

Bioprospecting in the Southern Ocean and Antarctica

A review of the issues and options

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Abstract

Bioprospecting is occurring in the Southern Ocean and Antarctica. There is no clear jurisdiction that currently governs bioprospecting in the Antarctic. Treaty parties are just beginning to discuss bioprospecting and its possible implications at various forums but there has been no agreement to date that it is a problem and a response is needed. This paper reviews the issues and options that have currently been identified.

Introduction

Bioprospecting is a relatively new activity. Advances over the last decade in genomics, genetic engineering, chemical engineering, cell technology plus the promise of large financial returns has not only made bioprospecting possible, but has also fuelled interest in the activity. Bioprospecting is now occurring all over the world including the Southern Ocean and Antarctica¹.

Bioprospecting raises a number of issues associated with ownership and benefit sharing wherever it is carried out². These issues are complicated in the Southern Ocean and Antarctica where territorial claims and jurisdiction is unclear.

Antarctic Treaty nations are only just beginning to realize that bioprospecting may have legal and policy implications that could, in a worst case scenario, destabilize the Antarctic Treaty system. The first tentative discussion of the possible implications of bioprospecting made its way onto the agenda of the Antarctic Consultative Meeting (ATCM) and Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) in 2002.

¹ Bioprospecting is already carried out in the Southern Ocean and Antarctica. A Russian patent claims unique multifunctional agent derived from a strain of Antarctic black yeast and a US patent describes a multifunctional enzyme derived from krill and fish. Other patents claim families of antifreeze polypeptides derived from fish and other organisms (Jabour-Green & Nicol 2003) and the food giant Unilever has a patent for a protein of bacteria found in the sediment of super salty Antarctic lake (Sunday Morning Herald April 2003). In December 1999 the Australian Government committed A\$30 million over 5 years to survey the continental shelf extending from the sector of Antarctica claimed by Australia, thought to be motivated in part by the potential wealth of the genetic resources of this area (Gateway Antarctica 2003).

² "Current policy work on bioprospecting stems from concern from New Zealand scientists that foreign researchers were benefiting from easy access to our biological resources without benefiting New Zealand (Ministry of Economic Development 2003).

This paper reviews the emerging issues and possible options associated with the practice of bioprospecting in the Southern Ocean and Antarctica.

What is bioprospecting?

Bioprospecting is a rather emotive term conjuring up images of mining and pending exploitation of a mineral resource. The process of bioprospecting is in fact quite similar to conventional prospecting as we know it. Bioprospecting is about looking in a targeted way for a commercially valuable resource. In the case of bioprospecting, the commercially valuable resource is found in the biochemical or genetic resources of plants, animals and microorganisms. Researchers often start with an end in mind and prospect biological material they consider is likely to result in a product that has a specific use such as a cancer or heart disease drug.

Bioprospecting has been defined by the Ministry of Economic Development (2002) as the;

“...examination of biological resources (eg. plants, animals, micro-organisms) for features that may be of value for commercial development. These features may include chemical compounds, genes and their products or, in some cases, the physical properties of the material in question. The main distinguishing feature from other biotechnology research is the concept of ‘prospecting’ – the search for biological material for as yet undiscovered applications.”

A rich resource for bioprospectors is the marine environment. The Southern Ocean and Antarctica is regarded as a good area for bioprospectors as there has been little exploration of the natural resources of the area. In addition, the extreme nature of the environments of the Antarctic (eg. coldest, highest, driest, windiest, saltiest etc.) give rise to a special type of organism called *extremophiles*. These organisms have developed various adaptations (eg. antifreeze, cold active enzymes, an ability to produce polyunsaturated fatty acids etc.) to cope with extreme climates that are of particular interest to the bioprospector (Maloney 2002).

What is the potential for bioprospecting?

Bioprospecting is an expensive business in terms of both the time and money needed to collect, isolate and manipulate the bioactives and then, if a useful product is discovered, commercialize it. The potential returns, however, are enormous. Many of the world's most successful and valuable pharmaceuticals have been derived from natural products. The value of pharmaceuticals for the

cancer market alone was estimated to be in the order of US\$24 billion by 2005 (Munro 2003)³.

“A further economic opportunity in Antarctica, which is only just beginning to be explored, is the exploitation of genetic resources. ... Some 80% of marine micro-organisms are yet to be described, and their first discovery may be in the context of a search for ways to manipulate and exploit them for pharmaceutical benefit. If this work is successful, it could well become for many years the single most profitable economic activity of the Antarctic.” (Press 2002)

Who is a bioprospector?

It is becoming increasingly difficult to differentiate bioprospectors from scientists as science moves toward an applied or commercial focus⁴. Funding agencies and governments have a growing interest in the financial returns on their investments and are eager to partner with private investors that not only spread the risk of investments but also provide expertise in the commercialization and marketing of a product⁵.

Bioprospectors can range from:

- scientists working on a pure science project who may unwittingly find themselves a bioprospector when they discover a valuable use for what started out as curiosity-driven research; to
- scientists who are commissioned or employed by pharmaceutical companies specifically to search for bioactives that can be developed into useful pharmaceutical products.

What is the problem?

Environmental damage and reduction in stocks can be caused by large scale harvesting of host organisms where the bioactive is in such small concentrations in the natural host or the bioactive is too complex to reproduce synthetically. Bioactives may also be gathered from existing collections negating the need to

³ For comparison New Zealand's GDP was estimated to be NZ \$75.4 billion in 2001.

⁴ Antarctic scientists have to some extent been exempt from the need to justify their research on economic grounds as maintaining a presence in the Antarctic to substantiate sovereignty claims and consultative status in the Antarctic Treaty system has been all important. This imperative, though still strong, has weakened in the post cold war era while economic imperatives have become stronger. Antarctic science is an expensive business and hence there is an increasing interest in its commercial application to offset the costs.

⁵ “*Foreign investment is often a prerequisite for research, as the required funding and expertise cannot always be sourced in New Zealand*” (Ministry of Economic Development 2003).

even travel to the Antarctic to collect samples making bioprospecting potentially an environmentally benign activity⁶.

Although the adverse effects on the environment are acknowledged as a potential problem of bioprospecting in the Antarctic much of the current discussion has focused on legal, political and ethical issues. These can be grouped under the following headings;

1. ownership and benefit sharing
2. jurisdiction
3. free exchange of scientific observations and results
4. ability to respond effectively.

1. Ownership and Benefit Sharing

Patent protection for inventions derived from biological resources is a relatively recent phenomenon. Patenting living organisms was first allowed in the United States in 1980 (Jabour-Green & Nicol 2003)⁷. There have already been a number of patents lodged in various countries for inventions derived from bioactives originating from the Southern Ocean and Antarctica (Munro 2003).

Patents are a form of an exclusive ownership right to an invention. A patent gives the holder the right to prevent others from exploiting their inventions without their permission for a period of up to 20 years. In return for exclusive ownership, the patent system requires full public disclosure when the patent is filed and at the expiry date of the patent the invention will become part of the public domain.

Not every invention can be patented. There must be a certain amount of novelty (newness) to the invention, it must illustrate an obvious inventive step and be capable of a useful application (Gateway Antarctica 2003).

Inventors often lodge patent applications in order to give them a period of market exclusivity on their invention and allow them to recover research and development costs as well as make a profit on their investment. This is

⁶ For example, Landcare Research is the custodian of a national data base and collection of microorganisms on plants. It is beginning work with a private company to search for potential bioactive compounds from selected micro-organisms that are held in the collection (Ministry of Economic Development 2003).

⁷ *Diamond vs Chakrabarty* Chakrabarty filed patent claims for a genetically engineered bacterium that was capable of breaking down multiple components of crude oil. The Supreme Court found that there were limits on what was patentable eg. laws of nature, physical phenomena and abstract ideas. Chakrabarty's organism, however, qualified for a patent on the basis that "*the patentee has produced a new bacterium with markedly different characteristics from that found in nature and one having the potential for significant utility. His discovery is not nature's handiwork but his own and accordingly it is patentable*" (Jabour-Green & Dianne Nicol 2003).

important for industries such as the pharmaceutical industry where research and development costs are high and there is a significant time lag between discovery and the marketing of a commercial product.

Patents are granted on a national basis and can only be enforced in that particular country. Most patent laws provide that non-commercial research can be undertaken by others on a patented invention. This “experimental use exemption”, however, differs from country to country and leads to some uncertainty for researchers as to the level of protection that they are guaranteed under these provisions (Jabour-Green & Nicol 2003).

The problem with patenting biological resources is finding a balance between private and public benefit – encouraging innovation and the development of products for the benefit of humankind while at the same time ensuring fair and equitable sharing of the benefits. There is also an ethical dimension when the initial biological material comes from the global commons, the Southern Ocean and Antarctica (owned by either all the people of the world or no-one) and developed for private benefit.

2. Jurisdiction

It is generally accepted that nations and indigenous people have some ownership rights to their country’s biological resources (UN Convention on Biological Diversity 1993). The United Nations Convention on Biological Diversity provides the international framework governing the access to genetic resources, transfer of technology and fair and equitable sharing of the benefits derived from genetic resources⁸. Not all countries, however, have ratified the Convention⁹. Moreover, the Convention does not deal with areas that do not come under the jurisdiction of a particular state such as the Southern Ocean and Antarctica.

In 2002 the Scientific Committee on Antarctic Research (SCAR) noted when addressing the issue of bioprospecting that “... *the Convention on Biodiversity does not apply to areas not under national sovereignty thus there is no clear over-arching authority to respond to possible pressures on Antarctic resources.*”

⁸ The UN Convention on Biological Diversity essentially focuses on sovereign rights of states over their genetic resources. Article 15 declares that the state that is the provider of the genetic material to determine access to the material and requires financial mechanisms should be established to provide fair and equitable sharing of research and development and the benefits of commercialization. Article 16 requires the transfer of technology to developing states on fair and favorable terms and Article 19 encourages the participation of provider states of genetic materials in the future development (Jabour-Green & Nicol 2003).

⁹ As of August 2003 168 countries have signed the Convention and 187 countries are party to it. The United States signed the Convention in 1993 after the ascension of President Clinton but has failed to ratify it (Campaign for UN Reform 2003).

Furthermore, the *Antarctic Treaty* system¹⁰ and the *United Nations Convention on the Law of the Sea*¹¹, that together provide a framework of governance for the Southern Ocean and Antarctica, were agreed to long before the potential for biosprospecting was recognized. Hence, neither, the *Antarctic Treaty* system nor *Law of the Sea* provide specific guidance for regulating biosprospecting.

The possibility of the Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR) applying to biosprospecting has been raised by Chile (ATCM 2003). The idea, however, appears to have attracted little support as it seems to stretch the interpretation of what has been commonly regarded as a “*marine living*” resource. CCAMLR also offers little guidance on ownership and benefit sharing of genetic products.

CCAMLR as it exists could, however, regulate the gathering of samples or bulk harvesting of host marine organisms for their genetic resource. It could set total allowable harvesting (catch) and require environmental impact assessments and reporting in the same way as it does the Southern Ocean fishery (Jabour-Green & Nicol 2003). These measures would not apply to parties outside CCAMLR and would face the same enforcement issues that are presently highlighted by the illegal toothfish industry¹².

The effectiveness the *Madrid Protocol* in regulating biosprospecting is also limited to environmental impact assessments of sampling and harvesting of terrestrial organisms and is silent on ownership and benefit sharing issues.

This leaves the Southern Ocean and Antarctica in a governance vacuum when it comes to managing biosprospecting. Consequently, the area is vulnerable to a form of biosprospecting that could result in the lock up, through patents, of biological resources that are developed exclusively for private benefit. It also makes biosprospecting in the Southern Ocean and Antarctica extremely attractive to prospectors as they are not regulated and are not required to share their profits with a host state or an indigenous people.

¹⁰ The Antarctic Treaty system provides the Antarctic governance framework. It is made up of the Antarctic Treaty 1959, Agreed Measures for the Conservation of Antarctic Fauna and Flora 1964, the Convention for the Conservation of Antarctic Seals 1972, the Convention on the Conservation of Antarctic Marine Living Resources 1982 and the Protocol on Environmental Protection 1991 (Madrid Protocol).

¹¹ The United Nations Law of the Sea 1982 provides a governance framework for the world’s oceans that cover ocean space, environmental control, scientific research, economic and commercial activity, the transfer of technology and a process to settle disputes relating to ocean matters (www.un.org/depts/los).

¹² Australia has announced that it will boost the protection of its sovereign interests with fulltime armed patrols of the remote and ecologically sensitive southern Ocean There are strong links suggesting organized criminal involvement in toothfish poaching ... (media release 17 Dec 03).

3. Free exchange of scientific observations and results

Potentially the most significant implication of bioprospecting in the Southern Ocean and Antarctica is its potential to destabilize the Antarctic Treaty system itself. The introduction of commercialism into science introduces new imperatives. Confidentiality and secrecy become key drivers as research organizations and companies compete in a race to file patents. These imperatives run counter to the principles on the *Antarctic Treaty* guaranteeing the freedom of scientific research and more importantly promoting the exchange of information on scientific programmes, scientific observations and results¹³ and scientific personnel (Department of Foreign Affairs 1986).

At the June 2003 Antarctic Treaty Consultative meeting in Madrid¹⁴ SCAR noted;

“...that bioprospecting could raise important issues of freedom of scientific information if confidentiality required by commercial developments limited opportunities for scientific publication”.

New Zealand's approach is a cautious one;

“As a Contracting party New Zealand fully accepts this important obligation (Article III 1(c)) of the Treaty. It is unclear whether the generation of intellectual property inherent in bioprospecting can be reconciled with this provision of the Treaty ... We do not agree that publication of structures of compounds arising from Antarctic organisms will necessarily meet New Zealand's obligations under Article III.” (Hughes 2002)

To date discussion on the tensions between the commercialization of science and the *Antarctic Treaty* has been limited. There appears to have been virtually no discussion on the type of scientific information that needs to be exchanged to comply with the Treaty and when such an exchange needs to take place. Bioprospectors may in fact be able to comply with Article III of the Treaty if expectations were more clearly set out.

Other implications associated with bioprospecting include states exerting their claim to Antarctic territory as well as claiming ownership of the biological resources and products derived from them¹⁵. It also raises some interesting

¹³ Article III 1(c) of the Antarctic Treaty states that “*scientific observations and results from Antarctica shall be exchanged and made freely available*”.

¹⁴ XXVI ATCM Madrid June 2003.

¹⁵ For example in 1999 the Australian Minister for Foreign Affairs announced that the Australian Government will take action to delineate the outer limit of the extended continental shelf off the Australian Antarctic Territory (Department of Finance and Administration 2003). Under Article 77 of the Law of the Sea coastal states have exclusive rights to the natural resources of the continental shelf. Australian's actions are a strong indication that sovereignty claims and commercial aspirations amongst Treaty parties

logistical issues if competing bioprospecting interests are forced to compete for logistical support. Countries may become reluctant to share their support services¹⁶ if there is no corresponding benefit sharing agreement. A perception that private companies are getting a “freeride” from publicly funded research and facilities (eg. such as transport and base facilities) may result in pharmaceutical companies being required to establish their own bases and support facilities to carry out bioprospecting. Facilities could be established close to areas rich in *extremophiles* (eg. Dry Valleys and Mt Erebus). Such moves would run counter to the basic premise of the *Antarctic Treaty* of preserving Antarctica as a natural reserve devoted to peace and science for the benefit of all humankind.

4. Ability to respond effectively

Since the Antarctic Treaty was signed in 1959 parties have responded to new issues as they have emerged and before they have become real problems. This approach has resulted in a series of further agreements addressing specific issues concerning the protection of flora and fauna, seals, marine living resources and environmental management. These agreements make up the *Antarctic Treaty* system. Signatories, however, have failed to resolve major issues such as sovereignty and mining and have been unable to reach agreement on measures of liability for environmental damage¹⁷.

Concerns have therefore been raised about the ability of parties to the *Antarctic Treaty* to respond to issues raised by bioprospecting in a timely and effective manner given that it is already occurring (Hemmings 2003). The speed of the technological progress of the bioprospecting industry¹⁸ challenges the ability of the consensual decision making process of the *Antarctic Treaty* system to respond before all benefits have been claimed by private interests. Achieving consensus in a timely manner will be made more

are alive and well. It is interesting to note this information is located on the Department of Finance and Administration’s website under “commercial projects”.

¹⁶ The United States, Italy and New Zealand share their air and sea transport to and from the Antarctic. For example, would the United States be prepared to transport New Zealand scientists and support personnel on its aircraft if they were engaged in commercial activity that was in direct competition with American scientists (Hemmings 2003).

¹⁷ The sovereignty issue was put to one side by acknowledging, but not necessarily recognizing, the various claims to Antarctic territory and not prejudicing their position by subsequent agreements. Consensus could not be found after 8 years of negotiation on the Convention on the Regulation of Antarctic Mineral Resource Activity (CRAMRA). Despite the fact that it was signed in 1988 it was never ratified. Instead it was overtaken by the Madrid Protocol that included a 50 year moratorium on mining. The annex on liability for environmental damage began life in CRAMRA and was transferred to article 16 of the Madrid Protocol and has been negotiated since 1991 with no immediate sign of agreement (Jabour-Green & Nicol 2003).

¹⁸ The Ministry of Economic Development predict a 5-7 year window of opportunity available for New Zealand to maximize possible economic benefits from the access to its own biological resources (in New Zealand) and the longer that it waits the more likely it will be that valuable discoveries will be made without benefiting New Zealand (Ministry of Economic Development 2003).

difficult by countries restating their territorial claims with renewed vigor (Press 2002).

In a working paper to the Committee on Environmental Protection in Warsaw in 2002 the United Kingdom challenged members by stating:

“To date it has been a hallmark or aspiration of the Treaty Parties to regulate, or commence the process of regulation for such issues ahead of them becoming a commercial reality (witness the proactive approach taken by parties in respect of, for example CCAS and CRAMRA¹⁹). By so doing, the issues, and the means of appropriately regulating them, can be debated without the pressures of commercial vested interests intervening. The UK believes that bioprospecting is a further matter on which pre-emptive discussion and decision-making is required. Ground-rules need to be put in place before this activity gains a momentum of its own.”

What are the options?

In the introduction to the this paper it was stated that bioprospecting was a relatively new activity in the Antarctic and that tentative discussions were just beginning to find a place on the agendas of the various forums of the *Antarctic Treaty*. Most of the effort to date has been directed toward issue rising. Recommendations have been to *Antarctic Treaty* parties asking for a place on their various agendas to discuss bioprospecting and its implications (UK 2002, SCAR 2002, Gateway Antarctica 2003, Jabour-Green & Nicol 2003).

There is no consensus on the proposition that bioprospecting is a problem that needs to be addressed. If it was decided, however, that a response was warranted and the Antarctic Treaty parties were capable of responding, there is no consensus on what that response should be or what it should be directed to (ie. the action of bioprospecting, ownership and benefit sharing and/or the exchange of scientific information).

It has been suggested that *United Nations Convention on Biological Diversity* could be extended beyond the jurisdiction of individual states to include global commons such as the Southern Ocean and Antarctica (Gateway Antarctica 2003). Parties to the Convention have produced a series of more detailed guidance, known as the Bonn Guidelines, which cover the issues of access to genetic resources and information and benefit sharing.

¹⁹ CCAS = Convention for the Conservation of Antarctic Seals, CRAMRA = Convention on the Regulation of Antarctic Mineral Resource Activity.

Antarctic Treaty parties, however, have been extremely reluctant to involve the United Nations in Antarctic affairs²⁰. It is more likely that the *Convention on Biological Diversity* and its associated guidelines would be acceptable to the *Antarctic Treaty* parties if it were to provide a model for new provisions that are annexed to the *Antarctic Treaty* system rather than extending United Nations governance to the Antarctic. A *Convention on Antarctic Bioprospecting* could be developed. This option would, however, leave a significant number of countries outside the *Antarctic Treaty* unregulated and able to bioprospect at will (Day 2003).

A less comprehensive option suggested is annexing specific guidelines on scientific information exchange and ownership and benefit sharing to the *Treaty*, CCAMLR or the Madrid Protocol. The downside of this option again is its inability to govern parties who are not signatories to the *Antarctic Treaty*.

In the past *Treaty* parties have been able to neatly side step difficult issues by setting them aside (sovereignty claims) or putting in place a moratorium (mineral exploitation). Bioprospecting, however, does not lend itself to this type of approach as it is already occurring and gathering momentum. A moratorium would also be extremely difficult to enforce as the experience of stopping illegal toothfish fishing has shown. A moratorium on filing patents with *Treaty* nations from bioactives derived from the Southern Ocean and Antarctica may be an option but once again this option leaves non-signatories to the *Antarctic Treaty* unrestrained. Under this option the incentive to bioprospect for private benefit is likely to be reduced to such an extent that little or no bioprospecting takes place and the benefits to the world of pharmaceuticals derived from Antarctic organisms would remain undiscovered.

Conclusion

Bioprospecting is a new activity. Efforts to date have been focused on raising the issue and its possible implications amongst *Treaty* parties.

As yet there is no consensus amongst *Treaty* parties that bioprospecting is a problem and that some kind of response is warranted. There have been only tentative discussions on what kind of response would be effective. If a response was called for, the suggestion of using the *United Nations Convention on Biological Diversity* as a model to develop a *Convention on Antarctic Bioprospecting* seems to hold the most promise. However, this would not restrain non-signatories to the *Antarctic Treaty*.

²⁰ “*Antarctic Treaty Parties fundamental belief that the UN, albeit capable of serving as a useful tool of government policy, should be kept firmly in its place and allow them to get on with their Antarctic responsibilities.....no advance on the UN’s present role was favored (by Antarctic Treaty parties).*” (Beck 2003)

The real challenge, however, is a commitment amongst Treaty parties to the *Antarctic Treaty* system itself. Bioprospecting raises issues of ownership, private benefit and the free exchange of scientific information that run counter to the principles of the *Antarctic Treaty*. New Zealand is taking a cautious approach and is prepared to forgo significant economic benefits to the country in order to fulfill what it sees as its Treaty obligations. Will other countries be prepared to do the same?

The rapid growth of bioprospecting in the Southern Ocean and Antarctica will also challenge the ability of the consensual decision-making processes of the *Antarctic Treaty* system to respond in a timely and effective manner. An alternative decision-making framework may be required in order to allow Treaty parties to respond more quickly to emerging issues such as bioprospecting. A danger of this approach, however, would be to undermine the basis of the *Antarctic Treaty* itself and last fifty years of *Treaty* agreements.

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