European Consortium of Microbial Resources Centres

Microbial Resources Success Stories

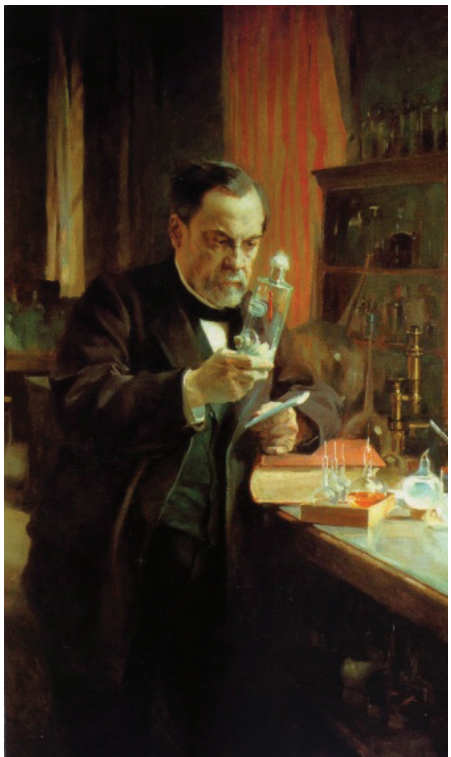
Microorganisms are everywhere, on the ocean floor, in our soil and buried deep in rocks. They are vital to human life and the environment we live in. Microorganisms are the source of many useful products and provide many solutions to healthcare, food security and industrial problems. Medicines such as penicillin and cyclosporin have saved millions of lives.

We eat microorganisms and their by-products every day, just think about mushrooms, cheese, bread, beer and wines.

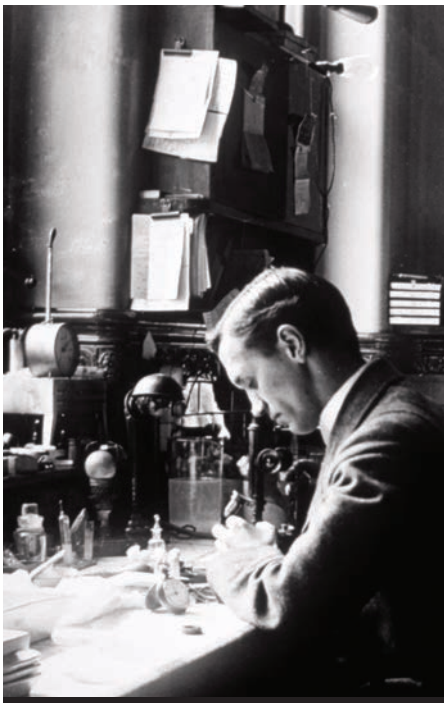
Microorganisms often get a bad press because of the diseases they cause or the damage they do, but their vast variety of properties can be harnessed for good.

There are over 1.7 million strains stored in World Data Centre for Microorganisms (WDCM) registered collections. These and many others stored in private researchers' laboratories have been the source of marvellous discoveries.

This brochure highlights some of these success stories and advocates the long-term preservation of microorganisms for future use and the benefit of humankind and our threatened planet.



Louis Pasteur by Albert Edelfelt, 1886. © Institut Pasteur



Alexander Fleming, is seen in his laboratory at St Mary's Hospital, Paddington, London, in 1909.
© ST MARY'S HOSPITAL MEDICAL SCHOOL/SCIENCE PHOTO LIBRARY

Pasteur and Fleming looked to microorganisms for their discoveries. The continued discovery of new species in nature opens up the potential for so many beneficial discoveries.

Fleming's penicillin production strain still available today from the CABI collection

EMbaRC

The properties of microorganisms have been exploited by man for thousands of years, particularly in food preservation, brewing and baking. Their uses continue to grow not just in food and healthcare but in almost all areas of industry and environmental maintenance.

Their authentication,characterisation, stable storage and supply are a major contribution to the knowledge-based bioeconomy.

EMbaRC is an integrating EU project funded under the Seventh Framework Programme Research Infrastructures action targeted to Biological Resources Centres (BRCs) for microorganisms. It aims to improve, coordinate and validate microbiological resource centre (mBRC) delivery to European and International researchers from both public and private sectors.

The EMbaRC project includes a combination of networking, access, training and research. To ensure harmonisation of the quality of mBRCs, EMbaRC plans to implement the current OECD best practice guidelines and emerging national standards for Biological Resource Centres (BRCs) at the international level. Outreach and training activities will enable not only the EMbaRC consortium but all European collections to operate according to the standards required to deliver products and services of comparable and consistent quality thus meeting customer expectations both present and future.

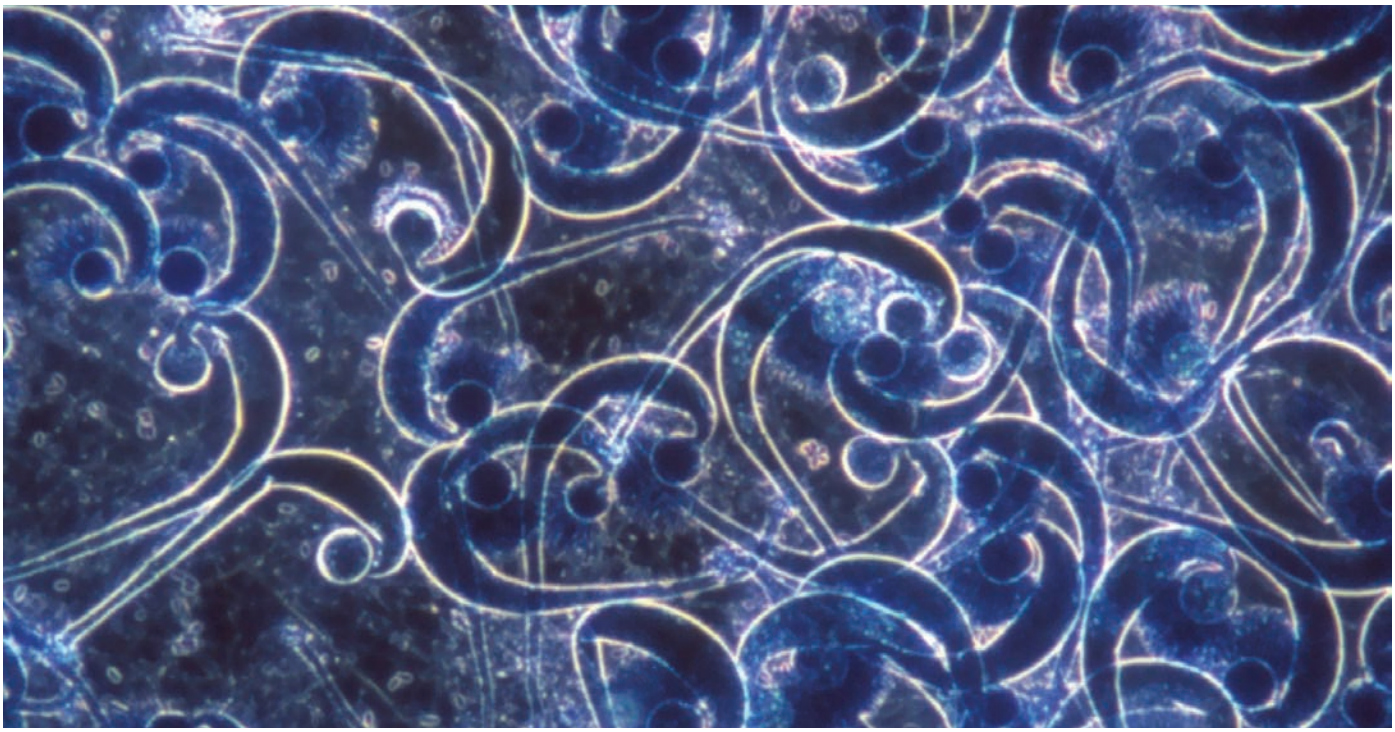
The EMbaRC project takes European collection networking to new heights of coordination and efficiency providing new services and better access for users.

The opportunity is being taken to work more closely with the user community. A one-stop access to the collections of EMbaRC and the wider European BRC community via a searchable web portal will be provided, building on the outcomes of the previous EU projects, CABRI and EBRCN, whilst adopting appropriate new IT technologies.

Study visits with high quality support and training are offered from the consortium partners via calls for access; these enable users to work in the partner facilities directly with staff using their resources and technologies.

The research part of the EMbaRC project will deliver new methods for strain and DNA preservation, novel techniques for identifying species and high throughput screening for enzymes of industrial interest. The networking elements will give better access to authentic microorganisms and validated associated data and provide a set of business models to increase self-sustainability of BRCs. This project creates the European node of the OECD envisaged Global Biological Resource Centre Network.

EMbaRC on Discovery
http://www.embarc.eu

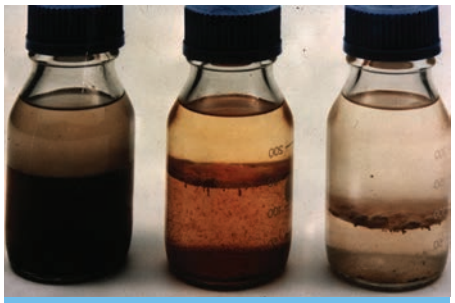


Syncephalus cornu © CABI

Fuel contamination test kits

The problem

Microbial contamination of distillate fuels is a longstanding problem. The microbes grow mainly on the fuel/water interface but can also stick to tank surfaces. The problems caused vary from filter blocking, tank corrosion, incorrect gauge readings to engine failure.
The microbes involved include filamentous moulds, yeasts and bacteria. Predominant in aviation kerosene is the mould *Hormoconis resinae* alongside a small number of bacteria. In diesel fuels a much larger group of organisms are involved and the profile can change over time. The yeast *Yarrowia lypolitica* can become very important in heavy contamination cases. The problem has become increasingly severe with the introduction of biofuels and ultra-low sulphur diesels.



Contaminated fuel (bacterial/fungal; fungal; and bacterial contamination)

Historically, identifying microbial contamination meant growing the organisms in a laboratory from fuel samples. Full analysis could take weeks to complete. A much quicker, on-site system was required.

The solution

The FUELSTAT™ resinae detection kit, which provides a semi-quantitative result in 10 minutes, was developed to detect contamination in aviation kerosene. It detects the presence of *Hormoconis resinae,* which is the indicator species for this type of fuel. The development phase relied upon dozens of strains of the mould that had been amassed in the CABI living collection, formerly the International Mycological Institute (IMI) Collection housing the UK National Collection of Fungus Cultures (NCFC). These strains were from many sources worldwide and provided the variety necessary to ensure the test could be used globally in all situations.

Following the success of the original aviation variant a test kit for use in diesel was developed.

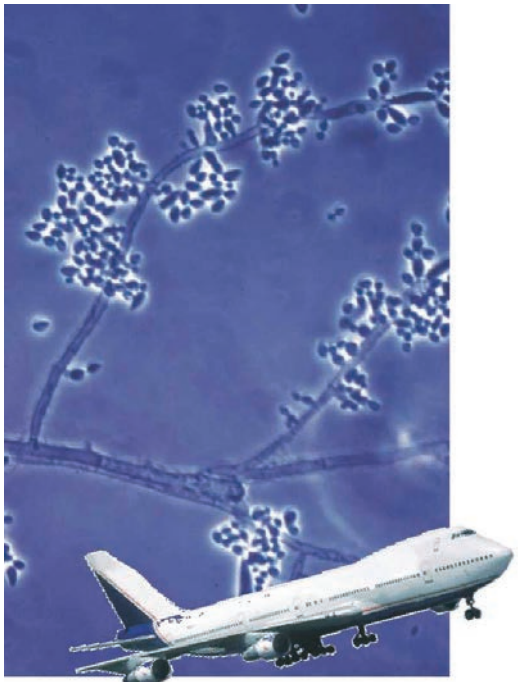
For this fuel the test needed to be widened in scope to detect the other fungi, mainly yeasts, which are present plus aerobic bacteria. For the yeasts, a similar process was undertaken as for the aviation kit, using strains of the hydrocarbon-utilising organisms held in the CABI collection.

Suitable bacteria were sourced from other collections and added to the CABI collection. The result is a 10 minute, onsite test that shows separate results for *Hormoconis resinae*, other yeasts and moulds and aerobic bacteria.

The future

Research is now underway to produce a test for anaerobes that contaminate fuel storage systems. The main group consists of Sulphate Reducing Bacteria (SRBs) and these are being added to the CABI collection as part of the project.

www.conidia.com



Conidia fuel test

Green muscle fighting locusts and saving crops

The problem

Desert locusts can invade 20% of the world land surface, their swarms can cover more than 100 km². They can devastate crops, each locust consuming its own body weight daily, a large swarm may weigh many tonnes and can eat as much as 25,000 people can.

The solution

The LUBILOSA programme brought together a multidisciplined team who developed Green Muscle™ which is highly selective in attacking locusts and grasshoppers, with no adverse effects observed on non-target organisms. However, more than 160 strains of fungi and other locust pathogens had to be studied before CABI scientists identified the fungus *Metarhizium anisopliae* var *acridum*, which is used in Green Muscle™. The product consists of spores of the fungus suspended in a mixture of mineral oils.

Key to the development was the stable storage of the production strain and its maintenance to ensure reproducibility. According to Dr Dave Moore of CABI, the development of a fungus-based pest control agent for locusts dispelled early reservations in the scientific community. “Most biological pesticides have a limited shelf-life,” he says. “However through persistent experimentation during the germination, drying and packaging stages, the LUBILOSA programme was able to produce large numbers of viable *M. anisopliae* spores, and a packaged product with a shelf life of 18 months at 30°C. Under refrigeration, Green Muscle™ lasts up to five years.”

Green Muscle™ provides effective control of locusts under desert conditions, and protection of the environment to safeguard biodiversity, establishing the continued presence of beneficial organisms. It is now manufactured in South Africa and Senegal (with a percentage of the profits going toward support for African scientists working in insect pathology).

www.lubilosa.org

Table Wine

The problem

The Portuguese wine industry is very important for the country. Wine exports account for 1% of GDP and 3.2% of export market share. A major problem was discovered in Europe, Ochratoxin A (OTA) was detected as a wine contaminant in 1996. Exposure to ochratoxins by ingestion can present acute toxicity to kidneys and may be carcinogenic.

The solution

The building up and study of a collection of isolates at Universidade do Minho, UMinho, Portugal helped demonstrate the role of *Aspergillus* section *Nigri* in OTA production. This toxin is now monitored and the maximum limit in wine has been set in EC regulation 123/2005 at 2 µg/kg ochratoxin A (OTA). Furthermore, the latitude of production has been shown to be an important factor in determining risk from OTA wine contamination. Some geographic regions in Southern Europe, like the Mediterranean basin, are more prone to contamination with OTA.

Photos courtesy of MUM, Portugal

The study of food bacteria to improve food storage

The problem

In France, like every other country, bacteria can be a major problem for the storage of food.

The solution

Food related bacteria were screened using the most diverse species in terms of biotrope and geographic origin. High throughput screening methods were developed using specific equipment. This resulted in improved preservation of fermented dairy products by the development of anti fungal bacterial cultures and the use of non-antibiotic strategies against pathogenic bacteria. This exploration of inhibitory capabilities of natural ecosystems was particularly successful against the contamination by *Staphylococcus aureus* in the dairy industry.

Screening of anti fungal activity in solid medium

Collection activities help discover new starter strain

The problem

Cachaça is an integral part of Brazilian culture; fermented sugar cane juice has been a favourite alcoholic beverage since the 1550's. It is estimated Brazilians consume close to 350 million gallons of cachaça per year – about two gallons per person. Cachaça's export capability was uncertain until the caipirinha became a bestseller in bars across Europe, United States, and Japan. The improvement of the fermentation of cachaça production in Brazil to meet customer tastes begins with a search for improved starter strains of *Saccharomyces cerevisiae*.

The solution

Brazil has been particularly active in looking for ways to convert biodiversity into biotechnology.

Their objectives are to collect and preserve microorganisms from tropical ecosystems, Antarctica and traditional local fermentations. 3,000 isolates of *Saccharomyces cerivisiae* from different Brazilian regions were tested and one strain was selected.

The contract was awarded to Danstar Technology (Lallemand) and Federal University of Minas Gerais for the commercialisation of this starter strain.

The pre-packed starter

The finished product ready to drink

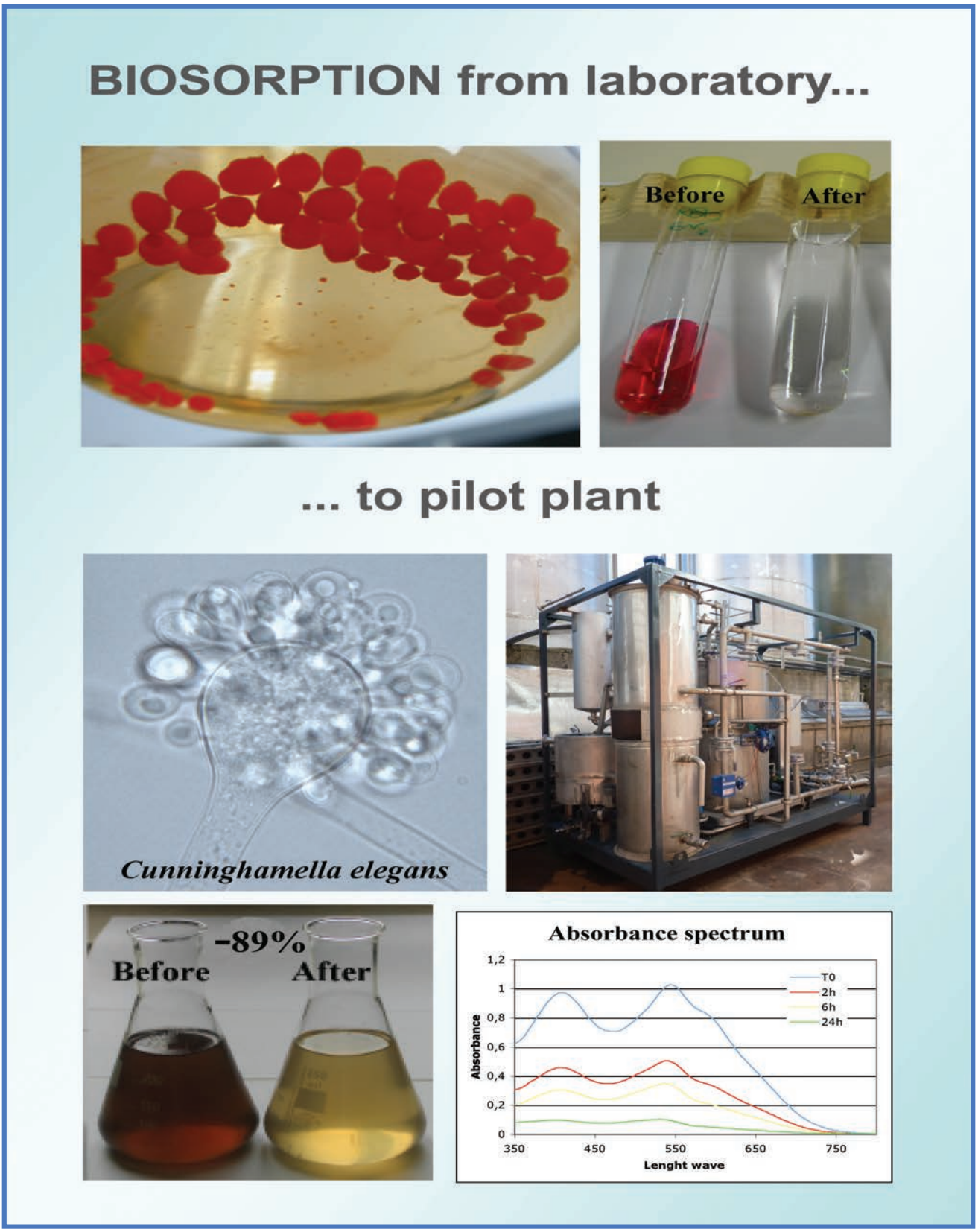
Industrial scale production

Distillation process

Wastewater decolourisation and detoxification by fungi

The problem

Control of pollution is one of the prime concerns of society today, since in both developing and industrialized nations a growing number of contaminants are entering water supplies from human activity. Actually, many industries consume substantial volumes of water, and use chemicals during manufacturing and dyes to colour their products, generating considerable amounts of polluted wastewaters.
Virtually all physico-chemical techniques have been explored to remove these toxic compounds from wastewaters, but all of them present drawbacks.



The solution

MUT is active in the development of innovative methods for wastewater treatment that overcome the problems of existing technologies coupling reduced costs, high decolourisation yields, wide detoxification and industrial applicability. Fungi can be applied in wastewater remediation through two different strategies: **biosorption** or **biodegradation.**

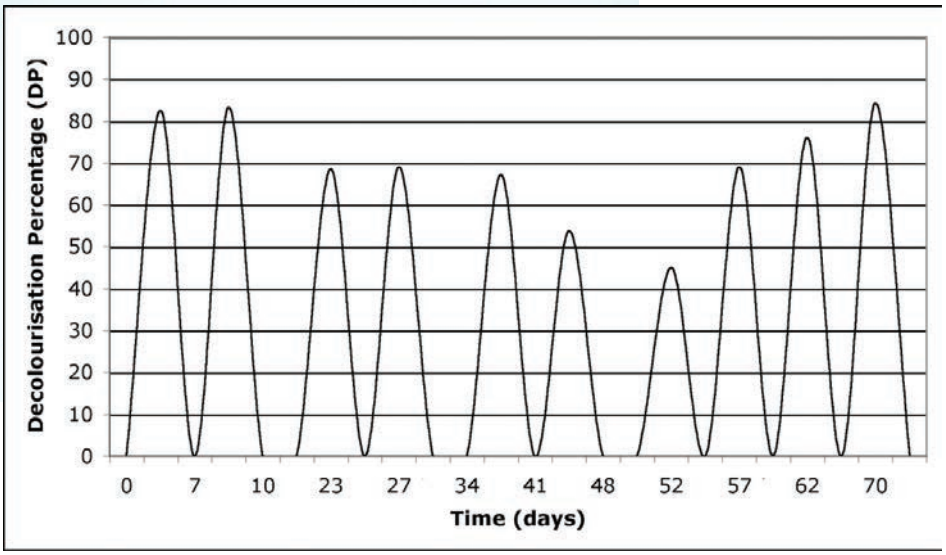
With regard to **biosorption**, *Cunninghamella elegans* MUT 2861, selected from hundreds of strains, was the most promising (EP10153195.2) and was optimized by physical and chemical pre-treatments in order to speed up the biosorption process irrespective of the particle size of the biomass and to facilitate the biomass conservation.

The biomass efficiency has been validated by tests in spent dye baths and on collected waste waters. This strain was really effective (up to 100% decolourisation within 20 min), and together with dyes, other important parameters (salts, surfactants and toxicity) decreased.

The optimisation of biomass production at an industrial scale was carried out in order to increase the biomass production using cheap substrates and to maintain the biosorption properties. Two different pilot plants were built and used to treat large volumes of both spent dye bath and wastewaters. Biosorption treatment was particularly effective and fast, towards spent dye baths, and good results were obtained also with wastewaters.

When utlilising **biodegradation**, the most promising strain was the basidiomycete *Bjerkandera adusta.* MUT 2295 was able to completely degrade most of the tested dyes and to decolourise and detoxify simulated and real wastewaters, by means of different peroxidase enzymes. In order to investigate its true biotechnological potential, the fungus was immobilized on carriers and used both in fixed-bed and in moving-bed reactors, for continuous treatment of large volumes of real textile wastewaters. The fungus was effective during several cycles in the decolourisation (up to 80%) and detoxification of the wastewaters, remaining active for a very long period, in non sterile conditions. The moving-bed reactor could be particularly advantageous because it can handle high loading conditions without any problem of clogging and with a relatively small footprint.

Textile wastewater treatment by *Bjerkandera adusta* in fixed-bed bioreactor. Ten cycles of degradation: colour, COD and toxicity were effectively reduced.



Acknowledgements to BIOTEX (http://www.progettobiotex.it/) and PURACQUA projects partners: Forniture Tessili Riunite s.p.a., Felli Color s.p.a, Centro Tessile Cotoniero e Abbigliamento s.p.a, Cittadini s.p.a, C. Sandroni & C. s.r.l., Linificio e Canapificio Nazionale s.p.a, Mascioni s.p.a, Stazione Sperimentale per la Seta, EuroD srl, Tessitura Enrico Sironi s.a.s, Tosi Spa, Vago Spa, Università di Torino, Università di Bergamo, Università Federico II di Napoli, ARPA Piemonte.

Oxidative enzymes in textile finishing

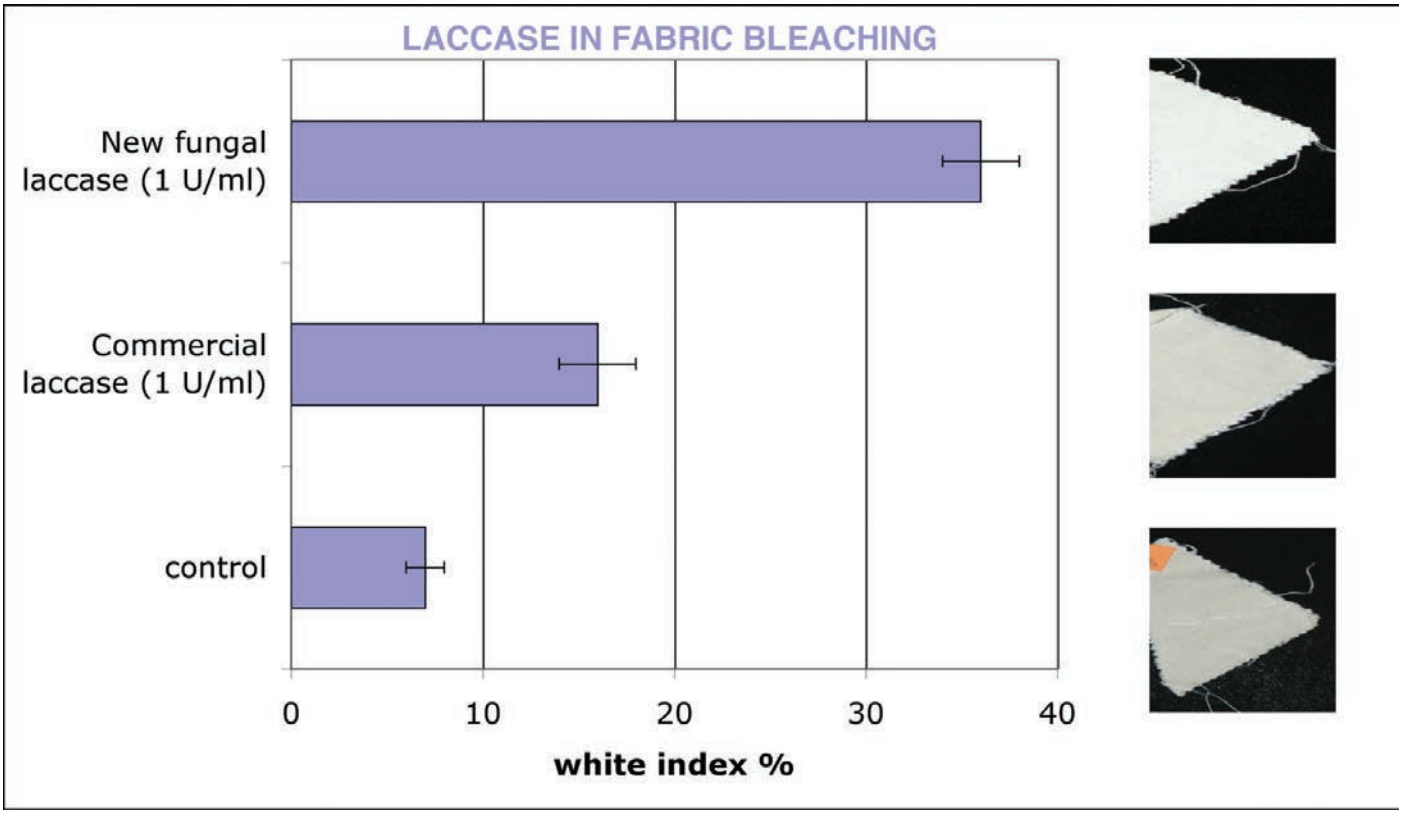
The problem

Textile industries are characterized by high consumption of energy, water and chemicals.

The solution

Biocatalysis by oxidative enzymes, mainly laccase and peroxidases, can improve textile finishing in terms of efficiency (optimization of mass and energy balances), security (reducing or eliminating the use of potentially dangerous chemicals to the environment and health, by promoting the use of biodegradable substances) and quality (improving current levels of quality, enrichment capabilities, development of new textile products to address emerging needs).

In the Greenmade project in collaboration with several SMEs, MUT selected several promising fungal strains with high production of laccases and peroxidases active at high temperature, basic pH values and high concentrations of salts. Enzyme production increased up to 100 fold by means of media engineering. The best results were achieved by a fungal strain that produced more than 200.000 U/L of laccase. Preliminary results by comparative trials with a commercial enzyme indicate that this new laccase is more effective in fabric biobleaching and bioscouring at low concentrations than commercial enzymes.



Acknowledgements to GREENMADE project partners: Forniture Tessili Riunite s.p.a., Actygea srl, Centro Tessile Cotoniero e Abbigliamento s.p.a, C. Sandroni & C. s.r.l., Linificio e Canapificio Nazionale s.p.a, Felli Color s.p.a, Mascioni s.p.a, Cittadini s.p.a, Stazione Sperimentale per la Seta, Tessitura Enrico Sironi s.a.s, Università di Torino, Università di Bergamo.

Phages - the natural viral enemies of bacteria

The problem

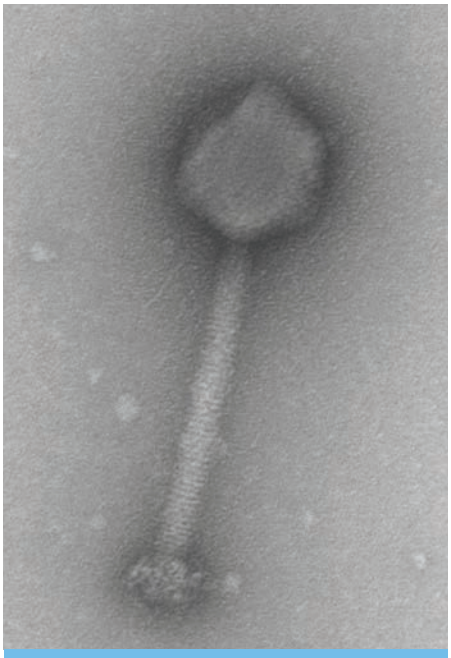
Certain bacteria are causative agents of life-threatening infections and represent a serious hazard worldwide for weak persons, immunocompromised or hospitalised people, young children and the elderly. Simple and fast methodology is required to help fight against or identify such pathogens.

Original, many decades old ampoules containing therapy phage preparations. They were transferred to the DSMZ by the Eliava Institute

a) The “best” example is the global dramatic increase of multiresistant MRSA (Methicillin Resistant *Staphylococcus aureus*) causing incredible numbers of nosocomial infections.

b) *Bacillus anthracis*, causative agent of anthrax, does not represent a global problem like MRSA, but infections can be deadly. There is a very high species number within the genus *Bacillus. B. anthracis* and *B. cereus* are so closely related (“cereus group”) that misidentification of strains of both species must be excluded, a problem also for culture collections.

c) The species *Escherichia coli* has non-pathogenic members derived from the widely used K-12 or from other harmless strains, whereas the “normal” *E. coli* is a slightly pathogenic faecal bacterium. However, verotoxin producers of the EHEC group (enterohemorrhagic *E. coli*) are highly dangerous members of the species.



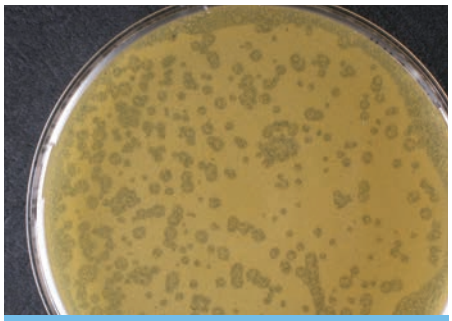
Electron micrograph of a Sb-1-like new potential therapy phage

The solution

Phages are the natural viral enemies of bacteria and can be found for all bacterial species. They represent the most abundant living entities on earth, among them there are specific phages against pathogens.

The value of such phages cannot be overestimated, they may be used as natural, cheap, reliable and fast therapeutic or typing agents in the fight against drug-resistant or otherwise harmful bacteria.

a) The therapeutic potential of staphylococcal phage Sb-1 against hospital MRSA has been demonstrated; Sb-1 was even successfully applied intravenously. In a research cooperation with the Eliava Institute, Tbilisi, Georgia, the DSMZ tested Sb-1 against large numbers of clinical MRSA. The high effectivity of Sb-1 in eradicating MRSA cells was verified.



Plaque photo of gamma

b) Phage *gamma* (DSM 10069) is highly specific for *Bacillus anthracis* and is therefore an indicator phage for distinguishing *B.anthracis* from *B.cereus.*

c) To differentiate harmless K-12 from other *E. coli* strains in a quick phenotypic test, phage U3 (DSM 8986) that is specific for *E. coli* K-12 can be used.

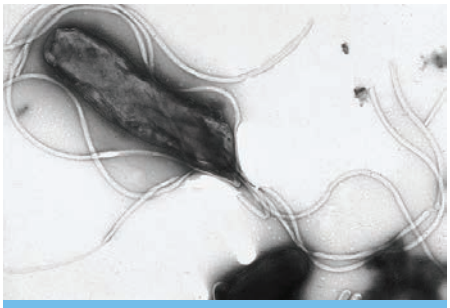
Plaque photo of U3

Photos courtesy of DSMZ and HZI, Germany

Probiotic identified to treat ulcers

The problem

Helicobacter pylori is considered one of the major risk factors underlying the development of gastritis and gastric and duodenal ulcers. Moreover, 50% of the population carry this bacterium, and consequently, when it is detected, eradication of *H. pylori* is strongly recommended. However, antibiotic-based treatment for *H. pylori* infection is neither sufficient nor satisfactory, with the most successful treatments reaching 75 to 90% eradication rates. The use of probiotics is a potentially promising tool to prevent *H. pylori* infections.

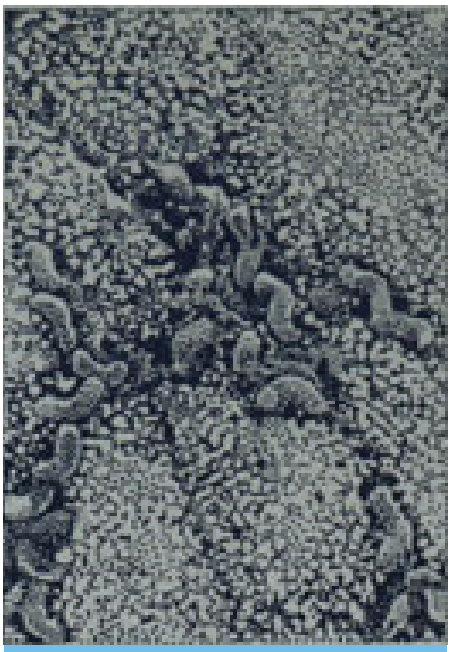


Electron micrograph of *Helibacter pylori* possessing multiple flagella (negative staining)

The solution

Researchers from two Spanish biotech companies (Biópolis S.L., Valencia, and Corporación Alimentaria Peñasanta, Asturias) have selected a strain of probiotic bacteria that may be useful in treating ulcers caused by *Helicobacter pylori.*

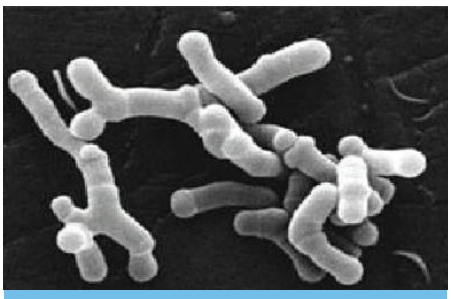
According to an expert consultation conducted by the Food and Agriculture Organization and the World Health Organization probiotics are 'live microorganisms which when administered in adequate amounts confer a health benefit on the host'. The regular intake of probiotic microoganisms has been demonstrated to prevent several disorders including diarrhea and inflammatory bowel disease.



Helicobacter pylori in peptic ulcer disease

Among probiotics *Bifidobacterium* is one of the favorite genera in studies focused on the prevention of gastrointestinal infection and is often used in fermented dairy products or food supplements. Chenoll et al. (2011) tested numerous strains of bifidobacteria isolated from the feces of breast-fed infants for activity against *H. pylori*. They identified one strain (*Bifidobacterium bifidum* CECT 7366) that under certain conditions had an inhibition level of nearly 95% in vitro and tested its activitity against infection in mice.

After 21 days, mice treated with the potentially probiotic strain developed significantly fewer ulcers than the control group. Additional tests suggest that treatment partially relieved damage to gastric tissue caused by *H. pylori* infection. Ingestion of the bacteria did not induce any disease or mortality in both healthy and immunocompromised mice. The results demonstrated that *Bifidobacterium bifidum* CECT 7366 can be considered a probiotic able to inhibit *H. pylori* both *in vitro* and *in vivo*. Human clinical trials must be performed before commercialization of this strain can be approved.



Cells of bifidobacteria

Chenoll E, Casinos B, Bataller E, Astals P, Echevarría J, Iglesias JR, Balbarie P, Ramón D, Genovés S. Novel probiotic ***Bifidobacterium bifidum*** *CECT 7366 strain active against the pathogenic bacterium* ***Helicobacter pylori****. Appl Environ Microbiol. 2011 Feb;77(4):1335-43.*

Anticancer medicine/drug developed from myxobacterial metabolite

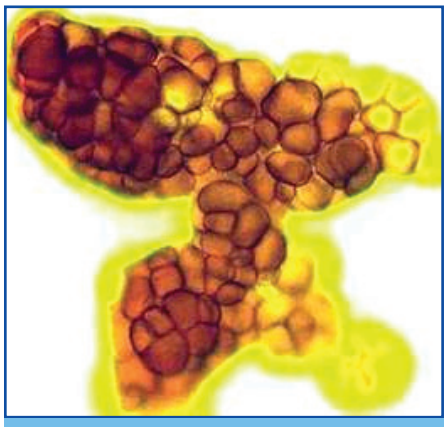
Problem

The fight against cancer diseases is still on. Apart from surgical and radiation measures, chemotherapy is one weapon of medicine against wildly proliferating cells. The problem is to find drugs which inhibit or kill cancer cells without damaging the healthy tissue too much.

Solution

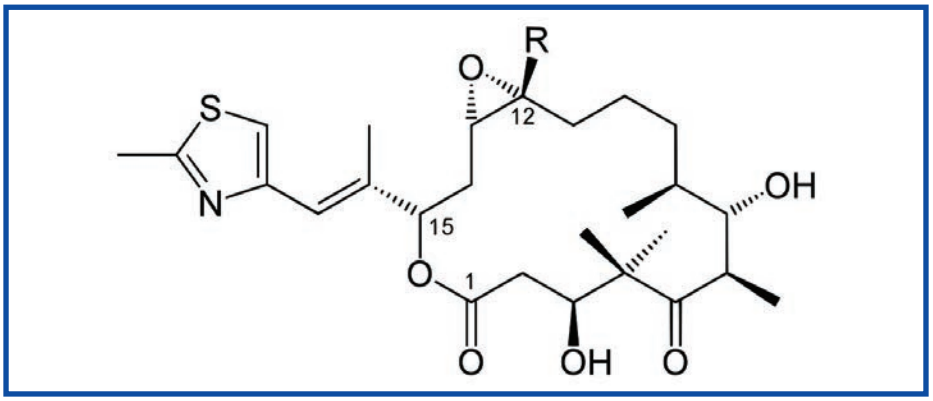
Myxobacteria – members of the order Myxococcales – have been found to produce various secondary metabolites of yet unknown structure and properties. The chemical structure of the compounds is divers covering mainly peptides and polyketides or a combination of both, but also lactams, aromatics, polyethers and alkaloids are produced. A high percentage of these compounds show distinct effects on other microorganisms, or plant or animal tissues. As the production of these metabolites is strain dependent collections of myxobacterial strains are useful treasure chests for screening aiming at finding novel bioactive compounds. For that reason, the DSMZ took in an endangered collection of 4500 myxo-strains from Hans Reichenbach. At that time, this number constituted more than 20% of the overall holdings of the DSMZ collection.

During such screening in the 1980's, compounds from a *Sorangium cellulosum* strain attracted attention by their antifungal activity. Because of their strong toxic effects against plant cells these metabolites, macrolides, and their derivatives were excluded from development as fungicides for agricultural applications. However, when it was detected that the cytotoxic effects of the so-called epothilones is due to their inhibition of the proper de-polymerization of the microtubules the second career of this group of metabolites began. If the microtubules of eukaryotic cells cannot work properly cell division is stopped and cell apoptosis is started resulting in cell death. Since cancer cells divide more rapidly the adverse activity hits cancer tissue much more heavily than healthy tissue, hence the therapeutic benefit. Meanwhile, many derivatives of the epothilone family were and still are designed in silico and in vitro and tested in (pre)clinical trials in order to minimize the adverse effects to patients. Total chemical synthesis and biofermentation of the best candidates compete for low production costs. One epothilone derivative passed successfully all medical trials and is now on the market to fight breast cancer – even those variants already resistant to other antitumor drugs.



Fruiting bodies of *Sorangium cellulosum* embedded in agar
© Gerth/helmholtz-hzi.de

With the epothilone structure as the template the development of drugs effective against other variants of cancer continues. This example underpins the role of culture collections as a valuable resource of microbial producers of bioactive compounds, and the necessity to collect and cultivate high numbers of strains, even if they belong to one species.



Epothilone A (R = H) and B (R = CH3), respectively

Bacteria as a meter – Detection of toxic compounds by the Luminescence Test

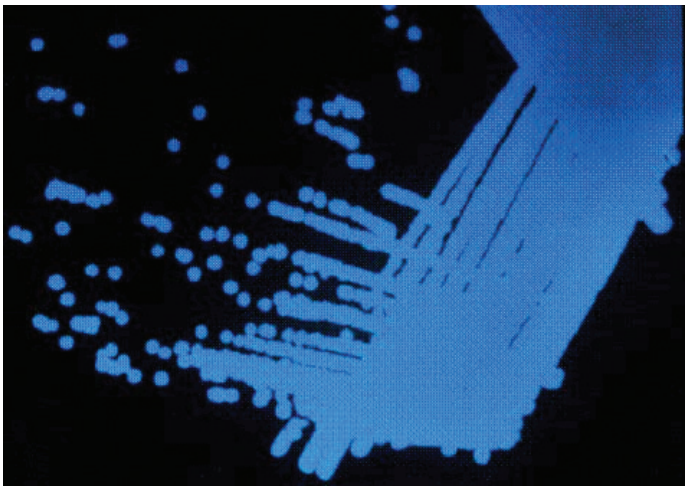
Problem

Through the release of effluents and sewage, surface and groundwater may receive toxic substances. In order to avoid adverse effects, waters must be monitored for the incidence of toxic compounds, however the number of animals (such as fish) being observed under these circumstances should be kept as low as possible.

Solution

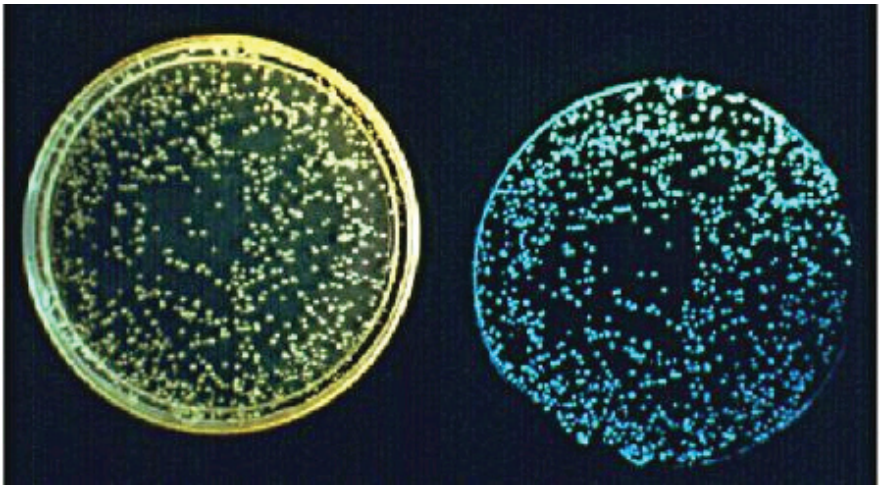
Instead of fish, a bacterium: *Vibrio fischeri* NRRL B-1117, was selected as the target organism. In order to minimize measurement expenses and the period of testing a luminescence test was developed based on the metabolic activity of *Vibrio fischeri*. These bacteria emit light when metabolically active. Toxic substances in a water sample tested will reduce light emission hence indicating a possible hazard to other water organisms.

The prerequisite for this test is the maintenance of the test strain under conditions ensuring genetic stability and the availability of the test strain without restrictions. Culture collections are the sole institutions which are able to retain strains stably for the long-term. Even companies offering ready-to-use preparations of these specific bacteria rely on culture collections as a back-up for their test cultures.



Colonies of *Vibrio sp.* on an agar plate, photo taken in the dark.
(http://1.bp.blogspot.com/_S5dFdpF6xm0/S8cmrJtPEEI/AAAAAAAABJ0/IyMZjSpeoeE/s1600/Vibrio_harveyi_bio-luminescence_quorum_sensing.jpg)

Vibrio fischeri colonies on an agar plate (©The University of Oklahoma)
Left: in day light. Right: in the dark.



Ensuring improved pathways to discovery for the future

Europe is laying down the foundation for a major push to harness biodiversity in its battle to overcome natural resource depletion and reduce our impact on the environment through the European Strategy Forum for Research Infrastructures (ESFRI) which establishes pan-European structures to drive innovation and provide the resources, technologies and services necessary to underpin research.

The European Consortium of Microbial Resource Centres (EMbaRC) in collaboration with the Global Biological Resource Centre Network (GBRCN) and the European Culture Collection's Organisation (ECCO) played a major role in ensuring the Microbial Resource Research Infrastructure (MIRRI) is one of the thirteen research infrastructures ESFRI has launched in the biological and medical science area.

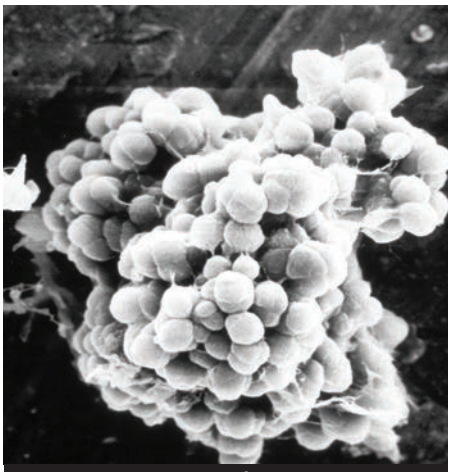
www.mirri.org

The ESFRI strategy recognises the weakness of fragmented individual policies and supports a coherent strategy on research infrastructures in Europe, which facilitates multilateral initiatives and provides Europe with the most up-to-date Research Infrastructures (RI).

Science frontiers are evolving and knowledge-based technologies need to be used more widely. In the microbial area, the OECD Biological Resource Centre initiative (1999 to 2006) proved important in providing frameworks for best practice and biological resource networking. Now MIRRI will integrate services and resources, and encourage innovative solutions. It will provide coherence in the application of quality standards, homogeneity in data storage and management, and workload sharing to help scientists release the potential of microorganisms.

MIRRI brings together European microbial resource collections with users, policy makers, potential funders and the plethora of microbial research teams. It aims at improving access to enhanced quality microbial resources in an appropriate legal framework. It will build the European platform for microorganisms within the future Global Biological Resource Centre Network (GBRCN).

Biological Resources, such as microorganisms and their derivatives, are the essential raw material for the advancement of biotechnology, human health and the Life Sciences. All 66 microbial resource centre members of the European Culture Collections' Organisation in the 26 European countries are included in the initial consortium of collaborators alongside the project consortia of EMbaRC and GBRCN.



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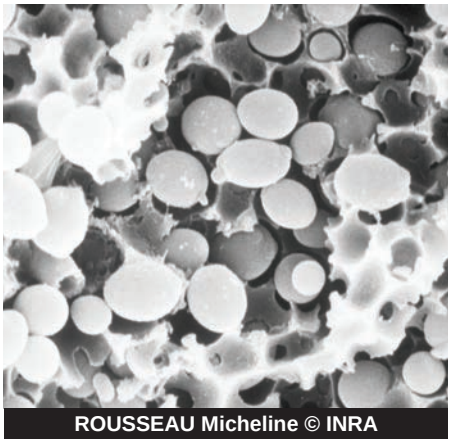

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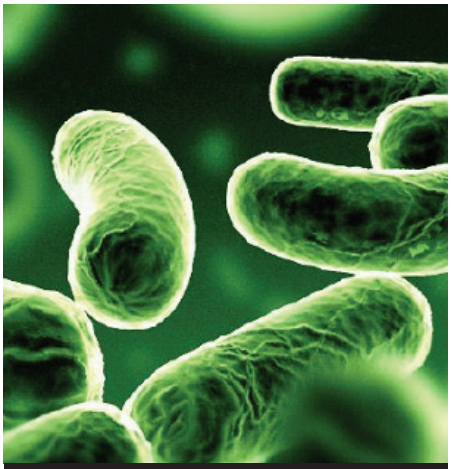

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MIRRI will enhance existing European microbial collections linking them to non-European country partners globally and will bring added value through:

- Networking of the partners allowing access to a wider range of bioresources and services.
- A co-ordinated approach to coverage of organisms, the expertise to handle them and the mechanisms to ensure best practice in the provision of the resources and services.

MIRRI will also tackle key obstacles to research in a co-ordinated way and will improve the provision of services beyond what is currently supplied by individual microbial resource collections through:

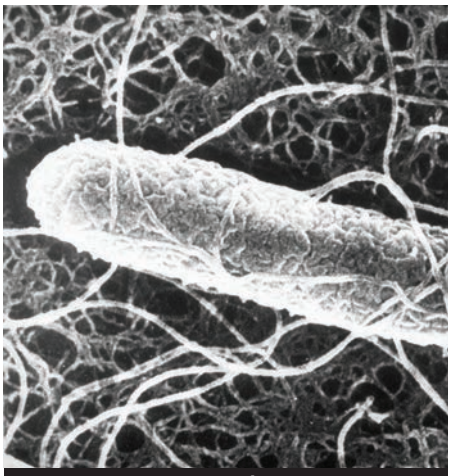
- Bringing together working groups to focus on delivery of resources that meet specific needs
- Implementing common policies that work across international boundaries to improve access
- Establishing facilities and resources in countries or regions rich in microbial diversity but without resources to make them readily available for research
- Linking to data in other systems relevant for data mining
- Enabling the targeting of specific microbial resources for specific tasks
- Establishing common operational procedures within the existing legal framework for easy yet legitimate and safe access
- Addressing areas where there is a shortage or fragmentation of expertise; for example a distributed platform for microbial taxonomy can be established.

MIRRI will focus efforts through a cluster model to improve resources to meet user needs. Close cooperation with other Research Infrastructures such as the Biobanking and Biomolecular Resources Research Infrastructure (BBMRI) that have different user groups, will serve the broad scientific user communities. MIRRI will support the efforts of the World Federation for Culture Collections (www.wfcc.info) and its World Data Centre for Microorganisms (www.wfcc.info/wdcmdb) adding value and quality.

User demands are varied and cannot normally be serviced by one collection alone; a co-ordinated response to their needs is required. International co-operation will provide:

- enhanced access to information and biological material
- co-ordination of operational procedures in delivery of quality
- linkage between scientific needs and government policies
- frameworks for regulation
- linking mechanisms for countries without BRCs
- enhanced efficiency and reduced redundancies
- improved transparency.

EMbaRC is playing a key role to enable further success arising from the conservation, characterisation and use of microorganisms held and supplied by mBRCs.



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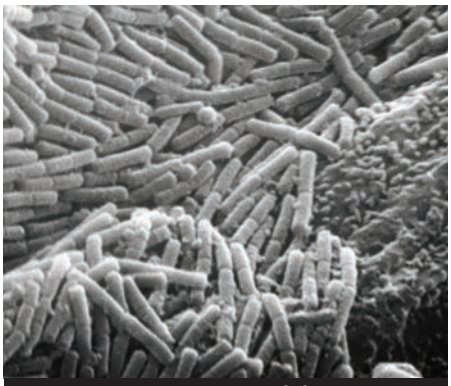

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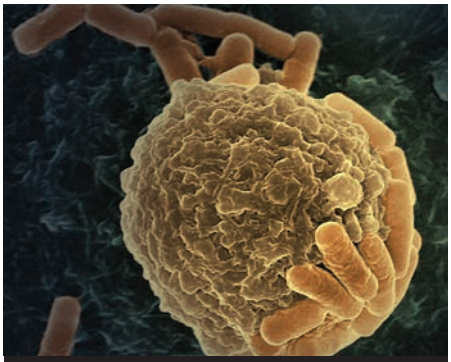

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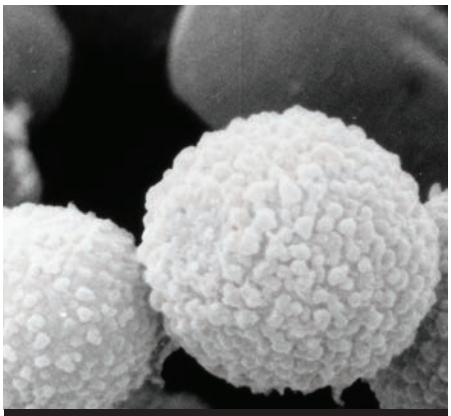

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www.mirri.org
www.wfcc.info
www.wfcc.info/wdcmdb

Partners

BRC	Partner	Holdings
CIRM	Institut National de la Recherche Agronomique, INRA embarc@rennes.inra.fr www.international.inra.fr/crb-cirm	Yeasts (CIRM-Levures) Filamentous fungi (CIRM-CF) Food bacteria (CIRM-BIA) Animal or human pathogenic bacteria (CIRM-BP)
CRBIP	Institut Pasteur, IP embarc@pasteur.fr www.crbip.pasteur.fr	Bacteria Fungi Viruses (class 2 and 3)
DSMZ	Deutsche Sammlung von Mikroorganismen und Zellkulturen GmbH, DSMZ joo@dsmz.de www.dsmz.de	Micro-organisms Human and animal cell lines Plant cell lines Plant viruses
CABI	CAB International Europe d.smith@cabi.org www.cabi.org	Filamentous fungi and yeasts Plant pathogenic bacteria; Nematodes Biocontrol agents belonging to these groups
CECT	Universitat de València-Estudi General, UVEG esperanza.garay@uv.es www.cect.org	Bacteria Filamentous fungi and yeasts
MUM	Universidade do Minho, UMinho micoteca@deb.uminho.pt www.micoteca.deb.uminho.pt	Fungi
CBS	Koninklijke Nederlandse Akademie Van Wetenschappen, KNAW g.verkleij@cbs.knaw.nl www.cbs.knaw.nl	Fungi (filamentous fungi and yeasts) Bacteria, Plasmids, Phages DNA libraries, DNA (from CBS strains)
BCCM/ LMBP & BCCM/ LMG	Universiteit Gent, UGent bccm.lmbp@dmbr.ugent.be bccm.lmg@ugent.be www.bccm.belspo.be	Plasmids and DNA libraries (BCCM/LMBP) Bacteria (BCCM/LMG)
BCCM/ MUCL	Université Catholique de Louvain, UCL bccm.MUCL@uclouvain.be www.bccm.belspo.be	Filamentous fungi and yeasts Arbuscular mycorrhizal fungi
SPP-PS	Service Public Fédéral de Programmation Politique Scientifique, SPP-PS depa@belspo.be www.bccm.belspo.be	
	Non-partners	
MUT	Università degli Studi di Torino, Dipartimento di Biologia Vegetale cristina.varese@unito.it	Filamentous fungi and yeasts

Glossary

BRC - Biological Resource Centre
mBRC – microbial domain Biological Resource Centre
CABRI - Common Access to Biological Resources and Information
EBRCN – European Biological Resource Centre Network
ECCO – European Culture Collection Organisation
EMbaRC - European Consortium of Microbial Resources Centres
ESFRI - European Strategy Forum for Research Infrastructures
GBRCN – Global Biological Resource Centre Network
MIRRI – Microbial Resource Research Infrastructure
OECD – Organisation for Economic Cooperation and Development
WFCC – World Federation for Culture Collections

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