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Gastrointestinal Health as a Stimulus for Native American Attraction to Medicinal Asteraceae and Further Implications for Human Evolution

Christopher David Stiegler
University of Arkansas, Fayetteville

Gastrointestinal Health as a Stimulus for Native American Attraction to Medicinal Asteraceae and Further Implications for Human Evolution.

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Christopher D. Stiegler
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Dr. Justin Nolan
Thesis Director

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Dr. Jerome Rose
Committee Member

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Dr. Peter Ungar
Committee Member

Abstract

The Asteraceae, or the daisy family, is the largest family of flowering plants in the world, and its ethnobotanical, medical, and economic value is readily apparent cross-culturally. The aim of this thesis is to examine why constituent genera of the Aster family have remained such an integral part of human medicinal plant knowledge, and thereby to reveal any potential physiological, biological, or evolutionary mechanisms underlining human patterns of use regarding the Asteraceae. The present study focuses specifically on Native American plant knowledge made available by the expansive database in the works Daniel Moerman (Moerman 2003). Frequencies of plant use and their corresponding applications for symptoms relating to human physiological organ systems are examined. Bar graph and T-test analyses reveal that gastrointestinal ailments comprise more medical uses for the Asteraceae than any other organ system targeted by taxa within the Asteraceae family. Therefore, it is posited here that the Asteraceae's biochemical effects on the gastrointestinal tract, including the elimination of intestinal worms and other pathogens, continues to sustain human attraction to medicinal genera within the Aster family. Data also suggest potential evolutionary advantages for human populations able to exploit the Asteraceae for medical purposes. These data exist in extant non-human primates, extinct hominins, Neandertals, and early humans. While this study and the data used in it were limited to Native North America, the conclusion are believed to inform anthropological understandings of human-plant selection, co-evolution, and the continued global use of the Asteraceae in traditional medicine more broadly.

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Ch. 1 Introduction

Consider the lowly dandelion, the ubiquitous sunflower, the roadside coneflower, or the lovely ornamental yarrow (Figs. 1, 2, 3, 4, 5). While not obvious to most, these plants belong to the largest known family of flowering plants, the Asteraceae. Asters are widely known for their manifold uses, including sweeteners, insecticides, foods, beverages, and especially medicine. For example, many are familiar with chamomile tea as an effective remedy for upset stomachs; others may know well the antimalarial properties of the sunflower, and even the diuretic uses of the dandelion.

These observable health advantages encourage anthropologists and ethnobotanists to ask what role the Asteraceae played in the evolutionary success of modern humans and extinct hominin ancestors. Certainly, perceptual and physiological medical stimuli within the Asteraceae appealed to human ancestors. They also allure extant non-human primates, and entice current peoples, rendering use of the Asteraceae evolutionarily adaptive and thus widely used in folk and traditional medical preparations (Nolan 1998; Quinlan 2005; Jernigan 2006; Balee and Nolan 2014). Furthermore, understanding humans' evolutionary and ethnobotanical relationship with the Asteraceae informs questions of medicines' role in natural selection and potentially illuminates new pathways for discovering medicines among the natural plant compounds available all over the world.

1.2 What is Ethnobotany?

The field of ethnobotany is defined as the interaction between plants and humans, both temporally and spatially (Albuquerque and Hurrell 2010). It studies how people understand, use, and co-evolve with the plants around them. It merges the fields of botany and ethnology, and aims to answer questions concerned with human evolutionary ecology, paleoethnobotany, cognitive and symbolic ethnobotany, folk taxonomy, historical ethnobotany, agrodiversity, biodiversity, medical ethnobotany, and many more (Nolan and Turner 2011).

Truly, ethnobotany embodies the essence biocultural anthropology, as it blends cultural understandings and uses of plants (Goody 1993), with the recognition that biological processes drive human-plant interactions. Undoubtedly, this fascination has influenced human biology and evolution (Nolan and Turner 2011), both in modern humans and hominin predecessors. Indeed, plants play a vital role in the lives of people living today, people of the past, and extinct hominins, such as early *Homo*, *Australopithecus*, and *Paranthropus*. Furthermore, plants are known to play a vital biological role in the lives of extant non-human primates. (Ungar 1998; Teaford and Ungar 2000; Scott et al. 2005; Ungar 2006; Ungar and Sponheimer 2011). All apes and humans depend on plants for subsistence (Dominy et al. 2001).

Ethnobotany's role as the study of human-plant relationships is immensely important to the progression of anthropological thought because it informs understandings of underlining biocultural and adaptive mechanisms influencing humans' relationships with plants, and their ecology more broadly. In a benchmark *American Anthropologist* article, Nancy Turner (1988) clearly elucidates that ethnobotany is a reflection of human cultural adaptations to the environment, and how analyses of human-plant relations inform how individuals within a cultural region learn which plants are ecologically most stable as dietary and medical resources.

Generally, plants have proportionally high frequencies of features that serve as perceptual signals (conspicuous morphological features), which lead to significant amounts of potential use value overall (Dominy et al. 2001). Essentially, ethnobotanical knowledge systems are biocultural adaptations to local ecologies that help and have helped both living and ancient societies to better survive and reproduce within their environment. Ethnobotany, thereby, is evolutionary in scope and adaptive in practice.

Indeed, the benefits of humans' relationships with plants are diverse. Plants have captured and sustained human senses and imaginations for millennia leading to many innovative uses for them. Plants feed and medicate us, and inspire our aesthetic sensibilities. Notably, the symbolic bases of religious ideologies can be observed in plant flowers, fruits, and fruit products. The lotus flower of Hinduism and Buddhism, the apple of knowledge and the chestnut as a symbol of strength in Christianity, all serve as reminders of the role plants play in the perpetuation of human knowledge and belief systems. Plants further propagate human experimentation as evidenced by our fascination with mind-altering substances as a means to enter altered modes of consciousness. In fact, while widely criticized today, Terence McKenna suggested the "stoned ape theory" in the 1970s as a mechanism for the expansion of human consciousness (McKenna 1993). It was an idea based on the effects of psychedelic drugs today.

Perhaps most importantly, the study of human-plant relationships serves as the basis for the study of diet and medicine, and ultimately their evolutionary origins (Johns 1996; Ungar 2006). Some authors argue that taxa as old as archaic *Homo sapiens*, *Homo erectus*, *Homo habilis*, and even *Australopithecus* had some knowledge of medicinal plants (Rahmatullah et al. 2010). Moreover, Timothy Johns (1994, 1996) suggests that the origin of medicine can be traced back to these ancestors' need to use plants for expulsion of intestinal parasites in order to maintain optimal gastrointestinal health. His conclusions are further supported by Michael Huffman's (2001) analysis of the Asteraceae species, *Vernonia amygdalina*, pith and leaf consumption in chimpanzees (*Pan troglodytes*) for expelling intestinal parasites (Fig. 8), and Eric Hoberg's (2001) idea that early hominins were affected by flatworm (*Platyhelminthes*) intestinal infections. Moreover, Karen Hardy (2012), of the Max Planck Institute, observed through phytolithic analysis, that fifty-thousand year old Neandertals buried in El Sidrón, Spain (Fig. 9) contain the Aster species, yarrow (*Achillea millefolium*) and chamomile (*Matricaria chamomilla*), in the matrix of their dental calculus; both of these species are known for their anthelminthic (or anti-worm) properties. At this same time, early *Homo sapiens* inhabitants of Borneo were using Asteraceae species as dietary and medical resources (Hunt et al. 2007).

Moreover, Michael Logan and Anna Dixon (1994) suggested that anthelminthic properties account for 29% of ethnomedical (cultural systems of medicine) data, the most of any other medical category tested. Also, Dorothy Crawford suggested in her book, <u>Deadly Companions: How Microbes Shaped Our History</u> that, "Coprolites (fossilized feces) found among archaeological remains from early farming communities commonly contain the eggs of intestinal worms (Crawford 2007 p. 59-60). Lastly, Horacio Fabrega Jr. (1997) briefly suggested the gastrointestinal tract as a leading selective force in the evolution of biological sickness among human populations; the gastrointestinal tract would need to remain healthy to keep human populations alive. These works taken together indicate the importance of an evolutionary understanding of human-plant relationships in medical progression – including, but not limited to, the need to keep the gastrointestinal tract healthy.

While many ethnobotanical studies are devoted to the interaction between humans, botanical species, and their medicinal and anthelminthic properties, much remains to be said about the medical properties of specific plant families. Few works seek to understand medical stimuli attracting humans to culturally salient families and the genera within them. Wendy Applequist's and Daniel Moerman's (2011) biochemical work on yarrow (*Achillea millefolium*) is a step in the right direction, but it fails to understand human attraction to yarrow's family (Asteraceae) as a whole. Still fewer studies have considered the impact ethnobotanical knowledge has on natural selection, human evolution, and the co-evolution of plants and humans. This seems odd given the obvious medical and evolutionary implications of existing studies, such as Johns' (1994, 1996) and Huffman's (2001) work. The present thesis seeks to provide initial answers to both of these issues. It attempts to understand humankind's global attraction to one particularly large and important medicinal plant family, the Asteraceae. It also aims to deploy information about that attraction to gain insights into naturally selected medicinal plant resources used by early humans and hominin ancestors as a means of survival and reproduction.

Populations of individuals better equipped at exploiting medically potent resources and plant families enjoyed and experienced an evoked evolutionary advantage over sister populations (Huffman 2001; Singer 2004). The remnants of these interactions are evident in the extant and become glaringly clear when anthropologists consider ethnographic work, specifically work that chronicles ethnomedical practices with ethnobotanical precision and detail. Reason dictates that plant families observed in high proportions cross-culturally contain bioactive ingredients that cause physiological change, and aid in attracting humans to them. Some ethnobotanical studies have analyzed the relationship between culturally salient plants and their biochemical ingredients, and conclude that the ability to exploit chemically and physiologically efficacious resources implements an evolutionary advantage (Johns 1996; Moerman and Pemberton 1999; Moerman and Estabrook 2003; Applequist and Moerman 2011).

Specifically, medicinal plant resources contain secondary metabolites, also known as alkaloids and allelochemicals, which catalyze physiological change and help rid the body of pathogens. Some of these alkaloids protect plants against herbivores and parasites (Johns 1994). They serve to deter herbivores and parasites from destroying plant tissue, and thereby can serve as a means for humans to expel harmful agents from their bodies, such as intestinal parasites, harmful bacteria, and various other pathogens (Johns 1994). Timothy Johns describes this behavior as the origin and earliest practice of medicine (Johns 1994, 1996).

Additionally, evolutionary psychologists hypothesize that when cross-cultural patterns exist, they are the products of evolutionary heritage. Patterns arise to keep populations alive, allowing greater reproductive potentials (Flinn 1997; Atran 2010). This seems to be true for plants used for medicine cross-culturally, specifically the Asteraceae.

1.3 The Asteraceae and Gastrointestinal Medicine

There is a particular plant family, composed of many genera, capable of easing the pain caused by intestinal parasites and other gastrointestinal pathogens. Its use is observed in *Pan troglodytes* (*Vernonia amygdalina* and *Aspilia spp*.), *Homo neanderthalensis* (*Achillea millefolium* and *Matricaria chamomilla*), and today serves as one of the highest medicinal use families among modern *Homo sapiens* (Moerman et al. 1999; Applequist and Moerman 2011). This family is commonly called the daisy family, and it is scientifically known as the Asteraceae. Cross-cultural studies performed by Daniel Moerman and colleagues (1999) concluded that of five cultures analyzed, four of them consider the Asteraceae the most important medicinal plant family. In fact, this pattern is observed across the board.

The Asteraceae family is native to South America and South Africa (Heywood et al. 1978; Bremer et al. 1994; Barreda et al. 2012), and consists of approximately 1,700 genera, with 25,000 species (Funk et al. 2009). It tends to inhabit dry shrub lands, and is diagnostically identified by alternative and trinerved leaves. Asters are also very bright in comparison with other plants (Robertson 1997), as they maintain high proportions of bright and vibrant pedal colors, such yellows, violets, blues, and whites (Robertson 1997). Yarrow, in particular stands out from most other plants in American backyards. Not to mention, any Google search of "Asteraceae" will clearly demonstrate the color contrast of the Asteraceae compared to other plant families.

Furthermore, the family's flowers are morphologically distinct. While the flower appears to be quite large, with a disproportionately large center, Asteraceae actually consist of two distinct flower types. Ray flowers occupy the outer ridge while disc flowers compose the center (Fig. 6). It's the flowers that contain the majority of the plant's secondary alkaloids, such as sesquiterpene lactones (Fig. 7) tannins, sesquiterpenes, and flavonoids (Funk et al. 2009). Interestingly, these compounds are bitter tasting, a suggested indicator of medicinal properties (Herz 1978; Peters and Amerongen 1998; Espirito-Santo et al. 1999). Moreover, each of these chemicals aid in gastrointestinal treatment and indicate "anthelmintic, anti- amoebic, antitumor, and antibiotic properties" (Huffman 2001 p. 656). Importantly, there is a significant absence of other biomedical chemicals in the Asteraceae, but those that are present are responsible for treating pathogens of the gastrointestinal tract (Funk et al. 2009).

1.4 Scope, Reasoning, and Hypothesis

There is little doubt, given their vibrant colors, bitter taste, and biochemical activity, that vision, taste, and biochemical stimuli attract humans, attracted extinct hominin, and attract non-human primates to Asteraceae genera (Dominy et al. 2001). Yet, the primary question addressed in this thesis is why that behavior was maintained and preserved throughout human biological and cultural evolution. What effect did and does the Asteraceae have on physiological systems that drives the high-use and cultural salience of these plants, culturally, regionally, and globally? Given the Asteraceae's significant gastrointestinal healing properties, and its prominent association with modern human cultures, extant non-human primates, and fossil hominins, I hypothesize that the ability to exploit and maintain Asteraceae as a culturally relevant medicinal plant family kept, and continues to keep, the gastrointestinal tract physiologically healthy of intestinal parasites and other gastrointestinal pathogens. Plants that stimulate positive effects on gastrointestinal health likely instilled an evolutionary advantage in human populations able to exploit them as medicinal herbs. Indeed, groups less able to exploit the Asters would have been more susceptible to diseases, including digestive pathogens and intestinal worms (Sekirov et al. 2010).

Additionally, recent evidence suggest that gastrointestinal health and its interaction with human microbiota influences pain humans feel and how they go about relieving that pain. Therefore, ancient hominins and humans likely selected medicinal plants based on their perception of gastrointestinal pain (Cryan and Dinan 2012). Perceived physiological pain and discomfort influenced ethnobotanical selection (Huss-Ashmore and Johnston 1994). Furthermore, pain seems to be a major factor in keeping gut microbiota balanced, influencing the selection of the Asteraceae as a gastrointestinal aid. I suggest that perceived gastrointestinal healing efficacy is most important for attracting people to and maintaining their use of the Asteraceae for medicinal purposes. Accordingly, gastrointestinal pain and health is more powerful a motivator than stimuli from any other physiological organ system. Other systems include the respiratory system, the integumentary system, the immune system, the cardiovascular system, the musculoskeletal system, the urinary system, the reproductive system, and the nervous system, including psychological conditions. I believe gastrointestinal treatment will appear at a higher frequency than each of these.

By contrast, if infections of the gastrointestinal tract are not the primary stimulus attracting humans to the Asteraceae for medicinal purposes, my hypothesis, along with Johns' ideas about the origin of medicine residing in gastrointestinal health, needs to be reevaluated. If this is the case, perhaps illnesses of another physiological system is more important than gastrointestinal health in the progression and evolution of human-Aster medicinal selection.

An alternative hypothesis suggests that specific physiological stimuli from the Asteraceae do not effect one organ system significantly more than another; selection is arbitrary. Plant use is dependent on localized cultural understandings of illness rather than biological and physiological stimuli, and evolutionary history. "Symbolic healing," or the placebo effect (Moerman 1979; Moerman 2002), may have a greater hold on health and wellness than biological efficacy. Rather than being driven by physiological and biological stimuli, Nancy Turner (1988) argues that plant use becomes culturally salient due to ecological availability. Within this framework, plant selection is more dependent on ecological and cultural salience and what's available. The cultural interpretation of the plants' effects on physiological systems is more important than actual biological efficacy.

Truly, an ability to improve human health and physiology draws people to the medicinal plants they select continually. People select plants that make them feel better, and I believe continued patterns of medicinal plant selection emerge because specific physiological and biological stimuli, which are rooted in evolutionary history, continually attract people to those plants. Here I propose it is the Asteraceae's ability to keep the gastrointestinal tract feeling healthy that is the primary driver in its continued selection as a medicinal plant family.

1.5 A Brief Description of Asteraceae Morphology and Taxonomy

The evolution and taxonomy of the Asteraceae is a field of botany all on its own (Heywood 1978; Kare and Bremer 1994; Funk et al. 2009). Like all fruiting plants (use fruit as a vehicle for seed dispersal and genetic diversity), the Asteraceae falls within the phylum, Magnoliophyta (Angiosperms). The earliest evidence places the origin of the Asteraceae family in the Paleocene/Tertiary, in South Africa, some 66 million years ago (Bremer et al. 1994; Zavada and de Villiers 2000; Barreda et al. 2012). The sunflower tribe, or Heliantheae, is the most primitive within the Asteraceae family as it retains opposite leaves and yellow flowers. The ancestor of the Asteraceae likely took on similar characteristics (Bremer et al. 1994), but recent studies suggest the ancestral Aster was woody, rather than its current herbaceous form. Some members of the Asteraceae do still remain woody, but they are primarily herbaceous (Bremer et al. 1994). Other recent studies suggest the genus, *Dasyphyllum* as the earliest Aster genus (Barreda et al. 2015). As related to this thesis, this early genus is known for its anti-inflammatory properties of the upper gastrointestinal tract, including the oral cavity and the pharynx (Castelucci et al. 2007).

1.6 Asteraceae Use and Gastrointestinal Medicine in Ancient Hominins

The evolutionary origins of this plant family rest in part within Africa, suggesting the Asters occurred throughout the same biogeographical location where humankind's hominin ancestors first evolved. Specifically, the Asteraceae occupied South Africa (Bayer et al. 2000), in the same region as *Australopithecus africanus*. Furthermore, Asteraceae uses a C4 (Mckown et al. 2005; Sage et al. 2011) photosynthetic pathways, which is the argued photosynthetic pathway of dietary resources consumed by *Australopithecus africanus*, *Paranthropus robustus*, and early *Homo* (Ungar and Sponheimer 2011; Levin et al. 2015). Therefore, it is likely that *Australopithecus africanus* and other extinct hominins maintained a symbiosis with the Asteraceae, possibly for the same purposes as extant human and non-human primates.

The idea that the Asteraceae co-evolved with humans is not unfounded. Scholars, including Karen Hardy (2012) and others (Sommer 1999) discovered Asteraceae botanical remains from *Homo neanderthalensis* burials dating over 30,000 years ago at El Sidrón, Spain and Shanidar IV, Iraq. The plants associated with these remains include, but are not limited to, yarrow (*Achillea millefolium*) and chamomile (*Matricaria chamomilla*). The tentative claim is that these plants were used for medicinal purposes, and chamomile and yarrow are both used primarily for gastrointestinal ailments. Furthermore, evidence from Applequist's and Moerman's (2011) work on the biochemistry of yarrow, including the species vast medicinal efficacy as a gastrointestinal aid, supports Hardy's predictions.

The long relationship between humans, their ancestors, and gastrointestinal medicinal plants further validates Sera Young's (2012) claim that clay, associated with and used by *H. habilis* some 2.5 million years ago helped to alieve gastrointestinal upsets and complications. If true, this further supports Johns' (1996) claim that the origin of medicine rest in gastrointestinal treatment. Certainly, for hominins and humans, this makes sense. Many pathogens, including intestinal parasites, enter the body via the digestive tract (Sekirov et al. 2010). Malaria (*Plasmodium*), for example, which played a significant role in human evolution within Africa (McNeill 1976; Tishkoff and Williams 2002) infects the liver, an accessory digestive organ, before traveling into the bloodstream. Furthermore, many fossilized pieces of feces (coprolites) suggest intestinal parasite infection (Crawford 2007; Fig. 10). Hence, it is suggested here that Asteraceae were as important as any other gastrointestinal medicine, like clay, in keeping human ancestors and their descendants healthy and evolutionarily fit.

1.7 Study Region and People

The Asteraceae is a biogeographically diverse family, with many constituent genera and species. This study focuses on the Aster use among Indigenous Peoples of North America, specifically Cherokees, Navajo, and Iroquois. Daniel Moerman's work compiling Native American plant use over the last forty years remains the definitive example of a comprehensive and detailed ethnobotanical database (http://herb.umd.umich.edu/). With these data available, it simply was a choice of access when comparing the uses and importance of the Asteraceae. While this study was limited to Native Americans, I argue that by studying their ethnobotanical uses of the Asteraceae, we can understand why both human ancestors and modern humans select these plants during our collective histories. We can understand accordingly how medicinal plants would have played a vital role in the perpetuation of hominin ancestor and human survival and reproductive success. Finally, we can potentially understand which physiological stimuli served, and continue to serve, as conduits for the acquisition, development, and transmission of plant-based ethnomedicinal knowledge. Specifically, we can understand how and why the Asteraceae became such an important ethnomedical resource.

Notably, the Asteraceae is the largest plant family on Earth so its high representation in botanical pharmacopeia and as a gastrointestinal aid is perhaps unsurprising. However, other large families of plants, notably the grasses (Poaceae), are very substantially underrepresented in medical botany, and offer little medical uses to humans overall. Other large families, such as the Orchidaceae and Fabaceae, do offer medical benefits, but their anthelminthic properties remain underrepresented compared to the Asteraceae (Pant 2013; Rahman and Parvin 2014). Therefore, this thesis aims to understand the overall effect the Asteraceae has and had on human health and how those effects made the plant family incredibly ethnomedically salient both temporally and spatially.

Patterns of attraction may exist at overall when all Native American cultures are considered as a whole. However, another intriguing vein of research would be to understand if the same patterns exists at the cultural level as well. If biological and physiological stimuli are observed overall among Native Americans and also within different cultural communities, it further supports the hypothesis that medicinal plant attraction is driven by those stimuli and not culturally mediated differences. However, if patterns of attraction differ for Native Americans at their overall and cultural levels, one can attribute local differences as more dependent on the plants' cultural meaning from community to community. To tease this apart, this thesis also considers cultural Native American communities, in addition to Native North Americans as a whole. Native American communities considered are the Cherokee, the Navajo, and the Iroquois. These groups were chosen because they represent a significant amount of Native American ethnobotanical data and also serve as different biogeographical regions within North

America. These groups serve to understand if the attraction to the Asteraceae for medicine is driven by the need to combat gastrointestinal pathogens at both the overall and cultural levels of Native Americans.

Ch. 2 Asteraceae in Native American Ethnobotany

The Asteraceae are used and have been used extensively as medicines within Native American cultures. In fact, 11.5% of all the plants in North America are used by Native Americans for medicinal uses (Moerman 1994), and the Asteraceae alone account for 123 of the utilized medicinal genera. By contrast with food, only 9% of plants in North America are used for food. Thus, the need and selection of medicinal Asteraceae plants by Native Americans has been and continues to be crucial for biocultural survival. Moerman and colleagues (1999) report the Asteraceae as the number one medicinal plant family used by Native Americans. This thesis suggest 2,591 different Native American medicinal uses for the Asteraceae, while only a limited number of uses for food (Moerman 1994). On those grounds, the Asteraceae are primarily used for medicine.

Furthermore, emerging molecular evidence form archaic Native America coprolites in Hinds Cave, Texas revealed that the Asteraceae, along with the Ulmaceae, were the only two plant families found in each coprolite specimen (Poinar et al. 2001). Also, Karl J. Reinhard (1988) revealed that ancient Anasazi of the Colorado Plateau developed increased amounts of helminthic infections during the advent of agriculture (Reinhard 1988), and the Asters were used significantly as diet and medicine in those ancient Anasazi populations (Kohler and Matthews 1988; Minnis 1989). Furthermore, paleoethnobotanical data also indicate Asteraceae use by Paleo-Indians at the Christianson site in Northern Illinois (Parker 2006). Undoubtedly, these studies suggest that ancient Native Americans faced gastrointestinal illnesses and relied on anthelmintic Aster plant medicines for continued health and survival.

Today, however, we view many of these medicinal plants as weeds. Contrary to common belief, many medicinal species occur as herbaceous, invasive weeds, including species of

Asteraceae. According to Moerman and Stepp (2001), species that act as weeds in open habitats are better adapted at preventing exploitation of their niche by other invasive species and herbivores. This may explain why weeds are chemically potent with medicinal properties, and furthermore, why plain-dwelling Native Americans have incorporated so many medicinal plants into their pharmacopeia, including the Asteraceae. Asteraceae weeds contain tannins which help the digestive system by reducing digestibility of nutrients and other substances, such as intestinal pathogens (Espirito-Santo et al. 1999; Stepp and Moerman 2001). The tannins' toxicity protects plants from herbivores, but ironically also promotes expulsion of intestinal parasites from herbivores who have ingested the tannins. Indeed, medicine is often derived from non-lethal doses of plants' poisons. Thus, in Native American ethnobotany, Asteraceae weeds becomes easy to collect and serve as an effective medicine that promotes continued gastrointestinal health. Asteraceae gastrointestinal medicine is very prominent among Cherokee, Navajo, and Iroquois cultures (Randolph 1964; Moerman 2003)

Perhaps the exploitation of the Asteraceae by Native Americans is unsurprising given their long history together. The role of the Asteraceae, specifically the sunflowers (*Helianthus annuus*), played a vital role in the exploitation of dietary resources for Native Americans dating to around 3,000 BCE (Tang and Knapp 2003). Ancient Native Americans also migrated with and exported sunflowers; the most obvious case being the introduction of sunflowers to the Spanish and other European explorers (Tang and Knapp 2003). Furthermore, this genus alone provides 15 different uses for gastrointestinal ailments, more than any other medicinal use for this genus. For people of the New World, this is important given the prevalence of gastrointestinal problems (i.e. worms), as observed in ancient Mayans (Berlin and Berlin 1996) and modern Dominicans of the West Indies (Quinlan et al. 2002).

Given their intimate relationship with the family, Native American ethnobotanical use of the Asteraceae makes for a good reference to understanding the ultimate reason the family has persisted so predominantly in human medical ethnobotanical knowledge. Specifically, the cultures consisting of Native Americans serve well in understanding which biological and physiological stimuli are most likely driving selection of the Asteraceae for medicinal purposes. The presence of gastrointestinal pathogens in Native Americans continues to suggest a need for Asteraceae to allow relief in gastrointestinal pain and discomfort in both current and ancestral populations.

Ch. 3 Methods

This study focused on Native Americans, specifically Cherokee, Navajo, and Iroquois as a proxies to understand the biological, evolutionary, and physiological needs, and thus sustained use of the plant family, Asteraceae, for medicinal purposes. This family was chosen given its global economic prevalence today, and its association with extant non-human primates, Neandertals, and likely as of yet undiscovered associations with other extinct hominins. Each genus of the Asteraceae used by Native Americans was surveyed for its listed medicinal properties. To compile all Asteraceae genera used by Native Americans, the list presented on the United States Department of Agriculture (USDA) served as a helpful tool (http://plants.usda.gov/java/ClassificationServlet?source=display&classid=Asteraceae).

Each listed USDA Asteraceae genus was cross-reference to Daniel Moerman's (2003) Native American ethnobotany database, from the University of Michigan-Dearborn (http://herb.umd.umich.edu/) to determine use by Native Americans. This database is a collective work spanning four decades of research, and includes a comprehensive list of all plant uses utilized by Native Americans. Notably, it list uses that include, but are not limited to, building materials, coloring materials, food, and medicine. Important for the purposes of this study, genera that had medicinal usage for Native American communities were considered part of the analysis, while genera that did not consist of medicinal uses were not considered part of the analysis. Overall, 123 Asteraceae genera contained some form of medicinal properties.

Once each Asteraceae genus was determined to be either used medicinally by Native North Americans or not, medical uses for each Aster genus were counted to determine frequency of use for each of nine human physiological organ system. Gastrointestinal uses (anthelminths, toothaches, liver problems, diarrhea, laxative, intestinal upsets, stomachaches, throat ailments, and vomiting, cathartic, emetic), respiratory uses (respiratory aid, lung and pulmonary problems, throat and trachea discomfort), integumentary uses (skin rashes, dried skin, dermatological aid, burn dressing), immune uses (febrifuge, cold remedy,), circulatory uses (blood ailments, lymph, heartburn, heart problems, antihemorrhagic), musculoskeletal uses (orthopedic, skeletal ailments, any muscular ailments including tendons and ligaments, antirheumatic), urinary uses (urinary ailments, kidney ailments), reproductive uses (gynecological aid, venereal aid, breasts treatment), and nervous/psychological uses (stimulants, psychological aids) were all considered. These organ systems were considered in an attempt to account for all physiological functions of the human body.

Liver and teeth were included as part of the gastrointestinal tract, in addition to the fore- (mouth to duodenum), mid- (duodenum to ileum), and hindgut (ileum to rectum). Technically, some of these anatomical features are alimentary organs to the digestive system, but were considered part of the gastrointestinal system for this analysis because they each aid in digestion. Additionally, some medical purposes, such as toothaches and throat upsets, overlapped in two or more physiological system categories, and were thus marked in all applicable categories. For example, upset throat could be considered a condition of the digestive tract and the respiratory tract. Another significant example of this was the categorization of "panacea." If a plant was used by Native Americans as a "panacea," or as a treatment for any number of physiological ailments, its use was considered to be useful in treating ailment all nine physiological organ systems. Some medical uses were excluded (i.e. "unspecified") from the analysis due to their ambiguity concerning which organ system they aided in healing. The analysis should not have been influenced by this.

Similar to other scholars (Turner 1988; Nolan and Robbins 1999; Ryan et al. 2000; Balee and Nolan 2014), these frequencies represent an overall portrait of Asteraceae medicinal uses by Native American communities. Chiefly, these frequencies reveal which Asteraceae plant genera are culturally important and what they are commonly used for. These frequencies also reveal which Aster genera have specific medical effects and which ones influence people's perceived feelings of physiological health. In short, Moerman's (2003) data provided a list of Native American uses for each Asteraceae genus, and the proportions of medical uses for each human physiological organ system.

From Moerman's database, an Asteraceae-specific list was compiled and numerically tabulated in Microsoft Excel to understand the frequency of ailments treated within Native American communities (Tables 13, 14, 15, 16). These methods follow similarly to Adiaratou Togola et al's (2005) work on medicinal plant uses from Mali, West Africa. For this study, 123 Asteraceae genera were tabulated for medical uses within Native American communities.

Because this thesis' hypothesis is concerned with the impact gastrointestinal health plays on Asteraceae medicinal plant selection, medicinal uses for gastrointestinal ailments and upsets of each genus was compared in frequency to the medicinal properties of the other eight physiological organ system. Once frequencies were acquired, they were graphically represented as bar graphs of descending frequency (Table 1). Additionally, a pie chart (Table 3) was tabulated to represent the percentages of ailments treated for each organ system of the human body by the Asteraceae.

Yet, while the raw frequency may indicate which physiological system has the most medicines for each Asteraceae genus, the question still remained if the differences in selection were due to random selection, or if selection was significantly difference between gastrointestinal uses and the upsets of other human physiological systems? In other words, was there a preference in selection of Asteraceae medicinal genera for gastrointestinal upsets? For example, was gastrointestinal and respiratory medical selection statistically different? Was gastrointestinal and integumentary medical selection statistically different? And so on.

To determine this, T-tests were employed. Specifically, T-tests were issued between the gastrointestinal tract and the eight other previously mentioned human physiological organ systems. Here, I tested if the number of medical uses differed significantly based on physiological systems. A T-test of independent samples was utilized because the sample genera were not related to one another (Thomas 1986). One Asteraceae genus and its medical uses did not influence the medical uses of another Asteraceae genus. Also, heteroscedasticity, or the circumstance in which the variability of a variable is unequal across the range of values was implemented due to the fact that Asteraceae medical selection towards ailments of a particular organ system (gastrointestinal) was hypothesized to exist at a higher proportion than Asteraceae medicinal plant selection for ailments of all other physiological systems (White 1980). In other words, medical selection was hypothesized to move in one particular direction, toward gastrointestinal treatment, rather than moving towards two organ systems equally.

A confidence interval of .95 was necessary because this number suggest selection is purposeful and not arbitrary or random. These tests were used to show that Asteraceae selection for gastrointestinal medicines may be happening at a statistically significant, non-random, and higher rate when compared to the other physiological organ systems of the human body.

In sum, the bar graph and pie graph illustrate raw data in terms of frequency of Aster-based gastrointestinal medicine compared to the other physiological systems, while the T-tests showed if Asteraceae medical selection based on gastrointestinal activity is statistically different than Asteraceae medical selection based on activity of other physiological ailments and upsets.

3.2 Cultural Patterns

Bar graph frequencies and t-tests were also used to compare cultural (Cherokee, Navajo, and Iroquois) medical uses of the Asteraceae for gastrointestinal tract to other human physiological organ systems.

It was important to compare these numbers to overall Native American Asteraceae medical uses, in order to answer questions such as: did the cultural pattern follow the overall Native American pattern? If so, selection pattern must rest in biologically consistent stimuli. If not, selection remains arbitrary, determined by cultural salience, understandings, and beliefs about plants.

This analysis compared the frequency of Asteraceae medical use for ailments of each human physiological system to the uses of the total Native American population. To do this, T-tests scores for Asteraceae genera used by the Cherokee, Navajo, and Iroquois for gastrointestinal ailments were compared to those genera's use by all Native Americans. Like before, gastrointestinal uses for each of these groups was compared to the uses for ailments of the other eight human physiological organ systems (respiratory, integumentary, immune, cardiovascular, musculoskeletal, urinary, reproductive, and nervous). The p-values ($p=.05$) of each comparison at the cultural level were compared to the p-values Native Americans overall. If the T-tests for each cultural group showed that gastrointestinal uses are statistically different than uses of the other organ systems, the pattern was the same as the pattern for Native

Americans as a whole, and thus based on biological and physiological stimuli, and evolutionary history. If the p-values were not statistically different than other physiological systems, then Asteraceae selection was based more on cultural understandings of plant families rather than underlining biological stimuli.

Specifically, T-tests were issued for each culture accounting for the difference in Asteraceae medicinal plants between the gastrointestinal tract ailments and the eight other previously mentioned physiological systems. Here, I tested if the number of medical uses differed based on physiological systems at the cultural level, and compared it to the overall pattern for Native Americans. The frequency of medicinal uses for one physiological system within one Asteraceae genus does not influence the frequency of uses for physiological systems within another Asteraceae genus. Also, heteroscedasticity, or the condition where the variability of the variable is unequal was considered. This was due to the fact that Asteraceae medical selection for a particular organ system's (gastrointestinal) ailments was hypothesized to exist at a higher proportion than other physiological systems' ailments (White 1980). In other words, selection was hypothesized to move in one particular direction (towards a gastrointestinal stimulus) as opposed to moving in two directions equally.

A confidence interval of .95 was necessary because this number is indicative of selection as purposeful as opposed to arbitrary and random. These tests were used to show that Asteraceae selection for gastrointestinal medicines may be happening at a statistically significant, non-random, and higher rate when compared to the other physiological organ systems.

These methods aimed to show if the same patterns of medicinal plant selection exist at both the cultural and overall level. If they did, it would further support the hypothesis that

Asteraceae medical selection is based on underlining biological, physiological, and evolutionarily adaptive stimuli.

Ch. 4 Results

A total of 2,591 medicinal uses by Native Americans were determined for the Asteraceae family (Tables 1, 13). 732 (28%) were used for gastrointestinal issues, 329 (13%) were used for respiratory issues, 492 (19%) were used for integumentary issues, 172 (7%) were used for immune issues, 127 (5%) were used for circulatory issues, 193 (7%) were used for musculoskeletal issues, 166 (6%) were used for urinary issues, 256 (10%) were used for reproductive issues, and 124 (5%) were used for nervous system issues, including psychological disorders. Based on these data, Asteraceae plants are selected for gastrointestinal ailments at a much greater frequency than ailments of any other physiological system. In fact, the gastrointestinal tract incorporate 240 more uses than the closest other system, the integumentary system at 492 (Table 1). The next system after that is respiratory at 329.

As represented in the pie graph (Table 2), 28% of the medicinal uses of Asteraceae by Native Americans are for gastrointestinal ailments. The next highest is integumentary ailments at 19%, 9% away from gastrointestinal ailments. This is the largest gap between two organ systems, with the next closest being the respiratory system at only 6% away from the integumentary system. This may suggests that people need gastrointestinal medicines more frequently and seek out Asteraceae plants with that property most commonly.

T-tests were issued between the gastrointestinal tract and the eight other physiological organ systems. Here, I tested if number of medical uses among the Asteraceae differed statistically significantly based on physiological systems. When analyzing the T-tests, gastrointestinal ailments significantly outweigh the number of Asteraceae medicinal uses for all other physiological systems, except one (Table 3). When the number of gastrointestinal tract uses were compared to respiratory uses, the P-value = 0.0013, and with the integumentary system, $p = 0.0956$. When gastrointestinal uses were compared with other physiological systems, the results were negligibly small. When the gastrointestinal tract was compared to the immune system, it was $p < .0001$, with the circulatory system it was $p < .0001$, with the musculoskeletal system it was $p < .0001$, with the urinary system it was $p < .0001$, with the reproductive system it was $p < .0001$, and finally with the nervous and psychological system it was $p = .0001$. With the exception of the integumentary system, all selection of medicinal plants affecting other physiological systems were statistically different when compared to those selected for treatment of the gastrointestinal tract. They fell below .05. In other words, the ethnomedicinal selection of Asteraceae specimens among Native Americans statistically differed from all physiological organ systems when compared to the gastrointestinal system, to the exclusion of the integumentary system. The gastrointestinal tract's greater frequency and statistically significant difference among most other physiological organ systems indicates Asteraceae selection is based on its ability to treat gastrointestinal ailments.

4.2 Cultural Patterns

The next question this thesis sought to answer is if this overall Native American pattern of selecting Asteraceae medicines for gastrointestinal health is also observed at the cultural level, within Cherokee, Navajo, and Iroquois communities. Based on simple frequencies, the pattern remains true within Cherokee, Navajo, and Iroquois populations. Indeed, each culture associates itself with several Asteraceae genera, and those they associate themselves with have the most potent ability to heal gastrointestinal ailments.

When considering Cherokee specifically, did gastrointestinal uses for asters differ significantly from that of other organ system ailments? A total of 195 medicinal uses by Cherokee were determined for the Asteraceae family. Forty-seven (24%) were used for gastrointestinal issues, 19 (10%) were used for respiratory issues, 18 (9%) were used for integumentary issues, 23 (12%) were used for immune issues, 12 (6%) were used for circulatory issues, 16 (8%) were used for musculoskeletal issues, 21 (11%) were used for urinary issues, 29 (15%) were used for reproductive issues, and 10 (5%) were used for nervous system issues, including psychological disorders. Based on these data, Asteraceae plants are selected for gastrointestinal ailments at a much greater frequency than ailments of any other physiological system. In fact, the gastrointestinal tract incorporate 18 more uses than the closest other system, the reproductive system at 29 uses (Table 4). The next system after that is immune at 23.

As represented in the pie graph (Table 5) show that 24% of the medicinal uses of Asteraceae, by the Cherokee, are used for gastrointestinal ailments. The next highest is reproductive ailments at 15%, 9% away from gastrointestinal ailments. This is the largest gap between two organ systems, with the next closest being the immune system at 3% away from the reproductive system. This suggest people need gastrointestinal medicines and seek out Asteraceae plants with that property most commonly.

T-tests were issued between the gastrointestinal tract and the eight other physiological organ systems. Here, I tested if number of medical uses among the Asteraceae differed based on physiological systems. When analyzing the T-tests, gastrointestinal ailments significantly outweigh the number of Asteraceae medicinal uses of the Cherokee people for all other physiological systems, except one (Table 10). When the number of gastrointestinal tract uses was compared to respiratory uses, the P-value = 0.0149, and with the integumentary system it was p = 0.0115. When the gastrointestinal tract was compared to the immune system, it was p = .0444, with the circulatory system it was p = 0.0018, with the musculoskeletal system it was p = 0.0071, with the urinary system it was p = 0.0550, with the reproductive system it was p = 0.1719, and finally with the nervous and psychological system it was p = 0.0007. With the exception of the reproductive system, all selection of medicinal plants affecting other physiological systems were statistically different when compared to those selected for treatment of the gastrointestinal tract. They fell below a p-value of .05. In other words, the ethnomedicinal selection of Asteraceae specimens among Cherokees statistically differed from all physiological organ systems when compared to the gastrointestinal system, to the exclusion of the reproductive system. The gastrointestinal tract's higher frequency of representation and significant difference among most other physiological organ systems indicates Asteraceae selection among Cherokee people is based on its efficacy in treating gastrointestinal ailments.

When considering Navajo specifically, did gastrointestinal differ significantly from that of other organ system ailments? A total of 486 medicinal uses by Navajo were determined for the Asteraceae family (Tables 5, 6, 14). One hundred and thirty-three (27%) were used for gastrointestinal issues, 48 (10%) were used for respiratory issues, 82 (17%) were used for integumentary issues, 47 (10%) were used for immune issues, 28 (6%) were used for circulatory issues, 31 (6%) were used for musculoskeletal issues, 28 (6%) were used for urinary issues, 60 (12%) were used for reproductive issues, and 29 (6%) were used for nervous system issues, including psychological disorders. Based on these data, Asteraceae plants are selected by the Navajo for gastrointestinal ailments at a much greater frequency than ailments of any other physiological system. In fact, the gastrointestinal tract incorporate 51 more uses than the closest other system, the integumentary system at 82 (Table 6). The next system after that is reproductive at 60.

As represented in the pie graph (Table 7), 27% of the medicinal uses of Asteraceae by the Navajo are for gastrointestinal ailments. The next highest is integumentary ailments at 17%, 10% away from gastrointestinal ailments. This is the largest gap between two organ systems, with the next closest being the reproductive system at only 7% away from the integumentary system. This suggest Navajo people need gastrointestinal medicines and seek out Asteraceae plants with that property most commonly.

When analyzing the T-tests, gastrointestinal ailments significantly outweighed the number of Asteraceae medicinal uses of the Navajo people when compared to all other physiological systems. T-tests were issued between the gastrointestinal tract and the eight other physiological organ systems. Here, I tested if number of medical uses of the Asteraceae among the Navajo differed based on physiological systems. When analyzing the T-tests, gastrointestinal ailments significantly outweighed the number of Asteraceae medicinal uses for all other physiological systems (Table 11). When the number of gastrointestinal tract uses was compared to respiratory uses, the P-value equaled $p = 0.0002$, and with the integumentary system it was $p = 0.0337$. When the gastrointestinal tract was compared to the immune system, it was $p = 0.0001$, with the circulatory system it was $p < 0.0001$, with the musculoskeletal system it was $p < 0.0001$, with the urinary system it was $p < 0.0001$, with the reproductive system it was $p = 0.0017$, and finally with the nervous and psychological system it was $p < 0.0001$. All selection of Asteraceae medicinal plant genera affecting other physiological systems were statistically different when compared to those selected for treatment of the gastrointestinal tract for the Navajo people. They all fell below .05. In other words, the ethnomedicinal selection of Asteraceae specimens among

Navajo statistically differed from all physiological organ systems when compared to the gastrointestinal system. The gastrointestinal tract's greater frequency and statistically significant difference among all other physiological organ systems indicates Asteraceae medical selection is based on its ability to treat gastrointestinal ailments.

When considering Iroquois specifically, did gastrointestinal differ significantly from that of other organ system ailments? A total of 231 medicinal uses by the Iroquois were determined for the Asteraceae family (Tables 7, 8, 15). Seventy (30%) were used for gastrointestinal issues, 22 (10%) were used for respiratory issues, 25 (11%) were used for integumentary issues, 172 (7%) were used for immune issues, 127 (5%) were used for circulatory issues, 23 (10%) were used for musculoskeletal issues, 15 (6%) were used for urinary issues, 15 (6%) were used for reproductive issues, and 4 (2%) were used for nervous system issues, including psychological disorders. Based on these data, the Iroquois select Asteraceae plants for gastrointestinal ailments at a much greater frequency than ailments of any other physiological system. In fact, the gastrointestinal tract incorporate 36 more uses than the closest other system, the immune system at 34 (Table 8). The next system after that are integumentary, at 25 uses.

As represented in the pie graph (Table 9), 30% of the Iroquois medicinal uses for Asteraceae are for gastrointestinal ailments. The next highest is immune ailments at 15%, 15% away from gastrointestinal ailments. This is the largest gap between two organ systems, with the next closest being the integumentary system, only 4% away from the immune system. This suggests people need gastrointestinal medicines and seek out Asteraceae plants with that property most commonly.

When analyzing the T-tests, gastrointestinal ailments significantly outweigh the number of Asteraceae medicinal uses of the Iroquois people for all other physiological systems. T-tests were issued between the gastrointestinal tract and the eight other physiological organ systems. Here, I tested if number of medical uses Asteraceae by the Iroquois differed based on physiological systems. When analyzing the T-tests, gastrointestinal ailments significantly outweigh the number of Asteraceae medicinal uses for all other physiological systems, except one (Table 12). When the number of gastrointestinal tract uses was compared to respiratory uses, the P-value equaled $p = 0.0355$, and with the integumentary system it was $p = 0.0447$. When the gastrointestinal tract was compared to the immune system, it was $p = 0.1305$, with the circulatory system it was $p = 0.0345$, with the musculoskeletal system it was $p = 0.0348$, with the urinary system it was $p = 0.0119$, with the reproductive system it was $p = 0.0127$, and finally with the nervous and psychological system it was $p = 0.0022$. With the exception of the immune system, all selection of medicinal plants affecting other physiological systems were statistically different when compared to those selected for treatment of the gastrointestinal tract. They fell below a p-value of .05. In other words, the ethnomedicinal selection of Asteraceae specimens among the Iroquois statistically differed from all physiological organ systems when compared to the gastrointestinal system, to the exclusion of the immune system. The gastrointestinal tract's higher frequency of representation and significant difference among most other physiological organ systems indicates Iroquois Asteraceae selection is based on its ability to treat gastrointestinal ailments.

Ch. 5 Discussion

Native Americans, both at the overall and cultural levels, select Asteraceae medicinal plants most commonly as gastrointestinal aids for pathogens, intestinal upsets, and feelings of physiological distress. The uses of the Asteraceae for gastrointestinal health outweigh medical uses of the Asteraceae for any ailments afflicting other human physiological organ systems of the human body. In fact, Native Americans use the Asteraceae to treat gastrointestinal treatments 240 more times than any other physiological organ system. When compared statistically by T-test, it is observed that not only is gastrointestinal selection much higher in raw frequency, but medical selection of the Asteraceae is statistically significantly higher when treating gastrointestinal ailments than when treating ailments or pathogens of most other human physiological organ systems.

This pattern is true at the cultural level as well. Cherokee, Navajo, and Iroquois all display the same pattern – Asteraceae most commonly are used for gastrointestinal medicine. First, the Cherokee have 24 more medical uses for the gastrointestinal tract when using the Asteraceae than any other human physiological organ system. Second, the Navajo have 51 more medical uses for the gastrointestinal tract when using the Asteraceae than any other human physiological organ system. Third, the Iroquois have 36 more medical uses for the gastrointestinal tract when using the Asteraceae than any other human physiological organ system.

When considering Native Americans as a whole, Asteraceae medical uses are statistically highest when treating gastrointestinal ailments, to the exclusion of ailment affecting the integumentary system. The integumentary system reports the second most uses at 492. When considering Asteraceae medicinal uses, the P-value between gastrointestinal ailments and integumentary ailments falls too high above statistically significance, at .0956. However, this value makes sense given the skin's direct interaction with the external environment. In order for a human organism to continue to survive, the skin must protect the body from external, harmful substances such as ultraviolet light and toxic chemicals (English et al. 2003). Therefore, the skin is the human body's first defense against harmful, external pressures, while the gastrointestinal tract is the human body's first defense against harmful internal pressures, such as pathogens and intestinal worms. Gastrointestinal treatment may not be statistically different from integumentary treatment, but when considering frequency, the gastrointestinal system comprises 240 more medicinal uses from the Asteraceae, showing that the family is selected at a more frequent rate for gastrointestinal ailments than integumentary ailments. Furthermore, the increase in use for gastrointestinal ailments from integumentary ailments is 9% of the total medicinal uses from the Asteraceae. This increase is larger than any other increase from one organ system to the next. Thus, while integumentary ailments may be important in Asteraceae medicinal selection and continued use, gastrointestinal ailments are the driving force attracting people to select Asteraceae for medicinal purposes.

Among Cherokee people, gastrointestinal use of the Asteraceae is more in raw frequency than reproductive, but not significantly different. Also, in Iroquois people, gastrointestinal is more in raw data than immune, but not statistically significant. An explanation of why reproductive and immunity is as important to the Cherokee and Iroquois as gastrointestinal health is not immediately clear. As little research has been conducted, but this may be a vein of further research.

At the overall and cultural levels, the use of Asteraceae for gastrointestinal ailments remains statistically significantly different when compared to most other human physiological organ systems, and its raw frequency is always greater. Thus, there is no question that the primary reason people, and specifically Native Americans, continually select the Asteraceae for medicinal purposes is the family's physiological effect on the gastrointestinal tract. If this was not the case we would expect to observe different and varying patterns emerge at the cultural and overall levels. Instead, we see this gastrointestinal pattern remain true at all levels of population, whether it be Native Americans as a whole or separate cultural groups, such as Cherokee, Navajo, or Iroquois. Indeed, this suggests attraction to the Asteraceae as a medicinal plant family rest in its underling biological and physiological stimuli.

5.2 Evolutionary Implications

Additionally, these data show that among Native American communities, the Asteraceae display the specific characteristic hypothesized to be related to the origin of medicinal plant use: the ability to rid the gastrointestinal tract of intestinal parasites and reduce the load of other pathogens (Johns 1994, 1996; Young 2011). An ability to exploit gastrointestinal medicines, such as the Asteraceae, likely gave humans an evolutionary advantage over other animals, and therefore played a significant role in humanity's survival as a species. This is especially likely given the hypothesized medicinal association of the Asteraceae with non-human apes, including *Pan troglodytes*, and the closely related extinct hominin species, *Homo neanderthalensis* (Huffman 2001; Hardy et al. 2012).

Due to the ancientness of pathogenic agents entering the body via the digestive system, the origin of medicine and its co-evolution with humans should rest in the medical efficacy of alieving gastrointestinal ailments. The digestive system often serves as the first defense against internal pathogenic agents (Brandt 2013), and therefore, an ancient need to expel parasites can explain the adaptive advantage of using the Asteraceae to maintain gastrointestinal health.

In sum, if biological stimuli from medicinal herbs can be determined in extant human and non-human primate populations, these processes were likely happening in the past. It is fair to assume these same symbiotic stimuli sustained the relationship between human ancestors and the medicinal plant resources they relied upon. Regarding the referential model, this research informs the evolutionary and ecological benefit to using the Asteraceae as a medical resource and the family's underlying biological efficacy.

Nancy Turner (1988) mentions one way in which plants become important ethnobotanically is through what she called, "potential utility," or biological attributes from the plant that influence its desired selection. Here, the Asteraceae affects the gastrointestinal tract in a positive way, and therefore influenced its development as an important medicinal plant family among Native American and other cultures. For the Asteraceae, Turner's idea of potential use plays a more important role than ecological salience, or current availability. Because selection is not arbitrary, but statistically different, both at the overall and cultural levels, Asteraceae selection based on gastrointestinal ailment is a selective behavior and therefore not purely dependent on what is available within the local ecology. In other words, selection is not arbitrary, but dependent on specific healing properties of a physiological organ system. In the case of the Asteraceae, selection is based on the family's continued ability to heal the gastrointestinal tract of intestinal worms, pathogens, and other upsets.

5.3 Ethnomedical Implications

Although this study only focused on one cultural region and one plant family, it is reasonable to conclude that plants affecting the gastrointestinal tract's health and physiology should be selected ethnomedically all over the globe. In addition to informing the evolutionary origins of medicine, this analysis also informs the importance of ethnomedicine. People, cross-culturally, seek plants that cause their gastrointestinal tract to feel good. Through traditional ecological knowledge and ethnomedical systems developed by them, Native Americans select plants that are biologically effective, culturally important, and in many cases, not yet know to Western medicine.

Many biomedical pharmaceuticals and traditional remedies are both derived from plants and plant parts. Therefore, Western medicine and traditional ecological knowledge often arrive at similar, if not the same conclusions about plants' medical efficacy. Plants in both cultural knowledge systems – biomedicine and ethnomedicine – derive from the same evolutionary botanical stock, and thus share many characteristics with one another. Defensive allelochemical evolution in plants remains the same in both biomedicine and ethnomedicine, and those chemicals effect varying groups of people in analogous ways (Moerman 1996; Moerman and Estabrook 2003; Applequist and Moerman 2011).

Therefore, practitioners of Western medicine can learn from recent, or even ancient, systems of ethnomedical and herbal knowledge. Anthropology must continue to make preserving cultural diversity and traditional ecological knowledge one of its most important goals. There is so much to learn!

From this, biocultural anthropologists suggest that culture's predecessor lies in biology, and that extant cultural behavior is often an extension of biological stimuli and evolutionary history. As many scholars have already eluded to, culture is a biological adaptation of humans within a given environment (Keesing 1974; Hass and Harrison 1977; Corning 2000; West et al. 2015). It helps them to understand their world and seek out effective resources, such as medicine, that maintain their continued survival and reproduction. Particularly, this thesis seeks to understand the biological and adaptive reason underlying a significant cultural behavior in the selection of medicinal plants from the Asteraceae family. This study aims to observe and explain the biological stimuli and evolutionary history driving a medical pattern observed in human cultures worldwide.

To understand medical patterns, human disease, and physiological ailments properly, we must consider humanity's evolutionary history as it relates to ethnomedical development. If we understand why maladies exist, then we can better analyze how to cure them (Nesse and Williams 1996). Also, if we understand humanity's co-evolution with plants and the evolved ways in which humans understand and use plants, we can develop more effective medicines to treat physiological diseases and ailments. We can understand which plants humans are most adaptive with, and therefore, which medicines humans are most responsive to. Indeed, the potential here to promote healthy lives in immense!

5.4 Further Research

To test hypotheses of medicinal plant attraction further, one could ostensibly isolate perceptual signals of attraction used by medicinal plant specimens and families to determine intra-culturally if *Homo sapiens* are guided by them constantly. One could also study another large medicinal plant family, perhaps legumes (Fabaceae) or roses (Rosaceae), for their degree of gastrointestinal medicinal properties – one could analyze the effect of other physiological systems as well.

Perhaps most importantly, this thesis promotes an understanding that Western science regard ethnomedicine as effective, and not trivial hocus-pocus. Biomedicine and pharmacology can ultimately be advanced lastingly through systematic analyses of human and non-human primate cultural and self-healing practices. In essence, pharmaceutical development is one natural application for such discoveries, in addition to scientific validation of traditional ecological and botanical wisdom. Botanical wisdom and traditional ecological knowledge informs effective medical insights into which taxa should be preserved in order to develop novel medicines (Etkin 1994).

The focus of this thesis is to understand the underlying attraction to one plant family by modern *Homo sapiens*, their hominin ancestors, and non-human primates. Specifically, Timothy Johns (1994, 1996), Karen Hardy's (2012), and Michael Huffman's (2001), among others, ideas are supported. The hypothesis of this thesis – that the Asters are selected for their medical effect on the human gastrointestinal tract – is supported. Indeed, humans and non-human apes are attracted to medicinal plants in the Asteraceae family most commonly for gastrointestinal upsets. Physiological efficacy of gastrointestinal health maintains Native Americans' selection of the Asteraceae. More broadly, it maintains *Homo sapiens*' use and cultural relevance of the Asteraceae.

Patterns of selection of medicinal plants/herbs rest in physiologically stimuli and evolutionarily history. Biology rest at the base of human behavior, including cultural phenomena, which makes ethnobotany and ethnomedicine valid fields of inquiry for people trying to discover new ways of healing. Ethnobotany and ethnomedicine validate humanity's vital relationship with nature and promote a need to preserve it – humans ARE nature. Certainly, ethnobotanical and ethnomedical knowledge are evolutionarily adaptive!

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Appendix – Tables and Figures

Table 1 – Bar graph of descending frequency for number of Native American medical uses of the Asteraceae, used for each physiological organ system.

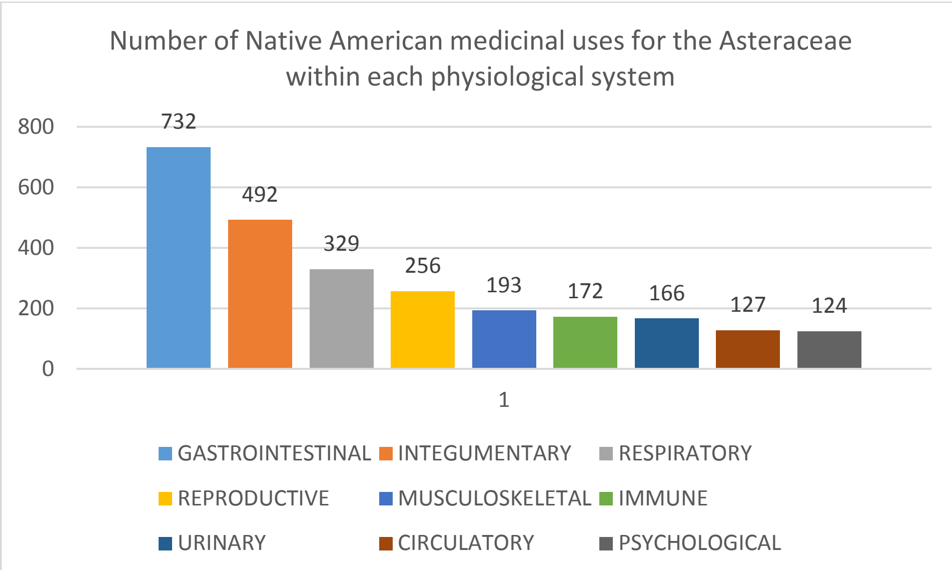


Table 2 – Pie chart representing the percentages of Native American medicinal uses of the Asteraceae, used for each physiological organ system.

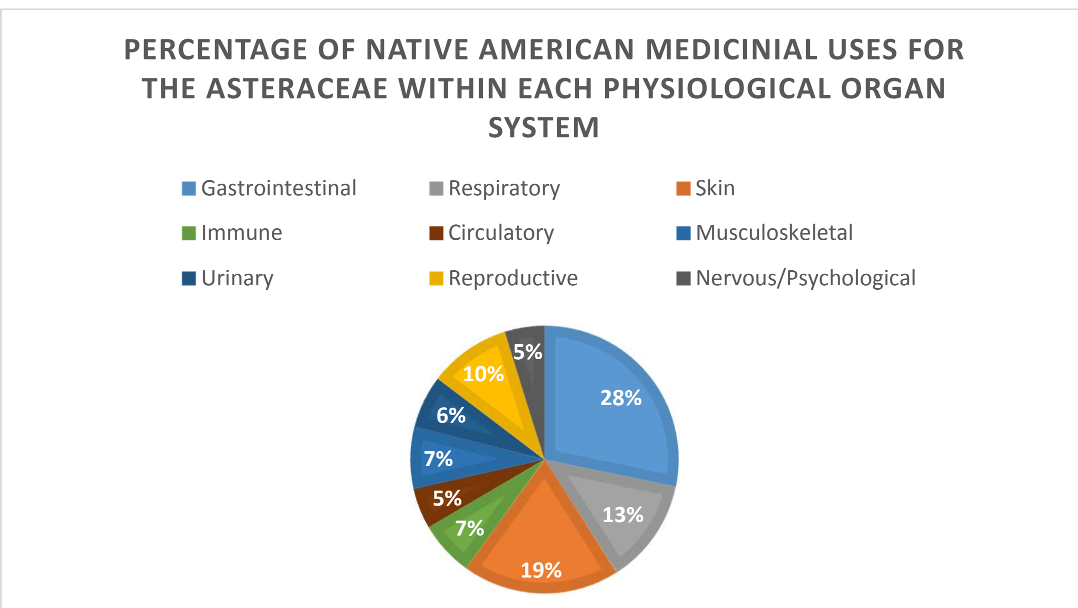


Table 3 – T-test calculation of Asteraceae gastrointestinal uses to each other physiological organ system.

$$t = \frac{\bar{x}_1 - \bar{x}_2}{SEM}$$

Physiological System 1	**Physiological System 2**	**P-Score for T-test**
Gastrointestinal	Respiratory	0.001
Gastrointestinal	Integumentary	0.095
Gastrointestinal	Immune	0.000003
Gastrointestinal	Circulatory	0.0000003
Gastrointestinal	Musculoskeletal	0.0000003
Gastrointestinal	Urinary	0.0002
Gastrointestinal	Reproductive	0.00009
Gastrointestinal	Nervous/Psychological	0.0000003

Table 4 – Frequency chart of medicinal uses for each physiological organ system and each medicinal plant genus of the Asteraceae used by Cherokee. Numbers collected from Daniel Moerman's Native American Ethnobotanical Database.

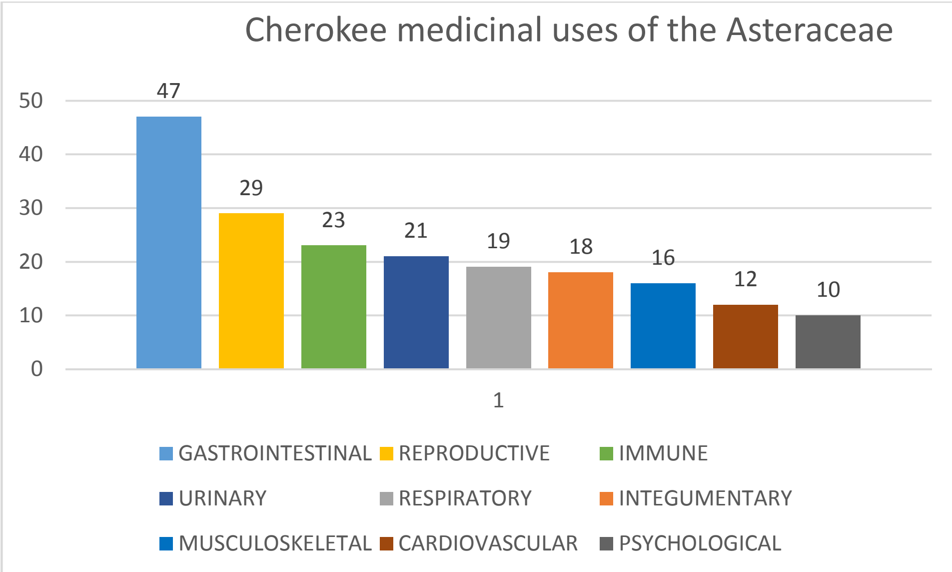


Table 5 – Pie chart representing the percentages of Cherokee medicinal uses of the Asteraceae, used for each physiological organ system.

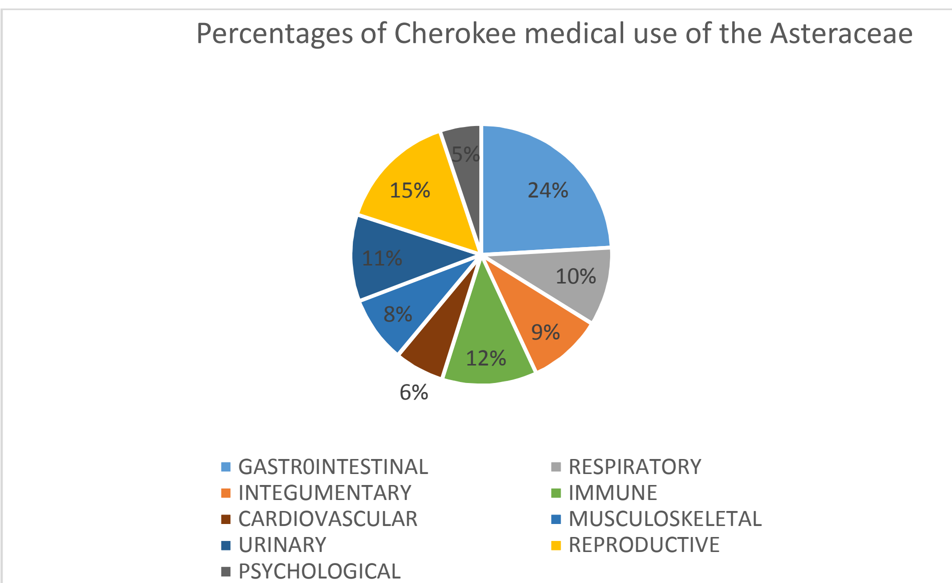


Table 6 – Bar graph of descending frequency for number of Navajo medical uses of the Asteraceae, used for each physiological organ system.

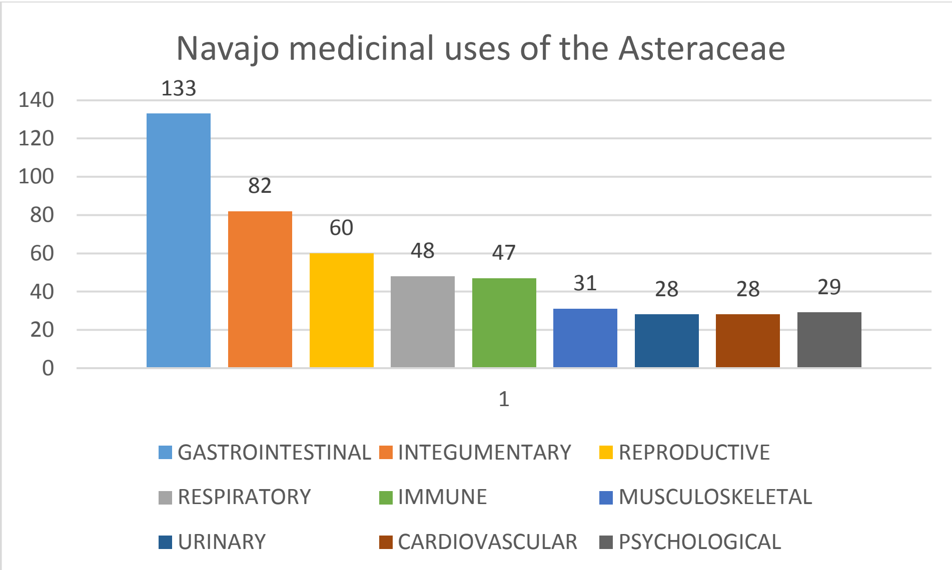


Table 7 – Pie chart representing the percentages of Navajo medicinal uses of the Asteraceae, used for each physiological organ system.

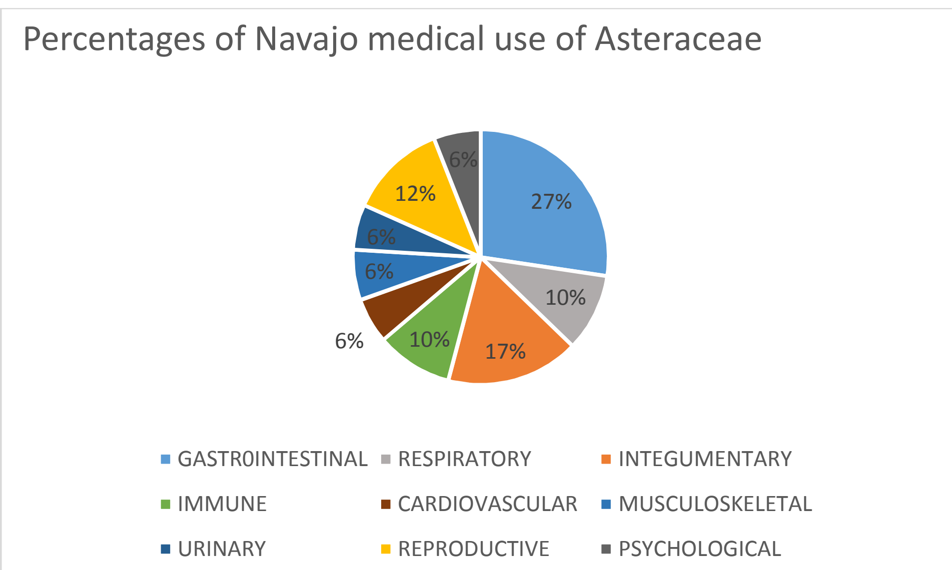


Table 8 – Bar graph of descending frequency for number of Iroquois medical uses of the Asteraceae, used for each physiological organ system.

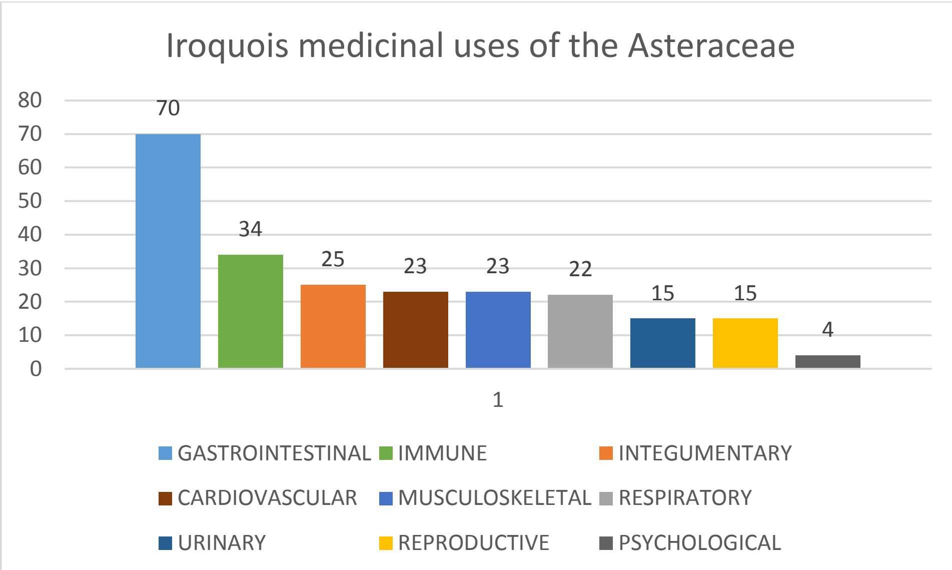


Table 9 – Pie chart representing the percentages of Iroquois medicinal uses of the Asteraceae, used for each physiological organ system.

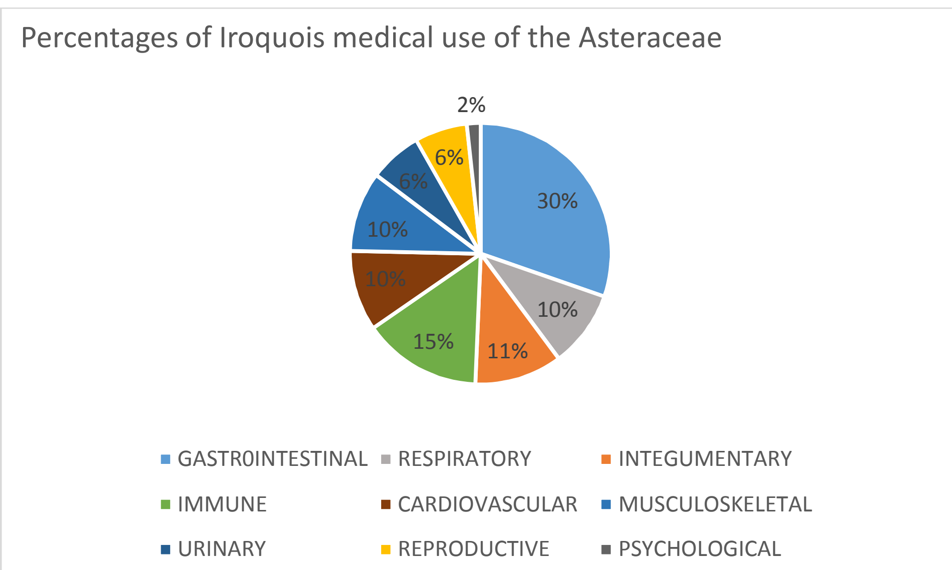


Table 10 – T-test calculation of Asteraceae gastrointestinal uses to each other physiological organ system (Cherokee).

Cherokee		
Physiological System 1	**Physiological System 2**	**P-Score for T-test**
Gastrointestinal	Respiratory	0.0149
Gastrointestinal	Integumentary	0.0115
Gastrointestinal	Immune	0.0444
Gastrointestinal	Circulatory	0.0018
Gastrointestinal	Musculoskeletal	0.0071
Gastrointestinal	Urinary	0.0551
Gastrointestinal	Reproductive	0.1719
Gastrointestinal	Nervous/Psychological	0.0007

Table 11 – T-test calculation of Asteraceae gastrointestinal uses to each other physiological organ system (Navajo).

Navajo		
Physiological System 1	**Physiological System 2**	**P-Score for T-Test**
Gastrointestinal	Respiratory	0.0002
Gastrointestinal	Integumentary	0.0336
Gastrointestinal	Immune	0.0001
Gastrointestinal	Circulatory	.000001
Gastrointestinal	Musculoskeletal	.000003
Gastrointestinal	Urinary	.000002

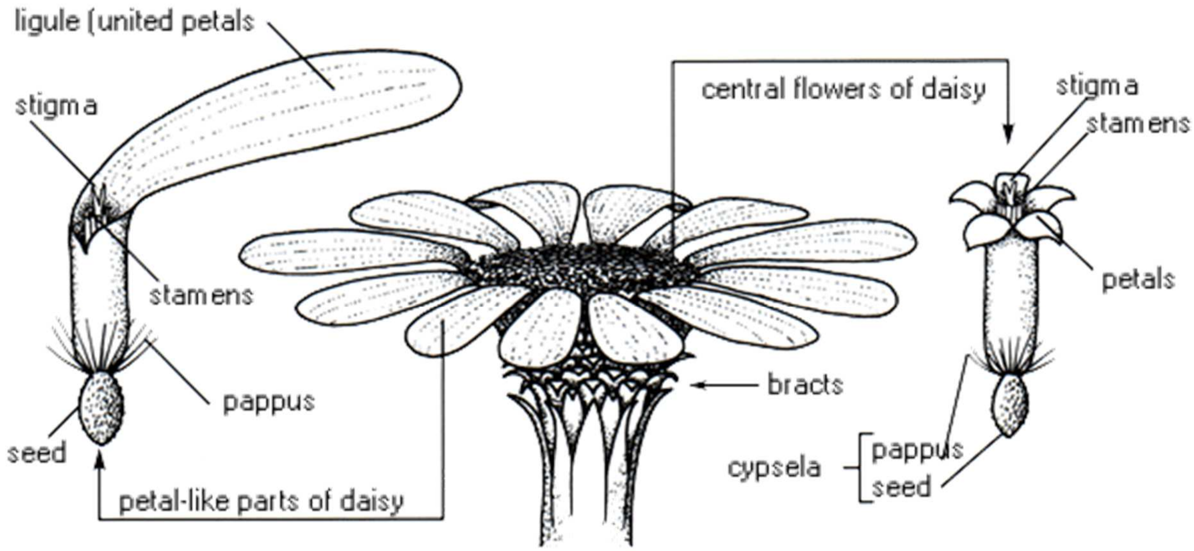
Table 11 (Cont)		
Navajo		
Physiological System 1	**Physiological System 2**	**P-Score for T-Test**
Gastrointestinal	Reproductive	0.0017
Gastrointestinal	Nervous/Psychological	0.000002

Table 12 – T-test calculation of Asteraceae gastrointestinal uses to each other physiological organ system (Iroquois).

Iroquios		
Physiological System 1	**Physiological System 2**	**P-Score for T-test**
Gastrointestinal	Respiratory	0.0355
Gastrointestinal	Integumentary	0.0447
Gastrointestinal	Immune	0.1305
Gastrointestinal	Circulatory	0.0344
Gastrointestinal	Musculoskeletal	0.0348
Gastrointestinal	Urinary	0.0119
Gastrointestinal	Reproductive	0.0127
Gastrointestinal	Nervous/Psychological	0.0022

Figures 1,2,3,4,5 – Pictures of chamomile tea, the lowly dandelion, the ubiquitous sunflower, the roadside coneflower, and the lovely ornamental yarrow (All images produced by Google Stock Images).

Figure 6 – Morphology of the flowers and petals within the Asteraceae – including ray and disc flowers. (Australian National Botanical Gardens)



A daisy flower (Asteraceae) — a composite head of many small flowers

Figure 7 – Sesquiterpene Lactone – a major compound found within the flower and petals of the Asteraceae, containing bitter taste which is indicative of medicinal properties (PubChem).

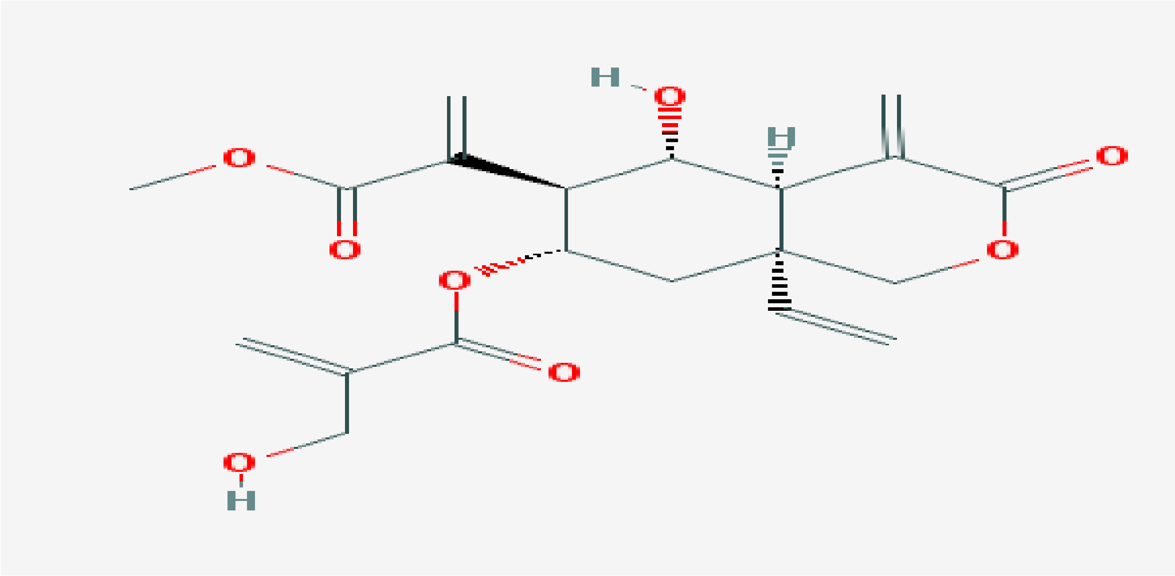


Figure 8 – Chimpanzee (*Pan troglodytes*) consuming medicinal plants including *Vernonia amygdalina* and *Aspilia species* (Francesco V., Kibale National Park).

Figure 9 – 50,000 year old phytolithic Asteraceae specimens trapped in the dental calculus of *Homo neanderthalensis* from burial sites in El Sidron Cave, Spain (Hardy et al. 2012).

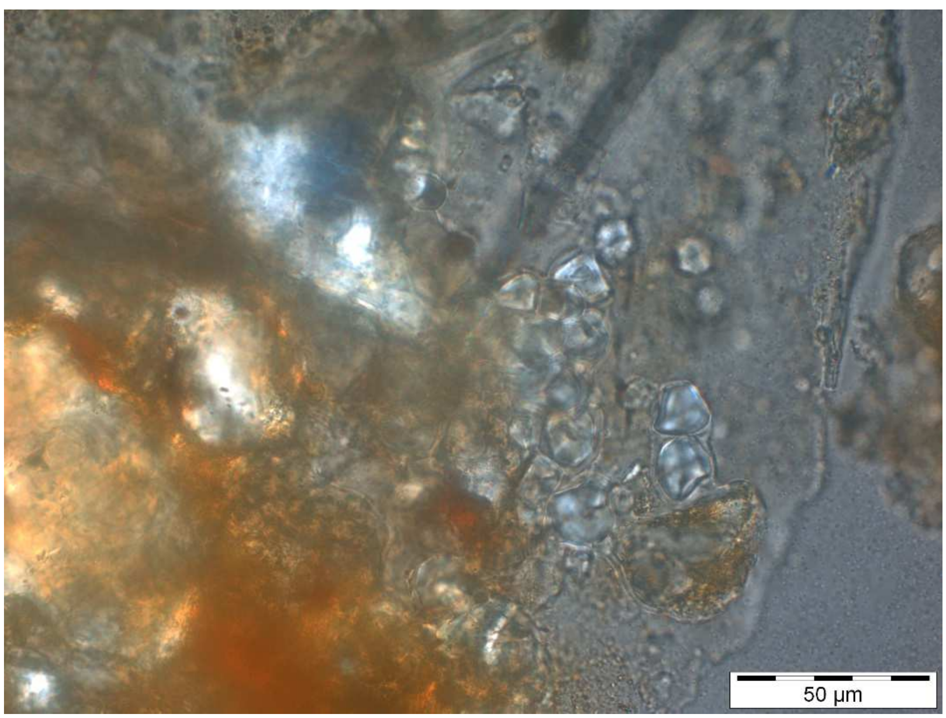


Figure 10 – Example of a human, Native American coprolite from Hinds Cave, Texas (Poinar et. al 2001).

Table 13 – Raw data of Asteraceae medicinal uses for each physiological system (**ALL Native Americans**). GI = gastrointestinal, Res = Respiratory, S = Integumentary, Im = Immune, Cir = Circulatory, MS = Musculoskeletal, Uri = Urinary, Rep = Reproductive, Ner = Nervous/Psychological, TOT = Total

Asteraceae genera used by Native Americans (Total)	# GI	# Res	# S	# Im	# Cir	# MS	# Uri	# Rep	# Ner	TOT
Acourtia	1	0	1	0	1	0	0	1	0	4
Adenocaulon	0	0	2	0	0	0	0	0	0	2
Achillea	86	28	67	15	16	45	22	20	12	311
Ageratina	4	1	1	0	4	0	0	3	4	17
Agoseris	3	1	4	0	1	2	1	1	2	15
Ambrosia	16	3	6	2	4	3	0	3	1	38
Ampelaster	0	0	2	0	0	0	0	0	0	2
Amphiachyris	0	0	1	0	0	0	0	0	0	1
Anaphalis	4	6	4	0	0	1	0	0	1	16
Antennaria	2	3	1	0	1	0	0	5	0	12
Anthemis	9	3	2	5	2	1	3	1	0	26
Arctium	4	4	12	2	7	1	3	3	2	38
Arnica	0	1	1	0	0	2	0	0	0	4
Arnoglossum	0	0	1	0	0	0	0	0	0	1
Artemisia	34	15	48	19	7	27	10	30	16	206
Aster	1	0	0	0	0	0	0	0	0	1
Baccharis	3	2	8	0	1	0	2	0	0	16
Bahia	6	1	3	1	1	1	1	2	0	16
Baileya	0	0	1	0	0	0	0	0	0	1
Balsamorhiza	17	7	15	1	0	1	3	6	0	50
Bellis	1	0	0	0	0	0	0	0	0	1
Berlandiera	0	0	0	0	0	0	0	0	1	1
Bidens	7	3	0	8	0	0	0	0	0	18
Brickellia	9	3	2	3	0	0	0	0	0	17
Calycadenia	0	0	0	1	0	0	0	0	0	1
Centaurea	0	0	2	0	0	0	1	0	0	3
Chaenactis	6	2	10	0	3	3	1	0	1	26
Chaetopappa	3	1	2	1	1	1	3	2	2	16

Table 13 (Cont)										
Asteraceae genera used by Native Americans (Total)	# GI	# Res	# S	# Im	# Cir	# MS	# Uri	# Rep	# Ner	TOT
Chamaemelum	3	0	1	0	0	0	0	0	0	4
Chaptalia	0	0	0	0	0	0	1	0	0	1
Chrysothamnus	6	3	2	1	0	0	0	2	0	14
Cichorium	0	0	1	0	0	0	0	0	1	2
Cirsium	31	18	13	9	5	6	7	11	5	105
Conyza	7	3	5	3	0	1	0	2	0	21
Coreopsis	3	1	1	1	1	2	1	2	1	13
Cosmos	0	0	1	0	0	0	0	0	0	1
Crepis	0	0	2	0	0	1	0	2	1	6
Doellingeria	1	0	0	0	0	0	0	0	0	1
Dyssodia	2	0	1	1	0	0	0	1	0	5
Echinacea	37	12	28	1	1	1	0	3	0	83
Encelia	2	0	1	0	0	0	0	0	0	3
Enceliopsis	1	1	0	0	0	0	0	1	0	3
Ericameria	16	11	11	3	1	4	2	6	2	56
Erigeron	17	8	17	3	3	4	5	6	3	66
Eriophyllum	0	0	1	0	0	0	0	0	0	1
Eupatorium	23	6	5	15	3	5	16	13	4	90
Eurybia	4	0	2	0	0	0	0	2	0	8
Euthamia	0	1	0	1	0	0	0	0	0	2
Gaillardia	3	2	1	0	0	2	4	2	2	16
Gnaphalium	0	1	1	0	0	1	0	0	0	3
Grindelia	19	21	11	0	3	6	7	4	0	71
Gutierrezia	14	4	9	1	1	4	4	6	1	44
Haplopappus	2	0	0	0	0	0	0	0	0	2
Helenium	10	17	4	0	6	1	3	5	1	47
Helianthella	1	1	3	1	1	2	1	1	1	12
Helianthus	6	5	15	3	2	1	1	2	1	36
Heliomeris	2	2	2	2	2	2	2	2	2	18
Heliopsis	0	1	0	0	0	0	0	0	1	2
Heterotheca	7	1	2	1	2	0	1	2	1	17
Hieracium	4	2	1	0	0	0	1	0	0	8

Table 13 (Cont)										
Asteraceae genera used by Native Americans (Total)	**# GI**	**# Res**	**# S**	**# Im**	**# Cir**	**# MS**	**# Uri**	**# Rep**	**# Ner**	**TOT**
Hymenopappus	**6**	**2**	**3**	**1**	**2**	**1**	**1**	**1**	**1**	**18**
Hymenoxys	**5**	**1**	**2**	**0**	**0**	**1**	**0**	**2**	**4**	**15**
Inula	**10**	**13**	**1**	**1**	**5**	**1**	**2**	**2**	**1**	**36**
Ionactis	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**
Isocoma	**1**	**2**	**2**	**0**	**0**	**1**	**0**	**0**	**0**	**6**
Iva	**5**	**1**	**2**	**0**	**0**	**0**	**0**	**1**	**0**	**9**
Lactuca	**9**	**0**	**2**	**0**	**2**	**1**	**1**	**2**	**1**	**18**
Leucanthemum	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**1**
Liatris	**13**	**1**	**4**	**0**	**1**	**1**	**6**	**1**	**1**	**28**
Lygodesmia	**3**	**1**	**2**	**0**	**0**	**1**	**2**	**9**	**1**	**19**
Machaeranthera	**5**	**5**	**1**	**1**	**1**	**0**	**0**	**2**	**2**	**17**
Madia	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**
Malacothrix	**1**	**0**	**1**	**0**	**1**	**0**	**0**	**0**	**0**	**3**
Matricaria	**17**	**1**	**2**	**0**	**3**	**1**	**1**	**4**	**1**	**30**
Mikania	**0**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**2**
Oligoneuron	**1**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**2**
Onopordum	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**
Packera	**3**	**2**	**3**	**2**	**3**	**2**	**2**	**4**	**2**	**23**
Parthenium	**1**	**0**	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**3**
Pectis	**5**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**5**
Pentachaeta	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**2**
Pericome	**2**	**1**	**1**	**2**	**0**	**0**	**0**	**1**	**0**	**7**
Petasites	**1**	**12**	**6**	**1**	**1**	**2**	**1**	**1**	**0**	**25**
Petradoria	**2**	**0**	**2**	**0**	**0**	**2**	**0**	**1**	**0**	**7**
Picradeniopsis	**4**	**1**	**3**	**1**	**1**	**1**	**1**	**1**	**1**	**14**
Picrothamnus	**2**	**4**	**6**	**0**	**0**	**1**	**2**	**0**	**0**	**15**
Pityopsis	**2**	**2**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**5**
Pluchea	**5**	**1**	**1**	**2**	**0**	**0**	**0**	**0**	**0**	**9**
Polymnia	**1**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**2**
Porophyllum	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**
Prenanthes	**2**	**0**	**5**	**1**	**0**	**0**	**3**	**2**	**2**	**15**
Pseudognaphalium	**8**	**12**	**3**	**2**	**1**	**5**	**0**	**1**	**6**	**38**

Table 13 (Cont)										
Asteraceae genera used by Native Americans (Total)	**# GI**	**# Res**	**# S**	**# Im**	**# Cir**	**# MS**	**# Uri**	**# Rep**	**# Ner**	**TOT**
Psilostrophe	6	2	4	1	1	0	1	1	1	17
Pterocaulon	4	1	0	1	0	1	0	3	0	10
Pyrrhopappus	1	0	0	0	1	0	0	0	0	2
Ratibida	7	3	6	4	2	2	2	4	2	32
Rudbeckia	4	0	4	1	1	0	2	4	0	16
Sanvitalia	5	4	3	1	1	1	1	2	1	19
Schkuhria	1	0	0	0	0	0	0	0	0	1
Senecio	3	0	9	0	0	5	1	2	1	21
Silphium	7	1	0	0	0	4	4	3	1	20
Smallanthus	2	0	3	0	0	1	1	2	0	9
Solidago	24	9	19	11	2	3	2	6	6	82
Sonchus	3	0	0	0	0	0	0	1	0	4
Stenotus	4	2	0	0	0	0	0	0	0	6
Stephanomeria	8	4	6	4	1	3	5	6	0	37
Symphyotrichum	7	3	6	7	2	1	1	1	6	34
Tagetes	5	2	2	3	1	1	1	2	1	18
Tanacetum	9	2	3	3	1	5	3	2	1	29
Taraxacum	14	3	5	0	5	4	3	3	0	37
Tetradymia	6	3	2	1	0	1	0	2	0	15
Tetraneuris	2	1	1	1	1	3	1	3	4	17
Thelesperma	1	3	0	0	0	0	0	0	1	5
Thymophylla	1	0	0	1	0	0	0	0	1	3
Townsendia	4	3	0	0	0	0	0	7	0	14
Tragopogon	2	1	2	0	0	0	0	0	0	5
Tussilago	0	2	0	0	0	0	0	0	0	2
Vanclevea	0	0	1	0	0	0	0	0	0	1
Verbesina	11	1	4	7	0	0	2	2	1	28
Vernonia	5	0	1	0	2	0	0	6	0	14
Wyethia	12	1	7	2	2	2	0	2	0	28
Xanthium	9	5	5	2	2	2	6	3	1	35
Zinnia	10	5	4	3	1	1	2	2	2	30
TOTALS	732	329	492	172	127	193	166	256	124	2591

Table 14 – Raw data of Asteraceae medicinal uses for each physiological system (**Cherokee**). GI = gastrointestinal, Res = Respiratory, S = Integumentary, Im = Immune, Cir = Circulatory, MS = Musculoskeletal, Uri = Urinary, Rep = Reproductive, Ner = Nervous/Psychological

Asteraceae genera used by Native Americans (Cherokee)	# GI	# Res	# S	# Im	# Cir	# MS	# Uri	# Rep	# Ner
Acourtia	0	0	0	0	0	0	0	0	0
Adenocaulon	0	0	0	0	0	0	0	0	0
Achillea	1	1	1	1	3	0	1	1	0
Ageratina	1	0	0	1	0	0	2	0	0
Agoseris	0	0	0	0	0	0	0	0	0
Ambrosia	0	1	2	1	0	0	0	0	0
Ampelaster	0	0	0	0	0	0	0	0	0
Amphiachyris	0	0	0	0	0	0	0	0	0
Anaphalis	2	3	0	0	0	0	0	0	0
Antennaria	2	0	0	0	0	0	0	1	0
Anthemis	1	1	1	2	0	1	1	0	1
Arctium	0	0	1	0	1	1	1	2	0
Arnica	0	0	0	0	0	0	0	0	0
Arnoglossum	0	0	1	0	0	0	0	0	0
Artemisia	2	0	1	0	0	0	0	2	0
Aster	1	1	0	1	0	0	0	0	0
Baccharis	0	0	0	0	0	0	0	0	0
Bahia	0	0	0	0	0	0	0	0	0
Baileya	0	0	0	0	0	0	0	0	0
Balsamorhiza	0	0	0	0	0	0	0	0	0
Bellis	0	0	0	0	0	0	0	0	0
Berlandiera	0	0	0	0	0	0	0	0	0
Bidens	2	0	0	1	0	0	0	0	0
Brickellia	0	0	0	0	0	0	0	0	0
Calycadenia	0	0	0	0	0	0	0	0	0
Centaurea	0	0	0	0	0	0	0	0	0

Table 14 (Cont)									
Asteraceae genera used by Native Americans (Cherokee)	**# GI**	**# Res**	**# S**	**# Im**	**# Cir**	**# MS**	**# Uri**	**# Rep**	**# Ner**
Chaenactis	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Chaetopappa	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Chamaemelum	**2**	**0**	**1**	**0**	**0**	**0**	**0**	**1**	**0**
Chaptalia	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Chrysothamnus	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Cichorium	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Cirsium	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**
Conyza	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Coreopsis	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Cosmos	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Crepis	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Doellingeria	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Dyssodia	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Echinacea	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Encelia	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Enceliopsis	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Ericameria	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Erigeron	**0**	**0**	**4**	**2**	**4**	**0**	**4**	**2**	**4**
Eriophyllum	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Eupatorium	**5**	**2**	**0**	**4**	**0**	**1**	**8**	**3**	**0**
Eurybia	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Euthamia	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Gaillardia	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Gnaphalium	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Grindelia	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Gutierrezia	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Haplopappus	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Helenium	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**
Helianthella	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Helianthus	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Heliomeris	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Table 14 (Cont)									
Asteraceae genera used by Native Americans (Cherokee)	**# GI**	**# Res**	**# S**	**# Im**	**# Cir**	**# MS**	**# Uri**	**# Rep**	**# Ner**
Heliopsis	0	0	0	0	0	0	0	0	0
Heterotheca	0	0	0	0	0	0	0	0	0
Hieracium	1	0	0	0	0	0	0	0	0
Hymenopappus	0	0	0	0	0	0	0	0	0
Hymenoxys	0	0	0	0	0	0	0	0	0
Inula	0	4	0	0	0	0	0	1	0
Ionactis	1	1	0	1	0	0	0	0	0
Isocoma	0	0	0	0	0	0	0	0	0
Iva	0	0	0	0	0	0	0	0	0
Lactuca	0	0	0	0	0	0	0	0	2
Leucanthemum	0	0	0	0	0	0	0	0	0
Liatris	2	0	0	0	0	1	2	0	0
Lygodesmia	0	0	0	0	0	0	0	0	0
Machaeranthera	0	0	0	0	0	0	0	0	0
Madia	0	0	0	0	0	0	0	0	0
Malacothrix	0	0	0	0	0	0	0	0	0
Matricaria	1	0	0	0	0	0	0	0	0
Mikania	0	0	0	0	0	0	0	0	0
Oligoneuron	0	0	0	0	0	0	0	0	0
Onopordum	0	0	0	0	0	0	0	0	0
Packera	0	0	0	0	1	0	0	1	0
Parthenium	0	0	0	0	0	0	0	0	0
Pectis	0	0	0	0	0	0	0	0	0
Pentachaeta	0	0	0	0	0	0	0	0	0
Pericome	0	0	0	0	0	0	0	0	0
Petasites	0	0	0	0	0	0	0	0	0
Petradoria	0	0	0	0	0	0	0	0	0
Picradeniopsis	0	0	0	0	0	0	0	0	0
Picrothamnus	0	0	0	0	0	0	0	0	0
Pityopsis	0	0	0	0	0	0	0	0	0
Pluchea	0	0	0	0	0	0	0	0	0

Table 14 (Cont)									
Asteraceae genera used by Native Americans (Cherokee)	**# GI**	**# Res**	**# S**	**# Im**	**# Cir**	**# MS**	**# Uri**	**# Rep**	**# Ner**
Polymnia	0	0	0	0	0	0	0	0	0
Porophyllum	0	0	0	0	0	0	0	0	0
Prenanthes	2	0	0	0	0	0	0	0	0
Pseudognaphalium	2	2	0	1	0	5	0	0	0
Psilostrophe	0	0	0	0	0	0	0	0	0
Pterocaulon	0	0	0	0	0	0	0	0	0
Pyrrhopappus	0	0	0	0	0	1	0	0	0
Ratibida	0	0	0	0	0	0	0	0	0
Rudbeckia	2	0	2	2	0	0	1	4	0
Sanvitalia	0	0	0	0	0	0	0	0	0
Schkuhria	0	0	0	0	0	0	0	0	0
Senecio	0	0	0	0	0	0	0	0	0
Silphium	0	0	0	0	0	0	0	2	0
Smallanthus	1	0	3	0	0	1	0	2	0
Solidago	2	1	0	4	0	0	1	0	0
Sonchus	0	0	0	0	0	0	0	0	1
Stenotus	0	0	0	0	0	0	0	0	0
Stephanomeria	0	0	0	0	0	0	0	0	0
Symphyotrichum	1	1	0	1	0	0	0	0	0
Tagetes	0	0	0	0	0	0	0	0	0
Tanacetum	2	0	1	0	0	2	0	0	0
Taraxacum	1	0	0	0	1	1	0	0	0
Tetradymia	0	0	0	0	0	0	0	0	0
Tetraneuris	0	0	0	0	0	0	0	0	0
Thelesperma	0	0	0	0	0	0	0	0	0
Thymophylla	0	0	0	0	0	0	0	0	0
Townsendia	0	0	0	0	0	0	0	0	0
Tragopogon	0	0	0	0	0	0	0	0	0
Tussilago	0	0	0	0	0	0	0	0	0
Vanclevea	0	0	0	0	0	0	0	0	0
Verbesina	0	0	0	0	0	0	0	0	0

Table 14 (Cont)									
Asteraceae genera used by Native Americans (Cherokee)	**# GI**	**# Res**	**# S**	**# Im**	**# Cir**	**# MS**	**# Uri**	**# Rep**	**# Ner**
Vernonia	**4**	**0**	**0**	**0**	**2**	**2**	**0**	**6**	**0**
Wyethia	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Xanthium	**3**	**1**	**0**	**1**	**0**	**0**	**0**	**0**	**0**
Zinnia	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
TOTALS	**47**	**19**	**18**	**23**	**12**	**16**	**21**	**29**	**10 = 195 (total)**

Table 15 – Raw data of Asteraceae medicinal uses for each physiological system (**Navajo**). GI = gastrointestinal, Res = Respiratory, S = Integumentary, Im = Immune, Cir = Circulatory, MS = Musculoskeletal, Uri = Urinary, Rep = Reproductive, Ner = Nervous/Psychological

Asteraceae genera used by Native Americans (Navajo)	# GI	# Res	# S	# Im	# Cir	# MS	# Uri	# Rep	# Ner
Acourtia	0	0	0	0	0	0	0	1	0
Adenocaulon	0	0	0	0	0	0	0	0	0
Achillea	3	0	0	1	0	0	0	0	0
Ageratina	0	0	0	1	0	0	0	0	0
Agoseris	2	0	0	0	0	2	0	0	0
Ambrosia	0	0	0	0	0	0	0	1	0
Ampelaster	0	0	0	0	0	0	0	0	0
Amphiachyris	0	0	0	0	0	0	0	0	0
Anaphalis	0	0	0	0	0	0	0	0	0
Antennaria	0	0	0	0	1	0	0	1	0
Anthemis	0	0	0	0	0	0	0	0	0
Arctium	0	0	0	0	0	0	0	0	0
Arnica	0	0	0	0	0	0	0	0	0
Arnoglossum	0	0	0	0	0	0	0	0	0
Artemisia	6	6	8	3	0	0	0	2	0
Aster	2	1	1	0	0	0	0	0	0
Baccharis	2	0	0	1	0	0	0	1	0
Bahia	2	1	2	1	1	2	1	4	1
Baileya	0	0	0	0	0	0	0	0	0
Balsamorhiza	0	0	0	0	0	0	0	0	0
Bellis	0	0	0	0	0	0	0	0	0
Berlandiera	0	0	0	0	0	0	0	0	0
Bidens	0	0	0	0	0	0	0	0	0
Brickellia	0	0	0	0	0	0	0	0	0
Calycadenia	0	0	0	0	0	0	0	0	0
Centaurea	0	0	0	0	0	0	0	0	0
Chaenactis	0	0	0	0	0	0	0	0	0
Chaetopappa	1	0	0	0	0	0	2	0	0

Table 15 (Cont)									
Asteraceae genera used by Native Americans (Navajo)	# GI	# Res	# S	# Im	# Cir	# MS	# Uri	# Rep	# Ner
Chamaemelum	0	0	0	0	0	0	0	0	0
Chaptalia	0	0	0	0	0	0	0	0	0
Chrysothamnus	1	0	1	0	0	0	0	1	0
Cichorium	0	0	0	0	0	0	0	0	0
Cirsium	6	5	5	6	5	5	5	5	5
Conyza	1	0	2	0	0	0	0	0	0
Coreopsis	1	1	1	1	1	1	1	2	1
Cosmos	0	0	1	0	0	0	0	0	0
Crepis	0	0	0	0	0	0	0	0	0
Doellingeria	0	0	0	0	0	0	0	0	0
Dyssodia	1	0	1	0	0	0	0	0	0
Echinacea	0	0	0	0	0	0	0	0	0
Encelia	0	0	1	0	0	0	0	0	0
Enceliopsis	0	0	0	0	0	0	0	0	0
Ericameria	4	1	0	2	0	0	0	1	0
Erigeron	2	2	3	2	1	1	1	5	1
Eriophyllum	0	0	0	0	0	0	0	0	0
Eupatorium	0	0	1	0	0	0	0	0	0
Eurybia	0	0	0	0	0	0	0	0	0
Euthamia	0	0	0	0	0	0	0	0	0
Gaillardia	2	1	0	0	0	0	0	0	0
Gnaphalium	0	0	0	0	0	0	0	0	0
Grindelia	2	0	1	0	0	0	0	0	0
Gutierrezia	5	1	3	2	1	1	3	2	2
Haplopappus	0	0	0	0	0	0	0	0	0
Helenium	0	0	0	0	0	0	0	0	0
Helianthella	1	1	2	1	1	1	1	1	1
Helianthus	2	1	2	1	1	1	1	1	1
Heliomeris	2	2	2	2	2	2	2	2	2
Heliopsis	0	0	0	0	0	0	0	0	0
Heterotheca	7	1	2	1	2	3	1	1	1

Table 15 (Cont)									
Asteraceae genera used by Native Americans (Navajo)	**# GI**	**# Res**	**# S**	**# Im**	**# Cir**	**# MS**	**# Uri**	**# Rep**	**# Ner**
Hieracium	0	0	0	0	0	0	1	0	0
Hymenopappus	1	2	2	1	2	1	1	1	1
Hymenoxys	2	0	1	0	0	0	0	0	0
Inula	0	0	0	0	0	0	0	0	0
Ionactis	0	0	0	0	0	0	0	0	0
Isocoma	0	0	1	0	0	0	0	0	0
Iva	0	1	1	1	0	0	0	0	0
Lactuca	4	0	0	0	0	0	0	0	0
Leucanthemum	0	0	0	0	0	0	0	0	0
Liatris	0	0	0	0	0	0	0	0	0
Lygodesmia	0	0	1	0	0	0	0	0	0
Machaeranthera	3	3	2	0	0	0	0	0	0
Madia	0	0	0	0	0	0	0	0	0
Malacothrix	1	0	1	0	0	0	0	0	0
Matricaria	0	0	0	0	0	0	0	0	0
Mikania	0	0	0	0	0	0	0	0	0
Oligoneuron	0	0	0	0	0	0	0	0	0
Onopordum	0	0	0	0	0	0	0	0	0
Packera	2	1	4	1	1	1	1	4	1
Parthenium	0	0	0	0	0	0	0	0	0
Pectis	2	0	0	0	0	0	0	0	0
Pentachaeta	0	0	0	0	0	0	0	0	1
Pericome	3	1	1	1	0	0	0	1	0
Petasites	0	0	0	0	0	0	0	0	0
Petradoria	3	0	2	0	0	0	0	0	0
Picradeniopsis	2	0	2	0	0	0	0	0	0
Picrothamnus	0	0	0	0	0	0	0	0	0
Pityopsis	0	0	0	0	0	0	0	0	0
Pluchea	0	0	0	0	0	0	0	0	0
Polymnia	0	0	0	0	0	0	0	0	0
Porophyllum	0	0	0	0	0	0	0	0	0

Table 15 (Cont)									
Asteraceae genera used by Native Americans (Navajo)	# GI	# Res	# S	# Im	# Cir	# MS	# Uri	# Rep	# Ner
Prenanthes	0	0	0	0	0	0	0	0	0
Pseudognaphalium	2	1	1	1	1	1	1	1	1
Psilostrophe	6	1	2	1	2	1	1	2	1
Pterocaulon	0	0	0	0	0	0	0	0	0
Pyrrhopappus	2	0	0	0	0	0	0	0	0
Ratibida	4	2	1	4	1	1	1	2	1
Rudbeckia	0	0	0	0	0	0	0	0	0
Sanvitalia	5	2	4	3	1	1	1	3	1
Schkuhria	1	0	1	0	0	0	0	0	0
Senecio	1	0	2	0	0	0	0	1	0
Silphium	0	0	0	0	0	0	0	0	0
Smallanthus	0	0	0	0	0	0	0	0	0
Solidago	0	0	0	0	0	0	0	0	1
Sonchus	0	0	0	0	1	0	0	0	0
Stenotus	4	1	1	0	0	1	0	0	0
Stephanomeria	1	1	1	1	1	1	1	2	1
Symphyotrichum	1	0	0	0	0	0	0	0	0
Tagetes	4	2	1	3	1	1	1	2	1
Tanacetum	0	0	0	0	0	0	0	0	0
Taraxacum	0	0	1	0	0	0	0	1	0
Tetradymia	2	1	0	1	0	1	0	1	0
Tetraneuris	2	1	2	1	1	1	1	1	2
Thelesperma	1	0	0	0	0	1	0	0	0
Thymophylla	0	0	0	0	0	0	0	0	1
Townsendia	2	1	0	0	0	0	0	5	0
Tragopogon	4	0	2	0	0	0	0	0	0
Tussilago	0	0	0	0	0	0	0	0	0
Vanclevea	0	0	1	0	0	0	0	0	0
Verbesina	1	0	1	0	0	0	0	0	0
Vernonia	0	0	0	0	0	0	0	0	0
Wyethia	2	0	0	0	0	0	0	0	0

Table 15 (Cont)									
Asteraceae genera used by Native Americans (Navajo)	**# GI**	**# Res**	**# S**	**# Im**	**# Cir**	**# MS**	**# Uri**	**# Rep**	**# Ner**
Xanthium	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Zinnia	**10**	**1**	**4**	**3**	**0**	**0**	**0**	**2**	**1**
TOTAL	**133**	**48**	**82**	**47**	**28**	**31**	**28**	**60**	**29 = 486 (total)**

Table 16 – Raw data of Asteraceae medicinal uses for each physiological system (Iroquois). GI = gastrointestinal, Res = Respiratory, S = Integumentary, Im = Immune, Cir = Circulatory, MS = Musculoskeletal, Uri = Urinary, Rep = Reproductive, Ner = Nervous/Psychological

Asteraceae genera used by Native Americans (Iroquois)	**# GI**	**# Res**	**# S**	**# Im**	**# Cir**	**# MS**	**# Uri**	**# Rep**	**# Ner**
Acourtia	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Adenocaulon	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Achillea	**11**	**1**	**1**	**5**	**1**	**2**	**1**	**3**	**0**
Ageratina	**2**	**1**	**1**	**1**	**2**	**1**	**1**	**3**	**1**
Agoseris	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Ambrosia	**2**	**0**	**0**	**0**	**2**	**1**	**0**	**0**	**0**
Ampelaster	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Amphiachyris	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Anaphalis	**2**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Antennaria	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**
Anthemis	**9**	**1**	**0**	**1**	**1**	**1**	**0**	**0**	**0**
Arctium	**2**	**0**	**5**	**1**	**2**	**4**	**2**	**0**	**0**
Arnica	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Arnoglossum	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Artemisia	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Aster	**0**	**1**	**0**	**1**	**1**	**0**	**0**	**0**	**0**
Baccharis	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Bahia	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Baileya	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Balsamorhiza	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Bellis	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Berlandiera	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Bidens	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Brickellia	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Calycadenia	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Centaurea	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Chaenactis	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Chaetopappa	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Table 16 (Cont)									
Asteraceae genera used by Native Americans (Iroquois)	**# GI**	**# Res**	**# S**	**# Im**	**# Cir**	**# MS**	**# Uri**	**# Rep**	**# Ner**
Chamaemelum	0	0	0	0	0	0	0	0	0
Chaptalia	0	0	0	0	0	0	0	0	0
Chrysothamnus	0	0	0	0	0	0	0	0	0
Cichorium	0	0	1	0	0	0	0	0	0
Cirsium	1	0	2	0	4	0	0	0	0
Conyza	0	0	0	3	0	0	0	0	0
Coreopsis	0	0	0	0	0	0	0	0	0
Cosmos	0	0	0	0	0	0	0	0	0
Crepis	0	0	0	0	0	0	0	0	0
Doellingeria	0	0	0	0	0	0	0	0	0
Dyssodia	0	0	0	0	0	0	0	0	0
Echinacea	0	0	0	0	0	0	0	0	0
Encelia	0	0	0	0	0	0	0	0	0
Enceliopsis	0	0	0	0	0	0	0	0	0
Ericameria	0	0	0	0	0	0	0	0	0
Erigeron	0	3	2	1	0	0	0	0	0
Eriophyllum	0	0	0	0	0	0	0	0	0
Eupatorium	8	2	1	3	0	2	1	3	1
Eurybia	1	0	0	0	1	0	0	1	0
Euthamia	0	0	0	0	0	0	0	0	0
Gaillardia	0	0	0	0	0	0	0	0	0
Gnaphalium	0	0	0	0	0	0	0	0	0
Grindelia	0	0	0	0	0	0	0	0	0
Gutierrezia	0	0	0	0	0	0	0	0	0
Haplopappus	0	0	0	0	0	0	0	0	0
Helenium	0	0	0	0	0	0	0	0	0
Helianthella	0	0	0	0	0	0	0	0	0
Helianthus	2	0	0	0	0	0	0	0	0
Heliomeris	0	0	0	0	0	0	0	0	0
Heliopsis	0	0	0	0	0	0	0	0	0
Heterotheca	0	0	0	0	0	0	0	0	0

Table 16 (Cont)									
Asteraceae genera used by Native Americans (Iroquois)	# GI	# Res	# S	# Im	# Cir	# MS	# Uri	# Rep	# Ner
Hieracium	1	1	1	1	0	0	0	0	0
Hymenopappus	0	0	0	0	0	0	0	0	0
Hymenoxys	0	0	0	0	0	0	0	0	0
Inula	5	7	2	3	3	2	2	2	1
Ionactis	0	0	0	0	0	0	0	0	0
Isocoma	0	0	0	0	0	0	0	0	0
Iva	0	0	0	0	0	0	0	0	0
Lactuca	0	0	1		1	1	1	0	0
Leucanthemum	0	0	0	0	0	0	0	0	0
Liatris	0	0	0	0	0	0	0	0	0
Lygodesmia	0	0	0	0	0	0	0	0	0
Machaeranthera	0	0	0	0	0	0	0	0	0
Madia	0	0	0	0	0	0	0	0	0
Malacothrix	0	0	0	0	0	0	0	0	0
Matricaria	0	0	0	0	0	0	0	0	0
Mikania	0	0	0	0	0	0	0	0	0
Oligoneuron	0	0	0	0	0	0	0	0	0
Onopordum	1	0	0	0	0	0	0	0	0
Packera	0	0	0	1	1	1	1	0	0
Parthenium	0	0	0	0	0	0	0	0	0
Pectis	0	0	0	0	0	0	0	0	0
Pentachaeta	0	0	0	0	0	0	0	0	0
Pericome	0	0	0	0	0	0	0	0	0
Petasites	0	0	0	0	0	0	0	0	0
Petradoria	0	0	0	0	0	0	0	0	0
Picradeniopsis	0	0	0	0	0	0	0	0	0
Picrothamnus	0	0	0	0	0	0	0	0	0
Pityopsis	0	0	0	0	0	0	0	0	0
Pluchea	0	0	0	0	0	0	0	0	0
Polymnia	1	0	0	0	0	1	0	0	0
Porophyllum	0	0	0	0	0	0	0	0	0

Table 16 (Cont)									
Asteraceae genera used by Native Americans (Iroquois)	**# GI**	**# Res**	**# S**	**# Im**	**# Cir**	**# MS**	**# Uri**	**# Rep**	**# Ner**
Prenanthes	0	0	2	0	0	0	0	0	0
Pseudognaphalium	0	0	0	0	0	0	0	0	0
Psilostrophe	0	0	0	0	0	0	0	0	0
Pterocaulon	0	0	0	0	0	0	0	0	0
Pyrrhopappus	0	0	0	0	0	0	0	0	0
Ratibida	0	0	0	0	0	0	0	0	0
Rudbeckia	1	0	0	0	1	0	0	0	0
Sanvitalia	0	0	0	0	0	0	0	0	0
Schkuhria	0	0	0	0	0	0	0	0	0
Senecio	0	0	0	0	0	0	0	0	0
Silphium	1	0	0	0	0	1	0	0	0
Smallanthus	1	0	0	1	0	1	1	0	0
Solidago	12	0	1	1	1	0	1	1	0
Sonchus	0	0	0	0	0	0	0	0	0
Stenotus	0	0	0	0	0	0	0	0	0
Stephanomeria	0	0	0	0	0	0	0	0	0
Symphyotrichum	0	2	1	7	0	0	0	0	0
Tagetes	0	0	0	0	0	0	0	0	0
Tanacetum	2	0	2	2	1	2	1	1	1
Taraxacum	3	1	2	0	1	3	3	0	0
Tetradymia	0	0	0	0	0	0	0	0	0
Tetraneuris	0	0	0	0	0	0	0	0	0
Thelesperma	0	0	0	0	0	0	0	0	0
Thymophylla	0	0	0	0	0	0	0	0	0
Townsendia	0	0	0	0	0	0	0	0	0
Tragopogon	0	0	0	0	0	0	0	0	0
Tussilago	0	1	0	2	0	0	0	0	0
Vanclevea	0	0	0	0	0	0	0	0	0
Verbesina	0	0	0	0	0	0	0	0	0
Vernonia	0	0	0	0	0	0	0	0	0
Wyethia	0	0	0	0	0	0	0	0	0

Table 16 (Cont)									
Asteraceae genera used by Native Americans (Iroquois)	**# GI**	**# Res**	**# S**	**# Im**	**# Cir**	**# MS**	**# Uri**	**# Rep**	**# Ner**
Xanthium	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Zinnia	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
TOTAL	**70**	**22**	**25**	**34**	**23**	**23**	**15**	**15**	**4 = 231 (total)**