

Birds are among the most colourful creatures in the natural world, and their vibrant displays are used for a variety of reasons—from attracting mates to signaling fitness or status. What makes bird colouration even more fascinating is the complexity behind how these colours are produced. Birds don't just rely on one type of mechanism to generate colour; instead, they use a range of different methods, making their colouration systems an ideal subject for studying the intricate ways animals communicate through visual signals.

The many ways birds create their colours offer researchers a unique opportunity to investigate how different layers of complexity interact to form signals. These signals can provide information about a bird's health, its ability to find food, or even its genetic quality. However, despite a wealth of research on this topic, the literature on bird colour signals is often inconsistent, with varying ideas about how these signals work and what they cost the birds in terms of energy and survival. Most importantly, in the past, scientists studied bird colouration using simple methods, mainly focusing on how much light different parts of a bird's feathers reflected. While this helped reveal some information, it was too simplistic to fully capture the complexity of how birds produce and use colour. By focusing only on individual points of reflectance, we missed the bigger picture of how these colours work together in a more holistic way.

This project aims to move beyond these simplified methods. Rather than relying solely on light reflection, it will study bird colouration in a more layered and detailed way. It will look at the different levels of mechanisms that generate colour, including structural features, pigments, and how these interact to create patterns and dynamic colour effects like iridescence, which changes depending on the angle of light. Importantly, the project will explore higher-level features of bird colours that could carry additional information. For example, the bright, changeable throat feathers of a hummingbird are thought to be a signal of health and vitality, adding extra layers of meaning to a bird's appearance.

To achieve this, the project will use a variety of methods. Fieldwork will be conducted at a research site on Gotland, Sweden, where the natural colour traits of birds will be studied in detail. Additional field studies will focus on closely related species that share similar but distinct colour features, allowing for evolutionary comparisons. The research will also include analysis of bird specimens from museums to track how colour traits may have evolved over time. Furthermore, the project will conduct a meta-analysis of existing scientific data to look for patterns across different studies.

Another important aspect of the project will be the use of genetic methods to investigate how specific genes are involved in producing colour. By studying which genes control the different colour-producing mechanisms—such as pigments or structural arrangements—the project will reveal how genetic differences influence bird colouration and how these traits evolve across species.

This research is expected to fill a crucial gap in our understanding of bird colouration. By using more realistic and comprehensive methods to study how birds produce and use colour, it will provide new insights into how these traits evolve and function as signals. For the first time, the project will establish the evolutionary dynamics of the complex, layered systems behind bird colouration, offering a clearer picture of how birds communicate through colour.

Beyond advancing our understanding of bird biology, this research may have broader implications for material science. By learning from the intricate ways birds produce their colours—such as the dynamic hues of a peacock's feathers or the shimmering green of a mallard's neck—scientists may be able to design new materials that mimic these natural effects, potentially leading to innovations in how we create coloured materials for everyday use.