New feather findings get scientists in a flap

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Mute Swan feather. Credit: University of Southampton

Scientists from the University of Southampton have revealed that feather shafts are made of a multi-layered fibrous composite material, much like carbon fibre, which allows the feather to bend and twist to cope with the stresses of flight.

Since their appearance over 150 million years ago, feather shafts (rachises) have evolved to be some of the lightest, strongest and most fatigue resistant natural structures. However, relatively little work has been done on their morphology, especially from a mechanical perspective and never at the nanoscale.

The study, which is published by the Royal Society in the journal *Interface*, is the first to use nano-indentation, a materials testing technique, on feathers. It reveals the number, proportion and relative orientation of rachis layers is not fixed, as previously thought, and varies according to flight style.

Christian Laurent, from Ocean and Earth Science at the University of Southampton, lead author of the study, says: "We started looking at the shape of the rachis and how it changes along the length of it to accommodate different stresses. Then we realised that we had no idea how elastic it was, so we indented some sample feathers.

"Previously, the only mechanical work on feathers was done in the 1970s but under the assumption that the material properties of feathers are the same when tested in different directions, known as isotropic - our work has now invalidated this."

The researchers tested the material properties of feathers from three birds of different species with markedly different flight styles; the Mute Swan (Cygnus olor), the Bald Eagle (Haliaeetus leucocephalus) and the partridge (Perdix perdix).

Christian, who led the study as part of his research degree (MRes) in Vertebrate Palaeontology, adds: "Our results indicate that the number, and the relative thickness, of layers around the circumference of the rachis and along the feather's length are not fixed, and may vary either in order to cope with the stresses of flight particular to the bird or to the lineage that the individual belongs to."

The researchers soon hope to fully model feather functions and link morphological aspects to particular flight styles and lineages, which has several palaeontogical implications and engineering applications.

Christian says: "We hope to be able to scan fossil feathers and finally answer a number of questions – What flew first? Did flight start from the trees down, or from the ground up? Could Archaeopteryx fly? Was Archaeopteryx the first flying bird?

"In terms of engineering, we hope to apply our future findings in materials science to yacht masts and propeller blades, and to apply the aeronautical findings to build better micro air vehicles in a collaboration engineers at the University."

More information: Nanomechanical Properties of Bird Feather Rachises: Exploring Naturally Occurring Fibre Reinforced Laminar Composites, rsif.royalsocietypublishing.or … .1098/rsif.2014.0961

Provided by University of Southampton