

NATURE?

Recent advances in developmental biology allow interference with normal developmental programs, thus making possible the creation of novel live organisms. It is common in scientific laboratories to generate animals with characteristics that were never seen before in Nature. My work explores this potential in order to create adult live butterflies with wing patterns modified for artistic purposes. Although the pattern is artificially determined, it is made of normal live cells—an example of something simultaneously entirely natural, but not designed by nature.

Nature is re-invented every day in research laboratories: *Drosophila* flies with limbs replacing antennae; worms (*Caenorhabditis elegans*) with twice the normal life span; chickens in which extra wings or legs are induced; and thousands of mice with different genes added or deleted, simulating human diseases, fluorescing green or apparently being normal. This kind of experiment has been crucial for a better understanding of what we are. Cloning, transgenesis and genomics are a few examples of the most recent fears and hopes of our society. We are entering a Post-Nature era. A time when humankind will achieve the ability to recreate life.

Nature? explores the knowledge of modern developmental biology in order to re-design live butterflies.

I have been working in Paul Brakefield's laboratory in Leiden, the Netherlands, where scientists study the development of butterfly wing-patterns and their evolutionary significance. They use *Bicyclus anynana*, a brown butterfly with prominent eyespots from Malawi, and *Heliconius melphomene*, a brightly coloured Latin-American species. During the pupation stage of the butterfly's life cycle, it is possible to interfere within the normal development of the wing. By cauterising specific regions where the wing will originate, one can delete or modify eyespots or generate novel ones in *Bicyclus* butterflies, or change the pattern of the *Heliconius* wing. It is also possible to graft portions of tissues to another positions in the same wing precursor or even into another butterfly's. It is important to note that all my procedures have been done following the current protocols of the laboratory, and with the same respect for the well-being of the butterflies. There are no nerves in the wing, therefore the procedures do not cause pain. The damage is caused at a cellular level (very different from our macroscopic experience of damage), thus the tissues are completely regenerated without dead cells or scars. Modified wings are indistinguishable from the unmanipulated ones, even at the cellular level, except for the new pattern. The modified butterflies have a normal life span and mating behaviour.

It has also been my intention to demonstrate that interactions between artists and scientists can be fruitful for all the parties involved. An artist working in a research laboratory has access to new technology, knowledge and many other possibilities to pursue. But it is also likely that an "artistic" approach to the experimental systems, with the consequent exploration of new possibilities, might lead



Detail of *Heliconius melphomene* modified wing.



Bicyclus anynana butterfly with modified right wing.

to new questions and new properly designed scientific experiments. Society as a whole can also benefit from this kind of interaction with an increased awareness and understanding of scientific issues.

In *Nature?* I have only modified the pattern of one wing of *Bicyclus* and *Heliconius* butterflies. As a consequence, all these butterflies have simultaneously one wing with the natural design and another one with my design. Through this asymmetry, I have tried to emphasise the similarities and differences between the unmanipulated and manipulated, between the natural and the novel natural.

I have been trying to express concepts in the butterfly wings that deal with our perception of shapes. By adding, changing or deleting eyespots and colour patches it is possible for our imagination to identify shapes and rhythms familiar to our senses. Another approach includes the highlighting of particular aspects of the natural wing—for example, the removal of the outer rings of an eyespot to show simply the white centre of it. I do not have the intention of enhancing in any way Nature's design. Nor do I intend to make something already beautiful even more beautiful. I simply aim to explore the possibilities and constraints of the biological system, creating (inasmuch as it is possible) different patterns that are not the result of an evolutionary process. It has also been my intention to create unique butterflies. The changes are not at the genetic level, and the germline is left untouched. As a consequence, the induced modifications are not transmitted to the offspring. Each modified butterfly is different from any other. The new patterns are something never seen in Nature before, and quickly disappear from Nature not to be seen again. This form of art has a life span—the life span of a butterfly. It is a form of art that literally lives and dies. It is simultaneously art and life. Art and Biology.

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