

International Symposium on the Ediacaran–Cambrian Transition (ISECT) 2017

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Alex G. Liu^{1*}, Jack J. Matthews^{2,3}, Duncan McIlroy², Guy M. Narbonne⁴,
Ed Landing⁵, Latha R. Menon⁶, and Marc Laflamme⁷

¹ Department of Earth Sciences, University of Cambridge, Cambridge, CB2 3EQ, UK; *Corresponding author, E-mail: agscl2@cam.ac.uk

² Department of Earth Sciences, Memorial University of Newfoundland, A1C 3X5, NL, Canada

³ Oxford University Museum of Natural History, Oxford, OX1 3PW, UK

⁴ Department of Geological Sciences and Geological Engineering, Queen's University, K7L 3N6, Ontario, Canada

⁵ New York State Museum, Albany, NY 12230, USA

⁶ Department of Earth Sciences, University of Oxford, Oxford OX1 3AN, UK

⁷ Department of Chemical and Physical Sciences, University of Toronto Mississauga, L5L 1C6, Ontario, Canada

Research into the long-recognized ‘Cambrian Explosion’ of animal life (e.g., Lipps and Signor, 1992; Briggs, 2015) has, in recent decades, increasingly sought to resolve the interplay between evolutionary, geochemical and environmental changes that occurred over an extended Ediacaran to Cambrian transitional interval. This wider interval encompasses several significant geological events, including large-scale glaciations, supercontinental reorganization, global marine transgression, and perturbations in oxygen levels, other isotope proxies, and UV-B radiation (summarised in Narbonne et al., 2012; Meert et al., 2016). These events occurred contemporaneously with evolutionary developments including the radiation of macroscopic eukaryotes, the appearance of the extant animal phyla, the onset of burrowing and biological sediment processing, and the evolution of biomineralization (e.g., Kouchinsky et al., 2012; Mángano and Buatois, 2016; Cunningham et al., 2017). Biological and geological phenomena are widely considered to have been linked during the Ediacaran to Cambrian transition (e.g., Canfield et al., 2007; Sperling et al., 2013; Boyle et al., 2014; Herringshaw et al., 2017; Shields, 2017), and their interaction across this interval is an area of considerable scientific interest. Stratigraphic correlation and subdivision of Ediacaran and Cambrian sections worldwide has been identified as a key objective in order to better understand the co-evolution of the Earth and life systems, and in recent years there have been substantial advances in discussions relating to this challenge (Narbonne et al., 2012; Peng et al., 2012; Landing et al., 2013b; Babcock et al., 2014; Xiao et al., 2016).

The island of Newfoundland in eastern Canada possesses several exceptional sedimentary successions from the palaeocontinents of Laurentia and Avalonia (Fig. 1). These successions are of relevance to debates surrounding both Ediacaran and Cambrian stratigraphy, and include the GSSP sections for the base of both the Cambrian and Ordovician systems (Brasier et al., 1994; Cooper et al., 2001). In recent years, significant progress has been made in understanding many of these sections. The mid-Ediacaran Gaskiers glaciation (as defined in its type region of eastern Newfoundland) is both well documented and temporally constrained. Late Ediacaran macrofossil assemblages are present throughout eastern Newfoundland, and their palaeoecology, palaeobi-

ology, and relationships to other global fossil assemblages are becoming better understood (e.g., Narbonne, 2004; Darroch et al., 2013; Mitchell et al., 2015; Boag et al., 2016; Liu and Matthews, 2017). The gradual transition from matgrounds to mixgrounds is well documented, with the oldest known probable surface and vertical traces of locomotion (Liu et al., 2010; Menon et al., 2013), and then complex burrowing (McIlroy and Logan, 1999; Droser et al., 2002; Buatois et al., 2014), followed by the appearance of small shelly faunas and eventually trilobites elsewhere in the region (Landing et al., 1988, 2013b). Importantly the geochemistry, and often the geochronology, of these sections has been studied to enable their correlation with other sections globally (e.g., Myrow and Kaufman, 1999; Landing et al., 2013a; Pu et al., 2016). An international meeting in Newfoundland was proposed in order to visit and discuss these sections, building on the progress of recent field workshops in Morocco (Devaere et al., 2014), China (Xiao et al., 2014), South Australia (Palaeo Down Under 2, 2016) and Namibia (in conjunction with the 35th International Geological Congress; Xiao et al., 2017). A Newfoundland meeting was considered to be particularly timely given recent discussions on the distinguishing criteria and placement of the Ediacaran–Cambrian boundary (Landing et al., 2013b; Babcock et al., 2014; Geyer and Landing, 2017). Additionally, the year 2017 offered the opportunity to celebrate both the 50th anniversary of the discovery of Ediacaran macrofossils at Mistaken Point (Anderson and Misra, 1968), and the recent (July 2016) inscription of Mistaken Point Ecological Reserve (MPER) on the UNESCO World Heritage List (Thomas and Narbonne, 2016). This designation made MPER the first Precambrian fossil locality anywhere in the world to achieve this status on the basis of its palaeontological attributes.

Two field excursions were offered prior to the ISECT symposium. The first involved a 6-day trip (15–20th June 2017) to the west coast of Newfoundland to explore Cambrian to Ordovician stratigraphy, palaeontology and geochemistry. The field trip was designed and run by Svend Stouge, Gabriella Bagnoli and Duncan McIlroy, and was focused on the Laurentian margin. The trip specifically focused on the Humber Zone of the Appalachian Orogen, which includes multiple

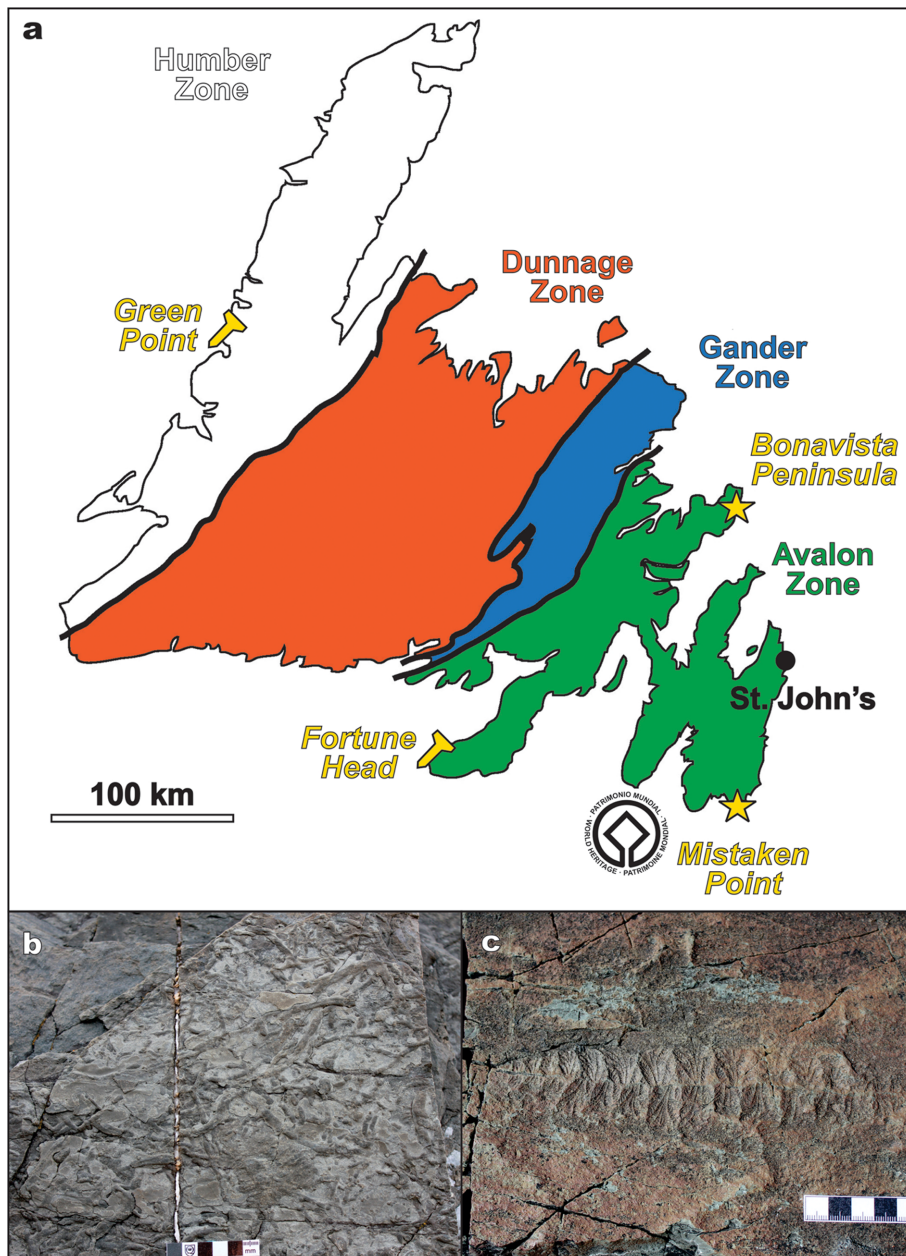


Figure 1. (a) Tectonic terranes of Newfoundland. The Avalon Zone was part of the micro-continent of Avalonia during the Ediacaran–Cambrian interval, whereas the Humber Zone was associated with Laurentia. Primary field localities visited by the ISECT field trips are indicated by either stars, or golden spikes (for GSSP sections at Green Point and Fortune Head). **(b)** A diverse ichnofossil assemblage from the Fortunian sections at Grand Bank Head. **(c)** *Fractofusus misrai*, an Ediacaran macrofossil from the ‘E’ Surface, Mistaken Point Ecological Reserve. Scale bar gradations = 1 mm.

sections spanning the Cambrian–Ordovician boundary interval in platform and base of slope settings. The GSSP at Green Point in Gros Morne National Park was visited, and encouraged lively discussion of the sedimentology of the beds containing the zonal index conodont *Iapetognathus fluctivagus* (Cooper et al., 2001).

The second pre-meeting trip was a 4-day excursion (17–20th June 2017) to view the middle Ediacaran (~582–560 Ma; Pu et al., 2016) geology and palaeobiology of the Avalon Peninsula, led by Alex Liu, Guy Narbonne, and Jack Matthews. The visited sections document a

broadly shallowing-upwards succession from deep-marine to fluvial facies, and included: the type section of the Gaskiers Formation and an associated cap carbonate horizon at Harbour Main; Ediacaran macrofossil assemblages of the Conception and St. John’s Groups at St. Shott’s and Mistaken Point Ecological Reserve; and the gradual shallowing of the sequence into marginal and fluvial deposits of the Signal Hill Group at Ferryland. Participants discussed the palaeoenvironmental interpretation of the sections; the utility of the Gaskiers event as a means to subdivide the Ediacaran System; the duration and severity of the Gaskiers event; and the palaeobiology of the earliest assemblages of the Ediacaran macrobiota, in light of recent palaeoecological, morphological, taphonomic and phylogenetic studies (e.g., Mitchell et al., 2015; Liu, 2016; Dececcchi et al., 2017; Dufour and McIlroy, 2017; Kenchington and Wilby, 2017). This trip also highlighted newly discovered fossil-bearing surfaces and surface textures.

The symposium itself took place at Memorial University of Newfoundland, St. John’s, from 20th–22nd June 2017, and consisted of 64 oral presentations, 70 poster presentations, and a public keynote lecture by Prof. Andrew Knoll. On the 21st June, voting members and corresponding members of the Cambrian Subcommittee held a meeting to discuss the progress of the various ICS Working Groups active in Cambrian stratigraphy. The Ediacaran Subcommittee held a meeting on the 22nd June, involving 12 voting members and 32 corresponding members, to discuss strategies to divide the Ediacaran System, with a particular focus on the boundaries for proposed Second and Terminal Ediacaran stages. ISECT 2017 also marked the beginning of formal activities to subdivide the Ediacaran System into series-level divisions. Further details of these meetings will be communicated to the respective subcommittees as part of their annual newsletters/reports.

Awards for the best student poster and best student presentation were sponsored by the International Subcommittee on Ediacaran Stratigraphy (ISES), and were awarded to Felicity Coutts of the University of Adelaide for her poster entitled “Growth and development of the Ediacaran fossil *Parvancorina* from the Flinders Ranges of South Australia”, and to Frankie Dunn of the University of Bristol for her talk entitled “The chronicles of *Charnia*: morphology and morphogenesis in an iconic Ediacaran taxon”. A selection of presentations from the meeting was recorded, and is available to watch online at www.palaeocast.com/isect/.

Following the ISECT meeting, further field excursions departed to explore the Ediacaran successions of the Bonavista Peninsula (23rd–26th June), and the Ediacaran–Cambrian of the Burin, Bonavista and Avalon peninsulas (23rd–29th June). The Bonavista trip (led by Alex Liu, Jack Matthews and Duncan McIlroy) was the first major international fieldtrip to the Trinity Facies diamictite (a probable Gaskiers equivalent; Normore, 2011; Pu et al., 2016), the Ediacaran macrofossils and marine strata of the Catalina Dome (cf. Hofmann et al., 2008), and shallow marine to terrestrial late Ediacaran facies of the Musgravetown Group. Discussions revolved around new radiometric dates for these sections; their correlation to other Ediacaran sections in Newfoundland; and the palaeoecology of frondose Ediacaran macrofossils.

The Burin–Avalon–Bonavista peninsulas trip (leaders Ed Landing, Paul Myrow and Guy Narbonne, with Luis Buatois, Gabriela Mángano, Brittany Laing, Romain Gougeon and Alan Jay Kaufman) provided two middle-Ediacaran-age stops that showcased deep-water biotas of the Avalonian fauna near Spaniard's Bay, before emphasizing the unconformably overlying terminal Ediacaran–Cambrian, siliciclastic-dominated shelf successions on the Avalonia palaeocontinent. Epeirogenic (trans-tensional) activity that defined elongate (NNE-trending) syndepositional basins and uplifts in Avalonia were illustrated by successions in the Burin and Avalon peninsulas—with particular emphasis given over several days to the basal Cambrian GSSP section and lowest Cambrian (Terreneuvian Series) sequences on the Burin Peninsula. The latter successions show the diversification of metazoan burrowing organisms, and feature representative successions of the oldest known Cambrian biomineralized organisms

(“*Ladatheca*” *cylindrica* and overlying *Watsonella crosbyi* zones). A number of volcanic ashes that have been dated or are under study in the lowest Cambrian—traditional middle Cambrian were shown to comprise important geochronologic brackets through the fossiliferous Avalonian Cambrian. The trip emphasized the stratigraphic and biostratigraphic evidence indicating that temperate-latitude Avalonia was latitudinally and biotically distinct from tropical West Gondwana by the terminal Ediacaran (e.g., Landing et al., 2013a, b). A PDF of this field trip guide (165 p., 49 fig.) has appeared as Geological Survey of Newfoundland and Labrador Open File NFLD/3323 and complements Landing and Westrop (1998).

Since the pre-conference fieldtrip to the Ediacaran of the Avalon Peninsula was quickly over-subscribed, the organizing committee offered an additional one-day field trip to the Mistaken Point Ecological Reserve – focused on the palaeontology of the iconic ‘D’ and ‘E’ surfaces, the trace fossil bed, and the juvenile fronds of Pigeon Cove – on 23rd June.

The ISECT meeting and field excursions provided participants with opportunities to visit multiple key sections of interest to the subdivision and correlation of the Ediacaran and Cambrian systems, and offered a forum for the sharing and discussion of palaeobiological, geochemical and geochronological data pertaining to these intervals. 141 delegates attended the meeting or participated in at least one field excursion (Figs. 2 and 3). The ISECT meeting was sponsored by Memorial University of Newfoundland, the ISES, and the Geological Survey of Newfoundland and Labrador. The organizing committee consisted of Alex Liu (Chair), Duncan McIlroy, Jack Matthews, Latha Menon, Marc Laflamme, Ed Landing and Guy Narbonne.



Figure 2. Participants on the Avalon Peninsula pre-meeting field excursion, visiting the Mistaken Point Ecological Reserve World Heritage Site. Standing from left: Ben Yang, Robert Taerum, Hao Yun, Luoyang Li, Wendy Taylor, Breandán MacGabhann, Malgorzata Moczyłowska, Ilya Bobrovskiy, Andrew Knoll, Michael Streng, Ulf Linneman, Emma Arvestål, Jochen Brocks, Chris Caran, Rachel Wood. Seated from left: Dongjing Fu, Tao Dai, Wei Liu, Jian Han, Pengju Liu, Jennifer Hoyal Cuthill, Olaf Elicki, Sebastian Willman, Alex Liu, Diego García-Bellido, Kathleen Taerum, Frankie Dunn, Katie Maloney, Jack Matthews, Guy Narbonne.



Figure 3. Participants on the Burin–Avalon–Bonavista Peninsula post-meeting field excursion, at Fortune Head, overlooking the basal Cambrian GSSP. Standing from left: Pavel Parkhaev, Tim Topper, Michael Streng, Emma Arvestål, Wei Liu, Tao Dai, Fangchen Zhao, Guoxiang Li, Ed Landing, Michael Steiner, Guy Narbonne, Luoyang Li, Diego García-Bellido, Tais Dahl, Ulf Linnemann, Olaf Elicki, Gabriela Mángano, Romain Gougeon, Maoyan Zhu, Paul Myrow, Glenn Brock, Brittany Laing. Bottom from left: Anne-Sofie Ahm, Emily Smith, Aihua Yang, Yuning Yang, Pengju Liu, Ben Yang, Hao Yun, Luis Buatois, Dongjing Fu, Xinglian Yang, Alan J. Kaufman. Not shown: Jin Peng, Shanchi Peng, Kendra Power.

References

- Anderson, M.M., and Misra, S.B., 1968, Fossils found in the Pre-Cambrian Conception Group of south-eastern Newfoundland. *Nature*, v. 220, pp. 680–681.
- Babcock, L.E., Peng, S.C., Zhu, M.Y., Xiao, S., and Ahlberg, P., 2014, Proposed reassessment of the Cambrian GSSP. *Journal of African Earth Sciences*, v. 98, pp. 3–10.
- Boag, T.H., Darroch, S.A., and Laflamme, M., 2016, Ediacaran distributions in space and time: testing assemblage concepts of earliest macroscopic body fossils. *Paleobiology*, v. 42, pp. 574–594.
- Boyle, R.A., Dahl, T.W., Dale, A.W., Shields-Zhou, G.A., Zhu, M.Y., Brasier, M.D., Canfield, D.E., and Lenton, T.M., 2014, Stabilization of the coupled oxygen and phosphorus cycles by the evolution of bioturbation. *Nature Geoscience*, v. 7, pp. 671–676.
- Brasier, M., Cowie, J., and Taylor, M., 1994, Decision on the Precambrian–Cambrian boundary stratotype. *Episodes*, v. 17, pp. 3–8.
- Briggs, D.E., 2015, The Cambrian Explosion. *Current Biology*, v. 25, pp. R864–R868.
- Buatois, L.A., Narbonne, G.M., Mángano, M.G., Carmona, N.B., and Myrow, P., 2014, Ediacaran matground ecology persisted into the earliest Cambrian. *Nature Communications*, v. 5. doi:10.1038/ncomms4544
- Canfield, D., Poulton, S.W., and Narbonne, G.M., 2007, Late-Neoproterozoic deep-ocean oxygenation and the rise of animal life. *Science*, v. 315, pp. 92–95.
- Cooper, R.A., Nowlan, G.S., and Williams, S.H., 2001, Global Stratotype Section and Point for base of the Ordovician System. *Episodes*, v. 24, pp. 19–28.
- Cunningham, J.A., Liu, A.G., Bengtson, S., and Donoghue, P.C.J., 2017, The origin of animals: can molecular clocks and the fossil record be reconciled? *Bioessays*, v. 39, pp. 1–12.
- Darroch, S.A., Laflamme, M., and Clapham, M.E., 2013, Population structure of the oldest known macroscopic communities from Mistaken Point, Newfoundland. *Paleobiology*, v. 39, pp. 591–608.
- Dececchi, T.A., Narbonne, G.M., Greentree, C., and Laflamme, M., 2017, Relating Ediacaran fronds. *Paleobiology*, v. 43, pp. 171–180.
- Devaere, L., Clausen, S., and Álvaro, J.J. (Eds.), 2014, *Stratigraphic Overview of the Ediacaran and Cambrian from the Anti-Atlas, Morocco*. University of Lille 1, Lille, 85 p.
- Droser, M.L., Jensen, S., Gehling, J.G., Myrow, P.M., and Narbonne, G.M., 2002, Lowermost Cambrian ichnofabrics from the Chapel Island Formation, Newfoundland: implications for Cambrian substrates. *PALAIOS*, v. 17, pp. 3–15.
- Dufour, S.C., and McIlroy, D., 2017, Ediacaran pre-placozoan diploblasts in the Avalonian biota: the role of chemosynthesis in the evolution of early animal life. In: Brasier, A.T., McIlroy, D., and McLoughlin, N. (Eds.), *Earth Systems, Evolution, and Early Life*. Geological Society of London, Special Publications, v. 448, pp. 211–219.
- Geyer, G., and Landing, E., 2017, The Precambrian–Phanerozoic and Ediacaran–Cambrian boundaries: a historical approach to a dilemma. In: Brasier, A.T., McIlroy, D., and McLoughlin, N. (Eds.), *Earth Systems, Evolution, and Early Life*. Geological Society of London, Special Publications, v. 448, pp. 311–349.
- Herringshaw, L.G., Callow, R.H.T., and McIlroy, D., 2017, Engineering the Cambrian explosion: the earliest bioturbators as ecosystem engineers. In: Brasier, A.T., McIlroy, D., and McLoughlin, N. (Eds.), *Earth Systems, Evolution, and Early Life*. Geological Society of London, Special Publications, v. 448, pp. 369–382.
- Hofmann, H.J., O'Brien, S.J., and King, A.F., 2008, Ediacaran biota on Bonavista Peninsula, Newfoundland, Canada. *Journal of Paleontology*, v. 82, pp. 1–36.
- Kenchington, C.G., and Wilby, P.R., 2017, Rangeomorph classification schemes and intra-specific variation: are all characters created equal? In: Brasier, A.T., McIlroy, D., and McLoughlin, N. (Eds.), *Earth Sys-*

- tems, Evolution, and Early Life. Geological Society, London, Special Publications, v. 448, pp. 221–250.
- Kouchinsky, A., Bengtson, S., Runnegar, B., Skovsted, C., Steiner, M., and Vendrasco, M., 2012, Chronology of early Cambrian biomineralization. *Geological Magazine*, v. 149, pp. 221–251.
- Landing, E., and Westrop, S.R. (Eds.), 1998, Avalon 1997 – the Cambrian standard. 3rd International Field Conference of the Cambrian Chronostratigraphy Working Group and I.G.C.P. Project 366 (Ecological Aspects of the Cambrian Radiation), New York State Museum Bulletin, v. 492.
- Landing, E., Narbonne, G.M., Myrow, P., Benus, A.P., and Anderson, M.M., 1988, Faunas and depositional environments of the upper Precambrian through lower Cambrian, of southeastern Newfoundland. *New York State Museum Bulletin*, v. 463, pp. 8–52.
- Landing, E., Westrop, S.R., and Bowring, S.A., 2013a, Reconstructing the Avalonia palaeocontinent in the Cambrian: a 519 Ma caliche in South Wales and transcontinental middle Terreneuvian Epoch sandstones. *Geological Magazine*, v. 150, pp. 1022–1046.
- Landing, E., Geyer, G., Brasier, M.D., and Bowring, S.A., 2013b, Cambrian evolutionary radiation: context, correlation, and chronostratigraphy – overcoming deficiencies of the first appearance datum (FAD) concept. *Earth Science Reviews*, v. 123, pp. 133–172.
- Lipps, J., and Signor, P.W. (Eds.), 1992, *Origins and Early Evolution of Metazoa*. Plenum Press, New York, 570 p.
- Liu, A.G., 2016, Framboidal pyrite shroud confirms the ‘death mask’ model for moldic preservation of Ediacaran soft-bodied organisms. *PALAIOS*, v. 31, pp. 259–274.
- Liu, A.G., and Matthews, J.J., 2017, Great Canadian Lagerstätten 6. Mistaken Point Ecological Reserve, Southeast Newfoundland. *Geoscience Canada*, v. 44, pp. 63–76.
- Liu, A.G., McIlroy, D., and Brasier, M.D., 2010, First evidence for locomotion in the Ediacara biota from the 565 Ma Mistaken Point Formation, Newfoundland. *Geology*, v. 38, pp. 123–126.
- Mángano, M.G., and Buatois, L.A. (Eds.), 2016, *The Trace-Fossil Record of Major Evolutionary Events: Volume 1: Precambrian and Paleozoic*. Springer, Dordrecht, 358 p.
- McIlroy, D., and Logan, G.A., 1999, The impact of bioturbation on infaunal ecology and evolution during the Proterozoic–Cambrian transition. *PALAIOS*, v. 14, pp. 58–72.
- Meert, J.G., Levashova, N.M., Bazhenov, M.L., and Landing, E., 2016, Rapid changes of magnetic field polarity in the late Ediacaran: linking the Cambrian Evolutionary Radiation and increased UV-B radiation. *Gondwana Research*, v. 34, pp. 149–157.
- Menon, L.R., McIlroy, D., and Brasier, M.D., 2013, Evidence for Cnidaria-like behavior in ca. 560 Ma Ediacaran *Aspidella*. *Geology*, v. 41, pp. 895–898.
- Mitchell, E.G., Kenchington, C.G., Liu, A.G., Matthews, J.J., and Butterfield, N.J., 2015, Reconstructing the reproductive mode of an Ediacaran macro-organism. *Nature*, v. 524, pp. 343–346.
- Myrow, P.M., and Kaufman, A.J., 1999, A newly discovered cap carbonate above Varanger-age glacial deposits in Newfoundland, Canada. *Journal of Sedimentary Research*, v. 69, pp. 784–793.
- Narbonne, G.M., 2004, Modular construction of early Ediacaran complex life forms. *Science*, v. 305, pp. 1141–1144.
- Narbonne, G.M., Xiao, S., and Shields, G., 2012, The Ediacaran Period. In: Gradstein, F.M., Ogg, J.G., Schmitz, M.D., and Ogg, G.M. (Eds.), *Geologic Timescale*. Elsevier, Amsterdam, pp. 413–435.
- Normore, L.S., 2011, Preliminary findings on the geology of the Trinity map area (NTS 2C/06), Newfoundland. Current Research. Newfoundland and Labrador Department of Natural Resources, Geological Survey Report, v. 11-1, pp. 273–293.
- Peng, S.C., Babcock, L.E., and Cooper, R.A., 2012, The Cambrian Period. In: Gradstein, F.M., Ogg, J.G., Schmitz, M.D., and Ogg, G.M. (Eds.), *Geologic Timescale*. Elsevier, Amsterdam, pp. 437–488.
- Pu, J.P., Bowring, S.A., Ramezani, J., Myrow, P., Raub, T.D., Landing, E., Mills, A., Hodgkin, E., and Macdonald, F.A., 2017, Dodging snowballs: geochronology of the Gaskiers glaciation and the first appearance of the Ediacaran biota. *Geology*, v. 44, pp. 955–958.
- Shields, G.A., 2017, Earth system transition during the Tonian–Cambrian interval of biological innovation: nutrients, climate, oxygen and the marine organic carbon capacitor. In: Brasier, A.T., McIlroy, D., and McLoughlin, N. (Eds.), *Earth Systems, Evolution, and Early Life*. Geological Society of London, Special Publications, v. 448, pp. 161–177.
- Sperling, E.A., Frieder, C.A., Raman, A.V., Girguis, P.R., Levin, L.A., and Knoll, A.H., 2013, Oxygen, ecology, and the Cambrian radiation of animals. *Proceedings of the National Academy of Sciences*, v. 110, pp. 13446–13451.
- Thomas, R., and Narbonne, G.M., 2016, Mistaken Point: nomination for inscription on the UNESCO World Heritage List. <http://whc.unesco.org/uploads/nominations/1497.pdf>
- Xiao, S., Zhou, C., and Zhu, M., 2014, International symposium and field workshop on Ediacaran and Cryogenian Stratigraphy. *Episodes*, v. 37, pp. 218–221.
- Xiao, S., Narbonne, G.M., Zhou, C., Laflamme, M., Grazhdankin, D.V., Moczyłowska-Vidal, M., and Cui, H., 2016, Toward an Ediacaran time scale: problems, protocols, and prospects. *Episodes*, v. 39, pp. 540–555.
- Xiao, S., Vickers-Rich, P., Narbonne, G., Laflamme, M., Darroch, S., Kaufman, A.J., and Kriesfeld, L., 2017, Field workshop on the Ediacaran Nama Group of southern Namibia. *Episodes*, v. 40, pp. 259–261.