

## Darwin Fellowship - Final Report

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

Darwin Fellowship reference	DPLUS123
Name of Darwin Fellow	Elli [REDACTED]
Lead organisation	Centre for Ecology and Hydrology, UK
Fellow's organisation(s)	Joint Services Health Unit in Cyprus Open University of Cyprus
Fellow's role within their organisation	Researcher
Start/end date of Fellowship	01 January 2022 – 21 December 2023
Location	SBAs of Akrotiri & Dhekelia (Cyprus)
Darwin Fellowship grant value (£)	28,015.00
Type of work (e.g. research, training, if other please specify)	Research
Main contact in UK organisation	Dr David [REDACTED]
Author(s) and date	Dr David [REDACTED], Dr Angeliki [REDACTED] Dr Elli [REDACTED] 26/02/2024

### 1. Background

Fellow Dr Elli Tzirkalli was actively engaged as a volunteer in two Darwin Plus projects (DPLUS056, DPLUS088) before the start of her Fellowship. Her work complements both projects as her Fellowship focused on promoting the monitoring of pollinators (butterflies and moths) through citizen science schemes, in order to address various threats to pollinators such as climate, land use change and invasive non-native species. In addition, the fellowship aimed to raise awareness of the importance of pollinators in SBAs areas, with particular emphasis on the Akrotiri wetlands and the surrounding peninsula. The project's objectives were to:

1. Provide an updated baseline of pollinator species in the Akrotiri SBA.
2. Promote innovative and distinctive citizen science as providing good value for money in monitoring of butterflies and moths, leaving a legacy for the SBA.
3. Collaborate with leading researchers to assess the impacts of climate, land use change and invasive alien species on beneficial species such as moths and butterflies. Transfer of knowledge to the SBA, whilst achieving high-quality science excellence.
4. Propose conservation measures to improve the conditions of pollinators within the SBA. Contribute directly towards the implementation of long-term strategic outcomes for the natural environment in the SBA as a UKOT.

Dr Elli Tzirkalli conducted fieldwork in Akrotiri SBA to monitor butterflies and moths as well as fulfilling all Fellowship activities under the guidance of Dr David Roy (UKCEH) and Dr Angeliki Martinou (JSHU). Continuous communication between Fellow and co-supervisors was maintained through e-mail, online meetings and face-to-face discussions, focusing on project activities, deliverables, work plan and next steps. The Open University of Cyprus (OUC), as the host organisation, provided support, guidance in project activities, and capacity building to the Fellow.

During the Fellowship, Dr Elli Tzirkalli participated in the Bee, Hoverfly, and Butterfly taxonomy training course organised under [REDACTED] project at the Laboratory of Biogeography and Ecology, Department of Geography, University of the Aegean from January 30<sup>th</sup> to February 4<sup>th</sup>, 2023. The course aimed to train professional recorders for the implementation of the EU Pollinator Monitoring Scheme (EU PoMS), with a specific focus on wild bees, butterflies, and hoverflies. The training aligned closely with the objectives of DPLUS123 project, enhancing its scope and objectives.

## **2. Achievements**

During the Fellowship, the Fellow conducted field sampling across Akrotiri Peninsula to monitor pollinators, specifically butterflies and moths, and compiled an updated list of Lepidoptera species in the Akrotiri SBA. She actively promoted the Cyprus Butterfly Monitoring Scheme and initiated the Moths of Cyprus recording project. The Fellow also visited the UK Centre for Ecology & Hydrology, enhanced her skills in developing and managing citizen science monitoring schemes and applying advanced modelling techniques for data analysis. Additionally, she participated in various dissemination events, including workshops, conferences, and lectures, to highlight the importance of pollinators in the Akrotiri Peninsula. As part of the project activities:

### Pollinator Database creation

The Fellow conducted an extensive literature review, gathering references from various sources such as Scopus, Google Scholar, grey literature, and Lepidoptera experts in Cyprus and beyond. The bibliographic database of the pollinators of Akrotiri SBA and Cyprus was created with Zotero reference management software. The choice of the specific software was based on its free availability, the technical features it supports (e.g. extension program in browsers, plugins in a word processor for creating reports and bibliography), and user-friendly interface. The resulting electronic reference database, named "Pollinators Reference Database" is formatted in .rdf format and contains 232 items.

In addition to the literature review, the Fellow gathered occurrence data on pollinators (butterflies and moths) from platforms such as iNaturalist (moths of Cyprus project), GBIF, and eBMS (Cyprus Butterfly Monitoring Scheme). These data, combined with the Fellow's field observations, were utilized to develop a spatial database. Using ArcGIS software a 2X2 km map illustrating the distribution of 202 species (incorporating 548 occurrence data points) was produced for the Akrotiri SBA. This information serves as a valuable resource for ongoing pollinator monitoring efforts, offering insights into distribution patterns of Lepidoptera crucial for conservation and management initiatives.

### Pollinator research at SBAs

The Fellow conducted bi-weekly butterfly sampling using the line-transect method across 10 sites within the Akrotiri peninsula. Transects were walked at a study speed, between 8 am and 5 pm, under favourable weather conditions. Moth sampling was conducted monthly at five sites using light-traps (LedTrap, provided by the SPRING project) that operated from dusk to dawn. The data were collected across five habitat types, namely eucalyptus and acacia plantations, artificial surfaces, agricultural areas, forest and semi-natural areas, and salt meadows, between April 2022 to May 2023. In addition, vegetation surveys were

undertaken in the spring of 2022 and 2023, using three randomly assigned quadrats of 4 m<sup>2</sup> (2 x 2 m) along the butterfly transect to record plant species with a focus on invasive plant species. All data gathered have been organised into a database (.xlsx) allowing for further analysis.

In total, 143 species (1767 individuals) of Lepidopteran were recorded, including two endemic butterfly species *Hipparchia cypriensis* (Holik, 1949) and *Maniola cypricola* (Graves, 1928), as well as five endemic macro-moth species *Agrotis sabine* Brandstetter, 2010, *Ammoconia aholai* Fibiger, 1996, *Dyscia simplicaria* Rebel, 1939, *Eumannia arenbergeri* Hausmann, 1995, and *Selidosema tamsi* Rebel, 1939. *Euplagia quadripunctaria* (Poda, 1761), a priority and Annex II species of the Habitats Directive (92/43/ECC) was sampled within the designated Special Area of Conservation of Akrotiri peninsula. Four invasive plant species were also recorded (*Oxalis pes-caprae*, *Acacia saligna*, *Lycium ferocissimum* and *Ricinus communis*). Micro-moths as well as macro-moths that were not possible to identify at the species level were excluded from the dataset and are kept in the Lab of Terrestrial Ecosystems Management Lab at OUC. The dataset containing records of Lepidoptera (butterflies, macro-moths) from the Akrotiri Peninsula in Cyprus has been prepared for submission to GBIF. In addition, a data paper is being prepared for submission to the Biodiversity Data Journal. This data paper will provide a detailed description of the Lepidoptera dataset, including its scope, methodology, and key findings. An information leaflet was produced by the Fellow on the importance of butterflies and moths in pollination services to raise awareness of pollinators and their value in the ecosystem. The leaflet is available online at <https://sites.google.com/view/dplus123/home>.

#### Visit the Centre of Ecology & Hydrology and reporting

The Fellow visited the UK Centre of Ecology and Hydrology in June 2023 and collaborated with four CEH experts. During her visit, she worked with Dr Dina Sadykova to apply modelling techniques to project the potential distribution of pollinators under current and future climates. Dr Diana Bowler provided guidance on best practices for citizen science initiatives and offered valuable tips on setting up citizen science schemes. Dr Mark Both offered hands-on training, conducting a butterfly transect and a moth monitoring event along with the Fellow, and shared his expertise on biological recording data assessments, including handling large datasets for annual butterfly monitoring reports. Dr David Roy held daily meetings with the Fellow to discuss project progress and plan future Darwin Fellowships to continue Lepidoptera monitoring. A concise report summarizing key points from UKCEH visit has been prepared by the Fellow. This report serves as a guideline for setting up a citizen science schemes, identifying necessary data for biological assessments, and exploring techniques to assess the impacts of climate and land-use change. Additionally, a scientific article on the Climate and Land-use Change Vulnerability Assessment of Lepidoptera in the Akrotiri Peninsula is currently in preparation.

#### Pollinator (butterflies and moths) monitoring

Two public engagement events (<https://martinoulab.weebly.com/events.html>, 10-11/6/2022) have been organised by the Fellow to increase the network of the Cyprus Butterfly Monitoring Scheme across SBAs and raise awareness on pollinators, including basic taxonomic training for butterflies and moths as well as available apps for data recording (ButterflyCount app, iNaturalist). Another training event (21<sup>st</sup> April 2023) for using available tools for monitoring and ID butterflies and moths was delivered by the Fellow (<https://sites.google.com/view/dplus123/news-events>). A citizen-science recording scheme has been constructed on the iNaturalist biodiversity recording platform concerning the moths of Cyprus (<https://www.inaturalist.org/projects/moths-of-cyprus>) and has been promoted in all training and dissemination events regarding the Fellowship.

In addition, as part of this Fellowship and the Global Citizen Science Initiative National Moth Week, an event was organised on July 22<sup>nd</sup> 2023 to raise awareness of the importance of

citizen science for the protection and conservation of moths in Cyprus, promoting Moths of Cyprus recording initiative.

Pollinator monitoring was also promoted during the Akrotiri BioBlitz event between 20-22 May 2022 as well as the 26-28 May 2023 at the Akrotiri Environmental and Education Centre (AEEC) (<https://martinoulab.weebly.com/events.html>). In addition, four field trips (23-24 June 2022, 22-23 October 2022, 22-23 April 2023, 22-23 July 2023) have been organised across the island to train volunteers in monitoring butterflies and moths using available apps for each scheme. In cooperation with the Cypriot Education Unit for the Environment and Sustainable Development, high school students participate in activities concerning the observation and recording of butterfly and moth species at Akrotiri Environmental Education Centre on 15<sup>th</sup> December 2023.

### Conservation measures

A comprehensive review of existing references regarding conservation measures for pollinators was conducted and a report focusing on Akrotiri SBA was produced. This report aimed to delineate suitable conservation measures aimed at protecting pollinators and mitigating the risk of pollinator loss tailored to the unique ecological context of the Akrotiri SBA. This report is intended to inform policymakers, land managers, conservation practitioners, and citizens facilitating informed decision-making and measures aimed at safeguarding pollinators.

### Result dissemination

The Fellow participated in various dissemination events such as:

- “Alien insects and citizen science”. Event held at the Akrotiri Environmental Education Centre and organised by JSHU (04 April 2022).
- “You can also become an entomologist through citizen science”. SCYence Fair 2022, organised by the Cyprus Institute and Aglantzia municipality (15-16 April 2022).
- Participation in European Researchers’ Night 2022 “Mission: INSPIRE”, organised by the Research and Innovation Foundation of Cyprus (30 September 2022).
- “Akrotiri Peninsula - Biotic & Abiotic Monitoring, Status & Trends”, workshop organised in the context of “DPLUS141: Habitat restoration & Wise Use for Akrotiri & Cape Pyla” project by Birdlife Cyprus and Terra Cypria (oral presentation, 8-9 November 2022).
- “Women in Biodiversity Conservation” (online presentation), “Women in Biodiversity Science talks” co-organised by the Postgraduate Programme in “Environmental Conservation and Management” and the Terrestrial Ecosystems Management Laboratory of the Open University of Cyprus (15 February 2023).
- “Butterfly Monitoring and its implementation in schools across Cyprus” (oral presentation), 14th Pancyprian Students Conference of SEMEP UNESCO entitled: “Citizen Science and Research Methods in Ecology and innovative approaches to STEM teaching aimed at Ecosystem Conservation and climate change mitigation” at “SCYENCE Fair 2023” organized by the Cyprus Institute and the Unit for Education for the Environment and Sustainable Development, Ministry of Education, Culture, Sports and Youth, Cyprus Institute, Nicosia (5 April 2023).
- Participate in the Akrotiri Spring Festival organised by Birdlife and Terra Cypria within the project DPLUS141. Recording moths at the Akrotiri Environmental and Education Centre using light traps where the Fellow had the chance to raise awareness on the importance are important pollinators and are a critical food source for many organisms. Their monitoring is very important for the study of populations and their protection(13 May 2023).

- Engage citizens in wildlife monitoring (oral presentation) conference organised by the HEIDI Project (Community-driven Digital Action: A catalyst for social change in the COVID-19 crisis), CYENS Centre of Excellence (16 May 2023).
- Recording the Butterflies of Cyprus by Local Schools around Cyprus and photograph exhibition under the project SEMEP-UNESCO Cyprus (South Eastern Mediterranean Environmental Project) organised by the Cyprus Museum of Natural History of the Fotos Fotiades Foundation (oral presentation, 30 June 2023).
- Participate in ██████████ project co-financed by the ERASMUS+ programme of the European Union. External advisor for implementing butterfly monitoring in deaf and hard-of-hearing adults (Final event, 13 December 2023).
- Preparation of dissemination materials for Akrotiri SBA for butterflies and moths, including 16 of the most common species of butterflies and moths.
- Development of a website for the project which includes all news and events as well as information concerning the project (<https://sites.google.com/view/dplus123/home>).

### Conferences

- Tzirkalli E., Martinou AF, Vogiatzakis IN, Roy D (2023) Butterfly diversity patterns on Akrotiri Peninsula, Cyprus. HELECOS 11 – Hellenic Conference of Ecology, Patra, Greece (poster presentation, 4-7 October 2023).
- E Tzirkalli, B.Beckmann, D. Chapman, M. Wiemers (2023) Spread of the lime butterfly *Papilio demoleus* in Europe: Projection of environmental suitability using citizen science data. XII European Congress of Entomology, Heraklion, Crete (oral presentation, 16-20 October 2023).

### **3. Outcome, lessons and impact**

During the Darwin Fellowship, the Fellow improved her knowledge skills regarding moth identification, the different methods used for pollinator monitoring, and biological data recording using citizen science apps (e.g. ButterflyCount app, iNaturalist) in Cyprus but also in Europe. These skills helped her to be recognised as a biodiversity monitoring expert within her organisation (OUC, Terrestrial Ecosystem Management Lab) and also gave her experience in drafting new Darwin Plus projects. She also had the opportunity to be involved in the Darwin Local project «Raising awareness about the importance of arthropods (DPL00014)» producing educational material for pollinators of the Akrotiri Peninsula.

Based on her acquired knowledge she will continue her collaboration with OUC within the framework of projects related to biodiversity monitoring, including Darwin Plus projects, building a long-lasting trust and partnership bond.

The Fellowship produced the first systematic database on macro-moth fauna not only in Akrotiri peninsula but also in Cyprus since records were mostly sporadic. It also enhanced the knowledge on butterfly and plant data including invasive alien species across the Akrotiri peninsula. These data can be used as a baseline for monitoring changes and also creating long-term monitoring data. The outcomes of this Fellowship can be effectively used in guiding the national Pollinator Monitoring Scheme of Cyprus and for future studies on management priorities for the conservation of the Lepidoptera fauna of the area.

During the Fellowship strong contact was made with scientists from the UK e.g. Dr Tom August, Dr Björn – CEH, Mr Stuart Roberts and Mr Eddie John and also across Europe e.g. Greece (Dr Thomas Tscheulin – University of the Aegean), Cyprus (Mr Christodoulos Makris, Lepidoptera Expert, Dr Anthemis Melifronidou, Mrs Despina Koukoularidou, Mr Kypros Hadjiafxentis – Department of Agriculture, Dr Eva Pitta, – Department of Environment, Ministry of Agriculture, Rural Development and Environment), Belgium (Dr Quentin Groom – Meise Botanic Garden, Dr Marc Pollet – Research Institute Nature and Forest), Netherlands (Mr André van Eck), Serbia (Dr Ante Vujić – University of Novi Sad),

Germany (Dr. Martin Wiemers – Senckenberg German Entomological Institute), with whom the Fellow collaborated and learned more on pollinator conservation and insect monitoring.

Due to her involvement with this Fellowship Dr Elli Tzirkalli had the opportunity to participate in the COST Action CA2219 «InsectAI - Using Image-based AI for insect monitoring & conservation» and participated in the first Management Committee meeting in Brussels (25 October 2023). She also participated in the final meeting of the European project [REDACTED] «Strengthening Pollinator Recovery through INdicators and monitorinG» in Bologna (4-6 October 2023) due to her involvement in pollinator monitoring in Cyprus. This Fellowship has substantially improved the Fellow's engagement in the conservation of Cyprus' biodiversity, particularly focusing on the pollinator fauna of Cyprus.

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

COVID-19 had a limited impact on the Fellowship. Fieldwork and data collection were designed to avoid delays and continued with all health and safety measures in place. Some activities moved online, including virtual meetings and promoting citizen science initiatives. Health and safety measures were strictly followed during face-to-face meetings. The project's outcomes, particularly in citizen science engagement, were adapted to comply with all health measures.