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Exploring the entomological wealth of North East India: Diversity, traditional uses, and prospects of edible insects

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Abstract
Insects are also a part of classic diets in most regions of the world, being especially appreciated due to their high level of nutritional value and dense source of proteins. They are a major source of renewable resources in North-East India, which is highly entrenched in the food culture and nutrition of various indigenous communities. Entomophagy is also notable in Assam, Arunachal Pradesh, Manipur, and Nagaland, where the various tribes prefer specific insect species depending on their culture, taste, and availability in their region. In India, there are almost 255 insect species that are known to be eaten as food. These include order Coleoptera, which comprises the largest percentage of about 34%, Orthoptera (24%), Hemiptera (17%), Hymenoptera (10%), Odonata (8%), Lepidoptera (4%), Isoptera (2%), and Ephemeroptera (1%). Traditional knowledge, availability of insects in a season, and culinary preferences usually influence the choice of insects. Recording and encouraging the utilization of edible and medicinal insects would create opportunities for economic growth and enable the use of this useful biological wealth in the northeastern part of India through sustainable means.

Keywords: Entomophagy, North-East India, nutrition, tradition, ethnic communities

Introduction

Entomophagy is the eating of insects and has been a long-standing practice of humans since the dawn of time. A variety of cultures have traditionally considered insects both as a delicacy and as a reliable source of nutrition (Fontaneto *et al*., 2011) [14]. They have been recorded to play an important role in the diet of human beings in various places on earth, such as Asia, Africa, and Latin America (Paoletti and Bukkens, 1997) [28]. In the world, over 1,900 insect species are eaten, including bees, caterpillars and grasshoppers, beetle grubs, winged termites, cicada, ants, worms, and aquatic insects (Bodenheimer, 1951) [4]. Approximately 52 edible species in 45 genera, 26 families, and 10 insect orders are reported in South and Central Asia, which includes India, Nepal, Pakistan, and Sri Lanka (Gope and Prasad, 1983) [18]. Now, more than two billion individuals are eating insects today, with some areas relying on insects as a significant source of animal protein (Van Huis *et al*., 2013) [44]. A 2004 FAO report has suggested that edible insect larvae and maggots contain high levels of useful minerals such as calcium, potassium, magnesium, zinc, iron, and vitamins (B-vitamins) (Fromme, 2002) [15]. The other researchers have also indicated that insects are good sources of protein, amino acids, lipids, vitamins, and valuable trace elements (Alamu *et al*., 2013) [1]. Nevertheless, they might vary in composition according to the host plant of the insect, seasonal availability, and the ecological setting where the insect develops.

Entomophagic customs in India are entrenched in the food culture of various ethnic communities. The tradition is particularly developed in the Northeast, between the tribes of Arunachal Pradesh, Assam, Manipur, Nagaland, but there are also minimal practices in Tripura, Sikkim, Meghalaya, and Mizoram. It is estimated that there are approximately 255 species of insects that are being consumed by various tribes in the country. One of the studies points to the fact that tribal Indians have a wide range of entomophagous practices, with Coleoptera (34%), Orthoptera (24%), and Hemiptera (17) being the most affected orders (Sangma *et al*., 2016) [37]. It is important to note that insect consumption is controlled by a rich indigenous body of knowledge that governs the species to consume, the stage of life to consume, and the seasons when to consume insects. In North-East India, entomophagy is not simply a matter of livelihood, but insects have also been appreciated as sources of medicine as well as culture, which has demonstrated the complex connection between entomophagy and the rich cultural traditions of the various tribal communities in India.

Diversity of edible insects in North East India and its prospects

In Arunachal Pradesh, there are about 158 insect species, which are eaten by the community (Chakravorty *et al*., 2011) [6]. Of this group, the Nyishi and Galo tribes are the only tribes that use insects as food (Chakravorty *et al*., 2013) [7]. They consist of 40 species of the order Coleoptera, 26 of the order Orthoptera, 12 of Hymenoptera, 8 of Homoptera, 4 of Odonata, 3 each of Diptera, Dictyoptera, and Ephemeroptera, and 2 each of Isoptera, Plecoptera, and Odonata. The tribes of Arunachal Pradesh, like the other tribal groups in India, are more inclined to the use of orthopteran species as a source of food (Singh and Chakravorty, 2008). Besides, approximately 51 insect species of nine different orders are eaten by a number of tribes in Eastern Arunachal Pradesh, including the Nocte, Wangcho, Singpho, Tangsa, Deori, and Chakma (Meyer-Rochow and Chakravorty, 2013) [7]. The highest proportion (~34%) belongs to Coleoptera, after which come Orthoptera (24%), Hemiptera (17%), Hymenoptera (10%), Odonata (8%), Lepidoptera (4%), Isoptera (2%), and Ephemeroptera (1%). The palatability, availability, nutritional value, feeding habits, and cultural practices of the indigenous

communities are major factors that influence the choice of edible insects by tribes and regions.

In Assam, Dhemaji district recorded approximately 15 species of edible insects of 15 genera of 12 families in the Mishing tribes of Assam (Doley and Kalita, 2011) [12]. Mishings mostly ate Giant Water Bugs (*Lethocercus indicus*), Muga Silk-worm (*Antheraea assama*), Eri silkworm (*Samia ricini*), and House cricket (*Acheta domesticus*) as edibles. The Assamese take the green Weaver ant (*Oecophylla smaragdina*) as food in the Bohag Bihu festival. Formic acid, which is found in these edible insects, is used to treat diseases such as scabies, malaria, toothaches, stomach disorders, and blood pressure abnormalities (Chakravorty *et al*., 2011) [6]. It was further reported that the Mishing tribe people feed on the immature forms (egg, larva, pupa, and nymphs), and they feed on adult insects. Dutta *et al*. (2016) [13] documented 16 edible insect species on the earth, which belong to six different orders in the Dhemaji district of Assam. These consisted of 3 species of Lepidoptera, five Orthoptera, three Hymenopterans, one each of Isoptera, Blattodea, and Hemiptera. Mulberry silkworm, muga silkworm, and larvae are typically used to cure chronic itching and sore throat. Likewise, pupae and larvae of the eri silkworm (*Samia cynthia ricini*) are used in the treatment of a common mouth and tongue infection, mostly found among infants called '*dudmur*'. Other delicacies are eaten by the residents; these include the cicada (Pomponia sp.), short-horned grasshopper (Eupreponotus sp.), long-horned grasshopper (*Mecopoda elongata*), adult cricket (Tarbinskiellus sp.), and mole cricket (Gryllotalpa sp.). Further, the green weaver ant toxin (*Oecophylla smaragdina*) is used as a curative against nose and throat infections, and the developmental stages of termites (Odontotermes sp.) are eaten as food. Larvae and eggs of the yellow jacket wasps (*Vespa orientalis* and *Vespa magnifica*) and the potter wasp nest (Eumenus sp) are all used as folk remedies for stomach ailments. Also, honeybee eggs and larvae (Apis sp.), along with their products, are applied to treat whooping cough, but the cockroach (*Periplaneta americana*) has been demonstrated to treat asthma symptoms. In one more work, Rahman *et al*. (2018) [34] reported the habit of entomophagy in the Tiwa tribe of the Morigaon district. They recorded the use of 15 insect species representing six orders and 14 families, including three Hemiptera, two Coleoptera, four Orthopteras, three Hymenopteras, and one Lepidoptera, Odonata, and Isoptera. The nutritional analysis indicated that the Giant water bug had the highest protein (19.8%) and lipid (8.3%) content, with crickets having the highest carbohydrate content (5.1%). It has also been reported that entomophagy occurs in the Karbi Anglong district of Assam (Ronghang and Ahmed, 2010) [35]. The Karbis and the Rengma Nagas were found to be the largest consumers and used 32 edible insect species in their orders, which are Hymenoptera, Orthoptera, Coleoptera, and Hemiptera, whereby their use depended on the seasonal availability. Eri silkworm (*Samia ricini*) and red ants (*Myrmica rubra*) were the most popular edible insect choices among these communities. Remarkably, in the Assamese festival of Bohag Bihu, Ahom people consume red ants (*Myrmica rubra*) as a festive delicacy. Moreover, the authors Hazarika and Goyari (2017) [20] documented 23 species of edible insects of orders Hemiptera, Coleoptera, Hymenoptera, Orthoptera, Lepidoptera, Isoptera, and Odonata in the Bodo community of the Udalguri district. Among this category, the Giant water bug (*Lethocerus indicus*) and eri silkworm larvae (*Samia ricini*) were the most desired ones. In a comparable study, Narzari and Sarmah (2015) [27] have also reported 25 edible insect species of eight orders and 14 families that the Bodo people consumed in the Bodoland Territorial Region, Sonitpur, and Dhemaji districts. The practice of entomophagy was observed in a population of 94.79% of people belonging to different ethnic groups in the Bodoland Territorial Region. Kalita *et al*. (2022) [21] claimed that preparation through frying is the most prevalent, and the next is smoking, followed by consuming raw or as paste, roasting, and consumption by curry preparation. They have documented 25 species of edible insects which fall under the following orders: Hymenoptera (5 species), Hemiptera (3 species), Lepidoptera (2 species), Coleoptera (4 species), Orthoptera (7 species), and one species of Mantodea, Termitidae, Blattellidae, and Gomphidae.

The Meitei, Tarao, Tangkhul, Chothe, and Thadou tribes of Manipur have a reputation for eating a wider variety of insects than any other ethnic group. It has been suggested that an average of 69 species of insects (29 families and 9 orders) is a part of their traditional diet (Shantibala *et al*., 2012; Singh *et al*., 2013; Devi *et al*., 2014) [9, 39, 40]. Hemiptera was the order that was noted to be the most dominant, containing 10 species (Shantibala *et al*., 2012) [39]. Moreover, Ayekpam *et al*. (2014) [3] found that a total of five ethnic tribes in Manipur share 46 insect species. Of these, Hemiptera has the most edible insects, whereas Dictyoptera and Isoptera have the least. The Manipuri ethnic groups are found to have a special liking for the true bugs (Hemiptera), and their customs of gathering and feeding on the brood of bees and wasps of tree hives, forestlands, and small nurseries resemble those of the Mizo tribes. Hymenopterans are also especially popular in their larval stages, where they are eaten raw or roasted. Out of the 46 species of edible insects in Manipur, five have been found to have medicinal values as they have been used in the treatment of various diseases.

The Ao tribes in Nagaland are said to feed on almost 42 species of edible insects, with most of them being of the Order Orthoptera and Coleoptera (Meyer-Rochow and Changkija, 1997) [24]. The economic importance of the region has a long-standing cultural perspective on the consumption of silkworm larvae and pupae. The number of insects that can be consumed in Nagaland has increased beyond 60 over the years (Meyer-Rochow, 2005) [22]. Traditionally, the red ants, grasshoppers, crickets, and the larvae of mulberry silk are eaten by the tribal people of Nagaland. They are also known to feed on green-coloured larvae, which feed on the Gulmohar trees between March and April (Srivastava *et al*., 2009) [42]. The Angami, Ao, Chakhesang, Khiamnuingan, Konyak, Lotha, and Sumi tribes of Nagaland traditionally consume 92 insect species belonging to 9 orders and 29 families (Mozhui *et al*., 2017; Pongener *et al.*, 2019) [25, 31]. A recent report by Mozhui *et al*. (2020) [26] described 106 species of edible insects in Nagaland, belonging to 32 families and 9 orders. The majority of these species were stated to be eaten variously, either boiled, roasted, fried, or toasted, having the influence of the variety of culinary practices in the state. Some insects: Cossus sp., the larvae and pupae of ants, bees, wasps, and hornets, as well as honey, bee comb, and beeswax, were reported to be eaten raw. Certain edible

species have been reported as having been domesticated, such as *Antheraea assamensis*, *Apis cerana indica,* and *Samia cynthia ricini*, and are semi-domesticated in their wild environment, including *Vespa mandarinia*, *Vespa soror*, *Vespa tropica*, and *Vespula orbata*. The results highlighted the wide potential of commercializing different edible insects and the associated products as sustainable bio-resources in Nagaland.

Termites in Meghalaya are well known for their good source of proteins and carbohydrates (Paul and Dey, 2011) [29]. Das *et al*. (2024) listed 10 species of edible insects in the Ri-Bhoi district of Meghalaya, with the Orthoptera (grasshoppers and crickets) as the most consumed insect species order. The northeastern states of Tripura, Mizoram, Meghalaya, and Sikkim, however, seem to have lower entomophagic rates compared to areas such as Arunachal Pradesh, Assam, Manipur, and Nagaland, where insect versatility as food and as both a cultural and artistic value are highly prevalent in their diets. In such relatively understudied states, a small number of species have been reported to date: *Udonga montana* in Tripura and Mizoram, and Apis sp. (honeybee), Solenopsis sp. (fire ant), and *Tetragonula iridipennis* (stingless bee) in Sikkim (Dhakal *et al*., 2019) [10]. The *Ochrophora montana* (or cinnamon bug, seed bug) is a culturally and nutritionally significant edible insect that is used in Northeast India. It is also known as '*Thangnang*' locally and is very abundant after bamboos have flowered, and is considered a delicacy by the tribal people of Mizo Hills (Sachan *et al*., 1987; Thakur and Firake, 2012) [36, 43]. These bugs are a good source of food, even though they are regarded as a significant bamboo pest. They are usually harvested following the light rainfall, and they are eaten fried or as chutney, and the extraction of oil used in culinary and domestic purposes is done using traditional means. In times of food shortage or natural disasters, pentatomid bugs are also a significant food source, and they are not only eaten in Mizoram but also by communities bordering Manipur, Tripura, Assam, and Myanmar. The paucity of the records in Mizoram, Sikkim, and Tripura leads to the conclusion that entomophagy there is not as culturally integrated and practiced as in the neighbouring northeastern states. Nevertheless, since such regions have a high biodiversity, it is possible to continue exploring and describing edible insect species and their applications in the past. These initiatives have the potential to build sustainable food agriculture and nutritional security in the area.

Edible insects can be found throughout the year in North East India; however, the abundance and variety of insects depend on season and host plants. There is a heavy infestation of coleopterans between June and September, the pre-monsoon and monsoon seasons, and Odonata, as well as Orthopterans, are also common in September and October. Orders Hemiptera and Hymenoptera may be found only in winter (November to February) except some bugs and ants, such as *Oecophylla smaragdina*, which can be found in March to May and are traditionally eaten at the Bihu festival (Bihu Bihu) in Assam.

Edible insects: traditional harvesting and culinary uses

The ethnic communities of Northeast India have a rich source of traditional ecological knowledge, which enables them to discern between edible and poisonous insects, as well as determine the habitat of insects precisely. Markers to identify easy collection of edible insects are behavior, habitat, and seasonal occurrence. Handpicking or simple handpicking is the most common method of collecting insects; in this case, the bamboo baskets, cloth nets, or hand-picking are used according to the type of insect and its availability. Tribal groups in Manipur have developed a special way of bee and wasp harvesting. They put a small fire under the hive at night, which soothes the insects, and they can collect the whole nest safely. Likewise, hemipteran insects can be trapped by shaking infected plants during the season of swarming and aquatic insects, like Cybister, by a light trap or a scooping device (Pradhan *et al*., 2022) [33]. Aquatic insects are also collected by the ethnic communities in Arunachal Pradesh. Naiads of *Crocothemis servilia*, *Hydrophilus triangularis*, and larvae of *Cybister fimbriolatus* of ponds, streams, and rivers are caught by several methods of the traditional methods. Some of the edible species, like *Coridius chinensis* and *Coridius viduatus*, hibernate under stones in the stream or riverbeds during the winter season; they are collected carefully by using local tools and methods (Sangma *et al*., 2016) [37]. Traditional insect collection activities in Nagaland are directly correlated with agricultural activities. The Karbi and Rengma tribes gather the orthopteran insects, including *Gryllotalpa africana*, *Schizodactylus monstrosus*, and *Gryllus campestris*, by pouring water down the gullies and ravines to force the insects out of the soil. *Chandracris rosea*, a type of grasshopper, is harvested in bushes found in farmlands and villages, and *Bombina orientalis*, a bush cricket, is harvested with light traps in towns or directly excavated in its burrows in the countryside. The experiment requires a bowl of water to be put under the light, and then the termites are put inside the bowl. Weaver ant (*Oecophylla smaragdina*), which can be obtained throughout the year, is taken by taking away its nests in the trees and then dipped in water briefly before being used in the making of traditional meals (Pradhan *et al*., 2022) [33]. Tribal farmers in Mizoram use cinnamon bug (*Ochrophora montana*) in large-scale harvesting, collecting up to 20-30 kilograms in the gunny bags or bamboo containers as the harvest season approaches (Sangma *et al*., 2016) [37].

The tribal communities in Northeast India are known to consume a vast number of species of edible insects, including some of the developmental stages in their life cycle. Using generations of traditional ecological knowledge, local people are sure that healthy insects should be taken alive and processed on the spot to retain their freshness and nutritional values. The insects are usually eaten at an immature and adult stage, depending on the species and cultural inclination of the individual community. To mention just a few, Assamese Ahom people eat the silkworm at the full pupal stage, whereas Bodo, Garo, Naga, Khasi, and Mishing ethnic groups eat it at the prepupal stage (Sarmah, 2011) [38]. Likewise, most Odonata species are consumed when they are in their immature aquatic forms, adults of Orthopterans and Hemipterans are more desirable because of their unique texture and flavour. Hymenopterans, on the other hand, find their application in all their life cycles: eggs, larvae, pupae, adults, and even their products, e.g., honey, wax, and propolis, have many applications in culinary and medical use. Another favourite is termites, which are usually eaten in the adult stage, roasted, dry-fried, or sometimes eaten raw. The adult stages are mostly preferred among beetles, although in some cases,

for example, Xylorhiza sp., they are eaten in the larval stage. At least in the case of Prosopocoilus sp. and Odontolabis gazella, both the larvae and adults are eaten as delicacies. Factors like palatability, ease of harvesting, seasonal availability, and cultural or religious beliefs are major factors that determine the preference of larval or adult forms. Practically, the water larvae of Odonata, and the grubs of wood-boring beetles of Coleoptera, are much more readily collected at the larval stage than as adults, and are thus more generally eaten. Similarly, the species that represent the orders Dictyoptera, Isoptera, Orthoptera, Hemiptera, and Coleoptera are also harvested and consumed in both the larval (or grub) and adult stages as an aspect of adaptive, resource-saving food systems within the indigenous communities (Sangma *et al*., 2016) [37].

The fact that edible insects are being prepared by the ethnic communities of Northeast India shows a close relationship between traditional culinary knowledge and ecological knowledge. Different techniques are used, including roasting, frying, boiling, smoking, and even eating the insect raw, depending on the texture and species of insect. The insects with hard bodies are usually fried/roasted so that their bodies adopt a crispy texture, whereas the insects with soft bodies are boiled or sometimes eaten without cooking. Pentatomid bugs, honeybees, and termites are insects that are eaten both raw and roasted, indicating that they are quite versatile in local cuisines. In order to add flavour, communities often spice up their insect meals with garlic, pepper, and salt to form savoury meals, which are a part of the gastronomic culture of the area. Orthopteran insects are usually grilled, roasted, or smoked in the Karbi Anglong district of Assam. The insects are stuffed into bamboo pipes in a special traditional process and are smoked three or four days thereafter. These are then seasoned with pepper and salt, and eaten in combination with rice meals. Although long-horned grasshoppers are not as commonly gathered as they are so solitary, they are usually roasted or fried in oil, with the wings cut off. The mole crickets, on the contrary, are gathered in large numbers on warm summer nights between May and July. The Asian dune cricket (*Schizodactylus monstrosus*) is culturally and cuisine-wise of particular importance in the Galo tribe. The new specimens are smoked in bamboo pipes and dried under the sun for almost one week, after which they are ground into fine powder. This powder is then mixed with pepper, salt, and bamboo shoots to form a unique traditional chutney that is used with rice or Apung, a local brewed rice beer- a delicacy that puts a high level of sophistication in terms of fermentation and the balance of flavours in the tribe. *Coridius chinensis* and *Aspongopus nepalensis*, and other species of Pentatomid, are frequently gathered on the banks of rivers, and are cooked in a chutney, and serve as a good protein supplement to staple foods. Dining on termites only as adults, they are roasted or dry-fried, having been stripped of their wings, to make them a nutritious-smelling delicacy (Chakravorty, 2014) [5]. Fried insects, especially Pentatomid bugs, eaten raw and roasted, are also part of the local cuisine in Manipur. The Mizo tribes also love the cinnamon bug (*Ochrophora montana*), also called Thangnang, a good dish eaten after frying. Silkworm larvae and prepupal stages are the delicacy foods in Nagaland, which are normally fried in oil or boiled in fermented bamboo shoots and spices. In the same style, the Meghalaya tribes are distinguished as having a taste of deep-frying silkworm prepupae, indicating the regional differences and cultural complexity in entomophagic practice in Northeast India (Sangma *et al*., 2016) [37].

Ethnomedicinal importance of edible insects

The dietary habits of ethnic communities, the ancient history of the entomophagic tradition, and the traditional ecological knowledge have not merely informed the dietary habits of these communities but also inspired a variety of indigenous therapeutic practices. These medical uses of insects could be extremely folk and highly secretive within traditional societies, especially those that are less westernized by contemporary ways of life. In the Karbi tribe of Assam, urinary ailments in infants are treated using dragonflies (*Aeshna mixta* and *Neurothemis fluctuans*). The desert locust (*Schistocerca gregaria*) is also said to be used in the treatment of lip cracks using the body oil of the insect, and the larvae and pupae of the European fire ant (*Myrmica rubra*) are said to increase the fertility of humans. Honey of the Indian honeybee (*Apis mellifera indica*) is also used to relieve cold and cough (Solanki and Chutia, 2008) [41] and also has cosmetic uses (Ronghang and Ahmed, 2010) [35]. The mango borer larvae (*Batocera titana*) were eaten alive by the people of Nagaland for the healing of wounds (Alemla and Singh, 2004) [2]. These traditional uses are corroborated by scientific evidence because most insects contain bioactive compounds that have immunological, antibacterial, diuretic, analgesic, anesthetic, and antirheumatic activity (Yamakawa, 1998; Costa-Neto, 2005) [8, 45]. The tribes of Arunachal Pradesh employ a mixture of roasted American cockroach (*Periplaneta americana*) extract and water to treat asthma and tuberculosis, while a baked powder of honeybees: *Apis indica*, *A. mellifera*, and *A. florae*; mixed with honey, is used as a remedy for cough, snakebite, and glandular swellings (Solanki and Chutia, 2008) [41]. Moreover, the roasted or boiled nymphs of the mayfly (*Ephemera danica*) are traditionally believed to cure stomach disorders (Chakravorty *et al*., 2011) [6].

Economic potential of edible insects in North East India

The northeastern part of India is an outstanding focal point of sericultural and entomological variety, with various economically significant insects that produce silk. It has traditionally been known to be a central place of silk production (Peigler and Nauman, 2003) [30]. Assam is the leader of this sector by providing 95% of the total Muga silk in the country and 65% of Eri silk (Directorate of Sericulture, 2021) [11]. Non-mulberry silk has also been cultivated in other northeastern states like Meghalaya and Manipur, and its remarkable progress has added more industrial and cultural significance to the region, associated with sericulture. Each by-product in this industry is put to use; the host foliage is used as cattle fodder, and the silkworm pupae are used as a good source of organic fertilizer, as human food, and as animal food. Another highly valuable by-product is sericin powder, a waste liquid in the process of degumming silk fibres, which has been reported to have high commercial value in the food, pharmaceutical, and cosmetic sectors (Gulrajani, 2008) [19]. Also, as well as silk, there is apiculture (honey production), another successful insect-based industry in the area. Northeast India, having a great abundance of floral diversity as well as pure forest ecosystems, has enormous unexploited potential in the identification and exploitation of native honeybee species. The region is currently topped in honey

production with Assam contributing approximately 1.20 metric tonnes of honey per annum; this means the increasing significance of this alternative sustainable livelihood activity. Edible insects have a significant international market potential, in addition to regional industries. Consumers from Belgium, the Netherlands, France, Mexico, the USA, and China are becoming more interested in terms of the use of cricket powder and insect-based meat substitutes internationally. This directly contributes to the growth of insects as a potential sustainable source of protein (Gahukar, 2016) [16]. Due to the nutritional value, versatility, and simplicity of rearing most insect species in India, there is high export potential and prospects of introducing insects into the global food industry in the future (Gahukar, 2018) [17].

Conclusion

Insects form part of the traditional diets of the tribal communities of Northeast India, showcasing strong linkages between culture, nutrition, and sustainability. Insects can be a feasible solution to the world's protein shortage due to their high nutritional value, reproduction rate, low rearing costs, and ability to consume organic waste. In addition to their nutritional purpose, entomophagy provides livelihood to people as well as commercial management of different insect-borne by-products such as honey, silk, beeswax, etc. Some of them are even frozen to use as medicine, and they are exported to countries where their diverse potential is valued. Food security can be improved by encouraging research and development of large-scale insect cultivation as an alternative source of livelihood and to aid in the sustainable utilization of bioresources. Maintaining and rejuvenating the practice of entomophagy, in turn, has enormous potential not only in regard to human health but also in terms of national progress.

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