Preface

How does a caterpillar transform into a butterfly? That question, which sums up the wonder and mystery of insect metamorphosis, has built a timeless enigma, which has fascinated humans since the earliest times. Thanks to the systematic observations initiated in the Renaissance and followed during the Enlightenment, today we know the details of metamorphosis in numerous species of insects of the most diverse groups. Scientific research began in the 19th century and in the years since has taught us what are the main factors that regulate it, which turned out to be mainly hormonal. The most notable progress was made in the field of experimental physiology, in which the most important hormones, juvenile hormone and molting hormone, were discovered and their essential functions were revealed, and in the field of chemistry, with the structural elucidation of these hormones. The most important developments of the last quarter of the 20th century came from molecular scale studies, which unveiled the essential mechanisms underlying the molting hormone action.

Only those mechanisms underlying the action of the juvenile hormone, arguably the most important hormone in the regulation of insect metamorphosis, were still pending. These mechanisms, at least the most essential ones, have been reported in the 21st century. Their importance goes beyond their strictly biochemical and molecular interest, since they allow envisaging the regulatory aspects from an integral point of view, leading to the reconnaissance of general rules and to the analysis of the evolution of insect metamorphosis in a more robust way. These recent achievements suggest that it may be a good time to prepare a book like this. Certainly the issues that clearly need an update are those related to molecular regulation and the evolutionary aspects. However, this book aims to explain insect metamorphosis in a comprehensive way, from natural history to regulatory mechanisms and evolution. And it goes without saying that in all fields there have been important advances in recent years that this book also tries to cover.

As for acknowledgments, I have kept my research on insect metamorphosis active for more than 30 years thanks to the uninterrupted financial support of the Spanish Ministry of Education and Science (now Ministry of Economy and Competitiveness), the Catalan Government, and the European Fund for Economic and Regional Development.

The significant diversity of topics discussed has led me to ask for help from colleagues who critically read different parts of the manuscript of which they

were experts. The colleagues involved are Javier Alba-Tercedor (Chapter 4), Jordi Bernués and Montserrat Corominas (Chapter 8 focusing on DNA methylation and histone modifications), Malcolm Davies (classical Greece, in Chapter 1), Ryo Futahashi (Odonata, in Chapter 4), Miquel Gaju-Ricart (Chapter 3), Arturo Goldarazena (Thysanoptera, in Chapter 4), Klaus Hartfelder (Chapter 12), Marek Jindra (Chapter 7 focusing on the transduction of the juvenile hormone signal, Chapter 10, and Chapter 12), Jeyaraney Kathirithamby (Chapter 1 and Strepsiptera, in Chapter 5), Pierre Léopold (regulation of right allometric growth, in Chapter 9), Jesus Lozano (Chapter 2), Jose-Luis Maestro (Chapter 6 and Chapter 7 focusing on peptide hormones), Chieka Minakuchi (Chapter 10), Gerald B. Moritz (Thysanoptera, in Chapter 4), Michael O'Connor (the metamorphic molt, in Chapter 9), Genta Okude (Odonata, in Chapter 4), Subba Reddy Palli (Chapter 8 focusing on DNA methylation and histone modifications), John D. Pinto (hypermetamorphosis, in Chapter 5), Lynn M. Riddiford (Chapter 12), Carl Thummel (transduction of the 20-hydroxyecdysone signal, in Chapter 7), Jose Manuel Tierno de Figueroa (Plecoptera, in Chapter 4), Yoshinori Tomoyasu (the wings, a crucial innovation, in Chapter 2), James W. Truman (Chapter 12), Jozef Vanden Broeck (Chapter 6 and Chapter 7 focusing on peptide hormones), and Isabelle Vea (Coccomorpha, in Chapter 4).

Moreover, I have discussed the topics of the book with many people, especially with Maria-Dolors Piulachs and Jose-Luis Maestro, my closest colleagues in the Institute of Evolutionary Biology (CSIC-Pompeu Fabra University, Barcelona), and with Takaaki Daimon, from Kyoto University, who critically read the entire manuscript. I would also highlight the discussions about paleontology, a subject on which I have relied more heavily on expert opinion. Thus I thank Jarmila Kukalová-Peck for her hospitality and advice during the week I spent in Ottawa in 2017, especially examining the juvenile stages of fossil mayflies, and André Nel for the rich discussions on the paleontology of insect metamorphosis at the National Museum of Natural History in Paris.

Needless to say, the fact that all these colleagues helped me to improve the contents of the book does not mean that they necessarily share the ideas presented in it. In this context, the author is aware that he alone remains responsible the opinions expressed in the book and for any imperfections that may have remained. Finally, the author would like to acknowledge the assistance of the Elsevier's team, mainly Pat Gonzalez, Anna Valutkevich, Narmatha Mohan and Punitha Govindaradjane, who has efficiently solved the logistics and technical issues involved in the preparation of the book.

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