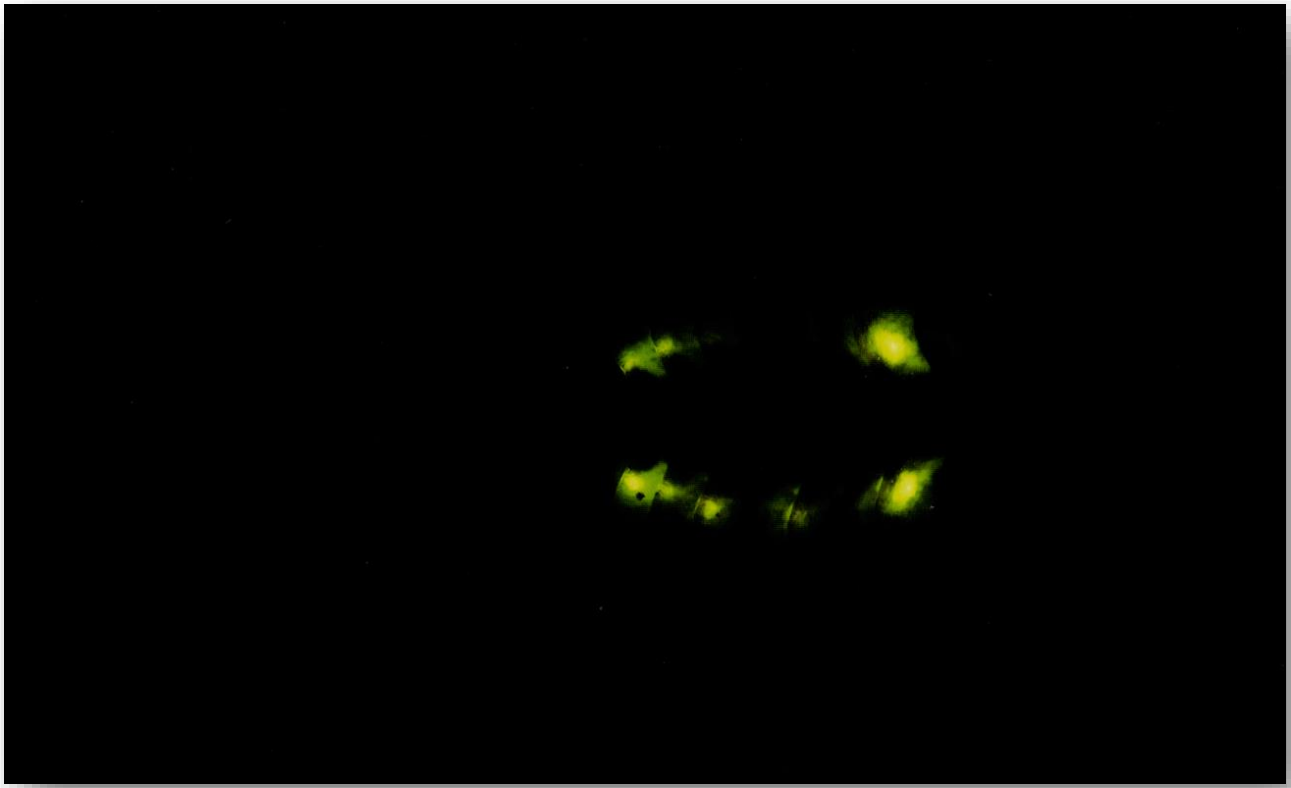
ABSTRACT BOOK

INTERNATIONAL FIREFLY SYMPOSIUM



15-18 June 2022

Parque Biológico de Gaia | Portugal

Organisation committee

VILA NOVA DE GAIA CÂMARA MUNICIPAL

PARQUES DE GAIA BIOLÓGICO DE GAIA

FIREFLYERS INTERNATIONAL NETWORK

SPONCERS

Organisation Committee

Organisation committee

VILA NOVA DE GAIA
CÂMARA MUNICIPAL

PARQUES DE GAIA
BIOLÓGICO DE GAIA

FIREFLYERS INTERNATIONAL NETWORK

Partners

Partners

FIREFLY EXPERIENCE

município de lousada

Parque Biológico de Gaia
4430-812 Avintes, Vila Nova de Gaia, Portugal
Tel. (+351) 22 787 8120
GPS: 41°05'49.5"N 8°33'21.9"W

ifs2020gaia@cm-gaia.pt

https://ifs2020gaia.parquebiologico.pt

❖ WELCOME MESSAGE

Dear firefly colleagues and friends,

Despite the fact that the pandemic situation is not yet been completely solved, we all agree that it is extremely important the promotion of scientific exchanges, collegiality and friendship.
So, the IFS2020-PBG-organising Team and FIN Steering Committee, proudly announce the presential congress IFS2022, this year, June, 15-18th.
For those whom unfortunately cannot be present in Portugal, there will be the possibility to assist online by video (streaming).
In recent years, the interest in the biology, behaviour, systematics and conservation of fireflies has increased dramatically around the world. These last decades, fireflies even gained attention for the sake of ecotourism, with both positive and negative consequences. The firefly serves as the model system for the study of bioluminescence, being the most commonly encountered and widely recognised bioluminescent terrestrial organism worldwide.
The main aim of the International Firefly Symposium is to gather people involved in firefly conservation and research around the world in order to exchange knowledge and form collaborative partnerships. The ecological, behavioural and morphological variation found in fireflies will be documented and evaluated by a diverse, international community. We will discuss the necesity and methodology how to protect threatened firefly species and their habitats.
The overall idea is to raise awareness and advance a public conservation ethic by sharing information about fireflies and their habitat requirements and to foster delight and appreciation of fireflies across different cultures by blending artistic and scientific perspectives about these amazing insects.

Organising Committee

❖ INDEX

Symposium Programme	5
Speakers	14
Abstracts talks	28
Abstracts posters	67

❖ SYMPOSIUM PROGRAMME

✓ Wednesday, 15th June

09:00 – Shuttle to the Conference Room

09:30-10:00 – Registration

10:00-10:30 – Opening ceremony

Session I: ECOLOGY AND BEHAVIOUR

10:30-11:15 – PLENARY TALK: "*How to be attractive? Social and visual environment affect female success in glow-worms*", **Arja Kaitala**, University of Oulu (Finland)

11:15-11:35 – "*Common glow-worms under artificial light: behavioural and evolutionary consequences*", **Mira Van den Broeck** *et al.*, University of Antwerp (Belgium)

11:40 – 12:10 Coffee-break with Poster Session I: Ecology and Behaviour

12:10-12:30 – "*Why are female glow-worms particularly vulnerable to urbanization*", **Topi Lehtonen**, University of Oulu (Finland)

12:30-12:50 – "*Space use behaviour of larvae of the common glow-worm*", **Stefan Ineichen *et al.***, Institut für Umwelt und Natürliche Ressourcen (Switzerland)

12:50-13:10 – "*The duration of artificial light defines sexual signalling in the common glow-worm*", **Christina Elgert** *et al.*, University of Helsinki (Finland)

13:10-13:30 – "*Host condition and pathogen identity influence bacterial infection survival in the Common Eastern Firefly, Photinus pyralis*", **Sarah Lower** *et al.*, Bucknell University (USA)

13:30-15:00 – Lunch

Session II: ART AND SOCIETY

15:00-15:45 – PLENARY TALK: "*Fireflies pretext for warning*", **Francesco Mariotti**, Artist (Switzerland)

15:45-16:05 – "*Beauty of fireflies through camera lens*", **Radim Schreiber**, Firefly Experience (USA)

16:05-16:25 – "*Be Careful What You Wish For: Firefly Tourism in Pennsylvania*", **Peggy Butler** *et al.*, Pennsylvania Firefly Festival and US Firefly Tourism Luminary Council (USA)

16:25-16:45 – "*The Lightscapes of Fireflies. From Literatures to their Habitat Restoration Landscapes: In the case of Thailand*", **Rachaya Wattanasirichaigoon**, Harvard Graduate School of Design (USA/Thailand)

16:45-17:05 – "On social bioluminescence", Chiara Falcone, Department of Social and Political Science of Unical (Italy)

17:15-17:45 – Coffee-break

17:45-18:00 – Firefly Fotography exhibition and Group Photo

18:00-19:00 – *Firefly Photography Class by* ***Radim Schreiber*** (*FireflyExperience.org*)

"*Covering basics and real world tips and tricks*"

19:00-19:30 – *Firefly Music Sessions* (**Raphael de Cock**)

19:30-21:00 – Dinner at Parque Biológico de Gaia

21:00-23:30 – **PBG Excursion** to see Fireflies

23:30 – Bus to hotel

✓ **Thursday, 16th June**

Session III: TAXONOMY, PHYLOGENY AND GENETICS

8:30 - Shuttle to the Conference Room

09:00-09:45 – PLENARY TALK: **"***Museum collections as information repositories on fireflies and training tools for new lampyrid researchers: the case of the University of Porto***"**, José Manuel Grosso-Silva, Natural History and Science Museum of the University of Porto (Portugal)

09:45-10:05 – "*Firefly Sensilla Diversity: with Emphasis on Sexual Signaling*", **Yelena Pacheco** *et al.*, University of Georgia (USA)

10:05-10:25 – "*A taxonomic conundrum in Pteroptyx: how to solve it and what it means for conservation of mangrove fireflies in Southeast Asia*", **Wan Jusoh** *et al.*, National University of Singapure (Singapore)

10:25-10:45 – "*Understanding comparative larviform morphology and its impact on the broader Coleopterology*", **Joseph Cicero**, University of Arizona (USA)

10:45-11:05 – "*The fireflies of Israel – taxonomy, ecology and the potential effect of light pollution*", **Ella Fishman** *et al.*, Tel Aviv University (Israel)

11:10-11:40 – Coffee break with *Poster Session III*

Session IV: BIOLUMINESCENCE, BIOCHEMISTRY AND PHYSIOLOGY

11:40-12:25 – PLENARY TALK: "*Resurecting the ancient glow*", **Yuichi Oba**, Chubu University (Japan)

12:25-12:45 – "Light color evolution in fireflies", Kathrin Stanger-Hall, University of Georgia (USA)

12:45-13:05 – "*Investigating the role of pigmentation in firefly bioluminescence color*" **Margot Popecki** *et al.*, University of Georgia (USA)

13:10-14:30 – Lunch

14:30-14:50 – "*A Modeling Approach for Studying Firefly Synchronization*", **Gonzalo Marcelo Ramírez-Ávila** *et al.*, Higher University of San Andrés (Bolivia)

14:50-15:10 – "*Three-dimensional tracking: Insights into firefly behavior and conservation*", **Orit Peleg**, University of Colorado Boulder (USA)

15:10-15:30 – "*Pteroptyx bearni firefly flash fewer and shorter when exposed to increasing brightness of white light LED*", **Vickly Mobilim**, University of Malaysia Sabah (Malaysia)

15:30-16:00 – Coffee break with *Poster Session IV*

Session V: CONSERVATION BIOLOGY

16:00-16:45 – PLENARY TALK: "*Firefly conservation: Protecting the Jewels of the Night*", **Sara Lewis** & **Sonny Wong**, Tufts University, Boston USA & Malaysian Nature Society, Kuala Lumpur & IUCN Firefly Specialist Group (USA & Malaysia)

16:45-18:15 – Workshop and Discussion – *Standardising Methods to Monitor Fireflies Populations* – IUCN Firefly Specialist Group – **Vor Yiu**, Hong Kong Entomological Society (Hong Kong)

18:20 – Bus to Lousada municipality (50 km)

19:15-22:30 – *Workshop of fireflies capture techniques,* by Raphael de Cock, University of Antwerp (Belgium), and dinner/picnic - Lousada

22:30 – Bus to the Hotel

✓ Friday, 17th June

08:30 – Shuttle to the Conference Room

09:00-09:20 – PLENARY TALK: "*The business model of the firefly restoration in Taiwan*", **Chiahsiung Wu** *et al.*, Tree-garden Co. Ltd. (Taiwan)

09:20-09:40 – "*Recolonization of Fireflies in Artificially Modified Habitats*", **Vor Yiu**, Hong Kong Entomological Society (Hong Kong)

09:40-10:00 – "*Placing Indiana's state insect on the map: Records of Say's firefly, Pyractomena angulata, in Indiana (Lampyridae, Coleoptera) and the bordering states of Michigan, Ohio, Kentucky and Illinois*", **Sergio Henriques**, Global Center for Species Survival, Indianapolis Zoo (USA/Switzerland)

10:00-10:20 – "*Coexisting Pteroptyx species, friends or enemies?*", **Anchana Thancharoen** *et al.*, Kasetsart University (Thailand)

10:20-10:40 – "*Evaluating Firefly Extinction Risk: A Key Step to Species Conservation*", **Anna Walker,** New Mexico BioPark Society (USA)

10:45-11:15 – Coffee break with *Poster Session V & VI*

Session VI: CITIZEN SCIENCE

11:15-12:00 – PLENARY TALK: "*Network of volunteers to monitor the Lampyridae of France: between constraints and opportunities*", **Fabien Verfaillie**, Group Associatif Estuaire (France)

12:00-12:20 – "*Fireflies in olive groves: searching a beloved and desired insect*", **José Ramón Guzmán Álvarez** *et al.*, Citizen science web project "Has visto una luciérnaga?" www.gusanosdeluz.com (Spain)

12:20-12:40 – "*Citizen Science Campaign in Search of a Forgotten Insect*", **Helena Virić Gašparić** *et al.*, University of Zagreb (Croatia)

12:40-13:00 – "*Quick spreading of populations of an exotic firefly throughout Spain and their recent arrival in the French Pyrenees*", **Marcel Koken** *et al.*, LABOCEA (R&D unit) - CNRS (France)

13:00-14:30 – Lunch

14:30-14:50 – Atlanta Firefly Project: *A community-science exploration of the effects of land management on the local abundance of the big diper firefly (Photinus pyralis) in city parks and residential landscapes and guidance for future community science efforts*, **Kelly Ridenhour *et al.***, University of Georgia (USA)

14:50-15:20 – Firefly International Network (FIN) General meeting (open to all participants): activity & financial reports, announcement of 2022-2025 steering committee

15:20-15:50 – Conclusions and Closing ceremony

16:00-19:30 – Vila Nova de Gaia guided city tour with visit to the Port Wine Cellars and Douro Estuary Local Nature Reserve

19:30 – Symposium Dinner

23:30 – Bus to hotel

✓ Saturday, 18th June

Post-symposium tour – Boat Cruise on the River Douro (all day excursion)

POSTERS

Session I: ECOLOGY AND BEHAVIOUR

"*Through a dog's nose: can sniffer dogs become a new tool for glow-worm surveying?*" **Mira Van den Broeck** *et al.*, University of Antwerp (Belgium)

"*Feeding habits of Lampyrid species in Spain: catalogue of preys from biodiversity citizen science data*", **José Ramón Guzmán Álvarez** *et al.*, Citizen Science web project "Has visto una luciérnaga?" *www.gusanosdeluz.com* (Spain)

"*Femmes fatales (Photuris lugubris) feeding on a tourist attraction (Photinus P. palaciosi)*", **Yara Maquitico-Rocha** *et al.*, National Autonomous University of Mexico (Mexico)

"*Effect of artificial nocturnal light in the bioluminescent signals associated to the matting and predatory behaviors of Photinus and Photuris fireflies*", **Laia Gaitán Botero *et al.***, Rosario University (Colombia)

Session III: TAXONOMY, PHYLOGENY AND GENETICS

"*Understanding comparative larviform morphology and its impact on the broader Coleopterology*", **Joseph. M. Cicero**, University of Arizona (USA)

"*Re-record of Luciola nicolleri (Coleoptera: Lampyridae: Luciolinae) from Sri Lanka*", **Dilshan De Silva** *et al.*, University of Ruhuna (Sri Lanka)

"*Systematic Review of Neotropical Vesta (LaPorte 1833): Distribution, Key and Description of New Species*", **Sara Rivera** *et al.*, Western Carolina University (USA)

"*On the natural history of the black-winged firefly, Phosphaenopterus metzneri Schaufuss, 1870 with comparative notes on Phosphaenina (Coleoptera: Lampyridae)*", **Viviane Nunes** *et al.*, Universidade de Lisboa (Portugal)

"*Shrouded in a flashing mystery: decoding the gene flow and species boundaries in the firefly Luciola lusitanica Charpentier, 1825*", **Viviane Nunes** *et al.*, Universidade de Lisboa (Portugal)

Session IV: BIOLUMINESCENCE, BIOCHEMISTRY AND PHYSIOLOGY

"*Hemocyte responses of Lamprigera tenebrosa larvae after bacterial infection*", **Parichart Laksanawimol** *et al.*, Ratchabhat Chandrakasem University (Thailand)

"*A firefly simple game for modeling synchronization*", **Stéphanie Depickère** *et al.*, Hight University of San Andrés (Bolivia)

"*Beetle bioluminescence outshines aerial predator*", **Yelena Pacheco**, University of Georgia (USA)

Session V: CONSERVATION BIOLOGY

"*The protection and restoration of terrestrial fireflies in Satoyama area in Taipei city, Taiwan—A 20+ years progress with the combination of Industry, Official and University*", **Chiahsiung Wu** *et al.*, Taiwan Ecological Arboriculture Society (Taiwan)

"*Ecological conservation of Rhagophthalmus spp. (Rhagophthalmidae) in Matsu islands, Taiwan*", **Chia-Hung Hsieh** *et al*., Chinese Culture University (Taiwan)

"*Conservation Activities of the IUCN SSC Firefly Specialist Group*", **Vor YIU** *et al.*, Hong Kong Entomological Society (Hong Kong)

"*Fireflies (Coleoptera: Lampyridae) in the Collections of Croatian Natural History Museums*", **Darija Lemic** *et al.*, University of Zagreb (Croatia)

"*Roadmap for firefly conservation planning and action: North America as a case-study*", **Anna Walker** *et al.*, New Mexico BioPark Society (USA)

"*Keep the forest shiny: mapping threats to inform conservation planning of firefly species endemic to the Atlantic Forest hotspot*", **Stéphanie Vaz Campos**, Federal University of Rio de Janeiro (Brazil)

Session VI: CITIZEN SCIENCE

"*The distribution of lampirids in Spain: an interpretation based on geography and history*", **José Ramón Guzmán Álvarez** *et al.*, Citizen science web project "Has visto una luciérnaga?" *www.gusanosdeluz.com* (Spain)

"*Fireflies' Nights – a programme of environmental education*", **Henrique N. Alves** *et al.*, Parque Biológico de Gaia (Portugal)

❖ SPEAKERS

EDUARDO VÍTOR RODRIGUES, Mayor of Vila Nova de Gaia, Portugal 15

HENRIQUE NEPOMUCENO ALVES, Biologist, Parque Biológico de Gaia, CMG, Portugal 16

RAPHAEL DE COCK, Ph. D. in Sciences, Biology, 2004. University of Antwerp, Belgium 17

ARJA KAITALA, Professor, Department of Ecology and Genetics, University of Oulu, Finland 19

SARA LEWIS, Professor of Biology, IUCN Firefly Specialist Group Co-chair, USA 20

SONNY WONG, Conservationist; co-chair of the IUCN SSC Firefly Specialist Group, Malaysia 21

JOSÉ MANUEL GROSSO-SILVA, Biologist, Natural History and Science Museum of the University of Porto, Portugal 22

YUICHI OBA, Professor, Department of Environmental Biology, Chubu University, Japan 23

FABIEN VERFAILLIE, Doctor in Ecology, President of the "Groupe Associatif Estuaire" 24

FRANCESCO MARIOTTI, Artist, Switzerland 25

RADIM SCHREIBER, Firefly Photographer and Cinematographer, USA 26

EDUARDO VÍTOR RODRIGUES

Mayor of Vila Nova de Gaia, Portugal

Eduardo Vítor Rodrigues (born in Vila Nova de Gaia on March, 30 1971) is a Portuguese university professor and politician. He is an assistant professor of the Department of Sociology at the Faculty of Arts (FLUP) of Oporto's University. Currently he is the Mayor of Vila Nova de Gaia, the biggest city of Porto Metropolitan Area, having been elected for the Portuguese Socialist Party in 2013 municipal elections.

As a professor he was responsible for the following disciplines: Development Sociology, Demography and Migrations, Processes of Social Exclusion (graduation), Environmental Sociology (master) and Social Policy (PhD). Due to his actual public functions the teacher career is currently suspended.

Eduardo Vítor Rodrigues was a visiting professor in several foreign universities (Leuven - Belgium, Cracow – Poland, Brno – Czech Republic) and a collaborator at various institutions. He has a PhD in Sociology since 2006 from the Faculty of Arts of Oporto's University with the thesis «Scarce ways: social immobilization processes of RSI beneficiaries». He obtained the degree in Sociology in 1994 and the master in Sociology – Local Power, Development and Social Change in 1997.

He is an investigator of FLUP's Sociology Institute on the line of research «Family, ageing and gender» and works in the areas of Sociology of Poverty, Political Sociology, Migrations, State, Social Policies and Development. He is author of conferences, books, articles and other publications in the fields he studies and teaches and member of diverse scientific, cultural and social action.

HENRIQUE NEPOMUCENO ALVES

Biologist, Parque Biológico de Gaia, CMG, Portugal

Henrique Nepomuceno Alves has a postgraduate degree in “Landscape Ecology and Nature Conservation”, and graduated in Biology - Scientific Branch, from the Faculty of Sciences of the University of Porto in 1994.

He has been working in Biological Park of Vila Nova de Gaia since March 1997 and is currently director of the zoo Biological Park and technical manager of the local Douro Estuary Nature Reserve.

He is currently coordinating the municipal team of Life Stop Cortaderia, an invasive alien species with great impact on natural habitats.

He is the author and co-author of several scientific works in the areas of nature conservation, environmental education, biodiversity, Portuguese flora and coastal issues.

His hobby is astronomy and nature photography.

RAPHAEL DE COCK

Ph. D. in Sciences, Biology, 2004. University of Antwerp, Belgium

Associate researcher at University Antwerp, Belgium

https://www.uantwerpen.be/en/staff/raphael-decock

I graduated at the UA as a biologist in 1997. I finished my PhD in sciences - biology in 2004. My doctoral research dealt with the adaptive value of bioluminescent behavior in fireflies (Coleoptera: Lampyridae). Between 2001 en 2008 I worked on as a Biologist at the Flemish Institute of Nature Conservation, nowadays called Institute of Nature and Forest Research (INBO). In 2007 I was co-organizer of the first international firefly network meeting at Parque Biológico de Gaia.

However, since 2008, I work more as an artist mainly in the worldmusic scene, performing in several music and art projects but also providing workshops and courses in musical instruments and vocal styles. http://www.raphaeldecock.be/

Yet, out of passion and dedication I still work as a volunteer researcher on this fascinating insect group. I do this as a "honorary" Associate Researcher at the University of Antwerp in Belgium. My “firefly” interests range from taxonomy, phylogeny, physiology, to biogeography, but mainly focus on behaviour, ecology and conservation. I have been involved in the set-up of several citizen science firefly survey projects and the realisation of many field studies abroad (USA, China, Spain). I act as a firefly specialist advisor. My own PhD research focused on “aposematic” warning signals (colour patterns and glows) in

lampyrid larvae and on the behaviour and sexual communication of diurnal and nocturnal fireflies. Current topics I focus on, are effects of light pollution on mate searching behaviours and mating success (Coleoptera: Lampyridae); Taxonomic, behavioral ecological studies of European genera Lampyris, Lamprohiza, Luciola, Nyctophila, Phosphaenus, Phosphaenopterus, Lampyroidea, and the biology of a newly discovered exotic species of *Photinus* in Europe; Support and assistance in the set-up of "citizen science/particitipative science" glow-worm and firefly projects, documentaries and surveys. Since 2018, I assist Mira Van Den Broeck, together with promotor Prof. Erik Matthysen, with her Master thesis about effects of artificial illumination on the reproductive behaviour of *Lampyris noctiluca*. Finally I am nominated IUCN regional coordinator of firefly species specialist for Europe.

Results of recent research can be found in my publication list on researchgate:
https://www.researchgate.net/profile/Raphael_De_Cock

ARJA KAITALA

Professor, Department of Ecology and Genetics, University of Oulu, Finland

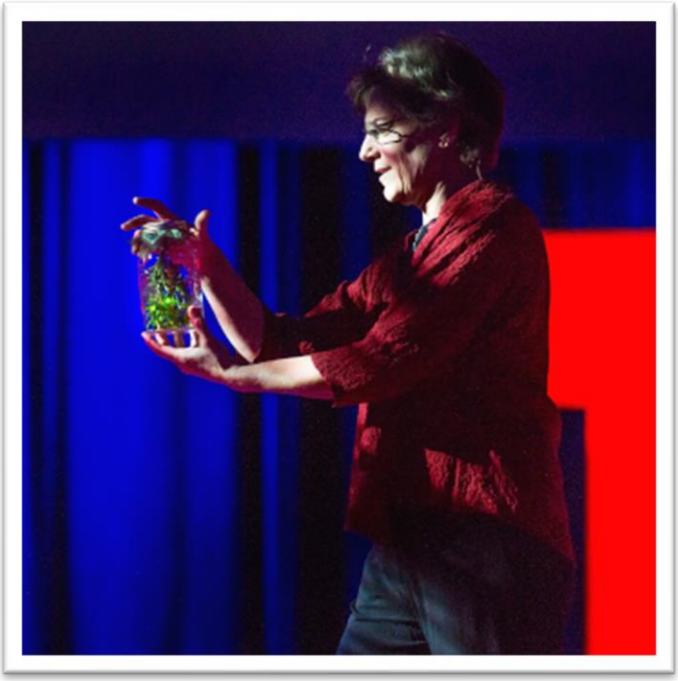
«I am a professor in animal ecology at the Department of Ecology and Genetics at the University of Oulu. My research program covers widely animal ecology. This includes evolutionary and behavioural ecology, population biology and applied ecology.

Within the fields of evolutionary and behavioural ecology, I focus on variability between individuals and on social interactions among individuals. Additionally, my research topics include how man-made changes in an environment affect sexual selection and thereby population survival.

Most problems are explored experimentally, but theoretical work in the form of mathematical modeling is carried out as well.

My research topics have included parental care and sexual selection in Heteropteran bugs, as well as polyandry in white butterflies. Recently, I have studied costs and benefits of sexual signaling in glow worms».

Link - https://glowwormoulu.wordpress.com/group/arja-kaitala



SARA LEWIS

Professor of Biology, IUCN Firefly Specialist Group Co-chair, USA

Sara Lewis, a Professor of Biology at Tufts University, has spent the past thirty years studying firefly ecology, behavior and conservation.

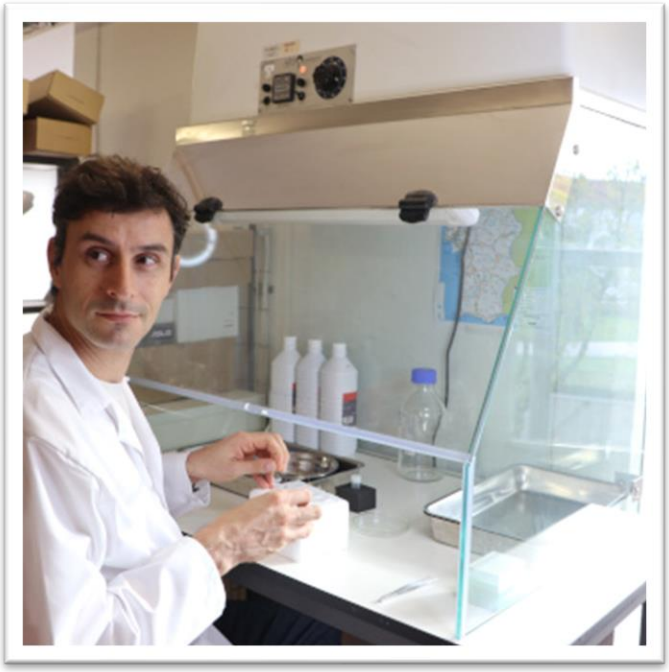
Author of more than 100 scientific articles, Lewis is committed to sharing knowledge about fireflies' luminous lives and has given a TED talk and written a popular book called Silent Sparks: The Wondrous World of Fireflies.

She has also written about fireflies for Scientific American, Undark, CNN, The Guardian, and Natural History Magazine.

SONNY WONG

Conservationist; co-chair of the IUCN SSC Firefly Specialist Group, Malaysia

Sonny works in the Conservation Division of the Malaysian Nature Society since 1997, working with the local communities in nature conservation, and incorporating ecotourism as part of livelihood improvement. Highlights of his work: Rafflesia conservation with the Semai villagers, bird flyway coastal wetlands conservation with rural communities, Kuala Selangor Nature Park for Ramsar, formation of Firefly Komuniti, started the World Firefly Day in 2018. Currently, he is the honorary secretary for the Fireflyers International Network and co-chairs the IUCN SSC Firefly Specialist Group.



JOSÉ MANUEL GROSSO-SILVA

Biologist; Natural History and Science Museum of the University of Porto, Portugal

José Manuel Grosso-Silva is a biologist specialized in insects. He has been studying the fauna of mainland Portugal for over 25 years and is the author of a series of scientific and popular works on the Portuguese fauna, especially on the orders Coleoptera and Hemiptera. He is currently the curator of the entomological collections of the Natural History and Science Museum of the University of Porto.

Site - *https://mhnc.up.pt/sobre-o-mhnc-up*

YUICHI OBA

Professor, Department of Environmental Biology, Chubu University, Japan

Yuichi Oba is full professor at Chubu University.

He is interested in the bioluminescence system and its evolution in various organisms. Some of his current researches includes:

a) determination of luciferin molecules;

b) isolation of luciferase genes;

c) molecular phylogeny of luminous organisms;

c) biosynthesis of luciferin;

d) DNA barcoding and biogeography of luminous organisms.

His lab uses the techniques of biochemistry, molecular biology, analytical chemistry, and bioinformatics.

FABIEN VERFAILLIE

Doctor in Ecology, President of the "Groupe Associatif Estuaire"

Doctor in Ecology, President of the "Groupe Associatif Estuaire".

Naturalist generalist (Fauna and Flora). Designer of automated solutions for biodiversity monitoring (acoustic sensors) and specialist in citizen science. Co-founder with the CNRS of the French program "Observatory of Glowworms and Fireflies" that benefits of more than 15 000 volunteer observers. Involved in European projects related to light pollution issues (biodiversity restoration contract, Quercy PNR, Cross-border Corridor Contract, France-Switzerland).

FRANCESCO MARIOTTI

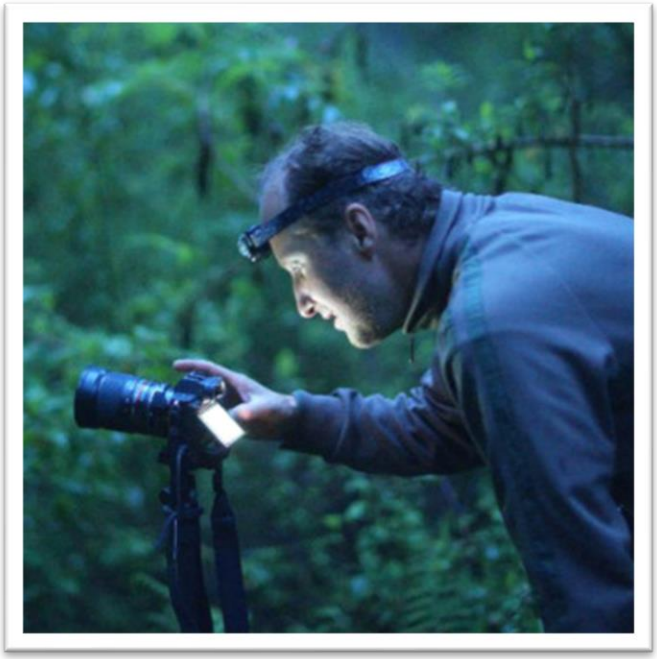
Artist, Switzerland

Francesco has lived and studied in Switzerland, France, Germany and South America. While studying at the Academy of Fine Arts, he focused on the complex relations between art, nature and technology. After a long stay in Latin America in the 1970s, he experimented with the possible interactions between electronic and IT devices and the creation of multi-sensorial installations and works.

Francesco has participated in major international exhibitions, from Documenta in Kassel, 1968 to the Biennales in Sâo Paulo, 1969 and Medellin, 1979 as well as Expo in Osaka, 1991. He has carried out in-depth research on video installations and video art, becoming one of the organisers of the Video Art Festival in Locarno which was planned by his friend Rinaldo Bianda. In 2005, together with the biologist Stefan Ineichen, he organised the first Festival of Fireflies in Zurich. This experience led to the development of the project 'Immigration' for the Park of Living Art in Turin and for the Symposion Lindabrunn near Vienna.

Francesco Mariotti lives in Zürich (Switzerland) and Punta Sal (Peru).

1943, Bern; 1953–1961, Lima, Peru; 1965–1969, Art studies in Paris and Hamburg; 1977–1978, Teaches at the Art school in Lima, Peru; 1982-1987, Collaborator of the Video Art Festival, Locarno; 2005, Member of the Society Fireflies Project in Zürich.



RADIM SCHREIBER

Firefly Photographer and Cinematographer, USA

https://fireflyexperience.org

I was born in the Czech Republic, but presently live in the United States. Photographing fireflies is my passion and my full-time vocation. When I first moved to Iowa, I was mesmerized by the abundance and brightness of fireflies during summer nights. I had never seen anything like that during my childhood in the Czech Republic, and I fell in love with fireflies. I had to wait for advancements in the low-light capabilities of cutting-edge camera equipment before I was able to photograph fireflies. That finally came, and every summer since then I have photographed and recorded fireflies on video. My firefly photos have been on exhibit in the USA, London, Rio de Janeiro, Hungary, and the Czech Republic. The images have been published in numerous publications and have won several prestigious awards. The debut of my book, Firefly Experience, was a nighttime show at Teeple Hansen Gallery in Fairfield, Iowa. I created an entire virtual environment with firefly photos, dim lights, and night sounds. I still remember the light and happiness on the people's faces. If you would like to see my other projects and photos, please visit *fireflyexperience.org*.

❖ ABSTRACTS


THE FIREFLIES OF ISRAEL – TAXONOMY, ECOLOGY, AND THE POTENTIAL EFFECT OF LIGHT POLLUTION ON THEIR POPULATIONS?
THE DURATION OF ARTIFICIAL LIGHT DEFINES SEXUAL SIGNALLING IN THE COMMON GLOW-WORM
Christina Elgert (1,3),* Topi K. Lehtonen (1,2,3), Arja Kaitala (2,3) and Ulrika Candolin (1,3)
(1) Organismal and Evolutionary Biology, University of Helsinki, PO Box 65, 00014 Helsinki, Finland
(2) Department of Ecology and Genetics, University of Oulu, PO Box 3000, 90014 Oulu, Finland
(3) Tvärminne Zoological Station, University of Helsinki, J.A. Palméns väg 260, 10900 Hanko, Finland. * Presenter
Artificial light at night is increasing globally, interfering with both sensory ecology and temporal rhythms of organisms, from zooplankton to mammals. This interference can change the behaviour of the affected organisms, and hence compromise the viability of their populations. Limiting the use of artificial light may mitigate these negative effects. Accordingly, we investigated whether the duration of artificial light affects sexual signalling in female glow-worms, Lampyris noctiluca, which are flightless and attract flying males to mate by emitting glow that is interfered by light pollution. The study included three treatments:
THREE-DIMENSIONAL TRACKING: INSIGHTS INTO FIREFLY BEHAVIOR AND CONSERVATION
Orit Peleg, University of Colorado Boulder (USA)
Firefly flashes are a marvel of natural communication systems. During mating season, fireflies gather in large groups, and often produce their species-specific flash pattern. Despite the immense visual clutter from other fireflies in the swarm, and visual occlusions from the terrain, fireflies can perform individual and collective mating signals decipherable by their peers. To better understand these communication signals, we developed a method to record flash displays in three dimensions, using pairs of cameras with 360 degrees of view (stereo-recoding). This tool allows us to track collective spatiotemporal flash patterns in the swarm, as well as track individual fireflies and their exact flash pattern. This talk will cover the potential this method has to provide new insights into firefly behavior, and serve as a monitoring tool for firefly conservation. On the firefly behavior front, we used this method to study the collective flash synchronization mechanisms of Photinus carolinus [1-2] and Photuris frontalis fireflies [3]. In addition, we extended our method to utilize an optimization algorithm to estimate the cameras' relative positions, removing camera calibration requirements [4]. This new technology not only makes data gathering easier; it also allows us to crowdsource data acquisition. On the firefly conservation front, this tool could enable citizen scientists to use smartphones, GoPros, and other common camera devices to collect complex real-life data on firefly signal dynamics. By revealing the details of firefly behavior, we hope to open a whole new world of questions and reflections, and enhance the firefly experience for both scientists and the broader public.
EMPHASIS ON SEXUAL SIGNALING

❖ Abstract index

Session I: ECOLOGY AND BEHAVIOUR

How to be attractive? Social and visual environment affect female success in glow-worms, Arja Kaitala 31

Common glow-worms under artificial light: behavioural and evolutionary consequences,
Mira Van den Broeck, Raphaël De Cock, Erik Matthysen 32

Why are female glow-worms particularly vulnerable to urbanisation?, Topi Lehtonen 33

Space use behaviour of the larvae of the common glow-worm Lampyris noctiluca (Coleoptera: Lampyridae), Stefan Ineichen, Lorenz Achtnich 34

The duration of artificial light defines sexual signalling in the common glow-worm, Christina Elgert *et al.*, University of Helsinki (Finland) 35

Host condition and pathogen identity influence bacterial infection survival in the Common Eastern Firefly, Photinus pyralis, Sarah Lower *et al.*, Bucknell University (USA) 36

Session II: ART AND SOCIETY

Fireflies pretext for warning. Francesco Mariotti, Artist (Switzerland) 37

Beauty of fireflies through camera lens, Radim Schreiber 38

Be careful what you wish for: firefly tourism in Pennsylvania, Peggy Butler *et al.*, Pennsylvania Firefly Festival and US Firefly Tourism Luminary Council (USA) 39

The Lightscapes of Fireflies, from Literatures to their Habitat Restoration Landscapes: In the case of Thailand, Rachaya Wattanasirichaigoon , Harvard Graduate School of Design (USA/Thailand) 40

On social bioluminescence, Chiara Falcone, Politics, culture and development, PhD Researcher Department of Social and Political Science, UniCal (IT) 41

Session III: TAXONOMY, PHYLOGENY AND GENETICS

Museum collections as information repositories on fireflies and training tools for new lampyrid researchers: the case of the University of Porto, José Manuel Grosso-Silva, Natural History and Science Museum of the University of Porto (Portugal) 43

Firefly Sensilla Diversity: with Emphasis on Sexual Signaling, Yelena Pacheco *et al.*, University of Georgia (USA) 44

A taxonomic conundrum in Pteroptyx: how to solve it and what it means for conservation of mangrove fireflies in Southeast Asia, Wan Jusoh *et al.*, National University of Singapure (Singapore) 45
Understanding comparative larviform morphology and its impact on the broader Coleopterology, Joseph Cicero, University of Arizona (USA) 46
The fireflies of Israel – taxonomy, ecology and the potential effect of light pollution, Ella Fishman *et al.*, Tel Aviv University (Israel) 47

Session IV: BIOLUMINESCENCE, BIOCHEMISTRY AND PHYSIOLOGY
Resurecting the ancient glow, Yuichi Oba, Chubu University (Japan) 48
Investigating the role of pigmentation in firefly bioluminescence color, Margot Popecki *et al.*, University of Georgia (USA) 49
Light color evolution in fireflies, Kathrin Stanger-Hall, University of Georgia (USA) 50
A Modeling Approach for Studying Firefly Synchronization, Gonzalo Marcelo Ramírez-Ávila *et al.*, Higher University of San Andrés (Bolivia) 51
Three-dimensional tracking: Insights into firefly behavior and conservation, Orit Peleg, University of Colorado Boulder (USA) 52
Pteroptyx bearni firefly flash fewer and shorter when exposed to increasing brightness of white light LED. Vickly Mobilim, University of Malaysia Sabah (Malaysia) 53

Session V: CONSERVATION BIOLOGY
Firefly conservation: Protecting the Jewels of the Night, Sara Lewis & Sonny Wong, Tufts University, Boston USA & Malaysian Nature Society, Kuala Lumpur & IUCN Firefly Specialist Group (USA & Malaysia) 54
The business model of the firefly restoration in Taiwan, Chiahsiung Wu *et al.*, Tree-garden Co. Ltd. (Taiwan) 55
Recolonization of Fireflies in Artificially Modified Habitats, Vor Yiu, Hong Kong Entomological Society (Hong Kong) 56
Placing Indiana's state insect on the map: Records of Say's firefly, Pyractomena angulata, in Indiana (Lampyridae, Coleoptera) and the bordering states of Michigan, Ohio, Kentucky and Illinois, Sergio Henriques, Global Center for Species Survival, Indianapolis Zoo (USA/Switzerland) 57
Coexisting Pteroptyx species, friends or enemies?, Anchana Thancharoen *et al.*, Kasetsart University (Thailand) 58
Evaluating Firefly Extinction Risk: A Key Step to Species Conservation, Anna Walker, New Mexico BioPark Society (USA) 59

Session VI: CITIZEN SCIENCE

Network of volunteers to monitor the Lampyridae of France: between constraints and opportunities, Fabien Verfaillie, Group Associatif Estuaire (France) 60

Fireflies in olive groves: searching a beloved and desired insect, José Ramón Guzmán Álvarez *et al.*, Citizen science web project “Has visto una luciérnaga?" 61

Citizen Science Campaign in Search of a Forgotten Insect, Helena Virić Gašparić *et al.*, University of Zagreb (Croatia) 62

Quick spreading of populations of an exotic firefly throughout Spain and their recent arrival in the French Pyrenees, Marcel Koken *et al.*, LABOCEA (R&D unit) - CNRS (France) 63

Atlanta Firefly Project: A community-science exploration of the effects of land management on the local abundance of the big diper firefly (Photinus pyralis) in city parks and residential landscapes and guidance for future community science efforts, Kelly Ridenhour *et al.*, University of Georgia (USA) 65

Session I: ECOLOGY AND BEHAVIOUR

HOW TO BE ATTRACTIVE? SOCIAL AND VISUAL ENVIRONMENT AFFECT FEMALE SUCCESS IN GLOW-WORMS

Arja Kaitala

Department of Ecology and Genetics, University of Oulu, Finland

PLENARY TALK

The main feature in fireflies and glow-worms is their nighttime signaling. In the common European glow-worm, *Lampyris noctiluca*, flightless females glow to attract flying males and visibility is the key to mate attraction. As adults do not eat thus energy used for maintenance and signaling is away from energy available for reproduction. For example, small females might lose 20% of their eggs if they fail to mate and have to wait until the next night. Thus, females should maximize their attractiveness to mate soon. How to be attractive depends on the male search strategy, the presence of competitors and on the visual environment. Males do not fly around comparing females but select the brightest female they notice. On the other hand, females do actively avoid competition with superior females by moving apart, making accurate comparison difficult. To increase visibility, adult females should select optimal timing and spacing according to their local environment. Surprisingly, at the northern range of the species distribution females glow around midsummer when nights are lightest and visibility of the glow poorest. To increase visibility, northern females grow larger and glow brighter. To stand out from the environment females often glow in open habitats where they are visible from a long distance. They choose the habitat during the final larval stage when female larvae actively move towards open habitats in daytime. This dispersal may have dramatic consequences in urban areas as larvae often use roads as dispersal routes. Also, light pollution decreases a male's ability to find females and it decreases female glowing. In summary, individual females increase attractiveness and avoid competition by moving apart and glow like twinkling stars far from each other. Females do not avoid light summer nights but glow brighter in the north. Female larvae disperse to habitats of better visibility. Urbanization has twofold costs: mortality during larval dispersal increases and light pollution hampers mate finding.

COMMON GLOW-WORMS UNDER ARTIFICIAL LIGHT: BEHAVIOURAL AND EVOLUTIONARY CONSEQUENCES

Mira Van den Broeck, Raphaël De Cock, Erik Matthysen

Evolutionary Ecology Group, University of Antwerp,

Campus Drie Eiken, Universiteitsplein 1, B-2610 Wilrijk, Belgium

Artificial light at night (ALAN) is a globally occurring anthropogenic stressor forming a major threat to biodiversity, and especially to nocturnal wildlife. ALAN emerged about a century ago with an important expansion observed for the past few decades. Changes in natural light regimes and wavelengths due to artificial lights are therefore recent in evolutionary times, presenting an unprecedented new selection pressure. The light based signalling system of the European common glow-worm (*Lampyris noctiluca* L.) makes it an especially vulnerable species to interfering light from the environment. There is growing evidence that nightly light pollution greatly hampers mate finding in glow-worms, however, it is hitherto unknown how exactly different light colours of different intensities affect male glow-worm behaviour. Preliminary experiments suggest that shorter wavelengths such as blue light elicit either no or a negative response and positive phototaxis was found towards longer wavelengths. However, there were no significant differences between cold and warm white light in attraction success to dummy females. We furthermore found that light intensity strongly affected the female dummy attraction success under white light, but also affected female finding success under low pressure sodium lamps in the field. These experiments formed the foundation for the upcoming project aiming to unravel the underlying behavioural and electrophysiological mechanisms lowering male mate finding success. This summer, arena experiments will be performed with five colours, three intensities and two orientations (light from above and light from beneath the males). Electroretinograms will also be performed to assess the spectral sensitivity of the males. Next, the hypothesis that isolated glow-worm populations that have been exposed to light pollution for an extended period are evolving adaptive traits to overcome the negative effects of artificial light on glow-worm reproduction will be tested. This will be done by comparing various reproduction linked traits and behaviours from individuals from highly light polluted areas and from less light polluted areas.

WHY ARE FEMALE GLOW-WORMS PARTICULARLY VULNERABLE TO URBANISATION?

Topi Lehtonen, University of Oulu

The European common glow-worm (*Lampyris noctiluca*) is one of the firefly species that is likely to be negatively affected by anthropogenic environmental change. It is also a species with female neoteny; during night-time, larva-like and wingless adult females glow continuously to attract flying males to mate. Our results show that after becoming adults, females need to mate quickly to avoid a significant fecundity decline. Female mating success, however, was compromised by insufficient visual exposure, proximity to rival females and light pollution. We also found that because adult females move very little, they, unlike males, disperse already at the end of the larval phase, are attracted to roads during this period and perish in high numbers when run over by cars. Hence, roads are a putative ecological trap to glow-worms. As highlighted by female glow-worms' substantial vulnerability to urbanisation due to neoteny, anthropogenic change can negatively affect wildlife in ways that do not necessarily catch the eye without a detailed understanding of the focal species' ecology and behaviour. Besides gathering knowledge, we should also try to alleviate the negative effects. Our findings suggest that glow-worms would benefit from decreased car use at locations where they reproduce, and we show that short periods of night-time artificial light disturb glow-worms less than longer ones.

SPACE USE BEHAVIOUR OF THE LARVAE OF THE COMMON GLOW-WORM *LAMPYRIS NOCTILUCA* (COLEOPTERA: LAMPYRIDAE)

Stefan Ineichen, Lorenz Achtnich

ZHAW Life Sciences und Facility Management, Institut für Umwelt und Natürliche Ressourcen, Schloss, Postfach 335, 8820 Wädenswil - s.ineichen@bluewin.ch

Little is known as yet about mobility and space use behaviour of the larvae of the common glow-worm *Lampyris noctiluca*. For the understanding of the spatial distribution, information on the behaviour of the larvae is of great importance, especially since the larval phase covers the major part of the perennial development cycle. Therefore, a field test with marked larvae was carried out. Two study areas (25 m2 and 288 m2) were set up on the disused shooting range Rehalp in the southeast of Zurich. During 28 investigation nights between August 12 and September 11, 2019, 90 larvae could be marked within the study areas and their finding coordinates were noted. Numbered plates, coated with paint that fluoresces under black light, were used for marking. A total of 361 larvae (marking and recapture) could be recorded. 85.6 % of the marked larvae were found again. The number of recaptures of single individuals was between 2 and 12.

Using the coordinates, the movements of the larvae could be traced and the area used could be estimated using the minimum-convex polygon. The median of the larval “home range” is about four square meters. The average distance covered per night is 153 cm. Furthermore, the larval density was estimated and with the result of almost one larva per square meter, the result of an earlier investigation in the area could be confirmed.

Besides, the movements of the larvae show a clear preference for areas with partial vegetation and a strong litter layer. In the peripheral areas of dense vegetation groups, many larval observations could be made. The marking of the larvae with paint fluorescent under black light facilitated the retrieval of the larvae extraordinarily. The method of marking developed especially for this experiment has proven to be very effective and can be recommended for similar field experiments.

The reed area and the surrounding forest edges are home to a large population of the common glow-worm. The area would also be suitable for further investigations. Last but not least, the area is worth protecting due to the large population of the common glow-worm.

THE DURATION OF ARTIFICIAL LIGHT DEFINES SEXUAL SIGNALLING IN THE COMMON GLOW-WORM

Christina Elgert (1,3),* Topi K. Lehtonen (1,2,3), Arja Kaitala (2,3) and Ulrika Candolin (1,3)

(1) Organismal and Evolutionary Biology, University of Helsinki, PO Box 65, 00014 Helsinki, Finland
(2) Department of Ecology and Genetics, University of Oulu, PO Box 3000, 90014 Oulu, Finland
(3) Tvärminne Zoological Station, University of Helsinki, J.A. Palméns väg 260, 10900 Hanko, Finland. * Presenter

Artificial light at night is increasing globally, interfering with both sensory ecology and temporal rhythms of organisms, from zooplankton to mammals. This interference can change the behaviour of the affected organisms, and hence compromise the viability of their populations. Limiting the use of artificial light may mitigate these negative effects. Accordingly, we investigated whether the duration of artificial light affects sexual signalling in female glow-worms, *Lampyris noctiluca*, which are flightless and attract flying males to mate by emitting glow that is interfered by light pollution. The study included three treatments: no artificial light (control), 15 min of artificial light, and 45 min of artificial light. The results show that females were more likely to cease glowing when the exposure to light was longer. Furthermore, small females were more likely to cease their glow, and responded faster to the light, than larger females. These findings suggest that glow-worms can react rapidly to anthropogenic changes in nocturnal light levels, and that prolonged periods of artificial light trigger females to stop sexual signalling. Thus, limiting the duration of artificial light can mitigate the adverse effects of light pollution on sexual signalling, highlighting the importance of such mitigation measures.

HOST CONDITION AND PATHOGEN IDENTITY INFLUENCE BACTERIAL INFECTION SURVIVAL IN THE COMMON EASTERN FIREFLY, *PHOTINUS PYRALIS*

Sarah E. Lower, Madden J. Tuffy, Deeshani N. Patel, Zhengkai Zhu, Moria C. Chambers

Department of Biology, Bucknell University, Lewisburg, PA, USA

The degree to which host, pathogen, and environmental characteristics determine fitness outcomes in response to infection across the tree of life is a key question in ecoimmunology. Because infection experiments require large sample sizes and careful controls, studies have generally been limited to lab-adapted organisms. *Photinus pyralis* is a charismatic firefly that is abundant during its annual summer emergence in the Eastern United States. Here, we assess the importance of host condition, pathogen identity and dose, and pre-infection environment on survival outcomes in response to bacterial infection in wild-caught adult male *P. pyralis*. Wounding in the absence of infection did not affect survival. *Serratia marcescens* and *Providencia rettgeri* infections increased mortality, especially at high doses. In contrast to studies in fruit flies, *Providencia sneebia*, *Pseudomonas aeruginosa*, and *Enterococcus faecalis* infections did not. Fireflies caught late in the season had increased susceptibility to *P. rettgeri*, but time in the season did not significantly impact mortality during other infections. These results highlight the importance of taking into account host, pathogen, and environmental factors when investigating infection outcomes in wild-caught, non-model systems. The differences in survival between fireflies and fruit flies emphasize that further studies in a broad array of organisms are needed to explore the diversity of infection responses across the tree of life.

Session II: ART AND SOCIETY

FIREFLIES PRETEXT FOR WARNING

Francesco Mariotti

Via Fregera 6A, 6605 Locarno, Switzerland

francesco@mariotti.ch - www.mariotti.ch

PLENARY TALK

Attracted by the mysterious phenomenon of bioluminescence, my interest in fireflies started in 1993, and I began to work on my first art projects involving these fascinating lightning bugs.

I took inspiration from the names of firefly species, from myths and legends as well as from scientific texts about fireflies about topics such as their sexuality and their light signals, about Luciferin and the hunting of fireflies for the commercialization of D-Luciferin, about the firefly larvae and how they devour snails, about environmental issues and light pollution.

It became clear to me that the firefly is a perfect indicator of an intact habitat and also a privileged communication tool for art projects.

In all its manifestations, the firefly and the survival of fireflies appear as a warning about the degradation of evolution, the destruction of the environment and the irresponsibility of extractivism and urban sprawl.

BEAUTY OF FIREFLIES THROUGH CAMERA LENS

Radim Schreiber

FireflyExperience.org (USA)

Growing up in Czech Republic I had seen fireflies only once, and they were very dim, deep in the forest. When I came to the USA I was quite surprised by their abundance and beauty. During my last year of college I had a vision to take a close-up photograph of a glowing firefly without any idea how it could be done. When I took first photos of glowing fireflies up close for the first time I had fallen in love with photographing them. I had discovered that there are different types of fireflies which opened for me new world of discovery and wonder. My journey of firefly photography brought me many unique experiences, made many friends and later inspired me to become full-time artist and a firefly photographer.

BE CAREFUL WHAT YOU WISH FOR: FIREFLY TOURISM IN PENNSYLVANIA

Ken Butler & Peggy Butler*,

Pennsylvania Firefly Festival and US Firefly Tourism Luminary Council (USA)

* Presenter

In 2012, a group of scientists from Tennessee booked 10 days at our B&B in Pennsylvania in order to study the fireflies in our area. At that time, we didn't realize there was anything special about our 'lightning bugs' or that there was even more than one kind of firefly. Little did we know that our life was about to change, and the fireflies in our backyard would lead us to meeting some of the world's most renowned naturalists and researchers.

In June of 2012, Lynn Faust of Tennessee brought her Firefly International Research and Education (FIRE) Team to survey the fireflies in the Allegheny National Forest. They were especially interested in identifying the species known as the 'Synchronous' firefly, *Photinus carolinus*. Once they were sure that species did exist in our area, Lynn suggested that we had a choice to make. We could keep the fireflies a secret and go on with our quiet lives in the forest, or we could embrace the opportunity to start our own firefly event. We obviously chose the latter, but Lynn also gave us a warning to prepare ourselves for an onslaught of people, and should start by educating ourselves. It was hard for us to believe that many people at all would be interested in our lightning bugs. Boy were we wrong!

Ten years later, we have learned more than we ever thought we would need to know about fireflies. We now know what it takes to provide an informative firefly experience that is both fun and educational, while also protecting the fireflies and managing our own well being. We've met some amazing people along the way including Lynn's FIRE Team, Sarah Lower, Raphael DeCock and Kathrin Stanger Hall and Zach Marion;; photographer, Radim Schreiber; author, Sara Lewis; researcher Avalon Owens, film makers Martin Dorn and Nicholas Brown, and last but not least, Sir David Attenborough. These extraordinary people were more than just encouraging and supportive of our efforts. They were patient and generous as we naively fumbled our way to where we are now. We made plenty of mistakes along the way. Now, we believe we have implemented some practical and sustainable procedures to the PA Firefly Festival that we can share with others who may want to consider a firefly tourism event. We continue to learn more every year and still find the awe and wonder of world of fireflies.

This presentation will highlight some of our lessons learned and changes we've made over the years that could benefit others.

THE LIGHTSCAPES OF FIREFLIES, FROM LITERATURES TO THEIR HABITAT RESTORATION LANDSCAPES: IN THE CASE OF THAILAND

Rachaya Wattanasirichaigoon

Project Advisors:

Dr. Sara Lewis, Tufts University

Edward Eigen, Harvard University Graduate School of Design

Project Brief

Through the lens of Landscape Architecture, the project aims to read the landscapes of illuminating fireflies through cultural literature and interpret them to reimagine design interventions in modern habitat restoration. Arguing that deep appreciation and true understanding of science are the keys to sustainable co-existence. The research studies the case of Japan, and focuses the application on the site in Amphawa, Thailand. Throughout the course, the project will create an atlas and guidelines of spatial Landscape qualities as the medium between humans and fireflies. (The project is still on-going).

NOTES:

*The project is funded by Penny White Project Fund 2022, Landscape Architecture Department, Harvard University Graduate School of Design and the trip funded by the GSD Student Conference Attendance Funding.

ON SOCIAL BIOLUMINESCENCE

Chiara Falcone

Politics, culture and development | PhD Researcher Department of Social

and Political Science, UniCal (IT)

Fireflies have always caught poets' attention for their magic appearance. They have often been presented as glimpses of wonder, breaking the darkness with their sparkling lights. Pier Paolo Pasolini (1) refereed to them as figures of dancing desire, fleeting and erratic luminescent beings, spreading joyful life during nighttime. In 1975 he wrote an article denouncing the disappearance of fireflies; he spoke about a fierce and stunning process caused by the increasing pollution in air and water in the Italian land, that turned fireflies in just a memory of the past. The writer used a poetic image, with a polemic intent: he wanted to underline a transformation in the Italian landscape – produced by economic and political needs – that was bringing people far away from the authenticity of uncontaminated nature and its genuine relations. The environmental situation was strictly linked to social issues: the disappearance of fireflies became, in his words, metaphor for the cultural genocide, that was causing the disappearance of traditional knowledge from popular farming lifestyle. Neofascism and neocapitalism were phagocytizing uncontaminated ecosystems, standardizing the way of living and polluting lands and minds. In its apocalyptic interpretation there was no way out from social stereotypy.

Georges Didi-Huberman (2) in 2010 reclaimed Pasolini's metaphor, pointing out fireflies survivance: he wrote that fireflies are in danger, but still alive. He wanted to underline that, both in and out of the metaphor, it's still possible to see fireflies: far away from dazzling spotlights of contemporary consumerism, there are ecosystems of resistance where communities of bioluminescent beings are still dancing in the dark. He referred to both communities of sparkling insects and of people living in resonance with them, protecting the environment and experimenting sustainable lifestyles. They promote gestures, practices, languages that connect past habits and future hopes in present experimentations, illuminating ecosystems of resistance and concretizing ecological and creative alternatives of survivance.

From this point of view, bioluminescence can be considered as a social phenomenon and fireflies become figures of experiences introducing a rhythmic path of ecological awareness and political imagination in daily life, leading to social transformation. They safeguard ancient practices and invent new crafts, becoming community innovators.

Turning these metaphors in operative tools, the ongoing research is drawing the first lines of a phenomenology of social bioluminescence in meridian landscapes, mapping experiences of social

transformation in Calabria (IT), i.e. informal educational centers and associations promoting practices of connection with nature, stimulating creativity, improving self-awareness, and enhancing the quality of life in marginalized areas. It suggests that these experiences act as fireflies, sending sparkling signals, attracting dancing mates with their movements, and activating change in their contexts (3).

This contribution aims to involve the participants in a reflection on possible parallels among the behavior of fireflies, the bioluminescent insects, and the communities of people who want to promote sustainable lifestyles and innovative practices of social change.

The poster presents the theme of the research (4), showing the multilayered map of Calabrian luminescent beings (elaborated through an artistic participative methodology).

It contains interactive spaces to promote interdisciplinary dialogue and to hold suggestions and interlace collaborations.

(1) Italian film director, poet, writer, and intellectual. P.P. Pasolini, Scritti corsari, Garzanti, Milano 2011.

(2) French philosopher. G.Didi-huberman, La Survivance des lucioles, Minuit, 2009.

(3) Maintaining the conditions for real fireflies to survive too. In fact, in most of the cases, bioluminescent insects still live in the lands where the involved experiences take place.

(4) It has an interdisciplinary approach: creating connections between philosophy and cultural studies, it mixes theorical reflection with practical experimentation, using qualitative methodologies of visual participatory sociology.

Session III: TAXONOMY, PHYLOGENY AND GENETICS

MUSEUM COLLECTIONS AS INFORMATION REPOSITORIES ON FIREFLIES AND TRAINING TOOLS FOR NEW LAMPYRID RESEARCHERS: THE CASE OF THE UNIVERSITY OF PORTO

José Manuel Grosso-Silva, Ph.D.

Natural History and Science Museum

of the University of Porto (Portugal)

PLENARY TALK

The entomological collections of the University of Porto, part of its Museu de História Natural e da Ciência, include a small number of lampyrids from the Palaearctic and Neotropical regions. These specimens can be a valuable resource in the training of undergraduate as well as graduate students for the study of the European and in particular the Portuguese fauna of Lampyridae. In this talk a brief characterization of the Lampyridae preserved in the collections of the Museu de História Natural e da Ciência is presented and some examples of the recent study of fireflies by students are discussed.

FIREFLY SENSILLA DIVERSITY: WITH EMPHASIS ON SEXUAL SIGNALING

Yelena M. Pacheco* (1), Joseph V. McHugh (2), Seth M. Bybee (3),
Marc A. Branham (4), Kathrin F. Stanger-Hall (1)
(1) Department of Plant Biology, University of Georgia, USA
(2) Department of Entomology, 4 University of Georgia, USA
(3) Department of Biology, Brigham Young University, USA
(4) Entomology and Nematology, University of Florida, USA
* Presenter (USA)

Fireflies are known to use one of two sexual signaling modes, bioluminescence or pheromones. Visual bioluminescent signals are detected by the firefly's eyes while volatile pheromones are detected by the antennae. Previous research showed diversity of sensory organ size based on sexual signal mode, with bioluminescent fireflies having larger eyes and pheromone using fireflies having larger antennae, relative to body size (Stanger-Hall *et al.* 2018). Additionally, it was shown that males have larger sensory organs than their conspecific females (Stanger-Hall *et al.* 2018), suggesting that males actively searching for mates use these enlarged sensory organs to increase the probability of finding mates. Firefly antennae, like all other insects, are covered in morphologically and functionally diverse sensilla. While previous research has documented the antennal sensilla of one species of firefly, Luciola cruiciata (Iwaski *et al.* 1995), little is known about the diversity of firefly antennal sensilla, especially in respect to signal mode. It also remains unknown which sensilla are used for pheromone detection and how they are distributed across the firefly antenna. Here we document the antennal sensilla of 4 bioluminescent and 3 non-luminescent pheromone using species. We compare the morphological diversity between these species to identify differences between sexual signal modes. Finally, we identify potential pheromone-sensing sensilla by comparing the relative number of olfactory sensilla between bioluminescent firefly species and species that rely exclusively on pheromones for mate-search.

A TAXONOMIC CONUNDRUM IN *PTEROPTYX*: HOW TO SOLVE IT AND WHAT IT MEANS FOR CONSERVATION OF MANGROVE FIREFLIES IN SOUTHEAST ASIA

Wan F. A. Jusoh (1) & Lesley Ballantyne (2)

(1) Lee Kong Chian Natural History Museum, National University of Singapore, (2) 10 Conservatory Dr, Singapore 117377, Singapore. (2) School of Agricultural Environmental and Veterinary Sciences, Charles Sturt University, Wagga Wagga 2678 Australia

In Southeast Asia, the genus *Pteroptyx* is famous for its synchronous flashing displays on mangrove vegetation assemblages. *Pteroptyx* was established by Ernest Olivier (1902) for two species, *Luciola testacea* Motschulsky, 1854 and *Luciola malaccae* Gorham, 1880. Only two features of the male, distinguishing it from other Luciolinae, were given: apices of elytra strongly deflexed and terminal abdominal sternite with posterior margin strongly trilobed. The genus was named for features thought to be present in both species. In 1920, Lucas designated *Luciola testacea* as the type species of *Pteroptyx*, but there is no evidence to suggest that he examined the type series. In 2015, i.e., 113 years after Olivier's genus description, the identity of testacea was finally determined when pictures of the types housed in the Zoological Museum of Moscow University, Russia were able to be accessed and they showed that testacea has no deflexed elytral apices. The discovery did not conform to Olivier's definition of *Pteroptyx* suggesting that another type species should be designated. The other issue arises from a series of phylogenetic analyses of Luciolinae, which have consistently recognized a *Pteroptyx* clade as a morphologically variable genus. An expanded generic description of *Pteroptyx* now divides the genus into three groups: Group I [deflexed elytra + meta femoral comb (MFC) + bipartite light organ (BLO)]; Group II [non-deflexed elytra + MFC + entire light organ (ELO)]; Group III (non-deflexed elytra + no MFC + BLO). In addition, species delimitation analyses on taxa of Group I revealed the presence of cryptic and incipient species in *Pteroptyx bearni* and *P. tener* in SE Asia. More troubling still, many of their habitats, specifically mangroves, are deteriorating or destroyed due to environmental degradation and land conversion. In our attempt to solve a taxonomic conundrum in *Pteroptyx*, we provide four options. Option 1 is *Pteroptyx* remains status quo with testacea as the type species. Option 2 is we discard testacea as the type species, advocate that L. malaccae replace it and subdivide *Pteroptyx* into two subgenera. Option 3 is we discard testacea as the type species, advocate that *Luciola malaccae* replace it, and subdivide *Pteroptyx* into two genera. Option 4 is we discard testacea as the type species, advocate that *Luciola malaccae* replace it, and erect a monotypic new genus to accommodate testacea, with either of options 2 or 3 to accompany it. We also discuss how each option of taxonomic solutions will impact the conservation efforts of mangrove fireflies in Southeast Asia.

UNDERSTANDING COMPARATIVE LARVIFORM MORPHOLOGY AND ITS IMPACT ON THE BROADER COLEOPTEROLOGY

Joseph M. Cicero PhD - University of Arizona, retired

The pharate pupal stage of Holometabola is the stage in which nearly all external post-embryonic metamorphosis occurs, not the pupa. It is during this stage that the legs, wings and antennae differentiate and elongate, the larval thoracic sclerites differentiate into the pterothorax, the stemma differentiate and proliferate into compound eyes, and so on for the entire body of typical adults. The pharate adult and teneral adult stages provide the finishing touches to the typical adult stage. For lampyrids and related groups, this is the "ontogeny" component of "ontogeny and phylogeny".

The term "adult" is in question because all larviforms pupate and are therefore imagos as well. Further, the term "larviform" is in question too, since, on emergence from pupation, some females look like their larvae, while others look like their pupae, while still others look like their adult male. For our purposes, they can all be called "larviform", and all with little exception can be considered neotenic relative to their males. Understanding this complexity is actually very simple when one realizes that the endocrine system controls the extent of elaboration during metamorphosis, and the endocrine system evolves too. This is the "phylogeny" component of "ontogeny and phylogeny". Together, this subject is called "ontophylogenetics" or "evo-devo".

The endocrine system orders the insect to quit pharate pupal elaboration and move on to the pupa at different points in the metamorphic program depending on the species. All phengodids terminate pharate pupal elaboration very early, all flightless *Photinus* females terminate late, and others, such as *Lampyris noctiluca*, terminate somewhere in between. All then move on to the pupa "ready or not", and proceed to the adult stage, presenting a phenotype that is more larval than their males. Several are known to lay eggs, suggesting that the reproductive system completes metamorphosis early.

Proof of this analysis comes with identifying concordance of morphology in these females. When it is seen that any one character is more imaginal in one genus than in another, it will also be seen that a large suite of other identifiable characters are correspondingly more imaginal. Said another way, characters of any one larviform are in register with each other with regard to the degree of metamorphosis each has experienced, and, since different larviforms quit metamorphosis at different points in the program, some adult females will be more imaginal or more larval than other adult females with regard to the whole body. It is clear that larviforms are drawing their phenotypes from a common, primitive, basal, metamorphic program. Somatic mutations are certainly in operation also, but it is the basal program that shows the concordance. Clarification of this issue can be increased when the broader, unknown or poorly described larviform fauna come into focus. Effort to find them is needed, and when discovered, allotypes need to be described with the same thoroughness as their males with special reference to character states that have been identified as ontophylogenetic, such as the degree of differentiation of the mesodorsum, incipient wing growth, ommatidial counts when less than 200, indications of tarsomeral and flagellomeral fission, head retractility, abdominal locomotion and anteriorization, and many, many more.

THE FIREFLIES OF ISRAEL – TAXONOMY, ECOLOGY, AND THE POTENTIAL EFFECT OF LIGHT POLLUTION ON THEIR POPULATIONS?

Ella Fishman (1), (2), Ariel-Leib-Leonid Friedman (3), Omri Bronstein (1), (3), Neta Dorchin (1), (3)

(1) The School of Zoology, George S. Wise Faculty of Life Sciences, Tel Aviv University

(2) The Entomological Laboratory for Applied Ecology, Steinhardt Museum of Nature, Tel Aviv University

(3) Steinhardt Museum of Nature, Tel Aviv University

Fireflies (Coleoptera: Lampyridae) have distinctive bioluminescent courtship displays that make them a potential flagship group for insect conservation studies, and specifically studies on the consequences of light pollution. The Israeli firefly fauna comprises eight species in three genera, which have never been the subject of a systematic study, and threats to their populations have not been evaluated. The present study is the first to review the taxonomic status of the Israeli taxa, document their distribution patterns and phenology, and included a laboratory experiment in which the effect of light pollution on firefly females was tested. The taxonomic work was included morphological and molecular analyses, which enabled to associate larvae, females, and males of the same species. For this purpose, beetles were collected throughout Israel in 2020-2021, and data on newly collected individuals was combined with that on specimens from the national collection of insects in the Steinhardt Museum of Natural History. Additional information on the phenology and distribution of fireflies in Israel was obtained from a citizen science project, in which the general public was asked to report firefly observations online. The results of the molecular analysis, based on sequences of the mitochondrial COI and 16S genes revealed that the Israeli fauna comprises 11 lampyrid species, including six species that are new to science. Three species previously reported from Israel were not found in the present study and may have been reported from it erroneously. All larvae found in this study proved to belong to a single species - *Nyctophila syriaca,* except a single larva of the genus Lampyroidea - whose larvae have not been recorded from Israel so far. In a controlled laboratory experiment in which we tested the effect of low-level night lighting on the behavior, lifespan, and number of eggs laid by *N. syriaca* females, we found a significant difference in activity patterns between females that were exposed to night light compared to females maintained in complete darkness. Lifespan and egg number were unaffected by artificial lighting. These findings attest to major negative effects light pollution may have on firefly activity patterns and reproductive success.

Session IV: BIOLUMINESCENCE, BIOCHEMISTRY AND PHYSIOLOGY

RESURRECTING THE ANCIENT GLOW

Yuichi Oba

Chubu University, Japan

email: yoba@isc.chubu.ac.jp

PLENARY TALK

Which color did the last common ancestor of firefly glow? Using the maximum likelihood method, we calculated the amino acid sequence of ancestral firefly luciferase in silico based on the luciferase gene sequences of the extant fireflies in the world. When the recombinant protein was mixed with firefly luciferin in vitro, it emitted deepest green light (□max, 548 nm) (Figure 1), suggesting that the common ancestor of fireflies emitted in green in the mid-Cretaceous period, about 100 million years ago (Oba *et al.*, 2020). But why green? In this presentation, I would like to talk about the evolution of fireflies based on recent advances in genomic and paleobiological studies.

References:

Y. Oba, K. Konishi, D. Yano, H. Shibata, D. Kato, T. Shirai, Science Advances 6 (2020) eabc5705.

INVESTIGATING THE ROLE OF PIGMENTATION IN FIREFLY BIOLUMINESCENCE COLOR

Popecki, MS; Wares, JP; Stanger-Hall, KF

Popecki, MS[1]*; Wares, JP[1]; Stanger-Hall, KF[2]

[1] Department of Genetics, University of Georgia, Athens, GA 30602

[2] Department of Plant Biology, University of Georgia, Athens, GA 30602

*Presenter, (USA)

Many fireflies use bioluminescent signals in courtship displays. Fireflies emit flashes or glows from their light organ, which ranges from green to orange in color. Signal color is determined by the amino acid sequence of luciferase, the enzyme that catalyzes bioluminescence. For optimal detection, fireflies have evolved a match between signal color and visual sensitivity. Recent work found unexpected variation in signal color between populations of the same species, which was not explained by coding changes to luciferase. It is possible that pigments in the light organ and screen bioluminescent light, tuning signal color to the visual sensitivity of their mates. To determine if pigments are present in the light organ, we will compare the gene expression of *Photinus pyralis* with signal color extremes. If pigments contribute to the variation in signal color within species, we expect that genes involved in pigment synthesis will be differentially expressed between signaling states and color.

LIGHT COLOR EVOLUTION IN FIREFLIES

Kathrin Stanger-Hall, University of Georgia (USA)

One of the most endearing features of fireflies (Lampyridae) is their use of bioluminescent mating displays during summer evenings. During these displays, the duration, repetition and pauses in light signals are used to attract and identify conspecific mates, and to reduce the risk for potentially costly mating mistakes. However, before these signals can be analyzed by potential mates they have to be detected and seen, and this makes light color relevant. Both theoretical and empirical evidence suggest that different firefly light colors, ranging from green to yellow-orange, have evolved across firefly species to enhance the signal contrast with their signaling background, and thus signal detection by potential mates. Despite considerable progress towards an understanding of why light color is under selection in fireflies, our understanding of how light color evolves and which parts of the luciferase gene are the molecular targets of selection, remain largely unknown. In the light organs of fireflies, bioluminescence is generated by the enzyme luciferase in the presence of oxygen, the substrate luciferin and ATP+Mg2+. This light reaction, mostly using the luciferase of *Photinus pyralis*, has been utilized in biotechnological applications to monitor gene expression in cell cultures and extensive luciferase mutation experiments have contributed to our understanding of the functions of individual amino acids in this enzyme, including some that caused dramatic shifts in light color. However, our understanding of light color evolution in natural firefly populations, and the more subtle light color changes in their bioluminescent displays, is just at the beginning. Here we report some insights from our phylogeny-based analysis of luciferase evolution in the firefly genus *Photinus*, with implications for light color evolution in fireflies.

A MODELING APPROACH FOR STUDYING FIREFLY SYNCHRONIZATION

Gonzalo Marcelo Ramírez-Ávila (1), Stéphanie Depickère (1),
Juergen Kurths (2) (3), and Jean-Louis Deneubourg (4)

(1) Instituto de Investigaciones Físicas. Universidad Mayor de San Andrés. La Paz, Bolivia
(2) Potsdam Institute for Climate Impact (PIK-Potsdam), Germany
(3) Department of Physics. Humboldt Universität zu Berlin, Germany
(4) Faculté de Sciences. Université Libre de Bruxelles, Belgium

Synchronization is one of the most common phenomena occurring in oscillating systems in nature and man-made systems. A paradigmatic example of synchronization is the one attained by males of several firefly species, allowing them to mate and reproduce. Fireflies' synchronization has multiple applications (in communication networks, swarms of robots, etc.) and was extensively studied theoretically and in experimental, using pulse-coupled oscillators. Here we present a game with simple rules to describe synchronization in such oscillators. We also calculate the basins of attraction to quantify the importance of the initial conditions in reaching or not synchronization and the time intervals required for that.

THREE-DIMENSIONAL TRACKING: INSIGHTS INTO FIREFLY BEHAVIOR AND CONSERVATION

Orit Peleg, University of Colorado Boulder (USA)

Firefly flashes are a marvel of natural communication systems. During mating season, fireflies gather in large groups, and often produce their species-specific flash pattern. Despite the immense visual clutter from other fireflies in the swarm, and visual occlusions from the terrain, fireflies can perform individual and collective mating signals decipherable by their peers. To better understand these communication signals, we developed a method to record flash displays in three dimensions, using pairs of cameras with 360 degrees of view (stereo-recoding). This tool allows us to track collective spatiotemporal flash patterns in the swarm, as well as track individual fireflies and their exact flash pattern. This talk will cover the potential this method has to provide new insights into firefly behavior, and serve as a monitoring tool for firefly conservation. On the firefly behavior front, we used this method to study the collective flash synchronization mechanisms of *Photinus carolinus* [1-2] and *Photuris frontalis* fireflies [3]. In addition, we extended our method to utilize an optimization algorithm to estimate the cameras' relative positions, removing camera calibration requirements [4]. This new technology not only makes data gathering easier; it also allows us to crowdsource data acquisition. On the firefly conservation front, this tool could enable citizen scientists to use smartphones, GoPros, and other common camera devices to collect complex real-life data on firefly signal dynamics. By revealing the details of firefly behavior, we hope to open a whole new world of questions and reflections, and enhance the firefly experience for both scientists and the broader public.

[1] R. Sarfati, J. Hayes, É. Sarfati, O. Peleg; Spatiotemporal reconstruction of emergent flash synchronization in firefly swarms via stereoscopic 360-degree cameras; J. R. Soc. Interface 17:20200179 (2020) [2] R. Sarfati, J. Hayes, O. Peleg; Self-organization in natural swarms of *Photinus carolinus* synchronous fireflies; Science Advances, 7:28, eabg9259 (2021) [3] R. Sarfati, O. Peleg; Chimera States among Synchronous Fireflies; bioRxiv (2022) [4] R. Sarfati, O. Peleg; Calibration-free 3D reconstruction of firefly trajectories from 360-degree cameras bioRxiv (2021).

PTEROPTYX BEARNI FIREFLY FLASH FEWER AND SHORTER WHEN EXPOSED TO INCREASING BRIGHTNESS OF WHITE LIGHT LED

Vickly Mobilim

University of Malaysia Sabah (Malaysia)

Lampyridae (Order: Coleoptera) fireflies use light for mating, defense, and prey. They emit light through their light organ and began flashing only at night. However, the presence of light pollution may be too much for the communicative firefly, muting them. Thus, while it has been proved that light pollution contributes to the decline of firefly populations, empirical evidence is still missing, particularly about the direct effect of artificial light on the flashing patterns of the common firefly in Sabah, the *Pteroptyx bearni*. Thus, this study aims to determine the influence of varying intensities of white light LED on the flash rates and duration of the *Pteroptyx bearni* firefly, as well as to describe its flashing pattern. Subjects (N = 76) were caged in separate Petri dishes for one hour and then recorded for five minutes before, during, and after light pollution (0.05 lux, n = 19; 0.1 lux, n = 20; 0.3 lux, n = 20; 0.5 lux, n = 17). The flash rates and durations of the flashes were retrieved from the video data by converting it to picture sequences using FFMPEG and then converting it to an 8-bit grey value with Image J. Friedman test combined with the Wilcoxon signed rank test reveals that flash rates are lowest when exposed to 0.1 to 0.5 lux of light intensity, compared to both before and after exposure to light. Flash duration is shorter when exposed to 0.1 to 0.5 lux of light pollution. The flashing pattern of *Pteroptyx bearni* is erratic, comprising of single and multiple pulses.

Keywords: Light pollution, flash patterns, firefly communication, congregative Firefly.

Session V: CONSERVATION BIOLOGY

FIREFLY CONSERVATION: PROTECTING THE JEWELS OF THE NIGHT

Sara Lewis & Choong Hay Wong

Tufts University, Boston USA & Malaysian Nature Society,

Kuala Lumpur & IUCN Firefly Specialist Group

PLENARY TALK

Fireflies are charismatic insects with remarkable bioluminescent courtship displays that have been admired for centuries. More recently, they have provided models for the scientific study of bioluminesence, chemical defense, sexual selection, nuptial gifts, and species diversification. Over the past few decades, however, declining populations have been noted for many of the 2200+ firefly species worldwide. Therefore, we now urgently need a global, coordinated effort to identify major threats and to protect the most at-risk firefly species.

In 2018, the IUCN SSC Firefly Specialist group was established to explicitly focus on global conservation issues. We aim to) 1) describe key threats faced by fireflies in different geographic regions, 2) evaluate the current conservation status of species in each region, 3) identify threatened species facing the greatest extinction risk, 4) develop and disseminate standardized methods for monitoring long-term population trends and 5) articulate and share guidelines for sustainable firefly tourism. In this two-part talk we will summarize the progress we have made to date, and outline our future goals.

THE BUSINESS MODEL OF THE FIREFLY RESTORATION IN TAIWAN

Chiahsiung Wu (1), Yutien Li (2) and Pingshih Yang (3)

(1) The ecological director, Tree-garden Co., Ltd., Taipei, Taiwan

(2) The president, Tree-garden Co., Ltd., Taipei, Taiwan

(3) CEO, Friends of Da-An forest park foundation, Taipei, Taiwan

The business model is (1). The core value of a company and this value could become a business service or production, and consumers will fell satisfied the business services/ production, and they believe the business services/ production worth the value and price. (2). The service provider/producer could get benefit by selling the business services/ production. (3). The benefit must satisfy service provider/producer and stockholder. The business model of firefly restoration in Taiwan has 7 processes in one progression, (1). Feasibility assessment of presumptive sites, (2) fireflies habitats construction/ modification, (3). Artificial mass rearing of firefly larvae, (4). The organization and host of firefly larvae-releasing event, (5). Releasing firefly larvae and adult population monitoring, (6). The organizion and host of firefly-watching event, (7) The maintain of firefly habita. The main assessing factors of each 7 processes are (1) appropriate habitat condition—water and plant/ forest/ pond/ditch, and the landscape 100+ years ago by using ancient map, (2) the budget of consumers, (3). Artificial rearing method and medical treatment of firefly larvae, and the budget of consumers (4). The ability of marketing campaign, and environment education, and the budget of consumers (5). Ecology training, (6). The ability of marketing campaign and environment education, and the budget of consumers (7) The maintenance personnel, the training course, and the budget of consumers. For different consumers, there were different projects could sell in various packages project and will show the detail in oral talk.

RECOLONIZATION OF FIREFLIES IN ARTIFICIALLY MODIFIED HABITATS

Vor YIU. Hong Kong Entomological Society, 31E,

Tin Sam San Tsuen, Kam Sheung Road, Yuen Long, N.T. (Hong Kong)

All the natural habitats on the 1100 km2 of land of Hong Kong had been artificially modified to different extent, at different time of the history. Large areas had been heavily modified and almost all vegetation cover had been completely removed. Today 29 species of fireflies are known to exist in Hong Kong. In terms of species density, it is exceptionally high when compared with that of Taiwan and Japan where fireflies are well studied. Sites with high diversity of fireflies and high density of fireflies are selected to study what factors constitute the successful recolonization of fireflies in artificially modified habitats.

PLACING INDIANA'S STATE INSECT ON THE MAP: RECORDS OF SAY'S FIREFLY, *PYRACTOMENA ANGULATA*, IN INDIANA (LAMPYRIDAE, COLEOPTERA) AND THE BORDERING STATES OF MICHIGAN, OHIO, KENTUCKY AND ILLINOIS

Sergio Henriques

Global Center for Species Survival, Indianapolis Zoo (USA/Switzerland)

Spider and Scorpion Specialist Group, IUCN Species Survival Commission, Gland, Switzerland

The United States has a century old tradition of designating official symbols of their states. All US states have an official plant and a bird, while 96% have a state insect. More than half of these insects are not native to the US, whereas three states have selected a native firefly, namely Photuris pensylvanica (Pennsylvania), *Photinus pyralis* (Tennessee) and *Pyractomena angulata* (Indiana). This latter state is also the home of the new Global Center for Species Survival, which aims to think globally while acting locally to protect nature and inspire people to care for our world.

As we approach the bicentennial anniversary of the scientific description of Say's firefly (*Pyr. angulata*) we compiled the records of this species in Indiana, as well as records from the four bordering states and were surprised to find how poorly known this species truly is in the region. The contribution of different data sources is presented, towards streamlining data gathering for analysis such as the IUCN Red Listing.

We aim to work closely with local stakeholders, and the broader scientific community at large, towards establishing a framework to monitor Say's firefly populations, as well as supporting its in-situ and ex-situ conservation. Say's firefly might not be the most threatened firefly species, but we hope that its strong connection to the state of Indiana set's an important precedent to support firefly conservation there, hoping it might become a beacon of hope to firefly conservation everywhere.

COEXISTING *PTEROPTYX* SPECIES, FRIENDS OR ENEMIES?

Anchana Thancharoen (1), Parichart Laksanawimol (2) and Soraya Jaikla (1)

(1) Department of Entomology, Faculty of Agriculture, Kasetsart University, Thailand

(2) Department of Biology, Faculty of Science, Ratchabhat Chandrakasem University, Thailand

Pteroptyx spp. is a congregating firefly species that inhabits mostly mangrove areas in brackish water and estuarine wetland ecosystem. Four from eighteen species of *Pteroptyx* spp. were found in Thailand. Of which, *P. malaccae* and *P. valida* are two common species that are often found congregation congregating in the same colonies of mangrove trees. The small proportion of non-synchronous species, *P. valida* probably receive benefits from mass synchronous *P. malaccae* to make their colonies more attractive for their sexual communication. However, the relationship of the coexisting species has still not been explained. Firefly diversity and their abundance have been monthly monitored in Khung Bangkachao area, Samut Prakarn province since 2017 by 6 community survey groups classified by 6 subdistricts. The survey results showed that the overall trend for five years exhibited a declining trend with different time activities in different species (*P. valida* hatched earlier than *P. malaccae*). The species composition has obviously been changed from high *P. malaccae* to high *P. valida* found in inland mangroves of two subdistricts. However, more than 80% of *P. malaccae* have still been found in riverbank areas. We hypothesized that the change of resource abundance in the inland mangrove (i.e., loss of riverbank vegetation, low water circulation system, low sedimentation rate, low tide level) probably lead to increased interspecific competition and decrease the potential for coexistence. Although *P. malaccae* are a dominant species in the area for very long time (since 1966), their habitats were modified and becaome poorer quality habitats which results in reduceding their reproduction and survival. On the other hand, *P. valida* has adaptive characters, for example, with larger body size and earlier hatching, it could compete and persist in the modified habitats.

Keywords: Thailand, species composition, conservation, population, habitat modification.

EVALUATING FIREFLY EXTINCTION RISK: A KEY STEP TO SPECIES CONSERVATION

Anna Walker

New Mexico BioPark Society
903 10th Street SW
Albuquerque, NM 87102
U.S.A.

Fireflies are some of the most beloved insects globally, yet in many places, anecdotal reports suggest their lights may quietly be going out. To better understand the conservation status of fireflies, the International Union for the Conservation of Nature Species Survival Commission (IUCN SSC) Firefly Specialist Group aims to identify which species are in decline and what threats they are facing. To accomplish this goal, we plan to conduct baseline IUCN Red List assessments for over 2,000 species globally. To date, IUCN Red List assessments for 132 species from the United States and Canada have been published. From this first round of assessments, we identified at least 18 species (14%) threatened with extinction, due to threats such as habitat loss, light pollution, and climate change (namely sea level rise and worsening droughts). In addition, more than half of the assessed species (53%) could not be evaluated against the assessment criteria due to insufficient data, highlighting the need for additional research. Assessment projects in other regions are now underway, including in Mexico, the West Indies, Europe, and Southeast Asia. These extinction risk assessments are a useful step in conservation efforts. Once species are assessed, priorities for conservation planning and action start to emerge.

Session VI: CITIZEN SCIENCE

NETWORK OF VOLUNTEERS TO MONITOR THE LAMPYRIDAE OF FRANCE: BETWEEN CONSTRAINTS AND OPPORTUNITIES

Fabien Verfaillie

Dr in Ecology, President of Groupe Associatif Estuaire

Groupe Associatif Estuaire,Observatoire des Vers Luisants & Lucioles

Rue de Louza, 85440 Talmont-Saint-Hilaire, FRANCE - Tel. 02 51 20 74 85 - Mail ovl.france@gmail.com - www.asterella.eu

PLENARY TALK

The French Glowworm & Firefly Observatory (website: www.asterella.eu) is a participatory science 60xperimente conducted since 2015. It mobilizes around 15,000 volonteers per year. Since identification of the French Lampyridae species is not always within the reach of a general non-naturalist public, monitoring must be based on criteria representing little error risks and ultimately a general framework of very simplified requirements. Our positive (and negative!) experiences will be shared

FIREFLIES IN OLIVE GROVES: SEARCHING A BELOVED AND DESIRED INSECT

José Ramón Guzmán Álvarez*(1); Raphaël De Cock (1); José Eugenio Gutiérrez Ureña (2); Emilio Morcillo Moreno (2); Álvaro de las Heras (2); Francisco Vañó (2); María Garrido Lozano (2); Juan Domingo Santos (3); Rafael Carrasco Gómez (1); Antonio Cobo Molinos (4)

(1) Citizen science web project "¿Has visto una luciérnaga?", www.gusanosdeluz.com. (2) Life Olivares Vivos. (3) Universidad de Huelva 4Universidad de Jaén. * Presenting author

Besides their relatively scarce number, Spanish Lampyrids species are characterised by a relatively discrete bioluminescence behaviour. The usual pattern of bioluminescence is based on a single female that glows some minutes from sunset in order to call the attention of flying males; when they are located and the mating happens, the females switch off their light. *Lampyris noctiluca*, one of the species present in Spain, is representative of this pattern, that is shown by most of the other spanish species: *Lampyris iberica*, *Nyctophila reichii*, *Nyctophila heydeni*, *Lamprohiza paulinoi* and *Lamprohiza mulsantii*. *Photinus signaticollis*, an exotic species native from South American that arrived in Spain, has changed this situation, because it shows a male-female flash communication pattern and a gregarious bioluminescence behaviour, comparable to a certain extent to the enthralling performances of tropical and subtropical species. Nevertheless its discrete behaviour, glow-worms are a very known and appreciated insect for Spaniards, being part of their cultural references.

Due to the special relationship that exists with these bugs, glow-worms can act as valuable bio-indicators. In fact, local people used to identify this species as beloved companions of orchards and gardens, and they tend to miss them when they do not observe the glow-worms lights anymore after years. Although the reasons of the no-observations can be others to the local extinction (for instance, the change in habits of rural people, with less time and occasions linked to possible events of bioluminescent glow-worms behaviour, as nocturnal wanderings), different changes in rural areas that have occurred during the past decades could have had a negative effect for lampyrids local populations (increasing in night artificial lighting, use of insecticides and herbicides, land use changes, etc.).

Under these circumstances, there is a need to study the relationship of glow-worms ecological requirements and the current land use and the management practices, following the assumption that we can improve the suitability for lampyrids of man-made habitats as agricultural fields. The case of olive crops is of particular interest due to its great surface importance and the opportunities for wildlife offered by non-aggressive management practices, together with the growing interest of olive growers in having fireflies in their fields (reported as queries to the citizen science web project "¿Has visto una luciérnaga?", www.gusanosdeluz.com). Our experience shows that olive groves are sound habitat for glow-worms (*Nyctophila reichii*, *Lamprohiza paulinoi*) even in a monoculture matrix, at least when they are managed using a herbaceous layer, and that for answering the desire of "having glow-worms in my field", the first thing to do is a proper search at due time, because in many times we will have a nice surprise.

CITIZEN SCIENCE CAMPAIGN IN SEARCH OF A FORGOTTEN INSECT

Helena Virić Gašparić (1), Katarina M. Mikac (2), Marija Andrijana Galešić (1), Matej Orešković (1), Ivana Pajač Živković (1), Darija Lemic (1)

(1) University of Zagreb, Faculty of Agriculture, Department for Agricultural Zoology, Svetosinumska 25, 10000 Zagreb, Croatia; hviric@agr.hr
(2) Centre for Sustainable Ecosystem Solutions, School of Earth, Atmospheric and Life Sciences, University of Wollongong Australia, Northfields Avenue, Wollongong NSW 2522 Australia; kmikac@uow.edu.au

In recent years, there has been a purported decrease in the number of fireflies in the Republic of Croatia. It is speculated that this has occurred because of a combination of habitat loss due to urbanization and an associated increase in light pollution; the latter interfering with the lifecycle of fireflies. As a result, concerned scientist and students from the University of Zagreb and the University of Wollongong Australia launched a citizen science campaign in 2019 called 'Krešo Krijesnica' and is still going. Starting in May 2019 the campaign organisers enlisted the help of Croatian media outlets to call citizen scientists to arms to help understand whether there truly was a decline in firefly numbers throughout Croatia or whether fireflies in Croatia had simply been forgotten. Through emails, Facebook and Instagram pages, firefly reports, including images and videos, from across the whole of Croatia were collected. The campaign relied heavily on the use of media (radio, print and online) to advertise the campaign. Media was used to educate Croatians about firefly biology, their identification and collection of data and how to report their data. Citizen scientist reported fireflies were collected throughout the spring and summer of 2019-2021. In total, over 1700 reports from all over Croatia were collected and processed during the campaign and over 400 photographs and videos were analysed. The processing of the collected data has identified over 10,000 individuals (mostly males, though females too) belonging to four species: *Lampyris noctilua*, *Lampyris germariensis*, *Lamprohiza splendidula*, *Luciola italica*). The main findings of 'Krešo Krijesnica' were that the number of fireflies in Croatia was significantly higher than expected with a greater number of species than previously reported. Future work will build on the success of the Krešo Krijesnica citizen science campaign and move towards formal scientific surveys of the four species identified as well as population genetic analyses.

Key words: fireflies, citizen science, population abundance.

QUICK SPREADING OF POPULATIONS OF AN EXOTIC FIREFLY THROUGHOUT SPAIN AND THEIR RECENT ARRIVAL IN THE FRENCH PYRENEES

Marcel Koken (1)*†, José Ramón Guzmán-Álvarez (2)‡, Diego Gil-Tapetado (3)§ , Miguel Angel Romo Bedate (4)‡, Geneviève Laurent (5)†, Lucas Ezequiel Rubio (6), Segimon Rovira Comas (7)§, Nicole Wolffler (1)†, Fabien Verfaillie (8)† and Raphaël De Cock (9)‡,k.

(1) LABOCEA (R&D Unit) – CNRS, 120 Avenue Alexis de Rochon, 29280 Plouzané, France;
(2) Independent Researcher, 41008 Sevilla, Spain;
(3) Department of Biodiversity Ecology and Evolution, Universidad Complutense de Madrid, 28040 Madrid, Spain;
(4) Independent Researcher, Villanueva de la Serena, 06700 Badajoz, Spain;
(5) OVL Citizen Science Project, Groupe Associatif Estuaire, 85440 Talmont St. Hilaire, France;
(6) Faculty of Exact and Natural Sciences, University of Buenos Aires, B1657, Buenos Aires C1428EGA, Argentina;
(7) Grup Cucadellum – ICHN Citizen Science Project, Catalan Institution of Natural History, 08001 Barcelona, Spain;
(8) Groupe Associatif Estuaire, Port de la Guittière, Rue de Louza, 85440 Talmont St. Hilaire, France;
(9) Evolutionary Ecology Group, University of Antwerp, B-2610 Antwerp, Belgium.
* Presenting author & Correspondence: mhmkoken@gmail.com; † “Observatoire des Vers Luisants et des Lucioles”, Citizen Science Project, France (OVL). ‡ Gusanosdeluz, Citizen Science Project, “¿Has visto una Luciérnaga?”, Citizen Science Project, Spain (GDL). § Grup Cucadellum–ICHN, Citizen Science Project, Catalonia, Spain (GC). k Glimwormenwerkgroep Natuurpunt, Citizen Science Project, Belgium.

In August 2018, a firefly (Coleoptera: Lampyridae) of American origin was observed in several localities in Girona (Catalonia, Spain) and was described as a new species *Photinus immigrans* by Zaragoza-Caballero and Vinolas, 2018. However, we discovered that the species had already been designated as *Photinus signaticollis* by Emile Blanchard in 1846 and originated from Uruguay and Argentina. Therefore, *P. immigrans* should be considered as a synonym of *Photinus signaticollis* (Blanchard, 1846) (= *Photinus immigrans* Zaragoza-Caballero and Viñolas, 2018, syn. nov.). We provided evidence for this via aedeagus analysis and by culturing Argentinian and French larvae to adulthood.

The three original populations expanded quickly (by about 10 km per year) and the first specimens appeared already in 2020in the French Pyrenees after crossing several mountain passes. Beside the Girona populations an additional one was localised in Extremadura in western Spain, more then 1000 km away from Girona. Its special status will be discussed.The animal’s quick progress is detailed, and part of its biology is described (dispersion speed, land use, phenology in Spain/France and Argentina, identification of all life stages amongst which the earthworm eating larval stages).

Most observations were collected through three citizen science platforms, the Spanish «Gusanosdeluz", the Catalan "Grup Cucadellum" and the French “Observatoire des Vers Luisants et des Lucioles”. This

underlines the importance of this type of approach involving the general public for academic research and in following this potentially invasive species.

The species seems highly expansive and may well be invasive; these citizen science platforms are thus ideally suited to monitor its progress. This is important to avoid future ecological problems with diverse native faunas, such as glow-worms, fireflies and earthworms. If no ways are found to stop the species' progression, the animals will quite probably invade substantial areas of France, Spain and the rest of Europe in the years to come.

To announce observations of this species: On the websites of the citizen science projects of via:

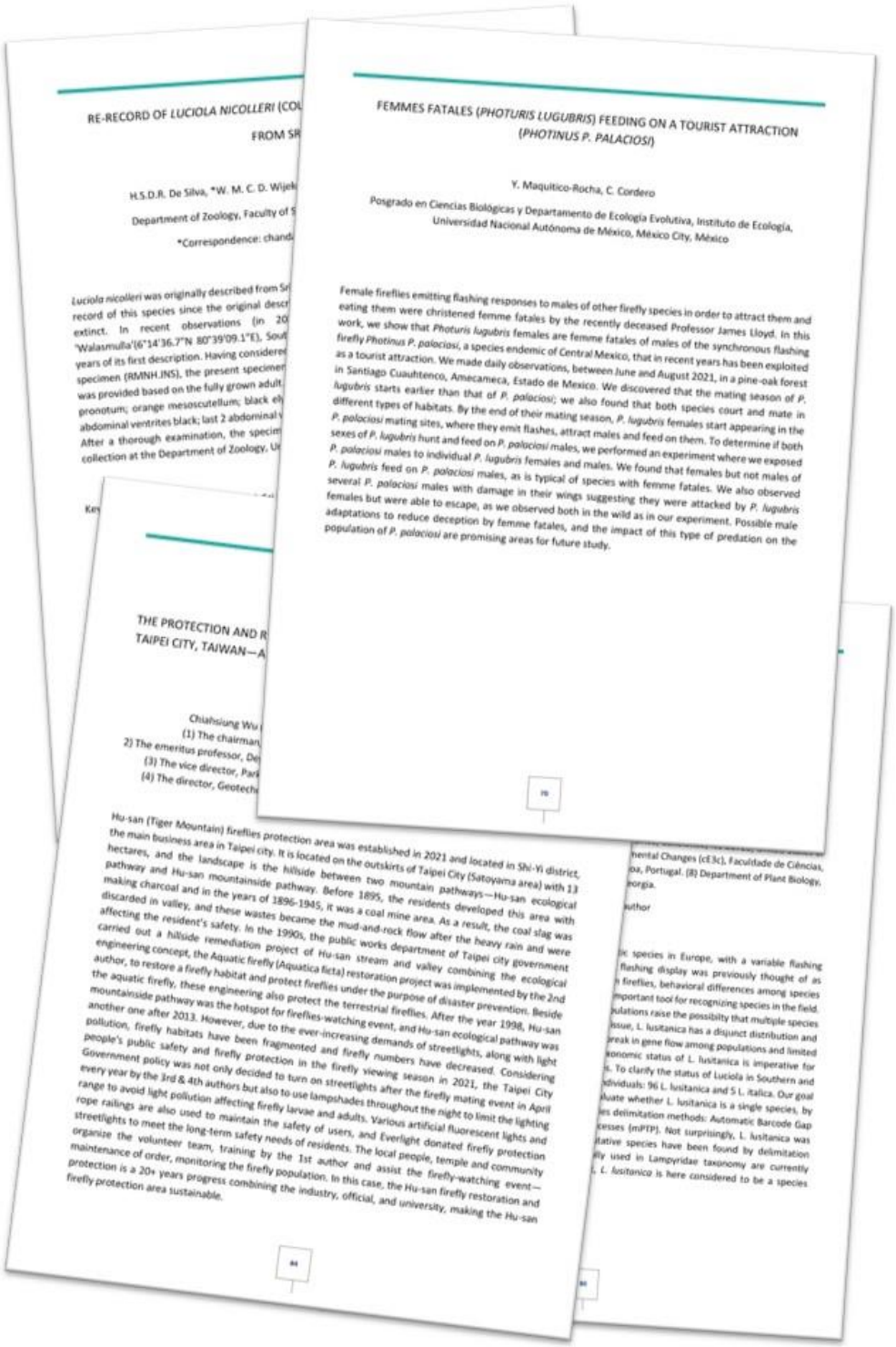
https://docs.google.com/forms/d/e/1FAIpQLScKQPQCeEvQ4zw7wSd5nbTOqbam9XsIb6ooEqpf17BLZse68Q/viewform

ATLANTA FIREFLY PROJECT: A COMMUNITY-SCIENCE EXPLORATION OF THE EFFECTS OF LAND MANAGEMENT ON THE LOCAL ABUNDANCE OF THE BIG DIPPER FIREFLY (*PHOTINUS PYRALIS*) IN CITY PARKS AND RESIDENTIAL LANDSCAPES

Lead Author: Kelly Ridenhour, Professional Landscape Architect, ISA Certified Arborist, M.S. in Integrative Conservation & Sustainability, Odum School of Ecology, University of Georgia (USA)
Co-Author: John Paul Schmidt, Ph.D. Ecology, Lecturer, Odum School of Ecology, University of Georgia (USA)

As human populations have become increasingly urbanized, residential landscapes and urban green spaces become correspondingly important locations for the experience of nature, a vital ecosystem service. Fireflies, globally distributed beetles in the Lampyridae family, while sensitive to the effects of urbanization, are at the same time charismatic and much enjoyed in residential landscapes. Here, I present results from the Atlanta Firefly Project, a community science effort to relate the effects of land management on the local abundance of *Photinus pyralis*. I found that firefly abundance increased with the amount of landscape greenness at the parcel level, whereas artificial lighting at night, insecticides targeting mosquitoes, removal of leaf litter, and applications of fertilizers reduced firefly abundance. Surprisingly, the use of herbicides increased *Photinus pyralis* numbers while irrigation decreased them, but these relationships are unclear. From these findings, I recommend conservation measures for residential property managers.

❖ POSTERS


RE-RECORD OF LUCIOLA NICOLLERI (COL
FROM SR
H.S.D.R. De Silva, *W. M. C. D. Wijek
Department of Zoology, Faculty of S
*Correspondence: chand
Luciola nicolleri was originally described from Sr
record of this species since the original descr
extinct. In recent observations (in 20
'Walasmulla'(6°14'36.7"N 80°39'09.1"E), Sout
years of its first description. Having considere
specimen (RMNH.INS), the present specimen
was provided based on the fully grown adult
pronotum; orange mesoscutellum; black el
abdominal ventrites black; last 2 abdominal
After a thorough examination, the specim
collection at the Department of Zoology, U
FEMMES FATALES (PHOTURIS LUGUBRIS) FEEDING ON A TOURIST ATTRACTION (PHOTINUS P. PALACIOSI)
Y. Maquitico-Rocha, C. Cordero
Posgrado en Ciencias Biológicas y Departamento de Ecología Evolutiva, Instituto de Ecología, Universidad Nacional Autónoma de México, México City, México
Female fireflies emitting flashing responses to males of other firefly species in order to attract them and eating them were christened femme fatales by the recently deceased Professor James Lloyd. In this work, we show that Photuris lugubris females are femme fatales of males of the synchronous flashing firefly Photinus P. palaciosi, a species endemic of Central Mexico, that in recent years has been exploited as a tourist attraction. We made daily observations, between June and August 2021, in a pine-oak forest in Santiago Cuauhtenco, Amecameca, Estado de Mexico. We discovered that the mating season of P. lugubris starts earlier than that of P. palaciosi; we also found that both species court and mate in different types of habitats. By the end of their mating season, P. lugubris females start appearing in the P. palaciosi mating sites, where they emit flashes, attract males and feed on them. To determine if both sexes of P. lugubris hunt and feed on P. palaciosi males, we performed an experiment where we exposed P. palaciosi males to individual P. lugubris females and males. We found that females but not males of P. lugubris feed on P. palaciosi males, as is typical of species with femme fatales. We also observed several P. palaciosi males with damage in their wings suggesting they were attacked by P. lugubris females but were able to escape, as we observed both in the wild as in our experiment. Possible male adaptations to reduce deception by femme fatales, and the impact of this type of predation on the population of P. palaciosi are promising areas for future study.
THE PROTECTION AND R
TAIPEI CITY, TAIWAN—A
Chiahsiung Wu
(1) The chairman
2) The emeritus professor, De
(3) The vice director, Par
(4) The director, Geotech
Hu-san (Tiger Mountain) fireflies protection area was established in 2021 and located in Shi-Yi district, the main business area in Taipei city. It is located on the outskirts of Taipei City (Satoyama area) with 13 hectares, and the landscape is the hillside between two mountain pathways—Hu-san ecological pathway and Hu-san mountainside pathway. Before 1895, the residents developed this area with making charcoal and in the years of 1896-1945, it was a coal mine area. As a result, the coal slag was discarded in valley, and these wastes became the mud-and-rock flow after the heavy rain and were affecting the resident's safety. In the 1990s, the public works department of Taipei city government carried out a hillside remediation project of Hu-san stream and valley combining the ecological engineering concept, the Aquatic firefly [Aquatica ficta] restoration project was implemented by the 2nd author, to restore a firefly habitat and protect fireflies under the purpose of disaster prevention. Beside the aquatic firefly, these engineering also protect the terrestrial fireflies. After the year 1998, Hu-san mountainside pathway was the hotspot for fireflies-watching event, and Hu-san ecological pathway was another one after 2013. However, due to the ever-increasing demands of streetlights, along with light pollution, firefly habitats have been fragmented and firefly numbers have decreased. Considering people's public safety and firefly protection in the firefly viewing season in 2021, the Taipei City Government policy was not only decided to turn on streetlights after the firefly mating event in April every year by the 3rd & 4th authors but also to use lampshades throughout the night to limit the lighting range to avoid light pollution affecting firefly larvae and adults. Various artificial fluorescent lights and rope railings are also used to maintain the safety of users, and Everlight donated firefly protection streetlights to meet the long-term safety needs of residents. The local people, temple and community organize the volunteer team, training by the 1st author and assist the firefly-watching event—maintenance of order, monitoring the firefly population. In this case, the Hu-san firefly restoration and protection is a 20+ years progress combining the industry, official, and university, making the Hu-san firefly protection area sustainable.

❖ Poster index

Session I: ECOLOGY AND BEHAVIOUR

Through a dog's nose: can sniffer dogs become a new tool for glow-worm surveying?, Mira Van den Broeck *et al.*, University of Antwerp (Belgium) 69

Feeding habits of Lampyrid species in Spain: catalogue of preys from biodiversity citizen science data, José Ramón Guzmán Álvarez *et al.*, Citizen Science web project "Has visto una luciérnaga?" (Spain) 70

Femmes fatales (Photuris lugubris) feeding on a tourist attraction (Photinus P. palaciosi), Yara Maquitico-Rocha *et al.*, National Autonomous University of Mexico (Mexico) 71

Effect of artificial nocturnal light in the bioluminescent signals associated to the matting and predatory behaviors of Photinus and Photuris fireflies, Laia Gaitán Botero *et al.*, Rosario University (Colombia) 72

Session III: TAXONOMY, PHYLOGENY AND GENETICS

Understanding comparative larviform morphology and its impact on the broader Coleopterology, Joseph. M. Cicero, University of Arizona (USA) 73

Re-record of Luciola nicolleri (Coleoptera: Lampyridae: Luciolinae) from Sri Lanka, Dilshan De Silva *et al.*, University of Ruhuna (Sri Lanka) 75

Systematic Review of Neotropical Vesta (LaPorte 1833): Distribution, Key and Description of New Species, Sara Rivera *et al.*, Western Carolina University (USA) 76

On the natural history of the black-winged firefly, Phosphaenopterus metzneri Schaufuss, 1870 with comparative notes on Phosphaenina (Coleoptera: Lampyridae), Viviane Nunes *et al.*, Universidade de Lisboa (Portugal) 77

Shrouded in a flashing mystery: decoding the gene flow and species boundaries in the firefly Luciola lusitanica Charpentier, 1825, Viviane Nunes *et al.*, Universidade de Lisboa (Portugal) 79

Session IV: BIOLUMINESCENCE, BIOCHEMISTRY AND PHYSIOLOGY

Hemocyte responses of Lamprigera tenebrosa larvae after bacterial infection, Parichart Laksanawimol *et al.*, Ratchabhat Chandrakasem University (Thailand) 80
A firefly simple game for modeling synchronization, Stéphanie Depickère *et al.*, Hight University of San Andrés (Bolivia) 81
Beetle bioluminescence outshines aerial predator, Yelena Pacheco, University of Georgia (USA) 82

Session V: CONSERVATION BIOLOGY
The protection and restoration of terrestrial fireflies in Satoyama area in Taipei city, Taiwan—A 20+ years progress with the combination of Industry, Official and University, Chiahsiung Wu *et al.*, Taiwan Ecological Arboriculture Society (Taiwan) 83
"Ecological conservation of Rhagophthalmus spp. (Rhagophthalmidae) in Matsu islands, Taiwan", Chia-Hung Hsieh et al., Chinese Culture University (Taiwan) 84
Conservation Activities of the IUCN SSC Firefly Specialist Group, Vor YIU *et al.*, Hong Kong Entomological Society (Hong Kong) 85
Fireflies (Coleoptera: Lampyridae) in the Collections of Croatian Natural History Museums, Darija Lemic *et al.*, University of Zagreb (Croatia) 86
Roadmap for firefly conservation planning and action: North America as a case-study, Anna Walker *et al.*, New Mexico BioPark Society (USA) 87
Keep the forest shiny: mapping threats to inform conservation planning of firefly species endemic to the Atlantic Forest hotspot, Stéphanie Vaz Campos, Federal University of Rio de Janeiro (Brazil) 88

Session VI: CITIZEN SCIENCE
The distribution of lampirids in Spain: an interpretation based on geography and history, José Ramón Guzmán Álvarez *et al.*, Citizen science web project "Has visto una luciérnaga?" (Spain) 89
Fireflies' Nights – a programme of environmental education, Henrique N. Alves *et al.*, Parque Biológico de Gaia (Portugal) 90

Session I: ECOLOGY AND BEHAVIOUR

THROUGH A DOG'S NOSE: CAN SNIFFER DOGS BECOME A NEW TOOL FOR GLOW-WORM SURVEYING?

Mira Van den Broecka, Hilde Vervaeckeb, Ellen Van Krunkelsvenc,
Raphaël De Cock, Erik Matthysena
(a) Evolutionary Ecology Group, University of Antwerp, Campus Drie Eiken, Universiteitsplein 1, B-2610 Wilrijk, Belgium
(b) Odisee University College of Apllied Sciences, Campus Waas, Agro- and Biotechnology, Hospitaalstraat 23, B-9100 Sint-Niklaas, Belgium
(c) K9 Unit Federal Police, Achter het Dorp 21, B-3350 Neerhespen, Belgium

Ecological detection dogs have proved to be efficient in surveying a variety of inconspicuous species for conservation purposes. The success depends on how well their presence can be detected with the aid of the dogs' strongly developed sense of smell. European common glow-worms (*Lampyris noctiluca*) have a short adult stage and have a short and nocturnal activity period which makes it difficult to survey the species. Finding glow-worm larvae can be challenging as they only emit a faint and short glow and have a restricted nocturnal activity period. Detection dogs could facilitate the detection of specimens and surveying of glow-worm populations. The aim of the project is to assess if the use of ecological detection dogs to detect glow-worm larvae is feasible and is more efficient than detection by humans only. Two dogs have been trained to detect L. noctiluca larvae. Firstly, the discrimination abilities and accuracy to detect glow-worms will be tested. Next, we will test in the field if the dogs can correctly detect the larvae. Then we will compare the larvae collection efficiency during the day and during the night with or without a detection dog. If this method proves to increase the detection efficiency it constitutes a good additional or alternative method to collect and survey glow-worms, and it can be an inspiration to apply this method to other similar elusive species.

FEEDING HABITS OF LAMPYRID SPECIES IN SPAIN: CATALOGUE OF PREY FROM BIODIVERSITY CITIZEN SCIENCE DATA

José Ramón Guzmán Álvarez*(1); Raphaël De Cock (1); José Ramón Arrébola Burgos (2); José Domingo Gilgado Hormaechea (2); Ferran Turmo Gort (2)

(1) Citizen science web project "¿Has visto una luciérnaga?", www.gusanosdeluz.com
(2) Universidad de Sevilla
(3) Universidad de Alcalá de Henares
(4) Biodiversidad Virtual
* Presenting author

The predatory larvae of *Lampyris noctiluca* – the most known and extended lampyrid species of Europe - feed on snails and slugs after injecting a digestive fluid. For other species of European lampyrids, the feeding behaviour is supposed to be similar to that of *Lampyris noctiluca*, although little is known about the specific species that are predated.

Some larvae photographical observations recorded while feeding and uploaded to biodiversity webs (Biodiversidad Virtual, iNaturalist) and queries sent to the citizen science web project "¿Has visto una luciérnaga?" allow to examine the prey species in order to propose the identification. Using this methodology we have studied roughly 80 records, including Lampyris sp. (*Lampyris noctiluca* or L. iberica) and *Nyctophila reichii* larvae. Although species identification proves to be difficult in many cases, we have determined the following species of terrestrial snails: *Cornu aspersum*(O. F. Müller, 1774), *Cepaea nemoralis* (Linnaeus, 1758), *Otala lactea* (O. F. Müller, 1774), *Theba pisana* (O. F. Müller, 1774), *Iberus gualterianus* (Linnaeus, 1758), *Cochlicella barbara* (Linnaeus, 1758), *Cernuella (Microxeromagna) vestita* (Rambur, 1868) and *Oxycillus* sp.. The slug *Arion ater* (Linnaeus, 1758) has also been recorded. It draws particular attention the observation of larvae of *Nyctophila reichii* feeding in a dry water channel on a freshwater snail (*Physella* sp.) and other observation feeding on an earthworm (Lumbricidae), which means enlarge the range of preys of European Lampyridae species.

FEMMES FATALES (*PHOTURIS LUGUBRIS*) FEEDING ON A TOURIST ATTRACTION (*PHOTINUS P. PALACIOSI*)

Y. Maquitico-Rocha, C. Cordero

Posgrado en Ciencias Biológicas y Departamento de Ecología Evolutiva, Instituto de Ecología, Universidad Nacional Autónoma de México, México City, México

Female fireflies emitting flashing responses to males of other firefly species in order to attract them and eating them were christened femme fatales by the recently deceased Professor James Lloyd. In this work, we show that *Photuris lugubris* females are femme fatales of males of the synchronous flashing firefly *Photinus P. palaciosi*, a species endemic of Central Mexico, that in recent years has been exploited as a tourist attraction. We made daily observations, between June and August 2021, in a pine-oak forest in Santiago Cuauhtenco, Amecameca, Estado de Mexico. We discovered that the mating season of *P. lugubris* starts earlier than that of *P. palaciosi*; we also found that both species court and mate in different types of habitats. By the end of their mating season, *P. lugubris* females start appearing in the *P. palaciosi* mating sites, where they emit flashes, attract males and feed on them. To determine if both sexes of *P. lugubris* hunt and feed on *P. palaciosi* males, we performed an experiment where we exposed *P. palaciosi* males to individual *P. lugubris* females and males. We found that females but not males of *P. lugubris* feed on *P. palaciosi* males, as is typical of species with femme fatales. We also observed several *P. palaciosi* males with damage in their wings suggesting they were attacked by *P. lugubris* females but were able to escape, as we observed both in the wild as in our experiment. Possible male adaptations to reduce deception by femme fatales, and the impact of this type of predation on the population of *P. palaciosi* are promising areas for future study.

EFFECT OF ARTIFICIAL NOCTURNAL LIGHT IN THE BIOLUMINESCENT SIGNALS ASSOCIATED TO THE MATING AND PREDATORY BEHAVIORS OF *PHOTINUS* AND *PHOTURIS* FIREFLIES

Camilo Arenas-Ríos (1) *, Zulma S. Barón-Garzón (1) *, Nicolás Bernal-Guatibonzo (1) *, Manuela Cardona-Restrepo (1) *, Laia Gaitán-Botero (1) *$, Sofía Garrido-Villegas (1) *, Juan S. Hillón-Salas (1) *$, Anyi D. Macías-González (1) *, Diego Mejía-Tovar (1) *, Juan D. Pineda-Dueñas (1) *, Harold Pulido (2), Andrés F. Robayo-Salek (1) *, Ana M. Romero-Chacón (1) *, Adriana A. Maldonado-Chaparro (1)

(1) Department of Biology, Rosario University

(2) Department of Biology, Military University

*Authors are in alphabetical order

Institutional Adress

$ presenting authors, adriana.maldonado@urosario.edu.co

Light pollution is a threat to many nocturnal animal species. Artificial light at night, also known as ALAN, is one of the main factors driving the decline of firefly populations worldwide. ALAN can impair the visual recognition of predators, prey, and conspecifics, and thus can affect several behaviors. We investigated the effect of ALAN on mating displays and predatory behavior in the genus *Photinus* and Photuris, in Tobia, Cundinamarca, Colombia. Using a mesocosm experiment we recorded changes in male flash rate and female responsiveness, under controlled environments with and without artificial light. Preliminary results show that ALAN has a significant impact on both, courtship activity and predatory behavior. Our results will contribute to the understanding of the effects ALAN on firefly behavior and to further understand the impact on their fitness.

Session III: TAXONOMY, PHYLOGENY AND GENETICS

UNDERSTANDING COMPARATIVE LARVIFORM MORPHOLOGY AND ITS IMPACT ON THE BROADER COLEOPTEROLOGY

Joseph M. Cicero PhD, University of Arizona, retired

Ontophylogenetic differences between larviforms can be detected by recognizing the polarity and shape changes that characters undergo during metamorphosis. For this detection, most any larva and fully winged adult can be used as templates at either end of the ontogenetic continuum. By definition, character metamorphosis is unidirectional- from the larval condition to the adult condition with no regression. For example, the larval mesodorsum actually shrinks in size as its shape changes from a wide, trapezoidal sclerite to a small, roundish sclerite with a scutum and scutellar lobe. The smaller it gets, the more imaginal it is.

Although among the most labile of characters, wings and compound eyes are also good examples to use for illustrating polarity and shape changes. In the larval template, wings are absent, but in the adult template, wings reach the end of the abdomen. Therefore, wing growth is first initiated, then it produces a consecutively longer and broader morphometric until the series of intermediates ends. A huge number of genes are in operation, but the other aspects of the adult wing they are responsible for are not of concern here, only elongation and broadening. Larval stemma somehow differentiate and proliferate into compound eyes. While the histological changes are not known, it is clear that facet number increases until the series of intermediates ends. These continua are called “character series”.

Another model involving ontogenesis of characters is “direct to adult”, wherein an adult character, such as the compound eye, is formed without viable intermediates, which were eliminated during evolution. This may be the case in contemporary species, but comparative larviform morphology indicates that metamorphic intermediates were viable at one time.

The larviforms present these intermediates as phenotypes because their endocrine system arrests metamorphosis earlier than their males, and these phenotypes are in fact the intermediates discussed above. Their morphology is therefore caught at different stages of elaboration depending on the species. Some species quit early, some quit late, and others quit somewhere in between. Such gradients are best observed by comparing different genera because their respective intermediate stages are well separated.

But importantly, these gradients actually occur within lineages, and the span of intermediates seen between species of the same genus are closely spaced. Diaphanes, Phausis and Microphotus are good

examples of this because more than one species is known for the genus. The female of each species can be arranged in order from the most larval to the most imaginal.

The critical concept here is that the most larval are different from the most imaginal because the distinguishing characters are those that had the potential to elaborate further when the arrest occurred. *Photinus* species are the best examples of this concept because their span of intermediates starts with brachypterous females and ends with what appear to be “fully imaginal” females, such as *P. pyralis*. As with the other genera, these *Photinus* show characters that had the potential to elaborate further at arrest, and those presented by *P. pyralis* are continued into the broader Coleoptera. Once understood and vetted by the broader audience, this conceptual breakthrough can put Lampyridology at the forefront of Coleopterology.

RE-RECORD OF *LUCIOLA NICOLLERI* (COLEOPTERA: LAMPYRIDAE: LUCIOLINAE) FROM SRI LANKA

H.S.D.R. De Silva, *W. M. C. D. Wijekoon, K.V.S.N. Bandara, H.C.E. Wegiriya

Department of Zoology, Faculty of Science, University of Ruhuna, Sri Lanka

*Correspondence: chandanadammika1984@gmail.com

Luciola nicolleri was originally described from Sri Lanka by Bugnion in 1922. However, there has been no record of this species since the original description, and subsequently, this species was considered extinct. In recent observations (in 2022), the species has been rediscovered from 'Walasmulla'(6°14'36.7"N 80°39'09.1"E), Southern, Intermediate Zone of Sri Lanka almost after 100 years of its first description. Having considered the expert's reviews and original description of the type specimen (RMNH.INS), the present specimen was confirmed as *L. nicolleri* and a detailed description was provided based on the fully grown adult. *L. nicolleri* male; 8 mm long; large exposed head; orange pronotum; orange mesoscutellum; black elytra with narrow pale margins; legs mainly orange; basal abdominal ventrites black; last 2 abdominal ventrites creamy orange and last ventrite tapers posteriorly. After a thorough examination, the specimen was preserved and deposited with the entomological collection at the Department of Zoology, University of Ruhuna, Sri Lanka.

Key words: *Luciola nicolleri*, re-record, Sri Lanka.

SYSTEMATIC REVIEW OF NEOTROPICAL VESTA (LAPORTE 1833): DISTRIBUTION, KEY, AND DESCRIPTION OF NEW SPECIES

Sara Rivera, Luiz Lima da Silveira

Western Carolina University, 1 University Way, Cullowhee NC, USA 28723

Fireflies in the beetle family Lampyridae are well-loved for the bioluminescent mating displays of some species. While some groups like flashing North American fireflies are well-known, other groups such as tropical dark fireflies are drastically understudied. The genus Vesta (Laporte 1833) is of great taxonomic uncertainty. Most species are only known from vague original descriptions with little modern follow up and most have no documented females or larvae. The genus is vaguely defined by their large, serrate antennae, a taxonomically unreliable trait that can vary widely among closely-related groups. Additionally, Vesta has a widely disjunct distribution with 21 Oriental and 10 Neotropical species. Their fractured distribution and vague diagnosis raise questions on the monophyly of the group and indicate the need for taxonomic review and revision of the genus. As a part of an ongoing review of the genus, I will here present my preliminary results including a distribution map, a key to species, and description of a new Neotropical Vesta species. This study will build the groundwork for further study of the Vesta and similarly neglected firefly species in the tropics. It will also help build understanding of the diversity and evolution of tropical fireflies.

ON THE NATURAL HISTORY OF THE BLACK-WINGED FIREFLY, *PHOSPHAENOPTERUS METZNERI* SCHAUFUSS, 1870 WITH COMPARATIVE NOTES ON PHOSPHAENINA (COLEOPTERA: LAMPYRIDAE)

Viviane Nunes (1) (2)*, Gonçalo Figueira (3), Luís Filipe Lopes (4) (5) & Paula Souto (6)

(1) Programa de Pós-Graduação em Biologia Evolutiva e do Desenvolvimento (BED), Faculdade de Ciências, Universidade de Lisboa, Lisbon, Portugal. (2) Computational Biology and Population Genomics Group (COBIG2), Centro de Biologia Ambiental, Departamento de Biologia Animal, Faculdade de Ciências, Universidade de Lisboa, Lisbon, Portugal. (3) Superior de Ciências Sociais e Políticas, Universidade Técnica de Lisboa, Lisbon, Portugal. (4) Instituto de Investigação Científica e Tropical (IHMT) and Global Health and Tropical Medicine (GHTM), Universidade Nova de Lisboa, Lisbon, Portugal. (5) Centre for Ecology, Evolution and Environmental Changes (cE3c), Faculdade de Ciências da Universidade de Lisboa, Campo Grande, Lisbon, Portugal. (6) Centre for Functional Ecology (CFE), University of Coimbra, Portugal

* Presenting author

Fireflies are better known by the soft-bodied adults, which often bear different sets of lanterns on their abdominal segments, producing flashes or glows. While lanterns are the most recognizable trait, not all species have conspicuous lanterns and are thought to be diurnal. For example, taxa belonging to the subtribe Phosphaenina comprise three species and two genera prima facie endemic to Europe - all diurnal at first glance. The monotypic genus Phosphaenus Laporte, 1833 is a widespread species in Europe and is unique among other lampyrid taxa due to its brachypterous condition in males - a condition only previously reported in females fireflies. In its turn, the genus Phosphaenopterus Schaufuss, 1870 possesses two species, P. metzneri and P. montandoni, both poorly reported in the literature and with vague descriptions of their morphology, behavior, distribution, and biology. To date, P. metzneri is the best-known species within the genus, and data on its distribution have been updated recently, with the first records in Spain - early reported only from Portugal and the French Pyrenees. However, data on P. montandoni, supposedly endemic to Romania, are absent since its original description. Not surprisingly, their original descriptions were based on males, and females of these species are unknown. By collecting larvae of Phosphaenina where males of P. metzneri occur, we reared them to adults, resulting in males and females of P. metzneri. The male-female association of this species was possible after observing copula ex-situ. Here, we describe for the first time the neotenic female of P. metzneri, a diurnal firefly, and redescribed the male. Illustrations of diagnostic features of the adults and an updated distribution checklist for P. metzneri are also provided. Because of morphological resemblance between all species within Phosphaenina, we also redescribe the male of Phosphaenus hemipterus (Goeze, 1777), a species also present in Portugal. After a thorough morphological comparison between males of Phosphaenus hemipterus and Phosphaenopterus metzneri, we found no morphological differences in important diagnostic traits traditionally anchoring

lampyrid taxonomy (e.g., terminalia, aedeagus). This study stresses and discusses a putative case of wing polymorphism in Lampyridae, a rare condition in fireflies. This is also the first study to report both species in sympatric distribution.

SHROUDED IN A FLASHING MYSTERY: DECODING THE GENE FLOW AND SPECIES BOUNDARIES IN THE FIREFLY *LUCIOLA LUSITANICA* CHARPENTIER, 1825

Viviane Nunes (1) (2)*, Raphaël De Cock (3), Marcel Koken (4), Paula Souto (5), Luiz Felipe Lima da Silveira (6), Octávio S. Paulo (7), Yelena Pacheco (8)

(1) Programa de Pós-Graduação em Biologia Evolutiva e do Desenvolvimento (BED), Faculdade de Ciências, Universidade de Lisboa, Lisbon, Portugal. (2) Computational Biology and Population Genomics Group (COBIG2), Centro de Biologia Ambiental. (3) Evolutionary Ecology Group, University of Antwerp, Belgium. (4) LABOCEA (R&D Unit)–CNRS, 120 Avenue Alexis de Rochon, 29280 Plouzané, France. (5) Centre for Functional Ecology (CFE), University of Coimbra, Portugal. (6) Biology Department, Western Carolina University, 1 University Drive, Cullowhee, NC 28723, United States of America. (7) Centre for Ecology, Evolution and Environmental Changes (cE3c), Faculdade de Ciências, Universidade de Lisboa, Campo Grande, 1749-016 Lisboa, Portugal. (8) Department of Plant Biology, University of Georgia.

* Presenting author

Luciola lusitanica Charpentier, 1825 is an emblematic species in Europe, with a variable flashing repertoire across its geographical distribution. Such flashing display was previously thought of as variable among populations, considered a “dialect”. In fireflies, behavioral differences among species are an important species-level diagnostic, and also an important tool for recognizing species in the field. Therefore, flashing differences among *L. lusitanica* populations raise the possibilty that multiple species are under the same name. To further compound the issue, *L. lusitanica* has a disjunct distribution and brachypterous condition in females, which suggest a break in gene flow among populations and limited dispersal ability, respectively. Understanding the taxonomic status of *L. lusitanica* is imperative for further investigating other biologically-relevant issues. To clarify the status of Luciola in Southern and Central Europe, we sequenced the COI gene of 101 individuals: 96 *L. lusitanica* and 5 L. italica. Our goal was to (i) assess genetic (COI) variation, and (ii) evaluate whether *L. lusitanica* is a single species, by combining Bayesian phylogenetic analyses and species delimitation methods: Automatic Barcode Gap Discovery (ABGD), and Multi-rate Poisson tree processes (mPTP). Not surprisingly, *L. lusitanica* was recovered as paraphyletic, and three to eight putative species have been found by delimitation methods. Because morphological traits traditionally used in Lampyridae taxonomy are currently ineffective in distinguishing these taxa in the past, *L. lusitanica* is here considered to be a species complex.

Session IV: BIOLUMINESCENCE, BIOCHEMISTRY AND PHYSIOLOGY

HEMOCYTE RESPONSES OF *LAMPRIGERA TENEBROSA* LARVAE AFTER BACTERIAL INFECTION

Parichart Laksanawimol*(1), Supakorn Tangsuan (2) and Anchana Thancharoen (2)

(1) Department of Biology, Faculty of Science, Chandrakasem Rajabhat University, Thailand

(2) Department of Entomology, Faculty of Agriculture, Kasetsart University, Thailand

* Presenting author

The rearing of univoltine *Lamprigera tenebrosa* larvae under laboratory conditions during high temperature of summer found an epidermic disease resulting in high mortality rate. The infected *L. tenebrosa* larvae displayed no feeding behavior, less active and abnormalities of leg joints and epithelium tissues near head and pronotum, swollen abdomen and death within about 5–8 days after having a symptom. However, the causes and basic information of the disease have still not been known. The histological examination by hematoxylin and eosin staining of thorax and abdomen segments was examined from diseased and healthy larvae of *L. tenebrosa*. The various kinds of hemocytes–prohaemocyte, plasmatocyte, spherulocyte and granulocyte–were counted, measured sizes and compared. The results showed that the number and size of hemocytes were different. The number of hemocytes except prohaemocytes of infected larvae increased than normal larvae about 2–7 times. Plasmatocytes and spherulocytes have increased size while prohaemocytes became smaller after the bacterial infection. It showed the immunological response to infection.

Keywords: *Lamprophorus,* Thailand, giant firefly, histology, disease.

A FIREFLY SIMPLE GAME FOR MODELING SYNCHRONIZATION

Stéphanie Depickère (1), and G. Marcelo Ramirez-Avila (1)

(1) Insituto de Investigaciones Fisicas, Universidad Mayor de San Andrés, La Paz, Bolivia

Synchronization is one of the most common phenomena occurring in oscillating systems in nature and man-made systems. A paradigmatic example of synchronization is the one attained by males of several firefly species, allowing them to mate and reproduce. Fireflies' synchronization has multiple applications (in communication networks, swarms of robots, etc.) and was extensively studied theoretically and in experimental, using pulse-coupled oscillators. Here we present a game with simple rules to describe synchronization in such oscillators. We also calculate the basins of attraction to quantify the importance of the initial conditions in reaching or not synchronization and the time intervals required for that.

BEETLE BIOLUMINESCENCE OUTSHINES AERIAL PREDATORS

Co-authors: Gareth S. Powell (1), Natalie A. Saxton (2) (3), Yelena M. Pacheco (4)*, Kathrin F. Stanger-Hall (4), Gavin J. Martin (5), Dominik Kusy (6), Luiz Felipe Lima Da Silveira (7), Ladislav Bocak6, Marc A. Branham (8), Seth M. Bybee (1)

(1) Department of Biology and Monte L. Bean Museum, Brigham Young University, 4102 LSB, Provo, Utah, 84602, USA. (2) Research and Collections Division, The Cleveland Museum of Natural History, 1 Wade Oval Drive, Cleveland, Ohio, 44106, USA. (3) Department of Biology, Case Western Reserve University, 2080 Adelbert Rd., Cleveland, Ohio, 44106, USA. (4) Plant Biology Department, University of Georgia, 4510 Miller Plant Sciences Building, Athens, GA, 30602, USA. (5) School of Math and Sciences, Laramie County Community College, 1400 E. College Dr., Cheyenne, WY, 82007, USA. (6) Laboratory of Biodiversity & Molecular Evolution, Czech Advanced Technology Research Institute - CRH, Slechtitelu 27, Palacky University, 783 71 Olomouc, Czech Republic. (7) Biology Department, Western Carolina University, 206 Stillwell Building, 1 University Dr., Cullowhee, NC 2723, USA. (8) Department of Entomology & Nematology, University of Florida, P.O. Box 110620, Gainesville, FL 32611, USA.

* Presenting Author

We understand very little about the timing and origins of bioluminescence, particularly as a predator avoidance strategy. Understanding the timing of its origins, however, can help elucidate the evolution of this ecologically important signal. Using fireflies, a prevalent bioluminescent group where bioluminescence primarily functions as aposematic and sexual signals, we explore the origins of this signal in the context of their potential predators. Divergence time estimations were performed using genomic-scale datasets providing a robust estimate for the origin of firefly bioluminescence as both a terrestrial and as an aerial signal. Our results recover the origin of terrestrial beetle bioluminescence at 141.17 (122.63–161.17) mya and firefly aerial bioluminescence at 133.18 (117.86–152.47) mya using a large dataset focused on Lampyridae; and terrestrial bioluminescence at 148.03 (130.12–166.80) mya, with the age of aerial bioluminescence at 104.97 (99.00–120.90) mya using a complementary Elateroidea dataset. These ages predate the origins of all known extant aerial predators (i.e., bats and birds) and support much older terrestrial predators (assassin bugs, frogs, ground beetles, lizards, snakes, hunting spiders, and harvestmen) as the drivers of terrestrial bioluminescence in beetles. These ages also support the hypothesis that sexual signaling was likely the original function of this signal in aerial fireflies.

Session V: CONSERVATION BIOLOGY

THE PROTECTION AND RESTORATION OF TERRESTRIAL FIREFLIES IN SATOYAMA AREA IN TAIPEI CITY, TAIWAN—A 20+ YEARS PROGRESS WITH THE COMBINATION OF INDUSTRY, OFFICIAL AND UNIVERSITY

Chiahsiung Wu (1), Pingshih Yang (2), Chienchun Wu (3), Lansheng Chih (4)
(1) The chairman, Taiwan ecological arboriculture society, Taipei city, Taiwan
2) The emeritus professor, Department of entomology, National Taiwan university, Taipei city, Taiwan
(3) The vice director, Park and streetlights office, Taipei city government, Taipei city, Taiwan
(4) The director, Geotechnical engineering office, Taipei city government, Taipei city, Taiwan

Hu-san (Tiger Mountain) fireflies protection area was established in 2021 and located in Shi-Yi district, the main business area in Taipei city. It is located on the outskirts of Taipei City (Satoyama area) with 13 hectares, and the landscape is the hillside between two mountain pathways—Hu-san ecological pathway and Hu-san mountainside pathway. Before 1895, the residents developed this area with making charcoal and in the years of 1896-1945, it was a coal mine area. As a result, the coal slag was discarded in valley, and these wastes became the mud-and-rock flow after the heavy rain and were affecting the resident's safety. In the 1990s, the public works department of Taipei city government carried out a hillside remediation project of Hu-san stream and valley combining the ecological engineering concept, the Aquatic firefly (Aquatica ficta) restoration project was implemented by the 2nd author, to restore a firefly habitat and protect fireflies under the purpose of disaster prevention. Beside the aquatic firefly, these engineering also protect the terrestrial fireflies. After the year 1998, Hu-san mountainside pathway was the hotspot for fireflies-watching event, and Hu-san ecological pathway was another one after 2013. However, due to the ever-increasing demands of streetlights, along with light pollution, firefly habitats have been fragmented and firefly numbers have decreased. Considering people's public safety and firefly protection in the firefly viewing season in 2021, the Taipei City Government policy was not only decided to turn on streetlights after the firefly mating event in April every year by the 3rd & 4th authors but also to use lampshades throughout the night to limit the lighting range to avoid light pollution affecting firefly larvae and adults. Various artificial fluorescent lights and rope railings are also used to maintain the safety of users, and Everlight donated firefly protection streetlights to meet the long-term safety needs of residents. The local people, temple and community organize the volunteer team, training by the 1st author and assist the firefly-watching event—maintenance of order, monitoring the firefly population. In this case, the Hu-san firefly restoration and protection is a 20+ years progress combining the industry, official, and university, making the Hu-san firefly protection area sustainable.

ECOLOGICAL CONSERVATION OF *RHAGOPHTHALMUS* SPP. (RHAGOPHTHALMIDAE) IN MATSU ISLANDS, TAIWAN

Chia-Hung Hsieh (1)*, Hua-Te Fang (1), Li-Ta Hsu1, Chung-Wei Lu (1), and Jen-Zon Ho (2) †

(1) Department of Forestry and Nature Conservation, Chinese Culture University, Taipei City, Taiwan; (2) Endemic Species Research Institute, Nantou County, Taiwan

Rhagophthalmus beigansis and *R. giallolateralus* are two endemic glowworm species found in Matsu islands, Taiwan. The two species are allopatric distribution on different islands. Human encroachment, light pollution and pesticides affected their habitat and survival. Small population size and narrow geographical distribution were observed from each species in recent years. Population genetic analysis revealed low genetic diversity in each species, perhaps affecting their adaptability. In fact, the two firefly species are at risk of extinction. Conservation strategies were proposed and applied to protect the two endangered species. Wildlife refuges have been established to protect wildlife habitat for benefit of the two glowworms. The lighting infrastructure near firefly hotspots was evaluated and replaced with firefly-friendly streetlights and roadside warning signs to ensure ecological protection and road safety. Multiple glowworm workshops have been held to promote ecological conservation. Under the conservation strategy, the population sizes of these two species have increased during the past few years. Biological conservation of *Rhagophthalmus* spp. in Matsu Islands will be achieved in the future.

Key words: glowworm, firefly, biological conservation, wildlife refuge, conservation strategies.

†Commemorating the deceased Dr. Jen-Zon Ho who is a namer of two Rhagophthalmus species in Matsu, Taiwan.

*Corresponding author e-mail: xjh4@ulive.pccu.edu.tw

CONSERVATION ACTIVITIES OF THE IUCN SSC FIREFLY SPECIALIST GROUP

Sara Lewis, Sonny Wong, Vor Yiu, Avalon Owens

Fireflies belong to a charismatic, ecologically and economically important insect group, with more than 2000 different species around the world. Currently, many firefly species are threatened by habitat loss, light pollution, pesticides and other stressors. In 2018 we established the Firefly Specialist Group within the International Union for the Conservation of Nature's Species Survival Commission (IUCN SSC). This volunteer group of global scientists and conservationists is working to achieve the following goals: 1) Identifying key threats to firefly species in different regions, 2) Evaluating conservation status of firefly species using IUCN Red List criteria, 3) Developing standardized methods to monitor population trends over time for various types of fireflies, and 4) Advocating for firefly conservation at the local, national, and global levels. Here we describe our accomplishments to date and identify top priorities for the next few years.

FIREFLIES (COLEOPTERA: LAMPYRIDAE) IN THE COLLECTIONS OF CROATIAN NATURAL HISTORY MUSEUMS

Ivana Pajač Živković, Helena Virić Gašparić, Darija Lemic

University of Zagreb, Faculty of Agriculture, Department for Agricultural Zoology, Svetosinumska 25, 10000 Zagreb, Croatia; dlemic@agr.hr

A total of seven species of fireflies (*Lampyris germariensis*, *Lampyris noctiluca*, Lampyris zenkeri, *Lamprohiza splendidula*, Phosphaenus hemipterus, *Luciola italica* and *Luciola lusitanica*) have been recorded in the museum collections of Coleoptera in Croatia. All these species are in the inventoried collections of Novak and Koča, which are kept in the Croatian Museum of Natural History. Only two species (*Lampyris germariensis* and Lampyris zenkeri) are inventoried in the Karaman collection in the Natural History Museum in Split, while the collections of the Natural History Museum in Rijeka and the Natural History Department of the Slavonian Museum in Osijek do not contain fireflies or are not inventoried. Very valuable data on the number of species and specimens of fireflies come from the Varaždin City Museum, which houses the Košćec insect collection and has inventoried three species of fireflies (*Lampyris noctiluca*, *Lamprohiza splendidula* and Phosphaenus hemipterus). In the relevant Catalog of Coleoptera of the Palearctic region for the territory of Croatia, eight species of fireflies are mentioned, and the only species that was not determined during the review of the museum collections is the species Lamprohiza germari. This species is widespread in Dalmatia, so it is assumed that the species is present in at least one of a dozen non-inventoried collections of the Natural History Museum of Croatia. In terms of the number of species, Croatia is within the European average, but since insects of this family are very poorly studied in Eastern and Southern Europe, it is assumed that the number and diversity of species of this family is much higher than currently known. Considering the fact that the fauna of fireflies in Croatia has not been studied for 70 years, it is necessary to conduct extensive field research to determine the number and composition of species of this family.

Key words: fireflies, museums, Croatia, collections.

ROADMAP FOR FIREFLY CONSERVATION PLANNING AND ACTION: NORTH AMERICA AS A CASE-STUDY

Candace Fallon (1), Anna Walker (2), Sara Lewis (3) and Richard Joyce (1)

(1) The Xerces Society for Invertebrate Conservation, Portland, Oregon, USA
(2) New Mexico BioPark Society, Albuquerque, New Mexico, USA
(3)Tufts University, Medford, Massachusetts, USA

In recent years, concern about the status of North American fireflies has revealed the need for a collaborative, strategic, and multi-prong approach to conserving these diverse and charismatic beetles. Together, the International Union for the Conservation of Nature Species Survival Commission (IUCN SSC) Firefly Specialist Group, the Xerces Society for Invertebrate Conservation, the Albuquerque BioPark, and numerous researchers and conservationists have made strides toward informing and prioritizing conservation actions by compiling resources, assessing species, and making information and guidance available to a variety of key stakeholders. While IUCN Red List assessments provide both big picture and species-level guidance, there are important steps that precede and follow assessments, such as consolidating data, engaging with government conservation agencies and the growing firefly tourism industry, advocating for protection of the most imperiled species, and continuing to build capacity among community scientists. In 2022 Xerces Society is launching Firefly Atlas, which will allow land managers, researchers, and firefly enthusiasts to help fill data gaps in the distribution, phenology, and habitat associations of North American firefly species.

KEEP THE FOREST SHINY: MAPPING THREATS TO INFORM CONSERVATION PLANNING OF FIREFLY SPECIES ENDEMIC TO THE ATLANTIC FOREST HOTSPOT

Stéphanie Vaz N. Campos

Laboratório de Ecologia de Insetos, Laboratório de Polychaeta,

Universidade Federal do Rio de Janeiro – UFRJ – Brazil

Fireflies are threatened worldwide by habitat loss and light pollution (OWENS *et al.* 2019), among other issues to be investigated, such as global change. However, their conservation in South America is hampered by the lack of basic biological data, such as species' taxonomic and geographic limits. Protected areas (PA) in the Atlantic Forest (AF) act as a shelter for thousands of species. However, bioluminescence communication is inhibited by artificial lights of urban sprawl (OWEN *et al.* 2019) that enter the PA (VAZ *et al.* 2021). Moreover, it is estimated that climate change will impact many terrestrial species in biodiversity hotspots and endemic species are the most threatened in areas of global conservation importance (MANES *et al.* 2021) such as AF. Therefore, global mitigation must be undertaken to prevent some firefly populations from being extirpated. The potential distribution of threatened species can be mapped via species distribution modeling (SDM), which may incorporate climate change scenarios. This approach informs conservation guidelines, by combining taxonomic and ecological knowledge to fill gaps in species biology. Thus, through appropriate conservation measures by the mapping of climate threats, fireflies will continue to thrive in the ecosystem, making the forests shinier.

Session VI: CITIZEN SCIENCE

THE DISTRIBUTION OF LAMPYRIDS IN SPAIN: AN INTERPRETATION BASED ON GEOGRAPHY AND HISTORY

José Ramón Guzmán Álvarez* (1), Raphaël De Cock (1)

(1) Citizen science web project "¿Has visto una luciérnaga?", www.gusanosdeluz.com

* Presenting author

The species of Lampyridae of Spain show a pattern of distribution that can be interpreted by hypotheses involving processes of geographical isolation and differentiation.

Nyctophila reichii, the species with the largest distribution, shows affinity for Mediterranean climate conditions, being practically absent in the Cantabria region, on the North, acting the Cantabrian Mountains System as a biogeographical frontier. On the other hand, *Lampyris noctiluca* and its related species, *Lampyris iberica*, are closely linked to Oceanic climate conditions

The case of *Nyctophila heydeni* (Olivier, 1884), currently present (as far as we have recorded) in the island of Mallorca in the Balearic Islands, can be interpreted as the result of a process of isolation/speciation.

The isolated presence of *Lampyris iberica* on Southern locations (in the Sierra de Grazalema and Sierra de los Alcornocales in Cádiz, and Sierra de Ronda en Málaga), in the humid Aljibico-Rondeño biogeographical sector in the Southwest of Andalusia (characterised by the presence of Macaronesian laurel forests) can be regarded as a relictual, taking into account the currently distribution both of *Lampyris noctiluca* and L. iberica, present in the Northern half of Spain, being separated the most of their populations by the Central System, the mountain range that separate in two parts the central plain of Spain.

FIREFLIES' NIGHTS – A PROGRAM OF ENVIRONMENTAL EDUCATION

Alves, H. N. (1), De Cock, R. (2), Gomes, J. P. (1)

(1) Parque Biológico de Gaia, Vila Nova de Gaia, Portugal
(2) University of Antwerp, Antwerpen, Belgium

For more than 20 years, the Biological Park of Gaia has reserved the month of June to open its doors at night in order for the public to participate in the “Noites dos Pirilampos” (Fireflies’ nights).
For about 18 nights the Park is host to more than 200 visitors who travel in groups led by a Guide without using artificial lighting to enjoy the observation of the light of hundreds of Fireflies either resting or in flight.
The popularity of this activity and phenomenon means that places - about 3,600 a year - are rapidly fully-booked and the Firefly Evenings become a particular means of making people of the region appreciate the need for Conservation of the Biodiversity and the problems of pollution.
To address this point, the visits are preceded with a short briefing and end with Astronomical Observations and to see the “Fireflies in the sky” where the visitor can see the effects of light pollution that is also a problem to Astronomers.
Within the Park six species of Firefly have been observed: *Luciola lusitanica, Lamprohiza paulinoi, Lamprohiza mulsantii, Lampyris noctiluca, Lampyris iberica* and *Phosphaenus hemipterus.*
The Park is dominated by an Oak Forest, Alders and Willow trees and is crossed by the river Febros. Owned by the Municipality of Vila Nova de Gaia, the main objective of the Biological Park of Gaia is Environmental Education. Parque Biológico de Gaia (Biological Park of Gaia) is the oldest permanent Environment Education Centre in Portugal and also one of the oldest in Europe.

INTERNATIONAL FIREFLY SYMPOSIUM 2022

https://ifs2020gaia.parquebiologico.pt