**////Title: Double-Yolked Eggs: Egg-cellent or Egg-cident?**

**////Standfirst:**

Eggs are marvellous – they contain all the sustenance needed to make a young bird within their protective shell, and when destined for the plate, they are nutritious and delicious. For many of us, cracking open an egg for breakfast to discover two yolks in the pan is a pleasant surprise. However, if eggs are nature’s miracle of packaging, then double-yolked eggs must be nature’s mistake – a mistake that still holds many mysteries. To answer some persisting questions, Dr Attila Salamon and Dr John Kent of University College Dublin examined our collective knowledge on double-yolked eggs in a recent review.

**////Main text:**

The structure of an egg is an incredible evolutionary feat that protects and nourishes the developing chick. The hard outer shell is strong enough to withstand the weight of the incubating parent, but weak enough to allow the chick to break out of the shell during hatching. Pores across the shell provide airways through which air can pass – allowing the developing chick to breathe. Additionally, the shell’s inner membrane provides a barrier against harmful microbes that could otherwise reach the chick through the shell pores.

Inside the shell, the egg contains all the nutrients, proteins, fats, and water needed to grow a young bird within the yolk and the albumen – also known as the egg white. The ratio of yolk to albumen determines the maturity of the young chick at hatching. Less mature hatchlings must spend a period within a nest being fed by their parents. Domesticated poultry species, such as chickens and ducks, are well-developed upon hatching and swiftly gain the ability to follow their parents and feed themselves.

Double-yolked eggs have predominantly been found in domesticated species. Several factors – such as hen age and nutrition, light levels, and genetics – are associated with the formation of double- or even multiple-yolked eggs. It is rare to find double-yolked eggs in wild bird species, which could hint at the underlying constraints in double-yolked egg development. Many double-yolked eggs seem to be reproductive wastes – and the chicks contained within them rarely make it to hatching day.

However, despite double-yolked eggs being found for hundreds of years, many questions around the formation and reproductive outcomes of these eggs remain. From findings in their recent review, Dr Attila Salamon and Dr John Kent conclude that double-yolked eggs represent one of nature’s mistakes.

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Eggs are produced layer-by-layer as the yolk moves through the bird’s reproductive canal, or ‘oviduct’. The forming egg spends differing lengths of time in each section of the canal, reflecting the complexity of the layer being formed in each section. The entire process takes around 24 hours in hens.

When more than one yolk is ovulated – or released – by the ovary within three hours, the formation of a double-yolked egg is likely – if not inevitable. This is because the forming egg spends around three hours within the section of the reproductive canal where the majority of the albumen is formed.

Approximately 70% of all double-yolked eggs are from yolks meeting in the albumen-forming section of the reproductive canal. Here, the yolks meet and then travel through the rest of the canal together, finally being encased within a single shell.

Two yolks can be packaged within a single egg for several reasons. A yolk may be ovulated but not make it into the reproductive canal until it is recovered along with a second yolk during the next ovulation. Two yolks can be ovulated together when they reach the same developmental stage in the ovary simultaneously. Alternatively, in some cases the yolks develop in the normal sequence, about a day apart, but one is ovulated a day late along with that day’s maturing yolk.

Double-yolked eggs are produced with greater frequency in younger hens, and therefore could be a phenomenon reflecting the immaturity of the bird’s reproductive system. The laying of double-yolked eggs could also be the outcome of a process aimed at dumping smaller yolks that may result in smaller, less healthy chicks. By packaging these less viable yolks into eggs with more robust yolks, fewer resources are wasted producing the necessary egg structures. Indeed, in double-yolked eggs where only one yolk is fertilised, the developing chick absorbs the other yolk. This often leads to double-yolked hatchlings that are even larger than single-yolked hatchlings.

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The fertility of double-yolked eggs is still understudied, mainly because it was assumed that these eggs didn’t hatch. However, double-yolked eggs do exhibit some hatching success. ‘Twinning’ – where two chicks develop and hatch from a single egg – is very rare, but has been recorded in chickens, ducks, geese, pigeons, and turkeys.

There are two critical periods during egg development in which most double-yolked chick death occurs. The first is early in the incubation period, when the circulatory system is developing, and the second is late in the incubation when the chick’s lungs switch on, ready for meeting the outside world. In the case of double-yolked eggs that only contain one fertilised yolk – so only one developing chick – the higher mortality compared to twinning eggs could be due to higher levels of infection from the unfertilised yolk.

The mortality peak recorded in double-yolked eggs right before hatching could be caused by several factors, such as developmental immaturity, inadequate egg surface area preventing enough oxygen reaching the developing chicks, or space constraints preventing optimal chick positioning during the difficult hatching process. In double-yolked eggs, chicks often mistakenly end up with their heads in the narrow end of the egg, preventing them achieving the leverage they require to force the shell open. Thus, aiding chicks through the tricky hatching process can increase the hatching success of double-yolked eggs.

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Overall, the survival of double-yolked eggs – whether single or twin chicks develop – is lower than single-yolked eggs. This means that double-yolked eggs are unlikely to evolve within bird species as a reproductive strategy. The formation and structure of bird eggs evolved to support the development and hatching of a single chick, and not two. Thus, double-yolked eggs are nature’s mistake.

However, double-yolked eggs do provide researchers with an opportunity to study important processes occurring during egg formation and embryonic development in greater detail, and explore the factors affecting egg fertility for the purposes of improving hatching success in chicken and duck farming. With more research, perhaps the remaining mysteries of nature’s miracle packaging – the egg – will be revealed.

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This SciPod is a summary of the paper ‘The double-yolked egg: from the ‘miracle of packaging’ to nature’s ‘mistake’’, in World's Poultry Science Journal. [doi.org/10.1080/00439339.2020.1729671](https://doi.org/10.1080/00439339.2020.1729671)

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