Submission regarding the inquiry into the development of high technology industries in regional Australia based on bioprospecting.

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Terms of reference

This submission addresses the terms of reference for the inquiry with specific regard to the opportunities for the development of high technology industries in the Illawarra Region based on marine bioprospecting. Reference is made to some exciting new research being undertaken by the Marine Bioprospecting Initiative at the University of Wollongong and proposals to develop SEAlab, the South East Australian laboratory for marine & coastal research. Rather than repeating information that has already been provided to the inquiry from other organizations, this submission refers to the other submissions where relevant.

(1) The contribution towards the development of high technology industries based on bioprospecting, bioprocessing and related biotechnologies.

Opportunities for marine bioprospecting in temperate Australia

As pointed out in the submission from the South Australian Government, the temperate marine waters of Australia support some of the highest levels of biological diversity and endemism in the world. However, the only real center for marine bioprospecting in Australia is situated in the tropical waters of northern Queensland (AIMS). Although some bioprospecting is being undertaken on specific groups of marine organisms in temperate waters (e.g., Porifera, Assoc. Prof. Rob Capon, University of Melbourne & Dr Peter Karuso, Macquarie University, marine microorganisms, Antarctic CRC), there is **no temperate Australian marine institute**, which offers similar opportunities to those provided by AIMS.

The most important advantage of the AIMS bioprospecting project is the coordination of taxonomic and ecological information, with biological screening programs and chemical studies. Optimal resource management for bioprospecting activities requires extensive and accurate field collection data to be stored along with well preserved specimens. Maintenance of an accessible bioinformatics database is necessary to maximize benefits for future research projects. Currently, the biological information from bioprospecting activities in temperate marine waters is not coordinated or maintained. Representative samples and associated information can be lodged in established institutes, such as the Australian Museum. However, the Australian Museum is still in the process of cataloguing it's existing collection and this database is not necessarily

in the most useful format for students and other researchers involved in bioprospecting in regional areas. Support for **regionally based collections** would facilitate rapid access to information and type specimens from relevant field sites.

The SEAlab proposal
The University of Wollongong is proposing to establish a major research, development and training facility on the south coast of NSW, with a focus on temperate marine and coastal environments. This research facility would be known as the South-Eastern Australian Laboratory (SEAlab) for ocean and coastal research and would be the first of it's kind in NSW. The SEAlab proposal is aimed at having a major regional economic impact through targeted research, development and consultancy programs. One primary area of research focus is bioresources from the local temperate marine flora and fauna. Similar to AIMS, the SEAlab could provide opportunities for maintaining an extensive collection database, as well as combining the fundamental biodiversity /ecological research, with bioprospecting and aquaculture. The proposed facility is strategically placed to develop into a center of excellence for research into the development of novel temperate marine resources.

Promising leads from the Marine Bioprospecting Initiative
Recent research undertaken at the University of Wollongong has identified several temperate marine organisms with great potential for bioresource development. In particular, a potent new antibiotic has been identified from the common mollusc *Dicathais orbita* (Benkendorff *et al*., 1999). AMRAD, along with the University of Wollongong are currently sponsoring a further Ph.D. project to chemically synthesize the antibiotic and a range of related compounds. As made clear in previous submissions to this inquiry, the high technology aspects of product development, such as chemical synthesis, are probably most suitably located in cities with existing research infrastructure. However, the submission by AIMS makes a very important point; which is that **there must be a commitment to identifying the most economic methods for supply** and quite often, natural biosynthesis followed by extraction and purification is the best option. Consequently, bioprospecting can lead to the development of bioprocessing industries that are more suitably located in regional areas.

This can be illustrated by our own research on the *Dicathais orbita* antibiotic. Chemical synthesis of this compound requires multiple steps, making it too expensive for commercial scale synthesis. But more importantly, it has not been possible to artificially replicate the high level of antibiotic activity observed in the natural product. This is due to the fact that artificial synthesis results in two inseparable steroisomers, where as only the most active stereoisomer is naturally synthesized. *Dicathais orbita* produces large quantities of the antibiotic under natural conditions and thus is a good candidate for controlled harvest and/or aquaculture. Consequently, this species could become the subject of a new "high value" fishery and bioprocessing industry on the NSW south coast, by

utilizing and expanding the existing infrastructure. After extraction and purification, the natural antibiotic has potential to be marketed directly or sold as a starting material for further chemical modification.

Dicathais orbita also holds potential for the development of several other bioresources including, an insoluable purple dye, a muscle relaxant, a glue and possibly even a biodegradable plastic (Benkendorff 1999a). Furthermore, there is an extensive overseas market for the shells and meat of species in the same family as *Dicathais* and some of these are currently threatened from overharvesting. Consequently, *Dicathais orbita* is a good example of a under-utilised Australia resource and provides a window of opportunity for regionally based fisheries and production industries.

Other promising leads from the local marine environment include antimicrobial extracts from the Turban snail *Turbo torquatus*. This species is currently subject to a fishery in NSW waters for it's meat, but there remains the potential to greatly value add the derived products. Further research into the medicinal properties of Turban snails could be used to promote the existing fishery by marketing the health benefits of this species and could also lead to the development of new pharmaceuticals and/or natural health products. As noted in the submission from the Northern Territory Government, the overseas "alternative medicine" market, has been estimated as being worth in excess of $10 billion per annum and is undoubtedly one potential area for regional economic development. The natural health industry relies on bioproduction and therefore represents an amalgamation of the high technology bioprospecting and bioprocessing activities, with sustainable harvesting and/or farming practices. As mentioned already, the production and processing of these types of biological products can be feasibly located in regional areas. High value products can be obtained through relatively small-scale operations. Financial returns are also likely to occur much sooner when compared to the time required to develop a product for the pharmaceutical market.

The Illawarra Region – local advantages

The Illawarra region has rapidly growing population and is in urgent need of economic diversification to create jobs and attract investment opportunities. The value of establishing centers of research excellence based on bioprospecting has already been demonstrated in several of the submissions to this inquiry, but the best example is the Cellulose Valley project associated with Southern Cross University, which has already generated 70 new jobs in the region and is expected to generate over 1000 in the next ten years (submission from Southern Cross University).

Additional benefits of locating new marine bioprospecting-based industries on the Illawarra Coast include a high quality of life and proximity to the pristine and biologically diverse waters in and around the Jervis Bay Marine Park. There are significant benefits in locating good research facilities in proximity to well

managed areas of high biodiversity, such as the JBMP. Some of these benefits have already been highlighted in the submissions to the inquiry from AIMS and Ecobiotics. It can be further noted that minimizing the time between the collection and processing of biological samples will reduce potential problems associated with the degradation/ decomposition of the samples.

The Illawarra region already supports several innovative environmental and technological industries (e.g. SWERF, tea tree bioremediation plantation), in addition to the extensive infrastructure and knowledge base associated with the University of Wollongong. Furthermore, the Illawarra region is within reasonable distance to large urban centers and the city of Sydney where most biotechnology based industries are currently located.

(2) Impediments to the growth of high technology industries based on these industries.

Natural history databases
Several other submissions into the inquiry have highlighted the taxonomic impediment to the growth of bioprospecting (e.g. The Royal Society of Western Australia, AIMS). Indeed taxonomic and systematic research is the primary basis for all bioprospecting activities. However, the relevance of natural history and ecology should also be highlighted. Environment Australia points out that a major impediment to bioprospecting is not knowing the extent of Australia's biodiversity or where a particular species may be located. Knowledge of how organisms function in their natural environment can also provide a foundation for biodiscovery by enabling researchers to target those species that are most likely to yield an appropriate natural product. Ultimately, this approach to the discovery of novel bioresources should help narrow the field of search to manageable proportions and increase the likelihood of discovering useful products. To address part of this problem, Environment Australia and Biotech Australia are supporting the establishment of the Australian Virtual Herbarium. However, no equivalent project has been proposed for our diverse marine flora and fauna.

Research & development infrastructure
Bioprospecting and bioprocessing industries can deliver significant social and economic benefits to regional Australia, however, this depends on the establishment of core research groups with adequate facilities in regional areas. As already mentioned there is currently no facility dedicated to marine research on the South East coast of Australia, although we hope to rectify this problems through our SEAlab proposal.

Funding
The Australian Institute of Marine Science has already pointed out the lack of funding available for the early phase of the bioprospecting process and we also perceive this as a serious impediment. The Governments Biotechnology

Innovation fund will clearly not fund the biodiscovery stage of bioprospecting, or research facilities and infrastructure - it specifically applies to advancing research to the commercialization stage. Applications for funding Centers of Excellence in bioprospecting are also likely to be disadvantaged because of their necessary interdisciplinary nature. For example, the focus for the Biotechnology Innovation Fund is on biotechnology and consequently the taxonomic/ecological/natural history side of bioprospecting may not be considered relevant.

Funding for research and development of unproven new bioresources can not depend solely on venture capital. So far, our attempts to attract substantial venture capital for a dedicated marine bioprospecting research facility and personnel have been unsuccessful, despite a display of significant interest during the preliminary discussions. Strong government support for Australian science is required to encourage industry investment and venture capital. Submissions from the Australian Society for Microbiology and others, have illustrated the crucial importance of sustained funding for basic research in the development of novel biological resources for the market place. Substantial commitment is required to establish and maintain active groups of world-leading researchers in regional areas. We support the suggestion in the submission from the University of Queensland for the establishment of a targeted R&D program to support bioprospecting research and the development of rural industries, and agree that such a program should include a mix of funding models.

Also worthy of note is the reluctance of the AFFA to support bioprospecting and bioprocessing as a priority area for research and development. During their second hearing Mr Morris stated that the areas of bioprospecting and bioprocessing fall within the Rural Industries Research and Development Coorporation. However, when I applied for RIRDC funding to research the feasibility of developing products from *Dicathais orbita* (discussed above), the application was rejected at the first stage. This is despite substantial industry support from the marine export company, who have offered to build a recirculating seawater system (~$150,000) for research on *Dicathais orbita*. The reason provided for the rejection of this application was that the corporation had commissioned a “Scoping paper on the potential for Australian Agriculture to produce New Pharmaceutical Neutraceutical and Industry Products”. It was suggested that it may be “some time before priorities for future R&D in those subjects are formulated by RIRDC”. I hope this is not at the expense of lost opportunities.

Support for postgraduate and postdoctoral awards are also particularly essential to provide the necessary training and experience in this discipline, and to encourage skilled Australians to apply their talents locally rather than contributing to overseas discoveries. My own experience illustrates the frustration experienced by many promising young Australian scientists. After discovering a novel antibiotic during my Ph.D. I was personally sought out by two international pharmaceutical and offered a fellowship from the British High Commission.

However, having already acquired a significant knowledge of our local marine organisms and realizing the opportunities for further development I was reluctant to leave Australia, despite the limited opportunities. I applied for and have now secured an ARC postdoctoral fellowship, but the long processing time and highly competitive nature of these applications means there is an absolute minimum of a one year gap between obtaining a Ph.D. and securing an ARC fellowship. In this crucial period of their careers, many innovative young scientists will seek other opportunities overseas.

Education
Education campaigns directed at informing Australians of the value of their natural resource inheritance need to be intensified. It is also necessary to dispel the bad image associated with bioprospecting that has been left behind biopiracy and environmentally unsustainable activities in the past. We recently experienced the potentially damaging effects of misguided information at a Jervis Bay community meeting. Two potential objectors to the SEAlab proposal were concerned that we would be raping the environment to provide profits to overseas multinational corporations. In order for regional communities to accept bioprospecting they must be assured that; 1) it can be undertaken in an environmentally sensitive manner; and 2) that some benefits will return to the local community/ environment. The lack of serious information regarding the benefits and drawbacks of developing industries based on bioprospecting in regional areas means that the community is unable to participate in the type of informed and on-going debate required for sensible decision making.

(3) the capacity to maximize benefit through intellectual property rights and other mechanisms to support development of these industries in Australia

Managing Intellectual Property
The optimal management of intellectual property is a difficult problem for many academic scientists with restricted time and funding, but in particular for Ph.D. students. Patents have to lodged at the most optimal time to maximise the returns and often this makes it necessary to hold on to research findings for extended periods. However, the publish or perish paradigm makes secrecy agreements impractical for any early career researcher. In other words, early career researchers may have to relinquish their intellectual property in favor of publication to maximize their chances securing a good postdoctoral position in the future. Well-funded “centers of excellence” in bioprospecting could help overcome this problem, by providing extended employment opportunities for Ph.D. graduates who have begun to develop significant intellectual property. Support should also be available to all bioprospecting startup companies to facilitate market analyses and the development of business plans when appropriate.

(4) The impacts on and benefits to the environment.

The impacts on and benefits to the environment have been covered in some detail in the submissions from the Australia Institute of Marine Science and Environment Australia. Further information regarding the potential environmental problems and conservation benefits of bioprospecting in the marine environment is provided by Benkendorff (in press). A Code of Ethics aimed at natural products chemists for the collection of biological material has been suggested in Benkendorff (1999b).

If you would like a copy of any of the references listed below and/or further information, please do not hesitate to contact me.

Sincerely,

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