Scientists publish the discoveries that saved the large blue butterfly

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Maculinea arion female in Dartmoor, UK. This image relates to an article appearing in the June 18, 2009, issue of *Science* Express, published by AAAS. The study, by Dr. Jeremy Thomas at the University of Oxford in Oxford, UK, and colleagues, is titled, Credit: David Simcox, Centre for Ecology and Hydrology, UK

On the 25th anniversary of the project that brought the large blue butterfly back from extinction in the United Kingdom, ecologists are for the first time publishing the decades of research that helped them rescue this spectacular butterfly.

The study shows how the large blue's extreme dependence on a single ant species led to the butterflies' demise, as their habitat became overgrown, causing soil temperatures to drop and ant numbers to diminish. Before

this discovery, butterfly collectors were generally blamed for the decline of this butterfly, also known as *Maculinea arion*.

This is an illustration of the large blue butterfly. This image relates to an article appearing in the June 18, 2009, issue of *Science* Express, published by AAAS. The study, by Dr. Jeremy Thomas at the University of Oxford in Oxford, UK, and colleagues, is titled, Credit: Image courtesy of Richard Lewington

The research, by Jeremy Thomas of the University of Oxford in Oxford, UK and the Centre for Ecology and Hydrology in Wallingford, and his colleagues, will be published online by *Science*, at the *Science* Express website.

"This study tells the story of a remarkable, 40-year research effort that began with painstaking fieldwork -- including the counting of individual butterfly eggs laid on flowers in the English countryside -- and culminated with a major conservation victory. Science is delighted to be publishing this impressive body of work, and we expect that the peer-

reviewed data will be an important tool for future conservation efforts," said Andrew Sugden, Deputy and International Managing Editor at *Science*.

"Human beings are so much larger than insects, it's very hard for us to appreciate that what to us is an imperceptible change in habitat can have devastating consequences for a species like the bizarre and beautiful large blue butterfly. A difference of a centimeter in grass length can change the soil temperature by 2 or 3 degrees C. If you're the size of an ant or butterfly that difference is massive," said Thomas.

In the 1970s, the International Union for Conservation of Nature selected three butterflies, including the large blue, as global flagships for the cause of lepidopteran conservation. These insects and others had been mysteriously disappearing for decades, despite attempts to save them.

The large blue butterfly was selected because of its beauty and prize-status for collectors, and because of its unusual life cycle, according to Thomas.

Adult *M. arion* females lay their eggs on thyme flowers in the summer. After hatching, the caterpillars stay very small and many eventually fall to the ground. They secrete chemicals that attract red ants and fool them into thinking the caterpillars are ant grubs. The ants then carry the tiny caterpillars into their underground nests.

In most cases, only caterpillars that have landed in the nest of one particular ant species, *Myrmica sabuleti*, will survive to adulthood. The caterpillars' secretions are a sufficiently close match to those of *M. sabuleti* grubs that the ants never discover that they have been duped, and instead continue to protect the caterpillars for 10 months even though they are feeding on the ants' own brood. In early June, the caterpillars

form a chrysalis near the colony entrance and then emerge to crawl aboveground two weeks later as butterflies.

While ecologists generally knew about this life cycle, the butterfly's intense dependence on *M. sabuleti* ants only came to light once Thomas began studying Britain's last surviving large blue butterfly colony.

"It was the nearest insect equivalent to living with the apes, I suppose," said Thomas.

"From May to late September, I was living with the last UK colony, measuring everything, including their behavior, how many eggs they laid, the survival of individual eggs, how many caterpillars were in the plants. It was a bit like a detective story."

The butterflies finally disappeared from Britain in 1979.

Thomas compiled this information into life tables, which show the number of new eggs and those that survived each year from 1972 to 1977, and which are now being published for the first time in the Science study.

With these field data, Thomas and his coauthors explored the possible factors that could be causing the butterflies decline. They realized that the grass in the butterflies' habitat had grown too long, as farmers had gradually stopped grazing their livestock on these hillsides and a viral infection had killed many of the wild rabbits in the 1950s.

The soil on these overgrown grasslands was therefore too cool to support adequate numbers of M. sabuleti ants. And, without enough ants to raise their young, the large blue butterflies dwindled. The researchers combined these ecological relationships into a numerical model, which is also being published for the first time in the Science study.

"I've been saving this paper up, as it were, for 25 years. None of the data points have been published. The life-cycle data and the life tables generated a model upon which all our conservation efforts were based. The description of this model is also new. There are few known examples of a model being able to predict the success of a conservation effort as well as ours did, for any insect," Thomas said.

In the late 1970s, after 40 years of trying to save the large blue by fending off butterfly collectors, conservationists followed Thomas' recommendations and restored the butterfly's proper habitat by clearing scrub and reintroducing grazing animals.

Starting in 1983, Thomas and his colleagues began introducing large blue butterflies imported from Sweden, into restored habitat sites. As of 2008, the butterflies occupied 30 percent more colonies than they had in the 1950s, before the major decline began. The large blue is now one of just three UK butterflies on course to meet the Convention of Biological Diversity's target to reverse species' declines by 2010. This rebound has closely followed the predictions generated by Thomas' model.

The picture in the rest of Europe is hazier, with the butterflies faring better in some countries than others. The data in this paper lay out the basis for similar restoration efforts for other butterflies with specific host requirements, such as the four related, globally threatened, species of large blue that are already starting to benefit from this approach across Europe, and the recovery of the Adonis blue butterfly from the brink of national extinction in the UK, according to Thomas.

He said that, while conservation efforts used to tend to focus on adult butterflies, this research has shown that the needs of juveniles are often much more specific and can primarily drive a population's overall health. Being aware of this fact may allow ecologists to take a shortcut around compiling the time-consuming life tables that are traditionally the first

step in understanding why a species is declining.

Restoring the large blue's habitat may also provide collateral benefits for other species that live there, the authors speculate in their study. On some of its conservation sites there have already been dramatic increases in rare birds, plants and other butterflies, such as the wood lark, pale heath violet and the pearl-bordered fritillary, Thomas said.

Source: American Association for the Advancement of Science