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Pridolian to Eifelian history of the Rhenish Sea in the mirror of brachiopod evolution (Rhenish Massif, Germany)

JANSEN, U.

Forschungsinstitut Senckenberg, Senckenberganlage 25, D-60325 Frankfurt am Main, Germany; *ulrich.jansen@senckenberg.de*

The Pridolian to Eifelian succession of the Rhenish Massif (Germany) documents the history of an extensive siliciclastic shelf sea along the southern border of Laurussia. Recent studies on articulate brachiopods from this area have resulted in a constantly growing knowledge on brachiopod systematics, biostratigraphy, palaeobiogeography and palaeoenvironment (JANSEN 2001, POSCHMANN & JANSEN 2003, WEHRMANN *et al*. 2005, SCHEMM-GREGORY & JANSEN 2005 and 2006a, b and 2007). In connection with detailed taxonomical studies, it is intended to establish a high-resolution brachiopod stratigraphy applicable to different facies and a correlation with successions outside the Rhenish Massif. Due to correlation problems, it is unavoidable to still use the regional Rhenish chronostratigraphy (units below in quotation marks). Different faunas typified by spiriferid taxa can be distinguished:

The Pridolian *Quadrifarius dumontianus* fauna represents the first marine fauna after the Caledonian orogeny and documents a widespread transgression visible in various sections of the Rhenish area (e.g. in the Taunus and Eifel areas). The transgression also reaches the Artois area (N France) and Podolia where very similar faunas occur. It is followed by the early Lochkovian (="Early Gedinnian" according to the regional subdivision) *Howellella mercurii* fauna whose spatio-temporal complexity is still little understood. The "Upper Gedinnian" to "Lower Siegenian" represents a regressive interval characterised by deltaic to terrestrial palaeoenvironments very poor in brachiopods. Fortunately, this gap is filled by phylogenetically linked brachiopods in the Moroccan Anti-Atlas and in the Cantabrian, Celtiberian and Armorican sections (CARLS 1987, JANSEN 2001).

The regressive period ends with a short-time transgressive event that is indicated by the onset of the "Middle Siegenian" *Multispirifer solitarius* fauna. A wealth of brachiopods, bivalves, trilobites, and even bryozoans and corals occur. In my opinion, this level possibly correlates with the *kitabicus* Event near the base of the actual Emsian in GSSP sense as defined in the pelagic succession of the Zinzilban gorge (Uzbekistan). The "Middle" and "Upper Siegenian" faunas include, apart from abundant *Acrospirifer primaevus*, a number of still poorly known brachiopod taxa presently under study. Together with the onset of the "Late Siegenian" *Hysterolites hystericus* fauna, a minor faunal change is documented at the "Middle/Upper Siegenian" boundary (POSCHMANN & JANSEN 2003) resulting from the transition from clear-water to more turbid palaeoenvironments. The regressive development during the "Late Siegenian" reflected by the monospecific "globithyrid facies" (BOUCOT 1963) is terminated by a transgressive event close to the "Siegenian/Emsian" boundary. As regards the brachiopods, a strong faunal overturn has been recorded: many "Siegenian" taxa go extinct and, thereafter, especially the genus *Arduspirifer* shows a radiation in the early "Early Emsian" (SCHEMM-GREGORY & JANSEN 2006a, b). Judging from the conodont development documented in approximately contemporaneous basal beds of the Mariposas Formation (Eastern Iberian Chains, Spain) and at the base of the Mdâouer-el-Kbîr Formation (Anti-Atlas), the Rhenish boundary beds must be much younger than the level of the present GSSP (JANSEN *et al*. 2007, CARLS *et al*. 2008, JANSEN 2008). In contrast to previous suggestions (e.g. WALLISER 1996) the classic boundary - not the GSSP-boundary - seems to correlate with the onset of the transgressive unit Ib by JOHNSON *et al*. (1985).

The German "Emsian" is a long interval with a number of smaller events reflected by a step-wise evolution of faunas. The typical "Lower Emsian" *Arduspirifer latestriatus* fauna disappears closely below the "Lower/Upper Emsian boundary". The transgressive development near the base of the Rhenish "Upper Emsian" could approximately coincide

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with the global Daleje Event. However, regional effects are considered as the main factor governing the environmental conditions: Whereas the uppermost "Lower Emsian" Klerf Formation documents strong subsidence completely compensated by continual sediment accumulation, the lowermost Upper Emsian Emsquarzit Formation stands for retarded subsidence and predominant sediment reworking and resedimentation. Nevertheless, the marine influence increased and rich marine faunas could establish.

A number of taxa first appear at or close to the base of the traditional "Upper Emsian". Most of them do not seem to have developed from direct ancestors of the Rhenish "Lower Emsian" but may have immigrated from elsewhere in the course of the trangressive development. In progressively greater water depth, the succession of *Arduspirifer arduennensis*, *A. mosellanus* and *A. dahmeri* faunas is accompanied by a diversification within the genus *Paraspirifer*.

The Emsian/Eifelian GSSP-boundary at Wetteldorf in the Eifel area is well discernible by brachiopods. A number of taxa go extinct at or close to the boundary, for example *Euryspirifer paradoxus*, *Arduspirifer dahmeri*, *Douvillinella filifer*, and *Rhenothyris compressa*. *Intermedites intermedius* and *Rhenothyris aequabilis tectiplicata* have their onset at the lower Eifelian boundary. Partly, the fauna of the lowermost Eifelian Lauch Formation still shows an "Early Devonian aspect": STRUVE's "OCA (*orbignyanus-cultrijugatus-alatiformis*) fauna" is of Kondel to Lauch age (STRUVE 1982). Although the group of "*Uncinulus orbignyanus*" has recently been revised and "*U. orbignyanus*" subdivided into different genera and species by SARTENAER (2004, 2005), the "morphotype *orbignyanus*" in connection with the other two nominative taxa remains still a valuable information to recognise this interval ending with the upper boundary of the Lauch Formation (Eifel area). The latter is terminated by the lower Eifelian OCA Event (STRUVE 1982), probably in connection with the global Choteč Event (cf. STRUVE *et al*. 1997).

To sum it up, the development of Rhenish brachiopods reflects regional as well as global environmental fluctuations from Pridolian to Eifelian times. The current study especially shows the importance of new detailed taxonomic studies that are still lacking for many fossil groups.

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