain eaten raw once can heal nausea for the next 3–4 years	
23	2) <i>Macaca mulatta</i>	2) Rhesus macaque	2) Woi				
24	3) <i>Trachypithecus pileatus</i>	3) Capped langur	3) Raq				
25	<i>Hoolock leuconedys</i>	Hoolock gibbon	Thukbai	Flesh, liver, blood (Fresh/cooked) Raw Blood (Fresh)	Asthma, malaria, tuberculosis, liver cirrhosis Weakness due to hypovolemia (decreased blood volume)	Cooked flesh, liver and blood to be consumed Fresh, raw blood to be drunk	

Table 1 (continued)

Nr	Scientific name	Common name	Local name	Parts used	Indication	Prescription	Remarks
26	<i>Homo sapiens</i>	Human being	Maiih	Gall bladder and bile (Fresh and dried)	Enlarged spleen	Fresh or dried (with water), rubbed onto the stomach by using a leaf (so as to avoid direct contact) for treating enlarged spleen due to malaria. Direct contact of bile to the stomach is avoided as it is believed that it could make the spleen disappear completely	
2. Aves							
1	1) <i>Buceros bicornis</i>	1) Great hornbill	1) Wuraang	Body fat (Fresh)	Toothache, cuts, burns, conjunctivitis	Urine applied on teeth to cure toothache; mud from urinated on mud is applied on cuts and burns; urine applied to eyes to cure conjunctivitis	The great hornbill is preferred the most as it is considered to be the most effective of all the hornbill species
					Body burns, muscular strain, sprain and bruises, fractured bones	Fresh body fat, i.e. no added hot water or heated over fire, is preserved in a bamboo jar or glass bottle. Sometimes it is dried over the fireplace on a locally constructed bamboo shelf (<i>kharaang</i>). It does not get spoilt easily and can be preserved for years. The fat is applied after melting it over fire	

Table 1 (continued)

Nr	Scientific name	Common name	Local name	Parts used	Indication	Prescription	Remarks
2	<i>Aceros nepalensis</i>	2) Necked hornbill	2) Wujung	Gall bladder and bile (Smoke-dried)	For easing gall bladder pain or a complete cure	Smoked dried and pre-soaked in hot water and applied on the body parts that suffer from pain. This treatment is considered very effective	
3	<i>Aceros undulatus</i>	3) Weathered hornbill	3) Wungip	Is Flesh (Fresh/cooked)	Consumption makes the body feel light/relaxed	The whole body is cooked and consumed	
4	<i>Anthracoeros albirostris</i>	4) Pied hornbill	4) Wukengkap	Tail fat only (atat) (Fresh)	Tail fat rubbed on body burns	Fresh fat extracted from the tail region is stored and preserved in a bamboo jar or glass bottle. The fat is applied whenever required by heat melting the raw fat first	
5	<i>Spilornis cheela</i>	Crested serpent eagle	Lang	Intestine (Smoke-dried)	Asthma, cough and cough	Smoke-dried and consumed in little amounts whenever necessary	
6 + 7	<i>Dicrurus paradiseus</i> + <i>Rana</i> sp.	Greater racket-tailed drongo + Frog	Wuram + Lik-kai	Body fat (Fresh) Feather + body fat (Fresh)	Massage oil for body pain and joint pain Ear problems and deafness	Fresh fat kept in bamboo jar or glass bottle is heated to melt and applied on the body for massage Feather of the bird dipped in frog body fat is rubbed on the ears to cure ear problems and even to cure deafness	

Table 1 (continued)

Nr	Scientific name	Common name	Local name	Parts used	Indication	Prescription	Remarks
8	<i>Corvus splendens</i>	Crow	Wukha	Blood (Fresh)	Lungs-related problems, body pain	Raw blood drank in fresh	Consuming crow's blood particularly on a new moon day is believed to be more effective in curing lung problems and other body aches than on other days
9	<i>Gallus domesticus</i>	Domestic chicken	Wuu	Tail fat (Fresh)	Body Burn	Tail fat preserved in bamboo jar or glass bottle is applied on body burns	
10	<i>Columba livia</i>	Pigeon		Flesh (Fresh/cooked)	Energy booster during weakness	The whole body of pigeon (mostly young ones) is prepared for soup and usually served to those who are recovering from illness and also for those who are considered to be weak	
3. Pisces							
1	<i>Monopterusuchia</i>	Cuchia	Powshai	Raw blood (Fresh)	For purifying human blood	Raw fresh blood consumed to purify human blood and to compensate for blood loss. Also, to gain strength	
				The whole body (Fresh/cooked)	As energy booster	Whole fish cooked and consumed as a supplement for energy, especially to those who are considered weak/unhealthy; at times fed to weak/thin cattle	

Table 1 (continued)

Nr	Scientific name	Common name	Local name	Parts used	Indication	Prescription	Remarks
2	<i>Mastacembelus armatus</i>	Spiny eel/Bami fish	Ngahchim	1) Whole body (Fresh/cooked)	Body pain, malaria, blood pressure, delivery complication (like slow childbirth, to speed up delivery), energy booster for weak domesticated animals when sick	For body pain chopped into fine pieces and applied as a fresh ointment; cooked and consumed for curing malaria, maintaining blood pressure and delivery complications; either cooked or in dried form also fed to domesticated animals	
				Gall bladder (Smoke-dried)		Dried, preserved and used when needed	
				Body mucus (Fresh)	Mucus is considered medicinal for all kind of disease, especially body burns	Fresh body mucus is swallowed	
				Raw blood (Fresh) and whole body (Fresh/cooked)	An energy booster for human whenever weak	Raw blood and cooked flesh for energy	

Table 1 (continued)

Nr	Scientific name	Common name	Local name	Parts used	Indication	Prescription	Remarks
3	<i>Labeo</i> sp.	Cyprinid	Nyahnyal (Hilguria)	Whole body used raw (Fresh, mixed with herbs)	Energy booster	The fish is crushed after removing the scales and gut and mixed with local spices and edible leaves (mostly uriam leaves (<i>Bischofia javanica</i>) and water. The liquid is sieved and drunk as energy booster and source of providing vitamins	
4	<i>Clarias batrachus</i>	Walking catfish	Ngahpak	Whole body (Fresh/cooked)	Energy booster	Boiled for soup and served to a weak person for energy	
4. Reptilia							
1	<i>Python reticulatus</i>	Reticulated Python	Paujung	Body fat (Fresh)	Burns, wounds, body pain and joint pain	Freshly extracted fat is preserved in a bamboo jar or glass bottle and are applied when necessary	The flesh is only consumed either boiled or fried. If consumed by roasting it is believed that the body texture of the person will change to snake-like with age
	<i>Python molurus</i>	Indian python		Gall bladder/bile (Smoke-dried)	Burns, tuberculosis, weakness, cough and cold	The smoke-dried bile in small amount is mixed with very little water and applied on burns; for tuberculosis, cough and general weakness, the smoke-dried bile is boiled and consumed	Not to be consumed by pregnant and lactating women as it is believed that the child feeding on the breast milk would develop allergies and skin problems. The child will be born with exposed tongue salivating nonstop

Table 1 (continued)

Nr	Scientific name	Common name	Local name	Parts used	Indication	Prescription	Remarks
2	<i>Testudo</i> sp.	Tortoise	Kongsharang	Head (Dried)	Fractured bones and piles	Dried and used	The treatment is believed to be most effective during the last week of a month and less effective during other days
				Shell/carapace (Sun/smoke- dried)	Malaria	A small piece of shell either sun-dried or smoke-dried, crushed and sprinkled on hot charcoal and the emitted smoke is inhaled by covering the head with a piece of cloth; smoke is believed to be a cure for malaria	Pregnant women do not consume as it is believed that a child may not walk or show delayed walking
				Shell/carapace (Heat-dried)	Skin disease, allergy, and as cattle feed; given also to other domestic animals as an energy booster and for healthy growth	Heated on a pan, softened, cooled and crushed into powder and mixed with the bile of bear and applied on the skin for allergies and other skin diseases; the dried shell is also powdered by rubbing the shell on stones; fresh or smoke-dried shells are preserved and later fed to weak/fill cattle	

Table 1 (continued)

Nr	Scientific name	Common name	Local name	Parts used	Indication	Prescription	Remarks
5. Insecta							
1	1) <i>Apis cerana</i>	Honey bee	1) Nyahkaai	All bees; honey (Fresh)	For coughs and colds, eye problems.	Honey along with Tulsi leaves (<i>Ocimum sanctum</i>) is to remedy coughs and colds; honey applied as an ointment used for eye problems.	The sting of a bee once a year is considered good for health and thought to prevent septic conditions
+	2) <i>Apis mellifera</i>		2) Nyahkhing				
4	3) <i>Apis dorsata</i>		3) Nyahkaan	All bees; their sting			
	4) <i>Apis florea</i>		4) Nyahbi				
	5) <i>Apis andreniformis</i>		5) Minmoi/Tangu				
6	<i>Vespa orientalis</i>	Oriental hornet	Langnen	Whole body (Fresh)	Anti-venom	Paste made from the wasp used as anti-venom for spider bites	
7	<i>Chondracris rosea</i>	Citrus locust	Kipshongrang	Whole body (Fresh/roasted)	Allergy	Roasted and consumed	Very common
8	Blattid spp.	Cockroaches (small sized, odourless)	Siplip	Whole body (Fresh/roasted)	Stops drooling in children	The entire body is roasted and fed to children to stop drooling	
6. Crustacea:							
<i>Malacostraca</i>							
1	<i>Maydeliathelphusa lugubris</i>	Freshwater crab	Khaan	Appendages (Fresh)	Anti-venom against snakebite	Fresh appendages are crushed and applied as anti-venom for snakebite	Causes malaria if consumed in large quantities. Therefore, some villages have altogether stopped its consumption

Table 1 (continued)

Nr	Scientific name	Common name	Local name	Parts used	Indication	Prescription	Remarks
2	<i>Sartoriana spinigera</i>	Small sized red coloured freshwater crab	Khaan	Whole body (Fresh/cooked/roasted)	Fever, skin disease, wounds	Body is cooked or roasted and consumed. For domesticated livestock raw meat is mixed with food and fed	Young alive crab is crushed and applied as anti-venom for snakebite
3	<i>Armadillidium</i> spp.	Pill bug	Situm luh	Whole body (Dried/fire)	Cuts and wounds in domesticated animals Epilepsy	Body crushed and mixed along with some medicinal plant herbs, fermented up to 4 days and applied	The whole body dried on a pan, cooled, crushed into powder, mixed with feed, fed to animals. Pan-dried, cooled, crushed into powder. Sometimes consumed mixed with medicinal herbs
7. <i>Amelida</i>							
1	<i>Pheretima</i> sp.	Earthworm	Khibai	Whole body (Fresh)	Dysentery	Raw, crushed and consumed directly or with water	
8. <i>Gastropoda</i>							
1	<i>Pulmonata</i> spp.	Freshwater snails	Kapkong	Whole body (Fresh/cooked)	For good eyesight	The whole body along with the shell is cooked in boiling water. However, only the fleshy part is consumed; shell is discarded	

Table 2 Zootherapy practiced by the Wancho tribe of Arunachal Pradesh

Nr	Scientific name	Common name	local name	Parts used	Indication	Prescription	Remarks (other uses)
<i>1. Mammalia</i>							
1	<i>Ursus thibetanus</i>	Asian Black Bear	Chapnu	Gall bladder/bile	Stomach ache, heart burn	Dried and consumed as needed	
2	<i>Melursus ursinus</i>	Sloth bear			Delivery pain (as pain killer)		
3	<i>Hystrix</i> sp.	Porcupine	Adi/Azi	Gall bladder/bile (Dried)	Stomach ache, malaria	Dried and consumed when needed	
4	<i>Cynopterus sphinx</i>	Bat	Phakphai	Flesh (Cooked)	Asthma, coughs and colds	Flesh cooked and bone marrow consumed.	
5	<i>Canis lupus familiaris</i>	Dog	Hee	Raw blood (Fresh)	Dysentery, diarrhoea	The region near the ear is cut and the blood is collected and drank in raw and fresh before drying out	
<i>2. Aves</i>							
1	<i>Buceros bicornis</i>	1) Great hornbill		Bone Marrow (Fresh)	Muscular strain, sprain and bruises; fractures/dislocations	The bone marrow is used as massaging oil.	Most preferred is the great hornbill.
2	<i>Aceros nepalensis</i>	2) Necked hb.	Ozang				
3	<i>A. undulatus</i>	3) Weathered hb.					
4	<i>Anthraccoceros albirostris</i>	4) Pted hb.					
5	<i>Gallus sp.</i>	1) Jungle fowl	Ohan/Okam	Wings and Feathers (Burned)	Allergy	Feathers are burned and the ash is applied to the body part with allergy	
6	<i>Gallus gallus domesticus</i>	2) Domestic hen	Oow				

Table 2 (continued)

Nr	Scientific name	Common name	local name	Parts used	Indication	Prescription	Remarks (other uses)
3. Pisces							
7	<i>Columba livia</i>	Pigeon	Oohtu	Flesh (Cooked)	Energy booster	Flesh cooked used as soup for energy (preferably young birds).	
1	<i>Mastacembelus armatus</i>	Eel	Ngahpuh	Whole body (Fresh)	Cuts, burns, boils, wounds and other skin problems	After consuming the whole body, the saliva of the person is considered to be medicinal over cuts, boils, wounds and any other skin related problems	
4. Insecta							
1	<i>Macrocheila grandis</i> Gray or <i>Melamphaus rubrocinctus</i>	Giant red bug, also fire bugs generally	Waan	Haemolymph (Fresh)	Energy booster	Energy booster to those who are considered weak due to lack of blood in the body, causing them to appear weak	Firebugs of forests and fields (also pineapple plantations). The haemolymph is very spicy and according to Wancho, no other animal (or insect) has spicy blood
					Cough and cold	The haemolymph is squeezed out by gently pressing the abdominal region. It is then either mixed and drunk along with water or directly fresh	

Table 2 (continued)

Nr	Scientific name	Common name	local name	Parts used	Indication	Prescription	Remarks (other uses)
2	<i>Apis cerana</i>	Honey bee	Nah	Honey (Fresh)	Cough and cold	Honey consumed for treating coughs and colds.	
3	<i>Apis mellifera</i>						
4	<i>Apis dorsata</i>						
5. <i>Amelida</i>							
1	<i>Pheretima</i> sp.	Earthworm	Chongkeh	Whole body (Fresh)	Malaria	Thin and reddish, small earthworm found in or on banana plants, vegetables, etc.; consumed in raw form to protect against malaria.	
2	<i>Haemadipsa</i> sp.	Leech	Watt	Live leech (Fresh)	Blood clot	Leeches are allowed to feed on swellings and areas where the blood is clotted due to injuries	

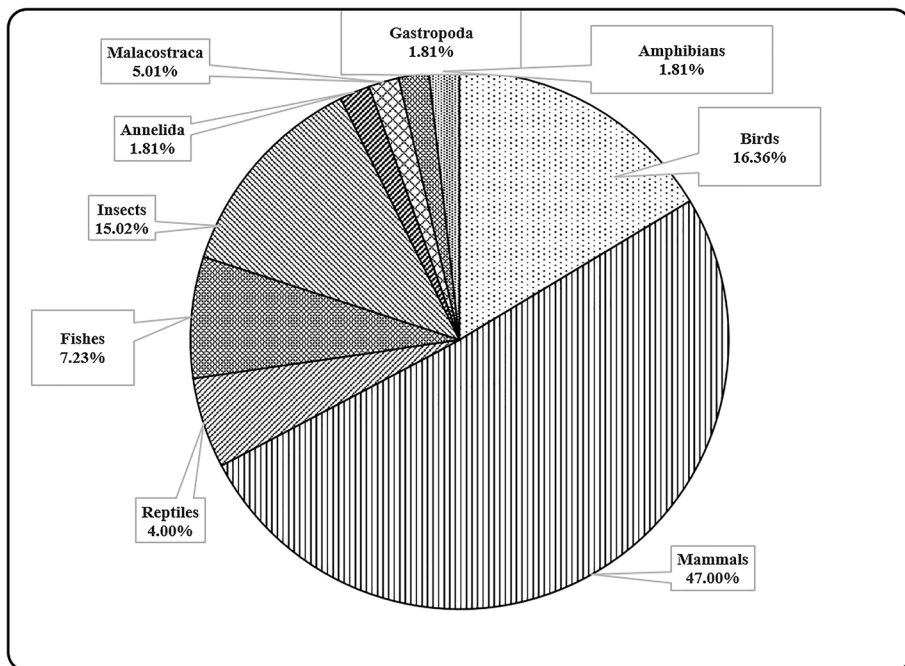


Fig. 1 Percentages of animal species in different categories reported to be used therapeutically by members of the Tangsa tribe of Arunachal Pradesh

Last but not least, there could be differences in the ways the surveys were carried out or local people were interviewed and chosen as informants, for not everyone is equally familiar or knowledgeable with regard to therapies involving animal species and a group ideally consisting of male and female interviewees of different ages goes a long way to insure that reliable information is obtained (Albuquerque et al. 2014).

3.2 Medical conditions treated by Tangsa and Wancho and the animal products involved

Most of the cures were limited to common day-to-day disorders, including general weakness and body pain, fever, asthma and allergies, diarrhoea, stomach ache and dysentery, as well as coughs and colds, dermal conditions and haemorrhoids. A few remedies, however, were aimed at some more serious ailments such as diabetes, jaundice, liver problems, malaria, epilepsy, tuberculosis, cancers and venomous snake bites. The relative paucity of therapeutic insects in our list is perhaps somewhat surprising, given the widespread use of insects (and spiders) used elsewhere in India to treat disorders in humans and even domestic animals (Senthilkumar et al. 2008; Meyer-Rochow and Chakravorty 2013; Borah and Prasad 2017; Meyer-Rochow 2017). Honey (in connection with coughs and colds) was made use of by Wancho as well as Tangsa, but the Tangsa, moreover, also employed two additional insects, namely wasps and the grasshopper *Chondacris rosea*, as an antidote for spider bites and allergies, respectively. Wancho on the other hand relied on the use of the

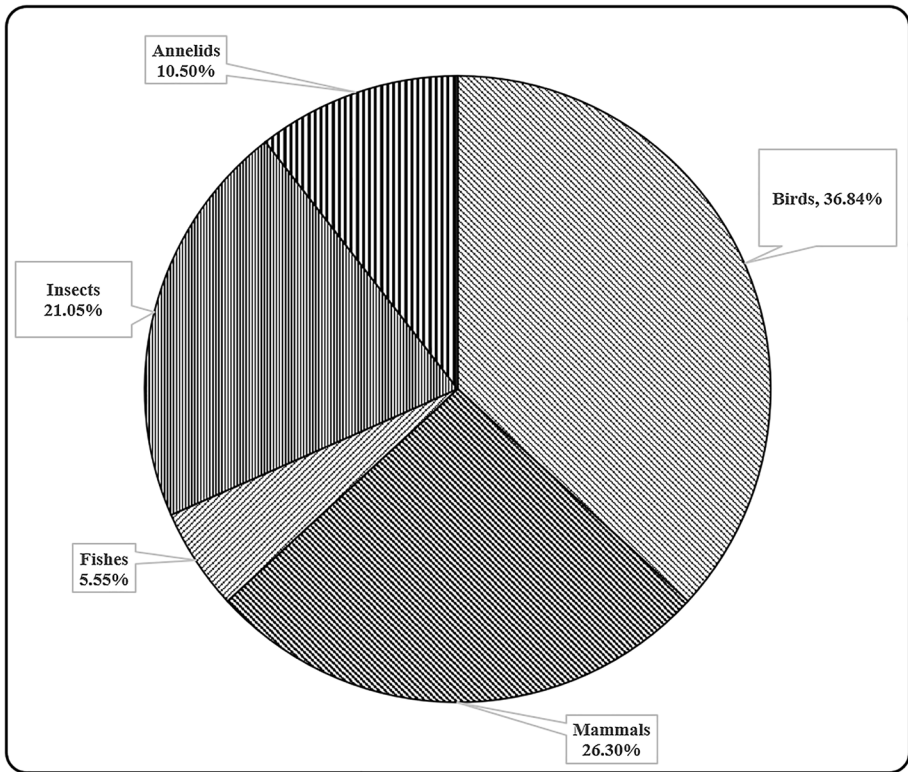


Fig. 2 Percentages of animal species in different categories reported to be used therapeutically by members of the Wancho tribe of Arunachal Pradesh

haemolymph of firebugs (*Macrocheraia* spp.) to treat coughs and colds. Spiders or their products (e.g. silk) were not mentioned by members of either Wancho or Tangsa.

The whole body or more frequently parts of the body of an animal were employed for treating different ailments in both humans and domesticated animals. But different parts of a variety of species were also often used in connection with specific ailments and the sought after body parts did not always come from the same species. For example, among the Tangsa, the gall bladder from ten different animal species was reported to possess therapeutic properties (Table 1). The maximum number of species used by Tangsa and Wancho to treat fevers, coughs and colds was 19 and 5, respectively, while gastrointestinal troubles were felt to be eased by 18 (Tangsa) and 6 (Wancho) different methods. To give a specific example: the treatment of body burns, for instance, could involve any one of these animals: eel, python, hornbill, chicken, leopard, tiger, goat and even some others as well. Remedies for body and joint pains were equally varied. On the other hand, some conditions like ear problems and deafness according to Tangsa informants involved only a combination of just two species (a bird and a frog, i.e. feathers and body liquid, respectively) or, according to Wancho healers, in case of having to remove a blood clot or swelling just one species: a leech was used. There are a few other cases in which very specific animals or their products are required: fresh body fat of the sloth bear to slow down greying of the hair or the use of roasted *Cynopterus sphinx* bats among the Tangsa to halt bed-wetting come to mind. It was

also observed by the locals that the treatment of one disease could have an effect, either positive or negative, on other diseases and dysfunctions and that similar body parts of different animals could exert identical or dissimilar effects, depending on the way these body parts are prepared and applied. Using a variety of remedies for the same ailment and then finding that one of them turns out more potent than the others has been a popular strategy.

Based on this strategy, the Tangsa people decided that the body fats extracted for medicines from a few vertebrates like tiger, civet, hornbill, eagle and python were most effective for curing any kind of body, joint, bone and muscle pain. In several cases, the animal-based medicines were either prepared alone or in combination with readily available medicinal herbs, for hundreds of plants have been identified from the North-East of India to possess medicinal properties (Holland 1994; Changkija et al. 2010). Tangsa prepare animal parts for treating disorders and illnesses either in fresh condition (i.e. raw) or cook or roast them (49 such treatments were recorded). Some parts may be used in dried form, i.e. sundried, smoked or fire-dried (as in 18 cases), or were part of combinations between fresh and dried material (as in three cases) and administered together with medicinal herbs (as in two cases).

The Wancho's zootherapeutic uses involve at least 10 cases in which the animal products are fresh and then cooked or roasted, but in the remaining three cases dried animal products are used. When blood is used as a remedy as in the case of the Wancho to treat dysentery and diarrhoea with dog's blood or in case of the Tangsa's treatment of lung-related problems with the blood of the crow *Corvus splendens*, it is to be drunk fresh. Cooked, fried or roasted meat when used therapeutically is usually meant to be consumed according to specific instructions as to where and when and how much, but oils and fats (and in case of the Wancho also bone marrow) were generally applied to or rubbed and massaged into the affected body parts. Powders, as in the case of the dried scales of the pangolin or the dried breast of the tiger, are placed on the skin, or in other cases to be taken with water, while fresh faeces, for example, those of the goat are used by the Tangsa on cuts and burns or in dried and powdered form applied to the navel of a newborn infant. Therapeutic ash, obtained by burning feathers, may be directly applied to a part of the body afflicted with an allergy by the Wancho, while bile and gall bladders may be dried and consumed as needed. Gall bladders of the Asian black bear are used by the Tangsa as containers for uncooked rice, to be dried and consumed when required, but dog liver and gall bladder may also be used raw and spread over a cut or dog bite injury or mixed with hot water and massaged into an aching joint.

3.3 Differences between Tangsa and Wancho zootherapies and those of other Indian tribals

Zootherapeutic uses of animal body parts and animal products as the raw material for potions and medicines prescribed to treat different human-related maladies and disorders can be characterized into 17 and 10 categories by the Tangsa and Wancho, respectively (Table 3). Tangsa, moreover, also use zootherapies to treat domesticated animals. Animal parts used therapeutically were used either in their raw or cooked states and most popularly consisted of an animal's body fat followed by the gall bladder in case of the Tangsa, while Wancho people most frequently used the bone marrow, followed by bile, raw blood and honey (Table 4). Our findings of the raw materials and animal body parts used therapeutically by the Tangsa and Wancho are in agreement with those used by Biate tribals of Assam, involving mostly flesh, followed by gall bladder and fat obtained from slaughtered

Table 3 Categories of disorders considered amenable to zootherapy by Tangsa and Wancho

Disorders considered amenable to zootherapy	Tangsa	Wancho
Gastrointestinal and digestive problems	18	6
Respiratory problems (TB, asthma, lung diseases)	10	2
Cardiovascular system (heart and blood)	6	1
Skin disorders and allergies	10	3
Muscular and skeletal problems, rheumatism	31	4
Fractures, burns, cuts, boils and wounds	36	7
Head problems (ear, eye, nose, mouth, hair, etc.)	12	0
Malaria	8	2
Liver problems, jaundice	7	0
Fever, nausea, coughs and colds	19	5
General weakness and fatigue	10	3
Reproductive and urogenital system (e.g. kidney stone)	2	1
Neurological disorders	1	0
Enlarged spleen	1	0
Venom and poisonings	5	0
Children-related conditions	2	0
Domesticated animal related illnesses	3	0

Table 4 Animal material used in zootherapy by Tangsa and Wancho

Animal material used in zootherapy	Tangsa	Wancho
Whole animal	15	2
Fat (body, skin, tail)	21	0
Gall bladder, bile	13	3
Muscle and flesh	9	2
Stomach and intestine	6	0
Innards and offal	8	0
Blood	8	2
Bones and bone marrow	3	4
Antlers, teeth, scales, carapace, etc.	6	0
Appendages (limbs, wings, feathers)	5	2
Urinary bladder, urine and other excreta	3	0
Body mucus	1	0
Haemolymph	0	1
Honey	5	3
Leech	0	1

livestock or hunted wild species (Betlu 2013). By comparison, for the 19 ethnic entities of North-East India reviewed by Das et al. (2017) the most commonly medicinally used mammalian and avian body components were also flesh, gall bladder, fat and liver tissue. Occasionally, some animal-derived medicines, based on dried and preserved animal body parts, were sold in local markets, but house vendors are still the commonest means by which wild animals and fresh parts for medicinal purposes can be obtained.

Tangsa apply the body fat of hornbills to burns, muscular strains, sprains and bruises as well as fractured bones and that of pythons they use to treat burns and flesh wounds. Body fats of the cat family (*Panthera tigris*, *Neofelis nebulosa* and *Panthera pardus*) are also applied to burns and wounds, but additionally these fats are used externally as a massaging oil to ease body pains, muscular strains, sprains and bruises and to assist fractured bones in their healing process. The body fat of the Asian sloth bear has been reported by the Tangsa to be used especially to slow down the greying of human hair while the body fat of the civet and related species are expected to help with problems of the feet. Somewhat surprisingly, there has been no mention of animal body fats being used by the Wancho tribals, but in agreement with the Tangsa's uses, body fats of hornbills, pythons and eagles for treating burns, body and joint pains have been reported from the Nyishi and Galo tribes of Arunachal Pradesh (Chakravorty et al. 2011), while fats of porcupines and tigers for treating body pains, rheumatic aches and unwellness have been used by various Naga tribes (Jamir and Lal 2005). According to Das et al. (2017), the porcupine (*Hystrix indica*) is the most widely therapeutically used mammalian species in North-East India.

Some of the animal-based remedies used by the Tangsa and Wancho are known in similar or modified form from other regions of India. The use of honey for treating coughs and colds, for example, is very common in many Indian states (Solavan et al. 2004; Verma et al. 2014; Borah and Prasad 2016), and it has also been reported as an ointment for eye infections by the Tangsa and tribals of the Chhindwara district of Madhya Pradesh to increase visual acuity and mitigate body burns (Neelima and Jain 2015). The Tangsa like many tribals elsewhere across India and in neighbouring countries use the scales of the Indian pangolin (in case of the Tangsa to treat piles, skin diseases and allergies: see Table 1) while the Biata of Assam use them against hookworm infections (Betlu 2013). Human urine used by the Tangsa to treat toothache and body burns has also been reported to be used on body cuts by members of the Rebari Gujarati (Vyas et al. 2009), for wound healing by Saharia tribes of Rajasthan (Mahawar and Jaroli 2007) and by tribals of the Khowai district of Tripura near Bangladesh (Das 2015). The Wancho consume bat meat for treating coughs and colds and so do tribal members of the Kachch district of Gujarat (Gupta et al. 2003). Uses such as these that are shared by communities with no historic contacts to the Tangsa or Wancho are likely to have been discovered independently.

On the other hand, cross-cultural links are likely to have played a role in north-eastern India, because they frequently share certain animal uses as in case of pigeons, preferably young individuals, which are consumed for energy and to cure general body weakness by not only Tangsa and Wancho tribals, but many other north-eastern Indian tribals like Ao Naga and Manipuri people as well (Kakati et al. 2006; Devi et al. 2015). The raw and fresh body slime of the eel (*Mastacembelus armatus*) is considered medicinal and applied to body burns by Tangsas, and a similar use has been reported by Nyishi and Galo tribes (Chakravorty et al. 2011). North-eastern Apatani, Nyishi and Monpa tribals also find eel slime useful as a remedy for pox and small wounds of the skin (Solanki and Chutia 2009). The consumption of raw and fresh blood and flesh of the cuchia fish (*Monomterus cuchia*) to improve the body's stamina and fight physical weakness is a common practice of many tribals of Arunachal Pradesh (Solanki and Chutia 2009), including the Tangsa.

The bile and/or gall bladder of the bear is considered an effective painkiller against many pain-causing conditions such as stomach, body, head and toothaches by the Tangsa and said to reduce labour pains according to Wancho and Biata tribes (Betlu 2013). It has also been regarded by Ao Naga (Kakati et al. 2006), Karbi (Verma et al. 2014), Monpa (Solanki and Chutia 2004) and Nyishi and Galo tribes (Chakravorty et al. 2011) to be effective in cases of diabetes and malaria. Leech therapy in which a live leech sucks out

the clotted blood from an affected area has been reported to be practiced by Wancho. A similar use of leeches has been described by the Karbi of the Anglong district of Assam (Verma et al. 2014), but somewhat surprisingly this method of treating swellings has not been mentioned by the Tangsa, whose territory is closer to that of the Wancho than that of the Karbi is.

The tender antlers of the Sambar deer are ground to a powder by the Tangsa as well as by the north-eastern tribals of Mizoram (Chinlapianga et al. 2013), and the powder is then consumed to improve the body's condition by lessening the feeling of general weakness. Raw earthworms are consumed alive by the Wancho and by the tribal population of Mizoram (Chinlapianga et al. 2013) in the belief that this will prevent malaria to develop. However, tribals of Manipur consume the raw earthworm as an antidote for snake and spider bites (Devi et al. 2015), whereas tribal communities of Assam use the same treatment in connection with ailments like arthritis (Verma et al. 2014) and piles (Borah and Prasad 2016). Tangsa consume the raw, but crushed earthworm with water to fight dysentery. The flesh of monkeys (macaques and gibbon), widely used in North-East India (Betlu 2013), is considered to affect blood pressure and cure asthma, malaria, tuberculosis and liver cirrhosis. It has traditionally also been used by north-eastern Monpa against typhoid, malaria and pox (Solanki and Chutia 2004).

A few of the zootherapeutic applications (details are found in Tables 1 and 2) are unique to the tribes under study. To mention the main ones: only the Tangsa use the tortoise carapace to treat malaria sufferers; pill bugs are used only by the Tangsa to treat epilepsy by drying these arthropods over a flame on a pan and then consuming them ground and mixed with medicinal herbs. The wings (actually the forelimbs) of bats are used by the Tangsa for curing tooth cavities, and the flesh is roasted and fed to children older than 4 years of age to stop bed-wetting. Members of the Wancho community, on the other hand, consume earthworms as a precaution to ward off malaria and use the haemolymph of bugs of the genus *Macrochereia* (formerly known as *Lohita*) for treating sufferers of coughs and colds. The possibility that some of the recorded differences between Wancho and Tangsa could be a reflection of different ecosystems and biodiversity in their respective areas cannot be discounted completely. However, the proximity of the two regions in question makes this an unlikely explanation.

3.4 One animal species to treat many illnesses or one malady to be treated by organs from many species

One common problem that doubters have with regard to the validity of at least some folk remedies is that one organ, e.g. the gall bladder is supposed to be effective in the treatment of a multitude of illnesses. Another is how gall bladders of a great number of different species (10 in the case of the Tangsa: see earlier in this paper) can exert identical health effects? A Brazilian review of ethno-zoological uses by Alves et al. (2017) even reported 67 and 60 different species in connection with treatments of asthma and rheumatism, respectively. Fact is that all vertebrates possess the same organs and these organs carry out the same functions as those in humans (Kahn 2005). Moreover, most pathogens, parasites and other aetiological agents of disease in humans, be they viruses, bacteria, fungi or poisons, are identical or similar to those that cause health problems in animals. Illnesses of animals and humans are more often than not based on the same essentials: discomfort, fever, lack of appetite, etc., and in the case of cancers mutated, rapidly proliferating cell lines. If therefore vertebrates suffer themselves from infections and even cancers, unifying

principles to fight the disease can be expected to have evolved in all vertebrates. It would therefore appear to be far more surprising to find that each group or even each species had evolved its own unique defence system to fight disease. To stay with the gall bladder, animal biles of 44 vertebrate species with information on chemical composition and applicability provided by Wang and Carey (2014) have been used therapeutically for at least 2500 years in China. All biles analysed were found to be rich in chemicals known to be “salutary in improving liver function, dissolving gall stones, inhibiting bacterial and viral multiplication, promoting cardiac chronotropism, as well as exhibiting anti-inflammatory, anti-pyretic, anti-congestive, anti-diabetic and anti-spasmodic effects” (Wang and Carey 2014). The same authors showed that although various biles were functionally identical, there were some that appeared to be most effective in connection with specific disorders. A very similar conclusion was reached when the question “For each malady one species or one species for all ills?” was asked by Meyer-Rochow (2017) in connection with therapeutic uses of invertebrates: most of them seem to work, but some work better than others.

What remains to be answered is how could totally different organ systems of the human body can benefit from the extracts, potions, powders, secretions, ashes or whatever from a single organ like that of the gall bladder for instance. It is likely that different pre-treatments like drying, smoking, mixing with rice, herbs or minerals and different kinds of uses like external application or ingestion with or without water at specific times of day can liberate and/or activate separate bioactive chemicals in the bile or gall bladder. Similar explanations can be advanced for other organs or tissues, e.g. flesh and blood. Although it is now accepted that some traditional remedies work and that certain animals and their organs do harbour identifiable bioactive compounds, not all traditional treatments or recommendations (obviously like the Tangsa’s drinking of a crow’s fresh blood during new moon being most effective in curing lung-related diseases or like pregnant women are to avoid consuming turtle tissue lest their children would become slow walkers) can be expected to possess scientific validity. In fact, many traditional zootherapies subscribe to the tenet “let likes be cured by likes”. To distinguish between a treatment’s real and imagined effectiveness therefore requires critical attention to detail and solid scientific checks by the investigator.

4 Conclusion

For the people of Eastern Arunachal, and especially those who still dwell in the remote villages with limited or no access to modern allopathic medicines, the knowledge of local medicinal plants and animals to alleviate complaints like headaches, stomach aches, joint pain, etc., is of the utmost importance. Traditional medicines are relatively low-cost items, and treatments by them are easier to arrange and obtain than from doctors at modern health facilities in faraway towns. Moreover, it is often believed that the traditional ways lead to a prompter cure and are without side effects.

There are, however, several major concerns. One of them, as elsewhere in the world where zootherapy is practiced (e.g. Brazil: Alves et al. 2008; Alves and Rosa 2013; Nigeria: Soewu 2008; Soewu and Sodeinde 2015; Izah and Seiyaboh 2018), is the depletion of local wildlife, loss of biodiversity. The increasing scarcity of certain therapeutically important species can result in steep increases in the cost for purchasing them or their parts. Numerous Wancho as well as Tangsa interviewees actually declared that the number of obtainable animals was getting lower and more expensive each year. Another related concern is the use of rare and protected species like, to name but a few, monkeys, tigers,

leopards, pangolins, peacocks, etc., and various suggestions, too many to list here, have been made to ease the pressure on species like these. Severe fines and punishments for harming or trading protected species have been introduced in many countries, the use of alternative, less endangered and domestic species has been suggested, even the commercial breeding of rare and threatened therapeutically important species has been muted. What is abundantly clear, however, is that more rigorous controls of the origins of animal parts are required and the barcoding of therapeutic species for identification and authentication seems a promising approach (Yang et al. 2018). It should also be possible to replace medicines from endangered species by herbal or chemical substitutes (Still 2003; Ferreira et al. 2016), but acceptance of such alternatives by traditional healers as well as their patients can be problematic.

Of regret is, last but not least, also the loss, if unrecorded, of years of accumulated folk wisdom related to the therapeutic uses of animals. Some of the age-old practices that have stood the test of time may hold clues of inestimable value in the quest to find new ways to fight certain diseases. The problem is that traditional healers are often reluctant to share their knowledge and youngsters are nowadays less and less interested in learning about the “old ways”. A shortage of dedicated investigators willing to spend time in remote places and visit and interview traditional healers also needs to be mentioned as one of the difficulties in obtaining reliable information.

Given the still rather extensive practice of the traditional medicinal system among the Tangsa and Wancho, sensitizing these tribal communities to the risk of losing flora and fauna if the resource is recklessly overused is important. The tribal people must understand that preserving their traditional knowledge of animals and their products to treat diseases and disorders depends on the availability of the raw material, i.e. the animals. To discourage needless killing of the latter and help tribal people to adopt an attitude that sees modern and traditional therapies side by side, effectively substituting each other, is a challenge of the future that needs to be met. Declaring certain species, threatened by extinction, taboo by elders or influential community leaders (cf., Meyer-Rochow 2009) rather than increasing fines could also help in this context.

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Author’s contribution JC conceived of the project and together with SJ designed the study. SJ was responsible for the field work, collected the data and carried out the statistical analyses. VBM-R provided advice and guidance throughout the study, helped with the evaluation and presentation of the results and wrote the final manuscript. All authors approved the final version of the manuscript.

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Compliance with ethical standards

Conflict of interest The authors declare they have no conflict of interest.

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Affiliations

Salomi Jugli¹ · Jharna Chakravorty¹ · Victor Benno Meyer-Rochow^{2,3} 

Salomi Jugli
galsalomi@gmail.com

Jharna Chakravorty
jharnargu@gmail.com

¹ Biochemical Nutrition Laboratory, Department of Zoology, Rajiv Gandhi University, Itanagar, Arunachal Pradesh 791112, India

² Andong National University, 1375, Gyeongdong-ro, Andong 36729, Republic of Korea

³ Department of Ecology and Genetics, Oulu University, 90140 Oulu, Finland