Institution: University of Nottingham

Unit of Assessment: 5 - School of Life Sciences

Title of case study:
Preserving the Ecological Diversity of the Planet: Conservation of the World's smallest butterfly, the Sinai Baton Blue.

1. Summary of the impact

The Sinai Baton Blue is the world's smallest butterfly, and is restricted to the St. Katherine Protectorate in the South Sinai region of Egypt. Research by Francis Gilbert's group on climate change and biodiversity in Egypt surveyed populations of the butterfly for the first time and ensured it received IUCN Critically Endangered status. The butterfly became the focus of biodiversity awareness campaigns in Egypt: appearing on a stamp, in Government-backed educational programmes in schools, and as the flagship species for conservation in Egypt's most important National Park. Current work contributes to international conservation of this extremely rare species and its host-plant, respecting indigenous Bedouin knowledge, benefitting their tribal community, and ensuring international conservation strategies incorporate local pastoralist traditions to sustain the genetic diversity of the planet.

2. Underpinning research

One of only a few plant and animal species endemic to Egypt, the tiny Sinai Baton Blue (*Pseudophilotes sinaicus*) is the world's smallest butterfly[1]. It occurs only in Egypt's St Katherine Protectorate above an altitude of 1800 m, within an area of just 7 km², dependent upon a single endangered host-plant, Sinai Thyme (*Thymus decussatus*) on whose flowers both the adults and larvae feed[1,2]. Its stronghold is Jebel Safsafa, the massif from which Mt Sinai springs. Marooned on the tops of the Sinai mountains by climate change over 5000 years, and isolated on each side by the Gulfs of Suez and Aqaba, the butterfly and its host-plant inhabit a very harsh, hyper-arid, mountainous environment, which may suffer years of little or no rainfall[3].

Barely recorded since its discovery and classification by Nakamura in 1975, the Sinai Baton Blue has been rediscovered and studied intensively by Francis Gilbert's research group from 2000 onwards, both in the field (Mike James, 2000-4; Amy Shepherd, 2009-10; Katy Thompson, 2009-12) and by modelling (Martin Hoyle, 2000-4). In 2001, the entire world population was surveyed, with adult numbers estimated at 3000. Some 50 patches of Sinai thyme were also catalogued, only two-thirds of which are occupied by butterfly populations. The butterflies are not particularly good fliers, but low levels of butterfly movement between patches maintain the species as a meta-population, distributed amongst the patches of thyme [1]. Larvae of the butterfly live in a complex dependency on two species of ants, one of which is nurtured by the caterpillars. This ant species then protects the larvae from predation by the other[1,2].

Threats to the survival of the butterfly include anthropogenic climate change, the effects of grazing by goats and camels tended by Bedouin herdsmen, human disturbance by visitors to the National Park, and collection of the host-plant for medicinal purposes, all pushing both the butterfly and host-plant towards extinction. This was demonstrated by a second survey a year later, by which time the population had crashed to only 60[1,2]. Gilbert's research suggests numbers fluctuate in a three-year cycle, with lows that threaten the species' survival[3]. Modelling[4] showed that extinction was highly likely if the effects of global warming continue. Two central large patches of thyme have been shown to be critical to long-term survival of the butterfly meta-population. This remains the only comprehensive study of the impact of climate change on biodiversity in Egypt, with important implications for conservation projects throughout the world.

Gilbert's group are now concentrating on the role of patchiness, grazing, and synchrony (both of the butterfly with the host-plant and among butterfly and host-plant populations) on the survival of the meta-population[5,6]. The host-plant populations flower at surprisingly different times, while butterfly emergence is more uniform across populations. However, the poor flight capability of the

butterfly restricts its ability to migrate to other flowering host-plant patches. Understanding what triggers flowering is therefore critical to survival of the butterfly. Grazing had previously been designated the main threat to the thyme, and measures were instigated to control grazing. However, Bedouin herdsmen - traditionally expert in local ecology - claim that the plants need grazing to produce the flowers upon which the butterfly depends[7]. The group's ongoing experiments on artificial grazing and fertilising indicate that limited grazing does not harm the plants. This offers a mutually-beneficial long-term conservation strategy based on locally-managed, controlled grazing to promote new plant growth to feed butterflies and livestock.

3. References to the research

Key Publications (Nottingham authors shown in bold, key author underlined)

1. **James M**, **Gilbert F** and Zalat S (2003) Thyme and isolation for the Sinai Baton Blue butterfly (*Pseudophilotes sinaicus*). Oecologia 134: 445-453. DOI 10.1007/s00442-002-1123-1
2. **James M** (2006) The natural history of the Sinai Baton Blue: the smallest butterfly in the world. Egyptian Journal of Biology 8: 67-85. A pdf copy of this article is available and can be provided.
3. **Gilbert F**, Rashad S, Kamel M, El Din IA, **James M** and Zalat S (2010) Monitoring of the endemic Sinai Baton Blue butterfly Pseudophilotes sinaicus in the St Katherine Protectorate, South Sinai. Egyptian Journal of Biology 12: 18-26. A pdf copy of this article is available and can be provided.
4. **Hoyle M** and **James M** (2005) Global warming, human population pressure and viability of the world's smallest butterfly. Conservation Biology 19(4): 1113-1124. DOI: 10.1111/j.1523-1739.2005.00166.x
5. **Newbold T**, **Gilbert F**, Zalat S, El-Gabbas A and **Reader T** (2009) Climate-based models of spatial patterns of species richness in Egypt's butterfly and mammal fauna. Journal of Biogeography 36: 2085-95. DOI: 10.1111/j.1365-2699.2009.02140.x
6. **Leach K**, Zalat S and **Gilbert F** (2013) Egypt's Protected Area network under future climate change. Biological Conservation 159: 490-500. DOI: 10.1016/j.biocon.2012.11.025
7. Grainger J and **Gilbert F** (2008) Cultural and spiritual values of Protected Landscapes - the St Katherine case study. pp. 1-17 in Mallarach JM (ed) Cultural and Spiritual Values of Protected Landscapes and Seascapes. IUCN. A pdf copy of this article is available and can be provided.

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2011	Mohamed bin Zayed Foundation Species Conservation grant	$1500
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2012	Mohamed bin Zayed Foundation Species Conservation grant	$2500

4. Details of the impact

The UoN has a long-established track record for conservation of rare species, starting from the 1970s: Bryan Clarke's studies of evolution rescued an entire genus of Pacific partulid snail from extinction (for which he received the Darwin-Wallace [2008] and Darwin [2010] medals). By developing a suitable diet, these snails were captive-bred in Nottingham and then zoos worldwide. The UoN's conservation research over the last 40 years provides the background to conservation of the Sinai Baton Blue butterfly. Francis Gilbert's long-standing research programme in South Sinai has enabled the work of his research group to have a far-reaching impact in Egypt and more broadly for conservation worldwide. This work specifically led to the butterfly being declared Critically Endangered by the International Union for Conservation of Nature (IUCN) in 2012[A].

Impact 1: Conservation of Sinai Thyme and the Sinai Baton Blue butterfly

The underlying context of the conservation activities is based on changes to the traditional Bedouin desert-dwelling, nomadic lifestyle. Bedouin families, usually accompanied by small herds of goats and camels, would migrate between wadis seeking fresh grazing for their livestock. The Bedouin managed their grazing lands through a tribal agreement, termed 'hilf', not to graze in certain wadis for a defined period[B]. However, exploitation of traditional grazing land by the Egyptian government from the 1980s onwards as developments for the Tourist industry, coupled with a desire by the Bedouin for a higher standard of living, has resulted in Bedouins settling around the outskirts of

cities and seeking employment within the city[B]. This has increased grazing pressure on the local environment, and led to abandonment of 'hilf' agreements. Fortunately, the inaccessibility of the regions in which Sinai thyme grows has somewhat protected it from over-grazing. Nevertheless, the effects of grazing on the condition of the Sinai thyme and the survival of the butterfly are key to successful conservation strategies. In 2009, as part of a Rufford Foundation Small Grants Award[C] to an Egyptian collaborator working with Francis Gilbert, fencing was erected around a central region of thyme to prevent access by livestock. Paved paths were also laid by local Bedouin workmen (using local stone as building materials, in keeping with the aesthetics of the region) for use by tourists visiting the Protectorate (bringing employment and financial benefits for local tribes). A traditional 'hilf' agreement was also reached with Bedouin herdsmen not to graze their stock near thyme patches for a defined period during 2009 to determine the effect on the thyme. This seemed to indicate that the Bedouin were correct and that lack of controlled grazing may prove harmful to the thyme, threatening the survival of the butterfly. Such observations are transforming the conservation strategy of the Protectorate to one that encourages traditional Bedouin natural resource management.

Impact 2: Ecological Awareness in Egyptian and Tourist populations

St Katherine Protectorate (established in 1996), was declared a UNESCO World Heritage Site (Cultural Landscape) in 2002. Gilbert's research made the butterfly a major target for conservation in the Protectorate management plan in 2003[D], which it has continued to be since 2007[E]. The area has enormous cultural and religious significance, attracting 300,000 visitors every year and hence provides a significant opportunity for raising public awareness of its unique biodiversity. Due to the close collaboration of Gilbert's research group with the Protectorate, photographs by Mike James feature prominently in the Protectorate's Visitor Centre. The butterfly has a display panel to itself. It features in all of the Protectorate's literature and websites, has acquired its own Wikipedia page[F], and is emphasised in ongoing management work and evaluation[E]. It also featured on an Egyptian stamp[G]. As a result, countless Egyptians and tourists have had an opportunity to reflect on its beauty and ecological importance, all stemming from the efforts of Gilbert's group. Few organisms receive such exposure and prominence in the public eye, and few ecological studies can claim such an impact on public awareness.

Gilbert's long-standing association with Egyptian ecology led in 2005 to his appointment as International Director of BioMAP[H], a $1-million Egypt-wide project running from 2005-8 inclusive, aimed at improving biodiversity research, monitoring and assessment across the Egyptian national park network. Project outputs included raising public awareness of biodiversity among Egyptians, which was woefully low despite indications of interest among young people. Its public awareness campaign targeted school children and the educated elite. A set of children's stories were written[I], each structured around a different environmental issue using a particular organism in a specified Protected Area. One of these was based on the biology of the Sinai Baton Blue (called 'Farfousha' - *farasha* is Arabic for 'butterfly'). Gilbert's group wrote, produced and printed four sets of each story (two Arabic, two English), with one pair aimed at young children aged 4-8, and the other at the 10-14 age-group. The story was converted into a short claymation film (Wallace-and-Gromit-style clay animation) in Arabic[I]. In collaboration with the Ministry of Education, a team of people was then commissioned to take these stories to more than 100 schools, and also to out-of-school clubs and school conferences all over Egypt. In each school, a lecture was given to 100-300 participants, followed by a discussion and writing/art competition, with prizes given by the Ministry of Education. More than 5300 books and 1350 CDs were distributed in this way. A further output of the story was a booklet and PowerPoint presentation[G,I] on the science behind each story, aimed at teachers and other adults. These materials are used as teaching resources in school in all regions of Egypt to this day.

Senior-level dissemination of Sinai Baton Blue educational materials on climate change and biodiversity conservation was achieved in national and international presentations to policy-makers by the head of Egypt's Nature Conservation Sector - the Government official responsible for Egypt's national parks. Additionally, academics, wildlife consultants and Nature Conservation Sector staff were trained in the Red Listing of Egyptian fauna and flora, at a workshop run by BioMAP and the IUCN in 2007, using the Baton Blue as a model.

Thus the Sinai Baton Blue butterfly has become one of the best-known examples internationally of

biodiversity within Egypt, as a direct result of Gilbert's research work.

Impact 3: Influencing Worldwide Conservation Policies
Unchallenged narratives of pastoral destructiveness have informed conservation policies worldwide. In Egypt, the Protectorate's conservation policy remains grounded in the assumption that overgrazing of the host-plant by Bedouin herders is the most significant threat to the butterfly's survival. However, both indigenous knowledge and recent research by Gilbert's group cast doubt on that assumption, providing the evidence needed to challenge the Protectorate's policy, to allow instead an effective, evidence-based conservation policy to be applied. This sets a precedent for replication elsewhere. Adoption of traditional land management habits into local conservation policies across the globe will have beneficial repercussions for conservation strategy and pastoralist indigenous peoples worldwide.

5. Sources to corroborate the impact

A. **Thompson K** and **Gilbert F** (2012) *Pseudophilotes sinaicus*. In: IUCN (2012) IUCN Red List of Threatened Species. Version 2012.1. http://www.iucnredlist.org/details/195289/0.

B. http://bedawi.com/Law_Hilf_EN.html, http://en.wikipedia.org/wiki/Bedouin

C. El-Din IA (2010) Sinai Baton Blue butterfly conservation project. Rufford Small Grant Foundation, Final report; http://www.rufford.org/files/16.08.08%20Detailed%20Final%20Report.pdf

D. Grainger J (2003) The St Katherine Protectorate Management Plan Reference Edition. Egyptian Environmental Affairs Agency (EEAA), Cairo.

E. Paleczny D et al (2007) The state of St Katherine Protectorate and World Heritage Site: an evaluation of management effectiveness. EEAA, Cairo.

F. http://en.wikipedia.org/wiki/Sinai_Baton_Blue_butterfly

G. http://www.wnsstamps.ch/en/stamps/EG018.07

H. http://www.biomapegypt.org/

I. Zalat S & Gilbert F (2007) The Sinai Baton Blue: the story of the smallest butterfly. BioMAP, EEAA, Cairo. (4 versions + animation film) http://www.nottingham.ac.uk/~plzfg/publicns.htm

J. Gilbert F et al (2007) Climate change and biodiversity conservation in Egypt. BioMAP, EEAA, Cairo.

Corroborative documents and copies of webpages are held on file and are available on request.