

## BUILDING DENTITIONS THROUGH REGULATED REPEATED TOOTH INITIATION

[Moya Meredith Smith](#)<sup>1</sup>

<sup>1</sup> *Dental Institute, King's College London.*

**INTRODUCTION:** The dentition for each clade of gnathostomes is unique and all show great diversity in patterns for tooth addition and replacement. The formation of a sub-epithelial dental lamina promotes regulated tooth development with distinctive addition patterns in both chondrichthyans and osteichthyans. The evolution of such a structure, judged essential to produce iteratively patterned teeth at the margins of the jaws, may have occurred independently in more than one gnathostome group and is not a plesiomorphic character of jawed vertebrates [1]. Thus the pattern of tooth addition acquired a unique signature, for each clade of jawed vertebrates (Placodermi, Acanthodii, Chondrichthyes, Osteichthyes). This character 'teeth produced from a dental lamina' can occur more than once on a gnathostome phylogeny and suggests non-homologous developmental mechanisms. This site-specific, sequential, timed tooth addition as a mechanism for tooth renewal also ensures a sequestered environment for potential odontogenic epithelial cells. This may be a permanent dental lamina as in chondrichthyans and tetrapods, or a transient and discontinuous one as in many osteichthyan fish.

A universal developmental model has been suggested [2] where all toothed fields start from a pioneer tooth. This autonomously regulates the pattern of tooth addition in the row and all successive replacement teeth in each family, envisaged as modular development. The aim is to obtain gene expression data for regulation of tooth sites for sequential succession of teeth both within a dental lamina, but also without, in osteichthyan and chondrichthyan fish.

**RESULTS:** The early pattern of tooth loci in the position of the dentary in the Australian lungfish (*Neoceratodus forsteri*) is observed from timed stages with gene expression data. There is a single pioneer tooth in position two of each side; the first in a triad of teeth with sequential teeth added in adjacent tooth positions, first three and then one. This is also the sequence identified in rainbow trout (*O. mykiss*) for the dentary bone, preceded at tooth initiation stage by activation of *Omshh*, *Ompitx2* and *Ombmp4* in a different spatial-temporal expression pattern for each dental field.

In *Neoceratodus forsteri* different levels of *Nfshh* expression reveal cryptic sequential timing of dentary tooth initiation at the triad stages. Sequential tooth buds also form from the dental epithelium of the previous tooth germ, as in the trout, rather than from a dental lamina [3]. Preliminary data on expression of *Scshh* shows an intense broad band laterally and medially restricted to the odontogenic region of the lower jaw.

**DISCUSSION & CONCLUSIONS:** Primary rudimentary teeth and all successional teeth are formed in a permanent and continuous deep epithelial dental lamina in the catshark *S. canicula*. Each module starts from one tooth to provide both alternate families. Conversely, neither initial teeth nor successional teeth of the rainbow trout *O. mykiss* are formed in a classical dental lamina but are sited in the dental epithelium of the predecessor tooth [4], as are those of the lungfish. It is proposed that a transient site in the dental epithelium of the preceding tooth germ is one stage in evolution of the permanent successional lamina of tetrapod osteichthyans. A mechanism for retaining a localised epithelial progenitor cell population for continuous tooth renewal deep to the oral surface is considered essential to regulate tooth addition to each specific pattern.

**REFERENCES:** <sup>1</sup>Smith M. M. and Johanson, Z. 2003. Separate evolutionary origins of teeth from evidence in fossil jawed vertebrates. *Science*: 299: 1235-1236.

<sup>2</sup>Smith, M. M. 2003. Vertebrate dentitions at the origin of jaws: when and how pattern evolved. *Evol. & Dev.* 5: 394-413.

<sup>3</sup>Fraser, G., Berkovitz, B. K., Graham, A and Smith, M. M. 2006. Gene deployment for tooth replacement in the rainbow trout (*Oncorhynchus mykiss*): a developmental model for evolution of the osteichthyan dentition. *Evol. & Dev.* 5: 446-457.

<sup>4</sup>Fraser, G., Graham, A. and Smith, M. M. 2006. Developmental and evolutionary origins of the vertebrate dentition: molecular controls for spatio-temporal organisation of tooth sites. *J. Exp. Zool. (Mol. Dev. Evol.)* 306B: 183-203.

**ACKNOWLEDGEMENTS:** Leverhulme Emeritus Fellowship, COST action B23.