

ian, and the early Upper Devonian some *Icriodus* species such as *I. fusiformis*, *I. culicellus*, *I. rectirostratus*, *I. retrodepressus*, *I. regularicrescens*, *I. obliquimarginatus* and *I. subterminus* have a wide or sometimes nearly cosmopolite dispersion in different magnafacies areas (type Ardenno-Rhenish and Hercynian-Bohemian) and there is no marked difference in the earliest occurrence of each species. This means that the geographical dispersion of at least some *Icriodus* species was due primarily to good communication seaways which could be modified in the course of time and not to very specialised local facies factors. Having in mind the SEDDON and SWEET model for conodonts, the dominance of *Icriodus* in shallow water shelf environment implies no restriction in geographical dispersion. Particularly in this environment, anomalies in the vertical distribution of *Polygnathus* taxa, e. g., *P. serotinus*, *P. linguiformis* div. subspecies, *P. cooperi cooperi* can be noticed.

## Reexamination of Late Pennsylvanian and Early Permian Conodont Apparatuses Using Clustering Techniques.

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Conodont faunas containing easily identified Pa elements assignable to the genera *Diplognathodus* and *Hindeodus* have been reported from Upper Pennsylvanian and Lower Permian strata of North America. If the seximembrate model for the apparatus of each genus is correct, the remaining elements should also be present. However, previous investigators have normally considered ramiform elements which might be assignable to the two genera as attributable to species of either the *Idiognathodus*–*Streptognathodus* plexus or *Adetognathus*. It is suggested that the ramiform elements reported from the uppermost Pennsylvanian and lowermost Permian are more likely related to the Pa elements of *Diplognathodus* and *Hindeodus* than to the previously accepted association with the Pa elements of the *Idiognathodus*–*Streptognathodus* plexus and *Adetognathus*.

Three data sets obtained from the literature were analyzed using a number of different similarity measures, clustering procedures and data transformations in order to examine various aspects of the faunas. The results of the different cluster analyses maintained remarkable consistency both within and between the three data sets and provide an interpretative outline. The results are interpreted as supporting the association of the various ramiform with *Diplognathodus* and *Hindeodus* rather than with *Idiognathodus*–*Streptognathodus* and *Adetognathus*. This satisfies the apparatus structure of *Diplognathodus* and *Hindeodus*, but opens the question of the Late Pennsylvanian and Early Permian apparatus structure of *Idiognathodus*–*Streptognathodus* and *Adetognathus*.

## Extinction of Triassic Conodonts.

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There is some agreement that extinction of higher taxa is one of the expected, even predictable results of evolution and not the result of inadequacies shared by all species of a group. This view is in contrast to ideas that higher taxa extinctions might be explained by a catastrophic, „across the board“ related cause.

The extinction of conodonts is an event that can be used to test different extinction models. For example, if diversity of species population size decreased, conodonts would be subjected to localized extinctions due to random fluctuations in environmental conditions and inability to recolonize. This should be identifiable in the rocks. Alternately, if there were adverse environmental factors that affected the conodont life style and caused extinction of the entire group, sedimentary petrology of the rocks in which this occurred might give some signal.

The Upper Triassic-Lower Jurassic rocks of western North America and Austria apparently bear normal marine faunas and have no significant unconformity. In Austria, 19 conodont form-species were progressively reduced by extinction during the Norian. Some 7 species reportedly evolved during the Norian-Rhaetian interval and 4 survived until near the close of the Rhaetian. In North America, only 5 species are present during the Norian. Two of the North American species survived until late Norian but became extinct prior to the Rhaetian. Carbonate sequences indicate that there were minor envi-



ronmental differences in North America and Austria. There is no indication from the rock record that extinction was caused by a catastrophic environmental challenge to the entire conodont population.

### Conodont Biofacies in the Belgian Famennian.

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Different mega-environments are differentiated on the undathem-clinothem of the tidal epicontinental Famennian sea in the Dinant and Vesdre Basins. The vertical succession of the sedimentary formations, which are diachronic with regard to the standard conodont zonation, represents a regressive megasequence, ranging from relatively deep offshore open marine, shallow nearshore, to backshore restricted marine environments (THOREZ, 1969–1977).

Different associations of platform conodont genera (biofacies) reflect different ecological conditions which are directly or indirectly related to water depth, turbulency, salinity and proximity to the coast.

In this way, the distribution pattern of conodont biofacies throughout the Famennian represents a normal response to the oscillating movements of a prograding coast in the studied basins; the presence moreover of mixed conodont biofacies is also related to sedimentological mechanisms. From the top of the Upper Frasnian (Matagne Shales) to the base of the Lower Carboniferous (Hastièrre Limestone) the following sedimentary environments are recognized, each of them characterized by its (mixed or not) conodont biofacies:

The nodular clayey limestones scattered within the Famenne Shales, deposited during the *triangularis*- and *crepida*-Zones, yield a *Palmatolepid* biofacies and represent open marine offshore sediments (enclosing also pelagic macrofossils). A faunal break at the Frasnian/Famennian boundary and a temporary outburst of *Icriodids* are indicative of a probable sedimentary gap and/or a sudden appearance of unfavourable facies.

The Esneux Formation, composed of alternating thin-bedded micaceous sandstones and shales, developed during the *rhomboidea*- and Lower *marginifera*-Zones, contains coarse grained lenticular crinoidal limestones locally enriched with iron oolites, which are interpreted as storm layers deposited in the coastal sand-shelf mud transitional zone. In the same way the presence of iron oolites and hematized skeletal debris in the nodular limestone facies of the underlying Famenne Shales may be attributed to the mechanism of „debris-flow“ („fluxo-turbidites“). The source of these oolitic ironstones are the high-energetical sea-sides of crinoidal mud mounds, dispersed on a shoal in the proximity of the coast. The surroundings of these reef-like bio-accumulations were probably prolific for a *Polygnathid* – *Icriodid* Biofacies, which was mixed up with elements of a *Palmatolepid* – *Polygnathid* Biofacies in the adjacent relatively shallow subtidal environments.

The Souverain-Pré Formation, composed of sandy subnodular crinoidal limestones with foraminifera, is considered as a „back-reef“ facies of those crinoidal mud mounds, during the *marginifera*- and Lower *velifer*-Zones. It is characterized by a (*Palmatolepid*) *Polygnathid* Biofacies often contaminated by elements of a *Polygnathid* – *Icriodid* Biofacies of the more shoreward intertidal environments.

During the *velifer*-Zone, the Comblain-la-Tour Formation and the Montfort Formation were deposited in adjacent tidal flat and sand barrier environments. Thin-bedded and fine-grained limestones, mostly sandy and dolomitized, intercalated within alternating shales and sandstones of the Comblain-la-Tour Formation, contain a *Polygnathid* – *Icriodid* Biofacies; local crinoidal lenticular limestones within sandstone units of the Montfort Formation yield a mixed conodont biofacies, composed of elements of both a *Polygnathid* – *Icriodid* and a *Clydagnathid* ? Biofacies. This mixed conodont thanatocoenosis and other sedimentological data (e. g. channels, intraclasts of restricted marine limestone) prove the presence of tidal inlets in the barrier complex, connecting restricted marine environments (tidal lagoon) to fore-barrier environments (very shallow subtidal to intertidal).

Because of the alluvio-lagoonal facies of the Evieux Formation (enclosing evaporitic dolomites and red arenaceous beds, probably related to sabkhas – after J. THOREZ, pers. comm.) and because of the supposed presence of a *Clydagnathid* Biofacies, the index conodonts for the *styriacus*-Zone have never been found in Belgium; further investigation is required to prove the existence of this

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