IOP NEWSLETTER 40

INTERNATIONAL ORGANISATION OF PALAEOBOTANY

INTERNATIONAL UNION OF BIOLOGICAL SCIENCES
SECTION FOR PALAEOBOTANY
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SPECIAL EDITION -THE PLANT FOSSIL RECORD

PLEASE MAIL NEWS AND CORRESPONDENCE TO YOUR REGIONAL REPRESENTATIVE OR TO THE SECRETARY FOR THE NEXT NEWSLETTER 41. The views expressed in the newsletter are those of its correspondents and do not necessarily reflect the policy of IOP.

IOP PFR NEWS

TOWARDS A PARADIGM SHIFT IN PALAEOBOTANY?

Very recently, new database management architectures have appeared that possess greatly improved flexibility: they can be designed to search for anything, anywhere. We want to exploit the power of computers and use them to answer complex questions. These queries might lead to new appreciations of evolutionary, migratory, stratigraphical and environmental patterns contained within the hitherto locked-up plant fossil record. Now we, and others who will find our data useful, have the chance to unlock Pandora's box. Who knows what it contains? One difficulty is for us to ask the right questions: this newsletter tries to help us all do that.

THE PLANT FOSSIL RECORD

The original proposal for this project was agreed by the IOP Executive Committee in May 1989 and was published in Newsletter 38. Since then events have moved at a swift pace. This newsletter reviews the latest state of progress.

The proposal was approved formally by the Executive Committee of the International Union of Biological Sciences, Paris, later in May 1989. The project has two parts. The first is nomenclatural and the second is taxonomic. The second depends on the first.

Names in Current Use (IAPT) plans to organise a peer review of all generic names (about 15,000) and report them to the 1993 International Botanical Congress in Japan.

The Plant Fossil Record (IOP) plans to include descriptive details of these genera, and useful sub-generic taxa, into an agreed standard PC database format. The first phase of the project, the "Feasibility Study" is being undertaken jointly with the Fossil Plants Committee of the International Association of Plant Taxonomy as part of the Names in Current Use project. It serves as a feasibility study for the more ambitious PFR and ends in May 1989. The work is financed by IUBS, IAPT, the Polytechnic of East London (National Advisory Board special research initiative II) and Informix Sofware Ltd who have also provided their database package SMARTWARE II to store and retrieve the data to be collected.

Objectives of the feasibility study

1. to encourage trials, the identification of errors and debate
2. to agree a platform configuration of hardware and software
3. to agree an internationally approved standard format for Records, software and hardware
4. to select all plant fossil Genera in Current Use within the database together with other information
5. to agree to a structure of the database (more formally and technically known as the SCHEMA), who it may serve, and its functionality.

The results will be presented and debated at a meeting in Frankfurt, May 1990, ***Towards agreeing an international standard format for the PFR database.***

Examples of use and searches from the Plant Fossil Record

1. To retrieve assemblages, associations, etc. in Regions, Localities, Rock Formations, Strata of the same age, etc.
2. To identify those Genera in Current Use
3. To retrieve an author's taxon, genera, the genera in a family, order, etc.
4. To enable synonomies to be quickly identified
5. To link organs of the same likely whole plant
6. To identify the nomenclatural status of each taxon, eg type, new combination, biorecord, comparison record
7. To encourage a standard format for all new descriptions
8. To enable links to other databases and quantitative data stores
9. To provide a living bibliography of palaeobotany
10. To enable others than palaeontologists to have easy access to the Plant Fossil Record, for example, by searching for localities, basins, ages etc.
11. To provide a research tool for a new era of study

Preparation

A variety of Records will be designed for SMARTWARE II. Other database programmes will be used for control. These Records were presented and discussed at the AASP meeting in Oklahoma, October 1989, and the IAPT meeting in Gran Canaria, November 1989 for consideration and discussion. Further demonstration and debate will be stimulated through the IOP Newsletter and other sources for consideration at a meeting in Frankfurt, West Germany, in May 1990.

Data Entry

Magnetically stored data from the Smithsonian Institution Index Nomina Genericorum (ING), with Records of 9,246 plant fossil genera, has been re-formatted and imported into the draft PFR Records. Other data, largely palynological, are also in existence in computer readable form and negotiations are progressing to import them to our embryonic annotated lists.

Existing printed data (eg Andrews 1970 et seq. - about 8,000 genera, Stover & Evitt - about 5,000 genera, and Meyen's catalogue - about 7,000 genera), will be captured by a combination of OCR scanning and manual editing for importation into the PFR.

Negotiations to import data from the large Palynodata database began in October 1989; at least the generic names listed will be used to ensure that all the pollen, spore, dinocyst etc. names are included in our PFR list.

The project's taxonomy assistant (Alan Hemsley) will merge these variously detailed Records into the draft PFR standard format. Of course, to begin with, there will be many empty Fields.

Search Requirements

To produce a useful product it is essential to consult those who will be working with the database. The kind of feedback required is discussed in the article by Peter Woolliams below. Please write for a copy of the Demonstration disk and the associated questionnaire to help design the most efficient system.

There are 34 Field titles for the feasibility study Plant Fossil Records. They are arranged in four sections: Nomenclature, Taxonomy, Geology/Geography and Bibliography.

Products

Genera in Common Use will be available through Smartware II and as a printed document and is planned to be complete as a first draft version early in 1991. Hopefully the database will include annotations for most taxa such as REGION, BIBLIOGRAPHY, ORGAN, BOTANICAL FAMILY etc. of the type material. More details are given below. The Plant Fossil Record project will expand the details of these generic Records and begin to add Records of species. The Record format and future organisation and funding of the project will be discussed at Frankfurt in May 1990.

URGENT ACTION REQUIRED BY IOP MEMBERS

This special PFR edition of the IOP Newsletter is to stimulate debate to achieve agreement on a set of international standards. Please send your comments in writing to the IOP Secretary. Either these will be included in the next Newsletter 41 or made available for debate at the Frankfurt workshop. There are three ways in which IOP members can help establish a computerised PFR.

1. Many IOP members may already have taxonomic data in computer readable form of fossil plants in their own sphere of interest. Copies of these details, on tape or floppy disk (any format) would be gratefully recieved to incorporate into the IOP database.

2. Send Records for all new taxa, especially genera, on paper, or preferably in ASCII on any kind of floppy disk. Better still, please send examples of Records in the formats suggested later in this newsletter, either typed or on floppy disk, to be incorporated into the database.

3. Demonstration disks to test search pathways are available from the IOP Secretary FREE. Details and reasons for this experiment are explained in the sections below. If you have access to an IBM compatible PC (XT, AT or PS/2) with a hard disk please request to study the demonstration and help influence the standards being sought.

   You must give us details of your disk and monitor system so we can give you the correct software. Systems with Hercules, EGA or VGA monitors will display the example images as well as the text. Systems with CGA or MGA will only display the text functions. It will save limited IOP money, if you sufficient formatted disks for 3 megabytes or a cheque for UKL 10.00 cleared at a London bank, but that is not essential.

REPORTS OF RECENT DATABASE MEETINGS

AMERICAN ASSOCIATION OF STRATIGRAPHIC PALYNOLOGY, Tulsa, Oklahoma October 16-20 1989

The Plant Fossil Record project was discussed and demonstrated at this meeting of about 120 palynologists.

Several other database systems were presented and discussed. Some of these are detailed below under the heading "Other Fossil Plant Databases". There was also a meeting of the Directors of the Palynodata project at which procedures for converting the database from mainframe operation to personal computer optical disc storage and retrieval were established.

INTERNATIONAL WORKING GROUP ON TAXONOMIC DATABASES FOR PLANT SCIENCES (TDWG), Gran Canaria, 9-11 November 1989.

More than 30 plant taxonomists worked in specialist groups for two days of discussions. Topics ranged from global geographical indexing to standards of data input and retrieval. Full details of the deliberations were minuted and the conclusions will be published by the Hunt Institute, Pittsburgh, on behalf of TDWG.

The group's existance is to react to the advent of PC data storage and retrieval technology and to present international data in a standard integrated format.

Four standards were accepted by votes at the final plenary session, including:

Names in Taxonomic databases (F. Bisby, Southampton)

Exchange data format (R. Allkin, Kew)

World geography system (R. Brummitt, Kew)

The new secretary of TDWG is Marshall Crosby, Missouri Botanic Garden.

LISTS OF NAMES IN COMMON USE, Gran Canaria, 12 November 1989.

This meeting reviewed progress, discussed schedules for the generic and specific lists and considered the future programme. Five members are responsible for accumulating and managing the data: algae (Paul Silva, Botany, Berkley), bryophytes (Marshall Crosby, Missouri Botanic Garden), fossil plants (Mike Boulter, Polytechnic of East London), fungi (Paul Kirk, Commonwealth Mycological Institute) and vascular plants (Dick Brummitt, Kew Gardens).

Decisions were made on the data format (see ING item below), the co-ordination of the input (through Ellen Farr, Smithsonian Institution), the schedule for integration and its publication. It was agreed that the five members listed above should send final lists, with complete data for the Fields underlined on page 11, to Ellen Farr before November 1990. She will produce a draft version of the complete generic list during 1991 so that a second, revised, list can be available for the Tokyo 1993 IBC. If voted there to be acceptable this will form the basis of a third version for formal publication in Regnum Vegetabile after the Tokyo Botanical Congress.

NEWS OF FORTHCOMING DATABASE MEETINGS

VIDEODISC AND CD-ROM: NEW MEDIA FOR TEACHING AND RECORDING OF BIOLOGICAL DIVERSITY. Linnean Society of London, February 15, 1990. Write to Dr F.A. Bisby, Botany Department, University of Southampton, UK.

PLANT FOSSIL RECORD WORKSHOP, Frankfurt, 26-7 May 1990.

This meeting forms the first part of the Krausel Memorial Symposium at the Senckenberg Museum from 26 May - 3 June 1990. More than 60 palaeobotanists (from USA, Argentina, Canada, South Africa, India, USSR, and most European countries) have submitted applications for the main part of the meeting and it is hoped that as many as possible will also attend this workshop during the first two days.

The workshop marks the formal end of the PFR feasibility study and all the results of our current work will be presented. The draft agenda is:

1. Summary of written comments on topics from this newsletter (and number 41) from IOP members
2. Alternative formats for Genera and Species Records
3. Alternative computer hardware and software
4. Demonstrations of pc databases with plant fossil records
5. Progress of the Names in Current Use project
6. A debate on the philosophy and methodology of the PFR project
7. A vote to establish the feasibility of agreeing international standards for pc hardware, software and Record design
8. If the vote in 7 above is positive, discussion of a draft ***"Frankfurt Declaration"*** setting these international standards, followed by a vote to declare them accepted, or not.
9. Consideration of plans for the second phase of the project.

DESIGNS FOR A GLOBAL PLANT SPECIES INFORMATION SYSTEM, Delphi, Greece, October 12-16, 1990

This is to discuss the philosophy and methodology of incorporating details of all plant species into a database and to use new technology for taxonomic purposes. There will be sessions on the demand for a global system, taxonomic and botanical decision-making and data-entry, data structure and logical design, system design machines and communication, management ownership and funding.

Write to Marshall Crosby, Missouri Botanic Garden, USA.

IMPROVING THE STABILITY OF NAMES, London, February 1991

This is to encourage the debate between plant taxonomists of how stability in nomenclature can be achieved. All extremes of view will be represented. Write to Prof D.L. Hawksworth, International Mycological Institute, Ferry Lane, Kew, TW9 3AF, U.K.

ORGANISATION OF THE PROJECT

FIRST PHASE OF THE PROJECT: FEASIBILITY STUDY

Administration The IOP has established a Plant Fossil Record Committee (IOP - PFRC) to monitor the project's work and to assist in its progress. The initiator of the PFR project, IOP Secretary M.C. Boulter, will be chairman until the end of the feasibility study at the Frankfurt meeting announced above. The committee consists of C. Beck, M.C. Boulter, J. Galtier, C. Hill, and W. Schopf. They will manage the finances and organisation of the project to June 1st 1990. The Polytechnic of East London is also providing staff to assist with text scanning, keyboarding and computer programming.

Hardware The project has access to two Prime mini mainframe computers at the Polytechnic of East London. Communicate with this facility with the JANET electronic mail facility by using the address: BOULTER @ PEL. Messages and data can be accepted through this file though large sets of data may need a larger buffer to be installed which will require one week's notice. The main work on the project will be undertaken on an IBM PS/2 model 80 with 111mbyte disk with optical storage 200mbytes per platter and several clones. Through the involvement of Dr Peter Woolliams, Department of Systems and Computing at the Polytechnic of East London, a range of other hardware and software will be allocated to the project. High quality text scanner, high capacity optical disc storage facilities and graphics scanners are available. Both 5 1/4 inch and 3 1/2 inch floppy disks are supported.

Staffing As well as the more senior participants Boulter and Woolliams, the Polytechnic of East London is releasing a member of its technical staff N. Ambihaipahan MSc to work on the PFR project for one day a week. He has experience and qualifications in PC networking, and linking to mainframe systems, and will use the PFR project as the customer input for his PhD project.

Funding from Informix Software Ltd, IUBS and IAPT is being used to pay Alan Hemsley (who has an MSc in Plant Taxonomy from Reading University) to edit the imported data, and to pay for secretarial and proof reading assistance. The PFR administering committee will also consider applications from IOP members who wish to receive grants to attend the May 1990 meeting in Frankfurt. These same funds are also financing the copying and distribution of the demonstration disks announced elsewhere in this newsletter.

Demonstrations of progress at AASP, Oklahoma, USA in October 1989 and at the Krausel Memorial Symposium at the Senckenberg Museum, Frankfurt, May 1990 are being provided by Informix Software Ltd. Demonstration disks of the proposed Field titles, including data from ING and other specially ambitious Records, are available FREE from the IOP office in London.

Feasibility Study Activities

1. Data are being imported from existing computer databases. The PFR project has already obtained Records of the 9,246 plant fossil genera contained within the Index Nomina Genericorum. This is through

the kind assistance of Dr Ellen Farr, Botany Department, Smithsonian Institution, Washington DC. This will serve as the first central listing of fossil plant genera which will be edited and added to as more data becomes available. Other databases, largely palynological ones, are being imported if copyright laws allow. These are detailed in a following section of this newsletter

2. Add other data from existing printed catalogues, such as Andrews 1970, Meyen (in preparation), Jansonius & Hills 1976, Stover & Evitt 1975, Lentin & Williams 1989.

3. Sort these data for proof print-outs to appropriate specialists for revision and criticism. Judge and edit for common usage and accuracy. This will involve the help of international referees, such as members of the IAPT fossil plant committee, to review the database content for their regions and geological ages. This process must be completed by the summer of 1990.

4. Incorporate these changes into the PFR database.

5. Import and merge other data provided by IOP members, especially new taxa, as they are being published.

SECOND PHASE OF THE PROJECT AFTER FRANKFURT 1990

If money and goodwill are available it is proposed to appoint Regional Advisors to accumulate data and edit and maintain it within their geographical and stratigraphical area. Perhaps different individuals could manage the three main groups of organisms: pollen/spores, dinoflagellate cysts and megafossils.

For example, megafossil specialists who have already shown an interest in being involved start to show the

	Proterozoic	Palaeozoic	Mesozoic	Cenozoic
Gondwanaland		Rossler	Anderson	
Euramerica		Beck	Penney	
Asia			Venkatachala	Akhmetiev
N. America	Schopf			
S. America				Romero
Australasia				
Europe		Galtier	Hill	

pattern of a management matrix:

One major objective of this project is to set standards for future work. Taxa included here can never be an exhaustive list but a "useful" one. Future published work will help complete the picture and cover other previously described taxa. The system and database should be allowed to evolve itself without too many rules.

Though estimates vary, about 30,000 species are described and even more Records in this database would be required eventually. So, in consultation with sponsors, agreement about priorites for inclusion would help plan the future organisation. eg. 1 dinoflagellate cysts, 2 Mesozoic pollen and spores, 3 Carboniferous megafossils.

For palynology the Palynodata database already identifies references to descriptions of types. These might be searched and details incorporated Heavy use of libraries will be required: photocopying, magnetic copying and keyboarding facilities will be used on a very large scale.

The number of Regional Advisors (see above) will need to be increased, and they should preferably be rewarded. They will be asked to nominate important taxa for early inclusion, either by reference or mailed/fax photocopy. A major task will be to make public taxonomic judgements.

At about annual intervals versions of the database would become available. If the Regional Advisory systems works efficiently, and if the project can process 30 Records a day (6,000 Records in a 200 working day year), substantial progress can be made in 5 years (= 30,000 Records).

NAMES IN CURRENT USE PROJECT

The **INDEX NOMINA GENERICORUM (ING)** database is published as hard- bound printed copy by the IAPT as part of the Regnum Vegitabile series and is now available on magnetic media at the Smithsonian Institution. IOP has the data of its 9,246 plant fossil genera on its first draft PFR database which serves as the embryo from which our entire list of generic, and hopefully specific, Records will be growing.

The list will also serve as the basis for the Names in Current Use project to establish a nomenclaturally acceptable set of plant fossil genera. Only those Fields underlined below will be included in the 1991 draft version.

The Field titles for each genus Record in the ING is:

ING RECORD NUMBER
GENUS
AUTHOR
TITLE OF BOOK OR JOURNAL
NUMBER OF EDITION, SERIES, VOLUME, PAGES
DATE OF PUBLICATION year only
HIGHER TAXON FAMILY algae, fungi, bryophytes, vascular plants
FAMILY
INITIALS OF PERSON MAKING CORRECTION
DATE THE RECORD WAS CHANGED
FOSSIL OR NOT
NOMENCLATURE STATUS
PUBLISHED ILLUSTRATION
ILLUSTRATION SEEN BY RECORDER
HYBRID
NAME IN CURRENT USE
TYPE MATERIAL
NOTES giving stratigraphic, geographical and organ details
FIRST OBLIGATE SYNONYM
SECOND OBLIGATE SYNONYM
REJECTED NAME
SECOND GENUS
SECOND AUTHOR
SECOND TITLE
SECOND PAGES
SECOND FIGURE
SECOND DATE

PRESENT DATABASE TECHNOLOGY

In comparison to the world of word processing and spreadsheets, the database industry is in an awful mess. In spite of the enormous range of database packages and the wealth of theory developed through practice, no single package seems ideal for a specific application let alone universal applications. They all claim benefits over their rivals whilst offering some degree of compatibility with each other (i.e. a facility to import or export data) but they don't actually give us what we want. This is partly our fault because we don't know what we want until we see it.

For these reasons, we have been undertaking some experimental work in producing several prototype databases each based on a different database technology. Our findings are offered as a contribution to the debate in the palaeobotanical community to aid the development of a full Plant Fossil Record (PFR) database. Our overall aim is to bring the power of the computer to the palaeobotanist as a readily used resource to enable the identification, selection and extraction of particular data and information relevant to his/her needs. The author partnership of Boulter and Woolliams brings together a practising palaeobotanist researcher and a computer researcher specialising in databases.

It is our view that an operational microcomputer-based database, containing a representative number of palaeobotanical records, can provide practical user experience and a platform for evaluation. Only then can the user profile and thereby the required features of such a system be assessed. We are constructing a number of different demonstrators based on different database technologies. These are available for a small handling charge to palynologists (see elsewhere in this newsletter) to evaluate and help identify the requirements of a full system. We will also use simulation techniques to determine the performance of the various final system designs which can be evaluated on the simulation model.

1. Size.

The full database will be large and will contain a significant number of records, about 65,000 including images. Much of the alphanumeric data exists in computer readable form in known formats. It is not difficult to re-format the data. The mass storage medium necessary to support this volume of data on PC systems would probably require and exploit optical disc technology. However, it is not usually appreciated that most existing database management systems and servers were designed and developed for magnetic disk based systems. As a result the characteristics of magnetic disks are embedded in the database system. Because of the differing technology of optical disc systems, existing database systems designed for magnetic disk systems do not transfer to optical disc to provide efficient implementations. ***We must beware of 'magnetic disk think'! (Ref 1).***

2. Definitions and standards.

If there is to be collaborative effort to establish such a facility, then certain issues concerning definitions, taxonomy and standards will need to be resolved. We can note that the resolution of such differences necessary for computer implementation may be much of the justification and motivation for the development of the facility.

3. Low data volativity.

Most database systems have been developed to support the continual revisions, additions and deletions of data. Thus the design priority has been for maintaining the integrity of the data with an efficient updating service. In contrast, the data in a PFR database has low volativity. We only need to make revisions to existing records by way of corrections rather than frequent updates. Once the full database is established, all new records will be APPENDED rather than inserted. Hence we can have less concern for the efficiency of updating and place higher priority on other requirements such as the search capability.

4. Variable length textual fields.

Most database applications are highly structured with the data divided into a series of discrete succinct fixed length fields. One of our prototypes uses the SMARTWARE II package because it is unusual in that it can handle variable length fields. Variable length fields are a feature of the PFR database.

5. Content searching requirement.

Classically, one of the database fields (often the first) is the key field which serves the purpose of an index. Data is retrieved by matching the contents of this key field to the search request. These are called flat file database systems. Thus,with a telephone directory, the surname is the key field. We can quickly find the surname BOULTER with initials M and C and hence immediately retrieve the telephone number (+44).1.590.7722. It is much more difficult to find the person for a given telephone number! One solution is to scan the database i.e. test every entry until we come across the one that matches our request. Most word processors include some form of word searching which at first glance might appear to satisfy this demand. This is normally achieved by scanning quickly through the word processing document testing each sequence of characters for a match with the query. Such scanning methods can produce satisfactory results in single documents that typically do not exceed 25 pages. The performance drops drastically for larger collections of longer documents and frequently do not allow for word conjunctions. These methods are impractical for databases unless you throw expensive hardware at the problem such as a Content Addressable File Store CAFS ***(Ref 2)***.

Our aim is that the PFR database design must provide a facility to search for anything, anywhere, in the database. Queries must not be restricted to simple look up applications e.g. just to retrieve the entry for *Lepidodendron aculeatum*. This could be provided at lower cost in a printed book. We want to exploit the power of the computer and ask complex queries. e.g. list all taxa containing COAL and PARICHNOS but not LEAF SCAR CENTRAL (i.e. search in several fields including the descriptive notes!). **By providing for this type of query (i.e. for anything!), we can begin to get "added value" from the computerisation of the database. Now we can undertake epidemiological studies, seek out evolution patterns, seek out geographical clusters, determine "missing" flora, perform entropy calculations on genera distribution, etc.** This so-called

content retrieval is obtained by first performing a CONCORDANCE analysis of the data i.e. we generate an index of all words and where they occur. (Concordance is more than just a file inversion).

Consider the following data:-

```
an line 2 word 3
and line 1 word 4,  line 2 word 2
Angara line 1 word 3
cushions line 2 word 1
Eurameria line 1 word 5
external line 2 word 4
from line 1 word 2
leaf line 1 word 9
lycopods line 1 word 1
parichnos line 2 word 5
striated line 2 word 8
```

Lycopods from Angara and Eurameria with striated leaf cushions and an external parichnos.

The CONCORDANCE list produced would be:-

In practice, we would exclude trivial words like "an", "and", "from", "with" by using a so-called STOPLIST. We can now search for anything because we have an index to everything. With a single command we could find the above by asking for any of the above significant words or collocations of the words. We could thus find all entries with 'leaf cushions', all entries of *Lycopods*, all entries of *Lycopods* AND NOT 'leaf' for example. All that is needed is for these words to be in the text of the Records. By performing this for the whole database, we have the basis of a system for "free text retrieval".

One of our demonstration PFR prototypes works on this principle. It is a development of a free text retrieval system CONCORD developed in our research laboratory. ***(Ref.3)***. The performance on such a system is maintained even in very large databases. Searches of anything from anywhere are fast and efficient. Typically a search can be completed and the relevant data retrieved from a WORM on an IBM PS/2 within a second. We have sacrificed some of the speed of generating indexes when performing the concordance to ensure that efficient retrieval performance can be realised. (indexing is typically 10 megabytes of source data per hour on an IBM PS/2). Similarly, the explosion in total storage required is prejudiced to achieve the performance aims. i.e. in addition to the original data we also have to keep the indexes and associated files. The degree of explosion depends on the nature of the source documents: thus 1 megabyte of closely spaced full lines of source data may explode by 1.5 megabytes. This explosion is less important in a system configured with optical storage, although our usual practice is to build the database on magnetic media and archive it to WORM ***(Ref.4)***. In practice, the indexing task has only to be performed once by us when the system is set up and does not detract from the final perception of performance by the user. It is to be noted that additional taxa can be appended without re-organisation of the existing indexes unlike traditional database methods. For this reason, our techniques consume storage space incrementally rather than exponentially. The demonstrator works well and enables the user to be creative in formulating queries. We want to know the nature and form of your queries, especially novel and innovative uses of the database.

In many ways this is the perfect system. Its disadvantage is the storage overhead which could be a problem if 200 megabytes of PFR data becomes 500 megabytes with the indexes.

6. Relational database

In a relational database, data is kept in simple tables which are "related" together by common keys and links. Thus we could have a series of part telephone directories. The first would consist of a reference number and surnames only, another with reference number and telephone numbers, another with reference number and addresses etc. We could then start with any one of these directories (i.e. from the name or the telephone number or the address etc) and cross reference the data in the others and find what we wanted. Many database packages like dBASE and SMART are claimed to be relational but are not. They give the appearance of a relational system when used for small databases but can't handle large applications like the PFR efficiently without a few clever workarounds. We have an expectation that we can use SMARTWARE II to give the best of the two worlds of relational databases and free form content searchable databases.

References

1.The structuring of databases on high capacity optical disk stores, Proceedings OPTICA '87 International Conference, Amsterdam, Holland, published by Learned Information Ltd. (P J H King and P Woolliams)

2.Performance evaluation of mixed IDMS/CAFS databases, submitted to BNCOD (British National Conference on databases) November 1989, M Everitt, P J H King and P Woolliams.

3.CONCORD: the development of a free-text retrieval system, Program vol 20, no. 3 July 1986. (M Slade & W Smith)

4.Design Constraints for generic Text-Graphic databases and proposed solutions exploiting Optical Disc technologies. Proceedings of the 12th International Online Information Meeting, London, December 1988 (M Slade, W Smith and P Woolliams).

7. GRAPHICS IN PALAEOBOTANICAL DATABASES

The prototypes for the PFR can also provide for the on-screen (as well as printing) display of proper names in italics simultaneously with normal characters for the body of the text. It is surprising that dominant commercial database systems don't provide such a facility directly. When text is generated using a word-processor, it is of course a sequence of characters that is stored in memory. Each byte represents one character from the text. The display adapter hardware contains a character generator for each of the symbols and letter shapes that comprise the complete character set. The display hardware looks up the values for each byte in the text sequence and produces a dot pattern on the screen for each byte. Thus each character on the screen corresponds to one byte in memory when text is being displayed. (Additional bytes may be used to store colour information). For such systems, such as earlier PC's, the user cannot vary the characters in the character set without changing the hardware.

However, there is another solution now available. ***(Ref. 5)***. We have developed a programmable font for palaeobotanical databases. Thus we store a bit pattern for each character in memory and tell the display adapter hardware to use these patterns rather than the in built font to generate the characters for display. The lower ASCII is standard text and the extended ASCII (128-255) is the

corresponding italic. We load the font from a disk file after starting the computer. This means that we can still write our text as a sequence of bytes and see it displayed on the screen in the characters required - both normal and italics. It is usually more convenient for experienced typists to use the standard methods for highlighting or italicising text e.g. using control strings in Wordperfect or Wordstar. A simple utility can then be used to change these blocks to the corresponding italic characters.

8. Image databases

The ubiquitous MSDOS/IBM-PC de facto standard was designed as a general purpose personal computer and not to optimise the particular applications associated with full text or picture databases. However, because of its high penetration throughout the world, it is appropriate to develop and derive design criteria for generic text and picture databases on such systems. We have developed techniques that by exploiting optical disc technologies overcome some of the limitations of the basic microcomputer and provide a cost-efficient delivery medium to satisfy evolving user demands. ***(Ref 6.)***

There is now significant demand from users for the retrieval of 'pictures' associated with text. Some 'picture' systems are already available e.g. Interactive video systems particularly in the area of computer based training. However, these systems, including LASERVISION and CD-I (Compact Disk Interactive), are essentially based on creating the video display by analog means. A sequence of video frames of low quality appears to be acceptable to the viewer because of the characteristics of the human eye which integrates variances from one picture to the next. Such systems do not support the direct printing of selected still frames of high quality but considerably less storage is required. In contrast, digital images can be created to any required degree of resolution. Because digital images consume vast amounts of storage space, statistical techniques are often used to compress the way the image is stored on disk. In our demonstrators, the user can easily display the image(s) associated with the query with a couple of keystrokes.

In deciding whether to use the original bit image or one of the possible compressed versions, we have to consider the following factors;

a) amount of storage space required

Optical disc systems now provide the cost-effective solution to picture databases. If we decide that optical disk space is of low cost and consumable then it becomes practical to store the raw bit image and save on decompression time.

b) data transfer rate from the magnetic/optical disk

The larger the file, the more time to read the file and hence the longer the access time to display the image from the inception of the query.

c) the decompression algorithm

These are usually computationally demanding which reduces the access time before the display can be presented unless special hardware is added.

d) the image size

If the image is larger than the screen, either the image will need to be cut into smaller images, or re-sized or some means of scrolling will have to be provided. Non-integral re-scaling produces undesirable striation effects. Some forms of compression lend themselves to drawing parts of an image, e.g. the FAX format, whereas for others the decompression must commence at the start of the picture even if only the last part of the picture is required on the screen. Similarly, some compressed formats are easier to scroll than others.

e) the image content

The amount and efficiency of compression and thus access time are also content dependent. The white part in the background of a single specimen photograph may mean a large section of the image can be easily compressed because the information content is low.

We have experimented with the above factors for different images and conclude that neither format is universally better. Some experimentation may be necessary to produce optimal solutions. In all cases, it is faster to display the full raw bit image rather than read a compressed image and de-compress it for display. At the moment all our demonstrators use PCX format (i.e. PC Paintbrush). Whilst interconversion between the formats is possible with no degradation, the provision of such utilities for a wide range of screens, printers and image file formats is inhibiting.

References

5.Word Processing and Desk Top Publishing in foreign language character sets, J. of the Association of Administrative and Business Computing, June 1989 (P Woolliams).

6.Generic text-image databases on optical disk Proceedings of the 6th International Conference on Technology in Education, Florida, March 1989. (M Slade, W Smith and P Woolliams).

9. EVOLVING DATABASE STANDARDS

Whilst the number of database software products continues to proliferate, no new database project should ignore the trend towards standardisation on SQL type systems. SQL (Structured Query Language) originally from IBM is becoming less proprietary and is available across the complete range from mainframe to minis to micros. It is likely that the final PFR should be SOL compatible. This will give wide portability to the database.

10. Client-Server architectures

Whilst our first objective is to produce a single user microcomputer version of the PFR, it is important even at this stage to consider the implications of networking and remote access. i.e. it is easier to consider this now rather than in retrospect. Access to a common file area (i.e. a file server) across a network is now a well established technology. However, performance drops dramatically when microcomputers are used to access large databases such as the PFR across any network. An entirely new type of networked database is just becoming available which gives all the advantages of a centralised system (e.g. control of the validity of the data and shared optical disc drives) yet enables the user to retain the advantages of the microcomputer workstation (e.g. accessing the database during a word processing session to retrieve from the database directly into the word-processed document). This new architecture enables the Client (i.e. the user) to make requests to the central Database Server

(rather than just a file server) for search requests. This new technology gives mainframe database power from any micro. Again, this should not be ignored in the final PFR design.

11. Hypertext databases

Much of the above discussion is concerned with the various database technologies. However, it is also important to consider the culture of the (palaeobotanist) user. For what and how will a palaeobotanist want to use a PFR database? (This is of course the reason we have produced the demonstrators!). Observations on how reference databases are actually used reveals little adherence to formal queries. Users seem particularly keen to browse, stumble across things that interest them and pursue this interest. Classical databases as described above don't lend themselves to this kind of use. Now normal text is called linear text because it is intended to be read from the beginning towards the end. HYPERTEXT is chunks of text that are interlinked. The user starts from an area of interest but soon jumps from one chunk to another by following the links provided. Thus we might start to read about *Lepidodendron aculeatum,* notice the author was R. Crookall, look to see what other references there were to/by Crookall, notice the inclusion of Locality A as the location of the find, follow other specimens with similar locations etc. HYPERTEXT databases satisfy this kind of use. The HYPERTEXT linkage facility might be very useful for palaeobotanists but it is difficult in practice to provide a good system. This is because it is difficult to anticipate the links that need to be provided. The problem suffers from combinatorial explosion and because users often get lost (often described as being lost in 'hyper-space'!). To overcome this, the principle can be combined with free form content retrieval. ***(Ref. 7).*** Again it is likely that some form of browse and hypertext walking facility should be provided in the final PFR.

A note of caution

We have had previous experiences of converting mainframe databases to microcomputer implementations and learnt some useful lessons. ***(Ref. 8.)*** One factor that was severely underestimated in our work was the time taken to perform many fundamental tasks due to the fact that the data files were much larger that one would normally deal with in microcomputer installations. In hindsight they could have been foreseen but not necessarily overcome. The time taken to download the raw data from the mainframe to an IBM AT would have required a mainframe session over several days. This was not possible due to mainframe system backup services that are run each night. The original data had to be segmented into manageable 0.5 megabyte files and each downloaded separately. (e.g. at 1200 bauds (120 characters/sec), 250 megabytes would take 575 hours to download even assuming no packets had to be re-transmitted). In order to undertake the concordance analysis of the data,(such as word frequency counting), commonly available utilities could not be used as these had maximum file restrictions such as 64k. When trying to write our own bespoke utilities, we came up against the constraints of commonly available compilers e.g. maximum array sizes being constrained by maximum size of integer allowed. Again we had to resort to segmenting the raw data, performing statistical analyses on the segmented files and then merge sorting the statistics to form the total statistics. Even fundamental MSDOS operations such as using the DOS COPY command took a long time to execute compared with the response times that one is familiar with when using a microcomputer.

CONCLUSIONS.

Making choices that are sympathetic to the characteristics of current computing machinery produces an efficient retrieval system and demonstrates that such systems are practical for the PFR ***(Ref 9).*** The development of optical discs, both CD-ROM and WORM provide a cost-effective delivery vehicle for image versions of the PFR. Our concordance version permits the incremental rather than exponential consumption of WORM space for a system in which the user is appending further images as his/her application grows. With the availability of the 80386 based systems with corresponding higher processor performance, screen resolution, multi-tasking, and operating system support for the full technology will have a dramatic effect on the satisfying the increasing expectation of the user in demanding rapid content and image based retrieval.

References

7. Marrying hypertext with free text retrieval. Paper accepted for 7th International Conference on Technology in Education, Brussels, Belgium, March 1990 J Peacham and P Woolliams.

8. Case Study: the transfer of a (bibliographic) mainframe database to an optical disk microcomputer implementation. Proceedings of the International Optical-Info conference, Amsterdam, Holland, March 1989, P J H King, Brown, M Slade, W Smith, P Woolliams (July 1988),

9. Prototypes systems for the storage and retrieval of courseware exploiting optical disc technology. Proceedings of the fifth International Conference on Technology in Education, Edinburgh, Scotland, March 1987. (M Slade, W Smith and P Woolliams).

Peter R Woolliams, London, U.K.

OTHER FOSSIL PLANT DATABASES

LENTIN INTERNATIONAL BIOSTRATIGRAPHIC Consultants Ltd

Angiokey is a database of all angiosperm pollen genera and contains all such taxa currently found in the Jansonius and Hills card catalogue. Its main feature uses graphics and options to key out each genus by morphological features.

Dino-key will be available soon and will contain all dinocyst genera found in the Lentin & Williams 1989 index with descriptions taken from Stover & Evitt 1978 and Stover & Williams 1987. There are more than 6,240 files of taxa and morphological character keys based on graphics.

For oil companies the cost is US$4,000 and for universities US$3,500. Details can be obtained from LIB Consultants Ltd., 2110, 505 - 4th Avenue S.W., Calgary, Alberta, Canada T2P 0JD.

PALYNODATA

This has about 13,000 genera in 16,000 documents, occupying about 600MB of memory. More than 8,000 of

the genera are of pollen and spores, the remainder consisting of dinoflagellate cysts, acritarchs, algae, fungi and other micro-organisms. The database is principally bibliographic, in that it records occurences of palynomorphs in documents, and so its purpose is different to that of the PFR. Nevertheless, some of its content is useful to check with the content of the PFR database and there is some taxonomic and nomenclatural detail which is useful to the PFR project.

TAXON

This IBM PC compatible data system lists 22,500 species of spores, pollen, dinocysts, acritarchs and chitinozoans.

Send enough formatted disks to hold 8 MB data to: R.L Ravn, BP Research Centre, Chertsey Road, Sunbury on Thames, TW16 7LN, UK for a free copy. Also send details of your hardware.

OTHER DATABASES

There are rumours that scores of palaeobotanists are producing their own databases in their own software format independently of any other groups. If you are compiling such a system, and would like it to be used by others, please let the IOP office have full details urgently. Better still, a magnetic copy would be gratefully recieved for incorporation into the PFR database.

THE DERIVATION OF DATA

Heidi and John Anderson have written to support the IOP's PFR project. They are concerned with how we arrive at the delineation of taxa and the choice of names as well as how the data are presented. "The two sides of the coin should be considered concurrently."

They support he use of this newsletter to make and share proposals and suggest a special IOP Symposium in the USA, one year after the 1990 Frankfurt Declaration meeting, and another in Paris in 1992 to formulate a standardised approach to taxonomy and nomenclature. "The Code must be flexible enough such that clauses can be repealed or adapted. Proposals for changes would be circulated and debated in the IOP Newsletter."

They have just published the second volume of the Upper Triassic Molteno Palaeoflora which outlines in some detail their approach to sampling, taxonomy, nomenclature and data presentation.

Their 1989 Palaeoflora of Southern Africa, Molteno Formation (Triasic) volume 2. Gymnosperms (excluding Dicroidium) 567pp is published by A.A. Balkema, Rotterdam.

DRAFT FORMAT FOR ALL PLANT FOSSIL RECORDS

These are the 34 Field titles for the Plant Fossil Records. They are arranged in four sections: Nomenclature, Taxonomy, Geology/Geography and Bibliography.

Five separate Record libraries would meet most user requirements:

Dinocysts / Algae, acritarchs, fungi / non-seed Vascular plants /

Gymnosperms / Angiosperms

For the prototype feasibility study to the end of May 1990 search facilities will be by any of the Field Titles or any content therein:-

NAME OF TAXON	genus or genus & species or biorecord
PFR NUMBER	
ORGAN	pollen, spore, dinocyst, reproductive, leaf, stem, wood, root, other
NOMENCLATURAL STATUS eg.:	cf T: type cf A: no different features cf B: one different feature cf C: more than one different feature
AUTHOR	of taxon
DAY/MONTH/YEAR	of first publication
REFERENCE	First diagnosis of this Record latest diagnosis/description of this Record
SYNONOMY	usually from SOURCE REFERENCE FOR PFR
---	---
ASSOCIATED ORGAN & TAXON NAME	
BOTANICAL RANKING ORDER	
BOTANICAL RANKING FAMILY	
NUMBER OF SPECIMENS	
DESCRIPTION	indicate source and graphics
PRESERVATION	
COMPARISON RECORDS PRESENT	cf B and C in this assemblage
---	---
REGION	North America, Europe, Asia, China, S.E. Asia, India, Australasia, South America and Antarctica, Africa, Euramerica or Gondwanaland
LOCALITY	locality
FACIES	
ROCK FORMATION	
SAMPLE POSITION	surface or borehole depth
SAMPLE LITHOLOGY	
ERA	Proterozoic, Palaeozoic, Mesozoic or Cenozoic
AGE OF SEQUENCE	Periods after Elsevier wallchart
RADIOMETRIC AGE	after given authority
ZONE	after named fossil type
---	---
REPOSITORY	
LINKS TO QUANTITATIVE DATA	other PFR filename
LINKS TO PALYNODATA	document number for type description
LINKS TO ING	taxon code number
LINKS TO MORE DETAILS	other PFR filenames
LINKS TO BIBLIOGRAPHY	code to single PFR bibliography
ADVISOR/DATE ADDED TO PFR	Regional Advisor's initials
SOURCE REFERENCE FOR PFR	best reference for this Record data

IOP members are invited to identify which of the above fields must be searchable if only a limited number of searchable fields can be implemented in the final database.

EXAMPLE OF A RECORD IN THIS STANDARD FORMAT

NAME OF TAXON	Onoclea hebridica
PFR NUMBER	00001
ORGAN	leaf
NOMENCLATURAL STATUS	cf T; cf A
AUTHOR	Gardner, J.S. & Ettinghausen, C.
DAY/MONTH/YEAR	1882
REFERENCE	Palaeontogr. Soc. Monogr. 1 - 86.
SYNONOMY	
1851 Filicites(?)hebridicus Forbes	
1868 Woodwardites arcticus Heer (Spitsbergen)	
1869 Woodwardites arcticus Heer (Spitsbergen)	
1882 Onoclea hebridica (Forbes) Gardner & Ettinghausen	
1883 Onoclea sensibilis Heer (Greenland)	
1883 Onoclea sensibilis arctica Heer (Greenland)	
1886 Onoclea hebridica Gardner	
1887 Onoclea (Filicites) hebridica Gardner	
1924 Onoclea hebridica Seward and Holttum	
1962 Onoclea hesperia Brown (N. America)	
*1990 Onoclea hebridica Sew & Ed. in Boulter & Kvacek	

ASSOCIATED ORGAN & TAXON NAME	spores MONOL SPINES; PFR 00021
BOTANICAL RANKING ORDER or	Filicales
BOTANICAL RANKING FAMILY	Dennstaedtiaceae
NUMBER OF SPECIMENS	about 30
DESCRIPTION	* "Fronds dimorphic. Sterile fronds reaching a length of 40cms and more, with petiole up to 30cm., oval-deltoid, pinnate, in the upper part the lamina is pinnatifid, dissected into entire or sinuate, decurrent segments which form a broad wing on the rachis; in the lower part of the frond the pinnae are longer and more deeply lobed, the ultimate segments short and broad or linear. The wing of the rachis gradually dies out in the lower part of the frond; the lower pinnae are basally contracted. etc. etc.
PRESERVATION	generally good, no cuticle
COMPARISON RECORDS PRESENT	none

REGION	Europe
LOCALITY	Ardtun, Isle of Mull
FACIES	autochthonous freshwater lake edge
ROCK FORMATION	BIP intrabasaltics
SAMPLE POSITION	unknown
SAMPLE LITHOLOGY	intrabasaltic mudstone
ERA	Cenozoic
AGE OF SEQUENCE	Palaeocene/Eocene boundary
RADIOMETRIC AGE	58Ma
ZONE	Apectodinium homomorphum

EARLIER RECORDS	1851 Filicites(?)hebridicus Forbes
REPOSITORY	type: GSM 76598, syntypes: BMNH
LINKS TO QUANTITATIVE DATA	none
LINKS TO PALYNODATA	none
LINKS TO ING	none
LINKS TO MORE DETAILS	none
LINKS TO BIBLIOGRAPHY	none
ADVISOR/DATE ADDED TO PFR	MCB June 1989
SOURCE REFERENCE FOR PFR	Boulter, M.C. and Kvacek, Z. 1990. Spec. Pap.
OTHER NOTES	none

EXPECTED AVERAGE RECORD CONTENT FOR MAY 1990

NAME OF TAXON	Aachenia
PFR NUMBER	00002
ORGAN	cone scale
NOMENCLATURAL STATUS	cf T: A. debeyi
AUTHOR	E. Knobloch
DAY/MONTH/YEAR	10 March 1972
REFERENCE	Neues. Jahrb. Geol. Paleontol. 1972, 401.
SYNONOMY	

ASSOCIATED ORGAN & TAXON NAME	
BOTANICAL RANKING ORDER or	Gymnospermae
BOTANICAL RANKING FAMILY	Coniferae
NUMBER OF SPECIMENS	
DESCRIPTION	
PRESERVATION	
COMPARISON RECORDS PRESENT	

REGION	Europe
LOCALITY	Aachen, Germany
FACIES	
ROCK FORMATION	
SAMPLE POSITION	
SAMPLE LITHOLOGY	
ERA	Mesozoic
AGE OF SEQUENCE	Cretaceous, Senonian
RADIOMETRIC AGE	
ZONE	

REPOSITORY	
LINKS TO QUANTITATIVE DATA	
LINKS TO PALYNODATA	
LINKS TO ING	2
LINKS TO MORE DETAILS	
LINKS TO BIBLIOGRAPHY	
ADVISOR/DATE ADDED TO PFR	MCB November 6th 1989
SOURCE REFERENCE FOR PFR	ING
OTHER NOTES	

NEW BOOKS

These two books were published in November 1989 and will be reviewed in the newsletter next year. Because their content impinges on the theme of the Plant Fossil Record project they are briefly described here.

FOSSILS AS INFORMATION: NEW RECORDING AND STRATAL CORRELATION TECHNIQUES. N.F. Hughes, 1989. Cambridge University Press. 136pp. ISBN 0521-36656-9

The back cover introduces this book as discussing "procedures for handling information derived from the fossil record, and the application of this information to solving problems in geological succession and earth history. The main purpose ... is to analyse shortcomings of the existing procedures, and to propose in their place a new set of data handling arrangements of much greater simplicity and efficiency.

"The author argues that the procedures in current use are cumbersome and inefficient, and that, partly as a consequence of these information handling methods, palaeontology has failed to make advances commensurate with technological improvements. In the book [Hughes] proposes a fundamentally new system which could make possible the integrated use of every detail of geological information taken from the rocks to achieve better resolution in sequence correlation, in palaeontologic interpretation and in logging the course of evolution. Compatibility of style with existing records has been maintained to avoid any danger of loss of valuable date, and to simplify the process of re-evaluatiing old records."

PALAEOFLORA OF SOUTHERN AFRICA, MOLTENO FORMATION (TRIASSIC) VOLUME 2, GYMNOSPERMS (EXCLUDING Dicroidium). J. & H. Anderson, 1989. 567pp. A.A. Balkema, Rotterdam.

The approach is designed as far as possible to reflect nature, and it aims at avoiding artificial taxa. It is based on extensive sampling and its core feature is the palaeodeme. The sampling strategy has four successive hierarchial levels:

Palaeodeme: the suite of individuals forming a natural population

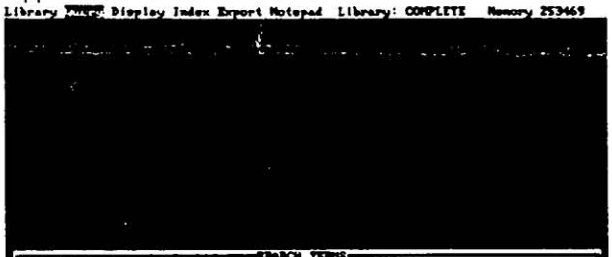
Assemblage: the suite of palaeodemes from a fossiliferous lithosome Palaeoflora: the suite of assemblages from a geological formation

Palaeo-empire: the suite of floras from a realm and geologica period.

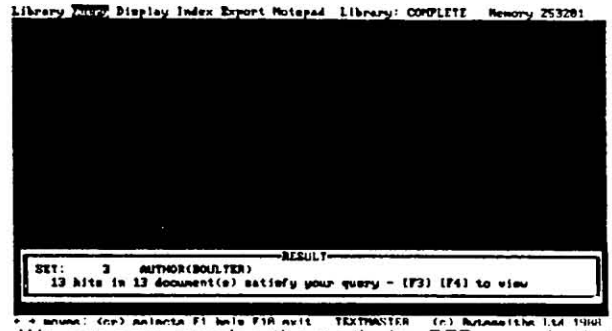
Example retrievals from our PFR demonstrator currently available:

The following are examples of user queries and the corresponding screen displays. Note that the searching can be either Field specific or just from anywhere in the database without having to specify a field(s).

Here we are requesting all records in which BOULTER appears somewhere in the AUTHOR field.



The database now informs us in how many PFR records the requested AUTHOR name appears in the database.

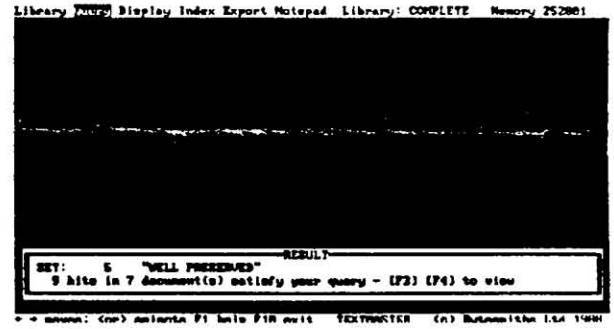


We can now examine the particular PFR records that satisfy our query. The next frame shows the first record containing the requested author. The system highlights this in reverse video (in black and white systems) or in colour as appropriate. Having retrieved the required PFR record that satisfies our query, we can scroll through the complete record if it is greater than one screen and/or print the whole or parts of the record. We can "cut" parts of the

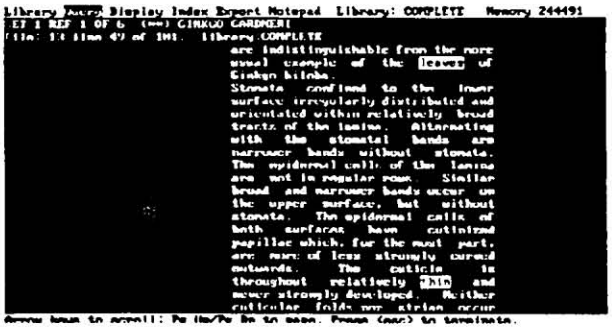
retrieved data into a document that we may be word processing.

Thus we can look up any record from a given AUTHOR, TAXON etc.

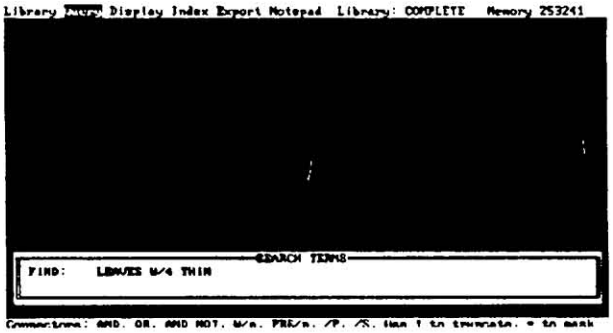
It gets more interesting when we can search for CONTENT e.g. let's find the phrase "WELL PRESERVED" from the database. i.e. what records contain this text?



Note that if we searched for "LEAVES AND THIN" we would be asking for any record that contained these two words. As a result we would obtain the following type of response:-

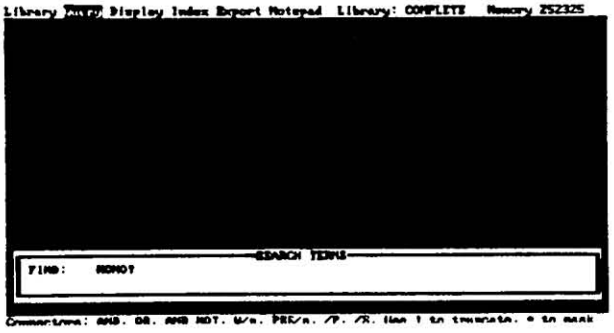


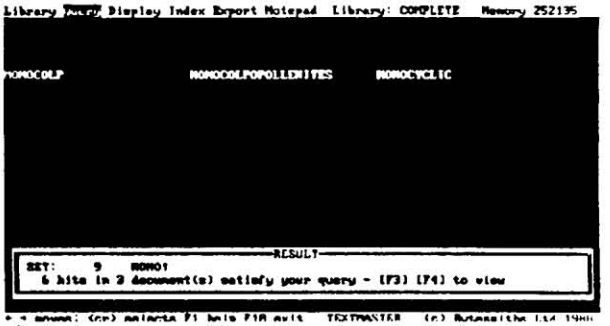
This is probably not very useful. We really want to be able to find the word "THIN" and "LEAVES" were they are close together and thus significant in the text. We therefore query the words to be "WITHIN 4 ADJACENT WORDS" i.e. W/4 as shown:-



This gives us a more useful hit as shown:

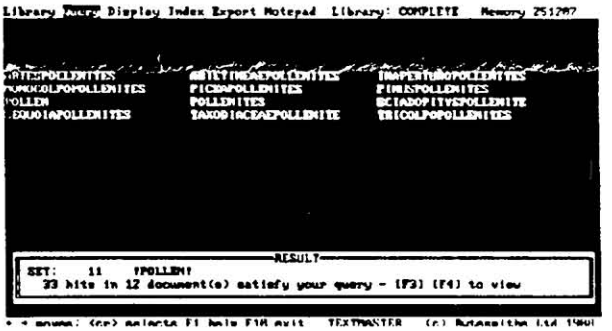
We can also search for parts of words e.g. everything that begins with "MONO". The symbol ! is used to denote "starts with":-





As before, we could use the above to find each specific PFR record.

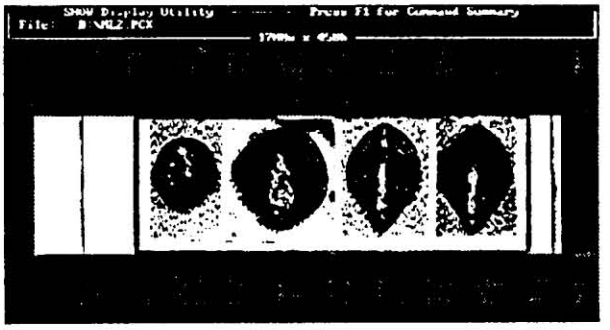
Even more powerful, we can search for words that contain a string of words e.g. !POLLEN!



WE can use a range of "BOOLEAN" conjunctions in formulating the query i.e. AND, OR, NOT, starts with, ends with, contains etc. We can also use the RUSSELL-SOUNDEX algorithm i.e. something that rhymes with (i.e. sounds something like BISARK and thus retrieve BISAC etc).

We should also note that we may not be interested in retrieving the actual record but only the statistics e.g. how many records contain BOULTER as author that contain CUTICLE? These statistics can be captured in a data file for subsequent analysis.

Finally, having found a particular record, we can then immediately display any image file illustrating it. We also provide the facility to see the whole image or zoom to selected regions of the image viz:-



INTERNATIONAL ORGANISATION OF PALAEOBOTANY

INTERNATIONAL UNION OF BIOLOGICAL SCIENCES
SECTION FOR PALAEOBOTANY
President: Prof C B Beck, USA
Vice Presidents: Prof D L Dilcher, USA, Gr J Galtier, France, Prof Z Zhou, China

Secretary: Prof M C Boulter
Polytechnic of East London,
Romford Road,
London, E15 4LZ, England

THE PLANT FOSSIL RECORD

Order form for PFR database demonstrator

To: M C Boulter,
Secretary,
IOP,
Polytechnic of East London,
Romford Road,
London
England UK
E15 4LZ

(You will require an IBM PC/XT/AT/PS2 compatible with an EGA or VGA with as much RAM as possible. 640K is sufficient in non-networked installations. A mouse is not required)

Please supply me with a copy of the PFR database demonstrator in order that I/We may contribute to the PFR debate

Floppy disk format required (NB MAC version not available) _____

I/We enclose 10 UKL by the following method of payment . _____

OR I/We enclose _____ floppy disk/microfloppies in _____ format sufficient for 3 megabytes

The IBM PC compatible equipment we will be using is: _____

Our likely future intended interest in the PFR is: _____

_____

_____

I/We will agree to abide by any restrictions of use or copying in order to protect copyrights where appropriate and to complete and return the evaluation questionnaire

Name _____ signed _____

Job title _____

Address for mailing diskettes _____

_____

_____

_____ NB allow until late Jan/early Feb 1990 for despatch