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Cultural entomology and edible insect diversity in a wetland ecosystem: A case study from the Loushi pat basin, Manipur

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Since time immemorial the Meitei community in the wetland ecosystems of Manipur valleys have been harvesting and consuming the edible insects. This paper brings out the diversity of the edible insects, traditional harvesting techniques, local food culture and its sustainability in the multi-use ecosystem of Loushi Pat basin in South Manipur. A total of thirty nine insect species were identified to be belonging to nineteen families and seven orders out of which thirty one are found to be edible. The edible insects consumed and sold are non-farmed and harvested from the wetlands. Harvesting and sale of the edible insects are largely done by local landless women from the local community. Understanding entomophagy and related livelihoods of the Loushi pat basin provides insightson sustainability of local livelihoods, vulnerabilities, food culture and ecology of modified wetlands in the region.

Keywords: Cultural entomology, Ecosystem, Entomophagy, Livelihoods, Loushi Pat, Meitei, Wetlands

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Food is one of the most important products that rural households derive from their natural environment[1]. Food from the natural surrounding also serves as a means of communication, of creating, affirming and reinforcing social relations, of expressing one's personal or group identity (e.g. ethnicity, class, gender) and of connecting to the living or ancestral peer group[2–5].

Insects are one of the most abundant animals on the planet and they play pivotal role our lives. We have been exploiting insects for several purposes such as food, medicines, for rituals, in art, in oral tradition and in technology. Archeological records too indicate the evidence for use of insect for food since time immemorial[6]. Human consumption of the edible insects as food commonly referred to as entomophagy is a widely practicing food culture all over the world[7–9]. There are ample archaeological evidences indicating that the ancestors of Homo sapiens were entomophagous, just like the extant primates (marmosets and tamarins) of today[10]. In Altamira, North Spain, depictions of the collection of edible insects and wild bee nests in cave paintings dating from about 30,000 to 90,000 BC provide unexceptional evidence of the establishment of a possible entomophagous society. Similarly, the ruins in the Shanxi province of China also indicate that the pupae of insects such as silkworms were consumed widely in around 2,500 BC[11]. There are more than 3,000 ethnic groups which are found to be practicing this food culture[12]. More than 2,140 edible insects are consumed in the World and this itself is a very small number as many of the newly documented edible insects are known by their vernacular names and at times many different species are understood by single vernacular names[13].

The food culture of a community is increasingly influenced by the kind of natural food sources that are available in its vicinity[14]. Thus, the practice of eating insects may be closely linked with environmental parameters such as habitat, species composition, abundance, stage in life-cycle, seasonality, etc. of insects. In response to these environmental parameters, traditional communities around the world have devised a plethora of practices for capturing, harvesting, storing and consumption. Many of these practices have become synonymous with local culture[8]. Cultural values have always been embedded in the natural environment and are often connected to components of the vegetation or

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fauna[15,16]. Cultural values do also relate to harvested wild resources[17].

In India some of the earlier pioneering works were carried out by Das as early as 1945[18]. Das reported that the locust (*Schistocerca gregaria*) was used as highly proteinous diet and as manure in India. In his work it was observed that the diets of the Muria tribes of Madhya Pradesh in India consisted besides many wild plants, the larval forms of the insects known as chin kara and the ants of certain species[19]. The Negrito tribes of the Andaman and Nicobar Islands are reported to be practicing the traditional use of plants and edible insects as food[20–22]. In the North eastern states of India edible insects are treated as delicacies. Entomophagy is a common practice in the region and nearly 255 edible insects are consumed as food by different tribes[9,23]. The practice of the entomophagy is well established among the tribes of Arunachal Pradesh, Manipur and Nagaland of Northeast India[23].

Objective of the Study

The two main objectives of the present study are: (i) to assess the distribution of the aquatic insect diversity of the Loushi pat basin and, (ii) to document the cultural significance of the edible insects and its associated livelihoods among the local community of the Loushi Pat basin.

Methodology

Study area

Encircled by nine ranges on all sides with a small and oval shaped valley at the center, Manipur is one of the states in the North eastern Region of India. The hilly state stretches between $92^0$58'23.422" East to $94^0$43'35.553" 'East longitudes and $23^0$49'45.530" North to $25^0$42'1.456" North latitudes. The state comes under the Indo-Burma Biodiversity hotspot and has a long international border with Myanmar of 352 km to the south east.The altitude of the state ranges from 20 m in Jiribam to 2994 m at Mount Isii (Tenipu) above the mean sea level. The climatic condition here is that of Sub-tropical temperate climate. The rainfall of the state in 2018, as recorded by ICAR, Lamphelpat is 1325.7 mm. The economy of the state is primarily dependent on agriculture. As the arable land is by and large marginal, agriculture in the state had persistently been on subsistence level.

The present study was conducted in the Loushi pat basin (Fig. 1). The Loushi pat was a perennially flooded lake till the middle part of the last century until it was drained with the aspiration of the villagers to convert it into paddy field which was also motivated by the claims of the authorities that villagers would be granted land once the wetland got drained in exchange of their labour in draining the

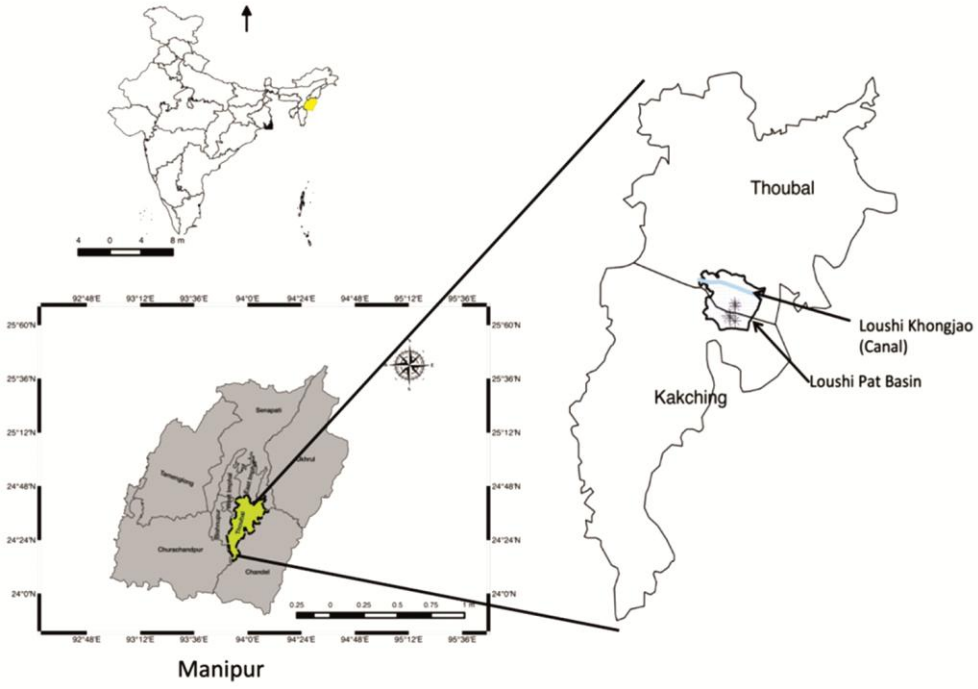

Fig. 1 — Map of Manipur in Northeast India showing location of the Loushi Pat Basin and the study area.

wetland. The major portion of the Loushi pat is located in the kakching District with the remaining part located in the Thoubal district after the bifurcation of the Thoubal district into Kakching and Thoubal respectively in 2016[24]. The total area of the Loushi pat is 18.64 km^2 and was once a waterlogged area covered by water all the year round till the beginning of the second part of the last century. The Loushi pat is located 35-40 km beyond the capital city Imphal. It is surrounded by the Tekcham, Patpal, Tentha in the North and Kakching in the South, Sora hill in the East and Mantak hills in the west. It was a waterlogged area of around 5500 parees[25]. The Loushi pat is bifurcated into two parts. One part is in the Thoubal district and the remaining part in the in the Kakching district after the bifurcation of the Thoubaldistict into two in 2016[24]. The Mantak hill resided by the Kom community stands erect like a natural embankment of the Loushi pat in the western part of the Loushi pat and it spreads towards the south - west upto the Sekmai River. Another associated lake called Kharungpatlies across the Mantak range. The water of the Loushi pat drained into Kharungpatdue to the cutting of a part of the hill range (Mantak Hill) that separated the two wetlands in the early part of 1950s[25]. Before converting it into an agricultural land by the villagers around the Loushi pat basin the Loushi pat was a fishing site for all the year round, a place for lilies, lotuses and various aquatic edible vegetables. The only variety of rice cultivated as and when conducive was Touthabi (local variety) which could grow in the flooded conditions for long time. It was harvested by the locals by using the boats made up of wood called 'hee'.

Ecological sampling

The primary objective was to find out the insect diversity in the Loushi Pat basinin by standard ecological sampling. The ecological sampling was conducted in the monsoon of 2017 and the household survey was done during the monsoon as well as in the post monsoon of 2017. Taking into account of the topography, drainage, vegetation cover, land use and other human activities, seven habitat types were identified for ecological sampling. They are Hirram (traditionally use for the boats to transport vegetables, fishes and paddies in the Loushi pat but are now used for draining water), Pats (low lying areas of the Loushi pat basin which usually do not get dried up in the summer and winter season), Village ponds (water tanks in the Loushi pat basins are artificially constructed community ponds), Paddy fields, Irum River, Fish Farms and the Loushi Khong (Canal). Insects were meticulously collected by scooping a D-net. The aquatic D-net having the frame diameter of 30 cm and standard 1 mm mesh pond (hand) net was used. A four feet long cane rod is attached in the frame as handle. In all the habitats the handle was held upright and placed the net on the bottom of each site of collection except in the canal and the fish ponds the net was submersed in the water for about four foot. As the habitats were not fast flowing water, there was no need of 'kick netting' to disturb the habitat or dislodging the stones or any other heavy objects where usually insects hide against the fast current of water. In all the habitats, after placing the net upright first the net was moved straight forward for five foots by holding the handle and pushing from behind. Whenever there were aquatic vegetation or debris the net had to be pushed a little bit harder to maintain constant scooping effort and volume. When the net is pulling out of the water the net is shaken gently to drain water and settle the content in the lower portion. Thereafter the contents were released in a white plastic tray just like the way that is practiced in pond netting[26]. The insects were photographed, some collected in the jar having alcohol or in the killing jar for further analysis and preservation. The collection, preservation and identification of insects were carried out following standard methods[27–29]. The data is collected in the period of 6 months from April to September 2017. This data was further analysed in R-Studio, using packages - Vegan and ggplot 2 for visualization.

Data collection for the study livelihood, cultural practices and historicities of the study site

The house hold surveys were conducted with a view to studying the edible insects and and their associated livelihoods that include the cultural implications. A stratified systematic sampling method was used and the semi structured interviews were conducted among the 75 households spread across five hamlets of the Irengband Gram Panchayet namely – Irum Turel Mamang, Irum Turel Maning, Irengband Sabal, Hawairou and Mairembam. Depending upon the wealth ranks, the households were chosen to ensure equal representation and 10% of the households from each hamlet were was interviewed. Key informant interviews, focused group discussions, participant observations were also conducted for collection of primary data and analysis.

Census data 2011 and 1991, base line survey 2018, archival materials, books, folklores associated with the wetlands of Manipur valley, gazettes, newspaper articles were used for the secondary data analysis and also for the study of the land use pattern change in the study area.

Results

Ecology of edible insects in Loushi

Insect species from the Loushi area were collected, photographed, described and identified. In all, a total of 39 different species of insects belonging to 7 different orders and 19 families were collected from seven different habitats of the Loushi pat basin namely LoushiKhong (Canal), Village ponds (3 in number), Hirrams (5 in number), Pats (Nganu pat, Thoibi pat), Irumturel, Fish farms and Paddy fields. The insects were described and identified following Imms'classification[30]. The insect species observed during the survey are listed in the Table 1 along with the descriptions on how they are processed for consumption. Out of these 39 species, 31 of the insects were recorded to be consumed by the locals. After collection, these insects are either consumed in households or sold in the market. Out of the eight species that were not consumed locally, four belonged to Hemiptera, two were from Hymenoptera, one was from Dictyoptera and one was from Coloeoptera.

All the 10 species belonging to 5 families of Odonata are edible. Hymenopterans represented here by 2 families and 2 species are not consumed in the area but local informants shared that they are

Table 1 — Table showing the insects collected and identified from the Loushi pat basin and their consumption practices

Order	**Family**	**Species**	**Common English Name**	**Local Name**	**Stage at which it is consumed**	**Mode of Processing or consumtion**	**Edible**
Odonata	Libellulidae	Crocothemis servilia	Dragon fly nymph	Maikhumbi	Nymph	Roasted/Fry in oil with salt	Yes
	Libellulidae	Acisoma panorpoides	Dragon fly nymph	Maihumbi	Nymph	Roasted/Fry in oil with salt	Yes
	Libellulidae	Leucorrhinia sp	White faced dragon fly nymph	Maikhumbi	Nymph	Roasted/Fry in oil with salt	Yes
	Libellulidae	Crocothermis sp	Dragon fly	Maikhumbi	Nymph	Roasted/Fry in oil with salt	Yes
	Libellulidae	Libellula sp	Common Skimmer	Maikhumbi	Nymph	Roasted/Fry in oil with salt	Yes
	Libellulidae	Pantala flavescens	Dragon fly nymph	Maikhumbi/ Kumjeng	Nymph	Roasted/Fry in oil with salt	Yes
	Coenagrionidae	Pseudogrion sp	Narrow wing damsel flies	Kumjeng	Nymph	Roasted/Fry in oil with salt	Yes
	Corduliidae	Cordulia sp	Green-eyed skimmer	Maikhumbi	Nymph	Roasted/Fry in oil with salt	Yes
	Lestidae	Lestes sp	Stalked wing damsel flies	Kumjeng/ Lakes or streams	Nymph	Roasted/Fry in oil with salt	Yes
	Coenagrionidae	Ischnura sp	Narrow wing damsel flies	Kumjeng	Nymph	Roasted/Fry in oil with salt	Yes
Hymenoptera	Apidae	Apis mellifera	Honey bee	Khoi	Larvae	Roasted/ Raw	No
	Apidae	Bombus sp	Bumble bee	Khoi muu	Larvae	Roasted/ Raw	No
Ephemeroptera	Baetidae	Baetis sp	Mayflies	Maikhumbi macha	Larvae/ Adult	Roasted/ Fry in the oil	Yes
Coleoptera	Dysticidae	Cybister sugillatus	Water beetle	Tharaikokpi/ Chikchribi	larvae/ Adult	Roasted/Fry in oil with salt	Yes
	Dysticidae	Cybister tripunctatus	water beetle	Tengbi	larvae/ Adult	Roasted/Fry in oil with salt	Yes
	Dytiscidae	Hydaticus sp	Water beetle	Tengbi	larvae/ Adult	Roasted/ Fry in the oil with salt	Yes
	Dystiscidae	Hydrophilus olivaceous	Water beetle	Tharaikokpi	Larvae/Adult	Roasted/Fry in oil with salt	Yes
	Dytiscidae	Rhantus sp	Water beetle	Tengbi	Larvae/ Adult	Roasted/ Fry in oil with salt	Yes
	Gyrinidae	Gyrinus sp	Whirligig beetle	Chini champra	Not Consume	Not Consume	No
	Hydrophilidae	Hydrous indicus	Water scavenger beetle	Tharaikokpi/ Chickchribi	Larvae/ Adult	Roasted/ Fry in oil with salt	Yes
	Hydrophilidae	Tropisternus sp	Water beetle	Tharaokokpi/ Chickcribi	Larvae/Adult	Roasted / Fry in oil with salt	Yes
	Hydrophilidae	Hydrous olivaceous	True water beetle	Tharaikokpi	Larvae/Adult	Roasted / Fry in oil with salt	Yes
	Scarabaeidae	Oryctes rhinoceros L	Rhinoceros beetle	kangchek	Not Consume	Not Consume	No

(*Contd*.)

Table 1 — Table showing the insects collected and identified from the Loushi pat basin and their consumption practices

Order	**Family**	**Species**	**Common English Name**	**Local Name**	**Stage at which it is consumed**	**Mode of Processing or consumtion**	**Edible**
Orthoptera	Gryllotalpidae	Gryllus orientalis	Mole cricket	Waahi	Adult	Roasted / Fry in oil with salt	Yes
	Acritidae	Gryllus sp	Field cricket	Koujeng/ Harou	Adult	Roasted / Fry in oil with salt	Yes
	Acritidae	Oxya hyla hyla Serville	Rice grasshopper	Koujeng	Adult	Roasyed/ Fry in oil with salt	Yes
Hemiptera	Belostomatidae	Diplonychus rusticus	Water bug	Kumjeng Kokphai	Larvae/ Adult	Roasted / Fry in oil with salt	Yes
	Belostomatidae	Lethocerus indicus	Giant water bug	Naoshek	Adult	Roasted/ Boiled/ Steamed	Yes
	Notonectidae	Enithare ciliate	Back swimmer	Long Khajing	Adult	Roasted/ Fry in oil with salt	Yes
	Notonectidae	Enithare mandalayensis	Back swimmer	Long khajing	Adult	Roasted/ Fry in oil with salt	Yes
	Noctonectidae	Notonecta glauca	Back-swimmer	Long Khajing	Adult	Roasted/ Fry in oil with salt	Yes
	Garridae	Gerris sp	Pond skater	Ishing mee	Not Consume	Not Consume	No
	Hydrometridae	Hydrometra geeni kirkaldi	Water measurer	Eshing cheitek	Not Consume	Not Consume	No
	Corixidae	Micronecta haploides	Water boatmen	Ishing khajing	Adult	Roasted/ Fry in oil with salt	Yes
	Corixidae	Micronecta sp	Water boatman	Long khajing chanadey	Adult	Roasted/ Fry in oil with salt	Yes
	Nepidae	Laccotrephes maculatus	Water scorpion	Haonaoshek	Adult	Roasted/ Fry in oil with salt/ Boiling / Steaming	Yes
	Nepidae	Ranatra linearis	Water stick insect	Thawai mee	No	No	No
	Nepidae	Ranatra sp	Water scorpion bug		No	No	No
Dictyoptera	Mantidae	Heirodula sp	Praying mantis	Horai lenbi/ Sallam katpi	No	No	No

consumed by other ethnic communities of Manipur. Ephemeroptera is represented by one family and is edible. The four families of Coleopterans are represented by 12 species and out of which 2 are not edible. All the three species of Orthoptera belonging to 2 families are edible. Hemipterans show 12 species belonging to 6 families and out of the 12 species 8 species are edible. Dictyoptera is represented by one family and one non-edible species. It is interesting to note that Hymenopterans (mainly honey bees and bumble bees), are considered edible among most communities in Manipur, but are not usually consumed by Meitei hindus, since honey is considered sacred and is used in traditional medicine. Another interesting observation the case of Dictyopterans represented by Praying mantis (Heirodula sp.), that are not consumed locally because of taboos associated with the spirit world.

As shown in the Fig. 2 all the different species collected and identified from all the seven types of habitats in the Loushi pat basin the most abundant ones are represented by *Gyrinus* sp (whirligig beetle) followed by grasshoppers (*Oxya hyla hyla*) and water beetle of the *Tropisternus* sp. Larvae of the dragonflies such as *Acisoma panorpoides*, *Crocothemis* sp are moderately abundant. Field crickets, praying mantis and stick insects are least encountered during the survey. Stalked wing damselflies (*Lestes* sp) is found out to be the most frequently sampled species followed by Common skimmer (*Libellula* sp) and water beetle (*Cybister sugillatus*). Water stick insects (*Ranatra linearis* and *Ranatra* sp) are least frequent during the sampling of the insects in all the habitats. The maximum relative density is shown by the *Gyrinus* species followed by the *Oxya hyla hyla*, *Tropistermus* sp, and *Cybister sugilatus*. *Gryllus* sp, *Heirodula* sp, *Hydrophilus olivaceous, Oryctes rhinoceros* are least in terms of their relative densities.

The local edible insect harvester collect the insects along with the fishes from the Loushi pat basin areas with the help of the traditional gear called as *Longthrao* or *Long* in short (Fig. 3, Fig. 4). It is a circular rimmed net all made up of bamboo strips or split bamboo. In the *Long* traditionally all the materials are made up of bamboo. Thicker bamboo strips/split bamboos are used for making the circular rims. The mesh is made up of paaya (fine bamboo strips) in the *Long* but in the *Longthrao* the mesh is

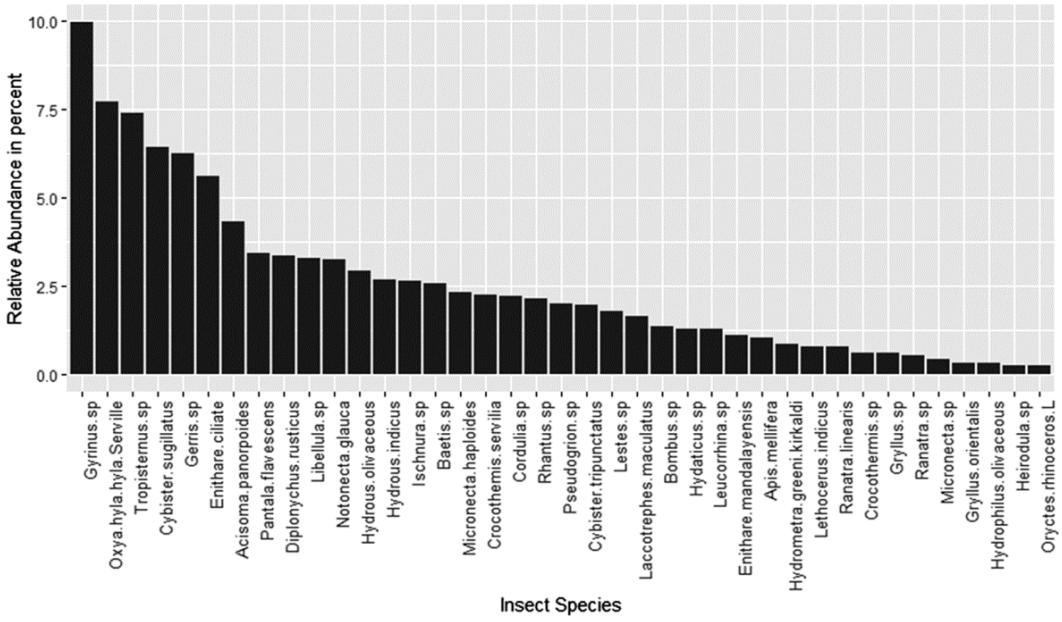

Fig. 2 — Graph showing the relative abundance of the Insects in the Loushi pat basin collected in 461 scoop samples (Scaled on 0-10)

Fig. 3 — A woman harvesting edible insects and fishes in the Nganu pat area of the Loushi pat basin by using Longthrao. The container tied in the waist is Tungol for keeping the harvested insects and the fishes together.

Fig. 4 — Traditional insect and fish traps along with the D-net (A- Tungol for keeping the fishes and insects while harvesting, B- Inn for catching and trapping fishes and insects in river or stream, C-Long, D-Women catching insects and fishes by using Long, E-Kaboru for trapping fishes and insects, F, G- Longthrao for trapping fishes and insects) and H- D-net scoop used for ecological sampling.

made by nylon or cotton fibres. The circumference of the rim of the *Longthra*o is more than the *Long*. The harvester put the *Long* by holding with the hands with the rim toward the harvester and kicks the water or aquatic vegetation so that the fishes and the insects may found themselves trapped in the net. This act of collecting the fish and the insects is called *Long Khonba*. The traditional Long is made up of bamboo strips. They are used in the canals and streams which typically have stronger water currents.

The locals after collecting the edible insects processed them for consumption, mostly after removing the wings. The processing and the ways of the consumptions of the edible insects in the given study area are given in the Table shown in the Table 1. They are roasted or fried preferably in mustard oil. Almost all the edible insect sellers of the Irengband village in the market of Kakching are the harvesters themselves. They mainly sell water beetles and giant water bugs, scorpion bugs, nymphs of dragon flies and damsel flies. Many of the edible insects such as larvae of certain water beetles can never reach market as they are such as ought-after delicacies among the locals that they almost always end up in the kitchens of the harvesters. Collection of

the edible insects by the harvesters or collectors are usually performed after the lunch at around 2 pm to 3.30 pm as many of the harvesters act as agricultural labourers in the morning or go for agricultural activities in their own fields if they have. The harvesters collect the insects mainly from the flooded paddy fields when not in use, fish ponds, hirrams, pats and water logged areas of the Loushi pat basin. The Loushikhong is avoided as the water is deep and it cannot be collected without using boats.

Cultural ecology of insect food and the edible insect associated livelihoods of the Loushi pat basin

The importance of the wetland in the annals of Manipur's history is unique. The royal chronicle (Cheitharolkumbaba) clearly shows that the wetlands have been treasured and cherished by the people living in the valley of Manipur [31]. It is now known that the use of wetlands including ponds for rituals in the valley dated back to the 1st century AD during the reign of the King Nongda Lairen Pakhangba who ruled during 33-154 AD[32]. Every lake or pat in the valley has interesting story associated in one way or the other to the folk tales of Manipur including legends and epic story like the Khamba and Thoibi. The Loushi pat ~~is~~ a part of the legend, when the young beautiful Princess Thoibi had to leave her brave and handsome but poor lover Khamba who was also an orphan and came to Kabo crossing several pats including the Loushi pat. There is still a small temple in Irengband dedicated to Thoibi. A part of the Loushi pat basin is called Thoibi pat because of the belief that Thoibi was fishing and collecting snails and insects at that waterlogged area. Thoibi pat is represented by a small canal now and locals have installed a check dam for irrigating the nearby paddy fields. It is said that during the reign of the King Khumomba (1263-78) the Shans of Burma invaded Manipur and occupied till Ikop pat including the Loushi pat area[25]. Women who harvest the edible aquatic insects and the fishes along with the snails in the Loushi pat basin still uses similar fishing traps and nets as described in the epic poem Khamba Thoibiseireng. The harvesters of edible insects, fishes, ponds and the flooded agricultural fields when not under cultivation in rainy season collect insects from the hirrams (that goes along with the sallams) and water logged areas by dipping the traps called longthrao made by the bamboo or nylon net in the water in front of them and kicking the water and the water vegetation by feet so that the hidden fishes and the insects run towards the traps. The technique or the way the harvesters collect the edible insects and the fishes are same as the one described to be used by Thoibi in the Khamba and Thoibiseireng[33,34]. This establishes the fact that the harvesting of the edible insects and the fishes in the Loushi pat is an old culture of Manipur and more especially of the people who reside on lakes, margins and shores of the lakes or the lake basins in the Manipur valley.

Although during the survey thirty-one insect species were found to be consumed in the study area, the ones frequently sold and caught for consumption are only seven (Tharaikokpi/water beetles, Maikhumbi/nymphs of dragon flies, naoshek/ Giant water bug, Chikchribhi/larvae of water beetle, haonaoshek/water scorpion , Kumjengkokphai/water bug and long khajing/back swimmer). All groups of people in the Irengband village consume insects except the Meitei Brahmins (Meteibamons). They are also not prepared for consumption in the Hindu religious feasts. The edible insect harvesters are mainly women. Men usually do not engage in the harvesting of the insects specifically. They tend to harvest edible insects which happen to be caught in the fish traps. Men go for fishing and agricultural activities in the submerged rice fields. If they do collect the edible insects trapped in their fishing nets these are only used for household consumption. Men are not involved in sale or purchase of insects in the market. The entire harvest and sale of edible insects in this area is handled by women almost exclusively.

Certain insect species such as water beetle including the larvae of the water beetles and giant water bug tend to garner good market prices and contribute to livelihood as important source of income. During the rainy season harvesting of the edible aquatic insects is rewarded with greater successes and the harvesters could earn around Rs 6000 – Rs 8000/ month, which is a significant amount considering monsoons are a lean period for wage labour in this area.

The price of the edible insects are not fixed by weight but by number of edible insects in the case of giant water bugs and by spreading the insects in a circular manner (of about 15 to 20 cm in diameter) on a stainless steel plate or a plastic sheets of the insects. Quality of the insects is determined mainly by size in water beetle and nymphs of dragon flies smell in the case of giant water bug and freshness of the insects. The demand for certain species is so high that people

travel far and wide to procure them. One of our respondents reported that she had gone to the Ema market of the capital city Imphal just to buy the giant water bugs that come from Dimapur, Nagaland.

Locals consume these insects as delicacies, and also associate the practice with their identity and nostalgia. People of all age groups are found to consume the edible insects in the study area. The locals are of the opinion that the edible insects are caught less nowadays in the Loushi Pat basin. The village commons and water filled Hirrams from where edible insects were frequently caught no longer hold water throughout the years now. Changes in the habitats of the edible aquatic insects are the primary reason for the low availability of the edible aquatic insects in the Loushi pat basin.

Discussion

Manipur's wetlands and the valleys provide an opportunity towards understanding the ecology of edible insects, and the livelihood opportunities that edible insects provide to local communities. However proper systematic documentation accompanied by standard ecological methods and multi species studies lenses have not been carried out although some qualitative studies have taken place in recent times[35]. The Valley of Manipur is well supplied with numerous wetlands and consumption of aquatic edible insects forms a part of local food culture in the valley[35–37]. In the recent past, aquatic habitats and their associated species have found to be increasingly threatened[38]. Studies based on the Quick Bird satellite image of 61 cm resolution prepared at 1:4000 scales showed that the Manipur valley covered an area of about 1920 km^2 in which the natural wetlands cover 61.2 sq. km[32]. Most of the data available on edible aquatic insects of the valley of Manipur are the ones that have been collected from Manipur's largest freshwater lake - the Loktak Lake. The information of the edible insect diversity of the other wetlands of the valley of Manipur is poor or non-available. As these wetlands are important the present study was undertaken on the ecology, cultural significances and livelihood importance of edible aquatic insects. The study also tries to document the traditional methods of trapping and harvesting the edible insects in the Loushi pat basin. We examined the entomophagy practices of the Meitei community residing in the Irengband village of the Loushi pat basin. Here the *pat* means lake in Manipuri (Meiteilon). The study is also taken up because of the prime importance of the Loushi pat in the history and the culture of Manipur. The drastic alteration of the wetland system by cutting a part of the Mantak hill range (called now as Chingkakpham) by draining the water for paddy cultivation, seemingly had profound impact on the ecology and society of the region. The study also attempted to understand the food culture and livelihoods associated harvesting edible insects thriving in an unpredictably fragile and rapidly declining ecosystem.

Along with the cultural significance that is associated with it, food derived from wild nature is also known to form a vital part of the nutritional requirements of several communities around the world[9]. Studies have shown that edible insects are a healthy and balanced food item that contains proteins, fats, and small amount of carbohydrates, fibrous materials, minerals and vitamins of importance. Proteins derived from edible insects are considered to be environment safe and friendly, and are interestingly referred to as 'eco-protein'. Further, in recent times, rising cost of animal protein, and the insecurities associated with animal feed (food given to domestic animals in the course of animal husbandry) have caused many to appreciate the value of insects as food, and as a relevant means to counter environmental pressures[9]. Insects constitute as one of the cheapest sources of protein requiring only a fraction of the area needed to cultivate larger animals such as cattle, sheep or pigs[39,40,41]. The insects as compared to conventional food also claim to have low ecological footprints[42]. According to the FAO, there are around 1,900 registered edible insect species, and some 2 billion insect consumers worldwide[9]. The cultivation of edible insects for human consumption, commonly referred to as mini-livestock rearing, is also gaining acceptance in the field of animal husbandry and edible insects are being increasingly viewed as future food[43,44].

Insects are also known to be associated with visual arts, music, rituals and many other cultural activities[45]. Besides, they are also a renewable natural resources and rich source of incomes for many people especially among the rural masses. Rural household's livelihood diversification through the utilization and selling of the edible insects are common practices in places such as the rural regions of Zimbabwe[46]. Studies have found that in Bikita, Zimbabwe, the utility of termites to rural households is remarkable. It complemented other off-farm livelihood activities while providing a sustainable way for livelihood diversification in among the dryland poor. It is also

said to be able to partly address the problems of food insecurity. Similarly, Gahukar, R. T. (2012) reported that entomophagy can support rural livelihood in India. In Laos it is observed that middle-men/ women sell on average 1,700 crickets in the market each day, earning 1200 Kip/10 crickets sold (US $1.00=10,000 Lao Kip, based on Exchange rates given in[48].

The edible insects therefore, have immense economic potential to uplift the rural livelihoods in this region, and perhaps ensure long-term livelihood security. One of the approaches that could be attempted is the domestication and rearing of these insect species since they fetch significant prices in the regional markets. Since the data indicates that the beneficiaries primarily are women and therefore encouragement by way of creation of women's Self Help Groups, for organized collection, processing and trade could greatly benefit the disadvantaged sections in this region.

Conclusion

The survey shows that entomophagy is an important food culture of the Meiteis in the Loushi pat basin. It is an important livelihood practice and an important source of nutritional supplement for the locals. The diversity of edible insect species and an equally diverse ways of harvesting, consuming and processing the edible insects from different habitats of the Loushi Pat basin indicates clearly the deep ecological knowledge of the locals. Edible insects provide livelihood support for economically marginalised local women that is qualitatively quite different from the exclusive agricultural labour market which tends to employ males more. The materials used in the traditional fishing and the edible harvesting traps such as the Long (Chegai Long and Longthrao) are derived mainly from the local natural resources. They are made by the local farmers during their off season or during the lean period when agricultural activities are low. The traps, harvesting processes, different ways of processing the edible insects before consumption demonstrate a deep understanding of the ecology and life cycles of the insect species among local community that needs further documentation.

The pursuit of developmental goals often results in large-scale conversion and transformation of natural ecosystems. In this case, the human made ecosystems such as paddy fields, fish farms, and canal vegetation still manage to harbor a vast variety of edible insect species. These habitats continue to provide critical livelihoods to the marginal and the poor. Further work is required to understand the impact of use of agro-chemicals in these working landscapes and the risk it may pose for insects. The complex relationship that exists between insects, wetlands and local cultural practices are the cornerstone for the long-term sustainability of the ecosystems and people in the valleys of Manipur.

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MOKS and SB conceived the project, MOKS conducted the field survey and data analysis, and both authors contributed to the preparation of the manuscript.

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