

Tropical genes for sale

Who benefits?

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Introduction

Development of modern medicines in the USA and Europe is often based on the diverse flora and indigenous knowledge in tropical countries. Biological diversity (or biodiversity) includes the diversity of species, ecosystems and genetic resources. Biodiversity prospectors (or bioprospectors) encompass pharmaceutical companies and research institutes that collect fragments of the biodiversity and screen them for therapeutic agents.

Nature's diversity of genes and their direction of the biological production is an important resource in economic sectors such as pharmaceutical industry. In contrast to other kinds of natural as well as man-made means of production, genetic resources have only recently been subject to ownership. The access has generally been open for everybody, and nobody has had the right to receive payment for the collection and use by other actors. Today, intellectual property rights related to biotechnology inventions provide for private ownership and commodification of the genetic resources which have been subject to scientific study (Kloppenburg 1988). On the other hand, the Convention on Biological Diversity (CBD) introduces a new regime of source countries' national sovereignty over the genetic resources that more or less can be considered as primary commodities² (Svarstad 1994).

One of the Convention's objectives is "the fair and equitable sharing of the benefits arising out of the utilization of genetic resources" (Article 1). This objective is specified in Article 15.7:

"Each Contracting Party shall take legislative, administrative or policy measures, as appropriate, ... with the aim of sharing in a fair and equitable way the results of research and development and the benefits arising from the commercial and other utilization of genetic resources with the Contracting Party providing such resources."

Furthermore, in the Preamble and in Article 8j, the Convention points to the traditional knowledge, innovations and practices of indigenous and local communities concerning biological diversity. The desirability of equitably sharing benefits arising from the use of such knowledge, innovations and practices is stressed.

The implementation of the Convention, however, has just started. Therefore, the proposed new regime is not yet accompanied by national institutions to facilitate and enforce the national sovereignty. Meanwhile, the major bioprospectors are themselves initiating ways of sharing benefits with the national and local providers of medicinal plants. Does this

² CBD was negotiated within the framework of United Nations Conference on Environment and Development and put out for signing at the summit in Rio in 1992. It was put into force December 29, 1993, and the first meeting of the Conference of the Parties took place in the Bahamas in the end of 1994.

imply that the bioprospectors now can get rid of the labels "gene hunters"³ and "biopirats"⁴? In the following, I will focus on how two important bioprospectors arrange for the sharing of benefits. We will see that these actors' designs of interaction models, including their choice of source country participants, are essential for how the benefits are to be shared. Furthermore, we will look at implications of how the bioprospectors share their benefits from the perspective of a sustainable management of biodiversity.⁵

The establishment of property regimes for natural resources will always have distributive consequences. Theoretical discussions on property regimes, however, tend to emphasize on questions concerning access to and control over the resources and implications for the maintenance of the resources. Distributive implications are less focused. This paper, however, concentrates on the question on distributive impacts of new institutional arrangements.

Types of interaction and relevant principles of justice

As a means to analysing the interaction models for the bioprospecting, the approach of Torstein Eckhoff (1974) is applicable. Moreover, his approach points to relevant principles of justice. Since a major intention in this paper is to look at the sharing of benefits, Eckhoff provides particularly useful perspectives. Eckhoff focuses on situations in which transfers take place between actors.⁶ This happens when one person undertakes some action in relation to another to which this latter person attaches a positive or negative value. There are certain forms of interaction in which two or more transfers are interconnected. Eckhoff distinguishes between two main types of such combinations: "reciprocation" and "allocation". The principles of justice are norms of equity for these types of interactions. The norms give indications of what should be equal and based on which criteria.⁷

³ Kloppenburg 1988, Juma 1989.

⁴ This label was used by Pat Mooney at the international symposium "Patents, Genes and Butterflies" which was arranged by SWISSAID and WWF in Bern in October 1994.

⁵ The paper's epistemological foundation consists of an empirical description of a social phenomena and a discussion of it in the light of specified value standards. This approach fits into the category of social research which Kalleberg (1992) calls *critical* or *evaluative*

⁶ Eckhoff is inspired by a philosophical tradition from Aristotle and American sociologists such as Homans's (1961) "distributive justice" and Gouldner's (1960) "norm of reciprocity".

⁷ In the following, I only refer to those of Eckhoff's principles of justice and their characteristics which are considered to be relevant in the case of bioprospecting.

Situations of exchange and retributive justice

Reciprocation is a situation of "give and take" between two parties. One transfer is conditioned by another. The relevant principles of justice here, are called "retributive justice".⁸ The central idea in these principles, is that there is some degree of reciprocity and balance in relations between the parties. The exchanged values must have equal weight according to certain measures. The notions will differ, however, as to what must be equal in order to satisfy this claim.

If positive values are reciprocated, the situation is an exchange. The fact that one party has performed a beneficial service or sacrificed something for the other, will require that the latter do something in return. There is a normative requirement to establish a balance.⁹

The notion of equality in the exchange can be sought by a requirement of the same ratio between expenditure and revenue (contribution *c* and benefit *b*) for both parties. When actor 1 and actor 2 exchange values:

$$\frac{b_1}{c_1} = \frac{b_2}{c_2}$$

This may also be expressed by saying that what the parties together earn in the exchange of values be divided relatively equally between them.

In cases of bioprospecting, we can distinguish between two major groups of actors. On the one side, there is the actor constituted by the receivers of medicinal plants (the foreign research institutes and pharmaceutical companies). On the other side, there is the source country of the biodiversity. It can also be useful to see all source countries that participate in a bioprospecting program as one single actor, in order to compare their total contributions and benefits to those of the first actor. The first actor receives plant material and knowledge from the second actor and gives some payment for this.

⁸. A clear illustration of retributive justice is found in the old Norwegian poem, *Håvamål*, which is probably from heathen times. "A man ought to be a friend to his friend and repay gift with gift. People should meet smiles with smiles and lies with treachery" (English edition by D.E. Martin Clarke, Cambridge 1923).

⁹ This idea of balance does not explain processes which lead to equilibrium in an economic sense. The focus is on the normative justification of demands and duties

Situations of allocation and distributive justice

The other set of instances for interconnected transfers are allocations. In these situations, the actors consist of one or more distributor(s) and an indefinite number of recipients. A typical example of an allocation takes place when a parent cuts a cake and gives each child a slice of it. In allocations, the relevant principles of justice are called distributive justice. The central idea of distributive justice is that recipients should be treated equally. Equal treatment, however, can mean different things. I will present three types, and discuss their relevance to bioprospecting.

1. Equal shares

According to this principle, all the recipients should get an equal allotment. Individual features of the recipients are not taken into account. The parent is to give each child an equally large piece of the cake.

It is difficult to see any aspects concerning the transfers of medicinal plants in which this principle would seem legitimate by the participants. On the contrary, the different actors involved in bioprospecting stress the importance of considering their contributions in the sharing of benefits.

2. Shares according to contributions

Here, importance is attached to the contributions of each recipient to the total result. The emphasis may, for instance, be put on how much work they have done and the effectiveness of the work. The demand for equality is satisfied if the ratio between the value of the allotment (a) and that of the input (p) is the same for everyone. The claim is met when

$$\frac{a_1}{p_1} = \frac{a_2}{p_2} = \frac{a_3}{p_3} \dots = \frac{a_n}{p_n}$$

This resembles retributive justice, although the interaction type is different. The principle could, as we will see later, be applicable for the sharing of benefits between source countries in a bioprospecting program. Furthermore, it is also one of the relevant principles to consider for distributions of benefits within a source country.

3. Distributive justice according to needs

According to this principle, each person should receive enough to acquire the same satisfaction. Whereas the previous principle focuses on the contributions as the relevant characteristics of the recipients, this principle focuses on the recipients' needs. The

distribution is to bring all recipients up to the same level when account is taken both of what they had previously and what they now obtain of the relevant value. This principle is, as we will see, relevant for the distribution of benefits within a source country.

As it has been claimed so far, it is possible to define the sharing of benefits from bioprospecting activities both as interactions of exchange and of allocation. This will be examined more carefully in the empirical presentation.

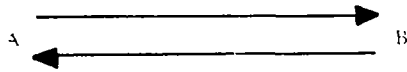
Overview of interaction types and principles of justice

Interaction type:

Principle of justice:

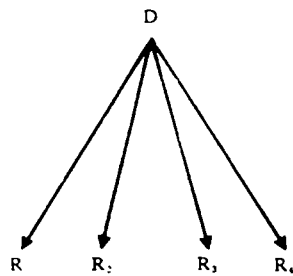
Exchange

Retributive justice



Allocation

Distributive justice



Equal shares

Shares according to contribution

Shares according to needs

D - distributor

R - recipient

Sustainable management of biodiversity

The ways the bioprospectors share their benefits can be evaluated from the influences on targets of a sustainable management of biodiversity. Management of biodiversity encompasses human actions related to these resources. The actions can be divided into aspects of utilization, maintenance and distribution¹⁰. The principle of distributive justice according to needs can be specified in connection with the management of biodiversity. Firstly, the principle can be specified to emphasize the goal of bringing all relevant recipients up to minimum standards of welfare such as fulfilling their material needs of subsistence¹¹.

Secondly, we can incorporate intra-generational perspectives in accordance with the World Commission on Environment and Development (WCED) who put up two goals for sustainable development concerning today and the future:

"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED 1987:43).

These goals are also reflected in the Convention on Biological Diversity that emphasizes the target of sustainable use of the components of biological diversity. CBD defines this as "to meet the needs and aspirations of present and future generations" (Article 2. Use of Terms).

If everyone's material needs of subsistence are to be met both today and in the future, all the three management elements have to be directed towards these goals. Therefore, each of the three management elements must be specified in ways that turn them into implications of the ultimate values.

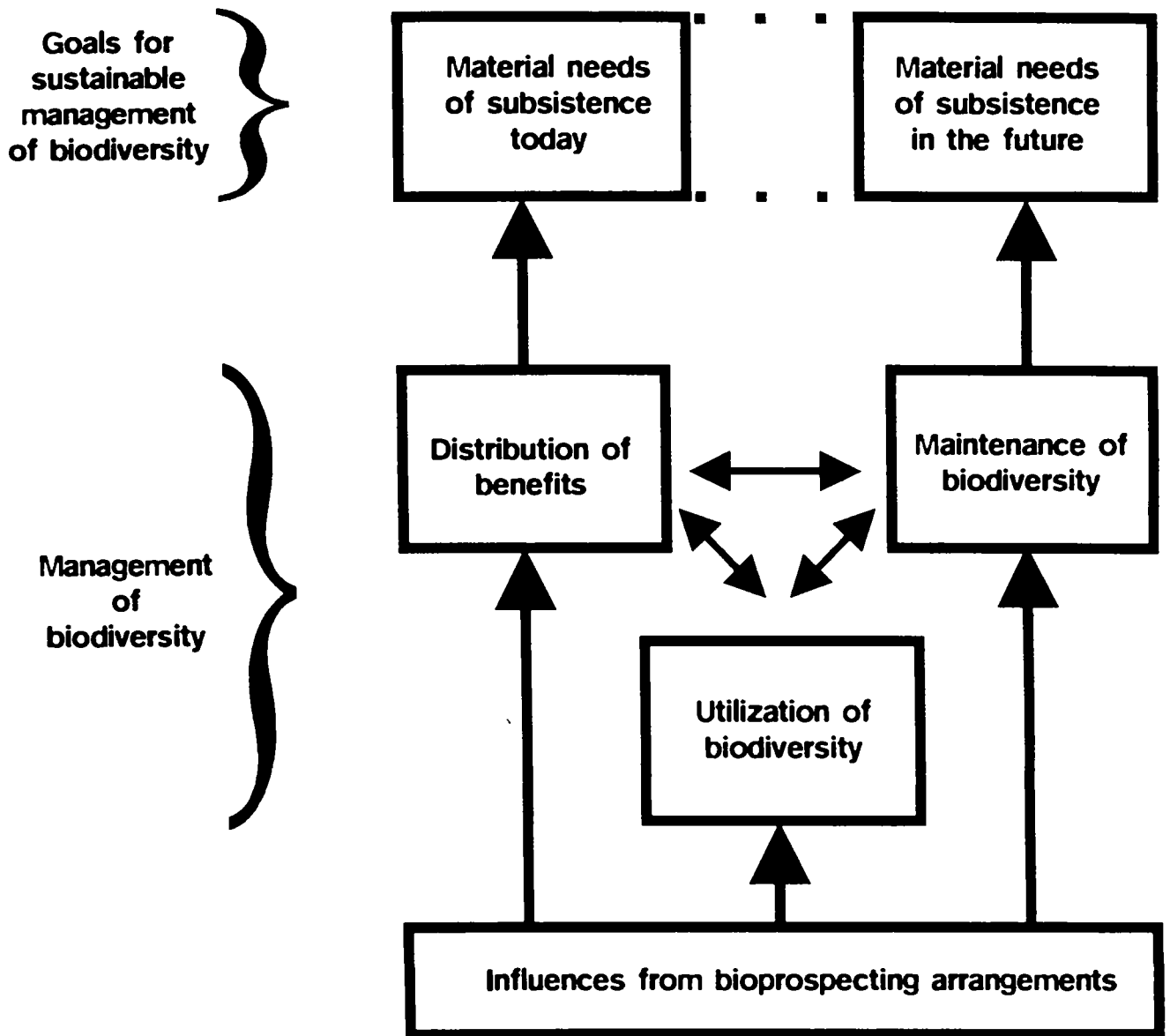
Firstly, the biodiversity has to be utilized in such a way that the material needs of subsistence today can be met. The production of food and medicines must be large enough and appropriate for this goal. Secondly, biodiversity must be maintained so that coming generations can utilize it in their production. Thirdly, in order to meet everyone's material needs of subsistence today, the distribution of benefits from the utilization must be appropriate.

It is important to stress that the distribution of benefits related to transfers of medicinal plants only is one of many factors that can add positively or negatively to an ultimate goal concerning the meeting of all material needs of subsistence in a society.

¹⁰ A more thorough discussion of goals, means and influences on the management of biodiversity is presented in Svarstad 1995.

¹¹ It is beyond the scope of this paper to go into the arguments from the basic needs debate. Malnes 1990 and Svarstad 1995 discuss needs in relation to resource management.

The figure illustrates the relationships between the need-oriented goals, the three management elements and influences from the bioprospecting arrangements:



The exchange between bioprospector and source countries

In the following, we will look at data concerning on-going bioprospecting activities and how bioprospectors themselves today organize for the sharing of benefits. The interaction between bioprospectors and source countries is analyzed in terms of the exchange model, and the distribution of benefits within the source countries are seen in terms of the allocation model. First, I will present data concerning the contributions and benefits of the bioprospectors. Likewise, information will be shown about the contributions and benefits of source countries¹². The question of which actors in the South are the most suitable "sellers" of the biodiversity in the exchange with the bioprospectors will be discussed. Thereafter, I will elaborate on the allocation of the benefits in the source countries.

I have chosen to focus on the arrangements for sharing of benefits initiated by two bioprospectors¹³. These are the National Cancer Institutes (NCI) - a US research institute - and Shaman Pharmaceuticals - a US private company. These two bioprospectors both have large collection programmes involving several countries in the South. Furthermore, they have both strong ethical commitments for sharing benefits with the providers of biodiversity components¹⁴.

Contributions and benefits of the bioprospectors

Pharmaceutical companies and research institutes have to spend a substantial amount of time and money from the collection of plants and until they have a commercial product. An estimated US \$ 231 million and 12 years on average are required to develop a marketable drug in the US (DiMasi et al. 1991, Reid 1994:244). These high costs must be taken into account when considering how the benefits may be shared fair and equitably. Furthermore, there are also considerable costs of the production that must be subtracted from the revenues before benefits from the development of the drug are to be shared.

The annually worldwide sales of the pharmaceutical industry amounts to roughly US \$ 200 billion (Lisansky and Coombs 1989). Some data give an indication of the amount of these present revenues which is based on biodiversity and traditional knowledge: One-fourth of the prescription drugs on the market in the US today are plant-derived (Principe 1988). Assuming that this percentage counts worldwide, this implies that about US \$ 50 billion is earned totally from plant-derived drugs. There are 119 drugs in use today with a known

¹² It is, however, beyond the scope of the paper to present a fullfledged economic analysis or evaluation of the parties' respective shares. The intention is rather to point to the relevant elements in the exchange.

¹³ As the emphasis is on these bioprospectors' arrangements for sharing of benefits with the providers of biodiversity, data have not been collected about their own particular contributions and benefits related to the bioprospecting. Such data are only presented in general. The benefits from the on-going bioprospecting will in any case not be clear before products in some years are released on the market.

¹⁴ An interesting question is *why* these bioprospectors have adopted such commitments. The reason may be found in internalized norms of justice as well as in a rational economic behaviour in response to an increased concern among source countries and Non-Governmental Organizations. However, it is beyond the scope of the paper to examine this question.

chemical structure that are extracted from higher plants. Three quarters of these were discovered by chemists who studied plants from traditional herbal medicine (Farnsworth 1990:6, Laird 1994:148). Today there is a growing demand for genetic and biochemical resources. One reason for this, is the improvements in screening techniques. The future demand, however, is uncertain.

The revenues earned from each drug may vary considerably. In the well-known case of the two drugs derived from the tropical plant rosy periwinkle, Eli Lilly¹⁵ earns US \$ 100 million annually (Farnsworth 1988, Reid 1994:244). A "blockbuster" drug does even generate as much as US \$ 1 billion in sales annually (Reid 1994:246).

The contributions of a source country¹⁶

A source country's contributions in biodiversity prospecting can be divided into different aspects. Firstly, there is the access that is given to natural resources. This access is comparable with the provision of access to other natural resources. For instance, countries with crude oil - like Norway - give concessions to oil producing companies in charge for a considerable share of the economic benefits. Countries with much biodiversity and many endemic species are of particular interest to biodiversity prospectors, and therefore these countries possess a valuable asset. This is true for many tropical countries. Tanzania, for instance, is estimated to have as much as 11,000 plant species of which over 10% are endemic (Mwalyosi 1993:9).

The possession of biodiversity as natural resources has to be seen in relation to the maintenance of these resources. There is often a high pressure on the biodiversity due to various economic activities. Sustainable practices and conservation efforts may in this context be seen as investments that facilitate and increase a country's value for bioprospecting. In Tanzania, traditional healers' strategies of collecting medicinal plants provide for the maintenance of these plants. Furthermore, the Tanzanian government has established forest reserves of 13,024 ha and 25% of the whole country is devoted to wildlife conservation purposes with varying degrees and kinds of restrictions on economic activities (Mwalyosi 1993:6-7).

Secondly, a country with much traditional knowledge on medicinal application of biodiversity possesses a considerable added value on the natural resources. Tanzania - with its more than 120 ethnic groups and many skilled traditional healers - is therefore highly appreciated by collectors. In the rural areas of Dodoma Region, there is reported to be a traditional herbalist in almost every village¹⁷ (Kayombo 1992). The use of traditional

¹⁵ A large pharmaceutical company in the USA.

¹⁶ Exemplification here is taken from Tanzania. Both the NCI and Shaman collect medicinal plants in Tanzania.

¹⁷ The reported herbalists were those among the traditional healers who treat illnesses by the use of biological or mineral materials and who are willing to work with formal health workers. The total numbers of herbalists and other traditional healers are much larger.

knowledge is considerably more effective than random sampling. Both the collections of the NCI and Shaman Pharmaceuticals are based more or less on ethnobotanical data. Most of Shaman's and much of the NCI's collection in Tanzania are based directly on ethnobotany. Besides, ethnobotanical data from journals and data bases are used as background information.

Thirdly, the participation of scientists and institutes in the various stages of the process from the collection to the screening and testing of therapeutic agents adds to the value of the product that is offered from the source country. In Tanzania, the few but highly skilled scholars with taxonomic competence therefore constitute a valuable asset for the country. There are also institutes in Tanzania that could use and improve their capability to carry out biochemical screening. In the present activities of the NCI and Shaman in Tanzania, however, all the screening is conducted in laboratories in the US.

Benefits to source countries

A share of the possible future sales of a drug is only one of several different ways source countries can be paid for their contributions. The very reason, however, why companies and research institutes are conducting their bioprospecting and screening activities, is to develop new drugs. Therefore, the benefits from new commercial products form the basis for any negotiations about different kinds of present and eventual future benefits for source countries. If we assume that all labour connected to the bioprospecting is paid fairly, source countries' share of future drug sales is a remuneration for access to the resources and traditional knowledge besides eventual contributions in the screening process.

In the pharmaceutical industry, typical royalties paid for samples of unknown clinical activity amount to 1-5 per cent of net sales¹⁸ (Reid 1994:245). A standard royalty share for a dried plant sample, is 1-2 per cent of the sales if any commercial drug developed from this sample, while an extract from a plant can potentially be sold for 3-5 per cent of sales. A promising chemical compound may give royalties from 5 to 15 per cent (McGowan and Udeinya 1994:64).

The National Cancer Institute relates to each partner in source countries according to an exchange model. The NCI has a policy of seeking patent protection on their inventions based on biodiversity prospecting. This is a means to ensure their own benefits from commercial products by licensing agreements with pharmaceutical companies. In case of a commercial product, the NCI intends to provide payment to source countries. Besides, the institute provides benefits in terms of research cooperation, provisions of the research results and the favouring of the source country as a supplier of raw materials for the drug production. The attention in this section of the paper is focused on the first kind of payment. In the Letter of Collection (LOC), the NCI states that it

"recognizes the need to compensate source country organizations and peoples in the

¹⁸ This means, in other words, that when a commercial drug is developed from such a sample, the supplier of the sample gets a royalty of 1-5 per cent of the drug sales.

event of commercialization of a drug developed from an organism collected within their borders".

However, contrary to the Convention on Biological Diversity (CBD), paragraph 15.7, the NCI does not make agreements with source countries on mutual agreed terms for benefit sharing prior to an eventual development of a commercial drug. Source countries can neither obtain an agreement on the share of total revenues from drug sales, nor on the share of the NCI's royalties. The argument of the NCI for not providing clear terms in the contracts with source country organizations, is that they claim that this is forbidden by US law. As a US Government Agency, the NCI

"is not authorized to promise or encumber future intellectual property (patent) rights to any invention of the NCI, except under the terms of a cooperative research and development agreement (CRADA); generally CRADAs are only considered in the case of projects which are in a state of advanced research and development" (Cragg et al. 1994:92).

It is questionable whether the referred law is consistent with the CBD (15.7 concerning fair and equitable sharing of benefits based upon mutually agreed terms and 16.5 about the ensuring that Intellectual Property Rights are supportive of and do not run counter to its objectives). The US has not yet, anyway, ratified the Convention.

Nevertheless, the NCI claims strong moral commitments to "make its best effort" to ensure that partners in source countries benefit from a new drug. Due to criticism, the NCI has recently made a change in the LOC which will be used in future contracts. In the new text, the NCI will require a licensee (the pharmaceutical company that has bought the rights from the NCI to produce the drug) to negotiate directly for the share of benefits with the appropriate Source Country Government agency(ies). It would, however, be more reasonable for the source country government to have a contract prior to the research activities stating its share of the royalties the NCI - and the source country party - obtain through the license negotiation with the drug company.

According to the LOC, the source country will usually not receive any share of benefits if the organism in question is freely available from different countries. Much biodiversity is located in areas with crossing borders, and this can be used by the NCI as an argument for refusing to provide any share of the benefits at all to source countries. Although the NCI follows an exchange model, their policy cannot be characterized as retributive justice since their transfer of benefits is undecided.

Shaman Pharmaceutical describes its approach as one which stands for "reciprocity". It has "a program of reciprocity", "reciprocal guidelines", and it provides "reciprocal benefits". Although the company's interaction with actors in source countries to a certain extent can be characterised as an exchange, its sharing of future benefits with its liaisons can also be seen as an allocation. Shaman has a policy of returning a portion of the profits of any and all products to all of the communities and source countries (King 1994). The Healing Forest Conservancy is established to distribute money among its liaisons in a manner which conserves biocultural diversity (Moran 1994). According to Shaman's policy, the company negotiates directly with communities for the funding of specific projects through the Healing

Forest Conservancy.

Like the NCI, Shaman has high moral commitments to return benefits to source countries and communities after a pharmaceutical product is commercialized. The size, however, of the share of benefits to source countries is not defined. Will all together as much as 10 per cent of future revenues be given to the providers of medicinal plants - or maybe only 1 per cent? As long as there are no indications or clear commitments of this portion, the approach has to be viewed as charity rather than fair and equitable sharing according to retributive justice. The source country liaisons get immediate benefits - often of a considerable size - from cooperation with Shaman. They have no means, however, of evaluating their total benefits from cooperation with the company.

The winner takes all?

Which actors in the South are the most suitable "sellers" of the biodiversity in the exchange with the bioprospectors? As we have seen, biodiversity prospecting can result in considerable revenues. A very small fragment of the collection activities, however, leads to a drug on the market as the end result. This is a special characteristic of biodiversity components which is important to consider for source countries who are about to establish institutional frameworks for their provision of access to these resources.

It is estimated that roughly about only one in 10,000 chemical substances screened will produce a valuable lead in the pharmaceutical and biotech industries, and less than one-fourth of the chemicals reaching clinical trials will ever be approved as a new drug (McChesney 1992:5, DiMasi et al. 1991, Reid 1994:245). With the use of multiple - and higher quality - screens, however, the probability of success could easily be ten times higher (Reid 1994:245).

Between 1960 and 1982, the NCI's screening program for cancer treatment obtained 114,000 plant extracts from 35,000 plants. Of these, only two extracts have resulted in applicable drugs, of which one, taxol, has been approved for marketing. Two other chemicals are in advanced clinical development. Today, the NCI plant collections are proceeding in over 20 tropical and subtropical countries. The screening is delimited to look for active agents only for the treatment of cancer and AIDS. However, the NCI has started to supply the extracts to other research organizations, and the chances of discovering novel drugs from the collected plants are thereby improved (Cragg et al. 1994:90-92).

Shaman Pharmaceuticals was founded in 1989, and it has worked in more than 30 indigenous communities and countries in Latin America, Africa and Southeast Asia (King 1994:74). Since the company bases its drug discovery program exclusively on information from traditional healers, the success rate might be higher than usual (Cragg et al. 1994:91). The company has, however, yet to commercialize a product, although potential products have been brought to clinical trials (Moran 1994:102).

In case of a commercial product of the NCI, only the source country will get some benefits, according to the NCI's contracts based on its Letter of Collection. When Shaman, on the

other hand, gets a drug on the market, benefits are to be divided between all participating countries and local communities. Whereas the NCI's approach is based on exchange between the institute and each source countries, Shaman's model is based on exchange between the company and all source countries seen together. I will argue that Shaman's model in this aspect is better than that of the NCI. Shaman's model provides for a sharing of benefits between all participating countries. The NCI model, on the other hand, may yield a large share of benefits to some lucky few, while the rest will not get any share of these benefits.

A question is which of the two models will be preferred by the source countries. The foreign parties can be considered as indifferent to this, with respect to their own interests, since their payment to one or more source countries will be the same. Both solutions may be considered as fair according to each definition of the relevant actors and contributions in the development of a successful drug. The first model will be preferred if the emphasis is put on the contribution of only the resources and knowledge in the specific case that led to the development of a new drug. If the emphasis is put on the total contribution of knowledge and resources as a remuneration of the maintenance of this, the second model is preferable. Besides, this model may also be considered as a better deal for each country participant instead of the "lottery-model". Furthermore, a sharing of benefits between several source countries will provide a better point of departure for distributive justice within the source countries based on the principle of shares according to needs.

A question then, is how to divide the share of benefits from a drug between the participating source countries. Firstly, according to the allocation model, there ought to be a distributor. In the case of Shaman Pharmaceutical, the distributor - the Healing Forest Conservancy - is an independent fund which has been established by Shaman. It is possible, however, to imagine that the source countries appoint a body themselves which can function as the distributor. Secondly, a principle of distributive justice must be chosen. Both the principle of equal shares and that of shares according to needs could be used. It is more likely to think, however, that the source countries here would prefer to apply the principle of shares according to contributions. The amount of samples collected from each country could provide the basic key for such a distribution. If, for instance one thousand samples were collected in a country and two thousand samples in another country - and no screening had been conducted by any of them - the latter country would get the double amount of the payment as the first country.

Allocation of benefits within source countries

Participants from the source countries in the reciprocal interaction with the foreign bioprospectors will influence the allocation of the source country's benefits fully or partly. If research institutes are invited to the negotiation table, they will be likely to take care of their own interests concerning research contracts, training possibilities, equipment, etc. If traditional healers were invited, they would present their own targets, and the same would the national treasurer or local participants of different kinds. This is quite understandable, but it leaves to the national legislators to provide the policy concerning participants and further requirements of the negotiations.

The NCI usually negotiates contracts about the bioprospecting with "country organizations". These organizations participate in the collection activities. Shaman Pharmaceuticals, on the other hand, has a policy of placing an emphasis on returning benefits to the local communities it works with.

NGOs in Costa Rica have criticized the non-profit organization INBio for being a private institution which, in the well-known deal with Merch & Co., sells Costa Rica's genetic resources unprecedentedly (Kloppenborg and Gonzales 1994).¹⁹ To a certain extent, the same criticism can also be made about how both the NCI and Shaman choose liaisons with which to negotiate, cooperate and share benefits. Policies, laws, and control concerning these activities and the distribution of benefits are still not in place. On the other hand, however, these activities must be considered as useful experiences on which the establishment of an institutional framework can be based. In Costa Rica, for instance, the discussion about INBio's activities has resulted in a national legislation concerning biodiversity prospecting.

Local contributions of knowledge as well as maintenance of biodiversity are essential for any bioprospecting. From the principle of distributive justice according to contributions, it would be appropriate to channel a large portion of the source country benefits to local communities. One mechanism for distributing the benefits to the local level could be to establish a national fund as the distributor. This fund could allocate finances to receivers such as local authorities, traditional healers' organizations, other NGOs, health agencies and anybody else with projects in the scope of a policy program, for instance in line with a sustainable management of biodiversity.

¹⁹ Kloppenborg and Gonzales themselves are most concerned about the neglect of indigenous people in decision making, since collection takes place in an Indian reserve.

Benefits to traditional healers

As stated above, traditional knowledge of medicinal plants provides a considerable contribution in the development of modern medicines from biodiversity prospecting. How should this be remunerated? If the principle of distributive justice according to contributions is to be applied, a traditional healer who provides essential knowledge, should be paid a share of the benefits from the drug sales which is proportional to the contribution. In most cases, however, the knowledge in question is found among several traditional healers and often also among other local inhabitants. Biodiversity prospectors use data on such knowledge from basic ethnobotanical research from a wide area, and they often record medicinal use of a plant from several sources. This is, of course, not an argument for not remunerating the traditional knowledge at all. Instead, it is a fact which makes the mentioned fund a more applicable mechanism in the construction of the institutional framework for the sharing of benefits within source countries.

Distributive justice according to contributions is a principle that could be applied to traditional healers as a group. A requirement could be built into the legal framework of biodiversity prospecting contracts that a certain portion of economic benefits be earmarked for basic health care projects involving traditional healers. This could provide support to initiatives such as projects of cooperation between the formal health sector and traditional healers on treatment of patients, dissemination of research results concerning side effects of certain medicinal plants, cultivation and refining of traditional healers' herbal remedies, etc.

Profit is not the only value which is to be distributed when modern medicine is based on knowledge about medicinal plants. Scientific and intellectual credit constitutes another important value. Both the NCI and Shaman Pharmaceutical have a policy of making proper acknowledgement of the contributions of communities and traditional healers. Such acknowledgement should include proper references to all the local providers of the knowledge and plants of the particular collection program as well as background data about the use of the plant remedy among various people and traditional healers.

There is a widely held opinion that biodiversity prospectors should disseminate the knowledge they collect in the local communities. McGowan and Udeinya (1994:66), for instance, propose that a biodiversity prospecting team publishes a guide in local languages with the information about medicinal uses of local plants. This guide would list plant names, descriptions, medical conditions, and the physical preparations of the plant compounds.²⁰ In Tanzania, I have met scepticism against such a strategy for two reasons. First, the knowledge of traditional healers is not a commons of the community. Instead, it is a competence the healers have gathered through their traditional training and own experience. Although much knowledge of traditional medicine *is* commonly known, there are important plant remedies that traditional healers would like to keep as a "trade secret". A local revealing of this knowledge by biodiversity prospectors, may pose a threat to the practice of the traditional healers. Second, the dissemination of the knowledge may be used by short-perspective profit hunters to start collecting and processing the plant material. This can cause threats to the

²⁰ McGowan and Udeinya do not, however, propose to reveal the process of healing used by different healers and practitioners since this often involved confidential information or spiritual practices.

local or total maintenance of medicinal plants.

In some countries there are nation-wide organizations with a high degree of legitimacy among the traditional healers. Such organizations could, by national law, be required as a part of negotiations for bioprospecting programmes.

Targets for a sustainable management of biodiversity

This section will focus on targets for the allocation of bioprospecting benefits within source countries. Do these targets give positive contributions to present people's abilities to fulfill material needs of subsistence without compromising the ability of future generations to meet their own needs? We will see to what extent present sharing arrangements are aimed at targets concerning the utilization and maintenance of biodiversity. Furthermore, we will look at targets for the distribution of benefits related directly towards fulfilment of material needs of subsistence by the provision of medicines and health facilities.

Utilization

Many source countries are among the poorest countries in the world. Benefits from the bioprospecting can be used to build and improve a country's capacity for utilization of its biodiversity and thereby generate income.²¹ According to the aim of maintaining biodiversity, sustainability must be a fundamental requirement of the utilization.

Bioprospecting itself can be seen as an economic activity for which the source countries can use the benefits to develop its capacity. Today, the source countries are to a large extent raw material exporting countries for the pharmaceutical industry. The capacity could be improved for carrying out collection, taxonomy, chemical screening and even drug production. The revenues from this sector - as most other economic activities - increase with an enhanced refining.

By cooperating with research organizations in the source countries, the NCI gives some contribution to the improvement of the countries' bioprospecting capacity. All the screening of the plant material, however, is conducted in the NCI's laboratories in the US. The NCI invites scientists from the country organizations to their laboratories for one to two weeks. Cragg et al. (1994:91) report that thus far, 28 representatives, mainly scientists, from 19 countries have been guests of the NCI in the US. Furthermore, the results of the NCI's screening are reported back to the relevant liaisons in the source country. The NCI's contracts with research organizations in the source countries are probably valuable for the involved organizations. Nevertheless, the total contribution of capacity building must be considered as relatively limited.

²¹ The government may allocate parts of this income to targets which benefit the poorest people and contribute to their fulfilling of material needs of subsistence. It is, however, beyond the scope of this paper to look further into the more fundamental questions of the general allocation of revenues in a poor country.

Shaman Pharmaceuticals does not usually cooperate with source countries' research organizations.²² According to its policy, Shaman's funding organization, the Healing Forest Conservancy, focuses on programs for collection, taxonomy and chemical screening on the local level (Moran 1994:103).

When a modern plant-based drug is developed, there will usually be a demand for plant material as a primary commodity for the drug production. This represents opportunities for a new income generating activity. If the plant species is endangered, the establishment of cultivation will be necessary for the maintenance of the plant. The NCI will require the drug producer to primarily use the source country of the screened plant also as the source of further supply of plant material for this plant (The NCI's Letter of Collection, clause 10). For Shaman Pharmaceuticals, an important part of the returning of benefits involves the creation of new natural product supply industries in the countries where the company works (King 1994:72).

Maintenance

The maintenance of biodiversity is necessary to enable future generations to fulfill their material needs of subsistence. In the case of the INBio/Merck agreement in 1991, INBio emphasized conservation as a major target. INBio decided to contribute 10 percent of the budget of US \$ 1,135,000 and 50 percent of any royalties to the Costa Rican government's National Park Fund (Aldhous 1991, Reid et al. 1993:1).

Both the NCI and Shaman Pharmaceuticals see their activities as positive for the maintenance of biodiversity. Bioprospecting generally represents a sustainable use of biodiversity that may take over for other unsustainable economic activities. Direct support to the maintenance of biodiversity, however, is not emphasized.

Bioprospecting may sometimes itself lead to destruction of biodiversity. In one example, the entire adult population of a medicinal plant was harvested in the 1970s when collectors sponsored by the NCI collected more than 27.2 tonnes from a game reserve in Kenya (Oldfield 1984, Juma 1989:198-199, Reid 1994:243). Such negative effects of bioprospecting should, however, be possible to avoid with the use of trained collectors and strict guidelines and regulations.

Medicines and basic health care

Benefits from the new drugs can be allocated directly to targets that improve peoples' fulfilment of material needs of subsistence. Since medicines are developed with the use of knowledge and resources from poor countries, it is natural to focus on the availability of these medicines. Often, however, the new drugs are designed to fight diseases common only in the rich world. In those cases, the product itself cannot improve the health conditions in

²² In Tanzania, however, they were negotiating for a contract with the Institute of Traditional Medicine in 1994.

the source countries. On the other hand, if the NCI's research leads to the production of effective medicines for AIDS patients, this could be of tremendous help in source countries like Tanzania with many AIDS patients. A question is, however, whether poor people in countries like Tanzania will be able to afford to purchase these medicines. To provide for such direct benefits from bioprospecting, the source country contractors could require that the production company provide the medicines to all source countries to cost price. A compulsory licence - without payment - could also be required to provide for any domestic production in source countries.

As mentioned in the section on traditional healers, benefits connected to drug sales could be earmarked for local health care projects, and especially projects that involve traditional healers. Allocation of benefits to this target would combine the principles of distributive justice according to contributions and needs.

Conclusion

Changes in property regimes related to natural resources have distributional consequences. This paper explores how such implications can be studied and evaluated. We are in the middle of a process where new property regimes are being established for genetic resources. This will have implications for the collection of plants in the tropics for medicinal screening. As an important part of the implementation of the Convention on Biological Diversity, countries are to establish institutional frameworks for realizing national sovereignty in a new area. In this process, it is useful to look at arrangements that the bioprospectors themselves already have established for whom they will include, and how, in their sharing of some of the benefits. Do bioprospectors - such as the NCI and Shaman Pharmaceuticals - deserve to get rid of the labels "gene hunters" and "biopirats"? Although both have adopted strong ethical commitments for equitable sharing of benefits, this paper shows that their provisions of benefits to the source countries are uncertain and relatively limited.

One important argument of the paper is that the source countries will benefit from an arrangement where they constitute themselves as one entity in the exchange with a bioprospector. Such a common strategy among source countries would secure all country participators a share of the benefits.

Finally, the paper points to targets for the allocation of bioprospecting benefits. With the source countries' establishment of necessary institutions, bioprospecting can provide for important contributions to a sustainable management of biodiversity.

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