

PALYNOPIEDIA: A NEW MICROSOFT ACCESS® DATABASE FOR PALEOPALYNOLOGY

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With 5 figures and 2 tables

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Zusammenfassung

Here we present a preliminary version of *Palynopedia*, a new Microsoft Access® palynological database. *Palynopedia* has been built with the purpose of collecting data from as many Triassic sporomorph species as possible, including their relative stratigraphic and geographic distribution and botanical affinity, and to simplify the identification with a user-friendly search engine.

This preliminary version of the database was filled with a set of 200 records of Middle – Upper Triassic sporomorph species. For each species a dataset has been created composed of: name of the species, author, year of publication, synonyms, holotype, diagnosis, original description, *locus typicus* and *stratum typicum*, pictures of the holo- and/or paratypes, biostratigraphic and geographical distribution and botanical affinity.

A search in *Palynopedia* can be done in two ways: based on the systematic of the species or on the main morphological features of the sporomorph (form, type of saccus, aperture, sculptures, etc.). The query filters and groups the records on the basis of these features; it is possible to choose keywords from a simple pull-down menu. Results are displayed in a list and each record of species found can be reached from it by a click. Furthermore, the database allows to seek a word or a group of words contained in one of the record fields just typing them in an easy search engine.

An on-line version of *Palynopedia* with the same functions and features described is under construction. In the future the number of species should be extended hopefully to the entire Phanerozoic palynomorphs.

1. Introduction

Paleopalynology *sensu stricto*, as the study of fossil pollen and spores, has become widely used for many geological, palaeoecological and palaeoclimatological studies, as well as pure palynology. Sporomorphs are successfully used in stratigraphy, for dating rocks and correlating continental and marine sections from different localities. Quantitative palynological analyses allow to reconstruct past floras and to observe how they have changed through time; thus, it enables us to reconstruct (palaeo)climatic variations. Academics, oil companies and many other private or public institutes employ palynologists for various uses. Each of these palynological applications needs a strong accuracy in spores and pollen identification by the scientists, based on a deep and

solid taxonomical background. Over the years a huge amount of species has been instituted for the Triassic from various paleogeographical realms. Many of these species have been afterwards emended and become synonyms. New studies allowed to refine the sporomorph classification and the use of instruments like the Scanning Electron Microscope (SEM) and the Transmission Electron Microscope (TEM) has enriched the knowledge on pollen morphology and ultrastructure. Pollen and spores found *in situ* have improved the knowledge on the botanical affinity of many sporomorphs. A lot of paleopalynological literature has been produced, but data are dispersed in a sea of papers often written in languages other than English and hard to find. These factors could preclude a wide diffusion of knowledge and promote the proliferation of species and synonyms.

Several palynologists have tried to arrange literature to simplify the search of references, species and genera. Many catalogues and bibliographies were created in the past, such as the "Triassic Palynomorphs: index to genera and species" published by Boersma and colleagues in 1987. It is an index of genera and species with relative references, *stratum typicum* and *locus typicus*, not only limited to spores and pollen but also extended to other palynomorphs. A very famous catalogue of fossil sporomorphs has been created by Jansonius and colleagues (1976): the "Jansonius files" are a set of more than three thousand paper-cards catalogued in alphabetical order; every record card contains information about one genus including original descriptions, drawings and bibliography. It has been a precious tool for scientists but is: i) not easy to handle as it requires an a priori identification of the taxon, ii) not very simple to transport and iii) limited to a generic level. Many other paper-atlases have been developed for regional or local palynology and almost every palynologist has created his own one, jealously held near the microscope.

Computers and Internet have strongly simplified the search, collection and sharing of palynological data; search engines like Palynodata (Palynodata Inc. & White, 2006) has been created to help scientists in finding references using simple research criteria (taxon name, age, location, author, etc.) and a lot of modern papers could be easily found on the web and downloaded using for example "Web of Knowledge" or "Google Scholar". Furthermore, computer-based

pollen catalogues have been produced for private or public use mainly to collect photos and references. The "New Zealand fossil spores and pollen: an illustrated catalogue" (Raine et al., 2008) is an example of an on-line database built to collect pre-Pleistocene pollen and spore taxa that have been found in New Zealand strata. Species are listed following the Potonié & Kremp (1954) systematic system and for every taxon a brief description, pictures, chronostratigraphic distribution and references are available.

Most of the existing databases are private, so used by one palynologist or a small community of scientists working in the same lab, and often "regional", i.e. restricted to a palaeogeographical studied area, and limited to a studied geological time interval. The article 32.3 of the International Code of Botanical Nomenclature, Vienna Code (McNeill et al., 2006) says that geographical origin and geological age do not meet the requirements for the diagnosis of a taxon. This new provision could have a strong impact in the taxonomy of pollen and spores reducing the number of species and genera often distinguished only on these differences (Chaloner, 2008).

Arrangement of the knowledge on sporomorphs in one database comprehensive of all instituted species could resolve part of the problems that afflict taxonomy of paleopalynology as well as to simplify palynologists' lives.



Fig. 1: Main mask of *Palynopedia*. It is possible to open the records of species (click on the button "Species"), the search engine ("Nehemiah's Eye") and a file with instructions ("Read Me").

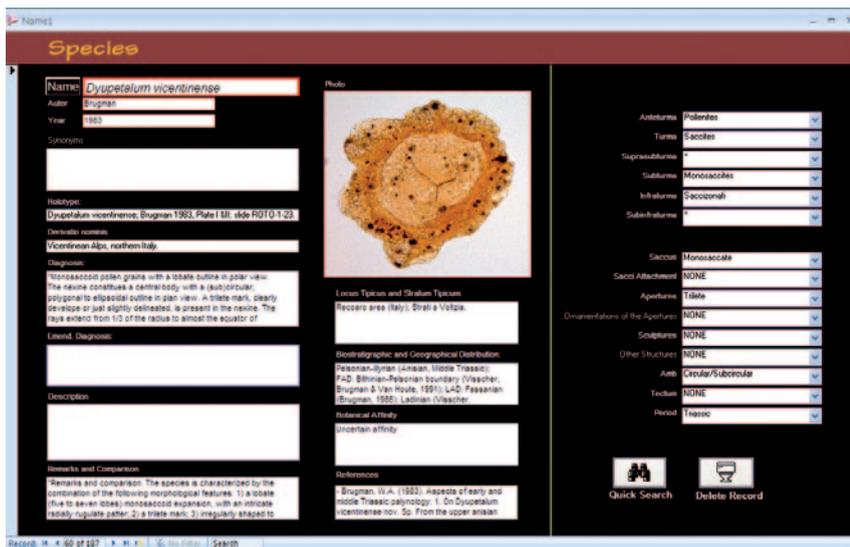


Fig. 2: Record of *Dyupetalum vicentinense* (Brugman, 1983). Every record contains the name of species, author, year of publication, synonyms, *derivatio nominis*, original diagnosis and description, remarks and comparisons, *locus typicus* and *stratum typicum*, biostratigraphic and geographical distribution, botanical affinity and references. Moreover, in the pull-down menus its taxonomy and main morphological features have been selected.

2. Palynopedia

We developed a new palynological database, *Palynopedia*, in order to collect in one tool as much as possible information on all Triassic sporomorph species to help palynologists during the sporomorphs' identification.

Palynopedia is a Microsoft Access based database that allows users to process and search stored data. We give here a description of the features of the database from a user's prospective; details of the structure and queries are beyond the scopes of this paper.

Through the main mask of *Palynopedia* (Fig. 1) it is possible to access a set of records ("Species") - each of them containing information on one species - a search engine ("Nehemiah's Eye") and a file with instructions ("Read me").

2.1 Records

Each record (Fig. 2) is composed of several fields containing the name of species, author, year of publication, synonyms, holotype, *derivatio nominis*, original (and emended) diagnosis and description, remarks and comparisons, *locus typicus* and *stratum typicum*, biostratigraphic and geographical distribution, botanical affinity and references. These are text boxes where information is entered manually for every species.

Photos (in transmitted light, SEM and TEM) are .jpg or .pdf files comprehensive of pictures of holotype and paratypes and could be viewed in the original resolution by a click on the thumbnail.

Some pull-down menus on the right hand side of the template allow selection of the taxonomic position of the pollen or spore grain and its main morphological features (Fig. 2). These are the same as used by the query (see Chapt. 2.2). The systematics proposed by Potonié & Kremp (1954) has been followed (Tab. 1): fossil sporomorphs are morphotaxa (art. 1.2 of the ICBN, McNeill et al., 2006) and could not be attributed to any suprageneric natural group; thus, fossil pollen and spores have been subdivided in artificial groups inspired by the roman army (Aneteturma, Turma, Suprasubturma, Subturma, Infraturma and Subinfraturma in decreasing rank order) on the basis of some constant morphological features. In order to summarize the morphological characteristics of the species independently of its systematic position, the second group of pull-down menus allows to define the most important morphological features of each species such as the type of saccus (e.g. monosaccate, bisaccate, trisaccate) and its attachment to the corpus (haploxylo-noid or diploxylo-noid), the kind of aperture (e.g. trilete, monolete), the ornamentations of apertures (e.g. kytomes), the amb (e.g. circular, elliptical), the sculptures (e.g. baculae, spinae, teaniae, verrucae), other structures (e.g. cingulum), the type of the tectum (e.g. tectate) (Punt et al., 2007). It is also possible to choose the Period (for more information on the pull-down menu content see Tab. 2).

Furthermore, a quick search of a word or a group of words contained in one of the record fields can be performed just typing the word in the field on the bottom of the mask (Fig. 2) or opening the search

- Anteturma **Sporites** Potonié, 1893
- Turma **Triletes** (Reinsch, 1881) emend. Potonié & Kremp, 1954
 - Subturma **Azonotriletes** (Luber, 1935) emend. Dettmann 1963
 - Infraturma **Laevigati** (Bennie & Kidston, 1886) emend. Potonié 1956
 - Infraturma **Apiculati** (Bennie & Kidston, 1886) emend. Potonié 1956
 - Subinfraturma **Baculati**
 - Granulati**
 - Nodati**
 - Punctati**
 - Verrucati**
 - Infraturma **Murornati** Potonié et Kremp, 1954
 - Turma **Hylates** Dettmann 1963
 - Turma **Zonales**
 - Subturma **Zonotriletes** Watz, 1935
 - Infraturma **Auricolati** (Schopf, 1938) emend. Dettmann, 1963
 - Infraturma **Cingulati** (Potonié & Klaus, 1954) emend. Dettmann, 1963
 - Infraturma **Tricrassati** Dettmann, 1963
 - Subturma **Zonolaminatriletes**
 - Infraturma **Cavati**
 - Turma **Monoletes** Ibrahim, 1933
 - Suprasubturma **Cavatomonolete**
 - Turma **Aletes** Ibrahim 1933
- Anteturma **Pollenites** Potonié, 1931
- Turma **Saccites** Erdtman, 1947
 - Subturma **Monosaccites** (Chitaley, 1951) emend. Potonié et Kremp, 1954
 - Infraturma **Triletesaccites** Leschik 1956
 - Infraturma **Saccizonati** Bharadwaj, 1957
 - Subturma **Disaccites** Cookson, 1947
 - Infraturma **Alete**
 - Infraturma **Striatiti** Pant, 1954
 - Infraturma **Disaccitriletes** (Leschik, 1955) emend. Potonié, 1958
 - Turma **Monocolpates** Iversen & Troels-Smith, 1950
 - Turma **Plicates** (Naumova 1937) emend. Potonié, 1958
 - Subturma **Polyplicates** Erdtman, 1952
 - Turma **Kryptaperturati** Potonié, 1966
 - Subturma **Circumpolles** (Pflug, 1953) emend. Klaus, 1960
 - Turma **Alete** Ibrahim 1933
 - Subturma **Asaccites**

Tab. 1: Systematics used in the database following Potonié & Kremp (1954).

Saccus	↓ *	NONE Bisaccate Monosaccate Saccate Trisaccate	Other Structures	↓ *	NONE Camera Cingulum Operculum Rimula Taeniae Zona
Sacci Attachment	↓ *	NONE Diploxytonoid Haploxytonoid	Amb	↓ *	NONE Circular/Subcircular Elliptic Quadrangular Quinquangular Rectangular Rombic Triangular
Apertures	↓ *	NONE Alete Monolete Trilete	Tectum	↓ *	NONE Intectato Semitectato Tectato
Ornamentations of Apertures	↓ *	NONE Kyrtores Labra Margo	Period	↓ *	NONE Triassic - Jurassic Triassic Permian - Triassic
Sculptures	↓ *	NONE Bacula Cingulum Clavae Columellae Coni Fossulae Gemmae Granula Muri Puncta Pila Spinae Verrucae			

Tab. 2: Content of the pull-down menus of the morphological search and Period menu. Select star (*) if the field is undetermined or unspecified.

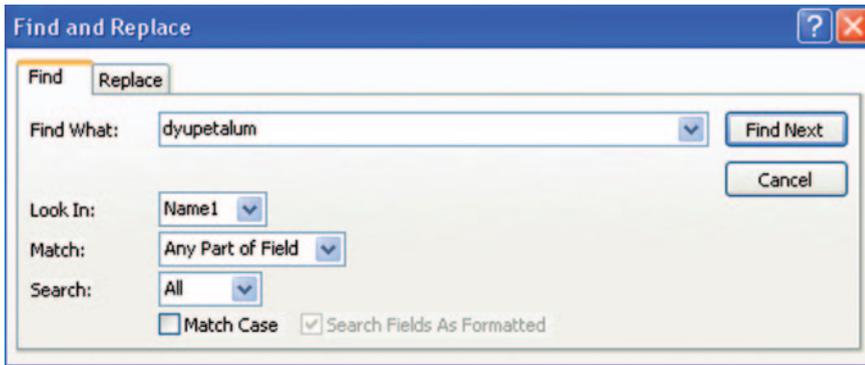


Fig. 3: Access® Search mask, e.g.: if the user wants to search for the species *Dyupetalum vicentinense* (Brugman, 1983) he has to: A) select the field "Name" on the record mask (Fig. 2); B) click on the button "Quick Search" (Fig. 2) to open the search mask; C) type the name in "Find What"; D) check if the field on which the search will be performed is correct ("Look in"); E) select "any part of the field" from "Match" and click "Find Next". The database will jump to the desired record.

mask ("Quick Search" button) (Fig. 3): in the first case the database performs the search in all of the records' text fields whereas in the latter case the field on which the user wants to perform the search can be selected.

2.2 Search Engine

Nehemiah's Eye (Fig. 4), after Nehemiah Grew (1641-1712), the first scientist who saw a pollen grain under the microscope, is a user-friendly search engine that filters and groups the records using simple predefined criteria (taxonomy and/or morphological features) (see Chapt. 2.1, Tab. 1 and Tab. 2). *Nehemiah's Eye* has been built to accelerate the identification processes. Except for some easy to define and well known species, indeed, during the microscope session most of our time is lost flipping through several publications and searching for a name or any information on the observed sporomorph. Thus, the identification of pollen and spores is often long-winded and our work becomes protracted and boring.

The search engine allows the classification of sporomorphs on the basis of some easily observable morphological features and/or taxonomy. When all available characteristics have been selected from the pull-down menus, the user only has to enter the query by a click on the eye-button (Fig. 4) and a list of species answering the requirements is displayed (Fig. 5). From there it is possible to open each species-record, see pictures, read descriptions and hopefully give a name to the sporomorph seen under the microscope. As an example, if the user wants to classify a monosaccate trilete pollen grain with subcircular form he only has to select from the menus "Saccus" ? "Monosaccate", "Aperture" ? "Trilete", "Form" ? "Sub-circular" and/or, if he is familiar with Potonié and Kremp (1954) taxonomy, "Anteturma" ? "Pollenites",

"Turma" ? "Saccites", "Subturma" ? "Monosaccites", than it is enough to click on the eye-button and a list of species with these features will be displayed (see also Fig. 4-5).

3. Conclusions

Palynopedia has been created for Triassic sporomorphs but could be extended to all published species of spores and pollen from the Paleozoic to the Cenozoic and to other palynomorphs (Acritarchs, Dinoflagellates, Algae, Chitinozoans, Scolecodonts, etc.) finding appropriate search keys to perform searches and speed up the identification.

It is clear that this database could become a complete tool for palynology. With the aid of "*Nehemiah's Eye*" users can find all the information about a taxon in few simple steps. The search engine can strongly simplify the classification process, but it can be used also in many other ways: it can be used to identify sporomorphs having the same characters, the same botanical affinity and/or belonging to the same period or stage, etc.

The database has been created in a preliminary version on 200 taxa from the Middle Triassic of Europe. In the future each palynologist could contribute to expand and enrich the database in order to create a network of information to share.

We are working on an internet-based version of *Palynopedia* with the same functions and features. This on-line database will allow to overcome the problems of compatibility due to the Windows®-only availability of Access®. Furthermore, its use will be easier, wherever an Internet connection is available.

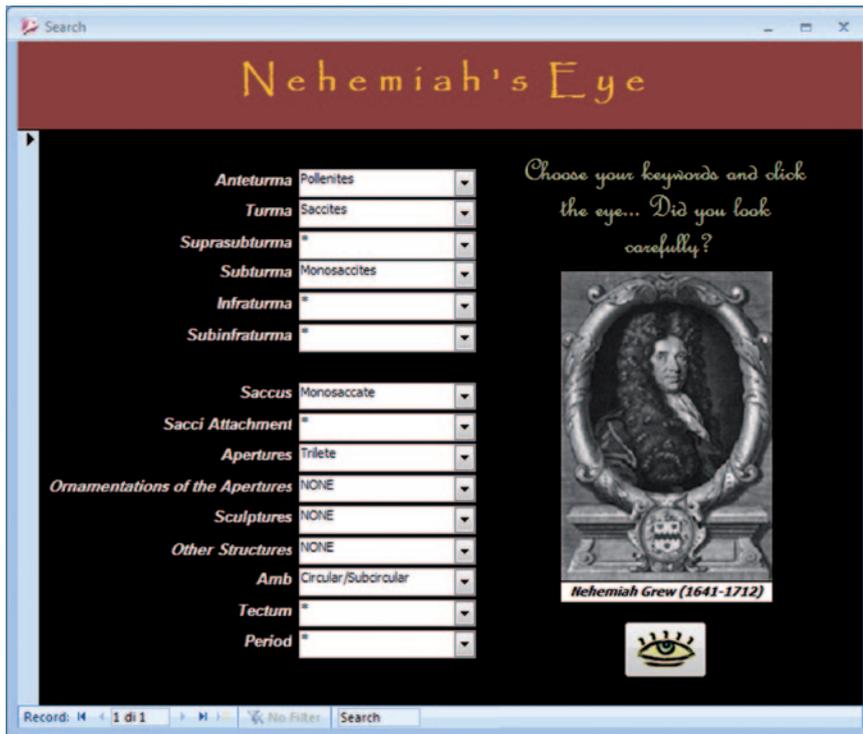


Fig. 4: *Nehemiah's Eye*. It is a search engine that filters and groups species records using simple criteria (taxonomy and/or morphological features). Once all the interested search criteria are selected the user only has to enter the query by a click on the eye-button.

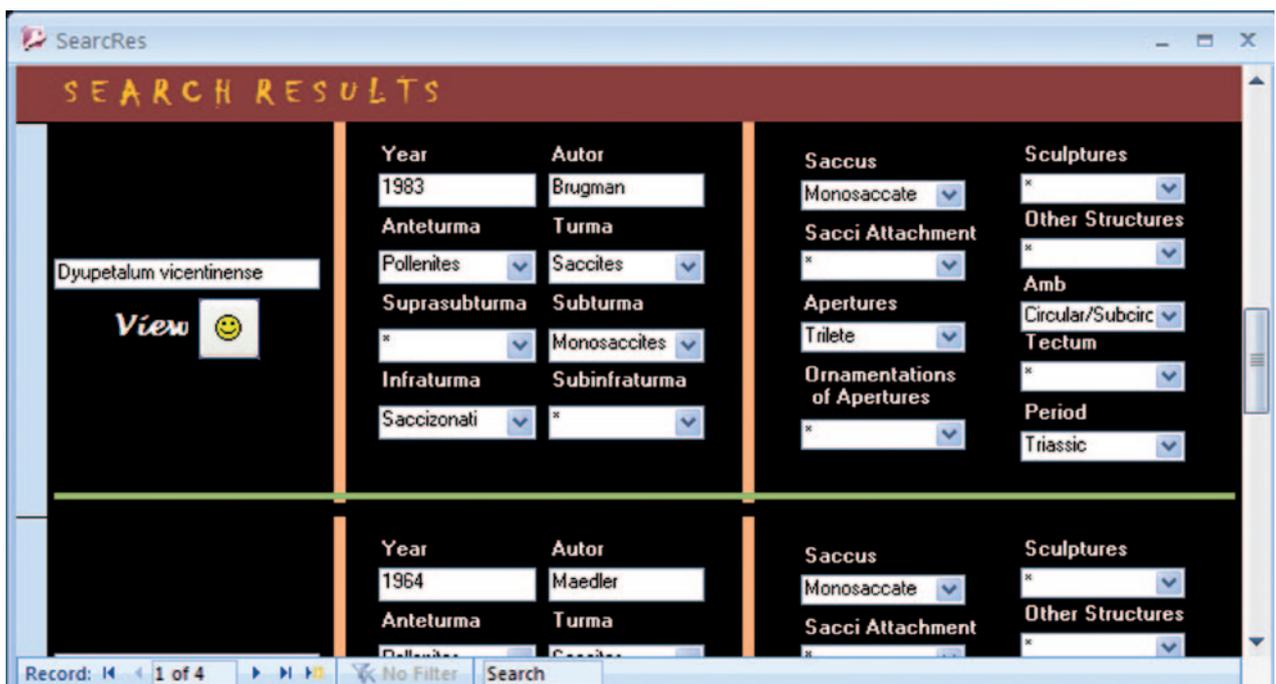


Fig. 5: Result of the query: species answering the requirements of the query in Fig. 4 are displayed. By clicking on the button "view" details on the species are shown as in Fig. 2. On the bottom of the slide the total number of datasets compatible to the query are shown as well.

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