



**XIV INTERNATIONAL
SYMPOSIUM ON
ZYGAENIDAE**

17-21 SEPTEMBER 2014



**TOBERMORY
ISLE OF MULL
SCOTLAND**



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Front Page Photos: Slender Scotch burnet by kind permission of - Anand Prasad

Transparent burnet by kind permission of - Tom Prescott

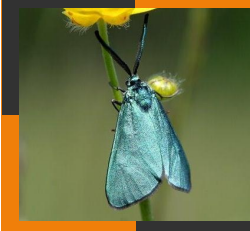
Page 3 Header photo : Forester moth by kind permission of - Keith Tailby

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WELCOME & INTRODUCTION

Welcome to the glorious island of Mull, one of Scotland's Inner Hebridean islands and a haven for rare Zygaenidae. We do hope that you enjoy the Symposium but that equally you immerse yourself in the experience of staying in such an historic and picturesque place. The people of Mull are delighted to welcome visitors to their beautiful island and we will try and give you time to enjoy Tobermory and, on our excursions, we will include some of the wonderful scenery along the iconic coastline.

Our Symposium includes papers on some Zygaenidae in very distant places; some of the results of recent work on the chemical ecology of Zygaenidae and the way that pheromones influence their lives; discussion of their ecology and behaviour; some recent work on the taxonomy of difficult species groups; and an account of conservation activities, focussing on Scottish burnet moths.

Symposium papers will be presented at Glengorm Castle, north-west of Tobermory; the main outing will visit the north-west coast of Mull, before travelling down to the small island of Ulva; and then on Sunday 21st the papers focussed on Scottish species and their conservation will be at the Aros Hall in Tobermory.

In this booklet you will find a list of those attending the Symposium, a full programme and then abstracts of the papers to be presented. We do hope that you find here everything that you need to help you enjoy yourselves.

We are delighted to welcome you to the Symposium!

Mark Young	Tom Prescott	Brigid Primrose
University of Aberdeen	Butterfly Conservation Scotland	Scottish Natural Heritage

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Programme

Wednesday 17th September

20.30hrs **Welcome reception** at An Tobar Arts Centre, Tobermory

Welcome speech by Olive Brown, local author and Sion Parkinson, An Tobar Centre manager. As well as receiving a welcome, and meeting old and new friends, you will be provided with the Symposium programme and all necessary administrative details. Nibbles and a drink provided!

Thursday 18th September

Scientific papers at Glengorm

08.45 **Transport** leaves from the **clock tower**, Main Street , Tobermory to Glengorm

09.15 **Registration**, welcome by Glengorm owner, Tom Nelson and Steph Cope (Glengorm Wildlife Steward) plus tea, coffee and cakes.

Talks:

10.00 Britain's Zygaenidae: an introductory account of the distribution of the species present in Britain, with some discussion of the factors that may limit these distributions.

Mark Young

10.30 *Zygaena dorycnii araratica* Staudinger, 1871 – new data on its Mendelian genetics, based on cultures reared in 2009-2014.

Axel Hofmann

11.00 The Mendelian genetics of the two larval morphs of *Zygaena (Mesembrynus) corsica* Boisduval, [11828] (Lepidoptera: Zygaenidae, Zygaeninae).

Gerry Tremewan

11.30 The *Zygaena purpuralis* complex: a new approach to resolve a complicated problem.

Ana Nahirnic & Gerhard Tarmann

12.00 **Discussion**

12.30 – 13.30 **Lunch**

Programme

13.30 Volatiles from the burnet moth *Zygaena filipendulae* (Lepidoptera) and associated flowers, and their proposed role in mating communication.

Mika Zagrobelny

14.00 Preliminary results of pheromone identification in *Zygaena loti*, and the potential for pheromones in burnet moth conservation.

Joe Burman, Alan Skeates, Stephanie Cope, Jean-Louis Lanteri, Mandela Fernandez-Grandon & David Hall

14.30 Using pheromone traps for detection and monitoring of the seasonal flight of vine bud moth *Theresimima ampellophaga* (Bayle-Barelle, 1808) (Lepidoptera: Zygaenidae) in Serbia.

Ana Nihirnic, Sonja Petrovic, Zoran Krivosej, Pedrag Jaksic & Teodora Toshova

15.00 **Discussion and Tea**

If the weather permits, we hope to run a short **field trip** to recently discovered sites at Glengorm where *Z. loti* occurs and where land management is designed to help conserve the species. Hosted by Steph Cope

Waterproofs and stout shoes or boots are essential!

17.30 **Transport** back to Tobermory.

Friday 19th September

Scientific papers at Glengorm

08.45 **Transport** leaves from the **clock tower**, Main Street, Tobermory to Glengorm

09.30 American Zygaenidae – an overview

Gerhard Tarmann

10.15 The Zygaeninae of South Africa – a historical review and impressions of a recent tour in 2014.

Axel Hofmann

11:00 **Discussion and coffee**

Programme

- 11.30 Indirect benefits of female multiple mating in the plum moth, *Illiberis rotundata* Jordan (Lepidoptera: Zygaenidae: Procridinae).
Chiharu Koshio
- 12.00 **Discussion**
- 12.30 – 13.30 **Lunch**
- 13.30 The phenology of *Zygaena (Zygaena) filipendulae* (Linnaeus, 1758) (Lepidoptera: Zygaenidae, Zygaeninae) in West Penwith, Cornwall.
Gerry Tremewan
- 14.00 Evolution of the biosynthetic pathway of cyanogenic glucosides in moths and butterflies.
Mika Zagrobelny & Lene Dalsten
- 14.30 2014 – My yellow year.
Axel Hofmann
- 14.45 A second record of mass-mortality of burnet moths in a high mountain pool.
Axel Hofmann
- 15.00 **Discussion session and tea**
- 15.30 Sexual Pheromones as a method for monitoring *Zygaena* populations in deteriorating Scandinavian landscapes
Nils Ryrholm
- 16.00 **General discussion and observations**
- 16:30 **Transport** back to Tobermory.
- 17.00 Brief visit to **Tobermory Distillery**
- 20.00 **Conference dinner** at Western Isles Hotel, Tobermory

Please arrive by 19:30 to allow for socialising & a prompt start to the meal

Programme

Saturday 20th September

08.45 **Field excursion**

Transport will leave from the clock tower, Main Street, Tobermory

A picnic lunch, tea and coffee will be provided. All you need is waterproof clothing, stout shoes, a camera, sunscreen (!), midge repellent (!!) and the luck to have good weather.

We shall visit various burnet moth sites on the west coast of Mull, ending with a visit to the island of Ulva.

Return to Tobermory around 18.30.

Sunday 21st September

Papers on the ecology and conservation of Scottish Zygaenidae at Aros Hall, Tobermory.

09.00 Arrive and settle in.

09.30 An introduction to the ecology and conservation of Zygaenidae (burnet and forester moths) in Scotland.

Mark Young

10.00 Colonisation of northern Europe by *Zygaena filipendulae*.

Mika Zagrobelny & Lene Dalsten

10.30 A survey of the Mountain Burnet moth *Zygaena exulans* in Scotland in 2009.

Pete Moore

11.00 **Coffee**

11.30 Conserving the New Forest Burnet moth *Zygaena viciae*.

Mark Young

12.00 Survey and conservation of the Slender Scotch Burnet moth *Zygaena loti*.

Tom Prescott

12.30-13:30 **Lunch**

Programme

- 13.30 Ecotourism and red deer management in the Inner Hebrides: implications for biodiversity management
Hagen O'Neill
- 14.00 From fossils to eagles: managing diverse interests on Burg Estate, Mull
Richard Luxmoore
- 14:30 Distribution and status of other Zygaenidae in Scotland.
Tom Prescott
- 15.00 **Final discussion and departure.**



Abstracts

Thursday 18th September

Mark Young

Britain's Zygaenidae: an introductory account of the distribution of the species present in Britain, with some discussion of the factors that may limit these distributions.

Three species of 'forester' moths (Procridinae) and seven species of 'burnet' moths (Zygaeninae) are found in the British Isles. Two of the forester moths are distinctly southern in range, as is one of the burnets, and two other burnet moths are widespread, but with an obvious northern limit in Scotland. However, the other species are either very localised and/or are characteristically found only on the extreme western fringe of Britain. The foodplants and general habitat requirements of these moths are not at all localised themselves, so that the explanations for their restricted occurrence seem to depend on climate and underlying geology.

This paper reviews these distributions and the very marked climatic patterns within Britain and speculates on the origin of species within Britain and which factors may be responsible for the localisation of the various burnet moths. Recent changes in status are also included in the discussion .

Axel Hofmann

***Zygaena dorycnii araratica* Staudinger, 1871 – new data on its Mendelian genetics, based on cultures reared in 2009-2014.**

In 2009, Hofmann, Kia-Hofmann, Tremewan & Turner published the results of cultures of *Z. dorycnii* Ochsenheimer, 1808, reared in 1995–2009, including populations that exhibit the melanistic morph *araratica* Staudinger, 1871. In contrast to its sister-species, *Z. ephialtes* (Linnaeus, 1767), this darkened form was found to be the dominant morph. At that time it remained unclear as to whether this morph is consistently heterozygous (PA/Pd) or whether homozygous individuals (PA/PA) also occur. Meanwhile subsequent cultures provide answers to some of the questions that remained open.

REFERENCE: Hofmann, A., Kia-Hofmann, T., Tremewan, W. G. & Turner, J. R. G. 2009. *Zygaena dorycnii* Ochsenheimer, 1808, morph *araratica* Staudinger, 1871 (Lepidoptera: Zygaenidae): its Mendelian genetics, sex ratios, hybridisation and speciation. *Entomologist's Gazette* **60: 3–23, figs 1–14.**

Abstracts

Gerry Tremewan

The Mendelian genetics of the two larval morphs of *Zygaena (Mesembrynus) corsica* Boisduval, [1828] (Lepidoptera: Zygaenidae, Zygaeninae).

The Mendelian genetics of the two larval morphs of the Tyrrhenian species *Zygaena (Mesembrynus) corsica* Boisduval, [1828], are described. All the larvae of the populations on Sardinia have crimson subspiracular band, whereas this band is various shades of grey or whitish grey in those from the island of Corsica. Breeding experiments taken to the F² generation by the author have shown that the crimson coloration of the subspiracular band in the Sardinian populations is a dominant character, in contrast to the recessive grey to whitish grey band found in the Corsican populations.

Ana Nahirnic & Gerhard Tarmann

The *Zygaena purpuralis* complex: a new approach to resolve a complicated problem.

Zygaena minos ([Denis & Schiffermüller], 1775) and *Zygaena purpuralis* (Brünnich, 1763) can be distinguished by the morphology of the genitalia and the larvae, as well as the different larval host-plants. Well-established differences in genital morphology of the males and females cannot only be observed between these two species but also within *Z. minos*, especially in the male genitalia of the northern populations, which are distributed from western Europe through the western Balkan Peninsula to Ukraine, Russia and Turkmenistan, and the southern populations which occur in central and southern Italy, the southern Balkan Peninsula, Turkey and northern Iran. Variation in genitalia has already been documented, but a reinvestigation based on geometric morphometry is planned.

The larvae of *Z. purpuralis* are yellow (olive green in the British Isles), but those of the northern group of *Z. minos* are whitish green, while those of the southern group of this species are greyish green and in Turkey they are very dark grey or blackish grey. The larvae of some southern populations are still undescribed.

So far, DNA barcoding of populations of the *Zygaena purpuralis* complex has been based on limited material (57 specimens belonging to 15 subspecies). The result shows that the COI mitochondrial gene failed to distinguish species and subspecies of *Z. minos* and *Z. purpuralis*. However, *Zygaena minos persica* Burgeff, 1926, has a large genetic difference when compared to all other populations. This supports the opinion that it may be a separate species. Although the results have been somewhat disappointing so far, more genetic analyses are planned.

Abstracts

The pheromone of *Z. minos* is still unidentified. In 2014 we tried to obtain further material to allow experiments for its identification.

Also, special studies on the habitat preferences of the *Z. minos* and *Z. purpuralis* populations from various localities are in progress.

Mika Zagrobelny

Volatiles from the burnet moth *Zygaena filipendulae* (Lepidoptera) and associated flowers, and their proposed role in mating communication.

Emissions of volatiles play an important role in communication between males and females of insects. The volatiles emitted or precursors thereof can be sequestered from plants as well as biosynthesized by the insect. They are often similar to flower volatiles and may elicit the desired effect in an odour plume together with flower volatiles. The burnet moth *Zygaena filipendulae* contain the cyanogenic glucosides linamarin and lotaustralin, which can be degraded to the volatiles HCN, acetone and 2-butanone. Linamarin and lotaustralin have previously been shown to be transferred from male to female during mating and additionally been hypothesized to be involved in mating communication. In this study, the volatile emissions from different ontogenetic stages of *Z. filipendulae*, and from flowers inducing mating were measured using Head space solid-phase micro-extraction (SPME) GC-MS. All *Z. filipendulae* life-stages were shown to emit HCN, acetone and 2-butanone. Virgin females showed higher emission than mated females, while mated males had higher emissions than virgin males. This infers a putative role of the cyanogenic glucoside-derived volatiles during female calling for males as well as during male courtship behaviour. Analysis of emissions from males and females as well as from flowers used during mate calling resulted in the additional identification of pheromones in *Z. filipendulae* different from the putative pheromones previously proposed based on attraction of males to artificial compounds.

Joe Burman, Alan Skeates, Stephanie Cope, Jean-Louis Lanteri, Mandela Fernandez-Grandon & David Hall

Preliminary results of pheromone identification in *Zygaena loti* and the potential for the use of pheromones in burnet moth conservation.

Abstracts

Zygaena loti scotica (Denis & Schiffermüller, 1775) is a threatened species endemic to Western Scotland. Its known distribution is currently limited to approximately 10km² in Western Argyll, which are under careful management for the insect's conservation as a Biodiversity Action Plan (BAP) priority species.

In 2014, a small number of *Z. loti* were collected from Scotland and reared for pheromone identification. Headspace collection and gland extraction was carried out on two female moths, from which compounds were subsequently analysed by Gas Chromatogram Mass Spectrometry (GC/MS).

Potential pheromone compounds eliciting an antennal response in males were assessed by GC-linked Electro-Antennographic-Detection (GC/EAD). Analyses revealed one potential compound present in female glands and headspace samples.

Candidate pheromone lures were produced and tested at various sites in Western Argyll in order to determine behavioural responses of male *Z. loti* to a synthetic blend containing the previously identified compound. In this presentation the study is discussed as well as the potential for pheromones as a tool for monitoring and studying rare zygaenids.

Ana Nihirnic, Sonja Petrovic, Zoran Krivosej, Pedrag Jaksic & Teodora Toshova

Using pheromone traps for detection and monitoring of the seasonal flight of vine bud moth *Theresimima ampellophaga* (Bayle-Barelle, 1808) (Lepidoptera: Zygaenidae) in Serbia.

The vine bud moth, *Theresimima ampellophaga* (Bayle-Barelle, 1808) is known as a vineyard pest in Europe, Asia Minor and North Africa. The literature data about occurrence of this species in Serbia are old and scarce. So far it has been recorded on Fruška Gora Mt. and in town of Niš. Delta sticky traps baited with the synthetic sex pheromone of *Th. ampellophaga*, (2R)-butyl (7Z) - tetradecenoate, were used for first time for detection and seasonal monitoring of this species at three sites in Serbia in 2013 – Đunis (municipality Kruševac), village Malča (municipality Niš) and Jelašnička klisura, and in 2014 at Jarinje (municipality Leposavić). In 2013 the pest was found in vineyards in two of the investigated sites – Malča and Jelašnička klisura. Catches of *Th. ampellophaga* males were recorded from the middle of June to the beginning of July. Further studies are needed to establish a possible second generation of the pest in Serbia.

Abstracts

Friday 19th September

Gerhard Tarmann

American Zygaenidae – an overview

All American Zygaenidae belong to the subfamily Procridinae (Forester Moths, Smoky Moths). The 150 described species seem to represent only a medium diverse group. However, many undescribed species are already known and it can be assumed that the real number of species can rise into hundreds. In contrast to the Palaearctic species, American Zygaenidae are rarely found in large numbers in collections. They are mainly diurnal and only rarely are they attracted to artificial light. In the tropics they seem to be canopy species that do not leave their habitat readily.

In 1984 the author published a generic revision of the American Zygaenidae (Tarmann, 1984). A monograph was planned but the flood disaster of 1985 in the Tiroler Landesmuseen in Innsbruck prevented such attempts. However, in recent years this work has been reactivated step by step.

An overview on the morphology, biology and distribution of the American Zygaenidae is provided and our present knowledge discussed. Interesting questions and new projects are presented.

Reference

Tarmann, G. M. 1984. Generische Revision der amerikanischen Zygaenidae mit Beschreibung neuer Gattungen und Arten (Insecta: Lepidoptera). *Entomofauna*, Supplement 2, vol. 1: 176 pp., vol. 2: 153 pp., 438 figs.

Axel Hofmann

The Zygaeninae of South Africa – a historical review and impressions of a recent tour in 2014.

The recent centre of generic diversity of the subfamily Zygaeninae lies in southern Africa. While the Palaearctic and Oriental regions are each inhabited by one genus, six well-differentiated genera (*Reissita*, *Epiorna*, *Orna*, *Praezygaena*, *Zutulba*, *Neurosymphoca*) are found in what is called the Afrotropical region, the last four even being restricted to southern Africa.

Abstracts

Accompanied by some of his students, Clas M. Naumann (1939 – 2004) visited the Republic of South Africa three times between 1983 and 1999. However, his untimely death prevented him from publishing his results and not a single line about all the taxonomic novelties and unknown biologies was ever made available. His diaries and transparency archive with all the documentations were kindly donated by his widow to A. Hofmann, who now feels obliged to provide a posthumous review. In order to obtain a better understanding, especially of the specific ecologies and biologies, the present author travelled to South Africa for the first time in February/March 2014.

Short remarks on the history of the discovery and the taxonomy and general ecological characters of the local Zygaeninae are followed by an overview of the tour and its results, new breeding experiences and photos providing memorable landscape impressions.

Chiharu Koshio

Indirect benefits of female multiple mating in the plum moth, *Illiberis rotundata* Jordan (Lepidoptera: Zygaenidae: Procridinae).

Females of the plum moth, *Illiberis rotundata*, mate multiply as reported in many other Lepidopteran species. Unusually for the Lepidoptera, copulation in this species lasts for over 20 hours. During copulation females receive a small ejaculate from the male, comprising 2.2% of male body weight. Fecundity is slightly but significantly increased with mating frequency, indicating that male-derived nutrients and/or stimulants enhance female reproduction.

Some females (“lagging”-females) delay oviposition after copulation, and instead exhibit “calling” behavior, whereby they release male-attractant pheromones. We found that lagging-females had received smaller ejaculates from their initial mates than females that began oviposition immediately after copulation (“sooner”-females). When lagging-females were prevented from remating, their fecundity, fertility, and egg hatchability were lower than those of sooner-females. Fertility and egg hatchability recovered in lagging-females that subsequently remated with a different male, but not in those that remated with the same male. Our results suggest that through polyandry, *I. rotundata* females enjoy indirect genetic benefits, and can overcome the costs of mating with lower quality or genetically incompatible males.

Abstracts

Gerry Tremewan

The phenology of *Zygaena (Zygaena) filipendulae* (Linnaeus, 1758) (Lepidoptera: Zygaenidae, Zygaeninae) in West penwith, Cornwall.

The district of West Penwith lies at the south-west extremity of Cornwall and, compared to the rest of the county, is noted for the earlier appearance of the flora and insect fauna in spring. In this respect, *Zygaena (Zygaena) filipendulae* (Linnaeus, 1758) is no exception, as the flight period of this species occurs there in May and early June whereas elsewhere in Cornwall at this time only diapausing larvae of this species can be found, with adults emerging from mid-July to August.

Fieldwork was undertaken in 2011–2013 at the following localities: Pendeen Watch (50–70 m a.s.l.), Botallick Mines (70 m), Cape Cornwall (35 m) and Porthnanven (10–25 m), all on the north-west coast of West Penwith, and on the east side of Lamorna Cove (5–15 m) on the south-east coast of the peninsula.

Surrounded on three sides by the sea, the peninsula enjoys mild seasonal temperatures that produce a unique microclimate. The overall contrast between the phenology of *Z. filipendulae* in West Penwith and the remainder of Cornwall might therefore be explained by the fact that the flora around the coastal areas of the former is always more advanced than elsewhere, so that the flowers are in full bloom much earlier in the season. It is suggested that, as a consequence, the early emergence of the adults of *Z. filipendulae* in West Penwith might be timed to coincide with the availability of resources such as nectar plants that are in flower at this time.

Mika Zagrobelny & Lene Dalsten

Evolution of the biosynthetic pathway of cyanogenic glucosides in moths and butterflies.

Cyanogenic glucosides are produced by numerous plants and by some specialized insects, and serve an important role as defence compounds due to their release of toxic HCN upon degradation. Burnet moth larvae are able to sequester cyanogenic glucosides from their food plant as well as to carry out *De novo* biosynthesis. Three genes (CYP405A2, CYP332A3 and UGT33A1) encode the entire biosynthetic pathway of cyanogenic glucosides in the Burnet moth *Zygaena filipendulae*. In both plants and insects, convergent evolution has led to two multifunctional P450 enzymes each catalysing unusual reactions, and a glucosyl-transferase acting in sequence to catalyse cyanogenic glucoside formation. Thus, plants and insects have independently found a way to package a cyanide time bomb to fend off herbivores and predators.

Abstracts

Species of *Heliconius* butterflies (Papilionoidea), are also thought to biosynthesize linamarin and lotaustralin, and *Parnassius* butterflies may be biosynthesizing sarmentosin, a chemical closely related to cyanogenic glucosides, sharing the first step in the biosynthetic pathway. As a consequence, the cyanogenic glucoside biosynthetic pathway could be a very old invention, dating back to the ancestor of butterflies and moths. In this study we have sequenced the first gene of the biosynthetic pathway (CYP405A2) from butterflies and moths to unravel the evolution of the cyanogenic pathway.

During the last ice-age (110,000 to 12,000 years ago) most of Denmark was covered in ice. Therefore *Zygaena filipendulae* presently living in Denmark must have come from ice-free areas further south to colonize Denmark after the ice age. We sequenced CYP405A2 from populations of *Z. filipendulae* in Denmark as well as populations from around Europe. The CYP405A2 gene contains 10 exons which are almost identical between populations. However, the gene also contains 9 introns of varying length with enough variation between populations to carry out phylogenetic studies. Preliminary results suggest that Denmark was colonized twice (early and late colonization), while Great Britain was only colonized once (at the early time point), presumably because the sea-level was much lower than today right after the ice age, but would present a barrier for later colonizations. Similarly to other insect species, colonization seems to originate from the Mediterranean areas.

Axel Hofmann

2014 – My yellow year.

The scarce yellow morph of ‘normally red burnet moths (*Zygaena* F.) is found in many species and is controlled by a single allele (Tremewan, 2006). As the yellow allele is recessive, the yellow phenotype is expressed only in homozygous individuals; the probability of yy occurring in nature depends on the frequency of the yellow allele in the population (acc. Hardy-Weinberg rule). During 37 years of intensive fieldwork with burnet moths, no more than five specimens of three different species have been found by the author – a statistical expectation of one specimen every seven years.

This result over a period of nearly four decades was excelled within a single year (2014), with one yellow morph even being new to science. Let me surprise you, wait and see...

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Reference

Tremewan, W. G. 2006. *Ecology, Phenotypes and the Mendelian Genetics of Burnet Moths (Zygaena Fabricius, 1775)* 390 pp., 194 figs. Wallingford.

Axel Hofmann

A second record of mass-mortality of burnet moths in a high mountain pool.

At the XIII International Symposium on Zygaenidae held in Innsbruck in 2012, Dr Peter Huemer reported on an observation of mass-mortality of adults of *Zygaena exulans* (Hohenwarth, 1792) in a small pool in the Austrian Alps. We listened to his lecture and looked at his photographs without being able to provide an explanation, but suggested that it might have been a single inexplicable event.

During a trip to Iran in 2014 the present author observed the same phenomenon with moths of *Z. carniolica* (Scopoli, 1763) on a pass in the central Alborz at ca 3000 m altitude, showing clearly that such an event is not a one-off but needs some explanation. Some ideas for understanding such a lemming-like behaviour will be discussed.

Nils Ryrholm

Sexual pheromones as a method for monitoring *Zygaena* populations in deteriorating Scandinavian landscapes

In Scandinavia as well as in most western countries habitat deterioration has been, and still is, an increasing problem. Among the many Lepidopteran taxa that are strongly declining are all *Zygaena* species. We have initiated a project in which we try to identify the sexual pheromones for a number of indicator species for different valuable habitat types. Among these, the Scandinavian *Zygaena* species which almost all are good indicators for habitat continuity and -quality. I will present some of the experiences that we have made so far. I will also describe how the method can be used and what we intend to do in the future. We would also like to investigate other European *Zygaena* species since a large proportion are good indicators for their declining habitat types. Therefore we are looking for more co-workers from other countries who would like to participate in the project.

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Sunday 21st September

Mark Young

An introduction to the ecology and conservation of Zygaenidae (burnet and forester moths) in Scotland.

A real concern in 1990 about whether the New Forest burnet moth (*Zygaena viciae*) had declined un-noticed to extinction in Britain led to a surge in monitoring and research on Scotland's Zygaenidae. Fortunately *Z. viciae* was found to be clinging on at its only British site and since 1990 a conservation programme has happily led to a dramatic increase in its population numbers. At the same time, attention has also been focussed on the very localised and apparently declining Slender Scotch Burnet moth (*Z. loti*), with some monitoring and survey also directed at the other less threatened species.

This paper reviews the general distribution and status of all of Scotland's Zygaenidae, so as to provide a background to the more detailed papers which follow.

Mika Zagrobelny & Lene Dalsten

Colonisation of northern Europe by *Zygaena filipendulae*.

During the last ice-age (110,000 to 12,000 years ago) most of Denmark was covered in ice. Therefore *Zygaena filipendulae* presently living in Denmark must have come from ice-free areas further south to colonize Denmark after the ice age. We sequenced CYP405A2 from populations of *Z. filipendulae* in Denmark as well as populations from around Europe. The CYP405A2 gene contains 10 exons which are almost identical between populations. However, the gene also contains 9 introns of varying length with enough variation between populations to carry out phylogenetic studies.

Preliminary results suggest that Denmark was colonized twice (early and late colonization), while Great Britain was only colonized once (at the early time point), presumably because the sea-level was much lower than today right after the ice age, but would present a barrier for later colonizations. Similarly to other insect species, colonization seems to originate from the Mediterranean areas.

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Pete Moore

A survey of the Mountain Burnet moth *Zygaena exulans* in Scotland in 2009.

In Britain, *Zygaena exulans* is known only from a relatively small area near to Braemar in the eastern Cairngorm mountains of the Scottish Highlands. Within this area there were four known sites for *Z. exulans* but with unconfirmed records from other locations.

A survey in 2009 confirmed the presence of this species at the four known locations and also at two new locations. The six colonies ranged in extent from 6ha to 55ha and population estimates ranged from just 60 moths to 15,000 with a total population estimate of at least 16,500 to 22,500.

Colonies occupied an altitudinal range of 670 to 1030 metres and were found to occupy three different habitat types: *Empetrum* heath, *Trichophorum-Nardus* grassland and blanket bog.

Mark Young

Conserving the New Forest Burnet moth *Zygaena viciae*.

After its extinction in the New Forest in 1927, the New Forest Burnet moth *Zygaena viciae* was unexpectedly found at a single coastal site in western Scotland in 1963. At this site it was seen intermittently in the 1960s, 1970s and early 1980s but in 1989 it was realised that the moth had not been seen for several years, leading to real concern that it had become extinct again. Fortunately a survey in 1990 found that a mere handful of adult moths were still present, on and close to an ungrazed ledge, whereas no moths were seen on the main site. This site had become heavily grazed and so was very different in its botanical nature, with the supposed main foodplant, Yellow Meadow Vetchling *Lathyrus pratensis* almost absent.

Urgent conservation action followed, with fences to exclude sheep, and there has been some real progress and the moth is no longer critically endangered. However, there are still some very difficult issues to be faced, before we have achieved enough to feel confident that long-term survival is assured. This paper reviews the current situation and considers the future.

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Tom Prescott

Conserving the Slender Scotch Burnet moth (*Zygaena loti*) at its satellite colonies.

The day-flying Slender Scotch Burnet moth (*Zygaena loti* subspecies *scotica*) is currently only known in the UK from five populations on the islands of Mull, Ulva and Gometra in western Scotland. Furthermore the subspecies *scotica* is presumed to be endemic to Scotland, not occurring anywhere else in the world. Butterfly Conservation Scotland (BCS) has focused its conservation action on the satellite colonies i.e. those away from the core sites on the Ardmeanach peninsula. This has included engaging with landowners to enhance the habitat for the moth, as well as survey and monitoring work.

Hagen O'Neill, Sean Twiss, Philip Stephens, and Alastair Ward

Ecotourism and red deer in the Inner Hebrides: implications for biodiversity management.

A new management scheme is planned for an island estate in the Inner Hebrides, aiming to promote biodiversity on the island whilst moving significantly away from the 'traditional' land use in the region. The island features short sward habitats which are breeding grounds for rare Lepidoptera species (namely the marsh fritillary - *Euphydryas aurinia* and the slender scotch burnet moth - *Zygaena loti scotica*), and one of the main aims of this new management scheme is to promote these habitats through controlled grazing pressures and distribution of red deer, whilst avoiding the negative impacts of deer overabundance.

Richard Luxmoore

From fossils to eagles: managing diverse interests on Burg Estate, Mull.

In addition to having 50-90% of the UK population of Slender Scotch Burnet Moths, Burg estate, managed by the National Trust for Scotland, is both nationally and internationally important for a number of other features. The oldest of these are some Jurassic rocks, some 300 MY old which form a Geological SSSI at the far west. The stepped landscape, which gave rise to its recognition as a National Scenic Area, results from massive Tertiary lava flows that also engulfed and preserved a remarkable fossil tree. The basalt lava has produced rich, basic soils that support some very rare plants, including one, the Iceland Purslane, found in only one other locality in the UK.

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The plant communities, in turn, support the Burnet moths, of which there are three species, a large range of other invertebrates and a suite of grazing mammals – deer, goats, sheep and cattle. Flying over the whole scene are White-tailed and Golden Eagles which provide the justification for its designation as a European Special Protection Area.

Any management plan for the property must not only balance the sometimes conflicting requirements of these features, the legal constraints of the designations and finally cater for public access as freely as possible. All this must be delivered within a very limited budget and, most importantly, must support and win the support of the local human community.

Management for the Burnet Moths mainly involves managing the large herbivores, both to produce a short, flower-rich grass sward, but also ensure that sufficient trampling is inflicted to break up the turf and provide niches for seeds to set. In the fenced land around the old farm house, this can be done by sheep and cattle but out in the remoter western parts of the property it is difficult to graze domestic livestock safely and most grazing is performed by wild deer and feral goats. This is achieved, respectively, by a grazing lease with a local farmer and a deer-stalking lease. Another problem is bracken encroachment which, in these rough conditions, can only be countered by aerial spraying from a helicopter. Fortunately funding is available for this via the EU Common Agricultural Policy, but this brings with it a number of restrictions and obligations. Finally, having produced the perfect habitat conditions, the moths must be monitored to confirm that they have responded in the way that the textbooks predict.

Tom Prescott

Distribution and status of other Zygaenidae in Scotland

Scotland is home to seven species of Zygaenidae (Burnet and Forester moths), five of these being represented by endemic sub-species. This talk will focus on the Scottish species not previously covered in the symposium providing a summary of their ecology, distribution and status; Transparent Burnet (*Zygaena purpuralis*), Talisker Burnet (*Zygaena lonicerae jocelynae*), Narrow-bordered Five-spot Burnet (*Zygaena lonicerae latomarginata*) and Forester moth (*Adscita statices*).

Poster Abstracts

Axel Hille

Preliminary results of predicting the current and past distribution of the arctic-alpine burnet moth *Zygaena exulans*, with a note on phylogeographic patterns among disjunct populations.

Statistical assessment of range determinants and prediction of species occurrences, so-called Species Distribution Modeling (SDM) in conjunction with phylogeographic methods give new insights in the reconstruction of potential current and past distribution of taxa.

Here we present a first attempt to apply such techniques to the arctic-alpine burnet moth *Zygaena exulans*. Our naïve expectation is to, (i) predict the present distribution by using a suite of environmental and landscape cover variables, (ii) discuss genetic relationships between Fennoscandian and Alpine populations, (iii) reconstruct the restricted range distribution in potential refugia during the Last Glacial Maximum (LGM ~ 20 kya), and finally (iv) project the optimal range expansion to the period of the Last Interglacial Maximum (LIG ~ 180 kya), using the key variables found in the previous steps.

Axel Hille and Marc Nicolle

Binning morphological differences and variation of the genitalia of the two “bad species” *Zygaena hippocrepidis* and *Z. transalpina* across specified regions of South of France by grid-based subplot mapping.

The geographic variation of distinctive features of the genitalia and the wing patterns is quantified by two hybrid indices, the GHI (hybrid index based on assessment of the genitalia) and the IM (composite index of wing pattern, “melanisation”). The respective density distributions (similar to smoothed histograms) are mapped for both sexes in specified regions of South of France using a technique called map-embedded subplots for visualization. The phenogeography is summarized and discussed in light of geographic covariation and asymmetry of the contact zones by contrasting differences among male and female variation.