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REVIEW OF THE CURRENT STATUS, ACTIVITIES AND FUTURE OF EXISTING BIOLOGICAL RESOURCE CENTRES

Background paper for the Report: "Biological Resource Centres: Underpinning the Future of Life Sciences and Biotechnology"

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FOREWORD

This paper was discussed by the Working Party on Biotechnology (WPB) in February 2001 and subsequently declassified by the Committee for Scientific and Technological Policy (CSTP).

This paper was prepared by Dr. Mark J. Bailey, Institute of Virology and Environmental Microbiology, Oxford, United Kingdom, at the request of the WPB Task Force on Biological Resource Centers. It is a background report which has provided important, up-to-date information for the main report "Biological Resource Centers: Underpinning the Future of Life Sciences and Biotechnology".

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Background to the Questionnaire-based review of existing BRCs

A questionnaire (Appendix 1) was distributed to 14 curators, directors or managers, representative of the global range of recognised Biological Resource Centres. The objective was to build a profile of BRCs from existing models – a coherent set of indicators that will form the background for the main WPB report: "Biological Resource Centres: Underpinning the Future of Life Sciences and Biotechnology" on current and future requirements, and on how existing collections and data sets are likely to evolve toward global virtual BRCs. This forward look can in turn improve both BRC structure and information exchange for users and providers. Appreciation is extended to the staff at the co-operating centres who provided succinct and comprehensive responses to the questionnaire.

The Task

Each participating centre was asked to respond in some detail to questions on the specific challenges they face and the strategies they have in place to meet real and projected demands. Respondents were asked to consider their current role and responsibilities with regard to maintenance, quality control and sustainability, and how these duties can or should be met. Clearly the funding issue is of major concern *vis-à-vis* meeting the demands of the user and the overall objectives of the collection/database. These should be defined and considered in terms of strengths, weaknesses, opportunities and threats (SWOT) to address historical, present and future situations. One of the main objectives of this exercise was to draw on the informed opinion of curators.

General response and comments

The respondents were asked to include any observations they considered to be pertinent that may not have applied specifically to the numbered survey questions. The outcome was intended to address the following:

- What were perceived as the most important challenges to the activity and maintenance of BRCs?
- What strategies are in place locally, nationally and internationally to meet those challenges?
- How will the role of BRCs change in the next decade?
- What are the requirements to meet this changing role across the globe?
- What strategic alliances are needed for sustainability? Are they truly desirable?
- What is needed for the preservation and potential exploitation of the expanding biodiversity? How can those requirements be met?

Rationale for the selection of institutions to which the questionnaire was sent

The following review includes edited versions of the response received to the questionnaire distributed on behalf of the WPB. Much of the information provided has been included in the body of the main text of the report. Following the recommendation of the Task Force on Biological Resource Centres (BRCs) at their second meeting in Paris, 24-25 January 2000, a small representative selection of culture collections and data centres around the world was contacted and sent the Questionnaire in March 2000.

Responses were received from 11 of the 14 centres contacted. These were:

1. **Agricultural Research Council (ARC), Pretoria, South Africa.**
2. **Agricultural Research Service Culture Collection (NRRL), Peoria Illinois, United States.**
3. **American Type Culture Collection (ATCC), Manassas, Virginia, United States.**
4. **Belgian Co-ordinated Collections of Micro-organisms (BCCM), Brussels, Belgium.**
5. **Centraalbureau voor Schimmelcultures (CBS), Baarn, The Netherlands.**
6. **Colecao de Culturas Tropical (CCT), Sao Paulo, Brazil.**
7. **Collection de l'Institut Pasteur (CIP), Paris, France.**
8. **Deutsche Sammlung von Mikroorganismen und Zellkulturen (DSMZ), Braunschweig, Germany.**
9. **Institute for Fermentation Osaka (IFO), Osaka, Japan.**
10. **Institute for Genomic Research (TIGR), Rockville, Maryland, United States.**
11. **Ribosomal Database Project (RDP-II), East Lansing, Michigan, United States.**

The information gathered from these centres has been essential in further developing the concept of the BRC which encompasses linkage (bioinformatics) to biological, genetic and molecular information on organisms, physical access to the collection of the organisms themselves, the cloned libraries of organisms and their genes.

The information provided and observations made by the responders reflect common themes for existing centres, which have been summarised below.

- Irrespective of their size or specialisation the future development and sustainability of BRCs is threatened by financial constraints.
- Finance is required to support the basic infrastructure needed to train staff and support the necessary research to address issues that range from the development of appropriate preservation methods to the detailed taxonomy needed for the adequate description of isolates and their functions. Perhaps the greatest danger is that of complacency.
- The user community has come to expect the services provided and relies heavily on the collaborative research projects in which BRCs are involved. This reliance has developed because of the quality of BRC activities and the expertise of the staff.
- BRCs have been and remain a fundamental resource to the scientific and economic advancement of humankind, they play a central role in the understanding of and preservation of biodiversity. The challenge is more than the requirement to maintain their current activities. The opportunity to establish a global BRC network must be embraced.

- To achieve this will require international collaborations to link the centres and the necessary information on a global scale. The rapid access to information and the associated genetic and biological materials, including data, will be the key determinant.

- International linkage will also facilitate the development of assured quality standards and the tools needed for the identification and preservation of increasing numbers of "novel" isolates representative of biodiversity and the accession of patent strains.

- Further advantages can be foreseen nationally, regionally and globally through the sharing of resources and information. These include regulation of access and ownership, and cost efficiency where national support is provided for a global resource.

- To achieve this there has to be a greater public and government awareness of the strategic importance of the BRC.

Status of culture collections and emerging Biological Resource Centres

Existing national co-ordination. The decision to have a system of independent collections, each covering a separate part of the spectrum of biological materials with a varying degree of overlap inevitably results from the strategies of the parent organisation or board. However, independent collections need to be replaced by a networked system leading to corporate identity at the national level. This should lead to the streamlining of authentication procedures and the application of standardised protocols. The harmonisation of methods will provide an improvement in standards worldwide. In other cases, the genetic material held for current national uses and for long-term conservation is dispersed in many collections. This is especially true for plant genetic materials, where public research institutions, private breeding companies and relevant Non-Governmental Organisations (NGOs) maintain such material within their own working or conservation collection. The approach chosen by France, for example, was to organise these different participants into networks, whose aim is to build and manage collectively BRCs on a species or group of species basis, called "National Collections".

Existing international co-ordination. The World Federation for Culture Collections (WFCC) currently provides guidelines and a framework for the establishment, operation and long term support of microbiological and cell collections. The WFCC links national and regional federations and includes individual scientists, curators of collections and scientific societies. The WFCC has limited linkages with government organisations though it did perform a key role in the development of the rules applying to the Budapest Treaty for the deposition of patent cultures. The WFCC is a multidisciplinary federation within the International Union of Microbiological Societies (IUMS) and the International Union of Biological Societies (IUBS) of the International Council of Scientific Unions (ICSU) with responsibility for maintaining and fostering relationships between microbial resource centres. WFCC-MIRCEN, World Data Centre for Micro-organisms (WDCM) is the component of the WFCC responsible for this networking. It has as its objectives the overall support of the activities of microbial resource centres and the promotion of a world network for information, communication, and exchange of microbial genetic resources. However the WFCC has no legal authority over any of its member collections.

The WDCM supports an international database for BRCs and as a consequence facilitates international communication and data exchange. A total of 495 culture collections in 59 countries have been registered in the WDCM: 50% of these collections receive government support and 12% provide patent depository services. The 495 collections registered with the WDCM containing nearly 1 000 000 microbial and cell cultures. Only 22 are privately run, another nine held by industry and 162 maintained within Universities (**http://wdcm.nig.ac.jp/statistics.html**). It is interesting to note that 113 of these produce catalogues of

their holdings of which many can be accessed on-line. Altogether those registered with the WDCM have about 400 000 cultures (11 000 species or sub-species) of bacteria and 400 000 cultures (20 000 species or sub-species) of fungi preserved, and collections of 20 000 viruses, 10 000 cell lines and 116 000 "other" microbes. Most of the recognised collections provide storage, distribution, identification, training and consultation services though facilities for patent deposits tend to reside in countries in the economically developed world.

Good examples of regional linkages already exist. The European Union has promoted the CABRI Project (Common Access to Biological Resources and Information) which includes resource and information centres of six countries and basically is built on the concept of a regional BRC. CABRI offers access to some of the European Biological Resource Centres, acting as supply and service organisations to the scientific community. It offers worldwide access to more than 25 databases and allows one to simultaneously check on the availability of a particular type of organism or genetic resource and to order the required items once located. Those include: bacteria and a*rchea*, fungi, yeasts, plasmids, phages, animal and human cells, DNA probes, plant cells, and plant viruses. The CABRI service has been built around quality and each member resource centre has therefore contributed to defining the set of technical specifications and procedures, which define how they should handle each resource type. The guidelines are available on the Web (**http://www.cabri.org**). In this way users of CABRI are guaranteed the highest quality materials and services. The CABRI Project was supported by the European Commission. Another interesting model in plant and animal genetic resources has been developed by the Nordic countries in Europe, organising management regionally through the Nordic Gene Bank.

EDITED OVERVIEW AND ASSIMILATION OF THE INFORMATION GATHERED FROM THE 11 RESPONDING ORGANISATIONS

The following section contains the edited response of individual organisations. These have been summarised and are presented according to the size or nature of the organisation, in the following order:

- Large collections: **ATCC**, **DSMZ**.
- Organisations that create and manage substantial amounts of molecular data: **RDP, TIGR**.
- Specialist or regional collections: **ARC**, **BCCM**, **CBS**, **CCT**, **CIP, NRRL**.
- Industrial type-collection: **IFO**.

Define the nature, activity, and role of your BRC in terms of size (collection, staffing, facilities), breadth of mission, and foreseen changes with respect to its primary and essential functions. *(In responding, please consider the extent of national and international collaboration, requests and distribution and how future requirements for networking will be met.)*

The American Type Culture Collection (ATCC, United States) is a highly diversified, full service biological resource centre with 260 employees located in a state-of-the-art facility in Manassas, VA. The on-going mission of the ATCC is to acquire, authenticate, preserve, produce, develop and distribute biological materials, information, technology, intellectual property and standards for the advancement, validation, and application of scientific knowledge. The ATCC has set the highest standards for its curatorial functions and strives to develop new and unique research tools and model systems that meet current and future international standards. It seeks to enhance the quality and authenticity of its holdings with additional strain data generated by ATCC staff, including visiting scientists, and from the external research work of depositors, collaborators, and users of the collection.

The Deutsche Sammlung von Mikroorganismen und Zellkulturen (DSMZ, Germany) was originally established to allow safe deposition of non-patented and patented biological materials and provide well characterised type and reference strains of bacteria, fungi and yeasts to academia and industry. These activities are supported by accompanying services such as consultancy, identification and taxonomic characterisation. These activities were expanded in 1988 to include additional biological materials, such as human and animal cell cultures, plant cell cultures and plant viruses. The essential functions are:

- Specialisation in type material of A*rchaea* and bacteria.
- Supply customer requests for biological materials, directly or through access to other national/international sources.
- Maintain the quality of authenticated biological materials.
- Added value to deposited material through taxonomic research.
- Publicise taxonomic and related research activities.
- Involve DSMZ staff in national and international scientific, legislative and organisational projects.

Staffing includes 62 permanent staff, 16 non-permanent staff and annex personnel (*e.g.* Ph.D. students and visiting scientists) and technical support for maintenance, distribution and investment. Staffs fulfil specific functions; as curators responsible for the accession, maintenance and provision of certain biological materials; identification service, patent and safe deposit service, database management (Web site, network facilities for education and supervision), and public relations. Collectively the staff represent a body of internationally respected research scientists and taxonomists. These scientists collaborate at the national and international level in scientific projects. The DSMZ is located in its own building and has close links with GBF, the Federal Biotechnology Institute, which is funded by the same stakeholders.

The microbiology department houses about 10 000 strains, preserved under optimal conditions, most of them in freeze dried state in ampoules or in small capillaries in liquid nitrogen at -196^{o}C. The DSMZ collects all micro-organisms including *Archaea*, thermophilic bacteria, phototrophic bacteria, Gram-positive bacteria (*Bacillus, Clostridia*, *Actinobacteria etc.*), Gram-negative Bacteria (*Proteobacteria, Flavobacteria, Myxobacteria etc*.) and yeast and fungi. Nearly 80% of all type strains can be ordered from the DSMZ. The DSMZ does not collect not culturable organisms like *Mycoplasma, Rickettsia, Chlamydia* and the highly pathogenic organisms of risk group 3. Cyanobacteria and algae are not collected because of a nearby existing *algae* collection in Göttingen.

As with many collections, the DSMZ participates in a range of activities *i.e.* custodianship, identification and consultancy services and research. The primary and essential functions are:

- The acquisition of cultures of taxonomic or biotechnological importance, preferably from the original source.
- To check the identity and purity and if possible the properties of the strains.
- To collect information on strains for print and electronic distribution.
- To propagate and preserve the strains under optimal conditions.
- To check the viability of the cultures from time to time.
- To distribute the cultures on request and advise customers on all questions regarding microbiology.
- To perform identification services using the most accurate techniques (16S rDNA sequencing, DNA/DNA-hybridisation, RFLP, FIGE, riboprinting) or chemotaxonomic methods (fatty acid -, mycolic-, or quinone-analysis, polar lipids, DNA G+C content).

The DSMZ places considerable emphasis on the continued improvement of the quality of material and services provided by focussing on methods for accurate and rapid identification, including molecular characterisation, for the purpose of authentication; establish criteria for working procedures and quality guidelines to streamline interactions between collections; provide education and training for taxonomists and culture collection staff; and provide expertise in the transition of information through national and international nodes from specialised collections to "virtual" collections criteria. Over the last six years each year has seen an increase in human and animal cell lines shipped in comparison to the previous year of 20-30% (average 29%), and an overall increase of 350% from 1993 to 1999. With the unprecedented growth of biotechnology and biomedical research and the resulting need for authenticated and validated biological materials, it is expected that this increase will continue in the foreseeable future.

The DSMZ relies on annual investment by national granting bodies for both scientific equipment and building maintenance. In addition the DSMZ is allowed to use equipment of the neighbouring GBF facilities. Neither type of investment has increased significantly over the years, making it difficult to

replace expensive equipment. Where appropriate, income surplus to the basic running costs can be used to buy new equipment for innovative research or for safeguarding and extending quality assessment. The ideal status would be the provision of funds on the basis of justified demand.

The most important challenge for the DSMZ is the collection and maintenance of the fast growing numbers of novel type and reference strains, as well as environmental strains which have been isolated and collected from diverse ecological niches which need to be identified by molecular biological methods such as 16S rDNA sequencing, riboprinting *etc*. The DSMZ is also involved in the planning and running of training courses for the following organisations; the European Culture Collection Organisation (ECCO), World Federation of Culture Collection (WFCC), National Federation of Culture Collections, UNESCO-supported Microbial Resources Centres (MIRCENS), patent offices, strain data bases (MSDN, MINE, MiCiS, NORDIC register, WD, *etc*.), FEMS and CABRI. Training courses form an integral part of the programme for setting quality standards in microbiology. This activity is particularly relevant, as there is an increasing customer demand for quality control, particularly where the customer operates under quality criteria, *e.g.* EN 45001 or ISO 9000. It is therefore necessary to define a minimum quality level for individual assets, such as those prepared for the CABRI project. This may be achieved by expanding existing co-operations among collections to establish a network expertise for different biological materials and different aspects within one group of biota (*e.g.* medically important variants, anaerobic bacteria).

The Ribosomal Database Project (RDP-II, United States) provides data, programmes and services related to ribosomal rRNA. The RDP-II is a value-added database (**http://rdp.cme.msu.edu**) which obtains the bulk of its rRNA sequences from the public nucleotide databases. However it is more than a collection of sequences. The RDP-II organises sequence data into alignments, annotates the sequence data, provides a phylogenetic context for the data and offers a suite of services and tools to assist in the handling and analysis of the data. Annotation includes information on binomial identity, strain and culture deposits, sequence length, data quality and relevant references.

With the most recent update (release 8.0), the database now contains 30 322 SSU rRNA sequences and 1 401 LSU rRNA sequences. Of the SSU sequences, 19 835 are aligned; most of these are sequences from prokaryotes in response to the need for this type of sequence in identifying prokaryotes and establishing their phylogenetic relationships. An ongoing effort at the RDP-II is the improvement of alignments in view of recent research on the ribosome.

The services provided by the RDP-II include: aligned sequences or sets of sequences for downloading, the provision of some phylogenetic trees, T-RFLP and TAP T-RFLP exploration, rapid identification of nearest matches to submitted sequences, a tree-viewing tool for user trees.

On-line analysis of data is also available. Tools for analysis include: a similarity matrix algorithm that uses RDP and user sequences, a fast aligner that aligns user sequences to RDP sequences, an algorithm that screens user sequences for chimeras (recombinant molecules formed through PCR errors), a pattern searching algorithm that allows users to check the specificity of nucleic acid probes and PCR primers, a viewer that allows users to examine “slices” of the RDP alignment for signature analysis, *etc*.

Currently the staff at the RDP-II consists of two Ph.D. scientists, two computer programmers and two undergraduate assistants. A four-member RDP-II advisory board provides guidance in matters of policy and long-term direction. The Project is housed in a single office equipped with eight computers representing all major operating systems and a ninth computer, the server, is maintained off site. An RDP-II mirror site is maintained in Japan by the National Institute of Genetics.

As mentioned above, the RDP-II provides a large collection of sequences used to identify and establish evolutionary relationships between, primarily, micro-organisms. Ribosomal sequences do not perform

uniformly well for these purposes across all taxa. Because of this, the RDP are considering the addition of other aligned molecules to the RDP-II database in order to enhance its usefulness. The need to place the growing flood of genomic sequence data in an organismal, evolutionary and ecological context has created new opportunities for the RDP-II as well; its huge data set could provide a map for navigating genomic data and for elucidating the function of un-categorised open reading frames.

The Institute for Genomic Research (TIGR, United States) does not describe itself as a Biological Resource Centre. TIGR is a not-for-profit research institute where the research focus is primarily sequencing and functional genomics analysis of bacteria, plants, animals, and viruses. Databases and other genomic research based information are provided as a resource to the scientific community through their Website.

The Agricultural Research Council (ARC, South Africa) is represented by the national collection of fungi and the nitrogen fixation unit, all small specialised collections. The Nitrogen Fixation Unit (NFU) of the ARC-PPRI made a significant contribution in making biological nitrogen fixation (BNF) technology available to South African agriculture over the past three decades. Its activities led to the establishment of a local legume inoculant industry run by the private sector. A key factor was the establishment of the internationally recognised South African *Rhizobium* Collection (SARC). This facility formed the basis of the NFU research programme linked to the selection of effective *rhizobia* for legumes important to commercial and small-scale farming. The SARC is the only recognised local source for supplying appropriate effective strains to inoculant manufacturers and currently contains about 600 strains of local and international origin. South Africa contains over 1 500 indigenous legume species: apart from taxonomic research, there is the added incentive of discovering rhizobium strains with novel properties that could be exploited in rhizobium inoculants, *e.g.* the isolation and provision of inoculants for indigenous legumes economically important for the production of herbal teas. Lack of personnel has hindered the role played by the SARC in research activities.

The National Collection of Fungi hosts a dried collection of 56 000 specimens of which approximately 2 000 are type specimens and approximately 4 500 living cultures. These collections mainly comprise filamentous plant pathogenic fungi collected in Southern Africa. Contributions to the collection are submissions as research reference material, from surveys, via the identification services of the unit and collections by members of staff. Members of staff include four researchers and one technician. The three support staff are two laboratory-assistants and another dedicated to the herbarium. Activities include the supply of cultures, identification and analytical services, the supply of biological and systematic information and systematics research on basiodiomycetous, ascomycetous and zygomycetous fungi.

The University of the Orange Free State (UOFS, SA) holds a general yeast collection with special interest in the family *Lipomycetaceae* and with service facilities for distribution and deposition. This active yeast collection can be considered the largest of its kind in the Southern Hemisphere. The collection consists of 2 500 yeast species of ascomycetous as well as basidiomycetous affinities representing some 90 different genera and more than 420 species. The collection is continuously expanded through isolation studies by the research activities of post-graduate students and UNESCO Fellows from other African countries. The core of the collection was isolated from different regions in southern Africa thus representing a unique gene pool. This collection also served as a basis for the establishment of the only UNESCO MIRCEN-Industrial Biotechnology Unit in 1996 and is supported by the director and two part time curators responsible for maintenance and distribution. Cultures are maintained in straws in liquid nitrogen and are mostly used as original master cultures, duplicate sets are prepared and stored at -80° C for distribution. Working cultures on slants are kept in duplicate at 4° C and at room temperature. Cultures of special interest are also deposited at the *Centraalbureau voor Schimmelcultures* (CBS) in Delft, The Netherlands.

The **Belgian Co-ordinated Collections of Micro-organisms (BCCM)** constitutes a consortium of four complementary research-based service culture collections co-ordinated by the Belgian Federal Office for scientific, technical and cultural affairs (OSTC). **BCCM/IHEM** biomedical fungi and yeasts collection (Mycology section of the Scientific Institute of Public Health – Louis Pasteur, Brussels); **BCCM/LMBP** a plasmid collection (Department of Molecular Biology of the Ghent University, Gent); **BCCM/LMG** a bacterial collection (Laboratory of Microbiology of the Ghent University, Gent); and **BCCM/MUCL** an agro-industrial fungi and yeasts collection (*Mycothèque de l'Université catholique de Louvain*, Louvain-la-Neuve). Although each of the four collections has its own field of specialisation, they co-operate and exchange information to develop common strategies on quality, information management, normalisation, marketing, pricing policy and international collaboration through WFCC and CABRI. In total some 43 permanent staff are employed: 22 scientists, 15 technicians and six administrative employees. The collections held are specialist and comprise some 18 000 bacteria, 30 300 filamentous fungi, 3 800 yeasts, 1 900 plasmids, and 14 unique cDNA libraries. Each year a growing number of strains and plasmids are distributed by the BCCM collections. More than half of the distributed strains and plasmids are sent to clients within the European Community.

The BCCM consortium aims to share the biological materials, related information and expertise in relevant fundamental and applied microbiology to the benefit of its partners and clients in the scientific and industrial community. To meet this challenge, the BCCM collections focus on the following activities: the preservation, distribution and validation of biological materials, information, the distribution and validation of data related to biological materials, the validation of microbiological know-how through services, R&D projects, training *etc*., international research collaboration and the preservation and distribution of biological materials for patent purposes under the Budapest Treaty (the BCCM consortium has been recognised as an 'International Depository Authority').

Centraalbureau voor Schimmelcultures **(CBS, The Netherlands)** carries a collection of 37 000 strains of yeast and fungi representing 11 200 species and 3 500 type strains. This is supported by the NCCB bacterial collection of 4 500 wild type reference strains, 5 000 *E. coli* and 250 *Agrobacterium tumefaciens*, 500 expression plasmids, several gene libraries and 6 000 phage (viruses). In total 14 staff are employed to run the collection and include a database manager and the ordering and patent department. The mission of the collection is to contribute to the knowledge of fungal diversity by establishing taxonomic and phylogenetic relationships, to maintain cultures as a genetic resource to the user community; to provide essential services (identification, accession, deposition (Budapest treaty), advisory body *etc*.) and to disseminate knowledge through courses, publications and monographs. In 1999 4 000 strains were distributed, of which 90% were sent abroad.

The *Colecao de Culturas Tropical* (CCT, Brazil) is a service culture collection of non-pathogenic micro-organisms (bacteria, filamentous fungi and yeasts, containment level 2) of environmental and industrial interest and a reference culture collection for research, education and taxonomic purposes. It is housed at the André Tosello Foundation, a private non-profit making research organisation. CCT also functions as a regional centre for training, biodiversity preservation and technological innovation in the national interests. CCT plays a key role in establishing standards for quality control, acts as an information centre for industrial and environmental microbiology in Brazil and offers key identification services. The primary activity is as the repository of microbial strains for science, education and industry providing research output training and other specialised services in microbiology for both industry and academia. The staff of nine scientists (plus visiting scientists, currently six), eight technicians, four trainees and a secretary are housed in a single appropriately equipped facility.

The collection specialises in regional biodiversity and represents a growing collection with the capacity to hold in excess of 300 000 freeze-dried cultures and 200 000 under liquid nitrogen. At present (1999) the collection comprises 3 500 bacteria, 1 400 yeast and 1 800 fungi of which approximately 15% are

distributed each year. Charges are levied for the preservation of safe deposits and restricted distribution deposits (commercial / patent) but not research material. Quality control is performed after preservation of the primary source to establish purity, viability and authenticity. Micro-organisms are distributed as freeze-dried ampoules or live cultures upon request. CCT also carries out regular surveys to assess the range of applications of cultures that are distributed and its main uses. This information is helpful for decision making as to which areas/holdings should be considered as priority for development. Most requests for cultures are from Brazil, requests from other Latin American countries are few. There is a tendency towards growth of requests from other countries mainly of strains isolated from natural environments in Brazil. Despite the limitations in funding, CCT places a strong emphasis on national and international collaborative efforts. CCT was the corner stone for the development of the National Programme for Culture Collections funded by Finep, a Brazilian financing agency (1988-1992) and a major recipient of international funds from capacity building programmes sponsored by international funding agencies such as JICA (Japan International Cupertino Agency) and The British Council.

BRCs have had to face major changes in their operational procedures in recent years. These include regulations for safe working practices, the distribution of micro-organisms and the emergence of new areas of research. The impact of information technology and the decline in public financing of culture collections represents a considerable challenge to the activities of BRCs. Expansion is needed for the accession of clone libraries that derive, for example, from the Brazilian Genome Programme. Furthermore users expect detailed information to be associated with the biological materials, this has to be collected and integrated at the strain level. The goal is to develop CCT as a resource centre/knowledge based institution, in the fields of taxonomy, phylogeny and functional genomics. It is predicted that high throughput methods for genome characterisation and rapidly growing information on microbial genomes will require continuous updating of staff with the new developments and the recycling of skills to acquire new technologies. The implementation of the Convention on Biological Diversity regulations, and increases in the costs of the transborder movement of genetically modified biological materials and pathogens, has also stretched the resources of regional collections in the poorer nations. This is a matter of concern both for the development of taxonomy and systematic biology and for the sales of cultures. Biodiversity collections must be developed to counter the rate of degradation of natural environments and the threat to endangered and unique habits (*e.g.* endemic species or unique biomes) in Brazil. There is an urgent need to carefully evaluate collection holdings to ascertain the extent of their biogeographic and taxonomic representation. To meet this challenge technologies have to be developed for the long-term, cost-efficient preservation of these materials.

The *Collection de l'Institut Pasteur* (CIP) was founded by Dr. Binot, who began to collect and maintain bacterial strains in 1891. Freeze-drying at CIP started in 1952. Since its establishment, the CIP has been located in the same building of the *Institut Pasteur*. The CIP is a unique private, non-profit resource dedicated to the collection, preservation and distribution of bacterial strains. The CIP has enlarged its collection primarily through collaborations with the specialised research laboratories of the Institut Pasteur. The role of the CIP is to ensure the maintenance and enrichment of its bacterial collection; the production of a catalogue; the diffusion of information on the strains distributed (phenotypic characters, particular properties, pathogenicity, *etc*.); the development of research on identification, taxonomy and preservation of bacteria; and participation in teaching activities in the Institut Pasteur.

The CIP holds about 7 000 bacterial strains (1 800 are type strains) available in the CIP catalogue. All strains are preserved separately by freeze-drying and by freezing at either -80°C or in liquid nitrogen at -196°C. The CIP collects highly pathogenic organisms of risk class 3. The CIP does not collect fungi, yeast and Cyanobacteria because there are specialised collections for these organisms in the *Institut Pasteur*. Each year, new strains are added which may come from researchers of the *Institut Pasteur*, from foreign collections according to exchange agreements between collections, or from newly described strains after contact with French or international scientists. The Collection also houses plasmids, transposons, host

strains and probes. Titrated spore suspensions (Bacillus and Clostridium genera) are also available. The information contained in the Collection is computerised and the catalogue is available on the Internet site of the *Institut Pasteur*. The CIP operates under ISO 9002 certification system. The Certification was achieved in June 1998 following the completion of a successful audit by the *Association Française d'Assurance Qualité* (AFAQ). This guarantees high quality services in acquisition, production and preservation of bacteria, plasmids and titrated spore suspensions. The aim of the CIP is to satisfy the needs and the expectations of its customers.

The CIP participates in various official organisations, including the ECCO (European Culture Collections' Organisation), the MINE network (Microbial Information Network in Europe), the WFCC (World Federation for Culture Collection) and CABRI (Common Access to Biotechnological Resources and Information). Expert investigations are carried out for industrial laboratories upon request; these include bacterial identification by the study of cell wall components, and antibiotic sensitivity testing. Within the framework of its research activities, the CIP is especially interested in all information concerning identification of strains (Gram-positive bacteria, Actinomyces, Achromobacter, *etc*.). Various techniques are used: whole protein electrophoresis, chemotaxonomic studies, ribotyping, carbon source utilisation patterns and 16S rDNA sequencing. There is currently a complement of 14 permanent staff and students. The staff have specific functions, *e.g*. database management, identification services, quality management, maintenance of biological materials, public relations, and national and international relations. The staff maintain close contact with developments in taxonomic research. A scientific council of six (expert researchers, industrialists and professors) periodically reviews and evaluates CIP activities. These council members provide advice to the CIP curator in all scientific matters.

The Agricultural Research Service Culture Collection (NRRL, United States) provides well characterised microbial germplasm for the research programmes of ARS/USDA and co-operating researchers with the aim of enhancing US and worldwide agricultural programmes. This responsibility includes maintenance, accession and characterisation of the germplasm. Because of the relevance of this collection for agricultural and industrial uses, its scope and importance have become international. In addition to germplasm maintenance, scientists/curators of the ARS Culture Collection participate in active research programmes. These include methods for the synthesis of by-products (*e.g.* antibiotics, gums and organic acids) and research into preservation and the taxonomy *Aspergillus, Fusarium, Penicillium, Bacillus, Lactobacillus,* Actinomycetales and yeasts. The collection includes 9 000 Actinomycetales; 9 000 bacteria; 48 000 filamentous fungi, 14 000 yeasts and a patent collection of 5 000. Each year between 1 000 and 2 000 new accessions are made. Approximately 4 000 strains are distributed annually. The staff of five Scientists/Curators (Ph.D.), two service scientists (MSc., Ph.D.), six technicians (BSc., MSc.) and one secretary have access to appropriate facilities for traditional and molecular studies. Research activities focus on taxonomy and the collection attracts taxonomists. The need for competent scientists is absolute to maintain the expertise, without this the service to the customer will become uninformed and inadequate. The curator expressed the opinion that collection centres "may even become a threat to society when the staff no longer understand the potential dangers of some of the cultures that they maintain. This thought should be a warning to those who believe that a culture collection can be operated by poorly trained and uninspired staff."

The Institute for Fermentation, Osaka (IFO, Japan) preserves around 16 000 strains of biological resources and has a staff of 18 (including 14 researchers). The biological resources handled at IFO are bacteria, yeasts, filamentous fungi, bacteriophages, and animal cells. IFO distributes around 8 000 strains annually, about 5% of which are distributed to foreign organisations. Approximately 80% of the collection is preserved by liquid-phase drying. The rest of the collection is preserved by freezing (-80^{o} C, or -150^{o} C to -190^{o} C). At the IFO, an appropriate system must be organised under the CBD for the procurement and distribution of strains established abroad. Providing and improving the service of classification and identification of biological resources and campaigning for the acquisition of the position of an international

patent deposit organisation based on the Budapest Treaty will be required to perform procedures related to the preservation of strains entrusted for patents in the IFO (presently, IFO belongs to EPO). Multiple patent deposit organisations are needed in Japan as in major foreign countries for the convenience of the users.

Define current sources of funding, their reliability, and how future funding requirements will be met. *(Please include details of any charges levied for accession or access to items, and how the imposition of charges influences policy and quality of service.)*

The American Type Culture Collection (ATCC, United States). Currently the ATCC receives only 9% of its funding for core activities from the federal government and generates the rest from culture fees and services. Government funding has dropped dramatically over the past 15 years and continued support is not guaranteed. The fees charged for core activities are not directly related to the total costs involved (*i.e.* authentication and documentation of cultures accessioned into the collection, studies on long-term preservation methods, maintenance and long-term storage expenses, the cost of distribution of cultures, and information service expenditures). ATCC has to match the shortfall in government support by competing for external funds and adopting a commercial approach to the distribution of biological materials with market-oriented fee schedules. Nevertheless, ATCC has an open accession policy, and no charge is levied for accession of cultures into ATCC collections.

Deutsche Sammlung von Mikroorganismen und Zellkulturen **(DSMZ, Germany).** Up to 1995 the DSM (now DSMZ) was supported by the Federal Ministry of Science and Technology. Having been granted the status of a service institute (within the *Leibnitz Gemeinschaft*) long-term funding is provided. DSMZ receives 50% of core funding from the Federal Ministry while the *Länder* (states) contribute the other 50%. As a result of the most recent evaluation in 1998, support for a further six scientists and 12 technical staff has been provided. The fees levied for the distribution of cultures do not meet the cost associated with their preservation or characterisation. No charges are levied for the accession of any biological material. However, a small charge is made for depositions under the Material Transfer Agreement for prokaryotic cells, and for Safe Deposits. Fees for products and services are nominal and non-profit only. Changing the individual collections into profit centres will have the immediate effect of reducing the activities to the few economically interesting items – less than 10% of the collection – and reducing the extent of service and expertise rendered to the client along with the products. As the DSMZ does not consider itself a collection bound to collect and provide "Biodiversity-per-se", accession policy largely depends upon the numbers of newly described type strains and material in demand. It is therefore unlikely that deposition will interfere with service and research. However, if the DSMZ is asked to change its mission, by accepting large collections of less well characterised material, the number of curating staff would need to be extended. If, however, these duties have to be managed by existing staff, certain aspects of the service provided today will suffer. As the quality and maintenance of the biological material has priority over collection-related research, the DSMZ would have to reduce research.

There is an absolute need to improve efficacy and knowledge by implementing strategies that enable the worldwide availability of data for all collections beyond current activities. Funds are needed to undertake curative tasks, for example the rescuing of endangered collections; for the development and maintenance of publicly accessible databases and for basic research for the development of robust and cheap strain identification protocols.

Ribosomal Database Project (RDP-II, United States). The RDP-II is currently funded by grants from the US government – originally from the National Science Foundation and now by the Department of Energy through their Microbial Genomics Program. Some essential supplemental support has also been obtained from the State of Michigan and the University. Granting agencies are on record stating that they alone cannot be asked to sustain speciality databases because such expenditures reduce funds for original research. Hence, continued funding of RDP is problematic. The RDP-II does not charge for data or

services and does not plan to do so since, in the absence of special agreements, this could disqualify RDP from receiving the grants it depends on.

The granting agency programme officers offered the following recommendations for funding: *a)* charge for access just like animal facilities, for sophisticated analytical services, and publication charges, and that these charges can then be requested when scientists are applying for funds; *b)* have professional societies support services central to their members; or *c)* develop partnerships among several agencies and groups to share the infrastructure burden. Of these, the last is considered to be the most feasible. The funding situation will need to be resolved by late 2001 to keep RDP viable. Stable funding is recognised as one of the two major strategic challenges.

Institute for Genomic Research (TIGR, United States). TIGR research is supported at nearly 100% of annual revenue from research grants from NIH, USDA, NSF, and DOE. Small amounts of money come from other sources. Future funding of the institute is contingent on faculty members writing and being awarded competitive research grants.

Agricultural Research Council (ARC, South Africa). The SARC is currently maintained by the Biological Nitrogen Fixing Unit of ARC-PPRI and is funded partly by a Parliamentary Grant (approximately 80% of total costs including salaries). This proportion is decreasing yearly. An additional yearly grant (16% of total costs) is currently received from the National Department of Agriculture, which recognises the SARC as a strategic genetic resource. Taxonomic research on indigenous *Rhizobia* in the collection is undertaken by post-graduate students in the UP component of SANFU (South African Nitrogen Fixation Unit), and is separately funded through grants from the National Research Foundation as well as collaborative agreements with groups at universities in other countries. Cultures supplied to researchers are provided free of charge by the SARC. Inoculant manufacturers wishing to register a product are required to pay a nominal amount but, after registration, cultures are supplied free. Additional revenue (about 13% of costs) is generated through an inoculant quality control service to manufacturers.

The Mycology section is funded by the South African government and funds generated by services and courses. The Parliamentary Grant has steadily decreased over the last few years resulting in more pressure to generate external income from other sources. Even though there is a great need for bio-systematic services, fees for these services will be unrealistic and impossible for clients to meet, if equivalent to the actual costs involved.

The University of the Orange Free State (UOFS, SA), SASOL Ltd. (deposits and maintenance), SA Breweries (deposits and maintenance), as well as The Volkswagen Foundation in Germany (bioprospecting studies) are funding this collection. Funds are also obtained through the NRF for postgraduate studies where this collection is used. The funding is only short term and each year new funds must be found. Consequently, there is a need for more regular and long term funds to continue with this service and expansion of this unique South African asset.

Belgian Co-ordinated Collections of Micro-organisms (BCCM). The Belgian government has declared to the World Intellectual Property Organization (WIPO) that the BCCM has been granted the status of International Depository Authority (IDA) as set out in the framework of the Budapest Treaty. In its capacity as an IDA the BCCM must have guaranteed financial support. In practice funding, and the allocation of the budget, is reviewed every five years by the Council of Ministers. The Office for Scientific, Technical and Cultural affairs (OSTC) is in charge of this support programme, and provides the co-ordination team responsible for the development of a common strategy in the fields of bio-informatics, quality management and internal as well as external co-operation.

Depositing strains in the public collection is free of charge; however charges are levied to access biological materials. As with most (all) BRCs two price tiers are applied: one for requests made by non-profit organisations (universities, public sector researchers) and one for requests made by industrial and commercial organisations. The revenue – both from the distribution of biological materials and from scientific services – is added to the collection's budget.

Centraalbureau voor Schimmelcultures **(CBS, The Netherlands).** Approximately 70% of the budget required to run CBS is provided by the government (RNAAS). The shortfall in the necessary financial support comes from charges made for the distribution of strains of commercial interest and half the cost to university and educational departments, research contracts and collaboration with industry. Service charges for distribution are calculated on an actual cost basis to meet preparation and the mailing of the sample – not on the overall cost of the collection.

Colecao de Culturas Tropical **(CCT, Brazil).** The income generated by the sale of services through the industrial services department generates about 60% of the total needed to maintain and operate the service collection. The Foundation provides the additional funding for the operation of the collection. As with most other centres research and development has to be maintained through grants and scholarships from national funding agencies, partnerships with Brazilian research institutions and international collaboration. No charge is levied for accession, but distribution costs are on two tiers, commercial standard price and at half the cost for Research Institutes/universities. However to sustain the activities of CCT it has been necessary to develop a strategic plan for the next five years. The goal is to secure 50% of the collection's operational costs with government funds to keep the archival collections with samples from Brazilian biomes, and the remaining 50% from services and partnerships. A growth in the budget of 100% in the next five years is planned. To increase the budget, CCT intends to implement an "associative model" with industrial partners who will contribute with monthly payments for preferential treatment and discounts in courses and routine analysis. CCT is also planning to establish a depository authority for patent strains in Brazil.

Collection de l'Institut Pasteur **(CIP, France).** The CIP belongs to a private institution, the Institut Pasteur. Funding is a major problem, which directly influences the accession of new strains. The Institut Pasteur does not receive funding specifically for the Collection. Furthermore, the fees charged for authenticated material do not reflect the true cost of the multiple tests undertaken, preservation, or the handling of the cultures. Primary support for activities, other than research, is provided from the fees charged. Charges are not made for depositing strains at CIP.

Agricultural Research Service Culture Collection (NRRL, United States). Support is obtained by the US Congress to sustain USDA/ARS programs. Funding increases do not occur annually and salary and other increases can and do lead to lean times that impact the ability of the unit to do research. Activities of the culture collection are placed ahead of research when this happens, but research is regarded as the primary role of collection scientists, and it is research productivity, not culture collection maintenance that leads to advancement within USDA as well as to recognition by the scientific society at large. There is no charge for accession or distribution of strains from the general culture collection because it is the intent of the US Department of Agriculture to provide free access to germplasm gathered under USDA programs. The ARS Patent Culture Collection has charged for services since 1985, but until two years ago the fees were returned to the US Treasury. Recent Congressional legislation has permitted the collection to retain these fees, which are adequate to pay the salary of the service scientist who maintains the patent collection.

Institute for Fermentation, Osaka (IFO, Japan). Funding is provided in the form of 50% as donations, 20% income from the basic assets of the collection and 20% from fees for strain distribution and services. The government provides a grant for 10%. A two-tier system of fees is levied for public research organisations and for private research organisations, the distribution and exchange of strains among BRCs

is free of charge. Since it is difficult to anticipate an increase in donations, attempts will be made to increase the income from fees for distribution by improving the quality of the service.

Describe how quality assurance and quality control are applied and maintained. *(Include details of accreditation, customer service response, and the numbers of complaints.)*

The American Type Culture Collection (ATCC, United States). Biological resource centre activities are not currently subject to ISO, GLP, GMP, and GCP regulations, which require documentation and maintenance of manuals and rules clearly defining lines of responsibility. However, the proper selection and use of their principles and guidelines contribute greatly to internal quality control and external quality assurance of the cultures and their associated data delivered by a centre. To confirm the authenticity and quality of biological materials, the ATCC has selected and adopted certain principles of good laboratory practice (GLP). GLP requires written standard operating procedure (SOP) manuals, which are the most important documents for standardisation and organisation of all observations, tests, and functions in the centre. When considering a quality programme in compliance with GLP standards and other federal or regulatory requirements, the ATCC distinguishes between quality control (QC) and quality assurance (QA). QC is the spectrum of assays used to fulfil requirements for quality. QA, on the other hand, is the system of checks that guarantees that laboratory work is documented and conducted according to approved protocols and standard operating procedures (SOPs). Quality assurance at the ATCC is founded on a set of specific guidelines and laboratory practices implemented on a daily basis. One of the more effective tools used by the ATCC for routinely monitoring quality assurance is an internal audit. An internal audit serves a purpose similar to that of a regulatory or funding agency-initiated review, in that it is an incentive for collection managers and laboratory personnel alike to follow SOPs, maintain QA documentation, and use appropriate controls. An internal review also identifies weaknesses in the handling of deposits and strain data management, incompetent personnel, and inadequate physical facilities. These problems are then corrected before users complain or external audits occur. Internal audits often result in preventive rather than corrective action, and in this sense, are viewed by the ATCC as proactive rather than reactive quality activities.

Deutsche Sammlung von Mikroorganismen und Zellkulturen **(DSMZ, Germany).** Prior to accessioning a strain into the DSMZ collection it has to pass a rigorous identity control programme. Every culture batch produced is tested for viability, purity and identity (conventional markers, riboprinting, fatty acid patterns *etc*.), all tests and results are documented. Only tested strains are included in the DSMZ Catalogues of Strains. The feedback from users is generally positive, achieved by public relations and the quality of the supplied strains. For example, 16 of 90 complaints related to broken ampoules and six to lost parcels. The others complained of contaminated cultures or inability to revive them. In these cases replacements are provided free of charge. Generally the lack of growth was due to the failure of the customer to handle the cultures correctly. The DSMZ provides instructions for the cultivation of individual cultures (catalogues, handling advice are routinely shipped with some cultures). The standard of service quality provided by DSMZ has led to a system of internal standards of accreditation for the CABRI project.

Ribosomal Database Project (RDP-II, United States). The RDP-II strives to ensure that all of the information passed on to users is correct. At a fundamental level, the quality of the information depends on the persons who submit the sequence(s) to GenBank. After passing into RDP-II hands, the sequence quality and the associated information (metadata) are verified. Ph.D. level biologists oversee this curation and any additional annotation, such as the addition of type information. Errors in sequences, for example, duplication of a stretch of nucleotides, are not corrected, but a note about the error is added to the metadata.

Users are encouraged to contact RDP-II with questions. RDP-II receives from one to five e-mail queries per week. It is also developing educational modules for use in education that will teach people how to use RDP-II information and services as well as some of the biological principles underlying this use.

Institute for Genomic Research (TIGR, United States). It was considered by the responders that the details of their sequencing and micro-array quality control and quality assurance procedures were not of relevance to this survey.

Agricultural Research Council (ARC, South Africa). Strict use of conventional microbiological procedures has ensured that only axenic cultures are supplied. Complaints are rare. All strains supplied to inoculant manufacturers are from freeze-dried cultures of effective strains. Other strains previously maintained on agar slant cultures are now being transferred to a glycerol medium for storage at - 80^{o}C. All activities are conducted according to written protocols. These protocols are reviewed from time to time to keep up with trends, knowledge and capacity. Cultures and specimens submitted are scrutinised for purity before and after processing before being stored. All cultures are plated and verified before distribution to clients. More than one preservation technique is used for each culture. Viability of cultures is checked from time to time. Much attention is given to provide as pure and stable reference material as possible but budget and human resource limitations hinder the execution of this task. As it is thus impossible to run routine tests on maintenance of characteristics and the occurrence of genetic drift there is a great need for a rapid and inexpensive method to assure stability of characters. Almost no information exists for many of the older strains in the collection as well as the history of many strains received. The value of cultures largely depends on the care taken upon receipt, the long-term preservation protocol followed and the availability of detailed information for every strain.

Belgian Co-ordinated Collections of Micro-organisms (BCCM). The BCCM collections are devising their own quality systems and intend to formalise this through accreditation or certification. All BCCM collections perform quality control tests on biological materials at different stages: before and after preservation of a newly acquired strain/plasmid, after the preparation of a new batch and at periodic intervals. The frequency of quality control for a culture is determined by the type of organism, the preservation method used and the rate of turnover of the strain. It is not feasible to apply an in-depth quality control system to all cultures held in large collections. Therefore, a selected core of the collection is submitted to thorough quality control tests, while other cultures are examined at a moderate level. Records of these tests are kept. Within the framework CABRI project (Common Access to Biological Resources and Information) BCCM/LMBP edited the plasmid guidelines, while the other BCCM collections contributed to the development of guidelines for micro-organisms. These have been peer reviewed and approved, resulting in a set of technical specifications and procedures on how the CABRI partners should handle each resource type. Adhering to the specifications laid down in the CABRI quality guidelines, and in the guidelines for catalogue production, the BCCM collections guarantee their clients high quality biological resources, information and related services. Complaints are registered and are dealt with immediately. Complaints usually refer to the distributed biological material. Only for a minority of complaints could the responsibility be assigned to the collection.

Centraalbureau voor Schimmelcultures **(CBS, The Netherlands).** The collection runs to internationally recognised quality standards. CBS was one of the founding members of CABRI and provided the quality guidelines for yeast and fungi. The users consider the standard of the collection as excellent and CBS receives few complaints (<1% resulting mostly from the inexperience of the recipient). All complaints are responded to rapidly, within seven days, and detailed support provided where necessary.

Colecao de Culturas Tropical **(CCT, Brazil).** Currently ISO Guide 25 is under implementation at CCT, as a part of Brazilian Government Guidelines for the National Laboratory Network (REBLAS). The standard of quality of CCT services and products is assured by the implementation of ISO25 to all activities in the

laboratory and complete documentation and registration (organisation of the collection, data management, customer information, strain data and catalogue, services management and internal communications) on a computerised database. Customer feedback classified activities at the 95% level as either "satisfactory" or "very satisfactory". No complaints due to broken ampoules or damaged package/material were recorded, and the remaining 5% of complaints were attributed to the incorrect handling or slow growth of cultures or their contamination. These were corrected by advice and quality verification of other batches. The quality control policy followed includes microscopy, viability check and cell count before and after the preservation procedure and biochemical characterisation and authenticity checking of all the strains on accession and on some selected lots of preserved material. Strains used as control in standard assays and testing undergo a stricter quality control. All preserved lots are tested for the intended application in assays carried out for routine work. Additionally, CCT is involved in developing quality control standards for several categories of products that are produced or destined to countries in tropical regions. In CCT experience, current international standards for microbiological testing of materials (such as ISO or ASTM) are not adequate for the certification of material in tropical environments.

***Collection de l'Institut Pasteur* (CIP, France).** In June 1998 the CIP was certified according to the ISO 9002 reference by the AFAQ (French Association for Quality Control) for its activities involving acquisition, production and distribution of bacterial strains, spores and plasmids. Procedures are formally noted in writing to comply with a documented system adapted to the CIP organisation. The certificate was officially granted to the Scientific Director of the CIP in the presence of the General Director of the Institut Pasteur and around 200 people from within and outside the Institut Pasteur. The overall activities are formally drawn up in writing within a carefully documented system adapted to the CIP organisation. All operations are noted. The measures established are continually applied and improved. Internal audits are regularly carried out so as to evaluate eventual differences between what is done and the written set of measures. Quality indexes are established based on laboratory incidents recorded and client complaints. Regularly, the person responsible for quality control draws up a report. Corrective and preventive actions are taken if necessary. The complaints from clients are always noted in a request book and a written answer is always provided. The complaints generally relate to inability to grow the received stains. Since January 2001, the CIP has implemented its Quality system in order to meet the new requirements of the revised ISO 9001 standard.

Agricultural Research Service Culture Collection (NRRL, United States). New accessions are examined for purity and preserved by lyophilization or in liquid nitrogen vapour or both if there is concern about long-term survival of the strain. Lyophilized strains are normally distributed, but if the material is frozen, it is revived, examined for purity and distributed as a slant culture. To date, few complaints have been received about service or culture viability. The few cases of inviable cultures are mostly attributed to overheating in shipment or the inexperience of the recipient. Because of the small staff size, strains in the general collection do not undergo scheduled viability checks after initial preservation. Distributions from the general collection are limited to 12 strains per request and not more than 24 strains per year per requestor. In the Patent Collection, new accessions are examined for purity and the depositor is notified if there is concern, the culture is preserved as received. All patent strains are preserved by lyophilization and by freezing in liquid nitrogen vapour. Each lot is checked for viability. In addition, a sample of the preserved preparation is returned to the depositor for verification of strain properties. The viability of patent cultures is verified shortly after initial preservation, at one year and then at five-year intervals thereafter. Patent cultures are handled under the conditions of the Budapest Treaty.

Institute for Fermentation, Osaka (IFO, Japan). IFO performs tests in accordance with published protocols for the species; identification by morphological observation, by gene analysis (analysis of base sequence, analysis of DNA by the RAPD method, and other methods) and sub-culturing. Particular attention is paid to the accumulating biological information and ensures that the taxonomic information, such as changes in species and scientific names, is regularly updated. In response to user enquiries

information is provided on the state of the preserved strains, appropriate culturing methods, their properties, and relevant literature. Specific information concerning changes in species names is distributed through the *IFO Research Communications*, which is published every two years, or the *IFO List of Cultures* (catalogue), which is published every four years, (present on the Website). Few complaints are received (two-three per year) which relate to the contamination of the distributed cultures. These complaints are dealt with quickly and the purity and identity of the collection investigated. The investigations sometimes indicate errors on the users' side. If the errors are IFO's, then a replacement is collected from the original depositors to preserve a new stock. In all cases the correct strain is distributed to the complainants and the information passed to other users.

Describe your current activities and infrastructure (staff, etc.) for technology and research, existing and projected integration with information technology, and your strategy for development. *(Include details of R&D, education and training, requirements for specialists, and the need for expertise relevant to BRC.)*

The American Type Culture Collection (ATCC, United States). The ATCC has three scientific/computational divisions: microbiology; cell, development, molecular biology and genetics; and information management, each include bioinformatics and information technologies (IT). There are 106 scientific staff members and 21 IT staff members. Information management departments interact with the operations, legal, regulatory, and sales and marketing departments, in the exchange of information between the microbiology and cell, development, molecular biology, and genetics divisions. With additional inputs of external proprietary and non-proprietary data, the bioinformatics unit uses this information to launch workshops and training, data mining, data analysis, visualisation, and data integration. Development strategies at the ATCC are devised by teams derived from scientists and other staff members, and include input from advisory groups, board members and customers.

Deutsche Sammlung von Mikroorganismen und Zellkulturen **(DSMZ, Germany).** New scientific and technical developments are implemented quickly provided that curators justify the purchase of the equipment or change in research direction. Except for certain aspects of bioinformatics, the DSMZ does not see a need to outsource parts of its service. Customers who require material or specific service aspects are referred to the appropriate institutes. The long-term strategy to meet scientific developments is proactive, particularly research in quality control, certification of authenticity and taxonomic techniques. The research component of the DSMZ has the potential to contribute significantly to these issues, however it is often difficult to attract diploma and Ph.D. students to study taxonomy. Information technology is supported by two scientists and a part time secretary, further support is obtained by the administration of the GBF staff through the Internet service.

Ribosomal Database Project (RDP-II, United States). RDP-II is a fully integrated WWW-based service which currently faces two major IT challenges: the need to keep pace with the growth in the number of available sequences and the need to modernise the site based on more efficient technologies that will integrate the Web-based services more tightly with the database.

All technology and research is carried out by the core staff, with the aid of collaborators. Projects are categorised as *a)* those that meet the immediate needs of the database, such as data-harvesting tools or annotation tools, *b*) those that enhance user services, such as data browsers or analysis programs, *c)* those that pertain to the Website, such as design or searching capabilities and *d)* those that enhance the information on the site, such as generation of phylogenetic trees or creation of downloadable versions of the information. The required expertise is broad – knowledge of systematics, molecular evolution, computational biology and systems administration are required in all personnel.

The second major challenge, brought on by the growth in sequences and new computer and software technologies, is in recruiting and retaining staff. Appointees are required to possess unique specialities and interests, in particular they must have good and current computer science skills combined with some understanding of the biological uses. Bioinformatics talent is in very short supply. Some plan for using BRCs as a resource in helping train new bioinformaticians has to be explored to extend and ensure that the tasks of BRCs can be accomplished and that the talent pool be augmented by education. However, much of this specialised training may not be appropriate for a graduate degree in computer science so training other than through normal degree mechanisms has to be considered.

Institute for Genomic Research (TIGR, United States). TIGR does not function as an integrated BRC where live collections are held. Support staff include 35 personnel and a 40-person informatics group, who provide extensive informatics infrastructure for managing and performing scientific analysis for genome sequencing and micro-array projects.

Agricultural Research Council (ARC, South Africa). The SARC is under the charge of the NFU manager and supported by two technicians; one maintains the collection while the other is responsible for inoculant quality control. The lack of funds, particularly for staff, is restrictive. Current activities are limited to viability and purity checks on cultures previously maintained on slants. The cultures are then stored frozen in glycerol. Some taxonomic research is undertaken by SANFU on newly isolated indigenous *Rhizobia* from different legumes and regions of South Africa. All isolates are deposited in the SARC. The existing SARC is catalogued on index cards and in a simple computer database. This will be upgraded to a more sophisticated system if personnel constraints can be overcome. Across ARC there is a lack of up to date expensive apparatus necessary for expansion (and an increase in quality) of services; for example basic requirements such as the ultra-low freezing of cultures (liquid nitrogen), optics and reliable computer equipment, software, IT support and maintenance need to be met. The shortage of funds limits capacity, stifles growth, and handicaps research. The integration of the collection with information technology is under discussion and the incorporation and participation with other BRCs, including PPRI (National collection of fungi), has not been clarified.

Belgian Co-ordinated Collections of Micro-organisms (BCCM). One of the strengths of the BCCM collections is that they are hosted in recognised research laboratories within Belgian universities and institutes. Collection and host laboratories share infrastructure and the mutual exchange of experience and knowledge brings added value to both parties. The collections are involved in several – publicly or privately financed – research projects. Research projects are selected with a view to continuously supporting and improving the services. In addition to technical and administrative personnel, the BCCM collections fully appreciate the need for additional specialists in taxonomy, information and laboratory technology.

Centraalbureau voor Schimmelcultures **(CBS, The Netherlands).** In November 2000 the collection moved to Utrecht to combine the separate fungal and yeast collections in facilities physically close to the bacterial collection. The direct collaboration with the University of Utrecht, and other institutes of the RNAAS will be improved and intensified, providing further support. The need to extend the research and development capacity, the associated expertise and specialist requirements, necessitate additional funds or the reorganisation of the collection and the appropriate prioritisation of duties.

Colecao de Culturas Tropical **(CCT, Brazil)**. The research infrastructure includes standard equipment and laboratory facilities necessary for any BRC associated activity. These include genomic characterisation (RAPD, REP-PCR, ribotyping, molecular probing and DNA-DNA hybridization), DNA sequencing and analysis, conventional phenotypic methods and access to laboratories in other institutions for chemotaxonomic work (GC, HPLC, mass spectrometric analysis). Current research activities focus primarily on the development and application of molecular systematics to complement the conventional

taxonomic characterisation of bacteria and fungi isolated from environmental sources. Many of the research projects lead to the implementation of specific techniques or approaches that become established for routine analysis within the collection service. The collection also receives a diverse range of samples for analysis through its industrial services activities, some 20% of these strains are difficult to identify and turn out to be new species by 16S rDNA sequence analysis. These organisms are deposited at the collection for future research, as sometimes they come out as the nearest neighbours of yet uncultured bacteria, represented on databases by sequences from environmental clones.

Integration of research activities with information technology at CCT is done through the development of specific modules of the SDMS database system to handle strain data derived from molecular and chemosystematic studies. Currently, these modules are still in a developmental stage and are restricted to internal use. Part of the effort is concentrated on developing standard referencing that allows linking the strain with data stored on already existing specialised database and analysis systems. Additionally, geo-referenced data derived from the Biota project will be entered into a specific database system **(www.biotasp.org.br/sia**), overlaid on maps of the State of São Paulo at the 1:50 000 scale, making it possible to plot species distribution of several microbial species identified and studied in the project, as well as access to additional data on environmental characteristics.

There is a requirement for specialists and expertise relevant to BRCs. This is particularly critical in relation to the taxonomy of *Archaea*, yeast and fungi, especially expertise on groups of environmental importance. Specialists in bioinformatics, particularly with familiarity with genomic data and data handling, will be important to complement current expertise on bioinformatics and database development.

Collection de l'Institut Pasteur **(CIP, France)**. Currently all technological and research applications are undertaken by the core staff of four scientists. Additional technicians are needed for carrying out further research. Where necessary, CIP staff call on the expertise of staff in the research laboratories of the Institut Pasteur. The CIP provides training and education in Bacteriology (taxonomy and identification in the Institut Pasteur) and intends to organise a course for shipping infectious substances. CIP interacts directly with the Institut Pasteur, *e.g.* the Department of Bacteriology and Mycology, the Computing Service, the Administrative and Financial Direction, the Juridical Direction, the Human Resource Direction, and the Business Development and Industrial Partnerships Department. The CIP needs assistance in the development of bioinformatics. For example, the CIP aims to provide 16S rDNA sequence information for strains on its Website.

Agricultural Research Service Culture Collection (NRRL, United States). The five scientist/curators are responsible for both a research programme and for maintaining that portion of the collection appropriate to their area of expertise. The focus of the ARS Culture Collection, and research programmes, is on agricultural and industrial micro-organisms. Research programmes include molecular systematics of yeasts, *fusarium*, related *Aspergillus/Penicillium*, *Streptomycin* and *Bacillus/Lactobacillus*. Each scientist has a technician to assist with research and culture collection activities. One service scientist maintains the patent collection (*ca*. 75% of time) and assists with research. The other service scientist assists with various research programmes. Research results are published in the scientific literature and DNA sequence data from these studies are deposited with GenBank. Several partnerships with industry have been initiated to develop diagnostic probes for detection of food spoilage and medically important species. As noted earlier, advancement of scientists in the organisation is based on research productivity and little or no credit is given for curatorial duties.

Institute for Fermentation, Osaka (IFO, Japan). IFO assigns two-three postdoctoral research scientists to each of the fields of interest (bacteria, actinomycetes, yeasts, filamentous fungi, animal cells). Each researcher is an expert in taxonomy and has some knowledge of bioinformatics. Most researchers in the IFO major in microbiology, cell biology or molecular biology, and have a MSc. or Ph.D. They are active

research scientists who publish their findings and in addition manage the collection, quality control, preservation and distribution of the biological resources. IFO has a facility that can handle level 2 biohazards, a facility that can handle level P2 DNA recombinants, low-temperature (4^{o} or 15^{o}C), L-dry and liquid nitrogen preservation rooms. The facilities are equipped for taxonomic studies (instruments for chemical analysis, DNA analysis, and morphological examinations) and instruments for bioinformatics are being acquired. A database of holdings and a Website are also being established. Collaborative investigations and studies with overseas scientists will further promote international co-operation between BRCs.

How are bio-informatics and related systems utilised with respect to your holdings? *(Include details of the extent and ease of access, and the quality of information and support. How will the impact of IT change the service with respect to integration and networking – between live collections and databases, for example – and to the need for improved technology and staffing expertise?)*

The American Type Culture Collection (ATCC, United States). The demand for the rapid delivery of cultures and information requires improvements in resource management practice and advanced-trained professionals in information services, communications, and bioinformatics. In 1997 the ATCC implemented an Enterprise system for company-wide data management. The major installed components of this system are for financial management, manufacturing, distribution, service and support, and inventory management. This integrated system allows for the management of accounts and costs, the management of acquisition and characterisation of ATCC materials, the handling of purchasing and sales order processing, the handling of difficulties associated with biohazardous materials and materials with restrictions on distribution, the maintenance of recipient lists and contact information, the management of customer support, and the support for storage at various levels without regard to physical form of storage. A Website (**http://www.atcc.org**) enhances ATTC's presence in the electronic arena, offering customers better access to its biological materials and services. It provides customers with in-site navigation and a user-friendly environment. The ATCC site includes a search engine for an on-line catalogue, which enables users to find ATCC resource material and services quickly and easily. The increased cost of sophisticated equipment, information technology, and training of personnel now figures as a percentage of the total operating expenses at the ATCC.

Deutsche Sammlung von Mikroorganismen und Zellkulturen **(DSMZ, Germany)**. Electronic databases with internationally agreed formats are used for administrative tasks (shipment of cultures) and for the production of printed catalogues, catalogues on disk, and internet publishing (**http://www.dsmz.de**). The extent of the data associated with the collection and cultures is constantly being updated and enhanced by molecular information. Databases integrated with information from several European collections are accessible online. A considerable rise in Website usage has been recorded, over 10 000 enquiries were noted in 1999. Although standardisation has been achieved through CABRI, there is no official European common policy.

Ribosomal Database Project (RDP-II, United States). The RDP provides users with several Web-based bioinformatics tools for specialised database searches and for analysis of user sequences. The quality of the data is typically higher than that obtained from sequence database searches, and has associated information not provided by those databases. User support is available from online help pages, via e-mail and the post, and over the telephone.

In-house, the RDP uses a custom database to store sequences, alignments, phylogenetic trees, and annotation data. Staff tools for working with the data include specialised sequence aligners and alignment editors linked to the in-house database. Phylogenetic trees are constructed by the staff using several well-known phylogenetic software packages. RDP-II has identified sequence alignment as a critical area

that could be improved with new tools. For annotating the data, a Web-based tool allows curatorial staff to work from any computer. The WWW has created the opportunity to further enhance the RDP-II data by linking to other databases. Caution is necessary; links must be to pages of recognised quality and of immediate value to the database users. At this time, for example, sequence data is linked to the GenBank record and links to Pub Med, DSMZ and the ATCC are planned. Web tools can also enhance the user experience; an online tutorial offering guidance on the use of the RDP-II is currently under development.

Institute for Genomic Research (TIGR, United States). TIGR do not possess physical holding of live collections, it functions as an extensive data orientated public Web resource **(http://www.tigr.org**).

Agricultural Research Council (ARC, South Africa). Although there are currently no bioinformatics facilities at ARC, once a suitable database has been established it will be incorporated into a suitable network *e.g.* the Microbial Strain Data Network of the United Nations Environment Programme. This will undoubtedly benefit the SARC by providing researchers with easy access to information and should increase demand for our cultures and increase possibilities of collaborative research. At best information is available from traditional indexes. Data input in a DOS based application is in progress but only 5 000 records of approximately 56 000 have been entered. Holdings of living cultures are available in MSWord documents.

Belgian Co-ordinated Collections of Micro-organisms (BCCM). Since the 1980s, each BCCM collection has maintained an electronic catalogue of its biological materials. The structure of the BCCM/IHEM, BCCM/LMG and BCCM/MUCL databases respects the minimal data set format defined by the MINE project (Microbial Information Network Europe) in which the BCCM participated and that was financed by the EC between 1986 and 1994. This data set constitutes the minimal information needed to describe a bacterial, fungal or yeast strain. Since 1996, catalogue information for the public collections have been accessible through the BCCM Website (**http://www.belspo.be/bccm**). The BCCM also participated in the CABRI project (**http://www.cabri.org**) and maintain a mirror site (**http://www.be.cabri.org**). In addition to the collections themselves other databases, containing scientific information (*e.g.* biomolecular data), information on the storage of biological materials or customer data are maintained. However, most of the collections' databases are still mono-user and are stored in different computers running different database software. Three out of the four collections are not supported by an IT manager and the databases were developed, implemented and are maintained by the institution's research scientists and/or a systems manager associated with the host laboratory.

Centraalbureau voor Schimmelcultures **(CBS, The Netherlands).** CBS has been at the forefront in the development and application of IT for collection database management, and participated in the European BAP, MINE and CABRI projects. Currently CBS operates a computer based quality management and stock control system, direct accession via the Internet either directly (CBS) or linked (CABRI) through the on-line catalogue. The database includes specialist information for the fungal groups and CBS develops CD-ROMs for identification and comparison, again supported on-line. In the near future CBS databases will be linked to gene bank and literature databases either independently or via CABRI. We also anticipate the establishment of a European Virtual Service Laboratory and provide support for data mining based on genomic and proteomic data useful in identification, phylogeny and the identification of new compounds.

To improve the management of these data, and to reach a total quality management system, BCCM have entered into a collaboration with the bioinformatic team of the Belgian EMBnet Node (http://ben.vub.ac.be). Following a technical audit on informatics, a multi-user database server will be developed and installed in each collection to store and integrate the diverse databases. This network of servers will share a common database technology and be used for on-line publishing on the BCCM Website and on other linked sites such as the CABRI site, which will be regularly extracted from the *collections' servers and processed accordingly.*

***Colecao de Culturas Tropical* (CCT, Brazil).** A database system (Strain Data Management System, developed by the André Tosello Foundation) supports the collection and is regularly updated **(http://www.cct.org.br).** Three categories of data are held which are organised to meet specific requirements, control the level of access and allow the management of the data. Strain accessions are classified into six groups: 0) strains no longer available in the collection, accession numbers are only kept for the record; 1) free access and distribution; 2) status pending, entries being processed and/or revised; 3) confidential deposits; 4) patent deposits; and 5) research strains. Status of strains assigned to groups 2, 3 or 5 may eventually be changed to group 1 and integrate the "open collection".

***Collection de l'Institut Pasteur* (CIP, France).** The information contained in the Collection is computerised and the catalogue is available on the Internet site of the Institut Pasteur **(http://www.pasteur.fr**). The CIP has developed its own database that includes information and a bibliography, when possible, of each of the 7 000 strains. The extent of the data is constantly updated. There are another 10 000 strains which are not available and have not been catalogued. The aim of the CIP is to catalogue these strains as soon as possible. A member of staff from the Computer Service of the Institut Pasteur is managing the CIP database with the help of a private company.

Agricultural Research Service Culture Collection (NRRL, United States). All strains in the general collection are listed in an "in house" database. Type strains, common reference strains, and those strains characterised by molecular genetic comparisons are listed on the ARS Culture Collection Website **(http://nrrl.ncaur.usda.gov).** All published and unpublished sequence data are maintained in unit computers. The Website shows high usage and the majority of strain requests from the general collection are now received by e-mail. Requests for patent cultures must be received as hard copy originals. Programming for the general collection database is currently being upgraded, but there are no plans to computerise patent holdings. Access to the gene sequence database allows rapid and accurate strain identification for the key organisms studied at the centre and these databases are provided to USDA research programmes and to those of collaborators, but the small size of available staff prevents a more widespread identification service.

Institute for Fermentation, Osaka (IFO, Japan). Of the 16 000 strains maintained in the collection, data for the unrestricted cultures, approximately 10 000 can be accessed via the Website **(http://www.ifo.jp)** so that the users can read, search, and ask for the distribution of biological resources. Since the database and the Website of IFO are synchronised, users can access the latest information. The need for an expert in bioinformatics is recognised.

***What are the extent and nature of existing strategic alliances and co-operative agreements in the context of national and international networks*?** *(Include details of how such alliances will be developed to meet the future needs of BRCs.)*

The American Type Culture Collection (ATCC, United States) does not have any strategic alliances or co-operative agreements at the present time.

The *Deutsche Sammlung von Mikroorganismen und Zellkulturen* (DSMZ, Germany) supports a Website, which provides intra-institutional Internet connections to other public culture collections and some large bioinformatic databases. Links have been established to the WDC Tropical database, CABRI, WFCC and Species 2 000. It is anticipated that the DSMZ will serve as the national node for the proposed BRC and the microbiological node for GBIF and the gateway for the regional/international node. Agreements are in place between European collections of *Bacteria* and *Archaea*, where for example, the DSMZ focus on strains of biotechnological importance, on the curation of type strains, and on their taxonomic research. The British NTCC and French CIP collect and distribute strains of predominantly

medical or veterinary relevance, whereas the Netherlands LMG is a resource for the taxonomy of Gram-negative bacteria. As a necessity there is substantial duplication of deposition of type- and test strains, however with the inevitable increase in the number of deposits of new taxa greater co-operation must be expanded and accession policies developed accordingly. This would greatly facilitate negotiations for finding new co-operative agreements. It is however important that commonly requested strains, such as test or teaching strains, should be available in national collections to ensure rapid and inexpensive distribution.

Ribosomal Database Project (RDP-II, United States). In order to speed access to the RDP-II from Asian countries, the Japanese National Institute of Genetics agreed to host a mirror site. Within the United States, RDP collaborates with other institutions to: *a)* accelerate the calculation of phylogenetic trees and to develop reliability statistics for those trees, *b)* develop new ways of exploring our data and of visualising the evolutionary relationships between sequences and *c)* update and standardise the alignment of the eukaryotic SSU rRNA sequences. The RDP are also linked to two other databases [the Ribosomal RNA Operon Copy Number Database (rrndb) and the Biodegradative Strain Database (BSD)] and supply them with sequence and phylogenetic information.

The non-interoperability of databases is probably the major obstacle to strategic alliances and co-operative agreements. At least one collaboration has foundered on the fact that the data was formatted differently and aligned differently from ours and no simple way was available for overcoming this obstacle. The use of mark up languages, such as SGML or XML to tag data with standardised data type descriptors (DTDs), has the potential to obviate these types of problems. It is important that efforts to write such DTDs not go ahead without input from BRCs.

Institute for Genomic Research (TIGR, United States). Most of projects involve national and international collaborations. These are research collaborations with other scientists and sequencing centres. A typical relationship with collaborators is that they provide biological expertise on an organism and we provide the sequencing and analysis expertise.

Agricultural Research Council (ARC, South Africa). National and International agreements exist with SADC countries via the Southern African LOOP (Locally Organised Operated Partnership) of BioNET-International. SAFRINET, which is owned by the southern African community, is a technical co-operative Network as prescribed by the UN for Technical Co-operation among Developing Countries. The Plant Protection Research Institute is the Network Co-ordination Institute within the sub-region. SAFRINET is dedicated to building taxonomic capacity through strengthening existing taxonomic centres. National Institutions are committed to sustaining the capacity developed through SAFRINET. The collections are affiliated to the World Federation of Culture Collections.

Belgian Co-ordinated Collections of Micro-organisms (BCCM). Functions as a consortium, or through its individual collections, is involved in different forums and networks. They participate in international organisations such as the European Culture Collection Organisation (ECCO), the World Federation for Culture Collections (WFCC), the UNESCO Microbial Resources Centres Network (MIRCEN) and CABRI. Nationally the BCCM collections are mutually beneficial, enjoy close collaboration and the free exchange of information in the development of common strategies on aspects of quality, information management, standardisation, regulatory affairs, collection management, international collaborations, marketing and price policy. The BCCM are linked to and co-operate with BELNET (the Belgian Research Network) and the Belgian node of the European Molecular Biology Network (BEN, Belgian Embnet Node). The BCCM are co-operating with the Belgian Institute for Normalisation and the Beltest accreditation office on a project concerning the normalisation of the certification, distribution and use of microbiological reference materials. Internationally BCCM collections build scientific networks of two types, either collaborative scientific research, or participate in co-operative projects with other collections. The BCCM international co-operation programme is being developed in respect of the principles of

sustainable development set out in Agenda 21, in compliance with the provisions of the Convention on Biological Diversity (CBD), and in accordance with other relevant international rules (*e.g.* TRIPs Agreement, Budapest Treaty). For example: BCCM has co-ordinated the EU funded MOSAICC project that provided support, at the microbial level, for the implementation of the CBD (Rio de Janeiro 5 June 1992). Common research programmes on microbial resources have been developed with China, and more recently with Morocco, to establish a national Moroccan culture collections network for the *ex situ* conservation of biological resources.

Centraalbureau voor Schimmelcultures **(CBS, The Netherlands).** Alliances and memorandum of understanding exist between CBS and CABI (United Kingdom), DSMZ (Germany), MUCL (Belgium), Denmark University of Lingby, Hong Kong, (China), University of Toronto (Canada), University of Peoria (USA). CBS actively participates, with board functions, in the European Culture Collection Organisation, and the WFCC. In addition CBS collaborates directly with industry and academic partners at the international and national level.

Colecao de Culturas Tropical **(CCT, Brazil)** has several national agreements, which can be differentiated into two categories, service alliances and research alliances. The service alliances are met under a third-party service agreement contract, Quarentenário EMBRAPA, where CCT is the accredited depository for microbial strains introduced into Brazil for the purpose of biological control and/or release into the environment. CCT provides authentication and the safe deposit of strains received by the Quarantine service of EMBRAPA. This is done on a confidential/restricted access basis. Some regulated phytopathogenic organisms, used as reference material for research purposes, are also introduced into the country via the quarantine service and vouchers are deposited at CCT. The CCT also enjoys a large number of research alliances as a partner or provider of direct support for the development of specific research projects that require microbiological resources (preserved or active cultures), identification, testing or safe-deposit of strains. Further strategies are being developed and implemented to enhance networking at local/state, national, regional and international levels which include the survey of service and research collections **(http://www.biotasp.org.br/biotasp/livros/busca)** or the Federal Pluriannual Plan of Action (PPA) for Biotechnology. **(http://www.bdt.org.br/publicacoes/padct/bio/cap2/5/)**;

Networking strategies at regional and international levels are being developed within the framework of the decisions made by the Conference of the Parties (COP) of the Convention on the Biological Diversity, specially on issues related to access to genetic resources and benefit sharing. Procedures for the distribution of biological materials, co-operative research and joint ventures are being developed by CCT, taking into consideration the legal framework of national and international laws and conventions. A project proposal on Information on Biological Collections (including BRCs, Museums and Herbaria) is being developed by members of the Organization of American States (OAS) under the framework of the Inter-American Biodiversity Information Network (IABIN, **http://www.iabin.org**). Internationally collaborative links with major service collections and strategic alliances are being developed, *e.g.* with the American Type Culture Collection (ATCC) and excellent informal collaborations exist with the DSMZ.

Collection de l'Institut Pasteur **(CIP, France)** participates in various official organisations, including the ECCO (see above), CABRI and the WFCC. In addition, the CIP collaborates directly with AFNOR to elaborate procedures in the field of chemical disinfectants and antiseptics at the national and international level. CIP considers that France requires a French BRC.

Agricultural Research Service Culture Collection (NRRL, United States). Each scientist/curator has informal research alliances with many US and foreign scientists. In addition, visiting scientists who wish to work in NRRL specific areas of research are welcome. The NRRL also trains a variety of domestic and foreign scientists in culture collection operations. Visiting scientists are responsible for their travel costs and living expenses, but there are no "bench fees". Formal research and development agreements have

been made with several companies to develop the NRRL gene sequence databases into commercial diagnostic probes as part of US Government technology transfer programmes. The NRRL anticipates that the main benefit will be practical use of research rather than financial gain for the research unit. The operation of the ARS Patent Culture Collection was formalised with the US Patent and Trademark Office in 1949 and under the Budapest Treaty in 1981. NRRL also has agreements with several foreign governments to serve as their official patent culture depository.

Institute for Fermentation, Osaka (IFO, Japan) co-operates with other BRCs through the system of mutual exchange of biological resources. This system will be maintained. To further strengthen the co-operation, discussions are under way to implement the sharing of databases among domestic BRCs. Internationally, IFO conducts joint research in the areas of strain isolation from nature, microbial identification, characterisation and preservation. Closer and more concrete international collaborations and joint operations are considered desirable now and in the future.

How are biodiversity, specialisation and representation covered? What strategy do you have in place for representation in the light of exploration and exploitation? *(Include details of how accession policy and access to holdings [stains, variants, libraries, clones or databases] might be restricted, and the rationale for maintaining or discarding material. Is there any intention to preserve mixed, biodiverse environmental samples and databases beyond the typical collection of pure, whole cells?)*

The American Type Culture Collection (ATCC, United States). Accessioning at the ATCC is based on the potential value of the material to science according to the needs of scientific and technological users. The ATCC's accession policy encompasses the traditional ATCC mission to provide well-characterised and documented experimental organisms to US and foreign research scientists, as well as added-value materials essential to the advancement of biotechnology. All materials accessioned by the ATCC are those for which a demonstrable demand exists or can be anticipated. Published criteria recommended by advisory committees and granting agencies are used to evaluate material for accession. Acceptance of cultures offered to the ATCC is at the discretion of the various collection scientists. Biological materials must be capable of being propagated in the laboratory and cryopreserved. ATCC is unable to handle agents requiring BSL4 containment in its central facility and is highly selective in accessioning agents requiring BSL3 containment. The ATCC will preserve biodiverse, environmental samples when the technology becomes available.

All collection scientists periodically examine their holdings for relevancy to the scientific community. Materials that have little scientific or historical significance as judged by the documented data, distribution rate and other pertinent criteria are candidates for de-accession. Advice from experts in the field on discarding a strain is sought where appropriate. Approval of the ATCC Board is required for actual removal. The ATCC policy is for open public access to its holdings. However, ATCC reserves the right to modify access to pertinent materials as new information or societal circumstances dictate. Access to certain critical protocols regarding propagation, storage or delivery of specific, potentially hazardous materials, may be similarly restricted. Such access restrictions are implemented for the protection of ATCC and the public.

Deutsche Sammlung von Mikroorganismen und Zellkulturen **(DSMZ, Germany).** The accession policy of the DSMZ is to collect taxonomically well characterised type material of human and animal cell cultures, especially hematopoietic lines; plant cell cultures of industrial importance, plant viruses, *Archaea*, thermophilic and halophilic bacteria, anaerobic Gram-positive bacteria, including *Bacilli, Lactobacilli, Staphylococcus, Streptococcus* and related taxa, Actinobacteria, phototrophic bacteria, myxobacteria, genetically well identified *E. coli* strains, and strains with degradative capacity. The accession policy is driven by the concept that even a small fraction of biodiversity is not collectable and not maintainable. The DSMZ favours the view of the WFCC, with the exception of a collection required to satisfy the national

demand. The degree of redundancy should be minimised among participating collections. This requires careful assessment of stocks in the large public databases including detailed information of their origin. The unification of the culture collection of the GDR, Jena and the DSMZ led to the policy that many strains originating from the same source were not included. Also, other holdings of the GDR such as the *Streptococcus* reference centre have not been included, while the fungal collection and patent strains were maintained. For example, the DSMZ is presently transferring the unique collection of myxobacteria, cytophagas and flavobacteria from the GBF (about 8 000 strains).

The DSMZ sees a possible role for the increased exploitation and generation of added value in the assimilation of molecular tests and reagents. These include the production of viral antibodies, mycoplasma detection and elimination, virus regulation elements, virus detection and cytogenetics (all in place), extracted DNA, PCR amplified rDNA (on demand), 16S rDNA clone libraries from DNA of specific sites, and DNA from genetically engineered micro-organisms. However, without an increase in facilities and personnel the DSMZ will not be in a position to significantly increase its scope by collecting microbial communities or host-microbe associations. It has, however, accepted several thousand soil samples from which myxobacteria have been isolated, but no strategic plans for exploitation or cultivation have yet been made.

Ribosomal Database Project (RDP-II, United States). Presently, biodiversity is under-represented in sequence databases. Even if each of the 30 000 sequences represented a unique species (which is not the case), and if it was assumed there were only 14 million species, the RDP database would only represent 0.2% of extant biodiversity. Although the number of sequences is increasing at an approximately logarithmic rate, it is doubtful that representation will ever be complete. All the same, the goal is to keep pace with this growth, which represents one form of exploration of the biosphere.

One problem faced is the inability to access privately held SSU rRNA databases. These are being built by companies who sell services in specialised fields such as medical and environmental microbiology. Other data exists that has simply never been submitted to the public databases. The private companies have access to publicly held data and are building up their holdings in their fields of specialisation. This is data which could be widely useful in areas outside the interests of these companies, and some form of licensing agreement for access to the data would be desirable.

Institute for Genomic Research (TIGR, United States). No culture collections are held. Sequence generated through funded projects is ultimately deposited in public databases as well as on the Website.

Agricultural Research Council (ARC, South Africa). Many of the inoculant strains originate from other collections and are freely available without any restrictions as these cultures originated before the CBD. For local isolates, however, an agreement of transfer form must be signed to ensure that they are used for research purposes only. New isolates are taken up in the SARC only after effectiveness on the legume(s) of interest has been confirmed. As an additional measure to conserve diverse populations, we are collecting local soils as a reservoir from which *rhizobia* could later be isolated. The Collections are managed according to a policy document in which details about accessioning, reservation and distribution of material *etc*. are addressed. Material that will contribute to the knowledge about the Mycota of the region will be accessioned if pest free, and of adequate quality and quantity. Quarantine organisms are only released on submission of permits from the relevant authorities. As cultures are not offered for sale, a policy of accession on merit can be followed. Each request is carefully considered as no guarantees are in place to avoid exploitation. Parties interested in exploring the collection may apply for collaboration with staff members of our department where the work will then have to be done. Most cultures deposited from other sources and certain valued strains are restricted for distribution. Because of the relatively small size of the collection no material is discarded although many strains are as yet unidentified because of the aforementioned limitations. No *in-situ* conservation has been done to date although ARC considers this of

great importance. The ARC would like to include this in its application to preserve microbiological materials in the three proclaimed UNESCO World Heritage Sites of South Africa – Robben Island, Lake St. Lucia and the Sterkfontein Caves.

Belgian Co-ordinated Collections of Micro-organisms (BCCM). Consortia have been established where each collection has its own domain of specialisation. The BCCM/LMBP plasmid collection holds a selection of recommended and/or required bacterial host strains, 14 unique cDNA libraries representing eukaryotic genomes ranging from fungi to man, and 1 900 plasmids that can replicate in prokaryotes, yeasts or animal cells. These plasmids have mainly been designed for high-level expression of homologous and heterologous genes in bacteria, yeasts, fungi or animal cells. The BCCM/LMG bacteria collection holds some 18 000 named bacterial strains, representing 1 800 species, subspecies or pathovars. The collection includes plant pathogenic or plant associated bacteria: (*Pseudomonas*, *Xanthomonas*, *Agrobacterium*, *Rhizobium* and allied taxa, *Erwinia*, *Pantoea*, coryneforms, *etc*.); Bacteria of medical or veterinary importance (*Arcobacter*, *Campylobacter*, *Helicobacter*, *Acinetobacter*, *Aeromonas*, *Flavobacterium* and allied taxa, *Alcaligenes*, *Bordetella*, *Corynebacterium*, *Burkholderia*, *enterococci*, *streptococci*, *staphylococci*, *etc*.); Bacteria of marine origin (mainly *Vibrio*); Various groups of potential biotechnological interest (N_2 fixers, *Clostridium*, *Agrobacterium*, streptomycetes, bacilli, lactic acid bacteria, acetic acid bacteria, *etc*.). Important sub-collections of lactic acid bacteria, X*anthomonas*, *Bacillus* and allied genera, *Pseudomonas*, *Rhizobiaceae*, *Campylobacteraceae*, acetic acid bacteria, *Flavobacteriaceae* and *Aeromonas* are also available.

Both the BCCM/IHEM and the BCCM/MUCL collection hold strains of fungi and yeasts. While BCCM/IHEM focuses on strains of public health or environmental interest, BCCM/MUCL contains strains of agro-industrial importance. The BCCM/IHEM collection holds about 20 000 strains including allergenic and pathogenic fungi for man and animal. Important sub-collections of strains set up in the framework of epidemiological studies are also available, mainly from the genera *Aspergillus*, *Candida* and *Cryptococcus.* Recently, BCCM/IHEM culture collection has incorporated the strains from the RV collection from the Institute of Tropical Medicine (Antwerp), a historical collection which is very rich in dermatophytes from all over the world. The BCCM/MUCL collection holds over 26 000 strains of filamentous and yeast-like fungi, representing more than 3 600 species of *Ascomycetes*, *Basidiomycetes*, *Deuteromycetes*, *Zygomycetes* and *Oomycetes*. The mycological herbarium contains over 40 000 specimens. BCCM/MUCL houses an important *Penicillium* collection, the UCL brewery yeast collection as well as numerous type strains and isolates of ecological and/or biotechnological importance. In particular, it holds numerous saprophytic and plant pathogenic fungal strains from tropical and subtropical areas. It is starting a monoxenic and *in vivo* collection of endomycorrhiza. The collection's biotechnological and agro-industrial focus is reflected in its extensive holding of starter cultures, *e.g.* the manufacture of fermented foods, animal feed, biopesticides and biofertilisers, as well as by the availability of cultures for the cultivation of edible mushrooms or the production of important primary or secondary metabolites. Test and control strains used in bio-assays, biodeterioration and biodegradation tests are also available.

Centraalbureau voor Schimmelcultures **(CBS, The Netherlands).** The accession policy is based on the requirement to maintain a broad spectrum of representative strains. Species not represented in the collection are accepted unless they do not meet the requirements for maintenance. The specific areas of research covered can result in the acceptance of a large number of strains. Currently DNA banks of CBS strains are under construction. Strengths lie in the study of yeast, *Aspergillus*, *Penecillium*, *Fusarium*, *Tricherma*, black yeasts, *Nectria*, *Chaetomium*, *Acremonium*, *Verticillium*, *Coelomycetes*, wood-inhabiting *Aphyllophorales*, *Zygomycetes* and *Oomycetes*. The development of closer collaboration within Europe and the establishment of a virtual service laboratory may result in greater specialisation.

***Colecao de Culturas Tropical* (CCT, Brazil).** Since 1994 investment has been made in specific research investigations into the diversity-rich habitats in Brazil and in industrial microbiology problems. The strains isolated in these studies greatly enriched the collection in terms of taxonomic representation and the genetic diversity of particular groups. For example from an Atlantic rainforest ecological survey (Juréia-Itatins ecological reserve) yeast, filamentous fungi and bacteria have been isolated and characterised both in Brazil and Japan. Strains and data associated are available for consultation and distribution. In addition, the study of the microbiology of the ethanol fermentation process in several sugar mills provided a number of isolates of *lactobacilli*, wild yeasts and acetogenic bacteria. The organisms isolated were characterised and represent a rich collection of contaminants of alcohol fermentation. Similarly acidothermophilic sporulating bacteria (ATSB) contaminating processed orange juice have been isolated and provide a unique and diverse collection of 620 *Alicyclobacillus* spp. strains isolated from different substrates and geographical areas in the state of São Paulo. Also several groups of important phytopathogenic bacteria associated with plant disease in Brazil, including *Xanthomonas* spp., *Xylella fastidiosa* and *Enterobacteriaceae*, are being characterised at the genomic level at CCT in order to understand the genetic diversity of these taxa and implications for phytopathogenicity.

A large part of CCT's holdings remain restricted. These holdings (approximately two-thirds of the collection are under this category) include many organisms not yet characterised in sufficient detail to be incorporated in the "open collection", and a range of organisms with particular properties of interest to biotechnological exploitation. Although concentrated research efforts result in major advances for CCT and their specialised holdings and data, there is a need for a more consistent approach to address questions of diversity, specialisation and representation.

Due to the relatively small size of the holdings at present (compared to international BRCs in the United States and Europe), CCT has a policy of not discarding material. In the future, CCT plans to revise and structure its holdings to represent the biogeographical distribution of strains, basic sets of strains that could be used for teaching, and the in-depth representation of certain groups of organisms in which CCT has active research programmes. These include phytopathogens, bacilli associated with biodeterioration and others. As CCT develops miniaturised low-cost storage preservation methods for liquid nitrogen, it will be able to expand the collection with high cost-efficiency and try to incorporate into the holdings a more representative collection of organisms from selected areas (*e.g.* those highly endemic or threatened) in Brazil. CCT's policy on distribution and access to strain data are not restrictive. They do not incorporate in the collection/database or refrain from distributing non-characterised material, based solely on scientific grounds. CCT's current distribution forms clearly state that strains are for research purposes only. Technological or commercial prospecting is not permitted. However, the enforcement and control of exploitation is the task of other organisations. Governmental involvement in this matter and education of customers as to CBD recommendations may take some time to be enforced.

CCT receive requests for the deposition and preservation of samples that are not "pure cultures". These include microbial consortia associated to specific processes (waste treatment bio-reactors and probiotic consortia used in fish farming which cannot be purified and cultivated as pure strains) and organisms which still cannot be cultivated outside of the host (certain insect pathogenic fungi used in biocontrol practices). CCT will have to develop alternative preservation methods for these types of samples. Additionally, CCT is setting up collections of genomic DNA for particular groups of strains that are highly fastidious and slow-growing (*Xylella fastidiosa*) and specific regulated groups of plant phytopathogenic bacteria. This type of material can be easily distributed and may represent a safer alternative to current restrictions on distribution of plant phytopathogenic bacteria for research in Brazil and internationally.

***Collection de l'Institut Pasteur* (CIP, France).** The CIP only holds pathogenic and non-pathogenic bacterial strains. The policy is to hold the type strain plus two others of each new bacterial species. In addition, strains with particular resistance to antimicrobial agents, reference strains and constructed

plasmids deposited by the scientists of the Institut Pasteur are also preserved. The aims of the CIP are to preserve Archebacteria and Extremophiles as soon as possible and to maintain strains which are published by Institut Pasteur scientists.

Agricultural Research Service Culture Collection (NRRL, United States). For the five main areas of research interest NRRL has accessioned one or more strains of all known species. NRRL regularly contacts authors describing new taxa in these groups. NRRL also attempts to maintain a relatively complete collection of other species of agricultural and industrial use. NRRL generally does not collect human, animal or plant pathogens above Biosafety Level 1, but NRRL does have facilities for BL2 organisms. The present accession policies will be retained and all current accessions will be maintained. There is no plan to preserve environmental samples. Although accession of new strains has not yet been noticeably affected by biodiversity treaty restrictions, or by those investigators who withhold published strains because they believe they have further biotechnological potential, there is genuine concern as the mission of the NRRL is to maintain useful and diverse holdings. In view of the concern about the loss of valuable microbial collections, the ARS Culture Collection has accessioned the following collections that would otherwise have been lost (strains from many of these collections are still commonly requested): Thom and Church Collection of *Aspergillus* and *Penicillium;* Blakeslee Collection of Mucorales; A. J. Mix *Taphrina* Collection; U.S. Army Quartermaster Collection; Fell Collection of Marine Yeasts; N. R. Smith Collection of Aerobic Spore-Forming Bacteria; L. T. Leonard Collection of Rhizobia; Dulmage Collection of *Bacillus thuringiensis;* International Streptomycete Project Collection; Waksman Collection of Actinomycetales.

Institute for Fermentation, Osaka (IFO, Japan). The basic activity is the collection of well characterised, identified strains for which additional biological information is available. With the exception of strains maintained on a contract such as patent deposits and strains utilised for the purposes of quality control, all strains and their catalogue information are available to the public. However, detailed taxonomic information is not released. Strains that are taxonomically questionable and those with qualitative problems are discarded unless they have been distributed within the past five years. Those that have no quality control problems are maintained over longer periods, even if they have not been requested for the last ten years. A BRC should perform and maintain long-term service operations for the isolation, quality control, preservation, and distribution of biological resources of scientific values. In this respect IFO are involved in the isolation and taxonomic characterisation of novel micro-organisms from the natural environment to increase the diversity of the collection. However due to the current financial restrictions in research staff and infrastructure there is no capacity for the active preservation of mixed, biodiverse environmental samples. However, IFO considers that its staff should act as consultants in the planning of research by venture businesses, and scientists employed by private firms and universities, and participate in new projects as long as they are useful for the essential activities of the BRC.

Is the public currently aware of BRCs? Do they accept that BRCs are necessary? Do they place any importance on biological resources in general?

The American Type Culture Collection (ATCC, United States). Greater efforts and education are required to increase awareness of users, policy makers, funding agencies, and the public of the importance of biological resource centres.

Deutsche Sammlung von Mikroorganismen und Zellkulturen **(DSMZ, Germany).** The public are not aware of the importance or role of BRCs. Historically only certain scientists working with micro-organisms are aware of the existence of the DSMZ. The situation is improving via access to the Internet. As the demand for quality controlled biological material increases, the market for non-authenticated material will reduce and accredited BRCs will be in further demand and their value recognised. It is imperative that competition among culture collections be avoided.

The future trend will probably see an increase in specialisation rather than in diversification. There is therefore a clear need for integrated co-operation and openness between the BRCs. Collections have to compromise between the needs of the scientific community (flexibility) and the desire to represent diversity without losing the skills and taxonomic expertise of their staff. Future needs might include specialisation and the development of strategies to diminish regionally redundancy, improvements in publicising quality standards that meet the demands of the user, improve and provide further links to associated biological, genetic and physiological databases. To achieve this it will be appropriate to develop national and international networks that link non-institutionalised collections to assess the uniqueness of their holdings and, by involving the public, users and funding bodies, develop a strategy for the long-term survival of BRCs. As the DSMZ is the only national German microbial culture collection it is anticipated that it will be invited to take a leading role in any of these issues once their importance is recognised by the government. These initiatives can only be implemented when additional staff are provided.

Ribosomal Database Project (RDP-II, United States). Among researchers using rRNA sequence data, the awareness of the RDP BRC is high. The RDP-II Website is visited from more than 2 500 distinct hosts every month and is used by researchers from over 40 countries in fields as diverse as molecular evolution and veterinary science. Among non-researchers, awareness is very low. This, in part, is the motivation for the educational modules previously mentioned. The initial module will be targeted to researchers needing a better understanding of our services and subsequent modules will seek audiences at the graduate, undergraduate and public school levels.

Institute for Genomic Research (TIGR, United States). The extent of public awareness of BRCs remains uncertain. The policy at TIGR is to deposit clones from sequencing projects for distribution through ATCC and Research Genetics. These resources and their need are well recognised by the scientific community.

Agricultural Research Council (ARC, South of Africa). Only certain individuals directly involved with or in need of services from these centres are aware of and understand the necessity of such centres, certainly not the public in a broad sense. Priorities of government, sponsors and policy makers exert pressures to focus on applied research. Taking the backlog in education in South Africa into consideration, the general public does not really have an understanding of the benefits and importance of biological resources. Micro-organisms are viewed as “bad bugs” while the everyday struggles of life take priority over matters such as conservation. Informative schooling in these matters should be addressed at all levels of education and it is here where a culture collection could play an important role to explain the intricate relationship between micro-organisms and mankind as well as the importance of preservation of pristine habitat for possible future use.

Belgian Co-ordinated Collections of Micro-organisms (BCCM). Although the public is aware of the concept of biodiversity in relation to insects, plants and animals they have little comprehension of micro-organisms. Indeed only a few scientists restricted to bioscience industries and the scientific community involved in biotechnology, agro-industrial, health and environmental fields are currently aware of BRCs and their importance, mainly as a source of high-quality, well-preserved strains. An awareness or publicity campaign could improve the public appreciation of BRCs. In this context, the BCCM has collaborated with the Belgian national television to produce a documentary film on micro-organisms and their impact on life (“The forgotten Legion”) where the importance of BRCs was also stressed. BCCM has also published some articles in weekly papers (*e.g.* “La bibliothèque du vivant”, *Le VIF l’express*, 14 October 1999 and "Paddestoelen bezitten onverwachte kwaliteiten", *Intermediair*, 16 February 1999).

Centraalbureau voor Schimmelcultures **(CBS, The Netherlands).** There is a growing awareness and appreciation of BRCs and collections of micro-organisms by both the public and politicians. However there is still a need for improved support to sustain activity. Furthermore, the need to apply more detailed molecular methods will incur additional costs.

Colecao de Culturas Tropical **(CCT, Brazil).** The attitude of customers towards the collection and services offered by CCT reflects a more general view of the academic and industrial community that BRCs do have a fundamental importance and are necessary for the development of microbiology, industry and biotechnology as a whole. In terms of the general public, this view does not seem to be shared. CCT perceives that in the general public there is very little awareness as to the importance of microbiology and the activities of microbiological BRCs. BRCs may help improve public understanding of their importance by promoting specific educational programmes directed specifically for this purpose. However, BRCs usually do not have active collaborations with professionals in educational programmes to develop this approach. At CCT, opportunities for developing collaborative efforts to raise public awareness and education on the importance of biodiversity are developed via the BIOTA-FAPESP programme: specific educational project aimed at schoolteachers targeting preservation of the environment and quality of life.

Collection de l'Institut Pasteur **(CIP, France).** The public and politicians alike do not appreciate the importance of BRCs, or that BRCs need governmental support to survive.

Agricultural Research Service Culture Collection (NRRL, United States). It is clear from audience attendance at sessions on BRCs at scientific meetings as well as from Website enquiries that there is considerable interest in BRCs. Most likely this interest peaks when cultures are needed and diminishes between times. Requirements for patent culture deposits help sustain this interest. If journals were to enforce their policy of deposit of strains that are the subject of study, there would be further interest in BRCs because of the increase in scientifically important strains that are held. Ideally, BRCs should maintain not only frequently requested cultures, but also others that are important to science, even though they may be only infrequently requested. With this philosophy, it is difficult for collections to be self-sustaining. However, if only popular cultures are maintained, much of our microbiological heritage will be lost. Consequently, it appears that most collections need governmental or other institutional support to survive.

Institute for Fermentation, Osaka (IFO, Japan). IFO considers that researchers in general understand the necessity of BRCs, recognising that biological resources are the basis for biosciences and have contributed to the development of science. However, researchers engaged in the most advanced research have no time to preserve biological resources while they may understand the importance of the constant accessibility to them. The public interest in protection and preservation of living organisms including micro-organisms as genetic resources appears to be growing due to increasing awareness of environmental problems and the possibility of their future utility. Furthermore, the presence of highly effective BRCs is undoubtedly necessary for the development of science in a country. It is also obvious that any single country or organisation cannot integrate preservation of all biological resources living or used in the country, considering their diversity. Therefore, international mutual support of BRCs is clearly needed. Although many "Libraries of books" are established and managed on the national level, the development of BRCs, which may be regarded as "Libraries of Life", is delayed. National policy makers and researchers in general must better recognise these facts. The industrial world also should not simply go after immediate profits but extend financial support for developing organisations that preserve biological resources (BRCs), which provide the basis for industrial activities.

APPENDIX 1: OECD TASK FORCE QUESTIONNAIRE ON BRCS - DISTRIBUTED MARCH 2000

(Extract from the Summary Record of the Second Meeting of the Task Force held Scientific and Technological Infrastructure – Support for Biological Resource Centres, held on 24-25 January 2000)

This questionnaire has been distributed to selected, representative curators, directors or managers of Biological Resource Centres. The objective is to build a profile of BRCs from existing models – a coherent set of indicators that will form the background for a report on current and future requirements, and on how existing collections and data sets are likely to evolve toward new-age, global, virtual BRCs. This forward look can in turn improve both BRC structure and information exchange for users and providers.

Attached to this document were the recommendations drawn up and ratified by the delegates attending the OECD Workshop "Scientific and Technological Infrastructure -- Support for Biological Resource Centres", held in Tokyo on 17-18 February 1999.

The Task

Each participating centre is approached formally through the OECD and asked to respond in some detail to questions on the specific challenges they face and the strategies they now have in place to meet real and projected demand. Respondents should also consider their current role and responsibilities with regard to maintenance, quality control and sustainability, and how these duties can or should be met. Clearly the funding issue is of major concern *vis-à-vis* meeting the demands of the user and the overall objectives of the collection/database. These should be defined and considered in terms of strengths, weaknesses, opportunities and threats (SWOT).

It would be helpful if SWOT responses addressed historical, present and future situations. One of the main objectives of this exercise is to draw on the informed opinion of curators.

General response and comments

Please include any observations you feel are pertinent that may not have applied specifically to the numbered survey questions. We are especially interested in details of unique activities. Some questions to keep in mind as you form your general response:

- What do you perceive as the most important challenges to the activity and maintenance of BRCs?
- What strategies do you have in place locally, nationally and internationally to meet those challenges?
- Do you see the role of BRCs changing in the next decade?
- What are the requirements to meet this changing role across the globe?
- What strategic alliances are needed for sustainability? Are they truly desirable?
- What is needed for the preservation and potential exploitation of the expanding biodiversity? How can those requirements be met?

Response time frame

Please respond by 30 March 2000 at the latest to allow adequate time for the information to be collected. Please also acknowledge receipt of this OECD questionnaire. All responses should be forwarded – preferably by electronic mail – to the questionnaire co-ordinator, Dr Mark J. Bailey, **mbj@ceh.ac.uk**.

In responding to these questions on the current and future status of the BRCs, please consider:

STRENGTHS WEAKNESSES OPPORTUNITIES THREATS

1. ***Define the nature, activity, and role of your BRC in terms of size (collection, staffing, facilities), breadth of mission, and foreseen changes with respect to its primary and essential functions***. *(In responding, please consider the extent of national and international collaboration, requests and distribution, and how future requirements for networking will be met.)*

2. ***Define current sources of funding, their reliability, and how future funding requirements will be met.*** *(Please include details of any charges levied for accession or access to items, and how the imposition of charges influences policy and quality of service.)*

3. ***Describe how quality assurance and quality control are applied and maintained.*** *(Include details of accreditation, customer service response, and the numbers of complaints.)*

4. ***Describe your current activities and infrastructure (staff, etc.) for technology and research, existing and projected integration with information technology, and your strategy for development***. *(Include details of R&D, education and training, requirements for specialists, and the need for expertise relevant to BRCs.)*

5. ***How are bioinformatics and related systems utilised with respect to your holdings?*** *(Include details of the extent and ease of access, and the quality of information and support. How will the impact of IT change the service with respect to integration and networking – between live collections and databases-and to the need for improved technology and staffing expertise?).*

6. ***What are the extent and nature of existing strategic alliances and co-operative agreements in the context of national and international networks?*** *(Include details of how such alliances will be developed to meet the future needs of BRCs.)*

7. ***How are biodiversity, specialisation and representation covered? What strategy do you have in place for representation in the light of exploration and exploitation?*** *(Include details of how accession policy and access to holdings [strains, variants, libraries, clones or databases] might be restricted, and the rationale for maintaining or discarding material. Is there any intention to preserve mixed, biodiverse environmental samples and databases beyond the typical collection of pure, whole cells?)*

8. ***Is the public currently aware of BRCs? Do they accept that BRCs are necessary? Do they place any importance on biological resources in general?*** *(Include details of how accession policy and access to holdings [strains, variants, libraries, clones or databases] might be restricted, and the rationale for maintaining or discarding material. Is there any intention to preserve mixed, biodiverse environmental samples and databases beyond the typical collection of pure, whole cells?)*