INTRODUCTION

Insect-Plant Relationships: the whole is more than the sum of its parts

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Aristotle, the father of biology, once wrote: 'the whole is more than the sum of its parts.' We, students of insect-plant relationships, fully agree with this dictum because when studying problems that involve the two different empires, plants and insects, one often detects perspectives which would remain imperceptible in studies restricted to either one of these two taxonomic units.

Green plants are the dominant life form on most parts of the continents. They form an immense cover of chlorophyl that can efficiently capture energy of the sun and give to the earth its thick green mantle, its oxygen, and its food. Truly, the green plant rules. All animals, including ourselves, live in this world as guests of green plants. A large part of them, that is 80% of all animal species, are insects. They surpass all other animals in numbers, in total biomass, and in distribution. They crawl and jump, fly and dig from pole to pole, from mountain to seashore. They consume every anatomical part of the plants, occupying every nook and cranny of their hosts. Therefore, their impact upon the floras of all continents is substantial. Natural vegetations loose 10% of their above-ground plant parts to insect damage. In addition, large amounts of plant saps are tapped by sucking insects, which absorb the energy-rich compounds contained in it. Thus, herbivorous insects are an ever-lasting and great burden to the plant world.

On the credit side, however, insects assist many plants in their reproduction. More than a hundred million years ago the plant kingdom discovered that insects could be employed as pollen carriers. Although at high latitudes wind pollination is a common phenomenon, it is much rarer in other parts of the world. Most plant species present in an abundant diversity in, for instance, the windless green cathedrals of a tropical rain forest, owe their existence to a partnership with pollinating insects.

Obviously insects would not exist were there no plants. Conversely, a plant world cleared of all insect life would be a dramatically impoverished one. Clearly insects and plants have, over the millennia, formed a biological partnership that has flourished to mutual benefit. The recognition of this successful partnership, together with the notion that plants and insects constitute the building blocks of most terrestrial habitats, forms the rationale for our research on their relationships.

In retrospect, it is curious that the analysis of insect–plant interactions, except for a few notable earlier studies, only started about 50 years ago. This late start may be explained by the fact that, for a long time, biologists worked within the bounds of one of the biological sub-disciplines that were sharply defined at the time, such as taxonomy, physiology, or genetics. The study of insect-plant relationships, however, crosses the boundaries of many of these traditional sub-disciplines. Its students have gained completely novel insights by pulling together findings obtained from different sub-disciplines. The ecological role of secondary compounds that appear as an unsurpassed richness in the plant kingdom was only understood when detailed studies of insect feeding behaviour showed a reciprocal richness of sensory systems in the insect world. Likewise, the effects of induced plant volatiles on natural enemies of a herbivore could only be discovered in painstaking studies that ignored the classical distinction between botany and zoology.

What feeds our desire to unravel the intimate and intricate relationships between insects and plants? Basic research on this topic is motivated by an insatiable curiosity about life, a curiosity common to all human beings. Knowledge leads to a deeper understanding of the laws of nature.

Unlike some other scientific areas, knowledge from our field of study holds keys to immediate material progress in applied science, such as agricultural production. The study of insect-plant relationships, once started by some curious biologists, has become a source of insights vital to an ever growing food production. Clearly, this branch of science helps man to successfully maintain the artificial balance in nature that is agriculture. In this context, however, it seems prudent to remind ourselves (or rather our financial backers) that the distinction between basic and applied research has become blurred or should even be considered fallacious terminology. Already Louis Pasteur put it clearly when saying: 'There is only one science, and the application of science, and these two activities are bound together as the fruit is to the tree.' Transgenic maize hybrids that express the *Bacillus thuringiensis* toxin to control the European corn borer could only be produced by combining

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fundamental knowledge of molecular biology and basic insights into insect pathology.

Nature conservation is another area that may profit from insights gained from studies of insect-plant relationships. Frighteningly high extinction rates of animal and plant species call for a deeper knowledge of the principles underlying healthy ecosystems. Only then, through good habitat management, may we slow down or even halt the current decimation of biodiversity. Biodiversity, not a luxurious plaything of biologists, is an essential prerequisite for avoiding the worst catastrophe ever to befall the human race.

A glance at the programme of the present meeting shows some clear differences with previous symposia in this series. The number of presentations on insect behaviour and sensory physiology has decreased, probably reflecting a worldwide trend on reduced research funds available to these research areas. This is to be regretted because the subtleties of an insect's behaviour, though more difficult to analyse than many a layman would think, hold the secrets of the prominent position insects take in the living world. More details about short- and long-term memory as found with induced preference and its neurophysiological background are waiting to be elucidated. One of the most striking characteristics of feeding behaviour is polyphagy as opposed to monophagy. Its neurophysiological basis is still a mystery.

Induced plant responses, not long ago considered by many to be a phenomenon too vague to be of any biological significance (not to mention those who denied its existence at all) is currently a flourishing line of scientific investigation. The attention now given to these responses, including their effects on higher trophic levels, is rightfully mirrored in a prominent place in this SIP-12 programme. No less than five out of 13 scientific sessions are devoted to plant responses to insect attack.

A novelty in the history of this symposium series is the fact that two sessions are devoted to the intimate partnerships between flowers and insects. I cannot resist thinking that this is not purely coincidence. I may recall the fact that here, in this very city of Spandau, more than 200 years ago a man, Konrad Sprengel, lived, worked and studied nature. Based on meticulous observations on many different flowers and their insect pollinators, he wrote a book entitled 'Das entdeckte Geheimniss der Natur im Bau und in der Befruchtung der Blumen' (The Secret of Nature revealed in the Structure and Fertilization of Flowers). The importance of this book for our understanding of nature is close to that of Darwin's 'The Origin of Species'. In this lavishly illustrated writing, Sprengel reveals details of the various features by which insects are duped into rendering a service to the plant, while at the same time its flowers offer suitable rewards. The attention given to pollination at the present meeting is a tribute to Konrad Sprengel, Karl von Frisch, and their eminent successors in this country. I do hope that pollination biology will obtain a permanent position in the future of this symposium series.

I may conclude with recounting a metaphor provided by Hermann Bondi[1] in which he pictures our scientific knowledge as an island, named *What We Know*. This island lies in the midst of a vast sea of the *Unknown*. Human beings, ever since their beginning, add, piece by piece, knowledge to the island. So, albeit slowly, the island of *What We Know* grows larger and larger. Sometimes a cliff crumbles back into the sea or a storm sweeps away parts of the newly added land. Despite such temporary regressions, the island does grow, unstoppably, through the centuries. And unless the *Unknown* is infinite, it surely must be shrinking. The continuous growth of *What We Know* has a strange consequence: its coastline, the line where we run up against the *Unknown*, grows longer and longer. The more we know, the more we realize what we don't know.

I am sure every one of us will add some grains to our own little island named: *What We Know About Insect–Plant Interactions* this week. In return, the organizers of this symposium offer us a long walk along its coastline and have the sea of the *Unknown* wet our feet and minds.

[1]Cited in K. Ferguson. Measuring the Universe. Headline, London (1999).