

Fruit Flyer



FFIPM Bulletin • ISSUE 07 • April 2023



Horizon 2020
European Union Funding
for Research & Innovation

FF•IPM



All rights reserved © 2020.

No part of this publication may be reproduced, stored in a retrieval system, stored in a database and / or published in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without the prior written permission of the publisher.



- 4 editorial
- 6 the project
- 18 the research
- 22 news + events

This is the seventh Newsletter Publication of the EU-funded research project FF-IPM, with the aim to protect fruit production and trade from threats posed by fruit flies.

The newsletter is published quarterly, highlighting the actions, news, progress related to the issue at hand.

Editor: University of Thessaly

Contributors: FF-IPM partners and experts

Editing & Graphic design:
R&DO Ltd





Dr. Nikos T. Papadopoulos, PhD

Professor of Applied Entomology
 Director of Entomology + Agricultural Zoology Laboratory
 University of Thessaly
 FF-IPM Project Manager

Heading into the last project year, FF-IPM partners are intensifying communication and dissemination activities, and are continuing to interact with stakeholders across all levels of fruit production and trading. Hence, in the past six months of our project, FF-IPM has participated in two major scientific meetings and one international workshop.

Three project workshops have been organized and additional interactions with international stakeholders were held. In addition, four new project papers were published in international peer reviewed journals. In a two-day event, the FF-IPM consortium held its annual meeting in Athens, where the progress achieved was presented, and thoroughly discussed within our group, and the advisory board. A list of achievements and products of the FF-IPM project have been analyzed and the exploitation opportunities have been discussed. Special emphasis was placed on the relevance of our achievements for the European and International policy. Some of our products, such as the electronic traps developed from our Israeli partner ARO (Agricultural Research Organization), is already considered as a fruit fly detection tool, while others such as the electronic keys are freely available for European and International stakeholders.

The new SME Cervantes, born out of the FF-IPM project, came to bridge an important gap regarding preparedness and biosecurity of fruit fly invasions. The CEO of Cervantes, Darren Kriticos recently delivered a very interesting, and highly attended, webinar on the population modelling and real-time forecasting of the oriental fruit fly.

The 11th International Fruit Fly Symposium that took place from 13 – 18 of November 2022 in Sydney Australia hosted many FF-IPM contributions including oral and poster presentations. Overall, five oral and nine poster presentations were given and discussed. It was a great opportunity for our group to discuss with our international colleagues the fruit fly problems and exchange data and ideas on addressing invasive fruit flies. The issue of detecting low density, incipient fruit fly populations

Heading into the last project year, FF-IPM partners are intensifying communication and dissemination activities, and are continuing to interact with stakeholders



during the early phases of invasion were discussed in the workshop organized by the New South Wales Department of Primary Industries of Australia. Our project participated with an interesting presentation on the detection of low fruit fly populations and the FF-IPM approaches.

Two members of our project participated and delivered interesting talks in the Pherofruits 2022 meeting that was organized by the International Organization of Biological Control in Girona Spain in September 2022. The meeting was a joint event of two working groups of IOBC, “Pheromones and other semiochemicals in integrated fruit production” and “Integrated protection of fruit crops”.

Continuing interaction with stakeholders, three meetings took place: one in Korinthos Greece, organized by our partner Benaki Phytopathological Institute and in Compomarino and Paliano Italy respectively, organized by the University of Molise. A group from our project interacted with Australian stakeholders in the southeast part of the country.

Lastly, four new FF-IPM publications cover a wide range of subjects and contribute to filling knowledge gaps in fruit fly and pest management literature. They address fruit fly biological control with ground predators and off-season application of entomopathogenic nematodes, response of the peach fruit fly to stress and the genetics of the invasion processes of *Bactrocera dorsalis*.

- All FF-IPM publications and abstracts of presentations given in various meetings are achieved, presented and are accessible in the [project exploitation platform](#).
- The promotional video of the project can be accessed [HERE](#).

I hope you enjoy exploring the 7th FF-IPM newsletter to get information on the various activities of our project.

We will communicate soon with the 8th FF-IPM Bulletin that will be distributed within the next two months.

3rd Annual meeting of the FF-IPM project



The 3rd Annual meeting of the FF-IPM project was successfully held virtually and in person on October 14-15, 2022, in Athens, Greece.

The event was organized by the University of Thessaly (UTH) and RND0. Researchers from all the consortium's partners met in order to discuss the progress of the project so far and take decisions about the future steps. Partners from the advisory board of the project were also present.

In the meeting, each Work package (WP) leader summarized the objectives, milestones and deliverables of each WP and presented relative results.

WP1 which concerns the financial and technical management, was presented by Georgia Pahlitzanakis. During her presentation, she reported the concluded tasks and highlighted the importance of stakeholders' engagement actions.



Georgia Pahlitzanakis

WP2 discusses the collection of new biological data for the three target fruit fly species in order to be used in other WPs. Nikos Papadopoulos presented results of selected experiments regarding fruit flies' biology.

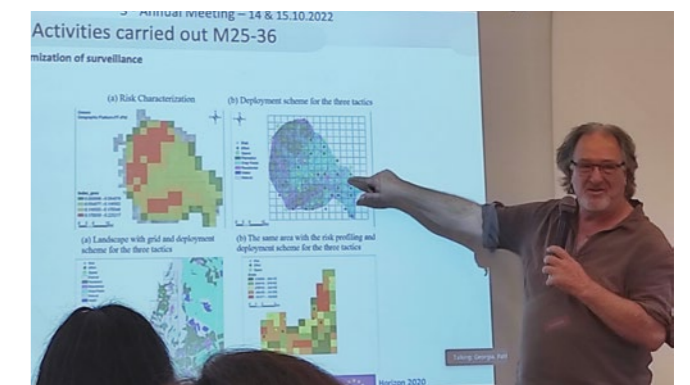


Nikos Papadopoulos

WP3 concerns the development of new tools for rapid and reliable detection of infested fruits and identification of specimens. Marc De Meyer presented results regarding the identification tools.

WP4 is related to the OFF-Season control of fruit flies. Josep Jaques presented results regarding the newly developed biocontrol tools.

WP5 refers to the use of CLIMEX and DYMEX models in order to predict the population dynamics of the target fruit fly species in different scenarios and assist surveillance. Darren Kriticos and David Nestel presented results regarding surveillance strategies.



Darren Kriticos and David Nestel

WP6 concerns the development of a decision-support system to optimize precision of Integrated Pest Management (IPM) for fruit fly management. Slawomir Lux and Andrea Sciarretta presented results regarding the development and the validation of this decision-support system.



Slawomir Lux

WP7 deals with the exploitation plan of the project. H el ene Delatte presented the progress that has been made regarding this field and referred to the FF-IPM platform.



Group photo of the 3rd Annual meeting of the FF-IPM project



Christos Genitseftsis and H el ene Delatte

WP8 is related to the dissemination of the project. Georgia Micheli presented the work that has been done regarding the visibility and communication of the project.

In the framework of this meeting, three workshops took place where partners discussed about several issues and future plans of the program.

The partners renew their appointment for next year's meeting, which is going to be the final meeting of the project and will be conducted in Spain.

FF-IPM PROJECT PARTICIPATION IN THE **11th International Symposium on Fruit Flies of Economic Importance**

The 11th International Symposium on Fruit Flies of Economic Importance (ISFFEI) was successfully held on November 13-18, 2022, in Sydney, Australia. The Symposium was hosted by the NSW Department of Primary Industries and organized in cooperation with the Food and Agriculture Organization of the United Nations (FAO) and the International Atomic Energy Agency (IAEA). It was conducted in a hybrid format with face-to-face and virtual attendance.



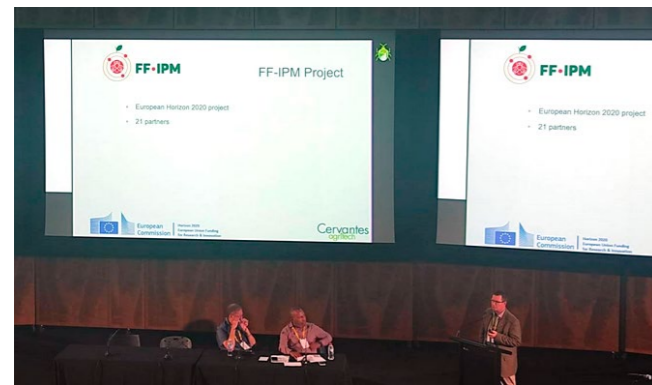
The Symposium hosted scientists, researchers, and those involved in plant protection agencies and phytosanitary operational programs who had the chance to share their valuable knowledge, technologies and experiences.

More than ten members of the FF-IPM project presented their most recent research output: Darren Kriticos, Kevin Malod, David Nestel, Nikos Papadopoulos Anna Szyniszewska orally presented their research, whereas Mario Bjeliš, Marc De Meyer, Pablo Deschepper, Darren Kriticos, Georgia Papadogiorgou, Welma Pieterse, Vasilis Rodovitis, Anna Szyniszewska and Sam Vanbergen presented posters of their work.



Presentations at the ISFFEI Meeting

Darren Kriticos (Cervantes Agritech Pty Limited) presented his research entitled “A forecasting system for fruit fly biosecurity and pest management”. The researcher presented the multi-scale pest alert system which has been created in the framework of the FF-IPM project. He highlighted the information that a system like this can provide regarding biosecurity, surveillance and pest management. Additionally, he explained the CLIMEX (estimate climate suitability) and DYMEX (population dynamics) models that are used in this system.



Darren Kriticos

Kevin Malod (Stellenbosch University) presented his research entitled “Effects of thermal history on *Bactrocera* and *Ceratitis* pests: Who flies better?” The results of this research revealed that *Bactrocera* species are great dispersers regardless of thermal history. The researcher highlighted that flies acclimated at lower temperature, flew for less time and covered shorter distances. He also mentioned the importance of these research results to predict movement in these pests with regards to climate change.



Kevin Malod

David Nestel (Agricultural Research Organization-Volcani Institute) presented his work, entitled “Smart-Traps for Fruit Flies: Their Integration into Pest Management and Biosecurity”. The researcher presented two proto-types of optical smart-traps for fruit flies that he and his team have developed. Both traps have been tested and provided good monitoring and detecting results. The main conclusion of the study was that Smart-Traps are proving to be valuable tools for fruit fly pest management and effort is made in order to combine them with other Integrated Pest Management (IPM) tools.



David Nestel

Nikos Papadopoulos (University of Thessaly) represented the FF-IPM project and presented “A holistic approach to address invasive fruit flies (Diptera: Tephritidae) in Europe: the FF-IPM project”. The speaker summarized the fruit fly invasions and the way that they threaten the fresh fruit production and trade worldwide. He presented the FF-IPM project and gave details regarding the methods used and the data which have been generated. Then, he mentioned the different Integrated Pest Management (IPM) tools which have been developed, improved, and tested for fruit fly management in the framework of the project. Finishing, he highlighted the complexity of the problem of fruit fly invasion and discussed the opportunities



Nikos Papadopoulos

to establish a more efficient preparedness strategy against invasions in fruit producing systems.

Anna Szyniszewska (Corvus Geostat) presented her work, entitled “Medfly in a warming world: using models to understand shifting range dynamics”. The researcher referred to the effect of climate change on the potential distribution of Mediterranean fruit fly. She presented evidence regarding significant trends in increasing climate suitability for Mediterranean fruit fly populations and their substantial northward expansion. The modelling revealed the need to use a climatology that is temporally concordant with species distribution data.



Anna Szyniszewska

11th International Symposium on
FRUIT FLIES
 of Economic Importance

13-18 NOV 2022 • SYDNEY • AUSTRALIA

Posters at the ISFFEI Meeting

Mario Bjeliš (University of Split) presented the poster with the title "Overwintering of Mediterranean Fruit Fly Adults in Dalmatia and Implications to Current Strategy of SIT Suppression Program in Neretva Valley". The results of the study confirmed that, in Dalmatia area, most of the medfly population overwinters as larvae in fruit, especially in Citrus and Fortunella species, and adult emergence least during April and May. Additionally, recent experiments show that a small percentage of adults are able to overwinter not only in protected spaces in urban areas, but also in open field conditions. The main conclusion of the study was that a concentrated release of sterile males on hotspots in open fields and urban areas during early spring, could optimize the current release strategy.

Marc De Meyer (Royal Museum for Central Africa) presented the poster with the title "Take a swipe at the fly: fruit fly (Diptera: Tephritidae) identification through mobile applications". This work presented two identification keys for frugivorous fruit flies, that have been developed as mobile applications. The applications provide information on general description, biology, distribution, management and host plant range and can be used to

facilitate identification of targeted fruit flies for the non-specialist.

Pablo Deschepper (Royal Museum for Central Africa) presented the poster with the title "Use of highly resolving molecular tools to assess the seasonal population dynamics of *Ceratitis capitata*". The genetic analysis of *C. capitata* specimens which have been collected from different areas of insect's distribution in Europe, revealed that *C. capitata* exhibits a low level of spatial genetic structuring in Europe. Also, there is evidence for annual variation in genetic composition at both the core and margin of the distribution of *C. capitata*.

Darren Kriticos (Cervantes Agritech Pty Limited) presented the poster with the title "QFly in a warming world: Biosecurity implications for Australia, New Zealand and globally". Due to the recent detection of *Bactrocera tryoni* in Tasmania and the eradication campaign that followed, researchers used CLIMEX model and applied different climate scenarios to assess the sensitivity of the potential distribution in Australia, New Zealand and globally. According to these scenarios, the risk of establishment of QFLY in areas like Tasmania and New Zealand appears to continue to increase.

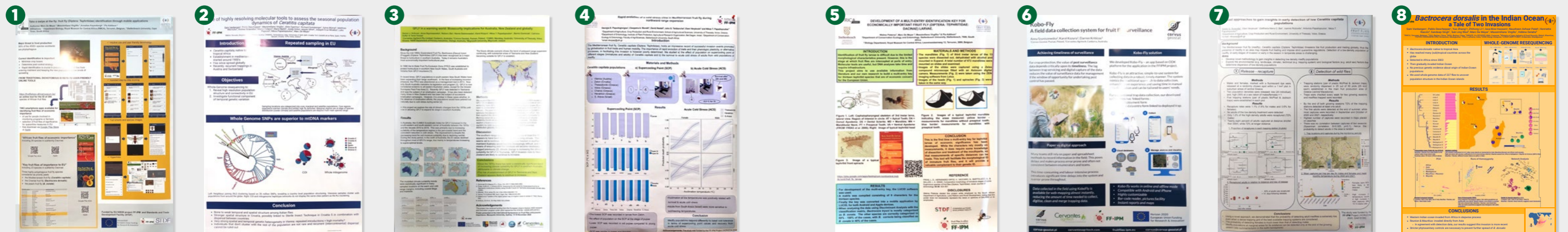
Georgia Papadogiorgou (University of Thessaly) presented the poster with the title "Rapid evolution of a cold stress cline in Mediterranean fruit fly during northward range expansion". In order to explore whether different *C. capitata* populations express phenotypic plasticity, two cold tolerance metrics were tested. The study revealed that the northward range expansion of the Mediterranean fruit fly is related with the rapid evolution of a cold tolerance cline. The results set the stage for predicting the geographical expansion of *C. capitata* due to climate change.

Welma Pieterse (Stellenbosch University) presented the poster with the title "Development of a multi-entry identification key for economically important fruit fly (Diptera: Tephritidae: Dacinae) larvae". This work presented a newly developed multi-entry identification key for larvae of frugivorous fruit flies, that has been developed as mobile application. The key starts with options for separating Tephritidae larvae from other commonly encountered insect larvae in fruit, including Drosophilidae, Tortricidae, Pyralidae, Nitidulidae and Lonchaeidae. The tool will be a valuable tool for enabling non-molecular identifications of fruit fly larval pests in fruit.

Vasilis Rodovitis (University of Thessaly) presented their poster with the title "Novel approaches to gain insights in early detection of low *Ceratitis capitata* populations". In this work, two different approaches of detecting low populations of *C. capitata*, were presented. The results revealed that the probability of detecting

POSTERS:

1. "Take a swipe at the fly fruit fly (Diptera Tephritidae) identification through mobile applications".
2. "Use of highly resolving molecular tools to assess the seasonal population dynamics of *Ceratitis capitata*".
3. "QFly in a warming world Biosecurity implication for Australia, New Zealand and globally".
4. "Rapid evolution of a cold stress cline in Mediterranean fruit fly during northward range expansion".
5. "Development of a multi-entry identification key for economically important fruit fly (Diptera: Tephritidae: Dacinae) larvae".
6. "Kobo-Fly: A field data collection system for fruit fly surveillance".
7. "Novel approaches to gain insights in early detection of low *Ceratitis capitata* populations".
8. "*Bactrocera dorsalis* in the Indian Ocean: a tale of two invasions".



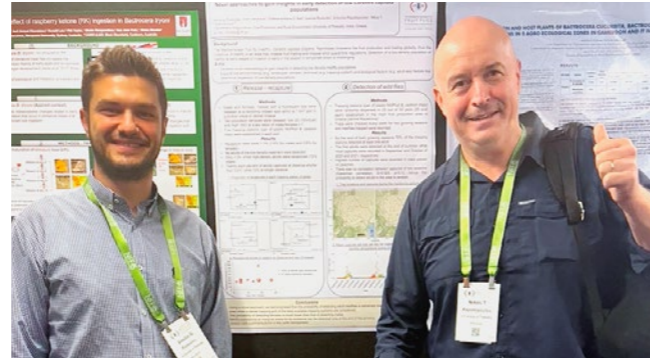
Mediterranean fruit fly adults under low population densities is extremely poor, regardless of the trapping grid density. Also, it was more likely to detect male than female flies.

Anna Szyniszewska (Corvus Geostat) presented the poster with the title “Kobo-Fly: A field data collection system for fruit fly surveillance”. This work presented a newly developed tool for uploading trapping data from the mobile while the surveillance is in progress. The use of this application is reducing the data latency (time needed to transfer manually the data from paper to spreadsheet), enabling manual trap data to be linked to an early-alert web-mapping system alongside e-trapping results.

Sam Vanbergen (Royal Museum for Central Africa) presented his poster with the title “*Bactrocera dorsalis* in the Indian Ocean: a tale of two invasions”. This work presented a genomic approach of invasion history. Genetic analysis of invasive populations of *B. dorsalis* on the islands in the Western Indian Ocean and in comparison with populations from the

African mainland and from Asia, showed that there are two invasion events that took place on these islands. The islands of the Comores, Mayotte and Madagascar were invaded from the African mainland in a stepping stone sequence eastwards. The *B. dorsalis* populations of Mauritius and La Réunion on the other hand appear to have originated from Asia. The results can be used in improving phytosanitary protocols.

The next International Symposium on Fruit Flies of Economic Importance will be held in Morocco in 2026.



Vasilis Rodovitis and Nikos Papadopoulos



Group photo of the 11th International Symposium on Fruit Flies of Economic Importance

FF-IPM PROJECT PARTICIPATION IN *Pherofruits 2022*

The Joint Meeting of the IOBC (International Organization for Biological and Integrated Control)/WPRS (West Palearctic Regional Section) Working Groups “Pheromones and other semiochemicals in integrated production” and “Integrated Protection of Fruit Crops” was successfully held on September 25-29, 2022, in Girona, Spain.

The conference was hosted by IRTA (Institute of Agrifood, Research and Technology) and organized in cooperation with IOBC committee. The theme of the conference was “The IPM in the XXI century: new tools, tactics and strategies to improve sustainability from old and new pests and diseases”. Scientists, researchers, and professionals involved both in the study of Semiochemicals and in Integrated Fruit Production, had the chance to share the latest research and technological advances that can help in the control of harmful agents, both indigenous and invasive.

FF-IPM Project participated in this conference with two oral presentations:

Eleftheria-Maria Bali (University of Thessaly) presented their work entitled “Effect of biotic and abiotic factors on trapping of adults of the Mediterranean fly”.

David Nestel (Agricultural Research Organization-Volcani Institute) presented their work, entitled “Surveillance strategies for invasive fruit fly species”.



Eleftheria-Maria Bali – presentation



David Nestel – presentation

FF-IPM promotional video



A video is chosen as a mean of communication to visually bring a project's key messages across and to illustrate the project's achievements. A promotional video provides a highly scalable and cost-effective communication that can reach a wide audience and various stakeholders on the devices of their choice, in a simple and efficient manner.

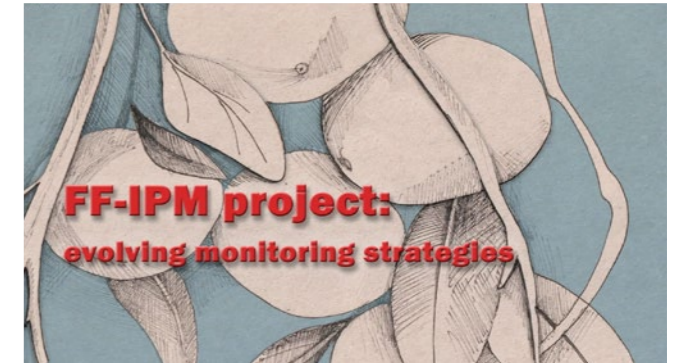
The FF-IPM promotional video developed in the frame of the project is an animated project video, a captivating, versatile and informative communication tool. With a carefully drafted script, it is tailor-made to showcase briefly and concisely the project on social media as well as during presentations and conferences the video can serve as a communication asset that can respond to the need of a broad array of stakeholders, from the general public to a more specified-scientific audience.

The FF-IPM video provides a powerful visual description of the project, its goals and the progress made so far. The video presents the same coordinated image and style of other communication materials realized – Website, Logo, Headed Paper template, PowerPoint Presentation template, Leaflet, Newsletter, etc.

The ultimate goal of this informative tool is to produce dynamic, user-friendly and easy-to-understand content to enhance public awareness and promote the project's products, through a recognizable and strong visual identity based on the project's communication guidelines. Moreover, particular attention was put into the use of simpleness both in language as well as visual content to address a broad public, expert groups, communities, stakeholders, end-users, and they intend to build a particular community around the project.

The FF-IPM video was originally developed in English language and will be translated additionally to other languages including Greek, Spanish and Italian with subtitles to be included in the video.

Hereafter, an overview of the video details is provided following its structure. The video brief outlined the following:



Background

- FF-IPM project is a European Union-funded Horizon 2020 project.
- The aim is to produce a video that will introduce the project to a lay audience and promote the access programme that it offers.
- The video will be shared via the FF-IPM and partners' social media accounts (Twitter, Facebook, YouTube, LinkedIn etc). It will also be shown at events giving it even more exposure.

General

- Target audience: All respective stakeholders, general public and policy organizations.
- Format: Short video presentation.
- Length: around 3 minutes.

Aesthetics

- Tone: The script presented includes animation, sketching by hand drawing and on-field shooting



The video starts with providing information about the problem of fruit flies and reviews main concept from the project's point of view explaining each stage of the process. As for the shooting process, several shoots were carried out at the UTH lab and on the field and BPI in order to provide a view on the lab.

The FF-IPM video is available at the [FF-IPM website](#) and at the [youtube channel](#) of the project



Publications

Four new articles have been published during the last months in the frameworks of the FF-IPM Project

1

Ground covers affect the activity density of ground dwelling predators and their impact on the Mediterranean fruit fly, *Ceratitis capitata*

JOURNAL NAME

BioControl

AUTHORS

J. Cruz-Miralles, M. Guzzo, M. V. Ibáñez-Gual, Ó. Dembilio & J. A. Jaques

ABSTRACT

Three developmental stages of the Mediterranean fruit fly, *Ceratitis capitata* (Wiedemann) (Diptera: Tephritidae), can be found in the soil (late third instar larvae, pupae, and teneral adults). These stages are susceptible to predation by generalist ground-dwelling predators. Our objectives have been to investigate the association between ground cover management (bare soil, a seeded cover of *Festuca arundinacea* and a mulch of straw), the emergence success of *C. capitata*, and the activity density of the most important groups of ground-dwelling predators (spiders, beetles, ants and earwigs). As expected, *C. capitata* emergence was lower in a seeded cover of *Festuca arundinacea* (FA) and a mulch of straw (M) (10.2%) relative to bare soil (BS) (13.2%). This was related to higher diversity and activity density of ground-dwelling predators in FA and M compared to BS. The contribution of the ground-dwelling predators considered in this study to this reduction highlights the key role of beetles, earwigs and, to a lesser extent, ants, while the contribution of the most abundant group of ground-dwelling predators, spiders, remains unclear. Ground covers appear as a strong and sustainable conservation biological control method that should be taken into consideration for the management of *C. capitata* populations.

Our objectives have been to investigate the association between ground cover management

 Springer Link

→ Read the article [HERE](#)

2

Larval nutritional-stress and tolerance to extreme temperatures in the peach fruit fly, *Bactrocera zonata* (Diptera: Tephritidae)

JOURNAL NAME

KFLY

AUTHORS

M. Ben-Yosef, Y. Altman, E. Nemni-Lavi, N.T. Papadopoulos & D Nestel

ABSTRACT

Within the factors affecting insect tolerance to extreme environmental conditions, insect nutrition, particularly of immature stages, has received insufficient attention. In the present study, we address this gap by investigating the effects of larval nutrition on heat and cold tolerance of adult *Bactrocera zonata* – an invasive, polyphagous fruit fly pest. We manipulated the nutritional content in the larval diet by varying the amount of added yeast (2–10% by weight), while maintaining a constant sucrose content. Adults derived from the different larval diets were tested for their tolerance to extreme heat and cold stress. Restricting the amount of yeast reduced the efficacy of the larval diet (i.e. number of pupae produced per g of diet) as well as pupal and adult fresh weight, both being significantly lower for yeast-poor diets. Additionally, yeast restriction during the larval stage (2% yeast diet) significantly reduced the amount of protein but not lipid reserves of newly emerged males and females. Adults maintained after emergence on granulated sugar and water for 10 days were significantly more tolerant to extreme heat (i.e. knock-down time at 42 °C) when reared as larvae on yeast-rich diets (8% and 10% yeast) compared to counterparts developing on a diet containing 2% yeast. Nevertheless, the composition of the larval diet did not significantly affect adult survival following acute cold stress (exposure to –3°C for 2 hrs.). These results are corroborated by previous findings on Drosophilid flies. Possible mechanisms leading to nutrition-based heat-tolerance in flies are discussed.

We address this gap by investigating the effects of larval nutrition on heat and cold tolerance of adult *Bactrocera zonata* – an invasive, polyphagous fruit fly pest

 Taylor & Francis Online

→ Read the article [HERE](#)

3

Early and off-season Biological control of Medfly with entomopathogenic nematodes: from laboratory experiments to successful field trials

JOURNAL NAME
Biological Control

AUTHORS
Apostolos Kapranas, Anna Chronopoulou, Arne Peters, Spyros Antonatos, Ioanna Lytra, Panagiotis Milonas & Dimitrios Papachristos

ABSTRACT
The Mediterranean fruit fly *Ceratitis capitata* (Wiedemann) (Diptera: Tephritidae) is an important pest of citrus and other deciduous fruit trees. There is a need for sustainable pest management tools and the use of entomopathogenic nematodes have been explored for controlling the stages of medfly that occur in the soil. We have investigated further this approach by assessing the efficacy of commercially available entomopathogenic nematodes applied early season or off-season when the medfly populations are passing through their annual bottleneck period, aiming at reducing their population before the growing season. In laboratory experiments, the efficacy of commercial strains of *Steinernema carpocapsae*, *Steinernema feltiae*, *Heterorhabditis bacteriophora* and *H. downsi* at doses of 1.5×10^6 IJs/m² and 2.5×10^6 IJs/m², at 15C° and 25C° was assessed. *Steinernema feltiae* was found to result in up to 70 % reduction of adult medfly emergence at a dose of 2.5×10^6 IJs/m² and lower temperatures, confirming its superiority over other commercially available species. Field trials in citrus groves in Corinthos, Greece in Spring 2021 (early season) and Autumn 2021 (off-season) showed that a single application of *S. feltiae* at moderate dose regimes can provide about 62–65 % suppression of adult medflies. Therefore, a single, moderate dose application of entomopathogenic nematodes early or off-season, which is more economically feasible can provide significant suppression of overwintering medflies and can be safely integrated with other tools for medfly management.

A single, moderate dose application of entomopathogenic nematodes early or off-season, which is more economically feasible can provide significant suppression

4

Genomes of the cosmopolitan fruit pest *Bactrocera dorsalis* (Diptera: Tephritidae) reveal its global invasion history and thermal adaptation

JOURNAL NAME
Journal of Advanced Research

AUTHORS
Yue Zhang, Shanlin Liu, Marc De Meyer, Zuxing Liao, Yan Zhao, Massimiliano Virgilio, Shiqian Feng, Yujia Qin, Sandeep Singh, Suk Ling Wee, Fan Jiang, Shaokun Guo, Hu Li, Pablo Deschepper, Sam Vanbergen, Hélène Delatte, Alies van Sauers-Muller, Tati Suryati Syamsudin, Anastasia Priscilla Kawi, Muo Kasina, Kemo Badji, Fazal Said, Lijun Liu, Zihua Zhao, Zhihong Li

ABSTRACT

Introduction: The oriental fruit fly *Bactrocera dorsalis* is one of the most destructive agricultural pests worldwide, with highly debated species delimitation, origin, and global spread routes.

Objectives: Our study intended to (i) resolve the taxonomic uncertainties between *B. dorsalis* and *B. carambolae*, (ii) reveal the population structure and global invasion routes of *B. dorsalis* across Asia, Africa, and Oceania, and (iii) identify genomic regions that are responsible for the thermal adaptation of *B. dorsalis*.

Methods: Based on a high-quality chromosome-level reference genome assembly, we explored the population relationship using a genome-scale single nucleotide polymorphism dataset generated from the resequencing data of 487 *B. dorsalis* genomes and 25 *B. carambolae* genomes. Genome-wide association studies and silencing using RNA interference were used to identify and verify the candidate genes associated with extreme thermal stress.

Results: We showed that *B. dorsalis* originates from the Southern India region with three independent invasion and spread routes worldwide: (i) from Northern India to Northern Southeast Asia, then to Southern Southeast Asia; (ii) from Northern India to Northern Southeast Asian, then to China and Hawaii; and (iii) from Southern India toward the African mainland, then to Madagascar, which is mainly facilitated by human activities including trade and immigration. Twenty-seven genes were identified by a genome wide association study to be associated with 11 temperature bioclimatic variables. The *Cyp6a9* gene may enhance the thermal adaptation of *B. dorsalis* and thus boost its invasion, which tended to be upregulated at a hardening temperature of 38 °C. Functional verification using RNA interference silencing against *Cyp6a9*, led to the specific decrease in *Cyp6a9* expression, reducing the survival rate of dsRNA-feeding larvae exposed to extreme thermal stress of 45° C after heat hardening treatments in *B. dorsalis*.

Conclusion: This study provides insights into the evolutionary history and genetic basis of temperature adaptation in *B. dorsalis*.

Invited presentation to Australian National Planning Workshop for Exotic Fruit Fly (EFF)



Nikos Papadopoulos was invited to present the FF-IPM Project in Australian National Planning Workshop for Exotic Fruit Fly (EFF) on November 22, 2022, in NSW, Australia.

His presentation entitled "Detecting and monitoring low fruit fly populations: the EU funded FF-IPM project".



Workshop for WP5 in Israel

Nikos Papadopoulos and Eleni Verykoui met Yafit Cohen, Eitan Goldshtein and David Nestel in Agricultural Research Organization in Israel on January 29-February 2, 2023. In this Workshop, FF-IPM partners made an overview of WP5 regarding the results and data analysis and they discussed the next steps.

Stakeholder meetings

CAMPOMARINO PILOT SITE (ITALY)

On 4 May 2022, a meeting was held with farmers from the Campomarino pilot site to illustrate the results of the 2020-2021 monitoring activities and to propose possible scenarios for medfly integrated management in 2022. The participants of the meeting were: Andrea Sciarretta and Marco Colacci (UNIMOL); Antonio

Di Labbio (Di Labbio farm); Maddalena Rinaldi and Carmine Raffaele Rinaldi (Rinaldi farm).

Farmers were assured of the monitoring of the medfly infestation and a rapid change of control strategy if a harmful increase in the medfly population was observed.

PALIANO PILOT SITE (ITALY)

On 6 May 2022, a meeting was held with farmers from the Paliano pilot site to illustrate the results of the 2020-2021 monitoring activities and to propose possible scenarios for medfly integrated management in 2022. The participants of the meeting were: Andrea Sciarretta, Marco Colacci and Guido Bernabei (UNIMOL); Daniele Lolletti and Claudio Ceccaroli (CREA-Research Centre for Olive, Citrus and Tree Fruit); Fabrizio Loffredi (Loffredi farm); Mariano Donati (Donati farm).

After illustrating the phenology of the medfly in the pilot site and in the experimental farms (with particular attention to the flight period) and the management used in the last two years, the various IPM scenarios developed within Pest-on-farm were illustrated.



KONIARIS PILOT SITE (GREECE)

A meeting with the administrators of the citrus farm at the experimental pilot site in Koniario Institute of Citrus Research, Kechries, Korinthos, Greece took place on Tuesday 14th of June 2022 and Scenarios for OFF- and ON-season medfly management were presented to stakeholders. The FF-IPM experts presented the strategy that is planned to be implemented in the citrus groves which deploy the use of Magnet traps. The farmers replied to several questions regarding technical support of the FF-IPM experts during these last two growing seasons and the usability of the detailed data collection related to socioeconomics, fruit fly phenology and targeted phytosanitary or other applications.

The farmers were extremely positive about the implementation of the medfly control program. Moreover, the farmers agreed that they were positively inclined to apply the results of the model after the finalization of the program. Furthermore, they can use the data and the models to be more targeted and specific in their applications and staff effort. Lastly, the farmers proposed that a series of technical workshops could be organized in the farms for other stakeholders and farmers of the area, for all the stakeholders to be informed and disseminated about the FF-IPM approaches, since these kinds of strategies can be applied in a wide scale area.

AUSTRALIA

Following the end of the conference in Sydney, Australia, the FF-IPM team, represented by Nikos Papadopoulos, Darren Kriticos, Anna Szyniszewska and Vasilis Rodovitis conducted a series of stakeholder meetings focusing on the fruit fly problem in Australia and especially in Southeast part of the country.



The first meeting was held in the Orange Agricultural Institute of New South Wales. The Institute focuses on a variety of solutions across a range of agricultural and biosecurity fields, holding one of the biggest insect and fruit fly collections in Australia.

Our team discussed with Peter Gillespie, the curator of the insect collection, the importance of collecting and maintaining physical specimens of pests. Equally important is the record of the collection data, like host plants and locations of detection. The collections provide information on reference species, distribution, and hosts for a range of important organisms. Such collections can be used to support diagnostic, research and educational outcomes.

The second meeting was held in apple orchards located near Bilpin town. The researchers discussed with the farmers the important issues they face regarding *Bactrocera tryoni*, a fruit fly that threatens several fruits cultivated for commercial use as well as the issues with fruit flies in general, focusing on new IPM management tools and strategies.

Upcoming Webinars



The series of FF-IPM webinars will be continued with the following webinars:

- **WEBINAR 4**
"Interception of fruit fly infested fruits in cargo shipment" by Dr. Panos Mylonas.
- **WEBINAR 5**
"Effect of ground management on survival of *Ceratitis capitata*" by Prof. Josep A. Jaques.

STAY TUNED

→ visit the [webinars page](#) for updates

WEBINAR 3

Modelling the population dynamics of Oriental Fruit Fly, *Bactrocera dorsalis*: Progress and prospects for a real-time fruit fly forecasting system

This third webinar with Mr. Kriticos as the presenter, took place at 24/2/2023 and sketched out the *B. dorsalis* model, showed how it performs against trapping data, and commented on future efforts to embed this model in a real-time pest modelling framework, including links to automated surveillance systems.

DYMEX was used to develop a process-based population dynamics model of *B. dorsalis* as the centrepiece of a real-time pest forecasting system. The model functions were derived mostly from the published literature, supplemented with experiments conducted within the FF IPM project. Attendants were informed about the attention was paid to the microclimates inhabited by the different lifestages of *B. dorsalis* and the model was tested using historical trapping data from a range of sites across the native and invaded range of *B. dorsalis*.



Upcoming Events

The **11th Wolbachia Conference** will be held on June 11-16, 2023, in Kolympari, Crete, Greece www.wolbachia2023.com

The **10th International Congress of Dipterology (ICDX)** will be held on July 16–21, 2023, in Reno, Nevada, USA www.dipterists.org

Rethink Food Resources, Losses, and Waste Third International Conference will be held on September 27-29, 2023, in Athens, Greece www.retaste.gr

XII European Congress of Entomology (ECE) 2023 will be held on October 16-20, 2023, in Heraklion, Crete, Greece www.ece2023.com

Entomology 2023 will be held on November 5-8, 2023 in National Harbor, MD www.entsoc.org



Fruit Flies In-silico
Prevention & Management
FF-IPM

 Horizon 2020
European Union Funding
for Research & Innovation

