Science Literature

A discussion of ID-related Reading

Post details: Structural colour in bird feathers

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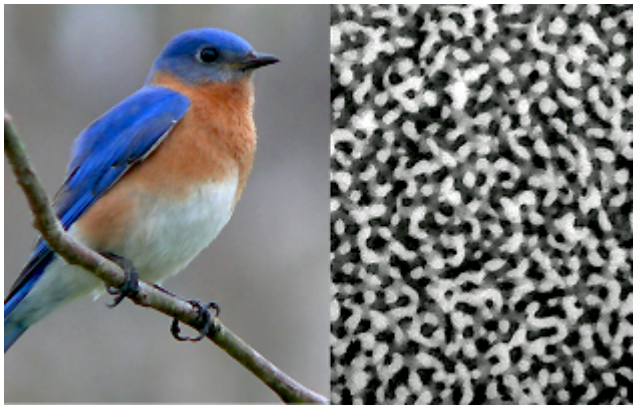
by David Tyler 02:03:47 pm, Categories: Literature - Articles, 898 words

Structural colour in bird feathers

Whilst our understanding of coloured objects is dominated by the role of pigments and dyes, the natural world makes extensive use of nanotechnology to yield vivid hues, often with added iridescence. The mechanisms involve constructive and destructive interference of light - this is referred to as structural colour. This is the best way to get a brilliant white or an ultrablack. Structural colours can be produced by highly periodic photonic crystals (as in butterfly wings), and also by "amorphous, or quasi-ordered, dielectric nanostructures where there are local correlations but little long-range order" (as in the feathers of some birds).



Nanostructures that produce some birds' brightly colored plumage, such as the blue feathers of the male Eastern Bluebird, have a sponge-like structure. (Photo: Ken Thomas, source here)

Some feather colours result from the presence of a spongy material with nano-sized air bubbles. In technical language, the visual effects are created by "light scattering from spongy beta-keratin and air nanostructures within the medullary cells of avian feather barb rami". An interdisciplinary research team have analysed the feathers from different birds and tested out various hypotheses for the formation of colour. They favour a phase-separation model:

> "They compared the nanostructures to examples of materials undergoing phase separation, in which mixtures of different substances become unstable and separate from one another, such as the carbon-dioxide bubbles that form when the top is popped off a bubbly drink. They found that the color-producing structures in feathers appear to self-assemble in much the same manner. Bubbles of water form in a protein-rich soup inside the living cell and are replaced with air as the feather grows."

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Mon	Tue	Wed	Thu	Fri	Sat	Sun
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

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- November 2011 (3)
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They identified two distinct classes of nanostructure: channel morphologies and sphere morphologies. From previous work, they find that these nanostructures are unrelated to phylogeny and they conclude that the "channel and sphere nanostructures have evolved independently in many lineages of birds".

In order to form recognisable, reproducible plumage patterns, it is necessary for the nanostructure development to be precisely controlled during feather development. This is no mean task. Based on their phase separation model, they are able to spell out the implications for managing the process.

> "In this model, birds develop color producing nanostructures by controlling the combined process of phase separation and kinetic arrest with three variables: the rates of beta-keratin expression, beta-keratin polymerization, and filament crosslinking."

There are two points worthy of note here. The first concerns the complexity of the process and the potential for biomimetics. The researchers speak of elegance and intricacy. Self assembly does occur - but only under closely engineered conditions. Thus, the context for self-assembly is intelligent design.

> "We have found that nature elegantly self assembles intricate optical structures in bird feathers. We are now mimicking this approach to make a new generation of optical materials in the lab."

The other point relates to Darwinian storytelling regarding bird plumage colours. Many have suggested that feather plumage colours are pointers to fitness - however that is defined. The new research effectively drives a wedge between Darwinian adaptation theory and the empirical data.

> "Many biologists think that plumage color can encode information about quality - basically, that a bluer male is a better mate," said Richard Prum, chair of the Department of Ecology and Evolutionary Biology and one of the paper's authors. "Such information would have to be encoded in the feather as the bubbles grow. I think our hypothesis that phase separation is involved provides less opportunity for encoding information about quality than most biologists thought. At the same time, it's exciting to think about other ways birds might be using phase separation."

Self-assembly of amorphous biophotonic nanostructures by phase separation
Eric R. Dufresne, Heeso Noh, Vinodkumar Saranathan, Simon G. J. Mochrie, Hui Cao and Richard O. Prum
Soft Matter, Online 30 March 2009, DOI: 10.1039/b902775k

Some of the most vivid colors in the animal kingdom are created not by pigments, but by wavelength-selective scattering of light from nanostructures. Here we investigate quasi-ordered nanostructures of avian feather barbs which produce vivid non-iridescent colors. These beta-keratin and air nanostructures are found in two basic morphologies: tortuous channels and amorphous packings of spheres. Each class of nanostructure is isotropic and has a pronounced characteristic length scale of variation in composition. These local structural correlations lead to strong backscattering over a narrow range of optical frequencies and little variation with angle of incidence.

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- Access Research Network
- Discovery Institute
- Evolution News Blog

  Evolution has become a favorite topic of the news media recently, but for some reason, they never seem to get the story straight. The staff at Discovery Institute's Center for Science and Culture started this Blog to set the record straight and make sure you knew "the rest of the story".

- Intelligent Design Network (IDNet)
- Intelligent Design Undergraduate Research Center
- Intelligent Reasoning

  A blogger from New England offers his intelligent reasoning.

- International Society for Complexity, Information, and Design (ISCID)
- Telic Thoughts

  We are a group of individuals, coming from diverse backgrounds and not speaking for any organization, who have found common ground around teleological concepts, including intelligent design. We think these concepts have real potential to generate insights about our reality that are being drowned out by political advocacy from both sides. We hope this blog will provide a small voice that helps rectify this situation.

- The Design Inference - The Writings of William A. Dembski
- The Intelligent Design and Evolution Awareness Center (IDEA)
- www.themonkeytrial.com

Such optical properties play important roles in social and sexual communication. To be effective, birds need to precisely control the development of these nanoscale structures, yet little is known about how they grow. We hypothesize that multiple lineages of birds have convergently evolved to exploit phase separation and kinetic arrest to self-assemble spongy color-producing nanostructures in feather barbs. Observed avian nanostructures are strikingly similar to those self-assembled during the phase separation of fluid mixtures; the channel and sphere morphologies are characteristic of phase separation by spinodal decomposition and nucleation and growth, respectively. These unstable structures are locked-in by the kinetic arrest of the beta-keratin matrix, likely through the entanglement or cross-linking of supermolecular beta-keratin fibers. Using the power of self-assembly, birds can robustly realize a diverse range of nanoscopic morphologies with relatively small physical and chemical changes during feather development.

See also:

Bird Feathers Produce Color Through Structure Similar to Beer Foam, *Yale University Office of Public Affairs* (April 2, 2009)

Tyler, D. **Optimal design for brilliant whiteness in a beetle**, (*ARN Literature blog*, 20 January 2007)

Website dedicated to comparing scenes from the "Inherit the Wind" movie with factual information from actual Scopes Trial. View 37 clips from the movie and decide for yourself if this movie is more fact or fiction.

Links - Of General Interest

- A Brief View of Time and Those That Live There

  Don Cicchetti blogs on: Culture, Music, Faith, Intelligent Design, Guitar, Audio

- A Quick Guide to Sequenced Genomes
- ARN Related Web Links
- Creation/Evolution Quotes

  Australian biologist Stephen E. Jones maintains one of the best origins "quote" databases around. He is meticulous about accuracy and working from original sources.

- CreationEvolutionDesign

  Most guys going through midlife crisis buy a convertible. Austrialian Stephen E. Jones went back to college to get a biology degree and is now a proponent of ID and common ancestry.

- Darwinian Fairytales by David Stove

  Complete zipped downloadable pdf copy of David Stove's devastating, and yet hard-to-find, critique of neo-Darwinism entitled "Darwinian Fairytales"

- ID The Future

  Intelligent Design The Future is a multiple contributor weblog whose participants include the nation's leading design scientists and theorists: biochemist Michael Behe, mathematician William Dembski, astronomer Guillermo Gonzalez, philosophers of science Stephen Meyer, and Jay Richards, philosopher of biology Paul Nelson, molecular biologist Jonathan Wells,

and science writer Jonathan Witt. Posts will focus primarily on the intellectual issues at stake in the debate over intelligent design, rather than its implications for education or public policy.

- John Mark Reynolds Blog

  A Philosopher's Journey: Political and cultural reflections of John Mark N. Reynolds. Dr. Reynolds is Director of the Torrey Honors Institute at
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