A MICROBIOLOGICAL HYPOTHESIS ON THE NATURE OF SPIRITUAL HEALING SITES[1]

Gerry A. Quinn

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Hypothesis
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Abstract

Sacred soils and holy waters associated with historical healing traditions are often located in geologically and chemically distinctive environments, such as karst limestone systems, alkaline substrates, caves, and mineral springs. These environments are also recognised as important habitats for Streptomyces, a genus of soil actinomycetes responsible for most clinically used antibiotics, as well as numerous antifungal, anticancer, antiviral, and immunomodulatory compounds. This article explores the testable hypothesis that some historically designated healing sites may coincide with ecologically distinctive landscapes capable of supporting bioactive microbial communities. Drawing on the documented isolation of antibiotic–producing *Streptomyces* strains from the "Blessed Clay" tradition in Boho (Northern Ireland), this paper 1. identifies shared ecological motifs between known *Streptomyces* habitats and selected healing sites, 2. examines how such environments have been interpreted within specific historical religious contexts, without presuming theological uniformity and 3. explores, at a philosophical level, whether ritual practice, sensory experience (including olfaction), and environmental exposure might inform contemporary biomedical inquiry. The broader reflections on ritual and meaning are interpretive and explicitly distinguished from empirical demonstration. Rather than reducing religious healing traditions to chemistry, our hypothesis suggests that cultural sacralisation and ecological distinctiveness may have intersected in historically complex ways. By integrating microbial ecology, genomics, metabolomics, and comparative analysis, this study proposes a framework for the interdisciplinary investigation of environmental dimensions in healing traditions.

KEY–WORDS: Streptomyces; Sacred sites; Microbiome; Science and Religion; Healing

* Gerry A. Quinn, Ulster University, Coleraine, Northern Ireland. E–mail: g.quinn@ulster.ac.uk

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Introduction

The isolation of streptomycin from *Streptomyces griseus* by Albert Schatz and Selman Waksman in the 1940s transformed the treatment of tuberculosis and revealed the pharmaceutical potential of soil actinomycetes (Schatz et al. 1944). *Streptomyces* and related genera now account for over half of known antibiotics, alongside antifungal, anticancer, and antiviral agents (Bérdy 2012). Several years ago, while screening extreme environments for novel antimicrobials, I isolated several Streptomyces strains from the alkaline soil at the grave of Fr. James McGirr (d. 1815) in Boho, County Fermanagh, Northern Ireland (Terra et al. 2018).

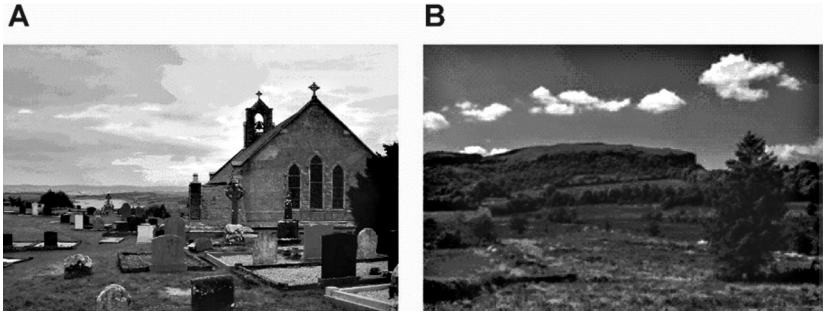

Figure 1. The Blessed Clay of Fr. McGirr is located (A) adjacent to the Church of the Sacred Heart in Boho, County Fermanagh. These highlands form a continuous limestone escarpment from Belmore mountain to (B) Knockmore.

Known locally as "The Blessed Clay," this soil is part of an oral healing tradition: Fr. McGirr, a reputed thaumaturge, assured his parishioners that "the clay that covers me will cure anything I was able to cure when I was with you." In one version of this soil 'cure', pilgrims collect a small amount of soil wrapped in cloth, maintaining silence on their way home and place the package underneath their pillow. The clay is then returned on the 3rd or 4th day (Quinn and Harris 2025; Terra et al. 2018). This practice, embedded in Ireland's broader "cures" tradition, may trace to pre–Christian medicinal knowledge (Ballard 2009, 26–33).

I managed to isolate 6–7 *Streptomyces* isolates from a small soil sample of the Blessed Clay. The most potent of these Streptomyces in inhibition tests was "McGirr strain 1 (McG#1)," which was renamed *Streptomyces* sp. myrophorea, in recognition of its strong sweet fragrance (myro) and multiple antiporters (phorea) encoded by its genome (Figure 2; Terra et al. 2018; Quinn et al. 2021). Coincidentally, Myrophoroi (Greek: "myrrh–bearers") also describes the women who carried fragrances and oils to anoint the body of Christ after his death in the Christian tradition.

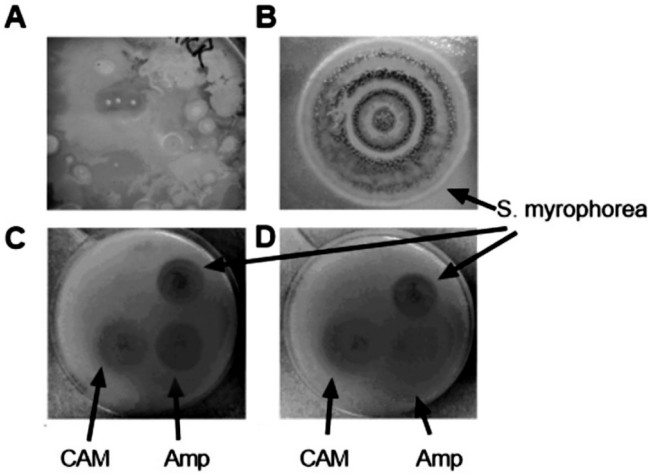

Figure 2. This image shows (A) the initial isolation of antibiotic producing organisms from a sample of the Blessed Clay from Boho (B) A mature colony of one of the antibiotic producing isolates from the Blessed Clay (C) Inhibitory activity of an isolate of the Blessed Clay, Streptomyces sp. myrophorea against Methicillin sensitive Staphylococcus aureus and (D) S. myrophorea antibiotic activity against Methicillin resistant Staphylococcus aureus. Control antibiotics included chloramphenicol (CAM–20 μg), ampicillin (AMP–20 μg), and a negative control of the original ISP–2 agar with mineral supplement. Streptomyces sp. myrophorea was originally isolated from the Blessed Clay at Boho, County Fermanagh Northern Ireland (Terra et al. 2018).

Further assays confirmed the activity of *S. myrophorea* against multi-drug–resistant pathogens (multiresistant *Staphylococcus aureus*, vancomycin–resistant *Enterococci*, carbapenem–resistant *Acinetobacter baumannii* and *Klebsiella pneumoniae*; Terra et al. 2018). Other Streptomyces isolates from the same soil sample also had antifungal, anticancer and antiviral properties (Quinn et al. 2021; Flanagan 2025). In addition, *in–vitro* work reported in a doctoral thesis (Flanagan 2025) observed marked reductions in SARS–CoV–2 viral titre during the first 48 hours of exposure for a further isolate (McG#5); these findings, however, await independent replication and peer–reviewed publication.

Beyond culture–dependent isolation, we have undertaken whole–genome sequencing of several *Streptomyces* isolates associated with healing traditions and used various biosynthetic gene cluster prediction software to identify putative polyketide synthase (PKS) and non–ribosomal peptide synthetase (NRPS) pathways. Preliminary metabolomic profiling using LC–MS has also been performed to correlate predicted gene clusters with detectable secondary metabolites. While these analyses remain ongoing and full struc-

tural elucidation (e.g., NMR confirmation) has not yet been completed, the data support the presence of diverse and partially unexplored biosynthetic capacity within these isolates.

More broadly, advances in high–throughput sequencing, metagenomics, and metabolomics allow sacred or historically designated healing soils to be analysed not merely for culturable taxa but for their total biosynthetic potential. Such approaches could provide a rigorous framework for testing the ecological dimension of the present hypothesis.

It later occurred to me that omission of cultural and ritual context of the Blessed Clay would render an ecological hypothesis methodologically incomplete, as site designation and environmental characteristics cannot be meaningfully separated. However, documenting these spiritual traditions also preserves important aspects of local cultural history. Therefore, this article operates at the intersection of empirical microbiology, ecological hypothesis, comparative interpretation, and philosophical reflection. The microbiological observations presented here are framed as testable ecological hypotheses concerning the distribution, biosynthetic potential, and volatile metabolite production of soil actinomycetes. The broader reflections on religious meaning and ritual practice are interpretive rather than evidential. Where speculative connections are proposed, particularly regarding historical site selection, olfactory sensitivity, or contemplative epistemology, they are explicitly marked as heuristic and intended to stimulate interdisciplinary dialogue rather than establish historical causation.

This article advances the thesis that a subset of historically designated healing sites may function as culturally preserved indicators of ecologically distinctive microbial environments. While alkaline limestone systems, fault–associated springs, and mineral–rich substrates are independently recognised as productive habitats for metabolically diverse actinomycetes, the clustering of certain healing traditions at such locations raises a testable ecological question: whether sacralised landscapes may inadvertently encode biogeographical information relevant to microbial bioprospecting. This proposal does not reduce religious healing traditions to chemistry; rather, it suggests that cultural designation and ecological distinctiveness may have intersected in historically complex ways, and that recognising this intersection requires a non–reductive, multi–level explanatory framework.

Therefore my hypothesis proceeds on three distinct but related levels: (1) empirical microbiology; (2) environmental –comparative analysis of site characteristics; and (3) philosophical reflection on ritual, perception, and healing. This structure ensures empirical claims remain grounded while allowing space for interpretive insights.

Section 1: Common motifs between the biogeography of Streptomyces and sacred sites

It is important to clarify that this article does not claim that clinically significant concentrations of antibiotics from *Streptomyces* necessarily enter the bloodstream of pilgrims. However, possible mechanisms of interaction include: dermal contact with soil–borne metabolites; inhalation of volatile organic compounds; ingestion of small quantities of soil or water in certain traditions; interaction between environmental actinomycetes and the human microbiome; or indirect immunomodulatory effects mediated by environmental exposure. These remain hypotheses requiring experimental investigation.

The purpose of the environmental comparisons that follow is not to demonstrate a statistically complete survey of sacred landscapes but to identify recurring ecological motifs across a number of historically documented healing traditions. Because these traditions arise in diverse geographical and cultural contexts, the available sources describe different environmental characteristics for each location. The examples presented therefore function as illustrative cases drawn from the literature in which geological or environmental descriptions are available. Because the hypothesis is new, existing studies on sacred sites have not used uniform microbiological or geochemical parameters; the present synthesis therefore identifies shared motifs rather than performing a controlled comparative analysis. When considered together, these descriptions allow a preliminary comparison between known habitats favourable to actinomycetes and landscapes historically associated with healing traditions. Future targeted metagenomic and metabolomic studies comparing sacred versus non–sacred alkaline limestone and fault–spring sites could empirically test the proposed clustering; the present work is intended only to identify recurring motifs and stimulate such research. These shared parameters include alkaline pH, limestone/karst bedrock, fault–spring interfaces, and low–nutrient stress.

From a microbiological perspective, Streptomyces are known to thrive in nutrient–poor, alkaline, or environmentally stressed soils, caves, deserts, high altitudes, where competition is limited (Chen et al. 2022; Antoraz et al. 2015). Secondary metabolite production (antibiotics, antifungals) can be triggered by pH, phosphate limitation, or mineral cues (Baranova et al. 2023). Many Streptomyces species also produce volatile organic compounds such as geosmin, responsible for the characteristic "earthy" smell of soil after rain, which humans can detect at extremely low concentrations (parts–per–trillion). Such olfactory sensitivity suggests that distinctive microbial environments may be perceptible to humans even in the absence of visible organisms (Garbeva et al. 2023; Kim et al. 2022; Jones and Elliot 2017).

Reported discoveries of novel Streptomyces taxa frequently occur in geologically distinctive environments, several of which resemble landscapes later designated as sacred or therapeutic. Commonly reported environmental features include limestone (karst) bedrock, thin soils, elevated pH (e.g., Lourdes, Fátima, Chimayó, Bom Jesus da Lapa; Figure 3), long histories of folk medicine layered on pre–Christian traditions, and locations often situated in areas of strong faith with a pilgrimage tradition.

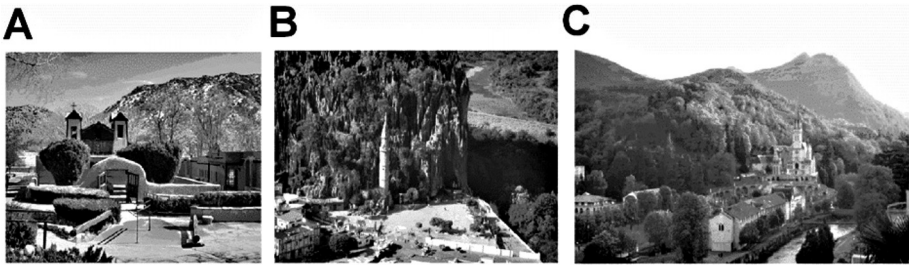

Figure 3. Spiritual healing sites situated on limestone bedrock include (A). El Santuario de Chimayo, New Mexico, USA. (B) Bom Jesus de Lapa, Brazil and (C) Gave de pau river valley, Lourdes, France.

Another common motif is the overlay of newer spiritual sites, particularly those connected to healing, on top of older spiritual sites, reflecting a continuity of spiritual association (Quinn and Harris 2025). For example, Boho's Sacred Heart Church, central to the Blessed clay tradition, was built on a site that was thought to be a Druid amphitheatre. This is adjacent to an even older, neolithic, ceremonial site (the Reyfad stones) (Figure 4) (Terra et al. 2018; Quinn and Harris 2025). El Santuario de Chimayó (New Mexico) was constructed on top of a now defunct hot–spring; previously used by Tewa Indians for healing (Bullington 2013, 42–43) and St. Catherine's Monastery is built on the alkaline granite foundation of Mount Sinai/Jabal Musa (Egypt), which encloses the Well of Moses, a pre–Christian sacred spring (Eyal et al. 2014; Atiya 1952).

Figure 4. (A) The Church of the Sacred Heart, Boho, situated on a location locally associated with a former Druidic ritual site; (B) AI–generated visualisation of the hypothesised amphitheatre within the local landscape; (C) the adjacent Neolithic Reyfad stones.

Streptomyces have also been associated with older Neolithic sites and rituals, such as Kisameet clay, which has been used by the Heiltsuk First Nation for millennia (Canada; Svensson et al. 2017; Behroozian et al. 2016), the red soils of Jordan (Falkinham et al. 2009), and *Streptomyces* isolated from ceremonial caves called the Grotti dei cervi (Cave of the Deer, Italy), which produced cervimycins A–D effective against methicillin–resistant *Staphylococcus aureus* (MRSA) and vancomycin–resistant *Enterococcus* (VRE; (Groth 2001; Herold et al. 2006).

Given these shared motifs, one possible hypothesis is that some locations, later sacralised, may have coincided with environments where perceived therapeutic effects were reported. Additionally, their shared geological characteristics such as alkaline nature, low–nutrient availability and undisturbed nature, may have selected for *Streptomyces* or other related organisms that produce useful pharmaceuticals, suggesting that such organisms may have contributed to environmental features later interpreted as distinctive, rather than serving as a replacement explanation for ritual belief. The recurrence of these ecological features does not establish causation; however, it justifies investigation into whether specific geochemical environments correlate with distinctive microbial biosynthetic profiles. For instance, comparative metagenomic sampling of sacred versus non–sacred alkaline sites could test this correlation empirically.

Traditional Knowledge as a Heuristic in Environmental Bioprospecting

It is well recognised in pharmacognosy that ethnomedical knowledge can function as an empirical filter in drug discovery. Researchers in natural products chemistry have observed that plant species with documented traditional medicinal use frequently yield a higher proportion of bioactive compounds than taxa selected at random (Cordell et al. 1994). Historical therapeutic designation, in such cases, may reflect long–term experiential filtering rather than purely symbolic attribution.

Although microorganisms themselves would not have been visible to historical communities, there is substantial evidence that ancient societies exploited microbial processes in other contexts. Fermentation practices involving yeasts and moulds were widely used in the production of bread, beer, and medicinal preparations. Archaeochemical analyses have also demonstrated the presence of tetracycline in skeletal remains from Nubian populations, likely derived from Streptomyces associated with fermented grain products (Nelson et al. 2010; Bassett et al. 1980). Such examples illustrate that pre–modern cultures were capable of interacting with beneficial micro-

bial activity indirectly, even without a microbiological understanding of the organisms involved.

The present hypothesis extends this heuristic principle from organisms to environments. Many limestone and physiologically extreme habitats are known to harbour distinctive *Streptomyces* populations with diverse biosynthetic capacity. However, the observation of interest here is not merely that alkaline or geochemically unusual landscapes support actinomycetes, but that a non–trivial subset of historically designated healing sites appear to cluster at limestone escarpments, fault–associated springs, and mineral–rich substrates. Fault–spring interfaces create chemically dynamic microenvironments characterised by mineral flux, pH gradients, and fluctuating hydration states, conditions known to stimulate secondary metabolite production in soil actinomycetes. If certain healing traditions consistently emerged at such locations, these sites may represent culturally preserved indicators of ecologically distinctive zones.

This proposal does not imply microbiological foresight on the part of historical communities. Rather, it suggests that repeated experiential associations between place and perceived therapeutic effect may have guided site designation in ways that inadvertently tracked underlying ecological productivity. Such locations may therefore offer a rational starting point for targeted microbial bioprospecting.

The microbiological hypothesis advanced here applies primarily to conditions plausibly influenced by antimicrobial, immunomodulatory, or neurochemical mechanisms such as superficial infections, inflammatory conditions, stress–related disorders, or microbiome–associated dysbiosis. It does not propose that soil–derived actinomycetes constitute a universal explanation for all illnesses. Historical attributions of healing must therefore be interpreted cautiously and with diagnostic differentiation.

Section 2: Religious interpretations at healing sites

This section does not attempt to summarise "the views" of entire religious traditions, rather, it examines specific historically situated examples in which soil or water has been interpreted as a medium of healing. These examples are illustrative case studies rather than representative theological systems. In addition, although some of the case studies discussed here (e.g., Boho) are embedded in Christian traditions, this article does not intend to advance a confessional theological argument. Rather, it examines how environments later incorporated into religious frameworks may coincide with ecologically distinctive landscapes. References to Islamic, Indigenous, and other traditions are descriptive and comparative rather than normative.

This being said, the opinions of people in particular spiritual/religious traditions to spiritual healing sites is by no means uniform. For instance there is a large diversity of opinion on the Blessed Clay from Boho, Co Fermanagh even within the indigenous population. Since this is an oral tradition, there are no definite strictures laid down for the cure. However, there is a notice beside the site encouraging people to say certain prayers and pray for certain intentions when using the Blessed clay.

The nearby church has neither endorsed the Blessed Clay nor banned pilgrims visiting the site but presently has a more neutral attitude. There are some groups of people, especially the older generation, who believe that the Blessed Clay has curative properties but these also rely on having a strong faith. There are others who believe that like most folk remedies, these things are the legacy of ancestral superstitions. This also means that there are people of strong Christian faith who believe that the Blessed Clay is not incompatible with their own faith (Quinn and Harris 2025).

When the discovery of antibiotic producing Streptomyces from the soil was publicly revealed (Terra et al. 2018) there were diverse opinions on the scientific discovery. Some (at the time) viewed the discovery as the promotion of paganism, while others were slightly surprised that the soil contained anything. Others, who had a deep belief in the cure, thought that science was superfluous and it is all based on faith (Quinn and Harris 2025; Quinn 2023, 51–59; Lidz 2020; Terra et al. 2018).

Of course there are other accounts of healing ceremonies taking place in limestone environments in the Christian tradition. In one account (John 9:6–7), Jesus opens the eyes of a man who had been blind from birth by mixing spittle with clay and anointing the blind man's eyes. He then sends him to wash in the Pool of Siloam (Elitzur 2008).

As well as having a religious interpretation there is a wider contextual relevance to this story. For instance, Jerusalem's clay is also well known to be rich in dolomite (formed through a magnesium alteration of limestone). Indeed, the pool of Siloam itself is fed through limestone tunnels (Elitzur 2008). In addition, from a physiological perspective, human saliva contains many antimicrobial peptides and signalling compounds (Grant et al. 2019). I do not claim that Streptomyces or saliva are responsible for this 'cure'; however, I am drawing attention to the wider interpretations of these events.

Analogous motifs appear across many traditions for instance the well of Zamzam in Mecca, Saudi Arabia is widely revered in Islamic tradition as a sacred source of healing and blessings. Indeed, drinking Zamzam water is a part of Hajj and Umrah rituals (Elhadary 2021). In a wider ecological context this well has an alkaline pH and is reported to have bacteriostatic, wound healing and anticancer effects as well as reports of mitigating cardiac

toxicity (in some animal models) (Khalid et al. 2014; Mahmoud et al. 2020; Shomar 2012; Hussein et al. 2025; Islam 2024; Sheikh et al. 2024).

In the Hindu tradition, the Ganges is seen as a sacred river and symbol of faith and is associated with healing (Roy 2025; D. Kumar 2017). In a secular context, there are reports from alkaline regions of the river where streptomyces have been isolated (Samson 2025).

These examples are not presented as proof of microbiological causation, but as instances where ecological distinctiveness and sacred attribution coexist.

In the following Orthodox example, comparable juxtapositions of geology and healing narrative are evident. According to long–standing monastic and pilgrimage traditions associated with the Pochaev Lavra, an apparition of the Theotokos left an imprint on stone from which a spring emerged, later becoming an object of healing devotion (Sciacca 2016). The Spring of St. Anne (Onishivtsi) is also in a location nearby. The Pochaev Hill is part of the Volyn–Podilsk Upland. The bedrock that the spring originates from is primarily limestone and chalk (a soft, white, porous form of limestone).

In many traditions, healing sites are interpreted as sacred portals, with scientific accounts and theological interpretations operating within different explanatory frameworks.

Section 3: Contemplation of the Spiritual Nature of Healing Traditions

This section offers philosophical reflection rather than empirical demonstration. Healing traditions are complex phenomena in which ritual symbolism, environmental exposure, psychophysiological regulation, and ecological variables may operate simultaneously. These dimensions are not mutually exclusive, nor reducible to a single explanatory model. The motifs considered below are therefore heuristic lenses intended to clarify possible interactions rather than reconstruct historical causation.

Wholeness and Host Physiology

The word “holy” derives from Old English *hālig*, sharing a linguistic root with “whole.” This etymology reflects a longstanding intuition that healing concerns restoration of integrated bodily, psychological, and social life rather than the correction of an isolated symptom. Early biblical narratives (e.g., Mark 2:5–11; John 5:14) similarly intertwine moral, social, and physical restoration.

Ritual practices associated with healing sites, including silence, pilgrimage, fasting, and prayer, have measurable physiological correlates. Meditation and repetitive prayer have been associated with reductions in sympathetic activation and cortisol (Bhasin et al. 2013). Fasting induces autophagy and modulates macrophage activity (Mackieh et al. 2024). Pilgrimage participation correlates with improved psychological well–being (Sarkar and Negi 2024; Charan et al. 2024)

While findings regarding prayer and clinical outcomes remain methodologically debated (Ironson and Ahmad 2024; Teut et al. 2025; Choudhary and Abirami 2025), ritual context demonstrably interacts with measurable physiological pathways.

These observations do not reduce reported healing to stress modulation. Rather, they establish that ritual environments can alter immune, endocrine, and neurobiological states in ways that may plausibly interact with environmental microbial, mineral, or atmospheric exposures discussed in Section 1.

Molecular Ecology and Combinatorial Complexity

The contemporary shortfall in antibiotic discovery for clinical medicine (Quinn and Dyson 2024) reflects not only antimicrobial overuse but also incomplete understanding of microbial ecology in natural environments. In soil ecosystems, antibiotics are often co–produced with biosurfactants, antioxidants, signalling molecules, and metal–chelating compounds that influence solubility, stability, and synergistic activity (V. Kumar et al. 2023; Banat et al. 2014; Dyson et al. 2025; Mattingly et al. 2020). Therapeutic effectiveness in situ may therefore involve combinatorial molecular ecologies rather than single isolated agents (Dyson et al. 2025).

If soils historically regarded as medicinal contain complex biosynthetic communities, any biological activity would likely arise from interacting metabolites rather than from a singular "miracle molecule." This ecological perspective encourages laboratory models that better approximate environmental complexity, including mineral gradients, spatial confinement, and microbial consortia.

Recent work on the *Streptomyces* "exploring phenotype" demonstrates how spatial constraint and nutrient limitation can activate previously silent biosynthetic gene clusters (Jones et al. 2017). Even intensively studied organisms continue to reveal unexpected metabolic capacities, cautioning against assuming that standard laboratory conditions capture the full biosynthetic repertoire of environmental isolates.

Importantly, isolating antibiotics for clinical use necessarily abstracts them from the ecological matrices within which they evolved. While this reduction has yielded extraordinary therapeutic advances, it represents a

simplification of a more intricate environmental chemistry. Contemporary systems–based strategies, including combination therapies and microbiome–aware interventions, increasingly recognise that therapeutic effectiveness and resistance dynamics are relational phenomena rather than purely single–agent effects.

It is noteworthy that many historical healing traditions frame illness and restoration in integrative rather than reductionist terms. This observation does not imply that spiritual traditions anticipated microbiology. Rather, reflecting on their holistic framing may encourage renewed attention to interaction, context, and balance, themes increasingly central to antimicrobial resistance management and systems pharmacology.

Time, Environment, and Variability

Healing traditions frequently incorporate temporal structure. Pilgrimages unfold over days, and in the Boho tradition the soil is retained for three days before return. Without implying causation, such temporal patterns invite empirically testable questions: Do volatile metabolites fluctuate over multi–day exposure? Does microbial metabolic output vary with hydration, temperature, or confinement?

Streptomyces exhibits a temporally regulated life cycle, with antibiotic production typically associated with maturation phases (Bentley et al. 2002). Many biosynthetic gene clusters remain "silent" under standard laboratory conditions. The broader insight is not that ritual time activates antibiotics, but that both microbial metabolism and human physiology are temporally structured systems responsive to environmental cues.

Beyond biological rhythms, environmental factors add further layers of variability. Naturally occurring geochemical factors associated with limestone substrates, including trace mineral flux and low–level radon emissions, further illustrate environmental complexity.

Variability in reported healing experiences may therefore reflect differences in immune status, microbiome composition, psychological state, environmental exposure, or ecological dynamics not yet characterised. Acknowledging such variability avoids simplistic causal claims while preserving the legitimacy of interdisciplinary investigation.

Fragrance, Perception, and Neurobiology

Fragrance occupies a prominent symbolic and sensory role in many healing traditions. Frankincense, myrrh, and sandalwood exhibit anti–inflammatory, antimicrobial, and sedative properties (Efferth and Oesch 2022; Batiha et al. 2023; Rajsmita and Keshavamurthy 2019). Olfactory neurons project

directly to limbic structures involved in memory and emotion, bypassing thalamic relay. Many *Streptomyces* species produce distinctive volatile compounds such as geosmin, detectable by humans at parts–per–trillion concentrations. Preliminary studies suggest that geosmin exposure during soil–related activities may correlate with altered serotonin signalling and reduced stress markers (Kim et al. 2022). Although early–stage and context–dependent, these findings are consistent with the possibility that microbial volatiles influence mood and perception through established olfactory–neurochemical pathways (Kim et al. 2022).

Whether environmental scents historically contributed to the memorability or perceived distinctiveness of particular landscapes remains speculative and would require archaeological or ethnographic corroboration. Nevertheless, volatile metabolites represent a measurable interface between microbial ecology and human neurobiology, and therefore remain compatible with the empirical ambitions of the present hypothesis.

Epistemic Posture

Taken together, these considerations suggest that healing sites may represent intersections of ritual psychophysiology, complex microbial ecology, geochemical context, sensory modulation, and temporal structuring. None of these dimensions alone provides a sufficient explanation, nor are they mutually exclusive. The appropriate scientific posture is therefore neither dismissal nor credulity, but disciplined attention to layered causation. Engaging seriously with the cultural and spiritual contexts of healing traditions may expand the conceptual frameworks through which ecological, microbiological, and therapeutic questions are posed, not by replacing empirical method, but by encouraging intellectual humility toward complex systems not yet fully understood.

Conclusion

The common motifs between Streptomyces biogeography and spiritual healing sites suggest that some environments later designated as sacred may independently possess ecological characteristics conducive to microbial metabolite production.

As noted earlier, rather than reducing religious healing traditions to chemistry, our hypothesis suggests that ecological distinctiveness and cultural interpretation may have coexisted in historically complex ways. Sacred designation need not be dismissed as naïve empiricism, nor microbiology as a reductive explanation; both may illuminate different dimensions of

the same environments. By attending to ritual context and environmental complexity, biomedical research may identify novel ecological cues relevant to antimicrobial discovery. The hypothesis advanced here invites targeted metagenomic and metabolomic investigation of historically designated healing environments. If empirically substantiated, historically designated healing sites may function as culturally encoded biogeographical leads, analogous to the role of ethnobotanical knowledge in plant–based drug discovery.

The hypothesis advanced here remains provisional and awaits systematic comparative sampling across sacred and non–sacred geochemical environments. A full global comparative study using standardised parameters at sacred and non–sacred sites would be a valuable next step but lies outside the scope of this philosophical hypothesis paper.

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Sažetak

MIKROBIOLOŠKA HIPOTEZA O PRIRODI DUHOVNIH MJESTA ISCJELJENJA

GERRY A. QUINN

Sveta tla i svete vode povezane s povijesnim tradicijama iscjeljenja često su smještene u geološki i kemijski specifičnim okolišima, poput krških vapnenačkih sustava, alkalnih supstrata, špilja i mineralnih izvora. Takvi okoliši također su prepoznati kao važna staništa roda *Streptomyces*, skupine aktinomiceta tla odgovornih za većinu klinički primjenjivanih antibiotika, kao i za brojne antifungalne, antikancerogene, antivirusne i imunomodulatorne spojeve. Ovaj rad razmatra provjerljivu hipotezu prema kojoj se neka povijesno identificirana mjesta iscjeljenja mogu podudarati s ekološki specifičnim krajolicima sposobnima za održavanje bioaktivnih mikrobnih zajednica. Polazeći od dokumentirane izolacije sojeva roda *Streptomyces* koji proizvode antibiotike iz tradicije „blagoslovljene gline" u Bohu (Sjeverna Irska), rad: (1) identificira zajedničke ekološke obrasce između poznatih staništa roda *Streptomyces* i odabranih mjesta iscjeljenja; (2) ispituje kako su takvi okoliši interpretirani unutar specifičnih povijesno–religijskih konteksta, bez pretpostavke teološke uniformnosti; te (3) na filozofskoj razini razmatra mogu li ritualne prakse, osjetilno iskustvo (uključujući njuh) i izloženost okolišu pridonijeti suvremenim biomedicinskim istraživanjima. Šira razmatranja o ritualu i značenju interpretativne su naravi te su izričito razlučena od empirijskog dokazivanja. Umjesto redukcije religijskih tradicija iscjeljenja na kemijske procese, ova hipoteza sugerira da su se kulturna sakralizacija i ekološka posebnost povijesno isprepletale na složene načine. Integriranjem mikrobne ekologije, genomike, metabolomike i komparativne analize, ovo istraživanje predlaže okvir za interdisciplinarno proučavanje okolišnih dimenzija unutar tradicija iscjeljenja.

KLJUČNE RIJEČI: *Streptomyces*; sveta mjesta; mikrobiom; znanost i religija; iscjeljenje

* Gerry A. Quinn, Ulster University, Coleraine, Northern Ireland. E–mail: g.quinn@ulster.ac.uk