Report to NCCARF National Climate Change Adaptation Research Facility

Anett Richter
Institute for Applied Ecology
University of Canberra

Effects of climate change on the host plant availability for the critically endangered Golden Sun Moth (*Synemon plana*)

The endemic critically endangered diurnal Golden Sun Moth (*Synemon plana*, Castiinidae) is a flagship species in natural temperate grassland (NTG)- an endangered ecological community that still occurs in small fragments and highly isolated in parts of NSW, Victoria and the ACT (ACT Government 2005). At the adult stage, Golden Sun Moths lack functional mouthparts and therefore do not feed. Instead they only survive for a few days after emergence. The larvae feed underground for several years on the roots of native grasses. Recent observations of Golden Sun Moth adults and larvae in both natural and highly weed infested Chilean needle grass (*Nassella neessiana*) grassland - a weed of national significance - has lead to the assumption that the species might not be restricted to native grasslands habitat and may use both native grass and exotic grass species as host plants.

Photo: Female adult Golden Sun Moth

There are several possible explanations for this very unusual situation: 1) Golden Sun Moths are not specialised in terms of their host plants (as previously assumed) and therefore can take immediate advantage of other plant species including palatable introduced species; 2) the species is currently undergoing a gradual shift in host plant preference following the introduction of non native species like *Nassella neessiana* mediated by a change in climate that favours the spread of exotic species.

In this project I proposed to investigate the impact of predicted climatic change on potential native and exotic host plants for the Golden Sun Moth. The intention was to shed light on the probability of resilience to climate change in temperate grassland for this endangered lepidopteran species. Specifically, I aimed to test to what extent native and exotic grass species are similar in their chemical composition to find causes for the potential dietary preference, and the possibility of an expansion or shift of host plants.

To investigate the effects of climate change on the host plant availability for the Golden Sun Moth during my PhD, I visited research institutions in Melbourne (Australia) (Department of Primary Industries, Department of Sustainability and Environment Victoria) and Innsbruck (Austria) (Institute for Ecology, University of Innsbruck) to

undertake laboratory work that examined the photosynthetic pathway (C3 or C4) in potential native and exotic host plants for the moths. Generally, C3 plants are much more common than C4 plants (accounting for more than 95% of Earth's plant species) and flourish in cool, wet, and cloudy climates where light levels may be low. C4 plants often inhabit hot, dry environments and have very high water-use efficiency. Consequently it is predicted that C3 grasses might be favoured under increasing atmospheric CO2 emissions whereas C4 plants might be favoured by increasing daytime growing season temperatures as part of the climate change scenarios. Thus, my proposed investigation about the current distribution of C3 and C4 plants in climate sensitive ecosystems, such as the temperate grasslands in South Eastern Australia are of great interest for the future conservation and management of temperate grasslands and their biota.

Research undertaken by me that was assisted by this grant involved the following steps. First, I checked the literature for information on the metabolic pathway of the dominant species of plants present in native and non native grassland occupied by Golden Sun Moths. I found that only limited information was available for this species. To address this lack of information, I collected grass and forb tissues in Golden Sun Moth habitats and prepared all plants samples for stable isotope analysis. Stable isotope analysis (SIA) is the species specific identification of isotopic signature - the distribution of certain stable isotopes and chemical elements within chemical compounds. Isotope ratios are measured using mass spectrometry, which separates the different isotopes of an element on the basis of their mass-to-charge ratio. A total of 46 plant samples from 15 plant species were prepared and sent to the Stable Isotope Laboratory at the University of Goettingen (Germany) for the analysis of the ^{15}N content and ^{13}C content. Unfortunately the analysis of the ^{15}N content failed due to equipment failure.

The analysis revealed that most of the species tested were C3 plants. These species included the exotic grass Chilean needle grass that I expected to be a host plant for the moths. Only four grass species in these samples were found to belong to C4 plants. These were Hairy Panicum (*Panicumeffusum), Kangaroo Grass (Themeda australis), Redleg Grass (Bothriochloa macra)* and the exotic African Lovegrass *(Eragrostis curvula).*

These findings combined with my earlier field observations support the hypothesis that the Golden Sun Moth might be restricted in its diet to C3 plants, and that its diet now includes the exotic Chilean needle grass. These findings are of importance for the future management, conservation and research of this critically endangered moth. Particularly, these findings have implications that should be considered in the context of broader issues relating to climate change. Climate change is expected to have great impacts on the dietary consumption of many herbivorous species. Among many plant ecologist agreement exists that the distribution (balance) of C3 and C4 plants around the world will change following a predicted drier and hotter weather and increasing atmospheric C02. For the temperate grassland biome it is predicted that C3 plants will be replaced by a dominance of C4 plants. This will have dramatic consequences for herbivorous species that are dependent on C3 plants. The reduced availability of food plants will be compounded for species that share life traits of low dispersal ability and short life spans- such as the Golden Sun Moth. The role of alternative food plants, including non native

species, and the management of food resources for the Golden Sun Moth under climate change as well as the effects of plant invasion needs to further scientifically investigated.

This research travel support scheme has enabled me to broaden my PhD research to investigate the isotopic signature of potential host plants for the Golden Sun Moth. Further isotopic and molecular analyses are underway and when completed, will provide the basis for a publication. I believe that my small study has contributed an important step in our understanding of the future of the Australian biodiversity under the overarching threat of climate change. I thank the NCCARF National Climate Change Adaptation Research Facility for their interest in this study and for providing financial support for travel costs and accommodation in Melbourne and Innsbruck.

Anett Richter