

DAZZLED AND DECEIVED
MIMICRY AND CAMOUFLAGE

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CONTENTS

<i>List of Illustrations</i>	<i>ix</i>
<i>Acknowledgements</i>	<i>xii</i>
<i>Prologue</i>	<i>1</i>
CHAPTER 1 Darwinians, mockers and mimics	6
CHAPTER 2 Swallowtails and Amazon	31
CHAPTER 3 Delight in deception	43
CHAPTER 4 Pangenesis	57
CHAPTER 5 On the wings of angels	71
CHAPTER 6 Dazzle in the dock: The First World War	85
CHAPTER 7 Camouflage and cubism in the First World War	101
CHAPTER 8 Hopeful monsters?	113
CHAPTER 9 The natural history of the visual pun	127
CHAPTER 10 Cannibals and Sunshields	138
CHAPTER 11 Dazzle (revisited) to D-Day	170
CHAPTER 12 From butterflies to babies and back	182
CHAPTER 13 The aromas of mimicry	197
CHAPTER 14 The tinkerer's palette	207
CHAPTER 15 The <i>Heliconius</i> variations	221
CHAPTER 16 A shifting spectrum	235
Epilogue	250
<i>Notes</i>	<i>256</i>
<i>Bibliography</i>	<i>273</i>
<i>Index</i>	<i>277</i>

PROLOGUE

As I write, a comma butterfly has just flown into the house, intending to hibernate. It sits motionless in the window, with its wings closed. Because it has to survive the winter without moving, it is a brilliant leaf mimic: the wings are scalloped ornately as if the margins had been nibbled, totally disrupting the typical butterfly wing pattern. Waves of mottled grey to brown spread across the wing, just like the patterns on a dead leaf, and there is a tiny crescent shape in white on each wing, like a fleck of bird's droppings. It is a tattered leaf, which can lie unnoticed throughout the winter.

The beauty and purpose of the comma's leaf mimicry are obvious. Since vision first developed in creatures in the Cambrian era, around 540 million years ago, appearances have been hugely significant in shaping the course of evolution. The art historian Sir Ernst Gombrich (1909–2001) was interested in more than paintings: he took the whole field of visual representation as his province and he wrote beautifully on mimicry and what nature's copying and stylised warnings mean for the art of human beings: 'For the evolution of convincing images was indeed anticipated by nature long before human minds could conceive this trick . . . the art historian and the critic could do worse than ponder these miracles. They will make him pause before he pronounces too glibly on the relativity of standards that make for likeness and recognition.'

Gombrich finds various styles of art in nature: a leaf butterfly can fancifully be considered to be 'a naturalistic artist', natural selection having

produced a facsimile of the dead-leaf pattern. But the eyespots sported by some butterflies are stylised gestures: ‘They represent, if you like, the Expressionist style of nature.’ Then there are patterns whose meaning is established by association. Creatures which are protected by toxicity or powerful defences such as stings signal their danger with bright warning colours: in temperate regions, wasps and ladybirds are typical examples. The warning colours of toxic species – red, yellow, black and white – are also the colours we use for our road signs and for hazardous materials logos. This may be an innate response of living creatures to bright colours, which stand out against the duller greens, browns and greys of vegetation and rock. Perhaps the colours have become associated with danger over long periods of evolutionary time, and so have only a conventional meaning, in the same way in which the names of objects are assigned by convention (a road is not intrinsically a ‘road’, but also a ‘rue’, an ‘ulitsa’ or thousands of other names in different languages). At any rate, the parallels between natural and human warning coloration are too obvious to ignore.

Deception has always played a large role in human affairs. Early humans – hunter gatherers – were as adept in the wiles of camouflage as any animal: they had to be.* The biblical story of Esau and Jacob has an uncannily biological feel to it. When the ‘smooth man’ Jacob wanted to impersonate the ‘hairy man’, his hunter brother Esau, in front of their blind and aged father Isaac, he covered himself with hairy goatskins. Isaac recognised Jacob’s voice but preferred to trust in the smell and hairy feel of the goat hunter – smell and touch being more primal and elemental senses than hearing: ‘The voice is the voice of Jacob, but the hands are the hands of Esau.’

Ambiguity and disguise exert a powerful hold on the human imagination. Mistaken identity, whether intentional or accidental, has permeated

* Strictly, the word ‘camouflage’ did not exist before it was coined by the French in 1917, during the First World War. The word derives from the verb *camoufler*: to dress up, disguise. Before its use in war, it had theatrical connotations and the terms ‘concealing coloration’ or ‘protective coloration’ were used instead. ‘Camouflage’ is so much the better word that I use it throughout, even when it is technically anachronistic. ‘Protective coloration’ can also mean, not concealment, but display.

myths, legends and literature. In particular, in the Oedipus legend or in many of Shakespeare's plots – *As You Like It*, *The Merchant of Venice*, *Measure for Measure*, *A Midsummer Night's Dream*, *Twelfth Night*, *The Winter's Tale* – falsifying a person's identity is the engine of many human dramas. In human society now, these doubts are put to the court of DNA testing; and in the realm of nature DNA reveals that many species are not what they appear to be on the surface.

Most deceptions in the human realm have a parallel in nature: when the Trojans led the Horse into their city, unsuspecting that it was packed with Greek soldiers, they were at one with the ants who, fooled by deceptive chemical odours, carry caterpillars of some blue butterflies into their nest and feed them in preference to their own larvae. The passage in *Macbeth* in which the men of Malcolm's army disguise themselves as trees in their approach to Dunsinane prefigures the modern sniper, decked out in tattered rags, twigs and leaves.

Until the end of the nineteenth century, troops wore intimidatory, bright uniforms, red being a favourite – as it is among the many toxic species which proclaim their dangerousness by conspicuous display. But in the later years of the nineteenth century the increased power of weaponry, especially the machine gun, made concealment a priority.

Camouflage in war has been a test case of the 'two cultures'. In normal times, attempts to find links between art and science are well meaning but mostly of no avail, because the territories and methods of their disciplines seem so different. But in camouflage in wartime, both biologists and artists felt they had unique expertise to offer. Now the territory was the same, but the mindsets were very different. The story of the attempt to apply lessons from nature's camouflage and mimicry to military combat in the two world wars has many intriguing twists, involving three principal naturalists – Sir John Graham Kerr, Hugh Cott and Sir Peter Scott – besides a cast of artists, soldiers and one magician. The convergence of nature, art and science in the world wars occupies the central period covered here: between the explorations of the pioneers and the hi-tech genetic work of today. As a recent themed issue of the Royal Society's *Transactions* recognises: 'Camouflage research has for a significant length of time linked biology, art and the military, stemming from the work and influence of Abbott Thayer and Hugh Cott.'

The artistic aspect of mimicry and camouflage lends an added dimension to the allure of the subject. I began to collect examples of mimicry twenty-five years before beginning this book, at a time when I was working as a natural history desk editor. At that stage I saw mimicry primarily in terms of descriptive natural history, with strong aesthetic overtones. The stories in Hugh Cott's *Adaptive Coloration in Animals* (1940), which was at the time still the most compendious and authoritative text on the subject, enthralled me with their revelations of surprising mimicry in exotic settings.

But mimicry is more than a fantastical tale of visual punning in nature: it can tell us so much about evolution. The story of evolution is the biggest prize in biology. To understand how living things develop from the egg; how the genes act to shape the organs; to know in depth how inheritance works; to unravel the genetic basis of disease and to devise cures: these are the normal goals of most biological research. But the more we know about organic processes in the here and now, the more we learn about the three-and-a-half-billion-year journey from the first replicating molecules to the current, multi-million species cornucopia of life. One of the most startling findings of molecular biology has been the revelation that all creatures are closer cousins under the skin than we had imagined. The question 'Are you a man or a mouse?' can now be answered 'Both' – since around 99 per cent of human genes have a mouse equivalent. It seems that large differences in the form and function of animals have been achieved by relatively minor genetic mutations.

But evolution did not occur only by shuffling a pack of genetic cards. Whether genes can be passed on at all depends on how an organism lives in a real environment with other creatures. Understanding how genes and the total environment interact over vast stretches of time is an enormously complicated issue and we don't have video footage of the past, but to look at the evolution of a restricted phenomenon can be a test case. Mimicry and camouflage – the resemblance that one life-form has either to another or to a part of the environment – have some special features which make them ideal for studying evolution in action. And the best subjects are insects – spiders, mantises, but above all butterflies and moths. There are many reasons for this. The rapid turnover of generations in insects and their vulnerability mean that natural selection bears

very heavily on them. And butterflies are special among insects because their whole being is displayed on their wings – two-dimensional objects are easier to study than anything with three.

Very often we fall into circular arguments when we speculate on evolution because there is no purpose to it – no end in sight. We see that some organisms have survived, so we say that these must have been the fittest. And which are ‘the fittest?’ Those which have survived. But in mimicry one creature has led and another has, through selection, copied it. The old problem of attributing to nature a goal when it has none dissolves in the face of mimicry because, although there is no purpose to the whole of it, for the mimicking species there *is* a goal: to copy the model. So we have an index of the success of evolution in producing the match. Similarly with the butterflies that mimic dead leaves. Success is demonstrable.

So, if we discovered the pattern-forming genes in a mimic and its related but non-mimetic cousins, we would learn something about adaptation, natural selection and the genetic mechanisms behind a particular instance of precise copying. Obviously camouflage is somewhat different, but no less intriguing. When a moth exquisitely disappears against the bark of a tree, it tells us something about the passive I-am-a-camera nature of the genetic pattern-forming processes; but there will be no correlation between the genes which make the bark in a tree and the genes which make the patterns on the moth’s wings. In mimicry, we will see how some quite similar pattern-making genetic machinery has been tweaked in one butterfly to match another.

As the genes behind mimetic resemblances and the time scale on which mimicry was achieved are revealed, the course of evolution will be reconstructed. Evolution leaves traces of its innovations in the DNA of present-day organisms: not a simple record that we can read as a timeline of development, but rather as forensic clues to be matched against fossil evidence. The story of evolution will probably be revealed first in mimetic and camouflaged creatures. I cannot think of a more enticing project, involving beautiful creatures in luxuriantly populated environments and the shifts in DNA which lie behind them.