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SHORT COMMUNICATION

Entomophagy and insect conservation: some thoughts for digestion

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Abstract There is an apparent contradiction between conserving insects and using them as food. Entomophagy can make a significant contribution to insect conservation if they are sustainably harvested in conjunction with appropriate habitat management. It can also be an alternative source of proteins for humans in order to reduce adverse environmental impacts of livestock production.

Keywords Entomophagy · Edible insects

In February 2008, a United Nations Food and Agriculture Organisation sponsored workshop, *Forest Insects as Food: Humans Bite Back*, was held in conjunction with Chiang Mai University in Thailand. Participants from Asia, Australia, Europe and the USA gathered to consider entomophagy in the Asia Pacific region. The workshop 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. The workshop identified that there are major knowledge gaps in our information on the extent of entomophagy, but also in the actual identities of the some of the species consumed, especially linkages between indigenous folk names and scientific names. As entomophagy is practiced by a large number of different indigenous cultures, documentation of indigenous knowledge was also considered a matter of high priority. Other important outcomes included 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.

The workshop attracted considerable media attention across the world. Many reports emphasized the unfamiliarity of entomophagy (to western society) while acknowledging that entomophagy is a wide spread practice that is driven by dietary preferences rather than necessity through food shortages. In parts of Asia, the practice of eating insects has been spread by recent internal migration; for e.g., entomophagy is traditionally important in north-eastern Thailand but has expanded into southern Thailand with movement of Thais from the north into the larger tourist centers in the south.

Entomophagy, including other invertebrates such as spiders and scorpions, is a normal component of the diets of many Asian, African, Central and South American cultures. The social, economic and nutritional value of edible insects is often overlooked. Over 1,500 species of edible insects have been recorded in 300 ethnic groups from 113 countries (MacEvilly 2000). In some ethnic groups, insects provide 5–10% of annual protein input as well as fats, calories, vitamins and minerals (MacEvilly 2000). It is now shunned by western societies, probably due to beliefs that insects are unhygienic and harbour diseases, and considered “starvation” food (DeFoliart 1999).

There is an apparent contradiction between the direct use of insects as food and the need for their conservation. The large number of potentially edible insect species (and other invertebrates) as well as the ability of many species to breed rapidly provides the potential to promote entomophagy

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for insect conservation. There are several ways in which edible insects can aid insect conservation: (1) development of sustainable harvesting protocols to protect individual edible species; (2) the use of an important edible insect species as a flagship for the habitats in which they occur; and (3) the provision of an alternative source of essential proteins for human consumption to reduce dependency upon more environmentally destructive sources such as livestock grazing. In some circumstances, especially in areas dominated by rural poor, an edible insect would be a more appropriate flagship taxon than the butterflies and dragonflies that are more commonly invoked in western societies.

Harvesting insects as food, like any other food hunting and collecting activities, has the potential to become a threat to both the target species and to their environment. 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 (Mbata et al. 2002). However, greater demand because of increasing human population numbers, more efficient access to caterpillar habitats and to markets, and harvesting by non-traditional collectors can threaten the insects. It is unclear whether harvesting per se or habitat damage is the main threat. Habitat damage may not necessarily be associated with insect food harvesting but caused by other activities (such as logging and grazing) (FAO Départment des Forêts 2004). Ramos-Elorduy (2006) reported that the populations of some of the 30 edible insect species in the Mexican town of Tulancalo have declined because of overexploitation by non-qualified 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 (Ramos-Elorduy et al. 2006).

A similar situation can potentially occur in continents where entomophagy is not necessarily a major food source any more. In Australia, honeyants, witjuti grubs and bardi grubs were important dietary items of Aboriginal societies (Yen 2005). There is an increasing threat to the sustainability of these insects due to increased exploitation by both indigenous owners (better access) and by the ecotourism and restaurant markets. One of the iconic Australian edible species, the Bogong Moth (*Agrotis infusa*) is an interesting example of the complexities involved in insect conservation. This species breeds in open pastures in southeastern Australia, and in some areas, is considered an agricultural pest. Its life cycle involves long flights by adults (1–2,000 km) to the alpine region for summer. It was during this summer period that Aborigines collected the moths as a food source. These summer sites were faced with cattle grazing (now removed) but are now confronted with global warming. The Bogong Moth is an important food source of the threatened Mountain Pygmy-possum (*Burramys parvus*), but agricultural spraying has resulted in accumulation of arsenic in the moths and they have introduced more arsenic into the fragile alpine food chain (Green et al. 2001).

Some of the edible Australian insects are now sought by recreational fisherman as bait. The extent of this has not been documented properly, and information about preferred species and how to collect them is available on angling web sites. The targets include beetle larvae (especially the trunk and log dwelling species) and hepialid moth larvae. The latter are root feeders, primarily on River Red Gums (*Eucalyptus camaldulensis*), and the number of reports of environmental damage to riverine habitats caused by digging up hepialid larvae is increasing.

There are approximately 250 edible insect species in sub-Saharan Africa that are high in nutritive value (Van Huis 2003). Preference for which species are utilized depends on their taste, nutritional value, and ethnic customs, preferences or prohibitions. Edible insects highlight the linkage between traditional knowledge and conservation. For example, the previously referred to example of edible caterpillars and the Basi people of Zambia involves traditional regulation of harvesting by monitoring development and abundance of caterpillars, changes in habitat, protection of host plants and moth eggs against fire, and temporal restriction of harvesting (Mbata et al. 2002). The recording and maintenance of such knowledge is not only important for the traditional cultures themselves, but also for science and conservation (Paoletti et al. 2000; Yen 2005).

There are economic, nutritional and ecological advantages to sustainable harvesting of traditional food source (Van Huis 2003). One of the better known edible insects in sub-Saharan Africa are mopane worms, the larvae of the Mopane Emperor Moth (*Imbrasia belina*) that feed exclusively on mopane trees *Colophospermum mopane* (Illgner and Nel 2000). Ghazoul (2006) summarizes the complex inter-relationship between mopane worms, management of mopane woodlands, and the socioeconomic factors associated with rural poor in southern Africa. The main issue is the over-harvesting of mopane worms (as well as use of mopane forest for other non-timber forest products). The value of the mopane worm trade is substantial, involving complex trading networks, access and harvest rules, and wholesale and retail distribution. Domestication of the mopane worm is one avenue that is being followed because it is possible to establish and maintain captive breeding populations. Food safety is another issue, and correct processing and storage is encouraged. The mopane worm is an important flagship taxon for mopane woodlands, and correct management of mopane worms and mopane woodland will ultimately benefit local communities.

While the recorded number of species of edible insects is relatively small compared to the enormous number of insects, they represent an important means to advocate insect conservation. They are often associated with indigenous groups living in regions where environmental threats are paramount. While the edible species may not be threatened themselves, they could be used as flagships for both other insects as well as their habitats. Edible insects provide an opportunity for insect conservation by combining food security and forest conservation issues (Vantomme et al. 2004): identification of valuable food resources, appropriate habitat management for sustainable production, recognition of local traditional knowledge and enterprises, and an important form of income. In summary, edible insects represent a most valuable resource for biodiversity conservation (DeFoliart 2005).

Insects are also potentially an important energy efficient source of protein for humans, either through direct consumption or as food supplements for stock (poultry, pigs and aquaculture) (DeFoliart 1989). Livestock (animal husbandry) compete with humans because of the land required for food production for livestock. Utilization of insects as a protein source could benefit insect conservation through habitat protection. The single largest anthropogenic user of land is livestock production. It accounts for 70% of all agricultural land (including feedcrop production) or 30% of the land surface area on earth; at the same time, it is a large source of greenhouse gases and a leading causal factor in loss of biodiversity through land degradation, soil erosion and water pollution (Steinfeld et al. 2006). Livestock now consume more human edible protein than they produce: livestock consume 77 million tones of protein in feedstuff that is potential for human nutrition to produce 58 million tones of protein. Using insects as a source of protein could reduce the pressure to utilize so much land for livestock production. Some interesting challenges include the integration of mass rearing of insects into small scale farming ventures such as development of organic waste recycling systems using insects (DeFoliart 1995; Ramos-Elorduy 2008).

One of the questions worth exploring is the practicality of harvesting pest insect species as food—would it protect crops as well as reduce the use of insecticides? Whether this is economically feasible needs to be addressed. Pest outbreaks can be unpredictable, and the mode of collection will depend on the target species. For e.g., few of the known edible insect species in Australia are considered pests (although Bogong Moth larvae can cause economic damage to plants). One of the important pests is the Australian Plague locust, *Chortoicetes terminifera* (Hunter 2004). Collecting Australian Plague locusts would be difficult because of the vast areas that they move over in quick time, and access to some of these areas can be a logistical challenge. Locust control in Australia is based on spraying hopper beds to reduce adult numbers, and this may preclude collection of surviving adults for human consumption. While locusts are collected and eaten in Africa (DeFoliart 1999), there are no records of indigenous Australians feeding on locusts; Schulze (1891) reported that the Aborigines around Finke River region would not eat them. There are probably cultural reasons why they are not eaten, and this highlights the importance of understanding indigenous attitudes to food types.

In the Puebla-Tlaxcala Valley 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 (Cerritosa and Cano-Santana 2008).

Wild harvest of insect pests in established crop or horticultural systems may be more practical (Banjo et al. 2006). These pests could be mass collected by light or chemical (pheromone) traps. Such 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 (DeFoliart 2005). Again, this is an activity that does require some thought; is there a level of harvesting of pest insects that is sustainable and does not cause significant disruption to the complex of natural enemies associated with them?

In conclusion, there is no doubt that insects and other invertebrates are potentially a more efficient source of protein for human consumption. Important edible species can be important flagship taxa for conservation, and there are opportunities to integrate edible insects into food production systems that will reduce the need to destroy native biodiversity.

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