Journal of Interdisciplinary Science Topics

Can I have a pet turtle duck?

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04/04/2024

Abstract
In the TV show *Avatar: the Last Airbender*, the turtle ducks are one of the fantastical creatures introduced. Through combining genes from mallards, *Anas platyrhynchos,* and green sea turtles, *Chelonia mydas,* it may be possible to produce an animal that looks similar. This article explores what additional research might be needed before a real turtle duck exists.

Keywords: *TV programme; Biology; Genetics; Avatar: The Last Airbender*

In *Avatar: The Last Airbender*, there are a variety of animals that are combinations of real-world animals, and the most infamous example is the turtle ducks. A group of the ducks live in the Fire Nation Royal Palace, and the audience is first shown them in the episode "Zuko Alone" in one of the flashbacks Prince Zuko has about his childhood in the Fire Nation [1]. But is it possible for a turtle duck to exist in real life? This article will explore the possibility of engineering a turtle duck from existing species.

Which Species?
Before a turtle duck could be created, the base species need to be determined. From figure 1, several phenotypic features of the turtle ducks can be observed. There is a mother and a baby duck, and all the features above the water can be observed.

Figure 1 – The turtle ducks as seen in Zuko's flashback from "Zuko Alone" [1]. Both the mother and the baby turtle duck have clear features that can be used for determining the base species of duck and turtle.

The baby turtle duck, on the right of figure 1, has lighter colouring in comparison to the mother turtle duck. The brown colouring on the mother is more distinctive. This is similar to female mallards, *Anas platyrhynchos,* as seen in figure 2, who start life as a yellow chick and, as they mature, become a brown adult. The female mallard also has the same shaped grey beak that can be seen in the turtle ducks, and similar brown stripes around the eyes. Furthermore, the lighter coloured chick is also consistent with *Anas platyrhynchos,* as mallards have yellow chicks that change colour as they mature. The chick in figure 1 could be female, as it shares similar stripes to the adult female, but it is unknown what mature male turtle ducks look like as they have not been shown.

Figure 2 – An adult female mallard for comparison to the turtle ducks. The two ducks share similar colours across the head and face areas, share the same beak shape, and have the same beak colour [2].

The turtle shell most closely resembles that of the green sea turtle, *Chelonia mydas.* The turtles can have either brown or green shells, and have the same pattern around the edge as the turtle ducks. From figure 1, there are no other obvious phenotypic features that originate from turtles.

Figure 3 – Green sea turtle. The shell is very similar to that of the turtle ducks, and can be used as a base species for combining with mallards to form a turtle duck [3].

Putting the species together

Producing a turtle duck cannot be done through breeding, as mallards have chromosomes so that $2n = 80$ [4], and green sea turtles have $2n = 56$ [5]. If the two species were to breed, an embryo would either not develop, or the resulting offspring would be infertile. It is assumed that, as the mother turtle duck in "Zuko Alone" [1] is shown with several baby turtle ducks, she can have offspring and is fertile.

The biology needs to be more sophisticated to create a turtle duck, but one advantage is that the embryos of chickens and turtles share many developmental genes [6]. Integrating new genes into the duck genome could produce the desired phenotypic results that would give a turtle duck. Observing figure 1, 2, and 3 again, the main feature that stems from the turtles is the shell, and so producing a duck with a shell would be a significant step forwards in the development of a turtle duck.

Turtle shells are composed of two major parts: the dorsal carapace, and the ventral plastron, and the two are connected along the midflanks by lateral bridges. The structure contains over 50 dermal bones that are in a unique order, and are overlain by dermal bones and an outer epidermal layer of keratinous scales [7]. The carapacial ridge controls early dorsal shell formation, and the development of turtle shells is similar to the development of ribcages [8, 9]. The carapacial ridge looks like a spinal cord underneath the shell. Turtle shells are directly linked to the vertebral column, like the spine, and the outward growth of the bones within the shell is comparable to the development of ribs [10].

There are several genes that are thought to contribute to the development of turtle shells. *Msx* genes are involved in limb and skeletal developments, and, outside of the carapacial ridge domain, have identical expression in turtles compared to chick embryos [8]. Stimulating *Msx* genes within a carapacial ridge domain could lead to a duck with a shell, exactly what is needed for a turtle duck, but *Msx* genes themselves do not produce the ridge.

Wnt5a is another gene expressed in the turtle carapacial ridge region and is the only *Wnt* gene to be expressed here. However, there is a lack of functional evidence to suggest that *Wnt5a* aids in forming the carapacial ridge [6], although the *Wnt* signalling related genes could be activated and expressed which, alongside some expression of *Fgfs* genes, lead to carapacial ridge development [9].

Conclusion

So, it seems that a pet turtle duck will not be feasible for a while yet. Further study into specific developmental genes of turtles is needed so that the genes that develop the carapacial ridge in embryonic development can be inserted into the mallard genome. The placement within the genome will need to be considered, and how well the duck can function with a newly added shell would also be a concern. For now, instead of a live turtle duck, a plush version might be a better replacement until research on turtle development catches up.

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