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HERBAL MEDICINE IN PLINY THE ELDER'S NATURALIS HISTORIA

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INTRODUCTION

Pliny the Elder (AD 23/4 – 79) was a famous Roman general and politician as well as an astute observer of the natural world. Thanks to him and his extant work, *Naturalis historia,*—an encyclopedic collection that spans all fields, from mathematics and astronomy to sculpture and painting—historians have access to the breadth of ancient knowledge circulating during the first century AD in the Roman Empire. Notably, his work is preserved as a complete collection of medicinal plant-lore from ancient times. Drawing on over a hundred previous authors, Pliny the Elder compiled all botanical and medicinal information available to him in books 20-23 of *Naturalis historia*. The translator, W. H. S. Jones, warns against applying Pliny's remedies today (Jones 1951: xvii):

> "Writing for laymen, he is concerned almost entirely with what may be called home medicines…Sometimes modern medicine approves of the prescriptions given in the *Natural History* but for the most part they are of little or no value, and occasionally even dangerous."

Even though Jones devalues Pliny's ancient remedies, some herbal medicines have since gained approval from modern medicine, showing that ancient peoples correctly discerned natural drugs and how to administer them. This paper will argue how a representative sample of Pliny the Elder's herbal therapies hold up against modern research on the function of biologically active compounds in nature. Surprisingly, most of Pliny's remedies are justified by current micro-biological research; misinterpretations or oversights reflect social limitations of the time.

Before examining Pliny's particular botanical-medicinal ideas, I will discuss the following background questions: What led early botanists and physicians to assign therapeutic applications to plants? What was the state of medicinal botany when Pliny was writing *Naturalis historia*? First, I will consider the early symbols and figures associated with healing.

Before peoples were able to tangibly explain illness, the foundation of medicine was built on religion. Next, I will consider how religious ideology related to healing developed. Disease was originally recognized as divine, but later became understood as physical, knowable process rooted in cause and effect relationships. This ideological transition set the stage for the emergence of herbal medicine.

Unsurprisingly, peoples across time have used plants for food, shelter, clothing, and other material needs. This intimate relationship with the natural world led humans to use plants to battle illness and disease, likely through a long process of trial and error in prehistory. The foundation of much medicine in the Greco-Roman tradition is thus rooted in botany, and there is a wealth of recorded ancient herbal therapies. In its early stages, medicine and healing was inextricably connected to mythology and magic. For, lacking scientific knowledge, how else could early peoples explain the mysterious power of plants? Thus, the field of medicine was not yet distinct from religious practice.

The Greeks honored Asklepios as the god of healing, regarding him as a parallel to health-giving deities of Egyptian religion (Underwood et al. 2020). His symbol, a serpent wrapped around a wooden staff, demonstrated the ancient mythical association of serpents with healing. These creatures were regarded as immortal beings, immune to disease because of their apparent rebirth through the shedding of their skin. Decorated with serpent iconography, the Asclepieia (temples to Asklepios) served as the primary establishments for healing: “These temples provided carefully controlled spaces conducive to healing” (Risse 1999:56). Medical practice was thus organized through its association with religion. The ill were brought to the temples with the hope that the gods would cure them of disease (Spina 2010). Although it is still unclear how healing occurred, this practice closely resembles modern hospitals in functionality because the sick are effectively separated from the healthy, thus protecting public health by providing an organized, private health care facility (Risse 1999:8). However, they remained unaware of the scientific causality that explained the "magic" of medicine.

By 400 B.C., Hippocrates, deemed the "Father of Modern Medicine," had begun to separate healing from the religious sector. It was during his time that the first physicians arose and focused on healing through direct rather than divine intervention. He believed that the four elements of the natural world (fire, water, earth, air) paralleled four humors of the human body (yellow bile, phlegm, black bile, and blood). Using 300-400 healing plants, Hippocrates's remedies primarily involved balancing these "cardinal juices" by ridding the body of excess humors through laxatives, diuretics, bleeding, etc. (Lonie 6:361-362). His school of thought rooted itself in the acceptance of rational medicine and rejection of the idea of divine intervention in human illness (Spina 2010). Using logic and reason, Hippocrates fashioned a medicinal approach that was holistic, focusing on the restoration of balance within the human body rather than on the disease itself. Physicians were required to evaluate patients' entire life circumstances and investigate their medical history. Using this method, they were able to recommend treatments designed to promote natural healing (Lonie 6:361-362).

It was not until Theophrastus (c. 371 – c. 287 B.C.), a student of Aristotle, made significant contributions to the botanical field, completing the shift from a religious belief system to empirical science. Even though Aristotle is famed for his scientific research and made some effort to catalog various medicinal herbs, his lesser known pupil had a lasting influence in this field. In his treatises *Inquiry Into Plants* and *Growth of Plants,* Theophrastus described parts of plants, studied plant reproduction, and documented the effect of climate, different soils, farming on plants (Irwin 2016). In doing so, he provided a template for the better cultivation of plants, nature's medicine. Even though he integrated information from Diocles of Carystos (c. 375 BC – c. 295 B.C.), an Athenian physician, Theophrastus was primarily a botanist and excluded pharmacology from his treatise on plants (Scarborough 1978:354). Following Theophrastus's works, the forerunner of all modern pharmacopeias was produced during Pliny the Elder's lifetime. Dioscorides (c. 40 AD – c. 90 AD), a Greek physician and pharmacologist, wrote *De Materia Medica*, for which he is credited as the founder of herbal medicine. During his time as a military surgeon under the Emperor Nero, Dioscorides observed and studied the medicinal properties of plants. As a product of this study, *De Materia Medica* is a pharmaceutical guide detailing over 600 plants and approximately 1000 simple drugs (Encyclopaedia Brittanica 2013: "Pedanius Dioscorides").

Now that the background of medicine has been discussed, I will focus on Pliny himself and his work. Working contemporaneously but separately from Dioscorides, Pliny the Elder documented over 1,000 medicinal plants in *Naturalis historia*, producing an unbiased, comprehensive collection of information from earlier authors. The scholar Stannard, in examining Pliny's methodology, claims that "Pliny was not always advocating or even accepting some of the grosser superstitions and magical practices about which he wrote" (Stannard 1984: 4). By comparing Pliny to a modern anthropologist, Stannard frames Pliny primarily as a reporter, recounting information that "do[es] not necessarily represent Pliny's personal opinion (Stannard 1984: 4). Thus, Pliny treated his sources carefully, passing on information even if it conflicted with his personal beliefs and is thus valuable as a compiler of earlier plant-lore. In his letter to Baebius Macer, Pliny the Younger (61 AD – c. 113 AD), a lawyer, author, and official of ancient Rome, describes his uncle's work ethic and compassion for knowledge with amazement (Pliny the Younger *Letters* 3.5):

> *Magis miraberis si scieris illum aliquamdiu causas actitasse, decessisse anno sexto et quinquagensimo, medium tempus distentum impeditumque qua officiis maximis qua amicitia principum egisse. Sed erat acre ingenium, incredibile studium, summa vigilantia.*
>
> "You will be more amazed if only you know that that man was engaged for quite some time in cases, and that he died in [his] 56^{th} year , and that he spent the intervening period of his life hindered partly by high public offices and partly by friendship with the foremost. However, he had sharp wit, incredible zeal, and utmost vigilance."

By day, Pliny the Elder attended to his various official duties as a procurator, which included financial and judicial authority over Roman provinces, but scholarship consumed all of his idle time. Pliny the Elder thus spent his leisurely hours either reading, writing, or listening to works being read aloud. Through his commitment to scholarship, Pliny was able to write seven impressive works, yet only the final, 37-book composition, *Naturalis historia* survives.

As the largest collection of Latin prose from Antiquity, the *Naturalis historia* has been categorized as an encyclopedia of the natural world. Pliny the Younger thus describes it as *opus diffusum eruditum, nec minus varium quam ipsa natura* ("an extended and educated work, and not less diverse that of Nature herself" *Letters* 3.5). Pliny the Elder was writing with the momentous goal of documenting all available knowledge on the natural world, applicable to a number of fields spanning from art to science. Pliny describes his novel subject in his preface, dedicated to his friend, the Emperor Titus (39 AD – 81 AD) (Plin. *HN* Praefatio.13):

> *sterilis materia, rerum natura, hoc est vita, narratur, et haec sordidissima sui parte, ac plurimarum rerum aut rusticis vocabulis aut externis, immo barbaris, etiam cum honoris praefatione ponendis. praeterea iter est non trita auctoribus via nec qua peregrinari animus expetat: nemo apud nos qui idem temptaverit invenitur, nemo apud Graecos qui unus omnia ea tractaverit.*

> *"A sterile subject, the nature of things (i.e. life) is being narrated; and this [subject is] in its most sordid aspect, and in relation to most of its parts [I will use] either rural vocabulary or foreign, nay barbarian [vocabulary], which even needs to be appended with a preface of honor. Moreover, the journey is not a path that has been worn down by authors and nor is it a path on which the mind looks forward to traveling on: no one is found among us who has tried the same thing, no one among the Greeks who has tackled alone all of it".*

Pliny argues that his volumes are necessary contributions because no Roman or Greek has yet singlehandedly attempted to study every expanse of the subject of nature. Pliny has thus written the *Naturalis historia* because of an existing need for the collection of all known information, factual and fantastical, on the natural world. He produces "works of reference, not books" that can be reasonably grouped into the encyclopedic genre (Healy 2004: 36).

In order to cover the world of nature, Pliny divides the volumes into separate books generally defined by organic (plant, animal) and inorganic subject matter (metal, mineral). Book I serves as the table of contents and details the topics covered in each book, tallies facts and observations included in the volume, and lists authorities on the subject he cites. The work is not organized alphabetically; instead, Pliny flows from topic to topic, describing nature in the first half of *Naturalis historia,* then recounting uses for nature in the second, beginning in Book 20. My analysis focuses on Pliny's treatment of plants in the latter half because it is about the medicinal uses of plants rather than their description.

Despite the breadth of herbal prescriptions provided in *Naturalis historia.* Pliny is often overlooked as a source on this topic in favor of other major figures discussed because, although Pliny reports similar information, unlike key players in the development of the field of herbal medicine (i.e. Hippocrates, Theophrastus, Dioscorides) he is not a scientist. Instead, Pliny is a historian and unbiased compiler of information. For Book 20 alone, Pliny lists over fifty Greek and Roman writers as authorities on the subject of medicines attained from plants, including medical pioneers Theophrastus and Hippocrates. But interestingly, Dioscorides is not included, even though his *De Materia Medica* is a primary text in pharmacology published about the same time as Pliny's *Naturalis historia*. This is surprising because Pliny acknowledges a range of authorities, including claims from better known physicians and scientists as well as folk beliefs and oral reports (Stannard 1982: 4). Even though Pliny the Elder does not cite Dioscorides as a source, many passages of *Naturalis historia* and *De Materia Medica* bear a direct resemblance to each other. Therefore, classicists speculate that they had several sources in common such as, Crateuas (c. 100 B.C.), a famous herbalist, who is mentioned by both authors, or Diocles of Carystos, an earlier physician and herbalist. According to notes from the translator, a fragment of Crateuas's work can be compared with a section of Dioscorides (2.176) and of Pliny's book 21. However, while corresponding phrases make it clear that Dioscorides used material collected by Crateuas, it is unclear whether or not Pliny read Crateuas at all. It may be the case that Pliny got most of his information from a Greek author called Sextius Niger or that Pliny and Dioscorides both cited information from Diocles of Carystos (Jones 1951: xix-xx). In any case, there were enough earlier sources available and cited by Pliny to dispel the idea that Pliny plagiarized his contemporary, Dioscorides.

Jerry Stannard, a professor of major international standing in the history of botany and folk medicine, argues in favor of *Naturalis historia* being valued alongside the contributions of Dioscorides, Hippocrates, Aristotle, and Theophrastus to the history of medicine. Traditionally, Pliny has been left out of the narrative because his purpose in writing was different from his predecessors and contemporaries: "Pliny's task was to collect, describe and record" (Stannard

1982: 5). Above all, Pliny was a historian, and unlike his sources, his mission was not to contribute new information through personal research, but to make Greek knowledge accessible by translating it into Latin. Comparable to how the Roman poet, Virgil, modeled his famous epic the *Aeneid* after Homer's popular Greek texts the *Illiad* and the *Odyssey,* Pliny produced *Naturalis historia* for his people, the Romans, in Latin so that knowledge of the natural world would be publicly accessible. By using the Latin language to standardize and condense this information, Pliny contributed to Rome's status as a world power and conquering nation. Pliny is not motivated by personal fame but rather finds contentment via his contribution to the glory of the Roman Empire.

As a result of his altruistic motivations and ambitious undertaking, Pliny left behind an ideal source for a comparative study of all information and misinformation provided: ancient vs. modern pharmaceutical botany. This study evaluates ancient, plant-based medical practices, as recorded by Pliny the Elder, against modern research on biologically active therapeutic compounds, arguing that many of the treatments he writes about were effective for the following plants: *Allium cepa, Vitex agnus-castus,* and *Helleborus niger.* These plants represent three case studies. Onions, as the first case discussed here, represent the category of common garden plants used primarily for food and lacking significant association with mythology. These plants have straightforward and practical therapeutic applications, and their benefits are easily backed by current scientific information. The second case, *Vitex agnus-castus* or chaste tree, represents a more mysterious class of plants. Its symbolic use in rituals like the Thesmophoria led Pliny to overlook its current principle medicinal applications. Lastly, *Helleborus niger* shows how Pliny treats plants known strictly in a therapeutic context. Interestingly, it was used historically as a poison, so Pliny's treatments, involving specific rituals for gathering and administering the plant, demonstrate how even toxic herbs might help fight disease.

PART I

This first chapter considers Pliny's *allium,* the ancient Latin term for onion, as *Allium cepa*, the Latin scientific name for the common onion. *Allium cepa* can be used in a number of concoctions and remedies, mainly for wounds, sores, and itches. Today, the common onion is used as an herbal treatment and preventative measure for a range of conditions including the following: cancer, coronary heart disease, obesity, hypercholesterolemia, type II diabetes, hypertension, cataracts, and gastrointestinal disturbances. I will show how, first, Pliny the Elder and his contemporaries, through trial and error and empirical study, documented the antimicrobial, antioxidant, and antifungal effects of *A. cepa;* and, second, that today these effects are understood as due to biologically active compounds working at a molecular level to combat illness.

It is possible that the "*allium"* Pliny references encompasses other onion varieties. Indeed, he details the therapeutic applications of other edible *Allium spp.* such as, garlic, chive, and leek in subsequent sections of Book 20, all of which are similar to that of the onion. However, this case study focuses on *A. cepa* because it is the most widely cultivated species of *Allium*.

Allium plants have been used extensively over the centuries for their pungent odor and flavor. Regularly found in a gastronomic context (e.g. chopped, pounded, boiled, fried, etc.), the common onion appears as a popular seasoning for various dishes across cultures. However, Pliny places little emphasis on its culinary versatility in *Naturalis historia.* Instead, he adheres to his organizational method of general descriptions in Books 1-19 followed by functional explanations beginning in Book 20. Since Book 19 is dedicated primarily to agriculture and horticulture, Pliny first mentions *allium* briefly there in Book 19.31 when describing varieties of root, leaf, and flower. In Book 19.32, the types of onion are distinguished by name, appearance, taste, as well as different methods of cultivation and storage. Here, Pliny is not yet interested in describing the uses of onions. Instead, he ensures his audience is familiar with the knowledge and skills necessary to raise and harvest onions. Then, in Book 20.20, Pliny explains how to use them medicinally, describing several effective remedies involving cultivated onions. These treatment recipes are paraphrased from the writings of early naturalists, as described above, who likely performed a series of experiments or inherited folk wisdom based on such trial and error, in which wounds treated with the onions healed without complication while untreated wounds became infected. Aside from these two sections, cultivation and use, onions are only mentioned in passing as a reference for other therapeutic plants.

The remedies that Pliny described show that ancient naturalists understood the effects of therapeutic plants, however, during his lifetime, Pliny did not have a conception of the specific therapeutic compounds they contain. Biologically active (bioactive) compounds are defined as naturally occurring essential or nonessential compounds shown to have an effect on human health (Zlabur et al. 2018: 1). In plant material (e.g. fruits, vegetables, herbs), these low-molecular weight compounds are typically classified as secondary metabolites, phytochemicals that do not play a role in primary plant metabolism (Wyk and Wink 2004:408). Because they are the active compounds in medicinal plants, secondary metabolites serve as pharmaceutical models, templates for drug manufacturing. Thanks to molecular analysis of modern herbal medicine, it is clear that preparatory methodologies have differential effects on the efficacy and/or toxicity of the secondary metabolites in the herb of interest. The secondary metabolites of interest in *Allium* include steroid saponins, flavonoids, and thiosulfinates (Zeng et al. 2017: 1).

Steroid saponins and flavonoids are more polar, stable compounds, tolerant of cooking and storage. Steroid saponins are triterpenes ($C_{30}H_{48}$), secondary metabolites belonging to the terpenoid class, that have several sugar molecules attached to them. Like other members of the terpenoid class, triterpenes are grouped based on their number of isoprene units. A single terpene unit contains two isoprene units. Triterpenes, with six isoprene units, can be converted to cholesterol and various steroids (Yadav et al. 2014: 272). Because of their triterpenoid structure, steroid saponins sometimes mimic endogenous hormones (e.g. glucocorticoids) and exhibit membrane activity, resulting in anti-inflammatory and antimicrobial effects (Wyk and Wink 2003:423-424). Meanwhile, flavonoids, more generally classified as phenolic compounds, are characterized by two aromatic rings with phenolic (C_6H_5OH) group(s) attached (Wyk and Wink 2003:428). The antioxidant activity of a plant species directly correlates with the concentration and types of phenolic compounds contained in the plant material. In human cells, antioxidant compounds inhibit oxidation processes by neutralizing free radicals (Zlabur et al. 2018: 2). Free radicals are natural products of chemical processes. However, these unstable molecules can cause cell damage when allowed to accumulate inside the body (Szalay 2016). Note that flavonoids, the largest class of naturally occurring phenolic compounds, exhibit more powerful antioxidant effects because they are polyphenolic (i.e the molecule consists of multiple phenolic units). Steroid saponins also display antioxidant activity; however, they are more relevant medicinally as templates for commercial development of steroid drugs and hormones (Zlabur et al. 2018: 1-2).

The therapeutic activity of thiosulfinates is even more well studied than the antioxidant activity of phenolic compounds (Lanzotti 2006: 4). The biological activity of organosulfur-containing compounds corresponds with their chemical volatility. Organosulfur-containing compounds readily rearrange into a variety of sulfur-containing derivatives (i.e. thiosulfinates, mentioned above) (Lanzotti 2006: 4). For example, mechanical processing of intact *Allium spp.* leads to the production of highly reactive sulfenic acids and/or sulfines via enzymatic activity*:* *"*The main fate of the sulfenic acids appears to be condensation to form thiosulfinates" (Sabiu et al. 2019). Then, the still volatile, biologically active thiosulfinates may undergo subsequent reactions depending on processing conditions, making them more volatile, less volatile (products formed when the thiosulfinates stand in solution at room temperature), or compounds produced by more vigorous processes (Sabiu et al.2019).

These subsequent reactions and the resulting range of reactivity for thiosulfinate products and byproducts explains the diverse effects of onions as they relate to various forms of processing that they undergo (e.g. powder, extract, juice, etc.) (Sabiu et al. 2019). For example, Pliny recommends boiling the onions before eating them to relieve patients of dysentery: *coctas dysintericis vescendas dedere (*"Feeding boiled onions to be eaten [cures people] of dysentery" *N.H. 20.20).* This method of preparation differs from his earlier prescription of chewing raw onions to treat facial ulcers: *ulcera oris sanare commanducatae cum pane ("*cure facial ulcers by chewing with bread" Plin. *HN* 20.20). Although not addressed specifically by scientific literature, it is likely, given the reactivity of thiosulfinate products, these differential forms of processing contribute to the efficacy of the treatment. That is to say, perhaps the molecules resulting from boiling help more with intestinal infection than those associated with minimal processing (i.e. raw, chewed).

In addition to their therapeutic effect, organosulfur containing compounds explain the pungent odor and flavor associated with *Allium spp.* Allyl-propyl disulfide and diallyl disulfide (allicin) are the main bioactive sulfur-containing metabolites associated with pungency (Sabiu 2019). Unknowingly, Pliny notes the bioactivity of sulfur-containing compounds: *Cepae silvestres non sunt*. *sativae olfactu ipso et delacrimatione caligini medentur, magis vero suci inunctione* ("[There] are no wild onions. The sown onions' smell itself [causes] watering of the eyes and certainly heals bad vision" Plin. *HN* 20.39). Pliny references the chemical precursors to the antimicrobial thiosulfinates, key compounds involved with generating *A. cepa's* characteristic smell and lacrimatory response.

Furthermore, the combined bioactivity of the volatile (thiosulfates) and nonvolatile (flavonoids and saponins) compounds explains why Pliny is able to use *Allium cepa* topically for dog bites and scrapes: …*et canis morsus virides ex aceto inlitae aut sicca cum melle et vino, ita ut post diem tertium solvantur. sic et trita sanant* ("…and fresh onions with vinegar or dry [onions] with honey and wine [can be] smeared over dog bites on the condition that it was unbinded after the 3rd day. Thus, in the same way, they cure wounds" Plin. *HN* 20.39). The inhibitory effect of onion oil on the growth of common gram negative and gram positive bacteria behind Pliny's advice was quantified in Assiut University's paper, "Antibacterial, antidermatophytic, and antitoxigenic activities of onion (*Allium cepa* L.) oil" (Zohri et al. 1995: 167). Overall, onion oil was effective against *E. coli, K. pneumoniae, B. anthracis, B. cereus, M.*

luteus, and S. aureus; common pathogenic bacteria that cause food poisoning, skin infection, or infectious diseases like anthrax and pneumonia. *A. cepa* oil inhibited growth of half the strains of gram-negative bacterial cultures tested. Compared to the gram positive inhibition zones, the diameters (mm) reflected low (*E. coli)* to moderate (*K. pneumoniae)* inhibition. However, the onion oil was moderately to highly effective against all strains of gram-positive bacteria.

Similarly, the oil was highly effective against all isolates of dermatophytic and toxigenic fungi. These species of molds include air and soil-borne fungi as well as a few species that occur commonly on the dead skin of animals (Zohri et al. 1995: 169). Dermatophytic fungi are aerobic fungi that infect superficial, keratinized layers of the hair, skin, and nails (Clinical Mycology 2009). These infections were likely recognized as rashes with characteristic patterns of inflammation, lesions, or blisters (Hainer 2003). The effects of mycotoxins are less readily observable and contribute more generally to illness. Typically found in contaminated agricultural products, the mycotoxins produced by toxigenic fungi adversely affect the immune system and are potent carcinogens. In any case, fungal growth and mycotoxin production were gradually decreased by increasing concentrations (100-500 ppm) of *A. cepa* oil. Therefore, Pliny was justified in treating injuries to the skin with onions, especially wounds from animals and "beasts of all kinds", such as scorpions and millipedes.

Coincidentally, Pliny documented arguably the most efficient methods of preparation for these particular ailments. He recommends applying them fresh or dried more often than he recommends using cooked or boiled onions. Modern science has confirmed that Pliny's advice was the most effective method. The application of fresh, minimally processed *allium* maintains therapeutic efficacy by preserving the volatile, sulfur containing compounds discussed earlier along with their antimicrobial activity. The low molecular (2, 4, 6, carbon) thiosulfinates in particular explain the differential inhibitory effect on Gram-positive vs Gram-negative bacteria discussed above. Research shows they more successfully inhibit growth of Gram-positive species like *Staphylococcus aureus* (Kim 1997). Thus, the antibacterial properties of onion oil can be traced to the biologically activity of low molecular thiosulfinates, volatile enzymatic products of organosulfur precursors.

In addition to claiming that the smell of an onion helps with bad vision, Pliny recommends the juice of the onion for common ophthalmic maladies: *suco et cicatrices oculorum et albugines et argema inunxere, ("*Rub in the sap [of the onion] for scars of the eyes and white ulcers [of the eyes] (i.e. albugines, white ulcers that could occur on the head) and small ulcers in the eye (i.e. argema, small white ulcers partly on the cornea and sclera*)"* Plin *HN.* 20.39)**.** According to an animal model study (Nejabat 2014), the juice has a similar effect on the normal microbial flora of eyelids and conjunctiva as the that discussed earlier for the skin. In ophthalmic conditions, the growth of *Pseudomonas, E. coli, Proteus,* yeast, and especially, *S. aureus* was inhibited when positive cultures taken before and after application of the juice were compared. To conclude this study, researchers propose that onion juice could indeed be used as eye drops for ophthalmic disease, just as Pliny described due to the antimicrobial properties of *Allium cepa.* By the same token, Pliny discusses the treatment of toothaches and oral ulcers with onion juice: *in dolore quoque ad dentes conluendos instillavere et plagis bestiarum omnium, privatim scorpionum* ("They used to drip it on teeth needing to be washed and in pain, for wounds of all kinds of beasts, particularly scorpions" Plin. *HN* 20.39). In Yongin University's study, *A. cepa* extracts were shown to have antimicrobial activity against

Streptococcus mutans and S. sobrinus, causal bacteria for dental caries (i.e. cavities), as well as *Porphyromonas gingivalis* and *Prevotella intermedia*, causal bacteria for adult periodontitis (Kim 1997).

Thus, the majority of onion-based remedies that Pliny mentions in Book 20.20 (i.e. curing dog bites, sores, toothaches, bad vision, and dysentery), have proven effective. A*llium spp.,* as dietary staples, may have prompted Pliny's predecessors to study the plants' effects on patients when used intentionally as treatment. The connections they were able to draw from the empirical study of a typical garden plant are impressive given the circumstances. Ancient peoples lacked any notion of the chemical processes at work in *Allium cepa,* or for that matter, of the molecules involved in them. They were limited to what was directly observable, and still managed to contribute effectively to medical literature. Ancient study of *Allium cepa* provided a base from which modern medicine could expand and explore why therapeutic plants affect our health in certain ways. For example, from what is now known about the biologically active components of onions discussed above, scientists have been able to discern additional compounds with novel applications unknown to the ancient world. A particularly valuable flavonoid called quercetin was found to have anti-cancer effects due to the antioxidant effects discussed above as being typical for flavonoids (Szalay 2017). Without Pliny's collection of knowledge in *Naturalis Historia*, modern medicine might not have considered the common onion as a novel therapy for cancer. Therefore, since plants contain key compounds for drug development, it is imperative to consider the foundation of herbal medicine even as we advance modern drug therapy.

PART 2

Similarly to how Pliny the Elder discussed medicinal garden plants in Book 20, he details the uses of several medicinal trees in Book 24. This chapter will discuss the therapeutic use of *Vitex agnus-castus,* a small deciduous tree referred to as *vitex* in ancient Latin. While *Allium* represents a typical example of Pliny's treatment of a medicinal plant, *vitex* is a typical example of his approach to a medicinal tree. As with the common onion, Pliny notes some medicinal qualities of the chaste tree (*V. agnus-castus)* that have since been supported by modern research. However, Pliny largely ignores its key current medicinal use for gynecological problems. This oversight is likely due to the distorting patriarchal mythology associated with *V. agnus-castus,* which Pliny discusses and thus accepts, connecting the plant paradoxically with both chastity and desirable fertility.

Although, *V. agnus-castus* can grow up to 5-6 meters, on average, the trees are small and shrub-like, only reaching about 2 meters in height (Niroumand et al. 2018: 103). Above its palmate leaves, which are about 10 cm long, the *V. agnus-castus* has terminal, branched inflorescences, described by Pliny as being white with some purple or completely purple ("PDR" 2000: 1222). These sweet-smelling inflorescences bear 3-4 mm globular, reddish-black fruits containing four seeds (Wyk and Wink 2004: 373). Since it is indigenous to the Mediterranean region, it is unsurprising that Pliny and his predecessors encountered it. In fact, Pliny describes two types of *V. agnus-castus*, a white and dark variety, distinguishing them by their size and flower color (Plin. *HN* Book 24.38):

> *duo genera eius: maior in arborem salicis modo adsurgit, minor amose, foliis candidioribus, lanuginosis. Prima album florem mittit cum purpureo, quae et candida vocatur, nigra quae tantum purpureum. Nascuntur in palustribus campis.*
>
> [There are] two kinds of it [vitex]: the larger grows up into a tree in the manner of a willow, the smaller [is] branchy, with brighter, downy leaves. The first [kind], which is

> called the white [agnus-castus], grows a unblemished lower with purple, the black [agnus-castus], which only grows purple [flowers]. They grow in marshy plains.

Pliny, however, does not indicate that the therapeutic uses of white and dark *V. agnus-castus* differ in any way, and in fact, his use of plural verbs in the following treatment descriptions suggests that either type could be used.

In this section, I will consider how the biologically active compounds in *V. agnus-castus* explain therapeutic effects observed in scientific literature. Then, I will evaluate the applications Pliny describes in Book 24.38 of *Naturalis historia.* The known medicinal phyto-morphology of *V. agnus-castus* includes the fruits and leaves. The German health authorities (i.e. German Commission E), among others (e.g. European Medicines Agency), have approved use of extracts from these plant parts for treatment of a variety of gynecologic problems: menstrual cycle irregularities, premenstrual syndrome (PMS), mastalgia or mastodynia (i.e. breast pain or tenderness), and menopausal disorders (Niroumand et al. 2018: 103). Many of these gynecologic issues, especially mastodynia, result from abnormally high levels of prolactin in the blood (Wuttke et al. 2003: 348).

Prolactin is a hormone secreted by the anterior pituitary, a major organ of the endocrine system, whose primary function is to promote normal lactation in mammals. Under normal conditions, it is released from the anterior pituitary in pulses in response to sleep, stress, pregnancy, chest wall stimulation, and even food ingestion (Majumdar and Mangal 2013: 168). During most life stages (i.e. when the patient is not nursing an infant), its secretion is inhibited by the hypothalamus, which maintains normal serum prolactin levels at 5-25 ng/mL in females (Majumdar and Mangal 2013: 169). The hypothalamus, another major endocrine organ, is attached to the pituitary glands (anterior and posterior) via the hypophyseal pituitary portal system. Neurons in these portal vessels secrete dopamine, a chemical messenger and, in this case, a hypothalamic inhibitor of pituitary prolactin release (Majumdar and Mangal 2013). When this dopaminergic inhibition of prolactin is insufficient, patients exhibit chronically high serum prolactin levels (i.e. hyperprolactinemia) (Wuttke et al. 2003: 349). Because of prolactin's function in the stimulation of the mammary glands, side effects of hyperprolactinemia primarily include mastodynia or mastalgia and abnormal milk discharge (i.e. galactorrhea). Hyperprolactinemia can also cause irregular menstruation, infertility, headaches and premenstrual symptoms such as depression, irritability, and increased emotional reactivity (Wuttke et al. 2003).

V. agnus-castus alleviates these gynecologic complications via dopaminergic compounds found in its extract: diterpenes ($C_{20}H_{32}$) (Wuttke et al 2003: 350). Like the steroid saponins discussed in Chapter 1, these secondary metabolites belong to the terpenoid class (Wyk and Wink 2004: 422). They are categorized into several classes, some of which include clerodanes, gibberellanes and taxanes (Pasdaran and Hamedi 2017: 236). The most prominent diterpenes found in *V. agnus-castus* fruit extract include vitexilactone and rotundifurane but, more importantly for our purposes, *V. agnus-castus* contains aqueous alcoholic diterpenes from the clerodane class (Wyk and Wink 2004: 373). These diterpenes are named clerodadienols and are the most important compounds for prolactin suppression because they have the most prominent dopaminergic activity (Wuttke et al. 2003: 350). Clerodadienols, along with other compounds in *V. agnus-castus* extract like rotundifurane, bind to dopamine protein receptors and inhibit prolactin release in the same way that dopamine released by the hypothalamus normally inhibits prolactin secretion. These diterpenes are able to bind to protein receptors and change their bioactivity to affect prolactin secretion because of the chemical reactivity of their inner oxides and peroxides (Wyk and Wink 2003: 423). Also, unlike other dopaminergic compounds and dopamine itself, clerodadienols are extremely stable, making them potent inhibitors (Wuttke et al. 2003: 352). Thus, clerodadienols and other diterpenes found in *V. agnus-castus* relieve hyperprolactinemia which, in turn, explains how *V. agnus-castus* fruits can treat a variety of menstrual disorders and menopausal problems.

Despite its frequent use today for gynecological issues, It seems Pliny and his predecessors largely overlooked the area for the most prominent medical applications*:* the female reproductive system. Pliny the Elder mentions the menstrual application of *V. agn*us-castus only briefly: *urinam cient et menses (“*It stirs urine and menstruation” Plin. *HN* 24.38). Though unaware of diterpenes, Pliny correctly identified how *V. agnus-castus* fruits regulate the menstrual cycle. However, Pliny also says that *lactis ubertatem faciunt (“*It [vitex] induces the richness and abundance of milk” Plin. *HN* 24.38). Given *V. agnus-castus*’s inhibitory effect on prolactin, Pliny’s claim that it stimulates lactation seems unlikely. Indeed, there are no valid clinical trials that support this effect; however, some non-standard studies do claim that low doses (below 120mg) of *V. agnus-castus* extract actually increase serum prolactin levels (LactMed 2006). Therefore, even though Pliny does not mention how much of the plant was used for a single dose, some modern research suggests that *V. agnus-castus* has opposite effects on prolactin secretion depending on how much of the medicinal extract is administered. Unfortunately, it is difficult to evaluate whether or not Pliny was mistaken about *vitex’s* uses because his mention of the plant’s effect on lactation and menstruation is so brief. By contrast, as we will explore below, Pliny describes at length treatments for more common ailments such as flatulence, diarrhea, gout, sores, headache, bites and boils. Despite Pliny's oversight, today, the chaste tree's effect on menstruation and lactation is its most well-studied application.

In addition to the diterpenes discussed above, *V. agnus-castus* also contains biologically active iridoid glycosides (e.g. agnuside, aucubin) and flavonoids (e.g. casticin, apigenin, orientin, isovitexin). Iridoid glycosides, another type of terpenoid, are a subclass of monoterpenes ($C_{10}H_{16}$) (Daniel 2006: 57). These compounds, along with flavonoids, have effects similar to those discussed for the onion. Aucubin, one of the most common iridoid glycosides in plants, is effective against infections and inflammations (Wyk and Wink 2003: 420). Iridoid glycosides and flavonoids are responsible for many of the other, non-hormonal therapeutic effects of *vitex,* such as antimicrobial, antifungal, insect repellant, antioxidative, anti-inflammatory, and antiepileptic activity. In addition, diterpenes, exhibit non-specific membrane activity (i.e. can bind to multiple types of receptors) and therefore show a range of antimicrobial and cytotoxic (cell-killing) activities (Pasdaran and Hamedi 2017: 236).

In his discussion of *vitex,* Pliny mentions some of the therapeutic effects attributed to iridoid glycosides and flavonoids (Plin. *HN* 24.38): *adversantur venenis serpentium, maxime quae frigus inferunt, minor efficacior ad serpentes, bibitur seminis drachma in vino vel posca aut duabus foliorum tenerrimorum. et inlinuntur utraque adversus araneorum morsus (*"They [*vitex*] work against the poison of serpents, most particularly those which bring in cold, the smaller one [is] more effective to snakes; one drachma of the seed or 2 of the most delicate leaves is drunk in wine or in vinegar and water. And either of the two can be spread [as an ointment] against the bites of spiders "). It follows that *vitex* was able to drive away poisonous creatures, such as snakes and spiders, with salves made from the seed because of the insect repellant activity of the secondary metabolites. Also, as with *A. cepa* in the previous chapter, *V. agnus-castus* was likely effective for healing bites because of its purported antimicrobial and anti-inflammatory activity.

Pliny, as seen below, also recommends treating headaches and migraines, among other things, using the seeds and flowers of *V. agnus-castus (*Plin. *HN* 24.38):

> *semen potum vini quendam saporem habet et dicitur febres solvere et, cum unguantur oleo admixto, sudorem facere, sicut lassitudinem dissolvere…capitis dolorem ex ebrietate sedant cum rosaceo flos tenerique cauliculi. seminis decoctum vehementiorem capitis dolorem dissolvit fotu, et vulvam etiam suffitu vel adpositu purgat, alvum cum puleio et melle potum… semen instillatur in oleo decoctum capiti in lethargia et phrenesi.*
>
> The seed, drunk, has a certain flavor of wine and it is said to break fevers, and [it] causes sweat when smeared on with olive oil mixed in, just as it dissolves weariness (i.e. lassitude)…The blossom and small stalks with rose oil brings to rest head pain from intoxication. A reduction of the seed applied directly as an ointment dissipates the rather violent pain of the head and it purges the uterus too by fumigation or by direct application and it, when drunk with penny royal and honey also purges the bowels…The seed having been boiled down in olive oil is poured in by drops to the head for [those suffering] from lethargy and delirium.

It is possible ingestion relieved internal inflammation of the tissues and thus, the headache. Also, hyperprolactinemia can cause headaches, and as discussed earlier, *V. agnus castus* is extremely useful for correcting this. The extracts from the seeds and flowers are rich in flavonoids, so there is a good chance Pliny's therapies were productive based on what is known about the therapeutic actions of these compounds. Still, there is not enough evidence available in modern scientific literature to warrant definitive support of Pliny's applications for *V. agnus castus.*

Pliny also prescribes its use for some dubious symptoms related to female chastity, which seems to relate to ritual uses reflected in its common name of the *chaste* tree. *Vitex* was associated with fertility rituals since, in ancient thought, chastity was associated with fertility in general. Although linking chastity and fertility seems counterintuitive, Roman principles of female sexuality connected both categories. Insofar as, control of the female libido was believed to be integral to the maintenance of the state. This belief likely resulted from the fact that participating in public cults, such as those proclaiming the importance of *pudicitia* (i.e. sexual virtue), was an important way for women to contribute to society (Langlands 2006: 52). Married women were expected to control their sexuality (i.e. protect their *pudicitia*), and, paradoxically, honor their fecundity since the ability to bear children was important to the prosperity of the Roman state.

More broadly, outside of Pliny, the *V. agnus-castus* was often associated with fertility rituals performed by married women and cults of Hera, the goddess of marriage and birth (Calame 1997:164). The *vitex* may have been used in these fertility rituals because it promotes conception. Today, *V. agnus-castus's* effect on fertility (and subsequently pregnancy) can be observed scientifically via changes in average progesterone levels. The corpus luteum, a temporary endocrine organ of the female reproductive system, forms after ovulation and secretes estrogen and progesterone. Progesterone stimulates changes in the uterus that encourage implantation of a fertilized ovum (Holesh et al. 2019: n.p.). Hence, progesterone enhances female fertility during the post-ovulatory period. In a three month, placebo-controlled study, *V. agnus-castus* was administered to 93 women who had been unable to conceive for six months or more. The study reported increased progesterone levels in the *V. agnus-castus* treatment group. Furthermore, 26% of women in the treatment group were pregnant after three months, while only 10% of the placebo group became pregnant in the months following the study (Niroumand et al. 2018: 109). Hence, *V. agnus-castus* extract stimulates secretion of progesterone, which, by modifying the uterine environment, increases the likelihood that a woman will become pregnant.

Even though modern research supports a direct link between of *vitex* and increased fertility, to Pliny, the *vitex* worked indirectly as an anti-aphrodisiac that restrained sexual desire, and by doing so, promoted fertility (Versnel 1992: 35). Pliny explains this mystical anti-libidinal effect elsewhere in his description of the *vitex* tree's uses, claiming: *ad venerem impetus inhibent, eoque maxime phalangiis adversantur, quorum morsus genitale excitat* ("They restrain the onset of sexual desire, and they work against venomous spiders, whose bite rouses the genitals" Plin. *HN* 24.38). Because *vitex* is labelled "chaste tree", Pliny uses the view that *vitex* promotes chastity to explain how it enhances fertility. For example, Pliny says that women littered their beds with the fragrant leaves of *V. agnus-castus* during this Greek fertility festival honoring Demeter, the mother goddess of harvest and fertility,: *Graeci lygon vocant, alias agnon, quoniam matronae Thesmophoriis Atheniensium castitatem custodientes his foliis cubitus sibi sternunt (*"The Greeks call [it] lygos, otherwise agnos, because the matrons preserving [their] chastity at the Thesmophoria of the Athenians scatter their beds with the leaves of them" Plin. *HN* 24.38). Assuming that the chaste tree decreased their libido, then matrons could participate more fully in the Thesmophoria, an all-female, three day ritual celebration where contact with men was not allowed. Thus, Pliny understands *vitex* via its association with the Thesmophoria, and, in this context, the chaste tree promotes fertility because of its association the diminution of the female libido.

Because Pliny mentions the *vitex's* role in the Thesmophoria and in controlling libido, he is aware of this plant's association with fertility, yet unaware that it may directly affect fertility.

Based strictly in Roman mythic thinking, Pliny's understanding of *vitex* is different from the broader ancient understanding of the plant which maintains that *V. agnus-castus* directly enhances fertility via its role in married women's rituals. This direct association of *vitex* with fertility, which was distorted by the mythic association of *vitex* with chastity, has since been supported by modern study. Thus, the potentially valid association of *V. agnus-castus* with enhanced fertility was clouded by the ideological-mythical association of fertility with chastity, leading to Pliny's invalid conclusion that the "chaste" tree suppresses libido. Overall, Pliny devoted more time to understanding the applications of *vitex* not linked to gynecology.

PART 3

Following his discussion of medicinal trees in Book 24, Pliny the Elder devotes Book 25 of *Historia naturalis* to plants used specifically for medicine. Unlike the onion, a common food source, and the *vitex* shrub-tree, a celebrated symbol of chastity and fertility used in rituals, the plants discussed in this book are harvested exclusively for medical use. Pliny begins his discussion with plants that are named after or whose discovery is attributed to certain important persons (e.g. kings, gods, mythic figures). Of these, we will focus on the medicinal plant named for Melampus, melampodion, as a representative example. Pliny tells us that Melampus, a shepherd, discovered the medicinal properties of melampodion while observing his goats grazing on the plant. Melampus gave the milk from the nannies that had eaten the plant to the daughters of Proteus, a mythological Greek king, as a cure for their madness (Plin. *HN* 25.21):

Melampodis fama divinationis artibus nota est. ab hoc appellatur unum hellebori genus melampodion. aliqui pastorem eodem nomine invenisse tradunt, capras purgari pasto illo animadvertentem, datoque lacte earum sanasse Proetidas furentes.

Melampodion is more commonly called by the name hellebore, which refers a group of plants discussed by Pliny at length. It is surprising that Pliny groups these species with other explicitly medicinal herbs because plants belonging to the *Helleborus* genus are infamous for their toxicity (Duke 1992: n.p.). Nevertheless, Pliny maintains that if the herbalist follows the proper rules and rituals for harvesting and utilizing hellebore, it has a range of therapeutic uses, including the one discovered by Melampus (Plin. *HN* 25.24):

> *medetur ita morbis comitialibus, ut diximus, vertigini, melancholicis, insanientibus, lymphatis, elephantiasi albae, lepris, tetano, tremulis, podagricis, hydropicis incipientibusque tympanicis, stomachicis, spasticis cynicis, ischiadicis, quartanis, quae aliter non desinant, tussi veteri, inflationibus, torminibus redeuntibus.*
>
> Thus [given], [hellebore] is a cure for epilepsy, or as we have said, for vertigo, melancholy, insanity, madness, white leprosy [i.e. the virulent kind], leprous sores, tetanus, trembling, gout, dropsy, and incipient tympanitis, disorder in the stomach, facial paralysis, pains in the hip [i.e. sciatica], quartan fever [i.e. malaria], which otherwise would not cease, chronic cough, flatulence, and returning colic.

Because Pliny is aware of hellebore's toxicity, he proposes some odd precautions for those looking to harvest and administer it, such as to avoid administering hellebore on a cloudy day (Plin*.* *HN* 25.24). These precautions may or may not have affected the efficacy of black hellebore. However, as with the common onion and the chaste tree, Pliny recorded some qualities of *Helleborus niger* that have since been supported by modern research.

Helleborus is a genus of perennial shrubs comprised of about 20 different species. Although they are well known as ornamental plants, these species are rarely recognized for their medicinal effects (Maior and Dobrotă 2012: 272). The principal species discussed by Pliny as hellebore include black (*nigrum)* and white *(album*) hellebore (*helleborum).* White hellebore will not be discussed here for two reasons: First, genetically, it is not related to hellebore plants at all. Termed false hellebore, white hellebore is classified in a separate genus from *Helleborus* as *Veratrum album.* Second, Pliny asserts that it is much more dangerous than the black hellebore and that, therefore, it must be taken with extreme caution when used therapeautically: *Album optimum, quod celerrime movet sternumenta, sed multum terribilius nigro, praecipue si quis apparatum poturorum apud antiquos legat* ("The best white hellebore [is] that which swiftly provokes sneezing, but [it is] much more dreadful [than the] black [hellebore] especially if one reads about the preparation of [its] medicinal liquor in the ancient sources" Plin*.* *HN* 25.22). Indeed, the secondary metabolites of *V. album* are violently poisonous (Jaffe et al. 1990: 161). For example, *Veratrum* alkaloids cause vomiting, bradycardia, and hypotension, and generally have a low index for therapeutic use (Jaffe et al. 1990: 161). Pliny describes white hellebore as being able to treat a few conditions: shivering, choking, and prolonged hiccough or sneezing (above) (Plin. *HN* 25.23).

However, as stated above, this chapter will focus on melampodion or, more specifically, black hellebore. This small shrub plant is referred to by Pliny as *helleborum nigrum,* and today, it is known as *Helleborus niger.* Of the medicinal *Helleborus spp.*, *Helleborus niger* is the one most widely used in traditional medicine for a range of symptoms and diseases (Maior and Dobrotă 2012: 273). *Helleborus niger* is a 50 cm high subshrub with long petioled, dark green leaves packed at its base (*PDR* 2000: 893). The white flowers grow from the leafless, woody stems of the plant, producing pod-like fruits with many matte black, ovate seeds (*PDR* 2000: 893). Pliny introduces black hellebore as a curative plant for paralysis and gout, in addition to conditions already mentioned above in 25.24, such as madness and dropsy (i.e. edema): *Nigrum medetur paralyticis, insanientibus, hydropicis, dum citra febrim, podagris veteribus, articulariis morbis; trahit ex alvo bilem, pituitas, aquas.* ("The black hellebore is a cure for paralysis, madness, dropsy, so long as there is no fever, chronic gout, [and) for disease affecting the joints; it draws off bile, phlegm, and fluids from within the belly" Plin. *HN* 24.22). When Pliny notes that black hellebore removes bile and morbid fluids, he reflects Hippocratic medical theory mentioned earlier in the introduction, as black hellebore was believed to balance the cardinal juices (yellow bile, phlegm, black bile, and blood) by purging the body; thus, as here, it was frequently used as an emetic.

The medicinal parts of *Helleborus niger* include "the dried rhizome with or without roots and the fresh underground parts" (*PDR* 2000: 893). The rhizome is a horizontal stem capable of generating the root and shoot systems of the plant that stores starches and proteins, enabling the plant to survive during unfavorable seasons (Encyclopaedia Britannica 2018). It is also where *Helleborus niger* accumulates most of its medicinal secondary metabolites (Duke 1992: n.p.). Pliny describes how these medicinal roots were prepared (Plin. *HN* 25.21):

> *antiqui radicem cortice quam carnosissimo seligebant, quod tenuior eximeretur medulla—hanc umidis spongeis opertam turgescentemque acu in longitudinem findebant, dein fila in umbra siccabant his utentes—nunc ramulos ipsos ab radice quam gravissimi corticis ita dant.*
>
> The ancient [physicians] used to choose the root which [had] the most fleshy bark, because the more slender pith could be taken out---- this, after it had been covered with wet sponges, and once it was swelling, they used to cut it lengthwise with a needle. Then, they used to dry the threads in the shade thus using them---now, they give the shoots themselves that [grow] from the roots with the heaviest of bark.

Thus, it seems the therapeutic effects of *H. niger*'s blackish-brown root were well known to early physicians. Pliny does not mention these specifically, but a range of therapeutic effects, such as cardiotonic, abortive, sedative, antioxidative, anti-inflammatory, and antimicrobial, have since been reported for the rhizome extract (Maior and Dobrotă 2012: 273).

The biologically active compounds of interest in *Helleborus niger* include a mixture of steroid saponins called helleborin, cardioactive steroid glycosides called hellebrin, and alkaloids called celliamine and sprintillamine (*PDR* 2000: 894). Recall that both steroid saponins and iridoid glycosides belong to the terpenoid class as triterpenes and monoterpenes, respectively. Since they are a subclass of steroidal saponins, cardioactive steroid glycosides, or simply cardiac glycosides, also belong to the terpenoid class (Wyk and Wink 2004: 425). Two types of cardiac glycosides exist: cardenolides ($C_{23}H_{34}O_2$) and bufadienolides ($C_{24}H_{34}O_2$) (Wyk and Wink 2004: 425). The latter type, based on a C24 steroid nucleus, occurs in *Helleborus* plants (Duke 1992: n.p.).

The first terpenoid of interest in hellebore, helleborin, gives hellebore its acrid taste. Indeed, Pliny describes the flavor of hellebore as sharp and hot: *optimum quod acre gustu fervensque in frangendo pulverem emittit* (" The best hellebore is that which [is] sharp to the taste, and when boiling gives out a fine dust in breaking it" Plin. *HN* 25.21). Helleborin's steroidal saponin structure also allows it to work as a potent narcotic, inducing drowsiness, sleep, or stupor, and relieving pain.

Also listed as a narcotic, the cardiac glycoside in *H. niger*, hellebrin ($C_{36}H_{52}O_{15}$), can be used therapeutically as an emetic or digitalic to induce vomiting or treat several heart conditions, respectively. If the glycosyl group on the glycoside molecule is replaced with a hydrogen atom, hellebrin becomes more potent (McNaught and Wilkinson 1997: 67). This naturally occurring aglycone form of hellebrin is called hellebrigenin (Duke 1992: n.p.). Pliny, as seen above, mentions the emetic properties of hellebrin/hellebrigenin above when describing how hellebore can be used to draw out bodily fluids. Hellebrin is also said to display anticarcinomic activity (Duke 1992: n.p.). Because bufadienolide cardiac glycosides inhibit Na+/K+ ATPase, a plasma membrane transport enzyme, they cause intracellular sodium and calcium levels to rise. The increased calcium concentration causes enhanced muscle contraction in cardiac tissue (Spoerke and Smolinske 1990: 12). It is because of this effect that cardiac glycosides can be used medicinally to treat defects in the dynamics and rhythm of the heart (Wyk and Wink 2004: 425).

Contrastingly, the alkaloid compounds of hellebore are infamous as neurotoxins. However, since they often derive from the same amino acid precursors as neurotransmitters like serotonin, noradrenaline, dopamine, GABA, or histamine, they can play a role in neuronal signaling and signal transduction (Wyk and Wink 2004: 409-410). This effect might lead to support for Pliny's claims that hellebore treats madness, melancholy, and insanity. Overall, given the properties of its biologically active compounds, hellebore seems to heal primarily via purging the body.

Consuming excess amounts of *H. niger,* however, could result in fatal poisoning since many of its secondary metabolites are considered toxic compounds. In order to prevent harm, Pliny advises against prescribing hellebore to more "delicate" people such as the elderly, children, or women: *Vetant dari senibus, pueris, item mollis ac feminei corporis animive, exilibus aut teneris, et feminis minus quam viris, item timidis*, ("They do not permit giving [hellebore] to old people or children, likewise for the delicate and of feminine body or mind, for the thin or delicate and for women less than men, likewise for the timid" Plin. *HN* 25.25) Indeed, the negative side effects of hellebore could be highly detrimental to medically vulnerable patient populations as cases of poisoning are characterized by potentially life threating symptoms such as vomiting, diarrhea, shortness of breath, asphyxiation, and cardiac arrhythmia (*PDR* 2000: 894). Thus, ancient physicians likely exercised extreme caution when working with hellebore. Some precautions, in Pliny, accordingly, such as his warning against larger doses, logically minimize the risk of poisoning (Plin. *HN* 25.22): *datur ad leniter molliendam alvum plurimum drachma una, modice quattuor obolis…in dulcibus datum copiosius periculum infert…*(" One drachma is given at most for gently softening the bowels; in a moderate dose [is] 4 oboli…a larger [dose] given in sweet [substances] is dangerous").

However, many of the preventative measures Pliny describes reflect mythology and superstitions about *H. niger.* For example, Pliny recommends that the herbalist gather the plant ritualistically, first drawing a circle around the black hellebore with a sword, then praying to the gods for permission to harvest it. The most peculiar aspect of this ritualistic event is the suggestion that the gatherer watch for a flying eagle, a bad omen signaling the gatherer's imminent death (Plin. *HN* 25.21).

> *hoc et religiosius colligitur, primum enim gladio circumscribitur, dein qui succisurus est ortum spectat et precatur ut id liceat sibi concedentibus diis facere, observatque aquilae volatus, fere enim secantibus interest et, si prope advolavit, moriturum illo anno qui succidat augurium est.*
>
> "This kind [black hellebore] is gathered rather carefully, first, for instance, [the hellebore] is enclosed with a circle using a sword, then the man who is going to cut it looks to the East and prays that with the gods willing he may harvest it, and [he] observes the flights of an eagle for you see frequently an eagle is by those cutting this plant, and if [the eagle] flies near, it is an augury that [the man] who cuts it will die in that year."

Following his advice on how to gather *H. niger,* Pliny also notes rituals associated with the administration of it*: Cavendum est felici quoque cura ne nubilo die detur, inpetibiles quippe cruciatus existunt. nam aestate potius quam hieme dandum non est in dubio.* ("Care must be taken, even in efficacious treatment, lest it is given on a cloudy day, as one might expect violent pains ensue for no doubt it is better given in summer rather than in winter" Plin. *HN* 25.24). Today, weather conditions and time of year would be considered irrelevant to medical efficacy. However, according to Pliny, ancient physicians recognized environmental conditions as influencing a plant's efficacy. Although it was impossible for them to have any concept of the secondary metabolites contained within hellebore, ritualistic harvesting conditions could have had an effect on the concentrations of hellebore's therapeutic compounds.

CONCLUSION

Pliny the Elder employed the works of many authors and scholars in his careful compilation of all accessible knowledge on nature. His exhaustive review of medicinal plant lore has provided a framework for the analysis of the efficacy of ancient medicine. In this paper, I have investigated representative cases of common garden plants, symbolic or religious plants, and toxic herbs, finding that the majority of Pliny's remedies are justified by modern research.

His descriptions of accessible plants like the onion have provided a reference for modern scientists developing novel medicines. Food is not often considered medicine, but Pliny's work supports the argument that it could be used as such. However, it is important to be cautious of Pliny's claims. As we saw with *vitex,* some therapeutic aspects of a medicinal plant could be misrepresented because of its symbolic or religious contexts. After all, the religious association with healing preceded scientific medical ideology. Also, Pliny has shown that even poisonous plants, such as hellebore, have medical uses. This application, although dangerous, shows some skill and awareness of dosage limits.

Certainly, myth can explain some mysteries of the natural world, such as with the chaste tree. Or, as with the onion, therapeutic effects can be explained because the plant is beneficial as part of a regular diet. Pliny's description of how to gather and use hellebore highlights the connection between ritual and medicine that has since been lost. Modern medicine is primarily rooted in empirical scientific study. While this logical approach likely played a role in the innovation of herbal treatments, ritual and superstition controlled whether or not certain plants, like hellebore, were prescribed. This method produced some treatments that complemented what empirical experience and later science would show, and others that directly opposed later information. The connection between ritual and medicine likely created an important bridge for the use of plants, known only in "magical" contexts, in medical treatments.

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