Ergot.

The fungi that ate medieval Europe.

Theophrastus von Oberstockstall,
2013

This work is dedicated to the members of
The Order of Artisans and Kindred Spirits,
Who have inspired this work for the
presentation at
The Abbey Medieval Festival, 2013,
Queensland, Australia.

Preface.

I hope that you find the topic of this pamphlet, written as a handout for the accompanying lecture, as fascinating as I have and to this end I hope that the bibliography may assist you to explore further. I have deliberately selected peer-reviewed journal articles that should be accessible in any university library. It has been my intention to compile my notes, thoughts and research on Ergot for several years. So, I thank the Abbey Medieval Festival for being a catalyst in this endeavour.

I had witnessed many threads that lay strewn throughout medieval commentary concerning Ergot and wished to tie many of them together in a comprehensive guide. What you may find when you weave all these disparate knots is a story that can best represent human folly, greed and ignorance over several centuries. Especially, how the loss of correctly identifying ergotism symptoms due to the closure of monasteries enabled later witchcraft accusations. But a warning to modern readers, your society is little immune to the greeds that torture the human soul. Whilst Ergot plagues no longer torment our society we remain unable to find a cure for gluttony.

The last Ergot outbreak that humiliated modern European society was as late as 1951. Over 200 Pont St. Espirit residents experienced ergot poisoning due to a chain of rapacious opportunists. An unscrupulous peasant farmer illegally sold ergot infected rye to a baker obtaining compensation for a harvest where there should have been none. The St. Martin la Riviere baker obtained a tax free advantage and avoided a government grain inspection. Though he progressed the conspiracy to milling the bad rye and mixing it with wheat flour he then sold it to an innocent Pont St. Espirit baker. This subsequent baker unwittingly poisoned his customers, tarnished his reputation but also excoriatingly killed four people. Why? The perception of an advantage gained and an ignored consequence.

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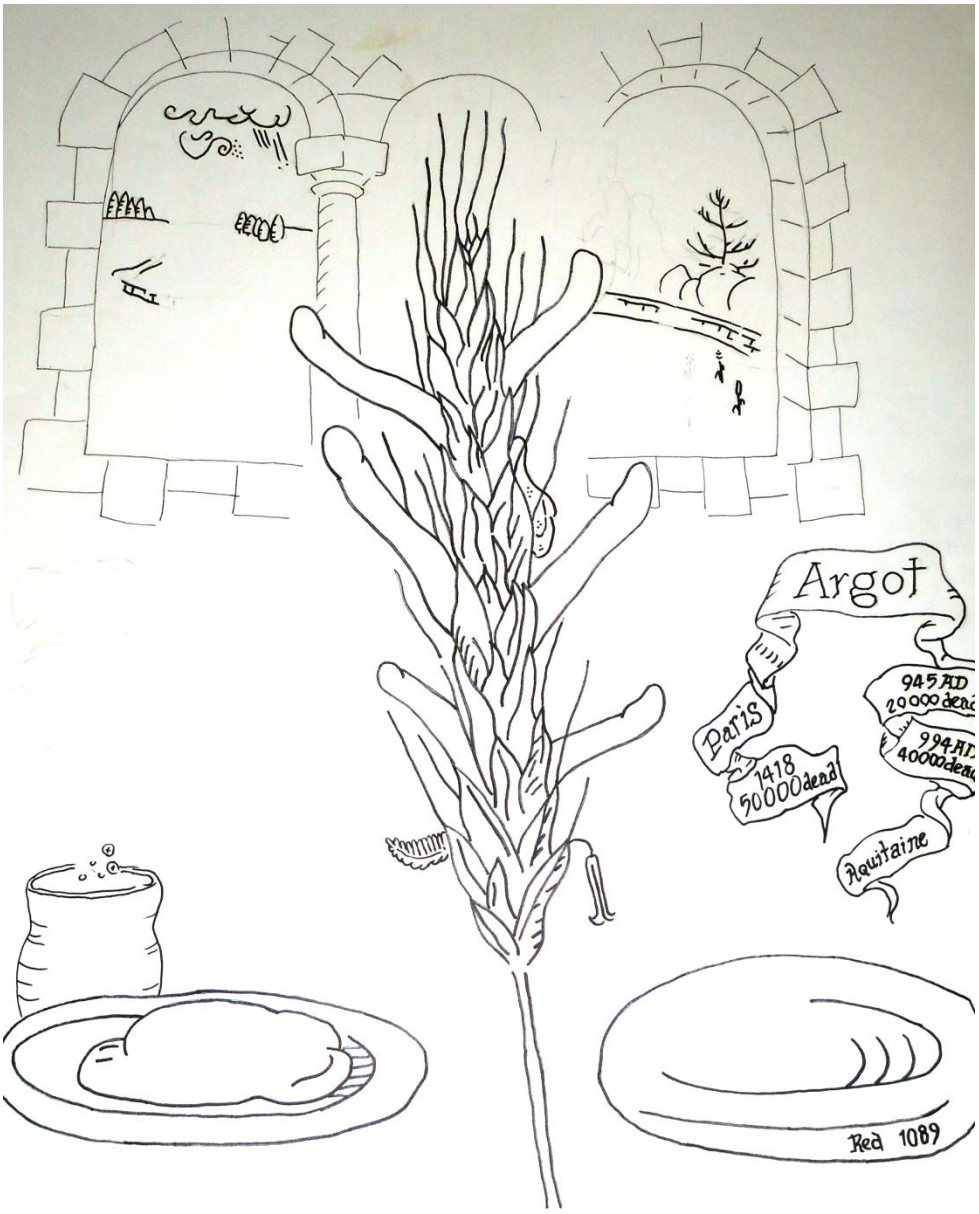

What is Ergot?

Ergot is a fungal infection of grass that results from wind carried spores opportunistically germinating in receptive developing grain ovaries. Completely reappropriating the host's nutrient assets of the grain, ergot then to grows into a hardened grain-like toxic 'pegs' in place of the grains in the cereal ear.

Once established in the grass ear, the fungus promotes a sugary secretion, "honeydew", from the developing grain that carries fungal spores to contaminate other grass spikelets. Continuing to develop within the grain, the fungus eventually replaces the ears' grain with a harden spur, three times the size of the grain it exploited. The spur contains a cornucopia of fungal poisons (*mycotoxins*).

A fungus with many names.

As the fungus had a long history within human society (dating back to Assyrian cuneiform clay tablet records of 600BC) it is known by several names. In the modern Linnaean system it is *Claviceps purpurea,* named in 1853 by Louis Rene Tulasne. Ergot was only recognised as a fungus in 1711 by Claude Joseph Geoffroy. Amongst the 46 known German names is *Mutterkorn,* the child of the *Kornmutter*; the French predominately refers to *Angot* (the origin of English Ergot) amongst the 19 different names for the *cock's spur;* and the English called in *Spurred* or *Horned Rye* initially considering it to be a part of the plant. The purple curved phallic spur shape is the most notable feature of the suspicious generally black (dark purple) grain mimic, the fungal *sclerotia.*

Ergot can infect most cereal crops give the right conditions.

Rye (*Secale cereale*) was predominately grown in a band from Holland to Russia and Austria to France. It is highly susceptible to windblown spores due to its exposed stigma during open pollination and takes longer to flower in cold wet conditions that promote fungal infection. Climatic conditions of Eastern Europe especially seasons remaining constantly damp increased ergot infectivity. Whilst rye is widely reported as the predominant host of ergot, many other grasses including wheat, spelt, oats, pearl millet and barley can be infected. Ergot infected seed from perennial ryegrass (*Lolium perenne*, the first grass to be domesticated) have killed pigeons and contaminated wild-rye (*Elymus virginicus*) has poisoned cattle. Crop fields mixed with wild rye or other grasses that are not harvested may develop ergot and act as an inoculation reservoir for future cereal crops.

Normally the sclerotia fall to the ground where silent contaminated soil maintains infection potential with the major fungal spread via wind distributed spores. Geographic constraints and climate variability characteristic of a wet season (promoting soil spore germination) ending in a windy dry environ (enabling spore distribution) produced ideal conditions for ergot to germinate and infect grasses and cereals especially rye.

Agricultural demand drove rye and ergot spread.

Agriculture expanded during the medieval period. Under rising food demands, rye crops expanded into marginal areas that did not suit other cereal crops (such as wheat) including drained marshland, poor or marshy soils with inadequate drainage or high acidity soils. The *Statute of Merton* in England (1235) enabled Lords to enclose and develop 'waste' lands. The spread of rye coincided with the increased ergotism outbreaks. Indeed, different soil types (eg. acid sulphur soils) affect the ergot's mycotoxin profile which influences reported symptoms.

Continental Europe's dramatic ergot epidemics following harvest climaxed in August and September. Though less susceptible wheat was farmed by peasants wheat was a valuable trade commodity and sold or used as land rent. In England, the acquisition of rye was not as widely accepted though pockets of local production were maintained.

Ergot: a Pandora's box of poisons.

Ergot produces more than 200 clearly recognised compounds (eg., ergometrine, ergotamine, ergopeptines, ergocryptine, and other lysergic acid derivatives) including a diverse array of toxins that can comprise a staggering 0.5 percent of sclerotia dry weight. The quantitative compositions of toxins can vary widely in ergot infected cereals. Ergot strains isolated across Europe have exhibited different poison production with certain strains not producing certain toxins. The toxic substances produced in an infected rye ear vary largely influenced by climate and soil type, so regional variability is common. The chemical stability and reactivity of ergot toxins means that they can maintain influential stimulus for at least eighteen months.

Diet in medieval times were highly susceptible to ergot.

Rye being the cheapest grain was predominately consumed by European subsistence farmers making them more susceptible to ergotism. A typical medieval peasant diet could be composed in excess of 80 percent cereal carbohydrates. By way of example, in medieval Scotland, the peasant diet mainly consisted of multi-grain porridge, Sop (a boiled porridge-like soup), and multi-grain bread. Cheese or milk occasionally supplemented meals. An ergot susceptible diet was exacerbated by vitamin and mineral deficiencies, existing compromised health and internal parasites such as worms.

Famine foraging increases ergot exposure.

During famine years and poor harvests, starving peasants would scavenge any wild cereals including grass seed. Combining the ergot riddled grains to make porridge or bread-like meals, they would have unwittingly exposed themselves a broad array of *Claviceps* fungi including the highly hallucinogenic *Claviceps paspalum* (this closely related grass pathogen was utilised in Greek antiquity by the Eleusis's Demeter Cult to induce mass mystical visions. Other mystic religious movements throughout history and across the globe have utilised ergot to inspire divine insight). The labouring families would desperately consume the meagre offerings which would only lead to their agonizing ergotic death.

Interestingly, in Germany and Russia during the early Middle Ages the general populous considered the unexpected appearance of ergot as a blessing and even considered it necessary to include at least one sclerotia to make good bread! Somewhat fortunately, the general tastes of the English and Italian people preferred wheat over the 'less aromatic and coloured bread' from rye and thus unknowingly reduced ergotism epidemics.

Strange coloured Bread and weird Beer.

In 1089 just prior to two massive ergot epidemic years, Sigebert de Gremblour commented that the bad bread from Lorraine's was 'dark red' (presumably as a result of considerable ergot contamination). Robert Dumont later observed in 1125 that bad bread in France was 'violet' coloured. Considering approximately 50 percent of pharmacologically active toxins are inactivated during baking a substantial initial amount of ergot in the flour must have been present to sustain toxicity in bakery goods. In some reports a single meal was adequate to result in death. Importantly, baking or brewing transforms the ergot mycotoxins both compositionally and chemically. For example, the hallucinogenic mycotoxin, lysergic acid diethylamide (only found in ergots), is enhanced during food preparation accentuating its manipulative power. Contaminated beer was common following epidemic years as mycotoxins, from using ergot infected rye or barley, was able to survive the malting and brewing process and remain active for over a year. This may have complicated the reputation of medieval brewers that had already been accused of adding hallucinogenic henbane (*Hyoscyamus niger*) to beer to enhance inebriation. Milk drinks have also been reported to induce ergotism though presumably they are the result of tainted bread being included in milk blended beverages.

Medieval Ergot epidemics.

During epidemics, milled flour from spoiled rye or commonly a mixture of grains was widely distributed. As a result, all levels of society were touched by the epidemic, especially where diet contained higher proportions of grains as the typical peasant's diet. As the epidemics were not associated with food poisoning it was widely interpreted, especially the common *Ignis sacer* symptom (which will be discussed later), to be a punishment from God for sins. Suffering people would find refuge in the church and religious hospitable services.

During the medieval period a mass poisoning epidemic occurred somewhere in Europe on average every 10 years, as calculated by Hirsch to be 130 events between 591 - 1879. As the disease usually did not lead to death but gross disfigurement it is considered the most horrific epidemic.

Unpredictable outbreaks of ergotism contributed to confusion.

In France records indicate the 10th, 11th, 12th and 13th centuries suffered 6, 11, 10 and three substantial outbreaks of ergot plaque respectively. Recorded fatalities are unreliable and mortality was estimated at 20 percent of inflictions. It remains terrifying that by example one French epidemic in Aquitaine in 944-945 AD had 20,000 deaths and in 994AD the same region suffered 40,000 deaths in a single poisoning. 8000 fatalities are attributed to one epidemic in Sologne, France and 50 000 gangrenous ergot related deaths occurred in 1418 in Paris. Confusingly, if we consider that the 20 thousand deaths in 945AD was estimated to be half the population at the time and that actual fatalities from gangrenous ergotism is proportionally low, therefore some form of poisoning may have experienced by nearly the entire population. Further, if we consider the reported fatalities are correct then a larger proportion of people experienced some form of poisoning in Aquitaine and nearly an entire region of Sologne inhabitants went partially mad, and early 15th century Paris was decimate by ergoteers.

Table. Documented French Medieval Ergot Epidemics. (Taken from Duncan, 1993)

945	Paris	1089	Lorraine	1109	Orleans, Chartes
994	Metz, Burgundy	1092	Tournai	1128	Soissons, Chartes
1041	Verdun	1093	Vienne	1129	Arras, Cambrai
1085	Lorraine	1094	Limoges, Nivelles	1200	Vienne
				1235	Aquitaine

The Black Death's improbable positive outcome.

The impact of the contagious Black Death (1348-50) may have produced an unlikely reprieve from ergot's influence. Cross Europe some areas experience less bubonic plague deaths but the communities remained susceptible to ergot, whilst in other districts the plague was further hellish with a combination of ergotism. The outcome of a reduced European population (for over a century and a half) foremost removed agricultural production pressure. Farming moved toward a proportional increase of more profitable and less ergot susceptible wheat agriculture.


Symptoms

Symptoms of ergotism.

In water the ergot sclerotia sink and toxins dissolve to establish an equilibrium mixture between inactive and active isomeric hydrophilic derivatives. Most of the toxins are easily orally absorbed. Individual poison tolerances, neurotoxic sensitivities and variations in saliva or digestive fluid interactions with mycotoxins influence symptoms. Notably, consumed dosage and repeated exposure within the diet greatly influence the disease outcome. Continued exposure to the mycotoxins and sustained ergotic symptoms may end in irreversible physical damage.

Initial signs of poisoning.

Initially, peripheral vaso-constriction effects are noted for both gangrenous and convulsive ergotism (the two common distinct forms of the disease). Commencing one hour after consumption, experiences include initial pain, sweating, salivation, tingling and aching of the limbs most frequently affecting lower extremities. There may also be an accompanying combination of violent nausea and involuntary digestive tract evacuation resulting in partially digested and highly bio-dynamically active, stinking faeces possibly accompanied by dead parasitic worms. Sensations increase to a sensitivity spectrum from *formication* (ants running or eerily crawling under the skin) to burning pain (Saint Anthony's / Saint Martial's fire, *ignis sacer* , a sacred fire characterised by the otherworldly description of an invisible fire that had no heat) or an intense cold-like freezing burn.

Gangrenous ergotism: a limbless life.

In the more lethal and horrific gangrenous ergotism the limbs become numb and painless due to the death of the nerves. The loss of vascular circulation leads to the skin becoming cold, lifeless and any painless incisions being bloodless. Secondary infection and eventually shrinking of the deprived limb culminates in dry stinking gangrene. Finally a bloodless and painless auto-amputation may terminate the limb. The blackened limb stump reinforced the belief that ignis sacer fire had burnt the appendage to a charcoal-like appearance.

Convulsive ergotism: dance till you're dead.

In the recurrent convulsive form of the disease a muscular impulse spectrum develops from sporadic twitching (irregular small muscle twitches appearing like bumps under the skin adding to the distress of formication), stronger irregular spasms (associated with the mysterious dancing disease that may appear and disappear over days) to continuous convulsions leading to complete muscle constriction and limb contortions eventuating in possible bone breakage. Cutaneous extravasation or inflammation advanced from tissue damage and

haemorrhages. Rigid limbs or strong convulsions were attributed to super-human powers of resistance or strength. Degeneration of spinal cord and brain damage due to blood clots can result. In convulsive ergotism, the tongue muscles and vocal chords were affected causing a change in the voice, speech or reduction to making 'animal noises'. Vocal muscle damage in the victim led to their eventual speechlessness.

The entire degenerative processes can progress over several hours, days or weeks with greater speed in severe poisoning cases. Whilst gangrenous and convulsive ergotism has not been reported simultaneously it has sequentially been observed in individuals. Recovering individuals have been reported as afflicted with voracious appetites that may have aided recurrent poisoning.

The madness of a fungus.

Due to the psychoactive chemicals produced by Ergot (especially *Claviceps paspalum*), the fungus has developed a notorious attribute of eliciting confusion, delirium, maniacal excitement, temporary insanity, rage, hallucinations, tinnitus (ringing in the ears) and insomnia lasting several days followed by deep sleep induction. Fascinatingly, common imagery of hallucinations included unsurprisingly fire (associated with *ignis sacer*), countless reports of flying sensations and macabre or mystical animal themes. Pupil restriction or dilation caused intense sensory magnification combining auditory amplification, light sensitivity, visual disturbance and spatial distortions (observing large fluctuation in size and proportion). Additionally, serotonin antagonism predisposed suffers to neuro-chemical depression.

Human fertility was heavy impacted by ergotism.

Loss of lactation resulting from the ergot alkaloid ergocryptine complicates breast-feeding. However, reports indicate that infants have been spared ergotic symptoms from consuming breast milk. Menstruation termination, loss of fertility, increased stillbirths, deformed births and abortion are described and was partly documented in Parsees holy text in the 7th century related to ergot.

The horror of recovery and survival.

Surprisingly, the death rate was low with an overall mortality of 20 percent and even lower with treatment as will be discussed in reference to Saint Anthony's hospices. Victims experiencing gangrenous ergotism may lose all of their limbs and be pitifully crippled, so a general outcome was a horrified survival. Convulsive ergotic death from the calamitous interruption of respiratory function may perform a welcome alternative. However, the survival rate and consequential grotesque

disfigurements (in the extreme, sufferers reduced to limbless trunks) and strange ideas due to mental disturbances reinforced the highly religious nature of medieval society. *Studies of beggars and vagrants*, a late 15th Century sketch by Hieronymus Bosch, maybe an indicator of the large proportion of the populous surviving gangrenous ergotism as strangely smiling hallucinating amputees. Combined all the symptoms appear too extraordinary to be from a natural or mundane cause. In the medieval mind, that primarily cure was a forgiveness from God with 'medical' intervention an added bonus. Ergot symptoms supported a belief of the *end of days*, the Last Judgement and the inevitable Christian Armageddon.

Ergot affects animals too.

Livestock feed infected grain or foraging contaminated pastures also experience ergotism with gangrenous and convulsive symptoms appearing in cows, horses, pigs, dogs, cats, geese and chickens. Symptoms included oral foaming, loss of claws or hooves, hyperthermia syndrome, demented behaviour commonly witnessed as animals careering around paddock or pens and driving into water where uncoordinated limbs led to drowning. Spasms increasing to stiffness and paralysed limbs, miscarriages, deformed or premature births exacerbated agricultural losses. Recovery from ergotism by animals is low.

In the late medieval period increased agricultural pressure including the advancement of enclosures (especially during the *Tudor period*, 1485 – 1603, in England) leading to restricted pasture availability of livestock amplified occurrence of ergot poisoning. Grazing animals restricted to confined fields met with limited ability to refuse to consume contaminated grasses. Moving animals to uninfected pastures (if the grass was questioned) may also have been unavailable. Yet, St. Anthony's pigs (discussed later) were entitled to roam freely. Strangely whilst ergot is avoided by animals, after poisoning livestock maintain a taste preference for the toxic plants. Unfortunately, dried, milled and stored grain that was intended to supplement animals' diet remained toxic hence prolonging and exacerbating the disease.

St Anthony of Vienne.

St. Anthony was the patron saint of ergot sufferers. He was a Red Sea fasting ascetic (251-356AD) who provided inspiration by steadfastly refusing the visions and temptations (including naked encouraging women that would later reflect a mandrake side-effect) induced by his lifestyle. In his lifetime he was pestered by demons and later the hospices would voluminously produce pestering prays to St Anthony continuing his torment in heaven. It was a common belief that St. Anthony was the dictator of Ergotism and also its savour. Judgement, punishment and treatment in relation to ergotism were administered by St. Anthony. Only he could transform a victims suffering into a holy learning experience.

The first hospice to treat ergot sufferers was established in approximately 1093 in the proximity of the St. Anthony's church in La-Motte-Saint-Didier, France. At the time this location had recently suffered the beginning of the major medieval ergot epidemics in 1085 (Lorraine), 1089 (Lorraine), 1092 (Tournau), 1093 (Vienne) and 1094 (Limoges, Nivelles). France witnessed proportionally more gangrenous ergotism than the convulsive form. Later, in 1297 the La-Motte-Saint-Didier church of Saint Anthony gained recognition as an Abbey.

The beginning of the modern hospital.

The hospice group received Papal recognition as a monastic order in 1227 and became custodians of Saint Anthony's bones to be used as relics. The Order grew by 1514 into a major European wide network of 372 hospices (200 of which were located along the four major roads on the pilgrimage pathways between France and Santiago, Spain). It was recognised as the fore-barer of large organised medical welfare infrastructure that had not previously existed. Whilst the majority of Antonine hospices were established on the Cameno de Saintiago Compostella to assist suffering pilgrims, later devotees would walk a path to Vienne rather than Spain for forgiveness and relief from ergotism. The medieval pilgrimage upsurge for repentant reduction of post-death purgatory potentially increased the spread of ergot amongst the cereal crops by unwittingly distributing spores in soiled clothes and footwear.

The Antonine hospice network aimed to recover patients from disease and restore their social, mental and religious wellbeing in an architectural arrangement that combined both infirmary and church in one open plan. Patients were perpetually in church, always able to see the vestments directly. Whilst specific mental treatment approaches are unknown it is anticipated that inclusion in daily pray routines and confession were central to the care of the soul. For bed ridden amputees with their accompanying severed limbs drying from their bed-heads, prays through the veil of hallucinations may have gained passionate pursuits. Alternatives were to resolve yourself to a life of virtuous despair in poverty.

Recognising a Antonine hospitaller.

The Antonine hospitallers could be recognised in the 12th century by an attire of black gown embroidered with a blue cross. Their alms collections would be attracted by bell ringing. In Northern European countries, affluent members of society would display their wealth not by offensive decadence but rather through sponsorship of a hospice. For example, the *Knights of St. Anthony* (started by Albrecht II of Bavaria in 1382) was a patrician society that donated money to Antonine hospices. Members were recognised by a golden Tau cross necklace. The

smaller hospices were little more than a converted house serviced by dedicated religious members with a dozen or so permanent patients. Medical care was primarily for the final days of suffers. Casualties would be moved there after the family members had grown exhausted of their madness or offensive odours.

Divine herbal wine.

Most famously, the bone relics of St. Anthony that had been transported from Constantinople by the crusader Geslin II to France were employed to strain the *St. Vinage*, a holy herbal wine. The blessed wine was offered as part of an annual Feast of Ascension, a pseudo-communion rite (Forty days after Easter) to enable holy forgiveness and purification on the front doorsteps of St. Anthony monasteries. A sixteenth century survey of the bone relics calculated in excess of the equivalent of five red wine soaked skeletons attributed to St. Anthony distributed throughout the hospice network. So popular was the St Vinage that three Papal Bulls reinforced the Order of St. Anthony's monopoly on its production. Its secret herbal ingredients (which may have opportunistically contained fermentation contaminates such as ethyl alcohol) encouraged counteractive vaso-dilative (dilating the capillaries) and analgesic effects. Whilst the annual public availability of St Vinage was limited, for a large price the higher societal tier could avail themselves access to the curative liquor from the Antonine monestary apothecaries. Regular vaso-dilative medicine may have increased the recovery and reduced permanent damage.

Herbal treatments: a balancing act.

High 'Cooling' humoured Galenic herbal extracts, to balance the 'hot' disease especially ignis sacer, including mandrake, henbane and plantain. The inclusion of analgesic herbs within the therapeutic treatment of ergot sufferers was in keeping with the herbal advice from the popular *Antidotarium Nicolai* of which 50 percent of the pharmacological recipes were for pain relief and amongst the major narcotic ingredients 20 percent included opium as an ingredient. However, overdose of mandrake, opium or henbane (suspected ingredients of the wine) would have led to permanent mortal escape of ergotism symptoms. Sadly, most of the Antonine apothecary knowledge was lost as was the treatments and herbal ingredients of the famous antonine-wine. Fourteen botanically correct herbs painted at the feet of Saint Anthony in an Isenheim altar triptych have been recognised for their therapeutic value and may have been associated with ergotism treatment.

Mandrake extract whilst providing analgesia services also contains the hallucinogenic alkaloids and toxins hyoscyamine, scopolamone and hyoscine (also found in henbane) adding to the distortion of reality by ergot. The roots and berries were used as an ingredient in the narcotic remedies administered before surgery and

in common analgesic medieval remedies for ergot symptom relief. Mandrake and henbane is also considered an aphrodisiac as it has been attributed to erotic visions, promoting sexual arousal and increased fertility. However, the stimulatory side-effect may be disturbing amongst the other experiences overwhelming the ergotism recipient.

Antonine treatment of the obvious non-contagious disease included: ergot free wholesome food enhanced by the removal of 'cursed black grains', herbal treatments, therapeutic ointments, the highly reputed wines, and careful linen bandaging of gangrenous limbs. In Antonine hospices treatment decreased mortality to five percent. The good quality ergot free bread in hospitals supplied from carefully harvested monastic fields was accompanied by meat from the abbey piggery. The Anthonite pigs were renowned and could be easily recognised by wearing a customary Antonine bell. The pigs may have also indicated harvest contamination by their death or distress from toxic grain-feed.

Surgical measures reduce lengths.

Friars were prevented from violating the human body in 1215 therefore surgical fraternities arose to fill the vacuum. If non-invasive treatments did not avail disease abatement then limb amputation was exercised to prevent gangrenous attack to vital organs. Brutal amputations and excisions were routinely performed by military medics contract servicing the religious hospices. By way of example, Hans von Gerssdorff was reported to have performed more than 200 amputations over a short period in one Strassburg Antonine hospice.

As Catholic custom necessitated the complete bodily burial in preparation of the resurrection any amputated limbs either spontaneous or surgically removed remained with the suffering patient. Upon death the patient could then be interred 'whole' or often as was the case the recovered patient would gift the lost limb to an Antonine altar or shrine. A number of the limbs would be displayed in the entrance portals for convenient retrieval when the Last Judgement occurred. Whilst the male member may be gangrenously affected no commentary suggests that this lost anatomical feature was displayed. The impact on fertility would have certainly been cause for alarm. Curiously, a large number of pilgrim badges include symbolic limbs and appendages.

Altar Art therapy.

For a hallucinating ergot sufferer the peculiarity of monastic life and subsequent hallucinatory medicine may have been overwhelming and impetus for painting themes of monastic artists. The Flemish artists Matthias Grunewald (1470-1528) and Pieter Bruegel the Elder (1525-1569) and Dutch painter Hieronymus Bosch

(1450-1516) all associated with hospices used ergot sufferers as authentic models. Purgatory and hellish scenery in church decorations especially altar triptychs in hospices and chapels, included the enormous diversity of ergotism deformities. Ergot symptoms were considered the first stages of decent into Hell. Inadvertently the artists also captured the medical inventiveness of the time with wooden legs, crutches and stilts employed by amputees. The disproportional depiction of amputees in the compositions may have been a reflection of the staggeringly proliferation witnessed in the communities. The contents of Bosch's surreal landscapes of immediate interest include nightshade plants, Antonine hospices, distillatory equipment and his most extensively painted saint, St. Anthony. The Lisbon St. Anthony triptych by Bosch is a fine example. His enchanting vision in the Garden of Earthy delights may have been an enjoyable welcome relief for the living horror of ergotism.

Candle magic in Arras.

St. Anthony did not monopolise the cure of ergotism. Two arguing musicians who had separately had visions of the Virgin Mary instructing them to visit St Vaast Cathedral, Arras, France were rewarded with another visitation by Mary. On this occasion with an occupying priest, she presented them with *La Sainte Channdelle* (The Saints candle) with instructions that water that had the candle (decorated with red, green and gold horizontal bands) dripped into it would cure ergotism. Elevating the candle to reliquary status (in 1215 it was housed in an ornate silver carrier) gained the cathedral pilgrimage status especially on Candlemas, 2nd February and a three day celebration in May when the candle was paraded around Arras. The painting *Legend of La Sainte Channdelle* by Michel Varlet in 1571 depicting the elaborate procession indicates that the candle therapy had maintained its power for over 350 years.

Other folk medicine knowledge.

Interestingly medicinal folk knowledge includes uses for ergot. In Norwegian folk medicine ergot water was advised for hernia. Powdered ergot was used by midwives in the 1500's to induce contractions, accelerate labour, quelling postpartum haemorrhage and decrease the likelihood of a young mother dying in childbirth. Literature suggests approximately 2 grams of powdered ergot in 280 mL of boiling water may be administered in 90 mL oral dosages to labouring women. However the non-standard quality frequently produced unreliable results, unintended poisoning and negative outcomes from overdoses. Migraine relief was also reported from using ergot that would centuries later be investigated. Its causative agent the fungal alkaloid ergotamine has been identified and commercialised.

The Late Medieval ergot epidemics change to a sinister character.

During the late medieval period swelling populations forced a need to enlarge agricultural production. Great demand returned to cereal availability seeing wheat become a higher commodity and even rye increasing in price. Increased rural population and metropolitisation accentuated food demands and strained community bonds. To meet rising cereal production increased draining of marshes

occurred with marginal lands utilized again by pioneering rye crops. In these conditions rye is more prone to ergot infection. In Finnmark, northern Norway, imported flour and grain to support the metropolitan populace disassociated them from an agricultural awareness. The grain was stripped of most information concerning the soil type it was grown in, the weather conditions during its production or harvest and especially its ergot content.

Monastary closures led to witchcraft increases.

The Reformation and political land grabbing by European royalty (such as England's Dissolution of Monasteries by King Henry VIII between 1536 and 1541 by legal manipulations) beheld the closure and seizure of monasteries. Ignorant destruction of the broader benefits of the monastic system due to the arguments of doctrine (especially by Martin Luther, though he may not have in the slightest intended to throw the baby out with the bath water) led to the loss of medical knowledge and herbal treatments for ergotism. Eventually the loss of understanding and diagnosis of ergotism symptoms often resulted in the catastrophic interpretation of witchcraft as the causal agent of the symptoms in 16th century society. The loss of animal husbandry knowledge also led to ergot poisoning in livestock associated with accusations of witchcraft. Graphic descriptions preserved in court records indicate accurate ergot symptoms especially in central and Eastern Europe. Stronger convincing evidence for ergotism exists in Norwegian records than the popular America or England witch trials.

> *"..a black spot appeared later on, and a piece of her flesh fell off, so that they could see straight in at her bones, and not long after, she died in great agony".*
> Gangrene symptoms recorded at a Norway witch trial, 1670.
> *".. in the evening the boy had nausea and got such a pain in his leg that he screamed, so you could hear it far away out in the street, and he was stretched so badly, as if he was lying on a stretch-rack, and could hear a breaking sound In his body.."*
> Convulsive ergotism in Stavanger trail records, 1662.

Unsurprisingly, higher incidences of witchcraft allegations in Late Medieval Essex focused around the lowland areas following the environmental conditions preferring ergot rye infection especially when tensions increased during elevated food resource competition.

Around 1500, ergot poisoning was associated with contaminate food. The implementation of preventative measures, such as grain beating and sieving to separate the ergot sclerotia and legislation of cereal quality, finally brought the

ergot epidemics under control. Today, the European Union imposes a strict maximum of 0.05% ergot in grain for human consumption.

There is always a nursery rhyme.

It has been suggested by Queenan that the *Pied Piper of Hamelin* story (a 1284 manuscript form referring to an earlier occurrence) may be interpreted as an ergot epidemic with the death of rats attributed to ingesting toxic grain and the more susceptible youth experiencing a deathly dancing mania at the end of harvest resulting in their disappearance. Further, *Four and twenty black birds* is also interpreted to have resemblance to ergot epidemics with the pocket full of rye and black birds (sclerotia) in bakery and pastry dishes leading to singing and daintiness.

Of interest.

In pharmacological history, ergot alkaloids have played two important roles:

1. The first identification of inhibitors of nervous system physiological receptors in the case of the brain transmitter serotonin and adrenaline antagonism, and
2. The awareness of minute dosage potential in the case of lysergic acid diethylamide of 30-100 micrograms (μg). In comparative context, until the discovery of the lysergic acid derivatives strength in the 20th Century previous medical dosage was a three-fold larger volume in milligrams (mg).

In conclusion.

Imagine a French city at the end of the 11th Century; walking toward the market place you pass a hospice wafting the sweet stench of gangrene whilst over its door dried hands wave at you in the gentle morning breeze. The street is crowded by begging amputees and religious zealots ringing bells to attract attention to the insane ranting of the approaching Judgement. A dog limps past on pawless limbs, and from the local cathedral you can hear the yelling of devoted pray strained by hallucinogenic madness. Pausing at the open entrance of an artist's workshop you admire the breathtaking beauty of the heavenly panorama that has been commissioned for the local hospices altar piece. You stop at your goal, a bakery selling fresh morning bread. Another customer remarks at the delightful creativity of the cheap, burgundy coloured rye loaf… The medieval period can be such a delight to explore, enjoy your pilgrimage.

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