10 mm

The fossil alga (seaweed) *Winnipegia cuneata* from Cat Head

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

Unmineralized eurypterid cuticle from Airport Cove

1 mm

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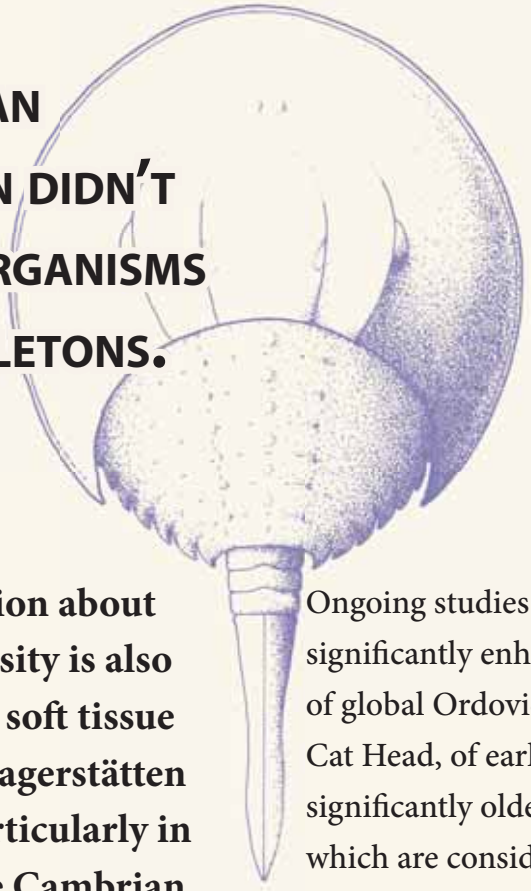
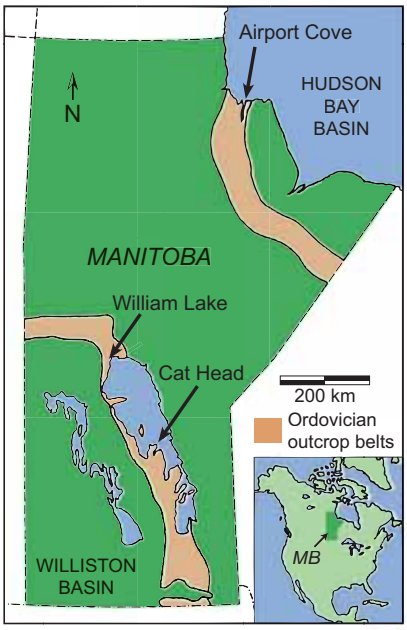
The Ordovician diversification didn't only affect organisms with hard skeletons.



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.

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.

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.

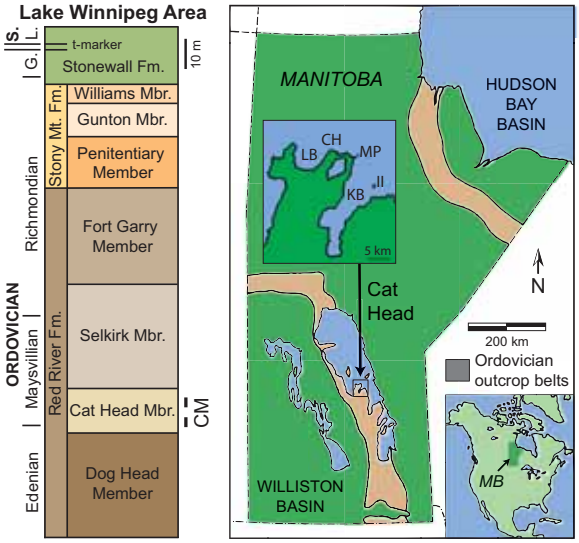


Lagerstätten occur in Ordovician outcrop belts along the northeastern margin of the Williston Basin (Cat Head and William Lake) and southeastern margin of the Hudson Bay Basin (Airport Cove).

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.

Cat Head

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).[1] 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.



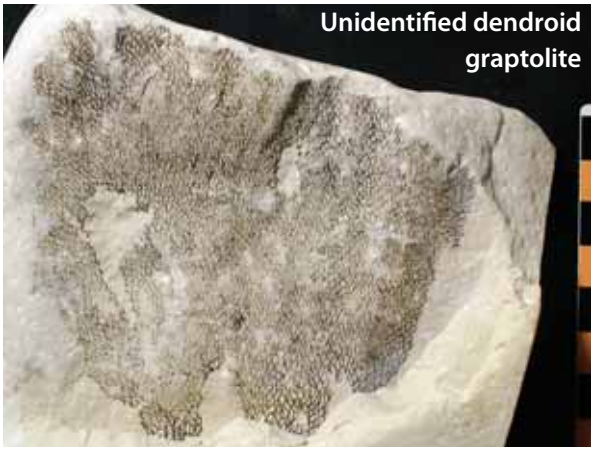
Strata in the Cat Head-McBeth Point area (CM), within the Cat Head Member of the Red River Formation, are exposed between Lynx Bay (LB) and Inmost Island (II), including at Cat Head (CH) and McBeth Point (MP). G = Gamachian; L. = Llandovery; KB = Kinwow Bay.[2,3]

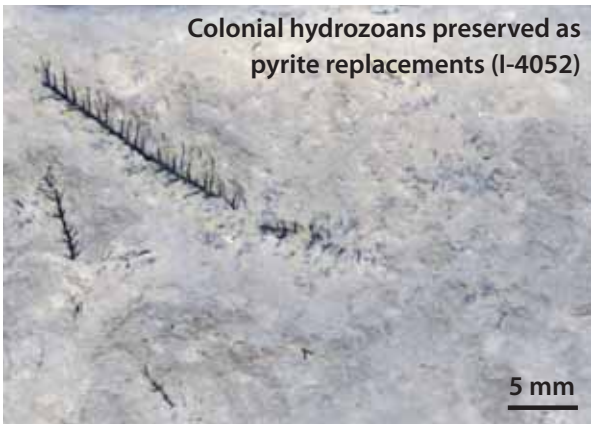
In addition to unusual fossils, the Cat Head biota includes normal marine elements such as these *Tetraphalerella neglecta*. Note the white chert; chert in a great range of colours is characteristic of many of the beds in the Cat Head Member.

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.

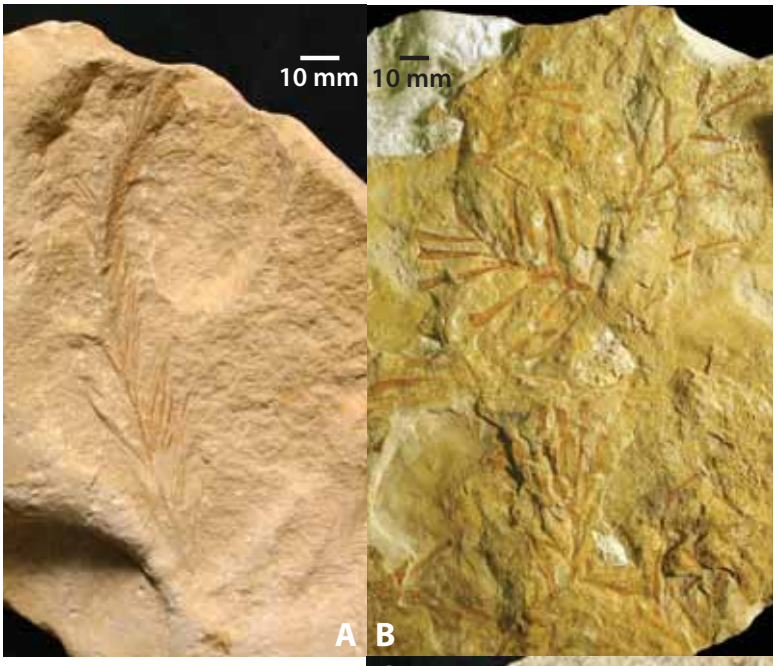
Cat Head Fossils

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.

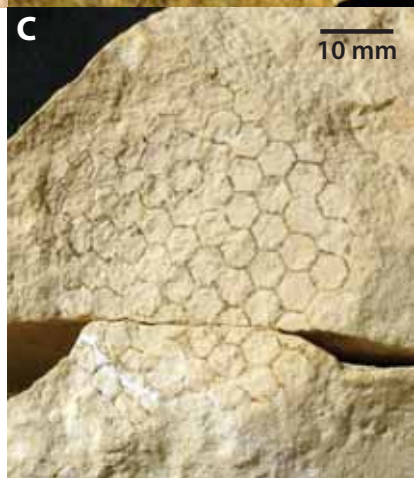

Unidentified dendroid graptolite



Colonial hydrozoans preserved as pyrite replacements (I-4052)



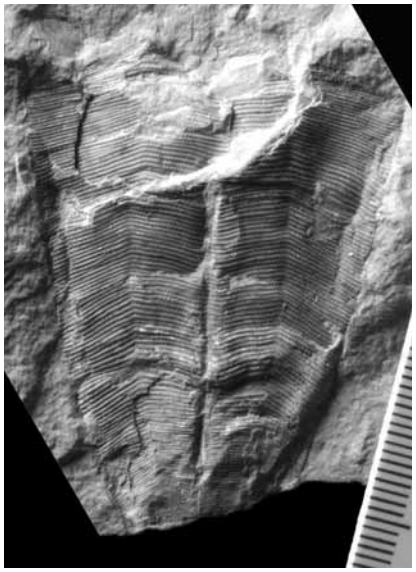
Soft algae at Cat Head are among the best anywhere in the Early Paleozoic.[1] A, *Dowlingia* (The Manitoba Museum, TMM B-224). B, probable heterokontophyte *Winnipegia cuneata* (B-241). C, Probable chlorophyte *Amia hexagona* (B-230).



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

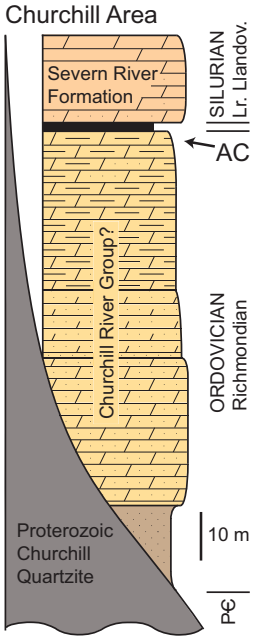
Articulated trilobites are common in the Cat Head area. This is *Isotelus* sp. (I-229).

The Cat Head area contains a great diversity of conulariids, including this *Conularia* sp. (I-1629).[4]

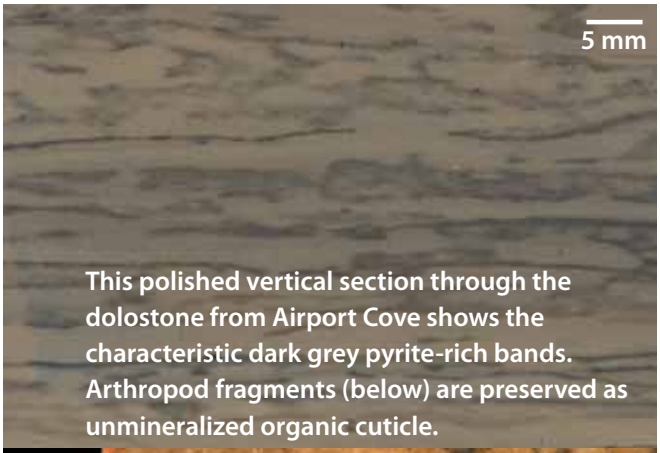


Airport Cove

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]



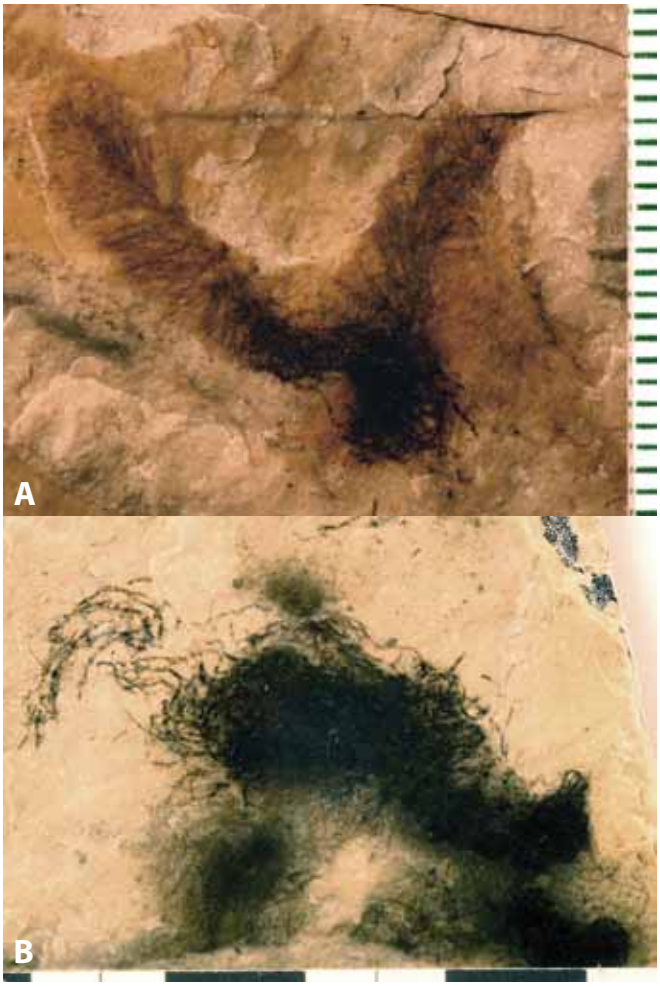
This polished vertical section through the dolostone from Airport Cove shows the characteristic dark grey pyrite-rich bands. Arthropod fragments (below) are preserved as unmineralized organic cuticle.

Typical summer collecting conditions at Airport Cove: Norman Aime (foreground) splits rock, while Ed Dobrzanski (with shotgun) watches for polar bears.

Airport Cove Fossils

Macrofossils at Airport Cove are preserved with pyrite, as carbonate, and as organic matter.[5] Eurypterid sclerites are commonly disarticulated or broken, but organic cuticle retains exceptional detail.

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



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

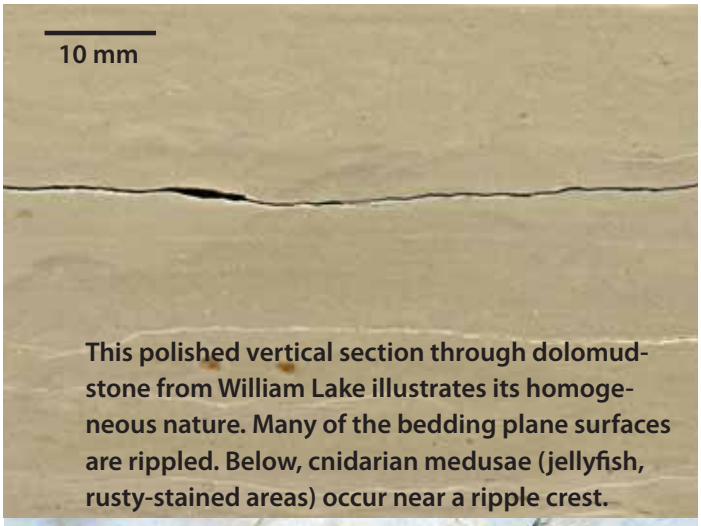
Articulated scolecodont apparatus (jaws of a polychaete, I-4062)

The holotype of the horseshoe crab *Lunataspis aurora* (I-4000A) is remarkably preserved, with unmineralized cuticle.[8]

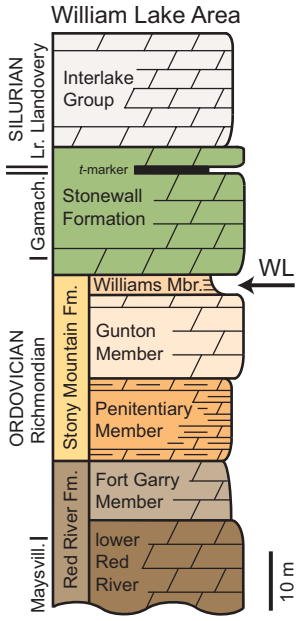
Prosoma and anterior preabdomen of a juvenile eurypterid (MM I-4064A)

William Lake

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]



This polished vertical section through dolomudstone from William Lake illustrates its homogeneous nature. Many of the bedding plane surfaces are rippled. Below, cnidarian medusae (jellyfish, rusty-stained areas) occur near a ripple crest.

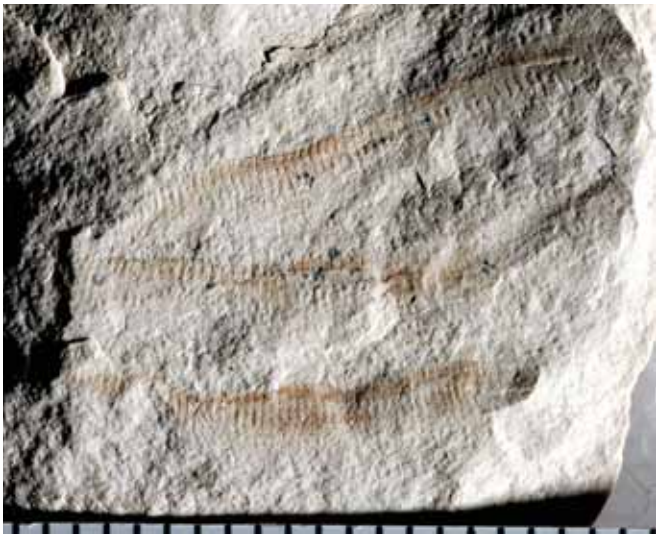


The beds containing unusual fossils at William Lake (WL, arrowed) are within the Williams Member of the Stony Mountain Formation. Maysvill. = Maysvillian; Gamach. = Gamachian; Lr. = Lower.[3,9]

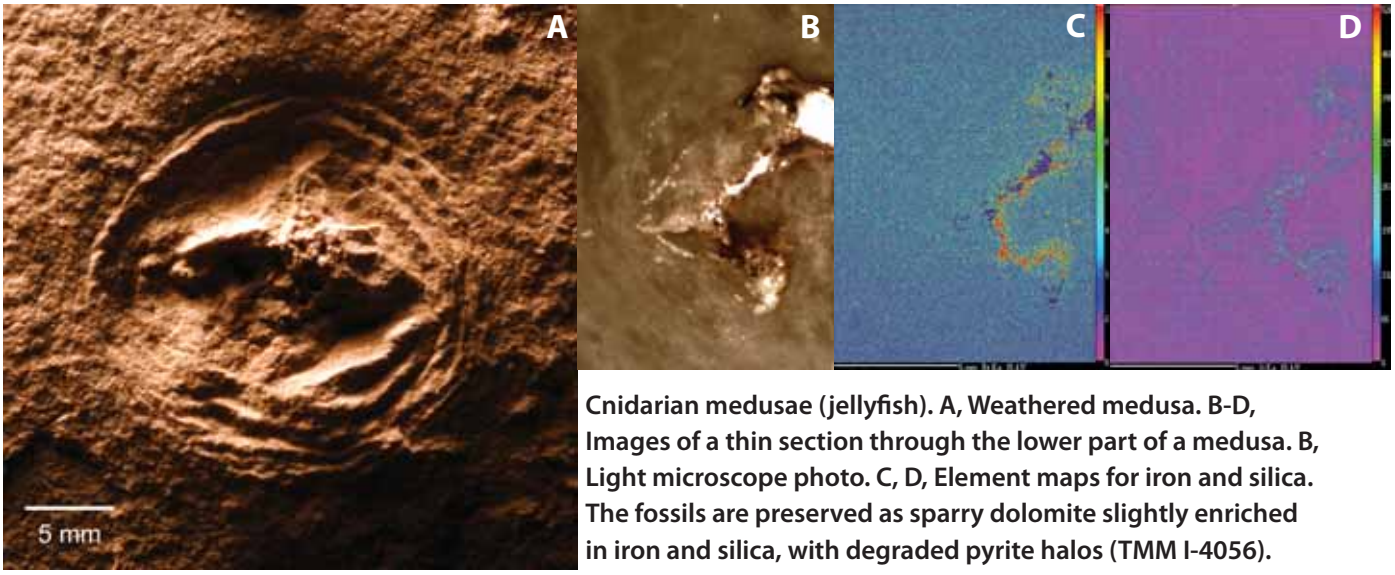
Collecting at the William Lake site in summer, 2007. Sean Robson, Graham Young, and Debbie Thompson remove rubble and soil from a bedding plane surface.

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).



Cnidarian medusae (jellyfish). A, Weathered medusa. B-D, Images of a thin section through the lower part of a medusa. B, Light microscope photo. C, D, Element maps for iron and silica. The fossils are preserved as sparry dolomite slightly enriched in iron and silica, with degraded pyrite halos (TMM I-4056).

***Lunataspis aurora*, juvenile**

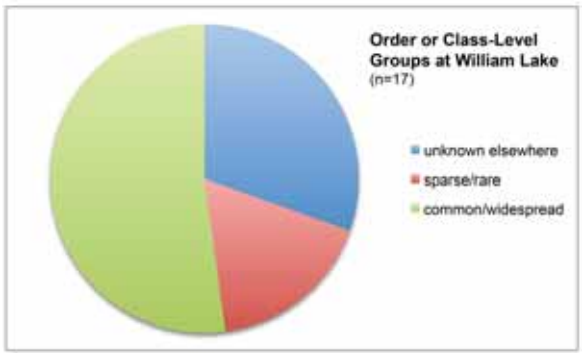
Eurypterids were preserved as organic cuticle, but much has been removed by weathering (new genus, new species; TMM I-4308).[11]

Significance

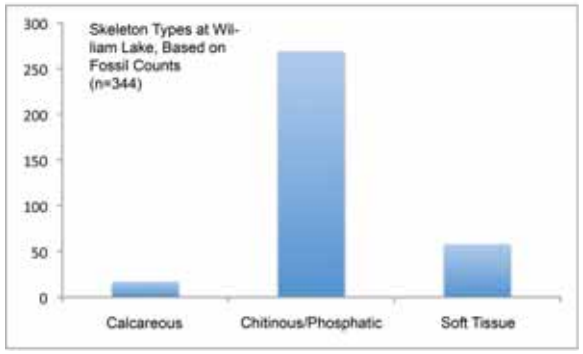
Many of the fossils found at these three sites are very different from those at other Ordovician sites, in Laurentia and globally. They provide essential diversity information, supplying evidence of taxonomic groups that would otherwise be unknown. We are most actively studying the William Lake biota, 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.

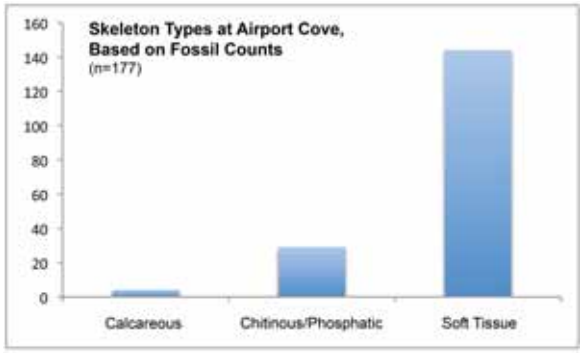
Phylum	Group	Relative Abundance
Cnidaria	cnidarian medusae	common
Cnidaria?	Porpitidae? (chondrophores)	rare
Brachiopoda	Lingulida	abundant
Brachiopoda	Rhynchonellata	rare
Brachiopoda	Strophomenata	rare
Mollusca	Gastropoda	rare
Mollusca	Nuculoida (Bivalvia)	rare
Mollusca	Nautiloidea	rare
Ctenophora?	ctenophores? (comb jellies)	rare
Arthropoda	Xiphosurida (*Lunataspis*)	rare
Arthropoda	Eurypterida	common
Arthropoda	Pycnogonida	very rare
Arthropoda?	Notostraca? (Crustacea)	rare
Arthropoda	Ostracoda (Crustacea)	rare
Chordata	Conodonta	common
undetermined	large tubes	common

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.

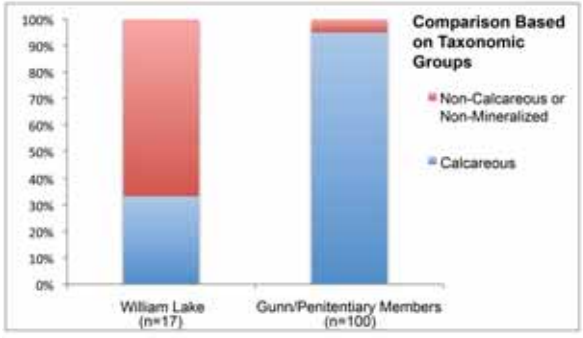


Many of the taxa found at William Lake are unknown elsewhere in the Ordovician of Laurentia. Several are globally unique.





In the William Lake and Airport Cove biotas, few of the fossils possess the calcareous skeletons typical of Ordovician shallow marine deposits. The graph below compares William Lake with the Ordovician biotas at Stony Mountain.[12]



Acknowledgments

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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.

This enhanced-contrast flatbed scan of a bedding plane surface from William Lake shows cnidarian medusae (jellyfish; arrowed) belonging to two distinct taxa.

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.

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