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Ethnozoology and entomophagy of Ao tribe in the district of Mokokchung, Nagaland

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The Ao Naga tribe inhabiting Mokokchung district of Nagaland, has a rich tradition of entomophagy. This paper explores their traditional knowledge and practice of entomophagy. Information on the mode of collection of the insects, cooking recipes, nutritional knowledge if any, allergies *etc*. were gathered using a questionnaire along with interviews of village elders, sellers and consumers. Eleven (11) edible insects species were identified out of which a few were found to be available all year-round, while some were reported to be available on a seasonal basis. In the present study, insects from coleoptera (2), hemiptera (3), hymenoptera (2), lepidoptera (3), and orthoptera (1) were identified. One species (Lepidoptera) was identified only to genus level, and another species (Hemiptera), was identified as an edible species for the first time.

Keywords: Ao Nagas, Edible insects, Mokokchung, Traditional, Tribals
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Mokokchung is one of the districts in the state of Nagaland. Its geographical location is 26°10'40.65"N and 94°17'22.32"E to 26°45'50.32"N and 94°45'30.30"E (GIS, Govt. of Nagaland[1]). It covers an area of 1,615 sq. km and is bound by Tuensang district in the east, Wokha district in the west, state of Assam in the north and Zunheboto district in the south (http://mokokchung.nic.in[2]). The physiography of the district shows six distinct hill ranges namely *Asetkong*, *Japukong*, *Langpangkong*, *Ongpangkong*, *Jangpetkong* and *Tzürangkong*. The ranges are more or less parallel to each other and run in a Northeast and Southwest direction.

Insects constitute an important dietary component of many cultures around the world, and their consumption meets the sustainable utilization of available natural resources. Global food crisis has hit 124 million people across 51 countries in 2017 and the number of undernourished people, defined as unable to acquire enough food to meet the daily minimum dietary energy requirements over a period of one year, has arrived at 793 million (FAO, 2015[3]). Entomophagy maybe the answer to many of these countries where consumption of insects is already practised. Even the United Nations has suggested entomophagy as one of the probable solution to the shortage of world food supplies (FAO 2012[4]).

About 200 species of edible insects are consumed in Southeast Asia (Johnson 2010[5]). Approximately 2100 species of edible insects have been identified (Jongema, 2017[6]) and people in many part of the World consider them as nutritious and a delicacy (Bodenheimer 1951[7]; Mitsuhashi 1984[8]; DeFoliart 1992[9]; Morris 2004[10]; Ramos-Elorduy 2005[11]). Insects which are eaten by humans are generally good source of fats, proteins, carbohydrates, vitamins, riboflavin and minerals such as zinc, magnesium and iron (Meyer-Rochow 1976[12]; Bukkens 1997[13]; Rumpold 2013[14]). Besides, edible insects could become a source of novel bioactive compounds in the future, to address human health challenges such as hypertension, obesity, diabetes, parkinson's diseases etc (Roos & Huis 2017[15]).

As far as India is concerned, the full potential of insects as food is still far from being appreciated. Yet, as early as 1945, Das (1945[16]) analyzed the food value of locust (*Schistocerca gregaria*) for use both as human food and fertilizer in India. Roy and Rao (1957[17]) reported about Muria tribes in Madhya Pradesh on their consumption of an insect larvae

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known as chin kara as well as some species of ants. Practice of entomophagy by Negrito tribes of the Indian Andaman Islands have been reported by Sharief (2007[18]), while Ayekbam et al. (2014[19]) documented 46 species of insects that are use as food among various tribes in Manipur tribals. An edible pentatomid bug (*Ochrophora montana*) is a delicacy by inhabitants of the Mizo Hills in North East India (Sachan et al., 1987[20]). Meyer-Rochow (2005[21]) mentioned some food insects of the Meeteis people of Manipur and the Khasis of Meghalaya. In Arunachal Pradesh about 158 edible insects altogether have been documented (Singh et al 2008[22]; Chakravorty et al. 2011[23] & 2013[24]) and Meyer-Rochow and Changkija (1997[25]) documented and listed vernacular names of 42 species of insects used as food by Ao-Nagas in Nagaland. The list included 11 species of Orthoptera, 9 species each of Coleoptera and Lepidoptera, 8 species of Hemiptera and followed by Odonata, Mantoidea and the remaining other insect orders. The most recent documention of edible insects mentions 82 insect species belonging to 28 families and 9 orders, that comprises 8 species of Odonata, 17 species of Orthoptera, 2 species of Mantoidea, 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 (Mozhui et al. 2017[26]).

Information on the Ao's history of entomophagy is poor. The Aos have passed down their knowledge of customary laws, ancestral history, traditions and food practices through oral renditions and folk songs. Likewise, the knowledge associated with entomophagy has been handed down through generations by imitation and oral transmission. Hence, the lack of written information on the traditional usage and practice of entomophagy is a great hurdle on its authentication.

Study Area and Methods

The survey was carried out in 12 villages representing the 6 ranges of Mokokchung district namely, *Longkhum* and *Chungtia* (*Ongpangkong* range), *Süngratsü* and *Longjang* (*Asetkong* range), *Chuchuyimlang* and *Merangkong* (*Langpangkong* range), *Waromong* and *Changki* (*Changkikong* range), *Lirmen* and *Nokpu* (*Japukong* range) and *Moayimti* and *Watiyim* (*Tzürangkong* range).

In the investigation, photographs of insects, (Fig. 1) along with a questionnaire were used. The photographs were arranged systematically in an album so that the respondent could identify them without any hassle of explanation and thereby save time to get precise information on the specific specimen. The questionnaire was also prepared to gather information about their seasonal occurrence, vernacular names, habit and habitat, stages of insects consumed, modes of consumption, presumed nutritive and therapeutic values, harvesting methods, method of cleaning and preparation.

The survey was carried out during 2016 and 2017. Local guides and informants were used to collect the specimens from the forests and local markets. Information was gathered with regular visits and interviews and compiled from 103 respondents during insect gathering season and off season. The respondents were generally elderly people having knowledge and experience in the traditional use of insects as food. The interviewed persons were categorised into three groups – frequent consumers (FC), infrequent consumers (IC) and non-consumers (NC).

The insects collected were preserved following standard methods (Ghosh & Sengupta 1982[27]) and identified with the help of published keys (Gahan 1906[28]; Arrow 1949[29]; Atkinman 1974[30]; Vazirani 1984[31];). Identification of some specimens was done using valid characters from published papers (Bhowmik 1977 [32]; Gogoi et al. 2017[33]).

Results and discussion

The investigatory survey revealed that the Aos consume several different species of insects of which, 11 have been identified (Table 1). One of the insects, *Malacosoma* sp. was identified only to the genus level. This study also reports the presence of *Darthula hardwickii* for the first time in the State of Nagaland.

Brief description of the insects

Aplosonyx chalybaeus (Hope, 1831)

Aplosonyx chalybaeus or corm borer of *Colocasia esculenta* is commonly known as *Melongtevu*. It is a seasonal and endemic pest causing damage to the foliage and corms, resulting in great losses to farmers of the region. In India, *A. chalybaeus* was reported from the North Eastern states for the first time as a new pest of *Taro (C. esculenta*) by Barwal (1988[34]). Later, *Taro* was also reported from several South Asian countries such as Cook Islands, Indonesia, Papua New Guinea, Solomon Islands and Fiji. (Maddison 1993[35]). During the build-up of the beetle (July-August), farmers in Mokokchung collect and

Fig. 1 — A-*Aplosonyx chalybaeus,* B-*Aeolesthes holosericea,* C-*Darthula Hardwickii,* D-*Coridius Singhalanus,* E-*Tessaratoma javanica,* F-*Oecophylla smaragdina* (Brood & Adult), G-*Vespamandarinia,* H-*Malacosoma sp.* I-*Prionoxyxtus robiniae,* J-*Samiaricinii,* K-*Gryllus testaceous*

Table 1 — Edible insects of *Ao Nagas*

Scientific name	Common name	Order	Family	Seasonality	Edible parts/stage	Mode of consumption	Vernacular name
Aplosonyx chalybaeus	Corm borer	Coleoptera	Chrysomelidae	Jul-Aug	Larva, Adult	Roasted, steamed	*Melongtevu*
Aeolesthes Holosericea	Longhorn beetle	Coleoptera	Cerambycidae	Jul-Oct	Larvae, pupae	Roasted, fried	*Tsüka*
Darthula hardwickii	Tree hopper	Hemiptera	Aetalionidae	Feb-May	Whole body	Dried, fried, steamed	*Atsürangdang, Longmi*
Coridius singhalanus	Stink bug	Hemiptera	Dinidoridae	Nov-Feb Jun-Sep	Whole body	Dried, fermented	*Bholo*
Tessaratoma javanica	Lychee stink bug	Hemiptera	Pentatomidae	Jun-Aug	Whole body	Dried, fried	*Tsüknü, Tsüngi*
Oecophylla smaragdina	Weaver ant	Hymenoptera	Formicidae	Year round	Brood, adult	Dried, fried	*Oravi*
Vespa Mandarinia	Giant Hornet	Hymenoptera	Vespidae	Year round	Larvae , pupae	Steamed, fried	*Nati*
Malacosoma sp	Tent caterpillar	Lepidoptera	Lasiocampidae	Jul-Dec	Larvae	Dried, steamed	*mejanglong*
Prionoxystus robiniae	Carpenter worm	Lepidoptera	Cossidae	Aug-Dec	Larvae	Steamed, chutney	*Temerem tsüka*
Samia ricini	Silk worm	Lepidoptera	Saturnidae	Year round	Larvae, pupae	Steamed, roasted	*Eri mesen, lota mesen*
Tarbinskiellus portentosus	Field cricket	Orthoptera	Gryllidae	May-July	Adult	Dried, fried	*Yimpi chokok, Angor*

kill the corm borer from the fields thereby keeping a check on the increase of the insect population.

They are collected opportunistically and only for the purpose of consumption. The adult beetle and the larvae are considered as pests, since they weaken the plant and eventually kill it by boring into the corm. Yellowing of the leaves indicate that the plant is infected and such plants are pulled out and the larvae are collected from the corm. This insect was never eaten by the Aos and was introduced as food by other migrant tribals, hence, only a miniscule of the Ao population consume this insect as food. It has a distinct colocasia-scented smell and is considered palatable and taken as an alternative source of proteins and fats. The adults and grubs have also been reported to be consumed as food by the tribes of Meghalaya and Arunachal Pradesh in India as a seasonal diet. They are also considered to be rich sources of proteins (Pathak & Rajasekhara 2000[36]; Chakravorty 2009[37]).

Aeolesthes holosericea (Fabricius, 1787)

Aeolesthes holosericea or longhorn beetle is commonly called as *Tsüka*. The larva or grub is found inside the trunks of oak tree (*Quercus serrata* and other species), alder tree (*Alnus nepalensis* and other species) and other hardwood trees. The grubs are known to damage healthy green trees, sickly standing trees and even freshly felled trees. The presence of *A. holosericea* has been reported in the state of Nagaland by Mitra et al (2016[38]). They are collected opportunistically by locals from a rotten or fallen tree trunk during their visits to the fields or forests for collection of firewood. It is considered as a rich source of fats and is the larva is wrapped in banana leaves and sold in local markets during summer (July-October). The whole package weighs approximately about 600-700 g and commands a price of Rs. 200/-. Traditionally, it is used as a remedy for mouth ulcers and the freshly boiled or dried larva are sucked for relief from pain. Though this coleopteran is considered a savoury treat among the Nagas in general, the Aos however, are not fond of this insect as food, inspite of them being aware of its rich food value. They are mostly collected for use as feed for poultry and fish farms.

Darthula hardwickii (Gray, 1831)

Darthula hardwickii or treehopper is commonly called as *Atsürangdang* or *Longmi.* This study reports the use of the treehopper *D. hardwickii* as an edible insect for the first time in the State of Nagaland. In North East India, the earliest research works were published on the biology of the species by Mandai & Biswas (1965[39]) and later on its population dynamics by Bhowmik et al (1990[40]). During on-field survey it was observed that the treehopper emerges only once in the year during spring (Feb–May) in places with moderate climatic condition and average temperature ranging from 18 to 27°C. This species is collected only for family consumption and rarely sold. Traditionally, this insect was considered as a pest and unpalatable for human consumption because of its queer odour which would be intolerable for a first timer. However, the smell disappears after several washes in warm water and can be cooked. It was introduced as food to the Aos from the neighbouring districts and is traditionally used as an appetizer, and also claimed to cure diabetes and high blood pressure. During its emergence the nymph as well as the adult are collected, washed properly and dry fried in a frying pan and kept in airtight containers for future consumption in off seasons as a hypoglycaemic medicine.

Coridius singhalanus (Distant, 1900)

Coridius singhalanus or stink bug commonly called as *bholo* are collected mainly from dried river beds during winter (November to February) and are found underneath rocks on dry river beds in groups of 10 to 20, stuck on the rock surface. In the *Jangpetkong range*, swarming of *bholo* occur in thousands during monsoon (June-September), particularly in years when bamboo begins to flower. It was also suggested that the best time for collection of swarms was either early in morning, at night or during rains, when the insects are least active. It is collected only for family consumption and is rarely sold in the local markets. However, this insect is sold when they occur in plenty during swarming. The locals collect the insects infesting the foliage and branches of bamboo and other trees in swarming areas called '*bholotem tenem*' meaning 'place where the bholo swarms'. Choice of these insects as a source of food in North East India has been reported as early as the beginning of the 20th century by Distant (1906[41]). Its delicacy is owed to its high fat content and a distinct smell which is reported to be addictive once the consumer is familiarised with it.

The insects are collected in gunny bags, washed in cold water to get rid of any impurities and then fried

or are mixed with chutney. The insect is also prepared by another traditional method where it is pounded into a paste and the concentrated liquid extracted from it is used as a sauce to flavour curries. The paste is also fermented and used as a flavouring ingredient in various food preparations. Consumption of the male bug has been reported to cause headache, nausea, drowsiness and fever to the consumers. Such patients are treated with garlic or an Avil tablet or a local anti-allergic herbal medicine called *tangmo* (dried and powdered seed of *Rhus semialata*).

Tessaratoma javanica (Thunberg, 1783)

Tessaratoma javanica or lychee stink-bug commonly called as *Tsüknü* or *Tsüngi* inhabit areas in the district where lychee trees are predominantly available with hot climatic conditions and environmental temperatures ranging from 24 to 40ºC. They are collected from the stem and leaves and are either eaten raw or prepared as a chutney after roasting. The chemical secreted from the metathoracic scent gland of adult *T. javanica* has been reported to cause a lethal effect on the black ants and small red ants (Janaiah et al 1979[42]) and is ejected when agitated during collection. This may enter the eyes of the collector and has been reported as excruciatingly painful, hence immense care and precaution needs to be taken by the collector to prevent accidents. The bug is highly savoured for its smell and fatty flavour which is very similar to that of *C. singhalanus* and traditionally, the secretion of the stinkbug is applied on warts to remove them.

Oecophylla smaragdina (Fabricius, 1775)

Oecophylla smaragdina or weaver ant commonly called as Oravi is considered as a good source of nutrients bioresource. Adult workers and brood are very popular for their palatable taste and pleasant flavour. It is reported to contain about 10-60% protein, 14.99% fat, 19.84% fibre, 2.59% ash and 7.30% carbohydrates (Borghohain et al 2014[43], Chakravorty et al 2016[44]) and consumed either separately or mixed together. They are washed in a large quantity of water to remove any impurities and then fried which causes the wings to fall off, which are then removed. They are then steamed with fermented bamboo shoot or used in chutneys and consumed. The adult ant has been claimed to cure high blood pressure in adults and asthma in children. The filtrate obtained after boiling the ants is used traditionally while bathing as an antiseptic tonic to cure chicken pox.

Vespa mandarinia (Smith, 1852)

Vespa mandarinia or Giant hornet commonly called as Nati is one of the varieties of wasp species used as food not only by the Aos but also by other Naga tribes. When a nest is found, it is harvested only when the moon is between its waning gibbous and last quarter since traditionally and based on their experience, it is believed that this is the time when the nests are full of larvae. At other times, the larvae are considered to be either in the last larval stage, pupae, or have already become a wasp. The Aos consider giant hornets as a gourmet dish and a small hive may cost around Rs. 1000 whereas a large hive can fetch between Rs. 5000 to 7000. The traditions of collecting social wasps' nests to pick the larvae for food have been documented by scholars from across five continents namely, North and South America, Africa, Oceania and Asia (Ramos-Elorduy et al 1997[45]; Chakravorty et al 2013[46]) and in recent time a comprehensive survey have been conducted on the practice of keeping wasps in hive boxes in Japan (Payne & Evans 2017[47]).

The traditional technique of the Aos to locate the nest consists of capturing a lone wasp, tying a knot of thread about 3-4 feet girded between the thorax and abdomen, and the other end tangled with shavings (white colour and light in weight) from inner wall of bamboo. As the wasp flies back to the nest with the tangle trailing behind, spotters posted at high vantage point or trees in the forest will observe the pathway of the returning wasp and mark its location.

Malacosoma sp. (Hübner, 1820)

The tent caterpillar, commonly called as Mejanglong or Mesanglong is a black and brown coloured caterpillar of the lappet moth *Malacosoma sp*. It is the most valued species in the community and is considered a delicacy because of its chicken like flavour. It is a favourite food item for the locals in almost all the ranges of Mokokchung. During its availability season, it is sold in the markets at an exorbitant price of around Rs. 1000/kg. The caterpillar feeds on the leaves of the oak tree (*Schima wallichii)* which is called mesang süngdong in the local dialect, and hence the caterpillar is known as mesanglong or mejanglong. Meyer-Rochow & Changkija (1997[25]) recorded the use of mesanglong by the Aos. The population of the tent caterpillar has been reported to be declining due to climate change, cutting of *S. wallichii* for firewood and unsustainable rampant collection of caterpillar without sparing any clusters for continuation of its life cycle.

Prionoxystus robiniae (Peck 1818)

The larva of the moth *Prionoxystus robiniae* or carpenters worm is commonly known as Temerem tsüka. They bore into the bark of the members of the red oak group, particularly *Quercus serrata.* They are not very widely seen nor is the tree species common in the forests of Mokokchung which could probably be the reason in its reduced popularity as a food in the district. The unique and strong smell these caterpillars emit also contributes to its less preference as food. Its value is however at a very high price of Rs. 5000/kg. This insect is claimed to be rich in fats and also used to treat tuberculosis. It is also considered beneficial for anaemic people, and believed to cause miscarriages in pregnant women. Also, traditionally, the broth obtained after boiling the caterpillar is used as an embrocation for arthritis, and body pain.

Samia ricinii (Anderson, 1788)

Samia ricinii or the Eri silkworm is commonly known as Eri mesen or Lota mesen. It is a traditional popular food for the Aos as well as other Naga tribes. It has been reared since time immemorial for both food and silk. The larva and pupal stages are sold for Rs. 500/kg in the local market which, is much cheaper that carpenters worm and tent caterpillars, making it more preferable by the tribals. It is also a good source of protein (16 g%), fat (8 g%) and mineral (Longvah 2011[48]) and antioxidants such as phenolic (17.69 mg catechin/g) and flavanoid content (3.47 mg quercetin/g). (Deori 2014[49]). Traditionally, the villagers prevent the worm from making a cocoon and manipulate the worms to produce the silk thread as they move about on a bamboo mat bordered with measured planks in order to produce the desired size. The worms are manoeuvred to move about as where needed to evenly fill up the silken sheet. These traditions are however no longer practiced and sadly lost. They are mainly reared and harvested in farms and shacks by the villagers and are either sold or consumed at home.

Tarbinskiellus portentosus (Lichtenstein 1796)

Tarbinskiellus portentosus or cricket is commonly known as Yimpi chokok or Angor. Earlier it was not consumed as food since the insects inhabit areas of the village where household and human waste were usually disposed. However, with increase in health awareness and proper sanitation in and around the village, people no longer consider it unclean. In recent days, this insect has become a much sought-after food in many villages and its chirping heralds the onset of rain showers. It is generally collected at nights when the crickets crawl out from their burrows and their collection during the daytime has become a pastime for village kids. Consumers have commented positively on its palatable taste and high fat content. Mlcek et al (2018[50]) reported an average crude protein content of 55.6±1.1% and an average fat content 11.9±0.5% in *G. assimilis*. A study by Adamek *et al*. (2018[51]) for confirmation of acceptability for consumption of cricket flour *(Acheta domesticus)* in protein and energy bar could also augment the use of edible insects as an the next alternative source of protein and fat supplement.

Data interpretation

The data (Table 2) shows that the species with the highest cultural value and considered to be a delicacy among all age and gender groups are *V. mandarinia*

Table 2 — Consumer types of different Insects

	Insects	FC	IC	NC	FM	FIC	C%
1	*Aplosonyx chalybaeus*	5	4	94	38	9	23.68%
2	*Aeolesthes holosericea*	41	34	28	103	75	72.82%
3	*Darthula hardwickii*	7	15	81	49	22	44.90%
4	*Coridius singhalanus*	17	33	53	83	50	60.24%
5	*Tessaratoma javanica*	21	36	46	103	57	55.34%
6	*Oecophylla smaragdina*	30	43	30	100	73	73.00%
7	*Vespa mandarinia*	58	40	5	103	98	95.15%
8	*Malacosoma sp*	30	24	49	78	54	69.23%
9	*Prionoxystus robiniae*	28	22	53	96	50	52.08%
10	*Samia ricini*	54	36	13	103	90	87.38%
11	*Tarbinskiellus portentosus*	26	30	47	88	56	63.64%

Legend: FC: Frequent Consumers, IC: Infrequent Consumers, NC: Non Consumers, FM: People aware of the Insect being used as Food or having medicinal value, FIC: Both Frequent and Infrequent Consumers, % C: Percentage who consume Insects knowing their food or medicinal value

(95%) followed by *S. ricinii* (87.4%), *O. smaragdina* (73%) and *A. holosericea* (72.8%). The reasons for their high consumption are delicious taste, rich food value, medicinal benefit and their traditional use since ancient times. The least eaten insects are *A. chalybaeus* (23.7%), *D. hardwickii* (44.9%) and *P. robiniae* (52%). Though the tribals are aware of the food and medicinal value, one common reason claimed for the unpopularity was the odd smell some of these insects emit, and others being their introduction as food by migrants and tribals from neighbouring districts and that they were not consumed as food by their ancestors.

Conclusion

The traditional knowledge of entomophagy among the Nagas is considerably rich when it comes to the group of insect species they consume but the in-depth knowledge of their nutritive and therapeutic value is still poor. Also, the population of tribals who do not consume insects could be convinced to turn to the traditional habit of eating edible insects once they are made aware of the nutritional benefits by conducting seminars and awareness programmes with the cooperation of tribal communities. Awareness on sustainable collection of insects using proper capture needs to be carried out. With the rapid increase in population, insects could be used as food alternatives or as supplements, since they are known to be rich in various nutrients and thereby, could help eradicate malnutrition particularly in rural areas.

Besides being used as food, some of these insects are claimed to possess medicinal and therapeutic applications which requires scientific validation. The knowledge associated with entomophagy has been handed down through generations by imitation and oral transmission therefore it is imperative that, such information be documented through relevant research tools and projects, while it is still possible. Further studies to estimate their nutrients and minerals content and their toxic effects, if any, needs to be carried out.

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