

# Early vertebrates: analysis from microfossil evidence

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## Abstract

Vertebrate microfossils provide data for potential origination, range and distribution of taxa, for phylogeny of organisms and for assessing response of taxa to events. Isolated vertebrate microremains (microvertebrates, ichthyoliths), such as thelodont and “shark” scales and “shark” teeth can and do provide evidence about the functional morphology and relationships of higher taxa such as the Thelodonti and Chondrichthyes. Vertebrate microfossils can also provide evidence for at least the earliest occurrences of various morphological features characteristic of taxa. Specialized sensory scales related to free neuromasts are identified from a loganellidid thelodont from the Lower Silurian of Devon Island, Nunavut, Canada. New material of early “shark” remains, scales and teeth from the Devonian of Australia and Canada, including the Early Devonian (Emsian) taxon, *Emsolepis hanspeteri* n. gen. et sp., from the *Receptaculites* and Jesse limestones of NSW and *Doliodus problematicus* (WOODWARD), from the Campbellton Formation of northern New Brunswick, add insights into the earliest stages of chondrichthyans. *Doliodus*, most recently regarded as a member of the Omalodontida, exhibits the earliest fossil record of the chondrichthyan teeth in situ.

## Introduction

Five hundred million years ago fish-like vertebrates radiated through marine then freshwater environments giving rise to higher vertebrates including humans. During the next 300 My fishes diversified into several major groups, which classically have been regarded as Agnatha (including Pteraspidomorphi, Cephalaspidomorphi, Thelodonti), Chondrichthyes (including Mongolepidida, Elasmobranchii, Holocephali), Placodermi, Acanthodii, and Osteichthyes (Actinopterygii, Sarcopterygii including Dipnoi and Actinistia). Some of these morphological groupings are still regarded as monophyletic taxa and many of those have been hypothesized as having originated in Gondwana (e.g., LONG 1995, McKERROW et al. 2000). Others (e.g., SANSOM et al. 2001), however, regard the evidence for a Laurentian origin of vertebrates as overwhelming, based on their hypothesis that conodont elements are vertebrate teeth. Consequently, they claim to have greatly enlarged the early vertebrate database. Yet others, however, have criticized their approach (e.g., SCHULTZE 1996, KEMP 2002, TURNER et al. in press a,b). And so, to assess the early stages of vertebrates during their first geological timespan, further fossil evidence must be examined. Here I present new data from two of the early vertebrate clades, Thelodonti and Chondrichthyes.

By studying material from diverse bonebeds, often large gaps in the fossil record can be filled with new data on the appearance and demise of morphotypes; these finds can contribute to the debate on origination of higher taxa. ELLIOTT (1990) and BLIECK et al. (1991) and, more recently with analyses of Cambrian and Ordovician taxa, SMITH et al. (2001) and TURNER et al. (2004) have considered the macro- and microfossil remains of the earliest vertebrates. Despite the constraints of evidence at the time, ELLIOTT (1990) surmized that there were at least two quite distinct assemblages in the mid Ordovician, which led to the conclusion of a long pre-Ordovician evolutionary history (now called ghost ranges). Confirmation of earlier hypotheses that vertebrates and their ancestors should date back to the Cambrian (e.g., GANS 1989) have come to fruition with the discovery of a series of purported chordates and vertebrates (e.g., SHU et al. 1999) in the late Atdabanian or Botomian Canglangpu and Qiongzhusi Formations of Chengjiang, Yunnan

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