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Committee Secretary
House of Representatives
Standing Committee on Primary Industries and Regional Services
R1 110
Parliament House
CANBERRA ACT 2600
AUSTRALIA

Dear Sir/Madam

please find enclosed a submission from the Australian Society for Microbiology to the House of Representative Standing Committee on Primary Industries and Regional Services Inquiry into the Regional Development of Bioprospecting Industries.

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A
Submission to the House of Representative Standing Committee on Primary Industries and Regional Services Inquiry into the Regional Development of Bioprospecting Industries

Bioprospecting in Tasmania – A case study

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Executive Summary

Bioprospecting activities undertaken in Tasmania are highlighted by two case studies, Antarctic microbial biodiversity and the development of alternative commercial sources of polyunsaturated fatty acids.

Bioprospecting activities in regional Australia are possible and deliver significant social and economic benefits through the establishment of core research groups in regional areas.

However funding for basic research is crucial to deliver the research outcomes necessary for commercialisation.

Further issues of access, ownership and benefits from the natural resources required for bioprospecting must be defined and hopefully standardised.

Lastly, while research institutions are good at what they do, they require assistance in the development and management of biotechnology outcomes.

Antarctic Microbiology

Antarctica is often thought of as a frozen wasteland. Indeed most (98%) of the Antarctic surface is a frozen sheet of ice, practically devoid of life. However, in those areas where liquid water may be found permanently (salt lakes) or seasonally (within soils in the summer), there are complex microbial communities. Micro-organisms living in these ecosystems have to cope with a variety of physical extremes that characterise the Antarctic environment. Likewise the Southern Ocean surrounding Antarctica teems with microbial life, which supports the basis of the Southern Ocean food chain.

Our research group began antarctic microbiology studies in 1986. This work was funded by Australian Research Council (ARC) competitive grants, including the award of 3 Large Grants, 4 ARC Fellowships and 3 Small Grants (~$555,000 since 1993). The aims of the research were to study the diversity of microbial life in Antarctica and to examine evolutionary adaptations to life in cold environments. This work demonstrated that Antarctic microbiota have a high degree of endemism, possibly due to their isolation and the selective pressures exerted by such a harsh environment. Since 1986, the group has described six new genera of bacteria and over 30 new bacterial species from Antarctica and the Southern Ocean.

To conserve this novel biodiversity, we established the Australian Collection of Antarctic Micro-organisms (ACAM). ACAM is affiliated with the Australian Federation of Culture Collections and the World Federation of Culture Collections. It is the only publicly accessible collection of microorganisms dedicated to strains isolated from the Antarctic continent, subantarctic islands and the Southern Ocean. It currently holds about 300 isolates of heterotrophic bacteria. Many of the Antarctic bacteria in international collections originate from ACAM.

Culture collections are important repositories of microbial biodiversity, and are essential for the long-term availability of authentic strains and their genes. They are also a key source of taxonomic expertise, expertise in the long-term preservation of strains, and organisms for biotechnological research. Considerable resources are required for the procurement of Antarctic bacteria. Unfortunately, because of a lack of funding, public culture collections generally hold only type strains of identified species rather than groups of strains or even unidentified strains. This limits the biodiversity present in collections and largely restricts researchers to working only with described species.

Our research into the microbial populations present in such a novel environment has achieved three key bioprospecting/biotechnological milestones:

- characterisation of Antarctic and Southern Ocean environments as microbiologically highly biodiverse
- identification of polyunsaturated fatty acid production as an adaptation to low temperature growth
- identification of cold active enzymes as an adaptation to low temperature growth

Our experiences with commercialising the first two of these areas are outlined below. We have only just begun to examine commercialising our research into cold active enzymes.

Our group has also begun an examination of the microbial diversity on Macquarie Island (a sub-Antarctic Island) and has also recently begun small-scale projects looking at temperate terrestrial environments and estuarine systems in Tasmania. Our preliminary results indicate that these areas are also microbiologically highly biodiverse and represent productive areas for future bioprospecting activity.

Bioprospecting in Antarctica (a success story)

The screening of microbial natural products continues to represent an important route to the discovery of novel bioactive and therapeutic chemicals. Of increasing interest is the evaluation of the potential of lesser-known and/or new microbial taxa. There is, therefore, an opportunity within Australia to make important contributions in the field of drug discovery through the acquisition and screening of Antarctic and other novel microbiota.

In 1995 the Antarctic CRC entered into a commercial agreement with ExGenix Operations, (formerly AMRAD Discovery Technologies) - a Melbourne based pharmaceutical discovery company - for the supply of Antarctic micro-organisms for pharmaceutical screening. ExGenix was established to investigate Australian biodiversity for pharmaceutical purposes. The objective of the company is to discover novel, pharmaceutically-active compounds for development as new medicines. ExGenix plans to achieve this aim through screening of natural product libraries against biological targets of major human diseases. We are jointly developing selective isolation protocols with ExGenix for the detection and isolation of rare and novel micro-organisms from the Antarctic environment.

The initial three-year contract has turned into an eight-year (and ongoing) partnership that has resulted in the creation of a culture collection containing over five thousand Antarctic microbial isolates. It has also injected considerable resources into the research program–with one million dollars of industry funding for Antarctic microbiology bioprospecting and biotechnology being obtained since 1997.

Summary

The Antarctic ecosystem represents one of the most undescribed extreme environments available to researchers of microbial diversity and ecology.

Ongoing industry partnership.

Culture collection of over 5,000 Antarctic micro-organisms.

Core group of researchers and knowledge retained in the group.

One million dollars of industry bioprospecting and biotechnology funding obtained for a regional economy since 1997 .

Polyunsaturated Fatty acids (opportunity on hold)

Our research into the adaptation of bacteria to the cold Antarctic environment led to the discovery that a group of previously unknown Antarctic bacteria produce PUFA to maintain the fluidity of their cell membrane at low temperature. In particular they produce Eicosapentaenoic Acid (EPA) and Docosahexaenoic Acid (DHA). These PUFA are essential dietary requirements for higher animals - including humans - and are in high demand for use as human neutraceuticals (health supplements) and additives to animal feeds, particularly for the aquaculture industry. The traditional sources of EPA and DHA are wild caught fish oils, and to a lesser extent cultured microalgae. The discovery that bacteria and some other protists produce PUFA has resulted in commercial interest in the production of PUFA from these alternative sources.

Our ARC-funded basic Antarctic research had resulted in:

- a bioresource of PUFA-producing micro-organisms
- partial purification of the enzymes involved in PUFA production
- pilot stage development of a system of *in vitro* PUFA production
- cloning and sequencing of some of the genes required for PUFA production

Because of rapidly increasing awareness of the health benefits of PUFA and our research indicating the existence of a renewable (microbial) source of PUFA, we believed as early as 1997 that we

were in a strong position to commercialise certain aspects of our research. Negotiations were held between the Antarctic CRC and several investment groups. One firm offer of capital was made to the CRC Board, but a partner in the CRC joint venture perceived unacceptable levels of risk and liability and the negotiations ceased. Subsequently, the impetus to commercialise was slowed until issues of IP ownership were resolved. Work in this research area has also been brought to a halt due to cessation of ARC support. While ownership is now clearly defined, the interruption of focussed research resulted in less than satisfactory progress, while highly skilled staff were diverted to other projects which were able to obtain continued funding.

Summary

Strong background in polyunsaturated fatty acid (PUFA) research.
Unique discovery of in vitro PUFA production.
Offers of investment from venture capital sources.
Confusion about IP ownership.
Loss of ARC funding at a critical point.
Research area loses priority.
Poor handling by University administration.
Commercialisation not yet achieved.

Issues and Recommendations

We have highlighted these two studies to illustrate both the success and frustration of biodiversity /bioprospecting research.

The first, Bioprospecting in Antarctica, required protracted negotiations with Federal Government Departments, before the contract with ExGenix Operations could be signed. The subsequent association has been long and productive and has injected >$1M into a regional economy. The model adopted was low risk for the research institution, in that finance was produced in advance to meet quota requirements (which the researchers consistently achieved). This satisfied the major objective of maintaining an active and productive research group with an international reputation in Antarctic microbiology and biotechnology. Bonuses are the return of cultures (potentially valuable for other purposes) at the end of the contact, and royalty returns if a successful pharmaceutical is developed. However the risks of achieving the latter are borne by our commercial partner.

The second, Novel Microbial Sources of PUFA, was perceived by the University/CRC as being inherently riskier as the research had not been finalised and the research outcomes could not be guaranteed. This highlights a dichotomy in attitude between Universities, who are used to selling guaranteed services/products, and venture capitalists, who are looking for investments with manageable risks. The failure to obtain further ARC funding to complete the research has effectively halted the commercialisation.

Together our case studies illustrate impediments to the growth of bioprospecting in Australia, which we identify as:

- lack of funding for basic research
- difficult access to natural resources
- uncertain ownership of those resources
- inequitable sharing of benefits from natural resource exploitation
- slow development of entrepreneurial skills in biotechnology management by research institutions
- lack of sources of pre-seed funding for proof of concept or product development

Impediments to Growth

Funding for Basic Research

Sustained funding for basic research is a crucial foundation for research outcomes for commercialisation. Perhaps more importantly, sustained funding for basic research is essential if research groups are to build and maintain a critical mass of world-leading researchers in regional/rural areas. Our commercial success with bioprospecting in Antarctica arose from ARC funded basic research into the microbial ecology of Antarctica. The success we had in obtaining continued ARC funding from 1986 till 1998 enabled us to keep the group together and focused on this area of research. The failure to commercialise the PUFA research that was ARC-funded up to the point of commercialisation demonstrates that interruptions to funding prior to commercialisation can easily derail promising commercial opportunities.

Uniform Guidelines for Access and Benefit Sharing

Bioprospecting relies on sustainably collecting material from the environment. Negotiating access and benefit sharing (e.g. royalty stream) agreements with all the parties involved in the particular environment can and does take considerable time. For example, it took two years of negotiation, including a ruling from the Attorney Generals Department on Australia's responsibilities under the Madrid Protocol, before we could commence bioprospecting in Antarctica.

There is a clear need for uniform guidelines covering all of Australia for access and benefit sharing. The Federal government has begun this process for Commonwealth areas (details) but the States and Territories also need to address this problem.

Office for Biodiversity/Bioprospecting

The ABRS currently funds basic research in the documentation of Australian biodiversity. Yet, as detailed above, major hurdles are present under the framework of University–driven commercialisation management. The Standing Committee may wish to consider the potential expansion of an ABRS-like activity to include an effective prospectus for bioprospecting research in Australia and for the investment community. In particular it would be valuable for such a structure to provide an initial interface between research organisations and commercial partners and to provide pre-seed funding

- biotechnology registry (help in linking research organisations with potential investors)
- managerial support (initial interface between research organisations and commercial partners)
- pre-seed funding (proof of concept, product development funding for technologies deemed to have commercial potential)

Rural and Regional Opportunity

Our group has successfully established an ongoing, commercially funded, bioprospecting project in a regional centre. Other attempts at commercialisation have not been hampered by our location. Indeed, we view biotechnological industries as a real opportunity for rural and regional areas. The products of such industries are usually small, high value commodities - so transport costs are a relatively minor component of the cost of manufacture.

Impacts and Benefits to the Environment

Collecting samples for microbial bioprospecting has minimal negative environmental impact. Samples collected are typically small (10-20g of soil, 5-10g of other material) and any industrial application uses the micro-organisms isolated and cultured in the laboratory, so there is no need to continually harvest from the natural environment.