



The Middle–Late Ordovician brachiopod *Plectorthis* from North America and its paleobiogeographic significance

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Abstract

Plectorthis is a commonly reported Late Ordovician brachiopod genus from Laurentia and several other tectonic plates. Examination of shells from the Cincinnati Arch type area shows that species previously assigned to the genus have a considerable range of variability, such as ribbing style, shell outline, and musculature. The type species, *Orthis plicatella* Hall, 1847 is characterized by generally simple costae, with double-rowed aditicles on each rib, and a cordate ventral muscle field. Some species previously attributed to *Plectorthis* have a subtriangular ventral muscle field and hence a closer affinity to the plaesiomyid genus *Austinella*. *Orthis fissicosta* is here demoted to a subspecies of *Plectorthis plicatella* based on its similar ribbing style to some specimens of the type species. In Laurentia, *Plectorthis* first appeared in the Darriwilian–Sandbian boundary interval, achieved a relatively high species diversity and wide paleogeographic distribution in pericratonic seas during the early Katian; the subequatorial species attained a notably larger shell than those in the higher paleotropics. The genus did not invade the intracratonic basins of Laurentia and became extinct by the late Katian.

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1. Introduction

Plectorthis Hall and Clarke, 1892, a commonly reported Late Ordovician orthide brachiopod of the family Plectorthidae, is characterized by a gently ventribiconvex shell, generally subelliptical outline, with an anterior commissure ranging from slightly sulcate to subtly uniplicate, and costate shell surface (Williams and Harper, 1997). These characters, however, are highly variable among species described so far in the literature, with shapes from subcircular to rather wide, and the ribbing from simple costate to strongly multicostellate or fascicostellate. In the early Late Ordovician, *Plectorthis* was an important part of the benthic shelly fauna that initially colonized the shallow epeiric seas along the continental margin in response to the sea level rise and marine inundation of the continents (Haq and Schutter, 2008). The earliest occurrences of *Plectorthis* are known from the uppermost Darriwilian, but the

genus is most diverse in Laurentia during the Sandbian and early Katian (Fig. 1). One species has been assigned to the genus in the Hirnantian (*Plectorthis magna* Cooper and Kindle, 1936), but its affinity to *Plectorthis* remains doubtful. The youngest known species in Laurentia is *Plectorthis inaequiconvexa* Roy, 1941 from the Amadjuack Formation (Edenian–Maysvillian, mid-Katian) of Baffin Island (Bolton, 2000).

In the Late Ordovician faunas of Laurentia, various species of *Plectorthis* usually occur as a common, but non-dominant taxon of brachiopod assemblages, such as in localities of the eastern United States (Hall, 1847, 1859; Meek, 1872, 1873; Raymond, 1905, 1910; Willard, 1928; Schuchert and Cooper, 1932; Weiss, 1955; Cooper, 1956; Titus, 1982, 1986; Davis, 1985) and Canada (Logan et al., 1863; Wilson, 1946), Baffin Island (Roy, 1941; Bolton, 2000), Nevada (Cooper, 1956; Ross, 1967, 1970), California (Phleger, 1933; Greife and Langenheim, 1963), and the peri-Laurentian terranes of Scotland and northern Ireland (Williams, 1962; Wright, 1964; Mitchell, 1977; Candela, 2003). Elsewhere, the genus has been reported from the Shropshire inlier (Avalonia) in England (Williams, 1974), the Farewell terrane of Alaska (Rasmussen et al., 2012), Australia

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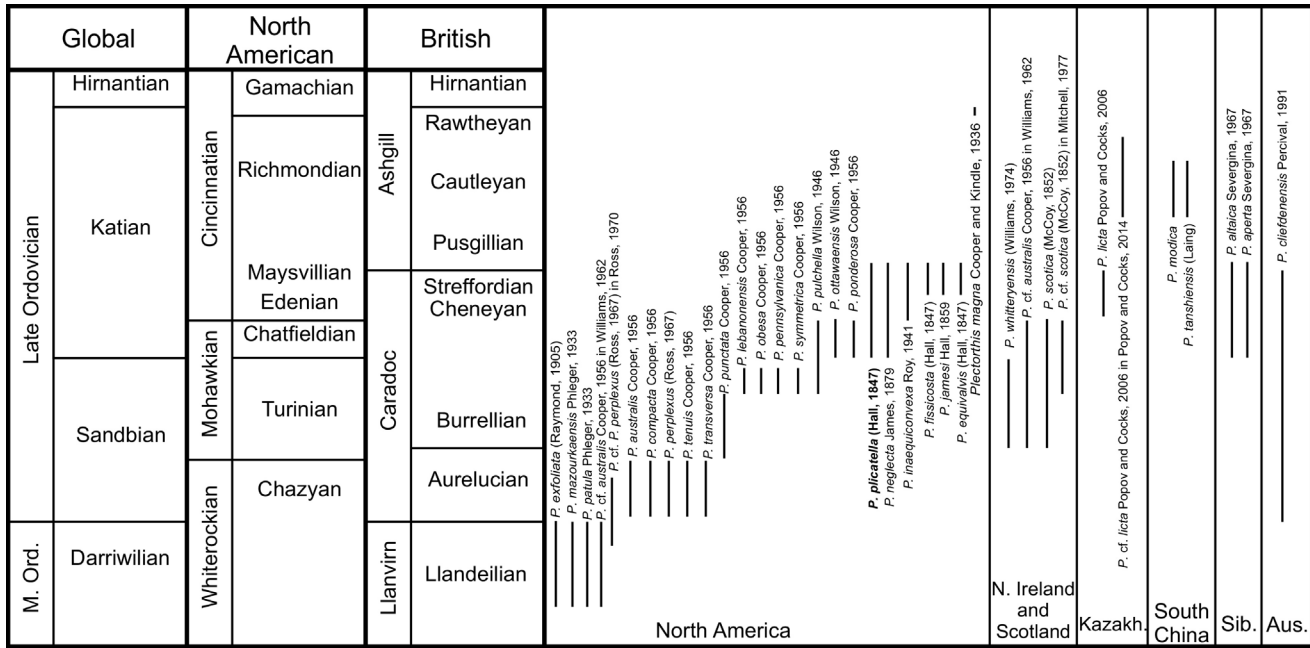


Fig. 1. Known ranges of *Plectorthis* species. Kazakh. = Kazakhstan, Sib. = Siberia, and Aus. = Australia. The earliest reported species are from the upper Darriwilian, but these species are not well preserved, rare, and poorly documented. *Plectorthis* is most diverse during the Sandbian with a number of species reported by Cooper (1956) from the eastern United States. Some of the most recognizable species, including the type species *P. plicatella plicatella*, are from the early Katian. Only a single doubtful species was reported in the Hirnantian by Cooper and Kindle (1936). Figure includes all species of *Plectorthis* previously assigned that have not been reassigned to other genera prior to this paper excluding only those assigned as *Plectorthis* sp.

(Laurie, 1991; Percival, 1991), China (Zhan and Cocks, 1998; Rong et al., 1999; Zhan et al., 2002, 2014), Kazakhstan (Nikitin and Popov, 1983; Popov et al., 2002; Nikitin et al., 2006; Popov and Cocks, 2006, 2014), Norway (Owen and Harper, 1982; Harper and Owen, 1984; Neuman et al., 1997), and Siberia (Severygina, 1967; Kulkov and Severygina, 1989; Cocks and Modzalevskaya, 1997), although the true identity of some of these remains to be confirmed.

Despite the wide geographic range of the genus, the original types of the type species of *Plectorthis*, *Orthis plicatella* Hall, 1847, have not been thoroughly examined for over a century in terms of contemporary taxonomy. Comparisons to these types have largely been limited to broad morphology (i.e., outline, ribbing pattern, etc.). Furthermore, the internal structures of *Plectorthis* have only been described once (Schuchert and Cooper, 1932), and some microstructures (e.g., aditicles) may have been overlooked in previous studies. This has led to some ambiguity about the definition of *Plectorthis* (*sensu stricto*), making it a ‘dump bag’ genus in some cases.

This study re-examines the types of *Orthis plicatella* and *Orthis fissicosta* used originally by Hall (1847) and subsequent studies from the collections at the American Natural History Museum (AMNH) in New York, supplemented with topotype material from the Cincinnati Museum Center (CMC). The main objective is to clarify the diagnostic characteristics of *Plectorthis* and to discuss its significance for understanding the evolutionary, paleoecological, and paleobiogeographical significance, as part of Late Ordovician benthic shelly fauna that invaded epicontinental seas during Late Ordovician marine transgressions.

2. Previous studies of *Plectorthis*

Hall and Clarke (1892) established *Plectorthis* based on *Orthis plicatella* Hall, 1847, for a group of orthides with strong external ribs that are not invariably simple, a low cardinal area, and subequally convex, with internal structures being essentially the same as their Group I (i.e., the *Hesperorthis* Group, with a blade-like cardinal process).

Schuchert and Cooper (1932) further refined the genus, noting the cordate, or heart-shaped, ventral muscle field and the nature of cardinalia. In particular, they noted the curved brachio-phores that differentiate the *Plectorthinae* from other orthides that feature straight brachio-phores, and the fulcral plates that form the base of the sockets in the dorsal valve that are characteristic of *Plectorthis* only. They considered the cardinal process of *Plectorthis* to be similar to that of *Dinorthis* in that it has a stout compressed shaft bearing a crenulated myophore. However, the cardinal process, especially myophore, of *Plaesiomyids* (e.g., *Dinorthis* and *Plaesiomys*) is usually more bulbous (especially in late Katian forms — see Sproat and Jin, 2013).

Subsequent studies commented on the large degree of variability between species, usually only in systematic remarks (e.g., Mitchell, 1977; Laurie, 1991; Percival, 1991; Zhan and Cocks, 1998), but detailed comparisons between species are lacking. The heart-shaped (cordate) ventral muscle field, for example, is a relatively reliable diagnostic feature for separating *Plectorthis* from other similar orthides, but is rarely mentioned in systematic discussions. This is probably due to the relatively rare occurrence of disarticulated valves in the genus.

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