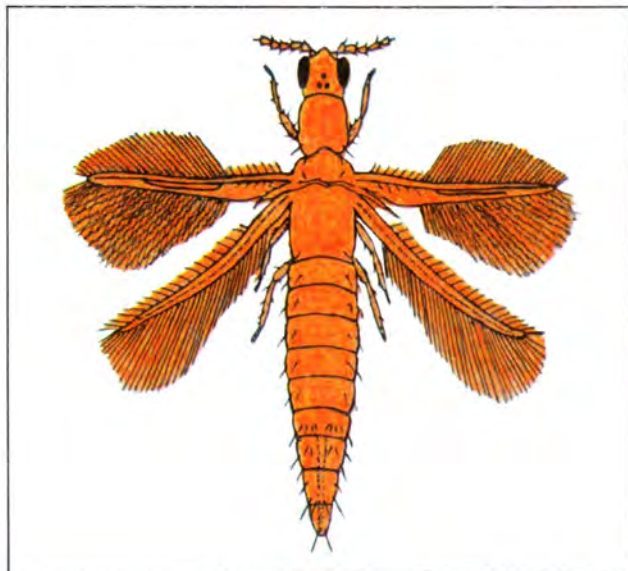
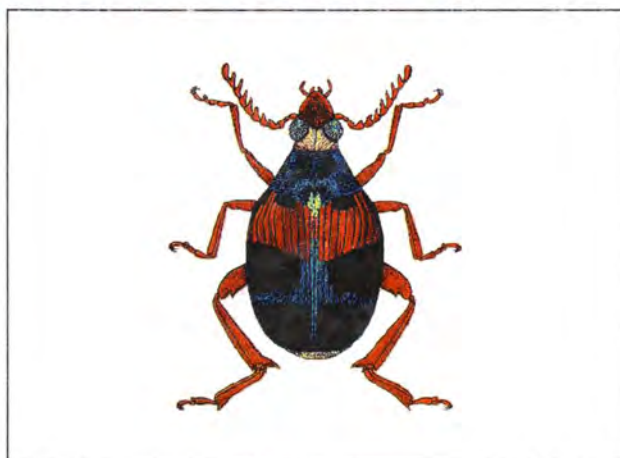


BIOLOGY AND MANAGEMENT OF STORED PRODUCT AND POSTHARVEST INSECT PESTS



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Romeo S. Rejesus



Biology and Management of Stored Product and Postharvest Insect Pests

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FOREWORD

This book fits into the needs of the developing world, especially the Southeast Asian nations, as well as other nations in the tropics.

Authors Dr. Belen Morallo-Rejesus, PCARRD Pantas Awardee, and Dr. Romeo S. Rejesus, both UPLB Professors, have come forth to address the need for food security in the way of protecting crops and the commodities in store.

We believe that if only losses in stored products were prevented, a large number of people in the ASEAN (Philippines, Cambodia, Laos, Malaysia, Indonesia, Myanmar, Brunei Darusalam, Thailand, Singapore and Vietnam) could have been adequately supplied with food.

Biology and Management of Stored Product and Postharvest Insect Pests focuses on stored products and put together under one cover the results, technologies, and management schemes obtained from and applicable in the ASEAN. However, other tropical countries also stand to benefit from this book in as much as the results and technologies were developed in a tropical setting.

With the senior author, being a leader in the research on storage entomology, this book likewise sets the trend in the development and application of technologies in this area. The junior author, at one time the only Filipino specialist in fruitflies, shares his experience in the area of postharvest (perishable commodities), pest management and quarantine disinfestation treatments.

The growing trend in the use of physical and botanical pesticide treatments of stored products as alternatives to chemical pesticides is demonstrated. As a consequence, the framework for environment-friendly technologies is reinforced.

While this book offers a lot of information on chemical control, it also provides vital knowledge on organic and physical methods of farming and protecting products in store.

It has been one of the visions of the Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD) that food supply is adequate and that the environment is healthful. One of its strategies is to encourage institutions and individuals to contribute towards these endeavors through awards and bookwriting grants.



PATRICIO S. FAYLON
Executive Director, PCARRD

PREFACE

This book was conceived out of deep concern for the tremendous losses of harvested products which could have prevented massive malnutrition, starvation and food shortages in the world especially in the so-called “developing countries”. With rapid human population increase food production hardly cope with the increasing number of mouths to feed and is aggravated by the dwindling arable and productive agricultural lands due to the escalating demand for shelter. Farmers are unable to extend storage life of their produce and to prolong the availability of food or to wait for a better price due to the paucity of appropriate and practical postharvest technologies and facilities.

The success of the “Green Revolution” of the 1960’s compounded the need for postharvest technologies to conserve the critical mass of products in order to reach the millions of mouths to feed in the developing countries. Food production is further aggravated by the changing climatic conditions and inefficient distribution systems. Increase food and feed production is inadequately addressed by progress in yield enhancing technologies, i.e. high yielding varieties, better pest management, proper fertilization, etc.

Increasing yield alone does not guarantee food security. Indeed few will be fed no matter how high food production is if only to be lost to postharvest pests. To alleviate losses due to pests, concerted efforts through international cooperative programs were initiated during the last decades targeting the food-deficient third world where shortage is more acute. In the Philippines and elsewhere in Southeast Asia this program reduced postharvest losses for cereals by about 10%. The equivalent food volume of food saved is sufficient to feed millions of starving and malnourished children.

After extensive experience in research, teaching and practice in postharvest entomology we realized the need for a comprehensive reference book. Many works to alleviate or reduce insect pest damage, prolong storage not only to conserve food/feed resource but also achieve international quarantine requirements have been undertaken and published. These information are scattered and often not available to post-production pest researchers, practitioners and ready reference for students. We anticipate that this book could serve as a viable information source to elicit awareness of the magnitude of post-production losses in the developing countries and stimulate the development of in-country insect pest management system for postharvest commodities. Pests other than insects were not covered only to emphasize that among others insect pests are considered to be the major cause of damage and quality deterioration.

It is hoped that this book will guide students, researchers, postharvest pest managers, food/feed processors and farmers in the management of postharvest pests. We endeavored to present the subject matter as simple and as comprehensive as possible for the appropriate clientele.

ACRONYMS

- ACIAR** – Australian Centre for International Agricultural Research, Canberra, AUSTRALIA
- AFHB** – ASEAN Food Handling Bureau, Kuala Lumpur, MALAYSIA
- ASEAN** – Association of Southeast Asian Nations (member countries include: BRUNEI DARUSSALAM, CAMBODIA, INDONESIA, LAOS, MALAYSIA, MYANMAR, PHILIPPINES, SINGAPORE, THAILAND and VIETNAM (in the text ASEAN refers to these countries).
- ASPAC** – Asia Pacific Region
- BCPC** – British Crop Protection Council, London, UNITED KINGDOM
- BIOTROP** - SEAMEO Regional Center for Tropical Biology, Bogor, INDONESIA
- BPRE** – Bureau of Postharvest Research and Extension (formerly NAPHIRE), Muñoz, Nueva Ecija, PHILIPPINES
- BSU** - Benguet State University (formerly MSAC), Benguet, PHILIPPINES
- BULOG** – Badan Urusan Logistik (the National Grains Logistic Agency), INDONESIA
- CABI** – Centre for Agriculture and Biosciences International, Wallingford, UNITED KINGDOM
- CSIRO** – Commonwealth Scientific and Industrial Research Organization, Canberra, AUSTRALIA
- DA** – Department of Agriculture, Quezon City, PHILIPPINES
- DEGESCH** – Deutsche Gesellschaft für Schädlingsbekämpfung mbH Frankfurt/M
- DOST** - Department of Science and Technology, Manila, PHILIPPINES
- FAO** – Food and Agriculture Organization of the United Nations, Rome, ITALY
- FPA** – Fertilizer and Pesticide Authority, Quezon City, PHILIPPINES
- GASGA** – Group for Assistance on Systems relating to Grains After Harvest (comprise of 8 organizations which includes: CSIRO, FAO, GTZ, IDRC, IRAT, KIT, KSU, and TDRI)
- GTZ** – Deutsche Gesellschaft für Technische Zusammenarbeit, Eschborn, GERMANY
- IDRC** - International Development Research Centre, Ottawa, CANADA
- IRAT** - Institut de Reserches Agronomiques Tropicales et des Cultures Vivrieres, Paris, FRANCE
- IRRI** – International Rice Research Institute, Los Baños; Laguna, PHILIPPINES
- JIRCAS** – Japan International Center for Agricultural Sciences, Ministry of Agriculture, Forestry and Fisheries, JAPAN
- KIT**- Koninklijk Instituut voor de Tropen, Amsterdam, THE NETHERLANDS
- MARDI** – Malaysian Agricultural Institute, Selangor, MALAYSIA
- MSAC** - Mountain State Agricultural College, Benguet, PHILIPPINES
- NAPHIRE** – National Postharvest Institute for Research and Extension, Muñoz, Nueva Ecija, PHILIPPINES
- NFA** – National Food Authority, Quezon City, PHILIPPINES
- NRI** – National Resources Institute, Chatham, UNITED KINGDOM
- ODA** – Overseas Development Agency, Chatham, UNITED KINGDOM
- PCARRD** - Philippine Council for Agriculture, Forestry and Natural Resources Research Los Baños, Laguna, PHILIPPINES.
- PhilRICE** – Philippine Rice Research Institute, Maligaya, Nueva Ecija, PHILIPPINES
- PMCP** – Pest Management Council of the Philippines
- QDPI** – Queensland Department of Primary Industries, Brisbane, AUSTRALIA
- SEAMEO** - Southeast Asian Ministers of Education Organization, SEARCA, College, Laguna, PHILIPPINES
- SEARCA** – Southeast Asian Regional Center for Graduate Study and Research in Agriculture, College, Laguna, PHILIPPINES
- TDRI** - Tropical Development and Research Institute, London, UNITED KINGDOM
- UPLB** – University of the Philippines at Los Baños, College, Laguna, PHILIPPINES
- USDA-ARS** - United States Department of Agriculture-Agricultural Research Service
- US-FDA** - United States-Food and Drug Administration, Washington, D.C. UNITED STATES OF AMERICA
- VISCA** - Visayas State College of Agriculture, Baybay, Leyte, PHILIPPINES

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To our children, Roderick and Robel Francis, who inspired us to produce this reference book for our people particularly the researchers, food producers and handlers.

* The PANTAS award is a recognition for the individual achievers, represented in two categories: the scientist and the research administrator. PANTAS means "sage", a "wiseman", or an "intellectual." The management of science and the pursuit of research undertaking require intelligence, knowledge and gut feeling. These also need foresight, insight, and hindsight - all of which spell wisdom.

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ABBREVIATIONS

< - less than	l - liter
> - greater than	L - light numbers (20-50 insects/90 kg)
acetyl coA - acetyl coenzyme A	lar - larva, pl.larvae
AchE - acetylchoilinesterase	LD ₅₀ - 50 percent lethal dose
ATP - adenosine triphosphate	LGB - larger grain borer
BPU - benzoyl phenyl urea	LN - light numbers (20-50 insects/90 kg)
bw - body weight	MC - moisture content
C - clear	Med - Mediterranean
CA - controlled atmosphere	MFO - microsomal oxidase system
CH ₃ Br- methyl bromide	mg - milligram
CHE - cholinesterase enzyme	min - minutes
CHI - methyl iodide	MN - moderate numbers (50-300 insects/90 kg)
CHIs - chitin synthesis inhibitors	MRL - maximum residue limits
Cl - chlorine	MW - molecular weight
CLM - chlorpyrifos methyl	N ₂ - nitrogen gas
CO ₂ - carbon dioxide	NKE - neem kernel extract
Codex - Codex Alimentarius Commission	NKP - neem kernel powder
COS- carbonyl sulfide	NO - neem oil
CR - cross resistance	NPV - nuclear polyhydrosis virus
Cs- cesium	O ₂ - oxygen gas
CS ₂ - carbon disulfide	°C - degrees centigrade
CT - concentration x time	OP - organophosphates
d - day	OS - <i>Oryzaephilus surinamensis</i>
DE - diatomaceous earth	oz - ounce
DNA -deoxyribonucleic acid	PH ₃ - phosphine
EC - emulsifiable concentrate	PM - pirimiphos methyl
EDB - ethylene dibromide	ppm - parts per million
ETL - economic threshold level	PT - <i>Prostephanus truncatus</i>
F- few	PTM - potato tuber moth
FF - fruit flies	PVC - polyvinyl chloride
Fl - fiducial limits	R - resistance
ft- foot, pl. feet	RAPD-PCR - randomly amplified polymorphic DNA
GABA- gamma amino butyric acid	RD - <i>Rhyzopertha dominica</i>
h - hour	rh - relative humidity
H ₂ O - water	SF - sulfuryl flouride
HAT - hot air treatment	SIT- sterile insect technique
HCN- hydrogen cyanide	SPP - stored product pests
HN - high numbers (300-1500 insects/90 kg)	SZ - <i>Sitophilus zeamais</i>
HWT - hot water treatment	TC - <i>Tribolium castaneum</i>
IGRs - insect growth regulators	TCl - tetrachlovinphos
IPM - Integrated Pest Management	VH- very high numbers (1500 insects/90 kg)
JHs - juvenile hormones	VHT- vapor heat treatment
JFPR - joint FAO/WHO Meeting of Experts on pesti- cide residue	VL- very light (<20 insects/90 kg)
kg - kilogram	VLN - very large numbers
kGy- kilogray, 1 Gray = 100 rads	WP- wettable powder