The water-hating egg found on many coastal cliff faces

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The humble guillemot – a penguinesque bird with a questionable domestic demeanour but a remarkable self-cleaning egg – has been making the headlines lately. These cliff-dwelling, coastal birds may not make nests or take home hygiene too seriously, but their eggs have found a way to shake off the detritus and sea salt that could otherwise cause them to suffocate—by having super-hydrophobic qualities.

Former Birmingham bio-scientist Dr Steve Portugal and current Chemical Engineer Dr James Bowen were responsible from shining the shimmering spotlight on these mucky and remarkable birds. Read below for a Q&A, and follow the links to see what the international press made of this discovery.

Q&A

1) Discovering the nano-scale conical features of the guillemot egg surface has garnered considerable media attention, but can you describe the technique used to gather this knowledge, and how the eggs repel water so effectively?

James Bowen: Scanning electron microscopy and white light interferometry were used to inspect the eggs on the micro- and nanoscale, constructing three-dimensional topographic data for the surfaces. Water contact angle measurements allowed us to quantify the hydrophobic properties of the eggs.

Steven J Portugal: For me, as a biologist, it was exciting to learn about these techniques, and what different approaches we could adopt to try and identify the purpose of these unusual structures.

2) How did a biochemist and chemical engineer end up working together to study these eggs? And what was it about the labs and culture at Birmingham that made it possible?

SJP: I studied the Chemical Engineering staff webpages attempting to identify people with a relevant skill set suitable for analysing the surface properties of the eggs. Eventually I made contact with Professor Mike Adams, an expert in the field of surface and materials analysis, and through him I began working with James.

JB: I was keen to work with Steve as the project sounded absolutely fascinating. Furthermore, his passion and enthusiasm for the work was apparent from our first meeting. The white light interferometer, housed in the Advanced Materials Laboratory in Chemical Engineering, was just what Steve needed to measure the 3D structure of the eggs surfaces.

3) As has been widely reported, this discovery was made by accident (spilling water over eggs) but has led to a deeper understanding of biomimetics – in what ways can you visualise industry and society utilising this hydrophobic knowledge?

JB: Industry currently uses previously acquired knowledge of other naturally-occurring water-repelling surfaces for technological uses. For example, the topography of sharkskin has led to the development of drag-minimising fabrics and are also being explored for their use on aircraft. Similarly, the superhydrophobic Lotus leaf has inspired a range of coating treatments which promote the removal of dirt particles from surfaces when water droplets roll across them. The applications via which the guillemot egg discovery could be used in a biomimetic technology are still being discussed, but we are hopeful that there will be a few!

4) During your study of every species of bird egg in the UK (some 450 in total), did any other eggs stand out for having remarkable qualities?

SJP: That's a good question! It was amazing how similar a large majority of the eggs were, especially when you consider the diverse range of nest environments which are exploited by British breeding birds. Two groups of birds, the divers and grebes, had very unusual looking eggshells, and interestingly, they too have to cope with a lot of water on the eggs and around the nest.

5) Guillemot egg casings come in a range of beautiful colours and markings – what is the reason behind this variety?

SJP: One reason is to help the parent birds recognise their eggs. Most species of bird do not recognise their eggs – they don't have individual egg recognition. Guillemots do. If you move their egg while they're out foraging and put another guillemot egg in its place, when they come back, they spot it's not their egg and go looking for their own. Most birds would just accept the egg that is there, assuming it was the egg they left behind.

6) The guillemot lays self-cleaning eggs that roll in circles (so won't fall off the cliff faces they lay directly on to), they don't bother to make nests, and are known to wade around in their own and their neighbours' mess – is the guillemot the laziest of all birds?

SJP: I think the guillemot might be the cleverest of all birds! Why go to the hassle of building and maintaining a nest when you can solve the problem with a slight redesign of your eggs. Living in such close proximity to your neighbours brings about all kind of other stresses, so maybe not having a nest is one less thing to worry about.

7) What's next for you and the guillemot?

JB: I am currently working closely with industry via the Science City Advanced Materials project; we have approximately two years remaining in order to meet our targets. For further details on the facilities, visit http://www.birmingham.ac.uk/facilities/advanced-materials-characterisation/index.aspx. Beyond that, who knows what the future holds!

SJP: I think the guillemot is a great example of a single species finding a solution to a specific problem, caused by its unique nesting niche. There must be other examples where the eggs of species have evolved physiological and morphological adaptations to cope with extreme nesting environments, and it would be great to discover what solutions have evolved.

8) So which came first, the idle guillemot or the ingenious egg?

SJP: Guillemots do an amazing job of exploiting a unique, yet harsh, nesting environment. It's always tricky to suggest what came first, either the egg design or the beginnings of nesting in a new environment. It is likely, of course, they evolved gradually together. The absence of these surface structures on the eggs of close relatives suggests perhaps the guillemots got a little idle. It may be of course that guillemots were outcompeted by rival species from other, less-harsh, nesting environments, and had to come up with a solution.

Read their original University of Birmingham research article here: **http://www.birmingham.ac.uk/university/colleges/eps/news/schools/guillemot-eggs.aspx (http://www.birmingham.ac.uk/university/colleges/eps/news/schools/guillemot-eggs.aspx)**

Press coverage

- http://www.bbc.co.uk/nature/23145291 (http://www.bbc.co.uk/nature/23145291)
- http://phenomena.nationalgeographic.com/2013/07/04/scientist-spills-water-discovers-self-cleaning-bird-egg/ (http://phenomena.nationalgeographic.com/2013/07/04/scientist-spills-water-discovers-self-cleaning-bird-egg/)
- http://phys.org/news/2013-07-unique-shell-guillemot-eggs-edge.html (http://phys.org/news/2013-07-unique-shell-guillemot-eggs-edge.html)
- http://metro.co.uk/2013/07/09/guillemot-eggs-found-to-be-self-cleaning-3874527/ (http://metro.co.uk/2013/07/09/guillemot-eggs-found-to-be-self-cleaning-3874527/)
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- http://www.theguardian.com/science/small-world/2013/jul/18/nanotech-roundup-cosmetic-fix-micro-batteries (http://www.theguardian.com/science/small-world/2013/jul/18/nanotech-roundup-cosmetic-fix-micro-batteries)