Synopsis

Bioprospecting: Effects on Environment and Development

The Convention on Biological Diversity (CBD) was one of two legally binding treaties that were put out for signing at the Rio Summit in 1992. More than 180 nations have ratified the Convention so far. The signatories to the Convention are obliged to set up legislation and regulations to meet the objectives of the CBD, these being *i*) the conservation of biodiversity, *ii*) the sustainable use of its components; and *iii*) the fair and equitable sharing of the benefits arising out of the utilization of genetic resources (Article 1). The CBD introduces a new regime of source countries' national sovereignty over genetic resources, where there has generally been open access to these resources without restrictions or regulative charges involved. The ownership, control, and distribution of benefits from the use of biodiversity have been contested vigorously—through economical, political, legal and even military means—for centuries. In recent years, especially since the coming into force of the CBD, more formalized and internationally sanctioned mechanisms have begun to emerge. Chief among these are the use of contracts and other agreements between source countries/institutions and recipients, who seek access to biological resources for the purpose of research, development, and commercialization.

Today, pharmaceutical companies constitute an important group of actors focusing on *bioprospecting* (biodiversity prospecting). This activity includes the collection of plants taxonomically identified and/or screened for medically active components. It is well established that the tropics are rich in biodiversity. More than two thirds of all plant species are also located in the Third World, attracting bioprospectors searching for medicinal plants (1, 2). Collection is in part based on ethno-directed sampling with the use of local and/or indigenous knowledge, as well as random and taxonomically directed sampling (3, 4).

WIN-WIN OR BIOPIRACY?

Some observers characterise bioprospecting as a win-win situation (5–9). A sustainable use of biodiversity promotes the conservation of these resources. Through bioprospecting countries in the Third World are faced with the opportunity of earning foreign currency relatively easily, while building capacity for a technologically more advanced industry. Income can be generated for such development purposes as well as for the conservation of biodiversity. On the other hand, observers criticize bioprospecting as a new type of colonialism where developing countries are exploited by the activity as well as by the involved patents, and that biodiversity is threatened by over-exploitation (10–14). The bioprospecting debate has generated the production of two polarized discourses in which narratives of specific cases are constructed as either win-win stories of mutual gains or 'biopiracy' stories with a cast of villains and victims (15).

Due to the multitude of factors and actors involved and the variation of claims regarding bioprospecting, it is impossible to obtain valid pictures of effects and causes in specific cases without independent analyses based on sound empirical investigations. Today, the volume of the claims can be characterized as inversely proportional to the existence of such analyses. The scope of our ongoing project is to contribute to a more scientific based picture by focusing on a few case studies using an interdisciplinary approach. In these cases, we examine the effects of bioprospecting on conservation and development: i.e. the conservation of biodiversity; the sustainability of collection; and the economic and social development in source countries. The project brings together a core team of researchers and students in biology-ecology, sociology and law, with input from scientists from different disciplines serving as a reference group. We integrate elements ranging from ecological examinations of the methods applied in the collections and study of plants, through sociological studies of local benefits and the production of discourses, to studies of the legal framework around bioprospecting arrangements. The project receives funding from the Research Council of Norway. We will in the following exemplify the approach of this study with central but very different cases of bioprospecting.

TOLYPOCLADIUM INFLATUM: A PRECIOUS FUNGUS FROM NORWAY TO NOVARTIS

Bioprospecting is claimed to generate substantial income for source countries for purposes such as conservation of biodiversity, health care, and social and economic development. Various individuals totally reject these arguments, or warn against too high an optimism. The range and magnitude of benefits from present arrangements on access to biological resources and benefit sharing will not be known for many years. There is also a lack of public information available on the details in present bioprospecting contracts.

Our project first focused attention on an "old" bioprospecting case. In 1969, the microfungus *Tolypocladium inflatum* was collected in a soil sample from the mountain plateau Hardangervidda in Norway and brought to Switzerland for pharmaceutical screening. *Tolypocladium inflatum* was found to produce cyclosporin, an immunosuppressant with positive effects for patients with organ transplantations. Today, medicines containing cyclosporin constitute the major pharmaceutical product for the life science company, Novartis. The collection was in this case completed a long time in advance of the establishment of the CBD and, thus, within an open access bioprospecting regime, implying that there is no benefit sharing with the source country from present sales of cyclosporin medicines. We estimated the source country's loss of benefits in comparison with present norms and expectations concerning bioprospecting arrangements. Annual royalties of 2% would have been a reasonable claim in this case, and in 1997 this amounted to USD 24.3 million.

Thus, in cases of discoveries of blockbuster drugs, the gains from bioprospecting for source countries may be substantial. Such examples are nevertheless rare, and the sharing of benefits depends upon the ability of the source country to establish a legal framework and related regulatory procedures. Our project examined the effects of patents related to cyclosporin medicines as well. Despite strong claims concerning bioprospecting, in general, and the focus on patenting as a cause of unfairness for source countries, patents related to the medicinal development were in this case not found to be a significant reason for the lacking benefits (16).

NORWAY AND TANZANIA: BIOPROSPECTING WITHOUT REGULATIONS

At the end of the 1990s, German researchers were collecting sponges for the screening of biochemicals from microbes in Norwegian coral reefs. At this time, there were still no regulations in place to secure

benefit sharing for the source country. Eventually, the Norwegian government has begun work to regulate this activity.

Likewise, in Tanzania bioprospecting has so far not resulted in conservation efforts, and development effects as well as local benefits are small. This is shown through a close study of the activities of Shaman Pharmaceuticals in Tanzania. The project draws attention to the lack of policy concerning bioprospecting, and the different ways various parts of the government use fractions of existing law to require a range of permits. The lack of consistency in legal framework and procedures and the lack of coordination among the involved parties result in a situation in which legitimate bioprospecting becomes very difficult. Thus, few benefits are derived, and there is no policy concerning benefit sharing among interest groups (17).

INBIO IN COSTA RICA: FUNDING CONSERVATION AS A CORE TARGET

INBio signed its first bioprospecting contract with the pharmaceutical company Merck & Co in September 1991. With this agreement Merck was obliged to pay INBio USD 1.135 million for extraction costs and equipment, an undisclosed share of potential royalties from the net sales of any product developed from the Costa Rican samples, and USD 50 000 to a patrimonial fund for the Marine Conservation Areas (18). As a precondition for this and other bioprospecting agreements, INBio agreed to contribute with 10% of the budget and 50% of the royalties to the Costa Rican government for the conservation of national parks. The Costa Rican Biodiversity Act, still being refined, will probably facilitate access to genetic resources, and also establish a domestic legislation that promotes the objectives of the CBD, provided that the legal standards of the Act are fulfilled and that the receiving countries ensure that their use of genetic resources within Costa Rica comply with the Convention (19). The Costa Rican case thereby contrasts in regards to bioprospecting activities in Norway and Tanzania, where there is a lack of norms and legal frameworks regarding the regulation of bioprospecting and thereby also the benefits.

THE LACK OF CRITERIA FOR SUSTAINABILITY IN BIOPROSPECTING

A collection accomplished by the United States Department of Agriculture (USDA) for National Cancer Institute, USA. NCI in Kenya in 1972 has been criticized for devastating the wild adult populations of *Maytenus buchananni* by removing up to 27.212 kg of the species. In this case, no prior investigations on species biology were conducted (20). It is not clear whether this experience has impacted NCI's collections, as nothing suggests that information on species biology/ecology or measures on sustainability are demanded from collectors, neither from initial surveys nor when promising species surface.

It is generally assumed that the bioprospecting activity is sustainable *per se*. We have examined this thoroughly in the case of INBio's bioprospecting, often acknowledged as a 'best-case' of bioprospecting by the combination of the considerations for benefit-sharing and conservation as well as the sustainable use of biodiversity. Our findings reveal that INBio's methodologies for selection and collection for bioprospecting were not sensitive to endemic or rare species, size of individuals or life form (21). Even though several ecologically important criteria exist for the selection processes, these are not always followed, as the criteria conflict with the requirements and interests of bioprospectors. Cultivation was only observed in one case, which means that resupply, mainly of high quantity/intensity, is generally extracted from wild sources until there are strong indications of a potential product in hand. There were no tools for measuring ecological sustainability of the collection processes for the biodiversity inventorying, prospecting, or in the selected Costa Rican cases of known potential leads. No monitoring or yield studies were reported in relation to the activities. Bioprospecting by INBio at the time of our study could therefore not be categorized as ecologically sustainable *per se*. The contribution of INBio to conservation in protected areas is also unclear. Nevertheless, based on more than a decade of working with bioprospecting, INBio has ample experience in the field, which could be applied in developing methodologies to ensure a sustainable use and conservation of biodiversity.

We also conducted a comparative survey of selected well known cases of bioprospecting for medicines to explore *i*) collection methods for species by bioprospectors; *ii*) characteristics of species vulnerable to harvesting; and *iii*) the requirements for the conservation of species that are harvested (4). We especially focused on characteristics of the species that could explain why a medicinal plant species becomes overharvested, and the strategies adopted for their conservation and management. This study revealed the scarcity of data on species biology for species collected for drug discovery or phytomedicines. Furthermore, the claimed assumption by some bioprospectors that it is only phytomedicine (herbal) production/search that results in overharvesting or population depletion is not always correct (3, 22, 23).

CONCLUSION

The project is currently progressing with detailed analyses of case studies. We feel that the collaborative effort in this project illustrates the feasibility of interdisciplinary research and its dire need for critical examination of the complex and controversial issues, as in this case, bioprospecting. Conclusions from case studies of our project presented here are first that some economic gains are possible from bioprospecting although the expectations should not be exaggerated. However, a fundamental necessity for source countries is to establish an institutional framework to facilitate sustainable bioprospecting with benefit sharing. Secondly, the activity may represent a sustainable use of biodiversity, but this requires that the actors develop adequate methodologies to secure ecologically sound collections.

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24. We are thankful to the following persons for discussions and input on bioprospecting: Lars Mjøset, Cary Fowler, Kristin Rosendal (reference group); Palamagamba J. Kabudi, Magnus Eriksen (Tanzania); INBio, Alexander López, Morten Walløe Tvedt, Dag Nagoda, Andreas Tveteraas (Costa Rica); La-aw Ampornpan, Ove Vold, Torunn M. Tysvær (Thailand). Thanks also go to Alida Boye for administrative help. The Research Council of Norway is acknowledged for funding this line of work to SSD, HS, and HCB. For more information on the project see [http://www.sum.uio.no/bioprospecting/bateng.htm].

Shivcharn S. Dhillion
Centre for Development and the Environment, University of Oslo and Department of Biology and Nature Conservation, Agricultural University of Norway, Pb 5014, N-1432 Ås, Norway.
shivcharn.dhillion@ibn.nlh.no

Hanne Svarstad
Division for Man-Environment Studies Norwegian Institute for Nature Research (NINA) Fakkelgården, N- 2624 Lillehammer, Norway.
hanne.svarstad@ninalil.ninaniku.no

Cathrine Amundsen
Centre for Development and the Environment, University of Oslo, Pb 1116, Blindern N-0317 Oslo, and Department of Biology and Nature Conservation, Agricultural University of Norway, Ås.
cathamu@hotmail.com

Hans Chr. Bugge
Department of Public and International Law, University of Oslo, Karl Johansgt. 47, N-0162 Oslo, Norway.
h.c.bugge@jus.uio.no