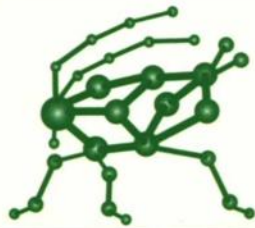


APHIDS IN A NEW MILLENNIUM



Editors

J.C. SIMON, C.A. DEDRYVER,
C. RISPE, M. HULLÉ

SCIENCE UPDATE



INRA
EDITIONS

APHIDS IN A NEW MILLENNIUM

Jean-Christophe Simon,
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Preface

This book contains the proceedings of the Sixth International Symposium on Aphids, held in September 2001 at Rennes, France. It contains four invited contributions and 75 peer-reviewed papers. Papers have been organised into five thematic chapters: Chapter 1, Aphid Biology and Ecology; Chapter 2, Taxonomy, Systematics and Faunistics; Chapter 3, Genetics, Population Biology and Evolutionary Biology; Chapter 4, Population Dynamics, Biological Control and Integrated Pest Management, and Chapter 5, Aphid-Plant Relationships. Within each chapter, papers have been classified by alphabetical order of the first author, except for invited contributions, which start the chapters.

"Aphids in a New Millennium" covers most aspects of aphid researches world-wide. As important crop pests, aphids (and the numerous viral diseases they transmit) still require a large effort in the development of efficient and environmentally friendly methods to control their populations. This book proposes new methods based on forecasting, decision making tools, but also on plant resistance and biological control. Because aphids are very sensitive to environmental modifications, their biodiversity and species composition would certainly be affected drastically in the context of global change. There is an increasing need in systematic and faunistic studies, such as those exposed in this book, to use aphid communities as indicator of short and long term anthropic effects. But what seems to be the next future of researches on aphids is their use as ideal model for studying many aspects of modern biology. During the last decade, aphid symbiosis has become one of the best known examples of mutualistic interactions in animals. Several papers of this book bring new insights into various facets of aphid symbiosis. It is very likely that other original features of aphids such as their reproductive mode, their polyphenism, their dispersal abilities will be used for integrated studies from the molecular and cellular bases of these traits to their ecological and evolutionary significance. Thus, it is probable that aphids will be considered by the scientific community more and more as model organisms. The next symposium which will be held in Perth, Australia, in 2005, will be a good opportunity to see whether this prediction is confirmed.

We are indebted to the scientific committee of the Rennes Aphid Symposium (Dr Shigeyuki Aoki, Dr Roger Blackman, Prof. Tony Dixon, Prof. Dinah Hales, Prof. Pavel Kindlmann, Prof. Juan Nieto Nafria, Dr Yvan Rahbé, Dr David Stern) and many anonymous referees who helped to select this collection of papers and to improve their quality and presentation.

This book is dedicated to Prof. François Leclant, who made an impressive contribution to aphid researches and who sadly died two years ago. Prof. Georges Remaudière, from the Museum d'Histoire Naturelle de Paris (France) kindly let us use his paper published in the *Annales de la Société Entomologique de France*, written *in memoriam* to F. Leclant.

We would also like to thank Institut National de la Recherche Agronomique, Pôle Agronomique de l'Ouest, Conseil Régional de Bretagne, Conseil Général d'Ille et Vilaine, Rennes Métropole, Aventis Crop Sciences and Bayer Agro for financial support. Anne-

Aphids in a New Millennium

Sophie Lecheminoux and Isabelle Sanoner are acknowledged for their involvement at different stages of preparation of this book.

The Editors

In Memoriam : Francois Leclant (1934-2001)*

REMAUDIÈRE GEORGES



A great French entomologist, Professor François Leclant has disappeared.

He was a third-year-student in the Ecole Nationale Supérieure d'Agriculture de Montpellier, when he was hired by the Institut National de la Recherche Agronomique (INRA) in February 1959, and appointed to the Laboratoire de Recherches de la Chaire de Zoologie of the Centre de Recherches Agronomiques du Midi, in Montpellier (France).

Under the influence of Professor Robert Delmas, François Leclant's research topics had then been focused on two major axes: (1) epidemiology of viral and mycoplasma diseases in the Mediterranean area, (2) the aphids and their natural enemies with an objective of integrated management in orchards.

Thus he has taken part in the study of about fifteen diseases of cultivated plants. He has notably demonstrated the vector role of a leafhopper in the case of "Lavander Withering", the vector role of a psyllid for "Carrot Proliferations", the role of several aphids responsible for "Plum pox" of fruit trees and the vector role of *Aphis craccivora* in the "Lucerne Enations disease". A wide interdisciplinary study on "Cucumber Mosaic" enabled to recommend

control methods consisting of environment management and fitting into a real ecological prevention.

His researches on aphids brought to the fore new pests in Europe such as the Cedar Aphid *Cinara laportei* coming from North Africa and the Clover Aphid *Nearctaphis bakeri* coming from North America. A better biological knowledge of the Green Peach Aphid *Myzus persicae* on peach tree enabled a drastic reduction of insecticide spray against this aphid in orchards. F. Leclant has actually discovered that previously recommended ovid treatments were in fact applied after egg hatching and brought on resistance to future treatments of this species.

Owing to his efficient involvement in concerted actions on biological control, F. Leclant has considerably contributed between 1965-1975 to the knowledge of aphids and of their enemies not only in cultivated areas but also in natural environment where secondary hosts can be found, and whose infestations have to be followed. The aphid fauna found in these areas favours the development of parasitoid and predator populations and of entomopathogenic fungi likely to have a beneficial effect in fields at some periods. In Morocco he discovered a new species of *Pauesia* (Hymenoptera: Aphidinae), a specific parasitoid of the aphid *Cinara laportei*. This species was then introduced in the south of France by scientist of the INRA Research Center of Antibes and acclimatized well.

Biogeographical researches on Mediterranean aphids, and more particularly Corsican ones, as well as researches on epidemiology and on transmission of some viroses had brilliantly been synthesized in F. Leclant's Thèse de Doctorat d'Etat in Montpellier on May 23th 1978. His Thesis report had been honoured by the Réaumur Prize of the French Society of Entomology.

F. Leclant's nomination in 1979 as "Professor of animal Ecology and agricultural Zoology" in the Ecole Nationale Supérieure Agronomique in Montpellier (ENSA-M, henceforth AGRO-M) and as Director of the associated Laboratoire de Recherches INRA has imprinted a deep evolution in his career. He focused his researches on faunistic and bio-ecological study of aphids in Palearctic and Ethiopian areas, while teaching and supervising of works carried out under his management supplanted his own activities. During this period he supervised a dozen of PhD thesis, most of them related to agricultural problems in developing countries of French-speaking Africa.

One of F. Leclant's constant concerns was the contribution to agricultural development. His constructive relations with the French Plant Protection Service, with technical institutes in agriculture, e.g. the Association de Coopération technique agricole, and with various producer organisations and chemical firms had greatly contributed to the recognition of Integrated Pest Management strategies which are nowadays put into practice by FARRE Group farmers in order to achieve respectful agriculture to environment.

The amount of his own publications, about 170 titles, is impressive; the large number of articles written with co-authors emphasized the trustful and cooperative relations he had with his colleagues. Fifteen of these publications deal with the original description of about twenty new aphid species, building then his international reputation in the sphere of aphid systematics. During the last years, F. Leclant has lent his support to collective works in which he has notably expounded the latest knowledge on cotton plant aphids and poplar tree aphids. Moreover, he has conceived original books which give identification keys of aphid species by types of crops. Those dichotomic keys rely on discriminating characteristics which can be

observed with a simple pocket magnifying glass (magnification 10) and are abundantly illustrated. Three of these planned books had been published, they deal with large crops, vegetable crops and fruit orchards; unfortunately the last two volumes respectively planned on aphids of ornamental plants and trees will not be published.

F. Leclant leaves a unique literature in France dealing with all the aspects of aphidology and an important aphid collection of about 11,000 samples among which some unknown species we had collected and kept in the sixties and we had planned to describe during his retirement. Actually, to me, F. Leclant has always been a partner and an extraordinary friend. I thought I knew him well: he had begun to study aphidology in my laboratory at the Institut Pasteur in Paris. After having spent two months investigating on his career, I discover with emotion the unsuspected scope of his activities, as well as new aspects of his attaching personality characterized by his receptiveness, his loyalty and his tireless dedication to missions he had chosen or accepted. One can wonder why his exemplary career had not been honoured with an official award. But then his modesty and his sobriety would probably have suffer.

* translated from *Ann. Soc. Entomol. Fr.* (N.S.), 2001, 37: 419-430.

CHAPTER 1

Aphid biology and ecology

Past and future of aphid biology (invited paper)

DIXON ANTHONY F.G.

Abstract

Aphids have, and continue to fascinate entomologists. There have been many great aphidologists who have not only given us a better understanding of aphids, but also of, behaviour, ecology, entomology and physiology. Much of what was achieved over the last 50 years was driven by what were then perceived as the important issues. Funding constraints will continue to operate in the future. It is now up to aphidologists to convince others that aphids are ideal models for studying and resolving the current issues in biology.

Introduction

The following is my personal view of the past and future of aphid biology. It has been shaped by the literature, the personal contacts I have had with other aphidologists and my own experiences of working with aphids for nearly 50 years. I shall not mention the present in any detail, not because it is unimportant but because I wish to avoid hurting others by omission or incorrect interpretation of their contributions.

As my expertise and interest was mainly in the field of population ecology I depended on others to identify the aphids I was interested in and enlighten me about their behaviour and physiology. These aspects will be dealt with below under the headings Taxonomy and Biology. Although at any one time a particular aspect of aphid biology is likely to be perceived as all important, such fashions should not be allowed to dominate or inhibit studies on other aspects of aphid biology. A multidisciplinary approach is essential if we are to understand aphids.

Taxonomy

Taxonomy is basic to biology because it is essential to be certain of the identification of the organism(s) one is working with. This is equally true whether we are studying an aphid's ecology or molecular biology. It is advantageous to know whether one is working with a distinct species or a species complex, and be able to define the taxa so that others can be sure they are working on the same species or can repeat the study. Therefore, it is very disturbing that there are currently very few young aphid taxonomists. In addition, Universities throughout the world, and especially in Europe and North America, no longer view entomology, and taxonomy in particular, as an important subject. The consequence of this is that there is likely to be even fewer taxonomists in the future. Thanks to taxonomists, past and living, we have a good knowledge of the aphid fauna and their host plants, especially in Europe. However, the aphid fauna of many parts of the world has been poorly researched, especially in the Southern Hemisphere.

Of the taxonomists I am indebted to Henry Stroyan for introducing me to aphid taxonomy. When I was still a postgraduate student he accepted me into his laboratory at Cambridge and instructed me in the art of mounting aphids on slides and in their identification. While still a postgraduate (1956) Dick Hille Ris Lambers wrote and asked me to obtain some living material of *Kakimia dasyphylli* from Kidlington churchyard, near Oxford. This aphid occurs in mountainous areas in Europe (Austria, Caucasus, Czech Republic, Spain and Switzerland) but in the lowlands in England. Dick wanted to see whether he could rear the English aphid on the host plants the species lives on in Europe, as he was interested in checking whether it belonged to the same species. He was successful and the specimens from Europe are now assigned to the species *dasyphylli*. This was the start of a long and close friendship that was sadly terminated by his death in 1984. He was my mentor and the person on whom I tried out my ideas. Having listened Dick would draw on his immense knowledge of aphids for exceptions to your generalisation. If one could account for these exceptions then Dick was prepared to accept the idea, which gave me greater confidence. Jaroslav Holman introduced me to aphids in the field, especially their host plant relationships. He also made his collections of aphids freely available to me, and guided my selection of material. Other taxonomists stimulated me mainly via their publications. Georgiy Shaposhnikov published many seminal papers on the taxonomy and biology of aphids. I very much regret that the plan to translate the manuscript of his book on aphids into English was never realised.

The taxonomist whose writings influenced me most was Fritz Müller. Unfortunately he died before I could arrange to visit him in what was then East Germany. He followed in the tradition of Carl Börner and kept large numbers of aphids in an insectary, following them through their seasonal cycle and over many years, transferring them between plant species and hybridising them. This revealed that several species are in fact species complexes. The two species complexes that he studied in considerable detail were *Aphis fabae* and *Acyrtosiphon pisum*. (Müller, 1962, 1971, 1980, 1982, 1985). Fritz Müller rarely attended meetings and his approach was not viewed favourably by Dick Hille Ris Lambers, who regarded Carl Börner and Fritz Müller as species "splitters". It is possible that this conflict over the definition of species was mainly a consequence of Dick's experiences at the hands of the Gestapo during the last war. It is likely that this experience clouded his judgement, especially in the years immediately following the war. Later he worked closely with H.