Artificial Rearing of Reduviid Predators for Pest Management

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Preface

The Reduviidae are members of the suborder Heteroptera of the order Hemiptera. Reduviids (Insecta, Hemiptera, Reduviidae) are general, polyphagous predatory insect and cosmopolitan biocontrol agent worldwide. The family are almost all predatory, except for a minority that are blood-sucking species of importance as disease vectors. About 7,000 species have been described, making it one of the largest families in the Hemiptera. They dwelled in all plantation crops including forest and social forest. Reduviids are efficient predators on insect pests of crops, playing a significant role in keeping pest populations in check. Some important biological control agents are *Platymeris laevicollis* Distant, *Zelus renardii* Kolenati, *Rhynocoris marginatus* (Fab.), *Rhynocoris kumarii* Ambrose and Livingstone, *Rhynocoris fuscipes* (Fab.), *Pristhesancus plagipennis* Walker, *Blaptostethus pallescens* Poppius, *Acanthaspis pedestris* (Stål), *Catamiarus brevipennis* (Serville), *Ectomocoris tibialis* (Distant), etc. But, why culture reduviid predators? For biocontrol agent, does the instinctive answer—high growth and multiplication rate, short life spans, and good bioefficacy after rearing with artificial diet—make these predators ideal candidates for commercial production in agriculture since they have the potential to rapidly reach farmers very easily?

This reliance points to the need to better understanding how and why artificial diet work and how and why they fail. In more than 25 years of research in reduviid predators, I have found that artificial diet for reduviid predator rearing makes up one of the most complex unexplored areas of research and need of the hours. Hence, this book is written to help explain these complexities and dynamics. Reduviid predator rearing for bio-intensive integrative pest management (BIPM) remains a sector in its infancy, and key future challenges will likely emerge as the field evolves. As such, readers are encouraged to contact the authors with feedback on this book. Such contributions will undoubtedly assist the future development of the proposed topic.

This 180-page volume book *Artificial Rearing of Reduviid Predators* is a book about artificial insect diet. The book consists of 29 tables, 14 figures, and 9 color plates in 7 chapters. The distribution and diversity of reduviids in different crops are provided in the first chapter with citations. How the predators were reared under laboratory for augmentative release program, constrains and how to ratify the same was provided in the first chapter. The note of needs and benefits of artificial rearing was given at the end of the chapter. Compositions of ingredients, developmental protocol, storage methods, feeding arena, artificial diet feeding acts, and biocontrol

efficiency after feeding the reduviids with artificial diet were highlighted in the second chapter. The importance of minerals, Cl^- ions, vitamins, and antimicrobial agents in artificial diet is discussed.

Of increased interest was Chap. 3, which expands on the biology of reduviids with artificial diet alone and/or along with laboratory host *Corcyra cephalonica* larvae and also provision of water. Later, it was assessed how the artificial diet alters the gut-microbial population, their hydrolytic enzyme production, macromolecular composition (carbohydrate, protein, and lipid contents), total body protein content, and its polypeptide profiles; gut content analyses with protein markers, DNA primers, and antigen–antibody interaction were studied to know how artificial diet modulates the physiology of the reduviids. In the last chapter of the book, artificially reared reduviid was released argumentatively in groundnut field, and its impact on pestiferous insects and other natural enemies of groundnut fields and also production of the oilseed, the groundnut, was recorded. These chapters, which discuss reduviid rearing, are an essential read for undergraduates and postgraduate students, technicians, amateur aquarists, researchers attempting to rear reduviids rearing with artificial diet, researchers attempting to improve mass multiplication and reduce production costs, and those in biocontrol industry looking to upscale reduviid mass production and supply to the farmers.

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India

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About the Authors

Dr. K. Sahayaraj is an associate professor of the Department of Zoology and the director of the Crop Protection Research Centre, St. Xavier's College, Palayamkottai, affiliated to Manonmaniam Sundaranar University, Tirunelveli. He is a recognized fellow of six national societies/academic bodies. Dr. Sahayaraj has published six books and one proceeding on *Ecofriendly Insect Pest Management*. He has more than 200 publications to his credit, including original research papers, book chapters, and popular articles in insect ecology, behavior, biology, and physiology, as well as numerous papers on the biological control efficacy of reduviids, botanicals, fungal pathogens, and bionanoparticles. He has been honored with several awards from regional (Best Researcher in Science, St. Xavier's College), national (Scientists of the Year, 2008, NESA, New Delhi; Young Achievers Award, 2010, by SADHNA, Solan; Bharat Seva Ratan Gold Medal Award, 2014, by GEPRA, New Delhi; Bharat Seven Rethan Gold Medal by GEPBRA, New Delhi), and international agencies (Hyoshi Environmentalist Award, Japan; YOUNG IOBC travel grant awardee).

He has guided more than 19 Ph.D. scholars and supervised two researchers. He has consistently worked to transfer laboratory findings to neighborhood farmers and to offer them guidance on BIPM. To this end, he has brought out five manuals/books in Tamil. Most recently, he has been engaged in publishing an international journal, the *Journal of Biopesticides*.

Dr. R. Balasubramanian received his bachelor's and postgraduate degrees in zoology from Madurai Kamaraj University, India, in 2000 and 2003, respectively. His research career began in year 2004 at the Fisheries College and Research Institute, Thoothukudi, Tamil Nadu, as a technical assistant, where he carried out research in shrimp culture with different diets. In 2005, Dr. Balasubramanian went on to pursue his Ph.D. at St. Xavier's College, Palayamkottai (Manonmaniam Sundaranar University), on the synthesis of artificial diet for mass production of hemipteran predators. Here, he learned about agricultural entomology, especially biological control, the bioecology of insects, advanced technologies in modern biological science, and the artificial rearing of predator insects. He has published a number of research papers on biocontrol, bioecology of insects, and oligidic diet preparation for reduviid mass production. In March 2009, Dr. Balasubramanian

joined the Department of Medical Entomology and Zoology, National Institute of Virology, Pune, where he began conducting research on medical entomology. More recently, he has served as a scientist at a national institute in Kerala field unit, Alappuzha, Kerala.

Abbreviations

AD	Artificial diet
AMG	Anterior midgut
API	Access proportion index
AT	Approaching time
BIPM	Bio-intensive integrative pest management
CBB	Coomassie Brilliant Blue
CBR	Cost benefit ratio
CC	*Corcyra cephalonica*
CFU	Colony-forming unit
CH	*Chrotogonus* sp.
CT	Consumption time
DC	Digestible carbohydrates
DD	Degree days
DGGE	Denaturing gradient gel electrophoresis
DP	Dietary protein
ELISA	Enzyme-linked immunosorbent assay
EOD	Extraoral digestion
EV	*Earias vitella*
FPI	Food preference index
HMP	Total heterotrophic bacterial population
hrs	Hours
HT	Handling time
IAA	Isoamyl alcohol
IPM	Integrated pest management
IRS	Insect ringer's solution
LPS	Lipopolysaccharide
MAb	Monoclonal antibody
MD	Meridic diet
mg	Microgram
min	Minutes
ml	Microliter
NA	Nutrient agar
NEL	Number of eggs laid
NES	Number of egg batches

NNH	Number of nymphs hatched
NRR	Net reproductive rate
NS	Not significant
OD	Oligidic diets (AD, artificial diet)
OO	*Odontotermes obesus*
OVI	Oviposition
PCR	Polymerase chain reaction
PMG	Posterior midgut
PMv	Perimicrovillar membrane
PO	Phenol oxidase
POVI	Post-oviposition periods
PRE	Preoviposition
rc	Capacity for natural increase
RFLP	Restriction fragment length polymorphism
RH	Relative humidity
RT-PCR	Real-time polymerase chain reaction
SGC	Salivary gland complex
SL	*Spodoptera litura*
T	Generation time
TAG	Triacylglycerol
Tc	Mean length of generation
TSA	Trypticase soy agar
US$	US dollar
μm	Micrometer