



A review of *Salterella* (Phylum Agmata) from the Lower Cambrian in Greenland and Mexico

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Records of *Salterella* from the Lower Cambrian in Greenland are reviewed and all specimens are referred to *S. maccullochi* (Murchison, 1859). Examples are illustrated for the first time from the Brønlund Fjord Group of Peary Land, central North Greenland and from the Hyolithus Creek Formation at Kap Weber and at C. H. Ostenfeld Nunatak, northern East Greenland.

S. mexicana Lochman in Cooper *et al.*, 1952, from Sonora, Mexico, is illustrated in thin sections and is placed into synonymy with *S. maccullochi*.

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This brief review of the distribution and nomenclature of the genus *Salterella* Billings, 1861 in Greenland was prompted by the recent re-description by Yochelson (in press) of *Salterella maccullochi* (Murchison, 1859) from the Northwest Highlands of Scotland. *S. maccullochi* is the earliest described species currently assigned to *Salterella* and it is considered by Yochelson to be a senior subjective synonym of *S. rugosa* Billings, 1861, the type and best known species of the genus. The recognition of this synonymy necessitates re-assignment of Greenland specimens from *S. rugosa* to *S. maccullochi*.

Salterella was first described from North-West Greenland more than fifty years ago (Poulsen, 1927; 1958; see Yochelson & Peel, 1980) and has been subsequently described from northern East Greenland (Poulsen, 1932; Griffin & Yochelson, 1975). Specimens are illustrated here for the first time from three additional localities in North and East Greenland; all are of Early Cambrian age.

The Greenland localities provide the northernmost record of *Salterella* on the present-day configuration of land and sea. During examination of collections from these localities, comparison has been made with the most southerly described specimens of *Salterella*, namely *S. mexicana* Lochman in Cooper *et al.*, 1952, from Sonora, Mexico. It is our conclusion that *S. mexicana* is also a junior subjective synonym of *S. maccullochi*. The two records are of interest in view of their considerable geographic separation – more than 50 degrees of latitude or a distance in excess of 7000 km. Both outcrops probably occupied a broad

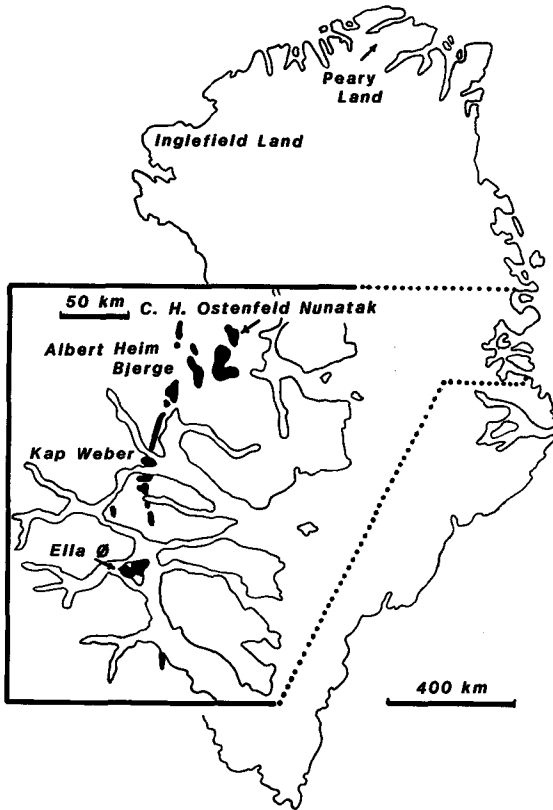


Fig. 1. *Salterella* localities in Greenland. Cambro-Ordovician outcrops in East Greenland are coloured black.

equatorial belt in Cambrian time, but the unchanged position of Greenland relative to mainland North America from the Cambrian to the present day (Christie *et al.*, 1981; Dawes & Kerr, 1982) maintains the separation.

Records of *Salterella* from Greenland

Salterella is now known from North-West Greenland, central North Greenland and northern East Greenland. Poulsen (1927, 1958) described *Salterella expansa* and an indeterminate species of *Salterella* from the Wulff River Formation of late Early Cambrian age in Inglefield Land (figs 1, 2). Yochelson & Peel (1980) examined Poulsen's type specimens as well as new collections and considered *S. expansa* to be a junior subjective synonym of *S. rugosa* Billings, 1861, the type species of *Salterella*. Associated trilobites described by Poulsen (1927, 1958) indicate the *Bonnia-Olenellus* Zone of the Early Cambrian. *S. rugosa* was also identified by Poulsen (1932) from the Ella Island Formation of Ella Ø, northern East Greenland (figs 1, 2) and the specimens were subsequently examined by Griffin & Yochelson (1975). The associated fauna also includes olenellids and *Bonnia* (Cowie & Adams, 1957).

INGLEFIELD LAND	PEARY LAND		EAST GREENLAND
Cape Kent Formation	Brønlund Fjord Group	Formation 6 ☆	Hyolithus Creek Formation ☆
Wulff River Formation ☆		Formation 1 ☆	Ella Island Formation ☆
Cape Ingersoll Formation		Buen Formation	Bastion Formation
Cape Leiper Formation		Portfjeld Formation	Kløftelv Formation
Dallas Bugt Formation			

Fig. 2. Stratigraphic distribution of *Salterella maccullochi* in the Lower Cambrian of Greenland. The section in Peary Land is from the area around Jørgen Brønlund Fjord, in central southern Peary Land; four additional formations are recognised within the Brønlund Fjord Group in more westerly outcrops in Peary Land (Ineson & Peel, 1980). No precise correlation is implied between the three sections. Occurrences of *S. maccullochi* are starred.

Troelsen (1956) recorded, but did not describe, *Salterella* from the basal Brønlund Fjord Dolomite of central southern Peary Land, central North Greenland (fig. 1). The strata from which the samples were collected are now referred to member A of formation 1 of the Brønlund Fjord Group (Ineson & Peel, 1980). The identification was confirmed by Peel *et al.* (1974) on the basis of a few specimens in Troelsen's collections. The associated fauna is probably indicative of the *Bonnia-Olenellus* Zone (Palmer & Peel, 1979). In 1980, J. S. P. collected abundant specimens of *Salterella* from higher levels of the Brønlund Fjord Dolomite in strata now assigned to formation 6 of the Brønlund Fjord Group (Ineson & Peel, 1980; fig. 2 herein). These specimens are described and illustrated below (fig. 5). The *Salterella*-yielding beds pass laterally into dolomites rich in archaeocyathaceans and overlie dark, silty dolomites with rich invertebrate faunas of *Bonnia-Olenellus* Zone age.

Cowie & Adams (1957) recorded *Salterella* from the Hyolithus Creek Formation at Kap Weber, Ella Ø and Albert Heim Bjerger, northern East Greenland (figs 1, 2). This material is illustrated here for the first time (fig. 3). In the same publication, Cowie & Adams (1957, footnote p. 45) noted specimens of *Salterella* collected by John Haller from C. H. Ostenfeld Nunatak, northern East Greenland, also from the Hyolithus Creek Formation (fig. 1). Haller's material is figured here for the first time (fig. 4). The sequence exposed on C. H. Ostenfeld Nunatak contains the most northerly exposures of Cambrian and Ordovician strata in the East Greenland region (Frykman, 1979).

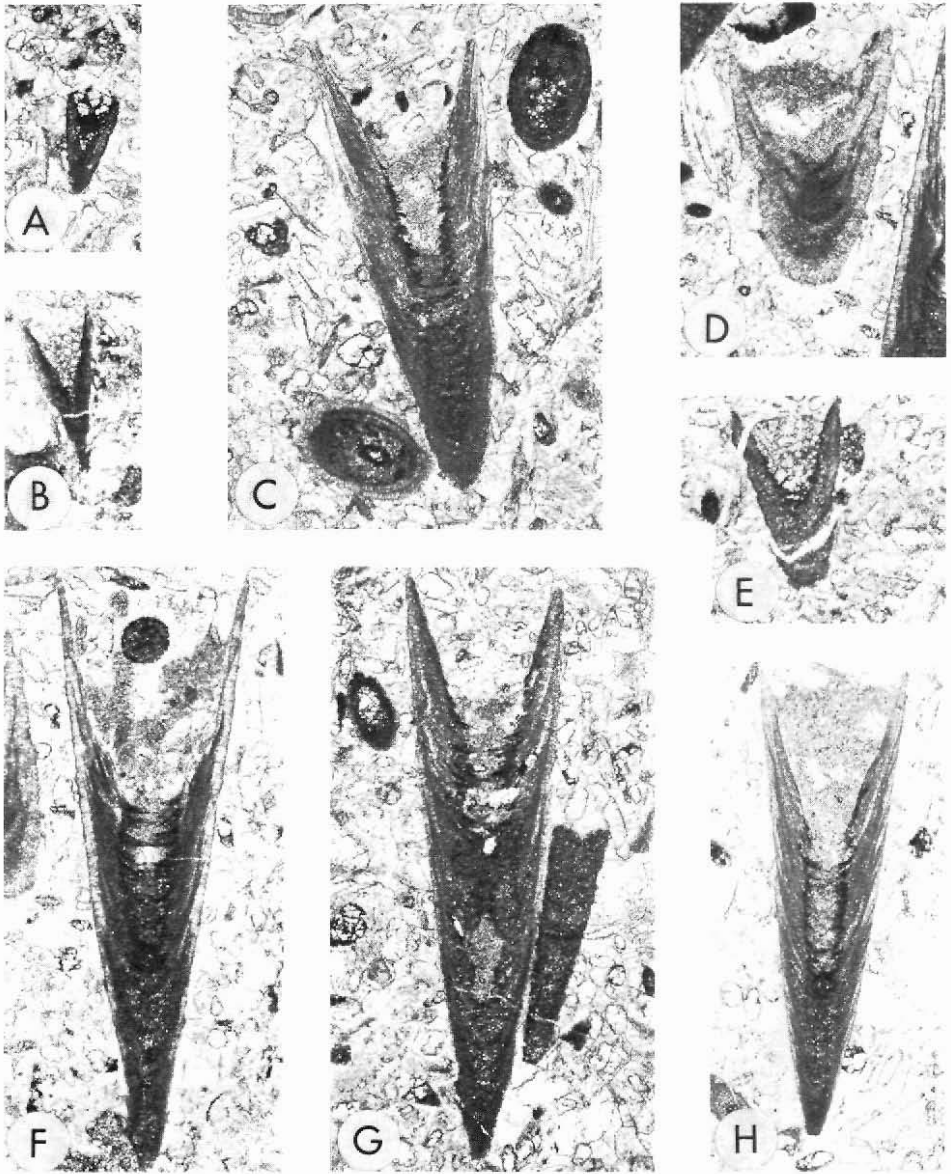


Fig. 3. *Salterella maccullochi*, Hyolithus Creek Formation, Kap Weber, northern East Greenland, $\times 10$. A–H, MGUH 15.913–15.920. Specimens collected by J. W. Cowie, locality 77.

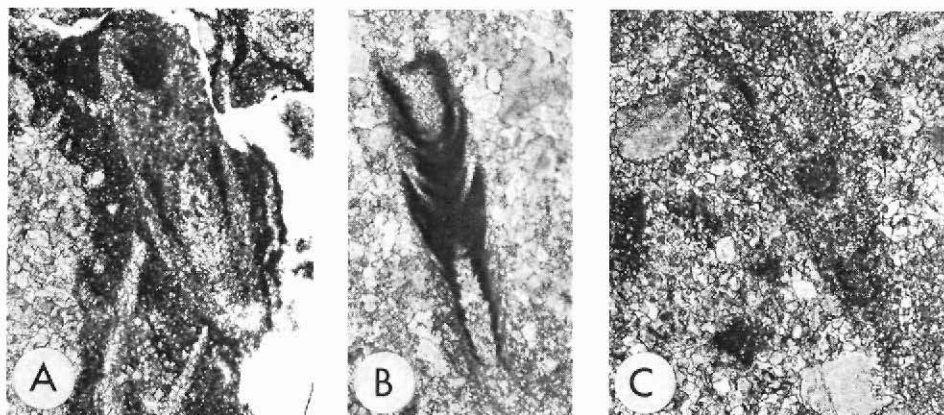


Fig. 4. *Salterella maccullochi*, Hyolithus Creek Formation, C. H. Ostenfeld Nunatak, northern East Greenland, $\times 10$. A–C, MGUH 15.895–15.897. Specimens collected by J. Haller, locality QERR.

Yochelson (in press) recently examined thin sections of specimens of *Salterella maccullochi* (Murchison, 1859) from the Northwest Highlands of Scotland and concluded that this, the first described species of *Salterella*, is a senior subjective synonym of *S. rugosa* Billings, 1861. The synonymy is currently extended to include all presently known specimens of *Salterella* from Greenland.

***Salterella* from Mexico**

Lochman (in Cooper *et al.*, 1952) gave the name *Salterella mexicana* to specimens from the Caborca region, Sonora, Mexico. These were illustrated in external view and as polished sections. One associated specimen was referred to *S. cf. S. pulchella* Billings, 1861 and some additional specimens were not determined to species. The material does not appear to have been redescribed subsequently, and we know of no additional records of *Salterella* from Mexico. Following examination of recently prepared thin sections, all the specimens are assigned to *S. maccullochi*. The single specimen of *S. cf. S. pulchella* is interpreted as a preservational variant, as tacitly implied by Lochman (in Cooper *et al.*, 1952, p. 88).

Systematic palaeontology

Phylum Agmata Yochelson, 1977

Family Salterellidae Walcott, 1886

Genus *Salterella* Billings, 1861

Type species. Salterella rugosa Billings, 1861.

Salterella maccullochi (Murchison, 1859)

Figs 3–6

Serpulites MacCullochii Murchison, 1859, p. 222.

Salterella rugosa Billings, 1861, p. 954, fig. 362.

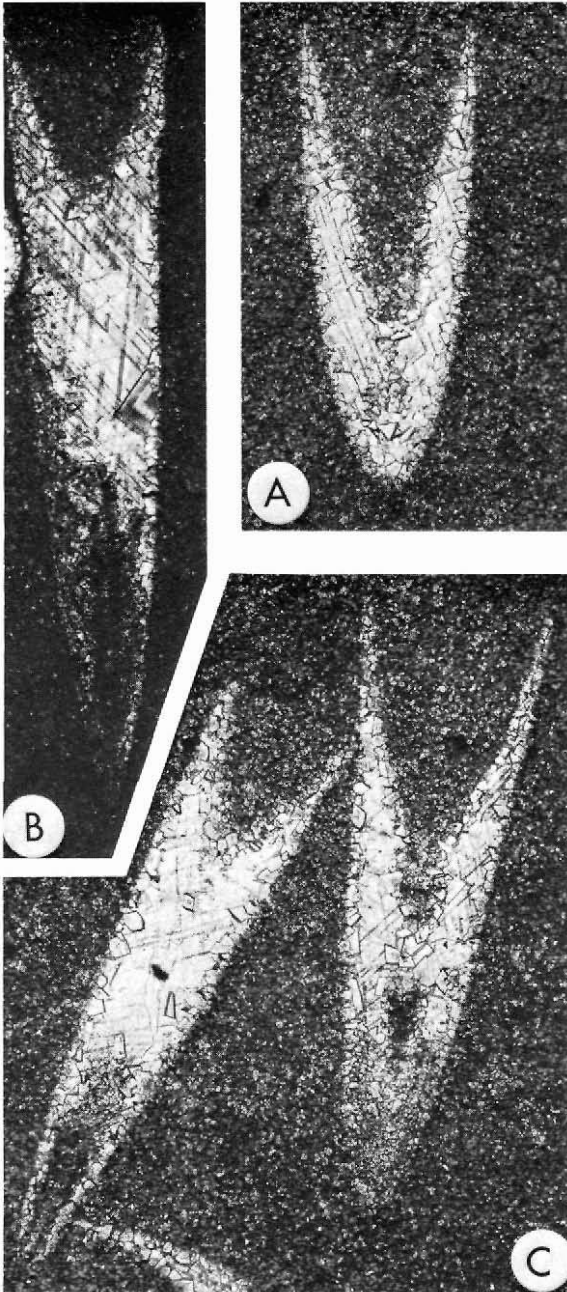


Fig. 5. *Salterella maccullochi*, Brønlund Fjord Group, formation 6, Paralleldal, central southern Peary Land, central North Greenland, $\times 10$. A–C, MGUH 15.921–15.924 from GGU sample 274910. Specimens collected by J. S. Peel.

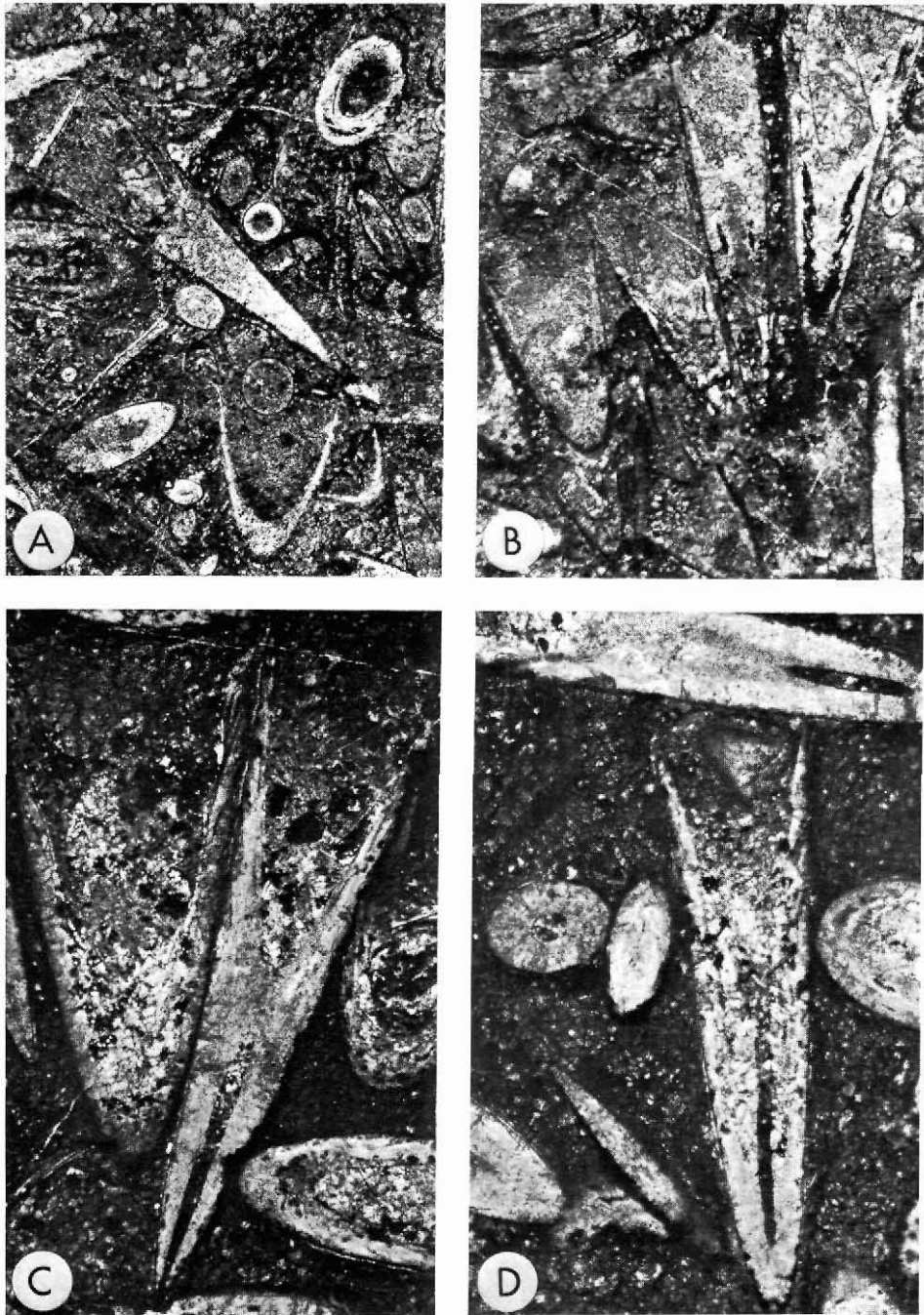


Fig. 6. *Salterella maccullochi*, Buelna Formation, Caborca, Sonora, Mexico. A, B, from USNM 115677a, b, a slab containing the holotype and one figured paratype of *S. mexicana*, $\times 10$. C, D, from USNM 115674 a-c, a slab containing figured paratypes of *S. mexicana*, $\times 15$.

- Salterella expansa* Poulsen, 1927, p. 251, pl. XIV, figs 10–12.
Salterella sp. ind., Poulsen, 1927, p. 251–2, pl. XIV, fig. 13.
Salterella rugosa, Poulsen, 1932, p. 32–34, figs 5, 6; pl. 7, figs 11–15; pl. 8, figs 1, 2.
Salterella mexicana Lochman in Cooper *et al.*, 1952, p. 85–87.
Salterella expansa, Poulsen, 1958, p. 10, pl. 1, figs 2, 3.
Salterella rugosa, Griffin & Yochelson, 1975, p. 221–227, figs 1–9.
Salterella rugosa, Yochelson, 1977, p. 442–448, pl. 1, figs 1–4; pl. 2, figs 1, 2–7; pl. 3, figs 4, 5.
Salterella rugosa, Yochelson & Peel, 1980, p. 33–35, figs 2–5.
Salterella maccullochi, Yochelson, in press.

Figured material. MGUH 15.913–15.920, from the Hyolithus Creek Formation, Kap Weber, northern East Greenland. MGUH 15.895–15.897, from the Hyolithus Creek Formation, C. H. Ostenfeld Nunatak, northern East Greenland. MGUH 15.921–15.924, from GGU sample 274910, Brønlund Fjord Group, formation 6 of Ineson & Peel (1980), central North Greenland. USNM 115674 a–c, 115677 a–b, from the Buelna Formation, Caborca, Sonora, Mexico.

Description. A full description of this species was given by Yochelson (in press). Descriptions and illustrations of *S. rugosa* were given by Yochelson (1977), Griffin & Yochelson (1975), and Yochelson & Peel (1980).

Discussion. The three collections of *Salterella maccullochi* illustrated here show contrasting states of preservation. Specimens from the Hyolithus Creek Formation at Kap Weber occur in limestone and are very well preserved (fig. 3). Details of the finer inner lamination and general structure of the conch are clearly visible. However, specimens showing breakage of the aperture and the apex are also present (fig. 3D, E). In marked contrast, the specimens of *S. maccullochi* from the Hyolithus Creek Formation at C. H. Ostenfeld Nunatak are poorly preserved in dolomite. Features of the inner lamination and the apertural cavity are discernible in the recrystallised carbonate, but the ‘ghosts’ visible in thin section are incomplete and often appear to lack the conch wall (fig. 4). In this respect, they resemble *Volborthella* Schmidt, 1888, long considered to be a separate genus but now known to be based on specimens of *Salterella* from which the outer wall has been removed by erosion or solution (Yochelson, 1977; 1981).

The specimens of *S. maccullochi* from North Greenland (fig. 5) are also preserved in dolomite. The matrix is an exceedingly tough, massive, pale buff grey dolomite which, in thin section, is seen to be weakly mottled. The conchs of *S. maccullochi* generally appear to be complete and outlines show well-preserved apices and apertural margins. However, the entire conch has recrystallised to spar and all details of internal structure have been lost (fig. 5).

It has now proved possible to examine thin sections of *S. mexicana* Lochman in Cooper *et al.*, 1952 (fig. 6). The species has previously been illustrated from polished sections and external views but the thin sections have only recently become available. After study of the thin sections, it is our conclusion that *S. mexicana* is also a junior subjective synonym of *S. maccullochi*.

Acknowledgments. We are grateful to the Dept. of Paleobiology, U.S. Natural History Museum, for permission to prepare thin sections from the type collection of *S. mexicana* (USNM prefix). MGUH denotes specimens in the type collection of the Geological Museum, Copenhagen.

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