

## Darwin Fellowship - Final Report

*Due within one month of the end date of the Fellowship (maximum 6 pages)*

Darwin Fellowship reference	DARFW124
Name of Darwin Fellow	Jakovos Demetriou
Lead organisation	Enalia Physis Environmental Research Centre, Acropoleos 2, Aglantzia 2101, Nicosia, Cyprus
Fellow's organisation(s)	Joint Services Health Unit Cyprus, BFC RAF Akrotiri BFPO 57, Akrotiri, Cyprus
Fellow's role within their organisation	Project officer
Start/end date of Fellowship	01/07/2021 – 30/06/2023
Location	SBAs of Akrotiri & Dhekelia (Cyprus)
Darwin Fellowship grant value (£)	32,000.00
Type of work (e.g. research, training, if other please specify)	Research
Main contact in UK organisation	██████████
Author(s) and date	Prof Helen Roy, Dr Kelly Martinou, Mr Marios Papageorgiou, Jakovos Demetriou  17/07/2023

### 1. Background

Before starting my Fellowship, I was studying in Greece for my MSc degree on “Ecology and Biodiversity Conservation” at the National and Kapodistrian University of Athens. During my Masters, I learnt about invasive non-native species (INNS) and relevant policies and started working on a checklist of alien insects present in Cyprus. During my research, I found about the online Cyprus Database of Alien Species (CyDAS) which was constructed during the DPLUS056 and DPLUS088 projects. From there, I contacted Dr Kelly Martinou and Prof Helen Roy, the lead researchers of the CyDAS project. We started discussing about INNS in Cyprus and the Darwin projects conducted at the SBAs Akrotiri and Dhekelia. This communication encouraged us to apply and get funding for the project DPLUS124, which aimed to complement the programmes that have been established with Darwin Plus funding. The project also aimed to increase our understanding of the impacts of INNS in a protected area through the involvement of citizen-scientists who can be stewards of biodiversity within the protected wetland of Akrotiri. The project's objectives were to:

1. Raise awareness on INNS by initiating and promoting a citizen-science recording scheme for invasive non-native invertebrates.
2. Identify knowledge gaps regarding the impacts of non-native invertebrates on the island of Cyprus.
3. Review the literature and other sources, including grey literature and social media, to update and create a public-facing interface for the CyDAS developed through DPLUS056.
4. Create information sources to raise awareness and develop alert/rapid response schemes for invasive non-native insects likely to arrive and establish at the SBAs that have impacts on biodiversity, economy and human health.
5. Create distribution maps for 10 invasive and non-native species present at the Peninsula.
6. Explore impacts of alien plants on ecological networks using entomological and citizen-science data for the orders Hymenoptera and Diptera.

Updating the CyDAS was mostly a desk-based job during which species profiles were created and/or updated. Informational and educational materials were prepared and made available online, while online and personal data were made available for the construction of distributional maps. In addition, sampling was conducted on non-native plants such as eucalypts, *Acacias* and fig trees to assess their biodiversity. During the literature review process and acquiring information sources, I contacted experts throughout the world. The Joint Services Health Unit (JSHU) hosted me and oversaw my daily work, while the UK Centre of Ecology and Hydrology was responsible for mentoring me and making sure that I was involved in national and international projects. Enalia Physis Environmental Research Centre oversaw the project's deliverables, work plan and project reporting to the Darwin Initiative. I had frequent meetings with all the involved organisations during which we discussed problems, timeframes and next steps.

## 2. Achievements

During the Fellowship I worked both remotely and in the JSHU premises updating CyDAS and creating educational material on INNS. I conducted fieldwork and contacted experts to decipher the non-native insect fauna of Cyprus and supplemented current knowledge on the non-native flora and fauna of Cyprus as a whole. I communicated the outcomes of the Fellowship with stakeholders such as the public, competent authorities, academics, etc. through dissemination events and published peer-reviewed scientific articles. Based on the project's objectives:

(1) I created and promoted a citizen-science recording scheme for invasive non-native insects (<https://www.inaturalist.org/projects/alien-to-cyprus-entomofauna>) as well as non-native species as a whole (<https://www.inaturalist.org/projects/cydas>) throughout the creation of two collection projects on the iNaturalist biodiversity data platform with the aim to raise awareness on INNS. Utilizing the capability of constructing "Collection Projects" on iNaturalist, records of selected species of interest (i.e. non-native species reported from Cyprus) are automatically pooled into the projects' webpages and their metadata can be easily downloaded for analyses. In addition, by selecting species that have not been recorded on the island before, we constructed a first line of defence against these species and maintain an early-warning system regarding their arrival, powered by the public. These endeavours have been promoted during dissemination events and conferences listed below.

(2) I performed a thorough literature investigation which led to the publication of a review article in the scientific journal *NeoBiota* (IF: 4.2; Q1) with the aim to identify knowledge gaps regarding the impacts of non-native invertebrates on the island of Cyprus. The article on the "Alien to Cyprus Entomofauna (ACE) database" addressed all current knowledge about biological invasion of non-native insects in Cyprus including their biodiversity, origin, trophic preferences, alien status, establishment, means of introduction and impacts.

(3) I performed a literature (scientific and grey literature) investigation and checked previously cited sources updating species profiles of non-native species found on the island with the aim to update and create a public-facing interface for the CyDAS developed through DPLUS056 project. After two years of work, I managed to double the number of alien species known for the island from 664 species profiles available on the CyDAS to currently 1220. However, with the publication of upcoming articles this number is expected to further increase. I added data on the species' habitats, references in scientific literature, common names in English and Greek, establishment status, first detection year as well as introduction pathways. Where possible, I included photographs of the species to make the platform friendlier to the public. The total number of non-native species in Cyprus as well as the impact of the CyDAS will be further communicated through the publication of a scientific article currently drafted by the project team.

(4) I drafted informational posters on a total of 50 non-native species of invertebrates, fishes, amphibian and reptiles, birds and mammals, aiming to raise awareness and develop alert/rapid response schemes for invasive non-native insects likely to arrive and establish at the SBAs. These posters have been made available online at: <https://ris-ky.info/invasive-species-and-biosecurity>. In addition, these posters were made available through iNaturalist and can be found on the projects' log alongside journal posts on newly detected non-native species on

Cyprus: <https://www.inaturalist.org/projects/alien-to-cyprus-entomofauna/journal><https://www.inaturalist.org/projects/cydas/journal>

(5) In addition, I created distribution maps for 10 invasive and non-native species present at the Peninsula. These can be found attached as separate files.

(6) I sampled non-native plant species to assess their biodiversity to explore the impacts of alien plants on ecological networks using entomological and citizen-science data for the orders Hymenoptera and Diptera. This led to the publication of scientific articles on newly detected non-native species (see below) while in accordance to findings of other studies non-native plants seem to host a variety of non-native insects specialized on their host-plants. As Diptera was a taxonomically challenging group of insects we focused more on Hymenoptera and Coleoptera providing a checklist of beetles found up-to-date on eucalypts on Cyprus as well as alien Hymenoptera of non-native eucalypts and fig trees.

#### International congresses:

- **UPCOMING!** Demetriou J, Koutsoukos E, Georgiadis C, Roy HE, Martinou AF (2023) Alien bees, wasps and ants of Cyprus: current knowledge, gaps and what's next. ENTO23' - Royal Entomological Society (oral presentation) (5-7 Sep 2023)
- Demetriou J, Georgiadis C, Koutsoukos E, Borowiec L, Salata S (2022) Alien ants on a quest to conquer Greece. Proceedings of the 15th International Congress on the Zoogeography and Ecology of Greece and Adjacent Regions (poster presentation) (12-15 Oct 2022).
- Koutsoukos E, Demetriou J, Kalaentzis K, Kazilas C, Georgiadis C, Avtzis DN (2022) The alien Chalcidoidea of Greece. 19th Panhellenic Entomological Congress (poster presentation) (23-27 May 2022).
- Demetriou J, Radea C, Roy HE, Arianoutsou M, Martinou AF (2021) The alien to Cyprus entomofauna. HELECOS 10 - 10th Hellenic Conference of Ecology (oral presentation) (14-17 Oct 2021).
- Demetriou J, Martinou AF, Radea C, Roy HE, Arianoutsou M (2021) Non-native insect species associated with eucalypts in Cyprus. ENTO21' - Royal Entomological Society (poster presentation) (23-27 Aug 2021).

#### Scientific publications:

- **UPCOMING!** Demetriou J, Georgiadis C, Martinou AF, Roy HE, Wetterer JK, Borowiec L, Economou EP, Triantis KA, Salata S (in press) Running rampant: the alien ants (Hymenoptera: Formicidae) of Cyprus. NeoBiota (submitted manuscript)
- **UPCOMING!** Salata S, Demetriou J, Georgiadis C, Borowiec L (in press) *Camponotus* Mayr, 1861 (Hymenoptera: Formicidae) of Cyprus: generic synopsis and description of a new species. Asian Myrmecology (submitted manuscript)
- **UPCOMING!** Christou M, Lippert S, Weigand A, Angelidou I, Athanassiou KC, Demetriou J, Schaffner F, Martinou AF (in press) First record of the invasive Asian tiger mosquito *Aedes albopictus* in Cyprus based on information collected by citizen scientists. Journal of the European Mosquito Control Association 41(1): xx-xx. <https://doi.org/10.52004/JEMCA2022.0008> (published online - issue not assigned)
- Martinou A F, Athanassiou K, Angelidou I, Demetriou J, Christou M, Georgiou M, Dillen M (2023). *Aedes albopictus* recordings in Cyprus based on information provided by citizens and experts. Version 1.7. Meise Botanic Garden. Occurrence dataset <https://doi.org/10.15468/sperfd> accessed via GBIF.org on 2023-07-10.
- Salata S, Demetriou J, Georgiadis C, Borowiec L (2023) The genus *Messor* Forel, 1890 (Hymenoptera: Formicidae) in Cyprus. Annales Zoologici 73(2): 215-234. <http://dx.doi.org/10.3161/00034541ANZ2023.73.2.006>
- Demetriou J, Davranoglou LR, Makris C (2023) First record of *Thaumastocoris peregrinus* (Hemiptera: Thaumastocoridae) in Cyprus. Travaux du Muséum National d'Histoire Naturelle "GrigoreAntipa" 66(1): 135–141. <https://doi.org/10.3897/travaux.66.e90065>
- Zahradník P, Demetriou J (2023) A review of the Ptinidae (Coleoptera: Bostrichoidea) of Cyprus, including new faunistic records and the description of a new species. Zootaxa 5306(2): 243-265. <https://doi.org/10.11646/zootaxa.5306.2.5>

- Demetriou J, Koutsoukos E, Mavrovounioti N, Radea C, Arianoutsou M, Roy HE, Compton SG, Martinou AF (2023) A rather unfruitful relationship? Fig wasps (Hymenoptera: Chalcidoidea) of the alien invasive *Ficus microcarpa* in Cyprus. *BioInvasions Records* 12(2): 573-580. <https://doi.org/10.3391/bir.2023.12.2.20>
- Koutsoukos E, Demetriou J (2023) Knowing no limits: First record of *Ozognathus cornutus* (Coleoptera: Ptinidae: Anobiinae) in Greece, including new host-plant records. *Entomologia Hellenica* 32(1): 1-6. <https://ejournals.epublishing.ekt.gr/index.php/entsoc/article/view/31415>
- Salata S, Demetriou J, Georgiadis C, Borowiec L (2023) The ant genus *Cataglyphis* Förster (Hymenoptera: Formicidae) in Cyprus. *Zootaxa* 5264(3): 301-322. <https://doi.org/10.11646/zootaxa.5264.3.1>
- Demetriou J, Radea C, Peyton JM, Groom Q, Roques A, Rabitsch W, Seraphides N, Arianoutsou M, Roy HE, Martinou AF (2023) The Alien to Cyprus Entomofauna (ACE) database: a review of the current status of alien insects (Arthropoda, Insecta) including an updated species checklist, discussion on impacts and recommendations for informing management. *NeoBiota* 83: 11-42. <https://doi.org/10.3897/neobiota.83.96823>
- Angelidou I, Demetriou J, Christou M, Koutsoukos E, Kazilas C, Georgiades P, Kalaentzis K, Kontodimas DC, Groom Q, Roy HE, Martinou AF (2023) Establishment and spread of the invasive ladybird *Harmonia axyridis* (Coleoptera: Coccinellidae) in Greece: based on contributions from citizen scientists. *Biological Invasions* 25: 889-900. <https://doi.org/10.1007/s10530-022-02955-8>
- Demetriou J, Georgiadis C, Roy HE, Martinou AF, Borowiec L, Salata S (2022) One of the world's worst invasive alien species *Wasmannia auropunctata* (Hymenoptera: Formicidae) detected in Cyprus. *Sociobiology* 69(4): e8536. <https://doi.org/10.13102/sociobiology.v69i4.8536>
- Demetriou J, Koutsoukos E, Davranoglou L-R, Roy H, Spodek M, Martinou A (2022) First records of the alien Eucalyptus psyllids *Blastopsylla occidentalis* (Hemiptera, Aphalaridae) from Cyprus and *Platyobria biemani* (Hemiptera, Aphalaridae) from Cyprus and continental Greece. *Travaux du Muséum National d'Histoire Naturelle "Grigore Antipa"* 65(1): 25-36. <https://doi.org/10.3897/travaux.65.e82873>
- Demetriou J, Kakiopoulos G, Háva J, Martinou A, Delobel A (2022) First record of the alien seed beetle *Stator limbatus* (Coleoptera, Chrysomelidae, Bruchinae) from Cyprus. *Travaux du Muséum National d'Histoire Naturelle "Grigore Antipa"* 65(1): 37-43. <https://doi.org/10.3897/travaux.65.e81350>
- Demetriou J, Koutsoukos E, Radea C, Roy HE, Arianoutsou M, Martinou AF (2022) Uninvited pests of an unwelcomed tree: A survey on alien chalcidoid wasps (Hymenoptera: Chalcidoidea) associated with *Eucalyptus* trees in Cyprus. *BioInvasions Records* 11(2): 390-400. <https://doi.org/10.3391/bir.2022.11.2.12>

#### Public and dissemination events:

- Presentation on the CyDAS in the framework of DPLUS175 "Enhancing monitoring and prevention of invasive non-native species across UKOTs" in Gibraltar (26-30 Jun 2023).
- "Akrotiri BioBlitz 2023". Organised by Dr Angeliki F Martinou and myself, under COST Action CA 17122 "Increasing understanding of alien species through citizen science" (26-28 May 2023).
- "Terrestrial Restoration, and Invasive Non-Native Species in the UK Overseas Territories and Crown Dependencies". Workshop organised by the UK Overseas Territories Conservation Forum (6-8 Mar 2023).
- "Akrotiri Peninsula – biotic & abiotic monitoring, status & trends". Workshop organised within the framework of "DPLUS141: Habitat Restoration & Wise Use for Akrotiri & Cape Pyla" (8-9 Dec 2022).
- "Online workshop on the management of invasive alien ant species". Organised by IUCN (7 Sep 2022).
- "How citizen scientists can help us monitor the alien butterflies and moths of Cyprus", within the framework of "Developing butterfly and moth monitoring in Cyprus as an element of an EU Pollinator Monitoring Scheme Workshop". Organised by DPLUS123 "Enhance the knowledge of pollinators (butterflies and moths) in the Sovereign Base Area of Akrotiri through citizen science schemes" and in cooperation with the European



project SPRING "Strengthening Pollinator Recovery through INDicators and monitorinG" (10-11 June 2022) (oral presentation).

- "Akrotiri BioBlitz 2022". Organised by Dr Angeliki F Martinou (Joint Services Health Unit) and Dr Niki Chartosia (University of Cyprus), under COST Action CA 17122 "Increasing understanding of alien species through citizen science" (20-22 May 2022).
- "You can also become an entomologist through citizen science". SCYence Fair 2022. Organised by the Cyprus Institute and Aglantzia municipality (15-16 Apr 2022).
- "Alien insects and citizen science". Event held at the Akrotiri Environmental Education Centre. Organised by Dr Angeliki F Martinou, Dr Maria Christou, Dr Elli Tzirkalli, Mr Evangelos Koutsoukos, Ms Joanna Angelidou, Ms Katerina Athanasiou, and Mr Jakovos Demetriou (04 Apr 2022) (oral presentation).
- "Identifying measures to tackle pressures from IAS on wild pollinators in the EU context – Expert consultation workshop". Organised by Environment Agency Austria (EAA) and Pensoft Publishers (27 Jan 2022)
- "The Pollinators Monitoring Scheme of K ypros (PoMS-K y) celebrates insect week". Event held at the Akrotiri Environmental Education Centre. Organised by Dr Angeliki F Martinou, Ms Joanna Angelidou, Ms Katerina Athanasiou, Dr Maria Christou and Mr Jakovos Demetriou (27 Jun 2021) (oral presentation).

### 3. Outcome, lessons and impact

Throughout my Darwin Fellowship I improved my knowledge skills regarding biological invasions and the biodiversity of non-native species on the island of Cyprus as well as in Europe in general. I improved my writing, management and problem-solving skills, which are vital to my future endeavours in pursuing a career as a researcher. I also gained expert knowledge on non-native insects, their impacts and interactions with native and non-native species which has been a primary focus of my scientific research. These skills have been crucial in advancing my career and enrolling in a PhD programme studying the systematics, conservation and biogeography of Eastern Mediterranean ants as well drafting a new Darwin Plus Fellowship project beginning on July 1<sup>st</sup> 2023.

During DPLUS124 my interest in ants grew over time, with a milestone being the discovery of the invasive non-native species *Wasmannia auropunctata* (the little fire ant), an invasive species of Union Concern which was swiftly reported to the competent authorities. This finding led me to sample ants around the island and draft a project proposal on studying "The biodiversity and spatiotemporal patterns of ants in the protected Akrotiri Peninsula" (DPLUS200), a project which will run from 01/07/2023 to 30/06/2025 (<https://darwinplus.org.uk/project/DPLUS200/>). This project will be supported by Enalia Physis Environmental Research Centre given our excellent cooperation in the framework of DPLUS124, building a long-lasting trust and partnership bond.

The Fellowship produced a baseline of the alien non-native insects of Cyprus summarizing all available knowledge and providing new insight on their trends and impact on native biodiversity, economy and human-health. Furthermore, the updating of the CyDAS has strengthened its potential use from policy makers, government officials as well as the public. The outcomes of this Fellowship can be effectively used in guiding management practices and future INNS policies on the island. Further studies on management priorities against INNS will be carried out on the island in the future, with the work conducted during DPLUS124 supporting these endeavours.

During the Fellowship I made contact with scientists around Europe e.g. Austria (Dr Wolfgang Rabitsch – Environment Agency Austria, 1090 Vienna), Belgium (Dr Quentin Groom – Meise Botanic Garden), Cyprus (Mr Christodoulos Makris, Mr Michael Hadjiconstantis – Forestry Department, Dr Nicos Seraphides – Agricultural Research Institute, Aglantzia, Nicosia, Dr Marios Aristophanous, Ms Anthemis Melifronidou and Ms Despina Koukkoularidou – Department of Agriculture, Ministry of Agriculture, Rural Development and Environment, Mr Savvas Savva – Veterinary Services, Ministry of Agriculture, Rural Development and Environment), Czechia (Drs Jiri Hava and Petr Zahradnik – Forestry and Game Management Research Institute, Praha), France (Dr Alex Delobel, Dr Alain Roques – INRAE, Zoologie Foresti re, Orl ans), Gibraltar (Dr Rhian Guillem – Gibraltar Botanic Gardens), Greece (Mr

George Kakiopoulos, Mr Evangelos Koutsoukos, Dr Kostas Triantis, Dr Christos Georgiadis, Dr Canella Radea and Prof Margarita Arianoutsou – National and Kapodistrian University of Athens), Israel (Dr Malkie Spodek – The Steinhardt Museum of Natural History, Tel Aviv University), Japan (Prof Evan Economo – Okinawa Institute of Science and Technology), the Netherlands (Mr André van Eck), Poland (Dr Sebastian Salata and Prof Lech Borowiec – University of Wrocław, Department of Biodiversity and Evolutionary Taxonomy, Myrmecological Laboratory, Wrocław), the UK (Mr Eddie John, Dr Alex Ramsay, Dr Leonidas Romanos Davranoglou – University of Oxford, Prof Stephen Compton – University of Leeds, Drs Oliver Pescott, Jodey Peyton, David Roy – UK CEH) and the USA (Prof James K Wetterer – University of Florida), with whom I got to collaborate, learn more about the biodiversity of native and non-native insects as well as publish scientific research articles.

I had the chance to participate in COST Action CA17122 “Increasing understanding of alien species through citizen science” by completing three short term scientific missions, enriching my knowledge and skills. In addition, my initial work on ants, which will be continued through DPLUS200 enabled me to participate in an “online workshop on the Management of invasive alien ant species” and review influential reports guiding INNS policy: “Rabitsch W (2022a) The management of Fire Ants (*Solenopsis geminata*, *Solenopsis invicta*, *Solenopsis richteri*) - Information on measures and related costs in relation to species on the Union list. Technical note prepared by IUCN for the European Commission” and “Rabitsch W (2022b) The management of the Little Fire Ant (*Wasmanni aauropunctata*) - Information on measures and related costs in relation to species on the Union list. Technical note prepared by IUCN for the European Commission”. My communication with Dr Christos Georgiadis, Dr Sebastian Salata and Prof Lech Borowiec led to the discovery of new species to science as well as novel non-native ants on the island. While investigating grey literature on non-native insects of Cyprus I got introduced to Mr Nicos Seraphides, researcher at the Agricultural Research Institute (ARI) Nicosia, Cyprus. Mr Seraphides provided me with valuable insight on the deliberate introduction of non-native biocontrol agents and our friendly communication and collaboration may lead to further studies on non-native insects of phytosanitary and agricultural significance. These contacts will be maintained through future collaborations on native and invasive non-native species checklists, identification keys, new additions to the fauna of Cyprus as well as in a broader scale on a European level.

#### **4. Impact of COVID-19 on Fellowship**

As I suffer from a chronic pulmonary disease safety measures had to be taken in order to avoid my infection with the virus. As such, during the peak of reported cases of COVID-19 I worked remotely, scheduling frequent online meetings with my supervisors. Due to both COVID-19 and my health condition, my planned visit to the UK Centre of Ecology and Hydrology was postponed. The project’s supervisors and I had a meeting on the subject and as Prof Roy would visit the island in the following months, we decided to include training sessions within the timeframe of Prof Roy’s travel to Cyprus. We filled in a change request form informing the Darwin Initiative of the problem that arose as well as the proposed solution. The funds reserved for the trip were diverted towards the dissemination of the project’s outcomes in scientific publications as article processing charges. Although COVID-19 had a great psychological impact and induced a lot of anxiety the overall objectives and deliverables of the project were not affected. Working remotely and having frequent online meetings was a quick way of keeping in touch and providing on the spot guidance.

### **Annex 1**

Screenshots of iNaturalist projects created: