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Diversity and traditional ethnozoological uses of ichthyofauna by the Bodo Tribes of Kokrajhar, Assam, Northeast India

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Abstract. *Basumatary G, Narzary B, Khangembam BK. 2023. Diversity and traditional ethnozoological uses of ichthyofauna by the Bodo Tribes of Kokrajhar, Assam, Northeast India. Nusantara Bioscience 15: 49-57.* Fish is an important component of ethnomedicine for treating many diseases in many tribal cultures worldwide. Traditional medicine remains the primary healthcare system in most rural populations worldwide, and ethnomedicine is the foundation of many modern-day disease management. The use of fish in traditional healthcare could be a potent source for finding new compounds with therapeutic prospects. Studies on ethnoichthyology have indicated fish as an important component for treating many diseases. However, such studies are yet to be fully documented in the northeastern states of India, especially in Kokrajhar, Assam. The Bodos are one of the largest tribal groups of Assam in Northeast India, with a rich traditional knowledge system. The study explores the traditional uses of fish for various ethnomedicinal properties and health benefits by the Bodos of Kokrajhar, Assam. The study was conducted in eight villages of Kokrajhar District from March 2019 to February 2020 through personal interviews and semi-structured questionnaires with 150 informants. Thirty-four different fish species from 20 different families were identified to be used for their health benefits and therapeutic properties. The highest number of fish species belonged to the family Cyprinidae (20.59%), followed by Channidae (11.76%) and Ambassidae (8.82%). The highest use value (0.58) and relative frequency of citation (0.37) was recorded for *Heteropneustes fossilis.* Anaemia, gastrointestinal and integumentary disorders, and body weakness were the most commonly mentioned ailments treated. The present study also reported some small indigenous fish species for their health benefits. The study also found some unique traditional methods for preparing and applying fish species (*Xenentodon cancila, Chitala chitala, Glossogobius giuris, Leiodon cutcutia,* etc.) not reported earlier. Identification and detailed study of the biochemical profile of these different species may be recommended to develop suitable alternatives to synthetic medicines. This study may be a valuable addition to the rich traditional knowledge of Northeast India.

Keywords: Bodo Tribes, ethnozoology, ichthyofauna, Kokrajhar

INTRODUCTION

Traditional medicine refers to health practices, approaches, knowledge, and beliefs incorporating plant, animal, and mineral-based medicines, spiritual therapies, manual techniques, and exercises, applied singularly or combined to treat, diagnose, and prevent illnesses or maintain well-being (Adnan et al. 2022; WHO 2022). Plants and animals having medicinal properties are being used throughout the world. Traditional medicine remains the most common and affordable form of therapy in low-income countries. About 70-80% of the world's rural population depends on it for primary healthcare, most of which reside in developing countries (Chhetri et al. 2020). Animals and animal-derived products have always been a source of traditional medications and have vital significance in some religions and cultures (Prakash and Prakash 2021). In modern medical science, about half of modern medicines are reported to be derived from biological sources. The traditional knowledge of the ethnic community worldwide has contributed to recognizing living organisms used for treating diseases in livestock and human beings. Consequently, it is important to document the traditional knowledge of different tribal communities on the verge of socioeconomic and cultural deprivation (Laishram and Dey 2021). Though popular worldwide, many of the reported cases of ethnomedicine are restricted to ethnobotany. While compared to medicinal plants, there is insufficient research and data on the use of animals for medicinal purposes (Alves and Rosa 2013). However, recent studies have revealed the use of animals and their products as natural remedies in folk medicinal practices worldwide (Zanvo et al. 2021).

Fish as a cheap protein source also plays a major role in preventing and curing many diseases, including coronary disease, asthma, mental illness, low birth weight, and nutrient deficiencies which underlines the importance of fish in our diet (Naranje and Mishra 2015). Ethnoichthyology focuses on local knowledge, linguistic expressions, nutritious importance, folk practices, material evidence and cognitive perceptions of fish, and the environmental consequences of these interactions (Svanberg and Locker 2020). Some studies have documented the role of ichthyofauna in traditional medicines, mainly in the indigenous rural and fishing community (Vallejo and González 2014; Altaf et al. 2020).

The northeastern region of India is a biodiversity hotspot, and 185 species of fish have been recorded in Assam alone (ASBB 2022). Biodiversity has always been paramount for providing and discovering medical

substances (Neergheen-Bhujun et al. 2017). However, studies to ascertain the magnitude and use of animals and their products in traditional medicine are yet to be fully documented in Northeastern India, including Assam (Kumar et al. 2021). Fish occupy an important place in traditional therapeutic practices in Assam (Rahman et al. 2014). Traditional uses of fish species by ethnic communities of Assam to treat human diseases have rarely been documented (Borah and Prasad 2017). To the best of our knowledge, there is no report available from Kokrajhar, although the district in lower Assam is blessed with diverse fish species (Baro et al. 2015). The Bodos are one of the major tribes of the district, and they have a rich indigenous traditional knowledge of using natural resources for various purposes. Das et al. (2022) reported the diversity and availability of dry fish species used by the Bodos in Kokrajhar, Assam. Fish provide affordable proteins, support livelihood, and have cultural significance in local folklore and traditional medicines. However, no report exists on this rich ethnozoology, especially the ethnoichthyology of the Bodo tribes of Kokrajhar. With increasing urbanization and modern lifestyle, this traditional knowledge faces extinction. Documenting and safeguarding Traditional Knowledge Systems, which is regarded as the unique cultural identity of a community, are an essential part of bioresources management (Wangpan et al. 2019) and for establishing new medicinal prospects and remedial measures for unknown diseases (Borah and Prasad 2017). The present study, therefore, aims to identify and document the vanishing indigenous traditional ethnoichthyological knowledge of the Bodo tribes in Kokrajhar District, Assam, India.

MATERIALS AND METHODS

Study area

The study was conducted in the Kokrajhar District of Assam, India (Figure 1). Kokrajhar is the headquarter of Bodoland Territorial Region (BTR), Assam, India, and is located between 89°46'E and 90°38'E longitude & 26°19'N to 26° 54'N latitude, covering an area of about 3,169.22 km^2. The region is considered the center of Bodo culture. The district is situated on the northern bank of the Brahmaputra River. Bhutan surrounds it in the north, with Chirang and Bongaigaon Districts in the east, Dhubri District in the south, and West Bengal in the western side of the district. The region is rich in biodiversity and natural resources like forests and water. In addition, the district is endowed with several wetlands (known locally as beels) like the Diplai, Dheer, and rivers like Gaurang, Ultapani, Samoka, Gongia, Swrmanga, Sankosh, and Champabati which are sources for a diversity of fish species. Agriculture and allied activities are the main economic activities in the district. The study was conducted in eight villages (Sundrijhora, Bashabil, Landangpara, Tengapara, Harigaon, Kokrajhari, Thulungapuri, and Chautara) of Kokrajhar District, Assam, from March 2019 to February 2020.

Demographics of informants

Information regarding the age, sex, education, and occupation of each informant was collected with the help of predesigned questionnaires. Before any data was collected, the informants' were informed about the study objectives. Their prior consent was taken for the interview and the utilization of the information they provided for publication without disclosing their identity.

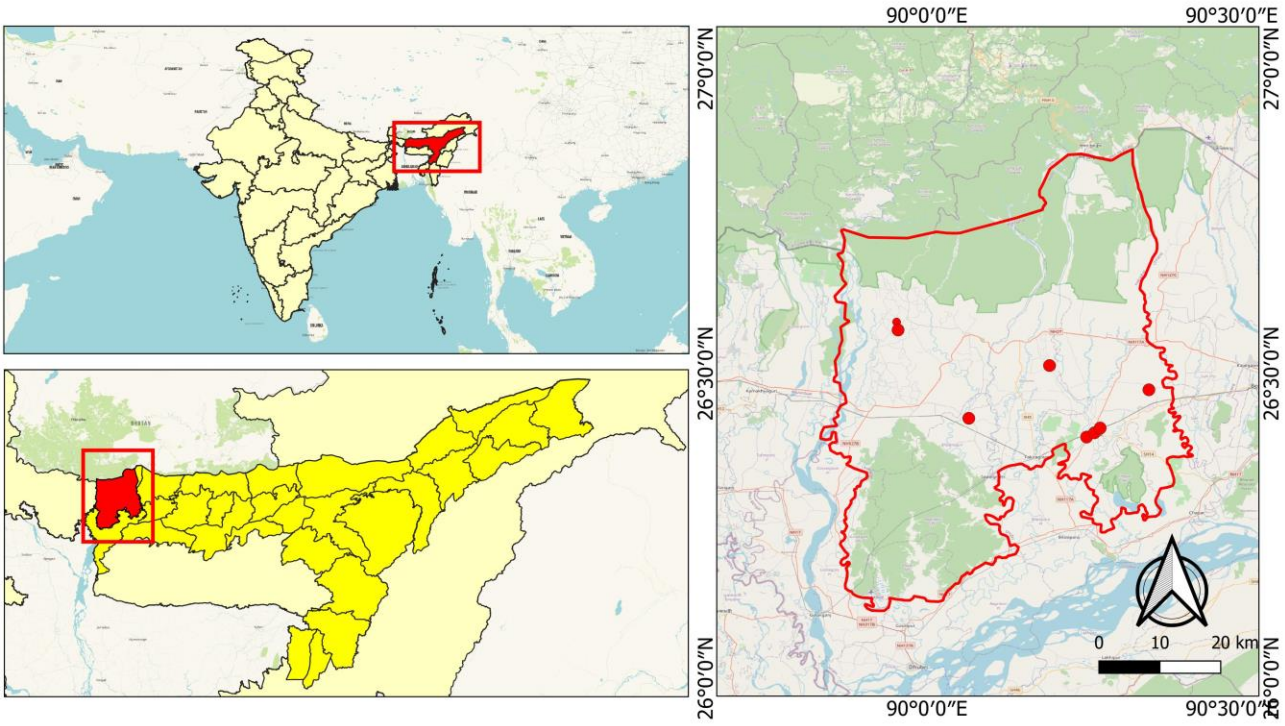

Figure 1. Map of Kokrajhar District, Assam in Northeastern India indicating the study areas

All informants were forthcoming, cooperative, and readily agreed to participate in the survey. None of the informants refused to participate in the survey. Altogether 150 informants participated in the study. A non-probabilistic snowball technique was used to identify potential informants by asking the participants for the location of new respondents fitting the criteria who again indicated the next potential participant. When information about the location of the population of interest is not available or clear, snowball sampling is regarded as effective (Young et al. 2018). All interviews were conducted in the local language of the informants (Bodo), and the interview duration ranged between 40 to 90 mins. Interviews were conducted anonymously, and the information gathered was kept confidential.

Data collection

Information regarding the traditional use of fish by the Bodo community of Kokrajhar, Assam, was obtained through semi-structured questionnaires and personal interviews with the respondents in different villages of Kokrajhar, Assam. The respondents were asked about the name and description of fish used, the mode of their utilization, and the traditional value of health benefits or treating ailments. The fish's local vernacular name and detailed description were used for preliminary identification of the species. Photographs and video clips of probable species matching the respondents' descriptions were shown to verify the species' identity. Whenever possible, fish samples were photographed and collected from the respondents (if they owned the species samples) and preserved (in 10% formalin) for further identification. Identification was done with the help of standard keys and references (Vishwanath 2017; Froese and Pauly 2022). The conservation status of the recorded species was evaluated from the Red List of Threatened Species of the International Union for the Conservation of Nature and Natural Resources (IUCN 2022).

Quantitative ethnozoology

Relative Frequency of Citation (RFC)

The relative frequency of citation (RFC) was calculated to understand the popularity and importance of a fish species. It was calculated following Vitalini et al. (2012) using the formula $RFC = F_c/N$, where F_c is the number of informants who mentioned using the species and N is the total number of informants. The value of RFC lies between 0 and 1, with higher values signifying more importance and citation.

Use value

The relative importance of each fish species was calculated using the use value (UV) Index (Albuquerque et al. 2006). The formula used was $UV = \Sigma U /n$, where, U is the sum of the total number of uses cited by the informants for a fish species, and n is the total number of informants. Higher UV scores usually imply the importance of the species. While low score approaching zero indicates few reports on its usage.

RESULTS AND DISCUSSION

Demographics of informants

A total of 150 informants from the eight villages of the Kokrajhar District of Assam took part in the study (Table 1). All respondents belong to the Bodo tribal community. Altogether, 53 males and 97 females between 25-80 years old participated in the study. The respondents belonged to different job categories: farmers, village elders, traditional healers, housewives, and government servants. The highest frequency was observed in the age groups 51-55 and 45-50 years, with 28 (18.7%) and 26 informants (17.3%), respectively. Most (79.3%) of the informants had at least a primary school education, whereas 21.7% did not receive any formal education. Of all the informants, 16 were practicing traditional healers, 33 were farmers, and 33 were in Government services. Twenty-six informants reported themselves as self-employed, while 38 informants were housewives, and another four were retired Government employees.

Relative Frequency of Citation (RFC) and Use Value (UV)

The UV of all the species ranged between 0.01 and 0.58, whereas the RFC value ranged between 0.01 and 0.37 (Table 2). The highest UV was recorded for *Heteropneustes fossilis* (0.58). *Clarias magur* recorded a UV of 0.48, while that of *M. cuchia* (0.39), *X. cancila* (0.35) and *C. gachua* (0.37) ranged between 0.35 and 0.39. The lowest UV was recorded for *P. sophore* (0.01) and *L. gonius* (0.01). The highest RCF value (0.37) was observed for *H. fossilis*, followed by *M. cuchia* (0.35). While *C. magur, C. gachua*, and *X. cancila* all recorded an RCF value of 0.29, the value was minimal (0.01) for *L. gonius, L. guntea*, *P. sophore*, and *W. attu*.

Diversity and traditional uses of fish

The study revealed 34 fish species belonging to 20 families in 10 orders, which the Bodos utilized for their traditional ethnomedicinal value or other health benefits (Table 2). The majority of the species (26.5% each) belonged to the order Anabantiformes and Cypriniformes (9 species each), while the least (one species each) was observed in the orders Anguilliformes, Beloniformes, Gobiiformes, Osteoglossiformes and Tetraodontiformes (Figure 2).

Order Perciformes and Synbranchiformes recorded three species each, while Siluriformes recorded five species. The highest number of species was recorded in the family Cyprinidae (7 species), which accounted for 20.6% of all the species recorded, followed by Channidae (11.8%) and Ambassidae (8.8%). Two species each were recorded in families Bagridae, Mastacembelidae, and Osphronemidae, while the rest of the families accounted for a different number of species ranging from 1 to 6 species in different families.

In the order Anabantiformes, the species identified were *Anabas testudineus, Badis badis, Channa gachua, Channa punctata, Channa striata, Channa marulius, Trichogaster fasciata, Trichogaster lalius,* and *Nandus nandus*. While, those belonging to order Cypriniformes were

Amblypharyngodon mola, Botia dario, Danio rerio, Labeo rohita, Labeo gonius, Lepidocephalichthys guntea, Puntius sarana, Puntius sophore, and *Rasbora* sp. Only one species each were observed from families Anguilliformes *(Anguilla bengalensis*), Gobiformes (*Glossogobius giuris*), Osteoglossiformes (*Chitala chitala*), and Tetraodontiformes (*Leiodon cutcutia*). Five species *viz. H. fossilis, C. magur, Wallago attu, Mystus tengara,* and *Mystus carcio* were recorded from the order Siluriformes. Other species recorded were *Xenentodon cancila* (Beloniformes), *Chanda nama, Parambassis ranga* and *Parambassis lala* (Perciformes), *Monopterus cuchia, Macrognathus aral,* and *Macrognathus pancalus* from the order Synbranchiformes. The majority of the identified species (30 species, 88.2%) belong to the least concerned (LC) category of the IUCN conservation status, while only two species were found listed in the near threatened (NT) category, and one species each in vulnerable (*W. attu*) and endangered categories (*C. magur*) of the IUCN list (Table 3).

The traditional uses of the different species of fish recorded in the study are listed in Table 2. In our survey, the muscles or the flesh were reported to be most commonly cited for their various health benefits. However, various other parts, such as the head, blood, oil, mucus, bile, viscera, bones, spines, skin, and scales, were also mentioned by some respondents for beneficial properties. The most frequently reported modes of preparation were either cooked fresh or dried before use. However, some species were reported to be used raw. In most cases, whole fish was reported to be used. The usage of specific fish parts was reported in a few species only. For instance: the blood and head of *M. cuchia,* the alimentary canal and bile of *P. sophore,* the skin and air bladder of *W. attu,* the scales of *C. chitala,* the long-pointed beak of *X. cancila* and caudal fin of *C. striata* (Table 2). Some of the ailments treated were associated with: the blood (e.g., anemia) and cardiovascular system, integuments, vision, body weakness, cold and fever, wounds, respiratory system, kidney stones, body pain, and stomachache. Other observed health benefits of fish recorded in this study included lactation in feeding mothers, good vision, improved wound healing, anti-allergy, increased strength, and overall health improvement after an illness.

Discussion

This study finds that the Bodos utilizes diverse fish species for various health benefits and for treating and managing many ailments. Similar studies have reported the use of fish for the treatment and management of a range of health issues, including night blindness, loss of appetite, wounds, skin burns, bronchitis, asthma, tuberculosis, arthritis, earache, cardiac diseases, rheumatism, blood pressure, rickets, calcium metabolism, nervousness, giddiness, smallpox, kala-azar, diarrhea, malaria, body-ache, cancer, and vitamins and minerals deficiency (Naranje and Mishra 2015; Rahman et al. 2018). The importance and popularity of a species for its ethnomedicinal or health benefits are usually estimated by UV and RFC. The UV is an important quantitative analysis that indicates the relative importance of an important ethnobiological species. Higher UV of *H. fossilis* and *C. magur* observed in the study shows that these species were used more widely than others. This also indicates their acceptance among the local population for their benefits. *H. fossilis* and *M. cuchia* recorded high popularity among the informants for their health benefits compared to other fish species, as indicated by their higher RCF values. Low RCF value for *L. gonius, L. guntea, P. sophore,* and *W. attu* indicates limited uses of these species. The highest RCF of *H. fossilis* and *M. cuchia* agreed with the diverse applications mentioned by various informants for these species. Species such as *A. testudineus* and *C. punctata* are considered important species in Kokrajhar for their preference and nutritional value (Devi et al. 2022) .

Table 1. Ethnographic data of informants participating in the study

Variable	Category	Number	%
Age groups	25-30	13	8.7
	31-35	7	4.7
	36-40	14	9.3
	41-45	21	14.0
	46-50	26	17.3
	51-55	28	18.7
	56-60	12	8.0
	61-65	16	10.7
	66-70	9	6.0
	Above 70	4	2.7
Gender	Male	53	35.3
	Female	97	64.7
Education	No formal education	31	20.7
	Primary school	11	7.3
	Secondary school	7	4.7
	High school	28	18.7
	Higher Secondary	33	22.0
	Graduate	36	24.0
	Postgraduates& above	4	2.7
Occupation	Traditional healer	16	10.7
	Farmer	33	22.0
	Housewife	38	25.3
	Government employee	33	22.0
	Self-employed	26	17.3
	Retired Government employee	4	2.7

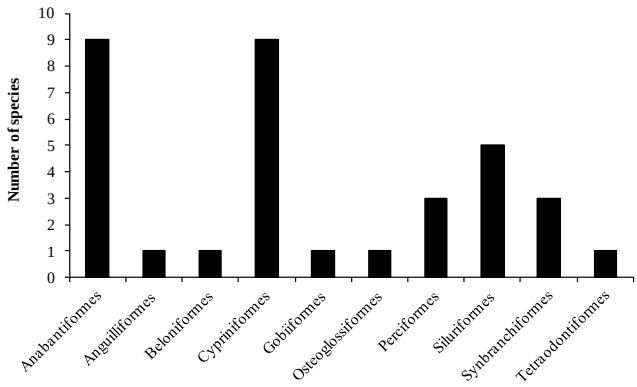

Figure 2. Different fish families were recorded in the study

Table 2. List of traditionally important fish species recorded in Kokrajhar, Assam, India and their traditional uses

Fish species	Local name	Parts used	Traditional uses, health benefits, and mode of usage	RFC	UV
Anabas testudineus	Kaowi	Meat	Provide relief from cold and fever, jaundice treatment, regain strength after any illness	0.07	0.10
Badis badis	Dusumwi	Flesh, head	Cooked with medicinal plants (known locally as Manimuni, Sibru, Jwglaori, and Nwrsing) and consumed to treat postpartum respiratory issues (locally known as Puwati).	0.24	0.28
		Whole fish	Preparation of a traditional fermented product (Napam)		
Channa gachua	Nasrai, nisla	Meat, head	Boiled with medicinal plants and consumed to promote lactation in mothers, improve bone health, relieves joint pain and arthritis	0.29	0.37
		Live fish	They are traditionally believed that the 'beating' or' slapping' by the caudal fin of the live fish on the lower limbs of children induces walking in them (in case of delayed onset of walking in some children).		
Channa marulius	Na sal	Meat, head	Treatment of cold and fever, purify the blood and increase in hemoglobin	0.02	0.03
Channa punctata	Na gwri	Meat, brain	Improve body weakness, provide relief from mild cold and fever, and is good for purifying blood	0.14	0.18
		Head	Treatment of renal stones: soup of ground dry head part in water		
		Whole fish	Preparation of a traditional fermented product (Napam).		
Channa striata	Sol	Meat, head	Good for wound healing, blood purification, and treatment of cold and fever.	0.05	0.22
		Caudal fin	The dry caudal fin is boiled with some medicinal plants and taken as soup to treat typhoid and gastric issues during the postnatal period in women.		
Nandus nandus	Tota	Flesh, head	Treating mild colds and fevers, believed to have anti-microbial properties, good for eyesight, and regaining strength after any illness.	0.11	0.15
Trichogaster fasciata	Bengshi	Flesh, head	Relieves cold and fever, jaundice management.	0.09	0.13
		Meat	Improve health and strength after illness.		
		Whole fish	Preparation of a traditional fermented product (Napam)		
Trichogaster lalius	Bengshi	Whole fish	Dry fish is boiled with vegetables and herbs and consumed during illness and typhoid.	0.07	0.1
Anguilla bengalensis	Nangdor	Head	Treatment of piles: Dry head part is roasted, ground, mixed with mustard oil, and applied. Anticancer properties	0.03	0.04
Xenentodon cancila	Kangkila	Head, snout	Used as a tool to remove dead erythrocytes in bruises or hematoma	0.29	0.35
		Whole fish	Dry fish is boiled and consumed to relieve headache		
Amblypharyngodon mola	Moaya	Flesh, head	Boiled fish improve low blood count, cures stomach ache, and improves eyesight	0.06	0.07
		Whole fish	Preparation of a traditional fermented product (Napam)		
Botia dario	Balabatia	Flesh, head	Provide relief from mild cold, fever, and anemia	0.04	0.04
Danio rerio	Nijou	Whole fish	Believed to be useful in the treatment of anemia	0.03	0.03
			Preparation of a traditional fermented product (Napam)		
Labeo gonius	Kursa	Meat, head	Anti-allergy properties	0.01	0.01
Labeo rohita	Rhou	Head, flesh, viscera	Good cardiovascular health, good for brain development, pain reliever	0.09	0.09
		Bile	Applied for pain relief		
Lepidocephalichthys guntea	Balabatia	Whole fish	Steam cooked wrapped in a special plant leaf, made into a paste, and applied to treat tongue and mouth ulcers.	0.01	0.02
Puntius sarana	Pitikri	Meat	Good for eyesight	0.03	0.03
		Whole fish	Preparation of a traditional fermented product (Napam)		
Puntius sophore	Pitikri	Alimentary canal, bile	Relieves pain caused by *H. fossilis* sting	0.01	0.01
		Whole fish	Preparation of a traditional fermented product (Napam)		
Rasbora sp.	Maoya	Flesh, head	Good for eyesight and brain development	0.01	0.07
Glossogobius giuris	Namutra	Flesh, head	Consumption of boiled or roasted fish is believed to prevent night bed-wetting in children	0.13	0.13
Chitala chitala	Chital	Scales	Remove dandruff in babies: dried scales are grounded, mixed with coconut oil, and applied to remove dandruff in babies	0.03	0.04
Chanda nama	Chandanga	Whole fish	Consumption of boiled fish improves health during illness	0.02	0.02
			Preparation of a traditional fermented product (Napam)		
Parambassis ranga	Chandanga	Whole fish	Treatment of mild cold and fever, consumption of boiled fish improves health during illness	0.08	0.08
			Used for preparation of a traditional fermented product (Napam)		
Parambassis lala	Chandanga	Whole fish	Boiled fish improve health during illness	0.02	0.02
			Preparation of a traditional fermented product (Napam)		

Clarias magur	Magur	Meat	Increase hemoglobin: boiled with some medicinal plants and prescribed for consumption for treating anemia Improve digestion, immunity, and general strength.	0.29	0.48
Heteropneustes fossilis	Singi	Meat	Consumption of boiled fish meat increases hemoglobin, which is useful in treating anemia. In addition, its believed to improve digestion and provide immunity and body strength.	0.37	0.58
Mystus carcio	Tengwna	Meat	Regain strength, especially after illness: the dry or raw flesh is cooked with vegetables or some medicinal plants	0.07	0.07
Mystus tengara	Tengwna	Meat	Regain strength, especially after illness: dry or raw fish is cooked with vegetables or medicinal plants.	0.11	0.16
Wallago attu	Barli	Skin	Cure dry skin	0.01	0.03
		Muscles, bladder	Removes scars on the skin Good nutrition		
		Whole fish			
Macrognathus aral	Turi	Meat	Treatment of mild cold and fever	0.04	0.04
		Whole fish	Preparation of a traditional fermented product (Napam)		
Macrognathus pancalus	Na thuri	Head	Treatment of ingrowing nail causing cellulitis: Roasted head part is ground with the flesh of a freshwater snail species and is applied to provide relief. Anticancer properties	0.07	0.09
Monopterus cuchia	Cuchia	Meat, blood	Increase hemoglobin: meat is boiled or cooked with medicinal plants (like *Lippia geminata*) and eaten to treat low blood or anemic condition. Believed to remove skin scars	0.35	0.39
		Head	Relieves stomach ache: dry head part is roasted, ground, mixed with water, and taken to cure stomach ache.		
Leiodon cutcutia	Na tepa	Whole body	Dry fish is ground and used as a paste in some skin wound types. Roasted fish are ground, mixed with water, and consumed to relieve gastric or stomach issues. Believed to prevent child habit of bed wetting (urination) at night.	0.17	0.24

Table 3. Diversity and IUCN conservation status of the fish species recorded in the study

Fish	Order	Family	IUCN status
Anabas testudineus	Anabantiformes	Anabantidae	LC
Badis badis	Anabantiformes	Badidae	LC
Channa gachua	Anabantiformes	Channidae	LC
Channa marulius	Anabantiformes	Channidae	LC
Channa punctata	Anabantiformes	Channidae	LC
Channa striata	Anabantiformes	Channidae	LC
Nandus nandus	Anabantiformes	Nandidae	LC
Trichogaster fasciata	Anabantiformes	Osphronemidae	LC
Trichogaster Ialius	Anabantiformes	Osphronemidae	LC
Anguilla bengalensis	Anguilliformes	Anguillidae	NT
Xenentodon cancila	Beloniformes	Belonidae	LC
Amblypharyngodon mola	Cypriniformes	Danionidae	LC
Botia dario	Cypriniformes	Botiidae	LC
Danio rerio	Cypriniformes	Cyprinidae	LC
Labeo gonius	Cypriniformes	Cyprinidae	LC
Labeo rohita	Cypriniformes	Cyprinidae	LC
Lepidocephalichthys guntea	Cypriniformes	Cobitidae	LC
Puntius sarana	Cypriniformes	Cyprinidae	LC
Puntius sophore	Cypriniformes	Cyprinidae	LC
Rasbora sp.	Cypriniformes	Cyprinidae	LC
Glossogobius giuris	Gobiiformes	Gobiidae	LC
Chitala chitala	Osteoglossiformes	Notopteridae	NT
Chanda nama	Perciformes	Ambassidae	LC
Parambassis ranga	Perciformes	Ambassidae	LC
Parambassis lala	Perciformes	Ambassidae	LC
Clarias magur	Siluriformes	Clariidae	LC
Heteropneustes fossilis	Siluriformes	Heteropneustidae	LC
Mystus carcio	Siluriformes	Bagridae	LC
Mystus tengara	Siluriformes	Bagridae	LC
Wallago attu	Siluriformes	Siluridae	VU
Macrognathus aral	Synbranchiformes	Mastacembelidae	LC
Macrognathus pancalus	Synbranchiformes	Mastacembelidae	LC
Monopterus cuchia	Synbranchiformes	Synbranchidae	LC
Leiodon cutcutia	Tetraodontiformes	Tetraodontidae	LC

Note: LC: Least Concerned, VU: Vulnerable, NT: Near Threatened

The method of preparation and utilization of the fish was generally simple, and in most cases, the whole fish was reported to be taken either cooked or roasted. Grounded paste, soup, or cooking with some medicinal plants were also common fish preparation methods. Most species recorded were normally used as food fish in most Bodo households. However, it was also observed that some fish species (such as *B. badis*, *C. striata*, *C. gachua*, *A. testudineus*, etc.) were often consumed occasionally in many Bodo households. That was probably due to the variation in seasonal availability and market price. The use of dry fish or its parts was also commonly reported by many informants. Small Indigenous Fish species (SIFs) like *P. sophore*, *P. sarana*, *T. fasciata*, *T. lalius*, *L. guntea*, *C. nama*, *P. ranga*, *P. lala*, *D. rerio*, and *M. pancalus* were the most common species found. Those fishes are also traditionally preserved as a unique fermented product known locally as *napam.* Similar traditional therapeutic uses of species like *G. giuris*, *A. mola*, *C. magur*, *H. fossilis*, *R. daniconius*, *Channa spp.*, *Puntius spp.*, *M. cuchia*, by different tribes and non-tribe indigenous people of Assam have been reported by Barman et al. (2013).

The *H. fossilis*, *C. magur*, and *M. cuchia* were widely mentioned by many informants for improving general health, especially after an illness, and also for increasing hemoglobin. Most recorded fish species were cited to improve general health and provide good nutrition to the body. The *M. cuchia* was also mentioned to be effective in removing scars from the skin. The dried *X. cancila* was boiled and consumed to relieve headaches. The *A. testudineus* was reported to be used to treat jaundice, cold, and fever. The *P. sarana*, *A. mola*, *Rasbora* sp., and *N. nandus* were reported to be good for improving vision. The flesh of *A. mola* was believed to be effective against stomachache. Health benefits of *M. cuchia*, *A. bengalensis*, and *A. japonica* include improvement of blood pressure, lower cholesterol and reduction of the risks of diabetes and arthritis, ease of menstrual pain, and improvement of the health of the skin (Rahman et al. 2014).

The present study also observed some unique uses of fish or its different parts. For instance, the head part of *M. cuchia* and *C. punctata* were found to be exclusively consumed by the Bodos for treating stomach pain and kidney stones, respectively, as prescribed by the local 'traditional healers' known locally as *Ojas*. The *Ojas* are the local traditional ethnomedicinal practitioners in many tribal communities in Assam, including the Bodos (Borah and Prasad 2017). A unique use of the head and long pointed snout or beak of *X. cancila* was also reported in this study. The dry preserved head of this species was generally used as a surgical tool to remove the dead blood cells in bruises or hematomas. This was traditionally believed to be effective in quickly healing bruises. Also, when applied, a special concoction made from the dried and grounded scales of *C. chitala* and coconut oil was reported to remove dandruff in infants. In addition, the Bodos used the muscles and air bladder of *W. attu* to remove scars from the skin. Consuming the muscles of this fish was also reported to be beneficial for removing or reducing scars or dark spots on the skin in this study.

The meat of *C. striata* was reported to be effective in healing wounds, relieving colds and fever, and inducing blood purification. Also, the soup of dried caudal fin of *C. striata* was prescribed for treating typhoid. In many Asian countries, *C. striata* are mostly consumed by people for its good taste and medicinal properties like wound healing and energy booster. Other reported pharmacological benefits of the species include anti-microbial, anti-inflammatory, cell proliferation, and induction of platelet aggregation (Shafri and Manan 2012; Rahman et al. 2018). In addition, the *Channa* species containing: docosahexaenoic acid, high glycine content, arachidonic acids, glycine, polyunsaturated fatty acids, and fatty acids may be responsible for its wound healing properties (Shafri and Manan 2012). In the present study, *C. magur* (magur) and *H. fossilis* (Singhi) were found to be traditionally important fish for consumption among pregnant and lactating mothers in Bodo society. Those fish were believed to induce lactation, provide pre and postnatal nutrition, and promote strength after childbirth. A similar report is available citing the use of the head, flesh, and liver of wels catfish for the treatments for skin, intestines, and throat disorders (Vallejo and Gonzalez 2014).

SIFs are reported to be widely used by the Bodos and other communities for their nutritional and medicinal properties (Roy et al. 2022). This study found that the alimentary tract, including the bile of *P. sophore*, was applied as a pain killer to relieve the pain caused by the poisonous *H. fossilis* fish stings. In the present study, when fed to infants and children, the boiled or roasted meat of *G. giuris* was believed to prevent night bed-wetting. Similar traditional use was also found for another fish species *L. cutcutia.* Also, the paste made of dry *L. cutcutia* was used for healing certain skin wounds by the Bodos in the present study. Another unique traditional belief among the Bodos was that the onset of first walking in children (with suppression/delay of this ability) could be induced by letting/making the caudal fin of live *C. gachua* 'slap' or 'beat' the limbs of such children. The head part of *M. pancalus* was roasted, grounded with the flesh of a local freshwater snail species, and applied to treat ingrowing nails causing cellulitis in the toe finger. The meat of *L. gonius* was known among the Bodos for its anti-allergic properties.

The popularity of animal-based remedies seems to be influenced by cultural aspects and the relations between humans and the surrounding biodiversity. For example, fish, an abundant resource in the region, has been an integral part of the traditional ethnic cuisine and culture of the Bodos of Kokrajhar. Hence, vast diversity in the species and usages of fish was reported in our present study. This indicates that the environment directly influences the choice of zootherapeutic resources, and medicinal use represents a strategy for optimizing the use of resources (Brito et al. 2019). The elaborate use of SIFs and air-breathing fish species for various health-related properties in the present study corroborates these observations.

Interestingly, in the present study, it was observed that some fish species, such as *W. attu*, *P. sophore*, *P. sarana*,

etc., were abstained during certain ailments or health conditions as they are believed to have an adverse effect on the body. For example, the consumption of *W. attu* was avoided in indisposed individuals when the person suffered from fever, chronic body pain, arthritis, etc. Similar reports are available from the Sikuani community in Columbia, where certain fish species are avoided in the traditional diet of Sikuani women during menarche, menstruation, gestation, and postpartum (Cubillos-Cuadrado et al. 2019).

Knowing the therapeutic value of fish increases awareness among people about the health benefits of fish, its essential nutrients, and its role in fighting against diseases and disorders (Naranje and Mishra 2015). The Bodos of Kokrajhar, Assam, inherited a rich ethnoichthyological knowledge through several generations. However, the scientific basis for several claimed health benefits and medicinal value has yet to be established for many species. For example, different species' amino acids, fatty acids, and mineral profiles may be the probable reasons for their health benefits. Nevertheless, proper documentation and mass awareness are important for preserving this rich knowledge as it not only represents the cultural identity of the Bodos, but may also help identify and develop a natural alternative to synthetic drugs in disease management.

In conclusion, the present study has identified and documented the traditional ethnoichthyology of the Bodo tribes of Kokrajhar, Assam. The use of thirty-four different fish species by the Bodos of Kokrajhar, Assam, for their traditional zootherapeutic properties to treat various ailments and for their health benefits indicates the vast diversity of fish species in the region and their importance in the life and culture of the Bodos. Further studies may be recommended to validate and identify the mechanism of action for their therapeutical properties. This information may be useful for innovations in healthcare industries, preventing biopiracy and preserving the rich indigenous traditional knowledge system of the Bodo tribes for future generations.

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