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How butterflies hide from birds

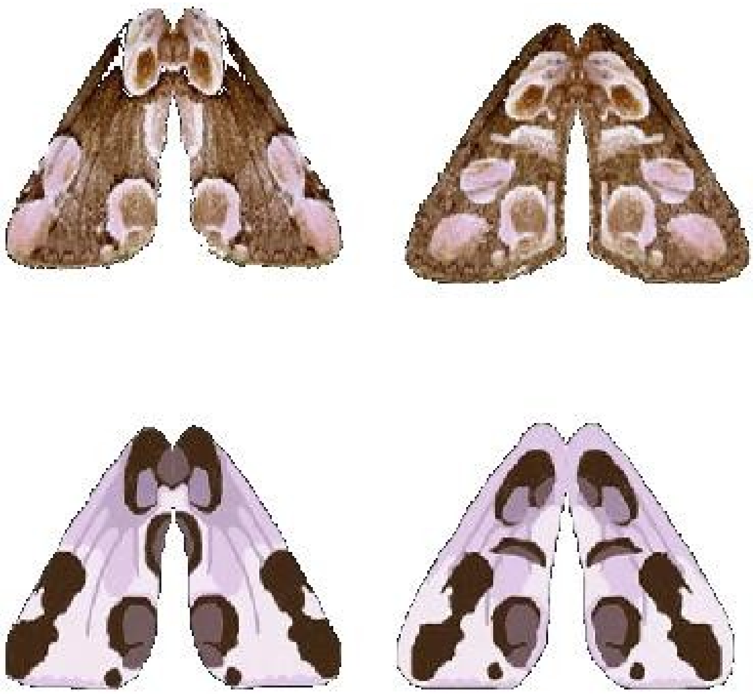
Prey animals only become prey when a predator actually discovers and kills them. Dr. Nina Stobbe from the University of Freiburg has spent the last three years investigating the ability of moths to prevent predators from detecting them. Her doctoral thesis has shown that colour spots on the wings of butterflies conceal their bearers, in particular when arranged and structured in a specific way.

An example of crypsis: the paper model of the peppered moth effectively blends in with the background pattern.
© Dr. Nina Stobbe

Many animals have "learnt" during evolution how to keep predators away. Some monarch butterflies (Danaus plexippus), for example, produce toxins whose presence is signalled by dazzling colours. Other butterflies adopt the colours and patterns of their environment. For example, peppered moths (Biston betularia) are outstandingly adapted to the colour and structure of birch tree trunks. Dr. Nina Stobbe from the University of Freiburg has done her doctoral thesis in the Department of Evolutionary Biology and Animal Ecology, in which she has dealt with the aforementioned strategy, also known as crypsis. Working in the research group of Dr. Martin Schaefer, she has also looked into a type of camouflage that up until 2005 only interested theoreticians and the military. This concerns a type of camouflage referred to as disruptive colouration.

How the moth disappears

“The principle of disruptive coloration was for the first time ever described theoretically by Abbott Handerson Thayer in 1900,” explained Stobbe. “During WWI, the navy painted their ships according to the principles of disruptive camouflage.” The theory is simple: A bird will only discover the body of a resting butterfly when it is able to discern the contours of the butterfly’s wings. Differently coloured patches at the edges of the wings break up the body’s outline and the bird will only see a lacerated pattern that no longer appears to be a wing. This belief has its roots in cognitive psychology and is based on the principle of closed contours according to which an animal or human can only identify an object as a unit if the object has uninterrupted contours. Many butterflies have differently coloured patches on the edge of their wings. “However, up until three years ago only one study had focused on the empiric investigation as to whether and how disruptive colouration works among animals,” said Stobbe.

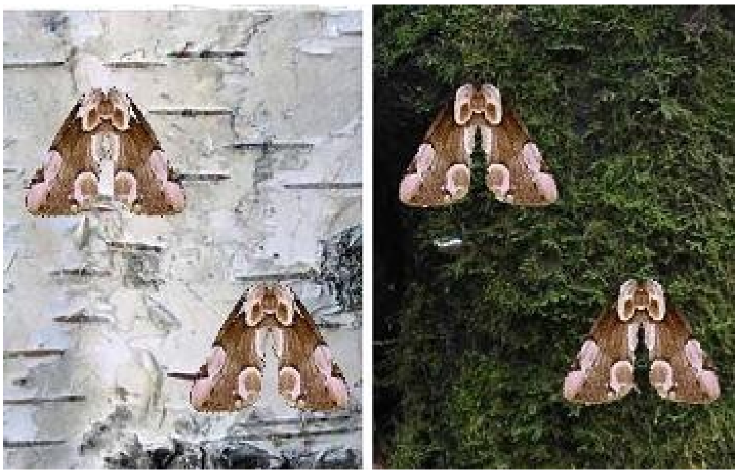


Four different models of disruptively coloured wings: top row: copy of the peach blossom (Thyatira batis) with patches on the wing edges (left) and inside the wings (right); bottom row: analogous negatives.

Stobbe has focused on finding out how disruptive colouration works in butterflies and moths. Over the last three years, Stobbe has applied differently coloured moth copies to tree trunks and carried out survival analyses: which moth copies are particularly favoured by birds and which copies are not attacked? Some of the paper moths were cryptically coloured to look like peppered moths, others resembled peach blossom (Thyatira batis) moths. The latter had pink patches on brown-green wings; some of them were the exact negative, i.e. had brown-green patches on a pink background. Some moths had the patches at the edge of the wings (peach blossom) and others had them distributed on the wing surface. Stobbe wanted to find out whether different colour constellations and patch distributions played a role in effective concealment or not. In addition, she also wanted to find out whether disruptive coloration also provides the moths with effective camouflage against the different backgrounds occurring in their typical habitats. Therefore, the moth copies were attached to birch trees and to mossy oak trunks.

However, at first Stobbe had to solve a problem: the theory of disruptive camouflage requires the patches and wings to be differently coloured. In addition, either the patches or the wings had to have a different colour from the background colour. The colour combinations used by Stobbe differed from one another and were placed against different backgrounds as far as the human eye could see. Would birds therefore also see the same colours as a human? The biologist confirmed that the colour perception was indeed the same by spectrometrically determining the copies and backgrounds used. This objective information on the reflected wavelengths of the light was set against a model of a bird's eye and all the contrasts discernible by birds were thus determined.

Adapted to any habitat whatsoever ?



That is what the peach blossom looks like when resting on a birch tree (left) or on a mossy tree trunk (right).

The experiments showed that disruptive colouration was far more effective when the differently coloured patches were located at the edge of the wing than when they were distributed across the wing surface," summarises Stobbe. "In addition, the disruptively coloured peach blossom copy and its negative survived quite well on either background, the cryptic copy only survived on the birch tree." Disruptive colouration is therefore an excellent camouflage strategy and works even better than crypsis. It works against different backgrounds, which is particularly important since moths usually inhabit habitats with the most diverse tree and bush species.

During her doctorate, Stobbe also studied other problems associated with the camouflage strategy of moths. For example, she was able to show that particularly conspicuous patterns on moth wings distract the birds' attention and they then have greater difficulties to discern potential prey. In future, the biologist hopes to test whether moths living in heterogeneic habitats such as mixed forests tend to follow disruptive colouration strategies more than other animals. This would explain whether disruptive colouration is actually an evolutionary adaptation to predator pressure. "However, this approach is very difficult because objective criteria that could be used to classify a moth as "disruptively coloured" are not available," said Stobbe who nevertheless hopes to find an answer to the question on the size of the patches and colour combinations. Maybe, it won't be long before she can come up with a solution.

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