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Abstract

Although traditional knowledge is often used as a starting point to direct plant research, indigenous communities are rarely given any share of the profit such efforts produce. This thesis explores the possibility of compensating American Indians for their contributions to medical research on the creosote plant (*Larrea tridentata*), a shrub native to the U.S. southwest and a large portion of Mexico. In order to provide a basis for such a proposal, I start by exploring the history of bioprospecting. I then provide an explanation of creosote’s properties. Additionally, I focus on Native use of creosote and current medical research being conducted around the plant’s compounds. In order to formulate a potential compensation proposal, I analyze ten interviews I conducted with American Indian individuals from creosote’s region. I structured the interview format to be open-ended in an attempt to allow individuals to express their personal opinions. From these interviews, I look to determine whether American Indians might be interested in receiving some form of compensation from future medical patents that involve the use of creosote that incorporate traditional knowledge. While many of my interviewees were entirely against the idea of patents, some felt that a compensation plan could benefit American Indian communities in creosote’s region. The strategy most individuals supported was a grant or scholarship to fund American Indians looking to learn traditional medicinal practices.
Introduction

Throughout history, people across the world have used plants for medical treatment (Hossan et al. 2010, Jimenez-Arellanes et al. 2003, Jouad et al. 2001). Still today, a large portion of pharmaceutical drugs has an origin in plant compounds (Veeresham 2012). Roughly three-quarters of these medications are used for the same purposes to which indigenous people applied them (Whitt 1999, 180). However, proceeds from such pharmaceuticals most often do not benefit those who originally discovered their medicinal uses (Twarog et al. 2004). Western medicine is closely intertwined with patents and patent law, which generates profit to those who claim intellectual property rights (Twarog et al. 2004). Patents may be widely accepted among the developed world, but that does not mean that they have global sympathy (Einstein 2011, 72, Odek 1995, 158, Shiva 1999, 74). In order to receive patent approval, an invention must be useful, novel and non-obvious (USPTO). This paper is written off the normative premise that if western researchers incorporate indigenous knowledge into their work, at the very least, they should give the option of compensation to those indigenous peoples as they have taken their novel knowledge and used it to create a profitable enterprise.

Measures such as the Convention on Biological Diversity (CBD) have provided some amount of protection for developing countries’ plant knowledge (Laird 2002, Xxiv). However, there is little to prevent the exploitation of American Indian medicinal information in western patents (Whitt 1999, 180). While there have been some very minor strides in acknowledging American Indian intellectual property rights through documents such as the Universal Declaration on the Rights

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1 Over the course of this paper, I will primarily use the term American Indian, as, from my research, it seems that this group prefers the term above others. In general I have chosen my words largely based on my interviews and hope that they will be acceptable to everyone who reads this paper.

Since the beginning of European colonization, the developed world has been using American Indian medicinal information (Vogel 2013, 6). The United States Pharmacopeia and the National Formulary includes at least two hundred drugs using American Indian traditional knowledge as a basis (Vogel 2013, 6). Due to their long-standing relationship with North-American flora, American Indians have a rich medical understanding of a wide variety of plants (Reinhard et al. 1991). One such plant is Larrea tridentata of the Zygophyllaceae family, commonly referred to as creosote (Gnabre et al. 2015). This shrub is ubiquitous in the U.S. southwestern deserts down through northern and central Mexico (Cole et al. 2003).

Native peoples from the United States and Mexico have been using creosote medicinally for centuries (Reinhard et al. 1991). Often administered in the form of a tea or paste, it is has been known to be used to treat over fifty maladies including chickenpox, diabetes, kidney stones, arthritis, STIs, tuberculosis, and cancer (Lü et al. 2010, Arteaga 2005, Gnabre et al. 2015).

Due to the high levels of nordihydroguaiaretic acid (NDGA), a phenolic compound that creosote leaves produce, there has recently been a great deal of scientific research examining creosote as an antioxidant and anti-inflammatory (Huang et al. 2004, Rahman et al. 2009). There is particular focus on whether it could be used as a treatment for skin cancer (Gnabre et al. 2015). Other research has shown it to have beneficial uses for HIV, HPV, and neurodegenerative
diseases (Boston-Howes et al. 2009, Goodman et al. 1994). While not all studies openly acknowledge indigenous application of creosote as a factor in their research focus, some such as Abou-Gazar et al. (2004) specifically cite the plant’s usage in traditional medicine as the basis for their work (Eads et al. 2009, Luo et al. 1998).

In response to all of the research going into creosote, this thesis will focus on a potential compensation plan that pharmaceutical companies could offer to American Indian communities who contribute to patents (with direct information or by way of their general knowledge). Through my thesis I will explore how American Indians might want to be compensated for the use of their knowledge, if at all. I will do this through analysis of a series of interviews conducted with American Indian individuals on their ideas regarding traditional knowledge, mass production of plant materials, and non-Native usage of traditional medicine, patents, and patent compensation. In Chapter 1, I will start by giving a brief history of bioprospecting worldwide and attempt to provide an overview of the current and historical patterns of biopiracy. I will also discuss international policy relating to bioprospecting and how it does not apply to American Indians. Subsequently in Chapter 2, I will talk about basic properties of creosote in order to provide a background on the plant for this case study. Chapter 3 will explain traditional uses of creosote as well as current medical research on the plant. In Chapter 4, I will discuss the results of my interviews with American Indians from creosote country. Finally, in Chapter 5, I will propose a potential compensation plan for pharmaceutical companies to offer American Indian communities whose knowledge they use to create patents on creosote. I will also discuss how pharmaceutical companies might respond to such a plan based off of a set of interviews with members of the industry.
Bioprospecting and Biopiracy: International Sentiment and Agreements

Overview

For millennia, people have traveled to foreign lands in search of desirable plants (Odek 1995, 141, Wynberg and Laird 2009). Over this time, explorers often chose to collect plant specimens based on indigenous usage (Shiva 1999, 74). Pursuing exotic plant species in order to reap a medical, economic, or cultural benefit is known as bioprospecting (Beattie et al. 2011). However, over the past few decades, many people have begun to refer to a large portion of bioprospecting as biopiracy (Shiva 1999, 5). Biopiracy is defined as the “appropriation of the knowledge and genetic resources of farming and indigenous communities by individuals or institutions that seek exclusive monopoly control (patents of intellectual property) over these resources and knowledge” (ETC Group). This term was defined by the Action Group on Erosion, Technology and Concentration, a prominent advocacy group that works worldwide to protect indigenous knowledge and to overthrow patents that unjustly make a profit off such knowledge (Appendix 1; ETC group).

While a large portion (the exact number is unknown) of western medicinal drugs possesses a basis in traditional knowledge, indigenous peoples have largely been left uncompensated for their contributions to this field (Odek 1995, 149, Whitt 1999, 180). As the practice of biopiracy has been going on for centuries, it is hard to tell exactly how much companies earn from medicines that were created using traditional knowledge (Wynberg and Laird 2009). However, according to the World Health Organization (WHO) the pharmaceutical industry as a whole is
valued at US$300 billion per annum (2016). As a large proportion of this money is gained as a result of traditional knowledge, it would seem that indigenous peoples should receive a share of the profit. However, as aforementioned, this is currently not the case (Whitt 1999, 180). As a result of this discrepancy, there has been a rise of criticism towards the systems of bioprospecting and patenting over the past few decades (Shiva 1999, 74, Odek 1995, 158). Partially in response to developing countries’ protests against biopiracy, the Convention on Biological Diversity (CBD), which entered into force in 1993, addresses indigenous rights regarding biotic material (Glowka et al. 1994, ix, 4).²

While the CBD, along with other international treaties, has provided some compensation for indigenous peoples, it is certainly far from a perfect system. Furthermore, agreements such as the CBD often deal with trans-boundary bioprospecting and do not address how researchers should approach it within their own countries (Mgbeoji 2006, 76, Snape 2010). As a result, scientists in the United States are not bound to negotiate with American Indians when creating patents that incorporate American Indian ethnobotanical or traditional knowledge (Merson 2000, Snape 2010). This is the case with research regarding creosote.

A Brief History of Bioprospecting

As early as 1495 BC, although bioprospecting likely goes back much farther than this time, Queen Hatshepsut of ancient Egypt sent men to Punt³ to collect the fragrant Boswellia tree for frankincense (Wynberg and Laird 2009). So too, colonial empires often took a great many plants

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² This was only part of the material included in the CBD, an extensive agreement ratified by 190 countries to prevent the loss of biodiversity worldwide (Balmford et al. 2005). The United States has signed, but not ratified the CBD (Snape 2010).
³ Punt is now modern day Ethiopia, Eretria and part of Sudan (Wynberg and Laird 2009).
from conquered territories and brought them back to their botanical gardens to conduct research on them and put them on show (Merson 2000, Schiebinger 2005). Upon reaching the New World, Christopher Columbus and his crew did a great deal of bioprospecting and brought back large supplies of botanical material to Europe (Wynberg and Laird 2009). The Great Columbian Exchange, a massive transfer of biotic material from the New World to Europe after Columbus’ arrival in the Americas, introduced the tomato to Italy, the potato to Ireland, and a great many other prominent plants onto European soil (Odek 1995, 141).

The colonial empires recognized the value in researching medical plant uses and were very invested in obtaining medicinal information from their conquests (Schiebinger and Swan 2005, 2). Due to the wealth of indigenous knowledge in colonial territories, the empires had access to abounding medical resources, which they took back to their home countries along with the rest of their plunder (Mgbeoji 2006, 93). At this time, certain indigenous cultures, such as those of the American Indians, are thought to have held a deeper medical understanding than European ones, resulting in great benefit for the Europeans (Mgbeoji 2006, 93). One prominent example of such procured knowledge was from indigenous use of the Cinchona officinalis tree, native to the Andes, whose bark produced the alkaloid quinine, a cure for malaria (Schiebinger 2009, 3).

Bioprospecting is still prominent in current times. While plants are often used for different purposes in western medicine than they were by indigenous peoples, traditional usage is frequently a starting point for further research (Prance 2008, 1). This is due to the fact that indigenous use often indicates that a plant is biologically active (one or more of its components

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4 Many prominent botanists, such as Carl Linnaeus, were also physicians (Schiebinger 2004, 124).
has a strong effect on organisms) which can serve as an indicator of medical benefit (Prance 2008, 1). Due to globalization and assimilation of indigenous peoples into western culture, some botanists feel pressure to research traditionally used plants before the knowledge is lost (Prance 2008, 1). However, there are a great number of barriers between scientific research and traditional practice. Such include limitations in the lab environment and a discrepancy in how western and indigenous peoples perceive disease (Prance 2008, 2). Not surprisingly, indigenous groups have most often received little no to benefit from pharmaceutical drug development making them reluctant to participate in such research (Odek 1995, 149, Prance 2008, 1, Shiva, 1999 74).

In some instances, Native peoples have been willing to work with botanists to share and document their knowledge. Started in 1988, the Belize Ethnobotany Project was a joint effort between the Ix Chel Tropical Research Foundation and the New York Botanical Garden (Balick 2008, 9). Through this project, more than 2,700 specimens were collected and placed in the two institutions’ herbaria. Indigenous peoples had knowledge and use for over half of these plants (Balick 2008, 9). Over this project, traditional healers who were descended from eight South American peoples provided information for the database at The New York Botanical Gardens (Balick 2008, 9).

So too, in 1991, the Costa Rican National Biodiversity Institute (INBio) and the U.S. pharmaceutical company Merck & Co. Inc. (Merck) signed a two-year agreement to share biotic

5 Oftentimes indigenous peoples use fresh cuttings or steep plant material in water. Contrarily, lab tests are frequently done on dried, pressed samples, which may not produce the same reactions (Prance, 2008.2)
information and samples for monetary compensation (Zebich-Knos 1997). In this agreement
INBio would provide genetic material and data to Merck in return for $1 million, training and
research equipment, and a portion of the royalties Merck incurred from drugs that incorporated
INBio information (Zebich-Knos 1997). INBio also agreed to give the specific biological data
they gave to Merck, exclusively to Merck (they could give other samples to other parties;
Zebich-Knos 1997). The Merck INBio agreement was lauded by the conservation community as
INBio promised to donate 10% of the money it received (as well as 50% of royalties) to
conservation efforts (Roberts 1992). The agreement was renewed after the first two years, but
It is also important to note that Merck was working with a university and not a group of
indigenous peoples.

In a majority of cases however, indigenous peoples are reluctant to share knowledge with
westerners (Hinton 1975). This stems from a plethora of concerns including political and
religious mistrust (Hinton 1975, Schroeder and Pisupati 2010, 31). Plants can also become
exploited by corporate powers by being over picked, which may factor into indigenous hesitation
at revealing their knowledge (Prance 2008, 2).

**Resistance to Bioprospecting**

As developing countries and indigenous peoples have gained some small amount of voice in the
world, they have begun to protest various injustices they face including many of the practices of
bioprospecting (Greene, 2004, Odek, 1995. 141). A number of leaders and famous thinkers have
spoken out vehemently against bioprospecting and biopiracy. Vandana Shiva, an eminent
scientist, social activist, and feminist has dedicated a great deal of her career to combating bioprospecting and written a large portfolio of publications on the subject. In one of her most famous works *Biopiracy: The Plunder of Nature and Knowledge* (1999) she makes the argument that bioprospecting creates strong competition between people and pulls them away from each other and the environment. She explains that this comes at the greatest cost to both indigenous peoples and the Earth. Throughout *Biopiracy: The Plunder of Nature and Knowledge*, Shiva strives to highlight the discrepancy between indigenous contribution to western medicine and the benefits they receive from it. According to Shiva,

> Of the 120 active compounds currently isolated from the higher plants and widely used in modern medicine, 75 percent have uses that were known in the traditional systems… The use of traditional knowledge reportedly increases the efficiency of pinpointing plants’ medicinal uses by more than 400 percent (Shiva 1999, 74).

She explains that even though under recent agreements some communities have been included, or invited to be included, in patents, the entire system is imperialistic and hence does little to benefit indigenous peoples (Shiva 1999, 74-76). She also expresses concern for the environment and emphasizes that the current system wrongly places value on profits rather than ecosystems (Shiva 1999, 77-78).

Through a slightly different lens, Prime Minister Mahathir bin Mohamed of Malaysia expressed the developing world’s frustration with their situation perpetuated by the developed countries at the 1992 Earth Summit at Rio de Janeiro:

> The poor countries have been told to preserve their forests and other genetic resources on the off-chance that at some future date something is discovered which might prove useful to humanity… We are also told that the rich will not agree to compensate the poor for their sacrifices. The rich argue that the diversity of genes stored and safeguarded by the poor are of no value until the rich, through their superior intelligence, release the potential within. It is then an intellectual property
and must be copyrighted and protected... The poor are not asking for charity. When the rich chopped down their own forests... and scoured the world for cheap resources, the poor said nothing. Indeed, they paid for the development of the rich. Now, the rich claim a right to regulate the development of the poor countries. And yet any suggestion that the rich compensate the poor adequately is regarded as outrageous. As colonies, we were exploited. Now as independent nations, we are to be equally exploited (Odek 1995, 158).

Although Shiva and Prime Minister Mohamed highlight different issues with biopiracy, their underlying message is consistent. They both represent a belief that millions hold, which is that indigenous peoples, and the developing world as a whole, are being taken advantage of by western bioprospecting on their soil. Not only are communities rarely compensated for their knowledge, but also, it is often sold back to them in the form of exorbitantly priced products (Odek 1995, 141). This is seen prominently within the pharmaceutical industry. After accumulating indigenous medical knowledge, collecting the plants used in traditional practice, and formulating medication based, in part, on this information, pharmaceutical companies make billions of dollars while indigenous peoples receive no compensation (Beattie et al. 2011). This culmination of grievances has led communities to take issue with western bioprospectors worldwide (Odek 1995, 158). However, some people have slightly different views on bioprospecting now that international treaties have addressed it. I will explore this more in the upcoming sections.

**International Policy Regarding Bioprospecting**

The Convention on Biological Diversity (CBD), otherwise known as the ‘Grand Bargain,’ is the primary international document that focuses globally on biodiversity (Louka 2002, 102). Signed at the Earth Summit in Rio de Janeiro, the CBD came about largely as a result of developing countries arguing that they needed an incentive to keep permitting companies to do research on
their biological material (Wynberg and Laird 2009). This convention incorporated a number of compromises regarding genetic resources and the balance of rights to these resources (Beattie et al. 2011). It delved into issues regarding genetic resource trade and bioprospecting and declared that in order for a company or group to procure genetic resources from a country, that body would have to provide a benefit for the country from which they were taking the material (CBD 1992, 6-8). In practice, companies would have to obtain permission from a government to collect genetic material and come to an agreement with that government on how they would provide them with a benefit from their findings (Wynberg and Laird 2009). Article 8(j) of the CBD states:

Each Contracting Party shall, as far as possible and appropriate…

(j) Subject to its national legislation, respect, preserve and maintain knowledge, innovations and practices of indigenous and local communities embodying traditional lifestyles relevant for the conservation and sustainable use of biological diversity and promote their wider application with the approval and involvement of the holders of such knowledge, innovations and practices and encourage the equitable sharing of the benefits arising from the utilization of such knowledge, innovations and practices.

This demonstrates the CBD’s concern with protecting indigenous knowledge and creating systems to benefit it. Additionally, a large part of the CBD was the introduction of the concept of prior informed consent (PIC), outlined in Article 15(5) of the CBD, which gives countries control over who is specifically allowed to partake in bioprospecting on their soil (Appendix 2; Laird 2002, Xxiv).

Despite these measures, much of the complexity of bioprospecting was left unaddressed in this initial framework and in other treaties and guidelines published since (e.g. in 2002, the CBD signatories published the Bonn Guidelines on Access to Genetic Resources and Fair and Equitable Sharing of the Benefits Arising Out of their Utilization, which left many holes). One
reason for this is because, as stated in article 8(j), countries are supposed to make their own laws on bioprospecting as opposed to agreeing to a certain set of prescribed ones. This may give developing countries some agency, but also creates intrinsic confusion and inconsistency (CBD 1992, Merson 2000, Snape 2010). Additionally, in 2010, the Nagoya Protocol was added to the CBD (CBD). It has now been in use since 2014 (CBD). The Nagoya Protocol aims to clarify procedure and provide a clear layout of access and benefit sharing (CBD). It also lays out indigenous rights over genetic material (CBD). This addition is very new so it is unclear whether it will bring any resolution to prior issues with the convention’s framework.

Furthermore, countries often do not respect their indigenous peoples or act in their best interest (Merson 2000). As a result, indigenous peoples still feel that they are the victims of biopiracy. Alejandro Argumedo, a Quechua activist from Peru explained: “Contractual benefit sharing is like waking up in the middle of the night to find your house being robbed. On the way out the door, the thieves tell you not to worry because they promise to give you a share of whatever profit they make selling what used to belong to you” (ETC 2004). The Aboriginal Australian activist Jack Beetson stated, “The more we give away, the more we build the power of non-Indigenous people and corporations who, in too many cases, go on to use that power to deny us our rights…” (Schoeder and Pisupati 2010, 31). Tying these thoughts together, the ETC group explained:

(T)he Convention is, in fact, less about protecting the wealth of nature and the custodians of biodiversity than it is about protecting the wealth of the few powerful economic actors in the gene business. Rather than safeguarding genetic resources, the Convention’s particular notion of “benefit sharing” and the interpretations that have been formulated subsequent to the Convention’s adoption have provided a legal framework for plundering resources and knowledge through the legitimization of intellectual property on life forms. As importantly, the CBD’s
endorsement of bilateralism through contracts has also legitimated and facilitated biopiracy (ETC 2004).

At the same time, botanists and other scientists argue there is too much bureaucracy brought about by the agreements (Wynberg and Laird 2009). Although a single plant compound rarely yields dramatic results, and can cost billions of dollars to research, those that do can produce immense revenue (Wynberg and Laird 2009). These conflicting opinions create a dilemma for researchers and developing countries, as there is no guarantee of sure results, but a possibility of extremely profitable ones.

In 2007, on an Amazonian research mission, the primatologist Marc van Roosmalen was arrested by Brazilian officials and sentenced to prison for a decade and a half on the grounds that he was stealing national genetic property (Rohter 2007). Scientists worldwide, including in Brazil, were outraged by the arrest (van Roosmalen was quickly freed, but had to deal with a variety of charges) (Rohter 2007). In response to the incident, van Roosmalen said:

We wanted to protect the environment and traditional knowledge, but the legislation is so restrictive that it has given rise to abuses and lack of common sense… The result is paranoia and a disaster for science. There are Talibans in the government who say they are defending the national interest, but they end up weakening and hurting it (Rohter 2007).

However, despite these negative feelings towards how the CBD has been implemented in practice in the law and regulations of several countries, there are also positive sentiments towards aspects of the convention (Tansey 2002). Vandana Shiva expressed her approval for the agreement explaining:
There are two new political conditions to which the CBD has given rise. First, it has recognized the national sovereign right of countries to their biological wealth. Second, it has recognized the contribution of indigenous communities knowledge about the utilization of biodiversity (1996).

Case Studies of International Benefit Sharing

There have been a select number of cases in which indigenous communities were included in patents (Pawar et al. 2007, Chaturvedi 2009, 261). However, most of these cases, such as that of the famous *Hoodia*, plant have not been huge success stories (Wynberg 2009). *Hoodia gordonii* is a succulent native to the southern regions of Africa (Moyer-Henry 2008). Its ability to act as an appetite suppressant has been known to the indigenous San people for centuries (Moyer-Henry 2008). As a nomadic people, the San used *Hoodia* to control their hunger when they had a long way to travel with little food (Moyer-Henry 2008). Using this knowledge, in 1963 the South African Council for Scientific and Industrial Research (CSIR) discovered that a compound named P57 was responsible for causing appetite suppression (Moyer-Henry 2008). Forty years later, in 2003 and after a great deal of controversy, the CSIR committed to paying the San installments of $30,000 during clinical testing of *Hoodia* products and 6% of royalties made off of the products put on the market (Moyer-Henry 2008, Pawar et al. 2007, Wynberg 2010). In the end, this did not turn out to be profitable for the San (Wynberg 2010). All the major pharmaceutical companies (Pfizer, Phytopharm and Unliever) that had been researching the plant for obesity drugs abandoned their efforts (Wynberg 2010). As the patent only included *Hoodia* extract, many independent companies bought large amounts of raw *Hoodia* that they put into a variety of herbal supplements (Wynberg 2010). Not only did the San receive no benefit from

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6 Although Shiva expressed some positive feelings towards the CBD, she clearly still takes issue with patents as can be seen in earlier quotes.
these products, but also the products were arguably ineffective and caused the plant to be put on to the endangered species list due to mass exploitation (Wynberg 2010).

The Kani tribe of Kerala India was also included in a patent that used their traditional knowledge to produce the Jeevani supplement (Wynberg et al. 2009, 3). This case was a bit more beneficial for the indigenous group, but was still somewhat problematic (Moran 2004, 155). In 1987, a research group from the country’s Tropical Botanic Garden and Research Institute (TBGRI) was conducting fieldwork in the Agasthya hills (Moran 2004, 155). These scientists learned from their local Kani guides that eating berries from the Arogyappacha plant (*Trichopus zeylanicus subsp. travancorius*) resulted in a powerful energy boost (Moran 2004, 155). The scientists pressured the unwilling Kani to share their knowledge of the plant (Chaturvedi 2009, 262). The TBGRI created a supplement, called Jeevani, from this information in which they included extractions from Arogyappacha (Chaturvedi 2009, 261). In 1996, the TBGRI sold this formula to the Arya Vaidya Pharmacy (AVP), a prominent Ayurvedic company in India, for approximately US$25,000 and 2% of royalties on the product (Moran 2004, 155). The TBGRI and the Kani currently sit together on a Business Management Committee for their share of the Jeevani’s profits (Chaturvedi 2009, 262). Kani profits from the supplement are put into a trust for various uses managed by the tribe (Chaturvedi 2009, 262). The Kani initially received US$25,000 of the initial licensing fee in 1995 and, as of most recent reports, were earning about US$5,000 annually from royalties (Padma 2005). There is not much literature discussing how the Kani view this deal, particularly because they are much more dispersed than they were when this patent was first implemented (Anuradha 1998). However, there are a number of parties that feel that Kani did not receive enough profit (Anuradha 1998). Others feel this was an inappropriate
way to disseminate Kani knowledge and that the Kani themselves should have much more agency in how this medical information should be brought to larger society (Anuradha 1998).

In other instances, patents have been challenged by claims that they appropriated indigenous knowledge without providing proper compensation. Such is the case with *Azadirachta indica* of India, commonly known as the Neem Tree, which was patented for its fungicidal properties (Wynberg and Laird 2009). In India, the Neem Tree is upheld as a sacred species and is deeply valued in Indian culture (Marden 1999). The Indian people have also used it for centuries as a fungicide as well as for a plethora of other purposes (Wynberg and Laird 2009). The patent, filed with the European Patent Office (EPO), was overturned (by the EPO) after much debate on the basis that it stole Indian knowledge and was unoriginal (Moyer Henry 2008). Other patents globally are still currently under opposition (Wynberg and Laird 2009).

**Thoughts on Patents**

Different nations and individuals have a variety of opinions on whether patenting traditional knowledge is beneficial or detrimental for indigenous groups (Greene 2004). Although some developing countries and groups of indigenous peoples have fought to be included in patents, many argue that the concept of intellectual property should be done away with all together (Einstein 2011, 72, Shiva 1999, 74-76). A large number of people believe that patented knowledge is taking an idea inspired by the collective whole and accrediting it to one group of researchers (Odek 1994). Professor Naomi Roht-Arriaza, a legal studies expert on human rights and international law, explains:
Most…local knowledge is collective and is passed down from generation to generation. It builds on prior knowledge in an organic, accretive way that makes it difficult to single out a certain individual inventor or inventive origin in time (Marden 1999). The historian and philosopher Lewis Mumford more directly stated, “A patent is a device that enables one man to claim special financial rewards for being the last link in the complicated social process that produced the invention” (Einstein 2011, 72) So too, Peter Kropotkin, a Russian anarchist, activist, and scientist claimed:

Science and industry, knowledge and application, discovery and practical realization leading to new discoveries, cunning of brain and of hand, toil of mind and muscle- all work together. Each discovery, each advance, each increase in the sum of human riches, owes its being to the physical and mental travail of the past and present.

By what right then can any one whatever appropriate the least morsel of this immense whole and say- This is mine, not yours (Einstein 2011, 72-73).

Charles Einstein, a philosopher and author, also speaks strongly against patents. In his book, *Sacred Economics*, he calls for an elimination of all patents and espouses the need for collective capital (2011, 71-73, 126). On the contrary, many believe that rather than fighting to own their biotic genetic material, developing countries should strive to procure their own technology to conduct extensive research to make their own patents and become a part of the system of intellectual property (Odek 1995, 152). Another argument for the continuation of patents is that without the incentives provided by Intellectual Property Rights, many inventions would never have been created.
Biopiracy in the United States

This complicated international fight for the rights to knowledge can somewhat explain the situation of biopiracy in the United States. American Indian knowledge has contributed to over 200 medications listed in the *Pharmacopeia of the United States and the National Formulary* (Keoke and Porterfield, 2003, xi, Vogel 2013, 6). American Indians have protested the lack of credit they have received for these contributions (Guest 1995/1996). In response, to such objections the American Association for the Advancement of Science stated:

> Be it resolved that the Council of the Association (a) formally recognizes the contributions made by Native Americans in their own traditions of inquiry to the various fields of science, engineering, and medicine, and (b) encourages and supports the growth of natural and social programs in which traditional Native American approaches and contributions to science, engineering, and medicine are the subject of serious study and research (Mgbeoji, 2006).

However, aside from resolutions such as these, there is no formal policy established to compensate and credit American Indians for their contributions to patented knowledge (Whitt 1999, 180). As a result, companies make billions off of products created with this information, while American Indians continue to be one of the monetarily poorest groups in the United States (Bishaw and Semega 2008, 3). It seems that there is a strong need for a redistribution of this wealth to deserving parties, but little is being done to initiate it. In the upcoming chapters, this paper will continue to explore the concept of compensating American Indians for their

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7 As mentioned at the beginning of this chapter, it is difficult to put an exact monetary amount for how much an indigenous group contributed to the pharmaceutical industry. Such is also the case with Native American contributions. However, according to the WHO (2016), the top ten pharmaceutical companies are collectively valued at US$100 billion per annum. All of these companies are based in the United States and Europe (WHO 2016). As Europe and the United States have used a great deal of knowledge from American Indians, particularly over the Columbian Exchange (Odek 1995, 141), it seems that a portion of this money can be attributed to American Indian contributions.
contributions to U.S. patents through a case study of how certain tribes could be potentially compensated for their role in creating patents on creosote.
Basic Properties of *Larrea tridentata*

*Larrea tridentata* is a desert shrub prevalent in the southwestern United States and throughout a large area of Mexico (Hunter *et al.* 2001). It is commonly referred to as creosote or greasewood in the United States and gobernadora, guamis or hediondilla in Mexico (Gnabre *et al.* 2015). For centuries, indigenous peoples have used creosote for a plethora of medicinal purposes (Lü *et al.* 2010).

**Distribution**

Creosote has the largest range of any shrub in North America and is also the most common (Hunter *et al.* 2001). Within the U.S., creosote can be found in Arizona, California, Nevada, Texas and New Mexico (Arteaga *et al.* 2005). In Mexico, it is distributed across San Luis Potosí, Coahuila, Chihuahua, Durango, Sonora, Zacatecas, Baja California Norte and Baja California Sur (Arteaga *et al.* 2005). Creosote’s range extends over 18 million hectares (ha) of the U.S. and 30 million ha of Mexico (*Figure 2.1*; Nabhan 1986, 12). Distribution is most concentrated in the Mohave, Sonoran and Chihuahuan deserts and ranges from sea level to 1600m above sea level (*Figure 2.1*; Duran *et al.* 2005, Hunter *et al.* 2001). There are also smaller patches of creosote in the Valle del Mezquital and Hidalgo (Wells and Hunziker 1976). Over the past few decades, the plant’s range has expanded due to increased desertification of dry grasslands brought about by overgrazing and other anthropogenic factors (Arteaga *et al.* 2005).

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8 Creosote should not be confused with genera *Sarcobatus* or *Atriplex*, which are also often referred to as greasewood (Nabhan, 1986. 11).
Figure 2.1. Creosote is found from regions in the southwestern deserts of the United States down through a large part of Mexico. Native people used the plant for medicinal purposes throughout this region. Distribution is indicated by green hatching. (Figure: Cole et al. 2003, Gnabre et al. 2015).
It is most probable that creosote originated in South America and slowly moved north appearing in North America 8.4-1.5 million years ago (Duran et al. 2004, Hunter et al. 2001). Biotic factors, such as birds, likely dispersed creosote from these areas in South America to North America (Duran et al. 2004). This was not uncommon during the Pliocene (5.3-2.6 million years ago) when a great many plant species were brought north from South America by long-distance dispersal (van der Hammen, 1974).

Although Pliocene temperatures were quite comparable to present ones, creosote did not move into its current range until after the Pleistocene glaciations (2.6 million to 11,700 years ago; Collins 2011, Crowley 1996, Duran et al. 2004, Robinson et al. 2008). Towards the end of the Pleistocene, during the latter Wisconsin glacial recession, forests covered the current deserts of North America (Wells and Hunziker 1979). At this time, there was a high annual rainfall in these areas (Wells and Hunziker 1979). These forests, which were dominated by junipers, pinyon pines and oaks, receded northward from the warmest areas of the Chihuahuan and Sonoran deserts at the beginning of the Holocene, approximately 12,000 years ago, and only from the northern Mohave about 9,000 years BP (Wells and Hunziker, 1979). As forests were replaced by desert, creosote was able to expand its range northward (Duran et al. 2004, Nabhan 1986, 12). In the early Holocene and late Pleistocene, 10,000 to 26,000 years ago, creosote grew around the Rio Grande at the south of Texas (Hunter et al. 2001). Its range then expanded to encompass the Chihuahuan Desert and by 6,400 year ago, it was present in the Sonoran Desert (Hunter et al. 2001).9

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9 This data was largely collected using carbon dating to measure the age of packrat middens containing creosote (Broyles et al. 2012, 146, Nabhan, 1986, 12).
**Basic Features**

Creosote grows as a shrub up to 1-3m in height and 8m in radius (Figure 2.2; Nabhan 1986, 12). It can produce both sexually and asexually (Duran et al. 2005). Creosote is a perennial that grows in deserts and dry shrub lands maintaining its dense leaves throughout the year (Arteaga et al. 2005, Brisson and Reynolds 1994, Hernandez-Damian et al. 2004). The leaves are small (around 1 cm long), simple, opposite, and shiny (Figure 2.3, 2.4, 2.5, 2.6; Arteaga et al. 2005). Their sheen comes from an amber resin (secreted by the leaves’ stipules) that coats the entire leaf and emits a strong odor (Lü et al. 2010, Nabhan, 1986, 13). Half of the leaves’ weight can be extracted for further use, leaving the dry material (Lü et al. 2010). Creosote has small yellow flowers, which eventually turn into white fuzzy fruits (Figure 2.3, 2.4, 2.5, 2.6; Arteaga et al. 2005).

**Figure 2.2. Creosote Shrub:** As creosote grows, its branches shoot upwards and split laterally (Nabhan 1986, 12). As it continues to increase in size, the middle of the plant dies, but the rest continues to grow outwards in a ring (Nabhan 1986, 13). Due to its ability to develop in this manner, creosote can live for thousands of years. The oldest known creosote, named King Clone, is 9,400-11,000 years old (Duran 2004, Photography: Niederman 2011).
Figure 2.3. Creosote flowers and leaves: Creosote flowers each have their own axil. They are small, complete and yellow, and have five petals (Arteaga et al. 2005, Photography: Perlman, 2009).

Figure 2.4. Creosote fruit and leaves: The yellow flowers turn into small, white, fuzzy, round fruits (Arteaga et al. 2005, Photography: Perlman 2009).

Figure 2.5. Creosote blooms and emerging fruits (Photography: Hooper 2015).
Figure 2.6. Botanical drawing of creosote (Drawing: Niederman 2016)
**Chemical Properties**

Creosote’s leaves contain 360 distinct compounds and a variety of different components (Table 2.1; Lü et al. 2010, Nabhan, 1986, 14).


<table>
<thead>
<tr>
<th>Components of the Resinous Coating</th>
<th>Functions</th>
<th>Additional Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alkaloids</td>
<td>Have strong physiological effects. This group has not been heavily studied in creosote specifically, but it often has strong effects on the liver, heart, nervous system and cell bodies.</td>
<td></td>
</tr>
<tr>
<td>Essential oils/Volatile Oils</td>
<td>The essential oils of creosote have not been closely examined, but essential oils often have antibacterial properties.</td>
<td>There are sixty-seven compounds within the volatile oils.</td>
</tr>
<tr>
<td>Phenolic Compounds</td>
<td>Antimicrobial, prevent herbivory and UV damage, help with water conservation.</td>
<td>Nordihydroguaiaretic acid is one of the plant’s most researched lignans.</td>
</tr>
</tbody>
</table>

One of the plant’s more biologically active components is nordihydroguaiaretic acid (NDGA), which can be found in both the leaves and twigs of the bush (Figure 2.7; Rahman et al. 2009).

Dried, NDGA makes up to 10% of the leaves’ weight (Lü et al. 2010). It acts as a powerful antioxidant, which is one of the reasons the plant is so medicinally beneficial (Lü et al. 2010). It is also cytoprotective, meaning that it shields cells from damaging factors (Hernandez-Damian et al. 2004). Additionally, NDGA protects the plant from herbivores (Arteaga et al. 2005). This component of the plant will be discussed further in the next chapter.

![Figure 2.7. Structure of NDGA. NDGA has a polyphenol-bearing, o-dihydroxy structure and contains four hydroxyl groups (Diagram: Arteaga et al. 2005, Lü et al. 2010).](image-url)
**Ecosystem Roles**

Creosote is one of the first plants present in areas that have undergone desertification (Arteaga et al. 2005, Duran et al. 2005, Rango 2003). By absorbing and storing water in its roots, creosote outcompetes surrounding plants and monopolizes the groundwater supply (Gnabre et al. 2015). Due to its ability to alter these supplies, its general ubiquity, and various other factors, creosote serves as a dominant species of the U.S. southwestern deserts (Laport et al.2012).

While creosote is largely inedible to most fauna, there are certain specialist herbivores and pollinators that feed on the plant (Arteaga et al. 2005, Laport et al. 2012). Such include a variety of grasshoppers, moths, butterflies, beetles and other arthropods (Rundel et al. 1994). Certain populations of woodrats in the Mohave Desert also consume creosote (Mangione et al. 2000).

**Ploidy Groups**

There are three separate creosote ploidy groups (three groups of creosote each with a different number of homologous chromosome pairs) (Laport et al. 2012). Each of these groups is predominately found in one of the three U.S. deserts in creosote’s range (Figure 2.8; Hunter et al. 2001). The diploid group (2n=26) can be found in the Chihuahuan Desert, the tetraploid (2n=52) in the Sonoran Desert, and the hexaploid (2n=78) in the Mohave Desert (Hunter et al. 2001). The three groups have been shown to have certain adaptations to their specific deserts leading to the conclusion that each likely outcompeted other ploidies due to selective advantages.

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10 Although the three different types of ploidy separate fairly neatly into the Mohave, Sonoran and Chihuahuan Deserts, there is some mixing. Tetraploids and hexaploids have some overlapping habitat in the Sonoran and Mohave Deserts (Laport et al. 2012). Furthermore, in a few isolated areas, diploid populations have been found outside the Chihuahuan desert (Hunter et al. 2001).
(Hunter et al. 2001, Pockman and Sperry 1997, Martínez-Vilata and Pockman, 2002). As creosote migrated northwards (as detailed in earlier in this chapter), it is likely that different ploidy groups were established as a result of adaptations to climate (Hunter et al. 2001). The ploidy level gradient is distributed from SE to NW corresponding with temperature and rainfall changes (Hunter et al. 2001).

**Figure 2.8.** Creosote ploidy distribution across the Mohave, Sonoran and Chihuahuan Deserts (Figure: Laport et al. 2012). These different ploidy groups were established through autoploidy and allopolyploidy with diploid mutation giving rise to tetraploids, and tetraploid mutation to hexaploids (Hunter et al. 2001). While this map shows a clear ploidy divide between deserts, there are some instances in which there is a small amount of overlap (Laport et al. 2012, Figure: Niederman 2016).
Systematics

In addition to creosote, the genus *Larrea* (Zygophyllaceae) contains four other species (Hunter *et al.* 2001).\(^{11}\) All of the *Larrea* species are native to South America except for creosote (Wells and Hunziker, 1976). *Larrea* is subdivided into two subgenera, Sect. *Larrea* and Sect. *Bifolium* (Poggio *et al.* 1989).\(^{12}\) Creosote is part of the *Bifolium* group (Hunter *et al.* 2001).

Creosote is most likely descended from *Larrea divaricata*, a species native to Argentina and Chile (*Figure 2.9*; Wells and Hunziker 1976, 854). The most prominent difference between the two species is in their stipules, which are small shoots on the end of the stem of a leaf (Hunter *et al.* 2001). Currently, there is a 5,000 km divide between the *L. divaricata* population found farthest north near Ica, Peru and the creosote population found farthest south around Ixmiquilpan, Mexico (Wells and Hunziker 1976, 854). However, this gap can be explained by the migration of creosote over the Pliocene, detailed earlier in this chapter.

There is significant genetic variation within the species of creosote (Duran *et al.* 2005). This high level of genetic diversity is likely related to creosote’s wide range (Duran *et al.* 2005).\(^{13}\)

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\(^{11}\) *Larrea divaricata, Larrea cuneifolia, Larrea nitida*, and *Larrea ameghiono* (Hunter *et al.* 2001).

\(^{12}\) The *Bifolium* subgenus is characterized by bifoliate leaves, and denser foliage than the *Larrea* subgenus. *Larrea* species have multifoliate leaves and smaller flowers than *Bifolium* ones (Hunter *et al.* 2001). *Bifolium* are considered to be more complex than *Larrea* (Poggio *et al.* 1989).

\(^{13}\) In looking at the genetic diversity of Sonoran Creosote plants, Duran *et al.* (2005) found that each locus they examined had at least five, and up to nine, alleles (a very high amount for a vascular plant). Across the entire species, each locus had an average of six alleles and within populations there was an average of 3.89 per locus. These loci were completely polymorphic on a species level and 95% polymorphic on a population level Duran *et al.* (2005).
Figure 2.9. Distribution of creosote and *L. divaricata* (Hunter et al. 2001).
**Limiting Factors**

The main factors that limit creosote are water, temperature, nitrogen, and fire (Boorse et al. 1998, Brisson and Reynolds 1994, Laport et al. 2012, Pockman and Sperry 1997, Fuentes-Ramirez et al. 2015, Martínez-Vilata and Pockman 2002). As a desert species, creosote obviously has limited access to water (Brisson and Reynolds 1994). Although creosote has mechanisms to effectively outcompete other species for this resource, there is a significant level of intraspecific competition for it as well (Brisson and Reynolds 1994, Gnabre et al. 2015). While drought certainly induces stress, mature plants rarely die from it (Boorse et al. 1998).

Although cold temperatures generally limit creosote’s range, the different ploidy groups tolerate freezing to various degrees. Diploids seem to be least affected by freezing, which explains why they are the dominant ploidy group in the Chihuahuan desert (the coldest desert in which creosote is found) (Appendix 3; Martínez-Vilata and Pockman 2002).

Nitrogen (N) is generally a limiting factor for plants in the southwestern deserts of North America (Peterjohn and Schlesinger, 1990). Creosote is one of many species affected by low availability of N and there is a significant amount of intraspecific competition for it (Brisson and Reynolds 1994, Peterjohn and Schlesinger, 1990).

Fire has recently become a factor in creosote distribution as well (Fuentes-Ramirez et al. 2015). Over the past few decades, invasive grasses have increased the prevalence of fire in U.S. deserts (Falk et al. 2006). Prior to the introduction of these grasses and other exotic species, vegetation was too sparse to fuel fire (Fuentes-Ramirez et al. 2015). An increased frequency of fire has
effected spatial distribution of creosote (Fuentes-Ramirez et al. 2015). Nevertheless, creosote has been shown to be extremely resilient. A survey taken ten years after the 1962 thermonuclear explosion conducted at Yucca Flat, Nevada showed that 20 out of 21 creosote plants present before the explosion had started to grow back (Nabhan, 1986. 19).
American Indian Traditional Usage and Current Medical Research of Creosote

Long ago, darkness just lay there. No earth, moon, or stars had yet been finished.

The old people of the desert—certain Tohono O’odham and Pima elders—remember such darkness whenever wintertime comes. They recall hearing of when there wasn’t anything.

As Darkness washed up against itself, a spirit grew inside it: Earth Maker. Earth Maker took from his breast the soil stuck to it, and he began to flatten this soil like a tortilla in the palm of his hand. He shaped this mound of earth, and from it, the first thing grew: the greasewood. From its branches, the first animal came. It was a tiny, scaly insect that could use the resin of greasewood to produce its own covering of lac. Earth Maker gathered this gumlike lac. He began to sing. Pounding out various shapes while singing, he formed the mountains. They hardened like shellac, making a hard crust for the earth. The space which brushed against their edges became the sky (Tohono O’odham and Pima creation story, Nabhan 1985, 11).

American Indian Usage of Creosote

Over many centuries, American Indians have used creosote for a range of medicinal and cultural purposes (Table 3.1; Rahman et al. 2009). Across various tribes, there are over fifty recorded Native uses of the plant (Arteaga et al. 2005). Like many other botanical remedies used by American Indians, creosote is administered in a plethora of different manners to most effectively treat specific ailments (Borchers et al. 2000, Rea 1997, 140-141). One of the most widely implemented methods of preparation is a tea brewed from creosote twigs and leaves most commonly referred to as chaparral tea (Gnabre et al., 2014, Lü et al., 2010). This aqueous solution is used to treat gallstones, diabetes, diarrhea, fever and a great many additional symptoms and diseases (Lü et al., 2010, Rea, 1997. 140-141). Other common methods of
preparation include boiling water with creosote branches to produce steam infused with the plant’s oils and grinding creosote into a poultice (Nabhan, 1985. 14).

**Table 3.1.** Diseases and ailments for which creosote was used as a remedy or preventative arranged by bodily systems they effect (Arteaga et al., 2005, Gnabre et al., 2015, Lü et al., 2010, Spindler et al., 2015).

<table>
<thead>
<tr>
<th>Bodily System</th>
<th>Diseases, Ailments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cellular</td>
<td>Tumor growth, cancer</td>
</tr>
<tr>
<td>Skin</td>
<td>Acne, bruises, burns, chicken pox lesions, chronic cutaneous disorders, dandruff, psoriasis, sores, wounds</td>
</tr>
<tr>
<td>Hepatic</td>
<td>Cirrhosis, gall stones,</td>
</tr>
<tr>
<td>Gastrointestinal</td>
<td>Bowel problems, diarrhea, gas, headache caused by upset stomach fever, hemorrhoids, indigestion, nausea, parasites, stomach pain, ulcers, vomiting</td>
</tr>
<tr>
<td>Immune system</td>
<td>Allergies, arthritis, bacterial infection, chest infection, cold, cough, fungal infection, influenza, impetigo, lung congestion, rheumatism, sinusitis, viral infection</td>
</tr>
<tr>
<td>Muscular system</td>
<td>Muscle pain</td>
</tr>
<tr>
<td>Nervous system</td>
<td>Headaches, neuritis, sciatica</td>
</tr>
<tr>
<td>Genitourinary</td>
<td>Cystitis, dysuria, kidney pain, kidney stones, urinary tract infections</td>
</tr>
<tr>
<td>Reproductive System</td>
<td>Menstrual pain, post-partum inflammation, sterility, STIs (used as a contraceptive)</td>
</tr>
<tr>
<td>Endocrine</td>
<td>Diabetes</td>
</tr>
<tr>
<td>Other</td>
<td>Arthritis, gout, headaches, snakebites, toothache, weight loss</td>
</tr>
</tbody>
</table>

*Also used as a cancer preventative, antioxidant, analgesic, and anti-inflammatory.

The various American Indian tribes that live throughout creosote’s range use the plant for a wide spectrum of different symptoms and diseases. The Pima and Maricopa prescribe creosote to treat chickenpox, tuberculosis, menstrual pain, snakebites, and a variety of STIs (Gnabre et al., 2015). Alternately, the Seri tribe of the Sonoran uses creosote as a contraceptive (Nabhan, 1985. 14). The Cahuilla treat a particularly wide variety of ailments with the plant ranging from body odor to cancer (Nabhan, 1985. 14). So too, creosote was the Tohono O’odham’s most versatile botanical remedy. They prepared it in a wide variety of manners for different ailments. Such

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14 They prepared the plant by burning it so that droplets of oil would melt off the leaves and drip into a cup of water. Women would then drink the water with the melted creosote (Nabhan, 1985. 14).
included using smoke from creosote to cure aches in sore feet and preparing beds of heated branches of creosote for women to lie on after childbirth (Nabhan 1985, 14).

In his book about the Gila River Pima Indians, Amadeo M. Rea speaks with a number of individuals on how they personally use creosote (141-142). He learned that the most effective creosote to employ for medical purposes should be picked when it is dark green as opposed to yellowish or light green (142). From his account, it is clear that the plant is still used ubiquitously among this community (140-141). As recorded in numerous other forums (Abou Gazar 2004, Arteaga et al. 2005, Gnabre et al. 2015, Lü et al. 2010), creosote, referred to as shegoi, by the Pima, is often prepared as a tea (Rea, 1997. 141). Rea spoke to Pima that use this tea to fight fever and a wide variety of other ailments (141). Oftentimes, one is made to throw up after drinking the tea in order to cleanse one’s body of sickness (141). As rates of diabetes have risen among the Pima in recent years (due to increased consumption of fats and simple carbohydrates resulting from acculturation) so too have incidents of diabetes. Many Pima now treat the disease with chaparral tea (tea made from creosote branches and leaves; 141). One woman named Carmelita, explained to Rea that she kept a jar of chaparral tea in her home to keep her diabetes in check. She drinks half a cup to a cup two to three times a day to keep her blood sugar down. She claimed that this was all she needed to manage her diabetes (141).

As aforementioned in the introduction of this paper, American Indians believe that a person’s spiritual, mental and physical bodies are intricately intertwined (Mehl-Madrona, 1999). In line with this philosophy, creosote is used for many aspects of spiritual healing as well as physical. The Tohono O’odham Nation believe that creosote was a primary factor in the earth’s creation
and adorn the graves of their dead with its branches (Adamson, 2001. 11, 17). Other tribes bury people with creosote laid upon their chests and seal pots of food with creosote lac to accompany them on the next phase of their journey (Nabhan 1985, 18). Additionally, the Pima used to burn a bundle of Apache hair, hawk father and owl feather with creosote in order to protect themselves after killing Apache (Rea 1997, 141).

Aside from treating spiritual and physical illness with creosote, Native groups used the plant for many practical purposes as well. When walking in the desert without water, the Pima strip a branch of creosote and suck on it to keep their mouths moist. They also use it to absorb moisture in their shoes (Rea 1997, 141). Additionally, creosote is often used as glue for various purposes (Nabhan 1987, 19).

There is a great deal of physical and recorded evidence for historic Native medicinal use of creosote. Tangible proof of consumption has been found in human coprolites from 1,400 years ago (Reinhard et al. 1991). So too, there are recordings from early Jesuit missionaries in Pimería Alta, now known as the north Sonoran Desert, that demonstrate Native use of creosote for a variety of different ailments (Nabhan 1985, 14). Creosote is still widely used by American Indians of the U.S. southwest as can be seen through speaking with individuals of these communities or reading literature written about them (Nabhan 1985, 14, 18, Rea 1997, 140-141).

Creosote, used both currently and historically, is of high importance to American Indians of the southwestern deserts. Over centuries, they have honed in on the various properties of the plant and how to best prepare and administer it.
Western Research Regarding Creosote


Oftentimes, these studies cite Native uses of creosote (Gnabre et al. 2015, Rahman et al. 2009) and commonly express that it is the reason they are researching a component of the plant (Abou-Gazar et al. 2004, Eads et al. 2009, Luo et al. 1998). This is likely due to the fact that widespread indigenous use of a plant oftentimes serves as a positive indicator of high biological activity (Prance, 2005. 286).

In addition to creosote, many other plants have also been heavily researched and developed into medications due to their therapeutic significance to American Indians (Table 3.2; Keoke and Porterfield 2003, Xi).
Table 3.2. “The 10 top-selling botanicals in the United States, their uses by Native Americans, and their current uses” (taken directly from Borchers et al. 2000 with minor formatting changes).

<table>
<thead>
<tr>
<th>Common name (Latin name)</th>
<th>Family</th>
<th>Sales ($ million)</th>
<th>Native American Peoples Who Used the Botanical</th>
<th>Native American Indications</th>
<th>Current Marked Indications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ginkgo (Ginkgo biloba)</td>
<td>Ginkgoaceae</td>
<td>90</td>
<td>None</td>
<td>Not used</td>
<td>Memory and circulation</td>
</tr>
<tr>
<td>Ginseng (Panax quinquefolius, Panax ginseng, Eleutherococcus senticosus)</td>
<td>Araliaceae</td>
<td>86</td>
<td>(P. quinquefolius only) Cherokee, Creek, Delaware, Fox, Houma, Iroquois, Menominee, Mohegan, Pawnee, Penobscot, Potawatomi</td>
<td>Tonic, expectorant; for fevers, tuberculosis, asthma, and rheumatism; as a strengthener of mental powers</td>
<td>Immune function and stress</td>
</tr>
<tr>
<td>Garlic (Allium sativum)</td>
<td>Liliaceae</td>
<td>71</td>
<td>Cherokee</td>
<td>Stimulant, carminative, diuretic, expectorant, mild cathartic; for scurvy, asthma, and prevention of worms</td>
<td>Cardiovascular health and cholesterol lowering</td>
</tr>
<tr>
<td>Echinacea (Echinacea purpurea, Echinacea angustifolia, Echinacea pallida)</td>
<td>Asteraceae (Compositae)</td>
<td>49&lt;sup&gt;1&lt;/sup&gt;</td>
<td>Cheyenne, Choctaw, Dakota, Delaware, Fox Kiowa, Montana, Omaha Pawnee, Ponca, Sioux, Winnebago</td>
<td>Pain relief; for coughs and sore throats, fevers, smallpox, mumps, measles, rheumatism, and arthritis; antidote for poisons and venoms</td>
<td>Immune function</td>
</tr>
<tr>
<td>Goldenseal (Hydrastis canadensis)</td>
<td>Ranunculaceae</td>
<td></td>
<td>Cherokee, Iroquois, Micmac</td>
<td>Tonic; for fever, whooping cough, and pneumonia</td>
<td>Immune function</td>
</tr>
<tr>
<td>St John’s wort (Hypericum perforatum)</td>
<td>Hyperiaceae (Guttiferae)</td>
<td>48</td>
<td>Cherokee, Iroquois, Montagnais</td>
<td>For fever, coughs, and bowel complaints</td>
<td>Antidepressant</td>
</tr>
<tr>
<td>Saw palmetto (Serenoa repens)</td>
<td>Palmacea</td>
<td>18</td>
<td>None</td>
<td>Not used</td>
<td>Prostate health</td>
</tr>
<tr>
<td>Grape seed extract (Vitis vinifera)</td>
<td>Vitaceae</td>
<td>10</td>
<td>None</td>
<td>Not used</td>
<td>Antioxidant status</td>
</tr>
<tr>
<td>Evening primrose (Oenothera biennis)</td>
<td>Onagraceae</td>
<td>7</td>
<td>Cherokee, Iroquois, Ojibwa, Potawatomi</td>
<td>For premenstrual and menstrual pain, obesity, and bowel pains</td>
<td>Antioxidant status; premenstrual and menstrual pain</td>
</tr>
<tr>
<td>Cranberry (Vaccinium macrocarpon)</td>
<td>Ericaceae</td>
<td>6</td>
<td>Montagnais</td>
<td>For pleurisy</td>
<td>Health of urinary tract</td>
</tr>
</tbody>
</table>

<sup>1</sup>Echinacea and goldenseal combined.

While there has been a wide spectrum of studies done to examine the possible benefits of creosote, some of the more heavily researched areas have been ways in which the plant may fight...
immunodeficiency virus, HPV, various cancers, neurodegenerative diseases, and cardiovascular disease (Gnabre et al. 2015, Lü et al. 2010). In a study in 2000, Craigo et al. observed that NDGA derivatives (Mal.4, M(4)N, and tetra-acetyl NDGA) were able to suppress Sp1 transcription in human papillomavirus. Gnabre et al. found similar results with NDGA’s ability to regulate Sp1 transcription in human immunodeficiency virus (HIV) five years earlier (1995). Rahman et al. (2009) reported that NDGA had a positive effect on skin tumors through visible antinflammatory and antioxidative properties. So too, Huang et al. (2004) demonstrated that NDGA might have an ameliorative effect on prostate cancer cells by causing the endoplasmic reticulum in these cells to release Ca2+ and a study by Soriano et al. (1999) showed that NDGA might provide preventative or therapeutic effects towards lung cancer when combined with 13-cis-retinoic acid. Goodman et al. (1994) found that NDGA may be able to serve a function in treatment of Alzheimer’s disease due to its ability to block toxic effects of A beta on hippocampal neurons in rats. Boston-Howes et al. (2009) also demonstrated positive neural effects of NDGA as it promotes glutamate uptake, which would prevent neuronal death that could occur from accumulation of glutamate in the synapses. Additionally, Ramasamy et al. (1999) and Kumar et al. (2007) highlighted potential benefits of NDGA on cardio-vascular disease due to its antioxidative properties. In 2001, Koob et al. found that NDGA promoted the growth of collagen fibers, which could serve as a beneficial tool in tendon reconstruction. Finally, Strong et al. (2008) observed a 12% increase in the average lifespan of male mice when they were adminstered 2.5g of NDGA for every kg of food they ate over a 4 week period. Harrison et al. (2014) supported this study when they found similar results (an 8-10% increase in lifespan) six years later. These are just a sample of the many studies that have looked into the
potential benefits of creosote. A more comprehensive list of researched diseases in provided in

**Table 3.3.**


<table>
<thead>
<tr>
<th>Bodily System</th>
<th>Western Research</th>
<th>Native Usage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cellular</td>
<td>Breast cancer, esophageal cancer, HL-60 cells (human promyelocytic leukemia cells), lung cancer, multiple myeloma, pancreatic carcinoma, prostate cancer, skin cancer</td>
<td>Tumor growth, cancer</td>
</tr>
<tr>
<td>Cardiovascular</td>
<td>Atherosclerosis, diabetes hypercholesterolemia, hypertension, mellitus,</td>
<td></td>
</tr>
<tr>
<td>Skin</td>
<td>Psoriasis, rheumatoid arthritis</td>
<td>Acne, bruises, burns, chicken pox lesions, chronic cutaneous disorders, dandruff, psoriasis, sores, wounds</td>
</tr>
<tr>
<td>Hepatic</td>
<td></td>
<td>Cirrhosis, gall stones,</td>
</tr>
<tr>
<td>Gastrointestinal</td>
<td></td>
<td>Bowel problems, diarrhea, gas, headache caused by upset stomach fever, hemorrhoids, indigestion, nausea, parasites, stomach pain, ulcers, vomiting</td>
</tr>
<tr>
<td>Immune system</td>
<td>Herpes simplex virus (HSV), human immunodeficiency virus (HIV-1), human papillomavirus (HPV), influenza virus</td>
<td>Allergies, arthritis, bacterial infection, chest infection, cold, cough, fungal infection, influenza, impetigo, lung congestion, rheumatism, sinusitis, viral infection</td>
</tr>
<tr>
<td>Muscular system</td>
<td></td>
<td>Muscle pain</td>
</tr>
<tr>
<td>Nervous system</td>
<td>Alzheimer’s disease, Huntington’s disease, cerebral ischemia</td>
<td>Headaches, neuritis, sciatica</td>
</tr>
<tr>
<td>Genitourinary</td>
<td></td>
<td>Cystitis, dysuria, kidney pain, kidney stones, urinary tract infections</td>
</tr>
<tr>
<td>Reproductive</td>
<td></td>
<td>Menstrual pain, post-partum inflammation, sterility, STIs (used as a contraceptive)</td>
</tr>
<tr>
<td>System</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Endocrine</td>
<td></td>
<td>Diabetes</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td>Arthritis, gout, headaches, snakebites, toothache, weight loss</td>
</tr>
</tbody>
</table>
Health Concerns Regarding Creosote

While there have been many promising studies done regarding creosote, there are some concerns in relation to the hepatotoxicity of the plant (Chitturi and Farrell, 2000, Sheikh et al. 1997, Spindler et al. 2015, Whiting et al. 2002). There have also been worries about a possible correlation between creosote consumption and internal hemorrhaging as well as stunted growth (Spindler et al. 2015). Liver problems that have arisen predominantly stem from issues with using creosote as a dietary supplement (Chitturi and Farrell, 2000). After eighteen instances of liver illness related to creosote were reported between 1992 and 1994, studies such as that of Chitturi and Farrell (2000) and Sheikh et al. (2007) began to examine the severity of creosote’s hepatic effects.

Of these eighteen cases, sickness ranged between “acute hepatitis, subacute hepatic necrosis, cholestatic hepatitis and acute liver failure” (Chitturi and Farrell, 2000). Nine of the eighteen instances (as well as four separate cases not included in this eighteen) resulted in liver injury (Chitturi and Farrell, 2000). In a majority of individuals, illness began 3-52 weeks after consumption of the plant was initiated and ended 1-17 weeks after it was terminated (Sheikh et al. 2007). From the thirteen instances of creosote associated liver illness, individuals most often experienced an onset of cholestatic hepatitis (a disease which effects bile secretion, but is less severe than acute hepatitis; Sheikh et al. 2007). Four individuals subsequently developed cirrhosis and two individuals that had been taking creosote dietary supplements for over a year required liver transplants (Chitturi and Farrell, 2000, Sheikh et al. 2007). However, one of these

15 Eleven out of the thirteen total cases of liver injury occurred in women (Chitturi and Farrell, 2000).
two patients was “anti-hepatitis C virus (HCV) positive and had a history of alcohol use” (Chitturi and Farrell, 2000).

It appears that there may be some correlation between liver injury and creosote consumption, but the results are inconclusive. According to Spindler et al. (2015), “the doses of NDGA which extend murine [mouse] lifespan appear to overlap the dosages which produce serious pathologies.” As with all medications, it is clear that creosote has varying effects on different individuals. Evidence from these eighteen cases does not seem to indicate that creosote is toxic to all people, particularly compared with the results of its usage over thousands of years.

**Patents on Creosote**

A number of patents have come out of the vast array of research conducted on creosote (Appendix 4). It is difficult to determine exactly how much profit these patents and creosote products have made, as private companies do not need to report their annual sales. Furthermore, many of the patents are not on existing drugs, but rather on specific preparation methods that may or may not yet be in use (Appendix 4). One public company, Larrea Biosciences Corporation (LarreaRx)\(^\text{16}\), which holds four patents on creosote derived products, reported $480,000 worth of sales in 2006 (Security and Exchange Commission, 2006). However, there is very little public data on sales related to creosote products. It seems that the creosote market is still largely in the research stage and may have not yet reached the market.

\(^{16}\) Gordian Holdings bought Larrea Biosciences Corporation in 2015 (Bloomberg 2016).
These preexisting patents do not provide any measure of compensation for the Native groups who originally held knowledge on the plant’s medical properties. The following chapter will explore this concept and whether or not American Indians with traditional knowledge regarding creosote wish to receive some form of payment for their contributions.

**Environmental Impacts of Creosote Collection**

It should be noted that it is possible to synthesize NDGA (McDonald *et al.* 2001). Therefore, long-term production of medicine based on creosote does not appear to have impending environmental ramifications. This is due to the fact that increased demand of NDGA would not necessitate exploitation of the creosote plant in the wild. Instead, it could be simply manufactured in the lab.
Native Opinions on Non-Native Usage of Traditional Medicine, Patents, and Compensation for Use of Traditional Knowledge in Patents

Methodology

In order to create a recommendation for how researchers should approach their usage of traditional knowledge in patenting information about creosote, I conducted a series of interviews with Native individuals from the region in which the plant grows. The purpose of these interviews was to understand how American Indians felt about non-Native people using traditional plant knowledge, what they thought about patents in general, and whether or not they wanted any form of compensation for the use of their tribe’s traditional knowledge when it contributed to a patent. I received approval from the Institutional Review Board to conduct these interviews, which were determined to be of minimum risk.

In total, I conducted ten interviews with Native individuals. I spoke with them over the phone or email depending on what method of communication they were most comfortable with. The majority of these people were from tribes that use medicinal creosote. However, two interviewees live outside creosote’s distributional range. One of them had a relevant job position and so I included his interview to demonstrate a different perspective. The other was a representative of a tribal council outside creosote country, whom I interviewed in order to involve the opinion of a formal tribal authority (I was unable to obtain such a perspective from a local tribal council). I communicated with the majority of interviewees multiple times, conducting one main interview and often continuing contact to ask follow-up questions. Over the
remainder of this chapter, I will attempt to convey the thoughts of interviewees and tie them together in a respectful, mindful way. Individuals will be represented either by their full name or a pseudonym based on their preference.

Interviewees

To present the most comprehensive overview on the topic of patent compensation as possible, I strove to conduct interviews with American Indians from a variety of tribes, genders, ages, jobs and tribal positions to provide a diversity of background and thought. At the same time, I mainly spoke with individuals who had some degree of background or authority in this area (Table 4.1).

Table 4.1 A brief background on interviewees.

<table>
<thead>
<tr>
<th>Name</th>
<th>Tribe</th>
<th>Age</th>
<th>Gender</th>
<th>General Information</th>
<th>Interview Forum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arnold Clifford</td>
<td>Navajo</td>
<td>50</td>
<td>M</td>
<td>Arnold is both a botanist and geologist. He has been the first botanist to describe a number of previously undocumented plant species in the U.S. southwestern desert. He is currently working to write a book on ethnobotanical plants to preserve Native knowledge on them.</td>
<td>Phone</td>
</tr>
<tr>
<td>Diho (pseudonym)</td>
<td>Navajo</td>
<td>32</td>
<td>F</td>
<td>Diho works at a Navajo heritage museum.</td>
<td>Phone</td>
</tr>
<tr>
<td>Josiah Pinkman</td>
<td>Nez Perce</td>
<td>42</td>
<td>M</td>
<td>Josiah works for the Nez Perce Cultural Resource Program protecting the interests of his people and working with outside parties.</td>
<td>Phone</td>
</tr>
<tr>
<td>LaKota Scott</td>
<td>Navajo</td>
<td>26</td>
<td>F</td>
<td>LaKota is currently attending a medical school for naturopathic medicine(^{17}) in Phoenix, Arizona. She wants to eventually set up her own</td>
<td>Phone</td>
</tr>
</tbody>
</table>

\(^{17}\) Naturopathic physicians receive the same standard training as MDs, but are also versed in “clinical nutrition, homeopathic medicine, botanical medicine, psychology, and counseling” (The American Association of Naturopathic Physicians).
Interview Findings

There are many factors that shaped people’s thoughts about how American Indians should receive compensation for their contributions to patents. In this section, I will explore how individuals formulated their ideas on patent compensation and discuss what they believe would...
be a reasonable payment plan for their communities. I will first discuss general views on traditional and western medicine. I shall subsequently review how interviewees felt about non-Native usage of traditional medicine and where the boundaries to this usage might lie. After this, I will delve into ideas about patents and how the individuals I spoke with navigate the idea of claiming knowledge in this manner. This will allow me to present interviewees’ thoughts on patent compensation in the last section of this chapter.

**Background and Understanding of Traditional and Western Medicine**

Every person I interviewed had a connection with Native medicine and used it in their lives to some degree. A vast majority of these individuals had grown up with this type of healing practice and many were either resistant or adamantly against the use of western medicine in their own lives. This was in part due to upbringing, cultural beliefs, and social issues with western medicine. Something that was made clear to me from the beginning of my interviews was that Native medicine is much more than a dosage of plant remedy. Its success is intricately connected with respect for the plant, the intention of the healer, and the ceremonies that surround it. I will discuss some specific thoughts on the two medicinal philosophies to illustrate these points. This information will give a bit of insight as to how Native individuals feel about the general concept of patenting and mass-producing Native knowledge.

**Traditional Medicine and Cultural Issues with Western Medicine**

LaKota Scott, a 26-year-old Navajo woman, has a very interesting perspective on the balance between traditional medicine and western medicine. She is currently in medical school, but was raised traditionally. Her understanding of both fields of medicine gives a good overview of the
issues Native people face with western medicine. Growing up, LaKota lived in Tuba City on the Navajo Reservation. While her parents were in college, her aunt and grandmother raised her until the age of five. Her aunt and grandmother were fairly traditional in that they spoke Navajo and were deeply engrained in their culture. Describing her medical care as a child LaKota explained, “If I got sick… my aunt was an herbalist and so she would be the one that would [treat me]” (Scott 2016). She also spoke about how important ceremonies were to the process of healing the spiritual side of disease as well as the physical and said, “you don’t really go to the hospital unless you’re bleeding” (Scott 2016). Lakota’s mother went to school to become a nurse. As LaKota grew older, she came to feel more comfortable in hospital settings because they reminded her of her mom. As a teenager, she began to learn about the concept of naturopathic medicine, a type of medicine that integrates homeopathy, chiropractics, and herbal medicine into treatment. This type of medicine intrigued her as she felt that it was a more appropriate form of care for traditionally based people. She explained:

> When you go to the hospital … they give you drugs, or you get surgery, … it’s very invasive and it’s very rough and so traditional wise, it’s… very similar to naturopathic medicine in seeing there’s a spiritual aspect and you can treat someone without being invasive into the body (Scott 2016).

Her aim is to use her knowledge from medical school to help Native people receive treatment that is more related to their needs both physically and emotionally. She sees a great deal of issues with the way that western medicine is treating Native people and her hope is to provide a different form of care that is more suited to their background (Scott 2016).

Josiah Pinkman, a 42 year-old Nez Perce man, works for his tribe’s Cultural Resource Program. Josiah is from outside of creosote’s region, but I decided to use this interview due to his position. He has been working for the Cultural Resource Program for a number of years. His job is to
“work as an interface between the Nez Perce tribal membership, the bureaucracy, and the multitude of different federal agencies that the Nez Pierce tribe is involved in” (Pinkman 2016). Because Josiah works with many different parties and understands a diversity of backgrounds, he approaches the issue of patents in an interesting manner. His account of his medical regimen reflects a number of LaKota’s sentiments. Josiah was raised with Native healing practices and says, due to his upbringing, he still follows these philosophies today. Describing the process of addressing an aliment he explained:

You have to rely upon yourself first for treating different health maladies and that comes as a result of basically being able to do a lot of self reflection, a lot of contemplation time and seeing what’s bugging you so that you can address [the issue]... when that doesn’t work, then you seek out these plant medicines, and they intervene and they help you to address things that you need to work on… these types of simple medicinal practices are essential to our long-term health and western medicine has a different approach to it. [It’s] oftentimes… ‘Go in, and cut it out, and remove it, and you don’t have to worry about it anymore’- well that’s distinctly not the case (Pinkman 2016).

The idea of addressing a medical problem directly was a common theme in my interviews. Similar to Josiah, a number of people felt that the intentionality in traditional healing contrasted the western idea of finding quick fixes to problems.

These thoughts from LaKota and Josiah highlight the discrepancies between Native philosophies and the principals of western medicine. Western medicine is arguably its own religious belief system. A great deal of the healing process is based on a willingness to undergo medical procedures and trust that they will be beneficial (Benedetti 2014, 45, Brown 1998, Crum and Langer 2007, Price et al. 2008). It seems that these two sets of cultural belief often come in tension with one another and as such, western medicine cannot always adequately serve Native populations.
Respect for the Plant

In addition to feeling that western medicine disregards the spirit, seven out of ten people also expressed how it could disrespect the plant one is using to heal oneself. Arnold Clifford, a Navajo geologist and field botanist (age 50), conveyed to me how plants should be properly used for medication:

You’re supposed to go and ask [a traditional healer for medical help], on a one to one basis. Then the holy plant people [the traditional healers] approach the plant like a person. They introduce themselves… say a prayer, and they collect that plant species. There is a one to one relationship with that plant. Once they collect that herb, [they ask the patient] for whatever that patient can afford- maybe a string of beads, maybe a few turquoises. The holy people know your financial standing so if you’re a rich person and you’re cheap, the healing powers may not heal you as strongly, but if you’re poor and you give your most valuable possession, you will be healed (Clifford 2016).

Arnold expressed how important it was to have this specific one-to-one connection with a plant and that the entire healing process could be overturned without it.

Monica Nuvamsa is a 41 year-old Hopi woman (although she does not really keep track of her age anymore). She serves as the executive director of The Hopi Foundation. Monica echoed Arnold’s sentiment and explained to me that if you disrespected a plant, it might simply choose not to grow back the next year. She also told me that if you highly manipulate a plant, it could lose its healing powers all together. She said, “When I think about commercializing a product like that, it becomes so morphed that it becomes meaningless” (Nuvamsa 2016).

Spiritual leader Wanekia applied this concept to creosote specifically and explained how this plant in particular must be respected. He said:
Plants can cure any ailment on Earth, if they are willing to share…. When this plant [creosote] is disrespected, it can cause illness and when respected, it can cure it. This plant is not a preventive “medicine plant” it is a fighter. You would not give it to people if they did not have a disease for it would cause the disease…By forming that relationship with the plant you learn the strength of the plant (Wanekia 2016).

He went on to speak about mass production explaining:

Stripping anyone of their identity is never a good thing. [If you] strip the plant of its identity, the spirit of the plant is no longer what it was. The plant people work with our bodies to make that change we need. When you try to syncretize a living thing, you come up with a compound of chemicals, but you will never have the true essences of the “medicine”. By doing this you may think you are serving the masses, but in reality you are killing the plant (Wanekia 2016).

In addition to having different philosophies on healing, American Indian and western thought also diverge around how people should treat plants. As illustrated in this section, Native people believe that plants are conscious beings while western medicine usually sees flora as a means to an end. This contrast can make American Indians skeptical of western medicinal remedies.

*The Power of Belief*

Six out of ten interviewees explained that in addition to respecting plants, it is also essential to couple their usage with belief. When a plant is applied in a western setting, the same rituals do not accompany it as within a Native one. Josiah explained that even if not all Native healing practices have direct chemical effects, faith in their value is essential to the healing process. He said:

There’s a lot of belief that’s imbued in a substance’s ability to help you with whatever health malady you might have and we’re expected to communicate with those plants in order to ask for those particular benefits that we’re looking for. One plant might have an entire litany of different benefits that it provides for the tribal people, but the placebo effect is a positive thing because…
it’s the power of belief that helps you and these plants are the vehicle… so the person that is looking for help willingly goes and is hoping [the plants are] going to help (Pinkman 2016).

Monica, among others, expressed this thought as well explaining that the process of healing is “two parts faith and two parts medicine” (Nuvamsa 2016).

Belief is not unique to American Indian healing practices however. In western medicine it is referred to as the placebo effect. Positive benefits of the placebo effect are well founded in scientific testing (Benedetti 2014, 45, Brown 1998, Crum and Langer 2007, Price et al. 2008). In both cases, faith helps individuals recover.

_Social Issues with Western Medicine_

Thus far, I have focused on a cultural resistance to western medicine that many interviewees expressed. However, three out of ten interviewees also spoke about detrimental physical and psychological effects of this type of medicine on the American Indian community. According to LaKota, painkillers have become a large issue on many reservations as the Indian Health Service, federally funded clinics for American Indians, doles them out in a fairly unrestrained manner. Other interviewees echoed this sentiment as well and many expressed particular resistance towards taking painkillers. Monica explained to me that while she will take certain drugs such as antibiotics if she really needs them, she does not take painkillers. So too, Josiah stressed that if he felt pain such as a headache, he did all that he could to address the issues behind his pain instead of “pick[ing] up that Tylenol off of the shelf” (Pinkman 2016).

LaKota spoke about the ramifications of the Indian Health Service’s widespread prescription of painkillers, stating:
We have high rates of people that are addicted to pain killers because all they give out are pain killers... we have really high rates of depression and suicide and addiction and a lot of that is really, really fueled by Indian health services because you’re constantly giving these people antidepressants and pain killers and they’re just feeding into the system (Scott 2016).

In light of the detrimental effects western medicine has had on many American Indians, it is to be expected that Native communities would be wary of the production of western drugs from their knowledge. American Indians might feel that by contributing their knowledge to western medicinal patents, they are helping to perpetuate a system that negatively effects a good deal of their community.

Summary of Ideas on Traditional and Western Medicine

As I tried to demonstrate with these few examples, I learned that many individuals were strongly against the methodology and intention behind a great deal of western medicinal practices (Scott 2016, Pinkman 2016, Yanaha 2016). Across American Indian culture, there is a widespread belief that plants have a spirit that must be respected (Clifford 2016, Nuvamsa 2016, Marcus 2016). When you take from the Earth in an unintentional way, you show a lack of deference for the plant you are gathering (Clifford 2016). Many Native individuals feel that a plant chooses whether or not to cure you (Nuvamsa 2016). They believe that when we disregard the fact that plants are sentient beings, or distort the plant’s essence through widespread commercial production, the plant may simply decide not to heal us (Nuvamsa 2016). Furthermore, ceremonies, tribal customs, and belief are an integral part of the healing practice (Scott 2016, Pinkman 2016). Due to these opinions towards western medicine and the pharmaceutical
industry, it is understandable that many Native people might feel resistant towards the idea of mass-producing Native plant remedies.

**Non-Native Usage of Traditional Medicine**

Among my interviewees, there was a variety of opinion on what degree non-Native people should be able to use traditional medicine. Five individuals generally felt that all knowledge should be open to the people of the Earth and that there should be no definite limits to who has access to Native plant healing (Clifford 2016, Flores 2016, Nuvamsa 2016, Marcus 2016, Yamka 2016). On the contrary, three of the people I interviewed felt that knowledge should only be shared with individuals who would give back to the community and treat the information with respect (Diho 2016, Scott 2016, Pinkman 2016). Two individuals did not express their feelings on this issue. These opinions are not quite as divergent as they may originally seem. As will be discussed later, respect for the Earth and traditional knowledge was a common theme in most interviews. Furthermore, different people referred to various aspects of the Native healing process including the plant, plant preparation, and traditional ceremonies around the plant. It was not always clear exactly what traditional medicine meant as individuals could be referring to a number of these components. I have done my best to clarify this, but there may be some ambiguity.

**Requirements for Non-Native Traditional Medicine Use and Plants as a Gift of the Earth**

Diho, a 32 year-old Navajo woman, works as an Education Director at a Navajo heritage museum. She feels that the line is crossed when non-Native people take Native ceremonial practices for their own. She believes that non-Native individuals can use Native plants, but that they have to be accepted into the community to practice the ceremonies associated with plant
healing. She said, “I think the person needs to have earned a path into the community that they have to have been embraced by the community… to practice… with the community… [and] with a medicine person who is able to help them” (Diho 2015).

LaKota argued that the only non-Native people who should be using traditional medicine (in terms of ceremony and plant preparation) were those that had deeply committed to the community and had a mutual relationship with a tribe. She said:

Someone coming into the community and learning something about the culture… and taking that away from the community and using that somewhere else, I think that’s very disrespectful and that’s not something that I personally support… because that’s not respecting the culture and being a part of it, that’s just taking from it and using it for your own gain (Scott 2016).

This belief comes in tension with her medical studies. She holds traditional knowledge that she does not necessarily want to share with the western medical community. She explained, “For me it’s a personal tug of war… I have traditional knowledge, but I don’t really want to share it [with outsiders] because people… want so much from you, but it’s not a conversation…[it’s] a one-way street” (Scott 2016).

Josiah voiced a similar opinion explaining that non-Native use should hinge on the level of trust between the tribal community and the individual. He stated, “It depends on the trust relationship that’s been built up between that individual that’s been deemed as an outsider and the population with whom they’re working” (Pinkman 2016). He went on to express that widespread use of a plant could potentially be acceptable if it did not threaten the Native population and their application of the plant in any way (by over-picking the plant, intruding into Native life, etc.). He explained that while “according to the tribal membership, there’s a tremendous outpouring of
thought and expression to lead you to think that that’s… not ok… across the board,” he feels that in certain situations this model could potentially work (Pinkman 2016).

While other interviewees all felt that respect for Native culture and plant healing was essential, they believed that the creations of the Earth belong to all people and as such could not be claimed by any tribe. They emphasized that while everyone should be able to use the plants, they should not disrespect them (Clifford 2016, Nuvamsa 2016, Marcus 2016, Moore 2015a).

Lee Standing Bear Moore, also known as Yonv, Gadoda Yonv and Bear, spoke to me on behalf of the Manataka Indian Council. He explained: “Because all healing things of the Earth are given freely by the Creator of All Things to all people and other creatures and beings, should we not share all healing things equally with all?” (Moore 2015a). Yamka, a 61-year-old Navajo artist and USDA worker, echoed a similar sentiment. She said, “We’re all humans more or less- that’s why [plants] are out there for everyone.” Monica too echoed this idea:

   It’s so easy to segregate non-Native and Native, black and white, [but] from a traditional standpoint, as long as the person is responsible with it [by respecting it and not overusing it]… these plants are gifts from an unknown source, an unknown power known to human beings (Nuvamsa 2016).

It is interesting to note where different individuals draw boundaries in non-Native use of Native healing practices. Interviewees had a variety of opinions on what threatens tribal knowledge as well as what is fair to share with whom. This can all have an impact in the degree to which Native individuals feel comfortable with their knowledge being used in western medicinal drugs.

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18 Yonv is from outside of creosote’s region. However, since he spoke to me on behalf of a tribal council, I included the interview to provide this varying perspective. I was unable to obtain an interview with a member of a tribal council in creosote’s range.
Working with Non-Native People in Business

I also interviewed two people that deal with this issue in their work. Leonard Marcus (age 50) and his wife Virginia own a small company called Medicine of the People “A Native America Made Product.” While Leonard is of Potawatomi descent, he does not necessarily “call himself Native American” (Marcus 2015). They produce a variety of herbal products using traditional knowledge. Among these, are a variety of salves and creams that use creosote, which they market for dry skin, eczema and psoriasis. Leonard explained to me that he feels the plants they use are “a gift from the earth” and as such, he is equally happy for all people to use his products. Miguel Flores, a 44 year-old man from the Pascua Yaqui Tribe and Tohono O’odham Nation also works in traditional healing. He is the president of Holistic Wellness Counseling & Consultant Services in Tucson Arizona. Similar to Leonard, Miguel told me that he treats patients regardless of their Native or non-Native background. His center uses a variety of healing methods such as acupuncture, traditional medicinal practices, herbal medicine, sweat lodges, group sessions, and cultural art.

Summary

Even though they expressed their views slightly differently, interviewees had a number of common ideas about non-Native usage of traditional knowledge. Generally, they felt that plants were a gift and therefore could not be owned by the tribes. Among individuals, there was a difference of opinion on how non-Native people should be able to practice Native customs, but most seemed to feel that no tribe could claim a plant entirely for itself. Some believed the line should be drawn at plant use while others thought it might be permissible for non-Native people to partake in Native preparation of the plant or Native ceremonies surrounding the plant. The
degree to which interviewees thought that non-Native individuals should be allowed to use traditional medicine hinged largely on a factor of respect. Many of these ideas will be elaborated on in the next section where I will explore how individuals felt about the idea of patents.

**Philosophies on Patents**

Five out of ten of the individuals I interviewed had strong negative feelings towards the general concept of patenting knowledge and four others expressed a similar, but perhaps less vitriolic sentiment. When I started this research, I had no idea how integral this portion would be to understanding how Native populations might want to be reimbursed for use of their knowledge in patents. Yonv was the first individual I interviewed. He began by making his, and the tribal council’s, opinions on patents very clear to me:

> American Indians, like their indigenous brothers and sisters in Central and South America, never claimed ownership of anything made by the Creator of all things… Indigenous medicine people do not guard the secrets of their primitive concoctions or patent them because they come from the Creator and in our way of thinking, they belong to all people… Because all healing things of the Earth are given freely by the Creator of All Things to all people and other creatures and beings, should we not share all healing things equally with all? Why is it necessary to make a profit from healing? What would happen to the world if all healing was free? -- just like it was given by the Creator…. Patents on food and medicines must be abolished… There should be no price placed on knowledge because most of it is priceless (Moore 2015a).

Josiah has studied this issue extensively as he was appointed by his tribe to recommend whether or not they patent a certain plant that they use for a plethora of different medical purposes. After much research he came to the following conclusion:

> The benefits for patenting a substance and its use are obvious because people can’t intervene and say ‘that’s mine’…The more problematic aspect is seeing what the negative consequences are.
One of those consequences is… other people use that substance in the same way we do. Are we going to patent it and say that they can’t use it now? And then turn around and try to sue other tribal people that use that medicine in the same way that we do and they’ve always done it the same way? (Pinkman 2016).

Aside from these issues, Josiah emphasized that the 25-year nature of a patent is problematic, as it does not take future generations into account. Additionally, he explained that it was undesirable to publicize the ways in which their tribe uniquely used the plant. In the end, his tribe did not patent the plant.

Leonard explained, “Industries care about the bottom line. They don’t care about where things came from or who gets hurt in the process” (Marcus 2015). He went on to say, “there is a right way and a wrong way to work with these things that have spirit or what you call medicine…Some people are bad and greedy, it doesn’t matter what color you are” (Marcus 2015).

Others spoke about patents with a sense of befuddlement. LaKota explained, “For me, it doesn’t make sense because knowledge is kind of like creativity, it constantly comes…into light and then it changes and it develops in different ways but there’s no such thing as something being original” (Scott 2015). She felt that Native thought on patents is simply antagonist to that of western ideology. In speaking specifically about plant patents she remarked:

Even if it was a tribe, to patent one type of herb, that wouldn’t make sense because it doesn’t belong to those people, it belongs to everybody, it belongs to every human, and it doesn’t belong to a corporation, it doesn’t belong to a tribe, and… it’s the opposite of a capitalistic or very American view of ‘this is mine and I knew it and therefore I can claim it,’ but that’s not the way it works (Scott 2016).
This may seem to come in tension with LaKota’s thoughts on non-Native usage of traditional medicine. However, she seems to be saying that while there should be boundaries to what knowledge a people has to share with outsiders, they do not necessarily own that knowledge or have a monetary claim over its broad usage.

Arnold also questioned the logic of patenting material that used traditional knowledge. He explained, “when it comes to that Native knowledge, I don’t think you can copyright it\(^\text{19}\) because it goes way back- it was given and bestowed to the people before there were federal laws. It’s not right for somebody- Navajo or non-Native- to take the indigenous knowledge and make a profit from it” (Clifford 2016).

Yamka didn’t wish to comment on patents, but said, “If they know how to get rich off it, that’s their thing I guess (Yamka 2016). Her tone conveyed that she did not see patents as a positive institution.

These are just a sample of many disapproving feelings expressed towards patenting Native knowledge. Interviewees generally felt that patents were out of line with Native philosophies and that they focused on earning a profit in a way that was unholy and greedy. This is because American Indian culture holds a great deal of other values above earning money (LaKota 2016, Nuvamsa 2016). On the contrary patents epitomize a capitalistic ideology. Societies build themselves to maximize that which they treasure. American Indian communities value personal connections and the Earth. As such this is what they seek to promote. Western society largely

\(^{19}\) While there is a difference between copyrights and patents, the distinction is not relevant to this paper.
values money. Subsequently, our systems are built to maximize monetary reward. These two philosophies do not harmonize well together when it comes to patenting Native knowledge.

**Compensation for Patents**

In discussing how individuals would potentially want to receive compensation for patents that incorporate traditional knowledge on creosote, it is important to keep the former discussion in mind. While some individuals agreed to discuss how they might envision a compensation plan, almost no one had sympathy for the idea of patents to begin with. Furthermore, there was a general resistance to the mass production of herbal remedies in general. As I move into exploring compensation methods, it is essential to understand that this would be a best-case scenario in what many Native individuals, as well as a great number of people worldwide, feel to be a flawed, corrupt system (see Chapter 2 for more).

In total, three people were totally against the idea of compensation, two thought it was unrealistic, two thought it could be applied on an individual level, and three thought it could be beneficial for communities.

**Negative Feelings Towards Compensation**

Monica was very antagonistic towards the idea of compensation. While she felt that each indigenous community should make their own decision about whether or not they would want monetary reimbursement for their traditional knowledge, she said that to her “to take money or get scholarship is shameful” (Nuvamsa 2016). This is because she feels that:
Money is not of particular value to the people that practice these beliefs. We value nature, we value spirit, we value our relationships. Money is the last thing people value. We have a community that has a long memory... we have gone through a lot of struggle... We are struggling financially because this is a system we are not familiar with... members of our community are considered to be living in poverty... but these members don’t consider themselves poor (Nuvamsa 2016).

Monica seems to be generally resistant to a capitalistic, western lifestyle. She explicates that the general conception of poverty as a dearth of monetary means does not match up with her and her community’s understanding of the term. As such, they do not believe themselves to be poor and she does not feel the need to be part of a system of payment that she morally disagrees with.

LaKota explained that monetizing a Native resource is often extremely harmful. She believes that when you put a price on a resource you are setting up a forum for exploiting people in the future as well as forcing them to look at their land through a monetary lens. She went on to discuss future generations and said, “This next generation of people, you’re telling them, this is how much your culture is worth and that’s not a good thing” (Scott 2016).

Diho explained, “As indigenous or Native people, we don’t believe these plants are ours, we don’t own them...” (Diho 2015). However, she did feel that if Native practitioners contributed knowledge, those people should be paid for their additions. Miguel agreed that individuals should be reimbursed for their input. He felt that traditional practitioners should be treated in the same way primary physicians or doctors are when they contribute to a patent. He thought that the method of compensation should be up to the individual (Flores 2016).

On the contrary, Yovv was very against the idea of compensation for individuals. He said:
American Indians, as individuals should not claim a share of the profits from pharmaceuticals because no one individual or group of individuals is responsible for creating the depth of the knowledge base that helped produce the income. Ancient knowledge is the compilation of many generations and millions of trial and errors… It is conceivable that a single tribe could be largely responsible for the cultivation, preservation and formulation of a specific plant species used to create a specific pharma drug. A tribe may have a ‘stake’ in the claim but an individual has no claim – in the NDN [American Indian] world (Moore 2015b).

However, in general, Yonv was extremely against the idea of patents, particularly in regards to food or medicine (Moore 2015b,c).

When I asked Wanekia about his feelings towards compensation he expressed exasperation at the United States’ history of biopiracy. He said:

> When has a company or this western society ever stopped using Native knowledge that has been handed down from Spirit, Creator and our Ancestors, from the structure of our government, to popcorn, to growing squash or to the plants that cure deadly diseases? This country has survived on Native Knowledge from the beginning, or since they landed, and now were being asked if we should be compensated? (Wanekia 2016).

These thoughts highlight the contrast between Native ideology and western capitalism. The individuals who I have quoted in the section above largely felt that they couldn’t justify being part of the western system in order to receive compensation.

**Positive Feelings Towards Compensation**

Contrasting these negative feelings towards compensation, there were a number of individuals that were open to the idea of payment on a community basis. Josiah explained that there could be situations in which some form of recom pense agreement could be helpful for tribal groups. He outlined how he envisioned this explaining that “the compensation needs to essentially be trans-
generational … you need to address the fact that there are future generations of people that are going to be coming into the world… you need to do something to help perpetuate [the benefits of the compensation]” (Pinkman 2016). He proposed that one way to do this would be to provide scholarships for Native students to go pursue degrees in health related fields.

Arnold felt similarly to Josiah. He explained, “If there’s compensation, (it should be to) set up some sort of account that provides funding for a school of Navajo traditional medicinal knowledge” (Clifford 2016). He told me that as elders pass away, a great deal of knowledge goes with them. He feels that setting up some sort of forum to perpetuate traditional knowledge would be a very beneficial thing for his community. Yamka also agreed that a traditional medicine scholarship would be the best form of compensation.

It seems that in contrast to the individuals in the former sections, these interviewees felt there was at least some positive reward their communities could gain from patents using their knowledge. While these individuals do not necessarily agree with the concept of patenting knowledge, they feel that while the system is in place, American Indians could benefit from it to some degree.

**Concluding Thoughts**

It is interesting to note that most of the individuals who were open to compensation had professions that were more integrated within western culture than those that disapproved of it. Out of the people who wanted a scholarship fund, Yamka works with the USDA, Josiah deals with government agencies, and Arnold does research with a number of non-Native botanists and
geologists. Of the two who believed individuals should be compensated, Diho works at a museum open to the non-Native public and Miguel treats non-Native patients and deals with hospitals. On the contrary, Monica works mainly within the Hopi community, Wanekia is a spiritual leader and Yonv serves on a tribal council. LaKota is the exception to this as she is currently attending medical school. It is possible that individuals more involved in the western world feel that there is less likelihood that this world will change anytime soon. They may have also simply accepted western philosophies in a way that the other interviewees have not felt that they needed to.

In the following chapter I will outline recommendations for a potential compensation plan based on these opinions of Native reimbursement for patents on creosote. I am very grateful for the time and energy these ten individuals gave to me. It was a tremendous honor to learn from them and to hear their ideas and philosophies. Each one of them holds a fascinating view of the world and approaches it in a beautiful way. These interviews greatly shaped my own ideas on these matters and I hope that I have conveyed them in a way that the reader will also gain some amount of insight.
5

Conclusion

Although Native groups worldwide have contributed to a vast proportion of western medicine, they have received little benefit for the use of their knowledge (Pan et al. 2004, Prance 1994, White 2013, 134). While it is true that pharmaceutical companies also contribute to these drugs in a major way, they should not be the sole beneficiaries. It seems unjust that western companies and researchers reap billions of dollars from the profits of patents that use indigenous knowledge, while the people who originally held these ideas and practices receive no return (Mgbeoji 2006, 6, White 2013, 134). Even if the entire system of patenting information is arguably immoral and nonsensical (Chapter 2, Chapter 4), parties seeking patents should at least provide the choice of benefit for indigenous peoples who contributed a share of the information used to create the patents. Each individual group has its own set of moral guidelines, needs and desires. As such, there is no blanket compensation plan that can fit all communities.

Over this chapter, I will provide a compensation proposal for American Indian tribes that have contributed knowledge to patents on creosote and briefly discuss the pharmaceutical industry’s potential response to this proposal. This proposal could be used as a model for other groups as well. In each case of a patent, the specific American Indian group that assisted in creating said patent, actively or passively, should be consulted. While my analysis proposes a plan for creosote patent compensation, I do not claim that all American Indian groups who use creosote would want this specific plan. I have formulated the following proposal based on a set of preliminary interviews and it is simply meant to serve as a conversation starter. My hope is that
my research will bring this issue into a more public light and that it may draw additional parties into thinking about discrepancies in patent profits.

**Proposed Compensation Plan:**

Over the course of my interviews I found that the majority of Native individuals I spoke with felt very negatively towards the idea of patenting knowledge (Clifford 2016, Diho 2015, Scott 2016, Nuvamsa 2016, Moore 2015a,b,c). They argued that inventions and discoveries are only revealed through generations of collective understanding and that no one individual can claim the rights to any specific piece of knowledge (Clifford 2016, Scott 2016, Moore 2015a,b,c). Additionally, interviewees explained to me that plants such as creosote are a gift from the Earth and the higher powers of the universe (Clifford 2016, Marcus 2015, Moore 2015ab,b,c, Nuvamsa 2016). As such, many of them would not even entertain the idea of receiving compensation for knowledge (Scott 2016, Moore 2015a,b,c, Nuvamsa 2016). However, in my interviews, there was one main idea that resonated with interviewees as a potential method of compensation. This was the proposal to create a type of scholarship or school for Native individuals to receive and perpetuate traditional medicinal knowledge.

As the older generation pass away, much tribal knowledge goes with them (Clifford 2015). Younger people are becoming continually acculturated into the mainstream U.S. and they often do not learn the practices of their tribes to the same degree as the elder generations used to (Clifford 2015, Nuvamsa 2016). Many middle-aged and elderly members of the community are worried about the lack of teaching young people are receiving in regards to traditional medicinal knowledge (Clifford 2016, Pinkman 2016, Yamka 2016). For this reason, it seems logical to provide traditional medicine scholarships with money from patents that use such knowledge.
From my research, it seems that no models like this currently exist, but it is possible that there is already a similar scholarship in place somewhere in the world.

Not all communities or individuals that contribute to patents on creosote may wish to establish this sort of scholarship, but it seems to be a suitable deal for some. I propose that when future companies and researchers create patents on creosote, they consider providing a scholarship for aspiring traditional medicine practitioners. If there are any specific Native individuals that assisted in the creation of the patent (by providing information), the patent holders should first ask these people if and how they would like to be compensated, if at all. After this, they should consult a variety of individuals from the tribes and regions from which they obtained knowledge for the best methods. This could be done through interviews or surveys. Patent holders should ask communities and individuals if a scholarship would be desirable to them. If it is indeed accepted by the Native groups, these groups should be in charge of designing and implementing the school or fund with whatever assistance from the patent holders they request. Throughout this process, it is essential that the patent holders be mindful of the communities they are working with and vigilantly treat them with the utmost respect. This is obviously a very difficult system, but it is essential for companies to do something.

**Pharmaceutical Responses**

In order to determine the potential effectiveness of this proposal, I spoke with three representatives of different branches of the pharmaceutical industry whose names will be kept anonymous. This was not a subject that these individuals had given much prior thought to and many were skeptical over whether or not the industry would be willing to provide such

One prominent medical supplier explained, “People steal ideas day in and day out. If one person can do it another person can do it” (medical supplier 2016). A drug developer explained “if they don’t have a previous patent on their knowledge, there is no way to know how much money to give them” (drug developer 2016).

However, all three of the individuals felt that a one-time grant might be feasible. One executive who has spent thirty years in the industry explained that while she felt it was unlikely pharmaceutical companies would provide compensation to specific healers, she thought it was possible that they might agree to some sort of fund for a large community with an organized representative (Pharmaceutical executive 2016). So too the medical supplier explained, “It would be hard for me to justify something on an ongoing basis, it would be more palatable if we were to give a one time grant or contribution to a program…. As a business person I can’t see providing compensation on an ongoing basis” (medical supplier 2016). He went on to explain that while he did not feel that the pharmaceutical companies owed indigenous groups anything, he felt that a “good-will” gesture, such as a one time grant, might help pharmaceutical companies get more information from those groups in the future (medical supplier 2016).

While providing compensation plans for patents may be an imperfect solution, it is possible that they could do something to even out an unbalanced organization of power. It seems that pharmaceutical companies might be willing to cooperate to implement some sort of compensation plan similar to that which I have proposed in this paper. I hope that this proposal
will continue the discussion on these issues and perhaps draw some new voices into the conversation.

**Potential Errors and Research Flaws**

There were a few factors that may have negatively skewed the results of my research. It was extremely difficult to connect with individuals to set up interviews. Understandably, many Native people are wary of researchers and hesitant to speak about these issues. Furthermore, a number of people felt they did not have the background to speak on these matters, lacked the time to discuss them, or were simply unreachable by either phone or email. Therefore, I only spoke with a limited number of individuals, which may have skewed results. Additionally, due to my geographic location and lack of funds, I conducted these interviews over phone and email. It is possible that interviewees would have been more comfortable speaking in person and may have shared more of their ideas in such a setting.

Although I tried to find interviewees over a spectrum of ages, most of the individuals I spoke with were middle-aged. I also did not interview any genders besides male and female. As a result of these issues, I may have missed important perspectives.

**Future Research**

While there may have been some drawbacks in this study, on the whole it can provide a very helpful forum for future research. Through my interviews I was able to gain an understanding of certain broad concepts and learn what questions are important to ask. In order to procure a more thorough perspective on Native thought towards compensation for traditional knowledge on creosote, my results could be used to formulate a survey to be distributed on a much broader
scale. This would allow for the input of a wider array of opinions. Additionally, if this proposal for a scholarship fund is implemented, future studies could assess its effectiveness.

Concluding Thoughts

Patents are a complicated institution. They encourage invention and discovery, which are both desirable for society. However, they also promote a very individualistic mentality and allow one person or group to take credit for the final stitch in a trans-generational fabric of creativity. Whether we view patents as a generally positive or negative construction, they have certainly caused pain to indigenous communities worldwide.

Some indigenous groups refuse to benefit from patent money, as they believe it disrespects the Earth and ancestral contributions. This is a very admirable position. Conversely, some communities feel that if patents are inevitably to be implemented, they should at least benefit those communities who originally contributed to the knowledge that created them. This belief is equally valid. The compensation plan proposed in this paper is an attempt to level the scales and provide indigenous groups with a greater amount of agency within the current system. This is a plan for communities that are interested in receiving compensation. Using money from patents on creosote to implement a traditional medicine scholarship, American Indian communities could potentially benefit from patents in some small way.

All the ideas presented in this paper are the result of generations of thought and experience. I hope that they have culminated to produce something worthy of your time and have allowed you to think about these issues in a mindful way.
Appendices

Appendix 1: ETC Mission Statement:

“ETC Group works to address the socioeconomic and ecological issues surrounding new technologies that could have an impact on the world’s poorest and most vulnerable people. We investigate ecological erosion (including the erosion of cultures and human rights); the development of new technologies (especially agricultural but also other technologies that work with genomics and matter); and we monitor global governance issues including corporate concentration and trade in technologies. We operate at the global political level. We work closely with partner civil society organizations (CSOs) and social movements, especially in Africa, Asia and Latin America.

We are…

• Dedicated to the conservation and sustainable advancement of cultural and ecological diversity and human rights. To this end, ETC Group supports socially responsible developments of technologies useful to the poor and marginalized and we address international governance issues and corporate power.

• Working in partnership with other CSOs for cooperative and sustainable self-reliance within disadvantaged societies, by providing information and analysis of socioeconomic and technological trends and alternatives. This work requires joint actions in community, regional, and global flora.

• Developing strategic options based on research and analysis of technological information (particularly but not exclusively plant genetic resources, biotechnologies and biological diversity), and in the development of strategic options related to the socioeconomic ramifications of new technologies.
• **Focused on global and regional (continental or sub-continental) levels.** ETC Group supports partnerships with community, national, or regional CSOs, but does not make grants or funds available to other organizations. We do not have members (ETC Group).”
Appendix 2: Convention on Biological Diversity, Article 15: Access to Genetic Resources

“1. Recognizing the sovereign rights of States over their natural resources, the authority to determine access to genetic resources rests with the national governments and is subject to national legislation.

2. Each Contracting Party shall endeavor to create conditions to facilitate access to genetic resources for environmentally sound uses by other Contracting Parties and not to impose restrictions that run counter to the objectives of this Convention.

3. For the purpose of this Convention, the genetic resources being provided by a Contracting Party, as referred to in this Article and

Articles 16 and 19, are only those that are provided by Contracting Parties that are countries of origin of such resources or by the Parties that have acquired the genetic resources in accordance with this Convention.

4. Access, where granted, shall be on mutually agreed terms and subject to the provisions of this Article.

5. Access to genetic resources shall be subject to prior informed consent of the Contracting Party providing such resources, unless otherwise determined by that Party.

6. Each Contracting Party shall endeavor to develop and carry out scientific research based on genetic resources provided by other Contracting Parties with the full participation of, and where possible in, such Contracting Parties.

7. Each Contracting Party shall take legislative, administrative or policy measures, as appropriate, and in accordance with Articles 16 and 19 and, where necessary, through the financial mechanism established by Articles 20 and 21 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. Such sharing shall be upon mutually agreed terms (CBD 1992).”
Appendix 3: Effects of Freezing on Creosote Plants

Freezing induces xylem embolism in creosote (Martínez-Vilata and Pockman 2002). At 0°C the xylem in the plant’s apoplast freezes and, due to negative pressure, produces air bubbles, which obstruct the flow of xylem (Mayr et al. 2007, Martínez-Pockman and Sperry 1997). In creosote, complete embolism takes place between -16°C and -20°C (Martínez-Vilata and Pockman 2002). While creosote roots are more susceptible to freezing than stems, the ground acts as a heat sink and does not freeze as rapidly as the air. Hence, stems usually experience freezing induced xylem embolism before roots (Martínez-Vilata and Pockman, 2002).

Freezing impedes Creosote’s ability to absorb water even after temperatures return to above 0°C (Martínez-Pockman and Sperry 1997). Subsequent to thawing, the bubbles created by freezing can either dissolve back into the xylem or nucleate (Martínez-Vilata and Pockman 2002). If the xylem remains blocked the plant will become dehydrated (Martínez-Vilata and Pockman, 2002). Different ploidy groups have different tolerances levels to freezing temperatures (Figure A.2.1.: Martínez-Vilata and Pockman 2002 ).
Figure A.2.1. Minimum temperatures across creosote’s range. Temperatures were collected from 1201 stations, which are conveyed by the points. Temperatures are a mean derived from an average 40.3 years of data collection. The solid lines signifies the boundary of creosote’s range and the dotted line signifies a rough divide between the Chihuahuan, Sonoran and Mohave Deserts and their respective ploidy groups (Pockman and Sperry, 1997).
### Appendix 4: Patents on Creosote Derivatives

Table A.3.1 Patents on *Creosote* derivatives (data compiled from Google Patents).

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<tr>
<td>US2535910 A</td>
<td>Treatment of unrendered fat with nordihydroguaiaretic acid</td>
<td>Aladar Fonyo</td>
<td>26-Dec-1950</td>
<td>24-Sep-47</td>
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<td>US5409690 A</td>
<td>Treatment of multidrug resistant diseases in cancer cell by potentiating with masoprococ</td>
<td>Stephen Howell, Atul Khandwala, Om P. Sachdev, Charles G. Smith</td>
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<td>23-Jun-93</td>
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<td>US 5663209 A</td>
<td>Compounds for the suppression of HIV Tat transactivation</td>
<td>Ru Chih C. Huang, John N. Gnabre</td>
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<td>US5945106 A</td>
<td>(N)ontoxic extract of Larrea tridentata and method of making the same</td>
<td>Robert A. Sinnott</td>
<td>31-Aug-1999</td>
<td>11-Sept-98</td>
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<td>US 6004559 A</td>
<td>Nontoxic extract of larrea tridentata and method of making the same</td>
<td>Robert A. Sinnott, W. Dennis Clark, Kenneth Frank DeBoer</td>
<td>21-Dec-1999</td>
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<td>US6365787 B1</td>
<td>Compounds for the suppression of HIV TAT</td>
<td>Ru Chih C. Huang, John N. Gnabre</td>
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<td>30-Sep-94</td>
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<td>US7182963 B2</td>
<td>Cosmetic and dermatopharmaceutical compositions for skin prone to acne</td>
<td>Karl Lintner</td>
<td>27-Feb-2007</td>
<td>2-Apr-04</td>
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<tr>
<td>US 7741357 B1</td>
<td>Heterocyclic and carbonate derivatives of NDGA and their use as new anti-HIV and anti-cancer agents</td>
<td>Ru Chih C. Huang, Apostolos Gittis, Evangelos Moudrianakis, Julie A. Dohm, Jih Ru Hwu, Ming-Hua Hsu</td>
<td>22-Jun-2010</td>
<td>13-Apr-07</td>
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<td>US20110014192 A1</td>
<td>Suppression of cancer growth and metastasis using nordihydroguaiaretic acid derivatives with metabolic modulators</td>
<td>Ru Chih Huang, Kotohiko Kimura</td>
<td>20-Jan-2011</td>
<td>8-Jan-09</td>
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<td>WO2012166778 A2</td>
<td>Conjugates of nitroimidazoles and their use as chemotherapeutic agents</td>
<td>Ru Chih C. Huang, David Edward MOLD, Jih Ru Hwu, Ming Hua HSU, Szu Chun WU</td>
<td>6-Dec-2012</td>
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<td>US20150018302 A1</td>
<td>Compositions comprising ndga derivatives and sorafenib and their use in treatment of cancer</td>
<td>Ru Chih Huang, Christopher RULAND, Yu-Chuan Liang, Jong Ho CHUN</td>
<td>15-Jan-2015</td>
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Nuvamsa, M. (03/12/2016) Phone Interview/Interviewer: T. Niederman.


Pinkman, J. (02/10/2016) Phone interview/Interviewer: T. Niederman.
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