DIATOMS AND DATABASES -A SHORT REVIEW

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DIATOMS AND DATABASES – A SHORT REVIEW

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DIATOMS
DATABASES
TAXONOMY
ECOLOGY
CODED LIST
CD-ROM
WEB PAGE
INTERNET

ABSTRACT. – It is becoming increasingly obvious that the transmission of information is crucial in the global scientific context. One only has to think of the consultation of type specimens from a diatom herbarium or the verification of an identification through electronic consultation of a photographic library. Computerized databases on diatoms could become indispensable tools supporting taxonomic uniformity. We are highlighting some advance in the field of electronic archiving diatom information and this should be regarded only as a short review. Examples are taken from various countries who have created electronic databases on diatoms. At the beginning of this new millennium, we will assist in a proliferation of websites devoted to diatom research. If we work together, we can develop the basis for a new era of research in diatomology, accord greater importance to computerizing the databases and ensuring their transmissibility to our colleagues all over the world.

DIATOMÉES
BASES DE DONNÉES
TAXONOMIE
ÉCOLOGIE
LISTE DE CODES
CD-ROM
PAGE WEB
INTERNET

RÉSUMÉ. – Il devient de plus en plus évident que la transmission d'information est primordiale dans le contexte scientifique global. Il suffit de penser tout simplement à la consultation des spécimens types d'herbier de Diatomées ou encore à la vérification d'une identification par la consultation d'une photothèque par voie électronique. Des bases informatisées sur les Diatomées peuvent devenir des outils indispensables permettant de supporter une uniformité taxinomique. Cet article se veut une brève revue des bases de données existantes sur les Diatomées et, pour cette raison, nous avons surtout mis en évidence les récents avancements technologiques dans le domaine de l'archivage électronique de données sur les Diatomées. Des exemples ont été puisés dans divers pays qui ont créé de telles bases de données électroniques sur les Diatomées. À l'aube de ce nouveau millénaire, nous allons assister à une prolifération de sites électroniques voués aux Diatomées. En travaillant ensemble, il nous sera possible d'élaborer les fondements d'une nouvelle ère de recherche en diatomologie, d'accorder une part plus importante à l'informatisation des bases de données et d'en assurer la transmissibilité auprès de nos collègues du monde entier.

INTRODUCTION

With the relentless advance of computer technology, it is becoming increasingly evident that transmissibility of information is crucial in the global scientific context. This is all the more true, as research teams are becoming not only multidisciplinary but multinational as well. Attention to this important topic from the current debate on diatom research was first drawn by a Roundtable that took place during the 18th Colloquium of the Association des Diatomistes de Langue Française held in Nice, France, on 14-17 September 1999 (Poulin *et al.* 2000). The relevance of maintaining diatom databases, the harmonization of data sets and the transfer of information have been recognized as being beneficial to the scientific community. Therefore, this paper highlights some of the advances in the field of electronic archiving diatom information available under various formats and for diverse purposes. Bare in mind that the scope of this paper is far to encompass an exhaustive review of the topic but instead wants to start a dialogue and, for this reason, it has to be seen as a short review.

CLASSIFICATIONS

One only has to think of the consultation of type specimens of a diatom herbarium or the verification of an identification through electronic consultation of a photographic library. Also to be remembered are the corresponding databases where the abiotic parameters of a given ecosystem are preserved. Computerized databases on diatoms could become indispensable tools supporting a kind of taxonomic uniformity even where there are differing classifications. For example, there is no reason why names valid under one school or another could not be kept; in any event, the information can be conserved in synonymy. In fact, Pullan *et al.* (2000) developed a model named, *Prometheus Taxonomic Model*, for representing taxonomic data in a flexible and dynamic electronic system capable of handling and comparing multiple simultaneous classifications. The model separates the process of nomenclature from that of classification, and enables the system to store multiple classifications. A prototype system is presently being tested on some groups of vascular plants and the latest information can be obtained via the Prometheus website (www.dcs.napier.ac.uk/~prometheus). On a more general point of view, databases would also make it possible to incorporate measurements of physicochemical parameters so that the autecology of the diatoms in question could be better described and understood.

GEOGRAPHICAL AND ECOLOGICAL DATABASES

In Canada, for instance, an initial attempt at computerizing the national phycological collection was begun by the Canadian Museum of Nature towards the middle of the 80s but was interrupted in early 1991, which seriously compromised the progress of this project. The system used, *CURATOR*, was developed from a special software program to manage the national natural history collections with an integrated geographical atlas and a taxonomic dictionary. By the time this software was abandoned, nearly 40 % of the phycological collection had been entered into that system. Recently a database for the diatoms of the northern hemisphere's circumpolar regions containing over 300 lakes in the Yukon, Siberia, Northern Quebec and Labrador was established by R. Pienitz of the Université Laval (Quebec City, Canada) and will be soon available on Internet. This database contains species names of diatoms that have been so far recorded from these circumpolar regions, and the accuracy of their identification is currently being verified. In addition to these taxonomic data, there are measurements of the physicochemical parameters of the water bodies that were studied, for example, temperature, oxygen levels, pH, conductivity, phosphorus and nitrogen, to mention only a few.

TAXONOMY AND SOFTWARES

The establishment of databases to help in the identification of diatoms has also aroused much interest in the last decades (Cairns *et al.* 1982, Droop *et al.* 1993, Williams 1993, Johnson & Lowe 1995). At the beginning of the 90s, a database and a computer-assisted identification program for marine protists were developed by Estep *et al.* (1989, 1992, 1993). The computer software, called *Linnaeus Protist,* is available on compact disk. It contains information on 312 marine protists (microalgae and protozoans) from northern European marine coastal waters. From a main menu, users may obtain information on particular diatom species that includes line drawings, descriptions, references, and in most cases, on-screen, photograph-quality micrographs. From a main menu, the user can access various other files, including taxonomic keys, distribution maps of toxic and blooming species, and a master list of species. This CD-ROM is a valuable educational tool for both the classroom and the field laboratory.

At about the same time, other developments were happening worldwide. In France, the software program *OMNIDIA* (http://perso.club-internet.fr/clci/) was developed to assist the rapid calculation of diatom indices as well as offering the users with a possibility to archive photomicrographs of diatoms monitored (Lecointe *et al.* 1993, 1999). The database, currently available on *OMNIDIA*, was created in 1981 by the Cemagref in Bordeaux from the need to codify the designations of diatom species used in establishing the index approach, and it is regularly updated. The last edition of the software contains a photographic library of 209 freshwater diatoms accurately identified from river systems of French departments.

Numerous new species have been described since the publication of the last volume of VanLandingham's Catalogue (VanLandingham 1967-1979) as well as a high number of taxonomic revisions have been proposed (Krammer & Lange-Bertalot 1986, 1988, 1991a, b, Round *et al.* 1990). To make it easier to work through the labyrinth of new or recent taxonomic designations, the *OMNIDIA* base attempts to make a few non-exhaustive additions to the catalogue of VanLandingham (1967-1979) in the form of abridged records, even an index. Since the number of publications consulted is relatively limited, the resulting gaps are necessarily significant. The file nonetheless reviews most of the classic publications in which new diatoms are generally described

(e.g., *Bacillaria, Diatom Research, Diatom, Arch Hydrobiol, Bibl Diatomol, Iconogr Diatomol, Nova Hedwigia, Phycologia, Canadian Botany, Europ J Phycol, Proceedings* of international seminars) and most of the works or monographs devoted to diatoms. Of course, the synonymies already mentioned in the catalogues of Mills (1933-1935) or VanLandingham (1967-1979) do not necessary appear there and the database does not in any way claim to substitute for them. It is only a modest stop gap measure designed for computer use, while awaiting the re-publication and updating of these works.

TAXONOMIC ENCODING

Numerous proposals for coding algae, and diatoms in particular, can be found in various authors (e.g., Fabri & Leclercq 1984, Droop *et al.* 1993, Williams 1993, Whitton *et al.* 1998). They were designed for different purposes, including collection management, taxonomy, morphological variability or even the codification of autecological data of fossil and recent diatoms, and they generally make use of complex codifications consisting of 5 to 8 codes (sometimes up to 15), associating either numbers (Whitton *et al.* 1978, 1979, Denys & Lodewijckx 1984, Güttinger 1986-1998, Williams *et al.* 1988, Denys 1991, Whitton 1991, Whitton *et al.* 1998), or letters (Klasvik 1974, Fabri & Leclercq 1984, van Dam *et al.* 1994), or numbers and letters (de Wolf 1982).

A simplification of computerized entry operations consisted in the use of 4-letter codes developed for the *OMNIDIA* database. Four-letter codes are easy to read, particularly using ecological data analysis programs such as multivariate statistics (Lecointe *et al.* 1993, Prygiel & Coste 1999). It is strongly recommended that a common codification system be adopted to facilitate exchanges and possible confrontations among the data inventoried and so that index methods can be more readily standardized.

NATIONAL PROJECTS

In France, beginning in the year 2000, the results of the diatom indices obtained from the Réseau National de Bassin will be centralized by the Réseau National des Données sur l'Eau in agreement with the Service d'Administration National des Données Relatives à l'Eau, an organization that is developing a common language for data concerning water and is establishing data standardization to make the definition and exchange of data among producers, users and databanks both compatible and homogenous. Recent developments lead us to believe that the Agence de l'Eau Artois-Picardie will take care of the diatom monitoring and indices for France while the Muséum National d'Histoire Naturelle in Paris will manage and conserve the raw diatom material and permanent slides (J Prygiel, pers comm). In addition, a free software program on compact disk *(TAX'IBD)* for identifying diatoms selected for calculating the Indice Biologique Diatomées or *IBD* (Lenoir & Coste 1996, Prygiel & Coste 1999) is now available and 700 copies have been reproduced and distributed through France by the water agencies (Prygiel & Coste 2000).

In Switzerland, a database was created in 1999 with the support of regulatory agencies such as the Office Fédéral de l'Environnement, de la Forêt et du Paysage in Bern, the AquaPlus' office in Unterägeri and the Office Cantonal de Protection des Eaux of Zürich, as well as professional Swiss diatomists. The database archives all data and information available on river diatoms from Switzerland in order 1) to bring together existing and usable raw data in a unique collection (diatom and physicochemical data), 2) to facilitate data comparison, 3) to complete observations in regions where data and information are lacking, and 4) to calibrate existing indices and develop one or more indices for Switzerland in terms of its various geological basins and in agreement with national regulations regarding water quality objectives.

For this project, the taxonomic and nomenclature base reference was limited to the use of the *Süsswasserflora* (Krammer & Lange-Bertalot 1986, 1988, 1991a,b) and five critical volumes from the series *Bibl. Diatomol.* (Krammer & Lange-Bertalot 1985, Lange-Bertalot 1993, Lange-Bertalot & Krammer 1987, 1989) and *Iconogr. Diatomol.* (Lange-Bertalot & Metzeltin 1996). For the raw database on Swiss diatoms, accessibility problems have not yet been resolved, because each canton remains the owner of the raw data that it has provided. Access to such data must be discussed on a case by case basis. In addition, the AquaPlus bureau has developed programs to access and validate these data, but this part of the database is private. The AquaPlus bureau and, in particular, J. Hürlimann (joachim.huerlimann@aquaplus.ch) are available, however, for any follow-up question or for any proposal to participate in joint projects related to this databank.

EUROPEAN PROJECTS

At the European level, Droop *et al.* (1993) are currently working on the Automatic Diatom Identification And Classification *(ADIAC)* project which seeks to develop algorithms allowing for the automatic identification of diatoms through information obtained from illustrations, for example, size

and ornamentation. Further information on the *ADIAC* project can be obtained from M. Bayer at the Royal Botanic Garden in Edinburgh (http://www.rbge.org.uk/ADIAC).

The European Diatom Database *(EDDI)* is another information system that is allowing diatom-based palaeoenvironmental reconstruction for pH, total phosphorus and salinity. It makes possible to gather and harmonize European data on diatoms and water chemistry in order to ultimately produce a CD-ROM and a website making available the combined data as well as photomicrographs of the main diatom taxa and software for data analysis. More information can be obtained at the website (http://www.geog.ucl.ac.uk/ecrc/eddi/).

Another European project, *PAEQANN* (http://www-cesac.cemes.fr/~paeqann/), consists in developing general methodologies based on advanced modelling techniques (mainly goal function and artificial neural networks) for predicting structure and diversity of key aquatic communities (diatoms, macro-invertebrates and fish) under natural and human-induced disturbances. The development of predictive models for aquatic ecosystem variability will contribute to create a comparative common base at the European scale and an overall appreciation of the water resources in Europe.

Species lists and iconography

It is important not to overlook all the websites or webpages that have been created in the last ten years. The project of Fourtanier & Kociolek (1999) lists the 1001 genera of diatoms (http://www.calacademy.org/research/diatoms/genproject) and proposes a description and illustration of 73 freshwater genera (http://www.calacademy.org/research/diatoms/genera/index.html). Recently, P. Compère, of the Jardin Botanique National de Belgique, made available on the website of the Association des Diatomistes de Langue Française or ADLaF (http://perso.club-internet.fr/clci/diatom-ADLaF.htm) the first identification key in French for all freshwater genera (http://perso.club-internet.fr/clci/ADLaF_Cle_des_genres.htm). In Australia, diatomists have proposed also an illustrated key to the common genera of freshwater diatoms (www.arts.monash.edu.au/ges/research.Cpp/Diatoms/generic.html). For the marine sector, it is interesting to consult the taxonomic list of phytoplankton of Skagerrak-Kattegat on the website of M. Kuylenstierna and B. Karlson (www.marbot.gu.se/SSS/SSShome.htm).

CONCLUSION

There are numerous websites that provide images of microscopic organisms for the purpose of ecological monitoring of harmful species of algae or illustrations showing the biological diversity of microalgae. In any case, the fact remains that, at the beginning of this new millennium, we will see a proliferation of websites devoted to diatoms. A list of the most important websites on diatom databases is summarized in Table I, which will be maintained on the *ADLaF* webpage and regularly updated. It is becoming increasingly crucial that we work together with research centres and organizations in the field of diatomology. With technological progress, we can now, directly from the microscope, preserve the image of the diatom that we are examining and transfer it to our personal computer or even send it electronically to a distant colleague. This is what lies in store for the new generation of diatom specialists.

But there is one crucial difficulty in this vision; no one wants to be the leader either because of diverging work objectives or for want of funds. However, there could be some light at the end of this tunnel. It would be sufficient if a dialogue were initiated with museological institutions to have them take on the task of preserving data on diatoms. A situation that recently evolved with the Muséum National d'Histoire Naturelle in Paris being considered the repository organization for all diatom material and slides originating from the monitoring of the French rivers. Is this not in any case one of the fundamental missions of a museum ? They should not only make science accessible to the general public, but should also participate in preserving our natural heritage by archiving their collections, computerizing them and disseminating them. A computerized collection is a collection that can be accessible to users; it is, as it were, alive. If a museum is most often defined as a centre of expertise on biodiversity, this must be widely disseminated to the public. Whence the interest presented by diatom databases that would include, for example, illustrations, descriptions, reference documents, distribution maps and measurements of the corresponding physicochemical parameters.

Unfortunately, we are still far from having such tools, but if we work together, we can develop the basis for a new era of research in diatomology, accord greater importance to computerizing the databases and ensuring their transmissibility to our colleagues all over the world.

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Table I. – Websites on diatom databases and on general information on diatom research.

Internet databases on diatoms (site addresses)	European project	Taxonomic database	Iconography database	Species list (checklist)	Genera list (checklist)	Diatom palaeoecology	Methods/Techniques	Geographical data	Environmental data	Bibliography data	Software on diatoms	Cultures diatoms database	Genetic database	Diatomist Association	International news groups	General Diatom Home page	E-mail & addresses data	Meetings & courses
http://www.rbge.org.uk/ADIAC/	x	x	x	x												x		
http://www.rbge.org.uk/ADIAC/db/Adiacgen.htm			x	x	x													
http://www.rbge.org.uk/ADIAC/db/adiacdb.htm			x	x	x													
http://www.rbge.org.uk/ADIAC/pubdat/prepro.html#1							x											
http://www.geog.ucl.ac.uk/ecrc/eddi/	x		x			x		x	x							x		
http://www-cesac.cemes.fr/~paeqann/	x	x		x				x	x									
http://www.indiana.edu/~diatom/dpdc/dpdc.html						x												
http://www.geog.ucl.ac.uk/ecrc/edgis/edgis.htm								x	x									
http://www.kv.geo.uu.se/inqua/news2/nl2-dfc.htm		x				x			x		x							
http://www.kv.geo.uu.se/inqua/news19/n19-ehj.htm		x	x			x		x	x									
http://www.nmnh.si.edu/ing/		x			x					x								
http://www.nmnh.si.edu/cgi-bin/wdb/ing/names/form		x			x													
http://www.bgbm.fu-berlin.de/iapt/ncu/genera/NCUGQuery.htm		x			x													
http://128.32.109.44/e-ina.html		x		x	x													
http://www.arts.monash.edu.au/ges/research/Cpp/Diatoms/			x	x	x		x			x				x				
http://www.msu.edu/~kirschte/biovol/											x							
http://perso.club-internet.fr/clci/			x								x							
http://206.67.72.201/catalog/np/jan95np/DATA/3-540-14502-8.html											x							
http://perso.club-internet.fr/clci/ADLaF_Cle_des_genres.htm					x													
http://megasun.bch.umontreal.ca/gobase/													x					
http://www.awi-bremerhaven.de/Biomeer/molekulargenetische-e.html													x					
http://www.calacademy.org/research/diatoms/					x							x				x		
http://www.calacademy.org/research/diatoms/genera/index.html			x		x													
http://www.calacademy.org/research/diatoms/genproject/					x													
http://www.umich.edu/~mongolia/index.html			x	x						x						x		
http://www-personal.umich.edu/~asalger/HomePage/Home.html			x	x												x		
http://www.umich.edu/~phytolab/GreatLakesDiatomHomePage/glspeciesok2.html			x	x												x		
http://www.nwl.ac.uk/~loissys/algal_coded_list.htm		x		x														
http://www.marbot.gu.se/SSS/SSShome.htm			x	x				x										
http://www.math.ualberta.ca/~bowman/diatom/			x	x														
http://www.umich.edu/~phytolab/GreatLakesDiatomHomePage/top.html			x	x	x													
http://www.bgsu.edu/departments/biology/algae/index.html			x	x														
http://seaweed.ucg.ie/search/default.html		x	x							x								
http://hjs.geol.uib.no/diatoms/Marbles/index.html-ssi			x															
http://www.weizmann.ac.il/home/crosta/Diat.html			x															
http://www.fxbrowne.com/html/micro/diatom.html			x															
http://www.mnhn.fr/mnhn/geo/diatoms/index.htm			x						x									
http://www.schweizerbart.de/j/										x								
http://www.koeltz.com/										x								
http://www.balogh.com/~balogh/										x								
http://www.serv.net/~mallard/diatom/diatom_biblio.html										x								
http://ccmp.bigelow.org/												x						
http://www.bgsu.edu/Departments/biology/algae/html/DiatomCulture.html				x								x						
http://www.ife.ac.uk/ccap/												x						
http://www.gwdg.de/~epsag/phykologia/catalogue/gatt_99/bacillo.htm												x						
http://www.bio.utexas.edu/research/utex/genus/genus.html												x						
http://www.ocgy.ubc.ca/projects/nepcc/diatoms.htm												x						
http://www.botany.utoronto.ca/utcc/list.stm												x						
http://www.bio.utexas.edu/research/utex/reference/reference.html										x								
http://www.indiana.edu/~diatom/diatom.html						x	x			x		x		x	x	x		x
http://www.isdr.org/										x				x		x		x
http://www.bgbm.fu-berlin.de/diatoms/default.htm																		x
http://perso.club-internet.fr/clci/diatom-ADLaF.htm					x					x				x		x	x	x
http://seaweed.ucg.ie/algae-l/default.html															x		x	
http://listserv.indiana.edu/archives/diatom-l.html															x		x	
http://www.indiana.edu/~diatom/members.txt																	x	
http://seaweed.ucg.ie/cost/MicroAlgalCultures.html												x					x	
http://seaweed.ucg.ie/cost/AlgalHerbaria.html																	x	
http://www.calacademy.org/research/diatoms/nads/nads.htm																		x

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