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# **Nerves and Spines: A Textual Analysis of the Significance of Nopal in the Florentine Codex**

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“auh can onjqjttac aytaque tepeoa. Ça ce in tonacaiotl ic man jn tlalli, ic ioltimanj in cemanaoatl in cemanaoac titentimanj, tocentemach in tonacaiotl:”

“Where have I seen one without provisions who conquereth? Alone it is by sustenance that the earth endureth, that the world maintaineth life, that we replenish the world. The sustenance is our hope.”

– Digital Florentine Codex, bk. 6 fol. 73r

The *nopal*, or prickly pear cactus, is a very common cactus that is native to Mexico and the southwestern United States. Nopal is a Spanish word derived from the Nahuatl *nopalli* or *nohpalli*, and refers to cactus species in the *Opuntia* genus. Nopalli is the collective term for nopal and is a general term in the same way that “fish” is a general term in English in that it can refer to either the singular or the plural nopal; both nopal and nopalli will be used interchangeably throughout the paper. Nopal most commonly refers to *Opuntia ficus-indica*, the most widespread and commercially-grown cactus in the world. Originating in central Mexico, nopal has since been introduced to every continent except Antarctica (Bakewell-Stone 8). Despite *O. ficus-indica* and its many variations making up the vast majority of cacti being cultivated, there are anywhere from 150–200+ acknowledged species of *Opuntia*, most scholars agreeing there are about 180 (Majure et al. 848) The Florentine Codex identifies thirteen distinct types of nopal, *O. ficus-indica* likely being the one called *tzaponochnopalli* (Martín del Campo 30), illustrated in the Codex (Fig. 1).



Fig. 1. Tzapolnochnohpalli, Florentine Codex Book 11, Folio 127r

The Nahua people are an ethnic group indigenous to central Mexico. They are sometimes referred to as Mexica, which is the indigenous group most commonly associated with the Aztec label. While some Nahua people were Mexica, others were not; some were conquerors and others were conquered. All were negatively impacted by Spanish colonization. As seen in Fig. 2, the Aztec Empire was composed of many different indigenous groups, stretching across central and southern Mexico. Many indigenous groups, including the Nahua, have a rich tradition of oral and glyphic history, recorded in documents often referred to as codices. This paper focuses primarily on the Florentine Codex, but references other codices from around the same period as well.



Fig. 2. Encyclopædia Britannica. “Mesoamerican civilization.”

The Florentine Codex, also sometimes called the *Historia general de las cosas de Nueva España*, is a 16th century manuscript that was written to serve as an encyclopedic record of the lives of the indigenous Nahuatl people. The manuscript is composed of twelve books, totaling 2,446 pages, and is written in both Nahuatl and Spanish. Franciscan friar Bernardino de Sahagún spent most of his life learning Nahuatl and compiling the Florentine Codex, which took approximately three decades to complete (Terraciano 2). The production of the Florentine Codex was directed by Sahagún to document Nahuatl culture and the Nahuatl language in collaboration with several Nahuatl elders, scribes, artists, and students literate in both Spanish and Nahuatl. Unlike other literature being produced at the time, such as the Codex Mendoza whose authors are

unnamed, Sahagún credits many of these Nahua collaborators for their work. Sahagún is often credited as the author of the Florentine Codex, but his actual role was as more of a “coordinator, compiler, editor, and translator [of the original Nahuatl]” (Terraciano 13).

Quotations from the Florentine Codex, unless stated otherwise, are sourced from the English translation provided by Arthur J. O. Anderson and Charles E. Dibble, made available through the online archive, Digital Florentine Codex. Quotations from the Florentine Codex will be cited in terms of the Book and Folio they are sourced from, bk. referring to which Book in the manuscript is being referenced and fol. referring to the page referenced (i.e. Florentine Codex bk. 11, fol. 13r). The Anderson and Dibble translation is widely accepted as one of the best and most complete translations available, although, as with any translation, there are nuances unexplored and ambiguities that obscure some of the originally intended meanings. In discussing indigenous-authored texts such as the Florentine Codex, the Western idea of figurative and literal as separate and mutually exclusive categories is unavailing. For example, *tlatlalhoia*, or *tlalhuayoa*, is translated by Anderson and Dibble as “it becomes like nerves” (Florentine Codex bk. 11, fol. 126r), when a more accurate translation would be “it becomes nerves,” “it” likely referring to the nopal. The cactus is not nerve-like, nor does it become like nerves; it becomes nerves; it possesses a vascular system that circulates water, circulates blood, through the plant. It is blood vessels, tendons, and nerves. The Western way of thought puts the ideas that the cactus is literally nerves and the idea that the cactus looks like nerves in opposition to each other, when the indigenous way of thought understands these as one and the same. Context lost to time and the destruction of indigenous literature and language by Spanish colonizers makes translation of these historical texts difficult, and not always accurate. By analyzing the textual and visual

representations of the nopal in the Codex, this paper seeks to understand and contextualize the many roles this plant played in the lives of the Nahua prior to and during Spanish colonization.

### 1. Tenochtitlán and Nopal in Cultural Identity

The heart of the Aztec empire was the city of Tenochtitlán, today known as Mexico City, the capital of Mexico. This massive city built on the waters of Lake Texcoco was the home of the Mexica, and many Nahua as well. The flag of Mexico features an eagle with a serpent clutched in its beak, perched atop a nopal. This image originates from the story of the Aztecs migration from Aztlán and founding of Tenochtitlán, their capital city and the heart of the Aztec Empire (Rojas).

The myth of Aztlán is as much a historical account of the migration of Uto-Aztecan tribes into Mexico as it is, today, a cultural symbol for Chicanos. Aztlán is the mythical homeland of the Aztec ancestors and is translated in several different ways; Aztlán meaning, “place of whiteness,” “place of the cranes/herons,” or “place of the Az” (from Áztin, “people”), depending on which translator is being consulted (Vento 14). Some of the oldest evidence that can be found of humans with a distinct and identifiable culture is from southern Arizona, dated at around 8,000 B.C.. The Cochise people of southern Arizona spoke the language from which the Uto-Aztecan language family is derived, and which Nahuatl is a part of. The Cochise people are thought to be the direct ancestors of many Mexican people, some of their descendants having migrated out of the southwest and into Mexico around 1000 B.C. (Chávez 9).

The Aztecs left Aztlán in the year 1168 A.D., their journey outlined in the Codex Azcatitlan. Guided by their primary god of war, Huitzilopochtli, and carrying an idol of his image, they left their homeland in search of a new promised land. As seen in the Codex Azcatitlan and illustrated in Fig. 3, they stopped for a year very early in their journey (1169-1170

A.D.) in a desert-like location where nopal grew. Nopal was not only a source of food during their journey, but also would become a marker of the end of their journey.



Fig. 3. Nopal in Codex Azcatitlan, folio 4

They arrived in Tenochtitlán, which literally translates to “rock-cactus” in the year 1325, nearly 200 years later. They knew they had arrived at their destination when they saw the sign they had been waiting for: an eagle perched atop a cactus (Morán 15). The iconic eagle atop the cactus has been illustrated several times over several hundred years, the myth retold over and over again, but one of the earliest and most iconic representations of the eagle perched atop the cactus can be seen in the Codex Mendoza, pictured below in Fig. 4.



Fig. 4. Codex Mendoza, folio 2r

The symbol of the eagle perched atop the nopal is prolific in Mexican culture as the national symbol of Mexico, and a version of the symbol has been present in every iteration of the Mexican flag as the coat of arms since they won independence from the Spanish Empire in 1821 (Villascán). The symbol of the eagle perched atop the cactus growing from the rock is also one of a category of glyphs called world trees. The image of the world tree is present across several Mesoamerican cultures, including the Aztecs. In Aztec cosmology, the world is represented as a tree, usually with a bird on top representing the celestial plane and growing out of a human body representing the land of the dead. The tree lies in the terrestrial plane, spanning across planes to connect the realms of celestial, terrestrial, and the underworld. Any plant's classification as a tree is, again, different from how we may understand it today; examples of plants representing the earthly realm in these world trees include corn, mesquite, and maguey (agave), as well as the nopal. An example of a world tree that may represent Tenochtitlán can be seen in the Codex

Borgia in Fig. 5, pictured below. It likely represents Tenochtitlán because the plant chosen for this particular world tree was a nopal, and the bird on top is likely an eagle; the same mythical eagle atop the cactus that signaled to the Aztecs that Tenochtitlán would be their new home.



Fig. 5. Codex Borgia, p. 50

## 2. Indigenous Anatomy of Nopal

In the sixth chapter of Book 11: Earthly Things, “which telleth of the various trees, and of the various properties which correspond to them, such as their strength,” the nopalli are divided into thirteen different varieties. They are notably described as “trees” having branches and leaves.

“The branches are wide, thick, green, thorny, smooth, like a smooth reed. It has an excretion; it has tunas, fruit, tubes. It is stringy; it becomes nerve-like, it becomes like nerves. It forms a branch, it forms branches, it produces leaves. This nopal is edible; it is edible uncooked, it is cookable in an olla. It is eaten in moderation.”

(Florentine Codex bk. 11, fol. 125v–126r)

The description of this nopal, in some parts, is very self-explanatory. The cladodes being “wide, thick, green, thorny, smooth,” is relatively straightforward; an image of the nopal can be easily conjured from these descriptors alone if one has a clear idea of what the nopal looks like. However, some of these descriptions are more unexpected, such as the nopal having “an excretion,” and being “stringy” or “nerve-like.” It is also unclear what it means for the plant to be eaten “in moderation” without a reference point for what amount of food is excessive.

The “excretion” here refers to the tunas, the fruits, that extrude from the plant. The idea of a fruit being excreted, rather than grown, from a plant may seem unusual, until one considers the way the fruit is grown from the plant. As seen in Fig. 6, the flowers and fruits are attached to the pads, or cladodes, by joints, the flowers and fruits often growing from the edges of the pad. In observing this, it can be seen how the flowers and fruits might appear as though they are being pushed out of the pad, excreted.



Fig. 6. Britton & Rose, *The Cactaceae : Descriptions and Illustrations of Plants of the Cactus Family (Volume 1)* Plate 27 (p. 156)

The description of the nopal as “stringy” is also unusual at first glance. The nopal pads that are eaten are often the young ones, whose flesh is tender and succulent, far from stringy. However, if one takes into account that this nopal being described has excretions (fruits), then one can conclude it is an older, mature nopal. Young nopal that are harvested for their pads do not grow fruits—it is only the matured plant that grows fruits. Mature nopal pads can lose their fresh, green color over time, becoming more grayish-green. Their flesh becomes tougher; it becomes stringy. The word translated as “stringy” here is the word *ichio*, or *ichyo*, is derived from the word *ichtli*, a type of thread made from *maguey*, or agave, fiber (Online Nahuatl Dictionary). Maguey, a plant which is very fibrous, can have thread extracted from its leaves and needles made from its spines. The nopal, too, when mature and dried-out, becomes fibrous, hence its likening to the fibers of the maguey plant.

As for the nopal being “eaten in moderation,” this is a translation of the phrase *çan vel ipan*, or *zan huel ipan*, which means “in a good way, or temperately and moderately; neither a lot nor a little” (Online Nahuatl Dictionary). It’s a vague description, but likely refers to the fact that nopal was not a staple crop. Despite the fact that the nopal pads and fruits were eaten often, they were not nearly as large a part of the Nahua diet as a staple crop like maize. It’s an important distinction to make, as the frequency of meals and the amount of food eaten by the Nahua people was very different to the amount of food we eat today. Most modern-day physicians will advise that a healthy diet consists of three hearty, well-balanced meals per day, with maybe light snacks in between meals. To the Nahua, who only ate twice a day and for whom fasting was part of many traditions, this would have been considered excessive. Thus, it is clear how “eat in moderation” could be interpreted in different contexts.

Through closely analyzing the texts that have survived from this period, glimpses of what life may have looked like for the Nahua begin to emerge. Language both explains and obfuscates; meaning does not always lie clearly on the surface. These texts are rich with what many would be tempted to call metaphor, or figurative language. However, from close analysis emerges deeper understanding, which is the primary goal of this paper: to analyze one type of plant from as many angles as possible; to bring a small piece of history back into focus.

### 2.1. Classifying the Nopal

There have been suggestions from scholars about possible species for some of these nopal (ex. *Tzaponochnopalli* as *O. ficus-indica*), all of which are identified as being within the *Opuntia* genus. However, not all of the thirteen nopalli described in the Florentine Codex have been identified as possibly being of a specific species.

This could be for any one of multiple reasons. As of 2024, Plants of the World Online, an online database published by the Royal Botanical Gardens, Kew, currently accepts 145 distinct species of *Opuntia*, while some sources recognize over 180 different species (Anderson 485). *Opuntia* has a strong natural tendency toward hybridization due to its polyploidy, the condition of possessing more than two complete sets of chromosomes, which allows it to fertilize itself and maintain hybrid vigor and heterozygosity (Woodhouse). Modern *O. ficus-indica* is octoploid (Griffith 1917) meaning it has eight sets of chromosomes. It is also worth noting the role that humans have played in the hybridization of *Opuntia* and its popularity as a food crop leading to its cultivation outside its native habitat of the Americas and into continents such as Australia and Africa where it is considered highly invasive (Majure et al. 848). With the proliferation of *O. ficus-indica* being used as a food crop came increased hybridization, which likely led to the vast amount of species seen in the genus today.

*Tzaponochnopalli*, likely *O. ficus-indica*, the cactus that is cultivated most frequently for consumption, is described in the Florentine Codex as such:

“matilaoac, iaiaoaaltic: in jatlapal nextic, nexeoac, amo veiaqujanj, amo izcalloanj, movilananj: in jxochiquallo itoca tzaponochtli, cujtlaiiaoaltic, ololtic iuhqujn aiocomolli cujtlaiiaoallivi, nanatzivi.”

“The branch is thick, round. Its leaf is like ashes, ashen. It is not one to extend far, not one to put out a stalk; it is a creeper. The name of its fruit is *tzaponochtli*. It is fat, round, like the *ayocomolli*. It becomes fat, corpulent.”

(Florentine Codex bk. 11, fol. 126v–127r)

The *ayocomolli*, where *ayoco* means black beans and *molli* means sauce, is translated elsewhere as black bean stew, but more likely refers to the dish we know as refried beans. It could be used here as a reference to the consistency of the tuna flesh. *Ayocomolli* could also be broken down into *ayoh* (full of water or juice) and *comolli* (sunken or hollow area; a gully or depression). If translated this way, it refers to water filling a gully, and could be describing the watery juice of the fruit.

Not every nopal mentioned in the Florentine Codex is of the *Opuntia* genus. *Tenopalli*, or “*nopal de las peñas*” (nopal of the rocks), a nopal described as growing in mountainous, grassland, and forested habitats and producing a fruit called *çacanochtli*, has been suggested to be part of the *Epiphyllum* genus, also part of the *Cactaceae* family (Martín del Campo 31). The *çacanochtli*, too, are edible, described in the Florentine Codex as, “sour, harsh, small—small and round.” While it cannot be said for certain what species of cacti the *tenopalli* is, it’s likely one of the *Epiphyllum* species native to Mexico: *Epiphyllum chrysocardium*, *Epiphyllum hookeri* (Plants of the World Online), *Epiphyllum laui* (Brickell 482), *Epiphyllum pumilum*, or

*Epiphyllum oxypetalum* (Plants of the World Online). Not mentioned in the Florentine Codex is the fact that this cactus was and is grown for ornamental purposes, coveted for its blossoms (Martín del Campo 32). The most famous of the *Epiphyllum* is by far the *Epiphyllum oxypetalum*, commonly “queen of the night,” native to Mexico and South America and introduced to southeast Asia for its ornamental value.

The various nopal mentioned are distinguished most easily by the colors of their *tuna*, or prickly pear fruits; *iztac nochnopalli* (Fig. 7), *camaxtle*, and *xoconochnopalli* are cacti with white tunas; *coznochnopalli* (Fig. 8) and *tlatocnochnopalli* (Fig. 9) have yellow and dark yellow tunas respectively; *tzoalnochnopalli* and *tlanexnopalli* have red tunas, etc. However, this isn't a reliable way of distinguishing distinct species of cacti. For example, *tlatocnochnopalli*, which in the text is said to have dark yellow tunas, appears in the illustration below, Figure 9, as having pink or red tunas. This could be a result of the dye used to paint the tunas degrading over time, a mistranslation, two or more species of cacti falling under the label of *tlatocnochnopalli*, or simply the one species of cacti producing differently colored fruits or fruits that change their color over time. None of these cacti, with the exception of *xoconochnopalli*, have suggested species names, for reasons already mentioned. There are so many species of *Opuntia* that identifying a potential species for any of these cacti based only on the descriptions in the Florentine Codex of their fruit color, taste, and sometimes cladode color or characteristics, is a near impossible task.



Fig. 7, 8, 9. Iztac nochnopalli, Coxnochnopalli, Tlatonochnopalli, Florentine Codex Book 11, Folio 126r

Xoconochnopalli was suggested by Rafael Martín del Campo, the scholar who has suggested all the genus and species classifications for these cacti mentioned thus far, to be of the species *Opuntia imbricata*. It has since been reclassified as *Cylindropuntia imbricata*, commonly the cane cholla, as the *Cylindropuntia* (chollas) and *Opuntia* (prickly pears) are now distinguished as separate genera. It's possible that some of these cacti described are separate, belonging to more than one species, but are grouped together based on their defining characteristics. Other than their fruit color and taste, they are often distinguished from each other by the size and shape of their cladodes or spines. It is also worth noting that at the time of writing the Florentine Codex, the Spanish had not yet brought these plants to other parts of the world to cultivate them elsewhere. At this point in time, *Opuntia* was likely only distributed throughout the Americas; there were certainly fewer species than are recognized today.

It is also likely that distinctions were not only based on defining characteristics, but utility. Were the cacti distinguished solely by their most apparent characteristics, their descriptions should include the cactus flowers. However, the flowers of the cacti are rarely, if ever, mentioned. The *nopalxochitl*, literally “flower of the nopal,” is mentioned later in Book 11 only to say that it is, “chili-red, the color of the roseate spoonbill, the color of the ground

blossoms. It is prickly, useless—an ordinary flower, with no aroma” (fol. 194v). The nopalli have many different colors of flower, as noted in Folio 170v: “Some are yellow, some rose, some white.” But the only flower described in any detail is the nopalxochitl, which has been identified as *Nopalxochia phyllanthoides* (Hernández 932) and later reclassified as *Disocactus phyllanthoides* (Hernández et al.). *O. ficus-indica*’s flowers go through a color progression as they mature, from white to yellow before arriving at its final color (Aruwa et al. 329), but this progression isn’t described anywhere in the Codex. It is also possible that nopalli existed at the time which have not been mentioned in the Florentine Codex because they were not useful as food, medicine, or ornament.

### 3. Preparation and Consumption

The prickly pear cactus is cultivated primarily for its edible parts: the cladode of the nopal, categorized as a vegetable, and the tuna, or prickly pear fruit. The cladodes are often referred to as the nopal itself, or nopales when used in the plural. When chopped into smaller pieces in food preparation, they are called *nopalitos* (Wilson et al. 1).

Before the prickly pear can be consumed, the glochids, or thorns, must be removed. All *Opuntia*, regardless of whether or not they are spineless (as most commercially grown varieties are), have glochids that can cause problems if they come into contact with the skin or are ingested. When the glochids come into contact with skin, they can cause *sabra dermatitis*, an irritant contact dermatitis that resembles scabies (Esmaeili 768), or, more rarely, painful cactus granulomas (Madkan), as a result of an allergic reaction. The glochids detach easily from the cactus, and farmers that harvest the prickly pear without both gloves and eye protection can experience these skin problems, or develop conjunctivitis or keratitis if the glochids are blown into the eyes by the wind (Odat 64). To safely prepare the tunas for human consumption, their

glochids can be singed off with fire or removed by abrasion (Wilson 5). However, if the nopal cladodes are being fed as fodder to livestock such as cattle, mules, or donkeys, the glochids do not harm them (Yetman 136).

While the exact time period and methods by which these fruits were introduced to the rest of the world is contested, it is known that the Spaniards learned of the fruit's antiscorbutic (high in Vitamin C, preventing scurvy) properties and would gift it to galleons that arrived in California, Baja, and the Sonoran desert to relieve their sailors who were suffering of scurvy. Despite this, they never became an important item of commerce nor were they part of the stores on any major ship (Ives 109).

The tunas were often mixed with maize to create sweet-tasting tortillas or tamales. It may seem unusual now, when most tortillas are either made with wheat flour or yellow corn, but early iterations of tortillas were often “made with honey, or with tuna cactus fruit” (Florentine Codex bk. 8, fol. 23v), “made with amaranth seeds [. . .] made with ground summer squash and green maize” (Florentine Codex bk. 10, fol. 51r). Tamales were also made with prickly pear fruit, sold alongside tamales made with meats such as fish, frog, axolotl, tadpole, mushroom, rabbit, and gopher (Florentine Codex bk. 10, fol. 50r). These foods, as well as the tunas by themselves, were sold in the marketplace (*tianquis*) directed by the ruler of the city and managed by appointed marketplace directors. Marketplace directors managed how and where goods were sold, dictating prices of goods so “that no one might deceive another” (Florentine Codex bk. 8, fol. 48v–49r), and it was a role of great importance and responsibility.

The illustration shown in Fig. 10 is of a female vendor, selling her goods at the marketplace. In the original Nahuatl text, there is no indication as to the gender of the tortilla seller. The corresponding Spanish text opens with reference to a woman (“La que es oficial”),

but subsequent references to the vendor in the text are male. Anderson and Dibble's English translation indicates the vendor as male. These conflicting accounts are another indication of how biases influence accounts of history and the importance of context, such as the knowledge that the preparation and cooking of food was primarily a feminine role in Aztec society.



Fig. 10. In tlaxcalnamacac, the tortilla (and tamale) seller, Florentine Codex Book 10, Folio 50

“Tlaxcalnamacac, tlaquanamacac, tlaxcale, anoço tlanecuilo: quinamaca nacatamalli, totolquimilli, icel tamalli, tlatemaltamalli, tlaconpaoxtli...”

“La que es oficial de hacer tortillas o las merca junto para vendellas, suele vender tortillas y tamales de cualquier manera...”

“The tortilla seller, the food seller [is] an owner of tortillas or a retailer. He sells meat tamales, turkey pasties, plain tamales, barbecued tamales, those cooked in an olla—they burn within;”

(Florentine Codex bk. 10, fol. 50r)

While the preparation and cooking of food was a feminine role, the planting and cultivation of crops was a masculine one. From as young as five years old, boys were expected to help in the fields, as seen below in illustrations from the Codex Mendoza. The illustrations below depict the growth and development of male (left) and female (right) children, the duties expected of them, and the tortilla rations they receive. In Fig. 11, the boys transport harvested crops and the girl learns to sew, a craft that takes many of her early years to learn and perfect. In Fig. 12 the boys, now thirteen years old, continue to transport crops, while the girl learns how to make tortillas, such as the ones made with tunas. She may later go on to sell these tortillas or her woven goods at the marketplace as an adult woman.



Fig. 11. Codex Mendoza, Folio 58r (Oxford)



Fig. 12. Codex Mendoza, Folio 60r (Oxford)

#### 4. Nopal as Medicine

Nopal is a very low-maintenance plant. It grows easily, rapidly, and prolifically. A cladode placed in the ground can easily take root and grow a tall, strong plant. With its widespread proliferation and use as an ingredient in several dishes, it is no surprise that its nutritional properties were well-known to the indigenous people. When the Nahua people described a group of Mexica ancestors, the Teochichimeca, they told of a nomadic tribe inhabiting the grasslands, plains, and forests.

“The following is the food of the Chichimeca: nopal, tuna, roots of the *cimatl* herb, *tziuactli* cactus, honey, maguey, yucca flowers, yucca sap, maguey sap, bee honey, wild bees, wild honey; and the roots of which they had knowledge, which were in the ground; and all the meats—rabbit, snake, deer, wild animals; and all [things] which flew.

Such was the food of these Chichimeca, that they never sickened much. They became very old; they died only at an advanced age; they went on to be white-haired, white headed.”

(Florentine Codex bk. 10, fol. 123r)

The Teochichimeca ate a balanced diet of many nutritious foods that sustained a person into old age, and the Nahua people were well aware of the nutritious and medicinal properties of many of these foods. Among these is the *tziuactli* cactus mentioned above, a small maguey with a spiny flower stalk, producing a soft, edible fruit and roots possessing medicinal value (Online Nahuatl Dictionary). The nopal cactus, too, has medicinal value and has been used by both modern and ancient indigenous people as a treatment for various ailments.

“If someone breaks a leg, it is cured in this way. *Acocotli* root is added to nopal root, [and] they are ground. They are placed there where the leg is broken [. . .] then [the leg] is wrapped with a cloth bandage. And on four sides splints are pressed, tightly bound, tied with cords.”

(Florentine Codex bk. 10, fol. 111v-112r)

Here, the root of the nopal is ground to create a powder that is applied to the site where foot bones are broken. It is likely being used as either an analgesic to reduce pain, an antimicrobial to reduce the risk of infection, or as an anti-inflammatory to reduce inflammation or swelling. Several species of *Opuntia* have been proven to exhibit these properties. Aqueous extracts, or mucilage, of the cactus have been found, when tested on rats, to have anti-inflammatory and analgesic properties (Loro et al. 218) and the effectiveness of its pain relief has been compared to aspirin (Park et al. 32). A study found that topical application of the nopal extract improved wound skin tensile strength and visually improved wound healing (Park and Chun 166). Nopal extracts have also been found to have antibacterial and antifungal properties, inhibiting the growth of microbes such as *E. coli*, *Bacillus subtilis*, *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Candida albican*, *C.glabrata*, and others (Gomez-Flores et al. 6) (Suryawanshi 86). However, research about the nopal’s possible applications in healthcare as a plant-based antimicrobial is sparse, even as researchers across the globe search for plant-based solutions to the threat of increasingly drug-resistant microbes (Chandra et al. 2). What is known about the nopal’s medicinal properties pertains mainly to its fruits, which are known to contain an abundance of vitamins and minerals and to be rich with antioxidants, and have been found to have an array of beneficial health effects. The fruit’s hypoglycemic activity (Paiz et al.) is well documented, and is often used to help treat type 2 diabetes in adults. Some studies have even

found extracts of the tunas capable of inhibiting the growth of cancer cells, such as the effect of betanin on chronic myeloid leukemia (Sreekanth et al. 745) and aqueous extract on ovarian cancer cells (Zou et al.). The mucilage in its cladodes, too, has been found to be incredibly beneficial, having an antiulcerogenic effect (Galati 4907) in addition to its aforementioned anti-inflammatory effect.

Interestingly, the indigenous Muslim Maranao group native to the island of Mindanao in the Philippines have been recorded using the *Opuntia cochenillifera* to treat inflammation, specifically of a sprain. Their practice is similar: pound the leaves, spread them across the affected area, and wrap it with a cloth, or “*hampol*,” a Tagalog word which refers to wound dressing or poultice (Olowa and Demayo 207). Despite the Nahua who authored the Florentine Codex and the Maranao who contributed their knowledge to Olowa and Demayo’s study being separated by several thousand miles and several thousand years, their shared knowledge of the nopal’s medicinal properties converges on the same treatment for similar injuries.

“The leaves of this nopal are peeled, ground up. They give this [in water] as a drink to the woman who cannot give birth, as is already mentioned [regarding] *ciuapatli*. When the baby has extended crosswise, they give this to her as a drink so that she may quickly eject the baby. When this happens to the young woman, that her child extends crosswise, that she gives birth with difficulty, perhaps she endures two days, three days of trying to give birth. Such is a young woman who does not abstain, who still sleeps with the man.”

(Florentine Codex bk. 11, fol. 170v)

The *ciuapatli*, sometimes *cihuapatli* or *zoapatle*, can refer to several plants but here refers to *Montanoa tomentosa*, a plant whose leaf extracts have been used in traditional Mexican medicine for varying reproduction-related purposes such as inducing and regulating labor

contractions, regulating menstruation, preventing pregnancy, and treating postpartum bleeding (Carro-Juárez et al. 129) (Venturella et al.). However, while the effectiveness of *ciuapatli* in reproductive issues has been thoroughly studied, the *nopal* has not. While claims of *nopal*'s health benefits in regards to treating conditions such as diabetes, rheumatism, and obesity abound, there are next to no modern medical studies that suggest *nopal* has anything to do with pregnancy, reproduction, or contains any compound or hormone that could affect sex. However, the Nahua were not the only tribe to use *Opuntia sp.* as a gynecological aid. Native American tribes such as the Lakota of the Great Plains and the Lummi of Washington state and British Columbia, as well as native Hawaiians, have also used *nopal* as a gynecological aid, consuming a watery infusion of the roots to facilitate birth (Moerman 368). But the question remains: Why?

The key to this question might lie in *nopal*'s quality in treating gastrointestinal problems. Along with being used in Native American medicine as a gynecological aid, it's also used as a diuretic, purgative, or laxative (Moerman). In the Florentine Codex, the very next section refers to *chia* (*Salvia hispanica*) as a preferred birth aid to *nopal* or *ciuapatli*, describing how, "it is ground raw. A little is mixed with opossum tail [and water], just a little[...] she drinks it; she will promptly give birth" (Florentine Codex bk. 11, fol. 171r). *Chia* (De Falco et al. 757) and *nopalitos* (López-Palacios et al. 1022) are both high in dietary fiber, which is linked to many health benefits, including relieving gastrointestinal distress. In fact, the *nopal* is still being studied and used today as treatment for bowel-related problems, such as relieving the symptoms of conditions like gastritis (Vazquez-Ramirez 4322) and irritable bowel system, or IBS (Remes-Troche et al. 8).

Like the *nopal* and the *ciuapatli*, the opossum tail, too, was used as an expellant, an ejectant:

“But its tail is a medicine which expels, which extracts, wherever something has gotten in, especially in an opening in a bone, which cannot come out. [Salve of] opossum tail is spread on thickly; it is spread on many times. Even if it is very well lodged, this draws it out; it gradually removes it. And [women] who have difficulty in childbirth, who cannot deliver the child, drink [the infusion]. Thus the little child is born quickly. And whoever can no longer defecate, who has a stoppage of the bowels, drinks it to open the passages, the tubes, to clean them, to purify them, to sweep out obstructions.”

(Florentine Codex bk. 11, fol. 13r)

Presumably the logic follows, then, that if a person’s bowels were to be evacuated by ingesting opossum tail, the woman, too, would have her womb evacuated by the same remedy (Sullivan 85). This may or may not be because of opossum tail’s fiber content—no dietary analysis of the composition of opossum tail could be found.

It is also possible that the chia and nopal were used to help hydrate the mother struggling to give birth, as they both have high water content and absorb water readily. The mucilage is also used as a lubricant by several Native American tribes, such as the Kumeyaay tribe of California using the mucilage of *Opuntia engelmannii* to lubricate wagon wheels (Moerman 366). It is possible that the slippery quality of the nopalli mucilage and its utility as a lubricant could have had an influence on the decision to ingest the ground nopal mixed with water to help along the birth. Regardless of the logic behind the decision to give expectant mothers a mix of ground nopal root or cladodes and water to help along their birth, it has been made across several indigenous groups living great distances and times apart.

Ethnobotany, the study of a people’s customs, traditions, and knowledge surrounding a plant, has led to countless discoveries of bioactive compounds that have led to the development

of life-saving new medications and products. The Florentine Codex is one of the most useful sources ethnobotanists who study the Aztecs have, along with Martín de la Cruz's "Libellus Medicinalibus Indorum Herbis" and Francisco Hernández's "The History of the Plants of New Spain" (Béjar et al.). The knowledge contained in these texts has led to modern pharmaceutical research being done and medicines being developed from plants such as cihuapatli and nopal. But much remains to be learned—or rather, relearned—about the truth of these plant's chemical compositions and their medicinal capabilities.

#### 5. Cochineal: A Prized Parasite

The *Dactylopius coccus*, commonly called the cochineal insect or *nocheztli*, are scale insects characterized by the white, waxy cotton-like secretion that covers their brightly pigmented red bodies that are used to create carmine dye and their diet of exclusively cactus. The Nahuatl name *nocheztli* is formed from the *nochtli* (cactus) and *eztli* (blood) "because it is formed on the nopal and is like blood, like a blood blister" (Florentine Codex, bk. 11, fol. 216r-v). Other species of *Dactylopius* such as *D. ceylonicus*, *D. confusus*, *D. opuntiae*, and *D. tomentosus* have been identified in Mexico and used to produce carmine dye in the past; however, *D. coccus* is the only one cultivated for commercial purposes due to the greater amount of higher quality dye they produce. They are sessile, which means that they are immobile for much of their lives; in their nymph phase they produce wax filaments that will later go on to be caught by the wind and carry their larvae when they eventually become immobile in their adulthood (Chávez-Moreno et al. 3338). They prefer *Opuntia cochenillifera* as their food of choice. Although they will feed on other *Opuntia* species, their growth and fertility are negatively impacted by doing so (Baranyovits 87).

The stability of the carmine dye the cochineal produces is of excellent quality. Texts and textiles that utilize the red dye have maintained their color into the present day, as is clearly seen in the Florentine Codex. Some books don't frequently feature colored illustrations due to the rushed nature in which they were authored, but many of the early books and other codices of the time featured richly-colored illustrations. Of the dyes used to color them, the cochineal has greatly outlasted the others in the richness of its pigment.

Cochineal was not the only red dye used by the Nahua. The *achiote*, or achiote (*Bixa orellana*), produces annatto, a spice that has an orange-red color. The Nahua used the ground-up flowers to create a light red or vermillion dye. They also used the rich orange-red wood of the *uitzquauitl* (*Paubrasilia echinata*) to create a vivid chili-red dye (Florentine Codex, bk. 11 fol. 218r). Unlike the cochineal red dye, the color produced by the *uitzquauitl* was not used for painting, only as a medium for dyeing.

The husbandry of cochineal was a process that was kept largely secret from anyone who was not the indigenous people who harvested them or the Spanish who exploited their labor. Cochineal husbandry is still practiced in many regions and countries, and within Mexico it is primarily concentrated in Oaxaca. The nopal the cochineal feeds on are deliberately infected with the parasite by collecting mature, fertile female cochineal in small, soft baskets and hanging them on the cactus, at which point the young, once hatched, will crawl onto the cactus and grow there. While their larvae can be carried by the wind, as often happens with wild varieties of cochineal, it is less effective a method of transporting the insects as human intervention. After they are deemed ready to collect, usually after about 90 days, they are extracted from the pad, sometimes picked off with wooden tweezers, other times knocked or brushed off. They are then killed by boiling and sun-drying, or baking, which dries them out so they can then be crushed

into powder. It takes approximately 70,000 insects to produce 1kg of dye (Harvard Museums of Science & Culture). The whole cycle is repeated every three to four months (Kellman 384). The process of harvesting cochineal and preparing its pigment for use as paint is illustrated in Fig. 13.



Figure 13. Nocheztli, Florentine Codex Book 11, Folio 216v

When the Spanish realized the cochineal was being used to make the rich red dye they greatly admired in the Aztecs clothing, they jumped at the chance to exploit this resource. In 1523, only a few short years after the arrival of the Spanish, Ferdinand Cortez was ordered to collect and send as much cochineal to the Spanish crown as he could, and from there the market exploded. The Spanish ordered for the cultivation of cochineal to be vastly expanded and kept the origin of the dye a secret from their European customers, many of whom believed it to be plant-based (Baranyovits 88). It was sent to colonies across the world such as India, Algiers, South Africa, Colombia, Jamaica, and the Canary Islands, which would soon become the biggest exporter of cochineal in the world. During this time, much of the concentration within Mexico was centered in Oaxaca, being produced by over 100 towns within Oaxaca. In 1774 alone, 716 metric tons (over 1.5 million lbs) of cochineal were exported, right after gold and silver in terms

of valuable products being exported in massive amounts (Dutton 131). From the mid-to-late 1800s, the Canary Islands overtook production in Guatemala and continued to export even as the invention of synthetic aniline dyes began to replace the market for cochineal as a textile dye (Nobel 222). Most of this was sent to England, where the increasing industrialization of textile production demanded larger quantities of products like bleach, detergent, and dyes to produce clothing in massive amounts (Baranyovits 85). Since the discovery of synthetic aniline dyes, which are cheaper and easier to produce than the carmine made from cochineal, the industry has greatly downsized, but not completely died out. Cochineal is still cultivated in several places such as Oaxaca, Chile, Spain, and Peru (Nobel 228).

Today, cochineal's use is mostly exclusive to food and drink, cosmetics, and pharmaceuticals. The use of synthetic red dyes has a contentious history. Many of them have been banned in America for various reasons, such as: causing liver cancer in animals (Red 1), possibly acting as a carcinogen (Red 2), damaging the adrenal cortex in dogs (Red 4), and damaging internal organs and acting as a weak carcinogen (Red 32) (Kobylewski and Jacobson). At the time of this paper's publication, Red 3 is banned in food products in California, but currently is not banned by the FDA or any other states in food despite its known carcinogenic properties and its banned usage in cosmetics (Center for Science in the Public Interest). Currently, three dyes—Red 40, Yellow 5, and Yellow 6—account for 90% of all dyes used. Red 40 has been found to accelerate the development of cancerous tumors in mice, cause hypersensitivity reactions in humans, and to be contaminated with carcinogens (Kobylewski and Jacobson 220). As more is learned about the negative health effects of some of these synthetic dyes, many search for natural alternatives. However, the market for cochineal has now

downsized so greatly that it's no longer being produced on a large industrial scale; the supply and demand simply do not exist as they once had.

## 6. Conclusion

The indigenous Nahua people of central Mexico spent many centuries living off the land, living in harmony with the flora and fauna of the region. One of many indigenous plants that grows in abundance within Mexico is the nopal, a versatile and hardy cactus, utilized for many purposes. Among these is its utility as a culinary ingredient, prepared and eaten in several different forms and eaten as part of several traditional dishes. It can be cooked in a multitude of ways, whether that be creating savory dishes from its cladodes or sweet treats from its tart fruits, and it is still eaten today in much the same way that it was centuries ago. It's a nutritious, fibrous food with multiple medicinal properties that were used by the Nahua to nourish and heal the body. Both its fruits and cladodes are high in various nutrients and vitamins necessary for the continued good function of the body. The nopal also possesses antiinflammatory and analgesic properties that made it part of treatment for broken bones, among other ailments. Nopalli also host a parasite, cochineal, that is immensely valuable for its vital role in the creation of rich carmine dye. The treasured, long-lasting dye it produces has been used to create beautifully dyed textiles, clothing, and paints that were used to create and illustrate manuscripts such as the Florentine Codex. By analyzing the text and images of the Florentine Codex, it becomes apparent the many varied roles this prolific cactus plays in the lives of the ancient Nahua and their descendents: the indigenous people of Mexico today. The nopal became an iconic symbol illustrating the origin story of the heart of the Aztec Empire; an enduring symbol that instills national pride and, for some, embodies Mexico itself.

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