

**EVALUATION OF INTRODUCED PARASITOIDS AGAINST *BACTROCERA*
INVADENS AND THEIR INTERACTION WITH INDIGENOUS NATURAL ENEMIES**

BY

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(M.Phil. Entomology)

This thesis is submitted to the University of Ghana, Legon in partial fulfillment of
the requirement for the award of the PhD Crop Science degree.

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DECLARATION

The work presented in this thesis is a result of my own research and has not been presented for the award of a degree in any other university

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DEDICATION

This thesis is dedicated to my dear parents,
Mr. Ernest Felix Appiah Snr and Miss Mary Buadu-Ekumah
and to my late brother, Emmanuel Ebo Appiah.

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ABSTRACT

The invasive fruit fly *Bactrocera invadens* (Drew, Tsurata & White 2005) is causing extensive socio-economic losses in West Africa as a pest in mango production. In addition to reducing crop quality and decreasing fruit production, the presence of the fruit fly has detrimental impact on the export market due to international trade restrictions. To manage the damage being caused by *B. invadens* to the mango industry in Africa, an Integrated Pest Management (IPM) strategy with biological control as one of its components was initiated by the African Fruit Fly Programme (AFFP) based at ICIPE. To this end, *Fopius arisanus* (Sonan) and *Diachasmimorpha longicaudata* (Ashmead) were introduced into Kenya for potential releases. A survey of indigenous tephritid parasitoids in the major mango growing provinces in Kenya was carried out as a first step to identify native parasitoids that are likely to interact with the introduced ones when released. Furthermore, studies on the performance of the introduced parasitoids on *B. invadens* reared on different host fruits, their thermotolerance levels as well as interaction with other indigenous natural enemies were conducted. A survey of indigenous tephritid parasitoids in the major mango growing provinces yielded several hymenopteran parasitoids belonging to four main families; Braconidae, Eulophidae, Chalcididae and Ichneumonidae. The family Braconidae accounted for the majority of parasitoids recorded with *Psytallia* as the dominant genus. Results of fruit fly species identified from the surveys confirmed *B. invadens* as the dominant fruit fly pest in the major mango growing areas in Kenya though members of the genus *Ceratitis*, *Trirhithrum* and *Dacus* were present in the general population. The effect of temperature on the developmental period, longevity and parasitism rates of *F. arisanus* and *D. longicaudata* reared on *B. invadens* was also investigated. A temperature range of 20-30 °C was suitable for the rearing of both parasitoids. Temperatures below 20 °C and above 30 °C were found to negatively

affect parasitism rates. Based on a combination of short developmental time and higher parasitism rates, the optimum temperature for the mass rearing of *F. arisanus* and *D. longicaudata* on *B. invadens* was 25 °C. Temperature also had a significant effect on adult longevity of both parasitoids, with longevity highest at 15 and 20 °C compared to the other constant temperatures. The effect of host fruit substrate on the preference and performance of *F. arisanus* and *D. longicaudata* was assessed through a range of experiments in the laboratory. Females of *F. arisanus* preferred mango compared to pawpaw, citrus, guava, marula and tropical almond in choice bioassays. For *D. longicaudata*, citrus was the most preferred fruit. Parasitism rates for both parasitoids were significantly higher on mango and pawpaw. Finally, interactions involving *O. longinoda*, *B. invadens* and *F. arisanus* and the implications of these interactions were studied through a range of laboratory experiments. Searching and/or oviposition by *B. invadens* females and the number of eggs deposited in mango domes decreased significantly as ant density increased. Direct interactions between *B. invadens* and *O. longinoda* under laboratory conditions primarily consisted of disturbance and deterrence, but predation was hardly observed. The number of *F. arisanus* females searching and/or ovipositing in mangoes infested with *B. invadens* eggs also decreased significantly with increasing ant density. Direct interaction between *F. arisanus* and *O. longinoda* under laboratory conditions primarily consisted of disturbance, deterrence and predation. Mortality of *F. arisanus* females due to predation by *O. longinoda* was significantly higher at higher ant densities. Ant cues or pheromones also had a negative effect on searching and/or oviposition by *F. arisanus*. The information generated in this study should serve as a guide for the future mass rearing and field releases of *F. arisanus* and *D. longicaudata* for the management of *B. invadens* in Africa.

LIST OF ABBREVIATIONS

AFFP	African Fruit Fly Programme
BAT	Bait Application Technique
CDFA	California Department of Food and Agriculture
CIRAD	French Agricultural Research Centre for International Development
DEEDI	Department of Employment Economic Development & Innovation
ESA	Eastern and Southern Africa
FAO	Food and Agricultural Organization
FPEAK	Fresh Produce Exporters Association of Kenya
HAL	Horticultural Australia Limited
HASS	Hawaiian Agricultural Statistical Service
IAEA	International Atomic Energy Agency
ICIPE	International Centre of Insect Physiology and Ecology
IPNI	International Plant Names Index database
IPM	Integrated Pest Management
IRIN	Integrated Regional Information Network
MAT	Male Annihilation Technique
NAQS	Northern Australia Quarantine Strategy
OABS	Optimal Agricultural Business Systems
SSA	Sub-Saharan Africa
SIT	Sterile Insect Technique
TAPP	Tanzania Agriculture Production Program
USAID	United States Agency for International Development

USDA

United States Department of Agriculture

MOSPANS

Ministry of State for Provincial Administration and National Security

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