

Small Carbonaceous Fossil Assemblages in the Burgess Shale (Ref IAP-16-49)

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In partnership with University of St Andrews & The Royal Ontario Museum

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Key Words

1. Palaeontology; 2. Cambrian Explosion; 3. Ancient Ecosystems; 4. Macroevolution; 5. Preservational Bias

Overview

The early stages of the Cambrian witnessed an unmatched period of ecological escalation, culminating in the establishment of biological communities with a fundamentally modern constitution.

Such assemblages are briefly visible in sites of exceptional soft tissue preservation such as the mid-Cambrian Burgess Shale — but such sites offer a restricted sampling of palaeoenvironments and time, and largely post-date the period of the Cambrian ‘explosion’ itself.

An alternative, fundamentally more representative rendering of early Cambrian life is provided by assemblages of small carbonaceous fossils (SCF) — which represent the teeth, scales, claws and other robust components of pioneering Cambrian organisms. SCF assemblages offer to provide a more comprehensive perspective on the gradual rise and diversification of Cambrian communities — but are likely subject to a suite of taphonomic biases.

Understanding the correspondence between SCF assemblages and original animal communities is essential to tracking the rate and pattern of evolution through the period of the Cambrian explosion. The Burgess Shale offers a unique opportunity to link SCF assemblages to bed-by-bed level surveys of representative macrofossil communities.

This reconciliation of microfossil and macrofossil assemblages will yield a new understanding of the

preservational biases associated with each taphonomic mode, and establish approaches to inferring original communities from fossil assemblages.

Taken together, this project will unlock the SCF record as a chronicle of early Cambrian evolution, bringing a new perspective on the increasing complexity of animal assemblages through the pivotal period of the Cambrian explosion.

Methodology

Detailed analysis of the macrofossil communities within the Burgess Shale has been conducted at a bed-by-bed resolution (Caron & Jackson, 2008), but scant attention has been paid to the SCFs that occur alongside the more famous macroscopic organisms (Butterfield, 1990; Gostling, 2006) – despite the rapidly emerging potential of this microfossil mode (Butterfield & Harvey, 2012).

Key Burgess Shale localities will systematically surveyed for macrofossil, SCF and acritarch abundance and diversity.

SCF extraction will employ a low-manipulation technique involving acid maceration of sediment samples and manual picking of fossils from residues. Acritarchs will be extracted through standard palynological techniques, entailing centrifugation and strew mounting. Fossils will be prepared for light and electron microscopy in order to allow taxonomic and ecological classification, with interpretation being

guided by detailed microscopic analysis of Burgess Shale macrofossils (cf. Smith *et al.*, 2015).

The integration of macrofossil, SCF and acritarch fossil data with data from sedimentological context, geochemistry and Raman spectroscopy will form the basis for a detailed analysis of fossil occurrence and co-occurrence, leading to a detailed model of environmental and taxonomic biases on assemblage composition.

The performance of these methods will be validated through a comparative study of the Sirius Passet macrofossil community, complemented by microfossil sampling from the Buen Formation. This will lead to a new reconstruction of the wider setting of these famous exceptional faunas.

This model will then be applied more generally to other SCF assemblages from the early- to mid-Cambrian, in order to identify systemic trends in marine biology and niche occupancy through this period. Taken together, this will provide a new perspective on evolutionary innovation through the Cambrian explosion and its consequences for ecosystem dynamics.

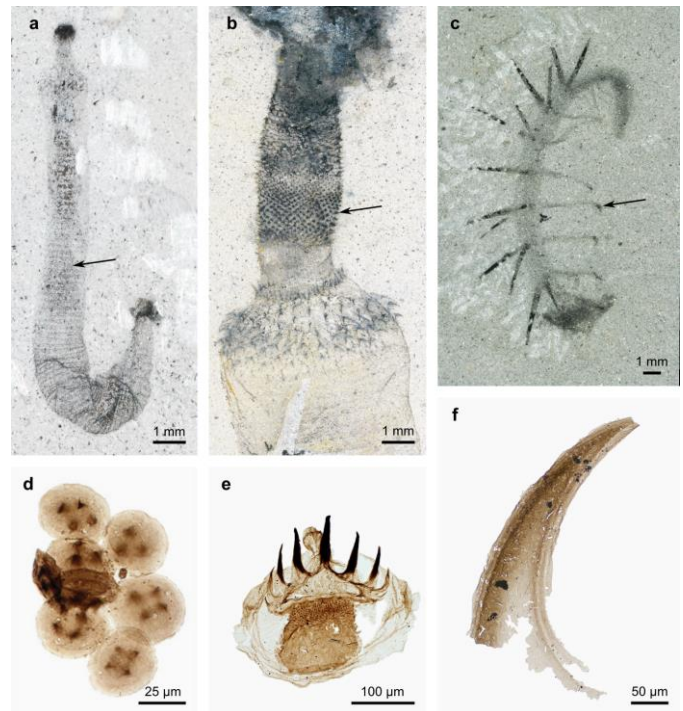


Fig 1 | Burgess Shale macrofossils (a–c) and corresponding SCF (d–f). a: *Scathascolex* (palaeoscolecid), d, sclerites; b: *Ottoia* (priapulid), e, tooth; c: *Hallucigenia* (lobopodian), f, claw.

Timeline

Burgess Shale samples will be selected from existing collections, with the possibility of gathering additional material through fieldwork in the summer of year two. Visits to the Royal Ontario Museum in the first two years will allow detailed examination of Burgess Shale macrofossils, to complement SCF and palynological preparations.

Statistical analysis of samples will be conducted in year two, in order to develop a model for SCF preservation. Year three will address material from the Buen Formation, and explore the wider implications of the study for Cambrian evolution.

Training & Skills

The successful candidate will be based in the Department of Earth Sciences at Durham University. The project will develop fieldwork, laboratory, analytical and statistical skills.

Training will be provided in palynological preparation and microfossil manipulation, in the use of electron microscopy, and in quantitative palaeontological approaches – including numerical and statistical methods. Skills in systematic taxonomy and quantitative biostratigraphy will also be developed.

References & Further Reading

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Further Information

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