

Egg Parasitoids in Agroecosystems with Emphasis
on *Trichogramma*

Progress in Biological Control

Volume 9

Published:

Volume 1

H.M.T. Hokkanen and A.E. Hajek (eds.):

Environmental Impacts of Microbial Insecticides – Need and Methods for Risk

Assessment. 2004

ISBN 978-1-4020-0813-9

Volume 2

J. Eilenberg and H.M.T. Hokkanen (eds.):

An Ecological and Societal Approach to Biological Control. 2007

ISBN 978-1-4020-4320-8

Volume 3

J. Brodeur and G. Boivin (eds.):

Trophic and Guild Interactions in Biological Control. 2006

ISBN 978-1-4020-4766-4

Volume 4

J. Gould, K. Hoelmer and J. Goolsby (eds.):

Classical Biological Control of *Bemisia tabaci* in the United States. 2008

ISBN 978-1-4020-6739-6

Volume 5

J. Romeis, A.M. Shelton and G. Kennedy (eds.):

Integration of Insect-Resistant Genetically Modified Crops within IPM Programs.

2008

HB ISBN 978-1-4020-8372-3; PB ISBN 978-1-4020-8459-1

Volume 6

A.E. Hajek, T.R. Glare and M. O'Callaghan (eds.):

Use of Microbes for Control and Eradication of Invasive Arthropods. 2008

ISBN: 978-1-4020-8559-8

Volume 7

H.M.T. Hokkanen (ed.):

Relationships of Natural Enemies and Non-Prey Foods. 2008

ISBN: 978-1-4020-9234-3

Volume 8

S.S. Gnanamanickam:

Biological Control of Rice Diseases

ISBN: 978-90-481-2464-0

For further volumes:

<http://www.springer.com/series/6417>

Fernando L. Côtoli · José R.P. Parra ·
Roberto A. Zucchi
Editors

Egg Parasitoids
in Agroecosystems
with Emphasis
on *Trichogramma*

 Springer

Editors

Dr. Fernando L. Cônsoli
Universidade de São Paulo
ESALQ
Departamento de Entomologia
e Acarologia
Avenida Pádua Dias 11
13418-900, Piracicaba, São Paulo
Brazil
fconsoli@esalq.usp.br

Dr. José R.P. Parra
Universidade de São Paulo
ESALQ
Departamento de Entomologia
e Acarologia
Avenida Pádua Dias 11
13418-900, Piracicaba, São Paulo
Brazil
jrpparra@esalq.usp.br

Dr. Roberto A. Zucchi
Universidade de São Paulo
ESALQ
Departamento de Entomologia
e Acarologia
Avenida Pádua Dias 11
13418-900, Piracicaba, São Paulo
Brazil
razucchi@esalq.usp.br

ISBN 978-1-4020-9109-4

e-ISBN 978-1-4020-9110-0

DOI 10.1007/978-1-4020-9110-0

Springer Dordrecht Heidelberg London New York

Library of Congress Control Number: 2010935670

© Springer Science+Business Media B.V. 2010

No part of this work may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, microfilming, recording or otherwise, without written permission from the Publisher, with the exception of any material supplied specifically for the purpose of being entered and executed on a computer system, for exclusive use by the purchaser of the work.

Cover pictures: Pictures on the cover are credited to BSc Heraldo Negri de Oliveira (ESALQ/USP – Departamento de Entomologia e Acarologia, Piracicaba, Brazil)

Printed on acid-free paper

Springer is part of Springer Science+Business Media (www.springer.com)

Contents

1	Reproduction and Immature Development of Egg Parasitoids . . .	1
	Guy Boivin	
2	Nutritional Ecology of Insect Egg Parasitoids	25
	S. Bradleigh Vinson	
3	Antennal Structures Used in Communication by Egg Parasitoids .	57
	Roberto Romani, Nunzio Isidoro, and Ferdinando Bin	
4	Host Searching by Egg Parasitoids: Exploitation of Host Chemical Cues	97
	Stefano Colazza, Ezio Peri, Gianandrea Salerno, and Eric Conti	
5	Genetics of the Behavioral Ecology of Egg Parasitoids	149
	Eric Wajnberg	
6	Sex Ratio Modulators of Egg Parasitoids	167
	James E. Russell and Richard Stouthamer	
7	Systematics of the Trichogrammatidae (Hymenoptera: Chalcidoidea) with a Focus on the Genera Attacking Lepidoptera .	191
	Ranyse B. Querino, Roberto A. Zucchi, and John D. Pinto	
8	Diversity and Hosts of <i>Trichogramma</i> in the New World, with Emphasis in South America	219
	Roberto A. Zucchi, Ranyse B. Querino, and Renata C. Monteiro	
9	Species Diversity and Host Associations of <i>Trichogramma</i> in Eurasia	237
	Andrew Polaszek	
10	Mass Rearing of Egg Parasitoids for Biological Control Programs .	267
	José Roberto Postali Parra	
11	In Vitro Rearing of Egg Parasitoids	293
	Fernando L. Cônsoli and Simon Grenier	
12	Quality Control of Mass Reared Egg Parasitoids	315
	Joop C. van Lenteren and Franz Bigler	

13	Biological Control with Egg Parasitoids other than <i>Trichogramma</i> – the Citrus and Grape Cases	341
	Jorge E. Peña, Josep A. Jacas, Serguei Triapitsyn, Bryan J. Ulmer, and R.E. Duncan	
14	Egg Parasitoids Commercialization in the New World	373
	José Roberto Postali Parra	
15	Egg Parasitoids in Biological Control and Integrated Pest Management	389
	Nick Mills	
16	Risk Assessment and Non-target Effects of Egg Parasitoids in Biological Control	413
	Franz Bigler, Dirk Babendreier, and Joop C. van Lenteren	
17	Genetically Modified Crops and Biological Control with Egg Parasitoids	443
	Julio S. Bernal	
	Subject Index	467
	Natural Enemy Species Index	473

Contributors

Dirk Babendreier CABI Europe, Rue des Grillons 1, 2800 Delémont, Switzerland, d.babendreier@cabi.org

Julio S Bernal Department of Entomology, Texas A&M University, College Station, TX 77843-2475, USA, juliobernal@tamu.edu

Franz Bigler Agroscope Reckenholz-Taenikon Research Station ART, Reckenholzstr. 191, 8046 Zurich, Switzerland, franz.bigler@art.admin.ch

Ferdinando Bin Department of Scienze Agrarie e Ambientali, Faculty of Agriculture, University of Perugia, Borgo XX Giugno 74, 06121, Perugia, Italy, fbin@unipg.it

Guy Boivin Centre de Recherche et de Développement, Agriculture et Agroalimentaire Canada, 430 Boul. Gouin, St-Jean-sur-Richelieu, QC, Canada J3B 3E6, boiving@agr.gc.ca

Stefano Colazza Department of S.En.Fi.Mi.Zo., Section of Acarology, Entomology and Zoology, University of Palermo, Viale delle Scienze 13, 90128, Palermo, Italy, colazza@unipa.it

Fernando L. Cônsoli Laboratório de Interações em Insetos, Departamento de Entomologia e Acarologia, ESALQ/USP, Av. Pádua Dias 11, 13418-900, Piracicaba, São Paulo, Brazil, fconsoli@esalq.usp.br

Eric Conti Department of Scienze Agrarie e Ambientali, Faculty of Agriculture, University of Perugia, Borgo XX Giugno 74, 06121, Perugia, Italy, econti@unipg.it

R.E. Duncan Department of Entomology and Nematology, Tropical Research and Education Center, University of Florida, Homestead, FL 33031, USA, red@ifas.ufl.edu

Simon Grenier UMR INRA/INSA, Biologie Fonctionnelle Insectes et Interactions, Villeurbanne, France, simon-grenier@orange.fr

Nunzio Isidoro Faculty of Agriculture, Department of Scienze Ambientali e delle Produzioni Vegetali, Politechnic University of Marche, Via Brece Bianche, 60131, Ancona, Italy, n.isidoro@univpm.it

Josep A. Jacas Departament de Ciències Agràries i del Medi Natural, Universitat Jaume I, E-12071 Castello de la Plana, Spain, jacas@camn.uji.es

Joop C. van Lenteren Laboratory of Entomology, Wageningen University, PO Box 8031, 6700EH Wageningen, The Netherlands, Joop.vanLenteren@wur.nl

Nick Mills Department of Environmental Science, Policy and Management, University of California, Berkeley, CA 94720-3114, USA, nmills@berkeley.edu

Renata C. Monteiro Departamento Entomologia e Acarologia, ESALQ/USP, Av. Padua Dias 11, 13418-900 Piracicaba, São Paulo, Brazil, renatathrips@yahoo.com

José Roberto Postali Parra Departamento de Entomologia e Acarologia, ESALQ/USP, Av. Pádua Dias 11, 13418-900 Piracicaba, São Paulo, Brazil, jrpparra@esalq.usp.br

Jorge E. Peña Department of Entomology and Nematology, Tropical Research and Education Center, University of Florida, Homestead, FL 33031, USA, jepe@ifas.ufl.edu

Ezio Peri Department of S.En.Fi.Mi.Zo., section of Acarology, Entomology and Zoology, University of Palermo, Viale delle Scienze 13, 90128, Palermo, Italy

John D. Pinto Department of Entomology, University of California, Riverside, CA 92521, USA, jpinto@ucr.edu

Andrew Polaszek Natural History Museum, London, UK, ap@nhm.ac.uk

Ranyse B. Querino Embrapa Meio-Norte, Av. Duque de Caxias 5650, 64006-220 Teresina, Piauí, Brazil, ranyse@cpamn.embrapa.br

Roberto Romani Department of Scienze Agrarie e Ambientali, Faculty of Agriculture, University of Perugia, Borgo XX Giugno 74, 06121, Perugia, Italy, rromani@unipg.it

James E. Russell Department of Biology, University of California, Riverside, CA 92521, USA, jeruss002@gmail.com

Gianandrea Salerno Department of Scienze Agrarie e Ambientali, Faculty of Agriculture, University of Perugia, Borgo XX Giugno 74, 06121, Perugia, Italy, Salerno@unipg.it

Richard Stouthamer Department of Biology, University of California, Riverside, CA 92521, USA, richard.stouthamer@ucr.edu

Serguei Triapitsyn Department of Entomology, University of California, Riverside, CA 92521, USA, serguei.triapitsyn@ucr.edu

Bryan J. Ulmer Department of Entomology and Nematology, Tropical Research and Education Center, University of Florida, Homestead, FL 33031, USA

S. Bradleigh Vinson Texas A&M University, College Station, TX 77843-2475, USA, bvinson@tamu.edu

Eric Wajnberg INRA – 400, Route des Chappes, BP 167 – 06903, Sophia Antipolis, Cedex, France, wajnberg@sophia.inra.fr

Roberto A. Zucchi Departamento Entomologia e Acarologia, ESALQ/USP, Av. Pádua Dias 11, 13418-900 Piracicaba, São Paulo, Brazil, razucchi@esalq.usp.br