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Insect Biodiversity, Ecosystem Services and Sustainable Agriculture

NK Krishna Kumar
Bioversity International, NASC Complex, Pusa Campus, New Delhi–110012, India

The conflict for food between man and insects is as old as agriculture itself. Insects by far outnumber all other forms of animal life and they have been in existence for more than 400 million years in comparison to man who inhabited this planet just two-four million years ago. Hexapods are one of most resilient and successful having survived three mass extinction and witnessed the birth and death of dinosaurs. The diversity of insects can be gauged by the fact that there could be one billion insects per ha in a tropical forest and constitutes 55% of all animals by weight. They are found in deserts, mountain tops in evergreen forests and sea. They could be a mere 0.1mm or to 300 mm. While some are aquatic, other are terrestrial and often crop and tree dwelling. One of the unique features of insects is their reproductive potential. A queen termite can lay ~30000 eggs per day whereas, a human female in her lifetime can give birth to a maximum 25 children. Similarly, metamorphosis conferring several advantages to insects to tie over adverse ecological conditions have rendered insects by far to outnumber all other forms of life. Insects were the first to conquer air much before birds and mammals. The insect flight is a marvel of nature. They fly with four wings, unlike an aeroplane, which has two. While a horsefly can fly at 150 km/hour, a human being can maximum run 30 miles. The mastery of communication to find a potential mate or food or the presence of coordinated 1000 eyes have rendered them masters of evolution. The ability of insects to produce light is phenomenal as it is 99% energy efficient. The chemical ecology or communication through chemicals or social livings or chemical warfare or mimicry were mastered by arthropods 100s of millions of years ago. They were the one of first to use tools much before we started using sickle and hammer. They have migrated 1000 of miles to capture the entire world building termite mound or a tailored leaf or a honey coomb each an engineering marvel, surpassing the best architect. Insect societies still hold an example to the civilized world, the essence of living. They give us very useful products like silk and honey and regulate our pests and diseases. Unfortunately, less than 1% compete with us but we have misunderstood the entire group of insect we have branded as our enemies. As very few are crop pest and vector of animal diseases. Let's not forget that they are excellent biocontrol agents, essential for nutrient cycling, essential for pollination and agriculture, necessary for crop diversity, one of the important source of food web in food chain, provide silk and honey besides stabilizing the ecosystem.

Ecosystem services as a concept was ingrained in the thought process and wisdom but over years the complexity of this holistic science has not been effectively documented. Unlike physical sciences, this requires a different approach and statistical validation over long term. ES is critical and is receiving emphasis more due to impact of agrochemicals than otherwise. Besides pollination and biological control, the decomposition of the dead and dead material, recycling of the waste, maintaining an ecological balance at different trophic levels, maintaining soil health, pollination of crop wild species and weeds providing seeds and berries for birds is critical in supporting regulating different services. Thus, any disturbance to insect population will impact pest infestation, pollination, predation and decomposition which will impact a chain of communities and agroecosystem.

Insects form an important linkage in food chain. It is now recognized insects contribute to not only decomposition but by the regulating services suppress pathogens of both livestock and humans. They provide services by conversing organic waste into nutrition rich humus and larvae of these insects are rich animal feed for chicken, pig and animal culture. In fact, bees as pollinators personify panda or tiger in educating people to support conservation.

Often ecosystem services are weighed on a scale of economic benefits alone. While economic return is a prerequisite for policy makers to make an investment,

**Author for Correspondence: Email- k.kumar@cgiar.org*

it would be unfortunate if ecosystem services suffer purely due to lack of scientific and economic assessment. The recent outbreak of insect transmitted diseases such as dengue, chikungunya reflects a need for scientific assessment of both urban and rural ecosystems, factors influencing epidemiology, food chain and food web and above all crop diversity as male mosquitoes are exclusively plant feeders.

In recent years, the infestation of stem borers on mango, citrus, cashew, pomegranate, grapes, coffee etc. is on the increase. The same is true of shot hole borers (Scolytidae) which are emerging a serious threat on coffee, grapes, pomegranate and other forest crops. Our export of any commodity on wooden crates infested with these borers pose a challenge to our international trade. Besides, many of these pests are extremely difficult to manage. A close perusal indicates that one of the reasons for their outbreak is deforestation. Thus, sustainable. agriculture requires sustainable forest and not monoculture. Diversity is the essence of life.

Recently, the word *Soil Health* is often discussed. Soil health and soil health cards measuring just nutrient status are different. Arthropods measuring 0.2 to 10 cm inhabit soil and play a significant role in converting dry matter to humus. In fact, this is a prerequisite for microbes to enact their role. The greatest contribution to agricultural biotechnology *Bacillus thuringiensis* is a soil dwelling bacterium. There are a host of others that need to be discovered. The world is beginning to appreciate the role of entomopathogenic nematodes in soil and their importance in pest control. From grasshopper eggs to a million others, soil is the source of survival.

Let us remember the words of George Washington who said *Nothing in my opinion is as valuable to a country as the top six inches of soil.* Indirectly, he was talking of the ecosystem services of soil arthropods and others along with microorganisms that are critical to soil health. Many are microscopic but their role is invaluable. Only one when we appreciate their direct and indirect benefits to the ecosystem, when sustainability is given more or at least equal importance as productivity and profitability, sustainable agriculture is possible. It is not just a matter of proof of concept, as the concept itself is complex and multidimensional. It is a matter of integrating learning with knowledge and wisdom.

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