

Insects and Humans

1. Introduction

This final chapter will focus on those insects that humans describe, in their economically minded way, as beneficial or harmful, though it should be appreciated from the outset that these constitute only a very small fraction of the total number of species. It must also be realized that the ecological principles governing the interactions between insects and humans are no different from those between insects and any other living species, even though humans with their modern technology can modify considerably the nature of these interactions.

Of an estimated 5–10 million species of insects, probably not more than a fraction of 1% interact, directly or indirectly, with humans. Perhaps some 10,000 constitute pests that, either alone or in conjunction with microorganisms, cause significant damage or death to humans, agricultural or forest products, and manufactured goods. Worldwide food and fiber losses caused by pests (principally insects, plant pathogens, weeds, and birds) are generally estimated at about 40%, of which 12% are attributable to insects and mites. These figures do not include postharvest losses, estimated to be about 20%, and occur despite the application of about 3 million tonnes of pesticide (worth more than US\$31 billion, including about US\$9 billion of insecticide) (Pimentel, 2002). In the United States alone, crop losses related to insect damage rose from 7% to 13% in the period 1945–1989, despite a tenfold increase in the amount of insecticide used (>120,000 tonnes each year) (Pimentel *et al.*, 1992).

On the other hand, the value of benefits derived from insects is severalfold that of losses as a result of their pollinating activity, their role in biological control, and their importance as honey, silk, and wax producers. That insects do more good than harm probably would come as a surprise to laypersons whose familiarity with insects is normally limited to mosquitoes, houseflies, cockroaches, various garden pests, etc., and to farmers who must protect their livestock and crops against a variety of pests. If asked to prepare a list of useful insects, many people most likely would not get further than the honey bee and, perhaps, the silkworm, and would entirely overlook the enormous number of species that act as pollinating agents or prey on harmful insects that might otherwise reach pest proportions.

Humans have long recognized the importance of insects in their well-being. Insects and/or their products have been eaten by humans for thousands of years. Production of silk from silkworm pupae has been carried out for almost 5000 years. Locust swarms, which

originally may have been an important seasonal food for humans, took on new significance as humans turned to a farming rather than a hunting existence. However, with rare exceptions, for example, the honey bee and silkworm whose management is relatively simple and labor-intensive, until recently humans neither desired nor were able, because of a lack of basic knowledge as well as technology, to attempt large-scale modification of the environment of insects, either to increase the number of beneficial insects or to decrease the number of those designated as pests.

Several features of recent human evolution have made such attempts imperative. These include a massive increase in population, a trend toward urbanization, increased geographic movement of people and agricultural products, and, associated with the need to feed more people, a trend toward monoculture as an agricultural practice.

The relatively crowded conditions of urban areas enable insects parasitic on humans both to locate a host (frequently a prerequisite to reproduction) and to transfer between host individuals. Thus, urbanization facilitates the spread of insect-borne human diseases such as typhus, plague, and malaria whose spectacular effects on human population are well documented. For example, in the sixth century A.D. plague was responsible for the death of about 50% of the population in the Roman Empire, and "Black Death" killed a similar proportion of England's population in the mid-1300s (Southwood, 1977).

An increasing need to produce more and cheaper food led, through agricultural mechanization, to the practice of monoculture, the growing of a crop over the same large area of land for many years consecutively. However, two faults of monoculture are (1) the ecosystem is simplified and (2) as the crop plant is frequently graminaceous (a member of the grass family, including wheat, barley, oats, rice, and corn), the ecosystem is artificially maintained at an early stage of ecological succession. By simplifying the ecosystem, humans encourage the buildup of populations of the insects that compete with them for the food being grown. Further, as the competing insects are primary consumers, that is, near the start of the food chain, they typically have a high reproductive rate and short generation time. In other words, populations of such species have the potential to increase at a rapid rate.

A massive increase in human geographic movements and a concomitant increase in trade led to the transplantation of a number of species, both plant and animal, into areas previously unoccupied by them. Some of these were able to establish themselves and, in the absence of normal regulators of population (especially predators and parasitoids), increased rapidly in number and became important pests. Sometimes, as humans colonized new areas, some of the cultivated plants that were introduced proved to be an excellent food for species of insects endemic to these areas. For example, the Colorado beetle, *Leptinotarsa decemlineata*, was originally restricted to the southern Rocky Mountains and fed on wild Solanaceae. With the introduction of the potato by settlers, the beetle had an alternate, more easily accessible source of food, as a result of which both the abundance and distribution of the beetle increased and the species became an important pest. Likewise, the apple maggot, *Rhagoletis pomonella*, apparently fed on hawthorn until apples were introduced into the eastern United States (Horn, 1976).

2. Beneficial Insects

Insects may benefit humans in various ways, both directly and indirectly. The most obvious of the beneficial species are those whose products are commercially valuable. Considerably more important, however, are the insects that pollinate crop plants. Other