SALTERELLA (EARLY CAMBRIAN; AGMATA) FROM THE SCOTTISH HIGHLANDS

by ELLIS L. YOCHELSON

ABSTRACT. *Serpulites maccullochi* Murchison, the earliest described species to be assigned to *Salterella*, is redescribed. Specimens are illustrated from thin sections from the Salterella Grit exposed on Loch Eriboll. Additional specimens are illustrated from the overlying Ghrudaidh Formation, there and at several other localities. Specimens from the Salterella Grit of *Salterella maccullochi* are identical to *Volborthella tenuis* from Estonia and that species is placed in the synonymy of *Salterella maccullochi*. The species is a senior synonym of *S. rugosa* Billings, *S. expansa* Poulsen, and probably *S. mexicana* Lochman.

A SMALL conical fossil, now known as *Salterella*, has been reported from the Scottish Highlands for almost a century and a half, yet it has been little studied. In an area where fossils are sparse, neglect of this form is curious. It is an indicator of the late Early Cambrian (*Bonnia–Olenellus* zone), and the limited vertical distribution of *Salterella* in eastern North America is strongly suggestive that it ranged only through an extremely short time interval during the Early Cambrian.

AUTHORSHIP, ORTHOGRAPHY, AND TYPE LOCALITY OF *SERPULITES MACCULLOCHI*

Tubes of a minute organism were found nearly a century and a half ago by geologists working in the Scottish Highlands and were interpreted as minute cephalopods. The geologic section at Skiag Bridge, near Inchnadamph, and discovery of this same fossil near there were mentioned in early accounts of the geology. Nevertheless, from the standpoint of nomenclature, the only significant literature is that which first mentions a specific name. Murchison (1859*a*, p. 222) was the first to do so; he wrote: 'The minute Annelide before spoken of as abounding in the quartz rocks of the N.W. Highlands is here figured. Although the tube is thicker in proportion than in any known species of Serpulites, it is here provisionally referred to that genus, and is named Serpulites MacCullochii, after the distinguished geologist who first noticed it.'

The figure caption of an accompanying woodcut gives to the left of figure 'Small, thick shelly tubes of Annelides (Serpulites? MacCullochii)'. To the right is recorded 'Collected from the Lower Quartz-rock of Durness, Sutherland, by Mr. C. Peach'.

Later in the same year, Murchison (1859*b*, p. 366) wrote: 'The minute cylindrical bodies which Macculloch supposed to be Orthoceratites have completely satisfied Mr. Salter that they belong to the class of sea-worms. I have therefore named them, in the new edition of "Siluria" (1859*a*, p. 222) *Serpulites Maccullochii*, in honour of the first discoverer of the oldest perceptible organic remains of the Highland Rocks.' The legend to plate 13, figure 31, is '*Serpulites*? *MacCullochii*, Murchison. In a mass of sandstone. These thick, short, free annelide-tubes are very common in the quartzose sandstones of Durness.' This illustration is of a different size and shape than the one used in *Siluria*; the fossils on it are somewhat larger. Within the article, a section on 'Fossils of the Durness Limestone' is attributed to J. W. Salter, but the quote given above is not included in that section, nor is the fossil in question mentioned.

Billings (1861, p. 954), after naming the genus *Salterella* and the species *S. rugosa*, wrote: 'This species must be closely allied to *Serpulites Macullochi* (Salter), but upon an average they are smaller than those figured by Salter in Jour. Geol. Soc. Vol. XV, Pl. 13, fig. 31.'

[Palaeontology, Vol. 26, Part 2, 1983, pp. 253–260, pls. 34–35.]

A few years later in the fourth edition of *Siluria*, Murchison (1867, p. 166) wrote: 'Although the tube of this Salterella (Billings) is thicker in proportion than in any known Serpulites, it was provisionally referred in my last edition to that genus, and named, at my request, Serpulites Maccullochii by Mr. Salter, after the distinguished geologist who first noticed it.' The same lithographic plate used in the third edition of *Siluria* is reproduced, and the material in the caption is identical, except the illustration is referred to as 'Salterella Maccullochi, Salter'.

With so many interesting variants in the name of a Scottish geologist, one is hard pressed to pick the best. Fortunately, it is possible to invoke the principle of first usage. Rules on punctuation and endings as currently treated by the International Code of Zoological Nomenclature indicate that the species name ought to be rendered today as *Serpulites maccullochi*.

The authorship is clear-cut, for the specific name must be attributed to Murchison as the first person to propose it in such a way as to fulfil the requirements of availability. That the scientific underpinnings of *S. maccullochi* Murchison were supplied by Salter, I have no doubt. He was a great figure in British paleontology, and Murchison recognized his contributions. Nevertheless, Murchison is unquestionably the author of this specific name. My private suspicion is that Salter may have done a fair amount of ghost writing for Murchison, but, for nomenclatural purposes, that is irrelevant.

In the current geologic literature of the north-west Highlands of Scotland, 'Fucoid Beds' still appears, and this name for a stratigraphic unit can be readily traced back to Murchison's work. The overlying quartz rock became known as the Serpulite Grit, and, in turn, as the Salterella Grit. This grit is overlain by a carbonate unit, the Ghrudaidh Formation, the lowest part of the Durness Group (Cowie *et al.* 1972); the contact between the two is gradational with thin beds of limestone and of siltstone alternating for about a meter. The information accompanying the original woodcut indicates that the *Salterella maccullochi* was originally described from the unit now known as the Salterella Grit. At Inchnadamph, *Salterella* occurs within the Ghrudaidh, but that locality is not the type locality although MacCullough and Peach collected there.

West of Durness, between Balnakiel Bay and the Kyle of Durness, the beds underlying the carbonates of the Durness Group barely crop out along the shore; the area is an exposed headland and is difficult of access except in very good weather (J. W. Cowie, oral comm., 1978). This area is probably where Peach collected the *Salterella* illustrated by Murchison (1859*b*). The same sequence crops out on An-t-Sron ('The nose') on the east side of Loch Eriboll, about 10 km to the east along the strike. In his discussions Murchison (1859*b*) differentiated Loch Eriboll from Durness and thus it is out of consideration as the type locality.

None of my material is from Durness as defined in a strict sense, but the Loch Eriboll section is so similar to the Durness one that I am confident that systematic conclusions based on fossils from there may be drawn with confidence and applied to the type. Throughout north-west Scotland, the Lower Cambrian section is thin, and *Salterella* is probably limited to an interval of 15–20 ms in the upper part of the Salterella Grit and the lower part of the Ghrudaidh Formation combined (Cowie 1974, pp. 130–137). None of the holdings of *Salterella* in the British Museum of Natural History or the Institute of Geological Sciences refer to the shore at Durness. The type lot illustrated by Murchison (1859*b*) cannot be identified with certainty and may have been lost.

Although it has nothing to do with the matters directly at hand, a footnote by Murchison (1867, p. 166) touches on the history and biology of *Salterella*:

'Speaking of these obscure little fossils, in a lecture on the Geology and Scenery of the North of Scotland (1866), Professor J. Nicol says (p. 31), "In the quartzite period organic life undoubtedly existed. Twoscore years ago Dr. Macculloch pointed out curious conical hollows, ending in long pipe-like bodies. These he described as Worm-holes, the prototypes of those seen on the shore, where the Lobworm sinks into the sand left dry by the retiring tide" (Geol. trans. vol. ii, p. 461). We have seen other, smaller holes identical in form with the holes which some small Crustacea on the Kyle of Durness are now digging in the sand washed out of these very rocks. The same sand is now lying in the same place, and beings of like organization are still burrowing it out for food or shelter. Yet the mind almost refuses to grasp the myriad ages that have intervened. The poor worm or insect in its daily

occupation was building itself a monument "aere perennius"—a tomb more enduring than king or kaiser. The moral needs not be drawn.'

SALTERELLA FROM THE SALTERELLA GRIT

The small fossil *Serpulites maccullochi* Murchison is described as follows: of simple conical shape, the walls diverging at an angle near 20°; apex simple and with same angle of divergence as sides. Cone laminated, with a variety of small grains arranged in layers, the laminae diverging from a narrow central tube, which extends through all laminae, at an angle of about 45°. The various features mentioned above are illustrated in Pl. 34, figs. 1 and 2, and Pl. 35, fig. 2.

This descriptive information is derived from the illustrated thin sections and others, all of which were cut from a fine-grained quartzite. Many specimens have been distorted and most are worn. So far as I can determine, all specimens from the outcrop at An-t-Stron fall within a single species. Because of accumulation of small grains which collectively are far larger and much darker than the arenaceous matrix, the specimens of *Salterella* are prominent in thin section. On the outcrop they are abundant but only in quite thin scattered layers; their distribution supports the observation that most, if not all, specimens are transported. All the material illustrated from the Salterella Grit is from an interval of less than 10 cm and not all of that thickness contained fossils.

In addition to the material I collected, I have examined weathered specimens from An-t-Sron in the collections of the British Museum of Natural History and Institute of Geological Sciences, London. Some material housed in Edinburgh was also sectioned in connection with this study; collection GSE 5396 located only as 'Loch Broom, Ullapool' in what is lithically the same as the Salterella Grit, also contains this species.

As will be developed, it is my view that the specimens in the Salterella Grit are quite incomplete in that there is nothing preserved to retain the laminae. Although it is within the realm of possibility that an organic sheath was present, I prefer the view that a calcium carbonate shell was present but that all specimens have lost it as a result of solution or transport, or both.

SALTERELLA FROM THE GHRUDAIDH FORMATION

In contrast to the specimens in the Salterella Grit, those in the overlying Ghrudaidh at An-t-Sron are not nearly so readily differentiated from the matrix. Although specimens are abundant, finding good ones is difficult. Many of the specimens are secondarily deformed, and some show evidence of partial recrystallization and solution. Representative individuals are shown in Pl. 34, fig. 5 and Pl. 35, fig. 3. In part, because of recrystallization of the laminae, the central tube is seldom seen but was observed in several thin sections.

Material from the type locality of the formation near Ghrudaidh Farm is a bit less deformed. The farmhouse is long abandoned, but its ruins are still preserved about 4 km south of the village of Durness. Along the shore of the Kyle of Durness at the spot indicated by 517 on the map of Peach and Horne, a carbonate unit was collected. A specimen is illustrated in Pl. 35, fig. 4.

Finally, some specimens 0·4 km south of Skiag Bridge, or 3·1 km north of the hotel at Inchnadamph, are illustrated in Pl. 34, figs. 2 and 3, and Pl. 35, fig. 1. These specimens are also moderately well preserved. Collectively these show that a species of *Salterella* occurs in this formation which has straight tapering sides, expanding at an angle of about 20°. Internal laminae are composed primarily of grains of calcium carbonate, but a few impurities do occur in some specimens. In addition, as noted at An-t-Sron in the Ghrudaidh, some specimens show no outer wall and are broken at the aperture and apex; the central specimen on Pl. 35, fig. 1, is representative of what one is likely to find in the average thin section.

Overall, finding a well-preserved specimen in the Ghrudaidh is difficult. Many are corroded on the edges, some are partially broken at the aperture, and still others are coated with algae. Nevertheless, one gains the impression that only a single, narrowly conical, species is present.

In addition to the straight-sided *Salterella*, another rare fossil has been seen in thin section. It might be a curved species of *Salterella*, it might be a badly deformed example of the poorly known *S. pulchella*, or it might be completely unrelated. The material is not adequate to describe at this time, or even to illustrate.

JUNIOR SYNONYMS OF *SALTERELLA MACCULLOCHI*

I have indicated in this paper that *S. maccullochi* occurs in a carbonate unit as well as in a fine siltstone. If, as suggested, the organims filled the tube with whatever particles were available (Yochelson 1977), principal specific features must be drawn from the external shape, not from the material filling the inner laminae. It is also evident that the kind of material does have secondary effects. Thus, those cones filled with calcium carbonate may deform whereas those filled with more discrete grains will break, in the same way that sandstones and carbonates react differently to the same geological forces.

If one allows for variation in the infilling, one has no alternative but to place several names in synonymy. Comparison of type material convinces me that *S. rugosa* Billings, the type species of the genus, is a junior synonym of *S. maccullochi*. *Salterella expansa* Poulson was earlier placed in the synonymy of that name (Yochelson and Peel 1980). If one allows for a lamination which is composed almost exclusively of calcium carbonate, it follows that *S. mexicana* Lochman (1952) is a synonym of *S. maccullochi*. The geographic gap between this form described from Sonora and *S. rugosa* from Labrador is lessened by the inclusion of undescribed specimens from southern Pennsylvania (Yochelson *et al.* 1968) and what was then called *Salterella* new species from south-western Virginia (Byrd *et al.* 1973). Additional documentation may be needed to confirm the identity of the excellent specimens from Mexico and the substantially poorer ones from northern Scotland.

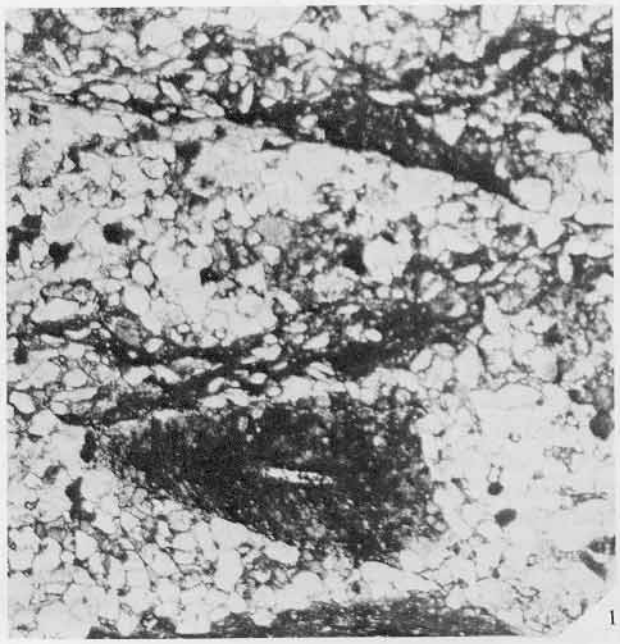
SALTERELLA AND *VOLBORTHELLA*

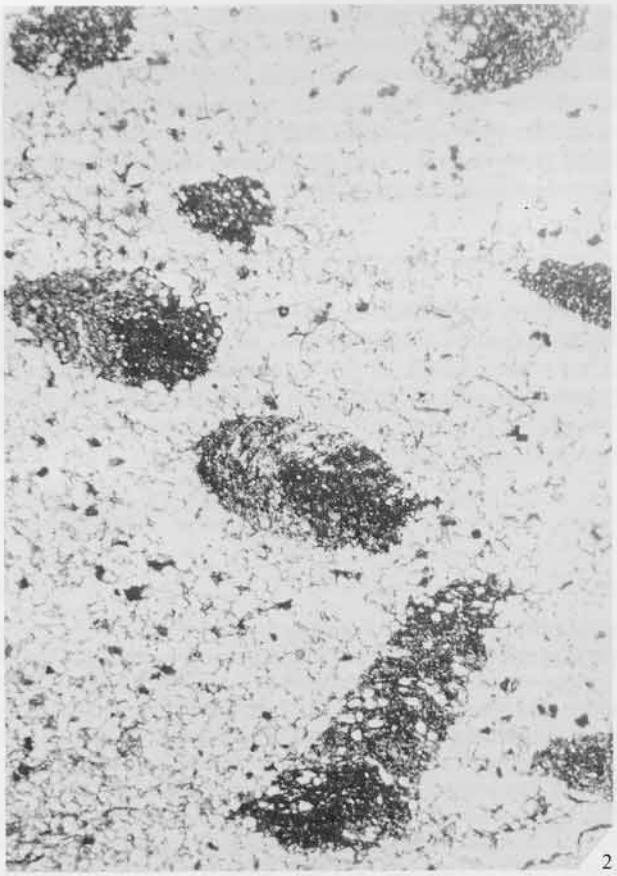
I have contended (Yochelson *et al.* 1970; Yochelson, 1977) that *Volborthella* from the Baltic region and *Salterella* may be the same organism, only affected differently by diagenesis. The material from northern Scotland seems to confirm this argument.

The Salterella Grit contains specimens that European specialists would identify as characteristic *Volborthella*. One individual, shown in Pl. 34, fig. 1, is identical in every aspect that I am aware of to *V. tenuis* Schmidt. Within the same rock occur more elongate specimens of *Salterella*, lacking only the outer calcareous shell (Pl. 35, fig. 2).

EXPLANATION OF PLATE 34

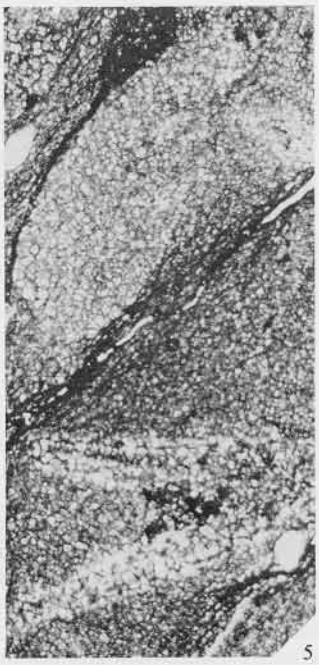
Figs. 1–5. Thin sections of *Salterella maccullochi* (Murchison) from the areas of Durness and Inchnadamph, Scotland. 1, two individuals in longitudinal section under polarized light, the one below having all the other characteristics of *Volborthella tenuis* Schmidt, and the one above, a V-shaped piece of calcite, which appears dark in the illustration, partly penetrated by grains from the matrix, having the shape and size of the apical area of a *Salterella*; from the Salterella Grit at An-t-Sron, ×25. USNM 311433. 2, specimens in various orientation and degree of wear, but showing the inner laminated area and thicker material filling the apertural cavity; from the Salterella Grit at An-t-Sron, × 15. USNM 311431. 3, cross-section of a specimen: the outer wall is sparry calcite, the area of inner laminations appears dark, and the lower part of the apertural cavity or the uppermost part of the connected central tube is sparry calcite; from the Ghrudaidh Formation at the top of a small road-cut just south of Skiag Bridge, Inchnadamph, × 15. USNM 311436. 4, longitudinal section of a small specimen; from the Ghrudaidh Formation at the top of a small road-cut just south of Skiag Bridge, Inchnadamph, × 15. USNM 311437. 5, below, a better-preserved specimen with the outer wall obvious; and above, a slightly distorted specimen with only the inner laminae preserved. The figure is rotated about 45° to the bedding so as to fit the illustration into the available space; from the Ghrudaidh Formation at An-t-Sron, × 15. USNM 311434.


1


2


3


4


5

YOCHELSON, *Salterella*

Although the Salterella Grit is a quartz siltstone, rare pieces of calcite occur. These are smaller than the *Volborthella* specimens. The pieces are essentially triangular, the sides diverging at an angle of 15°–20°. If one is willing to allow for some pressure solution of the sides and intrusion of individual quartz grains, these pieces can be interpreted as the apical portions of the *Salterella* shell, too small to show the characteristic infilling of detrital particles. It is impossible to rule out these occurrences as being calcite cement in the siltstone, but their rarity in the general matrix, their occurrence in the same laminae as those containing *Volborthella*, their orientation parallel to the *Volborthella*, and their consistency of shape regardless of the size or shape of surrounding quartz grains is to me strong evidence that these pieces of calcite are of organic origin. Because the type locality for *V. tenuis* Schmidt is in the non-indurated Blue Clay (Lükati Formation) of Estonia, I see little prospect of ever finding calcium carbonate remnants of shell in that matrix. It seems a lucky chance which has left some calcium carbonate in the Salterella Grit. It is an even luckier chance that left a *Salterella* fragment adjacent to as typical a *Volborthella* as one could hope to find (Pl. 34, fig. 1).

In addition to these two occurring together in the Salterella Grit, as further illustrated herein, *Volborthella* and *Salterella* occur intermixed in the overlying Ghrudaidh Formation. Because the Ghrudaidh is a carbonate unit, specimens filled the cone with carbonate detritus. However, a few individuals of *Salterella* do show the presence of sparse non-carbonate detritus in a calcium carbonate conical shell (Pl. 35, fig. 3). Worn specimens of 'pure *Volborthella*' occur in the same thin sections from Durness as *Salterella* (Pl. 35, fig. 5). To me this is the final piece of evidence needed to equate the two generic names. At several localities on Svalbard (Lauritzen and Yochelson 1982) these two preservational forms also occur together.

In order that there be no ambiguity in my position, on the basis of the evidence presented here, I formally place *V. tenuis* Schmidt in the synonymy of *S. maccullochi* (Murchison); the generic name *Salterella* has priority. I do not believe that any systematist can find a significant difference between topotypes of *V. tenuis* and of *S. maccullochi*. After looking at a number of collections, I have no reason to believe that more than one species of *Volborthella* exists, in spite of the fact that several varieties or subspecies have been named from the type area in Estonia. Further, I suggest that the various occurrences in eastern Europe are all of *S. maccullochi*.

STRATIGRAPHIC IMPLICATIONS

The occurrence of *Salterella* in the Scottish Highlands is within the zone of *Olenellus*; though trilobites are rare in the region, they do occur in the key stratigraphic sections (Cowie and McNamara 1978). In the outcrops in North America where *Salterella* can be dated by other fossils (Yochelson 1981), as well as in the Scottish Highlands, the genus is in beds of younger Early Cambrian age.

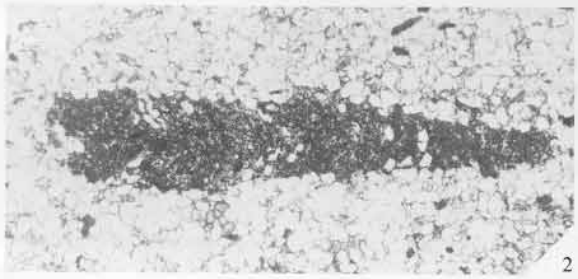
The range of *Volborthella* (A. Yu Rozanov, oral comm., 1974) is supposed to be throughout the Atdabanian and into the lower part of the Lenian, coincident with the *Holmia* zone; in his view, it

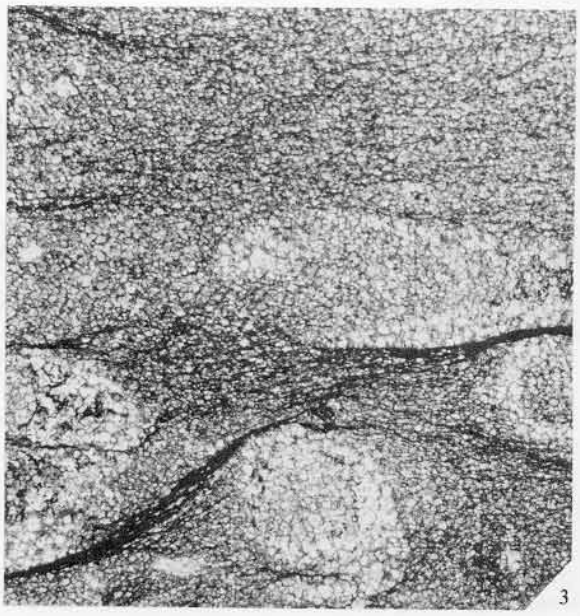
---

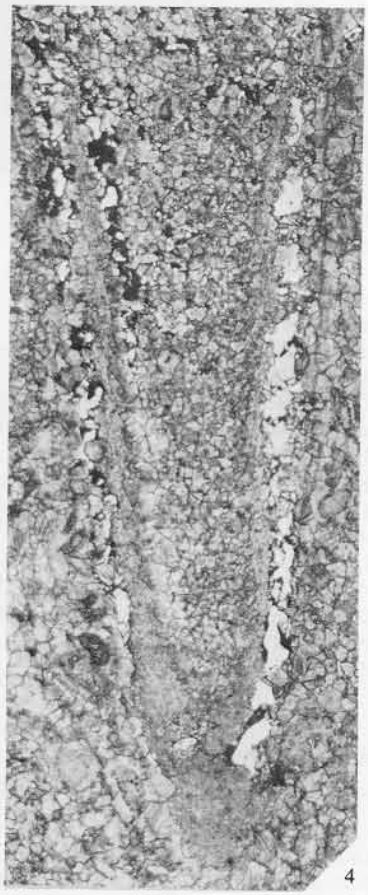
EXPLANATION OF PLATE 35

Figs. 1–5. Thin sections of *Salterella maccullochi* (Murchison) from the areas of Durness and Inchnadamph, Scotland. 1, abundant specimens in varying orientations and varying degrees of wear; from the Ghrudaidh Formation at top of a small road-cut, just south of Skiag Bridge, Inchnadamph, Scotland. USNM 311436. 2, a worn specimen in longitudinal section, showing many laminae; from the Salterella Grit at An-t-Sron, × 15. USNM 311429. 3, to the right, a longitudinal and a transverse section showing the outer wall and, to the left, several partly deformed individuals lying just above a small scour; these specimens of '*Volborthella*' are composed mostly of calcium carbonate, but a few dark grains are included in the partly recrystallized laminae; from the Ghrudaidh Formation at An-t-Sron, × 15. USNM 311433. 4, longitudinal section of an unusually well-preserved specimen, turned at right angles to the bedding; from the type locality of the Ghrudaidh Formation at Ghrudaidh Farm south of Durness. The light areas prominent on the right side are sparry calcite, × 15. USNM 311435.


1


2


3


4

YOCHELSON, *Salterella*

extends upward to overlap slightly the range of *Salterella*, which presumably occurs throughout the Lenian and Elankian, being most abundant near the boundary between these two stages.

As documented herein, there is no difference of biologic significance between the genera, and, I stand firm that there is no difference between *S. maccullochi* and *V. tenuis*. If my interpretation is correct, there is no reason to think the occurrences of '*Volborthella*' in the Baltic area are of any different age than those in the Salterella Grit. Thus, I would place the Norden '*Volborthella*' within the *Bonnia–Olenellus* zone, although they are conventionally dated as older.

Acknowledgements. I thank Dr. and Mrs. John Cowie, Bristol University, for providing lodging at Durness, Scotland, during April 1978. Without the guidance of Dr. Cowie in the field, probably no *Salterella* would have been found. Dr. Michael Bassett provided transportation to Durness and was an able field companion. Dr. A. W. A. Rushton, Institute of Geological Sciences (IGS), London, allowed me to examine fossils under his care, and Dr. R. B. Wilson, IGS, Edinburgh, lent additional collections in his charge. Dr. J. Pierce, Museum of Natural History, Washington, DC, USA, provided insight on sedimentary petrology. Thin sections and photomicrographs were prepared by Mr. Keith Moore, US Geological Survey.

REFERENCES

BILLINGS, E. 1861. On some new or little known species of Lower Silurian fossils from the Potsdam group (Primordial zone). *In* HITCHCOCK, E. (ed). *Report on the geology of Vermont; descriptive, theoretical, economical, and scenographical*, 942–955. [This material is repeated with some minor changes in *Paleozoic Fossils*, **1.** Geological Survey of Canada, 1865. Descriptions of *Salterella* on pp. 17–18 of that work are unchanged from pp. 954–955 of the 1861 reference.]

BYRD, W. J., WEINBERG, E. L. and YOCHELSON, E. L. 1973. *Salterella* in the Lower Cambrian Shady Dolomite of southwestern Virginia. *Am. Jl. Sci.* **273** (A), 252–260.

COWIE J. W. 1974. The Cambrian of Spitsbergen and Scotland. *In* HOLLAND, C. H. (ed.). Cambrian of the British Isles, Norden, and Spitsbergen. 123–183. *Lower Palaeozoic Rock of the World*, **2,** John Wiley & Sons, London, New York, Sydney, Toronto.

——and MCNAMARA, K. J. 1978. *Olenellus* (Trilobita) from the Lower Cambrian of North-West Scotland. *Palaeontology*, **21,** 615–634.

——RUSHTON, A. W. A. and STUBBLEFIELD, C. J. 1972. Cambrian. *Geol. Soc. London Spec. Rept.* **2,** 1–42.

LAURITZEN, Ø. and YOCHELSON, E. L. 1982. *Salterella rugosa* (Early Cambrian: Agmata) on Nordanstlandet and Spitsbergen, Svalbard. *Polar Research*, **1,** 1–10.

LOCHMAN, C. 1952. Trilobites. *In* COOPER, G. A. *et al.* Cambrian stratigraphy and paleontology near Caborca, Northwestern Sonora, Mexico. 60–161. *Smithsonian Misc. Coll.* **119** (1), 1–184.

MURCHISON, R. I. 1859*a* *Siluria, the history of the oldest fossiliferous rocks and their foundations; with a brief sketch of the distribution of gold over the earth*, 3rd edn., John Murray, London, 592 pp.

——1859*b*. On the succession of the older rocks in the northernmost counties of Scotland, with some observations on the Orkney and Shetland Islands. *Proc. Quart. Jl. Geol. Soc. London*, **15,** 352–418.

——1867. *Siluria*, 4th edn., John Murray, London. 566 pp.

YOCHELSON, E. L. 1977. Agmata, a proposed extinct phylum of early Cambrian age. *Jl. Paleont.* **51,** 437–454.

——1981. A survey of *Salterella* (Phylum Agmata). *U.S. Geol. Survey Open-file Report*, **81-743,** 244–248.

——and PEEL, J. S. 1980. Early Cambrian *Salterella* from north-west Greenland. *Grønlands Geol. Unders. Rap.* **101,** 29–36.

——TAYLOR, M. E. and CLOSS, E. 1968. The Lower Cambrian genus *Salterella* at Thomasville, Pennsylvania. *Geol. Soc. America, Northeastern Sect., 3rd Ann. Meeting, Washington, D. C., Program*, p. 64 (abstract).

——PIERCE, J. W. and TAYLOR, M. E. 1970. *Salterella* from the Lower Cambrian of central Nevada. *U.S. Geol. Survey Prof. Paper*, **643-H,** H1–H7.

ELLIS L. YOCHELSON
US Geological Survey
E-501 Museum of Natural History
Washington, DC 20560, USA

Typescript received 20 September 1981
Revised typescript received 15 March 1982

Note added in proof: *Salterella mexicana* Lochman has been placed in synonymy of *S. maccullochi* by J. S. Peel and E. L. Yochelson, 1982. A review of *Salterella* (Phylum Agmata) from the Lower Cambrian in Greenland and Mexico. *Grønlands Geols. Unders. Rap.* **108,** 31–39.