



Incarnation, Biology, and Ecology: A Theological Synthesis Through Laudato Si'

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Keywords:

Incarnation; Laudato Si'; Integral Ecology; Ecotheology; Biological Interdependence.

Abstract

The escalating ecological crisis, reflected in climate change, biodiversity loss, and ecosystem degradation, requires an interdisciplinary response that addresses its scientific, ethical, and spiritual dimensions. This study aimed to formulate an integral ecotheological framework by bringing Christian theology, particularly Laudato Si', into dialogue with molecular biology, evolutionary biology, and ecological science. It employed a qualitative, interdisciplinary, conceptual design based on hermeneutical and synthetic analysis. The study examined primary theological sources, Scripture, contemporary ecotheological scholarship, and established scientific literature through theological analysis, comparative interdisciplinary dialogue, ecological hermeneutics, and synthetic integration. The findings indicated that the Incarnation could be understood as divine participation in biological life, affirming the dignity, vulnerability, and interconnectedness of human and nonhuman beings. Molecular biology, microbiomes, biodiversity, and ecological networks revealed the biological unity and mutual dependence of life, while evolutionary suffering and extinction called for a broader soteriological perspective that encompassed the entire biosphere. These insights challenged anthropocentric perspectives and supported ecological conversion through sustainable consumption, environmental justice, ecological restoration, education, worship, and community action. The study concluded that integrating scientific knowledge with Christian theology strengthened integral ecotheology by grounding ecological responsibility in biological interdependence, humility, solidarity, and care for the entire community of life within a shared and vulnerable planet.

INTRODUCTION

The ecological crisis is one of the most pressing challenges of our age and concerns more than the destruction of the natural environment. At its core, it involves a complex network of ethical, social, and spiritual relationships that require critical attention. As concerns regarding climate change, biodiversity loss, and unsustainable resource exploitation become increasingly urgent, Pope Francis's encyclical Laudato Si' provides an important theological contribution toward an integral ecology that integrates ethical and ecological perspectives (Francis, 2015). As disciplines such as biology and ecology continue to reveal the interconnectedness of life and the

functioning of ecological systems, an important question emerges regarding how the theological insights of *Laudato Si'* can engage with contemporary biological and ecological research. Such dialogue may contribute to the development of an ecotheology capable of addressing both the spiritual and environmental dimensions of the ecological crisis. In response to this challenge, this paper proposes a theological synthesis based on the recognition of the interconnectedness of all creation and the need for renewed ethical and spiritual commitments.

The scope of this paper encompasses theology, biology, and ecology, with *Laudato Si'* serving as the theological foundation for analysis and synthesis. This study aimed to formulate an ecotheological framework grounded in Christian theological principles while engaging with contemporary biological and ecological understandings of the interconnectedness of life revealed through molecular biology, evolutionary biology, and ecological science. Based on the central themes of interconnectedness, the dignity of all beings, and the responsibility to care for our common home, *Laudato Si'* provides a critical foundation for examining biological and ecological systems from a theological perspective. Although scholarship on ecotheology and *Laudato Si'* has expanded, the integration of theological reflection with insights from contemporary biological and ecological sciences remains insufficiently explored. This paper seeks to contribute to this discussion by incorporating relevant scientific findings into an ecotheological perspective informed by both scientific knowledge and spirituality.

The goal of this study was to generate a synthesis that addressed both the spiritual and material dimensions of the contemporary ecological crisis by formulating an integral ecotheology informed by the insights of *Laudato Si'* and advances in the life sciences. The synthesis examined how Christian theological concepts, particularly creation and Incarnation, provide insights for ecological ethics and spirituality while generating practical and pastoral implications for ecological conversion, education, and action at individual and community levels.

To achieve this objective, theological literature was critically examined alongside research in molecular biology, evolutionary biology, and ecological science to develop an integral ecotheological synthesis. The sources included primary Christian theological texts, particularly *Laudato Si'*, as well as scientific literature in molecular biology, evolutionary biology, and ecological science. The theological analysis focused on key themes in *Laudato Si'*, including creation, Incarnation, and integral ecology, and examined their relationship with concepts emerging from scientific research. The study employed comparative analysis, synthesis, and ecological hermeneutics. The analysis included reflections on evolutionary suffering and biodiversity loss, the theological significance of human microbiomes and symbiotic relationships, and the relationship between biological interconnectedness and ecosystem structures as resources for theological and ethical reflection.

Analysis of current research in ecotheology and *Laudato Si'* scholarship revealed both significant contributions and remaining gaps. Theological and ethical studies have increasingly engaged with integral ecology and its relationship to contemporary ecological challenges, including climate change and biodiversity decline. However, research that incorporates biological and ecological perspectives, particularly those related to molecular biology, evolutionary science,

and systems ecology, remains limited. Although some theologians have incorporated scientific insights into ecotheological discussions, the systematic integration of scientific understandings of biological systems remains underdeveloped. This paper addressed this gap by constructing an interdisciplinary synthesis that connected theological reflection with scientific perspectives through critical analysis.

METHOD

Research Design

The study employed a qualitative, interdisciplinary, and conceptual research design to develop a theological synthesis integrating Christian doctrine, contemporary biological science, and ecological thought. Rather than generating empirical data, the research focused on interpretive integration by placing established theological sources in systematic dialogue with peer-reviewed scientific literature. The design was hermeneutical and synthetic, aiming to develop theoretical insights in ecotheology rather than test hypotheses.

The research framework was informed by integral ecology as articulated in *Laudato Si'*, which functioned not only as a normative theological source but also as an epistemological foundation for interdisciplinary engagement. Theology, biology, and ecology were approached as distinct yet complementary fields of inquiry, each maintaining its methodological integrity while contributing to a coherent interpretive synthesis.

Primary Theological Sources

The principal theological material consists of magisterial Catholic texts, with *Laudato Si'* (Francis, 2015) serving as the primary normative and conceptual reference. Additional theological sources include Scripture, especially Pauline texts on cosmic redemption (e.g., Romans 8), and contemporary theological scholarship in ecotheology, theological anthropology, creation theology, and soteriology. Secondary theological materials include works by major contributors to ecotheology and to the science–theology dialogue, such as Denis Edwards, Elizabeth Johnson, Celia Deane-Drummond, Sean McDonagh, and related authors who explicitly engage the biological and ecological dimensions of Christian doctrine. These sources are selected for their scholarly credibility, peer-reviewed status, and relevance to the themes of incarnation, evolutionary suffering, and ecological communion.

Scientific and Ecological Sources

Scientific materials are drawn from peer-reviewed literature in molecular biology, evolutionary biology, microbiology, and systems ecology. These include foundational biology textbooks, review articles, and empirical syntheses addressing genetic intelligibility, evolutionary dynamics, microbial ecology, biodiversity, and ecosystem networks. The study intentionally prioritizes well-established scientific findings rather than speculative or contested hypotheses. Scientific sources are not treated as theological authorities but as descriptive accounts of biological reality that inform theological interpretation. Particular attention is given to research on the human microbiome, ecological interdependence, and evolutionary processes involving suffering, extinction, and regeneration.

Methodological Approach

The research employs four mutually reinforcing methodological moves.

1. Theological Analysis

Key theological concepts — creation, incarnation, redemption, sin, and sacramentality — are analyzed using classical doctrinal methods, including textual interpretation, conceptual clarification, and internal coherence within the Christian tradition.

2. Comparative Interdisciplinary Dialogue

Theological claims are placed in dialogue with scientific descriptions of biological systems. This comparative step does not seek concordism but critical correlation, identifying points of resonance, tension, and mutual illumination between theological meaning and scientific explanation.

3. Ecological Hermeneutics

Biblical and theological texts are interpreted through an ecological hermeneutic that foregrounds non-human creation, materiality, and relationality. This approach allows scriptural motifs such as incarnation, groaning, communion, and hope to be reread in light of contemporary ecological realities.

4. Synthetic Integration

Insights from theology and biology are synthesized into a constructive ecotheological framework. This synthesis generates normative implications for ethics, spirituality, and pastoral praxis without collapsing scientific description into theology or theology into scientific naturalism.

Analytical Boundaries and Limitations

This study does not conduct primary empirical research in biology or ecology, nor does it propose testable scientific models. Its claims about biological processes rely on existing scientific consensus. Likewise, it does not aim to resolve metaphysical debates in the philosophy of science but adopts a realist, non-reductive stance toward scientific knowledge. The synthesis is situated within a Christian — specifically Catholic — theological horizon and does not claim universal applicability across all religious traditions. Nonetheless, the framework is presented as open to ecumenical and interreligious dialogue, particularly in contexts of shared ecological concern.

Ethical and Scholarly Integrity

All sources are cited according to academic standards appropriate for interdisciplinary theological scholarship. Scientific data are represented accurately and without theological instrumentalization. The study consciously avoids proof-texting, ideological readings of science, or the subordination of empirical findings to preconceived doctrinal conclusions. The methodology reflects a commitment to intellectual humility, disciplinary respect, and constructive engagement — principles that mirror the ethical vision of integral ecology developed within the study itself.

RESULTS AND DISCUSSION

Incarnation as Biological Participation

By participating in biological life, God indicates that the incarnation relates to the entirety of creation, implying a certain spiritual and material unity. This can be a difficult idea for those

coming from a dualistic perspective, but to consider Christ in terms of the evolutionary story, it is important to note the spiritual significance of biological life. This ties directly into the overall topic of ecological interconnectedness and its relationship to a theological worldview.

Francis's integral bioethical approach provides an epistemological foundation for understanding the Incarnation not merely as a spiritual event but as God's participation in the biological web of life, in which dignity, vulnerability, and the interdependence of all creatures form the horizon of ethical reflection and ecological salvation.

1. The Word Made Flesh and the Assumption of Biological Life

The Incarnation, understood as the Word made flesh, implies that God assumes not only human form but biological life itself — sharing in growth, mortality, and vulnerability common to all living things. It denies any dualism separating matter from spirit, affirming instead the unity of both dimensions. Edwards' concept of "deep incarnation" captures this: God is present in all of creation, including the evolutionary and ecological processes, imperfections and pain included.

This means God in Christ embraces the biological experience of all living beings, not just humans. Biological life is not merely a backdrop to spiritual life but is embraced by divine love through birth, growth, suffering, and death — conditions all creatures share interdependently. Kelly's ecological anthropology holds that "humans are not the sole, or even the most important, inhabitants of this earth," a view that calls for ecological conversion: not just scientific awareness, but a change of heart that reorients human existence within the wider community of life.

Read within the planet's evolutionary story, the Incarnation affirms biological existence as spiritually valuable, and requires dismantling hierarchies that place spirit above matter. As Kelly states, "salvation history is part of planetary, evolutionary history; they cannot be separated." Kampourakis adds the biological fact that *Homo sapiens* are, in evolutionary terms, a very recent arrival — a reminder to hold human significance with appropriate humility.

Evolutionary science reveals life's deep interdependence and gives the Incarnation added ecological weight. Kampourakis notes that microorganisms vastly outnumber all other species and form, in his words, "the very backbone of the Earth system without which no higher life forms would ever have evolved, not to mention humans." The Incarnation as biological existence thus extends to affirming even the microbial world — echoing Kelly's claim that "neighbor includes all our planetary neighbors, humans, and nonhumans."

Ecological hermeneutics offers a way to integrate these insights into scriptural reading. Daly-Denton argues that *Laudato Si'* reinterprets biblical themes in light of the ecological crisis, offering not just scientific analysis but hope and healing. She highlights neglected biblical "voices" of the Earth — celebration, lament, and resistance to ecocide — and reads the Incarnation as redemption not only for humankind but for the whole web of life. Under this lens, soteriology shifts: Christ's affirmation of biological existence becomes also the redemption of ecosystems and nonhuman species.

Scripture's recurring image of the "groaning of creation" (Romans 8:22) reflects the suffering all organisms bear amid ecological crisis. Edwards notes that biological death and suffering long predate humanity by hundreds of millions of years — facts that do not negate God's presence in

life, but deepen our understanding of divine solidarity with all suffering creatures. Through the Incarnation entering the biological world, this event carries ecological significance that renews the Earth's prospects.

The "whole Earth" framework, as Sean Mickey argues, is necessary for solving today's ecological crises, requiring theology and natural science to work together within one interconnected planetary narrative. Situating the Incarnation within this evolutionary and planetary story offers a path toward integrating theological and ecological thinking, calling faith and scientific institutions into joint pursuit of sustainable solutions.

Cooperation between theology and science can also strengthen ecological ethics: theology provides an ethical narrative of participation in God's engagement with creation, while science reveals biological interdependence. Edwards shows how evolutionary biology reflects both divine creativity across millions of years and the fragility of planetary life — a combination that helps explain both the origin and possible healing of ecological suffering. Katherine Rigby insists that "Christian ethics can no longer be only about what is owed to other humans," but must extend to animal welfare and ecological responsibility.

This grounds ecological discipleship: faith communities, Rigby notes, have long been part of environmental movements, from climate justice alliances to interfaith conservation partnerships. Anchoring ecological responsibility in the theology of a God who dwells in biological life strengthens the ethical and spiritual case for sustainable practices — sustainable consumption, community-based stewardship, and ethical waste management. Kelly's remark that "in the Eucharist, we can have communion with all of life on the planet" suggests daily practices, too, can be reimagined as communion with the whole web of life.

The Incarnation, then, calls Christian tradition to embrace both the biological narrative and ecological participation — a theological lens for understanding our place in Earth's community of life, and a call to join the global effort toward more sustainable solutions. This is necessarily a collaborative task between science and theology.

2. Soteriological Reach into the Whole Network of Creation

Laudato Si's vision of salvation moves beyond an individualistic and human centered understanding of redemption to include all creation. It recognizes the damaged relationship between humanity and the ecological community and considers nonhuman life as part of God's healing grace. Kelly (2016) argues that this perspective requires a radical ecological theology capable of responding to contemporary challenges involving biodiversity and ecological integrity. Salvation therefore needs to be understood not only as the spiritual destiny of human beings but also as the restoration of ecological relationships. Kelly (2016) emphasizes a re envisioned soteriology that directly connects ecological restoration with spiritual renewal. Within this framework, ecological care becomes an expression of God's redemptive purpose.

The concept of ecological sin is central to this expanded understanding of salvation. Ecological sin refers to the destruction of creation and the disruption of proper relationships between humans and the nonhuman world. Lane and Lane (2020) argue that recognizing ecological sin should become an important starting point for Christian ethical engagement and

redemption. Reconciliation with God therefore also requires reconciliation with creation. Through ecological conversion, Christians can express their faith by protecting and restoring ecological systems. Ecological restoration can consequently be understood as an act of redemption.

Biblical themes of cosmic redemption and interdependence also support this perspective. Banacos (2023) explains that the groaning of creation in Romans 8:22 can be interpreted more broadly when considered in relation to contemporary ecological crises. Mass extinction, ecosystem destruction, and environmental degradation demonstrate that suffering affects the wider biosphere. Banacos (2023) therefore argues that theology must address suffering throughout the history of life. This includes both environmental damage caused by humans and suffering that occurs within evolutionary processes. Salvation can thus be understood as involving creation itself rather than humanity alone.

The ecological wounds of the biosphere should therefore become a concern for theology as well as biology. Deane Drummond and Deneulin (2021) emphasize that Christian hope should take the nonhuman community seriously as participants in redemption. Limiting salvation to human beings overlooks the importance of ecosystems and other organisms within creation. Rolston (2006) offers another perspective by interpreting suffering, extinction, predation, and mutation within evolutionary processes as contributing to creativity, complexity, biodiversity, and regeneration. From this perspective, creation is an ongoing process rather than a completed event, and salvation can be associated with the continuing renewal of the whole planet.

This expanded soteriology also requires recognition of the Holy Spirit within natural processes. Lane and Lane (2020) argue that the natural world can be understood as a sacrament of the Holy Spirit. Integral ecology helps connect this theological understanding with ecological science by emphasizing cooperation between theology, natural science, social science, environmental ethics, and education. Christian communities can embody this perspective through ecological stewardship, worship, education, and participation in environmental restoration. In this way, salvation becomes something that is not only believed but also practiced through actions that contribute to ecological healing.

The ecological dimension of salvation also extends beyond Christianity. The Forum on Religion and Ecology, founded by Mary Evelyn Tucker and John Grim, reflects the growing involvement of religions in responding to ecological challenges. Tucker and Grim (2016) note that religions across the world are recognizing their responsibility toward ecological problems. Examples include ecological interpretations of Islamic law, conservation efforts, interfaith environmental initiatives, and religious participation in global climate discussions such as COP21. The Sustainable Development Goals adopted by the United Nations in 2015 similarly demonstrate the connection between ecological and social concerns. Tucker and Grim (2016) emphasize that planetary well being and human well being cannot be separated.

Integral ecology therefore requires attention to both biological diversity and cultural identity. Deane Drummond and Deneulin (2021) explain that ecological healing must address both ecological systems and the cultural histories of communities. This includes concern for poor and marginalized people, as well as other species. Laudato Si also emphasizes basic needs such as

clean water, clean air, food, health, and housing, which are closely connected to environmental conditions. Indigenous and marginalized communities may also provide important ecological knowledge because of their close relationship with local environments.

In conclusion, a soteriology of the biosphere expands redemption to include the wider community of life and reshapes the understanding of creation itself. Integral ecology and ecopedagogy provide a framework for connecting biological, cultural, social, and theological dimensions of ecological restoration. Johannine theology presents divine love as a force embracing all creation, while Max Planck's understanding of consciousness as a foundation of reality offers a broader metaphysical perspective on biological order and evolution. Together, these perspectives support an understanding of the Incarnation and salvation as a divine encounter with the whole ecological community rather than humanity alone (Tjandrawinata and Atawolo, 2024a, 2024b).

Creation as *Liber Naturae*: Molecular Biology and Divine Intelligibility

From the intricacy of the genetic code to the complexities of ecological networks, the intelligibility of biological systems expresses divine wisdom in creation. This inquiry investigates these natural orderings and explores how science and theology reveal God's presence within life. This exploration is anchored within the context of ecological and spiritual conversation.

1. Biological Order and Intelligibility as Expressions of Divine Wisdom

The order and intelligibility of biological systems, from DNA to ecological networks, can be understood as expressions of divine wisdom. Molecular biology shows that genetic information is encoded, transmitted, and repaired through highly organized processes. Campbell et al. (2009) argue that the intelligibility of the genetic code can direct theological reflection toward God as the source of creation's rationality. Biological order is also visible in the way cells with the same genome develop different functions through gene expression. Kampourakis (2013) explains that biological systems cannot be understood only through mechanical determinism because living organisms interact with their environments in complex and dynamic ways.

The importance of microorganisms further challenges anthropocentric understandings of creation. Microbial communities form a major foundation of planetary life and contribute to essential ecological processes. Kampourakis (2013) describes microbes as fundamental to planetary health because they support biogeochemical cycles and constitute a significant part of Earth's biomass. This perspective questions the assumption that humans occupy a superior position within creation. Instead, all organisms can be understood as participating in an interconnected order that reflects divine wisdom.

Evolution also demonstrates that biological order is dynamic rather than static. Campbell et al. (2009) describe the biosphere as a self organizing system in which old forms change and new forms emerge. Evolution therefore combines order, adaptation, creativity, and transformation. Sulfate reducing bacteria provide another example because they contribute to sulfur and iron cycles that are important for planetary health (Anandkumar et al., 2016). Even microscopic organisms therefore participate in processes with effects extending across entire ecosystems.

These findings provide an important foundation for dialogue between science and theology. Edwards (2019) and Campbell et al. (2009) emphasize that such dialogue should avoid both

scientific reductionism and simplistic theological explanations. Scientific mechanisms can be recognized while also allowing theology to interpret the deeper meaning of creation. Esbjörn Hargens (2009) further notes that ecology contains different approaches that reveal different aspects of nature. An integrative perspective can therefore bring these insights together and understand ecological order as a participatory expression of divine wisdom.

2. Scientific Inquiry and Contemplative Theology as Complementary

Scientific inquiry provides evidence about ecological change, including increasing carbon dioxide, rising temperatures, sea level changes, biodiversity loss, and ecosystem degradation (Howell, 2021). However, scientific data alone does not determine the ethical meaning of these changes. Contemplative theology provides a framework for interpreting scientific knowledge and connecting ecological facts with responsibility, purpose, and action. This relationship reflects the approach of *Laudato Si'*, which connects the book of nature with the book of revelation (Kelly, 2016).

The integration of science and theology helps prevent reductionism. Ecological problems such as biodiversity loss and ecosystem destruction are not only scientific issues but also moral and spiritual concerns. Kelly (2016) emphasizes ecological conversion, the relationship between science and religion, and ecological action based on religious ethics. Scientific findings can therefore strengthen faith based reflection and encourage communities to respond to ecological crises through responsible action.

The genetic code provides one example of this dialogue. The common molecular basis of heredity across living species reveals the biological unity of life and can encourage theological humility by placing humanity within the wider evolutionary community (Kampourakis, 2013). Microbial life provides another important example. Microorganisms contribute to plant growth, disease prevention, food production, ecosystem stability, carbon regulation, nutrient cycles, waste detoxification, water purification, medicine, biofuels, and human health. Their importance demonstrates that ecological relationships extend far beyond what is visible to humans.

Scientific knowledge also deepens understanding of human biological dependence on other organisms. Microbiomes consisting of bacteria and other microorganisms support digestion, immunity, and environmental adaptation (Kampourakis, 2013). This biological interdependence can strengthen contemplative theology by encouraging a broader understanding of communion with creation.

The order and beauty observed in nature have long provided resources for theological reflection. Campbell et al. (2009) argue that the intelligibility of nature allows science to investigate its rational structure while theology reflects on its meaning. Science provides measurable evidence, while theology contributes ethical interpretation and spiritual motivation. Deane Drummond (2015) therefore emphasizes that ecological problems require more than technical solutions because they also involve cultural, ethical, and spiritual dimensions. Science and contemplative theology can consequently work together to support ecological restoration, human flourishing, and responsible care for the Earth.

Evolution, Suffering, and the Paschal Horizon of Creation

The evolutionary process of constant suffering, extinction, and death poses a great challenge to classical theories that see creation as harmonious. Paleobiology and evolutionary science suggest the presence of pain as an intrinsic part of the creaturely world. Evolutionary suffering, Banacos (2023) writes, has been part of evolutionary history for hundreds of millions of years and millions of years prior to human beings. The evidence points away from theological claims for an innocent state without death preceding the fall in Eden. The sheer weight of the empirical evidence makes the possibility that God created the world perfectly prior to Adam's sin not only an incredulous explanation, it also leaves theology with the arduous task of interpreting suffering and death as being integral components of the process of species diversity and ecological complexity.

While classical doctrines claim that all suffering and death in the world are caused by humans through their fall from grace, modern evolutionary science reveals that these events have occurred for hundreds of millions of years before humanity existed. According to Edwards (2019) and Banacos (2023), fossil evidence for predation and extinction is present millions of years before humans, and biological death in itself has occurred since life's very inception. Thus, evolutionary science necessitates a soteriology that sees suffering and death as part of the goodness of creation. For Banacos (2023), a proper appreciation of the fact that evolutionary suffering is an intrinsic aspect of processes that have produced the biodiversity that makes life possible will lead to an appreciation of the need to reinterpret soteriology to accommodate evolutionary reality.

The evidence for mass extinctions and the evolutionary bottlenecks that they create reveal a world of creative destruction, where the cycles of dying and renewal were a significant contributor to the biological processes of adaptation and increasing biological and ecological complexity. According to Peacocke (1991), those discontinuities that occur in the history of the world are critical moments that offer opportunities to reinterpret suffering not only as a loss but as a context for appreciating divine creativity and presence. Peacocke's assertion helps open our thinking to a more dynamic view of creation, allowing suffering to be seen as playing a constructive role in the development of life on Earth. The recognition of the constructive role of such dramatic events is a theologically insightful countermeasure to the common experience of the loss inherent in the history of evolution.

Within this context, the biblical theme of creation's groaning in Romans 8:22 can be reinterpreted to reflect the evolutionary suffering of the entire universe. According to Banacos (2023) and Edwards (2019), the groaning of creation encompasses the entire cosmic and evolutionary reality, and it is not merely humanity's suffering as it is alienated from God. Consequently, suffering, death, and pain in the non-human world are crucial elements in the overall economy of redemption. This cosmic and evolutionary understanding of redemption serves as a powerful antidote to the traditional spiritualizing and individualizing reading of groaning that obscures the profound ecological and evolutionary relevance of the verse.

One of the major challenges for any type of evolutionary or scientific theology is to avoid being naive or overly pessimistic. Banacos (2023) acknowledges that we have to affirm God as

creator and hold fast to the goodness of creation while affirming the intrinsic reality of evolutionary suffering, death, and pain in the creation.

Modern evolutionary biology helps theology understand how the doctrine of original sin and any theodicy must be reinterpreted in light of the geological and fossil records. According to Edwards (2019), the fossil record reveals geologic and paleontological evidence of pain and organismal suffering millions of years before the arrival of humans on the planet, which contradicts any standard interpretation of the Fall in Eden. Another thing Edwards notes is that, if an organism has a complex nervous system, it has the capacity to feel pain. And as pain arises as a necessary consequence of having such a nervous system, it should not be assumed to be morally problematic. Therefore, suffering occurs as an evolutionary adaptation that fosters sentient and complex life. Thus, this helps put the traditional Western theodicy on trial and opens theology to consider divine providence as a way in which suffering is integrated into God's purpose for life.

As Edwards (2019) suggests, *Homo sapiens* have arrived relatively late in the evolutionary history of the universe. Thus, a theology of creation has to consider the cosmic and pre-human dimensions of redemption and reconcile this to a standard interpretation of creation as found in Genesis. In light of this, theology must develop new paradigms for addressing the evolutionary dimensions of life and death to better grasp God's engagement and participation with creation.

Because evolutionary suffering is part of divine providence and is thus present within creation, a soteriology that addresses suffering must encompass the entire history of the universe. For Banacos (2023), any proper appropriation of an evolutionary-scientific view in soteriology must reject the dualistic way of thinking of the world of nature, that separates spirit from matter and good from evil, to arrive at a soteriology that transcends dualism and addresses biological, evolutionary, and ecological dimensions.

According to Arthur Peacocke, the whole process of evolutionary history is made up of deaths and extinctions, and we can consider these cycles as elements in the construction of new levels of richness and diversity. The ways of life, through their death, make room for other and newer ways of life to emerge. In Peacocke's (1991) view, evolutionary processes are a mixture of both creative destruction and renewal.

Peacocke further highlights a theology of nature in which the entire universe is perceived to be open to continual participation in the creativity and life of God. Evolutionary creation, as it occurs, expresses the immanent and participatory nature of divine creativity and also leads us to acknowledge the inherent relationality and sacramental character of evolutionary change. Consequently, it reveals to us how divine creativity occurs in the world through relationality and emergence.

In *Laudato Si'*, Paschal redemption is understood in a very broad and all-encompassing cosmic, environmental, and ecological sense. For Gruber (2017), this notion expresses the Church as an ecosystem that is connected to other ecosystems within the biosphere. In the realm of life in general, the ecosystem concept helps us see connections and interconnectedness rather than division and discreteness, to better situate the role of divine creativity within this complex system of living beings. It helps theology overcome the Church as a discrete entity and calls us to solidarity

with the entire community of living things and encourages practical responses of mourning, caring, and active involvement as expressions of the Paschal nature of things.

The fact that many organisms have died to allow life to evolve to present times creates many spiritual and practical challenges, especially within the context of modern loss of biodiversity. According to Deane-Drummond (2022), the destruction of species and their habitats is one of the biggest ethical and spiritual challenges that humanity faces, and species loss poses a serious challenge to modern ecological thought. Thus, a science-inspired ecotheology should engage a discussion of evolutionary dimensions with modern ecology and work at addressing issues of habitat destruction and mass extinctions. Also, this theological conversation needs to be conducted as part of interdisciplinary discussions between biology and theology.

To put all this within the context of “integral ecology,” Ojeifo (2025) argues that ethics of place are integral to any ethics of human-earth interaction and any environmental and sustainability discourse, policy, and practice. To do so, it must become part and parcel of Christian and secular thinking, culture, and pedagogy.

The Human Body as Ecological Communion

The human body, understood as an ecosystem, shows how essential biological interconnection is to sustaining life. Research on the human microbiome, home to trillions of microorganisms, reveals how deeply the body is embedded within a wider ecological environment, performing vital functions from nutrient absorption and immune response to fighting pathogens. Iheka (2018) notes this microbial environment is damaged by pollutant exposure, antibiotic use, and industrial food processing, examples that reveal ecosystems' fragility while supporting Laudato Si's claim that caring for one's body is linked to caring for the planet. The microbiome thus grounds this ecological theology scientifically.

The body as ecosystem also depends on diverse life forms for health. The immune system thrives on exposure to diverse microbial life, yet the planet is rapidly losing this diversity through deforestation, pollution, overfishing, and rising temperatures, increasing susceptibility to immune-based disease and infection. Iheka's (2018) research suggests bodily health is directly harmed by biodiversity loss, meaning an integral ecology must treat both bodies and ecosystems as points of intervention.

Laudato Si' presents humanity as connected to creation rather than above it, rejecting anthropocentrism. Deane-Drummond and Deneulin (2021) note that while the body is often seen as the space of individual identity, its processes mirror the ecological environment, expanding Christian stewardship to include the body itself, individually and as a symbol of planetary health.

Iheka (2018) and Deane-Drummond and Deneulin (2021) examine cases from Flint, Michigan and Abidjan, Ivory Coast, where contaminated water and toxic dumping significantly damaged human health. Both show environmental degradation causing bodily harm that demands public and ecological justice together, disproportionately burdening marginalized populations, and raising questions about how integral ecology relates to social justice. Laudato Si', they argue, calls for responses to both ecological and social injustice through solidarity with vulnerable groups and

sacramental community, meaning integral ecology requires public health and social justice alongside ecological care.

Accepting the body as ecological communion carries theological responsibility for creation. Kampourakis (2013) argues bodily boundaries are more porous than once thought, with the surrounding environment shaping health; bodily health depends on clean air, water, and diverse microbial, animal, and plant life, all part of this broader communion, obligating humans to preserve ecosystems for both human and nonhuman flourishing.

Christian relationality shares affinities with deep ecology. Bhandari (2025) critiques Western philosophy's anthropocentrism, calling for recognizing human connection to all life forms and valuing each part of the web of life as highly as humans, a view supported by biological evidence of interdependence. Seen this way, human dominion sits in tension with the reality that each part of creation must thrive for others to thrive.

Kohlhaas and McLaughlin (2019) develop this into "relatiocentrism," an approach to Christian anthropology centered on relationship to others and the natural world rather than the isolated individual. For relatiocentrism to align with deep ecology, ecological relationships must be essential to human identity; the authors describe the body as "the ground of encounter, that is, the space where humans and nonhumans intersect" (p. 87), echoing St. Paul's image of the body as church, a relational organism whose parts depend on one another such that harm to one part harms the whole.

These implications are significant: damage to ecosystems is damage to all life within them, humans included. Iheka (2018) notes biodiversity loss disrupts biological networks essential to human functioning, making ecosystem care and human care inseparable, a point sharpened by the crisis's disproportionate impact on marginalized communities, who bear both economic burden and direct health harm. As Deane-Drummond and Deneulin (2021) put it, "environmental stewardship can only make sense if we consider human beings and their bodies as an inextricable part of a larger ecological system." Flint and Abidjan again illustrate this, with contaminated water and illegally dumped toxic waste causing lasting harm disproportionately to marginalized populations; Iheka (2018) argues that ignoring the public health dimension of ecological harm leaves communities unable to fully recover.

Laudato Si' extends ecological responsibility beyond plants, animals, and microbes to cultural and social environments, noting that "as well as the patrimony of nature, there is also an historic, artistic and cultural patrimony, which is likewise under threat" (no. 142). Deane-Drummond and Deneulin (2021) add that cultural diversity itself builds resilience, since "one does not merely use knowledge, one inherits cultural capital and becomes enriched and broadened from a world of diverse cultures."

Viewing the body as part of ecological communion demands moral and spiritual transformation. Kohlhaas and McLaughlin (2019) see this communion as space for relational theology to flourish, decentering humanity as merely one interdependent member of creation, echoing St. Paul's body of Christ, where each part's weakness affects the whole. This requires humility, understood not as self-degradation but as honest acknowledgment of humanity's place

within creation, paired with gratitude for creation's provision, virtues that ground Christian ecological responsibility even where they challenge assumptions of human superiority.

Practically, Deane-Drummond and Deneulin (2021) write that "integral ecology emphasizes that one has to embody the Christian virtues in one's bodily practices in order to be able to witness the Gospel," through changes in diet, energy use, and waste, such as reducing meat consumption, shifting to renewable energy, and moving from a "throwaway culture" to recycling and composting. Runtuwene (2025) shows this in practice: congregations exposed more often to ecological preaching and creation-themed worship participated more frequently in ecological service (p. 429), illustrated by a Surabaya church whose members planted over 400 trees as an ongoing ecological response. A second case describes a Brazilian church's twenty-year agroforestry effort that restored biodiversity while generating economic and cultural benefits that strengthened communal solidarity. Together these cases show embodied theology expanding outward from individual practice into ecological restoration and community life, underscoring that recognizing the body as ecological communion carries real implications for theology, ethics, and practice alike.

Practical and Pastoral Implications

The practical and pastoral dimensions of ecological faith stress that embodied spirituality and commitments to everyday practices of divine solidarity with creation are vital expressions of the belief in the oneness of God and the oneness of creation. In the pastoral sense, this part reflects on how personal and community practices of daily ecological awareness and care for the Earth nurture one's faith in divine solidarity with all life. Within this part of the exploration, these reflections invite a greater and more practical exploration of how ecological awareness and awareness of divine presence translate into our everyday actions.

1. Spirituality of Embodiment and Biological Humility

A spirituality of embodiment based on biological humility requires a new understanding of humanity's relationship with ecology. Modern biology shows that the human body is closely connected to biological systems through the microbiome, immunity, and relationships with other species. Iheka (2018) explains that biological interconnection challenges the separation between body and spirit and supports a theological understanding of the sacred within biological life and creation. Humans therefore should not be viewed as rulers of nature but as participants within the wider community of creation. Biological interconnection should be understood as an important part of spirituality and ethics because environmental destruction also threatens human biological life.

Pope Francis's integral ecology in *Laudato Si'* calls for humility at both personal and planetary levels. Kelly (2016) explains that human beings must recognize their limited understanding of the complexity of Earth's biological systems. This humility encourages relational care rather than human domination. The recognition that microorganisms and other forms of nonhuman life play essential roles in sustaining life further challenges human-centered thinking. Biological humility therefore becomes not only a spiritual attitude but also a moral responsibility toward the common home.

Practicing biological humility requires awareness of human dependence on other living beings. Collins (2010) describes this as spiritual intelligence, which should encourage people to reflect on their ecological footprint, reduce overconsumption, and develop ecological prayer and ritual. Environmental damage also affects human beings unequally. Peppard (2016), through the concept of water justice, shows that polluted water and toxic environments can seriously affect human health, particularly among marginalized communities. Ecological health is therefore closely connected to social justice and human well-being.

Traditional African indigenous knowledge also provides an example of ecological spirituality based on biological humility. Masoga (2023) describes traditions that promote conservation, stewardship, and rituals respecting the natural world. Such perspectives can contribute to Christian ecological thinking through intercultural dialogue. Deane-Drummond and Deneulin (2021) further emphasize that biological and cultural diversity are important for ecological resilience and should be protected together.

Moving from anthropocentrism toward communion also supports human moral development. Kohlhaas and McLaughlin (2019) describe *relatiocentrism*, which understands humans as existing in relationship with God, other people, and creation. This relational perspective encourages humility, gratitude, solidarity, and stewardship. Deane-Drummond and Deneulin (2021) show that embodied ecological action can include sustainable consumption, alternative energy, recycling, healthier lifestyles, and ecological restoration. Runtuwene (2025) also demonstrates that ecological liturgy can increase environmental awareness and participation among Christian communities. Thus, biological humility can become an active spirituality that supports both human flourishing and the protection of the wider ecological community.

2. Ecological Conversion as Biological Conversion in Daily Christian Life

Ecological conversion as biological conversion calls Christians to recognize that daily life, human health, spirituality, and ecological systems are deeply connected. Iheka explains that the human microbiome, local ecosystems, and human health depend on one another. This understanding challenges the idea that human well-being can be separated from environmental well-being. Therefore, ecological conversion must include concern for microorganisms, biodiversity, and the health of ecosystems. Sustainable agriculture, reduced chemical use, pollution control, and protection of local species are practical expressions of this conversion.

Kelly connects ecological conversion with bodily health and spiritual practice. Pope Francis's concept of integral ecology encourages Christians to reduce water and energy consumption, minimize waste, and make ethical consumption choices. Francis and McKim also suggest reducing meat consumption, using public transportation, supporting local farmers, and making choices that connect Christian faith with material and ecological realities. In this sense, biological conversion requires Christians to express their faith through practices that support both social justice and biological flourishing.

Ecological conversion also requires a shift away from consumerism. Kelly emphasizes the importance of integrating sacramental awareness into everyday life through prayer, ethical consumption, reduced waste, and responsible use of water and energy. Fasting can develop

awareness of the biological needs of other creatures, while feasting can become an expression of gratitude for the abundance of creation. Ecological practices can therefore function as forms of spiritual discipline. Choosing reusable materials, reducing meat consumption, and selecting less polluting products can cultivate simplicity, restraint, and awareness of human dependence on creation.

Scientific knowledge is also essential to this process. Scarel's discussion of planetary boundaries identifies climate change, land use, biodiversity loss, and changes in nitrogen and phosphorus cycles as major limits affecting planetary life. Ecological conversion must therefore respond to scientific evidence. Williams (2019) emphasizes that *Laudato Si'* encourages dialogue between theology and natural science rather than rejecting scientific inquiry. Christians are called to recognize their limitations, remain open to scientific knowledge, and apply this knowledge to protect the Earth community.

Finally, ecological conversion must include environmental justice and collective action. Deane Drummond and Iheka show that environmental degradation often affects vulnerable communities most severely. Iheka emphasizes the need to recognize how toxic substances and ecological destruction affect human bodies. Conversion therefore involves not only changing personal habits but also supporting healthier ecosystems and communities. Reducing emissions, supporting sustainable agriculture, protecting local environments, and participating in community action become expressions of faith. Ecological conversion is consequently both personal and communal, involving a practical reorientation of human life toward God, creation, and responsibility for the whole community of life.

Toward an Integral Ecotheology Grounded in Biology

The incarnational theology of *Laudato Si'* calls for dialogue with molecular biology and evolutionary science to develop an integral ecotheology. Kelly (2016) and Conradie (2020) argue that incarnation should not be understood only through God's presence in Jesus Christ, but also through God's presence in all biological life. Molecular biology, particularly the discovery of a universal genetic code, demonstrates the interconnectedness of all living beings and supports a theological understanding that moves beyond anthropocentrism (Kampourakis, 2013; Kelly, 2016). Evolutionary science also shows that nonhuman organisms possess their own agency, value, and role within ecological systems (Conradie, 2020). Therefore, humans should understand themselves as participants within the Earth Community rather than as rulers of nature.

Biological principles such as homeostasis, biodiversity, and interdependence can further enrich theological reflection. Homeostasis illustrates the importance of ecological balance, while biodiversity demonstrates the value of different forms of life. Kelly (2016) argues that biodiversity loss and extinction should therefore be treated as serious theological and ethical concerns. Interdependence is also evident in the human microbiome, where microorganisms are essential to human survival (Deane-Drummond & Deneulin, 2021). These findings support an ethic of ecological solidarity that rejects the idea that nonhuman beings exist merely for human benefit. Scientific exploration can also generate wonder and appreciation for the complexity of creation,

allowing science and theology to complement one another. As Conradie (2023) explains, science addresses questions of what happens, while theology explores why it matters.

This dialogue should lead to concrete ecological responsibility. Faith communities can express ecological accountability through sustainable land management, ecological liturgy, climate action, restoration programs, and environmental justice initiatives (Puglisi & Buitendag, 2022; Kelly, 2016). Such efforts should also recognize cultural diversity and the ecological knowledge of Indigenous and marginalized communities, whose experiences are closely connected to biodiversity loss and climate change (Deane-Drummond & Deneulin, 2021). Interreligious cooperation can further strengthen ecological action by bringing together different spiritual perspectives and resources to restore damaged ecosystems. Thus, integrating theology, biology, and ecology provides a foundation for humility, solidarity, and responsible care for the whole community of life.

CONCLUSION

This research demonstrated that an integral ecotheological approach can meaningfully connect Christian theology with contemporary molecular biology and evolutionary ecology in addressing the ecological crisis. The study showed that the doctrines of Incarnation, creation, and redemption could be understood beyond anthropocentric perspectives by recognizing the intrinsic value and interconnectedness of human and nonhuman life. Molecular and ecological systems revealed patterns of order, interdependence, and vulnerability that enriched theological reflection and supported ethical responsibility toward creation. In this context, *Laudato Si'* provided an important foundation for developing an ecological ethic based on humility, solidarity, care, and relationality. Integrating scientific knowledge with theological reflection therefore strengthened the practical and ethical dimensions of ecotheology and contributed to a broader understanding of humanity's role within the ecological community.

The study also contributed to the dialogue between science and theology by emphasizing the importance of biological unity, evolutionary history, and the embodied nature of life. Unlike approaches that primarily focus on ethical principles, this research situated ecological responsibility within a broader biological and evolutionary framework, clarifying why specific environmental actions are necessary and what consequences they may generate. This interdisciplinary perspective may inform pastoral, educational, and community-based initiatives to promote greater awareness of the interconnectedness and sacredness of life. Nevertheless, the study had methodological limitations because it was primarily theoretical and developed from an interdisciplinary interpretive perspective. The absence of extensive empirical evidence, limited engagement with diverse religious and cultural communities, and the lack of broader outcome assessments restricted the ability to demonstrate the practical effectiveness of the proposed integral ecotheological framework.

Future research should strengthen the empirical foundation of integral ecotheology through broader surveys, community-based studies, and evaluations of changes in ecological behavior. Further studies should also encourage interreligious and cross-cultural ecodialogue, particularly

through greater engagement with Indigenous communities and other groups directly affected by environmental degradation and climate change. In addition, interdisciplinary approaches should continue incorporating developments in molecular biology, genetics, systems ecology, and climate science into theological reflection. Through these efforts, integral ecotheology can become a more relevant and effective framework for promoting ecological justice, sustainability, and the restoration of human and nonhuman life. Ultimately, the integration of scientific and theological perspectives provides an important foundation for developing responsible ecological practices that recognize the dignity, interconnectedness, and flourishing of all living beings.

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