

Fruit Flyer



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for Research & Innovation

FF•IPM



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Fruit Flies In-silico
Prevention & Management

FF-IPM

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This is the eighth 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.

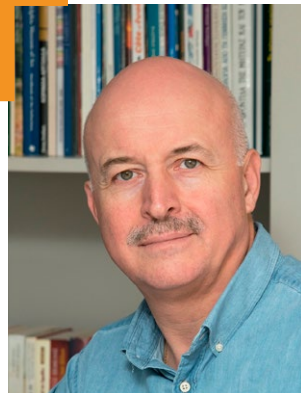
The newsletter is published quarterly, highlighting the actions, news, progress related to the issue at hand.

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

The last season to conclude experiments and pilot field testing of the FF-IPM project is progressing and several activities are in progress. Pilot field tests are running in Italy, Spain, Greece and Croatia and further testing and verification of our findings is underway. Several other activities, such as the finalization of deliverables, further refinement of analysis, submission of papers for publication and targeted dissemination activities are taking place in the FF-IPM community, which has grown substantially during the last four years.

In our continuous effort to reach as many stakeholders as possible we continued our communication and dissemination campaign and presented our project in the “Two Day Hybrid Science and Technology Exhibition” that took place in the Innovation Park of Larissa, Greece in February 2023. There was a lot of interest regarding the products developed in the FF-IPM project with fruitful discussion and exchange of ideas, setting the stage for emerging collaboration opportunities. Likewise, we have participated in the “PanHellenic Exhibition for Agriculture and Livestock AgroThessaly” that took place in Larissa in March 2023 with similar intense interest from various stakeholders. Results of our project and an overview of

our findings were presented in scientific meetings in Europe (Greece, Spain) and Africa (Kenya) further reaching the research community and additional stakeholders. Three additional papers from our partners have been published in prestigious journals addressing population patterns of medfly in Croatia, the invasion of the oriental fruit fly in the Indian Ocean and the response to thermal stress of different medfly populations originated from the northern hemisphere. The contribution of the FF-IPM project in fruit fly biology and management, as well as invasion biology in general is already substantial and is expected to grow in the months to come.

Last year the fruit fly community and the scientific community of Greece lost an eminent member, Antigone Zacharopoulou, a researcher and professor who set the ground for the research field of genetics and cytogenetics of fruit flies of economic importance. I was lucky to know and interact with Antigone and I am one of those who admired her passion for science and life. Antigone will be missed for her personality and generosity, as well as her dedication to the support and training of young students and research scientists.

The contribution of the FF-IPM project in fruit fly biology and management, as well as invasion biology in general is already substantial and is expected to grow in the months to come

The current newsletter includes a very interesting interview with Marc De Meyer, the technical manager of the FF-IPM project. With his long experience in research and fruit flies, Marc brings a wealth of information through his interview covering fruit fly taxonomy, the history of the Royal Museum of Central Africa of Belgium and the history of the TEAM (the group of Tephritid Workers of Europe Africa and the Middle East).

Prevention is among the most important elements in managing fruit fly biological invasions, and the harmonization of phytosanitary treatments at a global level of outmost significance. We are happy to host Vanessa Simoes Dias in the current Newsletter, to present and explain the effort of her group in the International Atomic Energy Agency to develop standardized post-harvest treatments for challenging commodities such as fresh fruits and vegetables.



The 8th FF-IPM Newsletter includes several interesting subjects covering activities of our partners and other subjects of interest. Enjoy reading and stay tuned for further news from the FF-IPM program.

Antigone Zacharopoulou

(1945–2022)

**Kostas Bourtzis &
Antonios A. Augustinos**

As it is well-known in the fruit fly community, Emeritus Professor Antigone Zacharopoulou passed away on 27 May 2022.

Antigone graduated from the Department of Natural Sciences of the Aristotle University of Thessaloniki, Greece in 1970. She received a PhD degree in Biology from the Department of Biology, University of Patras, Greece in 1978, with an emphasis on Genetics. She worked in this Department for her entire career, becoming a Professor in 1999, and recognized as an Emeritus Professor after her retirement in 2011. That said, Antigone never really retired, since she was active in research until her late days.

Antigone's initial research work focused on *Drosophila*, studying chromosome rearrangements and underlying mechanisms in *Drosophila melanogaster*. However, Antigone spent most of her career working with insects of agricultural importance. Antigone pioneered cytogenetic studies on the mitotic



Photo: www.symbolos.gr

and polytene chromosomes of major tephritid pest species as well as tsetse flies. Her polytene chromosome maps of the Mediterranean fruit fly, *Ceratitis capitata*, the first maps developed for Tephritidae, and directly correlated to *Drosophila Muller* elements A-F, have been used as a reference for all subsequent cytogenetic research performed in true fruit flies. Her research work contributed to the development and improvement of genetic sexing strains for SIT applications and provided tools for taxonomic, phylogenetic, and species resolution studies. In the new -omics era, the classical cytogenetic research that Antigone performed has supported the development of chromosome-level genome assemblies in medfly and closely related species, along with the fine mapping of genes and mutations.

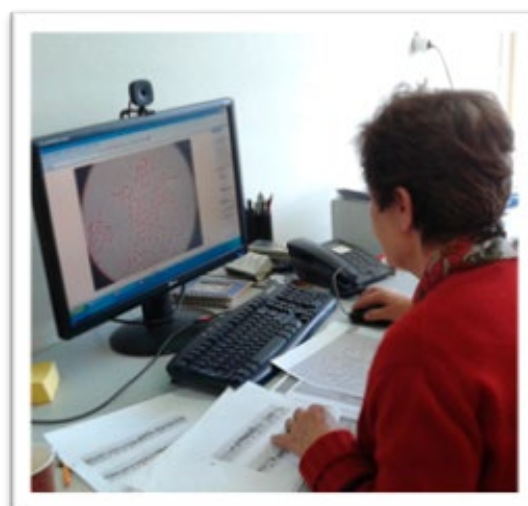
During her long career, Antigone collaborated with many research groups from all over the world. She was a long-standing collaborator of the Insect Pest Control Laboratory (IPCL) of the Joint FAO/IAEA Centre of Nuclear Applications in Food and Agriculture, including her stay for almost two years as a Consultant in Seibersdorf laboratories, acting at different times as an Expert in Genetics-Cytogenetics, and participating in numerous Co-ordinated Research projects. She was a visiting scholar at different Universities and Institutes including the Harvard University-USA, the University of Sydney-Australia, the Institute of Cytology and Genetics (Novosibirsk)-Russia, the Institute of Developmental Biology (Moscow)-Russia, and the Moscamed and Moscafrut Facility (Tapachula)-Mexico.

At the same time Antigone's lab was always open for visiting scientists, especially young ones, willing to work with cytogenetics of insects. Antigone supervised many MSc and PhD students; She was personally involved in guiding and training them and enjoyed it when they managed to develop their own skills in chromosome and banding pattern identification. She published more than 70 research papers and coordinated and/or participated in many national, European, and international research grants.

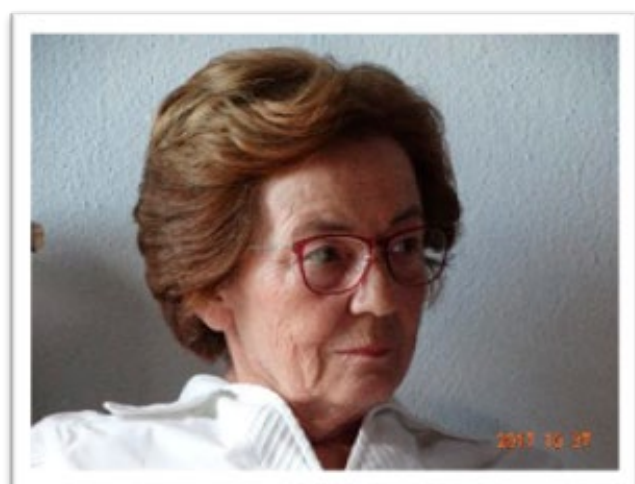
Antigone will be missed by all those who interacted with her. She set the ground for the research field of genetics and cytogenetics of fruit flies of economic importance and this gap cannot be filled. For all of us that have worked with her and/or have known her on a more personal basis, Antigone will be missed for her personality and generosity, evident by her dedication to the support and training of young students and research scientists. Antigone was always there for us, and this will not be forgotten.



Antigone in her lab in the Department of Biology of the University of Patras (1997)



Antigone in 2016 on her favorite spot: analyzing polytene chromosome preparations and reading polytene chromosome maps.



Antigone in 2017

FF-IPM

at Innovent Forum 2023

The project was presented at the Two-Day Hybrid Science & Technology Exhibition, held live at the JOIST Innovation Park (February 10-11) and online (February 12).

The participation's overall aim was to disseminate the scientific knowledge generated during the project as widely as possible to maximize the impact of the project.

We were given the opportunity for B2B & B2G Matchmaking meetings, networking with relevant market players, establishing contact and bound relations with target groups of the wide range of themes of the project for a wide dissemination of the project's results.

The exhibition was attended by 26 exhibitors from Universities, Research Centers, Public Organizations, Companies and Spin-offs, taking the opportunity to present their projects and services to the public.

20+ parallel events were held during the Two-Day Exhibition with the main purpose of informing the public about innovative actions, as well as numerous live broadcasting of participant interviews.



FF-IPM PROJECT PARTICIPATION in the 8th Panhellenic Plant Protection Meeting

The 8th Panhellenic Plant Protection Meeting was successfully held on February 21-24, 2023, in Larissa, Greece.

The event was organized by the Region of Thessaly in collaboration with the Greek Ministry of Agricultural Development and Food and a number of scientific and geotechnical bodies to discuss the “Plant protection in the context of the European Green Deal”.

Professor Nikos Papadopoulos represented the Fruit Flies-IPM Project – EU consortium. He presented, during the 1st day of the meeting (Tuesday 21/2), the “Holistic approach to tackling new emerging enemies of fruit trees: the

example of the European project FF-IPM”. In his presentation, he referred to the new tools and strategies, which have been developed regarding the management of biological invasions of fruit flies through the FF-IPM project. Emphasis was given to the new integrated pest management system that has been developed and implemented in two areas in Greece, with positive results for the Mediterranean fruit fly management.

He also presented results regarding the presence of the Mediterranean fruit fly in central Macedonia, where the insect seems to exist in the area in low numbers with a peak population during autumn.



Nikos T. Papadopoulos – presentation

3th Panhellenic Exhibition for Agriculture & Livestock AgroThessaly

The Department of Agriculture Crop Production and Rural Environment of the University of Thessaly participated in the 13th Panhellenic Exhibition for Agriculture & Livestock AgroThessaly. The exhibition was held on March 9-13, 2023, in Larissa, Greece.

A Scientific Conference was held on the 3rd day of the exhibition with subject: "Developments and prospects in the agricultural sector".

Professor Christos Athanassiou represented the Fruit Flies-IPM Project – EU consortium and his presentation entitled: "Novel technologies in insect pest management". In his presentation, he mentioned the new tools, methods and strategies, which have been developed concerning management of biological invasions of fruit flies through the FF-IPM project.

The FF-IPM promotional video was also presented as part of Laboratory of entomology and agricultural zoology activities.



Christos Athanassiou



Representers of The Dept. of Agriculture Crop Production and Rural Environment of the University of Thessaly

Invited presentation to the African Workshop on Area-wide IPM

Nikos Papadopoulos was invited to present the FF-IPM Project in “Aligning fruit fly IPM to African settings; A workshop on linking research efforts for sustainable area-wide IPM of tephritid fruit flies in Africa” on March 29-31, 2023, in Embu town, Kenya, Africa.

The workshop was jointly organized by the Swedish University of Agricultural Sciences, Alnarp, Sweden and the International Center of Insect Physiology and Ecology, Nairobi Kenya. His presentation entitled “A holistic approach in managing emerging and invasive fruit flies in Europe”.

The speaker gave details regarding the fruit fly invasions and their relation to climate change. He presented the FF-IPM project and summarized the methods used in order to address the different steps of invasion. Then, he mentioned the various Integrated Pest Management (IPM) tools which have been developed, improved,

and tested for fruit fly management in the frameworks of the project.

By referring the complexity of the problem of fruit fly invasion he highlighted the needed support by national, European and regional organizations. In the end, the opportunity of establishing a more efficient preparedness strategy against invasions in fruit producing systems, was discussed.



Nikos T. Papadopoulos



Group photo from the Workshop in Kenya



Interview by **Ana Larcher Carvalho, Ulli Schiefer and Vasilis Rodovitis**

Marc De Meyer is an entomologist at the Royal Museum for Central Africa (RMCA, Tervuren, Belgium). He has a PhD in zoology. He joined the RMCA in 1998, after working in Africa for 10 years. He is head of the invertebrates unit, acting head of the department of African Biology, and member of the directive and scientific committees at the RMCA. He is also the RMCA co-ordinator of the Joint Experimental Molecular Unit (JEMU) and the BopCo (Barcoding Facility of tissues and organisms of policy concern) unit.

His field of expertise is taxonomy, systematics and phylogeny of Diptera with emphasis on particular African groups including tephritid fruit flies. He published more than 250 articles and book chapters on different aspects of Diptera. In recent years he has coordinated and participated in national and international research

programmes on fruit flies in Europe and Africa. He is currently member of the scientific committee of the CORAF/WECARD support project of the regional plan for control and monitoring of fruit flies in West Africa (SyRIMAO) and member of the Standing Advisory Group on Nuclear Applications (SAGNA) of the International Atomic Energy Agency. He was the chairman of the TEAM (tephritid workers of Europe, African and the Middle East) steering committee from 2012 till 2022.

Marc De Meyer is the Technical Manager of the FF-IPM project, as well as Work Package leader for tasks related to the development and enhancement of tools and methods for fruit fly prevention (WP3).

Your work on Fruit Flies has developed into a very extensive and rich career. Could you tell us a bit about the beginnings of it all? How did you get started?

I started my career as a taxonomist which mainly involves describing, identifying and classifying organisms. I was focusing on Diptera or flies. When in 1990 I moved from Belgium to Kenya, I discussed the knowledge gaps in Diptera taxonomy in Africa with fellow researchers. While there were many groups in need of taxonomic revisions, some colleagues like Ian White, Amnon Freidberg and Elmo Hardy pointed out the limited knowledge of African tephritids and in particular those of economic significance. At that time, being based in East Africa, a region with a high diversity of fruit flies made this an ideal study topic and I gradually started revising several groups of fruit infesting tephritids. Gradually other aspects, such as pest control, distribution patterns, and evolutionary processes related to speciation were added to the pure taxonomic research.

What are, for you, are the most important aspects of your work? What did you most enjoy doing and what do you consider most relevant?

The starting point is that you have to know what you study. Taxonomy is, from that perspective, the first and foremost step in any research. If you don't know which species you are studying or have some idea of the species boundaries and its relationships with other species, you are blindfolded and groping in the dark. Taxonomy is, therefore, a very relevant research topic despite it being considered out of fashion and not a research priority for funding agencies. Despite all the other research disciplines that I am involved in from close by or at a distance, I still enjoy the pure traditional taxonomic

work. Looking at specimens, discovering repeated patterns of characters that they have in common or that differentiates one specimen from another; trying to put some order in it; deducting relationships between the species. It is all an adventure that can take place behind a microscope.

You have worked at the Royal Museum for Central Africa (RMCA, Tervuren, Belgium) for 25 years. Could you describe your work there?

The Royal Museum for Central Africa is an unique place as it is a museum and research institute oriented towards Africa but not based in Africa. It is a legacy from the colonial period when the Democratic Republic of Congo was first privately owned by the king of the Belgians Leopold II, and afterwards administered as a colony by the Belgian government. The focus of the institute was at the beginning exclusively Congo (and to a lesser extent Burundi and Rwanda) and even today a lot of my colleagues are mainly active in this region. But several of us are conducting research in other parts of the continent as well. My work is manifold. First of all, I am a researcher with my own research topics. Within that framework I am also acting as a coordinator of several research projects, predominantly but not exclusively focusing on fruit flies. In addition to my research I am also head of the Invertebrates Section and acting head of the Biology Department. This means that I have to take care of a lot of administrative duties as well.

You are the outgoing chairman of TEAM (Tephritid Workers of Europe, Africa and the Middle East), could you tell us a bit about this network, your work in it and its importance for Fruit Fly research? What is it, what does it do, what has it achieved so far, and what are its main challenges for the future?



With colleagues from Ministry of Agriculture and Mondlane University Mozambique during a survey in the country

Since 1982 every four years there is an international symposium on fruit flies organized which brings together researchers from around the world. While this is still an important event, there was the need for more direct communication at a smaller geographical scale. The first such regional group was started in the Western Hemisphere. In 2005, during a meeting in Vienna, a group of researchers decided to develop a similar regional working group for Tephritid Workers of Europe, Africa and the Middle East: TEAM. At that time there were about 60 people involved in it. Nowadays we have more than 200 people on our mailing list. TEAM is mainly a platform for interaction and communication among scientists from this region. This is done in a very informal way through a mailing list. We exchange publications, inform colleagues on job opportunities or specific activities or put up requests. Every four years we also organize a meeting which is usually attended by more than 100 people. Due to COVID the previous one, scheduled to take place in southern France, was cancelled as a physical meeting but

was organized online in 2020. The next one is planned in 2024 and will take place on the island of Mauritius. If you talk of achievements, I think the main one is that it has facilitated enormously the networking between partners and countries. Putting a consortium together for projects such as FF-IPM is largely facilitated by the network you build through a regional group such as TEAM. Especially for our African colleagues, it has created opportunities as it allowed them to interact with scientists from other parts of the world. That is also why I am happy that the new chairperson, Aruna Manrakhan, is a female colleague from Africa and that we can take the regional meeting in 2024 to Africa for the second time. Challenges: well, currently TEAM uses a rather old-fashioned communication channel like a mailing list. Modern social media provides several alternative options and it will be important to explore and exploit these if we want to be known among the younger generation. This is requiring a considerable investment of time and resources which is something that is becoming rare in the demanding

Africa has known a fruit industry for a very long time, especially in some countries like South Africa. With the demand for more tropical fruits this industry has gained in importance over the last decades

research world of today. I hope we will find some means to tackle this and make the unit a bit more modern after almost 20 years of existence.

How does TEAM integrate into the overall organizational landscape of plant protection?

TEAM focuses on a particular pest (fruit flies) and a particular region (Europe, Africa, Middle East). Plant protection requires a global approach but regions are differently structured and tackle the problem in their own way. I can see TEAM providing that specific insight from a regional perspective.

You have extensive experience of fruit fly work in Africa: Could you also tell us about your research work in Africa? And more generally, could you tell us a bit about the importance of the Fruit Fly problem in Africa and its evolution? What are the differences and similarities to the problems in Europe? Do you see any direct influence of the Fruit Fly problem in Africa and other continents on the situation in Europe?

As mentioned earlier, my initial research work in Africa focused on taxonomically revising a number of fruit fly groups from Africa. That way tools could be developed for the researchers to understand the diversity of the group in the region, and how to recognize the most important ones. This was then extended into other fields. Through the taxonomic revisions, I looked at vast collections originating from different parts of the continent and gathered a lot of information on aspects such as their distribution or host plant range. Gradually, this brought me to more applied aspects such as where and when does what species occur, which fruits is it infesting, how can you try to control it, how are different populations related to each other, etc.

Fruit flies are one of the main problems in the fruit industry in Africa. Africa has known a fruit industry for a very long time, especially in some countries like South Africa. With the demand for more tropical fruits this industry has gained in importance over the last decades. But Africa is facing similar problems like Europe or North America, especially with regard to invasive species. There is a long history of invasive patterns between Europe and Africa. Just think of the Mediterranean fruit fly, *Ceratitidis capitata*, which is actually not of Mediterranean origin but originates from eastern or southern Africa and that was introduced in the former region in the first half of the 19th Century. Over the last decades Africa has faced the problem of invasive species as well, the most notorious one being the Oriental fruit fly, *Bactrocera dorsalis*. Of Asian origin, it was detected in Africa in 2003 and has since spread throughout Africa at a tremendous speed, outcompeting indigenous species. It is nowadays the most important fruit fly pest in the region. Recently it has been reported also in European countries like France and Italy, and it is one of the



With colleagues and trainees during a training course at Stellenbosch University South Africa

target species in FF-IPM. Because of this and other species, Africa is facing the same challenges as early detection of other invasive species, developing control measures, or tackling the trade implications of having such pest species. But the main differences between Europe and Africa are those inherent to developing countries. Africa just has far too limited means to tackle these problems in an effective way. It is very hard for any African country to establish appropriate surveillance programs, or to develop control measures at an area-wide scale. This requires considerable input of funds which are largely lacking. In addition, because of the tropical to subtropical conditions in the majority of the countries and the importance of horticulture in most countries, being it for local consumption or as an international trade commodity, it is a lot more vulnerable.

What are the key lessons learned from your experience for the management of problems caused by fruit flies for food security in Europe and worldwide?

I think the key lessons are prevention and fast reaction. Preventing a problem is much easier than solving a problem. This means having pro-active detection systems put in place which can detect and intercept new incursions in a fast and efficient manner. Should any new detection be discovered, the government must ideally have an action plan in place that can be put at work immediately. Fast reaction may actually prevent new species becoming established. With the increase in trade, but more importantly people travelling between continents, the risks of import of new pests also increases. On top of that climate change may make certain parts in the world more suitable for

particular pests in a way that was not considered relevant a few decades ago. So, governments should invest in these pro-active measures.

What do you see as the main challenges in this area?

Unfortunately, a problem that is not yet there is often not considered a problem and action will only come once it is too late. We need to convince policy makers that they could save a lot of money in the long run if they invest some money now for preventing a future threat. It is not easy, especially because there are so many different issues and problems a country or region is facing, each of them requiring funds.

Finally, could you tell us a bit about your work in FF-IPM, what do you consider to be the main contributions of the project for future Fruit Fly management?

With a team of four scientists, we are involved in some of the research aspects within FF-IPM. In addition, as

the technical manager, I follow up on the technical developments of the different components of the project and thus assist the principal coordinator in the general management of the project as a whole.

FF-IPM is actually aiming to develop different tools to allow countries reacting fast and in an appropriate way, as outlined earlier. FF-IPM is a two-pronged approach. We develop tools such as e-traps, e-nose, fast identification tools, and predictive models that can be a warning system for potential threats and allow fast detection and interception. It will improve the border control and mitigate the risk of new invasive species entering the region of expanding their range. On the other hand, if a species should become established, we should be able to mitigate its impact on the fruit production. With the more stringent regulations in Europe regarding use of insecticides, we need a more environmental friendly toolbox for this. FF-IPM focuses on 'off-season' control targeting the pest species at the moment when the populations are not at their peak and using a variety of Integrated Pest Management tools.

TEAM (Tephritid Workers of Europe, Africa and the Middle East) is a regional network of researchers dealing with different aspects of tephritid fruit fly work (Diptera: Tephritidae).

It consists as an independent, professional and scientific organization that intends to

- provide a platform of interaction that will promote collaboration and communication among scientists of Europe, Africa and the Middle East,
- pursue and stimulate the generation of basic and applied research to solve agricultural and trade problems related to fruit flies in these regions,
- serve as a consulting forum to State Agencies on topics related to the noxious effect of fruit flies,
- act as a link between other world organizations dealing with fruit flies in order to generate joint activities,
- serve to bring the general public closer to the scientific and technical community working with fruit flies.

→ See: <https://nucleus.iaea.org/sites/naipc/twd/Pages/TEAM.aspx>

Publications

IOBC-WPRS Bulletin

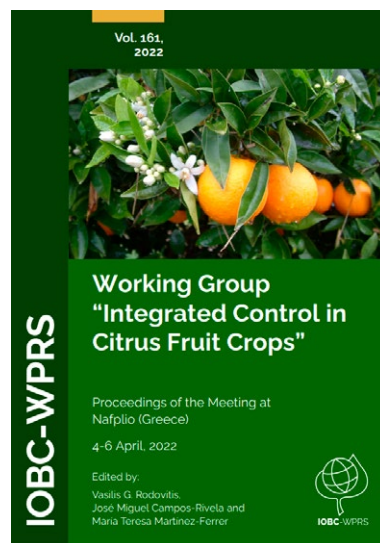
The Proceedings of the 13th IOBC-WPRC Meeting of the Citrus Working Group on “Integrated Control in Citrus Fruit Crops” (April 4-6, 2022, in Nafplion, Greece) were published.

As it was mentioned in the 5th Newsletter, several members of the FF-IPM project presented their research work. In this Bulletin, all the abstracts of the works presented during the Meeting, are included. Additionally, several oral presentations and posters are included in the publication as full papers. One of them belongs to Mario Bjelis (University of Split) and his team.

It is entitled, “Invasion of *Ceratitis capitata* W. (Diptera, Tephritidae) from coastal to inland areas of Dalmatia region of Croatia: E-traps as an improved detection tool”.

ABSTRACT

The Mediterranean fruit fly, *Ceratitis capitata* (Wied.), is a pest of great economic importance worldwide and in the coastal areas of Croatia. After the introduction and establishment of this pest in the coastal areas, there was no evidence of its spread to the less favourable neighbouring areas north of the coast. In order to investigate the spread of *C. capitata* to inland areas, a grid of conventional and electronic traps was established in 25 sites, at the edges of the pests' current distribution, where populations expand and contract their range seasonally. For each site, data was collected on host species,



habitat description, elevation and geographic location using a GPS. Two types of conventional traps were used to monitor *C. capitata* population: Tephri traps baited with 3C lure (tri-methyl amine, putrescine, and ammonium acetate) and Jackson traps baited with trimedlure. A new improved detection tool, e-traps, was developed under the EU Horizon 2020 project “Fruit flies In Silico Pest Management (FF-IPM)”. This improved method of fruit fly detection and monitoring was incorporated into a conventional network of traps. The e-traps were set using locally purchased SIM cards and batteries. A total of 12 e-traps were successfully set at six sites (two e-traps per site, one with 3C bait and one with trimedlure) in trapping stations adjacent to existing Tephri traps and Jackson traps. Traps were inspected at weekly intervals and the number of males and females of *C. capitata* and other non-target insects were recorded.

Surveys conducted in 2020 and 2021 showed that *C. capitata* has spread and invaded large parts of the sub-Mediterranean inland area of Split – Dalmatia and Šibenik – Knin counties. The e-traps provided a good early warning of the presence of the *C. capitata* in costal and invaded areas.

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

1

***Bactrocera dorsalis* in the Indian Ocean: A tale of two invasions**

JOURNAL NAME

Evolutionary Applications

AUTHORS

Pablo Deschepper,
Sam Vanbergen, Yue Zhang,
Zhihong Li, Issa Mze Hassani,
Nausheen Azhaar Patel,
Henriette Rasolofoarivao,
Sandeep Singh, Suk Ling Wee,
Marc De Meyer,
Massimiliano Virgilio
& H el ene Delatte

ABSTRACT

An increasing number of invasive fruit fly pests are colonizing new grounds. With this study, we aimed to uncover the invasion pathways of the oriental fruit fly, *Bactrocera dorsalis* into the islands of the Indian Ocean. By using genome-wide SNP data and a multipronged approach consisting of PCA, ancestry analysis, phylogenetic inference, and kinship networks, we were able to resolve two independent invasion pathways.

A western invasion pathway involved the stepping-stone migration of *B. dorsalis* from the east African coast into the Comoros, along Mayotte and into Madagascar with a decreasing genetic diversity. The Mascarene islands (Reunion and Mauritius), on the contrary, were colonized directly from Asia and formed a distinct cluster. The low nucleotide diversity suggests that only a few genotypes invaded the Mascarenes. The presence of many long runs of homozygosity (ROH) in the introduced populations is indicative of population bottlenecks, with evidence of a more severe bottleneck for populations along the western migration pathway than on the Mascarene islands. More strict phytosanitary regulations are recommended in order to prevent the further spread of *B. dorsalis*.



WILEY

→ Read the article [HERE](#)

2

Acute cold stress and supercooling capacity of Mediterranean fruit fly populations across the Northern Hemisphere (Middle East and Europe)

JOURNAL NAME

Journal of Insect Physiology

AUTHORS

Georgia D. Papadogiorgou,
Cleopatra A. Moraiti,
David Nestel, John S. Terblanche,
Eleni Verykoui,
Nikos T. Papadopoulos

C. capitata is
gradually expanding
its geographic
distribution to cooler
temperate areas of the
Northern Hemisphere

ABSTRACT

The Mediterranean fruit fly, *Ceratitidis capitata* (Diptera: Tephritidae), holds an impressive record of successful invasion events promoted by globalization in fruit trade and human mobility. In addition, *C. capitata* is gradually expanding its geographic distribution to cooler temperate areas of the Northern Hemisphere.

Cold tolerance of *C. capitata* seems to be a crucial feature that promotes population establishment and hence invasion success. To elucidate the interplay between the invasion process in the northern hemisphere and cold tolerance of geographically isolated populations of *C. capitata*, we determined (a) the response to acute cold stress survival of adults, and (b) the supercooling capacity (SCP) of immature stages and adults. To assess the phenotypic plasticity in these populations, the effect of acclimation to low temperatures on acute cold stress survival in adults was also examined. The results revealed that survival after acute cold stress was positively related to low temperature acclimation, except for females originating from Thessaloniki (northern Greece). Adults from the warmer environment of South Arava (Israel) were less tolerant after acute cold stress compared with those from Heraklion (Crete, Greece) and Thessaloniki. Plastic responses to cold acclimation were population specific, with the South Arava population being more plastic compared to the two Greek populations.

For SCP, the results revealed that there is little to no correlation between SCP and climate variables of the areas where *C. capitata* populations originated. SCP was much lower than the lowest temperature individuals are likely to experience in their respective habitats. These results set the stage for asking questions regarding the evolutionary adaptive processes that facilitate range expansions of *C. capitata* into cooler temperate areas of Europe.



Harmonization of phytosanitary treatments to prevent the spread and introduction of fruit fly pests



Vanessa Simões Dias | Entomologist (Phytopsanitary)
Insect Pest Control Section, Joint FAO/IAEA Centre
of Nuclear Techniques in Food and Agriculture

Killing or inactivating plant pests in fresh agricultural commodities by applying harmonized phytosanitary treatments, also known as post-harvest treatments, has been a primary strategy to facilitate the international trade of agricultural commodities and ensure global plant health protection. Physical and chemical phytosanitary treatments are applied to disinfect harvested commodities and control regulated pests. This practice reduces the risk of introducing and establishing quarantine insects in pest free areas.

Although the phytosanitation of agricultural products seems straightforward, in business practice, its application relies on agreements between trade partners that can take many years to complete. Research and development constitute significant factors in these bilateral negotiations. The evaluation of phytosanitary treatment efficacy and the proposal of new treatment schedules require access to a large number of colonized insect pest species, proper equipment, and qualified human resources to be conducted.

Aware of the bottlenecks in the phytosanitation of agricultural commodities, the Joint FAO/IAEA Programme of Nuclear Techniques in Food and Agriculture through the Insect Pest Control (IPC) Subprogramme established a scientific collaboration with the U. S. Department of Agriculture (USDA). The research projects on phytosanitary treatments conducted in the Insect Pest Control Laboratory (IPCL) of the Joint FAO/IAEA Centre support

the harmonization and development of scientifically sound and efficacious phytosanitary treatments using ionizing radiation, cold, and heat against the most destructive fruit fly pests of economic importance of the world. The IPCL maintains colonies of many tropical tephritid fruit fly species of economic importance and numerous fruit fly populations from around the world, allowing for unparalleled phytosanitary treatment research against plant quarantine pests.

Concrete regulatory accomplishments have been achieved based on the scientific data generated by the phytosanitary project conducted in the IPCL during the past decade. For instance, research on the effect of low-oxygen storage on phytosanitary irradiation efficacy conducted at IPCL was evaluated by the Technical Panel on Phytosanitary Treatments (TPPT) of the International Plant Protection Convention (IPPC) and supported its recommendation to remove the restriction from irradiation treatments



Left: Irradiation of infested blueberries for research on phytosanitary treatment .
 Right: Inajara Viana and Fabio Luís Galvão, FAO/IAEA interns, dissecting fruit infested by *Zeugodacus tau* after exposure to cold phytosanitary treatment

under modified atmosphere against tephritid fruit flies. Our results showed that with phytosanitary irradiation doses approved internationally for tephritids, low oxygen treatments applied before and during irradiation did not reduce the efficacy of irradiation protocols for fruit fly pests. In 2021, the Commission on Phytosanitary Measures (CPM-15) adopted the TPPT recommendation to remove the restriction of phytosanitary irradiation application against fruit flies for commodities stored in a modified atmosphere.

As a result, the disclaimer “This irradiation treatment should not be applied to fruits and vegetables stored in modified atmospheres” was removed from nine annexes of the International Standard for Phytosanitary Measure number 28 (ISPM 28). The removal of the restriction to phytosanitary irradiation treatments targeting fruit fly pests has the potential to increase their applicability and advance the use of nuclear technology for agricultural purposes.

Comparative research on cold and heat treatments against populations of *Bactrocera dorsalis* and *Ceratitis capitata* from different geographical origins led to the adoption of eight annexes to ISPM 28 by the IPPC. This facilitates global cooperation to protect plants from harmful pests, such as fruit fly pests, that may be introduced and spread through international trade.

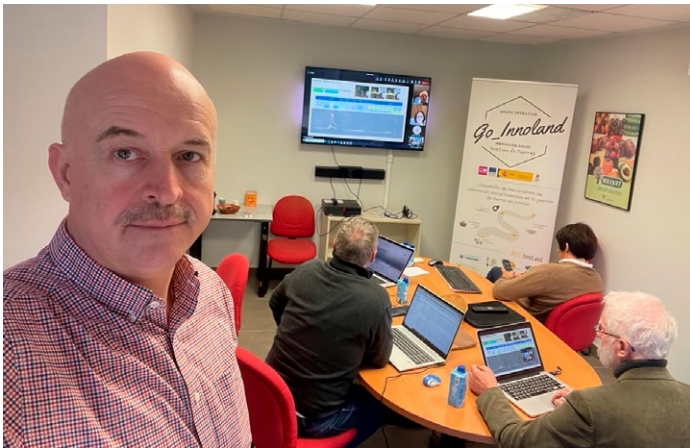
Future research will continue to evaluate the effect of physical and biological factors on the efficacy of phytosanitary treatments to provide data for advancing their application. Additionally, the thermal limits of *Anastrepha ludens* have been assessed to determine whether thermal tolerance under acclimation and non-acclimation differs among *A. ludens* populations. Information on thermal tolerance should enable us to understand better the potential for *A. ludens* to extend its geographical distribution to temperate areas.



Vasilis Rodovitis conducting experiments to measure the thermal limits of *Anastrepha ludens*



Vanessa Simões Dias



Workshop for WP6 in Spain

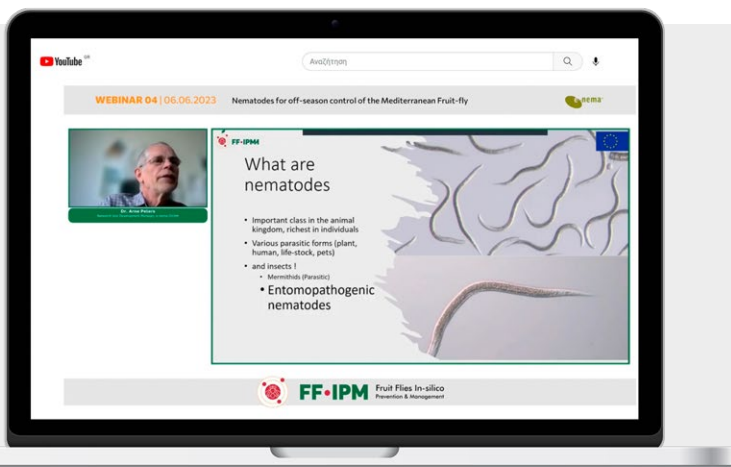
Partners involved in WP6 met in Valencia, Spain, on March 2, 2023. Slawomir Lux, Andrea Sciarretta, Nikos Papadopoulos, Angel del Pino and Nicolas Juste met in person while Josep Jaques and Ana Larcher connected online. In this Workshop, FF-IPM partners made an overview of WP6 regarding the progress of field work, the economic analysis and the future pilot testing.

Invited presentation to IRTA Plant Health Workshop

Nikos Papadopoulos was invited to present the FF-IPM Project in Plant Health Workshop: "Advances in plant disease and pest management: a holistic approach" on February 28, 2023, in Barcelona, Spain. The workshop was held by IRTA (Institute of Agrifood Research and Technology). His presentation entitled "A holistic approach to address invasive pests of fresh fruits".



Webinar 04



Upcoming Webinar

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

WEBINAR 5

"Interception of fruit fly infested fruits in cargo shipment" by Dr. Panos Mylonas.

STAY TUNED FOR UPDATES

→ visit the [webinars page](#)

First report of the solanum fruit fly *Bactrocera latifrons* in France

The NPPO of France recently informed the EPPO Secretariat of the first occurrence of the solanum fruit fly *Bactrocera latifrons* (Diptera: Tephritidae – EPPO A1 List) on its territory. An adult of *B. latifrons* was caught and frozen by an arboriculturist in November 2022 in Rhône department (Auvergne-Rhône-Alpes region). The regional phytosanitary services were informed of this detection in January 2023. This is the first time that *B. latifrons* is found in France.

Investigations are ongoing at sites considered 'at risk' in the vicinity of the detection site (e.g. fruit and vegetable retailers, fresh produce wholesale market, composting sites). Until now, no symptoms have been observed and no larvae of *B. latifrons* have been found.

The NPPO considers that this isolated finding is most likely linked to the import of infested exotic products, and not linked to an outbreak. In addition, it is very likely that the cold weather prevailing in January in the Rhone department has killed any other specimens.

The pest status of *Bactrocera latifrons* in France is officially declared as: **Transient, isolated finding, not linked to an outbreak.**

Source: NPPO of France (2023-02)

Upcoming Events

The [10th International Congress of Dipterology \(ICDX\)](#) will be held on July 16–21, 2023, in Reno, Nevada, USA

[Rethink Food Resources, Losses, and Waste Third International Conference](#) will be held on September 27-29, 2023, in Athens, Greece

[XII European Congress of Entomology \(ECE\) 2023](#) will be held on October 16-20, 2023, in Heraklion, Crete, Greece

[Entomology 2023](#) will be held on November 5-8, 2023 in National Harbor, MD

FF-IPM Training Workshop on developed ID tools will be held on October 12, 2023 in Nafplio, Greece

FF-IPM Final project meeting and Stakeholder Event will be held November 12 – 15, 2023 in Valencia, Spain



Fruit Flies In-silico
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