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Late Ordovician jaw-bearing polychaetes from Anticosti
Island, eastern Canada, and their biogeographic significance

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Abstract

The Upper Ordovician to Lower Silurian shallow marine succession of Anticosti Island, eastern Canada, provides one of the most complete records across the Hirnantian in the world. This study reports a diverse assemblage of scolecodonts (polychaete jaws) from the upper Katian and Hirnantian Vauréal, Ellis Bay and basal Becscie formations of western Anticosti. The collection of ten samples includes ca. 30 species representing 10 families. The fauna is dominated by polychaetaspids, mochttyellids, paulinitids and polychaeturids. The family Xanioprionidae and genera *Pistoprion*, *Tetraprion* and *Rakvereprion* are documented for the first time from the Ordovician of Laurentia. The Anticosti polychaete fauna shows great similarity to the contemporaneous faunas of Baltoscandia. This is evidenced by a high relative abundance of mochttyellids and polychaeturids and a number of common species, thus suggesting that the closing Iapetus Ocean at that time did not constitute a barrier for the dispersal of jaw bearing polychaetes. Some Laurentian influence is, however, indicated by the occurrence of hadoprionids. Distinct Katian Vauréal and Hirnantian Ellis Bay scolecodonts are likely reflecting faunal reorganization linked to local environmental changes rather than the initial phase of the Hirnantian mass extinction.

Key words: scolecodonts, jawed polychaetes, Ordovician, Anticosti, paleobiogeography.

Introduction

The richly fossiliferous Upper Ordovician to Lower Silurian succession of Anticosti Island, eastern Canada, is long known as one of the most complete records spanning the Ordovician-Silurian in the world. It contains key sections to document and decipher the environmental and biotic changes of the Hirnantian glaciation and mass extinction (Copper 2001; Delabroye et al. 2011a; Copper et al. 2013; Copper and Jin 2014; Ghienne et al. 2014). The Anticosti strata have been studied for various groups of shelly fossils, stratigraphy and sedimentology since the early 20th century (Schuchert and Twenhofel 1910). Data on microfossils started to emerge somewhat later, with recent years giving a number of contributions on chitinozoans (Achab et al. 2013), acritarchs and cryptospores (Vecoli et al. 2011; Delabroye et al. 2011a). The scolecodonts (polychaete jaws), common organic-walled microfossils in Paleozoic rocks, have remained virtually unknown from Anticosti, apart from few notes (Bertrand and Héroux 1987; Petryk 1987) and a single systematic paper (Courtinat and Racheboeuf 1997). In the latter study, a small collection from the Upper Ordovician Vauréal Formation was described using the obsolete single-element-based classification (as opposed to natural multi-element-based taxonomy; see Eriksson et al., 2000 for review). In spite of its limited scope, the study (Courtinat and Racheboeuf 1997) suggests that the Anticosti succession should yield diverse well preserved scolecodont assemblages.

Several recent papers have described Late Ordovician polychaete faunas of Baltoscandia (Hints 2000; Hints and Eriksson 2007, 2010; Eriksson and Hints 2009; Hints et al. 2010; Eriksson and Frisk 2011), Laurentian mid-continent (Eriksson and Bergman 1998, 2003; Eriksson et al. 2005), and Gondwanan areas (Hints et al. 2015). These studies have helped to shed new light on the paleobiogeographical patterns as well as biodiversification history of early Paleozoic jaw-bearing

polychaetes (Hints and Eriksson 2007; Eriksson et al. 2013). They also highlighted gaps in the data currently available. Moreover, the ongoing studies on polychaete faunas across the end Ordovician mass extinction in Baltoscandia and elsewhere (by OH and PT) stress the need to initiate similar work in other key regions, using appropriate methods and multi-element-based taxonomy. This approach should allow a better understanding of distribution patterns and increase the usefulness of scolecodonts in stratigraphy, paleogeography and environmental interpretations.

For the present study, we analyzed a set of relatively small samples from the upper Vauréal, Ellis Bay and basal Becscie formations, spanning the late Katian and Hirnantian interval. Our aims are to: (1) document the taxonomic composition of the fauna and contribute to the understanding of paleobiogeographical patterns of jawed polychaetes, (2) reveal any temporal changes in polychaete communities in link with the Hirnantian mass extinction; (3) assess most suitable habitats for jawed polychaete faunas, and (4) spot the best lithologies and stratigraphic levels for scolecodont studies.

Geological settings and stratigraphy

During the Late Ordovician, Anticosti Island was on the eastern margin of Laurentia and located 20–30° southern paleolatitudes (Torsvik and Cocks 2013). The Upper Ordovician to Lower Silurian succession exposed on the island consists mostly of sediments formed on a carbonate ramp in a shallow epeiric sea (Sami and Desrochers 1992). Facies changes across the island are distinct: the central and western sections consist of offshore storm-dominated carbonate facies, whereas the eastern sections are made up of mixed storm-dominated siliciclastic–carbonate facies

typical of a proximal shore environment (Desrochers et al. 2010). The succession did not record the major Taconian compression present in the nearby Appalachians, thus the Anticosti strata are thermally and tectonically unaltered (Bertrand and Héroux 1987; Bordet et al. 2010).

The original stratigraphic framework (Schuchert and Twenhofel 1910; Twenhofel 1928), was recently modified and enhanced (Desrochers et al. 2010, Copper et al. 2013, Copper and Jin 2014 and references therein). The Upper Ordovician to Lower Silurian succession of the western Anticosti is represented by the upper Vauréal, Ellis Bay and basal Becscie formations.

Subdividing these formations into members have recently been resolved at the regional scale (Achab et al. 2013). We follow here the usage of Desrochers et al. (2010) and Copper et al. (2013). An ongoing debate is the correlation of the Ellis Bay Formation with other sections, particularly in Baltoscandia (Delabroye and Vecoli 2010). Several studies have recently proposed that the entire ~90 m thick Ellis Bay Formation in western Anticosti is of Hirnantian age (Desrochers et al. 2010; Achab et al. 2011, 2013; Copper et al. 2013; Melchin et al. 2013; Copper and Jin 2014; Ghienne et al. 2014). On the other hand, a contrasting interpretation based largely on chemostratigraphic data suggests that only the upper part of the Ellis Bay Formation, the topmost Lousy Cove and Laframboise members, correspond to the Hirnantian Stage (Kaljo et al. 2008; Jones et al. 2011; Bergström et al. 2014, 2015). In either case, the sampled interval of the present study corresponds to the latest Katian and Hirnantian (the topmost sample analyzed lying below the base of the Silurian (Desrochers et al. 2010; Achab et al. 2013).

Materials and methods

For the present study, ten samples were collected by AD from the Anse aux Fraises to Pointe Laframboise in the western part of Anticosti Island (Fig. 1). A comprehensive lithological description of these localities is available in Desrochers et al. (2010).

The samples, 80–270 g in weight, were dissolved in ca. 7% acetic acid. The insoluble residues were gently washed through 45 micron sieve and microfossils were hand-picked from water by a glass pipette to be stored in glycerin. Selected specimens were imaged using a Zeiss Evo MA15 scanning electron microscope. The abundance of each taxon was derived from the count of the most abundant diagnostic elements in the sample (usually either left or right posterior maxilla, but others have used the count of all posterior maxillae giving a ca. 1.5 times larger number). The descriptive terminology and naming of apparatus elements follow Kielan-Jaworowska (1966). The specimens are deposited at the Institute of Geology, Tallinn University of Technology, under a collection number GIT 714.

Results

Abundance, diversity and taxonomic composition

All but one samples from the Laframboise Member in the uppermost Ellis Bay Formation, were productive for scolecodonts. The maximum abundance reached nearly 800 specimens per kg (Fig. 2; corresponding to ca. 1300 posterior maxillae per kg), being comparable with latest Ordovician samples of Baltoscandia (Hints et al. 2010). The entire collection contains 304 posterior maxillae that are diagnostic at least to the genus level. Taking into account the simple

teeth and fragmented specimens, the overall number of scolecodonts extracted was about 500.

The preservation of the material is good to excellent with numerous three-dimensional jaws, but fractured and pyritized specimens are also present. A few partial jaw apparatuses were found. At present, the collection is not large enough to confidently reconstruct the jaw apparatuses of all species and assess their range of morphological variability. Thus several forms discussed below and shown on Fig. 3 are referred to using an open nomenclature.

The entire collection contains nearly 30 species representing 16 genera and 10 families (Fig. 2).

In the richest sample, 13 species are recorded, which is less than productive Katian to Rhuddanian samples of Baltoscandia. This difference is largely attributable to relatively small sample size of the Anticosti samples. Only three Anticosti samples are sufficiently large to discuss the scolecodont diversity and assemblage structure. The latest Ordovician polychaete faunas of Anticosti are mainly composed of polychaetaspids, mochttyellids and paulinitids. This is characteristic of Ordovician and Silurian assemblages worldwide (Hints and Eriksson 2007; Eriksson et al. 2013). In two Anticosti samples, polychaeturids and xanioprionids are also common, but all other families are representing a minor portion of the scolecodont assemblage. Taxa with placognath and ctenognath type jaw apparatuses (mochttyellids, xanioprionids, tetraptionids) are relatively abundant, reaching up to 20% in the Vauréal Formation and 35% in the Ellis Bay Formation. This contrasts with previously reported Late Ordovician polychaete faunas of Laurentia, where ctenognath-placognath taxa are less abundant (Hints and Eriksson 2007). In contemporaneous Baltic faunas however, ctenognath-placognath taxa account for nearly 50% of specimens (Eriksson and Hints 2009).

Remarks on selected taxa

Mochtyellidae. In Anticosti samples, the mochttyellids are represented by at least four genera: *Mochtyella*, *Pistoprion*, *Vistulella*, and *Rakvereprion*. Additionally a few specimens belonging to the enigmatic *Lunoprionella* and to a similar yet undescribed genus, have been recorded. All these genera are also common in Baltoscandia. The genus *Mochtyella* is represented by at least five different species: *M. cf. trapezoidea* (Fig. 3C), *M. cf. duplicidentata* (Fig. 3D), *M. cf. cristata*, *M. ex gr. polonica* and *M. ex gr. fragilis*. Additionally several mochttyellid jaws are assigned to *Mochtyella* spp. as the left compound maxillae often lack good diagnostic features. Stratigraphically *M. cf. trapezoidea* is restricted to the Vauréal Formation, whereas other species are common in the Ellis Bay Formation. This pattern shows local ranges likely related to different environmental preferences, possibly transition from warm-water to cool-water conditions. *Pistoprion transitans* (Fig. 3G, H) occurs through the Ellis Bay and basal Becscie formations, occasionally accounting for ca. 30% of the assemblage. The present find is the first record of intercontinental distribution of this species. Another, yet undescribed, species of *Pistoprion* is restricted to the Silurian and has previously been documented from different regions including Baltica, Canadian arctic and Perunica (Hints and Eriksson 2007; Tonarová et al. 2012, 2014). *P. transitans* is common in the Baltic Upper Ordovician strata (Hints 1998, 2000; Eriksson and Hints 2009) and spans into the lower Silurian. It may be one of predominating taxa in both latest Katian as well as Hirnantian strata, with maximum relative abundance over 70% recorded in the Kuldiga Formation (Hints et al. 2010). Notably, *Pistoprion* is regarded to be an environmentally sensitive genus restricted to relatively shallow shelf settings (Hints 2000), which may limit its occurrence in Anticosti. *Vistulella cf. kozlowskii* (Fig. 3E, F) occurs sporadically through the Vauréal and Ellis Bay formations. It is another long-ranging taxon common in Baltica and

elsewhere. In addition to the above-mentioned genera the collection contains a single specimen of *Rakvereprion* cf. *balticus*, which is one of predominating taxa in Baltoscandian deeper shelf settings during the Katian Pirgu Regional Stage (Hints 2000, 2001).

Xanioprionidae. The family is represented by a single species, *Xanioprion* sp. A (Fig. 3I, J), characterized by differentiated MI and MII elements of sub-symmetrical placognath type jaw apparatus. It occurs in two samples of the Ellis Bay Formation, providing the first confident identification of the family Xanioprionidae in Laurentia. In the Baltic region very similar forms are recorded through the Upper Ordovician and lower Silurian strata (Hints 1998, 2000).

Tetraprionidae. *Tetraprion* cf. *pozaryskae* (Fig. 3A) was recovered from sample 410 in the Ellis Bay Formation. A similar and likely conspecific taxon is common in the Sandbian and Katian of Baltoscandia (Hints 1998), but has so far not been recorded from other regions. Another, yet undescribed species of tetraprionids (*Tetraprionidae* gen. et sp. nov., Fig. 3B) is more common on Anticosti, occurring in both Vauréal and Ellis Bay formations. The same species may be abundant in the Hirnantian strata of Baltoscandia (Hints 2001; Hints et al. 2010). Its full stratigraphic range is, however, extending from the Katian to at least the early Wenlock (Szaniawski 1970; Rubel et al. 2007). A similar taxon has been documented previously from the Late Ordovician of Laurentia (Eriksson and Bergman 2003) and Ludlow of Perunica (Tonarová et al. 2012).

Polychaetaspidae. The family is represented by at least five species assigned to the genus *Oenonites* (= *Polychaetaspis* according to Szaniawski and Drygant 2014) in the Anticosti samples. Most samples contain isolated jaws belonging to this genus, but lacking distinct features; these are referred to as *Oenonites* spp. (example on Fig. 3O). In the Ellis Bay Formation

two species of the genus are determined, the rare *Oenonites* sp. B and *Oenonites* aff. *wyszogrodensis* (Fig. 3K, L, Q). The latter taxon belongs to a group of very similar species that occur through Ordovician and Silurian strata worldwide. In the Vauréal Formation polychaetaspids are represented by at least three species. Maxillae of *Oenonites* sp. A, and a single jaw of *Oenonites* cf. *marlenediesae* (Fig. 3P) were recovered from sample 268. The latter species closely matches the material described from the type Cincinnati region (Eriksson and Bergman 2003), but the full identification requires the left MI and basal plate to be found. *Oenonites* aff. *latus* (Fig. 3M, N) occurs abundantly in sample 268. This species differs from the typical Baltic *O. latus* in having much longer shank on right MI and overall smaller size. Similar specimens have been previously documented from the Pirgu Regional Stage (upper Katian) of Baltoscandia (cf. Hints, 2000, pl. 1:21).

Polychaeturidae. *Pteropelta gladiata* (Fig. 3R–U) occurs most abundantly (up to 30% of scolecodonts) in the Vauréal Formation, but also spans through the Ellis Bay Formation. Previous records of polychaeturids from Laurentia are rare, limited to few specimens of *P. gladiata* from the upper Richmondian of Ohio (Hints and Eriksson 2010). This family occurs on other paleocontinents, but is thought to be one of the most characteristic features of the Baltic faunal province during the Ordovician (Hints and Eriksson 2010; Eriksson et al. 2013). This suggests a relatively close faunal link between Anticosti and Baltica. The Anticosti specimens are morphologically identical with those occurring in the Pirgu Regional Stage of Baltoscandia, where *P. gladiata* sometimes accounts for more than 20% of specimens in nearshore settings. Polychaeturids are, however rare in the Porkuni Regional Stage as well as in the Silurian in Baltoscandia (Hints and Eriksson 2010).

212 **Ramphoprionidae.** This family is most common in the Vauréal Formation, where *Ramphoprion*
213 cf. *ineptus* (sensu Eriksson and Bergman 2003) (Fig. 3V, W, Y) reaches over 12% of specimens
214 in sample 268. This taxon was reported from the Cincinnati region (Eriksson and Bergman
215 2003), but closely related taxa also occur in the Late Ordovician of Baltoscandia. In some
216 samples, ramphoprionid jaws are present, but not in sufficient number for complete apparatus
217 reconstructions, thus they are referred to as *Ramphoprion* sp. (Fig. 3X). A relatively high
218 percentage of ramphoprionids is generally characteristic of Laurentian and Gondwanan rather
219 than Baltic assemblages (Hints et al. 2015).

220 **Paulinitidae.** A single paulinitid genus *Kettnerites* (see the taxonomic discussion by Szaniawski
221 and Drygant 2014) is present in the Ellis Bay and basal Becscie formations. In sample 318, it
222 accounts for nearly 40% of specimens. Its absence in the Vauréal Formation is probably either
223 due to our small sample size or unfavorable environment, as paulinitid jaws have been collected
224 from the Vauréal Formation below the currently sampled interval (Courtinat and Racheboeuf
225 1997). Paulinitids are a typical component of Ordovician faunas in Laurentia and Gondwana. In
226 Baltica, they are rare until the Hirnantian and become abundant only in the Silurian (Eriksson et
227 al. 2013). At the species level, the identification of paulinitid jaws is difficult. Based on the most
228 diagnostic second maxillae (Bergman 1989), the Anticosti collection seems to hold two separate
229 species. *Kettnerites* sp. A (Fig. 3Z–AD) in the Ellis Bay Formation is characterized by single
230 cusp on the left MII and double cusp with intermediate denticle on the right MII. A different
231 species occurs in the Becscie Formation. Neither of these species seems to match the
232 stratigraphically closest Laurentian species *K. invisibilis* revised by Bergman (1991), *K.*
233 *sylvanensis* described by Eriksson et al. (2005), or the paulinitids collected from the Ordovician-
234 Silurian boundary interval of Baltoscandia (OH and PT unpublished data).

Hadoprionidae. This monotypic family is represented in the Anticosti collection by *Hadoprion cervicornis* (Fig. 3AH, AI), a conspicuous and easy-to-identify taxon occurring in sample 318 from the Ellis Bay Formation. *H. cervicornis* was first described from the Cincinnatian of Toronto (Hinde 1879), and later thoroughly revised and discussed based on large collections from the Cincinnati region (Eriksson and Bergman 1998, 2003). The same species has been recently recorded from the Silurian (but not Ordovician) of Baltoscandia. Thus, Eriksson et al. (2013) considered hadoprionids as rare, but typical element of Laurentian polychaete faunas of the Ordovician Period.

Kalloprionidae and Atraktoprionidae. These families are represented by only a few specimens attributed to the geographically and stratigraphically widespread genera *Kalloprion* (Fig. 3AE), *Leptoprion* and *Atraktoprion* (Fig. 3AF, AG). Additional material is necessary for comparison.

Discussion and conclusions

Paleobiogeographic affinities

Katian polychaete faunas are well known from Baltoscandia (Hints 2000; Eriksson and Hints 2009; Hints and Eriksson 2010), the type Cincinnati area of Laurentia (Eriksson and Bergman 2003; Eriksson et al. 2005) and to some extent Gondwana (Hints et al. 2015). The latter authors studying scolecodonts from the Arabian Peninsula proposed that Gondwanan and Laurentian polychaete faunas were more similar to each other than to Baltica, based on high proportion of paulinitids, ramphoprionids and polychaetaspids, and relative scarcity of placognath forms in both regions. The late Katian polychaete fauna from Anticosti, however, shows Baltic rather than

mid-continent Laurentian affinity. In particular, this is suggested by a number of common species and high abundance of polychaeturids and mochttyellids (Fig. 4) that is considered characteristic of Baltic Late Ordovician faunas (Hints and Eriksson 2007; Eriksson et al. 2013). Still, Laurentian elements are also present in the Vauréal assemblage, notably *Oenonites* cf. *marlenediesae* and the occurrence of paulitinids as reported by Courtinat and Racheboeuf (1997).

The Hirnantian scolecodonts are less known globally, with the main collections coming from Baltoscandia (Hints 1999, 2001, Hints et al. 2010; OH and PT unpublished data), complemented by a brief report from South Africa, Gondwana (Whittle et al. 2008). The Anticosti jawed polychaete assemblage from the Ellis Bay Formation is strikingly similar to the fauna described from the Kuldiga Formation of Estonia and Latvia (Hints 2001; Hints et al. 2010). This is especially apparent at the genus- or family-level assemblage structure (Fig. 4), in addition to a number of common species, most importantly *Pistoprion transitans*. The fact that several Baltic taxa typical of, or restricted to the Hirnantian have not been identified in the Anticosti samples may be explained by the small size of the collection. Alternatively this may be due to restricted biogeographic distribution of these taxa or misinterpreted correlations. The Laurentian influence on the Ellis Bay assemblage is suggested by the occurrence of *Hadoprion cervicornis*, unknown from the Hirnantian of Baltoscandia, and possibly from the higher proportion of paulinitids.

The similarity between the Anticosti and Baltoscandia polychaete faunas may either reflect a close biogeographic link between the two basins or a globally distributed Hirnantian polychaete fauna, much like the *Hirnantia* Fauna; this remains to be tested. New data from other continents is vital to resolve this question. The closing of the Iapetus Ocean, however, did not constitute a barrier for the dispersal of jaw bearing polychaete worms since relatively similar faunas were

present on both sides of that ocean (e.g. Laurentia and Baltica) during the latest Ordovician. A close biogeographic link between Anticosti and Baltoscandian Basin has also been documented for acritarchs and cryptospores (Delabroye et al. 2011b; Vecoli et al. 2011).

Stratigraphic distribution

Comparison between the scolecodont assemblages of the Vauréal and Ellis Bay formations shows some differences (Fig. 2); for instance, the occurrence of *Oenonites* aff. *latus* and *Mochtyella* cf. *trapezoidea* in the former, and the appearance of *Kettnerites* sp. A and *Pistoprion transitans* in the latter formation. It is well documented that near this boundary about two thirds of coral, stromatoporoid and brachiopod genera gradually disappear, which is interpreted as the first pulse of the Hirnantian mass extinction event on Anticosti (Copper et al. 2013). Microphytoplankton (acritarchs) show a step-wise turnover in the upper Vauréal and lower Ellis Bay formations, with few taxa becoming extinct, but many forms making their first appearance (Delabroye et al. 2011a).

Previous data on latest Ordovician and earliest Silurian scolecodonts show that few, if any, polychaete genera become extinct during the Hirnantian (Eriksson et al. 2013). Some species that contribute to the local turnover pattern on Anticosti succession are known to be long-ranging elsewhere. An example is *Pistoprion transitans* that spans from the Sandbian to Llandovery in Baltoscandia (Hints 2001; Hints et al. 2010). The changes between Vauréal and Ellis Bay scolecodonts may largely reflect assemblage reorganization linked to local environmental changes rather than extinction. With further sampling, some species (e.g., *Kettnerites* sp. A,

300 *Oenonites* aff. *latus*) should be tested whether they mark stratigraphic or environmental events
301 on Anticosti.

302 The scolecodonts reported in this study provide no conclusive evidence to add to the debate on
303 Anticosti–Baltoscandia correlation issues (Delabroye and Vecoli 2010). Overall the Ellis Bay
304 assemblage is very similar to that of the Porkuni Regional Stage (Kuldiga Formation), only
305 *Tetraprion* cf. *pozaryskae* would suggest Pirgu rather than Porkuni age.

306

307 **Paleoenvironmental notes**

308 The late Katian (Pirguan) scolecodonts from Estonia (Hints 2000) show a clear differentiation of
309 polychaete faunas along the paleobasin gradient, with the richest assemblages present in the
310 shallowest-water settings. Several long-ranging species were also identified as potential
311 environmental indicators. The Anticosti assemblages in both Vauréal and Ellis Bay formations
312 represent the typical shallow-shelf assemblage characterized by a relatively high diversity and
313 abundance, and by the occurrence of environmentally sensitive species such as *Pteropelta*
314 *gladiata* and *Pistoprion transitans*. The comparable Baltoscandian faunas are documented in the
315 Adila Formation (Katian) of northern and central Estonia, and in the Kuldiga Formation
316 (Hirnantian) of southern Estonia and Latvia, where shallow-water environments shifted during
317 the Hirnantian sea-level drawdown. This environmental similarity is corroborated with other
318 elements of the studied Anticosti microfossil assemblage; for instance, the occurrence of
319 *Blastammina*-type foraminiferans and relatively low abundance of chitinozoans in the richest
320 scolecodont samples.

321

Future study prospects

Scolecodont samples were too small in number and in size to allow a full taxonomic or quantitative study of the Anticosti polychaete faunas. Our study, however, documents good to excellent preservation, high abundance and diversity of scolecodonts in the Upper Ordovician strata, suggesting a clear potential for a thorough work in the future. Based on the scolecodont yield of our samples, we estimate that 0.5–1 kg samples should be used to recover most species and sufficient number of specimens for apparatus reconstructions. The most interesting stratigraphic intervals are the Vauréal–Ellis Bay boundary beds up to sample 318, the topmost part of the Lousy Cove Member, and the basal Silurian strata of the Becscie Formation. This should provide further insights into the paleobiogeographic distribution and extinction patterns of jaw-bearing polychaetes globally and add to the stratigraphic and paleoenvironmental usefulness of scolecodonts.

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Figure captions

Figure 1. Locality map showing the study area and distribution of the Vauréal, Ellis Bay and Becscie formations.

Figure 2. Stratigraphic background, sample positions and ranges of scolecodonts. Size of the circles denotes relative abundance. Note that some samples were too small to provide reliable taxon counts (member names in accordance with Copper et al. 2013).

Figure 3. SEM photos of selected scolecodonts. Scale bars 0.1 mm. C, F, M–N, P, R–W, Y and AE from the Vauréal Formation, all others from the Ellis Bay Formation. A, *Tetraprion* cf. *pozaryskae*, right MI, GIT 714-1, sample 410; B, Tetraprionidae gen. et sp. nov., right MI, GIT 714-2, sample 410; C, *Mochtyella* cf. *trapezoidea*, left MI, GIT 714-3, sample 246; D, *Mochtyella* cf. *duplicidentata*, right MI, GIT 714-4, sample 410; E, *Vistulella* cf. *kozlowskii*, right MIa, GIT 714-5, sample 410; F, *Vistulella* cf. *kozlowskii*, left MI, GIT 714-6, sample 246; G, *Pistoprion transitans*, left MI, GIT 714-7, sample 410; H, *Pistoprion transitans*, right MII, GIT 714-8, sample 410; I, *Xanioprion* sp. A, left MII, GIT 714-9, sample 410; J, *Xanioprion* sp. A, right MI, GIT 714-10, sample 410; K, *Oenonites* aff. *wyszogrodensis*, left MI, GIT 714-11, sample 318; L, *Oenonites* aff. *wyszogrodensis*, right MI, GIT 714-12, sample 318; M, *Oenonites* aff. *latus*, right MI with fused basal plate and additional teeth, GIT 714-13, sample 268; N, *Oenonites* aff. *latus*, right MI, GIT 714-14, sample 268; O, *Oenonites* sp., right MI, GIT 714-15, sample 410; P, *Oenonites* cf. *marlenediesae*, right MI, GIT 714-16, sample 268; Q, *Oenonites* aff. *wyszogrodensis*, basal plate, GIT 714-17, sample 410; R, *Pteropelta gladiata*, left MI, GIT 714-

510 18, sample 268; S, *Pteropelta gladiata*, left MI, GIT 714-19, sample 268; T, *Pteropelta gladiata*,
 511 right MI, GIT 714-20, sample 268; U, *Pteropelta gladiata*, right MI, GIT 714-21, sample 268; V,
 512 *Ramphoprion cf. ineptus*, basal plate, GIT 714-22, sample 268; W, *Ramphoprion cf. ineptus*,
 513 right MI, GIT 714-23, sample 268; X, *Ramphoprion* sp., left MII, GIT 714-24, sample 410; Y,
 514 *Ramphoprion cf. ineptus*, left MI, GIT 714-25, sample 268; Z, *Kettnerites* sp. A, left MI, GIT
 515 714-26, sample 318; AA, *Kettnerites* sp. A, left MII, GIT 714-27, sample 318; AB, *Kettnerites*
 516 sp. A, right MII, GIT 714-28, sample 318; AC, *Kettnerites* sp. A, right MII, GIT 714-29, sample
 517 318; AD, *Kettnerites* sp. A, right MI, GIT 714-30, sample 318; AE, *Kalloprion* sp., right MI, GIT
 518 714-31, sample 268; AF, *Atraktoprion* sp., right MI, GIT 714-32, sample 318; AG, *Atraktoprion*
 519 sp., left MI, GIT 714-33, sample 318; AH, *Hadoprion cervicornis*, left MI, GIT 714-34, sample
 520 318; AI, *Hadoprion cervicornis*, right MI, GIT 714-35, sample 318.

521

522 **Figure 4.** Pie-charts showing family-level composition of latest Ordovician polychaete faunas
 523 from Anticosti Island, and comparison with type Cincinnatian area and Baltoscandia
 524 assemblages. Type Cincinnatian area data are after Hints and Eriksson (2007), Orjaku core data
 525 showing lumped counts from two samples from the Adila Formation, Pirgu Regional Stage;
 526 Stirnas core data after Hints et al. (2010) lumping counts from 38 samples from the Kuldiga
 527 Formation, Porkuni Regional Stage. Placognatha division also includes tetraprionids with
 528 ctenognath apparatus architecture. Note that individual samples from all regions and intervals
 529 may show different patterns.

Figure 1. Locality map showing the study area and distribution of the Vauréal, Ellis Bay and Becscie formations.

44x23mm (300 x 300 DPI)

Figure 2. Stratigraphic background, sample positions and ranges of scolecodonts. Size of the circles denotes relative abundance. Note that some samples were too small to provide reliable taxon counts (member names in accordance with Copper et al. 2013).
194x166mm (300 x 300 DPI)

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268; T, *Pteropelta gladiata*, right MI, GIT 714-20, sample 268; U, *Pteropelta gladiata*, right MI, GIT 714-21, sample 268; V, *Ramphoprion* cf. *ineptus*, basal plate, GIT 714-22, sample 268; W, *Ramphoprion* cf. *ineptus*, right MI, GIT 714-23, sample 268; X, *Ramphoprion* sp., left MII, GIT 714-24, sample 410; Y, *Ramphoprion* cf. *ineptus*, left MI, GIT 714-25, sample 268; Z, *Kettnerites* sp. A, left MI, GIT 714-26, sample 318; AA, *Kettnerites* sp. A, left MII, GIT 714-27, sample 318; AB, *Kettnerites* sp. A, right MII, GIT 714-28, sample 318; AC, *Kettnerites* sp. A, right MII, GIT 714-29, sample 318; AD, *Kettnerites* sp. A, right MI, GIT 714-30, sample 318; AE, *Kalloprion* sp., right MI, GIT 714-31, sample 268; AF, *Atraktoprion* sp., right MI, GIT 714-32, sample 318; AG, *Atraktoprion* sp., left MI, GIT 714-33, sample 318; AH, *Hadoprion cervicornis*, left MI, GIT 714-34, sample 318; AI, *Hadoprion cervicornis*, right MI, GIT 714-35, sample 318.
236x308mm (300 x 300 DPI)

Draft

Figure 4. Pie-charts showing family-level composition of latest Ordovician polychaete faunas from Anticosti Island, and comparison with type Cincinnatian area and Baltoscandia assemblages. Type Cincinnatian area data are after Hints and Eriksson (2007), Orjaku core data showing lumped counts from two samples from the Adila Formation, Pirgu Regional Stage; Stirnas core data after Hints et al. (2010) lumping counts from 38 samples from the Kuldiga Formation, Porkuni Regional Stage. Placognatha division also includes tetraprionids with ctenognath apparatus architecture. Note that individual samples from all regions and intervals may show different patterns.

53x15mm (300 x 300 DPI)