Shifting Propagation: The Political Economy of Bioprospecting in Madagascar

Proposed Dissertation Research
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April 19, 2004

ABSTRACT

Addressing a worldwide concern, the 1992 Earth Summit in Rio provided the first global regulatory consortium dealing with the plight of genetic resources. However, far from settling concerns, the ratification of the Convention on Biological Diversity (CBD) sparked numerous debates coalescing around the proprietary use and control of genetic resources. Some contend it is the subsequent phrasing and adoption of the term *genetic resources* by the CBD protocols that framed genetic or biochemical material and information in the context of an "exchangeable commodity," thereby conflating the value of genetic materials to that of a commodity to be captured, extracted and manipulated similar to previous forest-based natural resources (e.g., high-value timber, charcoal). Genetic resources are similar in ways to forest-based commodities by the spatial configurations they both share. But researchers theorizing natural resources note that it is the "different properties and commodity characteristics" that shape the processes according to which labor and value are appropriated for the distribution of benefits (Peluso and Watts, 2001:26). My research question focuses on how the material (biophysical and social) characteristics of genetic resources shape the spatial and temporal dimensions of bioprospecting in Madagascar. As my point of departure, I have constructed a three-part resource typology of plants that were once or are currently being extracted from Madagascar for biomedical uses. This resource typology follows the temporal stages leading to commercialization. These different stages of commercialization include: (1) *non-articulated* (early stage- relies on the biological material), (2) *semi-articulated* (intermediate stage- semi-synthetic) and, (3) *fully articulated* (most advanced stage- have isolated the compound for chemical synthesis). For this research, I will employ a Commodity Chain Analysis (CCA) to follow the relations of each of the types of resources included in the typology. With the use of a CCA, I will investigate the chain of relations including the prospecting or exploration, production/collection, transport and exchange of genetic resources. The product of this research will be helpful by those evaluating the relevance of current Access and Benefit Sharing protocols (ABS), and the application of more efficient distributive mechanisms.

Project Description

The use and control of genetic material is central to the study of natural resources. Recent scholarship in critical geography and political ecology has opened new ways of analyzing, defining and theorizing access to and extraction of natural resources (Peluso and Watts, 2001; Zerner, 2000; Neumann, 1998; Peluso, 1992) and the distributive mechanisms of benefits captured from the resource (Schroeder, 2000; Ribot, 1998; Rocheleau et al., 1995).

Addressing a worldwide concern, the 1992 Earth Summit in Rio provided the first global regulatory consortium dealing with the plight of genetic resources. The summit developed a number of access and benefit sharing protocols, conventions of intellectual property rights, and frameworks for regional biodiversity agreements, culminating with the signing of the Convention on Biological Diversity's (CBD). The main focus of the CBD was the conservation of *in situ* and *ex situ* genetic resources, monitoring and assessment of the components of biological diversity and fair and ethical access to genetic resources (ten Kate and Laird, 1999). However, far from settling concerns, the ratification of the CBD sparked numerous debates coalescing around the proprietary use and control of genetic resources.

This global debate posed some sobering realities for advocates of biological prospecting (bioprospecting for short). Bioprospecting, observed by Barrett and Lybertt (1999) is founded on the idea that the commercialization of valuable genetic resources for potential improvements in medicine and food will foster social and economic development in areas that have marginal economic opportunities while maintaining a high level of resource-rich biodiversity. This will then provide the motivation to finance biodiversity conservation in the tropics (Eisner, 1992; Reid, 1993). Advocates pose images of research scientists in the medical and pharmaceutical industries working side by side with local shamans searching for remedies to all of humanity's ills within the canopy of the rainforests, whereas critics forecast warnings of "piracy" of biological material and knowledge (Shiva, 1997), which prompts concerns about the "commercialization and potential monopolization of a fundamental constitutive of life - genetic material" (Parry, 2000:374).

Some contend it is the adoption of the term *genetic resources* by the CBD protocols framing genetic or biochemical material and information in the context of an *exchangeable commodity*. This subsequent phrasing thereby conflated the value of genetic resource to that of a commodity to be captured, extracted and manipulated similar to previous forest-based natural resources (e.g., high-value timber, charcoal). As McAfee observes, "the dominant paradigm of environmental resource management attempts to incorporate nature within [a] neo-classical economic framework, emphasizing the role of markets in the valuation and allocation of natural resources, including genetic information" (2003: 204). It is this "economic reductionism" as McAfee calls it, appropriated by the CBD protocols, which politicizes the landscape surrounding genetic resources.

Biological and genetic resources are similar in ways to forest-based commodities as they may share some spatial configurations for those claiming resource use, for example

place-based sites useable for resource extraction and commercialization, including geographic range, growing provenance, tenure configurations, etc. Current research theorizing natural resources stress that it is the "different properties and commodity characteristics" that shape the processes according to which labor and value are appropriated for the distribution of benefits (Peluso and Watts, 2001:26 also Peluso and Ribot, 2003). Questioning the direct relationship between violence and natural resource scarcity, Peluso and Watts mention that to adequately address natural resource access, "the starting point …must begin with the appropriation of nature that is necessarily historical (what sort of labor) and which is social (the appropriation of Nature is determined by social relations, particularly relations of ownership and control)" (2001:27). Following this argument to effectively theorize genetic resources one must take into account both the biophysical and social characteristics that help shape the "processes of transformation" and "societal relations of production" of resources and their meaning in its commoditized form (Peluso and Watts, 2001).

In concert with the wave of global neo-liberal economic reforms, market-based conservation grew increasingly popular in the 1990s as a central tenet of Integrated Conservation and Development (ICDP) schemes. These schemes include: ecotourism, bioprospecting, non-timber forest products, game ranching, intensive commodity production, carbon sequestration credits and conservation trust funds for debt reduction. It was the adoption of bioprospecting within this wave of ICDPs that immediately transformed its character into a friendly, happy and commercialized *gene hunt*. As noted by Lybbert et. al,"market-based conservation strategies hold that only through valorization of a particular natural resource will those living closest to the resource begin to understand the need and necessity for conservation" (2002:125; c.f. Barrett, and Lybbert, 1999). This strategy is reinforced by the creation of novel and expanded markets, entrepreneur training, quality control and assurance and environmental labeling. Market based conservation's purpose is to improve locals' motivation for the conservation of natural resources by tapping into newly created markets for that resource (Lybbert et. al, 2002; Barett and Lybbert, 1999).

Since that time with the appropriation of technological innovations in horticulture, genomics and biotechnology, we have in essence observed the *rules of the hunt* change dramatically. Parry notes that new advances in rational drug discovery processes such as pharmacological screening, combinational chemistry and robotics have "fundamentally alter[ed] the nature of the biological materials so that they become infinitely more amenable to collection, concentration and control" (2000:382). Following Parry, I argue that this is hardly a benign activity exploratory searches and collection, and produces highly politicized ecological and social spaces.

This is nowhere more apparent then on the island nation of Madagascar. Due to its divergent evolutionary history, Madagascar maintains the richest diversity of flora and fauna in the world. It contains more than 12,000 plant species, of which 80 percent are endemic (Myers et al. 2000). Over time the plants of Madagascar have cultivated distinctive phenological, growing and provenance traits as well as exceptional chemical properties (i.e., compounds- including alkaloids, proteins, etc.). For pharmaceutical companies engaged in bioprospecting, a key objective is to isolate novel compounds found in the plants genetic structure. These compounds become the potential lead for

drug development and the knowledge of plant structure used in chemical synthesis. Because of these unique plant properties Madagascar is now seen as a potential goldmine of novel pharmacological discoveries.

My research question focuses on how the material (biophysical and social) characteristics of genetic resources shape the spatial and temporal dimensions of bioprospecting in Madagascar. As my point of departure, I have constructed a three-part resource typology of plants that were once or are currently being extracted from Madagascar for biomedical uses. This resource typology follows the temporal stages leading to commercialization. These different stages of commercialization include: (1) *non-articulated* (early stage- relies on the biological material), (2) *semi-articulated* (intermediate stage- semi-synthetic) and, (3) *fully articulated* (most advanced stage- have isolated the compound for chemical synthesis).

For this research, I will employ a Commodity Chain Analysis (CCA) to follow the relations of each of the types of resources included in the typology. With the use of a CCA, I will investigate the chain of relations including the prospecting or exploration, production/collection, transport and exchange of genetic resources. These spatial relations include: (a) differing nodes of production/collection transport activities, i.e., cold chains, packaging, sorting, storing, contracting, etc. (b) spatial patterning of collection sites such as: biological reserves, and (c) political actors within pharmaceutical companies, academic and botanical collecting institutions, development and donor agencies and conservation organizations. The CCA allows for the investigation of this nexus of spatial patterning and material relations embedded with the use and control of genetic resources. I question the role that technology is playing in shaping the landscape that bioprospecting operates. The product of this research will be helpful by those evaluating the relevance of current Access and Benefit Sharing protocols (ABS), and the application of more efficient distributive mechanisms.

I. The Shift in Propagation

Due to its unique biogeography, Madagascar maintains the highest species richness per unit area, playing host to 3.2 percent of global endemic plants (Myers et al., 2000). The ancient forests of the island's central plateau are home to the rosy periwinkle (*Catharanthus roseus*), a plant distinguishable by its tiny pink flowers and shiny green leaves. In 1958, Gordon H. Svoboda, of Eli Lilly Pharmaceutical Company, tested extracts of the rosy periwinkle as part of a detailed investigation of previous "folkloric usage" of the plant as a possible oral hypoglycemic (ten Kate and Laird, 1999). The chemical screening found two distinctive *vinca* alkaloids and led to the subsequent development of a novel treatment for childhood leukemia. This distinguished the indigenous Malagasy plant as a global pharmacological treasure. But for Eli Lilly the collection of thousands of kilograms of the plant's leaf material from the rainforests of Madagascar never seemed plausible. As a result the company shifted its focus away from collection towards production of periwinkle plantations on farms in McAllen, Texas.

This shift toward cultivated periwinkle was a calculated move on behalf of the pharmaceutical company to ensure a steady source of biological material for drug

discovery and subsequent patent. And I hold it is this separation from the source of origin (both spatially and temporally) that strips the resource of its true value. Questioning the value of genetic resources in biotechnology, McAfee stresses, “natural-resource values and knowledge about nature are inseparable from place-specific ecologies, cultural practices of farming and science” (2003:203). Therefore in this case, the periwinkle is now reduced to that of a tradable commodity without any accountability to the country of origin, region of endemism or place-based knowledge of its chemical components.

This shift in the “collection” practice is featured in Bronwyn Parry's brilliant essay: *The Fate of the Collections*. Parry's work examines an ignored facet of bioprospecting: "what happens to the samples of genetic and biological materials after they leave the localities in which they were collected."(2000:375). This analysis highlights the importance of the collected material and the power of the actors controlling the resource. For Parry, collecting is "a process that enables individuals or groups to alienate (both territorially and epistemologically) particular bodies of material for their exclusive use" and the “complex process of collection that entails not only the acquisition but also the concentration, disciplining, circulation, and regulation flows of material" (2000:375).

The case of the periwinkle shows a growing trend toward alternative sourcing for genetic resources. Increasingly, large national botanical repositories such as the cryogenic stored collections of US National Cancer Institute are now becoming ideal sites for extraction (Parry, 2000). This potential trend toward bioprospecting directly out of *ex situ* collections, conjures notions of a *leasing of life* and raises many ethical questions concerning power relations and accountability of the collectors toward people at the source of origin. It is the use of *ex situ* libraries of biological and genetic material that "operates on the premise that these materials can be utilized and reutilized by any number of interested parties" (Parry, 2000:390). As Schroeder notes, it is this increasing trend of bioprospecting toward “re-mining," that has made accountability “up and down the production chain next to impossible" (2000:55).

Shifting technology

Another shift found in bioprospecting industry is one toward technological advances. With the appropriation of high-input technologies in the fields of horticulture and genomics, plant material collected may be regenerated at a quicker rate and stored for longer periods of time (Parry, 2000). Using a process called micro-propagation and tissue culture, the plant science industry can take advantage of plant *totipotency* or undifferentiated plant cells that can give rise to unlike cells and develop into or generate a new organism or part. Some plants even have somatic cells and whole organs, such as leaves, shoots, or roots that can be created from cells or tissues in a process called *organogenesis* (Kyte and Kleyn, 1996). While countless other plants can be cultured *in vitro* purely from a few seeds or embryos produced from a few somatic cells in a process called *somatic embryogenesis*.

The increasing use of existing botanical collections, gene-banks and tissue-culture sourcing illustrates how biological and genetic material is constantly refashioned spatially through ongoing recycling and control of flows of capital and is analogous to

Page who notes that "the ongoing transformation of nature under capitalism" (Page, 1997:144). Furthermore, Harvey (1985) mentions that the "drive for capital accumulation is not only expansionist but also dynamic." For Harvey, central to capitalist accumulation was what Marx theorized as the "annihilation of space by time." Following Harvey, capital is geographically mobile, and capitalism is always moving to conquer its spatial barriers and "speed up the velocity of circulation of capital in the spheres of both production and exchange" (1985:37). Although Harvey was questioning the advancement of technology on obliterating space through transport of goods and services to benefit the production process, I argue that we are witnessing a new kind of annihilation, one of the controls of biological time through space- or the speeding up of the period when genetic material can be obtained for the full advantage of the collector.

In today's bioprospecting, biological material is transferred, stored and manipulated in *ex situ* collections setting the stage for a highly politicized and uneven landscape. Parry argues that two fundamental changes in the collection process have exacerbated its unevenness of approach to development and politicized it on a global scale.
These include " (1) as process of technological innovation fundamentally alter the nature of biological materials so that they become infinitely more amenable to collection, concentration and control; and; (2) as processes of global economic and regulatory change improve collectors' ability to recirculate and regulate the flow of collected materials more strategically and thus to further advantage" (2000; 382). This transformation, appropriated through the shift towards advancements in technology is captured by a select few actors involved in the practice and plays itself out spatially through the production/collection, exchange and manipulation of genetic resources. It is this spatial development in the landscape of Madagascar that this research proposes to investigate.

Shifting benefits

Taking on the pressing questions concerning access and benefit sharing mechanisms (ABS) is the focus of Laird, Cunningham and Lisinge (2000) insightful piece, *One in Ten Thousand? The Cameroon Case of Ancistrocladus korupensis*. Laird and co-workers, provide a range of approaches and constraints regarding the distribution of benefits from the capture of genetic resources. The authors outline a "distribution dilemma" regarding specific geographic, biophysical and social limitations to the potential effectiveness of any ABS policy. The three approaches are outlined as follows:

"(1) *point of collection*- benefits should be returned and negotiated directly to communities, institutions or governments (or all) in areas where a species or knowledge of that species is collected(this is the approach outlined by the CBD); (2) *the bioregional approach*- benefits should be returned to a bioregion area to which a species is native; and (3) *global funds*- benefits should be fed into a global fund that will return benefits to communities and institutions throughout the developing world" (Laird et al., 2000:361).

Laird and coworkers explain the geographic dimensions of the "distribution dilemma," concerning the case study of *Ancistrocladus korupensis* (2000). A. *korupensis* is a woody vine found in the tropical forests of central Africa that was identified in 1987 "to have great promise in the US National Cancer Institute (NCI) and the Missouri Botanical

Gardens Institute (MBG) natural products screening labs (Laird et al., 2000). In 1990 the NCI drafted a Letter of Intent (LOI) and in 1993 was reformulated the basic agreement as a letter of collection (LOC) signed by parties representing the NCI and Cameroon. This was effectively a "point of collection" distribution agreement, and benefits would be shared to those in Cameroon who actually collected the resource in the wild. But, the species is found growing and collected across both boundaries of Cameroon and Nigeria, an example of regional endemic species that ideally calls for a bioregional approach. The bioregional approach (BR) has the advantage of distributing benefits towards those countries and/or ethnic groups whose territories all share a resource. It holds the underling assumptions that "neither species nor cultures conform to political boundaries, thus benefits should be distributed amongst those who share the geographical distribution of the species." But what is to stop collection in Nigeria where there will be no accountability to those who deserve benefits? Should the distribution cover all plant resources being collected in the area or just A. *korupensis*? This case raises many ethical issues surrounding the current policy governing ABS agreements.

The global fund for the distribution of benefits does not depend on detailed accounting of genetic contributions of peoples, communities or nations throughout the developing world. Advocates have suggested that this fund might be best for species with no "biogeographic endeminism" and for a global fund for all communities (Laird et al; 2000). Critics of this approach mention that it undermines the incentive for those to use biodiversity-prospecting ABS conceived through the CBD for sustainable development and conservation. As noted by Laird et al., the case Rosy periwinkle makes an argument for the rights of global fund for the distribution of benefits. But its biophysical characteristics as a pan-tropical provenance provide complications to how benefits were to be distributed. As noted by researchers, although the species was found with the active components in Madagascar, the Philippines and Jamaica would have a better argument for benefits, because the plants compounds were found in use in both of these countries and originally sparked scientists interests (Laird et al; 2000; Schroeder, 2000).

The constraints found in establishing sufficient ASB protocols and fair distributive mechanisms may be found in the CBDs attempt to cover *all* genetic resources under a generic and simplified definition, one that produces space unevenly for the advancement of certain actors. Contrary to this, I argue that it is material characteristics, both the distinctive biophysical and appropriation of the social relations of production, that compound the constraints and make the effectiveness of ABS incomplete. And by focusing on only the collected form of the resource, as seen by Parry (2000), forgets about a whole range of processes and transformations leading up to the collection. For my forthcoming research I will be investigating the spatial processes up to the point of placing the sample into these large botanical repositories. Looking at the material characteristics (biophysical and social) of the resource will help map the spatial and temporal relations and provide accountability to those actors involved in the chain of production.

Commodity Chains Analysis

Commodity Chain Analysis (CCA) or global commodity analysis is a useful empirical and theoretical tool especially for those investigating commodities across temporal and

spatial scales. Such analyses concern the networks of labor and the production used in furnishing of finished products or commodities. Bernstein notes that the original approach to constructing a commodity chain was found in the earlier French industrial economic literature, their term *filières vivrieres* (food commodity chains), investigated, "the interconnectedness of various stages" through the sequential period of physical transformation" (1996:120). Commodity Chains introduced by Hopkins and Wallerstein (1994), to theorize international agricultural products saw CCA "as a network of labor and production processes whose end result is a finished commodity." They highlighted specific nodal points along the processes of production, and used the CCA to understand how "key" actors build, coordinate and control the links and flow of commodities. Raikes et al., mention that the early theorists of commodity chain analysis were concerned with the "roles played in the input-output structure, geographical or spatial configuration, the governance structures and organizing of international trade, from primary production to final consumption" (2000:393). And mention that the Global Commodity Analysis were devoid of any real political, or social-economic dissection.

It was the theorists concerned with the political economy of the chain, who later conceptualized "the markets" as particular objects of investigation (Ribot, 1998; Goodman and Watts, 1997; Gereffi et al., 1994; Bernstein, 1996; Thrupp, 1991). Rather than as an abstract object of empirical understanding, these researchers used the market as a way to investigate questions of power and access. Bernstein notes that they also see the political economic structuring as "the sources, exercise, and effects of unequal market power and the relations between differentiated agents" (1996:121).

The empirical political economic focus on markets is what Ribot (1998) follows in his use of the global *filière* approach. The *filière* approach heavily influenced by the French Regulation School and was first used in the French colonial and post-colonial states for agricultural commodities. As noted by Raikes et al (2000), it was the *filière* approach that incorporates historical nuances and regulation issues to the CCA structural components. Ribot mentions how this approach places attention to "webs of power relations" that are nested within multiple scales (1998). This framework focus on a material study of natural resources rooted in historical and social relations, incorporating the whole geographic landscape of production, exchange and distribution around chains of market relations. Ribot's study "broadens predominate focus on individual mechanisms of control and accumulation"as an approach to how politics and the embeddings of political institutions gain entry into the spaces of the market (1998:308).

Schroeder makes note of how rare the factors of "political economic dimensions of resource extraction" that are highlighted in a CCA figure into the analysis of policies of resource use (2000:58). Ribot and Peluso, (2003) illustrate that it is the "bundles of powers," that ultimately affect how a resource is valorized and subsequently shape the ability to benefit from that resource. They list a host of categories (i.e., technology, capital, markets, labor, knowledge, authority, identity and social relations) that must be factors into a political economic analysis of natural resource extraction. The purpose of this research is to unpack the power relations within the existing practice of the extraction of a resource. I question how the appropriation of new technological advances has refashioned the landscape in which bioprospecting operates, and has developed unevenly in Madagascar. For my proposed research, I follow Ribot's (1998) "commercial circuits,"

as a CCA including not only the relations of production toward its "exchange and final use," but as my research proposes to show how a particular commodity is recycled and re-mined for future use.

II. Methodology

The material characteristics of genetic resources in bioprospecting: Constructing the typology

Background: Biological prospecting for genetic resources is a complex practice and is compounded by a myriad of factors contributing to process of discovering, developing and bringing to the market new drug products. Of the top 150 prescription drugs in the US today, the total numbers of compounds that derive directly from plants are 34, with 25 of those drugs in a semi-synthetic state. But interestingly also out of the top 150, 64 are synthetically derived (Gifo et al., 1997). The slippery *nature* of how genetic resources are conceptualized and valued, leads me to question if this resource can be conceptualized the same way other natural resources have been framed in the past. For example, in Ribot's theorizing of the Senegalese charcoal commodity chains, the commodity charcoal is valued by a finished product (kg. of processed bricks) (1996). But, as mentioned previously, the purpose of this research is to evaluate the distinctive material characteristics of genetic and biological resources for use in drug discovery, and if the valuation and conflation of these resources by the actors involved politicizes the landscape in where extraction takes place. As my point of departure, I have constructed a three-part resource typology of plants that were once or are currently being extracted from Madagascar for biomedical uses. The typology's purpose is to construct a crude guide to the nexus of the material (biological resources) and non-material (knowledge) forms of what is valued as a genetic resource.

This resource typology follows the temporal stages leading to commercialization. These different stages of commercialization include: (1) *fully articulated* (most advanced stage-isolated the compound for chemical synthesis), (2) *semi-articulated* (intermediate stage-semi-synthetic or biological extraction) and, (3) *non-articulated* (the mining or prospecting stage). The importance of this typology is to highlight the distinctiveness of selected genetic and biological resources and underscore the differing ways the resource is valorized. Later, through a commodity chain analysis, I will show how labor is incorporated into the process and benefits captured among all the actors involved. I will be following this typology to help guide my methodology, I will employ three distinct narratives (three tales) providing the framework for my empirical evidence and subsequent data to be collected in my fieldwork.

1-Fully articulated- The Tale of the Rosy Periwinkle

For pharmaceutical companies engaged in bioprospecting, key to its objectives is to isolate a novel compound found in the plants genetic structure. This compound becomes the potential lead for drug development without the "excess baggage of raw material" (Parry, 2000). Such resources are in a highly developed stage of development and are characterized by the use of the knowledge of the compound chemical structure to create

the drug. This knowledge-based genetic resource is *fully articulated* and is in an advanced stage of commercialization.

The purpose of telling *the tale of the Rosy periwinkle* is to establish a historical context for biological prospecting and find a comparative basis for study. For this knowledge-based genetic resource I will provide an account of the *boom and bust* of the Rosy periwinkle (*Catharanthus roseus*). This historical reconstruction will follow the commercialization of Rosy periwinkle within Madagascar and abroad- as future research may entail examination of *ex situ* production sites in western Texas and elsewhere. This story will allow me to provide a historical backdrop to the processes involved in the capture of a genetic/biological resource through all the three stages of commercialization. This analysis will show how space and time are transformed allowing for the periwinkle's current use, valuation and ownership.

Key methods include:

- Surveying scientists and researchers who were involved in the initial interest of prospecting the periwinkle in Madagascar.
- Find and examine records on global, national, regional and local natural resource laws, judgments, amendments and historical accounts of extraction in Madagascar concerning the Rosy periwinkle from 1950-1990.
- Conduct interviews with those actually involved with providing the labor across the chain of spatial and temporal relations that eventually led up to the commercialization of the periwinkle.
- Evaluate the biophysical characteristics of the periwinkle, showing how its distinctive characteristics have helped shape its current commercial trajectory (growing provenance, phenology, propagation, etc.).
- Conduct a archival and historical search for the eastern forest corridor in Madagascar regarding natural resource extraction and research protocols concerning bioprospecting.

Building on my previous work conducted in the eastern forest corridor, I will provide the political economy of shifting cultivators in Madagascar. This will involve a historical analysis of *tavy*[1], colonialism, post-colonialism, structural adjustment and current economic indicators and trajectories. It also includes a detailed analysis on the substance and commercial agricultural sectors, including agriculture, mechanized agriculture and indigenous farming knowledge. I will proceed by collecting published data: (1) agricultural sector in Madagascar, including imports, exports, agrarian land tenure and land reform (2) demographic data on population, family size, and community structure, and (3) history of development interventions and assistance programs on the global, national, regional and local scales. This political economic analysis will allow a backdrop to the importance of the extraction of natural resources in the economies of those living closest to collection and exploration sites. These including the *Betsimisaraka* , *Betsileo* and *Merina* ethnic groups. This will help show how historically the incorporation of local labor transforms the political relations and spatial dynamics of bioprospecting in

[1] Shifting cultivation (*Tavy* in Madagascar) is an agricultural practice that has been in use throughout the humid-high and montane forests of Eastern Madagascar for hundreds of years. *Tavy* utilizes slashed and burned forest vegetation for release of nutrients in the production of upland rice. Sparse populations and extensive forests allowed for shifting cultivation to be a sustainable agricultural practice for many centuries.

Madagascar. The juxtaposition of cultural practices with new forms of labor and technology will help provide a historical backdrop for the continuing research.

2- Semi-articulated- The Tale of Pygeum (Prunus africana)
The second type of genetic resource has been clearly identified as possessing important medicinal properties but cannot yet be chemically synthesized, and may rely still on the extraction of the biological material. This intermediate or *semi-articulated* stage of commercialization will allow me to show a developing resource, through its scientific, social and biophysical transformations across a temporal sequence from exploration towards exploitation.

Bark extracts from P. *africana* are useful in the treatment of benign prostatic hyperplasis (BPH) and prostrate gland hypertrophy. The commercial value of its bark and bark extracts is estimated at over US $200 million annually (Cunningham et al., 2000). But due to its cocktail of active chemical components synthesis is not viable (because its active components have been found to be effective only in a bound relationship to other components found in its chemical makeup) and those who are involved in the process must rely on the raw material for commercialization.

Pygeum has limitations on supply, and the reasons for these limitations may be many, i.e., CITES listed. This type will allow for the study of a developed biological resource in current collection and commercialization stages. Most noteworthy, how labor and labors are incorporated into the process. Furthermore, due to the heavy exploitation of the species, this type will show how conservation and resource extraction are connected and politicized, which is a process I term as *extractive conservation*.

Key methods include:

- Commodity Chain Analysis (CCA)- following the exploration, production/collection, exchange, and transport/storage of biological resources.
- Ethnography of actors through a empirical exercise of access mapping.
- Use Geographic Information System (GIS) maps of sites of extraction and growing provenance, not only allowing for participatory mapping (comparing local accounts to those of state and NGOs). But with time-sequence mapping to counter claims of extraction and exploitation.
- Find records on global, national, regional and local natural resource laws, judgments, amendments and historical accounts of extraction.

3- Non-articulated –The Prospector's Tale
The third type of genetic resource is what I will term as being *non-articulated*. It is in a protean state of development and either has not yet is located as a species or is in an explorative stage of commercialization. This real or imagined resource is valued in a much different way then the previous two. Its value is constructed by either the collection of the biological materials for samples in the lab or access given to a certain geographic area (usually primary or secondary forest) for prospecting for new plant materials.

***Background*:** Providing a clear methodological framework for the issues that concern biological prospecting and natural resource conservation in Madagascar involves a detailed critical analysis of the relationships between the actors involved. The

methodology of *access mapping* is expressed by Ribot, as a way of "evaluating the distribution of benefits along the [commodity] chain" also "tracing out the mechanisms by which access to benefits are maintained" (1998: 307). For Ribot, these "inter-related mechanisms" were traced out across the Senegalese charcoal networks. The approach taken for my study adds another element to Ribot's methodological framework. It attempts to question if prospecting for genetic resources, in essence an *imagined resource* can be theorized as a material discrete object. This analysis will evaluate how the networks involved in this process is shaped spatially as well as the discourse surrounding the act of bioprospecting has changed temporally in Madagascar.
These networks of actors include: pharmaceutical companies, state agencies, research institutions, development agencies, environmental non-governmental organizations, marketers, consumers and buyers of the product, and those actors who discovered the species or the process involved in the extraction of the genetic resources involved.

***Data*:** The purpose of access mapping will be to get data that can: (1) Provide and express the different relationships of power that exist between actors. This may be expressed with different types of evidence, those including: political influence, monetary budgets, scientific and resource capacity, property tenure, access and distribution of natural resources, (2) State the roles of the actors involved in biodiversity prospecting; their mission, outcomes etc. and, (3) Convey the actual and sometimes perceived environmental, social and political conditions/ justifications that exist for bioprospecitng and if these justifications change. Some of these institutions (which will include many people in one institution or organization) include: New York Botanical Gardens, Missouri Botanical Gardens, Eli Lilly and Bristol Myers Squibb, USAID, World Bank, World Resources Institute, the Timbhazza Zoological Institute, University of Antananarivo, and ICIP Research Center. Also it will be important to speak to those who are currently involved in scientific and technicians currently in labs in Madagascar these include: National Center for Application of Pharmaceutical Research, Malagasy Institute for Applied Research Foundation (IMRA), National Center for Environmental Research (CNRE), Chemistry and Microbiology Laboratory, Ministry of Commerce (LCM).

Semi structured interviews surrounding collection sites
Much of the information on the rural political economy on the shifting cultivators in Madagascar will be gathered from sources including: semi-formal interviews within districts closest to the largest natural reserves, locations where most of the biological collection and extraction is taking place. These sites include; (1) Zahamena Protected Area (2) Masoala National Park (3) Ranomafana National Park. These interviews will include open-ended survey questions about their perceptions of and involvement in the exploration and collection of medicinal plants from their primary and secondary forests. Also I will attempt to interview different classes of collectors 'medicine men,' laborers involved in the chains (i.e., packaging, sorting, storing, contracting, etc.) as well as those involved in the process of prospecting for genetic resources coming form different academic or professional circles.

Interviews will consist of an hour-long quasi-structured questionnaire leaving room for discussion. The interviewees will be chosen in a stratified random sample, which would ensure that gender, age education and income status could be structured into the study as variables. The villages will be targeted within each of the three locations including sites

with a history of development interventions concerning bioprospecting. The information gathered will help me to investigate the perceptions, and positive and/or negative affects of bioprospecting on their livelihoods. The purpose of this is to provide a general awareness of the moral economy of collection sites and how the institutional actors that have constructed a discourse around bioprospecting have played out in certain localities.

Key methods:

- Conduct interviews with those who are conducting medicinal plant research, i.e., including researchers in national research institutions and private institutions, and students both (foreign and Malagasy).
- Conduct semi-structured interviews with national and international collection agencies including the Missouri and Kew Botanical gardens and the National Cancer Institute.
- Collect archrival documents from the Malagasy National Forest Service (FOFIFA); National Park Service (ANGAP); Malagasy Department of Environment and Agriculture and Department of Medicine. Conduct a general survey on bioprospecting its future and past collaborations with the selected departments.

IV. Significance of this Research

The significance of this research is twofold, scholarly and pragmatic. This work will contribute to recent scholarly studies rooted in the discipline of geography, those including political ecology and applied critical social theory. It builds upon studies of natural resource extraction (Neumann, 1998; Ribot, 1996; Peluso, 1992) theories of access to vital forest resources (Ribot and Peluso, 2003; Ribot, 1998; 1996) benefit sharing and traditional knowledge concerning biological and genetic resources (Laird, 2002; Parry, 2002; ten Kate and Laird, 2000).

Methodologically, it uses a commodity chain analysis that has a long history in French regulation theory(Raikes et al., , webs of power relations (Ribot, 1998; Bernstein, 1984) and disenfranchisement of actors along the chain (Thrupp, 1995). I will highlight the use of a commodity chain analysis, expressing macro-scalar processes found in political economy as well as what Page notes as political ecologies contribution to the "micro-politics of peasant struggles over access to productive resources" (1997). This work also takes into account a plurality of differing explanations, "concentrating on the process of negotiation, contest and resistance in and across multiple social arenas at multiple geographic scales, from the household to the state" (Page, 1997:145). The engagement and revealing of shortfalls in current policy will help to develop a more nuanced and distributive mechanism for the dynamic flows of genetic resources. The practical applications of the proposed research is directed towards policy makers, academics, industry who are engaged in the process of bioprospecting, intellectual property rights, access and benefit sharing agreements. My hope in trying to adequately theorize "genetic resources," as an incipient commodity can provide the framework to those working to establish equitable mechanisms for the distribution of benefits.

V. Qualifications of the Researcher

Research and course work in my tenure as a PhD student in Geography at Rutgers University has provided me with a sturdy academic toolkit for this proposed research. I currently hold a Master's of Science degree out of the Horticulture Department, in International Agriculture and Agroforestry at Cornell University. My Master's research (M. Sc., 2001) consisted of vegetative propagation experiments on multipurpose fruit and high-value forest trees in the eastern rainforests of Madagascar. This research conducted was in cooperation with the Cornell International Institute for Food, Agriculture and Development (CIIFAD) and the Landscape Development Interventions (LDI) (USAID/ Chemonics International). The telos of this research concentrated on multi-story fruit and forest tree systems called *tanimboly* in Malagasy. The focus was to develop agricultural alternatives to the rapid destruction of primary forests due to swidden cultivation. This research was conducted during two 4-month trips to Madagascar, the first in September-December 1999, and the second May-August 2000.

Currently, I hold a position as a project coordinator at the Agribusiness in Sustainable Natural African Plant Products (ASNAPP) centered at Rutgers University. This development organization has a current sub-contract in Madagascar with USAID, and this hands-on work experience in natural product research gives me a head start on the

policies and issues facing biological resources in Madagascar. In addition in 1995-1997 I served 24 months as a United States Peace Corps Volunteer in the highlands of southeastern Albania as a private-farm forestry extension agent in 3 villages in southwest Albania, I acquired a lot of experience with participant observations and conducted semi-formal interviews about the effects of environmental/ agricultural development interventions.

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