Late Ordovician Lagerstätten in Manitoba, Canada: Glimpses of Soft-Bodied Diversity

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Important information about Ordovician biodiversity is also hidden in the sparse soft tissue record. Ordovician lagerstätten are rare globally, particularly in comparison with the Cambrian. Manitoba has least three Ordovician sites with preserved soft tissue: at Cat Head, Airport Cove, and William Lake.

Lagerstätten occur in Ordovician outcrop belts along the northeastern margin of the Williston Basin (Cat Head and William Lake) and southeastern margin of the Hudson Bay Basin (Airport Cove).

The horseshoe crab Lunataspis aurora symbolizes the biodiversity significance of Ordovician lagerstätten. The discovery of this new species, at William Lake and Airport Cove, pushed the fossil record of xiphosurids back by 100 million years.

Ongoing studies at these sites will significantly enhance our understanding of global Ordovician biodiversity. The Cat Head, of early Maysvillian age, is significantly older than the other two, which are considered to be Richmondian. Depositional environments also differ: the William Lake and Airport Cove biotas represent restricted marginal marine conditions, while the Cat Head was probably deeper water.

Ed Dobrzanski (L) and Sean Robson collecting from the Cat Head Member at McBeth Point in 2006. Although Cat Head material has been in museum collections for decades, much of what we know about all three lagerstätten has come from recent field research. The Airport Cove and William Lake sites were discovered as a result of our Ordovician studies.
The Cat Head fossils are found along the west shore of Lake Winnipeg, in bedded fine-grained dolostones of the Cat Head Member, Red River Formation. Fossils from this area have long been known; it is most famous for algae (seaweeds). The lithology and associated biota are consistent with deposition in the photic zone below storm wave base, although it has also been suggested that this could have been a restricted marine environment having little contact with the open sea.

In addition to unusual fossils, the Cat Head biota includes normal marine elements such as these *Tetraphalerella neglecta*. Note the white chert; chert in a great range of colours is characteristic of many of the beds in the Cat Head Member.

Strata in the Cat Head-McBeth Point area (CM), within the Cat Head Member of the Red River Formation, are exposed between Lynx Bay (LB) and Inmost Island (II), including at Cat Head (CH) and McBeth Point (MP). G = Gamachian; L. = Llandovery; KB = Kinwow Bay.

The Cat Head area is far from road access. Here, the 2006 field crew unloads gear from an Otter floatplane at the McBeth Point fishing station.
In the Cat Head-McBeth Point area, fossils, generally rare but abundant at some levels, include algae, sponges, conulariids, brachiopods, hydrozoans, nautiloids, trilobites, and dendroid graptolites.


The sponge Aulocopella sp. cf. A. winnipegensis (I-3614)

Articulated trilobites are common in the Cat Head area. This is Isotelus sp. (I-229).

The Cat Head area contains a great diversity of conulariids, including this Conularia sp. (I-1629).
Airport Cove fossils are found in rocks tentatively assigned to the Churchill River Group. The Airport Cove and William Lake biotas both represent very shallow, marginal marine conditions.5 As a result of these similar conditions, they share biotic elements: eurypterids, xiphosurids, algae, and large problematic tubes. At Airport Cove, laminated calcareous dolostones, deposited under more open circulation, contain scolecodonts and common noncalcified algae.

At Airport Cove, Ordovician strata sit unconformably against Proterozoic Churchill Quartzite. The strata bearing unusual fossils (AC) are near the top of the Ordovician succession. Lr. Llandov. = Lower Llandovery.6,7

Typical summer collecting conditions at Airport Cove: Norman Aime (foreground) splits rock, while Ed Dobrzanski (with shotgun) watches for polar bears.
Macrofossils at Airport Cove are preserved with pyrite, as carbonate, and as organic matter. Eurypterid sclerites are commonly disarticulated or broken, but organic cuticle retains exceptional detail.

**Airport Cove Fossils**

These large phosphatic or chitinophosphatic tubes are of unknown affinities (The Manitoba Museum, TMM I-4061).

Articulated scolecodont apparatus (jaws of a polychaete, I-4062)

The holotype of the horseshoe crab *Lunataspis aurora* (I-4000A) is remarkably preserved, with unmineralized cuticle.

Green algae (chlorophytes) from Airport Cove. A, Dasycladacean alga similar to *Chaetocladus* (B-319). B, Filamentous algae.

Prosoma and anterior preabdomen of a juvenile eurypterid (MM I-4064A)
The William Lake fossils are preserved in thin-bedded dolomudstones of the Williams Member, Stony Mountain Formation. These rocks were deposited in restricted, shallow-water marginal marine (mud flat to lagoon) conditions.\(^5\)

The beds containing unusual fossils at William Lake (WL, arrowed) are within the Williams Member of the Stony Mountain Formation. Maysvill. = Maysvillian; Gamach. = Gamachian; Lr. = Lower.\(^3,9\)

Collecting at the William Lake site in summer, 2007. Sean Robson, Graham Young, and Debbie Thompson remove rubble and soil from a bedding plane surface.
William Lake Fossils

In addition to fossils similar to those at Airport Cove, the dolomudstones at William Lake also contain common medusae (jellyfish). A single pycnogonid specimen is the geologically earliest known adult sea spider.\(^{10}\) Medusae and articulated arthropods occur in largely homogeneous mud layers or lenses; both fossils and lithology suggest rapid deposition.

These recently discovered fossils may represent the comb rows of ctenophores (comb jellies).

Lunataspis aurora, juvenile

Eurypterids were preserved as organic cuticle, but much has been removed by weathering (new genus, new species; TMM I-4308).\(^{11}\)
SIGNIFICANCE

Many of the fossils found at these three sites are very different from those at other Ordovician sites, in Laurentia and globally. They provide essential diversity information, supplying evidence of taxonomic groups that would otherwise be unknown. We are most actively studying the William Lake biota, so most of the cumulative data concern that site, which represents remarkably restricted and shallow-water conditions. The other sites, though less well understood, supply complementary information on quite different settings.

<table>
<thead>
<tr>
<th>Phylum</th>
<th>Group</th>
<th>Relative Abundance</th>
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<tbody>
<tr>
<td>Cnidaria</td>
<td>cnidarian medusae</td>
<td>common</td>
</tr>
<tr>
<td>Cnidaria?</td>
<td>Porifera? (chondrophores)</td>
<td>rare</td>
</tr>
<tr>
<td>Brachiopoda</td>
<td>Lingulida</td>
<td>abundant</td>
</tr>
<tr>
<td>Brachiopoda</td>
<td>Rhynchonellata</td>
<td>rare</td>
</tr>
<tr>
<td>Brachiopoda</td>
<td>Strophomenata</td>
<td>rare</td>
</tr>
<tr>
<td>Mollusca</td>
<td>Gastropoda</td>
<td>rare</td>
</tr>
<tr>
<td>Mollusca</td>
<td>Nuculoida (Bivalvia)</td>
<td>rare</td>
</tr>
<tr>
<td>Mollusca</td>
<td>Nautilioidea</td>
<td>rare</td>
</tr>
<tr>
<td>Ctenophora?</td>
<td>ctenophores?</td>
<td>rare</td>
</tr>
<tr>
<td>Arthropoda</td>
<td>Xiphosurida (Lutetaspis)</td>
<td>rare</td>
</tr>
<tr>
<td>Arthropoda</td>
<td>Eurypterida</td>
<td>common</td>
</tr>
<tr>
<td>Arthropoda?</td>
<td>Pycnogonida?</td>
<td>very rare</td>
</tr>
<tr>
<td>Arthropoda?</td>
<td>Notouroidea?</td>
<td>rare</td>
</tr>
<tr>
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<td>? (Crustacea)</td>
<td>rare</td>
</tr>
<tr>
<td>Arthropoda</td>
<td>Ostracoda (Crustacea)</td>
<td>rare</td>
</tr>
<tr>
<td>Chordata</td>
<td>Conodonta</td>
<td>common</td>
</tr>
<tr>
<td>Undetermined</td>
<td>large tubes</td>
<td>common</td>
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</table>

Constituents of the William Lake biota. Based on the hundreds of specimens examined so far, this biota is dominated numerically by linguloid brachiopods, but arthropods are probably the most diverse phylum. Most fossils from the site are currently identified only to higher-level group.
The Cat Head, Airport Cove, and William Lake sites each provide unique information about Early Paleozoic communities and biodiversity. Each represents a combination of conditions and biota unknown elsewhere in Laurentia.

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REFERENCES

10. Young, G.A., R.J. Elias, S. Wong, and E.P. Dobrzanski. 2003. Upper Ordovician Linguloids at William Lake are most common in horizons that exhibit horizontal burrows and degraded pyrite. These layers may have accumulated during times of reduced sedimentation.