

Middle and Upper Devonian Events in Belgium: review and new insights

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Numerous events (bioevents or global sedimentary events) have been defined in the Devonian (for a recent summary, see Becker *et al.*, 2012). Most of them were defined in basinal facies, based on extinction of pelagic fauna such as ammonoids and conodonts and have a global scale. However, few of these events have been recognized in neritic settings. In southern Belgium, the Upper Devonian bioevents, particularly the Kellwasser (Late Frasnian) and Hangenberg (Latest Famennian) events, received much attention (*e.g.*, Mottequin & Poty, 2014; 2015) because they are associated with stage or system boundaries. Conversely, Middle Devonian events inspired very few studies. Here we provide a review of expression of the main events recognized in the Middle and Upper Devonian through the lithostratigraphic succession of southern Belgium (Fig. 1).

The Choteč Event, situated in the upper part of the Eifelian *partitus* zone falls within the lower part of the Foulerie Member (Mbr) of the Couvin Formation (Fm) and theoretically within the Station Mbr of the Jemelle Fm. Gouwy & Bultynck (2003) postulated that the event could be recorded as a transgressive pulse ending the development of the first biostrome occurring within the Foulerie Mbr in the type area. No significant extinction corresponding to this event has been highlighted so far. The Bakoven Event within the *australis* Zone should fall within the Chavées Mbr of the Jemelle Fm. De Santis & Brett (2011) correlated it with a large-scale transgression leading to the deposition of black shale and disappearance of the Onondaga fauna. No black shale is known in the Chavées Mbr but the sudden dismissal of the limestones of the Couvin Fm, covered by the shaly Chavées Mbr is not incompatible with the Bakoven Event. Moreover, the transgression led to small-scale extinctions in the coral fauna (Tsien, 1969). The Stony Hollow Event, in the *kockelianus* Zone is marked by the expansion of tropical faunas into subtropical areas that may correspond to a rise in sea-level and temperature (De Santis & Brett, 2011). In Belgium, it could correspond to the onset of bioherms in the upper part of the Jemelle Fm but neither extinction nor dysoxic facies are known to date at this level (Bultynck *et al.*, 1998). At the end of the Eifelian, in the *ensensis* Zone, siliciclastic deposits reappeared in the basin (the Lomme Fm and its lateral equivalent, the Pepinster Fm), witnessing a regression, have been interpreted by Bultynck & Hollevoet (1999) as the expression of “Struve’s Great Gap” which corresponds to a period with many hiatuses in the sedimentary record in shallow environments. The following transgression led to the deposition of the carbonate Hanonet Fm (*ensensis* Zone), which took place within the Kačák event succession but the Lower Kačák Event (*otomari* Event) left no trace in Belgium after Gouwy & Bultynck (2003). Similarly, the Upper Kačák Event (*ostiolatus* Event) should be located in the basal Hanonet Fm but Bultynck & Hollevoet (1999) highlighted the lack of significant extinction and typical facies.

Within the lower part of the Trois-Fontaines Fm (Lower Givetian *hemiansatus* Zone) coral genera suffered a minor extinction (Coen-Aubert, 2004) which does not seem to be related to any yet recognized global extinction event. The Pumilio events (middle and upper *varcus*) are possibly correlated to two shelly beds rich in brachiopods in the Flohimont Mbr of the Fromelennes Fm (Maillet *et al.* 2013). As noted by Gouwy & Bultynck (2003), the Taghanic Event (and the Geneseo Transgression) does not appear as a single unit but covers the *ansatus* to *semialternans* zones and is consequently spread along the whole Fromelennes Fm with decoupled extinctions within ostracods (Maillet *et al.*, 2013), corals (Coen-Aubert 2004), brachiopods (Brice *et al.*, 2008). The last occurrence of stringocephalid brachiopods in the Moulin Boreux Mbr of the Fromelennes Fm is regarded by Bultynck *et al.* (2001) and Coen-Aubert (2004) as a marker of the Taghanic Event.

Frasnian events are rather well-situated stratigraphically. The Frasnian Event corresponds to the development of shaly facies at the base of the Frasnian (La Prée Mbr of the Nismes Fm; Becker, 1993) and possibly with the deposition of the chamositic and haematitic ironstone horizons of the Presles Fm. The *punctata* Event, close to the Lower–Middle Frasnian boundary has been located in the Ermitage Mbr of the Moulin Liénaux Fm but no significant extinction has been observed (Casier & Olempska, 2008). The Timan, Middlesex and Rhinestreet events (*punctata* to *hassi* zones) are theoretically situated within the Moulin Liénaux and Grands Breux formations and their lateral equivalents (Pont-de-la-Folle, Philippeville and Justin

formations) but have not been highlighted so far in Belgium. The Upper Frasnian Crisis is the best known as it is responsible for both extinctions within benthic and pelagic faunas. Extinctions of macrofauna started near the Middle–Upper Frasnian boundary (close to the base of the Lower *rhenana* Zone), at the top of the Grands Breux, Philippeville and Lustin formations (Poty & Chevalier, 2007). The Lower Kellwasser Event has been proven to be related to a third order transgression (*semichatovae* Transgression) bringing anoxic water onto the platform but extinctions are diachronic and clearly linked to the progression of the anoxia (Mottequin & Poty, 2015). The Lower Kellwasser Event is recognized at the base of the Matagne and the Les Valisettes formations and within the middle member of the Aisemont Fm (Bultynck *et al.*, 1998; Poty & Chevalier, 2007). The Upper Kellwasser Event covers the upper part of the Matagne and Barvaux formations and the middle part of the Lambermont Fm within the *linguiformis* Zone (Bultynck *et al.*, 2000).

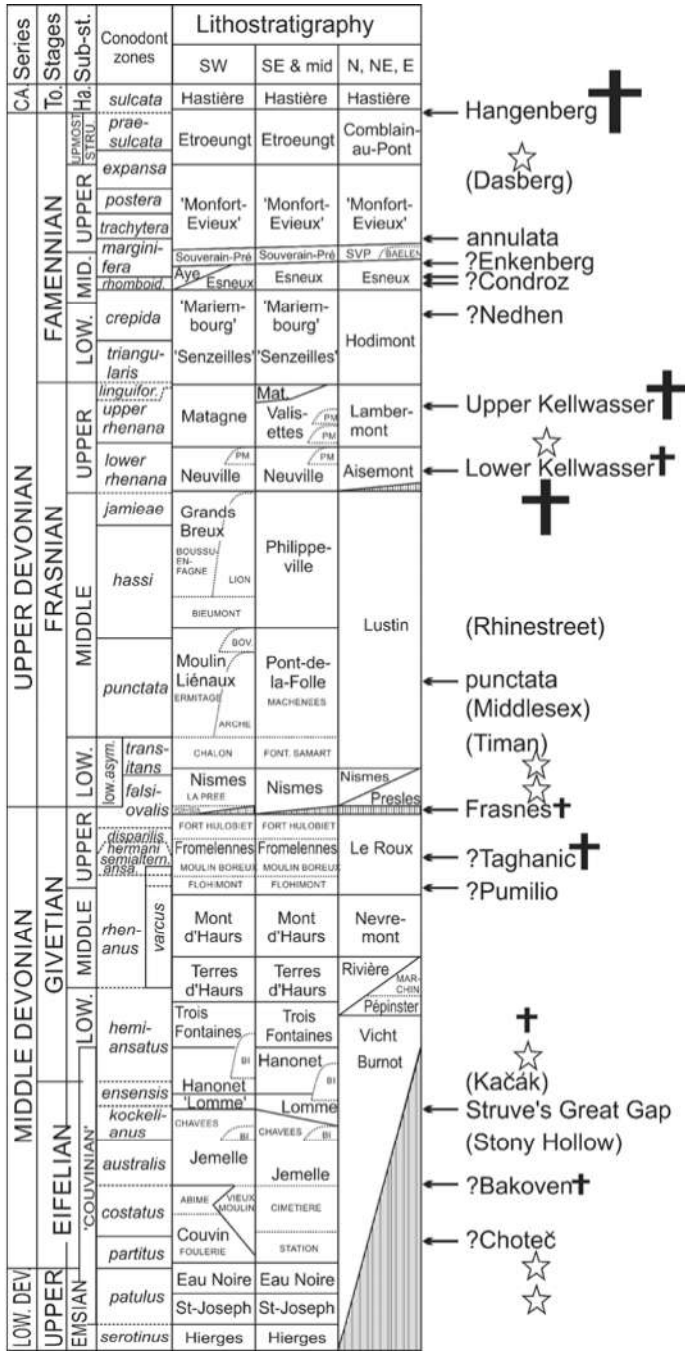


Fig. 1: Synthetic simplified stratigraphic scale of the Middle-Upper Devonian of southern Belgium with position of the bioevents. Names between brackets indicates the theoretical position events not recognized in Belgium, named preceded by a question mark. Crosses indicates extinctions in macrofauna, stars indicate diversification or colonisation events. Strongly modified from Bultynck *et al.* (2001) and Thorez *et al.* (2006). Abbreviations: BI, bioherm; Bov., La Boverie Mbr; Ca., Carboniferous; Font. Samart, Fontaine Samart Fm; Ha., Hastarian; PDA + SDA, Pont d'Avignon and Sourd d'Ave members; PM, Petit-Mont Mbr; Stru., Strunian; To., Tournaisian

Because the Famennian is dominantly represented by proximal siliciclastic facies, the events defined on the basis of ammonoid extinctions are not obvious. Three oolitic ironstone horizons described by Dreesen (1982) have been correlated by Becker (1993) respectively to the Nedhen Event (horizon IIa within the Famenne Fm,

upper *triangularis* zone) and the Condroz Event (horizons IIIa and IIIb in the Esneux Fm, Lower *marginifera* Zone) that questionably recorded a drop in sea level and the development of coarser siliciclastic sediments after the monotonous deposition of the lower Famennian shales. The Enkenberg pulse is questionably correlated with the transgressive limestone of the Souverain-Pré Fm starting by the IV horizon of oolitic ironstone and associated to carbonate mounds of the Baelen Mbr. The *annulata* Event, marked by the shaly Bon Mariage Mbr of the Evieux Fm (Thorez *et al.*, 2006). The Dasberg Event remains unrecognized in Belgium. Finally, the Hangenberg Event (*praesulcata* Zone) has been recognized in the uppermost Famennian Comblain-au-Pont and Etrœungt formations with the record of several decimetre-thick dysoxic shales whereas the very base of the Hastière Fm is correlated with the Hangenberg Sandstone.

In conclusion, it has to be noted that (1) the Upper Devonian bioevents clearly received more attention than the Middle Devonian ones, the latter are consequently in a preliminary state of knowledge; and (2) preliminary data seems to indicate that the Eifelian–Givetian Choteč, Kačák and Taghanic events had few effect on shallow neritic environment biotas.

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