

Insect pests as food and feed

A. van Huis

Laboratory of Entomology, Wageningen University & Research, P.O. Box 16, 6700 AA Wageningen, the Netherlands;
editor-in-chief@insectasfoodandfeed.com; arnold.vanhuis@wur.nl

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EDITORIAL

Abstract

When insects occur in large numbers, and these are often insect pests, people want to get rid of them. In countries where insects are already consumed, the idea of eating them is quickly formed. Harvesting them as food can be a strategy to replace other methods of control.

1. Introduction

Insect pests can be controlled mechanically when collected either for home consumption or for the market. In this case pest control and food procurement are combined. Sometimes the control obtained by consuming them may be limited, as is the case with certain locust species. For example, during an upsurge or a plague of the desert locust *Schistocerca gregaria* (Orthoptera: Acrididae), the swarms are often so large that the part of the locust population that can be harvested is not sufficient to contribute to population suppression. This is in addition to other logistical problems of finding and harvesting them (Van Huis *et al.*, 2007).

A 'pest' is defined as any organism that causes annoyance or injury to human beings, human possessions, or human interests. Our definition of a crop pest is that it causes economic loss (Hill, 1997). Injury is the physical damage you can observe on a plant which may or may not lead to economic loss. An example of injury without yield loss is cutting a young maize plant to ground level while the yield remains the same or even increases (Hicks *et al.*, 1977). This can simulate an armyworm attack (Brown and Mohamed, 1972). The shea caterpillar *Cirina butyrospermi* (Lepidoptera: Saturniidae) is collected and consumed, however it seems that the defoliation does not lead to yield loss of the shea nut tree the following year; on the contrary, the defoliation seems to increase the yield of maize growing underneath (Payne *et al.*, 2019).

Below we will give some examples of pest insects from different orders being used either as food or feed. However, there is also an indirect way of controlling pests using edible

insects. Frass of the black soldier fly *Hermetia illucens* (Diptera: Stratiomyidae) as soil amendment seems to control wireworms (Coleoptera: Elateridae) (Temple *et al.*, 2013; Vickerson *et al.*, 2017).

2. Orthoptera

Locusts

Locusts (Acrididae) are consumed when an upsurge or plague occurs. In the second century before Christ, Diodorus of Sicily already talks about 'acridophagi', the 'locust eaters' of Ethiopia (Bodenheimer, 1951: 41). The only risk associated with consuming locusts is poisoning since the insects may have been treated with pesticides (Saeed *et al.*, 1993).

Other species besides the desert locust eaten in Africa are the red locust (*Normadacris septemfasciata*), the brown locust (*Locustana pardalina*), mentioned for example by Obopile and Seeletso (2013), and the (often reared) migratory locust (*Locusta migratoria*) (Mohamed, 2015). In Latin America the locust species *Schistocerca cancellate*, which has recently been causing upsurges (Medina *et al.*, 2017), is also eaten (Loiácono *et al.*, 2016).

In 1876 the U.S. Congress declared the Rocky Mountain locust (*Melanoplus spretus*) 'the single greatest impediment to the settlement of the country between Mississippi and the Rocky Mountains'. Throughout the 19th century, swarms of locusts swept across the American continent. In 1875, one swarm was estimated to be more than half a million km². The outbreaks subsided in the 1890s and then vanished

(last specimen found in 1902) and the species was declared formally extinct in 2014 (Hochkirch, 2014). The famous American entomologist C.V. Riley (1843-1895) headed a commission to fight the locust. About five pages of the first report of the commission were devoted to consuming the locust. This was mainly because Riley wanted to help people who were suffering from starvation (Lockwood, 2004: 116-117).

Between 1960 and 1970, the Bombay locust *Nomadacris succincta* was a major pest of corn and sorghum crops in Thailand (Chen *et al.*, 1998). When aerial spraying with pesticides proved unsuccessful, a campaign was organised (1978 to 1981) to capture the locust for consumption. This was so successful that the locust is no longer a pest but rather one of the best known and most popular edible insects in Thailand (Hanboonsong, 2010).

Grasshoppers

In the Sahelian region of Africa many grasshopper species are eaten, most of which are crop pests (Van Huis, 2003). Jago *et al.* (1993) showed that the investment in pesticides to control grasshoppers in millet does not pay off. In fact the sale of grasshoppers from the millet raised more revenue for the farmers than selling the millet (Van Huis, 2016). Many articles have been written about the pest status and control of the variegated grasshopper *Zonocerus variegatus* (Pyrgomorphidae) in West Africa. However, few publications deal with its role in the human diet. The insect is very much appreciated because of its taste and nutritional value (Kekeunou *et al.*, 2020).

In most of Asia, rice field grasshoppers of the genus *Oxya* spp. (Acrididae) are traditional food. However, increased pesticide use in the final quarter of the twentieth century reduced its abundance (Payne, 2015).

The grasshopper *Sphenarium purpurascens* (Pyrgomorphidae) is a pest of corn, bean, pumpkin, and alfalfa in Mexico, but is also a popular food. Cerritos Flores *et al.* (2015) proposed changing the practice of using pesticides to harvest them mechanically for human consumption.

3. Coleoptera

The lesser mealworm, *Alphitobius diaperinus* (Coleoptera: Tenebrionidae), is a common insect pest in commercial poultry farms. It appears in large numbers in poultry litter and manure, and even eats sick and weakened or dead chickens. The lesser mealworm is a source and vector of several pathogens such as bacteria, viruses, fungi, protozoa, and platyhelminths that cause serious poultry and human diseases (De Las Casas *et al.*, 1968; McAllister *et al.*, 1996;

Poole and Crippen, 2009; Szczepanik *et al.*, 2019; Watson *et al.*, 2000). The lesser mealworm is now an insect that is commercially reared as food on side-streams of the agri-food sector (Gianotten *et al.*, 2020; Rumbos *et al.*, 2018).

An example of an insect that people are starting to consider eating and that occurs in huge numbers is the cockchafer *Melolontha* sp. (Scarabaeidae). This pest insect was very abundant in Europe until pesticides were used. The larvae eat the roots of plants and develop in the earth for three to four years, which is why they appear in a cycle of every three or four years. Bodenheimer (1951: 66) mentions that in years of famine, such as in 1688 in Ireland, people would eat them. Cockchafer soup is a European dish made from the cockchafer insect. It was a delicacy in Germany and France until the mid-1900s. Also in Luxembourg they were made into a soup, in particular during the plagues in 1868, 1880 and in 1896, when children were paid to collect them (Massard, 2007). In the Philippines the grub *Leucopholis irrorata* (Scarabaeidae) is a serious pest in maize and rice (Litsinger *et al.*, 1983), but is at the same time considered a delicacy (grubs grilled over charcoal, deep-fried, spicy adobo and sautéed with vegetables) (Adalla and Cervancia, 2010). In India another white grub *Lepidiota mansueta* (Scarabaeidae) is a serious pest of potato, sugarcane, Colocasia, and green gram (Bhattacharyya *et al.*, 2015). Majuli, an island on the Brahmaputra River in Assam, one of the largest freshwater islands in the world, has been severely infested by the beetle. Farmers now make dishes from the beetle: for example, roasted beetle fried with tomato, plain roasted beetle and beetle curry (Borah, 2016).

There are several other coleopteran pests which have become a popular food all over the world, such as the palm weevil *Rhynchophorus* spp. (Curculionidae) and rhinoceros beetles *Oryctes* spp. (Scarabaeidae) in palms; their consumption is a pest management strategy (DeFoliart, 1993).

4. Hymenoptera

In 2019, a giant hornet was spotted in Washington State in the USA, and since then alarming newspaper articles have talked about the 'murder hornet' (it may kill bees, but rarely humans). The wasps come from Japan, where they are called 'hebo' (*Vespula* spp.) (Vespidae). It is a popular food in some parts of the country (Nonaka and Yanagihara, 2019).

However, there is another way of turning insect pests into food. This is accomplished by the weaver ant *Oecophylla* spp. (Formicidae), which is used as a biological control agent (predator) for insect pests in orchards (Van Mele, 2008). The weaver ant is a popular food in most of southeast Asia (Offenberg and Wiwatwitaya, 2009).

5. Lepidoptera

One of the major teak pests around the world is *Hyblaea puera* (Hyblaeidae), which defoliates the trees (Tripathy *et al.*, 2018). However, the cocoons are considered a delicacy in Java, Indonesia (Lukiwati, 2010).

Worldwide, foresters have looked at insect pests as wood pests to be suppressed or controlled (Schabel, 2010). However, many insect pests in forests are edible, such as the caterpillars in central Africa (Malaisse, 1997: 199-218).

6. Diptera

In an editorial of the first issue of this journal this year, Tomberlin and Van Huis (2020) indicated that in the past the black soldier fly was considered a pest, as it could produce myiasis in humans and pets. Now it is considered a promising species in the biotransformation of organic waste and as feed for pets, fish, poultry, and pigs. The same is true for the house fly *Musca domestica* (Muscidae), which is considered a pest while the maggots can also be used as feed (Van Huis *et al.*, 2020).

An opportunity exists when pest insects are artificially available in large numbers. This is the case for the Mediterranean fruit fly *Ceratitis capitata* (Tephritidae), which is mass-reared in controlled facilities and whose sterile males are released as a control method (Gavriel *et al.*, 2010). Such facilities are present in Israel, prompting one company there to make protein and oil out of the larvae; the powder is used as an additive in baked goods and energy bars.

7. Conclusion

When insects occur in large numbers (such as locusts) people are more inclined to use them as food, even in the western world as mentioned above in the case of the Rocky Mountain locust and cockchafer. In addition, when they are available by rearing them for other purposes such as the sterile insect technique, they may also be considered as food or feed (e.g. the Mediterranean fruit fly). Control of pests by pesticides often causes resurgence or secondary pest outbreaks (DeBach, 1964), for example in rice agroecosystems, as they are controlled by a huge reservoir of natural enemies (Settle *et al.*, 1996). By refraining from using pesticides, there are opportunities to use insect pests as food, such as the *Oxya* spp. grasshoppers in Asia. Several fly species were considered pests in the past, but are now used as food or feed.

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