THE DEVONO-CARBONIFEROUS TRANSITION
IN THE FRANCO-BELGIAN BASIN WITH
REFERENCE TO FORAMINIFERA AND BRACHIOPODS

by

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(4 figures and 1 table)

ABSTRACT. - After a brief summary of the most striking evolutionary trends of the Upper Frasnian through Lower Tournaisian foraminifer assemblages in Northwestern Europe, some new biostratigraphic data are discussed mainly from an important section near St. Hilaire (Avesnois area, Northern France) as well as their impact on the problem of the Devono-Carboniferous boundary in the Franco-Belgian Basin.

RESUME. - Apres un bref resume des tendencies evolutives les plus marquee des assemblages de foraminiferes du Frasien superieur au Tournaisien inferieur du Nord-Ouest de l'Europe, quelques nouvelles donnees biostratigraphiques sont discutees provenant en particulier d'une importante coupe pres de St. Hilaire (Avesnois, Nord de la France) ainsi que leur impact sur le probleme de la limite Devonien-Carbonifer dans le Bassin franco-belge.

The first appearances and the modifications of the Frasnian through Lower Tournaisian foraminifer assemblages reflect significant paleogeographic and ecologic changes in Western Europe (Conil & Lys, 1977, p. 10).

1. In the Franco-Belgian Basin, the Middle Devonian-Frasnian foraminifer association is characterized by *Nanicella*. This form has not been observed above the Frasnian-Famennian boundary. Its highest occurrence has recently been recorded from the uppermost Frasnian reef level (red "F2j"-type mudmounds) in southern Belgium, which corresponds to the Upper *P. gigas* Zone (Sandberg & Dreesen, in Johnson et al., 1985: fig. 2 and p. 577). A fairly similar association (zone 3) has been recorded by Kaldoa from the Frasnian in Moravia. However, here it ranges into the Lower Famennian and disappears within the *P. crepida* Zone (Friakova et al., 1985).

2. The next foraminifer zone (zone 4 in Moravia) corresponds to the extinction of a long-ranging foraminifer fauna in the Franco-Belgian Basin, and precedes the quick development of new evolutionary trends leading to the characteristic Carboniferous foraminifer faunas. The root of this new stock consists of a few primitive tourayellids only (Conil & Lys, 1977, tab. 2).

3. Foraminifera reappear in the Mid-Famennian and characterize the zone D13 of Conil et al., (1977) in the shallow Condroz shelf areas (*P. marginifera* Zonal intervals). Here, an important migration concomitant with a short-term transgressive pulse introduced a new, but already rather complex foraminifer assemblage in the Franco-Belgian Basin (Bouckaert, Conil & Thorez, 1967; Dreesen et al., 1985, p. 346). However, the persistence of siliciclastic influx and the general regressive trend during most of the "FaZbc", are unfavourable for the development of foraminifera in the Franco-Belgian Basin and in the Campine Basin (Bless et al., 1981). Only in a few outcrops, it can be demonstrated that the evolution of *Quasiendothyra* is very slow below the LV spore zone. The following species appear successively: *Q. bella*, *Q. communis* (Conil & Lys, 1968, fig. 126; Bouckaert, 1968 : 47, 51) and *Q. regularis*.

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Figure 1. - Tentative correlation chart of miospore, conodont and foraminifer Zones from the Franco-Belgian Basin: transgressions and extinctions are indicated by symbols (see legend below table), ecological events by stippled areas. The shaded areas represent intervals where foraminifera are absent or where only unilocular forms and Earlandia occur. Note: Gran.-Trn. Par.: Granuliferella, Tournayella, Paraendothyra. (from Conil, Dreesen & Streel, 1985, unpublished).
During this particular stratigraphic interval, the Avesnois area remains predominantly marine, with perhaps one short-term erosion period (Conil, Lys & Paproth, 1964, pl. I, k/l). In this region, foraminifera are known from the VCQ spor zone, but only where fossiliferous limestone microfossils prevail. The following taxa have been identified: Avesnella, Rectoavesnella, Rectoseptaglomospiranella (Conil & Lys, 1970, p. 261).

On the other hand, the coeval lagoonal facies in the Ourthe Valley, have yielded abundant Cryptophyllus (ostracodes), Quasiubella, Ellenia and unilocular foraminifera only (Conil & Lys, 1964, pl. V, "Fm2b").

4. The uppermost Famennian transgression starts in the upper part of the VCO spor zone. The lithological change at this stratigraphic level is more pronounced in the southern part of the Franco-Belgian Basin. At St. Hilaire and Avesnelles (Northern France) it is even possible to follow the transgressive event in detail, as well as the progressive faunal colonisation. The Quasiendothyra-tournayellid assemblage, the corals and the stromatopores appear very gradually (Conil et al., 1975, p. 14-16, beds 88-92). Furthermore, due to the considerable thickness of the carbonate deposits, it is possible to study the evolution of the Quasiendothyra Zone in great detail, up to the top of the Calcaire d’Etroeungt s.l. (beds 146-190 at Avesnelles; beds 1-8 at St.-Hilaire, railway cut):

- diversification of the tournayellids with microgranular wall;
- development of the endothyroids leading to a remarkable differentiation of the wall structure ("Endothyra" parakosvenis struniana Conil & Lys, 1964);
- rapid evolution of Quasiendothyra: O. regularis; O. radiata; O. kobeitusana; O. konensis, large Klubovella species with double wall (Conil & Lys, 1967, fig. 9) and large Quasiendothyra species with strong chomata and inflated septa (O. rafaeli Grozidilova, 1975: Conil & Lys, 1964, fig. 806). All specimens of Quasiendothyra figured in W. Europe come from the Strunian and not from the Calcaire d’Hastiére (Tn1b).

This correction has to be applied in Conil & Lys, 1964, pl. XXXIX, and in Conil, Lys & Paproth, 1964, pl. IX, X. The drawings have been improved in Conil, 1968, table III, in Conil & Graulich, 1970, pl. XI, XII and in Paproth, Conil et al., 1983, p. 216, Hastière, remarque. Thus the evolution of Quasiendothyra seems to be nearly completed in the LV spor zone, as shown by comparison with the faunas of the Omolon region in NE-Siberia (Shilo et al., 1984). The last representatives of this fauna - apparently very large specimens, according to Reitlinger (1961) - are unknown in Western Europe.

From the Ourthe Valley towards Aachen (FRG), the colonisation becomes more completed, from the first stromatoporoid "biostrome" level onwards. Limestones become gradually more important towards the top of the Strunian sequence. Micropalaeontological analysis of the Toghnoge borehole and the Yves-Gomezé road section, has revealed two important details for the biostatigraphic zonations: first, Protagnostodus meischneri appears near the base of the LV spor zone (Bouckaert & Dusar, 1976, fig. E; Dreesen, Dusar & Grossens, 1976); secondly, Quasiendothyra kobeitusana appears within the first "biostrome" (Bouckaert et al., 1978, fig. 87).

Figure 2. - Localisation of the outcrops.

5. The Devono-Carboniferous transition and the Tournaisian transgression. In spite of detailed studies, micropaleontological evidences are either lacking or unsatisfactory near the lithological boundary between the Étoieungt and Hastière-Avesnelles Formations. The presence of an erosional unconformity, a non-deposition event, or paleontological condensations at this particular level, is still a matter of discussion.

In a large part of the Franco-Belgian Basin, the boundary is rather sharp-cut between the Calcaire d'Étoieungt and the Calcaire d'Hastière and especially between the Calcaire d'Étoieungt and the Calcaire Noir d'Avesnelles. Some rare new biostratigraphic data recently suggested that the lowermost part of the Calcaire d'Hastière could be of Devonian rather than of Carboniferous age (Austin, Conil et al., 1970, p. 309; Van Steenwinkel, 1984, p. 58).

This possibility has been reexamined in most of the reference sections in Belgium and in the Avesnois area (France) (fig. 2).

5.1. Calcaire d’Hastière (Belgium; Paproth et al., 1983). Systematically, the first layers of the Calcaire d’Hastière contain an impoverished population of Strunian-type Foraminifera with Quasiendothyra, in association with Cryptophyllus (fig. 3). The same layers yield locally, at least in their lower part, a macrofauna (Brachiopods, Trilobites) with clear Devonian affinities.

In general the Strunian brachiopod fauna has the aspect of a transitional fauna. Devonian elements (majority) are mixed with Carboniferous elements (minority). In the different brachiopod groups, the transition from Devonian to Carboniferous forms takes place at quite different times. But as a whole the Strunian brachiopod fauna is very characteristic and can easily be recognized all over the world. In the Franco-Belgian Basin there is a very sharp upper boundary of Strunian-type associations, the principal guide forms like Phacops (Ome-
gops), Sphenospira juli, Eobrachythyris struniana, Araratella moresnetensis, and Whidbournella caperata all disappearing at about the same level i.e. within the first meter of the Calcaire d’Hastière, but unfortunately there is no sharp lower boundary of the Hastarian-type macrofauna. This missing of an immediate replacement of the Strunian by a Carboniferous macrofauna is principally due to the scarcity of macrofossils in the Calcaire d’Hastière, but also to the gradual incoming of its characteristic elements. So, Unispirifer and Tylothyris occur already in the Calcaire d’Étoieungt whereas others like Springothyris and Brachythyris are only found well up in the Calcaire d’Hastière. Consequently, on the basis of the macrofauna, the Devonian-Carboniferous boundary has to be traced by using a negative criterium, namely by the disappearance of the Devonian fauna, rather than by a positive one which would be the beginning of the Carboniferous fauna.

<table>
<thead>
<tr>
<th>Calcaire d’Étoieungt</th>
<th>Calcaire d’Hastière (basal 1 m)</th>
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<tr>
<td>2,6,8,9,10,11; topmost 1-2 m</td>
<td>6,8,9,10,11; 8,9</td>
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1. Chanxhe (Conil, Lys & Paproth, 1964, p. 50, pl. VIII bed 147, 15 m below the top of the Calcaire d’Étoieungt).
2. Rivage quarries (ibid., pl. IX).
3. Rivage railroad station (ibid. p. 46, pl. IX-X, bed 160, 7 m below the top of the Calcaire d’Étoieungt).
8. Gendron–Celles, quarry near the road (ibid., p. 36).
9. Guides which have never been found in beds younger than Strunian.

5.2. Calcaire Noir d’Avesnelles (Avesnois area, N. France). The transition of the Calcaire d’Étoieungt to this formation is even sharper. A black and pure limestone, poor in macrofossils, succeeds the argillaceous sediments which are rich in corals and stromatoporoids (fig. 4). The foraminiferan fauna with Quasiendothyra disappears, while the basal part of the Calcaire d’Avesnelles contains over 2 m, an association of tournayelliids and Cryptophyllus. Immediately above, the association of tournayelliids contains many Tournayellina beata (Conil & Lys, 1970, pl. 13*). The transition from black biomicrites to black pelspartes (beds 21/22) does not affect the foraminifer association.

* The specimen figured in Conil & Lys (1970) at a Strunian one comes in fact from the upper part of the Calcaire d’Avesnelles (pl. 12, fig. 120, RC 6364 (6909), Avesnes 1/21). N.B. The bed member 19 of the plate 13 has to be changed into 21.
Figure 3. - Stratigraphic correlation of the major sections in the Franco-Belgian Basin displaying the Devonian-Carboniferous transition.

Jen.: Jenneret; Tav.: Tavier; Combl.: Comblain-au-Pont; Riv.: Rivage (Conil, 1968, pl. III);
ju: Sphenospira jullii; mo: Araratella morenetensis; Pelek.: Pelekypynax; Ph.: Phacops; Qu. Cr.: Quasiendothyra,
Cryptophyllus; st: Eobrachythryis struniana; s: Siphonodella.
Figure 4. - Columnar section of the St-Hilaire railway cut.

Note the succession of 3 micropaleontological associations: *Quasiendothyrax + Cryptophyllus; Tournayellida + Cryptophyllus; Cherynshinella + Tournayellina beata.*

h1, h2: hypothesis of correlation with the base of the Hastarian. Bed 42 c: *Cynthaxonia cornu.*
Tournayellina beata is essentially known from the Tournaisian in the USSR, and does not occur below the Upinisky Horizon, except for one isolated specimen from the C1ta of the Donbass area (personal communication of O.A. Lipina). The lowest occurrence of this species corresponds also to the Lower Hartonian in the Netherlands (Bless, Boonen et al., 1981, pl. 12, fig. 5–7) and to the Hartanian in Turkey; (Dil 1976, pl. 2, fig. 23).

The same species has been listed under the name of Tournayellina primitive in the Southern Urals (Berchogur; Barskov, Simakov et al., 1984**, p. 210) above Devonian miospores (LN) and below Siphanodella sulcata. The conodont fauna collected by Conil and Lentz in the section of St-Hilaire is listed on fig. 2. This occurrence of a Devonian-type conodont association is quite unexpected, and would imply a correlation of at least the lower 8 meters of the Calcare d’Avesnellers with the basal bed of the Calcare d’Hastière (fig. 3).

Two possible explanations can be forwarded here. The first idea is that most of the Calcaire Noir d’Avesnellers is of Tournaisian age, according to the foraminifer assemblage (beds 13–30), which is well known in the Tournaisian of other countries; in that case conodonts could possibly have been reworked from the Devonian into the Lower Tournaisian.

The second idea is that an important part of the Calcaire Noir d’Avesnellers (beds 9–29) is of Devonian age, according to the conodont faunas, and would belong to the Upper praesulcata subzone, at least from the bed 16; therefore it could be correlated with the lowest part of the Calcare d’Hastière (beds 159–161). Thus the “Tournaisian” foraminifer assemblage here observed (beds 13–30) would occur in the Uppermost Devonian. However this low range has never been recorded before in other countries. Anyway, the microfaunal assemblages and the Devonian–Carboniferous boundary occur between two events; the first one corresponds to a widespread extinction of the Strunian stromatoporoids in Europe, the second one introduces the second Tournaisian sequence and could correspond to the “Unilocular foraminifer zone” of the USSR. (Tn1bγ–Tn2a; Shilo, Bouckaert et al., 1984, p. 140, fig. 4).

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REFERENCES


** The specimens of Berchogur are practically identical to the specimens of St-Hilaire, as it has been verified on the original material by Simakov & Conil.


