Shark study reveals taste buds were key to evolution of teeth

January 18 2017, by Gareth J. Fraser

Credit: Martin Fisch/Flickr, CC BY-SA

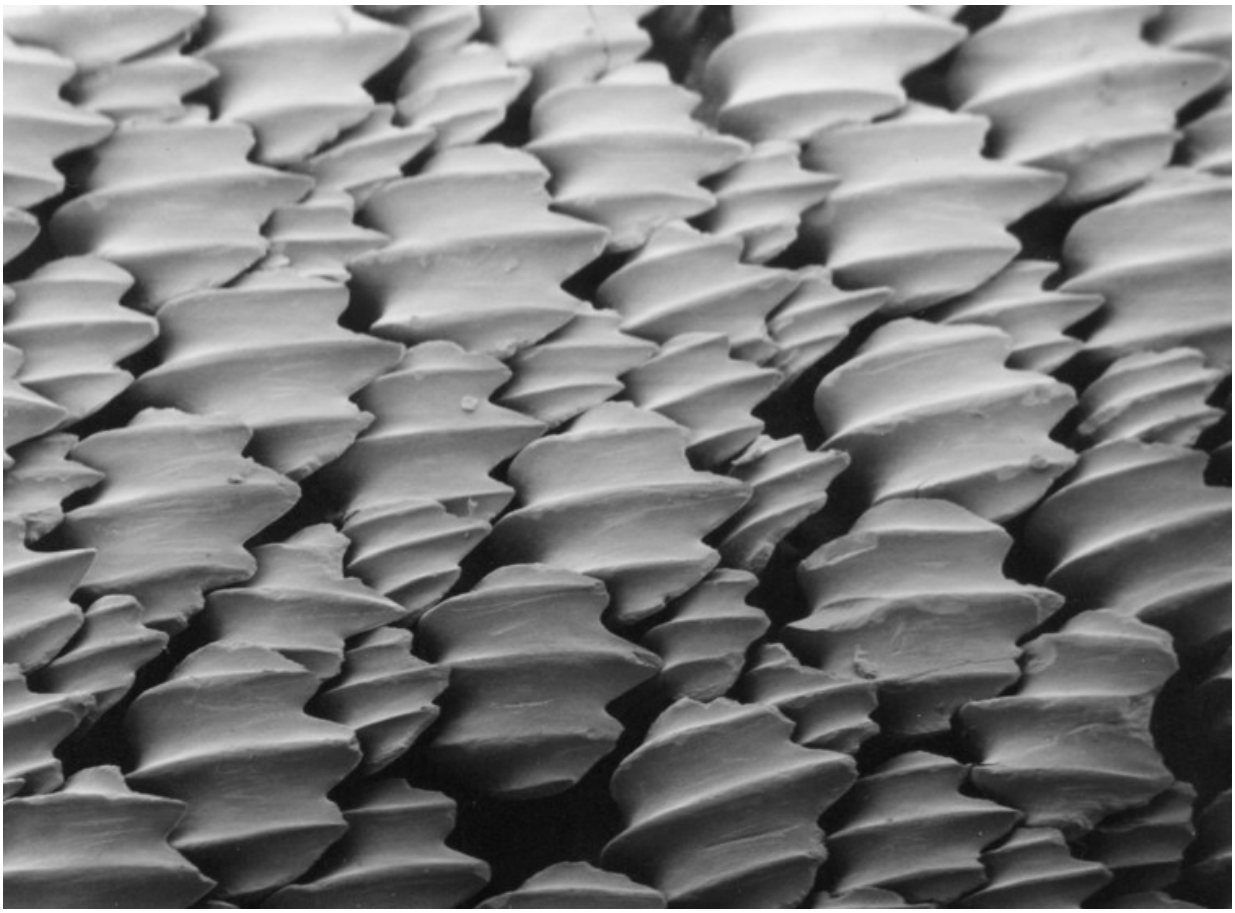
The first creatures to evolve teeth didn't have jaws. Many scientists believe these ancient fish developed the first tooth-like structures on their skin that were similar to the "denticle" scales that still cover sharks today, even after 500m years of evolution. It is thought that these denticles gradually migrated into the mouth to form oral teeth. However, research conducted by my colleagues and I suggests modern teeth – at least in sharks – may have also evolved from taste buds. In fact, we have shown that both teeth and taste buds develop from the same stem cells in

an embryonic shark's mouth.

While human taste buds sit separately on the tongue, many animals – particularly non-mammal vertebrates – have taste buds that line the regions of the jaws that also house teeth. We can see this especially clearly in sharks, which have multiple rows of continually regenerating teeth. The regions of a shark's mouth with the highest concentration of taste buds are directly behind the last row of teeth in both the upper and lower jaws, suggesting an important association between biting and tasting.

By studying shark embryos, we were able to track the stem cells in the mouth before teeth and taste buds formed. We discovered that these cells migrate and contribute to both structures. Even later in development when teeth and taste buds were established, taste-linked cells could still migrate to tooth forming regions deep in the jaw.

These stem cells also govern the teeth's ability to regenerate throughout the shark's life, and it turns out the shark's taste buds also share this ability. This suggests that teeth and taste buds not only develop and function together but may also have a close evolutionary link.



Shark denticles close up. Credit: Pascal Deynat/Odontobase, CC BY-SA

Genetic similarities

We also tested the idea that teeth in the mouth also share an evolutionary history with skin denticles. Although both are made from similar materials – dentine and enamel-like mineralised tissues – they have a number of clear differences. For example, shark denticles cannot regenerate like their teeth can.

Our research findings echoed this at a genetic level. The way genes are turned on and off in both teeth and denticle cells is almost identical. But

a key exception is in a gene known as "sox2", a stem-cell marker involved in the development and regeneration of many tissues in the body. We found the gene is not turned on in shark denticles but is involved in oral tooth development and regeneration. And it is also expressed in taste buds.

This led us to the new theory that shark teeth actually evolved their regenerative ability from taste buds. We know that taste buds evolved in ancient fishes before oral teeth because taste bud-like structures are present in jawless fishes such as lampreys. So if denticles did migrate into the mouth and evolve into oral teeth, their development may have become linked with that of taste buds, developing from the same cells and adopting their regenerative ability. This might have been because it gave the animals the advantage of tasting and processing food at the same time. Which means sharks may have their taste buds to thank for their conveyor belt of regenerating teeth.

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