

Correction: proposal of the four global series of the Cambrian

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The superb *Bulletin of Geosciences* issue (2011, Volume 86, Number 3) compiled by Oldřich Fatka has a review article on the 50-year history of accomplishments of the International Subcommittee on Cambrian Stratigraphy (Peng & Babcock 2011). One part of their discussion, subtitled “Four-fold subdivision of the Cambrian established”, correctly notes that the Subcommittee voted to subdivide the Cambrian System into four series and ten stages (Peng & Babcock 2005, Babcock *et al.* 2005) following a plan outlined by Peng (2004). Peng & Babcock (2011, p. 392) noted that this four-part subdivision was “prompted by some specialists (*e.g.*, Palmer 1998),” but failed to note the much earlier development of the concept of four series-level divisions of the Cambrian. (In this report, “Lower”/“Early,” “Middle”/“Middle,” and “Upper”/“Late” Cambrian are informal subsystem and subperiod divisions that equal the Terreneuvian + Series/Epoch 2, Series/Epoch 3, and Furongian Series/Epoch, respectively; Landing 2007.) In accordance with the rules of stratigraphic nomenclature, the two or three major divisions of a system or period must be capitalized (North American Commission on Stratigraphic Nomenclature 1983, Salvador 1994).

The utility and reality of four Cambrian series was first proposed based on the study of stratigraphic successions on the non-Gondwanan, insular Avalon continent (*e.g.*, Landing 1996, 2005). In particular, the traditional Lower Cambrian of Avalonian North America and southern Britain was noted to consist of two “natural” divisions: a lower part that extended from the basal Cambrian GSSP in southeastern Newfoundland (Narbonne 1987, Landing 1994) up to a regional unconformity with the overlying, trilobite-bearing Lower Cambrian. Landing *et al.* (1989) termed this Avalonian sub-trilobitic Lower Cambrian the Placentian Series, and correlated it on the basis of small shelly fossils with the Siberian pre-trilobitic “Nemakit-Daldynian”

Stage and overlying Tommotian Stage and into the trilobite-bearing, lowest Atdabanian Stage. The overlying, trilobite-bearing Lower Cambrian of Avalon was later named the Branchian Series by Landing (1992).

The Placentian and Branchian series plus the traditional Middle Cambrian (Acadian Series) and Upper Cambrian (Merionethian Series) meant that the Cambrian of Avalon comprised four regional series (Landing *et al.* 1989). Subsequently, the lower Lower Cambrian series was formalized as a global Terreneuvian Series with a lower Fortunian Stage (Landing *et al.* 2007). The upper part of the Terreneuvian remains as an informal “Stage 2,” and this stage is associated with the appearance of diverse small shelled metazoans as represented in the “type” *Watsonella crosbyi* Zone of Avalon (Landing *et al.* 1989; see also Zhu *et al.* 2006, 2008).

W.H. Fritz (*in* Fritz *et al.* 1991) later followed a similar approach to the series-level subdivision of the Cambrian on the Laurentian paleocontinent. He referred sub-trilobitic Lower Cambrian strata to the Placentian Series and limited the traditional Lower Cambrian of Laurentia, the Waucoban Series, to include part of the trilobite-bearing Lower Cambrian. Fritz *et al.* (1991) defined the Waucoban’s base by the lowest occurrence of nevadiid trilobites. These two Lower Cambrian series, the Placentian and Waucoban, and the traditional Middle and Upper Cambrian series made for a total of four regional Cambrian series in Laurentia.

Palmer (1998), in a series of papers edited by Landing (1998b), cited the Fritz *et al.* (1991) proposal in his proposal of a revised Laurentian Cambrian chronostratigraphy. Uncertainty about intercontinental correlation of the Placentian Series led Palmer (1998) to name a sub-trilobitic Begadean Series. Palmer (1998) also expanded the concept of the Waucoban Series by redefining its base at a lower horizon than that specified by Fritz *et al.* (1991). Palmer (1998) defined the base of the Waucoban Series at the lowest occurrence of Laurentian trilobites – the purported fallotaspid trilobites of eastern California and adjacent Nevada. Hollingsworth (1999) has summarized the strengths of these alternative definitions of the Waucoban Series.

The proposal of four global, not regional, Cambrian series first appeared as a section titled *Four Cambrian series and a Lower Cambrian Subsystem* (Landing 1998b) in the galley of the program of the 1997 Cambrian Subcommittee meeting in Avalonian eastern Newfoundland

and southern New Brunswick. The program volume was published in early 1998 (Landing 1998a). No names were proposed for the four global Cambrian series, but their sequence corresponded to the sub-trilobitic Lower Cambrian, trilobite-bearing Lower Cambrian, and Middle and Upper Cambrian series as long recognized on the modern continents. In order to conserve and maintain the traditional tripartite division of a Cambrian that has four global series, the sub-trilobitic and trilobite-bearing Lower Cambrian series were regarded as a Lower Cambrian subsystem. Similarly, subsystem status was proposed for the temporally much shorter, traditional middle and upper parts of the Cambrian (Landing 1998a).

A seeming small error in reporting the development of scientific syntheses (*i.e.*, Peng & Babcock 2011) has a greater significance than that of clouding a correct history of science in an article and journal of international record. It also transcends any sense of being “overlooked”. Of greater importance is that the proposal of four global series emphasizes that the small Avalon continent is particularly vital to Cambrian syntheses for the insights it provides into the importance of litho- and biofacies relationships on fossil distributions, the record of the Cambrian evolutionary radiation, and evidence of global diachroneity in the earliest occurrences of taxa with potential in global correlation. The Avalon Cambrian also shows the often exceptionally long stratigraphic ranges of many taxa, emphasizes the relatively condensed nature of Cambrian successions on many other paleocontinents, and has provided comparatively numerous U-Pb zircon dates from volcanic ashes. These volcanic ashes show that the Terraneuvian, the lowest Cambrian series (Landing *et al.* 2007), represents about 20 m.y. of time and is about as long as the Silurian, while the presently unnamed, typically trilobite-bearing Series 2 represents about 10 m.y. The *ca* 30 m.y. of the Lower Cambrian comprises more than half of the period, and reflects the dramatic biotic and geologic history that took place during the first two of the four Cambrian epochs (*e.g.*, Landing 1994; Landing *et al.* 1998, 2000; Landing & Westrop 2004).

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