

A database of conodont occurrences between the Changhsingian (Late Permian) and the Spathian (Olenekian, Early Triassic)

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Introduction

Conodonts are extinct jawless marine vertebrates (Donoghue et al., 2000) that lived from the late Cambrian (ca. 500 Ma) to the Triassic-Jurassic boundary (ca. 200 Ma) (Du et al., 2020; Müller, 1959). They are mainly known as powerful biostratigraphic index fossils (Ferretti et al., 2020) and paleothermometers (Rigo et al., 2012; Trotter et al., 2008) thanks to their microscopic and apatitic (Frank-Kamenetskaya et al., 2014; Pietzner et al., 1968) feeding elements called conodont elements. Beside their biostratigraphic and paleoenvironmental interest, conodonts can be used as a model for evolutionary, diversity, biogeography and macroecology studies in deep time (Girard and Renaud, 2008; Guenser et al., 2019; Martínez-Pérez et al., 2014; Petryshen et al., 2020; Souquet et al., 2022). Indeed, their global distribution, their taxonomic diversity, their abundance and their quasi-continuous record allows to statistically investigate such topics at high temporal resolution. These paleobiological studies are made easier thanks to databases of conodont occurrences through time and space. However, few of them are currently freely available online. To date the most famous online records of conodont occurrences is integrated in the PaleoBiology DataBase (PBDB) and in the GeoBiodiversity DataBase (GBDB). The GBDB record is known not to be global as it is mostly restricted to China samples. On the contrary, the PBDB should gather global occurrences of extinct taxa. Yet, recent publications have highlighted the incompleteness of the PBDB record (Du et al., 2023; Servais et al., 2023).

We introduce here a database of global occurrences of conodont species around the Permian/Triassic boundary (PTB, ca. 251.9 Ma). The PTB is known for its biotic crisis, corresponding to the most important mass extinction event of the whole Phanerozoic (Benton, 2003; Raup and Sepkoski, 1982; Stanley, 2016). According to the literature, the causes of this crisis lie in the intense volcanic activity that built the Siberian traps and led to a global rise in temperatures as well as changes in ocean chemistry (Algeo et al., 2011a; Benton, 2003; Bond and Wignall, 2014; Foster, 2015; Winguth et al., 2015). The PTB crisis profoundly impacted the marine biosphere and was followed by a complex Early Triassic (ca. 5 myrs) biotic recovery. Indeed, an alternation of short periods of high and low taxonomic richness (Brayard et al., 2009; Brosse et al., 2017; Dai et al., 2018; Orchard, 2007; Scheyer et al., 2014) and uneven record of $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ show different episodes of environmental disturbances (Grasby et al., 2013; Romano et al., 2013; Sun et al., 2012). While the PTB crisis has been extensively studied and conodonts are a choice model to study the impact of this event on biodiversity, conodont evolution around the PTB was barely studied quantitatively and, when it was, the data were not available online (Charpentier, 1984; Klets, 2008; Martínez-Pérez et al., 2015; Orchard, 2007).

The present database is a csv file of about 12,000 entries. It is a data compilation from the available literature gathering a total of 260 publications dated from 1967 to 2022. It includes taxonomic, sampling, sedimentological, temporal, (paleo)geographical and bibliographical information. The minimum unit, i.e. a row of the table, corresponds to a species in a sample. The database allows different type of investigations. The taxonomic and temporal information allow diversity studies at the stratigraphic stage and sub-stage level around the Permian/Triassic boundary. The paleogeographic information allow biogeographic and macroecological investigations such as Guenser et al (in prep.). The sampling information allow biochronological study, e.g., using the Unitary Association Method (Monnet et al., 2011; Savary and Guex, 1999). Finally, thanks to the GPS coordinates associated to each section, all these evocated topics can be investigated either locally, regionally or globally. Compared to similar data available in the PBDB (downloaded on 12/20/2023), our database owns 100 times more entries, 10 times more sections, 4 times more references and twice more species.

Description of the database

Taxonomic information

Each species is listed according to two classifications: the species name used in the original publication (*Species_in_paper* column), and the species name currently used (*Gn_Species_current* column). This double classification eases connecting the original name of a species from one publication to its contemporary classification in more recent publications. The most recent genus name, i.e., after taxonomic homogenization, is recorded in the *Gn_current* column. Each sampled species is assigned a status: an empty box means that the species in question corresponds to the holotype; the corresponding morphotype (e.g., M1, M2, etc.) or subspecies may also be present; other statuses corresponding to open nomenclature: *confer* (*cf.*), *affinis* (*aff.*), “quoted” status has a similar meaning), *ex grege* (*ex gr.*, *gr.*), *species incerta* (?), and *sensu lato* (*s. l.*).

Sampling information

For each species, the corresponding sampling bed is available in the *Sample* column. When the information was available, the number of specimens corresponding to the species found in the sample is recorded in the *Quantity* column; the proportion of each species within a sample calculated in the *Proportion* column. However, these last two columns contain very little information.

Sedimentological information

For each sample, its facies is recorded in the *Facies* column and its associated depositional environment is recorded in the *Environment* column. Additional stratigraphic divisions are noted in the columns *Member*, *Formation*, *Group* and *Unit_Terrane_basin*. These information originate only from the publications in which the conodont samples are described, so articles that did not deal specifically with the sedimentology of the field. Further sedimentological work would be required for most localities to complete the information provided.

Temporal information

Each sample is assigned a stratigraphic stage (*Stage* column), a stratigraphic sub-stage (*Sub_stage* column) and an additional stratigraphic sub-division (*Sub_sub_stage* column). The database is restricted to the Terminal Permian and Lower Triassic, including the Changhsingian, Induan and Olenekian stages. The latter two are respectively divided into two sub-stages: the Griesbachian and Dienerian for the Induan, and the Smithian and Spathian for the Olenekian. A more precise division

(lower, middle, upper) is present in few publications. The Changhsingian was not subdivided as it does not include formal sub-stages.

(Paleo)geographic information

The section where the conodonts were sampled is noted in the *Section* column. Each section is associated with its current GPS coordinates (*Latitude* and *Longitude* columns). When coordinates were not directly available in the publication, they were estimated on Google Map based on the topographic map provided in the publication. Additional current geographical information are noted for each section using the administrative divisions of each country (*Department_District*, *Region_Province_State*, *Country*, and *Continent* columns).

Current GPS coordinates were converted to paleocoordinates (*PT_paleolat* and *PT_paleolong*) with Rgplate R package (Kocsis et al., 2023; Müller et al., 2018) using the PALEOMAP model dated at 250 Ma. Tectonic movements between the early Changhsingian and late Spathian were deemed negligible given the global nature of the database. However, there are two exceptions with the sections from Japan and Bulgaria. The paleolocations of the Japanese sedimentary deposits are still open to debate, particularly those of Triassic age. The Japanese sections are thought to be located off the Panthalassa, at a latitude close to the equator (Algeo et al., 2011b; Choi, 1984; Maruyama et al., 1997; Onoue et al., 2017; Sano et al., 2012; Shi, 2006; Uno et al., 2012). The paleocoordinates estimated by the PALEOMAP model located these sections in the northeastern part of the Tethys, so they needed to be corrected. The Bulgarian sections were located by the PALEOMAP model on the inner western edge of the Tethys. Considering that they belong to the Moesian platform (Budurov et al., 2004; Dercourt et al., 2000; Ruban et al., 2007), they would be more northerly located, on the inner northern edge of the Tethys.

Data Availability

The present database is available on GitHub: https://github.com/PaulineGnsr/Permian-Triassic_assembly-process.

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