

## Diversity of Edible Insects and Practices of Entomophagy in India: An Overview

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### Abstract

Insects, a traditional food in many parts of the world, are highly nutritious and especially rich in proteins and these represent a potential food and protein source. The ethnic people of India also consume insects as food. A review on the practices of entomophagy in India revealed that about 255 species of insects are taken as food by different tribes of India. Among these edible species of insects, consumption of coleopteran species was highest constituting about 34%; followed by Orthoptera (24%); Hemiptera (17%); Hymanoptera (10%); Odonatae (8%); Lepidoptera (4%); Isoptera (2%) and the least was Ephimeroptera (1%). Food insects are chosen by members of various tribes according to their traditional beliefs, taste, regional and seasonal availability of the edible insects. Depending on the species, only certain, but sometimes all, developmental stages are consumed. Preparation of the edible insects for consumption involves mainly roasting or boiling. Sometimes spices are added to enhance the taste. Practice of entomophagy is quite common among the ethnic people of North East India particularly among the tribes of Arunachal Pradesh, Assam, Manipur and Nagaland and to a lesser extent by the tribes of Meghalaya and Mizoram. Comparatively this practice is much lower (constituting about one to five insect species) among the ethnic people of Kerala, Tamil Nadu, Madhya Pradesh, Odisha of South and Central part of India. Therefore, there is an urgent need to focus on the studies related to entomophagy, and to promote entomophagy/ethno-entomological research to document all edible insects and their mode of consumption by various tribal communities in India.

**Keywords:** Edible insects; Entomophagy; India

### Introduction

Of all the species on earth 73.5% are invertebrates and most of these are arthropods. Insects-the most successful of all the arthropods in terms of survival and adapting to their environmental make up more than half of all species alive today. Among the animal kingdom, Insects are one of the most successful group. Over 80% of all living animals are insects. About one million species of insects are known. Over 7000 new species described every year. Prominent reasons for their success are: ability to live in and adapt to diverse habitats, high reproductive capacity, ability to consume different kinds and qualities of food, and the ability to escape quickly from their enemies [1].

Insects play both negative and positive roles in the lives of humans. They may destroy our crops as pests and transmit diseases to man as vectors. However, not all insects are pests or vectors. The majority is harmless and many are beneficial. Although, man suffers and benefits from the insect legions, Vines and Rees [2] noted that the suffering outweighs the benefits. A number of insects are dietary components in many developing countries [3]. Ene [4] has listed grasshoppers, locusts, crickets, beetles, termites, ants and caterpillars among the commonly consumed insects in Nigeria. Insects represent a class in traditional food in many cultures of the world. More than thousand insect species used as food around the globe. Van Huis [5] has reported about 250 highly nutritious edible insect species in sub-Saharan Africa; Ramos-Elorduy [6] has registered around 535 edible species in Mexico; Mitsuhashi [7] has arrived at a figure of at least 1,900 identified species of edible insects worldwide. According to the recent report (List of edible insects of the world (April 4, 2012), <http://www.ent.wur.nl/UK/Edible+insects/Worldwide+species+list>) the

number has arrived up to 2000 [8]. The insects in traditional societies often has a role to play in other contexts e.g., as suppliers of raw materials (for dyes, poisons, and traditional medicines), as objects for decoration, entertainment, even admiration etc. [9-11].

In a report by FAO [12] one could read that an estimated 15 % of the world's population was still undernourished in the year 2000. Meyer-Rochow [13] pointed out that the much celebrated "green revolution" had not been able to keep pace with the growth of the global population. Then, as well as now, insects as an alternative sustainable food source have been mentioned on several occasions, e.g. [14-18]. However, for many people of the world insects are not an alternative, but are rather a staple and a normal nutritional commodity. According to Bodenheimer [19] they have played an important part in the history of human nutrition in Africa, Asia and Latin America. Most of the insects and their larvae contain more protein than do equal amounts of beef or fish, and insects are of a higher calorific value than meats, maize, soybeans, lentils, or other legumes [20-26]. Available data show that of the insects analyzed so far, 50 % had a caloric value higher than soybeans, 87 % higher than corn, 63 % higher than beef, 70 % higher than fish, lentils and beans, and 95 % scored higher values than wheat, rye or teosinte [26-31]. In some African countries, children are fed with flour made from dried caterpillars to curb malnutrition, while pregnant and nursing women as well as people who are anaemic are encouraged to eat caterpillars that are high in protein, calcium, and iron [20,22,32].

India lies north of the equator between 8°4' and 37°6' north latitude and 68°7' and 97°25' east longitude. It is the seventh largest country in the world with a total area of 3,166,414 square kilo metres (1,222,559 sq mi) and total population is about 1210.2 million with 645 distinct tribes and over 65% of the population lives in rural areas. Its unique geo-climatic features support rich biological diversity. India

being the tropical country the diversity and abundance of insects are greater. Varshney [33] has reported 589 families and 51450 species of insects from India. In another estimate, Alfred et al. [34] reported 59353 species of insects from India belonging to 619 families. Therefore, India can be a potential land for insect bio-resource to be utilized for their vast potential. However, India is no exception and that in this country too, there is a positive side of human–insect-interactions. Thus, supporting the still existing entomophagy in this country and perhaps even reviving some entomophagic practices have to be seen as actions benefiting the nation as a whole [35].

The purpose of this article is mainly focused on to review the work to look at the status of entomophagy in different states of India and to enlist the diversity of edible insects so far recorded from here with their cultural values along with indigenous knowledge associated with it. India being the tropical country with diverse insects resource and insects being the potential alternative source of nutritious food, the purpose of the study is to increase appreciation of the insects and its habitat, as a source of food nutrients, its role in traditional medicine and other cultural practices in which the insects play a role. The rationale is that the edible insects have a potential income generation for poverty alleviation in rural India beside their role in nutrition and therapeutic values. Increased appreciation of this insects would also contribute towards conservation of the threatened biodiversity of insects.

### Ethno-entomophagy in India

Though it is known and most of the observation claims that ‘medicine is food and food is medicine’ ; however, in this paper insects that are taken as food is considered and a consolidated inventory on what is known to date on the edible insects from various parts of India is presented in Figures 1-4.

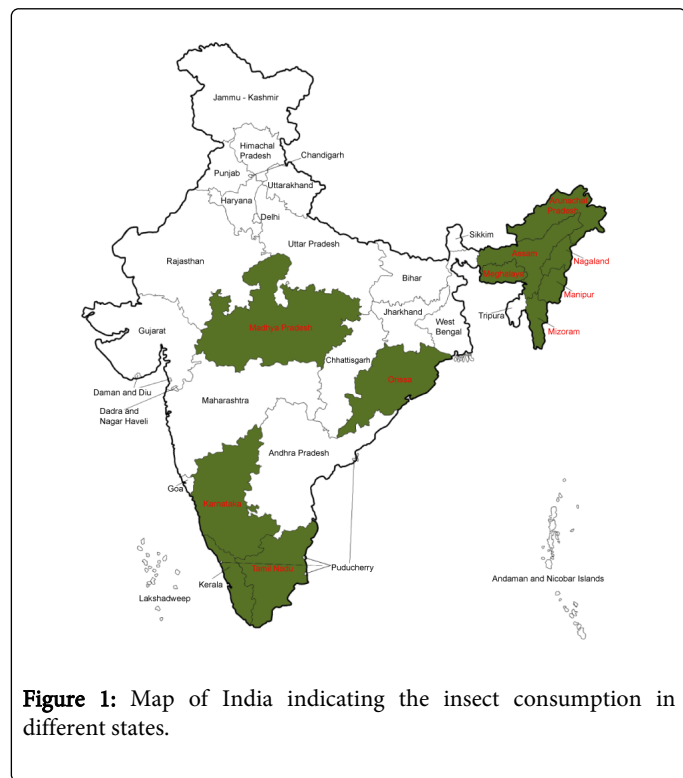


Figure 1: Map of India indicating the insect consumption in different states.

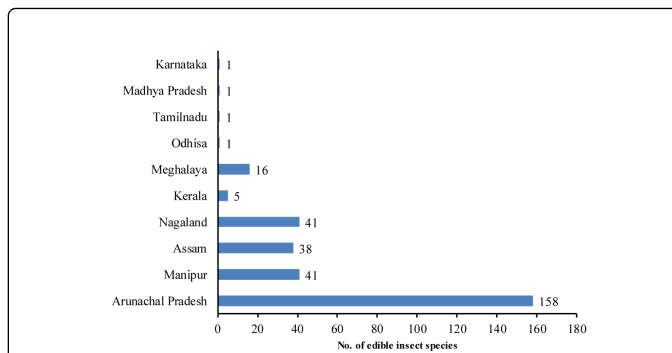


Figure 2: Number of edible insects species recorded from different states of India. Source: Reference No.2, 9,10,14,28,38, 45, 48,50,51,52,60,62.

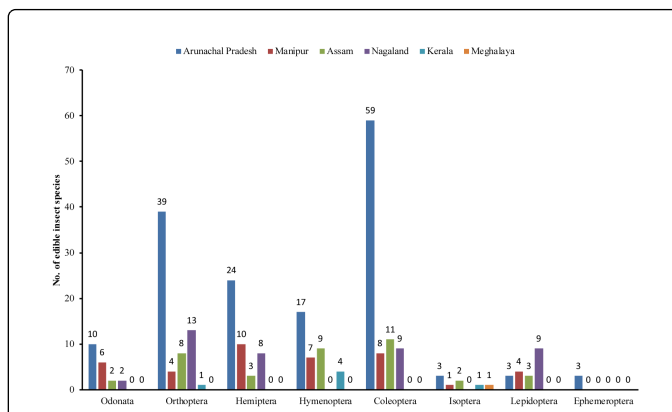


Figure 3: Comparative graphical representation of insects species in eight major orders consumed by ethnic people of India. Source : Reference No.4, 9,10,14,28,38, 45,48,50,51,52,60,62.

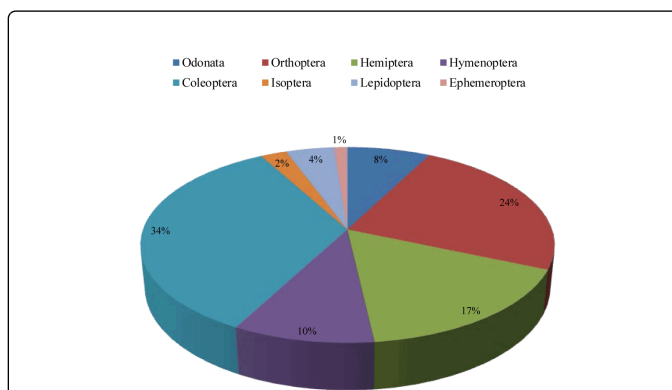


Figure 4: Order wise distribution of edible insects from India. Source : Reference No.1, 9,10,14,28,38, 45,48,50,51,52,60,62.

**Edible insects from South and Central parts of India:** A perusal of the literature has revealed scanty and fragmentary information about edible insects in India. Yet, as early as 1813, Forbes [36] had mentioned that termites are eaten by local tribes in Mysore and the Karnatak region. Das [37] analyzed the locust *Schistocerca gregaria* for

use both as human food and fertilizer in India and he has concluded that locusts were high in crude protein and fat. Roy and Rao [38] conducted a dietary investigation of the Muria tribes in Madhya Pradesh. The two authors found that consumption of insect larvae known as *chin kara* as well as certain species of ants recorded in connection with various other food items. Rajan [39] had reported that the tribe, 'Irumbars'. in the North Arcot district of Tamilnadu, and tribes in Karnataka, the winged termites, commonly called as *Eesal* are consumed as food. He has also noted that in some villages of Karnataka, the queen termite is collected and fed raw to weak children. Similar is the case in Odisha where termites are eaten alone or together with rice [40]. Other than this, so far, there is no report about the other insects as food consumed by them. While in Kerala at least five species of insects (bees, ant and termite) were reported as food by Wilsanand [41] and Yesodharan [42]. Insects as an item of food for Negrito tribes of the Indian Andaman Islands were reported by Sharief [43]. Kavita [44] covered management skills of the Nicobar Shompen Islanders in connection with native honey bees' use. Srivastava [40] gave a brief overview of insect prospecting in India.

**Edible insects from North East India:** Thakur [45] reported that the cinnamon bug, *Ochrophora* (Udanga) montona (Distant) Heteroptera; Pentatomidae) is fried in oil and consumed in Assam, Mizoram Manipur and Tripura. A total of 40 different species of insects are consumed by ethnic tribes of Karbi Anglong and Dhemaji district of Assam and most common among them are 5 different varieties of silkworms pupae and the tribe, Karbis Rengma and the Nagas are found to be the highest number of insect (32 insect species) consumers [46,47]. Paul and Dey [48] mentioned termites from Meghalaya served as a source of protein and carbohydrate. While, in Manipur, a total of 41 insect species belonging to 8 orders under 24 families and 36 genera are recorded as food items. The order Hemiptera has the maximum number of edible species (10) and the least number (1) in Dictyoptera and Isoptera. Meitei, Tarao, Tangkhul, Chothe and Thadou tribes consume a higher number of species (28-30) in comparison to other ethnic groups in Manipur [49].

Meyer-Rochow and Changkija [50] identified and provided vernacular names of at least 42 species of insects used as food by Ao-Nagas in Nagaland. Their list included 11 species of Orthoptera, 9 species each of Coleoptera and Lepidoptera, 8 species of Hemiptera and the rest distributed amongst the remaining insect orders with Mantodea and Odonata taking a leading role. An edible pentatomid bug (*Ochrophora montana*) had earlier been mentioned by Sachan [51] as a delicacy for inhabitants of the Mizo Hills in Northeast India. Meyer-Rochow [52] expanded this list to over 60 edible species, mentioning some food insects of the Meiteis of Manipur and the Khasi of Meghalaya also.

Documentations of edible insects amongst tribes of Arunachal Pradesh have recently begun and so far enlisted about 158 species [53-57]. Nyishi and Galo tribes of Arunachal consume about 102 species of insects [56]. Out of the 102 species, 40 belonged to the order Coleoptera; 26 to Orthoptera; 12 to Hymenoptera; 8 to Hemiptera; 5 to Homoptera; 3 to Ephemeroptera; 4 to Odonata; 2 to Plecoptera; 3 to Dictyoptera; 2 to Isoptera; and 3 to Diptera. The research has shown that Arunachal tribes consume comparatively greater numbers of Orthopterans than do other insect-consuming tribes in India [55]. In another study a consolidated list of edible insects used in the eastern part of Arunachal Pradesh (N.E. India) by Wangcho (Wancho) and Nocte tribes of the Tirap District and the Shingpo, Tangsa, Deori and Chakma of the Changlang District was reported. At least 51 insect

species, belonging to 9 orders were considered as edible. The largest number of edible species belonged to Coleoptera (14), followed by 10 each of Orthoptera and Hymenoptera, 9 of the Hemiptera, 3 Lepidoptera, 2 Isoptera and one each of Ephemeroptera, Odonata and Mantodea [57].

A total of about 255 species of edible insects so far recorded from different parts of India. Among the ethnic people of India, the tribes of Arunachal Pradesh outreaches in terms of number of edible insects taken as food, a total of about 158 species, this is followed by in Manipur, Assam and Nagaland (16 to 40 insect species) and to a lesser extent in Meghalaya. However, in Kerala, Madhya Pradesh, Odisha Tamil Nadu and Karnataka, this number limits only six insect species.

None the less, the consumption of coleopteran species was highest constituting about 34%; next come Orthoptera (24%); Hemiptera (17%); Hymanoptera (10%); Odonatae (8%); Lepidoptera (4%); Isoptera (2%) and the least was Ephemeroptera (1%). Preference of edible insects, though varies from tribe to tribe and region to region but in general the ethnic tribes of Manipur prefer to consume more of Hemipterans while in Arunachal it is Coleopteran species. Isoptera, the termites are preferred by the tribes throughout India. Preference given to insect species utilized as food by ethnic people of India depends on the insect's palatability, availability, and nutritional value as well as on local traditions and customs. Besides being described by many insect enthusiasts as a tasty food commodity, many insects are also considered to have health-enhancing properties and not insect control strategies as is practiced in other parts of the world.

**Seasonal availability of edible insects:** Although edible insects generally occur throughout the year, their densities and diversities are determined by their food plants as well as by seasonal conditions. Observations on the seasonal availability of the edible insects indicated that the largest number of edible Coleopterans occurred during June to September (pre monsoon and monsoon) and then got reduced during winter and early spring [56]. Seasonal trends were also observed in some Odonata and Orthopterans, which were most abundant in September and October (late summer). Insects belonging to the Hemiptera and Hymenoptera were found to be restricted to the period lasting from November to February (winter). Some edible insects like certain bugs and ants were found to be available (and used) throughout the year.

**Cultural practices associated with collection of edible insects:** The ethnic people rely on the conventional local wisdom to quickly find which insects are edible as well as where to find and how to catch them. These traditional, highly developed skills have been passed down from generation to generation. This indigenous knowledge has, however, gradually declined with changing socio-economic conditions and dietary habits. Rarely or occasionally people have a toxic effect from eating wrongly identified poisonous insect species.

Mostly the healthy insects only are collected and processed immediately for consumption. The collection of grasshopper, *Chondracris rosea* is done mainly from the surrounding bushes of villages and towns as well agricultural fields. In urban areas, bush cricket, *Bombina orientalis* is collected with the aid of light traps, but in rural areas people still know how to find the burrows/holes of *B. orientalis* and collect specimens by pouring water into their burrows. When the insects emerge from their shelters they are picked up by hand. Crickets and mole crickets (Gryllidae and Gryllotalpidae) are collected mostly in summer nights because of their abundance during May- July. *Odontotermes* sp., the termite, is abundant during the rainy

season, mainly during May to June. The termites are harvested by placing a bowl of water under a light source. Attracted to the light, they get trapped when they fall into the water. *O. smaragdina* the weaver ant is available throughout the year and collect them as and when required from the plants where a nest of ants are found as they available throughout the year. The ants are harvested by plucking the nest from the tree and drop them in a bucket of water before being sorted out for consumption. Usually the wings, hard exoskeletons and intestines are removed before cooking. Most edible insects are cooked in various ways before being eaten: deep-fried, grilled over an open fire, parched and ground, or steamed in banana leaves and curried. Spices and herbs like garlic, pepper and salt are used to increase the taste and flavor.

**Cultural practices associated with stages (life farms) and modes of insect consumption:**

A wide range of edible insect species can be consumed at various stages of their life cycles, for example, silkworms are eaten at both larval and pupa stages. Local people have used their traditional knowledge for a long time to consume each insect species in a different way but according to them healthy insects must be caught alive and processed immediately. Members of the ethnic tribes from North East India in general and Arunachal Pradesh in particular interviewed by us explained that they consume both immature as well as adult stages of insects. However, sometimes almost all of the Odonata whose aquatic larvae were greatly preferred to the flying adults, only immature insects were consumed, but in others, as with the Orthoptera and Hemiptera the adult stages were more highly appreciated. Katydid species were an exception and preferred as wingless, immature specimens. Hymenopterans were eaten at all developmental stages: eggs, larvae, pupae and adults and even their products like honey, propolis, and wax were used. Only the adult stages of termites are consumed either roasted or dry fried after discarding wings though they also take them as raw. Most of the edible beetles were consumed as adults, although some like *Xylorhiza* sp. were clearly preferred in their larval stages. The beetles *Prosopocoilus* sp. and *Odontolabis gazella* were consumed equally readily as larvae and adults. Preference for larval or adult stages almost certainly depended on a variety of factors: palatability of the insects (which may change between developmental stages), availability and the convenience with which the sought-after insects can be obtained, and furthermore taboos or religious beliefs may be involved. With regard to Odonata their aquatic larvae are easier to collect than their adults and for Coleoptera their wood-boring grubs, the same would hold true. Methods to prepare the edible insects for human consumption include roasting, boiling, or frying. Pentatomid bugs, honeybees, ants and termites however, consumed both raw and roasted. Members of the ethnic tribes interviewed by us explained that they have various ways to improve the taste of an insect dish. Spices and herbs like garlic, pepper and salt are used to increase the taste and flavor. Short-horned grasshoppers (Acrididae), for instance, are fried in oil after having their wings removed and are then simply eaten with salt. The insects, however, may also be stuffed in a bamboo pipe, smoked dry for 3-4 days, mixed with pepper and salt and then added to rice meals. Long-horned grasshoppers (Tettigonidae), collected in smaller numbers than their short-horned cousins because of the solitary habits of the former, are roasted or fried in oil after having their wings removed. They are usually fed to children or aged persons. Crickets and mole crickets (Gryllidae and Gryllotalpidae) are collected mostly during summer nights between the months of May and July. Yet the most highly valued orthopteran food insects amongst the Galo are Asian dune crickets of the species *Schizodactylus monstrosus*

(Schizodactylidae). Freshly collected specimens are put inside a bamboo pipe and smoked dry for nearly one week. Completely dried material is then crushed into a powder and mixed with pepper, salt and bamboo shoots to form a special type of chutney (traditional recipe). This chutney is taken with rice or with a local drink (a fermented rice beer) known as Apung and is regarded as most delicious by all members of the tribe irrespective of age and sex. Insect chutneys can also be based on other species, raw or dried, which are turned into a paste with chili and salt. Pentatomid bugs like *Aspongopus nepalensis* and other species, collected from river banks, are also highly appreciated in the form of chutney. Only the adult stages of termites are consumed either roasted or dry fried after discarding wings. Rajan [39] reported that in Tamil Nadu, the winged termites are collected and sold to the merchants in the market by a forest tribe The termites are fried as it is or fried along with groundnut by adding Bengal gram (pulse), puffed rice, salt. The fried pulses, spices and salt enhance the taste and are consumed in rural villages in south India.

It is important to note that, though insects are most abundant in India and there are about 645 district tribes and a large percentage of the population live in rural or semi urban areas but the diversity of insects taken as food is much lower especially in south and central parts of India. Moreover there is no instance of insects as food from other parts of India. It is hard to explain why the scenario is being like this, whether insects as food seems to be far from being appreciated or ethnic people abandoning their traditions and discarding their rich indigenous knowledge of the varied utility of insects in general and as food in particular before any scientific documentation. In 1975, Meyer-Rochow [13], pointed out that traditionally-living folk often hope to gain acceptance from people of Western and/or industrialized civilizations by discarding their own age-old traditional eating and other habits in favor of western styles and this seems particularly true of members of the younger generation. There are, however, other reasons that could be involved, and they include over-exploitation of insect resources, dwindling populations of insect species used as food and/ or ingredients of folk medicine due to degradation of their ecological niches, or simply rules and regulations obstructing the use of insects imposed on the local custodians. However, there is an urgent need to expand the study of entomophagy, and to promote entomophagy/ethno-entomological research.

**Need for linking entomophagy in India with food security system and conservation:**

In a recent International workshop sponsored by United Nations Food and Agriculture Organisation on "Forest Insects as Food: Humans Bite Back" covered three main themes: (1) edible forest insects as a natural resource, (2) models of sustainable insect management for food and other products, and (3) development potential for edible forest insects. It identified that there are major knowledge gaps in our information on the extent of entomophagy and was also considered a matter of high priority for documentation of indigenous knowledge. One of the important outcomes of the need to promote the view that although entomophagy can be adopted as a response to famine, in some cultures it represents an important seasonal source of protein and is a normal part of the diet of a large proportion of the human population. The workshop identified the main species of edible insects in the Asia Pacific region that should be assessed on the basis of food security and safety especially in relation to forest conservation [58]. Ramos- Elorduy [59] reported that the populations of some of the 30 edible insect species in the Mexican town of Tulancalo have declined because of over exploitation by unqualified independent workers who are not natives of the town.

This has led to a call to regulate exploitation of edible insects in Mexico to ensure better management, production and conservation. There are examples of sustainable harvesting of edible insects based on traditional ecological knowledge, such as the harvesting of *Gynanisa maja* and *Gonimbrasia zambesina* caterpillars by the Bisa people of northern Zambia [60]. Edible insects provide an opportunity for insect conservation by combining food security and forest conservation issues [61,62]. In Mexico, the grasshopper *Sphenarium purpurascens* is collected for sale as food, but it is also controlled by Organophosphorous insecticides. The effectiveness of control through the manual harvesting of this species was compared to chemical control. Although harvesting was less effective than the insecticides, it still significantly reduced numbers of the grasshopper and it generated additional income source, reduced insecticide cost, and reduced chemical runoff and contamination [63]. Wild harvest of insect pests in established crop or horticultural systems may be more practical [23]. The pest insects could be mass collected by light or chemical (pheromone) traps. Such a mass collection of pest insects may not necessarily be for direct human consumption but rather for the production of food supplements or as stock food. Collecting such pests would not only protect plants but it could benefit the environment by reducing the need to use pesticides [62].

Therefore, there is a need to assess insect biodiversity and the role of ethno-entomophagy in particular in India for conserving this valuable natural resource and the local traditional knowledge for posterity. It is also suggested that there is a good scope to exploit this socio-cultural attribute in finding ways to tackle the increased pest incidences as a consequence of global climate change in the fragile tropical forest ecosystems here and elsewhere in the world under similar ecosystems. Mass collection of pest insects may not be for food but rather for production of food supplements or feed for livestock and helps in maintaining healthy environment. In other words, most preferred edible insects, especially those with high nutritional content, can be reared or cultivated in the home gardens with the application of modern tools and techniques and sold to the people, who regard them as delicacies. There is also a scope to make an effort to increase their commercial value as food and feed for livestock specially chicken and availability on demand in a sustainable manner. On a long run this may serve the twin purpose of insect (natural resource) use as food (food products and feed) and conservation. Supporting the still existing entomophagy in this country and perhaps even reviving some entomophagic practices have to be seen as actions benefiting the nation as a whole [57].

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