

Culture Collections: A Field for International Cooperation

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Abstract

The role of culture collections in international co-operation is described. Attention is drawn to a network of Microbiological Resources Centres (MIRCENS) based in the developed and developing countries. This international network is essentially based on the conservation and judicious utilization of microorganisms for environmental management and sustainable development in diverse sectors of human existence.

Keywords: culture collections, MIRCEN

The interdisciplinary nature of research and industrial microbiological processes in several fields of biotechnology such as food microbiology, the pharmaceutical industries and biofuel production, calls for an international effort that is directed to the preservation, maintenance and ready availability of authenticated species of microorganisms — i.e. an international network of culture collections. Hawksworth (1985) in establishing a cogent and comprehensive case for the use of fungal culture collections as a biotechnological resource has traced the growth and achievements of the World Federation of Culture Collections which was established with support of UNESCO. Furthermore, attention is drawn to an European initiative i.e. the European Culture Collection Curators' Organization (ECCCO) which was established in 1982. DaSilva and Heden (1985) in reviewing the role of international organizations in biotechnology documented the interest of UNESCO and UNEP in the promotion of culture collection activities at the international

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and regional levels. More recently, DaSilva and Taguchi (1986) highlighted the importance of regional culture collections in the global network of microbiological resources centres (MIRCENS), particularly in the fields of research and training. It is worth recalling that proposals for regional culture collections of microorganisms, especially in developing countries was made over a decade ago (Martin, 1974).

An important factor in the development and establishment of culture collections is the extreme difficulty encountered in re-isolating from Nature an exact replica of a particular strain. This is so, because the reservoir of Nature is almost infinite in size and complexity when measured at the scale of a microbial cell. The extinction of a microbial strain is virtually as final as that of a higher organism, if extinction means a situation in which retrieval is only possible at prohibitive cost.

The international support of culture collections — the treasure houses of the planet's microbial genetic heritage, can be traced back to the early catalytic support provided by Unesco, in 1946. Several of today's well-known culture collections have been beneficiaries of such support (DaSilva et al., 1977). Moreover, such support was extended also to the promotion of research on the applied use of microorganisms and to relevant publications such as the *International Bulletin of Bacteriological Nomenclature and Taxonomy*. In 1962, Unesco's Twelfth General Conference adopted a resolution by the Government of Japan to initiate and intensify research and training activities in microbial biotechnology in view of the growing domestication and use, at that time, of microbial resources in the sector of food, energy, industry, medicine and agriculture.

The growth of microbiology and the evolution of the new biotechnologies are founded on the basic knowledge of pure cultures and their interactions with one another in the artificial and natural environments. There are many microbiological associations that are intrinsically important in nature and which relate to the well-being of man and his utilization of the available natural resources. It is this cornerstone of microbiology that illustrates a challenging area of research for anyone concerned with the conservation, use and management of the microbial gene pool. It is worthwhile noting that many of the interesting species and rich diversity of the existing microbial flora maintained in established culture collections of today are the result of painstaking, meticulous and well-defined recording of data as for example in the well documented researchers of Pringsheim and Kluyver.

Today, it is microbiology and its treasures housed in culture collections

that offer great scope to the developed and developing countries for scientific progress and development. Culture collections are more than storehouses of cultures. Their responsibilities go beyond routine operations relating to the order, receipt, storage and distribution of cultures. They are valuable resources that serve as the fount responsible for the growth of the different aspects of the discipline of microbiology and are undeniably the powerhouses for generating active and applied research. In fact, culture collections are centres of reference, centres where the best techniques of preservation of cultures are perfected and applied, where taxonomic research is done, and where microbiological methods are devised and standardized. Therefore, microbiological societies and national federations of culture collections in these areas should give attention to:

1. The promotion and development of national culture collections when they do not exist;
2. the formulation of policies, procedures and standards for culture collection research;
3. the acceptance, acquisition and exchange of local cultures which have satisfied the established standards, thereby, facilitating co-operation amongst local and regional laboratories;
4. the support and encouragement of local basic and applied research in governmental, industrial and academic laboratories;
5. the education of science policy-makers and administrative cadres in relation to the socio-economic-cultural benefits stemming from microbiological and culture collection research;
6. the updating of local microbiological curricula and the upgrading training for the development of succeeding generations of trained scientific manpower.

The training of manpower for education and research in microbiology is an essential necessity to mobilize existing inputs and spin-offs. Well aware of the importance of this aspect of training and rejuvenation of scientific manpower, UNESCO plays an important catalytic role in the transfer of scientific knowledge and suitably adapted techniques and their applications from the developed areas to the developing countries.

The establishment and continuity of culture collections have been clearly enunciated in the recommendations of the United Nations conference on the Human Environment in Stockholm in 1972. It was this meeting which drew attention to the need for intensive action to preserve the world's ge-

netic resources and gave rise to the United Nations Environment Programme (UNEP) (Martin, 1976).

Following that conference, experts from UNEP, UNESCO and the international scientific community, met in 1974 and 1975 at UNEP at Nairobi, to jointly formulate a world-wide programme aimed at the preservation of microbial gene pools and making them accessible to developing countries through the establishment of a network of microbiological resources centres (MIRCENS). The objectives of the MIRCEN network (Annex 1) are:

1. to provide a global infrastructure which would incorporate national, regional and interregional co-operating laboratories geared to the management, distribution and utilization of microbial gene pools;
2. to reinforce the conservation of microorganisms, with emphasis on *Rhizobium* gene pools in developing countries with an agrarian base;
3. to foster the development of novel technologies native to specific regions;
4. to promote the economic and environmental applications of microbiology; and
5. to serve as focal centers in the network for the training of manpower and diffusion of microbiological knowledge

The first development in the World network of Microbiological Resources Centres was the establishment of the World Data Centre (WDC) for Microorganisms at the University of Queensland, Brisbane, Australia. The WDC houses a master copy of the World Directory of Collections of Cultures of Microorganisms and serves as a pivotal point for fostering development of culture collections in developing countries.

The total number of culture collections registered with the WDC is 356, from 52 countries. Several facilities are available through the current programmes and activities of the WDC (Table 1).

In recent developments to help provide permanency and continuity to the work of the WDC, negotiations have been underway, throughout 1985, to relocate the World Data Center. From July 1986, the Center has been transferred to Life Science Research Information Section, RIKEN, Tokyo, Japan.

A major problem facing a large number of developing countries is production of more food for their expanding populations. In this quest several developing nations have been expanding their agricultural lands into areas which are marginally capable of sustaining productivity, which is invariably limited by the availability of nitrogen fertilizer. By the end of the third

Table 1. Research activities of the World Data Centre MIRCEN.

A. <i>Facilities available to culture collection curators and researchers</i>	
•	The acceptance of data from research workers, matching it against data in the centre, and supplying the output, either unclassified or classified, to the research worker.
•	The location of cultures in various culture collections.
•	The provision of information on the geographical distribution of microorganisms, host ranges, or the occurrence of organisms with specific properties.
•	The provision of lists of contents of any collection.
•	The provision of lists of all collections maintaining particular organisms.
•	Supplying culture collections with their own collection data.
B. <i>Research activities</i>	
•	Collection and updating of strain data.
•	Compilation of data on economically important strains, e.g. <i>Rhizobium</i> .
•	Interaction with other MIRCENS in culture collection work.
•	Provision of training facilities within the MIRCEN networks.

quarter of this century, world food production was in fact dependent on a supplemental supply of synthetically fixed nitrogen fertilizer amounting to 40 million tons and costing US\$8-10 billion.

The production of biofertilizers — cyanobacteria for rice and *Rhizobium* inoculants for leguminous crops — can help greatly in the productivity levels of the planet's soil resource and in the consequent judicious utilization of petroleum and its hard technologically processed products.

In this context, the emphasis on the development of biofertilizers or *Rhizobium* inoculant material, particularly in legume-crop areas of the developing countries, appears to be sound. In interaction with other international programmes, modest schemes are already operating through the MIRCENS on a level of regional co-operation in Latin America, East Africa and Southeast Asia and the Pacific, with additional support from FAO and UNEP.

These are at the University of Nairobi, Kenya (1977); at Porto Alegre, Brazil (1978) through two integrated institutions: the Institute of Agronomic Research of the State Department of Agriculture and the Department of Soils of the University of Rio Grande do Sul; at the NifTAL/University of Hawaii/USAID Project Maui, Hawaii, USA (1981); the Cell Culture and Nitrogen Fixation Laboratory, USDA, Beltsville, USA (1981); and at the Centre National de Recherches Agronomiques, Bambey, Senegal (1982).

Table 2. Culture collection services of BNF MIRCENS.

A. <i>Rhizobium</i> Culture Collections at MIRCENS		
MIRCENS	Number of strains	
Bambey	50	
Beltsville	938	
Hawaii	2,000	
Nairobi	208	
Porto Alegre	650	
	3,846	

B. <i>Distribution of Cultures of Rhizobium</i>		
MIRCEN	Number of Cultures	Recipient institutions in
Bambey	8	Gambia, Mali, Yemen
Beltsville	508	Zimbabwe, Nigeria, Yugoslavia, India, Spain, Vietnam, Ireland, Malaysia, England, Italy, Canada, Brazil, Mexico, Colombia, South Africa, Senegal, Egypt, Poland, Argentina, Turkey, W. Germany, Austria, Australia and New Zealand
Hawaii	200	Global
Nairobi	95	Uganda, Malawi, Tanzania, Mauritius, Sudan, Congo, Zaire, Rwanda.
Porto Alegre	943	Argentina, Chile, Bolivia, Uruguay, Peru, Ecuador, Colombia, Venezuela, El Salvador, Dominican Republic, Mexico, U.S.A., Trinidad, Brazil.

In order to produce sufficient rhizobial inoculant material, it is necessary to have good cultures of *Rhizobium*. In this regard, the MIRCENS play a valuable role in maintaining and distributing efficient cultures of *Rhizobium* (Table 2). Over 3,000 strains are maintained in the MIRCEN Collections collectively, and over 900 strains have been distributed to researchers and culture collections in some 50 developed and developing countries.

Biotechnology, today, constitutes a frontier area offering a new technological base for the provision of solutions to the problems of *all* countries

— developed and developing. The Japanese — the acknowledged *maître de la biotechnologie classique*, consider the applications of microbiology and the new biotechnology to be the last major technological revolution of this century (Nikkei, 1982).

In the area of biotechnology, there are eight MIRCENS in operation. These are at the Thailand Institute of Scientific and Technological Research, Thailand (1976); Ain-Shams University, Cairo, A.R.E. (1976); the Central American Research Institute for Industry, Guatemala (1979); the International Centre of Co-operative Research in Biotechnology, Osaka, Japan (1985); Planta Piloto de Procesos Industriales Microbiológicos, Tucumán, Argentina (1984); University of Maryland, U.S.A. (1984); the Institute of Biotechnological Studies, London, U.K. (1983); and at Ontario, through two co-operating institutions: the Universities of Waterloo and Guelph (1984).

The MIRCEN in the U.K. is sponsored by the Polytechnic of Central London, University College, London and the University of Kent at Canterbury. In addition, the first co-operating laboratory in the network is the Commonwealth Mycological Institute's CMI MIRCEN for mycology.

In the region of Southeast Asia, the MIRCEN, with its co-operating laboratories in the Philippines, Indonesia, Singapore, Malaysia and Hong Kong and other institutions in Thailand, serves the microbiological community in the collection, preservation, identification and distribution of microbial germplasm; in the dissemination of information relevant to the cultures and their uses; and in the promotion of research and training activities that are directed towards the needs of the region.

A major task of the MIRCEN was the identification of activities of regional economic development in which microorganisms play key roles. A survey of culture collections in ASEAN countries revealed that Research and Development activities were primarily focussed on food fermentation with limited work in the area of other industrial fermentations. Regional workshops and training courses are organized periodically at the national and regional levels with a view to strengthening local expertise and regional capability in the utilization of culture collections for economic development.

Culture Collections in Southeast Asia registered with the World Data Center numbering 23 maintain bacteria, filamentous fungi, yeast, algae, protozoa, lichens, viruses and tissue culture lines (Atthasampunna, 1986). Most culture collections are relatively small, holding less than 500 strains of microorganisms. Some have special interest in agricultural, industrial, medical

or veterinary fields; others maintain taxonomic collections of more general interest (Table 3). While some of these collections provide cultures only by special arrangement and do not publish catalogues, others not only provide cultures and advisory services but also publish catalogues.

The majority of culture collections is sponsored by Universities or Governments while less than 9% is funded by private/industry. The commitments by both the universities and governments indicate the value of collections in government service in education, research, agriculture, human and animal health.

At present, the Bangkok MIRCEN is operating with seven co-operating laboratories, being in Hong Kong, Indonesia, Malaysia, Philippines, Singapore and two in Thailand. These laboratories interact with the Bangkok MIRCEN in the promotion of MIRCEN activities at the national level and cooperate in dissemination of information. The Bangkok MIRCEN helps strengthen their roles by providing them technical assistance especially in the field of culture collection, funding for maintenance of culture collections and research grants.

The Bangkok MIRCEN preserves microbial gene pools vital to agriculture and industry to make them accessible to the Southeast Asian region. At present it maintains over 1,800 strains of bacteria and fungi, preserved mainly in freeze-dried form. Catalogues of its holdings have been prepared and extensively distributed. So far the Bangkok MIRCEN has already distributed over 1,600 cultures, free of charge, to various universities and research institutions within and outside the region of Southeast Asia.

In the region of the Arab States, the MIRCEN at Ain-Shams University, Cairo, promotes research and training courses on the conservation of microbial cultures and biotechnologies of interest to the region. With the active co-operation and support of UNESCO's Regional Office for the Arab States, specialized courses have been organized in Sudan, Libya, Morocco and Iraq.

In the regions of South America and the Caribbean, the MIRCENS have pioneered the applications of microbiology, process engineering and fermentation technology through the establishment of joint collaborative research projects; the exchange of technical personnel; regional training; and the dissemination of scientific information among network institutions. Research and training facilities are available in biomass production, biogas, liquid fuels, solid waste treatment (aerobic thermophilic solid fermentations), photosynthetic systems in liquid waste treatments, and biopolymer degradation.

The MIRCENS in the industrialized societies function as a bridge with those in the developing countries. In such manner, increased co-operation

Table 3. Culture collections in Southeast Asia region.

A. *Number of culture collections*

Country	Collections	Sponsor		
		University	Private/Industry	Govt.
Indonesia	2	1	1	—
Malaysia	4	2	1	1
Philippines	7	4	—	3
Singapore	1	1	—	—
Thailand	9	5	—	4

B. *Kinds and number of culture collection holdings*

Kind of holding	No. of collections
Algae	4
Bacteria	19
Filamentous fungi	17
Lichens	1
Protozoa	1
Tissue culture lines	3
Viruses	
Animal	4
Bacterial	2
Plant	1
Yeasts	11

C. *Main interest of various collections*

Microbiological interest	No. of collections
Agricultural	12
General	12
Industrial	11
Insect	2
Medical	8
Veterinary	2

Source: McGowan and Skerman, 1982.

is promoted between the developed and developing countries. Moreover, as these MIRCENS are engaged in the frontier areas of research, the lead-up time in the transfer of new techniques and knowledge is considerably shortened. For example, the Guelph-Waterloo MIRCEN with its expertise at the University of Waterloo in biomass conversion technology, microbial biomass protein production and bioreactor design is of immense benefit to

the work of the MIRCENS at Cairo, Guatemala and Tucuman.

As indicated earlier, all the above-mentioned areas of microbiology have required and will continue to require as a basic element the supply of authentic cultures of microorganisms.

The importance of culture collections has only now been accepted with increased recognition by a growing number of microbiologists and biotechnologists who are faced with situations requiring authentic microbial cultures. In this regard, Sly (1986) has recently reviewed the case of culture collection technologies in conserving the planet's microbial heritage. Again as indicated earlier and again emphasized by Sly (1986), the pivotal point for information exchange and co-ordination is the World Data Centre (WDC) MIRCEN, now at Brisbane, Australia and soon to be transferred to Tokyo, Japan. The establishment of this Centre resulted from a number of requests, that increased with the passage of time, for information on the location, history, and characteristics of strains in culture collections and of the recognized fact that these could be best met by the development of an adaptable system for storing, retrieving and exchanging information which could be used by all microbiologists (McGowan and Skerman, 1982).

A recent survey of 356 culture collections in 52 countries by the WDC revealed a 40% increase, since the last decade, in the preservation of microbial cultures in the world's culture collections. In numerical terms, this amounts to well over a half a million cultures and do represent an enormous gene pool of national, regional and international interest. Moreover, they manifest an enormous financial investment by governments and industry, since they are at the very base of a number of activities in the commercial sector. For instance, microbial cultures are used in medical and veterinary pathology; in industrial fermentations in the chemical, brewing and pharmaceutical industries; in agriculture, in biological nitrogen fixation, plant pathology and dairies; in food technology and biotechnology; in vaccine production; and in environmental and ecological studies. Furthermore, they are the biological "tools" in the production of goods or in testing product quality, in food spoilage and food preservation, and international standard references for strain diagnosis of pathogens in human, plant and animal health as well as in numerous taxonomic and ecological studies.

Culture collections are either service collections, institutional collections or private collections. Service collections, often few, are permanent resource collections which normally have national status in terms of funding. These collections usually attempt to assemble a broad collection of cultures without

holding a large number of strains of each type.

Service collections are a truly available world as well as national resource. This type of collection supplies cultures on demand to the scientific community at large. Service collections usually charge a fee for cultures and publish comprehensive catalogues.

Institutional collections are usually associated with research departments or institutions that provide a microbiological service of some kind. This service may range from education and research in a university, to support of an identification service in a government department or hospital, to research and development in industry. Many institutional collections are internationally known for their expertise in the identification of particular types of microorganisms. This expertise is often recognized by designation as a reference centre by the World Health Organization (WHO) or other bodies.

Private culture collections are usually personal research collections with no guaranteed permanency beyond the working life of the microbiologists actively working with the collection. Such collections are often the result of a lifetime of research on a particular project or group of microorganisms. These research collections are usually highly specialized and are often the only source of particular strains, serotypes, or genetic mutants. The continuity of these collections is vulnerable and often reaches a crisis when the research scientist retires or when the research project ends.

In order to promote the development of culture collections and to further foster their interests and activities, a number of international initiatives have been made. Chief amongst these is the World Federation for Culture Collections (WFCC) that was founded in the early 1970s with support from UNESCO. The WFCC is an Interdisciplinary Commission of the International Union of Biological Sciences and contributes towards the conservation of the planet's microbial heritage as is best seen from its stated objectives:

- to establish an effective liaison between persons and organizations concerned with culture collections and between them and the users of cultures
- to encourage the study of procedures for the isolation, culture, characterization, conservation, and distribution of microorganisms
- to promote the training of personnel for the operation of culture collections
- to promote the establishment of an international data service concerned with the location of, and information about, microorganisms

maintained in culture collections and to publish a world directory of culture collections and list of species maintained therein; to promote and aid the establishment of culture collections

- to promote the establishment of special reference collections and identification services and aid existing identification services
- to establish official means of communication
- to organize conferences and symposia on topics and problems of common interest
- to attempt solution of international problems of distribution of cultures of microorganisms that may arise through quarantine regulations, and
- to attempt to provide for the perpetuation of important collections or cultures.

Prominent amongst the activities of the WFCC are education and training. Training courses on culture collections and preservation technologies have often been held concurrently with International Conferences on Culture Collections in developing countries. Courses, in co-operation with UNESCO, UNEP and ICRO have been organized in Australia, Brazil, Czechoslovakia, Egypt, Ethiopia, Guatemala, Hong Kong, India, Indonesia, Japan, Kenya, Kuwait, Malaysia, Mexico, New Zealand, Nigeria, Philippines, Republic of Korea, Singapore, Sri Lanka and Thailand. The courses cover such subjects as continuous culture systems, enzyme kinetics, microbial engineering, fermentation technology, conservation of genetic stocks for industrial efficiency and output, formulation of soil inoculants, development of waste recovery systems, microbial environmental control and management, and other trends in applied microbiological research and development.

Discoveries made in the fields of microbiology and cell and molecular biology have significantly altered the socioeconomic aspects of human life during the past fifteen years. The harnessing of microbial activities for such purposes as soil enrichment through nitrogen-fixation, the improvement of traditional food industries, the control of insects and pests, and the recycling of utilizable wastes, offers enormous potential benefits especially for developing countries. In the coming decades, both developed and developing countries will rely heavily on microorganisms in their efforts to meet the crises precipitated in the environment, in the food sector, and in socio-economic fields. Consequently there seems no question that the network of microbiological resources centres with their collections of cultures of microorganisms will have an important role to play on both the regional and international scales.

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