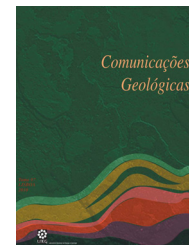


The Foraminifera.eu Project A paleoinformatics bridge between science and community

O Projecto Foraminifera.eu Um elo paleontológico e informático entre ciência e sociedade

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Artigo Curto
Short Article

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Abstract: Foraminifera.eu is a non-commercial international project to foster the interest in foraminifera. A freely accessible image database with an online multi-criteria search facility based on high quality SEM and optical images and drawings has been developed. The website has become a popular resource with more than 5000 monthly unique visitors viewing more than 50000 pages. About 120 scientists and amateurs are contributing samples, images, drawings, ideas and working on projects, publications, exhibitions, talks and collection. Foraminifera from the Oporto Seamount, from the Luz Formation and from the Mem Moniz spongolitic limestone are the first Portuguese contributions to this project.

Keywords: Foraminifera, Online database, Paleoinformatics, Society.

Resumo: Foraminifera.eu é um projecto internacional, não comercial, para divulgar e promover o interesse por foraminíferos. Foi desenvolvida uma base de dados online de acesso livre, com possibilidade de pesquisa por multicritérios, apresentando imagens obtidas por microscopia electrónica ou óptica e com ilustrações de elevada qualidade. A página na internet tornou-se muito popular com mais de 5000 visitantes por mês e acima de 50000 visualizações de página. Cerca de 120 cientistas e amadores têm contribuído com amostras, imagens, ilustrações, ideias e participação em projectos, publicações, exposições palestras e coleções. Foraminíferos da Montanha submarina do Porto, da Formação da Luz e dos calcários espongolíticos de Mem Moniz são os primeiros contributos portugueses para este projecto.

Palavras-chave: Foraminifera, Base de dados online, Paleontologia e informática, Sociedade.

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1. Introduction

Foraminifera are an important life form in the marine realm, comprising over 55% of Arctic biomass and over 90% of deep sea biomass (Armstrong & Brasier, 2005). They account for almost 25% of the present-day carbonate production of the oceans (Langer, 2008). It is estimated that today 47% of the ocean bottom or about 126000000 km² are

covered by their shells, which fall in a constant rain to the seafloor (Bellier *et al.*, 2010). They are important as biostratigraphical and paleoecological indicators in marine rocks of the Late Paleozoic, Mesozoic and Cenozoic as they are abundant, diverse and easy to use. Though almost everybody will have stepped on thousands of foraminifera in sands, sediments and rocks they are widely unknown and neglected even among geologists.

Avocational paleontologists (Cozart, 2000) are independent individuals or amateur paleontologists who have great interest in paleontology, collect, study or teach about fossils, but earn a living through other means and often do not have an academic degree in paleontology. Paleontologists discussing the future of paleontology and the role of avocational paleontologists concluded that a symbiotic relationship with professional community would be desirable and perhaps critical, in order to increase the public interest in, understanding of, and support of paleontology.

Paleoinformatics (MacLeod & Guralnick, 2000) concerns the use of information technology to manage, preserve and distribute paleontological data for the purposes of research and education. Online databases provide excellent ways of sharing information, especially when the web allows querying for data (Dolven & Skjerpen, 2011).

Foraminiferal research has produced numerous catalogues, atlases, books and articles dealing with taxonomical, stratigraphical, faunal and environmental data plus accompanying illustrations. A comprehensive web-based database with a multi-criteria search query has not been established yet, although online databases have become very popular and easy to handle. Ellis and Messina is the most comprehensive catalogue delivered online, but is not free (~5000 € per year subscription fee), and does not offer a multi-criteria search. Encyclopedia of Life and similar web based projects are based on the one-dimensional Tree of Life structure. Outputs are fixed in structure and cross searches may be time-consuming if not impossible. World Foraminifera Database (<http://www.marinespecies.org/foraminifera/>) focuses on taxonomy, which leads to long lists of names, but many taxa

have no illustrations or descriptions. It is very good as a reference to species names, and very useful to experienced scientists. We find the Smithsonian National Museum of Natural History online catalog (<http://collections.nmnh.si.edu/search/paleo/>) difficult to use because only a few of the specimens are photographed and criteria such as geological age and locality are rarely entered and are thus not searchable. Other general databases are EOL.org (only life-forms), radiolaria.org (excellent for radiolaria), and fossilworks.org (collection oriented, not many images).

References to paleontological databases are very scarce in Portugal.

Meco *et al.* (2003) developed a database concerning Miocene ostracoda of Portugal, using Macintosh system and the 4D First 1.2.5 program. Presently, there are only two small paleontological online databases: the "geoBases - Paleontologia" presenting information of general characteristics, taxonomy, chronostratigraphy, locality of occurrence and a picture of 173 selected fossils from the paleontological collection of the Geological Museum (LNEG) and the "Base de Dados Paleontológicos (DCT, Universidade de Coimbra)" with information, but without images, of the ammonite species, respective family and subfamily, biozone, stage and bed, and local of occurrence from the Toarcian to Aalenian of the Lusitanian Basin.

Building online databases requires large amounts of time and work (Dolven & Skjerpén, 2006). In our opinion and experience, an accessible and popular online database, with user-oriented documentation, should be built based on the following propositions:

- 1) Each object gets an optical representation with high quality illustrations. No poor quality images are allowed. A dataset without an illustration is not acceptable.
- 2) Each class of objects bears specific information. A specific database with a consistent structure should be built on a profound knowledge of the objects. A historic mask and an insect will need different databases as too much information is lost when putting them together.
- 3) Only criteria should be used for which values may be addressed to almost every object of the collection.
- 4) The user interface should allow the user to sort the collection according to his/her needs.
- 5) The access should be fast and interactive.
- 6) The user is presented with illustrations and text information together.

2. The Foraminifera.eu Project

Foraminifera.eu is a non-commercial international project (Hesemann, 2009, 2010) building a bridge between science and community to foster the interest in foraminifera. It is run by amateurs and supported by scientists. Professional foraminiferalogists have a platform to share their knowledge with inexperienced ones. Practical help in sample-processing, imaging and identification is offered. Foraminifera.eu is also seen by professional scientists as an opportunity to promote their publications as we just show images with basic data. Each image is shown with a

reference to the contributor and the relevant publication. Whoever wants to learn more needs to get the original publication, to which we refer on each single page.

The Foraminifera.eu website has become a popular resource with more than 5000 monthly unique visitors viewing more than 50000 pages. About 120 scientists and amateurs are contributing samples, images, drawings, ideas and/or are working on projects, publications, exhibitions, talks and collections. The amateurs make a variety of contributions. Some are pleased to contribute by cleaning, sorting and mounting samples. Others are interested in the technical challenges involved in the imaging of specimens. Some of the amateur contributors have access to SEM and are producing high quality images for the project (Fig. 1). Many of the optical images produced are of an extremely high standard (Fig. 2).

3. The Foraminifera.eu database (FEUDB)

FEUDB (<http://www.foraminifera.eu/querydb.php>) is a freely accessible image database with an online multi-criteria search facility based on high quality SEM and optical images and drawings. So far the illustrations are searchable on 23 data-criteria with 3800+ defined values. Six of the criteria are taxonomic, two morphological, four geographical, one faunal, four stratigraphic, two source-related and three refer to the reliability of the identification.

A selection from the available choices results within seconds in a plate filled with thumbnails and basic accompanying information. A click on any thumbnail leads to a single webpage with a bigger illustration and more information. FEUDB is also used to build web pages with thumbnails on genera, a key to genera, catalogues on single localities and collections.

FEUDB contains so far 8000+ illustrations of 2200+ species, of which about 50% are identified and published by professional scientists. 17% are illustrations of type specimens, a percentage which will increase due to the permission of the Smithsonian Institution National Museum of Natural History in Washington and Austrian Geological Survey to show their illustrations of type specimens.

To facilitate accessions to the database, we are currently developing a system to enable scientists to directly enter their images and the associated metadata (<http://www.foraminifera.eu/upload>). A future task is to analyse how users are interacting with the database and to investigate how well it is meeting their needs.

4. Working groups and subjects

We are able to establish longer lasting working groups on single subjects. The following projects have been successfully completed:

- to create a foraminiferal road show, an exhibition, shown three times so far.
- the foraminiferal analysis of two drill cores for the Hamburg Geological Survey.

– a foraminiferal analysis of Miocene strata for the Calvert Cliffs Marine Museum, Maryland, USA resulting in an exhibition for 15 months in the museum and a micropalaeontological weekend workshop with 22 participants.

Ongoing projects include:

– Foraminifera of the Sternberger Gestein.

– Atlas of Maastrichtian foraminifera with species pages and synonym lists.

– Key to foraminiferal species. Although at an early stage of development, a simple visual key is already available online. This is proving very useful for amateurs with little knowledge of the foraminifera and it can also be used as a pedagogical tool.

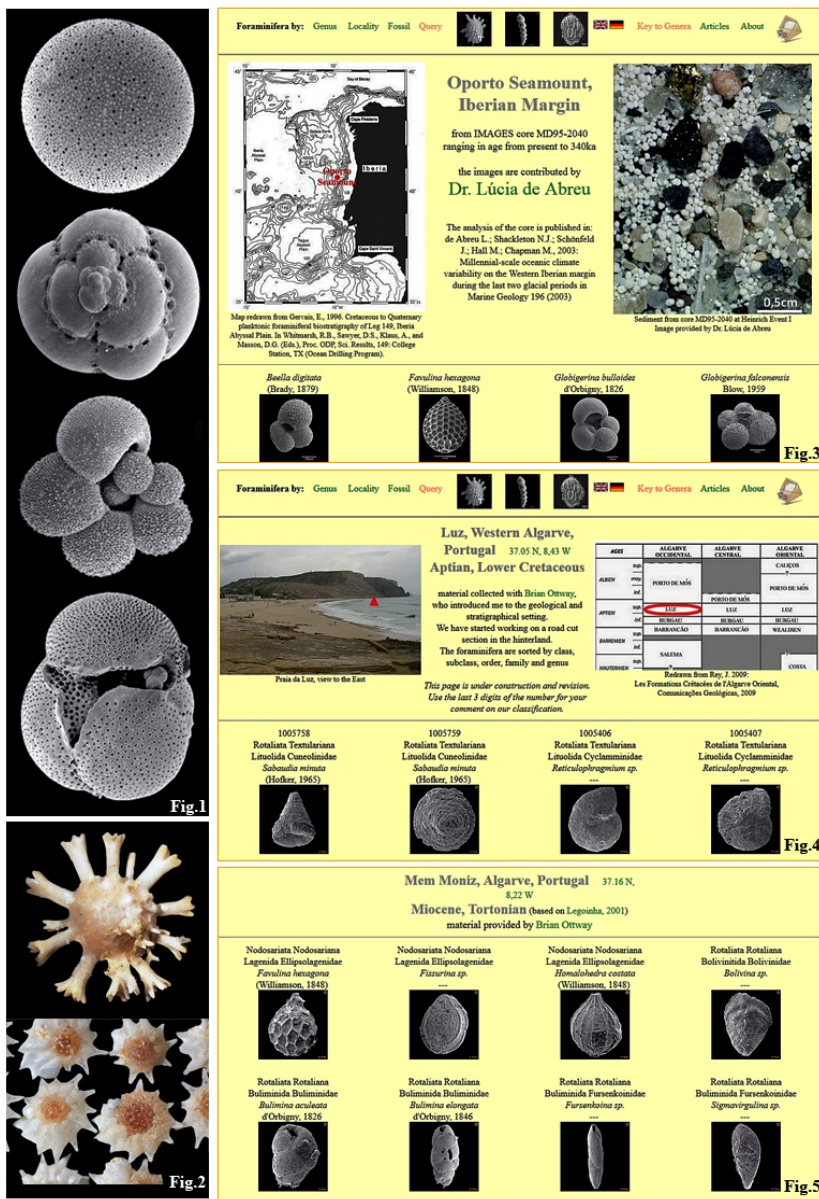


Fig. 4. Screenshot of the Luz page at <http://www.foraminifera.eu/luz.php> as seen on 2014-03-22. The images are made by Michael Hesemann and Georg Rosenfeldt. The specimens were found by Michael Hesemann in material collected together with Brian Ottway.

Fig. 4. Captura de ecrã da página de Luz em <http://www.foraminifera.eu/luz.php> (consultada em 2014-03-22). Imagens obtidas por Michael Hesemann and Georg Rosenfeldt. Espécimes triados por Michael Hesemann em amostra recolhida com Brian Ottway.

Fig. 5. Screenshot of the Mem Moniz page at <http://www.foraminifera.eu/memmoniz.php> as seen on 2014-03-22. The images are made by Michael Hesemann and Georg Rosenfeldt. The specimens were found by Michael Hesemann in material collected together with Brian Ottway.

Fig. 5. Captura de ecrã da página de Mem Moniz em <http://www.foraminifera.eu/memmoniz.php> (consultada em 2014-03-22). Imagens obtidas por Michael Hesemann e Georg Rosenfeldt. Espécimes triados por Michael Hesemann em amostra recolhida com Brian Ottway.

Fig. 1. From top to bottom, images of *Orbulina universa* (d'Orbigny, 1839), *Candeina nitida* d'Orbigny, 1839, *Globigerinella siphonifera* (d'Orbigny, 1839) and *Sphaeroidinella dehiscens* (Parker & Jones, 1865) made by Michael Hesemann and Dr. Georg Rosenfeldt. The specimens were found in a sample from the Muertos Trough, Caribbean, provided by Prof. Gerhard Schmiedl, University of Hamburg.

Fig. 1. De cima para baixo, imagens de *Orbulina universa* (d'Orbigny, 1839), *Candeina nitida* d'Orbigny, 1839, *Globigerinella siphonifera* (d'Orbigny, 1839) e *Sphaeroidinella dehiscens* (Parker & Jones, 1865) obtidas por Michael Hesemann e Dr. Georg Rosenfeldt. Os espécimes foram triados numa amostra da Fossa de Muertos, Caraíbas, cedida pelo Prof. Gerhard Schmiedl, Universidade de Hamburgo.

Fig. 2. Optical images of *Calcarina defrancii* d'Orbigny, 1826 (top) and *Neorotalia calcar* (d'Orbigny, 1839) made by Bernard Remaud, creator of "Sables du monde". The specimen were collected in modern sediments from Odlot, Cebu, Camotes Sea, Philippines.

Fig. 2. Imagens à lupa binocular de *Calcarina defrancii* d'Orbigny, 1826 (topo) e *Neorotalia calcar* (d'Orbigny, 1839) obtidas por Bernard Remaud, autor de "Sables du monde". Os espécimes foram recolhidos em sedimentos actuais de Odlot, Cebu, Mar de Camotes, Filipinas.

Fig. 3. Screenshot of the Oporto Seamount page at <http://www.foraminifera.eu/oportoseamount.php> as seen on 2014-03-22. The images are provided by Dr. Lúcia de Abreu.

Fig. 3. Captura de ecrã da página da Montanha Submarina do Porto em <http://www.foraminifera.eu/oportoseamount.php> (consultada em 2014-03-22). Imagens cedidas por Dr^a. Lúcia de Abreu.

5. Project activities in Portugal

After recent contacts with Portuguese scientists we propose to develop an Electronic Atlas of Portuguese foraminifera. Oporto Seamount foraminifera (Fig. 3) was the first Portuguese contribution to the Foraminifera.eu Project, by Lúcia de Abreu. Foraminifera of the Aptian of the Western Algarve (Fig. 4) result from a preliminary study of a short section of the Aptian Luz Formation in the western Algarve. Foraminifera have been used to identify marine sediments in a 25m section dominated by freshwater marls and paleosoils. The foraminifera and lithology indicate sediments laid down in estuarine, salt marsh and lagoon conditions. We have also been able to add to the number of foraminifera species previously recorded from the formation (Rey & Ramalho 1974; Rey 1986). The study has been carried out by amateurs, but has received generous advice from professional geologists and foraminiferologists.

Several Portuguese scientists are making material available and to involve amateurs in the project, we have initiated a sampling programme in the Algarve. Foraminifera from Mem Moniz (Fig. 5) represent some of the specimens collected, imaged and classified to date.

6. Concluding remarks and perspectives

We view the permissions given in 2013/2014 by prominent scientists and institutions to use their illustrations as a substantial acknowledgement of our work and as a motivation to move on. Foraminifera.eu is seen by professional scientists as an opportunity to promote their publications as we just show images with basic data. Whoever wants to learn more needs to get the original publication, to which we refer on each single page.

As our work is based on naturalist enthusiasm and only voluntary efforts are involved it will take time to integrate the thousands of images made available to us. Nobody wants to be a data-clerk only. In 2014 we plan to integrate a further 1000 illustrations from major works plus another 700 from our own work and from junior scientists and amateurs.

In order for Foraminifera.eu to continue to develop, it is of course important to maintain the enthusiasm and

engagement of both the amateur and professional scientists. This is the key challenge for the future, made easier, of course, by having such a fascinating group of organisms as our common focus. But whatever the future may bring, we can say that we have already achieved a major objective – to build a bridge between science and community.

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