

Table S1. Occurrences of published radiodontans around the world. Chronostratigraphic orders are adopted from various sources. Symbols: ‘?’: the radiodontan nature of these taxa is doubtful; ‘*’: the controversial phylogenetic position of *Schinderhannes bartelsi* influences the monophyly of Radiodonta. Abbreviations: BF: body flap; CB: (nearly) complete body; DG: digestive gland; EY: eye; FA: frontal appendage; FM: fragment of body part; FU: furca; GT: gut; HS: head sclerite; IB: incomplete body; MS: musculature; NR: nerve; OC: oral cone; SB: setal structures; TF: tail fan.

| Deposits | Fossil zones | Age | Strata | Body parts | Taxa/sclerites | References |
|---|---|---------|--------------------------------------|---|--|--|
| Zawiszyn Formation, Kaszuby, Pomerania, Poland | <i>Fallotaspis</i> Zone | Cam. S3 | Zawiszyn Fm. | FA | <i>Peytoia infercambriensis</i> (Lendzion, 1975) | Lendzion, 1975, 1977; Dzik & Lendzion, 1988; Daley & Legg, 2015. |
| Zunyi biota, Guizhou, South China | <i>Tsunyiidiscus niutitangensis</i> Zone | Cam. S3 | Niutitang Fm. | FA | <i>Amplectobelua symbrachiata</i> Hou <i>et al.</i> , 1995 | Shu <i>et al.</i> , 1992; Steiner <i>et al.</i> , 2005. |
| Chengjiang biota, Yunnan, South China | <i>Yunnanocephalus</i> Subzone, <i>Eoredlichia-Wutingaspis</i> Zone | Cam. S3 | Maotianshan Shale Mb., Yu'anshan Fm. | HS, FA, EY, OC, BF, S, TF, FU, CB, NR, GT, DG | <i>Amplectobelua symbrachiata</i> Hou <i>et al.</i> , 1995 <i>Anomalocaris saron</i> Hou <i>et al.</i> , 1995 <i>?Cucumericrus decoratus</i> Hou <i>et al.</i> , 1995 <i>Lyrarapax unguispinus</i> Cong <i>et al.</i> , 2014 <i>Lyrarapax trilobus</i> Cong <i>et al.</i> , 2016 <i>?Parapeytoia yunnanensis</i> Hou <i>et al.</i> , 1995 <i>Tauricornicaris latizonae</i> gen. et sp. nov. <i>Tauricornicaris oxygonae</i> gen. et sp. nov. <i>Zhenghecaris shankouensis</i> Vannier <i>et al.</i> , 2006 Chengjiang P-element R-element A-element | Chen <i>et al.</i> , 1994, 1996, 1997, 2004, 2007, 2012; Hou <i>et al.</i> , 1995, 2004; Vannier <i>et al.</i> , 2006; Cong <i>et al.</i> , 2014, 2016; This paper . |
| Sirius Passet biota, Peary Land, Greenland | <i>Nevadella</i> Zone | Cam. S3 | Buen Fm. | FA | <i>Tamisiocaris borealis</i> Daley & Peel, 2010 | Daley & Peel, 2010; Vinther <i>et al.</i> , 2014. |
| Shuijingtuo Formation, Yichang, Hubei, South China | <i>Hupeiidiscus orientalis</i> Zone | Cam. S3 | Shuijingtuo Fm. | HS | <i>?Huangshandongia yichangensis</i> Cui & Huo, 1990 <i>?Liantuoia inflasa</i> Cui & Huo, 1990 | Cui & Huo, 1990; Daley <i>et al.</i> , 2013a. |
| Indian Springs biota, Esmeralda, Nevada, USA | <i>Olenellus</i> Zone | Cam. S3 | Middle Mb., Poleta Fm. | FM | Unnamed radiodontans | English & Babcock, 2010. |
| Malong fauna, Yunnan, South China | <i>Drepanuroides</i> Zone | Cam. S3 | Hongjingshao Fm. | FA | <i>Anomalocaris saron</i> Hou <i>et al.</i> , 1995 | Zhang <i>et al.</i> , 2001; Luo <i>et al.</i> , 2008. |
| Eager Formation, Cranbrook, British Columbia, Canada | <i>Bonnia-Olenellus</i> Zone | Cam. S3 | Eager Fm. | FA | <i>Anomalocaris canadensis</i> Whiteaves, 1892 | Resser, 1929; Briggs, 1979; Briggs & Mount, 1982. |
| Kinzers Formation, Lancaster, Pennsylvania, USA | <i>Bonnia-Olenellus</i> Zone | Cam. S3 | Kinzers Fm. | FA | <i>Anomalocaris pennsylvanica</i> Resser, 1929 | Resser, 1929; Resser & Howell, 1938; Briggs, 1979; Briggs & Mount, 1982. |
| Latham Shale, San Bernardino, California, USA | <i>Bristolia</i> Subzone, <i>Bonnia-Olenellus</i> Zone | Cam. S3 | Latham Shale | FA | <i>Anomalocaris canadensis</i> Whiteaves, 1892 | Briggs & Mount, 1982. |
| Pioche Formation, Lincoln, Nevada, USA | <i>Olenellus</i> Zone to <i>Eokochaspis nodosa</i> Zones | Cam. S4 | Comet Shale Mb., Pioche Fm. | FA, OC, BF, FU, IB, GT | <i>Anomalocaris pennsylvanica</i> Resser, 1929 <i>Anomalocaris</i> cf. <i>saron</i> Hou <i>et al.</i> , 1995 Unnamed radiodontans | Lieberman, 2003. |
| Guanshan biota, Yunnan, South China | <i>Palaeolenus</i> and <i>Megapalaeolenus</i> Zones | Cam. S4 | Wulongqing Fm. | FA | <i>Anomalocaris kunmingensis</i> Wang <i>et al.</i> , 2013 <i>Paranomalocaris multisegmentalis</i> Wang <i>et al.</i> , 2013 <i>?Parapeytoia</i> sp. Hou <i>et al.</i> , 1995 | Luo <i>et al.</i> , 2008; Hu <i>et al.</i> , 2010, 2013; Wang <i>et al.</i> , 2013. |
| Balang biota, Hunan, South China | <i>Arthricocephalus chauveau</i> Zone | Cam. S4 | Balang Fm. | FA | <i>Anomalocaris</i> sp. Whiteaves, 1892 <i>Peytoia</i> cf. <i>nathorsti</i> Walcott, 1911 | Liu, 2013. |
| Emu Bay Shale biota, Kangaroo Island, South Australia | <i>Pararaia janeae</i> Zone | Cam. S4 | Emu Bay Shale | FA, EY, OC, BF, SB | <i>Anomalocaris briggsi</i> Nedin, 1995 <i>Anomalocaris</i> cf. <i>canadensis</i> Whiteaves, 1892 | McHenry & Yates, 1993; Nedin, 1995; Paterson <i>et al.</i> , 2011; Daley <i>et al.</i> , 2013b. |
| Mantou Formation, Tangshan, Hebei, North China | <i>Luaspides huoshanensis</i> Zone | Cam. S5 | Mantou Fm. | FA | Unnamed radiodontans | Huang <i>et al.</i> , 2012. |
| Kaili biota, Guizhou, South China | <i>Oryctocephalus indicus</i> Zone | Cam. S5 | Kaili Fm. | FA | <i>Anomalocaris saron</i> Hou <i>et al.</i> , 1995 | Zhao <i>et al.</i> , 2005, 2011. |
| Spence Shale, Wellsville Mountains, Utah, USA | <i>Glossopleura</i> Zone | Cam. S5 | Spence Shale Mb., Langston Fm. | OC, SB, IB | <i>Anomalocaris</i> sp. Whiteaves, 1892 <i>Hurdia</i> sp. Walcott, 1912 <i>Peytoia nathorsti</i> Walcott, 1911 | Conway Morris & Robison, 1982, 1988; Robison, 1991; Briggs <i>et al.</i> , 2008; Daley <i>et al.</i> , 2013a. |

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|---|--|--------------------|-----------------------------------|--|--|---|
| Burgess Shale biota, British Columbia, Canada | latest <i>Glossopleura</i> Zone to early—middle <i>Bathyriscus</i> — <i>Elrathina</i> Zone | Cam. S5 | Burgess Shale Fm. and Stephen Fm. | HS, FA, EY, OC, BF, SB, TF, CB, GT, MS | <i>Amplectobelua stephenensis</i> Daley & Budd, 2010 <i>Anomalocaris canadensis</i> Whiteaves, 1892 <i>Caryosyntrips serratus</i> Daley & Budd, 2010 <i>Hurdia triangulata</i> Walcott, 1912 <i>Hurdia victoria</i> Walcott, 1912 <i>Peytoia nathorsti</i> Walcott, 1911 <i>Stanleycaris hirpex</i> Caron <i>et al.</i> , 2010 | Conway Morris, 1978; Briggs, 1979; Whittington & Briggs, 1985; Collins <i>et al.</i> , 1996; Daley <i>et al.</i> , 2009, 2013a; Caron <i>et al.</i> , 2010; Daley & Budd, 2010; Daley & Bergström, 2012; Daley & Edgecombe, 2014. |
| Kuonamka Formation, Olenek, Yakutia, Siberia | Unknown | Cam. S5 to Drumian | Kuonamak Fm. | SB, IB | Unnamed radiodontans | Ponomarenko, 2010. |
| Wheeler Formation, House Range, Utah, USA | <i>Ptychagnostus atavus</i> Zone | Cam. Drumian | Wheeler Fm. | HS, FA, OC, BF, TF, CB, GT | <i>Anomalocaris</i> sp. Whiteaves, 1892 <i>Hurdia</i> sp. Walcott, 1912 <i>Peytoia nathorsti</i> Walcott, 1911 | Robison & Richards, 1981; Conway Morris & Robison, 1982, 1988; Robison, 1991; Briggs <i>et al.</i> , 2008; Daley <i>et al.</i> , 2013a. |
| Marjum Formation, House Range, Utah, USA | <i>Ptychagnostus punctuosus</i> Zone | Cam. Drumian | Marjum Fm. | BF, IB, GT, DG | <i>Peytoia nathorsti</i> Walcott, 1911 | Briggs & Robison, 1984; Conway Morris & Robison, 1988; Robison, 1991. |
| Jince Formation, Barrandian, Bohemia, Czech | Uppermost part of interval between <i>Eccaparadoxides pusillus</i> and <i>Paradoxides gracilis</i> Zones; <i>Ellipsocephalus hoffi</i> - <i>Rejkocephalus</i> Zone | Cam. Drumian | Jince Fm. | HS | <i>Hurdia</i> sp. Walcott, 1912 | Chlupáč & Kordule, 2002; Daley <i>et al.</i> , 2013a. |
| Weeks Formation, House Range, Utah, USA | <i>Proagnostus bulbus</i> Zone | Cam. Guzhangian | Weeks Fm. | FA | <i>Anomalocaris</i> aff. <i>canadensis</i> Whiteaves, 1892 <i>Anomalocaris</i> sp. Whiteaves, 1892 | Lerosey-Aubril <i>et al.</i> , 2014. |
| Klonówka Shale Formation, Wiśniówka, Poland | <i>Protopeltura</i> Zone | Cam. S10 | Klonówka Shale Fm. | OC | ' <i>Peytoia</i> '-type radiodontan | Masiak & Żylińska, 1994. |
| Fezouata biota, Zagora, Morocco | <i>Araneograptus murrayi</i> Zone (graptolids) | Ord. Tremadocian | Fezouata Fm. | HS, FA, OC, BF, SB, CB | Unnamed hurdiid radiodontans <i>Aegirocassis benmoulae</i> Van Roy <i>et al.</i> , 2015 | Van Roy & Briggs, 2011; Daley <i>et al.</i> , 2013a; Van Roy <i>et al.</i> , 2015 |
| Hunsrück Slate biota, Bundenbach, Germany | <i>Polygnathus excavatus</i> Zone (conodont) | Dev. lower Emsian | Kaub Fm. | FA, EY, OC, TF, FU, CB | * <i>Schinderhannes bartelsi</i> K i h l <i>et al.</i> , 2009 | K i h l <i>et al.</i> , 2009. |

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