Taylor & Francis
Taylor & Francis Group

J Hum Ecol, 60(1): 42-54 (2017)
DOI: 10.1080/09709274.2017.1399632

A Study on the Use of Insects as Food in Seven Tribal Communities in Nagaland, Northeast India

Lobeno Mozhui[1*], L. N. Kakati[1] and Sapu Changkija[2]

[1]*Department of Zoology, Nagaland University, Lumami 798 627, Nagaland, India*
[2]*Department of Genetics and Plant Breeding, Nagaland University, Medziphema 797 106, Nagaland, India*

KEYWORDS Entomophagy. Food Security. Nagaland. Tribal Communities. Use Value. Utilization

ABSTRACT This paper documents the use of insect as food among seven tribal communities of Nagaland. Information was obtained through personal field interviews with 240 informants with the help of semi-structured questionnaires. It was found that 82 species of insects belonging to 9 orders (Odonata, Orthoptera, Mantodea, Isoptera, Hemiptera, Coleoptera, Hymenoptera, Lepidoptera and Diptera) are an important traditional food item principally consumed by the tribal people. Insects are preferred as eggs, larvae, nymphs, pupa or adult which are cooked, roasted or consumed raw. Documentation was done by calculating the "use value" (UV) of each species. It is evident from the study that insects can enhance nutritional deficiencies and can also improve the livelihood of the rural poor in the region. Hence, an inventory of food insects covering as many tribes is necessary so as to get benefit from their natural diversity before the existing traditional information is lost.

INTRODUCTION

Although some insects can transmit diseases and be pests, the vast majority is harmless and beneficial. Insects are actually rendering to humans inestimable services as pollinators, as predators of crop and storage pests, as sources of raw materials and as food. The utilization of insects as food by humans, known as entomophagy, is widespread and known from different parts of the world (Bodenheimer 1951), but it varies with regard to local population and ethnic group (Johnson 2010). Insects may have originally been used as an emergency food item, but today about 2,140 insects are consumed by over 2 billion people on a regular basis (Mitsuhashi 2016; Bernard and Womeni 2017).

Insects are appreciated as food because compared to conventional meat sources (example beef, pork and chicken), edible insects often contain more protein and in fact are usually richer in polyunsaturated fatty acids and minerals (Bukkens 1997; Chakravorty et al. 2011a; Rumpold and Schlüter 2013) than the conventional foods mentioned. The world population is rapidly growing and in order to provide for the increasing population developing insects for food and feed, as first suggested by Meyer-Rochow (1975) is now considered a viable strategy (Van Huis et al. 2015). Entomophagy has, therefore, been advocated worldwide as a source to combat future food security mainly because of its abundance, high nutrient composition, high feed conversion efficiency, digestibility and ease with which they can be bred (Van Huis et al. 2015; Seni 2017; Alexander et al. 2017). Furthermore, as a food source, edible insects can help to uplift the nutritional status of residents of poor developing countries and at the same time can serve as a complimentary food or food ingredient for developed countries (Sogari et al. 2017).

A good amount of research on edible insects has been carried out across different regions of India viz. Arunachal Pradesh (Chakravorty et al. 2011b, 2013), Assam (Ronghang and Ahmed 2010; Doley and Kalita 2011; Narzari and Sarmah 2015; Dutta et al. 2016; Rabha 2016), Manipur (Shantibala et al. 2012) and Tamil Nadu (Wilsanand et al. 2007; Samuel et al. 2016). In fact, Meyer-Rochow and Chakravorty (2013) have reviewed uses of edible insects in India and reported that about 255 insect species were known at that time to be consumed by the members of

Address for correspondence:
Lobeno Mozhui
Research Fellow
Ecology Laboratory, Department of Zoology,
Nagaland University,
Lumami 798 627, Nagaland, India
Telephone: 9615328799
E-mail: Lobenommozhui@gmail.com

various ethnic communities in the country. There is, however, limited information on edible insect consumption in Nagaland. Meyer-Rochow and Changkija (1997) prepared a list of 42 insect species consumed by the Ao-Naga tribe and Ao and Singh (2004) have carried out surveys in Mokokchung and Zunheboto districts, inhabited by Ao and Sema tribes and reported consumption of 15 edible insect species by the two tribes. Also, Srivastava et al. (2009) confirmed that some tribal communities from Dimapur, Phek and Kohima districts of Nagaland ate grasshoppers, crickets, red ants, silkworm larvae and unidentified larvae obtained from the 'Gold Mohar' tree but for the majority of the Naga tribes information on edible insects is still unavailable. Since, Naga people like any other ethnic communities of the country are known to use different kinds of plant and animal foodstuffs, and given the cultural dissimilarities between the tribes and its geographic and climatic variation, differences are expected with regard to the appreciation of insects as food as well as the way specimens are gathered and processed.

Objectives of the Study

People of Naga ethnicity have been consuming insects since time immemorial as a traditional food but in recent time people have realized its benefit to one's health. A lot of individuals who haven't tasted are willing to consume a variety of insects. Therefore, this study was initiated in order to prepare inventories of edible insects covering seven tribes so as to be able to assess the insect's benefit before either the existing traditional information is lost or overexploitation of useful insect species occurs.

MATERIAL AND METHODS

Nagaland, situated at 93° 20'-95° 15' E and 25° 6'-27° 4' N is bordered by Arunachal Pradesh in the North, Manipur in the south, Myanmar in the East and Assam in the West and considered one of the major biodiversity hotspots (Indo-Burma region) of the world (Myer et al. 2000). Nagaland has a total area of 16,579 square km and a population of 1,980,602 with 931 female for every 1000 males (Anonymous 2012). The seven Naga tribes namely Angami, Ao, Chakhesang, Khiamnuingan, Konyak, Lotha and Sumi occupy different section of the state and some areas are accessible facing a considerable amount of difficulties due to improper road access. Angami tribes account to 7.2 percent, Ao tribes 13.3 percent, Chakhesang 7.7 percent, Khiamnuingan 2.2 percent, Konyak 14.0 percent, Lotha 8.5 percent and Sumi 13.9 percent of the total tribal population of Nagaland (Anonymous 2001). Members of the mentioned tribes differ from each other not just physically but speak different dialects, follow different customs and habits, including food procurement and processing.

An extensive field investigation was conducted in 35 villages across seven districts viz. Kohima, Mokokchung, Mon, Phek, Tuensang, Wokha and Zunheboto inhabited by the seven ethnic tribes during October 2014-October 2016, shown in Figure 1. Data were collected by conducting personal interviews with the help of semi-structured questionnaires from 240 informants (150 male and 90 female). From each village 6-8 respondents comprising of village heads, traditional knowledge holders (key informants), educated youths and homemakers (general informants) were interviewed for the study, provided in Table 1. The questionnaire was based on collecting information on insect species used as food, habitat, seasonal availability, the traditional mode of preparation and trap techniques. Collected edible insects were preserved in seventy percent alcohol (Cherian et al. 2004; Gill et al. 2010), identified at Department of Zoology, Nagaland University with the help of published keys, books (Anonymous 2006; Mitra 2006; Mandal et al. 2007; Animesh and Biswas 2013)

Table 1: Demographic characteristics at the study area

Variables	*Number of informants*
Gender	
Male	150 (63%)
Female	90 (37%)
Age Group	
25-34	22 (9%)
35-44	29 (12%)
45-54	50 (21%)
55-64	55 (23%)
65-74	47 (20%)
75-84	26 (11%)
85-94	6 (2%)
95-104	5 (2%)
Educational Status	
Below high school	145 (60%)
Above high school	95 (40%)
Informants Status	
Key informant	108 (45%)
General informant	132 (55%)

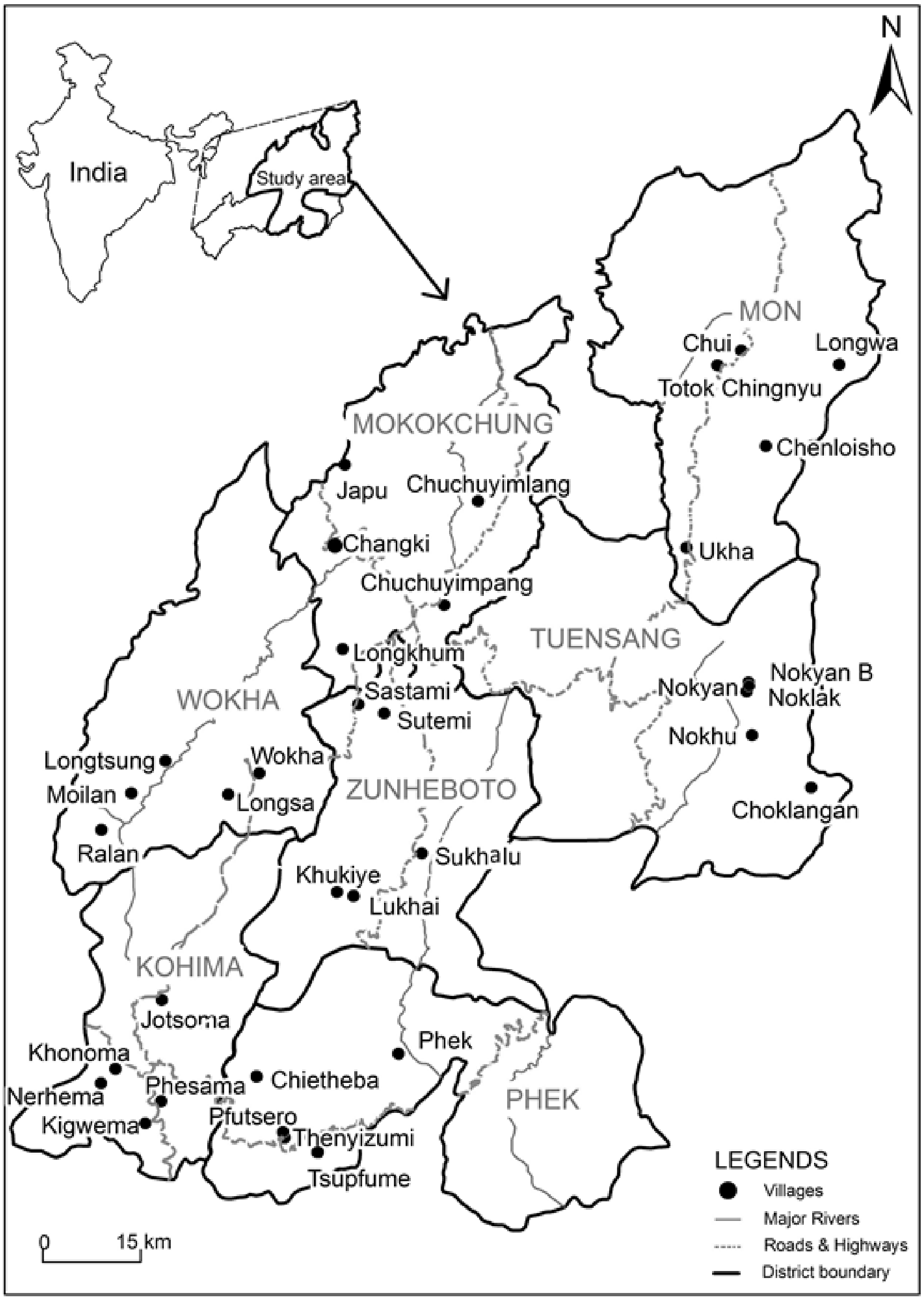

Fig. 1. Map of Nagaland showing study area and tribes
Source: Survey of India toposheets

and authenticated by experts from the Zoological Survey of India, Kolkata.

Quantitative data analysis was done by calculating the use value of all the insect species as proposed by Phillips et al. (1994) and was calculated by using the formula, UV= "*U/n* where UV is the use value of the species, *U* is the number of citations per species and *n* is the total number of informants.

RESULTS AND DISCUSSION

Based on the responses from the informants in this study, it is evident that 82 insect species belonging to 28 families and 9 orders, provided in Table 2 are consumed as food by the tribal communities. Edible insects, considered delicacies comprise different kinds of bees, beetles, bugs, cicadas, crickets, grasshoppers, locusts, wasps and various larval forms of insects. The list includes 8 species of Odonata, 17 species of Orthoptera, 2 species of Mantodea, 1 species of Isoptera, 19 species of Hemiptera, 9 species of Coleoptera, 20 species of Hymenoptera, 5 species of Lepidoptera and 1 species of Diptera. Insects generally are accessible throughout the year, but their densities and diversity are determined by the availability of their host plants and climatic conditions. Insects are most abundant during the rainy and post-rainy season which means that some insect species' availability as human food is seasonal. During every cycle of the season, characteristic varieties of insects are sold at the local markets indicative of seasonal abundance. Generally, edible insects that are sold at local markets are collected by people residing in rural places, who earn or at least augment their livelihood from the sales. However, the collection of wild species to supply the urban market can have both positive and negative impact on the rural biodiversity (Cerritos and Cano-Sanatana 2008) and this aspect requires further investigation. Most of the edible insects consumed by the tribals are available during the months of October and November, which is the time when locusts, grasshoppers, water beetles, dragonfly nymphs, carpenter worms as well as, different species of hornets and wasps are widely marketed which are generally sold by women.

Almost all the edible insects are handpicked, however, in case of bees and wasps, adults are driven away either by shooting camphor (a compound commonly used as an insect repellent) or pastes of *Gynocardia odorata* (R. Br.) and *Litsea cubeba* (Lour.) into their nests to collect the useful products. Smoking is also a method whereby a piece of cloth, tied onto a long bamboo stick is lit to kill or drive away the adults allowing the nutritious larvae and pupae to be collected. A similar smoking method to capture bees is practiced by the Manipur tribals (Shantibala et al. 2012). For capturing hornets, especially *Vespa mandarinia* (Smith), a small piece of meat (bites) is tied onto one end of a thin threat and a light feather or fluff of cotton fixed on the other end. When an adult hornet attacks and grabs the meat piece and flies away with it, the hunters follow the feather/cotton attached to the bite and in this way easily locate the nest. A similar capturing method like that of hornets is reported in Japan for capturing yellowjackets (Nonaka 2007). Cicadas are trapped with the help of a long bamboo pole, the tip of which is covered with latex extract of the Indian rubber bush *Ficus elastica* (Robx. Ex Hornem). The cicadas get stuck on the sticky extract and are captured easily. Aquatic insects are captured while fishing or with the help of traditional sieves.

The present study gives an overview and provides an insight into attitude and knowledge of entomophagy among different tribes of Nagaland wherein insects are consumed as eggs, larvae or nymphs, pupae and adults depending on the insect species. Preference is given to species primarily on the basis of availability, palatability and cost. Insects are cooked, roasted, consumed raw or turned into pickles. Traditional methods of preparation are followed while making insect dishes serving as the main meal for the Nagas. Most of the Naga dishes are prepared by adding fresh or dried bamboo shoots. The bamboo borer larvae *Omphisa fuscidentalis* (Hampson) is wrapped in banana leaf and covered by warm ash for steaming. The steamed larvae are then consumed directly. Crickets like *Tarbinskiellus orientalis* (Fabr.) and *Teleogryllus sp.* (Chopard) and dragonfly nymphs are mixed with salt and bamboo shoot, put in cut bamboo pipes (approximately 30 cm in length). The mouth of the bamboo pipe is closed with a banana leaf to enhance the aroma and is then placed in the fire to cook. However, certain species like *Oecophylla smaragdina* (Fabr.), *Parapolybia varia* (Fabr.), *Polistes olivaceus* (De Geer), *Vespa mandarinia* and *Vespa tropica tropica* (Linn.) are consumed raw. Among

Table 2: Insect species utilized as food at the surveyed tribes

Scientific name	*Family*	*Common name*	*Local name*	*Seasonal Availability*	*Edible Stage*	*Use value (UV)*						
						A	*An*	*C*	*K*	*Kh*	*L*	*S*
Diplacodes trivialis Rambur	Libellulidae	blue percher	Tsakwie (An)	July-Nov	nymph, adult	0.8	0.8	0.8	0.6	0.4	0.8	0.7
Orthetrum pruinosum neglectum Rambur	Libellulidae	common red skimmer	Tsutalang (A)	July-Nov	nymph, adult	0.8	0.8	0.8	0.6	0.4	0.8	0.7
Neurothemis fulvia Drury	Libellulidae	fulvous forest skimmer	Zakho (C)	July-Nov	nymph, adult	0.8	0.8	0.8	0.6	0.4	0.8	0.7
Crocothemis servilia servilia Drury	Libellulidae	dragon fly	Susao (L)	July-Nov	nymph, adult	0.8	0.8	0.8	0.6	0.4	0.8	0.7
Potamarcha congener Rambur	Libellulidae	dragon fly	Atsungosuh(S)	July-Nov	nymph, adult	0.8	0.8	0.8	0.6	0.4	0.8	0.7
Orthetrum sabina sabina Drury	Libellulidae	slender skimmer	Khudu (An)	July-Nov	nymph, adult	0.8	0.8	0.8	0.6	0.4	0.8	0.7
Orthetrum triangulare triangulare Sely	Libellulidae	yellow tailed ashy skimmer	Tsutsukha (S)	July-Nov	nymph, adult	0.8	0.8	0.8	0.6	0.4	0.8	0.7
Pantala flavescens Fabr.	Libellulidae	globe skimmer	Khudu (An)	July-Nov	nymph, adult	0.8	0.8	0.8	0.6	0.4	0.8	0.7
Acrida exaltata Walker	Acrididae	Chinese grasshopper	Amachongkok (A)	June-Oct	adult	0.4	0.5	-	-	-	0.5	-
Attractomorpha sp. Saussure	Acrididae	grasshopper	Khomong (L)	June-Oct	adult	0.5	0.7	0.6	-	0.5	0.7	0.6
Chondracris rosea De Geer	Acrididae	grasshopper	Surapong (A)	June-Oct	adult	-	0.2	-	-	-	0.3	-
Hieroglyphus banian Fabr.	Acrididae	rice grasshopper	Tuluqhu (S)	June-Oct	adult	0.7	0.8	0.8	0.8	-	0.8	0.6
Melanoplus sp. Stal	Acrididae	locust	Koksha (K)	June-Oct	adult	0.8	0.8	0.7	0.6	0.7	0.8	0.7
Melanoplus bivattus Say	Acrididae	two striped grasshopper	Kuprei (An)	June-Oct	adult	0.7	0.7	0.6	0.6	0.6	0.8	0.6
Oxya hyla Serville	Acrididae	short horned grasshopper	Teku (An)	June-Oct	adult	0.7	0.8	0.7	0.7	-	0.7	0.7
Acheta sp. Linn.	Gryllidae	house cricket	Petu (An)	Aug-Nov	adult	0.7	0.7	0.8	-	-	0.8	0.7
Gryllus sp. Linn.	Gryllidae	field cricket	Panto (L)	Sept-Nov	adult	0.7	0.5	0.8	0.5	0.8	0.9	0.6
Meloimorpha cincticornis Walker	Gryllidae	cricket	Auvushou (S)	Aug- Nov	adult	-	0.2	-	-	-	0.3	-

Table 2: Contd...

Scientific name	*Family*	*Common name*	*Local name*	*Seasonal Availability*	*Edible Stage*	*Use value (UV)*						
						A	*An*	*C*	*K*	*Kh*	*L*	*S*

Table 2: Contd...

Scientific name	*Family*	*Common name*	*Local name*	*Seasonal Availability*	*Edible Stage*	*Use value (UV)*						
						A	*An*	*C*	*K*	*Kh*	*L*	*S*
Teleogryllus sp. Chopard	Gryllidae	ground cricket	Chokok (A)	Aug- Nov	adult	0.7	0,7	0.8	0.5	-	0.9	0.6
Tarbinskiellus orientalis Fabr.	Gryllidae	cricket	Shungru (L)	Aug- Nov	adult	0.8	0.7	0.7	0.6	0.7	1.0	0.6
Gryllotalpa orientalis Burmeister	Gryllotalpidae	mole cricket	Langhoi (K)	Aug-Nov	adult	-	0.5	0.6	-	-	0.7	0.5
Mecopoda nipponensis Haan	Tettigoniidae	katydid	Lephak (K)	June-Oct	adult	0.7	0.8	0.6	0.8	-	0.8	0.5
Mecopoda elongata Linn.	Tettigoniidae	katydid	Shulong (L)	June-Oct	adult	0.7	0.8	0.7	0.8	-	0.8	0.5
Pseudophyllus titan White	Tettigoniidae	katydid	Tyotyo (L)	June-Oct	adult	0.4	0.4	0.4	0.5	-	0.5	0.2
Tettigonia sp. Linn.	Tettigoniidae	katydid	Chure (C)	June-Oct	adult	0.6	0.7	0.8	0.7	-	0.8	0.7
Tenodera sinensis Saussure	Manitidae	Chinese mantis	Zierho (An)	July-Sept	adult	0.5	0.3	0.4	-	-	0.5	0.3
Heirodula coarctata Saussure	Manitidae	giant Asian mantis	Shopilea (S)	July-Sept	adult	0.5	0.3	-	-	-	0.5	0.3
Macrotermes sp. Holmgren	Termitidae	termite	Holum (L)	Nov-Dec	adult	0.8	0.8	0.8	0.8	-	0.9	0.7
Lethocerus indicus Lepeltier and Serville	Belostomatidae	giant water bug	Atsuluplu (A)	Nov-Jan	adult	0.7	0.9	0.9	-	-	0.8	0.8
Tibicen pruinosa Say	Cicadidae	cicada	Kiang (Kh)	Aug-Nov	adult	-	0.6	-	-	0.4	0.6	0.5
Dundubia intemerata Walker	Cicadidae	cicada	Ghoi (S)	Aug-Nov	adult	-	0.6	-	-	0.4	0.6	0.5
Dundubia oopaga Distant	Cicadidae	cicada	Yoro(L)	Aug-Nov	adult	-	0.6	-	-	0.4	0.6	0.5
Pomponia sp. Walker	Cicadidae	cicada	Yangyang (A)	Aug-Nov	adult	-	0.6	-	-	0.4	0.6	-
Pycna sp. Amyot and Serville	Cicadidae	cicada	Thakpu (S)	Aug-Nov	adult	-	0.6	-	-	0.4	0.6	-
Dalader planiventris Westwoood	Coreidae	dead leaf-footed bug	Lejuptsseni (L)	May-July	adult	-	-	0.5	-	-	0.7	-
Anoplocnemis phasiana Fabr.	Coreidae	coreid bug	Tsseni (L)	May-Aug	adult	-	0.3	-	-	-	0.5	-

Table 2: Contd...

Scientific name	*Family*	*Common name*	*Local name*	*Seasonal Availability*	*Edible Stage*	*Use value (UV)*						
						A	*An*	*C*	*K*	*Kh*	*L*	*S*
Notobitus meleagris Fabr.	Coreidae	leaf footed bug	Khuna (C)	Aug-Sept	adult	0.8	0.7	0.7	0.7	0.7	0.6	0.7
Aspongopus nepalensis Westwood	Dinidoridae	black sting bug	Pfenya (An)	Dec-Jan	adult	-	0.6	-	0.6	-	0.6	0.6
Coridius chinensis Dallas	Dinidoridae	stink bug	Azupaza (S)	May-July	adult	-	0.4	-	-	-	0.5	0.3
Coridius ianus Fabr.	Dinidoridae	red pumpkin stink bug	Khwino (C)	May-July	adult	0.5	0.5	0.5	0.6	-	0.5	0.4
Laccotrephes ruber Linn.	Nepidae	water scorpion	Julyupli (L)	Oct-Jan	adult	0.7	0.8	0.9	-	-	0.7	0.7
Chinavia hilaris Say	Pentatomidae	green stink bug	Amtsu (S)	May-July	adult	-	0.4	0.5	-	-	0.4	0.3
Cyclopelta siccifolia Westwood	Pentatomidae	stink bug	Tseni (L)	May-July	adult	-	0.3	-	-	-	0.3	0.2
Dolycoris sp. Mulsant and Rey	Pentatomidae	shield bug	Oshang (L)	May-Nov	adult	0.5	0.6	0.8	0.6	-	0.7	0.6
Erthesina fullo Thunberg	Pentatomidae	yellow spotted stink bug	Pfunya (An)	Aug-Sept	adult	-	0.6	-	-	-	0.3	0.4
Eurostus grossipes Dallas	Pentatomidae	pentatomid bug	Tsüngi (A)	May-July	adult	0.5	0.6	0.5	0.6	0.5	0.6	0.5
Tessaratoma javanica Thunberg	Tessaratomidae	litchi stink bug	Gea (K)	May-July	adult	0.6	0.7	-	0.6	-	0.7	0.6
Anoplophora sp. Hope	Cerambycidae	long horn beetle	Sungkhao (L)	Sept-Jan	larva, adult	-	-	0.5	-	-	0.6	-
Batocera rubus Linn.	Cerambycidae	long horn beetle	Sunglong (A)	June-Nov	larva	0.7	0.8	0.8	0.7	-	0.6	0.7
Batocera parryi Hope	Cerambycidae	long horn beetle	Yeak (K)	June-Nov	larva	0.7	0.8	0.8	0.7	-	0.6	0.7
Orthosoma sp. Serville	Cerambycidae	long horn beetle	Langkho (Kh)	July-Nov	larva, adult	0.9	0.8	0.8	0.7	0.8	0.6	0.7
Rhynchophorus sp. Herbst	Curcurlionidae	palm weevil	Akhulo (S)	Oct-Nov	larva	0.5	0.8	0.6	0.6	0.7	0.6	0.6
Cybister limbatus Fabr.	Dytiscidae	water beetle	Befu (S)	July-Nov	adult	0.6	0.9	0.9	-	0.7	0.7	0.5
Hydrophilus caschmirensis Redtenbacher	Hydropillidae	large scavenging water beetle	Khuju (C)	July-Nov	adult	0.7	0.9	0.9	-	0.6	0.7	0.5

Table 2: Contd...

Scientific name	Family	Common name	Local name	Seasonal Availability	Edible Stage	Use value (UV)						
						A	*An*	*C*	*K*	*Kh*	*L*	*S*
Xylotrupes gideon Linn.	Scarabaeidae	brown rhinoceros beetle	Shushu (L)	June-Aug	adult	-	-	-	-	-	0.5	-
Lepidiota stigma Fabr.	Scarabaeidae	white grub	Bonge (An)	Aug-Sept	adult	-	-	0.3	-	-	0.3	-
Apis cerana indica Fabr.	Apidae	Indian honey bee	Loviidzii (C)	Whole year	all	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Apis dorsata dorsata Fabr.	Apidae	giant honey bee	Tsakhmhen (L)	Sept-May	all	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Apis dorsata laboriosa Smith	Apidae	Himalayan honey bee	Lungnang (A)	Sept-May	all	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Apis florea Fabr.	Apidae	dwarf honey bee	Rhontso (L)	Sept-Feb	all	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Lepidotrigona arcifera Cockerell	Apidae	stingless bee	Ruyo (An)	Sept-Feb	all	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Lophotrigona canifrons Smith	Apidae	underground stingless bee	Litsaktsu (L)	Sept-Feb	all	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Xylocopa violacea Linn.	Apidae	violet carpenter bee	Khvukhvu (L)	May-Oct	honey	-	-	-	-	-	0.3	-
Oecophylla smaragdina Fabr.	Formicidae	weaver ant	Kheyao (K)	May-July	all	1.0	0.6	0.8	0.6	0.5	1.0	0.7
Parapolybia varia Fabr.	Vespidae	lesser paper wasp	Vobhazho (C)	May-Sept	all	0.8	0.8	0.7	0.7	0.6	0.8	0.7
Polistes olivaceus De Geer	Vespidae	common paper wasp	Kheahrean (K)	May-Sept	all	0.7	0.8	0.7	0.7	0.6	0.8	0.7
Polistes stigma Fabr.	Vespidae	paper wasp	Pughughi (S)	May-Sept	all	0.7	0.8	0.7	0.7	0.6	0.8	0.7
Provespa barthelemyi du Buysson	Vespidae	nocturnal wasp	Pfize (An)	Sept-Feb	all	0.5	0.8	0.7	0.7	0.6	0.8	0.7
Vespa affinis indosinensis Perez	Vespidae	lesser banded hornet	Rongi (L)	Sept-Feb	all	0.5	0.8	0.7	0.7	0.6	0.8	0.7
Vespa auraria Smith	Vespidae	hornet	Khwibi (C)	Sept-Feb	all	0.8	0.8	0.7	0.6	0.5	0.8	0.7
Vespa basalis Smith	Vespidae	hornet	Nati (A)	May-Nov	all	0.8	0.8	0.7	0.6	0.6	0.8	0.7
Vespa ducalis Smith	Vespidae	hornet	Heseno (An)	May-Nov	all	0.8	0.8	0.7	0.6	0.6	0.8	0.7
Vespa mandarinia Smith	Vespidae	giant hornet	Lamla (Kh)	Sept-Feb	all	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Vespa tropica t ropica Linn.	Vespidae	greater banded hornet	Akizu (S)	May-Nov	all	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Table 2: Contd...

Scientific name	Family	Common name	Local name	Seasonal Availability	Edible Stage	Use value (UV) A	An	C	K	Kh	L	S
Vespa soror du Buysson	Vespidae	hornet	Pfigwi (An)	Sept-Feb	all	0.8	0.8	0.7	0.6	0.5	0.8	0.7
Vespula sp. Thomson	Vespidae	hornet	Otssak (L)	May-Nov	all	0.3	0.5	0.6	0.4	0.1	0.3	0.4
Cossus sp. Fabr.	Cossidae	moth	Loungu (An)	July-Feb	larva	0.7	0.8	0.7	0.7	0.7	0.7	0.7
Omphisa fuscidentalis Hampson	Crambidae	bamboo borer	Kavuli (C)	Aug-Oct	larva	0.4	0.8	0.6	0.7	0.6	0.8	0.7
Erionata torus Evans	Hesperiidae	rounded palm-redeye	Leshong (Kh)	Sept-Nov	larva	0.4	0.7	0.6	0.	0.4	0.7	0.6
Malacosoma sp. Hübner	Lasiocampidae	tent caterpillar	Mesanglong (A)	Nov-Dec	larva	0.8	-	-	0.6	-	0.4	0.5
Samia cynthia ricini Boisduval	Saturniidae	eri silkworm	Gishong (K)	Whole year	larva, pupa	0.9	0.9	0.7	0.9	0.8	0.9	0.8
Tipula sp. Linn.	Tipulidae	cranefly	Sonhe (An)	Sept-Jan	larva	-	0.9	0.8	-	0.8	-	0.6

A-Ao, An-Angami, C-Chakhesang, Kh-Khiamnuingan, K-Konyak, L-Lotha, S-Sumi

the different section of the world, edible insects are either consumed alive right after being caught or consumed after further processing such as cooking, baking, frying or drying (Kourimska and Adamkova 2016). Ant pupae were used as delicacies for the nobility in China (Chen 1994) while in Mexico grasshoppers are a commonly served national dish together with beef and beans (Cerritos and Cano-Santana 2008). However, the acceptability of edible insects will depend largely on their market availability, categorization as an acceptable food product, proper marketing strategies, mode of preparation and education (Sogari et al. 2017).

Differences regarding consumption of edible insects among the seven tribes investigated by the researchers are presented in Figure 2. It is found that members of the Lotha tribe consume the most number of insects with a total of 81 edible insects (8 Odonata, 17 Orthoptera, 2 Mantodea, 1 Isoptera, 19 Hemiptera, 9 Coleoptera, 20 Hymenoptera and 5 Lepidoptera). Members of Angami tribe consumes 76 species (8 Odonata, 17 Orthoptera, 2 Mantodea, 1 Isoptera, 18 Hemiptera, 6 Coleoptera, 19 Hymenoptera, 4 Lepidoptera and 1 Diptera) and those belonging to Sumi tribe consumes 71 species (8 Odonata, 14 Orthoptera, 2 Mantodea, 1 Isoptera, 15 Hemiptera, 6 Coleoptera, 19 Hymenoptera, 5 Lepidoptera and 1 Diptera). Chakhesang tribals consume 65 species (8 Odonata, 14 Orthoptera, 2 Mantodea, 1 Isoptera, 8 Hemiptera, 8 Coleoptera, 19 Hymenoptera, 4 Lepidoptera and 1 Diptera) while the Ao tribals make use of at least 60 species of insects as food (8 Odonata, 14 Orthoptera, 2 Mantodea, 1 Isoptera, 5 Hemiptera, 6 Coleoptera, 19 Hymenoptera and 5 Lepidoptera). Konyak tribals consumes 54 species (8 Odonata, 10 Orthoptera, 1 Mantodea, 1 Isoptera, 6 Hemiptera, 4 Coleoptera, 19 Hymenoptera and 5 Lepidoptera) while those belonging to the Khiamnuingan tribe consumes the least number, with 48 species (8 Odonata, 5 Orthoptera, 7 Hemiptera, 4 Coleoptera, 19 Hymenoptera, 4 Lepidoptera and 1 Diptera).

Not all the listed 82 insect species are consumed by all the seven tribes. The differences regarding consumption seem due to three reasons which are the availability of the specific insect species in particular area, taboos associated with the insect species (Meyer-Rochow 2009) and allergy caused by eating certain in-

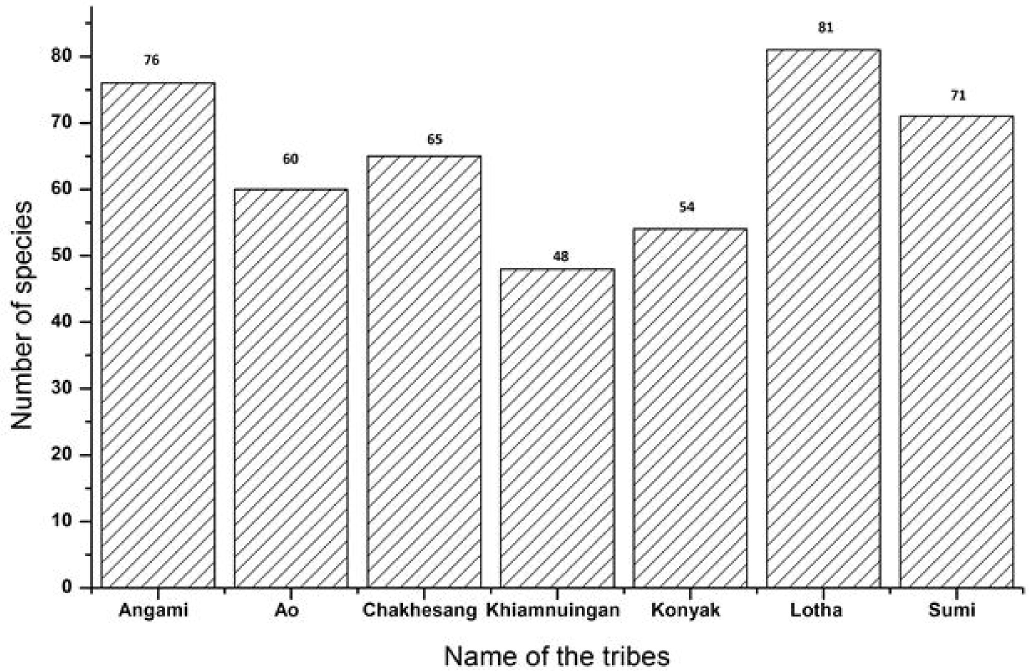

Fig. 2. Utilization of edible insects among seven tribes

sects. With use value of 1.0, it is obvious that Hymenopterans like *Apis cerana indica* **(**Fabr.), *Apis dorsata dorsata* (Fabr.), *Apis dorsata laboriosa* (Smith),*Apis florea* (Fabr.), *Lepidotrigona arcifera* (Cockerell), *Lophotrigona canifrons* (Smith), *Vespa mandarinia* and *Vespa tropica tropica* are most preferred by the all of the seven tribes. With a use value of 1.0, *Oecophylla smaragdina* is preferred by the Ao and Lotha tribals. *Acrida exaltata* (Walker) is found to be consumed by Ao, Angami and Lotha members alone, the most likely reason being its unavailability in the places of the other tribals. Evidence suggests that individuals who are sensitive to shrimp may be allergic to certain insects like grasshoppers and disparity in geographical food traditions may lead to variation in food allergy risks (Meyer-Rochow 2009; Belluco et al. 2013). *Chondracris rosea* (De Geer) whose chemical composition was analyzed by Chakravorty et al. (2014) is consumed by the Angami and Lotha tribe alone because many locals feel that its consumption can cause allergy. With a use value of 0.9 *Lethocerus indicus* (Lepeltier and Serville), *Cybister limbatus* (Fabr.) and *Hydrophilus caschmirensis* (Redtenbacher) is popular food insects of the Angami and Chakhesang tribals. *Samia cynthia ricini* (Boisduval), also achieves a use value 0.9 and is the preferred species of the Angami, Konyak and Lotha tribals. The use values demonstrate that every tribe has a preference of its own with regard to insect consumption. Obviously, if all tribes possessed the same preference of edible insects and selected only the same species, there would be a tremendous pressure on the resources. By spreading across many different species of insects, edible insect as a resource is less vulnerable and less at risk of getting exploited excessively. However, whether this ecological aspect is one reason for the observed differences between tribal choices of selecting particular insect species as food or whether other factors are involved in governing their food preferences, for the time being, remain unexplored.

CONCLUSION

In the majority of the surveyed tribes, the consumption of insects represents a major component of their main nutritional intake. The extensive number of insects consumed by the tribal communities of Nagaland indicates that insects represent an essential regular food type and not an emergency food item. Yet, still many insects are to be identified as edible and the number of consumable insects should not be seen as limited to the present findings. Edible insects can enhance nutritional deficiencies and as such, efforts should be made to identify as many insect species appropriate for utilization as a food source as possible. Also, proper commercialization and marketing strategies can improve livelihoods of tribal communities (and especially the womenfolk) living in remote villages. However, educating the people on overexploitation, unsustainable harvesting methods, increased commercialization and pesticide use is necessary so as to maintain the insect biodiversity and future availability of the insect resource.

RECOMMENDATIONS

Altogether there are 16 tribes in Nagaland but the present study has focused primarily on documenting the diversity of edible insects consumed by seven tribes. Hence, extensive surveys for the remaining tribes and additional scientific studies are required to determine the most suitable type of insects for production of new food products of appreciable nutritive value with the added potential of combating nutritional deficiencies that are of public health concerns.

ACKNOWLEDGEMENT

The researchers are thankful to the tribal people of Nagaland for sharing their valuable information and wish to acknowledge the support from the Department of Zoology, Nagaland University, Lumami and the Zoological Survey of India for species identification. Prof. VB Meyer-Rochow's attention to the manuscript is gratefully acknowledged.

REFERENCES

Animesh B, Biswas B 2013. *Handbook on Major Hemipteran Predators of India*. Kolkata: Zoological Survey of India.

Anonymous 2001. Census of India 2001. Nagaland, Data Highlights: The Scheduled Tribes. From <http://census india.gov.in/Tables_Published/SCST/dh_st_nagaland> (Retrieved on 20 May 2015).

Anonymous 2006. *Fauna of Nagaland, State Fauna Series 2005*. Kolkata: Zoological Survey of India.

Anonymous 2012. *Statistical Handbook of Nagaland 2012*. Nagaland, Kohima: Director of Economics and Statistics.

Alexander P, Brown C, Arneth A, Dias C, Finnigan J, Moran D, Rounsevell M 2017. Could consumption of insects, cultured meat or imitation meat reduce global agricultural land use? *Global Food Security*, (in press). Doi:10.1016/j,gfs.2017.04.001.

Ao A, Singh HK 2004. Utilization of insects as human food in Nagaland. *Indian Journal of Entomology*, 66(4): 308-310.

Bernard T, Womeni HM 2017. Entomophagy: Insects as food. In: Dr. Vonnie Shields (Eds.): *Insect Physiology and Ecology*. Rijeka: InTech, pp. 233-253. DOI: 10.5772/67384.Bukkens SGF 1997. The nutritional value of edible insects. *Ecology of Food and Nutrition,* 36: 287-319.

Belluco S, Lossaso C, Maggioletti M, Alonzi CC, Paoletti MG, Ricci A 2013. Edible insects in a food safety and nutritional perspective: A critical review. *Comprehensive Reviews in Food Science and Food Safety,* 12: 296-313. Doi:10.1111/1541-4337.120 14.

Bodenheimer FS 1951. *Insects as Human Food*. The Hague, Netherlands: Junk.

Cerritos R, Cano-Santana Z 2008. Harvesting grasshoppers *Sphenarium puppurascens* in Mexico for human consumption: A comparison with insecticidal control for managing pest outbreaks. *Crop Protection,* 27: 473-480.

Chakravorty J, Ghosh S, Meyer-Rochow VB 2011a. Chemical composition of *Aspongopus nepalensis* Westwood 1837 (Hemiptera: Pentatomidae) a common food insect of tribal people in Arunachal Pradesh (India). *International Journal for Vitamin and Nutrition Research,* 81(1): 49-56.

Chakravorty J, Ghosh S, Meyer-Rochow VB 2011b. Practices of entomophagy and entomotherapy by members of the Nyishi and Galo tribes, two ethnic groups of the state of Arunachal Pradesh (North-East India). *Journal of Ethnobiology and Ethnomedicine,* 7:5.

Chakravorty J, Ghosh S, Meyer-Rochow VB 2013. Comparative survey of entomophagy and entomotherapeutic practices in six tribes of eastern Arunachal Pradesh (India). *Journal of Ethnobiology and Ethnomedicine,* 9: 50.

Chakravorty J, Ghosh S, Jung C, Meyer-Rochow VB 2014. Nutritional composition of *Chondracris rosea* and *Brachytrupes orientalis*: Two common insects used as food by tribes of Arunachal Pradesh, India. *Journal of Asia-Pacific Entomology,* 17: 407-415.

Chen Y 1994. Ants used as food and medicine in Chine. *The Food Insects Newsletter, Madson*, 7(2): 1-10.

Cherian PT, Srivastava GK, Thirumalai G 2004. Insecta. In: JRB Alfred, Ramakrishna (Eds.): *Collection Preservation and Identification of Animals*. Kolkata*:* Zoological Survey of India,pp. 133-180.

Doley AK, Kalita J 2011. An investigation on edible insects and their role in socio-economic development of rural communities: A case study on edible insects of Dhemaji district of Assam (India). *Social Science Researcher,* 1(1): 1-11.

Dutta L, Ghosh SS, Deka P, Deka K 2016. Terrestrial edible insects and their therapeutic value in Moridhal Panchayat of Dhemaji district, Assam, Northeast-India. *International Journal of Fauna and Biological Studies,* 3(6): 11-14.

Gill HK, McSorley R, Buss L 2010. The Insect Community on the Soil Surface. University of Florida IFAS Extension ENY-859. From <http://edis. ifas. ufl.edu/in876> (Retrieved on 10 April 2014).

Johnson DV 2010. The contribution of edible insects to human nutrition and to forest management. In: PB Durst, DV Johnson, RN Leslie, K Shono (Eds.): *Edible Forest Insects: Human Bite Back*. Bangkok, Thailand: FAO Publication, pp. 5-22.

Kourimska L, Adamkova A 2016. Nutritional and sensory quality of edible insects. *NFS Journal,* 4: 22-26.

Mandal SK, Dey A, Hazara AK 2007. *Pictorial Handbook on Indian Short-horned Grasshopper Pests (Acridoidea: Orthoptera)*. Kolkata: Zoological Survey of India.

Meyer-Rochow VB 1975. Can insects help to ease the problem of world food shortage? *Search,* 6: 261-262.

Meyer-Rochow VB, Changkija S 1997. Uses of insects as human food in Papua New Guinea, Australia and North-East India: Cross-cultural considerations and cautious conclusions. *Ecology of Food and Nutrition,* 36: 159-185.

Meyer-Rochow VB 2009. Food taboos: Their origins and purposed. *Journal of Ethnobiology and Ethnomedicine,* 5:18.

Meyer-Rochow VB, Chakravorty J 2013. Notes on entomophagy and entomotherapy generally and information on the situation in India in particular. *Applied Entomology and Zoology,* 48: 105-112.

Mitra TR 2006. *Handbook on-Common Indian Dragonflies (Insecta:Odonata)*. Kolkata: Zoological Survey of India.

Mitsuhashi J 2016. *Edible Insects of the World*. London: CRC Press. Doi: https://doi.org/10.1201/978131 5367927-1.

Myer N, Muttermeier RA, Muttermeier CA, da Fonseca GAB, Kent J 2000. Biodiversity hotspots for conservation priorities. *Nature,* 403: 853-858.

Narzari S, Sarmah J 2015. A study on the prevalence of entomophagy among the Bodos of Assam. *Journal of Zoology and Entomology Studies,* 3(2): 315-320.

Nonaka K 2007. *HEBO YellowJackets: From the Fields to the Dinner Table - A Delightful Culinary Experience*. Japan: Tamasaya.

Phillips OL, AH Gentry, C Reynel, P Wilkin, Galvez-Durand B 1994. Quantitative ethnobotany and Amazonian conservation. *Conservation Biology,* 8: 225-248.

Rabha B 2016. Edible insects as tribal food among the Rabhas of Assam. *International Journal of Management and Social Sciences,* 3(2): 349-357.

Ronghang R, Ahmed R 2010. Edible insects and their conservation strategy in Karbi Anglong district of Assam, North East India, *The Bioscan,* 2: 515-521.

Rumpold BA, Schlüter OK 2013. Nutritional and safety aspects of edible insects. *Molecular Nutrition and Food Research,* 57: 802-823.

Samuel P, Govindarajan R, Krishnmoorthy R, Leo VJ, Selvam A, Paramasivan R 2016. Entomophagy and entomotherapy practiced among the indigenous population of Western Ghats of Tamil Nadu, India, *International Journal of Zoology Studies,* 1(1): 30-33.

Seni A 2017. Edible insects: Future prospects for dietary regimen. *International Journal of Current Microbiology and Applied Sciences,* 6(8): 1302-1314.

Shantibala T, Lokeshwari RK, Sharma HD 2012. Entomophagy practices among the ethnic communities of Manipur, North-East India. *International Journal of Integrative Sciences, Innovation and Technology,* 1(5): 13-20.

Sogari G, Menozzi D, Mora C 2017. Exploring young foodies' knowledge and attitude regarding entomophagy: A qualitative study in Italy. *International Journal of Gastronomy and Food Science,* 7: 16-19.

Srivastava SK, Babu N, Pandey H 2009. Traditional insect bioprospecting- As human food and medicine. *Indian Journal of Traditional Knowledge,* 8(4): 485-494.

Van Huis A, Dicke M, van Loon JJA 2015. Insects to feed the world. *Journal of Insects as Food and Feed,* 1(1): 3-5.

Wilsanand V, Varghese P, Rajitha P 2007. Therapeutics of insects and insect product in South Indian traditional medicine. *Indian Journal of Traditional Knowledge,* 6(4): 563-568.

Paper received for publication on August 2017
Paper accepted for publicaiton on September 2017