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NEW CREATION STUDIES

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EDITORIAL

Do we need another creationist journal?

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Core Academy of Science

Years ago, I found myself embroiled in a heated editorial controversy, which I felt very strongly threatened the integrity of creationist publishing. These many years later, the details of our dispute seem much less important, but I can viscerally recall how angry I was when my objections were ignored. After losing that fight, I wrote a paper arguing for the Christian basis of double-blind peer review, the form in which the author and reviewers are unknown to each other. I sent it around to a few others who agreed with my perspective, and they suggested modifications and agreed to join as co-authors. We published it in the inaugural volume of *Answers Research Journal*.[1] Google Scholar tells me it has been cited once, which is perhaps more than it deserves.[2]

I look back at that paper with a bit of chagrin, not exactly regret, but certainly closer to embarrassment than pride. The paper is not a bad paper *per se*, but it is not very good either. The argument put forth is an (unfortunately common) exercise in using the Bible to justify current practice rather than allowing the Word of God to challenge those practices at every level. Given the circumstances and my attitude at the time, I do not think I could have imagined much beyond what I wrote in that paper, so perhaps the intervening years of maturity and growth were necessary to bring me to the ideas I will describe here.

I now have three decades of experience in all aspects of scholarly publication: author, reviewer, and editor. I have given helpful reviews and critical reviews. My reviews have been accepted, and others were ignored. I have received dozens, maybe hundreds, of reviews of my own work. Some suggestions have been very helpful, and others have been aggravating and nitpicky. Some of my papers were published with nearly no changes requested at all, which frankly leaves me very uneasy. Other papers were rejected for reasons I still think were unreasonable. My work as an editor has been much more limited, and I have begun actively refusing invitations to work in that role. Nevertheless, there are a few papers I edited that I recall with great fondness, and there are some papers I edited that can still tie my insides into a knot of anxiety.

Throughout my experience in scholarly publishing, I also watched as the internet completely transformed the publication process. When I started out, I received proofs of my articles printed on paper. Journals back then primarily distributed paper copies through the mail. The entire process from submission to print could take months or years. Over the years, digital editing, open access, predatory publishing, preprint archives, and academic piracy have all changed scholarly publishing, not always for the better. Today the individual article is king, and many (most?) journals have entirely abandoned printing individual issues.

Even amidst these changes, much of the core experience remains the same. Blind peer review, at least in the sense of not knowing who the reviewers are, remains the primary means by which scholarly publication occurs. This peer review was the process I wanted to defend in 2008, and now seventeen years later, I seriously suspect it may not be worth saving.

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The model of peer review we described in 2008 works well, as long as everyone involved understands the system exactly the same, respects the process even when they disagree, and agrees on the basic criteria of what makes a "good paper." The reality of course is that none of these things are realistic. Different people, even highly educated scholars, have different ideas of what constitutes a good paper and what the role of the editor or reviewer should be. And those are the reasonable problems.

What really undermines blind peer review is the anonymity. The cloak of anonymity allows us to speak the truth without fear of reprisal, but the truth delivered in such a way is often ungracious and cruel.[3] Delivery of these reviews by impersonal email only compounds the problem by creating too much opportunity for misunderstanding. Anger is far too common, and that anger is covered up, rather than resolved, by the anonymous process.

Sometimes however, the anger is inevitable because a manuscript simply fails to be a good paper by any reasonable measure. The most common outcomes are either confrontation, argument, and appeal or, if that fails, sending the paper to some other outlet. This for me is the biggest shortcoming to the entire process. I could understand going through the hardship and struggle of peer reviewed publishing *if* I knew the outcome would be respected, good papers would be published, and bad papers would disappear and not confuse or mislead the public. That is certainly not the world we live in.

The democratizing power of the internet and social media has led to vast opportunities for people to express their opinions. No one needs a journal article, especially in the world of creation research. Making an attractive video explaining your ideas will probably have a much greater public impact through social media than the arduous process of producing a technical paper that a handful of people will read and fewer will understand. Why bother with scholarly publishing at all? Have the new realities of the internet and social media rendered peer reviewed publications futile and irrelevant?

These frustrations have led me to reflect more deeply on scholarly publishing, especially in light of my Christian commitments and theology. The first question I want to know is what value scholarly publication actually brings. The truth is that I love a well-written, scholarly paper. I love citations that I can check. I love methods that I can understand. I love following an articulate argument, even if I disagree with the conclusion. There is something beautiful and beneficial about knowing exactly what the evidence is, how it was studied, and how it is being interpreted. In non-scholarly publications, like press releases or social media posts, I can make any unsupported claim I like, but in scholarly publication, I must support my statements, either by citation or appeal to evidence. There is nowhere to hide bad reasoning or weak evidence. Even if such works can be understood by only a few, they *can* be understood with discipline and effort. We can identify where someone might have gone wrong in their thinking. We can see where new evidence needs to be sought. We can trace citations to make sure that past ideas have been represented correctly. In short, a good scholarly article is *fruitful*. It gives us a place to go to look for more evidence and data, where a nonscholarly publication leaves us wanting more detail and unable to verify or falsify its basic claims. That is a value worth preserving.

The second value I want to preserve is the journal itself, which is effectively now a website that publishes scholarly articles. Journals have become a shorthand or insignia for editorial practices and quality of publications. I want to be able to recognize a journal name and know that it means the paper is worth reading. We all know this function already happens, and it seems to me to be a practical time saver.

Journal reputation also leads to a public value. I never recommend any publications or websites unreservedly to anyone (especially my own), because I want people to think carefully and critically about everything they hear or see, but I will recommend some sites as more worthwhile and less error prone than others. Having a journal/site with a convenient name that has a good reputation for quality publications is helpful in that regard, not that we can "trust" what they publish but that reading through the latest publications is worth your time even if you disagree with the conclusions.

The third value I recognize in scholarly peer review is the ability to improve scholarly work. At its most basic level, peer review could be seen as an opportunity to correct embarrassing mistakes before the paper is published, but more deeply, for a community supposedly dedicated to understanding the history of God's creation, we ought to welcome opportunities to expand our understanding even of our scholarly shortcomings. In our quest to understand God's creation, we ought to be motivated at every step by the question, "How can we improve?"

I am happy to say that I have experienced this in many different ways in my career. I have edited papers that ended up much stronger than they were when they were submitted. I have reviewed articles where my suggestions were taken seriously, and I have benefited greatly from thoughtful responses to my own work. When peer review works well, it can be quite beautiful.

With these values in mind, how can we achieve them in a way that demonstrates the two greatest commandments, loving God and loving neighbor? I suppose there are many ways to answer that question. One could simply continue the course with blind peer review and hope to cultivate better authors, reviewers, and editors, but what if we tried something really different and strange and uniquely Christian? What if we tried to do peer review in a way that values our place in the *community* of Christ? What if we valued the Christian community as much as we value good scholarly publishing?

We call our proposal *community review*. The first distinctive of this process is our intention to dispense with anonymity. When given a paper to review, the reviewers will know who wrote it, and when the reviews come in, the authors will know who wrote them as well. No more hiding. If you need to say something negative about a paper, you will have direct accountability for the way you say it. If you accuse someone of incompetence, malpractice, or deception, you will be held accountable.

Thinking about this component more positively, everyone has value to Jesus Christ. He died for us all, and for those of us who are Christians, we know that we were created in Christ Jesus to walk in good works that God made for us. A simplistic, blunt editorial rejection might be adequate, but how much more powerful could it be to find ways to affirm authors even if we have to admit their paper is not very good?

That brings me to the second distinctive of community review. We intend, as often as possible, to deliver reviews in person or by the next best means through teleconferencing. We want to value authors and reviewers personally as human beings and neighbors that we should love. I have witnessed and experienced many hurt feelings over the years due to misreading or misunderstanding coldly worded assessments, but with the opportunity to directly interact with people, we will experience the love of Christ even in this sensitive practice of "peer review."

Third, we have dispensed with the editorial hierarchy and detailed procedures manual. Jesus chided the Gentiles for exercising tyrannical authority and encouraged us his followers to serve the community. Our editorial board will act together as a community that cares for its members and everyone who interacts with us, even as we also seek to improve submissions, choose outstanding papers to publish, and (God willing) build a testimony for quality and excellence. We do not believe these goals are mutually exclusive. Rather, we anticipate that excellence will be born from pursuing Jesus' desire that we build up the body of Christ.

At this point we have also spurned any detailed procedures manual. We only ask that prospective authors follow use numbered endnotes for references following either the Chicago Manual of Style or the Vancouver format. We also provide authors and reviewers with no procedures or processes to appeal decisions. Authors and reviewers are welcome to bring grievances to the editorial board, but those grievances will be decided on an individual basis by the editorial community. Each case will be different, and there is little sense in trying to devise one uniform process that applies to everything.

How can you be a part of this community? Submit a paper and see what happens. We are not a closed community. We invite everyone everywhere to give it a try. Join us in this crazy experiment. Consider this a call for papers. We plan to publish a single annual issue, and papers must be submitted by September 12, 2025 for inclusion in the next issue.

And that brings me to the title question here at the conclusion of my essay. Do we need another creationist journal? The answer, I think, is an easy no. We have more than enough creationist journals. Community review, on the other hand, intrigues me (and the editorial community) enough to warrant a test run. So we offer to Jesus and the church this new journal *New Creation Studies* as the first journal to practice community review. Could this go terribly wrong? Certainly, but it might also bear fruit that we cannot even imagine at the moment. God only knows what will happen, but choosing a path that is deliberately Christian and intentionally obedient to the commands of Christ cannot be a complete disaster.

Ultimately, our success will be determined by our output. Will you find these articles to be quality works that advance our understanding of God's creation? Will participating in the editorial process build up the body of Christ? In this inaugural issue, we present two research articles, two essays, and the abstracts from Origins 2024. The article by Brand and Chadwick presents the results of their survey of bioturbation in the fossil record. Their work helps us to better understand the meaning of trace fossils in Flood sediments. The second article by Guzman and McLain reports on the baraminology of Silesauridae, a terrestrial group of dinosauriforms said to be the evolutionary precursors of true dinosaurs. This work will aid in our understanding of silesaurids and the origins of the various dinosaur kinds. The essay by Hans Madueme contains his assessment of the young age creationist community as a relative newcomer, with both commendations and admonitions that we creationists need to consider. Finally, my own essay reflects on the 2024 book *Perspectives on the Historical Adam and Eve: Four Views*, edited by Kenneth Keathley.

On behalf of the editorial community, welcome to *New Creation Studies*! We pray that our small offering here will bring glory to God and build up the community.

Notes

1 Roger W. Sanders et al., “Toward a Practical Theology of Peer Review,” *Answers Research Journal* 1 (2008): 65–75.

2 Gene P. Siegal, “Navigating Interpersonal Conflict and Peer Review,” *Laboratory Investigation* 89, no. 3 (March 2009): 256–58, https://doi.org/10.1038/labinvest.2008.160.

3 I am as guilty as anyone, maybe moreso, of writing excessively aggressive and harsh reviews. I want to do better.

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EDITORIAL

Quo Vadis?
Some Reflections on the State of Creationism

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This article was first delivered as a plenary address at the 2024 Origins Conference in St. Louis, MO. I have preserved the oral style of my original remarks with light edits. I'm grateful to the organizers of that conference for inviting me to reflect on these matters, and to the attendees for their stimulating questions and refreshing dialogue.

In C. S. Lewis' *The Lion, the Witch, and the Wardrobe*, the Pevensie children must have felt like outsiders in Narnia. All four of them—Peter, Susan, Edmund, and Lucy—were strangers in a strange land. I can relate as a relative newcomer to young earth creationism. I only joined the movement eight years ago. Before 2023, I had never attended a creationist conference, nor have I ever written anything for ICR, AiG, CMI, or CRS. I lack the pedigree of many creationist stalwarts who have toiled for decades during a long and bitter winter. So, you may wonder, who am I to be giving these remarks?

Thanks for asking. I'm a systematic theologian from the Presbyterian Church in America (PCA), and I'm a young-age creationist. I believe in six literal creation days, a universe 6–10,000 years old, and a past global flood. I hold many other convictions related to creationism that are controversial in academia today but fully within the mainstream of Christian orthodoxy down the ages. I have many friends and colleagues who are old earth creationists and theistic evolutionists, and I dream of a day when they will all be young-age creationists. Creationism, after all, is the most compelling theological synthesis of the biblical witness—or so I would argue.

In what follows, I offer some reflections on the state of creationism today, warts and all. What is the future of the creationist[1] movement in 2025? My remarks focus on five areas of concern that keep me awake at night. These musings are offered with some fear and trembling, knowing my biases and limitations, and that some creationists will not agree with all my insights. Yet I hope they stimulate fruitful dialogue among creation scientists and theologians.

I. The Quirks of Personality

If you spend any time with creationists, you are probably all too familiar with weird personality quirks.[2] These men and women can be sharp-edged, prickly, and combative in personality. They can take offense easily. They can be difficult to work with. Even when you're squarely on their side, they are too often hyper-sensitive,

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thinking you're somehow out to get them. They are predictably skeptical of the conclusions of "mainstream science," but their skepticism is pervasive, extending even to fellow creationists. They end up distrustful of the motives and intentions of other creationists and their ministries.

One of my friends, a creationist, is unwilling to change his views on any theological position, even when it is objectively the right thing to do.[3] He suffers from what I call "cognitive" or "intellectual" self-righteousness. He knows creationism is the kosher position and that non-creationists are wrong on the main points. So far so good. But then he acts as if everything he believes, every position he holds, must be correct, and that a non-creationist can't be right on any substantive issues. This way of thinking is false. I know many creationists who believe things that are demonstrably untrue, and they could learn a great deal from non-creationists.

Let us refer to these traits, loosely, as "personality quirks." I hasten to add that my descriptions are generalizations, even familiar stereotypes, but they have more basis in reality than we might like to admit. At any rate, one can understand why such quirks arise. Creationist scientists live in a world ceaselessly nagging that your views are shameful, impossible, downright ridiculous. Christian non-creationists share the sentiment; they accept you as a fellow believer but are embarrassed that you claim to be a scientist. In this environment, it's no surprise that creationists can be prickly and combative. Odds are most people in the same situation would end up surly, tightly wound, bent out of shape.

If you're a creationist scientist and you've done significant work, you are likely a pioneer. You're an independent thinker. Given your strong personality, you're stubborn and probably not known for being a team player. Of course, there are happy exceptions to these stereotypes, especially in the younger generation. My point is that when I meet a creationist with an angular personality, I always feel sympathy.

However, if we are biblical, Christ-centered creationists, we should not be known *primarily* as people with strange personality quirks.[4] Rather we should have reputations of being Christians who are at once passionate about our theological views but also calm and cheerful—*because the truth is on our side*. Let them mock us. Let them marginalize us. Let them critique us. Let them make fun of us. "Do not repay evil with evil or insult with insult. On the contrary, repay evil with blessing, because to this you were called so that you may inherit a blessing" (1 Pet. 3:9).[5] Jesus is our model for how to respond to opposition. His enemies mocked him. They persecuted him. They beat him. They ultimately killed him—yet he never struck back.

Same with the apostles. As Paul writes in 2 Corinthians 11:24–27, "Five times I received from the Jews the forty lashes minus one. Three times I was beaten with rods, once I was pelted with stones, three times I was shipwrecked, I spent a night and a day in the open sea, I have been constantly on the move. I have been in danger from rivers, in danger from bandits, in danger from my fellow Jews, in danger from Gentiles; in danger in the city, in danger in the country, in danger at sea; and in danger from false believers. I have labored and toiled and have often gone without sleep; I have known hunger and thirst and have often gone without food; I have been cold and naked." Elsewhere Paul says: "I know what it is to be in need, and I know what it is to have plenty. I have learned the secret of being content in any and every situation, whether well fed or hungry, whether living in plenty or in want" (Phil. 4:12). Taking our cues from Jesus and the apostles, we creationists should be people who exemplify passion, fortitude, and—when the going gets tough—equanimity under duress.

But one final point on personality quirks: we should distinguish *eccentric* from *awkward*. Every movement has eccentric personalities (so-called oddballs). It's probably fair to say that creationism has a higher proportion of such people. In my view, eccentrics are part of the beautiful diversity of the local church that stands head and shoulders above any other human institution. I do not think it wise or realistic to expect, much less demand, eccentrics to "change." We should happily include such men and women in creationism and be ready to listen for their occasional moments of insight that others miss. Yet we should not let such eccentric members unduly influence how we function as a movement.

The bigger problem, however, lies with those creationists who tend to be awkward—they are individualists and struggle to work with others. This issue is prevalent in creationism for the reasons mentioned already. Creationism as a movement needs "team players" and leaders who can handle the occasional disagreements within the "team." Awkwardness is a character trait that can be addressed and improved upon. At an individual level, we should all resist the Devil's temptations to fall back into combative modes of being: Keep reading widely. Keep reading people from different perspectives. Don't just read fellow creationists or even "conservative" Christians. Read people you disagree with. Read people who hate creationism—not merely to refute them; that's easy. Rather, read to expose your cultural and theological blind spots. Don't just read; get to know Christians who think differently from you. Engage in dialogue. Cultivate friendship.[6] Sanctification comes from the most unlikely places.

The most effective remedy, however, is to integrate creationism fully into the life and ministry of the local church. This should be a key component of our future vision. For too long, creationism has suffered from being centered around single-issue, parachurch ministries, which left unchecked can foster imbalance and quirkiness. Healthy churches with healthy structures of discipline provide the context in which creationists mature in character and grow in grace as we relate to one another. Of course, no local church is perfect here; even those sympathetic to creationism need to see creationism as integral to normal Christianity rather than an apologetic side-issue for the misfits.

II. Peace With Other Creationists

True confession: I have mixed feelings about standard creationist ministries. While some of them are helpful, typically they don't put creationism in the best light. I dislike the tone, the conduct, the infighting, the hyper-polemics—all of it. I don't often see the grace and truth of Jesus. Creationism deserves better. However, my disillusionment has frequently led me to be dismissive of creationist ministries in conversation with others. I realize in retrospect that I've spoken in disparaging and even hurtful ways about them. The problem is not my concerns with their approach; it's the *way* I expressed them.

Ironically, I am far closer theologically to Christians connected with ICR, AiG, and other creationist ministries than I am with most theologians in academia. Take Ken Ham as an example: I dislike some of the ways he represents creationism (and he may feel the same way about me!). But aside from being a fellow creationist, he is my dear brother in Christ. Ham and other creationist apologists have been defending creationism consistently in the face of extreme hostility from the culture and the church. Almost single-handedly and for decades they kept creationism front and center for millions of lay believers around the world; like a thorn in the flesh, Christians in academia kept having to deal with the arguments of these creationists. I am grateful God often uses creationist ministries to edify his people and glorify his name.

In the field of modern creationism, I find it helpful to see ministries like AiG, ICR, CMI, and others as operating *in a particular lane*. They are parachurch ministries oriented to educating laypeople in apologetics, evangelism, and the Christian life with a wide range of print and online media. While creationists like me have concerns, we must still recognize God can use such ministries, sometimes in significant ways. Be careful you don't throw out the baby with the bathwater and find yourself resisting what God is doing. As the Pharisee Gamaliel says in another context, "if it is from God, you will not be able to stop these men; you will only find yourselves fighting against God" (Acts 5:38). I am preaching especially to myself here.

That said, creationist ministries are not blameless. They tend to be narrow, inflexible, and overly dogmatic. It is as if they fear challenge or disagreement from others. They double down in reaction and hold their views more stringently, even when those views are not as clear as they think, and even when other creationists can reasonably disagree. This is a sign of fragility and insecurity, not faithfulness. Worse yet, the real issue for some individuals may be their big egos—in a word, sin.

Others have voiced the same concerns. Logos Research Associates (LogosRA), for instance, a creationist organization founded by John Sanford, has published a set of principles to guide their ministry, including how they approach fellowship with non-creationists and other creationists with whom they disagree. On this last point, they include a letter from Gordon Wilson, Senior Fellow of Natural History at New Saint Andrews College. He writes:

> It is apparent to us that division in the creation apologetics movement is widespread and at times there has been clear evidence of ungodly actions and sinful anger. Disagreement is not our problem; discord is. . . . Not only does it displease our Lord when we YEC creationists are not on speaking terms with each other, it is a poor testimony to the watching world. Will they know we are Christians by our love or by how staunchly we refuse to make things right? We think it is impossible to reconcile because it is impossible to get them to admit they're wrong and I'm right about a particular creationist model or ministry philosophy. We are sure the enemy is quite pleased at the growth of the root of bitterness that he has cultivated in the YEC community over these years.[7]

The rest of the letter is in the same spirit.

More recently, the Creation Theology Society (CTS) sounded the alarm bells in 2023 in an online document titled "A Call to Unity" garnering a list of creationist signatories. The document was prompted by a growing alarm over the rank divisiveness emanating from certain sectors of creationism. I quote from two of the nine commitments:

> As servants of Jesus Christ, we have the privilege and responsibility to cultivate Christlikeness in our interactions with one another. In our exchange of ideas and investigations of both biblical and scientific data, a gracious and irenic spirit should motivate and undergird our posture and our manner of engagement (Ephesians 4:1–3). . . . As we enter into discussions, present our papers, and publish our findings, we should season our words with grace, love, and respect for fellow believers no matter how much we might disagree with one another (Proverbs 16:24).[8]

Evidently LogosRA and CTS feel compelled to urge all creationists to be consistently Christ-centered in word and deed.

Of course, throughout his ministry Jesus was often scathing toward the Pharisees and Sadducees in their hypocrisy and legalism (e.g., Matt. 23:1–36; Mark 7:1–13; Luke 11:37–54). He opposed the moneychangers when he violently overturned their tables (Matt. 21:12–13). Sometimes he had harsh rebuke for people close to him (e.g., Mark 8:31–33; Luke 8:22–25). The apostles were hardly different, as when Paul warned the Galatians against apostasy (Gal. 1:6–10) and rebuked the Corinthians for tolerating sexual immorality (1 Cor. 5:1–13). The list goes on—clearly there are times we should firmly oppose error in fellow Christians. But we should always be striving for the right balance and doing things with the right motive. As Rhyne Putman notes, "Correction is for the building up of the individual or party in the wrong (2 Tim. 3:17), not for acclamation or scoring points. It must also be epitomized by kindness, gentleness, and forgiveness (Eph. 4:32; Prov. 15:1)."[9]

Dietrich Bonhoeffer coined the phrase "cheap grace" for Christians who love to champion God's grace but without repentance or transformation. "Cheap grace," he wrote, "is the deadly enemy of our Church. . . . Cheap grace therefore amounts to a denial of the living Word of God, in fact, a denial of the Incarnation of the Word of God."[10] It is using justification by grace through faith as a license for sinning. By analogy, we should diagnose a disease called *cheap creationism*. What are the symptoms?

I am guilty of cheap creationism when I defend my position tooth and nail with little evidence of Jesus and the fruit of the Spirit. I care more about the rightness of my views than about Christian character. Creationists with this affliction are driven by a Javert-like resolve, an obsession, to discredit or marginalize the work of other creationists. Such hyper-critical fault-finding is not only counterproductive, but it drives people further away from creationism. Cheap creationism is rampant on social media platforms where the name of Jesus is maligned by misguided Christians who use words as a weapon against their opponents (James 3:1–18).

Christocentric creationism prioritizes what we believe *and how we live* (1 Tim. 4:16), which includes how we treat other people, not least fellow creationists we disagree with. The gospel constrains us to die to pride and status. Jesus exhorts us to be Christians with a calm, cheerful, and quiet confidence in our theology, always tempered with humility. But this starts from the top—it must come from the leadership of the creationist movement so that lay believers, who inevitably take their cues from us, imitate a grace-based, Spirit-filled creationism.

The relevant point is this: *not all disagreements are equally serious*. Not all differences of opinion are heretical. Christians throughout church history acknowledged some notion of "dogmatic rank," the idea that "teachings need to be ranked, and the ranking has to do with importance for faithfulness and fellowship. Not all teachings we hold have the same importance, although all biblical teaching is important."[11] Playing fast and loose with core doctrines like justification or the resurrection is dangerous, potentially damnable, but other disagreements do not rise to that level. As creationists, we need to recognize such distinctions in our intramural debates; otherwise, we risk devouring ourselves and thus undermining our own cause. If every disagreement we have with other young-age creationists automatically means they are now "liberal" or have bought into evolutionary assumptions—presumably hook, line, and sinker—then we are in trouble.[12]

I am not saying creationists should never engage in healthy debate or disagreement. There is a time and place for dispute. But it's one thing to raise concerns to a fellow creationist in private discussion or to publish a technical article raising questions about a position, but cordially without animosity. However, it's quite another thing to post incendiary diatribes designed to blacklist fellow creationists because they think differently from you. That kind of bullying will never adorn the truth of the gospel (Titus 2:10). All creationists must do better, especially those with a big audience and following.

III. The Promise of the New Creationism

In evangelicalism, the relationship between church and academia is always fragile. Believers often have a dismissive view of academic institutions as embodying all the sins of secularism. This sentiment runs deep in American history and culture.[13] The "conservative" wing of American Protestantism often has a smug anti-intellectualism suspicious of universities and PhDs. While I disavow this attitude, I recognize there's much to criticize about academic institutions. Anti-biblical ideologies are taught and defended in lecture halls across the country.

At the same time, we should recognize the vital role that Christian colleges, seminaries, and parachurch ministries affiliated with academic institutions play in the lives of believers. Influential professors train and mentor our young people. Our seminaries train future pastors who will be leading churches and shaping the next generation. *What such institutions are saying about creationism matters a lot.*

The reality is this. Most professors at these institutions have an extremely low view of creationist ministries. They find them intellectually embarrassing, distasteful, and dishonoring to the Lord. Some readers will be thinking: "well, prof, they're liberals—that's why they don't like creationist ministries." With all due respect, that is a lazy response. It is true that professors often accept old-earth and evolutionary perspectives, hence their disagreement with creationist ministries. However, we cannot ignore the ambiguous legacy of creationist organizations.

On the one hand, such organizations have done much positive good. God has used them in the lives of many people. Give credit where credit is due. On the other hand, we must speak frankly about their shortcomings and limitations (see above). They operate in a particular lane oriented towards equipping lay people. Such ministries, for good or ill, tend to use rhetoric that oversimplifies and sometimes demonizes the other side. As a result, their arguments are perceived by non-creationists (and many creationists!) as uncritical, imbalanced, and lacking nuance.

Given this cultural moment, creationist ministries stand no chance with Christian academic institutions. I say that without malice or glee—I wish it were otherwise. And yet, if we believe that young-age creationism is the most faithful articulation of Scripture, that it most closely aligns with the catholic (small "c") tradition, and that it is integral to the whole structure of Christian theology, *then we cannot be satisfied with the current situation*. Something must change.

It is here that the New Creationism holds great promise for the future of the movement. The British geologist Paul Garner used that phrase as the title of his 2009 book *The New Creationism*.[14] The book introduced readers to the most interesting scientific developments within creationism at the time. Some years later, Joel Duff—a professor of biology at the University of Akron—mapped out a new movement within creationism with different emphases from mainstream creationist ministries. He called it the New Creationism.[15]

Joel Duff hails from the same denomination as mine (PCA) and is a theistic evolutionist. He disavows the young earth position, which means we disagree on a host of origins-related issues. However, Duff knows more about the history and current state of creationism than most creationists (no hyperbole) and has done creationists a great service by drawing attention to the New Creationism. If creationism has any future in Christian colleges and seminaries—and among people influenced by such institutions—the New Creationism stands a chance to reach such audiences. The future of creationism lies with the New Creationism.

Do not misunderstand. We need mainstream creationist organizations defending the cause in their lane. My intention is not to split the creationist community into another *us vs. them* divide. Rather we should recognize that the mainstream community and the New Creationist community operate at different levels within the broader creationist movement. For the good of the church and the flourishing of creationism, I am increasingly convinced we need far more scientists and theologians operating in the New Creationism lane.

Let me highlight key characteristics of the New Creationists summarized by Duff on his blog *Naturalis Historia*.[16] New Creationists are:

- More gracious in dialogue with other creationists and willing to engage with non-YEC Christians. They treat Christians with other views as misinformed rather than as compromisers who do not have genuine faith.
- More likely to be involved in academia than be employed by a large creationist ministry.
- More comfortable applying an academic approach to questions which entails application of testing and

criticizing ideas rather than relying on fideistic tendencies and creation dogmatism.

- More comfortable not having an answer to every question and more likely to say, "I don't know," holding out hope their work will stimulate future answers.
- More driven by a curiosity of creation and desire to understand the world, not simply content to poke holes in conventional theories. They seek to be forward-thinking and develop creationist models faithful both to the available data and to Scripture.
- More willing to acknowledge the substantial empirical evidence for evolution from multiple fields, including biology, paleontology, genetics, biogeography, and so on.
- Less likely to fear or discourage new discoveries. While new discoveries pose challenges for the New Creationists, they find these challenges exciting rather than daunting.

I agree with Duff that the New Creationists are not yet a monolithic group. Nor are they a wholly different species from other creationists—there is overlap. Nonetheless, they represent a less combative way of articulating and defending creationism in the 21st century. If we want to reach people informed about the scientific evidence against creationism, including college graduates and seminary-trained pastors, New Creationism has more resonance and persuasive power.

Mainstream creationist ministries cannot deliver on that front. I have no doubt one can find examples of scientists within mainstream evangelical academia who are excited by standard creationist apologetics. Maybe readers can point me to testimonies of secular evolutionists converted after reading resources from a traditional creationist ministry—after all, salvation belongs to the Lord, and he can use anything to accomplish his purposes (Isa. 43:11; Eph. 2:8–9). But such cases are rare. Our challenge is to present creationism that is as open-spirited and generous in dialogue with fellow creationists as it is clear-headed and compelling in dialogue with non-creationists.[17] My prayer is that God raises up a new generation of creationists—New Creationists—who will be more credible to new audiences.

IV. Some Thoughts on Epistemology

"Epistemology" is the theory of knowledge: How do we come to know things? How do we know what beliefs are true or false? The standard epistemology in most creationist settings begins by recognizing the Bible as the absolute word of God. Everything Scripture says is true. Since mainstream science is based on secular assumptions, rather than Scripture, we don't need to take it seriously. We can ignore what conventional geologists and biologists are saying because they are unbelievers operating from unbiblical assumptions. That's the picture, doubtless oversimplified, but still true to prevailing attitudes within creationist ministries.

I sympathize with this perspective. However, it's a simplistic epistemology that leads to theological imbalance. Creationists who think this way assume that whatever their side believes on origins and a raft of related issues are the sober truth, and they dismiss critics because "they have the wrong assumptions." But this position is implausible on its face. It is a false assumption that everything creationists believe about science is true, and whatever secular scientists and Christian evolutionists believe is wrong.

If I were a practicing physician, I would recommend two antidotes. The first is for creationists to reclaim the ancient insight from Augustine and other early Christians that *all truth is God's truth.*[18] Some readers fell off their chairs reading the last line, given how theistic evolutionists love to proclaim this maxim. It is a convenient spiritual cover to embrace all the conclusions of mainstream science, including deep time and evolution: “Darwin was right because all truth is God’s truth!” My point is rather different. Just because Christians have abused this theological truth doesn’t mean we throw it out. Rather we should affirm it from a fully creationist point of view, loudly and without apology: *All truth is God’s truth.*

Consider the nature of truth. The triune God is the true God. The eternal Son is the embodiment of that truth—in John 14:6, Jesus says, “I am the way and the truth and the life. No one comes to the Father except through me.” The reality of truth is grounded in the intrinsic perfection of God’s character. God made all things, and therefore his wisdom is the source of truth *about everything*. As believers, we don’t know all the truth there is to know. We see through a glass darkly (1 Cor. 13:12). Yet truth itself is unified in the wisdom of God. As for unbelievers, they may deny the existence of God intellectually, but they cannot deny God’s creation. God made them in his image and placed them in a world full of truths waiting to be discovered. Unbelievers can’t know *spiritual* truth without supernatural assistance, but they can know truth nonetheless. They can know 3 x 3 is 9, that two contradictory claims can’t both be true, and that Shawshank Redemption is a great movie.

The same principle holds for proximate and contingent truths. These are facts about the world, science, statistics, the weather, and so on. All truth is God’s truth means *all facts are God’s facts*. Creationists should not be afraid of the truths non-religious people discover. Unbelievers are made in God’s image, so naturally they will know all kinds of truths about creation. Paul even says they know some truths about God (Rom. 1:18–23). They get many things wrong too—as 1 John 5:19 says, “the whole world is under the power of the evil one.” Still, creationists should not be constantly dismissive or hyper-skeptical about every mainstream scientific conclusion.

Our problem is we live in a “post-truth” world. People base their opinions on feelings and ideology, not objective facts. Truth is irrelevant in the post-truth era. There are no real facts anymore—politicians speak of “alternative facts,” bending the truth to suit their agenda. People no longer believe the news—it’s fake news. They don’t believe what scientists say—it’s fake science. Both the political left and right are guilty of these post-truth shenanigans. How we got here as a society is a complicated story, some of it related to postmodernism, much of it symptomatic of how social media corrupted public discourse.[19]

Not to mince words, but post-truth epistemology is anti-Christian. God’s people believe in the triumvirate of truth, facts, and objective reality. The gospel vanishes without it. Ironically, the epistemological habits of traditional creationists can sometimes become a gateway for embracing post-truth perspectives. They become so skeptical of *any* mainstream scientific knowledge that they end up denying what is objectively true. They overcompensate. They reject evidence. They don’t believe in facts. They only accept whatever fits within their own ideology or whatever “feels” right. The association between flat-earthism and young earth creationism is a case in point—as is the anti-vax movement.[20] Such post-truth attitudes are disconnected from biblical Christianity.

To be clear, merely affirming all truth is God’s truth does not mean we accept everything "experts" present as objective reality. Surely not! For one thing, truths derived from Scripture are non-negotiable—that the universe is young, that original creation was free from sin, that there was no death before the fall, that Adam and Eve existed, that the fall happened, and the rest. Since God revealed these truths, they are de facto part of objective reality. Creationists will therefore be skeptical of a scientific claim contradicting any of these revealed truths. In addition, raw data gleaned from scientific observation and testing sometimes appears to fit into an old age or evolutionary framework better than a creationist one. Young age creationists must be willing to admit this when it happens, but only *provisionally* without giving the impression unwittingly that the alternative frameworks are ultimately true.

The second antidote is from Abraham Kuyper (1837–1920), the remarkable Dutch leader of the neo-Calvinist movement in the 19th and early 20th century. He gave us the two concepts of *antithesis* and *common grace*. What is the antithesis? Kuyper describes the world as divided between two kinds of people, those who have experienced regeneration and the internal work of God's Spirit—and those who have not. The "spiritual" person versus the "natural" person. The spiritual person sees the world through the lens of Scripture; the natural person does not. The antithesis is the deep chasm between the thinking of believers and the thinking of unbelievers. Antithetical language is common in Scripture, e.g., the children of Abraham and the children of the devil (John 8:39–44); those who walk in the light and those who walk in darkness (1 John 1:5–10).[21]

Modern creationists are typically very alert to the antithesis. Creationist ministries know all too well that secular scientists and Christian non-creationists have the wrong starting assumptions and cannot think rightly about the world we live in. That's what Kuyper meant by the antithesis. But he didn't stop there. He also invoked the mitigating idea of common grace, a concept he inherited from John Calvin, the Genevan Reformer.[22] Calvin taught that all humans are affected by sin. Our nature is corrupted by the fall. But God did not leave unregenerate people in total darkness. While unbelievers are certainly sinful, God by his common grace mercifully restrains the effects of sin. He works in the lives of unbelievers in a *non-saving* way and bestows natural gifts on both believers and unbelievers. When unbelieving politicians, artists, and scientists do things that are wise, good, and beautiful, that is the work of the Holy Spirit—common grace.

In mathematics and logic, Kuyper saw little difference between believers and unbelievers. But with disciplines like psychology, sociology, or religion, the antithesis looms large. Even so, God's common grace remains at work in those fields.[23] Popular-level creationist writing usually ignores common grace. Everything is cast in black and white categories. "We're right; they are wrong." The doctrine of common grace can serve as a needed corrective. Moreover, Scripture and experience teach us that the antithesis affects believers as well—it runs through our very hearts (cf. Rom. 7). Since we still struggle with indwelling sin, it is naïve to think we will always see things correctly just because we are born again. Sometimes unbelievers see more clearly than we do. Sometimes evolutionists see more clearly than we do.

Some creationists will balk at these concepts of common grace and all truth is God's truth. Perhaps they worry it will invite error and liberalism. They would rather create boundaries to delineate who's in and who's out. But while such instincts are well-meant, they can be overprotective, even retrogressive, and often end up stifling the power of orthodoxy. Sadly, they recapitulate the worst instincts of American separatist fundamentalism.

Recall the wisdom of dogmatic rank. Creationism has core commitments that are non-negotiable. You cannot be a creationist without them: six ordinary creation days; a young universe; a global flood; a cosmic fall, to name four. Thus, we should be less dogmatic about other beliefs and areas of research that do not question the doctrinal core of creationism (e.g., the extent of death in lower creatures like viruses and insects prior to Adam's transgression). Like any other theological tradition, creationists can and should have a spectrum of views. There is room to explore, speculate, and float ideas.

Henry Morris and John Whitcomb's classic book, *The Genesis Flood*, serves as a useful parable. Imagine if creationist leaders in the 1960s and 70s had drawn a hard line in the sand and insisted that no one could be a "true" creationist unless they agreed with every theory defended in the book. Either you believe in the vapor canopy theory, or you are a compromiser of the highest order![24] This mode of reasoning would have been detrimental for modern creationism. It would not have allowed our movement to thrive.

V. Theologians Missing in Action

In recent decades, the most exciting work in creationism is from scientists. I have had the privilege of working with leading creationist scientists whom I consider outright geniuses. All the same, the secular establishment does not give them the time of day. They are relegated to working with shoestring budgets, limited avenues to publish research, and ostracized from the broader scientific guild (unless they keep their creationism private). These challenges aside, creationist scientists are spearheading the brightest developments in creationism.

I cannot say the same for creationists who are biblical scholars and theologians. They are missing in action. I realize, of course, that creationist ministries are publishing biblical and theological resources with the associated strengths and weaknesses noted earlier. Important essays have appeared in journals like *Creation Research Society Quarterly*, *Journal of Creation*, *Answers Research Journal*, and other creationist publications. Noteworthy monographs have been published by Masters Books, Wipf & Stock, Compass Classroom, and lesser known publishers.[25] But most evangelicals are not reading these essays and, even if they know about them, would likely not take them seriously as reliable scholarship.[26] Compounding the issue, very little creationist writing of any note is published in mainstream evangelical settings (e.g., IVP, Baker, Zondervan, Crossway, P&R, etc.). The situation is much the same with respected journals in Christian academia. In my own field of systematic theology, I can count on one hand the number of top-tier creationist essays published in the last twenty or thirty years.

For some reason, most Christians think there is nothing new to say about creationism from a theological perspective. In their minds, the main issues are easy and settled, case closed. But this view is muddled on at least two fronts. The first becomes clear if we reflect on theology more generally. Even though Christian orthodoxy has stable creeds and confessions, theology itself, unlike Scripture (Isa. 40:8), is not static but answers fresh questions for every new generation and cultural context.[27] Since creationism has no creeds and confessions, that's even more reason to be articulating creationism afresh for new generations. But where are those theologians and biblical scholars?

Second, it is misleading to say creationism is a "settled" theological tradition. Lots of interesting questions still have no good answers. Also, creationism potentially has insights on theological and exegetical questions that have puzzled non-creationists for decades. Just to be clear, I am not saying we need to be quoting Bible verses more—citing Scripture texts is not the same thing as doing theology. Endless attention to word studies and grammar will only get us so far. We need *theology*. We need to draw out the theological richness of the biblical story in synthetic ways that connect with people. Where is creationist theological reflection on "incarnation anyway" Christologies that are on the rise in academia?[28] What about creationist perspectives on the nature of language and linguistic diversity, and how they relate to the Babel account in Genesis 11:1–9? And where are creationists wrestling theologically—not just culturally or politically—with difficult questions about gender dysphoria, transgender ideology, and their connection to the biblical teaching that human sexuality is binary (esp. Gen. 1–2)? These questions only scratch the surface. Creationist theologians can serve the global church in distinctively orthodox and spiritually penetrating ways. To borrow the gospel idiom, "The harvest is plentiful but the workers are few. Ask the Lord of the harvest, therefore, to send out workers into his harvest field" (Matt. 9:37–38).

You might respond that mainstream publishers are often anti-creationist or at least reluctant to publish creationist books. They have no qualms publishing volumes on theistic evolution and old earth creationism, but we creationists get no such love. However, we should not heap all the blame on evangelical publishers. While anecdotal, I've had private conversations with some publishers who are open to creationist projects if they are competent. Furthermore, some of us who write in mainstream settings have decided it's not worth investing time and scholarship defending creationism. That was me, but I now think that's a mistake.

We need good creationist theology. We need good creationist theology at the highest academic level, and we need good creationist theology at the lay level as well. We need this kind of literature from mainstream evangelical publishers like InterVarsity, Crossway, Baker, B&H, P&R, and the like. Most of these publishers rarely if ever publish anything defending creationism explicitly. While that presents major hurdles, they are not necessarily insurmountable. Besides, my bigger point is *we need creationism in those settings*. We should be presenting the theological depth and power of creationism. This task is urgent because the rising generation of intellectually minded evangelicals coming through college and seminary do not see the need or the relevance of creationism for the flourishing of Christian theology.[29]

But we need similar work from theologians, New Testament scholars, historians, and philosophers. In my field of systematic theology, we need theologians showing the coherence, power, and beauty of creationism to a new generation—not merely in apologetics but on behalf of robust Christian doctrine. Christians need to see that creationism makes the most sense of biblical Christianity. We need that kind of work from academic theologians, from Baptists, Presbyterians, Lutherans, Anglicans, and non-denominational theologians. We need that kind of work at the popular level, at the semi-popular level, and at the highest academic level. Not only for academic and popular-level books, but also in book reviews, essays, book chapters, and articles. Again, I realize some of this is happening with creationist organizations, but that's irrelevant to my point. People connected with evangelical academia are unmoved and don't care. The bottom line: we need creationist theologians writing for mainstream, non-sectarian, Christian audiences.

If we keep regurgitating the same arguments in creationist echo chambers, we end up only preaching to the choir. In any case, most evangelicals who are not creationists will never be exposed to that material and—this is the biggest shame—will never encounter, much less feel in their bones, the theological vitality of creationism. More pragmatically, some of us need to be writing in mainstream settings if only because it will challenge us to wrestle with the gaps and problems on our own side, figuring out where we need to strengthen our position and learn from others. We need theologians in the fray at academic conferences making the case to our critics with patient humility and deep conviction. All of that is healthy for the creationist movement.

Some will worry about the inherent dangers of my proposal. If creationists are now bending over backwards to get published by Crossway or P&R (or whomever), then the tail will be wagging the dog: hello, theological compromise. As Paul said, "Watch your life and doctrine closely" (1 Tim. 4:16). I heartily agree creationists should always pursue doctrinal integrity and biblical faithfulness. However, this worry can be overblown; it can become a creationist crutch to keep producing sophomoric theology that will not stand up to scrutiny. Enough! We can't keep hiding behind the cry: "we're the persecuted minority!" Instead of whining, we must raise our game.

VI. Conclusion

I don't need to tell you it's hard to be a creationist in academia. Blood and tears, all sweat and no glory. But I remain unflinchingly optimistic. Young earth creationism is the future of Christian theology—and the truth is on our side.

Just ask the Pevensie children. The long winter is ending. Spring is in the air. Aslan is on the move. Don't ask me how I know that; it's a feeling I have that I can't shake. It won't let me go. Where is creationism headed in the coming decades? What comes to mind will sound like a tired cliché, but I'm dead serious: The best days of creationism are still very much ahead of us.[30]

Notes

1 For present purposes, I use the term "creationist" as shorthand for young-age creationist.

2 To be fair, many competent academics (and laypeople) who are not creationists are just as "quirky"!

3 For the record, this "individual" is a composite of several creationists I have known in years past. I am not referring to any one person in particular!

4 These personality quirks probably end up having character flaws attached to them over time; personality quirks are not inherently sinful, but character flaws can be.

5 Scripture quotations are from the New International Version.

6 If theistic evolution is in doctrinal error—and I believe it is—should we not avoid fellowship or even friendship with Christians who hold this position? I cannot give a full answer here but let me say that if a Christian evolutionist affirms the essential teachings of Christianity, then we can enjoy fellowship (even though, in my view, their evolutionary commitments implicitly undermine, if not deny, their creedal confession). For relevant discussion, see my comments in *Defending Sin: A Response to the Challenges of Evolution and the Natural Sciences* (Baker Academic, 2024), 67–80. For a concrete example, see Todd Wood and Darrel Falk, *The Fool and the Heretic: How Two Scientists Moved beyond Labels to a Christian Dialogue about Creation and Evolution* (Zondervan, 2019).

7 Logos Research Associates. "Convictions," September 3, 2024. https://logosresearchassociates.org/convictions/.

8 Creation Theology Society. "A Call to Unity." https://creationtheologysociety.org/about/a-call-to-unity/.

9 Rhyne Putman, *When Doctrine Divides the People of God: An Evangelical Approach to Theological Diversity* (Crossway, 2020), 258.

10 Dietrich Bonhoeffer, *The Cost of Discipleship* (Simon & Schuster, 1995), 43.

11 Graham Cole, *Faithful Theology: An Introduction* (Crossway, 2020), 76.

12 In my view, creationists should not vilify each other over scientific or non-theological arguments that are relatively marginal to the core of the biblical story (e.g., feathered dinosaurs; the flood boundary; Septuagint vs. the Masoretic text)—these issues are important but not *that* important. Relatedly, we should differentiate between doctrinal disputes (which are inherently more serious) and external, non-doctrinal differences (which are not).

13 For example, see Nathan O. Hatch, *The Democratization of American Christianity* (Yale University Press, 1989).

14 Paul Garner, *The New Creationism: Building Scientific Theories on a Biblical Foundation* (Evangelical Press, 2009).

15 For the first mention of the New Creationism, see Joel Duff, "Young-Earth Creationism in 2021: The Dawn of The New Creationists, Part 1," https://thenaturalhistorian.com/2021/06/24/young-earth-creationism-in-2021-the-dawn-of-the-new-creationists-part-1/. In private email communication (August 8, 2024), Duff confirmed that he coined the phrase "New Creationists" independently of Garner's *The New Creationism*.

16 The list is from Duff's blog with small edits: https://thenaturalhistorian.com/2021/07/01/young-earth-creationism-in-2021-defining-characteristics-of-the-new-creationists/.

17 I adapted the wording from David K. Clark, *To Know and Love God: Method for Theology* (Crossway, 2003), 420: "Our challenge is to write theology that is as open-spirited and generous in dialogue with fellow evangelicals as it is clearheaded and compelling in dialogue with non-evangelicals."

18 See the classic statement in Arthur F. Holmes, *All Truth Is God's Truth* (Eerdmans, 1977). In Augustine's own words, "Let every good and true Christian understand that wherever truth may be found, it belongs to his Master." Augustine, "On Christian Doctrine" in *A Select Library of the Nicene and Post-Nicene Fathers of the Christian Church*, 1st series, vol. 2, ed. Philip Schaff (Christian Literature, 1887), 545.

19 See Lee McIntyre, *Post-Truth* (The MIT Press, 2018); Tom Nichols, *The Death of Expertise: The Campaign Against Established Knowledge and Why It Matters,* 2nd ed. (Oxford University Press, 2024).

20 From a sociological perspective, see Alex Olshansky, Robert Peaslee, and Asheley Landrum, "Flat-Smacked! Converting to Flat Eartherism," *Journal of Media and Religion* 19, no. 2 (2020): 46–59. However, we should note that some creationist ministries have published critiques of flat-earthism. For example, see Danny R. Faulkner, *Falling Flat: A Refutation of Flat Earth Claims* (New Leaf, 2019).

21 John Frame, "Antithesis and the Doctrine of Scripture," in *The Doctrine of the Word of God* (P&R, 2010), 335–46.

22 John Calvin, *Institutes of the Christian Religion* (Westminster: 1960), 2.2–3. See also Richard Mouw, *He Shines in All That's Fair: Culture and Common Grace* (Eerdmans, 2001).

23 For critical analysis, see Stephen Moroney, *The Noetic Effects of Sin: A Historical and Contemporary Exploration of How Sin Affects Our Thinking* (Lexington Books, 2000), 27–48.

24 Richard Averbeck, an evangelical OT scholar and longstanding professor at Trinity Evangelical Divinity School (now retired), knows this from personal experience. Decades ago, his mentors at Grace Theological Seminary in Winona Lake, Indiana, ostracized him for refusing to accept the vapor canopy theory. Averbeck was a young earth creationist at the time—though he later abandoned the view—but that dark experience makes it extremely difficult for him to even contemplate returning to his young earth creationist roots (Averbeck, personal email communication, August 14, 2024).

25 Some helpful creationist volumes have also appeared from Reformation Heritage Books—e.g., William VanDoodewaard, *The Quest for the Historical Adam: Genesis, Hermeneutics, and Human Origins* (Reformation Heritage, 2015); Cornelis Van Dam, *In the Beginning: Listening to Genesis 1 and 2* (Reformation Heritage, 2021).

26 Of course, there are exceptions. Todd Wood's recent work has been widely read and discussed in non-YEC settings. See especially Todd C. Wood, *The Quest: Exploring Creation's Hardest Problems* (Compass Classroom, 2018).

27 Francis Turretin's *Institutes of Elenctic Theology* and Charles Hodge's *Systematic Theology* were fine volumes for their day (17th and 19th century, respectively) and are still worth reading today; nonetheless, many later works of theology have since been written for new generations and for different cultural contexts. As missiologists remind us, this dynamic reflects the very nature of the gospel—e.g., see Andrew Walls, "The Gospel as Prisoner and Liberator of Culture," in *Missionary Movement in Christian History: Studies in the Transmission of Faith* (Orbis, 1996), 3–15.

28 For an account of incarnation anyway Christology, see Edwin Chr. Van Driel, *Incarnation Anyway: Arguments for Supralapsarian Christology* (Oxford University Press, 2008). Theistic evolutionists often adopt this approach to sidestep the classical doctrine of the fall of Adam and Eve, e.g., see Patrick Franklin, "Theodicy and the Historical Adam: Questioning a Central Assumption Motivating Historicist Readings," *Perspectives on Science and Christian Faith* 74, no. 1 (2022): 39–53.

29 I've been painting in broad strokes, so let me add nuance. Old Testament scholars have made a better showing than other Christian scholars—may their tribe increase. For example, see Andrew E. Steinmann, *Genesis: An Introduction and Commentary* (InterVarsity, 2019); Andrew E. Steinmann, "A Note on the Refrain in Genesis 1: Evening, Morning, and Day as Chronological Summary," *Journal for the Evangelical Study of the Old Testament* 5, no. 2 (2016–2017): 125–40; William D. Barrick, "Historical Adam: Young-Earth Creation View," in *Four Views on the Historical Adam*, ed. Matthew Barrett and Ardel B. Caneday (Zondervan, 2013), 197–227. In past years, Barrick has presented several penetrating essays at the Evangelical Theological Society meetings. We could add Todd Beall, Eugene Merrill, and others.

30 My thanks to Robert Erle Barham, Ken Coulson, Neal Doran, Stephen Lloyd, Michael Radmacher, and Henry B. Smith Jr. for helpful comments on an earlier draft.

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RESEARCH

Bioturbation: Worm burrows and geological time

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Abstract

In the study of earth history one of the important goals is to understand how much time was involved in producing the principal fossil-bearing sediments of the Phanerozoic. The research reported here examines one measure of time that can be compared with the time indicated by radiometric dating. On the earth today animals and plants are continually burrowing into the substrate, and this disturbance is called bioturbation. Bioturbation can, in time, homogenize the sediment, destroying any record of the boundaries between layers of sediment. In the modern world the rate of this process can be measured, and bioturbation generally homogenizes the sediment in hours, days, or weeks. Under normal environmental conditions it does not take years. To quantify this process in the rock record we measured vertical sections through 37 sedimentary formations in western United States, from Cambrian to Eocene, recording the amount of observed bioturbation on these rocks. In all measured sections, 97% of the thickness showed no bioturbation or occasional isolated burrows. The remaining 3% of the vertical surfaces contained some bioturbation, with a very small amount (<1%) being thoroughly bioturbated. Such a low level of bioturbation is inconsistent with sediment accumulation over the time indicated by radiometric dating.

Introduction

As we seek to understand earth history, the fossil record, and their relationship to origins, one important factor to deal with is time: how can we best measure the amount of time in the Phanerozoic geological record? We cannot go back in history and directly measure time. Even radiometric dating cannot do that. It will be useful to have other indicators of the passage of time that we can measure today, and then apply to the geological record with an acceptable level of confidence. We quantified bioturbation through the geological column as one measure of how much time passed as the sedimentary record formed.

Today, sedimentary processes deposit layers of sediment in rivers, lakes, nearshore marine environments, and others. These sediment layers do not remain undisturbed. A host of small animals burrow through these sediments looking for food, plant roots grow through them, and erosion processes disturb them (1). The rates at which these processes churn the sediments and erase clear evidence of the boundaries between sediment layers is the subject of much research. This research provides a quantified measure of how much time it takes to erase the boundaries between sediment layers and leave behind homogenized sediment. Even terrestrial sediments are processed in similar manner by mice, gophers, squirrels, insects, other terrestrial invertebrates, including a myriad of worms and by plant roots. We think that these modern analogues can be compared directly to ancient sediments formed in similar environments.

Citation Brand L, Chadwick A. Bioturbation: Worm burrows and geological time. New Creation Studies. 2025 Jul;1(1):21-33.

With this background we conducted an extensive survey of a select sample of sedimentary formations from Cambrian to Eocene in western USA, including Utah, Arizona, and Colorado, quantifying the frequency and intensity of bioturbation in each formation. We predicted, based upon described experimental rates of bioturbation in the present environment, that sediments deposited on a time scale of millions of years, or even hundreds of thousands of years, would be thoroughly bioturbated, and divisions between individual layers of sediment would be largely obliterated by this process. On the other hand, sediments deposited rapidly, especially if deposited during a large-scale catastrophe, would likely have few intervals of intense bioturbation. But even under these conditions we would expect that there would be organisms in the water or transported with the sediment, seeking a place to settle. Consequently, we would expect some bioturbation, but probably not long intervals of intense bioturbation.

There are conditions that can interfere with bioturbation. A lack of oxygen in the water can reduce bioturbation, because many animals cannot live there (2–5). It is also recognized that if the sediment was deposited so rapidly that not much animal activity could occur, this would prevent or greatly reduce bioturbation (6,7). We will discuss how each of these is likely to relate to the sedimentary record.

Methods

We used standard procedures to measure sections through each of the studied formations, documenting the amount of bioturbation in adequately exposed intervals, centimeter by centimeter. We measured rock thickness using a Jacobs staff with an Abney level for accuracy (8). Intensity of bioturbation was categorized according to the scale in **Figure 1** and illustrated in **Figure 2**. This scale is a modification of the ichnofabric index used by Droser and Bottjer (9), modified to suit our research design. The bioturbation measured in this study was primarily seen on vertical or nearly vertical surfaces, not on horizontal surfaces. This design was chosen as a practical matter because rock exposures suitable for measuring a section seldom had many horizontal exposures for quantifying bioturbation. We made the assumption that the level of bioturbation seen on vertical surfaces will provide a sufficient estimate of the amount of bioturbation to be expected on horizontal surfaces in the same interval. In addition, our primary goal was to understand how often there was sufficient bioturbation to obliterate the boundaries between sediment layers. For this purpose, bioturbation on horizontal surfaces is not as pertinent.

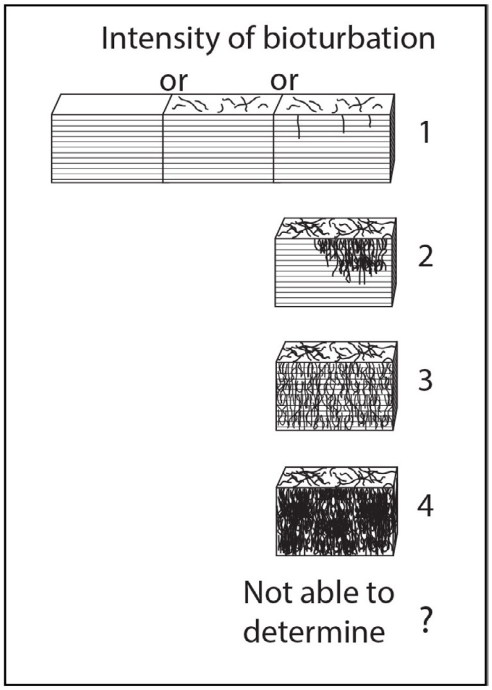
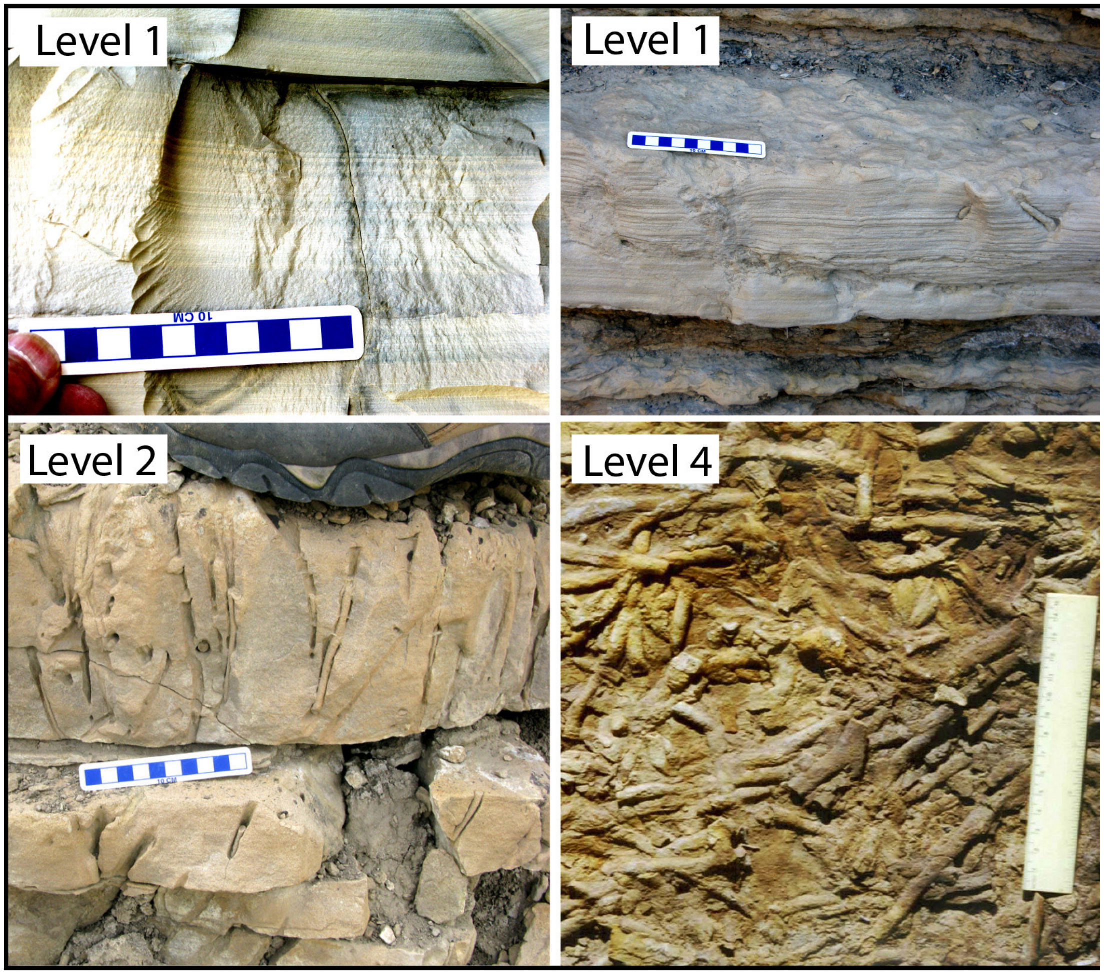


Figure 1. Scale of bioturbation used in this research. The question mark indicates intervals that were covered or obscured, where we could not evaluate bioturbation.

The scale in **Figure 1** does not begin with zero bioturbation. This is because we had no measure of bioturbation on horizontal surfaces, and thus we could not document a level of zero bioturbation. Also, since we would not be surprised if some bioturbators were present, even with rapid deposition, we did not expect to see zero bioturbation as a rule. Our scale is designed to measure the extent to which sediment layering was obscured by bioturbators, as would be expected with the passage of time. The first level included the possibility of a small amount of vertical burrowing, but not enough to have much effect on the sediment layers. Levels two and three are intermediate bioturbation levels, and level four

Figure 2. Examples of different levels of bioturbation, as defined in Figure 1.



is bioturbation that fully obscures sediment layering. In uniformitarian geological processes, we expect that level four would be the most common, as it usually is during modern processes (10).

Using this method, we surveyed bioturbation in 37 geological formations, selected to sample the Phanerozoic record, from Cambrian to Eocene. **Figure 3** is a record of the sampled formations and their position in the geological column. The vertical extent, in meters, of bioturbation in levels one to four was determined in all 37 formations that we measured. Some formations were surveyed at several different locations. For each of these formations we used a maximum of two sections in our calculations. This resulted in the use of 46 sections. **Table 1** describes the location of each study site.

Study sites were chosen for clean rock surfaces over as much of each section as possible, accessibility of the site, and practical access to the entire section without risk of bodily injury. Figure 4 shows researchers at several study sites. A variety of sediment types were surveyed, including limestone, dolomite, shale, mudstone, and sandstone. **Figure 5** has photographs of several study outcrops.

Figure 3. The rock formations we surveyed, and their position in the geological column. Red symbols indicate approximate levels at which we documented at least some bioturbation.

Labels such as "M2" allow correlating this list with locality information in **Table 1.**

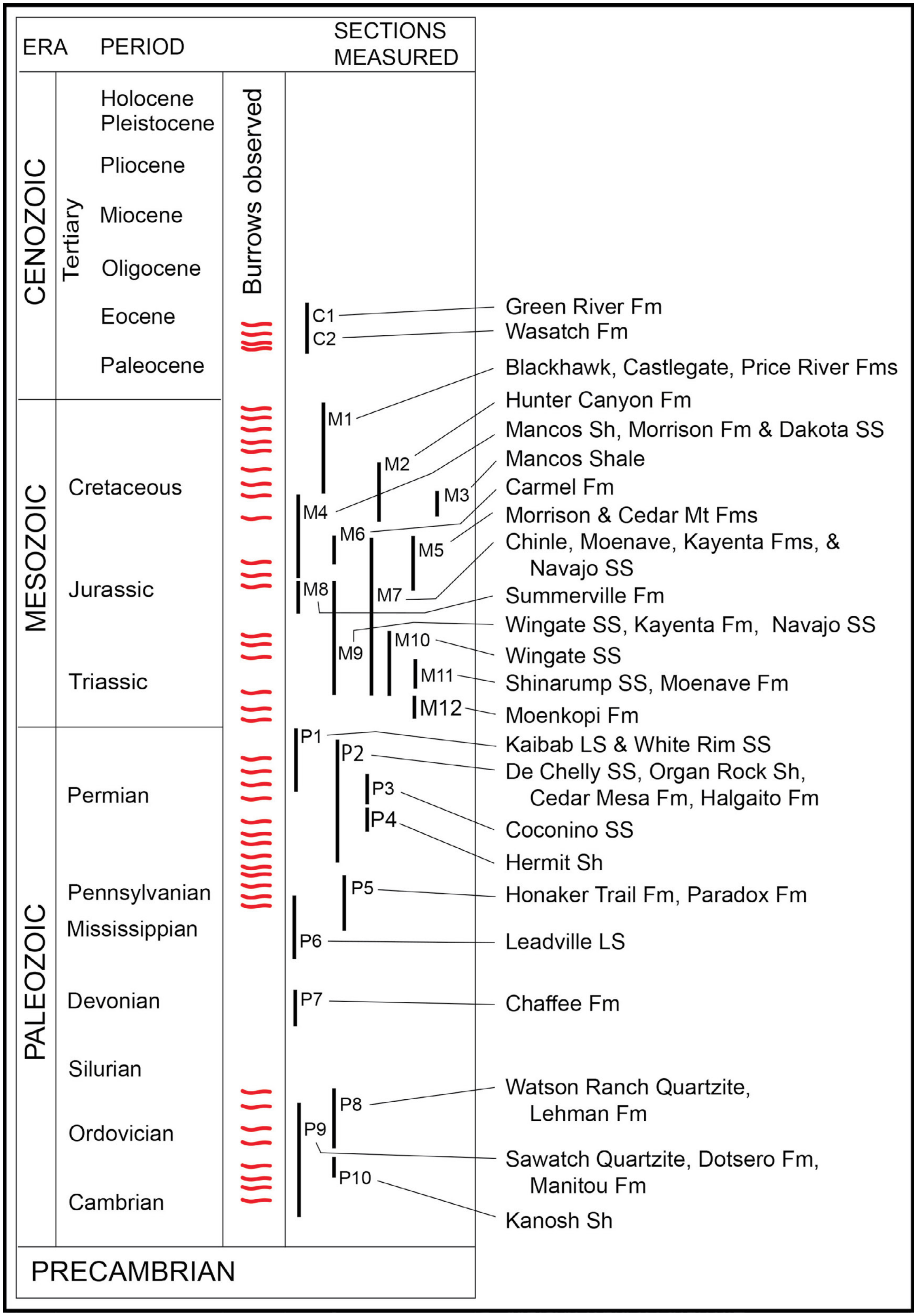


Table 1. Locality information for **Figure 3.**

C1.	Rifle, Colorado. Green River Fm, Eocene.
C2.	Rifle, Colorado. Wasatch Fm, Eocene.
M1.	Price, Utah. Blackhawk Fm, Castlegate Fm, Price River Fm, Cetaceous.
M2.	Northeast of Grand Junction, Colorado. Hunter Canyon Fm, Cretaceous.
M3.	San Rafael Swell, I 70, 54 miles west of Green River, Utah. Mancos Sh, Cretaceous.
M4.	East side of Capital Reef N P, Burr Trail, Utah. Mancos Sh, Morrison Fm, Dakota SS, Jurassic.
M5.	San Rafael Swell, I 70, 20 miles west of Green River, Utah. Morrison Fm, Cedar Mt Fm, Jurassic.
M6.	San Rafael Swell, I 70, 20 miles west of Green River, Utah. Kayenta Fm, Carmel Fm, Navajo SS, Triassic to Jurassic.
M7.	Cockscomb monocline, 20 miles east of Kanab, Utah. Chinle Fm, Moenave Fm, Kayenta Fm, Navajo SS, Triassic to Jurassic.
M8.	East side of Capital Reef N P, Burr Trail, Utah. Summerville Fm, Jurassic.
M9.	East side of Capital Reef N P, Burr Trail, Utah. Wingate SS, Kayenta Fm, Navajo SS, Triassic to Jurassic.
M10.	Kanab, Utah. Wingate SS, Triassic.
M11.	Hurricane Mesa, 24 miles northeast of St George, Utah. Shinarump Conglomerate, Triassic.
M12.	Hurricane Mesa, 24 miles northeast of St George, & San Rafael Swell, I 70, 54 miles west of Green River, Utah. Moenkopi Fm, Triassic.
P1.	San Rafael Swell, I 70, 54 miles west of Green River, Utah. Kaibab LS, White Rim SS, Permian.
P2.	Comb Ridge, 13 miles southwest of Blanding, Utah. De Chelly SS, Organ Rock Sh, Cedar Mesa Fm, Halgaito Fm, Permian.
P3.	Grand Canyon, Arizona. Coconino SS, Permian.
P4.	Virgin River Gorge (Arizona), 8 miles southwest of St George, Utah. Hermit SS, Permian.
P5.	Goosenecks State Park, 5 miles west of Mexican Hat, Utah. Honaker Trail Fm, Paradox Fm, Pennsylvanian.
P6.	Glenwood Springs, Colorado. Leadville LS, Mississippian.
P7.	Glenwood Springs, Colorado. Chaffee Fm, Devonian.
P8.	Fossil Mountain, 50 miles southwest of Delta, Utah. Watson Ranch Quartzite, Lehman Fm, Ordovician.
P9.	Glenwood Springs, Colorado. Sawatch Quartzite, Dotsero Fm, Manitou Fm, Cambrian to Ordovician.
P10.	Fossil Mountain, 50 miles southwest of Delta, Utah. Kanosh Sh, Ordovician.

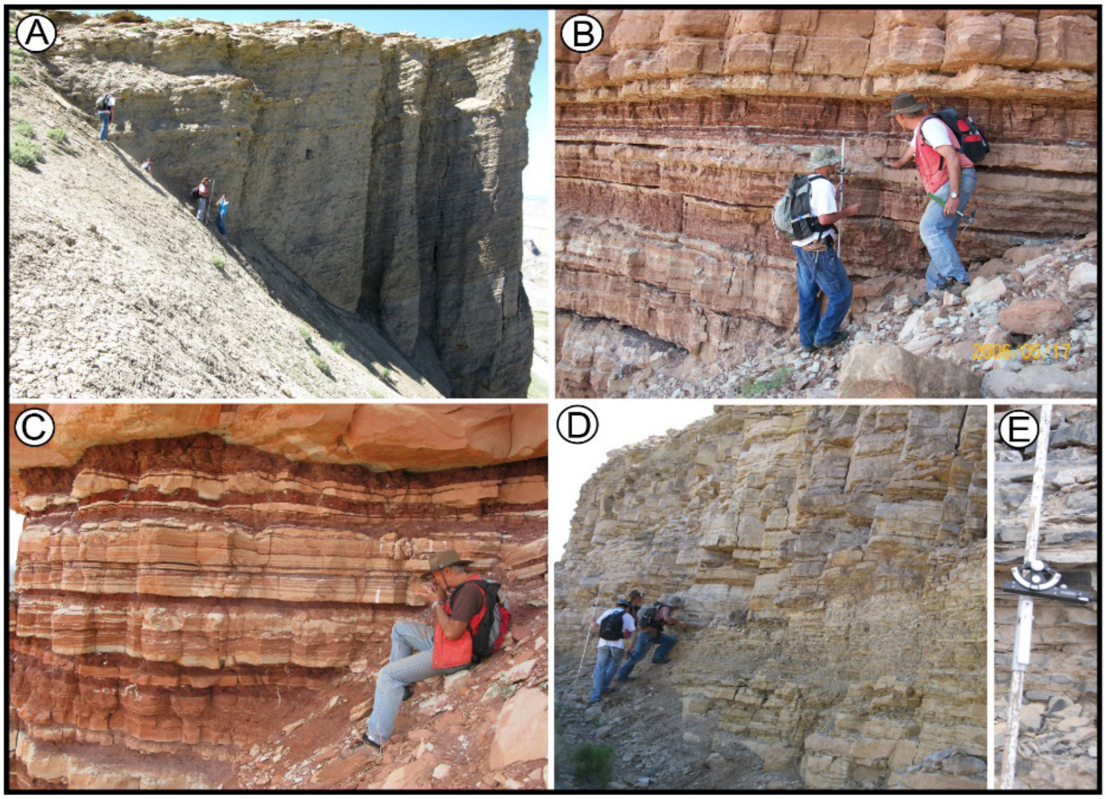


Figure 4. Researchers at representative study sites.

A: Cretaceous Mancos Shale., Caineville, Utah; **B**: Jurassic Summerville Fm, east side of Capital Reef N.P, Utah; **C**: Jurassic Moenave Fm., Kanab, Utah; **D**: Triassic Moenkopi Fm., San Rafael Swell, I 70, 54 miles west of Green River, Utah; **E**: the Jacobs staff with Abney level we used.

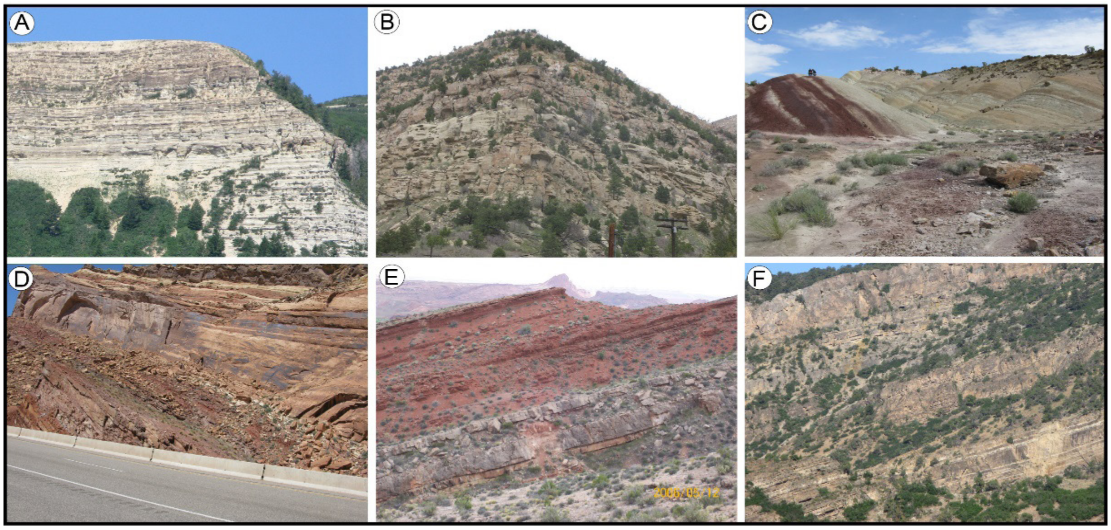


Figure 5. Representative outcrops used in this research.

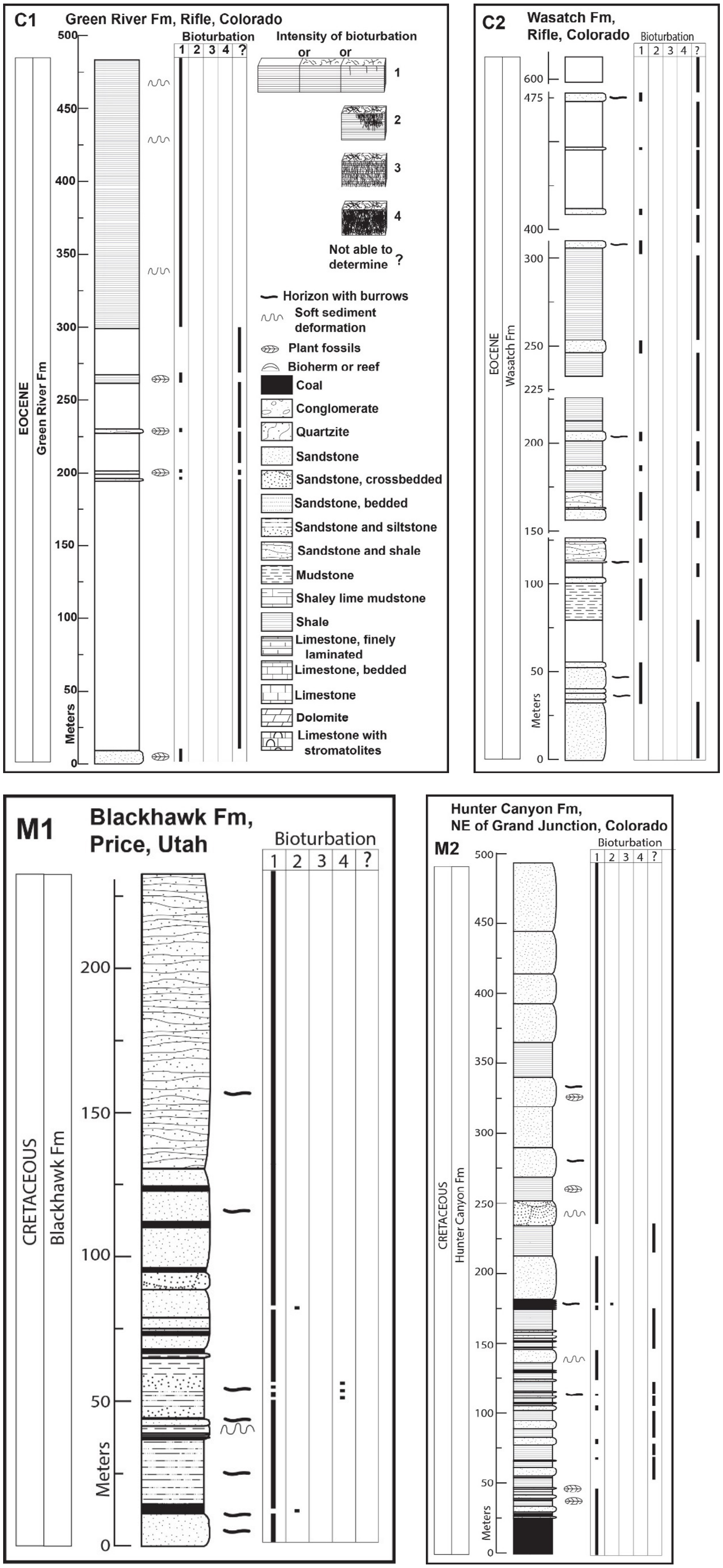
A: Eocene Green River Formation, Rifle, Colorado; **B**: Cretaceous Price River Fm., Price, Utah; **C**: Upper Jurassic Morrison Fm., east side of Capital Reef N P, Utah., **D**: Lower Jurassic Wingate SS, San Rafael Swell, I 70, 20 miles west of Green River, Utah; **E**: Permian Comb Ridge, 13 miles southwest of Bluff, Utah; **F**: Cambrian-Ordovician, Glenwood Springs, Colorado.

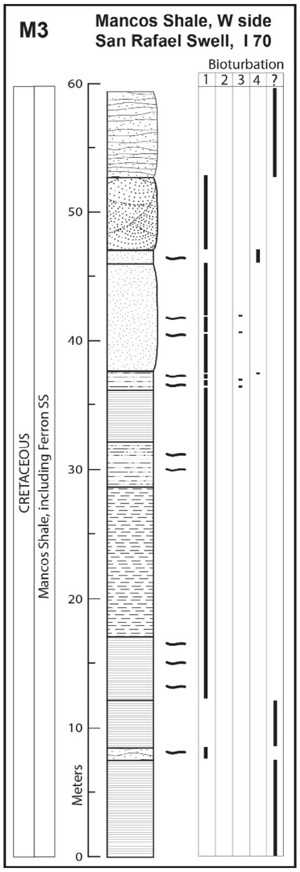
See **Figure 4** for additional outcrops.

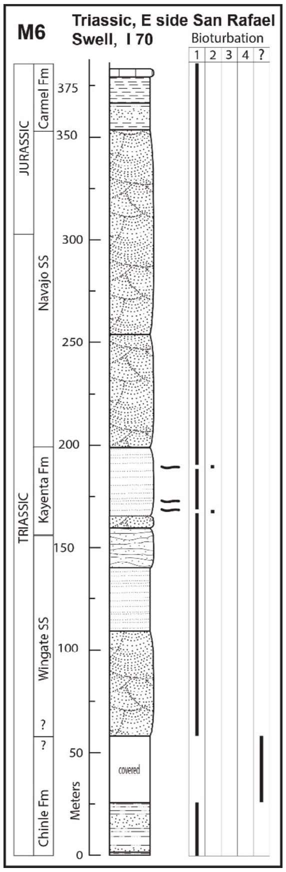
Results

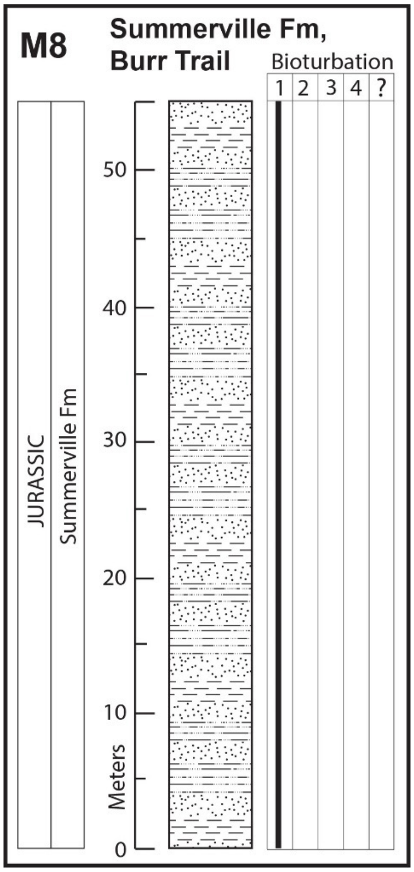
Figure 6 shows our results for ten representative measured sections. These sections were chosen to include the maximum and the minimum amount of bioturbation for all our measured sections. The information on the right side of the Green River Fm. section applies to all the sections. Portions of sections labeled "?" were obscured (covered by vegetation or talus) or otherwise did not provide adequate detail for analyzing bioturbation. The largest amount of obscured section in our study was found in the Eocene formations, which were exposed on steep hillsides. Column on the left in each diagram contains symbols indicating the primary type of sediment in each part of the section.

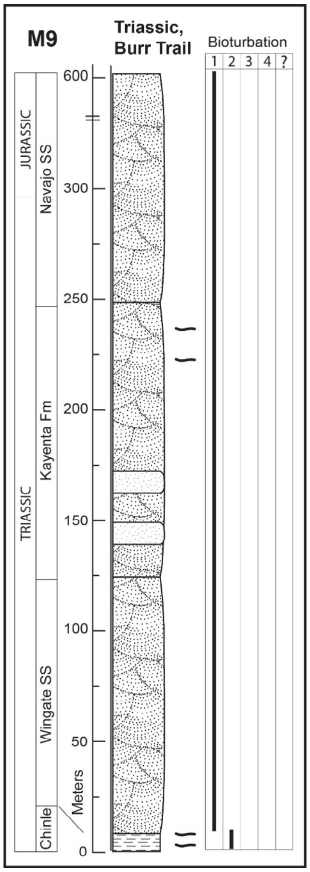
Figure 6. Amount of bioturbation in ten measured sections, selected to show the range of bioturbation density seen in the entire study. Sections are arranged in descending stratigraphic order. Symbols such as "M2" are the symbols used in **Figure 3** identifying each section. Blank portions of the stratigraphic columns represent intervals that were too obscured to be sure of the type of sediment.

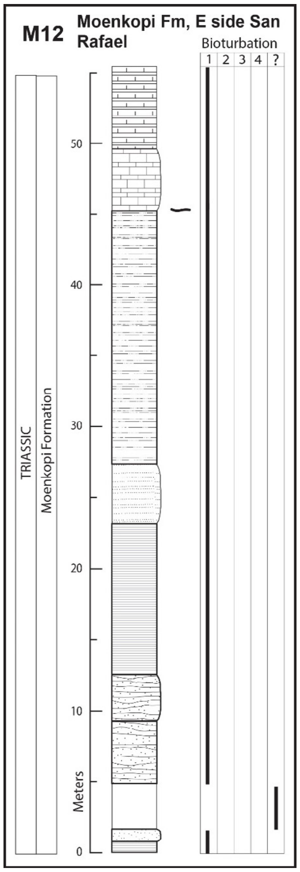



M3
Mancos Shale, W side San Rafael Swell, I 70
Bioturbation
1 2 3 4 ?
CRETACEOUS
Mancos Shale, including Ferron SS
Meters
0
10
20
30
40
50
60


M6
Triassic, E side San Rafael Swell, I 70
Bioturbation
1 2 3 4 ?
JURASSIC
Carmel Fm
Navajo SS
TRIASSIC
Kayenta Fm
Wingate SS
?
?
Chinle Fm
Meters
covered
0
50
100
150
200
250
300
350
375


M8
Summerville Fm, Burr Trail
Bioturbation
1 2 3 4 ?
JURASSIC
Summerville Fm
Meters
0
10
20
30
40
50


M9
Triassic, Burr Trail
Bioturbation
1 2 3 4 ?
JURASSIC
Navajo SS
TRIASSIC
Kayenta Fm
Wingate SS
Chinle
Meters
0
50
100
150
200
250
300
600


M12
Moenkopi Fm, E side San Rafael
Bioturbation
1 2 3 4 ?
TRIASSIC
Moenkopi Formation
Meters
0
10
20
30
40
50

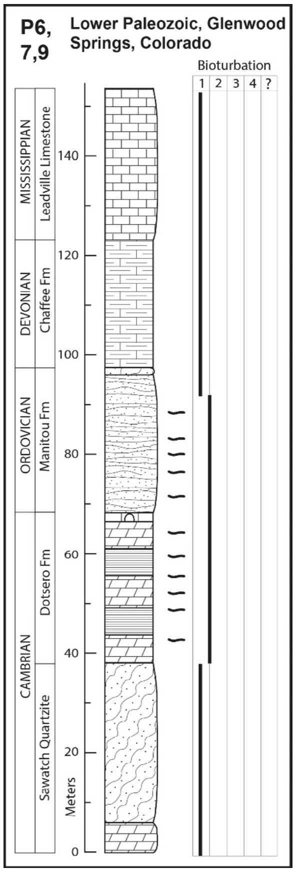

P6, 7,9
Lower Paleozoic, Glenwood Springs, Colorado
Bioturbation
1 2 3 4 ?
MISSISSIPPIAN
Leadville Limestone
DEVONIAN
Chaffee Fm
ORDOVICIAN
Manitou Fm
Dotsero Fm
CAMBRIAN
Sawatch Quartzite
Meters
0
20
40
60
80
100
120
140

Table 2. Percent of all measured sections in each bioturbation level. Number of occurrences indicates the number of measured sections in which this bioturbation level was seen at least once. Percent of total is percent of vertical distance of all sections that were in each bioturbation level (including only portions of the section that were not obscured).

Bioturbation level	1	2	3	4
Meters of section	5,172	138	19	4
Number of occurrences	46	7	3	2
Percent of total	97	2.6	0.36	0.09

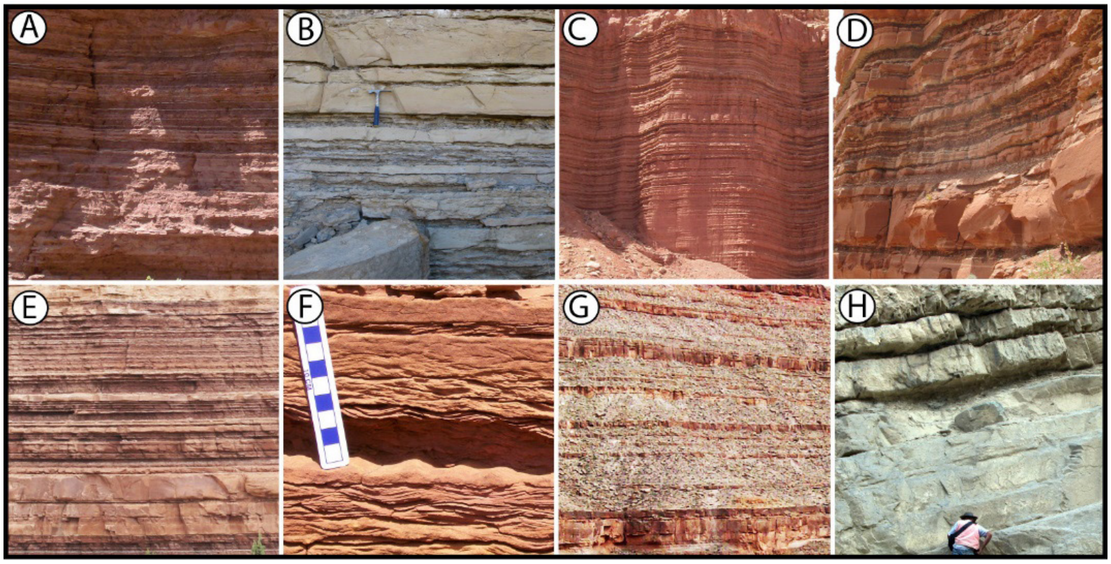


Figure 7. Typical well-preserved bedding in our study sections. **A**: Cretaceous Mancos Sh.; **B**: Ferron SS, part of the Mancos Sh.; **C**. Jurassic Summerville Fm.; **D**: Triassic Chinle Fm.; **E** and **F**: Triassic Moenkopi Fm.; **G**: Pennsylvanian Honaker Trail Fm.; **H**: Mississippian Leadville LS.

Scale in **F** is ten cm. All others are seen in outcrop scale – meters to tens of meters.

For each section, the vertical distance (in meters) of the total section was determined, and also the vertical distance of the portion of that section that was not obscured. For all measured sections combined, the vertical distance (in meters) in each bioturbation level was divided by the total number of meters of the non-obscured portions of all sections. This gave the percentage of all sections combined that were in each bioturbation level (**Table 2**). Ninety seven percent of all sections were in bioturbation level one, and lesser percentages in levels 2-4. For some formations, more than one section was measured, at different localities. For each of these formations only two sections were used in the calculations.

Throughout the geological formations that we surveyed, the bedding in all sections is very well preserved. Boundaries between beds are intact and have not been destroyed or seriously damaged by bioturbation. **Figure 7** includes typical examples of the bedding in representative formations that we studied.

Discussion

From the evidence we collected it is evident there is very little bioturbation in our sampled sections, from Cambrian to Eocene. There are other locations in the geological record that have more bioturbation than this, including in the middle Paleozoic, but the results presented here are what we found in our sample. There are scattered examples of bioturbation, but very few cases of intense, level four bioturbation, and they are limited in vertical extent. This is consistent with our predictions if the sediments were deposited in rapid succession with little time for bioturbation, but very different from the predictions of uniformitarian processes involving slow deposition over long periods of time. Examples of intense bioturbation are not extensive enough to obscure a significant amount of the sediment layering, as seen in **Figure 7**. This is not surprising, considering how little bioturbation there is in all these studied outcrops. This aspect of the geological record is very different from what happens in the modern world. If the uniformitarian assumption that processes forming ancient rock formations were comparable to processes today in rivers, flood plains and other environments was true, the boundaries between these beds would all or mostly have been destroyed (10).

The measure of time that most of the scientific community has confidence in is radiometric dating. Physicists have developed an understanding of the radiometric isotopes, and decay sequences from one to another. They have also measured the decay rates in the laboratory. We don't see reason to question that part of the method. The uncertainties, we suggest, come from other aspects of the method, such as the unknown history of each rock sample.

Since the radiometric dating method gives ages that are compatible with the other assumptions accepted by a uniformitarian approach to earth history, confidence in this method is not surprising and might seem to be warranted. However, it will be very beneficial to have some other methods for measuring the passage of time, that yield estimates of time in the geological record that can be compared with radiometric dates, without undue dependence on assumptions (11). Twidale said, "At present, physical dates do not stand on their own. They must be compatible with stratigraphy. Stratigraphy has also served to highlight flaws and the relevance of unexpected factors in some physical procedures. So-called absolute dating is a misnomer, for physical dates provide numerical approximations, preferably considered within and constrained by a stratigraphic framework."

One such method is evidence for the life activities of organisms (such as bioturbation) in the fossil record. This evidence should give us an insight into the amount of time involved; how fast these activities occur, and how much time is indicated by these data.

Today bioturbating organisms are extremely common and continuously active. Measured bioturbation intensity or rates indicate that divisions between newly deposited sedimentary layers are destroyed in hours, days, or weeks, as bioturbators homogenize the sediment. It does not normally take years. An experimental study showed complete homogenization of sediments down to a depth of 10 cm in an hour if bioturbators are abundant (12). This is not unrealistic, since some small bioturbators can reach 16,000 to 60,000 individuals per square meter (13). This is not the usual abundance, but bioturbation clearly does not require long time periods. Another experimental study of bioturbation found that a small number of marine organisms that feed while moving through the sediment can bioturbate a square meter plot in an hour to 42 days (6). In some cases there is seasonal alternation between highly bioturbated units, and units with laminated beds because of a lack of active bioturbation (14), as observed in study of a modern river.

One prominent bioturbation researcher (10) concluded that "one hundred percent bioturbation of the substrate is the natural end-product of the activity of bioturbating organisms." "Failure to reach 100 percent, or failure of that state to be preserved in the rock record, are conditions that require explanation" (p. 223-225). Since bioturbation today has been shown to completely process the sediment in a short time frame, we should expect to see this reflected in ancient sediments, if those sediments were deposited in a way that was similar to what happens today. If sedimentary rocks often contain distinct layering undamaged or minimally damaged by bioturbation, that does not seem to be consistent with the expectations of uniformitarianism, or even of neocatastrophism as understood today. This would be a condition that requires, according to Bromley, a serious level of explanation.

Two processes have been recognized as possible causes for limited bioturbation. One is lack of oxygen in the water, because many animals cannot live there (2–5). It apparently requires truly anoxic conditions to prevent all bioturbation. A study of modern sediments off the coast of Peru found that bioturbation can be common in low oxygen conditions (hypoxia), but anoxic conditions in up to 15 cm of sediment resulted in laminated sediment with no bioturbation (15). The other factor affecting bioturbation is rapid deposition of sediment, not allowing time for active bioturbation (6,7,16).

In the oceans today and apparently during the Quaternary, large areas of the ocean have low oxygen levels (17,18) and low biota. We would expect very little bioturbation there. Although oxygen can be limited in such situations today, this is not likely to be a widespread condition in areas of active, rapid deposition of sediment in shallow water in the past. On the other hand, extremely rapid sediment deposition is expected to occur during a global catastrophe, and we suggest that this was the primary factor limiting bioturbation during much of the sedimentary record. In such a consistently rapid process, bioturbators would likely be in the water, searching for a place to settle. We would expect them to leave some evidence, occasionally, as we found in our research, but areas of extensive bioturbation are rare in the sections we examined.

Bioturbation is the subject of very abundant research, much of it in modern environments, but also in the rock record. Some studies of the rock record report higher levels of bioturbation than we found. For example Tarhan et al. (19) studied outcrops of a Cambrian-Ordovician marine succession along the coast of Newfoundland, interpreted as deposited in a passive margin or shelf environment. That study is not directly comparable to ours, because their methods were quite different. They evaluated bioturbation on horizontal surfaces as well as vertical surfaces. They report bioturbation levels at some localities that were near their maximum level, level 6 on their scale. We also found some uncommon examples of bioturbation level 4, the highest level on our scale. They report finding, on average, higher levels of bioturbation than we found, but they state that "average levels of bioturbation along this margin remained low throughout much of this interval, relative to those of environmentally analogous seafloor settings in modern oceans." It would be instructive to search the rocks and the literature to determine what factors differ between formations with common bioturbation and those which, like our sample, have little bioturbation. However, it is likely that rock formations with rare bioturbation or rare body fossils will not often be the subject of published papers (4).

Consistent with the scarcity of serious bioturbation, the divisions between sedimentary layers in the geological column are persistently distinct and well-preserved. These have not been obscured by bioturbation and other routine processes that affect sediment and exposed ground surfaces today. The low level of disruption of laminated sediment by bioturbation as seen in **Figure 7** is an important verification of the low levels of bioturbation that we found in our sample. This is consistent with the expectations of rapid geological processes, which had only a small amount of time for each formation to be deposited, and very little time or no time passing between the deposition of successive layers. A comparative study of bioturbation through the Cenozoic could have potential to yield insights into the timing of the transition from catastrophic conditions in the flood to quieter conditions postflood.

The idea of a global catastrophe will be quickly dismissed by many persons, but the rapid processes during that global catastrophe are actually the only possible reason why the sedimentary layers have sufficient preserved details to allow geologists to seek to understand them at all. In a uniformitarian process, most of these sedimentary details should have been obliterated or damaged by bioturbation (10), leaving little prospect for today's geologists to interpret the rocks. Much of the sought-for evidence would have been replaced with evidence of bioturbation. Sedimentologists may study the sedimentary structures preserved in outcrops without ever recognizing that the existence of these preserved features argue against a slow extended period of deposition.

Creationist interpretations of geological evidence are often attributed to lack of knowledge or closed-minded unwillingness to consider other options. For those who are experienced scientists the explanation can be very different. They understand the evidence, and how and why the evidence is usually interpreted the way it is. However, their minds are likely to be open to comparing different models (including models they don't like, and models not accepted by the general scientific community), and evaluating how effective each model is in explaining the evidence. This comparative approach allows us to recognize conflicts between the evidence and the accepted interpretations of this evidence, if there are such conflicts. For these individuals their willingness to compare such a diversity of models makes them more open-minded. That is what it takes to recognize the disconnect between the reality that we see in the geological record for bioturbation, and the standard interpretation of geological time. Our purpose in this work is not to prove we are right. Proof is not a realistic goal, and we don't need to prove our viewpoint. The evidence will speak for itself, if we allow it to. The only satisfying approach is to seek to know, in all fairness, what the evidence says about geological history.

Conclusions

In this research we sought to apply a fair-minded method to an analysis of the abundance of bioturbation through most of the geological column. In our random sample of rock formations we found a very low level of bioturbation from Cambrian to Eocene. There is much too little bioturbation in this sample to be compatible with the passage of the long time periods postulated in the standard geology paradigm. The meagre bioturbation record is consistent with the conditions and the brief time periods expected in a global geological catastrophe. This evidence is just what we would expect if the record in Genesis is true.

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RESEARCH

Evidence for a Silesaurid (Archosauria: Dinosauriformes) Holobaramin with a Discussion of Triassic Dinosaurs

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Abstract

The Silesauridae is a family of non-dinosaurian dinosauriforms thought by some conventional paleontologists to be the evolutionary bridge from non-dinosaurian archosaurs to dinosaurs. Thus, in order to advance the creationist understanding of the silesaurids, we analyzed character datasets from four studies: Nesbitt et al. (1), Martz and Small (2), Müller and Garcia (3), and Norman et al. (4) with statistical baraminology using BARCLAY to conduct baraminic distance correlation (BDC), 3D multidimensional scaling (MDS), partitions around medoids (PAM), and fuzzy analysis (FANNY). The results showed evidence of continuity within the Silesauridae and discontinuity surrounding the family. Because of this, we propose that the Silesauridae is a distinct holobaramin. From these analyses, we also tentatively conclude that the Silesauridae holobaramin might include *Lagosuchus (Marasuchus)*, and maybe *Pisanosaurus mertii*. We also observed evidence of discontinuity among the stratigraphically lowest dinosaurs, which are found in Upper Triassic rocks.

Keywords Dinosauromorpha, Silesauridae, Baraminology, Paleontology, Dinosauria, Triassic

Introduction

The Silesauridae is a family of fossil archosaur reptiles which was erected upon the discovery of *Silesaurus opolensis* (5). The clade is only represented by fossils from the Middle to Upper Triassic (Anisian-Rhaetian) strata. More than a dozen taxa are currently recognized as silesaurids, including *Asilisaurus kongwe* (1), *Lewisuchus admixtus* (6), *Sacisaurus agudoensis* (7), and *Kwanasaurus williamparkeri* (2). The inclusion of two taxa is disputed: *Pisanosaurus mertii* (8) and *Agnosphitys cromhallensis* (9). This group is of interest in the conventional paleontological literature due to its significant role in dinosaur evolution. However, the silesaurids' relationship to the dinosaurs is still unclear **(Fig. 1)**. While most authors consider the Silesauridae as the sister group to Dinosauria (e.g. Baron et al. (10), Benton and Walker (11), Langer et al. (12), Langer et al. (13), Nesbitt et al. (1), Nesbitt et al. (14), Benton (15)) others have recovered the Silesauridae as within Dinosauria and Ornithischia as either a true clade (e.g. Cabreira et al. (16); Langer and Ferigolo (7)) or a paraphyletic grade leading to classic ornithischians ((e.g., Fonseca, et al. (17); Müller (18); Müller and Garcia (3); Norman et al. (4)).

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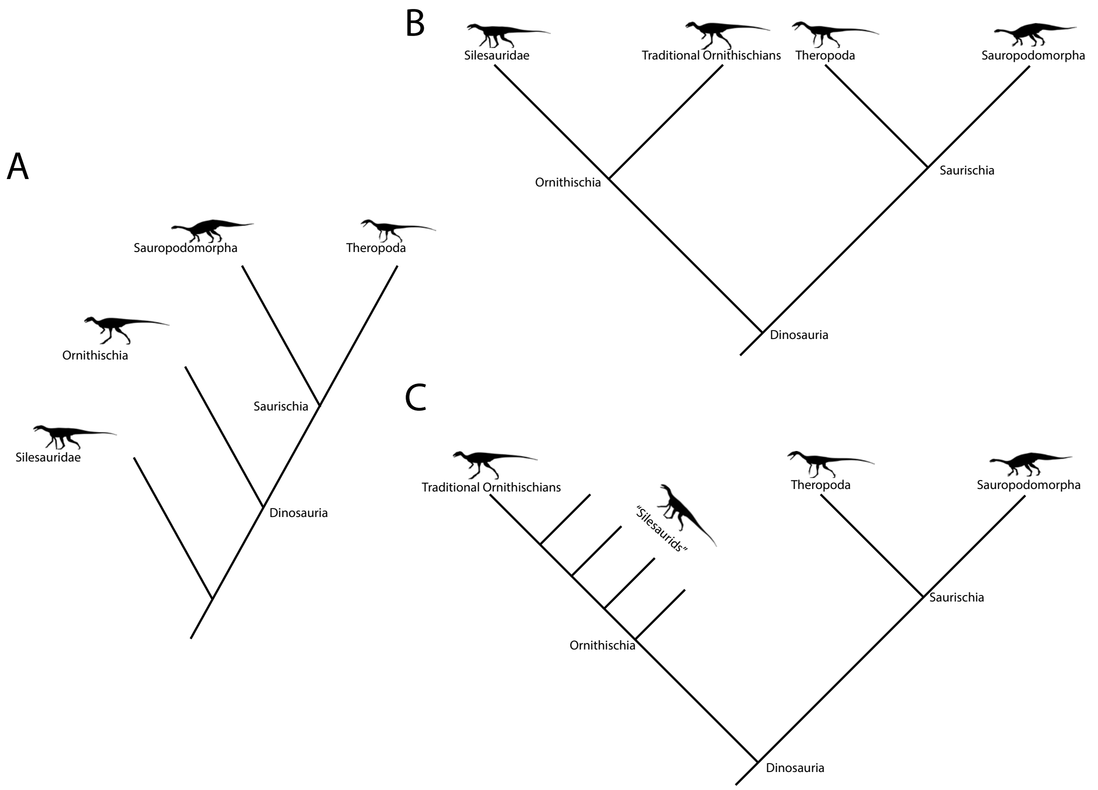

Figure 1. Cladograms showing proposed relationships of silesaurids to dinosaurs in the literature: **A)** Silesauridae as the sister group to Dinosauria, **B)** Silesauridae as a clade of ornithischians; and **C)** "Silesaurids" as an ornithischian grade leading to traditional ornithischians.

Silhouettes from Phylopic (https://www.phylopic.org/). All silhouettes are public domain except for *Asilisaurus* by Scott Hartman, CC BY 3.0 (https://creativecommons.org/licenses/by/3.0/deed.en).

Some baraminological work has been done including members of the Silesauridae, but no analysis has been conducted with the silesaurids as the main focus of the study. Doran et al. **(19)** analyzed a dataset from Baron et al. **(10)** which showed that silesaurids had the tendency to group separately from all of the major dinosaurian groups. McLain, et al. **(20)** found evidence for a Silesauridae holobaramin based on statistical baraminological analysis of a phylogeny of all archosauromorphs through subdividing the dataset into smaller taxonomic groups. Given the results from previous work, we predict that the Silesauridae will be a holobaramin.

Materials and Methods

For the analyses, we employed four datasets. The first dataset was from Nesbitt et al. **(1)**, and it contained 290 characters and 35 taxa (see **Table 1** for a breakdown of taxa). This dataset was analyzed at a 0.2 taxonomic relevance cutoff and a 0.75 character relevance cutoff.

The second dataset was an updated Peecook et al. **(21)** matrix by Martz and Small **(2)**, which contained 294 characters and 39 taxa (**Table 1**). This dataset was analyzed at a 0.2 taxonomic relevance cutoff and a 0.75 character relevance cutoff. This dataset will be referred to as "Martz and Small **(2)**" for the remainder of this paper.

The Müller and Garcia **(3)** dataset contained 266 characters and 62 taxa (**Table 1**). Due to *Asilisaurus kongwe* and *Daemonosaurus chauliodus* not sharing characters in common, this dataset was analyzed at a 0.3 taxonomic relevance cutoff and a 0.75 character relevance cutoff.

Lastly, the Norman et al. **(4)** dataset contained 282 characters and 71 taxa (**Table 1**). Due to *Abrictosaurus consors* and *Agilisaurus louderbacki* not sharing characters in common, this dataset was analyzed at a 0.3 taxonomic relevance cutoff and a 0.75 character relevance cutoff.

To reduce confusion, we refer to *Marasuchus lilloensis* and *Lagosuchus lilloensis* as *Lagosuchus talampayensis*

Table 1. A breakdown of the taxa in each dataset.

Colors: White - Outgroup; Yellow -Lagerpetidae; Sea Green - Lagosuchidae; Red - Silesauridae; Green - Ornithischia; Orange - Herrerasauridae; Purple - Sauropodomorpha; Blue - Theropoda.

	Nesbitt et al. (1)	Martz & Small (2)	Müller & Garcia (3)	Norman et al. (4)
Erythrosuchus africanus	✓	✓		
Euparkeria capensis	✓	✓	✓	✓
Revueltosaurus callenderi	✓	✓		
Aetosaurus ferratus	✓	✓		
Arizonasaurus babbitti	✓	✓		
Effigia okeeffeae	✓	✓		
Batrachotomus kuperferzellensis	✓	✓		
Postosuchus kirkpatricki	✓	✓		
Dromicosuchus grallator	✓	✓		
Eudimorphodon ranzii	✓	✓		
Dimorphodon macronyx	✓	✓		
Dongusuchus efremovi			✓	
Spondylosoma absconditum			✓	
Teleocrater rhadinus			✓	✓
Dongsuchus efremovi				✓
Spondylosoma absconditum				✓
Yarasuchus deccanensis			✓	✓
Lagerpeton chanarensis	✓	✓	✓	✓
Dromomeron gregorii	✓	✓	✓	✓
Dromomeron romeri	✓	✓	✓	✓
Dromomeron gigas			✓	✓
Ixalerpeton polesinensis				✓
UFSM 11611				✓
PVSJ 883				✓
Lagosuchus/Marasuchus lilloensis	✓	✓	✓	✓
*Saltopus elginensis**			✓	✓
Asilisaurus kongwe	✓	✓	✓	✓
Suomyasaurus aenigmaticus		✓		✓
Diodorus scytobrachion		✓	✓	✓
Eucoelophysis baldwini	✓	✓	✓	✓
Sacisaurus agudoensis	✓	✓	✓	✓
Lewisuchus admixtus	✓			✓
Pseudolagosuchus major	✓			
Lewisuchus/Pseudolagosuchus	✓	✓		
Silesaurus opolensis	✓	✓	✓	
Kwanasaurus williamparkeri			✓	✓
Lutungutali sitwensis			✓	✓
Technosaurus smalli		✓	✓	✓
Soumyasaurus aenigmaticus			✓	✓
Ignotosaurus fragilis		✓	✓	✓
*Pisanosaurus mertii***	✓	✓	✓	✓
Scutellosaurus lawleri			✓	✓
Lesothosaurus diagnosticus	✓	✓	✓	✓
Eocursor parvus			✓	✓
Fruitadens haagarorum			✓	✓
Echinodon becklesii			✓	✓

Tianyulong confuciusi			✓	✓
Heterodontosaurus tucki	✓	✓	✓	✓
Abrictosaurus consors				✓
Manidens condorensis				✓
Emausaurus ernsti				✓
Pegomastax africanus				✓
Chilesaurus diesgosaurezi				✓
Laquintasaura venezulae				✓
Agilisaurus louderbacki				✓
Hexinlusaurus multidens				✓
Scelidosaurus harrisonii				✓
Herrerasaurus ischigualastensis	✓	✓	✓	✓
Staurikosaurus pricei			✓	✓
Sanjuansaurus gordilloi			✓	✓
Gnathovorax cabreirai			✓	✓
Panphagia protos			✓	✓
Eoraptor lunensis	✓	✓	✓	✓
Pampadromaeus barberenai			✓	✓
Buriolestes schultzi			✓	✓
Nhandumirim waldsangae			✓	✓
Saturnalia tupiniquim	✓	✓	✓	✓
Chromogisaurus novasi			✓	✓
Pantydraco caducus			✓	✓
Bagualosaurus agudoensis			✓	✓
Efraasia minor	✓	✓	✓	✓
Macrocollum itaquii			✓	✓
Unaysaurus tolentinoi			✓	✓
Plateosaurus engelhardti	✓	✓	✓	✓
Guaibasaurus candelariensis			✓	✓
Chindesaurus briansmalli			✓	✓
Tawa hallae	✓	✓	✓	✓
Daemonosaurus chauliodus			✓	✓
Eodromaeus murphi			✓	✓
Coelophysis bauri	✓	✓	✓	✓
Liliensternus liliensterni			✓	✓
Syntarsus rhodesiensis			✓	✓
Syntarsus kayentakatae			✓	✓
Zupaysaurus rugeiri			✓	✓
Petrified Forest theropod			✓	✓
Dilophosaurus wetherelli	✓	✓	✓	✓
Allosaurus fragilis	✓	✓		
Velociraptor mongoliensis	✓	✓		

*Here *Saltopus elginensis* is considered as a lagosuchid, however it is difficult to give an exact placement to this taxon.
**Our analysis of *Pisanosaurus* was inconclusive, here we display it as an ornithischian, per its original description (Casamiquela 1967).

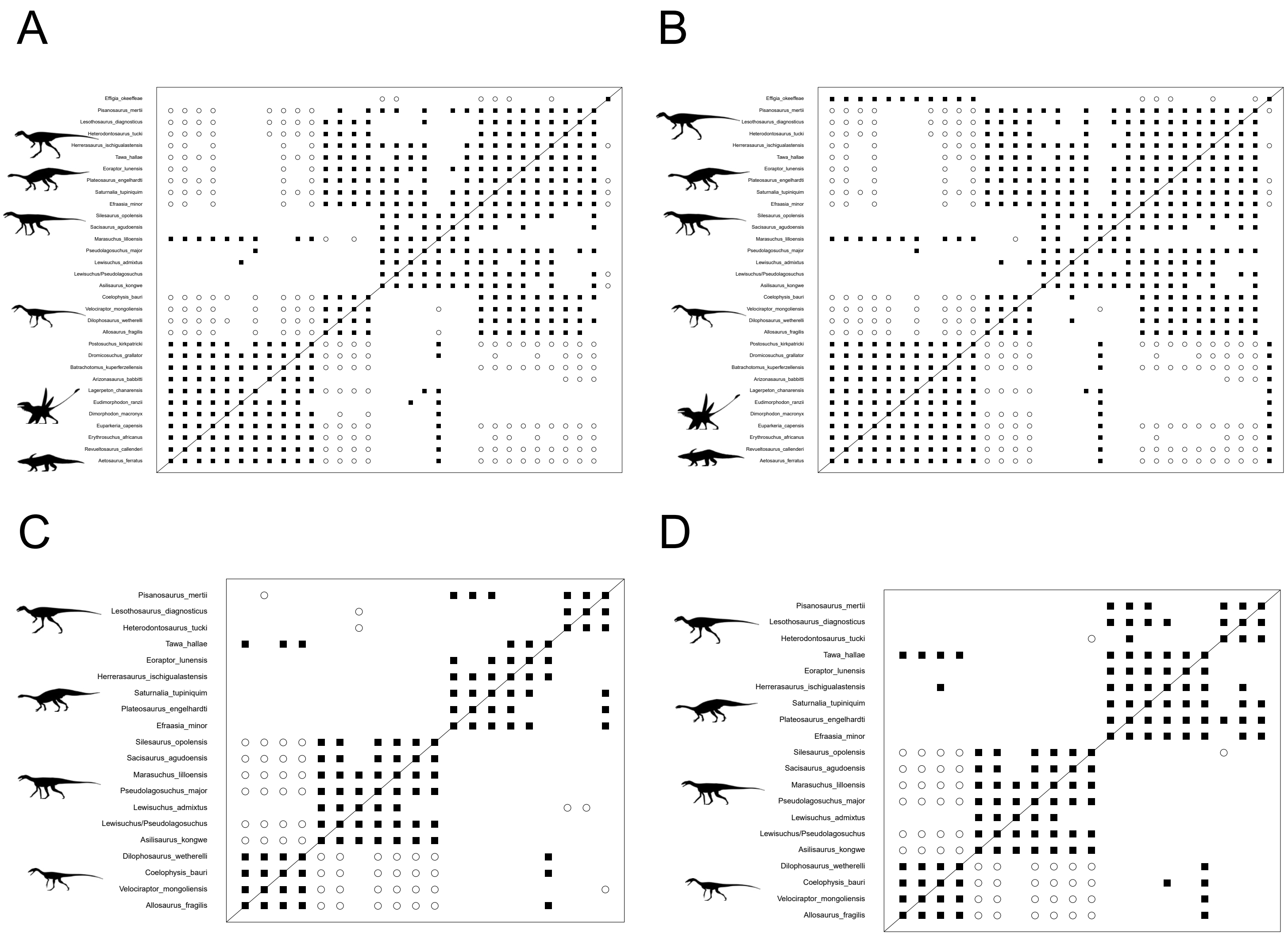

Figure 2. BDC plots of the Nesbitt et al. (1) dataset: **A)** Pearson, all taxa; **B)** Spearman, all taxa; **C)** Pearson, only Dinosauromorpha; and **D)** Spearman, only Dinosauromorpha.

Taxonomic relevance cutoff = 0.2; character relevance cutoff = 0.75.

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in the text even when a dataset refers to it by a different name (see discussion, *Is Lagosuchus talampayensis a Silesaurid?*).

We used BARCLAY (22) to evaluate the datasets using statistical baraminological methods: 1) baraminic distance correlation (BDC) with both Pearson and Spearman correlation coefficients, 2) 3D multidimensional scaling (MDS), 3) partitions around medoids (PAM), and 4) fuzzy analysis (FANNY). We filtered all the datasets following the above listed constraints. In BDC, black squares are interpreted as significant positive correlation, while open circles are interpreted as significant negative correlation. In MDS points of close clustering are interpreted as positive correlation, while points which are farther from each other are interpreted as negative or weak correlation. For a greater discussion of the newer PAM and FANNY methods, see Wood (23) and Sinclair and Wood (24).

Results

Nesbitt et al. (1)

When following the above listed constraints for the Nesbitt et al. (1) dataset, 32 of the 35 taxa were preserved (*Dromomeron gregorii, D. romeri*, and *Eucoelophysis baldwini* were dropped due to not meeting the taxonomic relevance cutoff) and 161 characters were retained. Three groups (the outgroup, Theropoda, and the rest of the Dinosauromorpha) were distinguishable in the Pearson BDC plot (**Fig. 2A**), in addition to the shuvosaurid *Effigia*, which did not share positive correlation with any other taxon. In the Spearman BDC plot (**Fig. 2B**), the theropod block is positively correlated with the other dinosauromorph taxa, and *Effigia* is positively correlated with the outgroup taxa.

In order to recover clearer results, we conducted this same analysis exclusively with Dinosauromorpha (**Fig. 2C-D**). The results here showed four distinguishable groups in Pearson (**Fig. 2C**): the bottom left corner was occupied by the Theropoda, the next group up was the Silesauridae (not including *Pisanosaurus mertii*) + *Lagosuchus talampayensis*, the third group was the Herrerasauridae + Sauropodomorpha, and the last group (upper right corner) was occupied by the Ornithischia + *Pisanosaurus mertii*. *P. mertii* shared significant positive correlation with *Efraasia minor*, *Plateosaurus engelhardti*, and *Saturnalia tupiniquim*, while *Tawa hallae* shared significant positive correlation with *Dilophosaurus wetherelli*, *Coelophysis bauri*, and *Allosaurus fragilis*. The Spearman BDC plot (**Fig. 2D**) showed the same blocks of positive correlation, but the Ornithischia block shared more extensive positive correlation with the Sauropodomorpha + Herrerasauridae block. The Silesauridae + *Lagosuchus* block did not share positive correlation with any other taxa, but they did share negative correlation with the Theropoda block (and *Silesaurus* shared negative correlation with *Plateosaurus*). There were a few examples of shared positive correlation between the Theropoda block and the Sauropodomorpha + Herrerasauridae block (*Coelophysis* with *Herrerasaurus* and all of the theropods with *Tawa* (which is probably a theropod anyway).

The MDS results (**Fig. 3**) for the Dinosauromorpha subset of the Nesbitt et al. (1) dataset show four clusters of taxa: 1) Silesauridae + *Marasuchus*, 2) Ornithischia + *Pisanosaurus*, 3) Sauropodomorpha + *Herrerasaurus* + *Tawa*, and 4) Theropoda. Both the theropod and silesaurid clusters appear as biological trajectories, whereas the Sauropodomorpha + *Herrerasaurus* + *Tawa* cluster is found in the center between them. The two ornithischian taxa, although close in morphological space to *Pisanosaurus*, do not form a trajectory with it.

The PAM model with the highest average silhouette value is at five groups (0.42), followed by three groups (0.39), four groups (0.36) and finally two groups (0.16). The three-group model (**Fig. 4A**) divides up the taxa into: 1) Theropoda, 2) Silesauridae + *Marasuchus* + *Eoraptor*, and 3) Ornithischia + Sauropodomorpha + *Pisanosaurus* + *Herrerasaurus*. *Eoraptor* has a negative silhouette value in the silesaurid group. The four-group

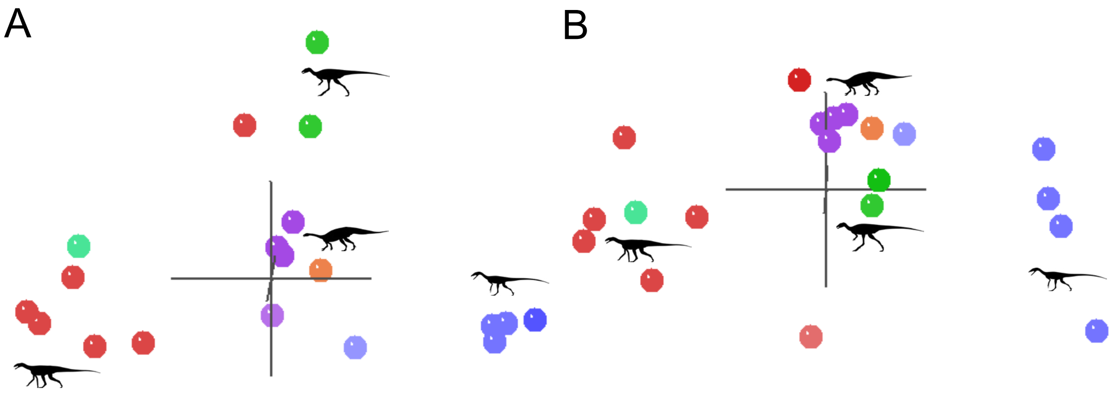

Figure 3. MDS plots of the Dinosauromorpha subset of the Nesbitt et al. (1) dataset in two rotated views **A)** and **B**).

Colors: red - Silesauridae; light green - Ornithischia; purple - Sauropodomorpha; orange - Herrerasauridae; blue - Theropoda.

Taxonomic relevance cutoff = 0.2; character relevance cutoff = 0.75.

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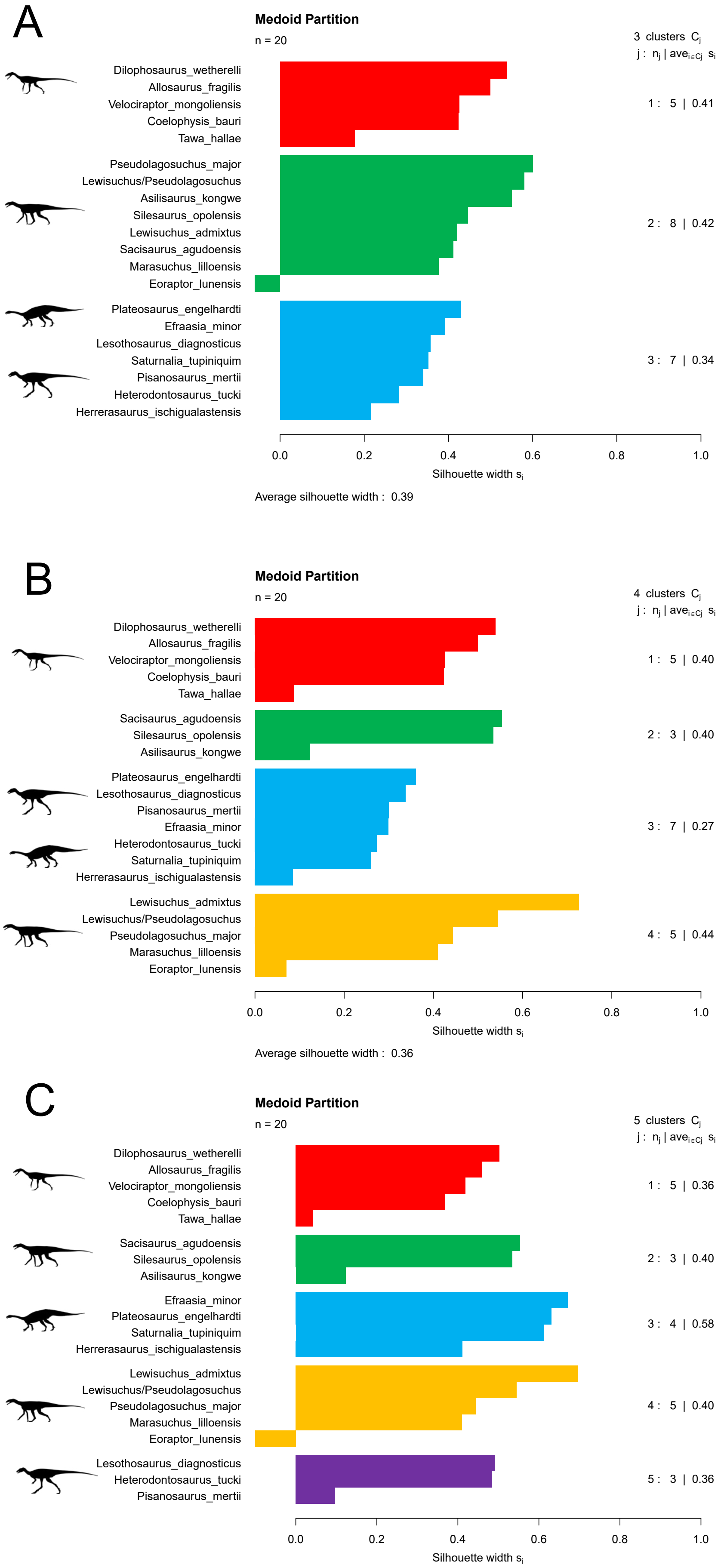

Figure 4. PAM analysis of the Dinosauromorpha subset of the Nesbitt et al. (1) dataset: **A)** PAM in three groups; **B)** PAM in four groups; **C)** PAM in five groups. Taxonomic relevance cutoff = 0.2; character relevance cutoff = 0.75.

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model (**Fig. 4B**) surprisingly divides the Silesauridae group into two groups with *Sacisaurus*, *Silesaurus*, and *Asilisaurus* forming their own group instead of splitting up the ornithischians from the sauropodomorphs. The five-group model (**Fig. 4C**) is the one to split Ornithischia + *Pisanosaurus* into its own group. *Eoraptor* is still included among the silesaurids (and *Marasuchus*) in both the four- and five-group models.

As with PAM, the FANNY model with the highest average silhouette value is the five-group model (0.44), followed by the three- and four-group models (both at 0.4), and then finally the two-group model (0.37). The two-group model (**Fig. 5A**) splits the taxa into Silesauridae + *Marasuchus* (green) and the rest of the taxa (red). At three groups (**Fig. 5B**), the Silesauridae + *Marasuchus* block is retained, but the remaining taxa are split into Theropoda (red) and the rest of the dinosaurs (blue). The four-group model (**Fig. 5C**) further splits up the non-theropod dinosaur taxa into Sauropodomorpha (blue) and Ornithischia + *Pisanosaurus* + *Eoraptor* (yellow). *Eoraptor* has a very negative silhouette width value. Finally, the five-group model (**Fig. 5D**) is the only one that splits up the Silesauridae into two groups: a green one containing *Sacisaurus*, *Silesaurus*, and *Asilisaurus* (although *Asilisaurus* has a negative silhouette value) and a purple one containing the rest of the silesaurids and *Marasuchus*. *Eoraptor* is included with the sauropodomorphs (blue) in the five-group model, and *Tawa* has a negative silhouette value among the theropods (red).

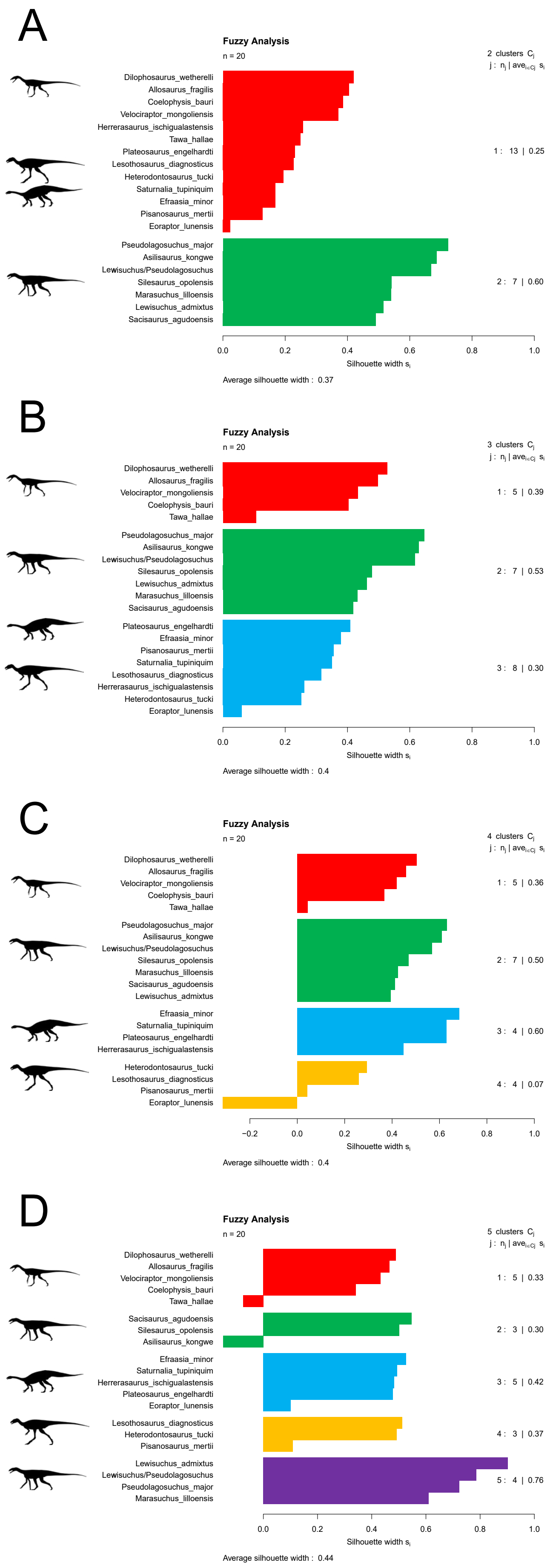

Figure 5. FANNY analysis of the Dinosauromorpha subset of the Nesbitt et al. (1) dataset: **A)** FANNY in two groups; **B)** FANNY in three groups; **C)** FANNY in four groups; and **D)** FANNY in five groups.

Taxonomic relevance cutoff = 0.2; character relevance cutoff = 0.75.

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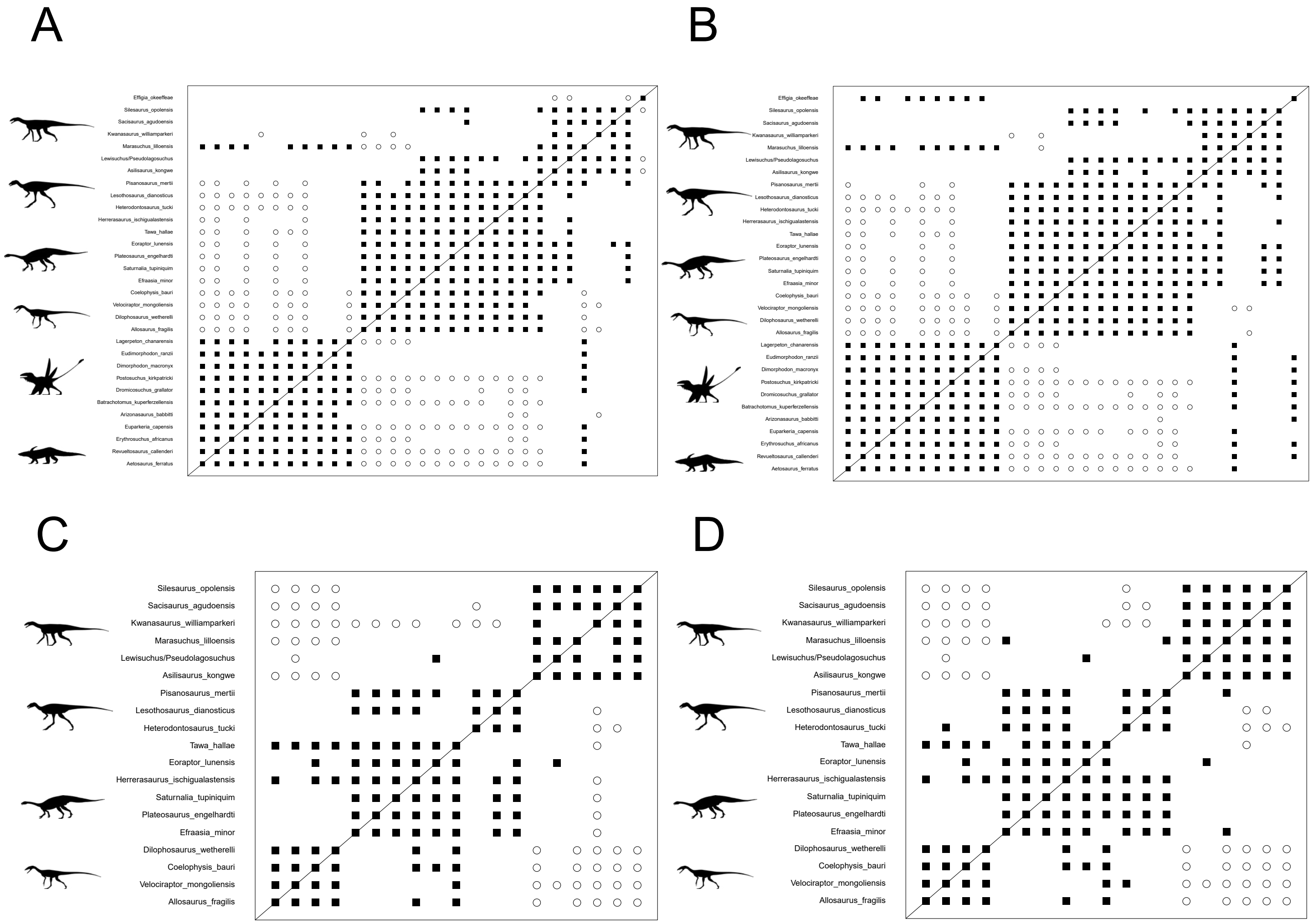

Figure 6. BDC plots of the Martz and Small (2) dataset: **A)** Pearson, all taxa; **B)** Spearman, all taxa; **C)** Pearson, only Dinosauromorpha; and **D)** Spearman, only Dinosauromorpha.

Taxonomic relevance cutoff = 0.2; character relevance cutoff = 0.75.

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Martz & Small (2)

When following the above listed constraints for the Martz and Small (2) dataset, 31 of the original 39 taxa were preserved (*Diodorus scytobrachion, Eucoelophysis baldwini, Dromomeron gregorii, romeri, Lutungutali sitwensis, Ignotosaurus fragilis, Technosaurus smalli,* and *Soumyasaurus aenigmaticus* were dropped due to not meeting the taxonomic relevance cutoff) and 125 characters were retained. The BDC results (**Fig. 6A-B**) are similar to the ones in the first analysis. Two large blocks are distinguishable in both the Pearson and Spearman BDC plots: the outgroup and the Dinosauromorpha. *Effigia*, once again, clustered with no taxa. The Silesauridae, in this analysis, lack any significant negative correlation with the Dinosauria. In the Pearson BDC (**Fig. 6A**), *"Lewisuchus/Pseudolagosuchus"*, *Asilisaurus kongwe*, *Pisanosaurus mertii*, *Silesaurus opolensis*, *Sacisaurus agudoensis*, and *Lagosuchus* (*Marasuchus lilloensis*) all exhibit significant positive correlation with dinosaurian taxa. *P. mertii* shares significant positive correlation with all of the Dinosauria except *Velociraptor mongoliensis*. There are more examples of shared positive correlation between silesaurids and dinosaurs in the Spearman BDC plot (**Fig. 6B**).

We also analyzed this dataset with only dinosauromorph taxa (**Fig. 6C-D**). In this Pearson BDC analysis (**Fig. 6C)** *Asilisaurus kongwe* does not exhibit positive correlation with the dinosaurian cluster, nor does *Lewisuchus/Pseudolagosuchus* with the exception of *Eoraptor lunensis*. *Pisanosaurus mertii*, on the other hand shares positive correlation with *Eoraptor lunensis*, *Herrerasaurus ischigualastensis*, *Saturnalia tupiniquim*,

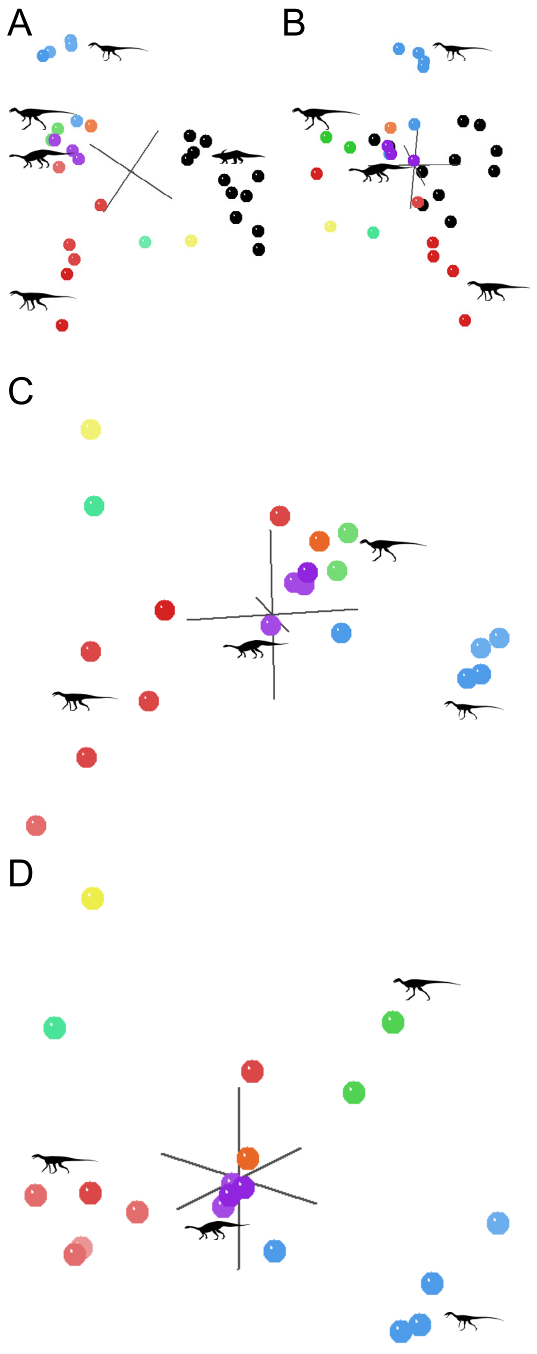

Figure 7. MDS plots of the Martz and Small (2) dataset: All taxa in two rotated views **A)** and **B**) and the Dinosauromorpha subset in two rotated views **C)** and **D**).

Colors: black - outgroup; yellow - Lagerpetidae; red - Silesauridae; light green - Ornithischia; purple - Sauropodomorpha; orange - Herrerasauridae; blue - Theropoda.

Taxonomic relevance cutoff = 0.2; character relevance cutoff = 0.75.

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Plateosaurus engelhardti, and *Efraasia minor*. Also, *Lagosuchus* (*Marasuchus lilloensis*) groups within the silesaurid block. The Spearman BDC plot (**Fig. 6D**) is similar except that there are a couple more examples of shared positive correlation between the silesaurid block and the dinosaurs (the non-silesaurid *Lagosuchus* (*Marasuchus lilloensis*) positively correlates with *Efraasia* and *Pisanosaurus*) and amongst the dinosaurs.

The 3D MDS plot yields similar results (**Fig. 7A-B**). The non-dinosaurian dinosauromorphs are distinguishable from the outgroup (shown in black) and Dinosauria (blue, purple, light green, and orange). The Silesauridae (shown in red) group separately from the dinosaurian clusters, except for one taxon (the putative silesaurid *Pisanosaurus mertii*), which clusters with the ornithischians. *Lagosuchus* (green) is the closest taxon to the silesaurid cluster.

Another MDS analysis was conducted excluding the outgroup (**Fig. 7C-D**), the results of which show the Silesauridae (red) grouped more distantly from the larger dinosaurian cluster (except for *P. mertii*) and more closely with *Lagerpeton* and *Lagosuchus*. As with the MDS plot involving all of the taxa, the theropod cluster is distinct (except for *Tawa*, which groups closer to the other dinosaurs), but in this subset analysis, the ornithischians are also distant from the other dinosaur taxa.

The PAM results (**Fig. 8A-B**) for the Martz and Small (2) dataset have the highest silhouette values at two and four groups (both at 0.34). At two groups (**Fig. 8A**), the split is between the non-dinosauriform taxa (red) and Dinosauriformes (green), with *Lagosuchus* in the non-dinosauriform group. At four groups (**Fig. 8B**), the taxa are split into the non-dinosauriforms (red), theropods (green), silesaurids (blue), and other dinosauriforms (yellow). *Pisanosaurus* and *Lewisuchus* are in the yellow group, although *Lewisuchus* has a negative silhouette value.

The FANNY results (**Fig. 8C**) for the Martz and Small (2) dataset have the highest silhouette value (0.36) at three groups, with the taxa split into non-dinosauriforms (red), dinosaurs (green), and silesaurids (blue). *Lewisuchus* is included in the silesaurid group with a silhouette value near 0.2, whereas *Pisanosaurus* is in the dinosaur group. *Lagosuchus* is included in the non-dinosauriform outgroup cluster, but it has a negative silhouette value.

Figure 8. PAM and FANNY analysis of the Martz and Small (2) dataset:

A) PAM in two groups; **B)** PAM in four groups; and **C)** FANNY in three groups.

Taxonomic relevance cutoff = 0.2; character relevance cutoff = 0.75.

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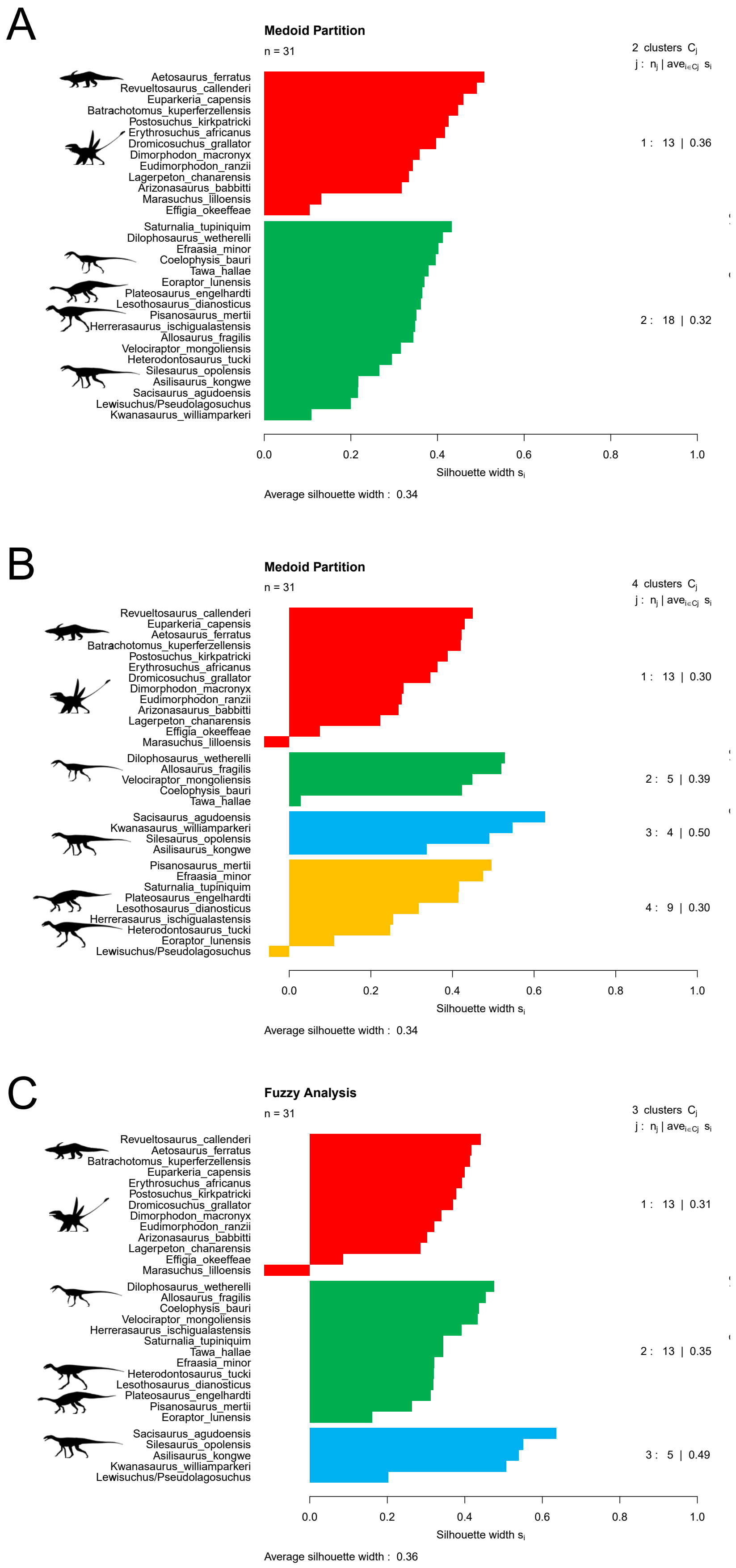


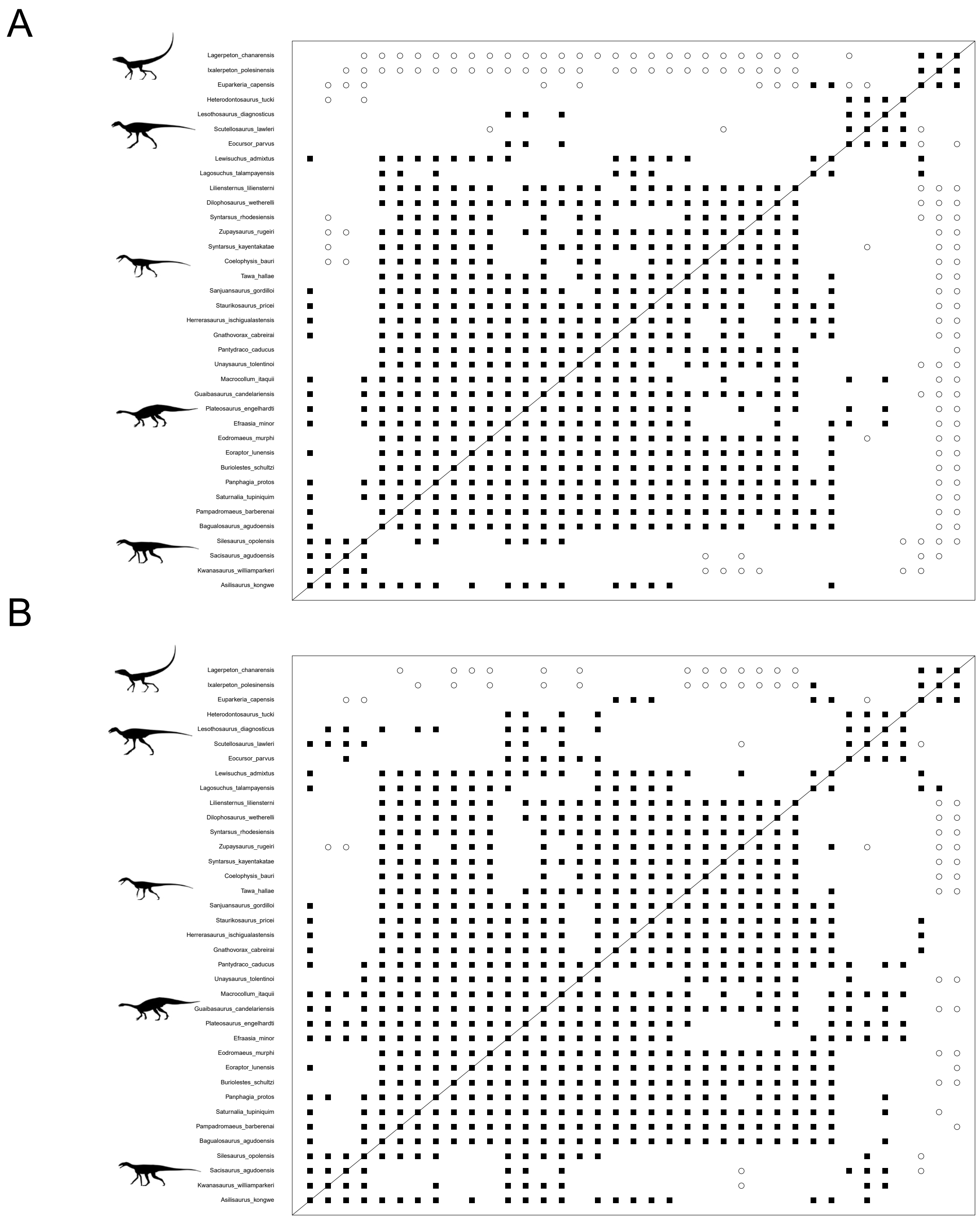


Figure 9. BDC plots of the Müller and Garcia (3) dataset: **A)** Pearson and **B)** Spearman.

Taxonomic relevance cutoff = 0.3; character relevance cutoff = 0.75.

Silhouettes from Phylopic (https://www.phylopic.org/). All silhouettes are public domain except for *Asilisaurus* by Scott Hartman, CC BY 3.0 (https://creativecommons.org/licenses/by/3.0/deed.en).

Müller and Garcia (3)

The BDC analysis (**Fig. 9A-B**) for the Müller and Garcia (3) dataset (conducted at a ≥0.3 taxic relevance cutoff) preserved 37 of the 62 taxa (*Chromogisaurus novasi*, *Daemonosaurus chauliodus*, *Diodorus scytobrachion*, *Dongusuchus efremovi*, *Dromomeron gigas, Dromomeron gregorii, Dromomeron romeri*, *Echinodon becklesii*, *Eucoelophysis baldwini*, *Fruitadens haagarorum*, *Ignotosaurus fragilis*, *Lutungutali sitwensis*, *Nhandumirim waldsangae*, PVSJ 883, Petrified forest theropod, *Pisanosaurus mertii*, *Saltopus elginenis*, *Soumyasaurus aenigmaticus*, *Spondylosoma absconditum*, *Yarasuchus deccanensis* were dropped due to not meeting the taxonomic relevance cutoff) and 186 characters were retained. Four blocks of positive correlation are apparent in the Pearson BDC (**Fig. 9A**): Silesauridae (lower left corner), Saurischia, Ornithischia, and the outgroup (*Euparkeria*) + Lagerpetidae. *Lewisuchus admixtus* + *Lagosuchus talampayensis* appear in a small block at the very tip of the larger Dinosauria block, while *Lewisuchus admixtus* also shares positive correlation with *Asilisaurus kongwe*. *A. kongwe* shares positive correlation with many members in the dinosaurian block. None of the taxa in the Silesauridae block share positive correlation with the Ornithischia or outgroup, and only *A. kongwe* shared positive correlation with any taxa outside the group. The Spearman BDC results (**Fig. 9B**) are similar except there are more examples of shared positive correlation between the silesaurid taxa and the dinosaurs (including the ornithischian block).

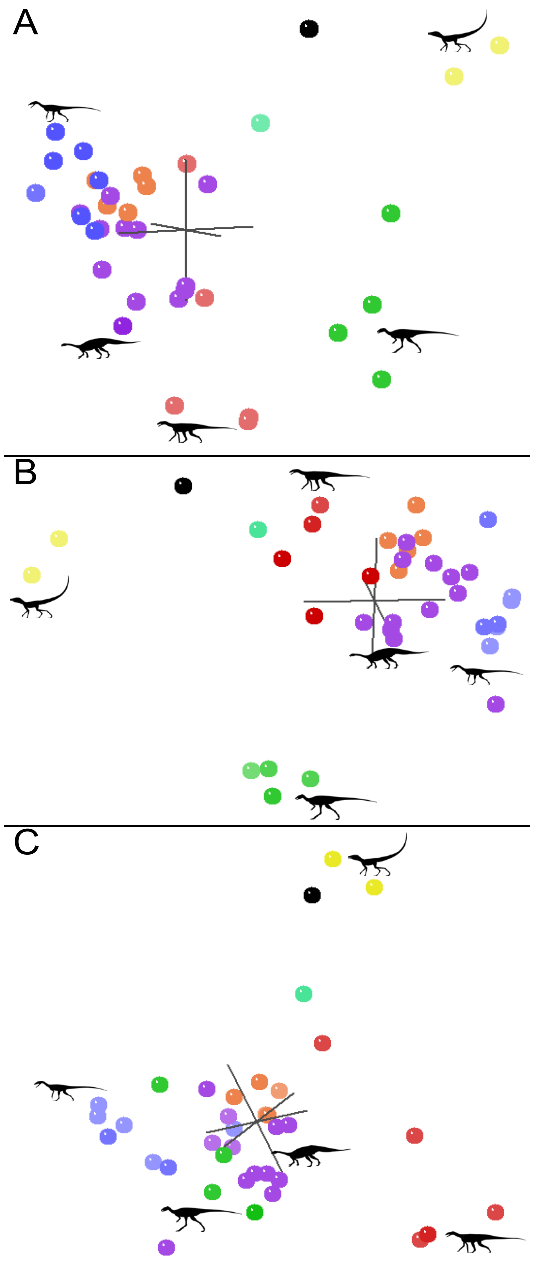


Figure 10. MDS plot of the Müller and Garcia (3) dataset in three rotated views (**A, B,** and **C**).

Colors: black - outgroup (*Euparkeria*); yellow - Lagerpetidae; red - Silesauridae; light green - Ornithischia; purple - Sauropodomorpha; orange - Herrerasauridae; blue - Theropoda.

Taxonomic relevance cutoff = 0.3; character relevance cutoff = 0.75.

Silhouettes from Phylopic (https://www.phylopic.org/). All silhouettes are public domain except for *Asilisaurus* by Scott Hartman, CC BY 3.0 (https://creativecommons.org/licenses/by/3.0/deed.en).

The MDS plot yielded interesting results as well (**Fig. 10**). The Silesauridae (red) forms a diffuse cluster and is separated from the larger, more tightly clustered dinosaurian group. The Ornithischia (light green) is also quite distant from the larger dinosaurian group. These results conform well to the BDC plot (**Fig. 9**). The likely silesaurid *Lewisuchus* is farthest from the main silesaurid cluster, closer to *Lagosuchus* (green) and the herrerasaurids (orange) than it is to the next closest silesaurid (*Asilisaurus*).

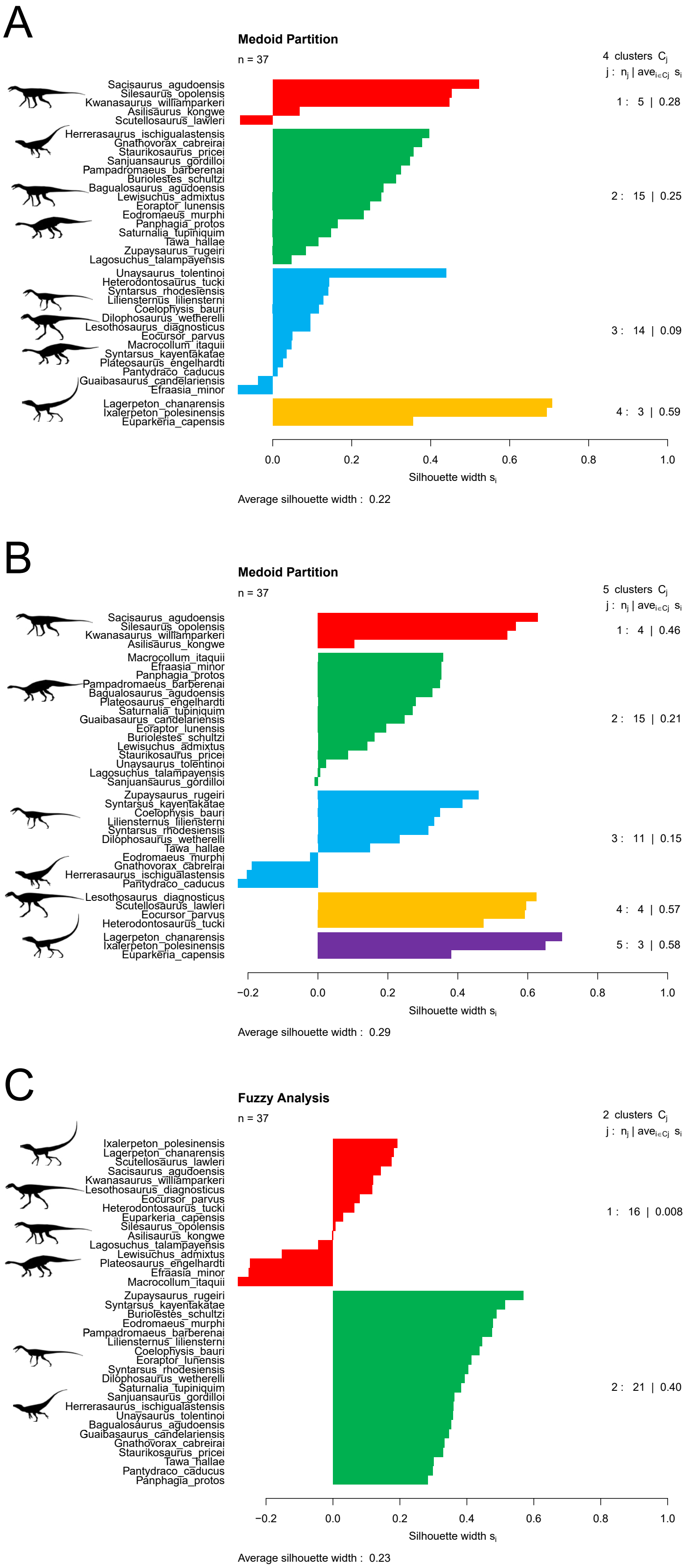
The models with the highest average silhouette values in PAM (**Fig. 11A-B**) for the Müller and Garcia (3) dataset are for four groups (0.22) and five groups (0.29). Four groups (**Fig.11A**) split the silesaurids (red) apart from the non-dinosauromorphs (yellow) and two groups of non-silesaurid dinosauromorphs (green and blue). The ornithischian dinosaur *Scutellosaurus* is in the silesaurid group, but it has a negative silhouette value. *Lewisuchus* is in the green group of dinosauromorphs as is *Lagosuchus*. The five-group model (**Fig. 11B**) splits the ornithischians (yellow) away from the rest of the dinosauromorphs, and *Scutellosaurus* is correctly grouped with the ornithischians rather than the silesaurids. The blue group mainly consists of theropods, as well as two herrerasaurids (*Gnathovorax* and *Herrerasaurus*) and the sauropodomorph *Panytdraco*, which have large negative silhouette values.

FANNY only correctly ran results in two groups with an average silhouette value of 0.23 (**Fig. 11C**). Silesaurids are in the red group along with ornithischians, lagerpetids, *Euparkeria*, *Lagosuchus*, and some sauropodomorphs. The green group is made up of various saurischian taxa.

Figure 11. PAM and FANNY analysis of the Müller and Garcia (3) dataset: **A)** PAM in four groups; **B)** PAM in five groups; **C)** FANNY in two groups.

Taxonomic relevance cutoff = 0.3; character relevance cutoff = 0.75.

Silhouettes from Phylopic (https://www.phylopic.org/). All silhouettes are public domain except for *Asilisaurus* by Scott Hartman, CC BY 3.0 (https://creativecommons.org/licenses/by/3.0/deed.en).



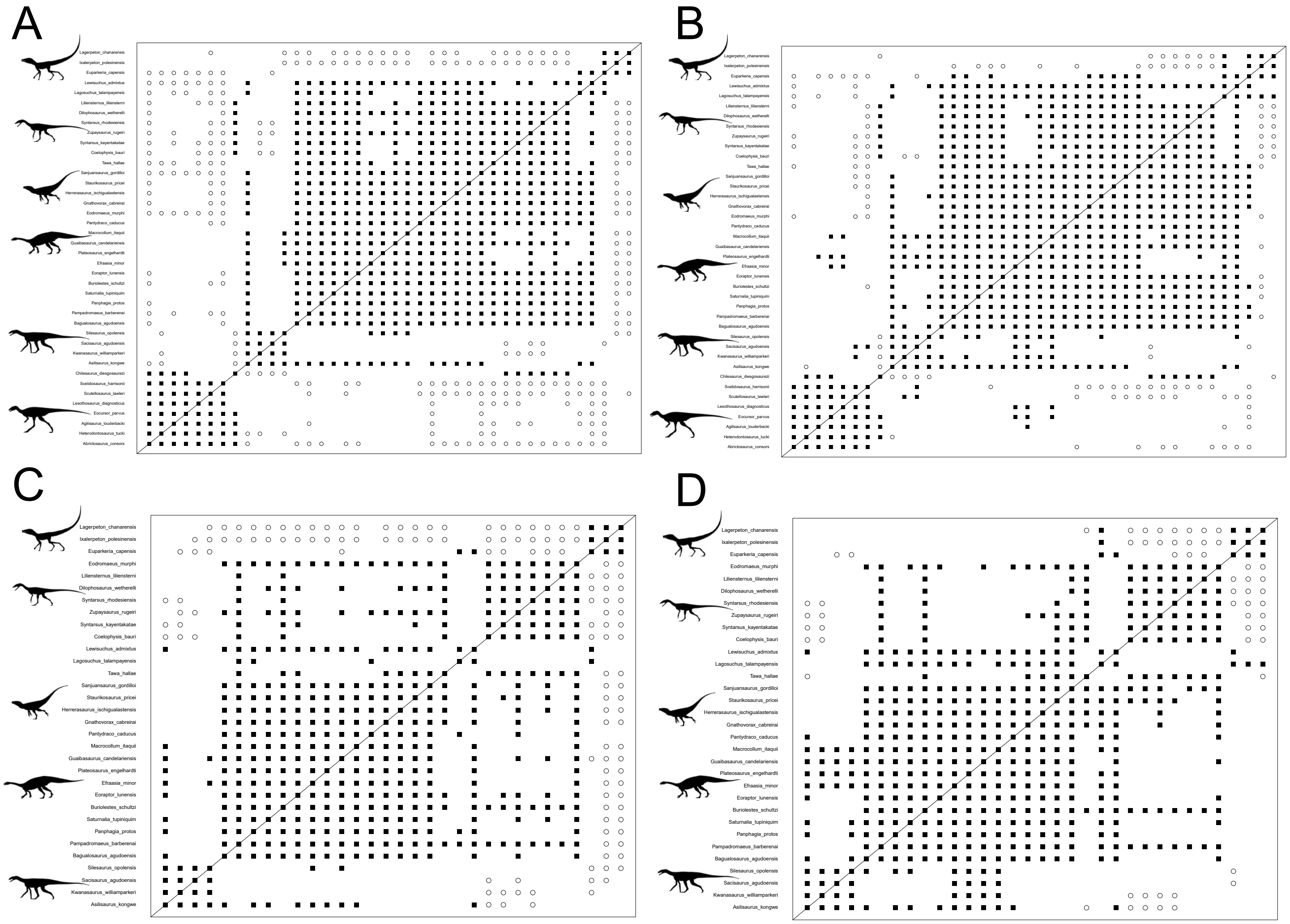


Figure 12. BDC plot of the Norman et al. (4) dataset: **A)** Pearson, all taxa; **B)** Spearman, all taxa; **C)** Pearson, Ornithischia and *Chilesaurus* removed; and **D)** Spearman, Ornithischia and *Chilesaurus* removed.

Taxonomic relevance cutoff = 0.3; character relevance cutoff = 0.75.

Silhouettes from Phylopic (https://www.phylopic.org/). All silhouettes are public domain except for *Asilisaurus* by Scott Hartman, CC BY 3.0 (https://creativecommons.org/licenses/by/3.0/deed.en).

Norman et al. (4)

When following the above listed constraints, 40 of the original 71 taxa were preserved (*Dromomeron gregorii, Dromomeron romeri, Dromomeron gigas,* UFSM 11611, PVSJ 883, *Saltopus elginenis, Diodorus scytobrachion, Eucoelophysis baldwini, Lutungutali sitwensisl, Technosaurus smalli, Soumyasaurus aenigmaticus, Ignotosaurus fragilis, Pisanosaurus mertii, Fruitadens haagarorum, Echinodon becklesii, Nhandumirim waldsangae, Chromogisaurus novasi, Chindesaurus briansmalli, Daemonosaurus chauliodus,* Petrified forest theropod, *Dilophosaurus wetherelli, Teleocrater rhadinus, Dongusuchus efremovi, Spondylosoma absconditum, Yarasuchus deccanensis, Manidens condorensis, Emausaurus ernsti, Pegomastax africanus, Laquintasaura venezulae,* and *Hexinlusaurus multidens* were dropped due to not meeting the taxonomic relevance cutoff) and 91 characters were retained.

The BDC analysis (**Fig. 12A-B**) for Norman et al. (4) yielded four or five blocks of positive correlation in Pearson (**Fig. 12A**). From left to right, bottom to top, they are as follows: Ornithischia, Silesauridae, Saurischia, *Lagosuchus* + *Euparkeria*, and possibly Lagerpetidae. The ornithischian block is well-defined, however, *Chilesaurus diegosuarezi* shows no correlation with *Lesothosaurus diagnosticus*, *Scutellosaurus lawleri*, or *Scelidosaurus harrisonii*, and it shares positive correlation with some saurischian taxa (*Coelophysis bauri*, *Syntarsus kayentakatae*, *Zupaysaurus rugeiri*, *Syntarsus rhodesiensis*, *Dilophosaurus wetherelli*, and *Liliensternus liliensterni*). In the Silesauridae block, *Asilisaurus kongwe* shares positive correlation with *Lagosuchus*

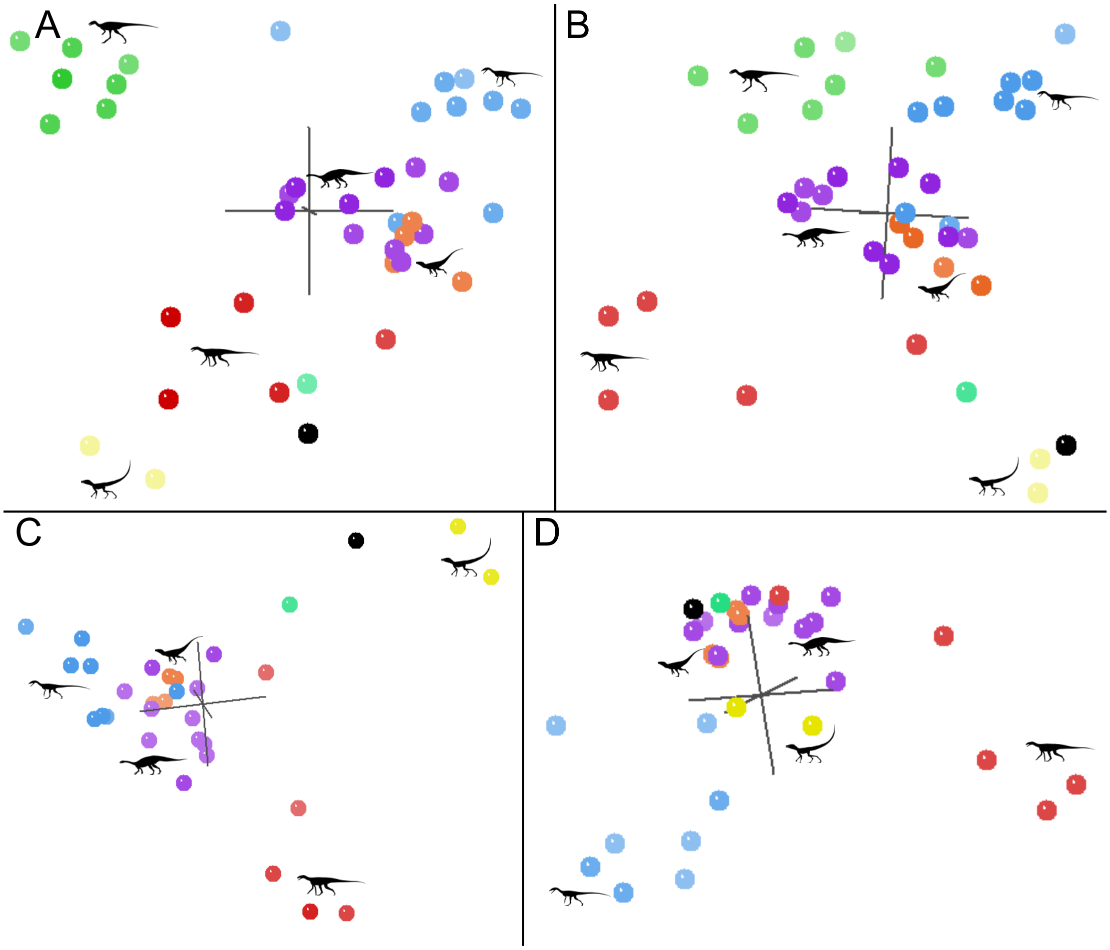


Figure 13. MDS plots of the Norman et al. (4) dataset: All taxa in two rotated views **A)** and **B**) and the subset excluding Ornithischia and *Chilesaurus* in two rotated views **C)** and **D**).

Colors:
black - outgroup (*Euparkeria*);
yellow - Lagerpetidae;
red - Silesauridae;
green - Lagosuchus;
light green - Ornithischia;
purple - Sauropodomorpha;
orange - Herrerasauridae;
and blue - Theropoda.

Taxonomic relevance cutoff = 0.2; character relevance cutoff = 0.75.

Silhouettes from Phylopic (https://www.phylopic.org/). All silhouettes are public domain except for *Asilisaurus* by Scott Hartman, CC BY 3.0 (https://creativecommons.org/licenses/by/3.0/deed.en).

talampayensis and *Lewisuchus admixtus* (which is grouped in the saurischian block) and 15 other saurischian taxa (*Bagualosaurus agudoensis*, *Pampadromaeus barberenai*, *Panphagia protos*, *Saturnalia tupiniquim*, *Buriolestes schultzi*, *Eoraptor lunensis*, *Efraasia minor*, *Plateosaurus engelhardti*, *Guaibasaurus candelariensis*, *Macrocollum itaquii*, *Eodromaeus murphi*, *Gnathovorax cabreirai*, *Herrerasaurus ischigualastensis*, *Staurikosaurus pricei*, and *Sanjuansaurus gordilloi*). *Silesaurus opolensis* shares positive correlation with four saurischian taxa (*Efraasia minor*, *Plateosaurus engelhardti*, *Guaibasaurus candelariensis*, and *Macrocollum itaquii*). *Euparkeria capensis* unites the lagerpetid and lagosuchid blocks, and *Lewisuchus admixtus* connects the lagosuchid block to the saurischian block. The Spearman BDC (**Fig. 12B**) still shows a relatively distinct Ornithischia, although it is positively correlated with a few other taxa, whereas the silesaurids show much greater positive correlation shared with other taxa.

The MDS results for Norman et al. (4) show the ornithischians clustered together at a distance from all of the other taxa (**Fig. 13A-B**). The bizarre and taxonomically controversial dinosaur *Chilesaurus diegosuarezi* splits the gulf between the ornithischians and the theropods (**Fig. 13A**). The remaining taxa fall into a V-shaped pattern in character space (**Fig. 13B**). The saurischians form the vertex of the V with the silesaurids on one end and the lagerpetids on the other. The silesaurids, except for *Lewisuchus*, are all clustered together at a distance from the other taxa. *Lewisuchus*, by contrast, falls at the edge of the saurischian cluster close to *Lagosuchus*.

Given how distinct the ornithischians were from the rest of the taxa in both BDC and MDS, we decided to remove them (and *Chilesaurus diegosuarezi*) and run the analyses again. The new BDC has three blocks of

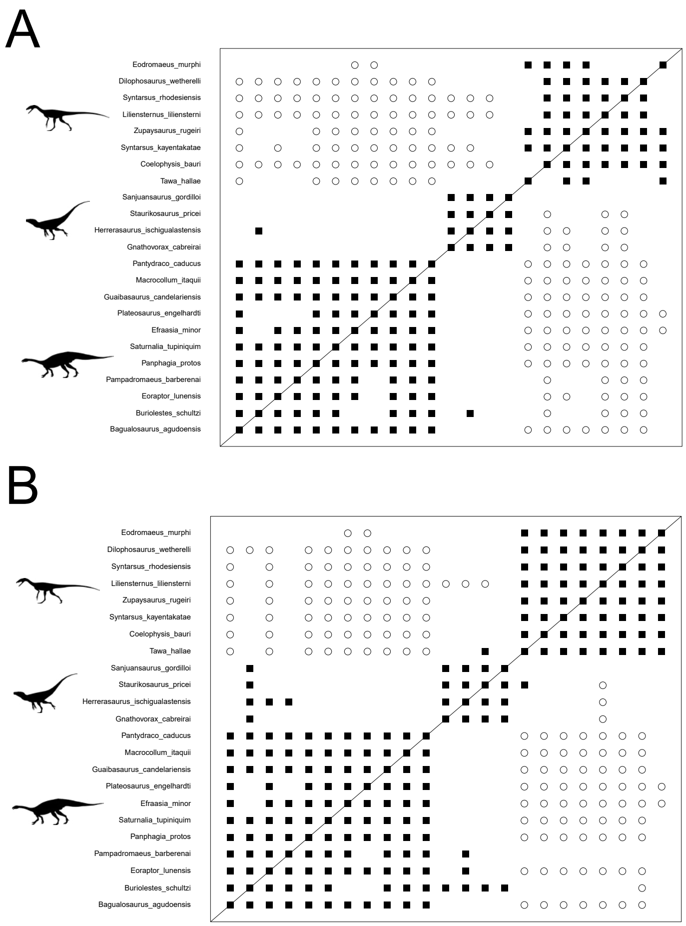


Figure 14 (Left). BDC plots of the Saurischia subset of the Norman et al. (4) dataset: **A)** Pearson and **B)** Spearman.

Taxonomic relevance cutoff = 0.3; character relevance cutoff = 0.75.

Silhouettes from Phylopic (https://www.phylopic.org/). All silhouettes are public domain.

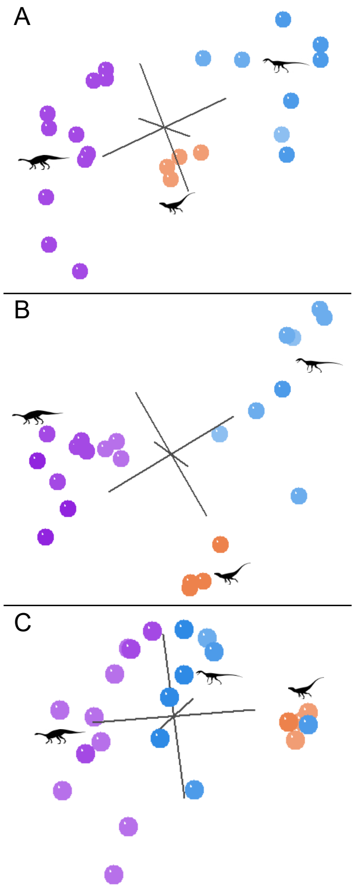


Figure 15 (Right). MDS plot of the Saurischia subset of the Norman et al. (4) dataset in three rotated views (**A**, **B**, and **C**).

COLORS:
purple - Sauropodomorpha;
orange - Herrerasauridae;
blue - Theropoda.

Taxonomic relevance cutoff = 0.3; character relevance cutoff = 0.75.

Silhouettes from Phylopic (https://www.phylopic.org/). All silhouettes are public domain.

positive correlation with only slight differences between the Pearson **(Fig. 12C)** and Spearman (**Fig. 12D**) versions. The silesaurid block is in the lower left, with *Asilisaurus kongwe* still sharing positive correlation with some saurischians and *Silesaurus* sharing positive correlation with *Efraasia* and *Guaibasaurus*. The lagerpetid + outgroup block is in the upper right, and it shares negative correlation with almost every other taxon in the analysis. However, there are two examples of shared positive correlation between *Euparkeria capensis* and *Lagosuchus talampayensis* and *Tawa hallae*.

Out of curiosity, we decided to run just the saurischians to see what results we might get in BDC and MDS. The BDC results (**Fig. 14**) showed three very separate blocks of positive correlation (Sauropodomorpha, Herrerasauridae, and Theropoda), with only one example of shared positive correlation between blocks (*Herrerasaurus ischigualastensis* and *Buriolestes schultzi*) in Pearson (**Fig. 14A**) and a few more shared positive correlations in Spearman (**Fig. 14B**). The 3D MDS results (**Fig. 15**) revealed an interesting triangular pattern, where each group from the BDC results occupied a corner in multidimensional character space (**Fig. 15B**).

We also ran all of these versions of the Norman, et al. (4) dataset through PAM and FANNY. Analyzing all of the taxa with PAM resulted in two options that had an equal average silhouette width of 0.31: two groups and five groups (**Fig. 16A-B**). Not surprisingly, the two group version (**Fig. 16A**) separated mainly between Ornithischia and the rest of the taxa, and the five group version showed Ornithischia (red), Silesauridae (green), Sauropodomorpha (blue), Theropoda + Herrerasauridae + *Pantydraco* (yellow), and Lagerpetidae + *Euparkeria capensis* (purple). Within the yellow group, three taxa had negative silhouette values (two herrerasaurids and the sauropodomorph *Pantydraco caducus*). FANNY would only run with two groups, and the two groups do not seem to reveal anything of value (**Fig. 16C**).

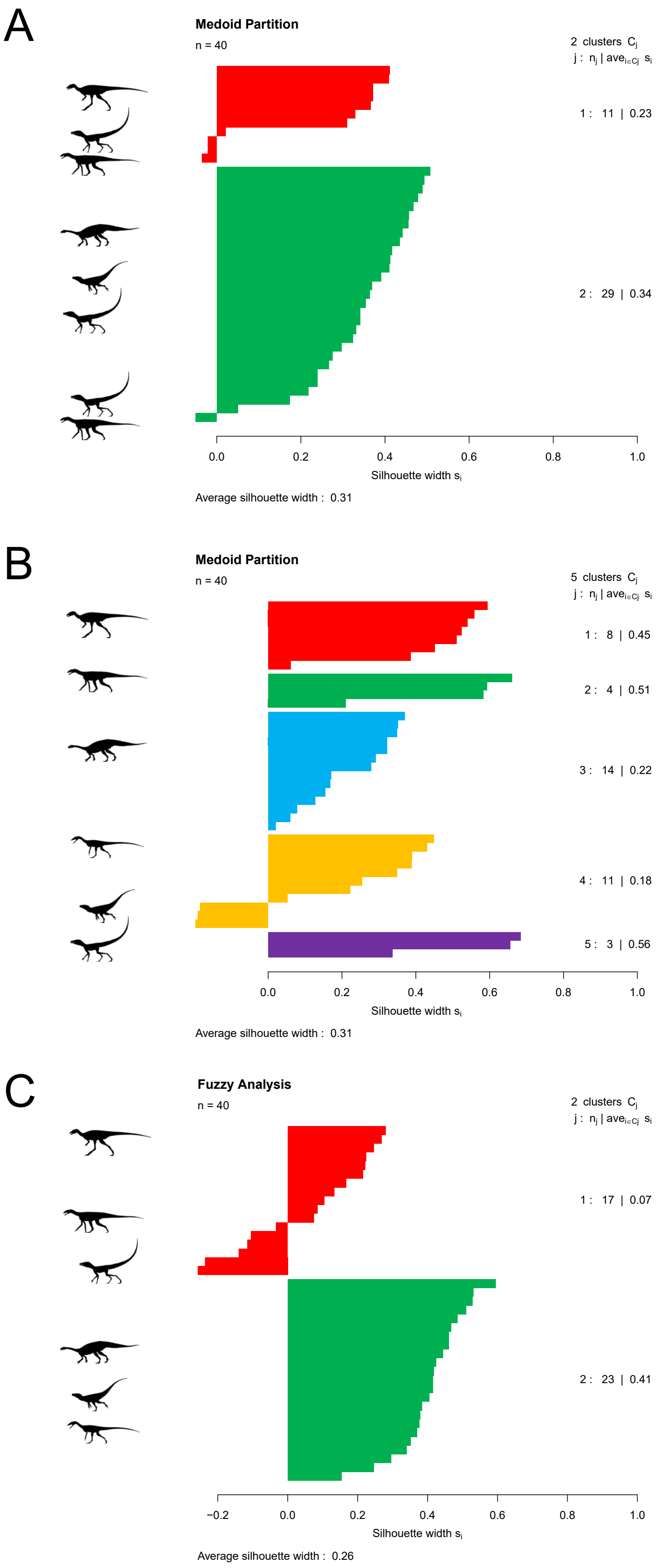


Figure 16. PAM and FANNY analysis of the Norman et al. (4) dataset: **A)** PAM in two groups; **B)** PAM in five groups; and **C)** FANNY in two groups.

Taxonomic relevance cutoff = 0.3; character relevance cutoff = 0.75.

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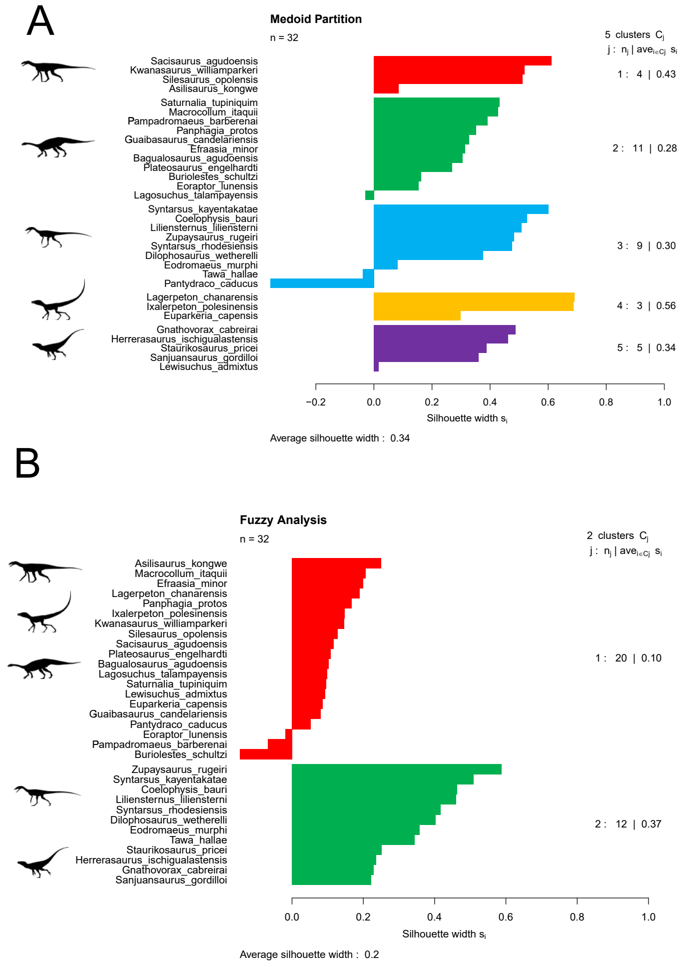

Figure 17. PAM and FANNY analysis of the subset of the Norman et al. (4) dataset lacking ornithischians and Chilesaurus: **A)** PAM in five groups and **B)** FANNY in two groups.

Taxonomic relevance cutoff = 0.3; character relevance cutoff = 0.75.

Silhouettes from Phylopic (https://www.phylopic.org/). All silhouettes are public domain except for *Asilisaurus* by Scott Hartman, CC BY 3.0 (https://creativecommons.org/licenses/by/3.0/deed.en).

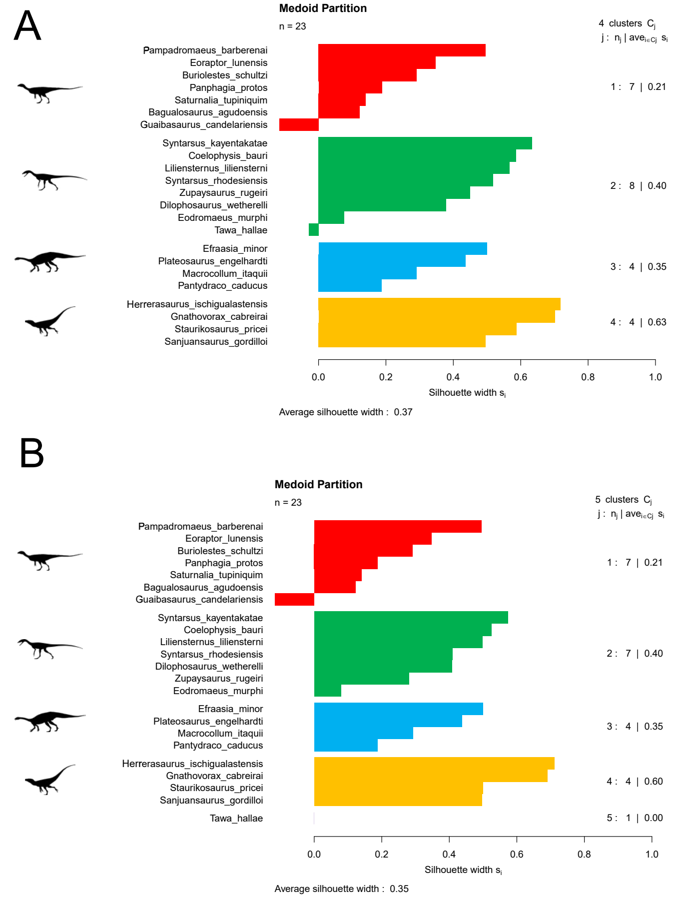

Figure 18. PAM analysis of the Saurischia subset of the Norman et al. (4) dataset: **A)** PAM in four groups and **B)** PAM in five groups.

Taxonomic relevance cutoff = 0.3; character relevance cutoff = 0.75.

Silhouettes from Phylopic (https://www.phylopic.org/). All silhouettes are public domain .

When the ornithischians and *Chilesaurus diegosuarezi* were excluded, the PAM version with the highest average silhouette width value (0.34) was 5 groups (**Fig. 17A**). The five groups were Silesauridae (red), Sauropodomorpha (green), Theropoda (blue), Lagerpetidae + *Euparkeria capensis* (yellow), and Herrerasauridae (purple). *Tawa hallae* and *Pantydraco caducus* were in the theropod group, but with negative silhouette values. Likewise, *Lagosuchus talampayensis* grouped with the sauropodomorphs, but with a negative silhouette value. *Lewisuchus admixtus* grouped with the herrerasaurids, but its silhouette value was 0.02. FANNY would not run correctly for any model with more than two groups (**Fig. 17B**). The two group model had an average silhouette width value of 0.2. The red group contained the silesaurids, sauropodomorphs, lagerpetids, *Euparkeria capensis*, *Lagosuchus talampayensis*, and *Lewisuchus admixtus*, whereas the green group included the herrerasaurids and theropods. Three sauropodomorph taxa in the red group have negative silhouette values (*Eoraptor lunensis*, *Pampadromaeus barberenai*, and *Buriolestes schultzi*).

Finally, the saurischian subset of Norman et al. (4) was also analyzed with PAM (**Fig. 18**) and FANNY (**Fig. 19**). The PAM average silhouette value was highest for four groups (0.37, **Fig. 18A**) and then five groups (0.35, **Fig. 18B**). The four-group model includes Herrerasauridae (yellow), Theropoda (green), and two sauropodomorph groups: "basal" Sauropodomorpha (red) and "classic prosauropods" (blue). *Guaiabasaurus candelariensis* and *Tawa hallae* have negative

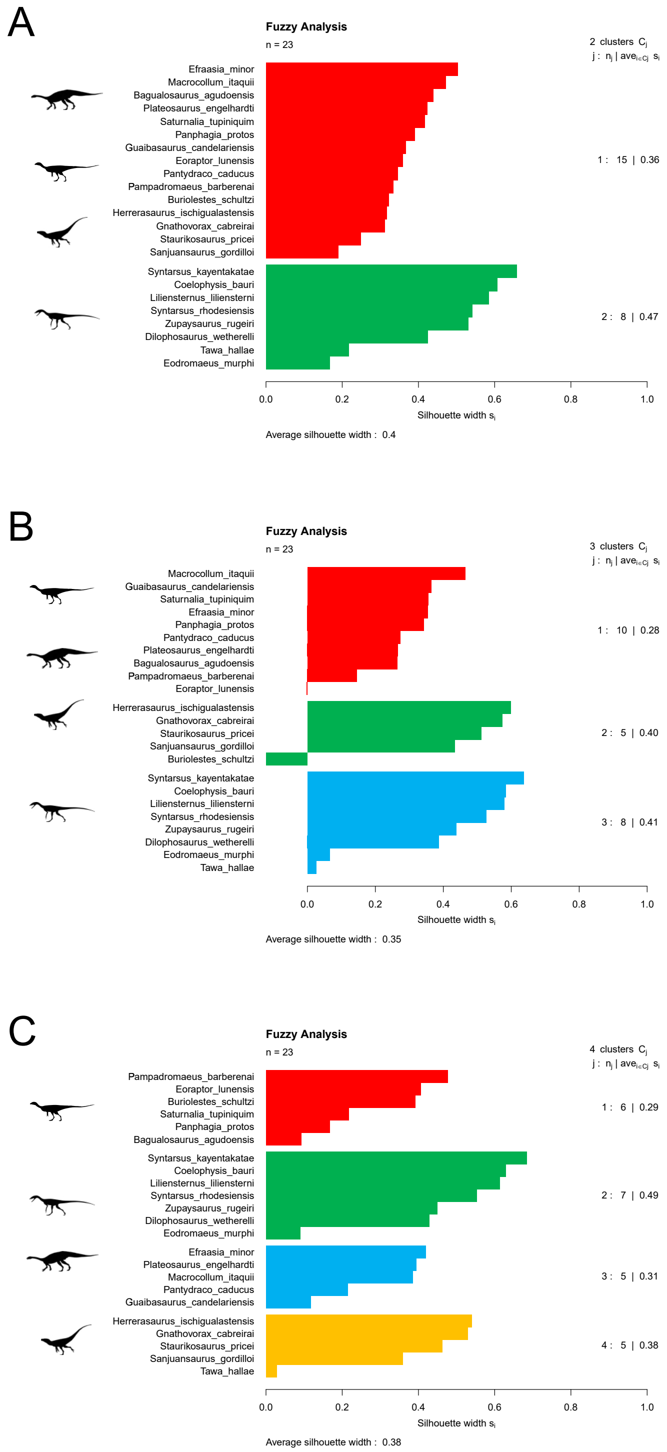

Figure 19. FANNY analysis of the Saurischia subset of the Norman et al. (4) dataset: **A)** FANNY in two groups; **B)** FANNY in three groups; and **C)** FANNY in four groups. Taxonomic relevance cutoff = 0.3; character relevance cutoff = 0.75.

Silhouettes from Phylopic (https://www.phylopic.org/). All silhouettes are public domain .

silhouette values in their groups (red and green, respectively). The five group model is nearly identical except that *Tawa hallae* is placed in its own group. FANNY would not run correctly at five groups, but it did work for two groups (0.4, **Fig. 19A**), three groups (0.35, **Fig. 19B**), and four groups (0.38, **Fig. 19C**). The two-group model separates theropods (green) from sauropodomorphs and herrerasaurids (red). The three-group model splits up the larger group into Herrersauridae (green) and Sauropodomorpha (red). *Buriolestes schultzi* is in the herrerasaurid group, but with a negative silhouette value, whereas *Eoraptor lunensis* is in the sauropodomorph group with a very small positive silhouette value. Four groups, like its equivalent in PAM, splits up the sauropodomorphs into the same two groups, except that *Guaibasaurus candelariensis* groups with the "classic prosauropods." *Tawa hallae* groups with the herrerasaurids (yellow), but with a very small silhouette value.

Discussion

The Silesaurid Holobaramin

In our survey of the silesaurid datasets we used BDC, MDS, PAM, and FANNY to identify continuity and discontinuity between groups. Throughout our analyses, we observed evidence of continuity within the Silesauridae, as interpreted via positive correlation in BDC and close clustering in MDS, and placement in the same groups in PAM and FANNY. We also observed evidence of discontinuity surrounding the Silesauridae via negative correlation with non-silesaurid taxa in BDC, lack of clustering with non-silesaurid taxa in MDS, and separation of silesaurids into their own groups in PAM and FANNY. For instance, in the Nesbitt (1) subset analysis, the silesaurid block did not share positive correlation with any other taxa in Pearson or Spearman BDC, and they shared negative correlation with the theropods (**Fig. 2C-D**). This evidence for discontinuity is supported by their separate clustering from the other taxa in MDS (**Fig. 3**), and in how they were grouped in PAM and FANNY (although two of the group models did split up Silesauridae in PAM and one in FANNY; **Figs. 4-5**).

Likewise, in the Martz and Small (2) subset BDC (**Fig. 6C-D**), the silesaurid block is set apart from the rest of the taxa by no correlation or negative correlation (except for one instance of shared positive correlation in Pearson and three in Spearman). These results suggest discontinuity surrounding Silesauridae, which is supported by their unique trajectory in MDS (**Fig. 7**), and their separate grouping in FANNY (**Fig. 8C**). The two- and four-group models of PAM for this analysis had equal average silhouette values (0.34), but this is likely because of the inclusion of so many non-dinosauromorph taxa in the analysis. Regardless, the four-group model did separate out the silesaurids from the other taxa (**Fig. 8B**).

The Müller and Garcia (3) BDC plots (**Fig. 9**) do not show strong evidence for discontinuity between silesaurids and the rest of the taxa, especially with *Asilisaurus kongwe*. However, this is likely due to the inclusion of so many disparate groups of taxa. They do appear to be somewhat set apart from the other taxa in MDS space (**Fig. 10**), and the two PAM models with the highest values separate them out from the rest of the taxa.

Even in the full Norman et al. (4) analysis BDC plots (**Fig. 12A-B**), the silesaurid block is distinct, but after removing the ornithischians it becomes even more distinct (**Fig. 12C-D**), with *Asilisaurus kongwe* again showing positive correlation with some saurischians. The MDS results lend support to discontinuity surrounding Silesauridae in the large separation between them and the rest of the taxa (except for *Lewisuchus*) whether the ornithischians were included (**Fig. 13A-B**) or not (**Fig. 13C-D**). Similarly, silesaurids were recovered as their own group in PAM whether ornithischians were included (**Fig. 16B**) or not (**Fig. 17A**) in the higher group models.

Because the Silesauridae seems to be continuous within itself and discontinuous with outside groups, we interpret it to be a holobaramin. However, this designation is dependent upon which taxa are included. In our analyses, we found the silesaurid holobaramin contains *Silesaurus opolensis*, *Sacisaurus agudoensis*, *Asilisaurus kongwe*, *Kwanasaurus williamparkeri*, and likely *Lewisuchus admixtus* (*Pseudolagosuchus major*), but excluding *Pisanosaurus mertii*. *Pseudolagosuchus major* and *Lewisuchus admixtus* are sometimes treated as separate taxa, but a new specimen of *Lewisuchus admixtus* described in 2019 demonstrated that they are the same species (25). This was previously suspected (e.g. Norman et al. (1)), but the two species previously had very few overlapping elements (only a tibia). All of the datasets we used had them combined, although Nesbitt (1) listed them as separate taxa and as a combined taxon, all of which were included in our analyses. However, we obtained conflicting results as to its placement. In the Nesbitt (1) BDC (**Fig. 2**) and in the Martz and Small (2) BDC (**Fig. 6**), MDS (**Fig. 7**), and FANNY (**Fig. 8C**), *Lewisuchus* clusters very nicely with other silesaurids. However, in the Norman et al. (4) and Müller and Garcia (3) analyses, the connections between *Lewisuchus* and the silesaurids are weak if visible at all. We think that it is likely that, with the data from the new specimen described by Ezcurra et al. (25) *Lewisuchus* will cluster nicely with other silesaurids in future analyses. The many poorly known silesaurid taxa (e.g., *Diodorus*, *Lutungutali*, *Technosaurus*, *Ignotosaurus*, etc.) will likely turn out to be within the silesaurid holobaramin, but it is difficult to say without better fossils.

Pisanosaurus mertii, Ornithischian or Silesaurid?

The results for *Pisanosaurus mertii* have raised interesting questions as to how it relates to the rest of the Silesauridae. Originally, *P. mertii* was described as an ornithischian dinosaur (8), which was followed by later authors (e.g., Bonaparte (26), Butler et al. (27), Ryan (28)). Agnolín and Rozadilla (29) and Baron et al.(10) recognized similarities between *P. mertii* and silesaurids, and recovered it within Silesauridae using phylogenetic analyses. However, its position remains unresolved and contentious. Müller and Garcia (3) have posited that *P. mertii* may be the most derived member of the Silesauridae, thereby bridging the gap between the Silesauridae and the "basal" Ornithischia.

The problem with forming a solid taxonomic conclusion on *P. mertii* is that it is a very poorly known taxon. The species is known from only one specimen, the holotype, PVL 2577 (housed in the Colección de Paleontologıa de Vertebrados, Instituto Miguel Lillo, Tucuman, Argentina) and it is still debated on how many elements of *P. mertii* are represented in that specimen (26, 29–33). Because of the poor nature of the specimen, *Pisanosaurus* falls out of our analyses when conducted at a taxonomic relevance cutoff of 0.3 (as occurred in Müller and Garcia (3); Norman et al. (4)). However, the limited results listed here support placing *P. mertii* outside the silesaurid holobaramin and perhaps the Silesauridae. Given its close clustering with ornithischian taxa in the Nesbitt (1) and Martz and Small (2) analyses, it seems likely that it will belong to an ornithischian holobaramin. Nevertheless, there are a number of alternative hypotheses that can be formulated to explain why *P. mertii* may be clustering with the Ornithischia:

1. *P. mertii* is too poorly known.

   When a taxon is solely known from fragments, it becomes frustrating to assign it to a specific group. Not only is PVL 2577 the only specimen known, but the number of elements associated with the specimen is debated, and some elements have been lost (29).

2. The ornithischian sample is too low.

   Perhaps the dataset uses too few ornithischian taxa, which may cause some characters to be emphasized, whereas others are diminished. The Norman et al. (4) dataset contains a larger ornithischian sample size, but *P. mertii* fell under the 0.2 taxonomic relevance cutoff, so its relationship was not tested.

3. Homoplasy

   Perhaps *P. mertii* is a silesaurid with ornithischian traits, or vice versa. Homoplasy is difficult to identify in fossil taxa (especially fragmentary taxa). Because of this, it is most likely safe to say that we lack sufficient material to conclusively show homoplasy is a major factor.

4. *P. mertii* is a chimeric taxon

   This was a hypothesis originally put forth by Sereno (32) and supported by other authors (33,34). However, this hypothesis has fallen out of favor in recent years (27,30).

In order to possibly gain clarity, we ran a version of the Norman et al. (4) dataset with *Pisanosaurus* and as many silesaurid taxa as possible (**Supplemental Figs. 1-2**, analysis details in Supplemental Data). These results recovered *Pisanosaurus* as clustering closer to silesaurids than ornithischians. For even more clarity, we ran a subset of the Norman et al. (4) dataset with the same parameters that only included Silesauridae, Ornithischia, *Lagosuchus*, and *Chilesaurus* (a possible ornithischian). These results strongly supported *Pisanosaurus* as in the silesaurid cluster and not the ornithischian cluster (**Supplemental Figs. 3-4**). However, it should be noted that these analyses were run with very fragmentary specimens included. While these results are intriguing, they do leave a number of unanswered questions. If *P. mertii* is truly an ornithischian, then why does it cluster with silesaurids in these specialized analyses? There are no definite Triassic ornithischians, which has been discussed by many authors (e.g. Baron (35), Müller and Garcia (3)), thus if *P. mertii* is an ornithischian, it would then fill this gap; but if it is a Triassic ornithischian, then where are the others? *P. mertii* as a silesaurid makes sense of its stratigraphic placement, but if *P. mertii* is a silesaurid, then why does it cluster with ornithischians in some of the analyses? It is necessary to answer these questions, but they will require further work with new fossils of *Pisanosaurus*. Not only is there a need for more *P. mertii* specimens, but for more Triassic ornithischians and silesaurids in general.

It is worth noting that *Pisanosaurus* is far from the only potential silesaurid to have a curious mixture of traits from different groups. *Asilisaurus* and *Lewisuchus*, despite being avemetatarsalians and ornithodirans, possess crocodile-normal ankle joints, which might seem fitting given their basal status in phylogenies closer to *Lagosuchus*, aphanosaurs, and pseudosuchians, which all possess this joint (14). However, pterosauromorphs (both pterosaurs and lagerpetids) possess "advanced mesotarsal" ankles also seen in dinosaurs and *Silesaurus*, even though the Pterosauromorpha/Dinosauromorpha split occurs prior to the Silesauridae/Dinosauria split (1,14). Thus, in the evolutionary model, either the "advanced mesotarsal" ankle evolved separately two to three times or *Asilisaurus* and *Lewisuchus* reverted back to the crocodile-normal ankle joint. These kinds of surprises should lead creationists to consider how a creation model might better explain the diversity we see in organisms.

Is *Lagosuchus talampayensis* a Silesaurid?

Alfred Romer described two species of *Lagosuchus* in 1972, *L. talampayensis* and *L. lilloensis* (6). A subsequent reanalysis of the fossil material by Sereno and Arcucci (36) concluded *Lagosuchus talampayensis* to be a *nominum dubium* due to its lack of autapomorphies. However, the authors found a number of features which would distinguish '*Lagosuchus*' *lillioensis* enough to name a separate species. They renamed it *Marasuchus lillioensis*, and considered it to be a non-dinosaurian dinosauromorph. More recently, Agnolin and Ezcurra (37) reassessed the holotype of *L. talampayensis* and found it to have features which would make it unique from other avemetatarsalians, but would not distinguish it from *Marasuchus lilloensis*, making *Marasuchus lilloensis* a junior synonym of *Lagosuchus talampayensis*. If *Marasuchus lilloensis* is a junior synonym of *Lagosuchus talampayensis*, it would follow that the two 'taxa' would group closely in our BDC or MDS analyses. None of our analyses were able to verify this since none of the datasets included both "species" as different taxa.

While *Lagosuchus* (*Marasuchus*) displayed positive correlation with some silesaurids in some analyses (Norman et al. (4) with *Asilisaurus*; Martz and Small (2) with *Asilisaurus*, *Lewisuchus*, *Sacisaurus*, and *Silesaurus*; Nesbitt et al. (1) with *Asilisaurus*, *Lewisuchus*, *Pseudolagosuchus*, *Marasuchus*, *Sacisaurus*, and *Silesaurus*), it also showed positive correlation with outgroup taxa (including *Eudimorphodon*), herrerasaurids, and basal sauropodomorphs. This further gives us less confidence to say *Lagosuchus* is of the silesaurid holobaramin. Furthermore, in more recent datasets, the only silesaurid *Lagosuchus* correlates with is *Lewisuchus*, a taxon that has the tendency to correlate with non-silesaurids. The early Nesbitt et al. (1) dataset gives *Lagosuchus* the best example of shared positive correlation with the silesaurids of any other dataset, which is possibly some kind of artifact of older, less complete data.

On the Silesauridae as a Paraphyletic Group within the Ornithischia

Müller and Garcia (3) proposed a paraphyletic grouping of the silesaurids within the Ornithischia. As we have seen prior, this is not the consensus. Although Müller and Garcia's (3) hypothesis is interesting (one that the authors claim to be more parsimonious than competing hypotheses), the results here do not show evidence for continuity between silesaurids and ornithischians, not even the results for the Müller and Garcia (3) dataset. The Silesauridae consistently grouped separately from the ornithischian taxa, except when considering *Pisanosaurus*, although even with its inclusion in the specialized subset of Norman et al . (4) there was a clear demarcation between silesaurids and ornithischians (**Supplemental Figs. 1-4**). It is important to point out that Ornithischia appears to contain multiple holobaramins (19), and the results here do not necessarily preclude a hypothesis that recovers the Silesauridae as a group taxonomically within Ornithischia (as taxonomy and baraminology are not the same thing).

Insights into Saurischian Baraminology

Although we were not seeking to understand the baraminological relationships of saurischians, our analysis of Norman et al. (4) revealed some fascinating insights. We see clear evidence of discontinuity between Herrerasauridae, Sauropodomorpha, and Theropoda, even when only considering Upper Triassic/Lower Jurassic taxa. This could potentially raise challenges to a progressive evolutionary explanation for the Triassic origin of the Dinosauria. We hope that this small insight will be an encouragement to creationist paleontologists to investigate Triassic dinosaurs in an attempt to discern why there are so many similarities between these three saurischian groups and how we might explain the patterns we see from a creationist model, especially given the likelihood of these fossils being deposited during Noah's Flood.

Conclusion

The results we present here almost unanimously support a distinct silesaurid holobaramin containing *Silesaurus opolensis*, *Sacisaurus agudoensis*, *Asilisaurus kongwe*, *Kwanasaurus williamparkeri*, and possibly *Lewisuchus admixtus* (*Pseudolagosuchus major*). Given the incompleteness of the only known specimen of *Pisanosaurus mertii*, we recognize its baraminic status as inconclusive. *Lagosuchus* (*Marasuchus*) may be a member of the silesaurid holobaramin, however more research must be done into its exact placement. We also recognize the desperate need for more complete specimens to be discovered of both the Silesauridae and Triassic Ornithischia (if they do exist).

Acknowledgments

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Supplemental Information

In order to test the baraminic relationships of *Pisanosaurus* with a large ornithischian and silesaurid dataset, we decided to re-run the Norman et al. (4) dataset with a character relevance cutoff of 0 and a taxonomic relevance cutoff of 0.2 for most taxa, but a 0.1 for silesaurids. This allowed us to include additional silesaurids (*Pisanosaurus mertii*, *Lutungutali sitwensis*, *Eucoelophysis baldwini*, and *Diodorus scytobrachion*). However, in order to run this analysis, we had to remove some non-silesaurid taxa that had a taxonomic relevance score higher than 0.2, as the analysis would not run including them as they shared no characters in common with other taxa in the dataset: the likely theropod *Daemonosaurus chauliodus*, the sauropodomorph *Nhandumirim waldsangae*, and the thyreophoran (ornithischian) *Emausaurus ernsti*.

The Pearson and Spearman BDC results show four blocks of positive correlation with more examples of shared positive correlation between the blocks in the Spearman BDC **(Supp. Fig. 1)**. The lower left block contains ornithischians, the next block diagonally contains silesaurids, then a large block of saurischians, and finally a smaller block containing non-dinosauriform taxa. The enigmatic dinosaur *Chilesaurus* shares positive correlation with the ornithischians and a few theropods. *Pisanosaurus* shares positive correlation with the silesaurids and the ornithischians. *Lewisuchus* shares positive correlation with some silesaurids, with many saurischians, and with most of the non-dinosauriform taxa.

PAM results (Supp. Fig 2A) for this special dataset have the highest silhouette value at five groups (0.38, Supp. Fig. 2). *Pisanosaurus* is grouped with the silesaurids (green) with a silhouette value of 0.29. *Lewisuchus* is grouped with the sauropodomorphs and herrerasaurids (blue) with the low silhouette value of 0.04. FANNY (Supp. Fig 2B) only ran at two groups (average silhouette value = 0.26), with the ornithischians and silesaurids in one group (red) and the rest of the taxa in the other group (green), although *Lewisuchus* is in the green group.

Because we wanted more clarity on the baraminic relationship between Silesauridae and Ornithischia, especially as it relates to *Pisanosaurus*, we made a subset of this modified dataset that only included the silesaurids, ornithischians, *Chilesaurus* (since it keeps clustering with ornithischians), and *Lagosuchus* (since it sometimes clusters with silesaurids). The resulting BDC plots are almost identical between the Pearson and Spearman coefficients **(Supp. Fig. 3)**. The silesaurid and ornithischian blocks of positive correlation share no positive correlation between each other, and they are mainly separated by instances of negative correlation. *Chilesaurus* is positively correlated with the ornithischians, and *Pisanosaurus* only positively correlates with silesaurids, although it is not negatively correlated with any taxa except *Chilesaurus*. *Lewisuchus* shares positive correlation with other silesaurids and with *Lagosuchus*, which only positively correlates with one other taxon: *Asilisaurus*.

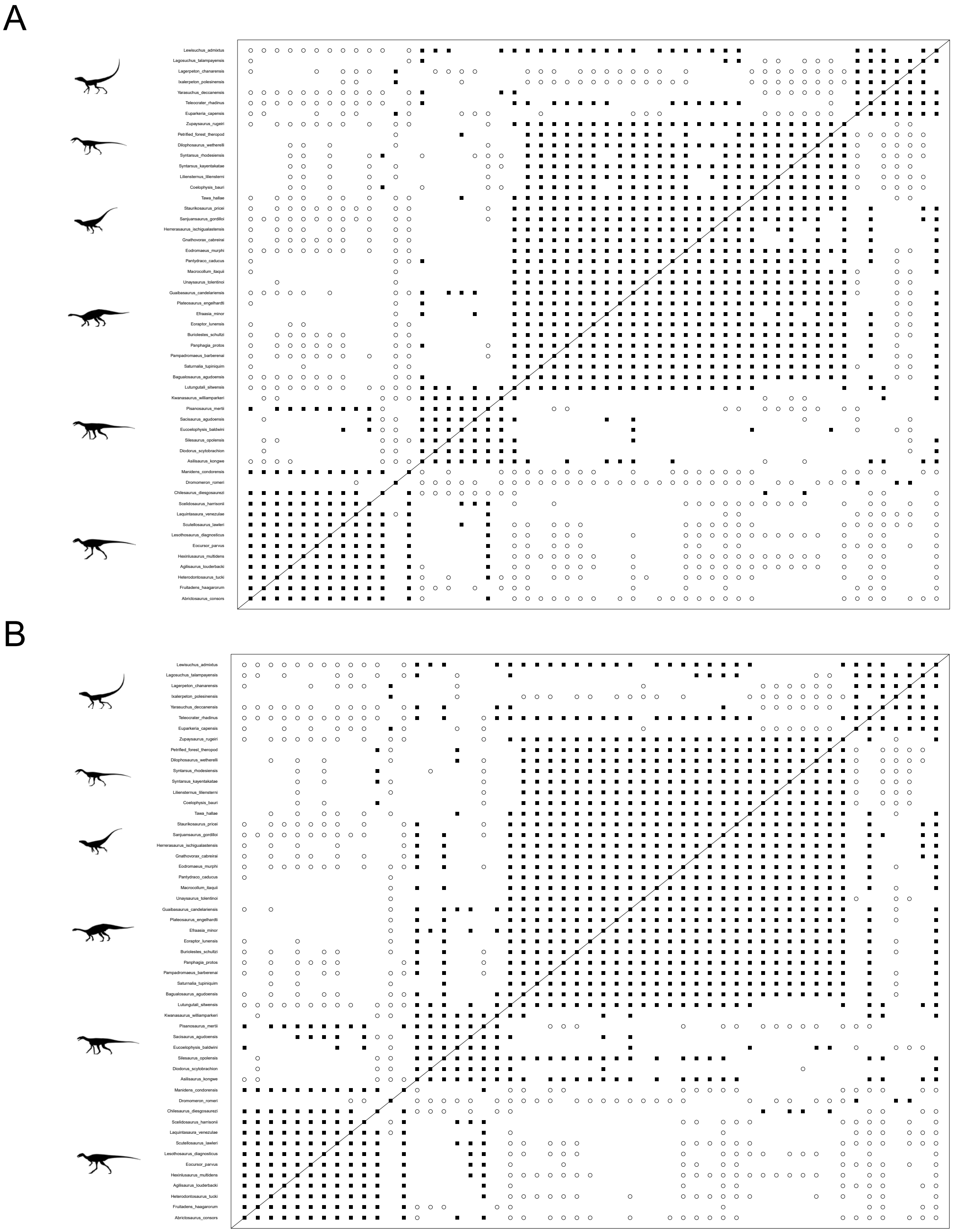
The PAM results **(Supp. Fig. 4A)** for this silesaurid and ornithischian subset of the Norman et al. (4) dataset had the highest silhouette value at two groups (0.46), which was the same case for FANNY **(Supp. Fig. 4B)**. In both PAM and FANNY, the two groups were Ornithischia + *Chilesaurus* (red) and Silesauridae + *Lagosuchus* (green). *Pisanosaurus* and *Lewisuchus* were both included in the silesauridae group.

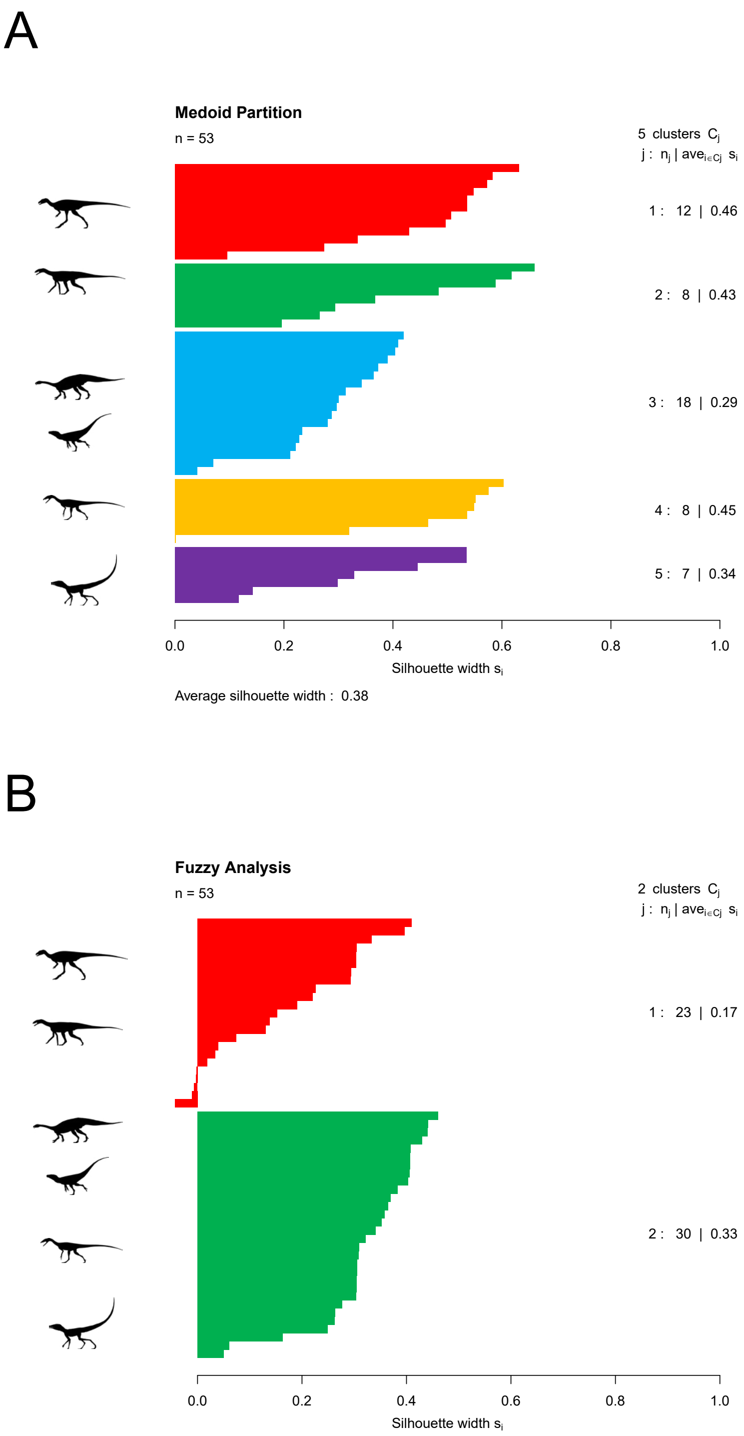
We did not include separate 3D MDS plots for these analyses since the component plots on the PAM and FANNY analyses provided ample representations of those plots.

Supplemental Figure 1. BDC plots of the special subset of the Norman et al. (4) dataset: **A)** Pearson and **B)** Spearman.

Taxonomic relevance cutoff = 0.2 with additional modifications (see text for description); character relevance cutoff = 0.

Silhouettes from Phylopic (https://www.phylopic.org/). All silhouettes are public domain except for *Asilisaurus* by Scott Hartman, CC BY 3.0 (https://creativecommons.org/licenses/by/3.0/deed.en).





Supplemental Figure 2. PAM and FANNY analyses of the special subset of the Norman et al. (4) dataset: **A)** PAM at five groups and **B)** FANNY at two groups.

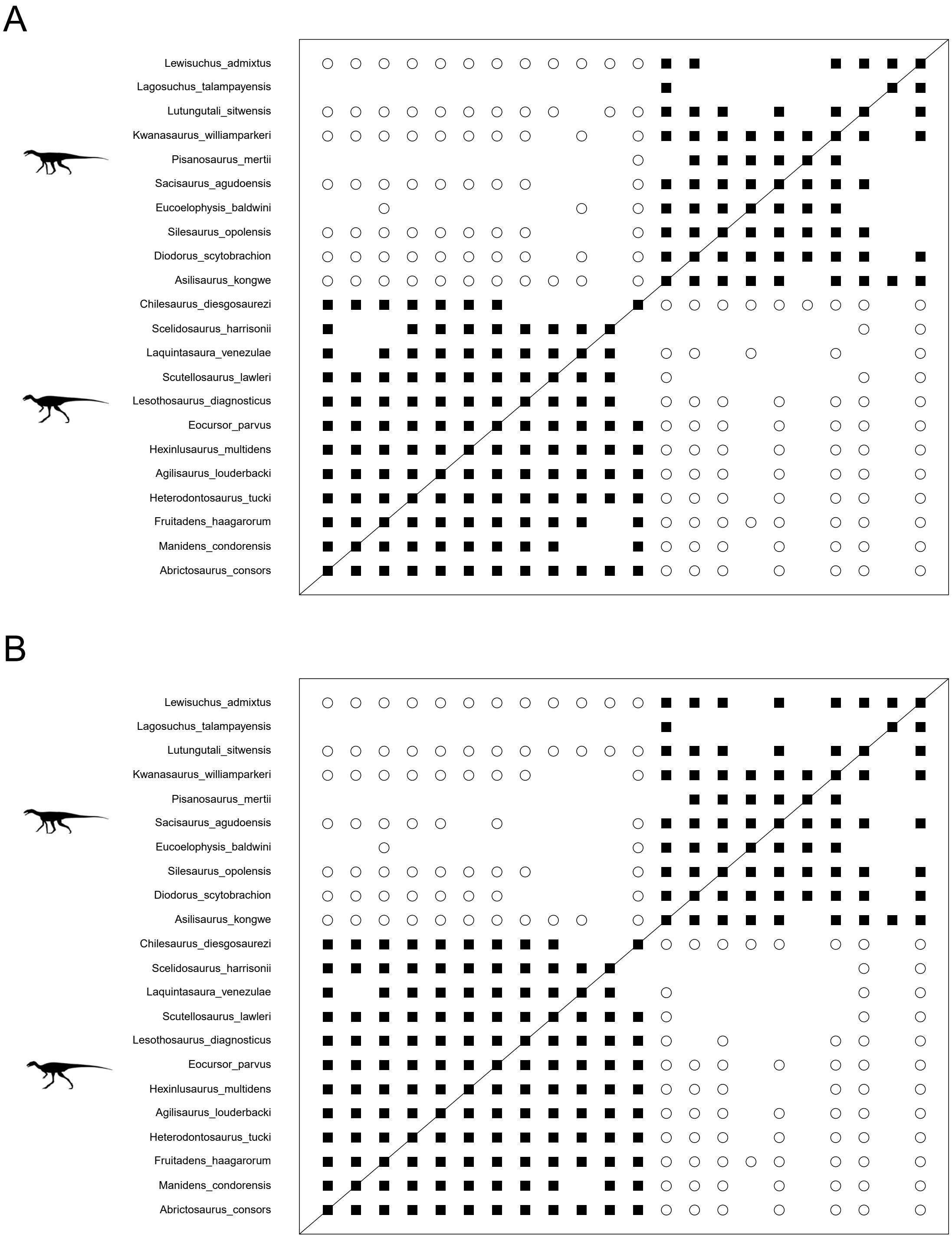
Taxonomic relevance cutoff = 0.2 with additional modifications (see text for description); character relevance cutoff = 0.

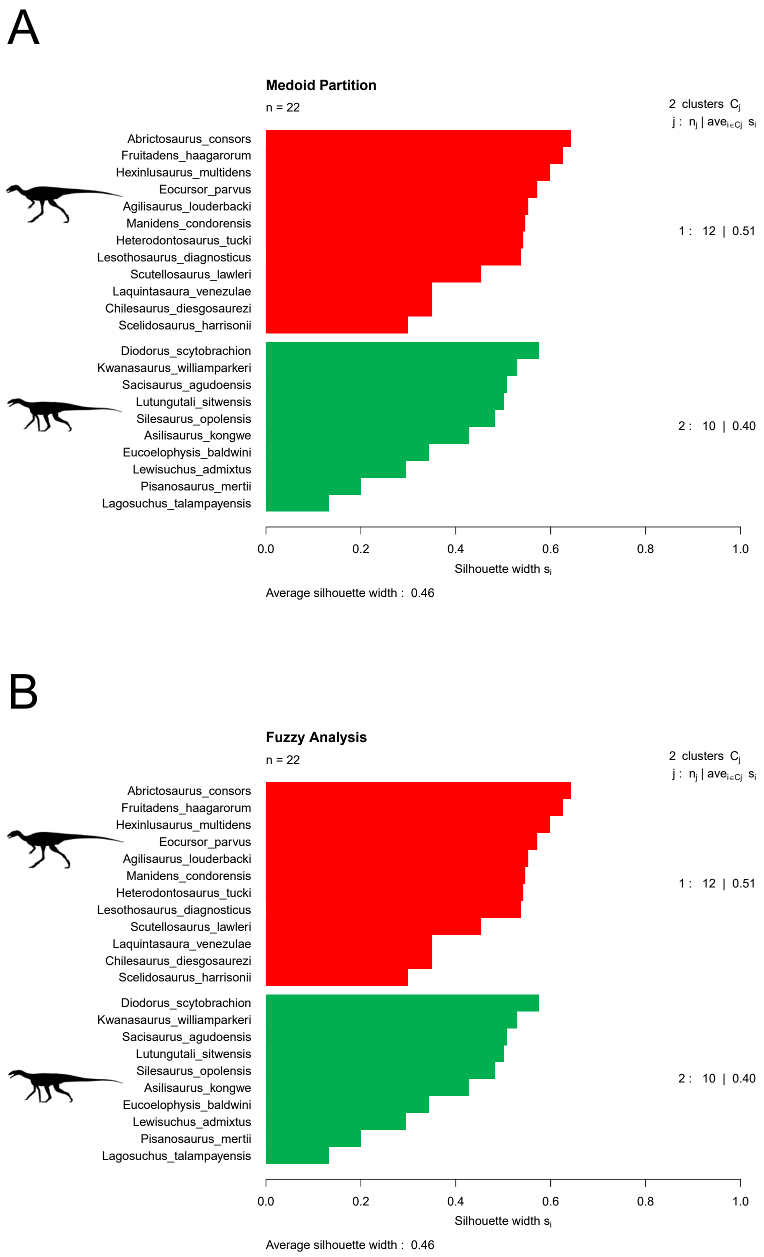
Silhouettes from Phylopic (https://www.phylopic.org/). All silhouettes are public domain except for *Asilisaurus* by Scott Hartman, CC BY 3.0 (https://creativecommons.org/licenses/by/3.0/deed.en).

Supplemental Figure 3. BDC plots of the Silesauridae and Ornithischia subset of the Norman et al. (4) dataset: **A)** Pearson and **B)** Spearman.

Taxonomic relevance cutoff = 0.2 with additional modifications (see text for description); character relevance cutoff = 0.

Silhouettes from Phylopic (https://www.phylopic.org/). All silhouettes are public domain except for *Asilisaurus* by Scott Hartman, CC BY 3.0 (https://creativecommons.org/licenses/by/3.0/deed.en).





Supplemental Figure 4. PAM and FANNY analyses of the Silesauridae and Ornithischia subset of the Norman et al. (4) dataset: **A)** PAM at two groups and **B)** FANNY at two groups.

Taxonomic relevance cutoff = 0.2 with additional modifications (see text for description); character relevance cutoff = 0.

Silhouettes from Phylopic (https://www.phylopic.org/). All silhouettes are public domain except for *Asilisaurus* by Scott Hartman, CC BY 3.0 (https://creativecommons.org/licenses/by/3.0/deed.en).

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REVIEW

Still More Thoughts on the Historical Adam

Reflections on *Perspectives on the Historical Adam and Eve: Four Views.*

Ed. Kenneth D. Keathley. 2024. Nashville: B&H Academic. 230 pp.

Reviewed by **Todd Charles Wood**
Core Academy of Science

Christian beliefs about origins—of the cosmos, the earth, life, and people—have been flashpoints of controversy for centuries now, at least dating back to Isaac de la Peyrère's "pre-Adamite" humans[1] (and even further if one considers Christian refutations of Aristotle's eternal cosmos). The arguments persist today with a new wardrobe of fossils, genomes, and hybrids, but beneath this dressing, the fundamental questions remain much the same. To what extent should we read Genesis 1-11 as an account of history and therefore binding on our beliefs about the past? Or can we understand these primordial stories as a sort of theological fable without worrying about the details? Or is there a *via media*, where we might retain certain details as necessary historical beliefs that are expressed within parabolic or hyperbolic narratives?

One could also divide up Christian reactions to creation along a more non-scriptural, scientific axis. Some scholars accept scientific models of the past as well-supported and generally correct. Others insist that claims about the past are speculative and erroneous and that the evidence is best interpreted according to a more literal reading of Gen 1-11. Still others take that middle route, accepting certain scientific claims as accurate while questioning others.

The four main authors of *Perspectives on the Historical Adam and Eve: Four Views*, edited by Kenneth D. Keathley, offer us four positions that represent various nexus points along these different ideological trajectories. Kenton Sparks represents a willingness to understand Genesis as nonhistorical, while Marcus Ross affirms the major events of Genesis 1-11 as historical. The views presented by Andrew Loke and William Lane Craig select only certain textual claims of Genesis as true historical claims. Along the science spectrum, Sparks, Craig, and Loke present their views as largely accepting of conventional claims about human evolution, while Ross offers a substantial re-interpretation of paleoanthropology.

Following the format of other multi-view books, each author's essay is followed by short responses written by the other authors, to which the essay's author then replies in a rejoinder. Unlike some multi-view books, the appearance of this volume was preceded by a personal meeting of the authors and other scholars, at which drafts of the essays were presented and audience members could then offer their own reviews and responses. I attended this meeting, hosted by Southeastern Baptist Theological Seminary, as one of the respondents. Only two authors presented in person: Ross and Sparks. Loke joined us from Hong Kong via teleconferencing, and Craig unfortunately missed due to a COVID-19 infection. In the published volume, the authors mention the meeting as an important component of the composition of this book and as an exemplar of cordial interaction. Sparks in particular seems to have received a warm welcome, despite his

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self-admitted role as the "proverbial 'liberal'" (p. 20).

In a brief introductory essay, Keathley presented a short orientation to the topic and then explained the goals of the essays. Each author is expected to address three questions. "1. How does your position interpret the biblical witness concerning the historicity of Adam and Eve? 2. How does your interpretation integrate with the current scientific consensus concerning hominids? 3. How does your position impact the message and ministry of the church?" (p. 15).

Sparks opens the volume with his essay on the nonhistorical Adam position, which can be summarized rather succinctly. The Bible as a whole contains discrepancies and even errors that falsify the claim of inerrancy. Since the Bible is as errant as any other ancient document, we should not expect it to correlate especially well with extrabiblical evidence and science. Consequently, the science of anthropology can be left to its own work studying the evolution of humanity without any worry about the existence of Adam and Eve. The witness of the church can only be improved by separating the gospel from the far-fetched hermeneutics or specious science of the other three views.

Craig's essay on the "mytho-historical Adam" is a condensation of his book *In Quest of the Historical Adam*[2] and presents a more complicated argument. Craig focuses on the genre of Genesis 1-11 by presenting a series of criteria for recognizing myth, of which the biblical text exhibits eight. In his essay, Craig focuses mostly on the etiological nature of myth, particularly showing the way Genesis 2-3 fits the mythical bill. But Craig acknowledges that there is more going on in Genesis, especially in the way the stories create a forward momentum, framed by the genealogies of Genesis 5 and 11. When considered with Paul's citation of a real, historical Adam in Romans 5, this historical concern of Genesis 1-11 suggests that this is a mythical work containing some historical details, a *mytho-history*. Adam then is a "progenitor of the entire human race through whose disobedience moral evil entered the world" (p. 82). Craig then turns to the science of paleoanthropology to attempt to identify when this Adam might have lived. Using criteria for behavioral modernity from a paper by McBrearty and Brooks,[3] Craig deduces that Neandertals and *Homo heidelbergensis* must be included in the human family as descendants of Adam. He concludes with speculations about how that initial Adam came to be and what future research might reveal but curiously omits Keathley's third question regarding the ministry of the church.

Loke's essay purports to present "The Genealogical Adam and Eve Model" not by showing that his model is correct but by showing that his model is merely *possible*. Thus, the burden of proof will be on those who disagree to show that his model is *not* possible (along with all possible variants of his model). Unfortunately, his essay struggles to present the elements of his model succinctly and clearly. Instead, the reader must glean the details from his prose, which from my reading seems to depend on four main claims. First, the Bible does not contradict evolutionary biology. Second, the Bible does claim that Adam was the first bearer of God's image. Third, the image of God consists minimally in the ability of humans to have a relationship with God. Fourth, by distinguishing a genealogical ancestor from a genetic ancestor, we may understand Adam to be a biological *Homo* sp. chosen from a large number of conspecifics to receive the image of God. The reader would benefit greatly from having read Swamidass's *The Genealogical Adam and Eve*[4] prior to reading Loke's essay. Loke concludes with a short paragraph that highlights a personal testimonial of the importance of apologetics for sharing the gospel.

Ross's essay rounds out the book with a view that closely tracks with my own. Briefly, the Bible describes the events of Genesis 1-11 clearly enough for us to discern their doctrinal importance, especially for the doctrine of the Fall. Attempts to harmonize biblical teachings with evolution fail. Ross spends quite a bit of time on the Flood in order to lay the foundation for his version of Flood geology. His presentation of paleoanthropology incorporates my own work on hominin baraminology as well as a review of archaeology that emphasizes how well the behavioral evidence fits with the baraminological analyses. Ross's discussion of Christian ministry emphasizes the need for a consistent, biblical theology in our missions outreach.

The book concludes with a reflective essay by Joshua Swamidass that essentially reviews the chapters and emphasizes the need for Christian unity in our exploration. He sees the different views falling along three lines: 1. Whether we should accept conventional evolutionary science, 2. Whether Adam is ancient or recent, and 3. Whether there could be people outside the garden. He claims that the plurality of available views is a strength to be valued.

Obviously, the quality of any multiple-views book will depend greatly on the reader's own preferences and prejudice in addition to the quality of the essays. Multi-view books certainly have their uses in helping students parse through issues in a succinct and affordable fashion, and the responses and rejoinders can give even more insight into the positions and their proponents beyond what might be discernable from an isolated set of monologues. For the rest of us, what is to be gained from these books and from this book in particular? For the present volume, I think its greatest asset is not the most recent positions represented (both of which can be examined in greater detail elsewhere) but in the opinions that rarely appear for public discussion.

On the one hand, Sparks's essay does indeed represent the "token liberal" of the volume, but here we have a very frank and very well-written exposition of the errantist perspective. For decades, young-age creationists have warned of the doctrinal costs of accommodating theology to evolution. Paper after paper, lecture after lecture, and meme after meme try to show how the doctrine of creation connects inextricably to other Christian doctrines that are perceived as more valuable and essential. We cannot compromise on creation without losing much of what makes us uniquely Christian, says the creationist apologist. On the one hand, Sparks's essay appears to confirm many of our worst fears with the loss of the doctrine of inerrancy, but upon closer inspection, the careful reader will note that Sparks has done something much more challenging.

Because of course, Sparks does *not* proceed with a desire to reconcile evolution to the Bible and thereby conclude that inerrancy must be wrong. Instead, he presents a review of many well-known textual problems within the Bible itself and attempts to explain them with one simple conclusion: The Bible contains errors. The Bible is simply a product of its time, with its own ancient idiosyncrasies and flaws and tall tales. With that as his premise, he sees no need to reconcile the Bible to human evolution, or the Big Bang, or germ theory, or any of the other myriad scientific ideas of today. The Bible simply isn't about that, and we do it a grave disservice when we torture the text in search of these sorts of answers.

It is greatly tempting to read his essay with all the usual ideological blinders and to fall back on the usual apologetic explanations of these textual "problems." I certainly bristled at his assertion that "Conditions outside of the garden were harsh" (p. 39), which is not a claim of Genesis. But before we become too distracted by these details, we should observe the more potent element of his presentation, namely its parsimony. According to the principle of parsimony, the simpler explanation is to be preferred over the more complex explanation. In this case, the simpler explanation (errors in the Bible) should be preferred against however many volumes of *Bible Difficulties Explained* can fill a library. To a traditional inerrantist such as myself, Sparks's essay is by far the most unsettling of this entire volume.

Even as I recognize the power of a parsimonious explanation, I also must say that many of the apologetic responses resonate with me. Some of the so-called "problems" really do appear exaggerated and eisegetical, while many others have very plausible explanations. Still, there exist more than one stubbornly uncertain passage, such as the identity of Goliath's killer (2 Sam 21:19), Luke's extra Cainan (Luke 2:36), or Matthew's citation of Jeremiah (Matt. 27:9-10). Clear away the chaff in whatever idiosyncratic fashion you like, and these puzzling passages remain. It is with these that Sparks offers his strongest case for biblical errors.

Responding to a parsimonious model requires a parsimonious model of our own, and this format does not afford me the space to compose a decisive rebuttal. Yet, I wonder if this form of argument is the best for a Christian to adopt? After all, we do not doubt God's goodness even amidst the most difficult of personal circumstances. Why would we doubt the truthfulness of God's Word even amidst challenging passages? The question ought not be whether such errors might occur in modern Bibles, but rather, what made us think the Bible was inerrant in the first place? Here, we are on much firmer, and I might add, more parsimonious, ground. First, there are copious places in the Old and New Testaments that affirm the truthfulness and reliability of Scripture. Jesus himself tells us that, "until heaven and earth pass away, not an iota, not a dot, will pass from the Law until all is accomplished" (Matt 5:18, ESV). Thus, before judging the Bible's reliability, the reader must wrestle with its claims *about itself*. Second, I look to the basic theological principle that doctrines with many scriptural attestations should be affirmed. I find it difficult to claim that biblical truthfulness is not a claim of many passages of Scripture. Third, have other Christians of the past—especially our leading theologians—observed the same doctrine of biblical reliability as I perceive? Again, I can hardly cite everyone, but I find the truthfulness of Scripture is a longstanding doctrine of the Church. I quote here only Augustine in one of his letters to Jerome, "I have learned to yield this respect and honour only to the canonical books of Scripture: of these alone do I most firmly believe that the authors were completely free from error."[5] Inerrancy is no modern theological novelty.

At this point, a skeptical reader could complain that I've constructed a circular argument, that the Bible is without error because the Bible says it is without error. The formula at present requires some anchor to make us think that the major claims of the Bible, among which is its truthfulness, are to be affirmed as true, and that anchor I see in Christ's resurrection and the gift of the Holy Spirit, both of which manifest in the transformed lives of the saints down through the ages (including my own). The Christ who claimed that even the biblical jots and tittles are important is the same Christ that God raised from the dead. He is the same Christ that the Father affirmed, "This is my beloved Son; hear him." And when we listen to the Son, we hear him quote the Bible as decisive over and over again. Can we, Jesus' disciples, rightfully question the authority and deep truthfulness of the written Word? It would appear that Jesus has not left us that luxury. The truthfulness of God's Word is a matter of faith, as are all the other doctrines faithfully inferred from God's Word. Considering all of these evidences, the Bible's own claims, the historical witness of the church, and the miraculous confirmation of Christ's ministry, Biblical truthfulness is a most parsimonious conclusion indeed.

None of this explains any specific textual challenge or excuses poor scholarship in brushing away the challenges, but then, what doctrine does offer comprehensive explanations for our individual circumstances? Christians continue to endure real pain and suffering despite confessing God's goodness and power to intervene. In the same way, even as I observe these puzzling passages of Scripture, I confess the eternal and unerring truth of the Word of God. Problems arise not from the written revelation but from my own misunderstandings, and if I am to resolve the problems, I must investigate my own misunderstandings. Again, I recognize that this leaves a myriad of details to be worked out, not the least of which would be Sparks's own detailed perspective on what the truthfulness of the Bible actually entails (and which no doubt he affirms). But I can only offer this meager framework of a response in this review. There are three other essays to consider.

As I previously confessed, Ross's essay most closely tracks with my own perspective on the historical Adam. With Ross, I see the biblical account of Adam's creation and subsequent fall inextricably entangled with other doctrines of more obvious importance. Insofar as human evolutionary science wreaks havoc on the biblical depiction of Adam, it also wreaks havoc on Christian theology itself. Like Ross, I hold these entangled doctrines as a matter of faithful conviction, and that leads me to seek answers to the scientific challenges in the science itself, even as I continue to study the biblical witness. I would add that this surely is a matter of basic logic, that an apparent conflict between two witnesses requires a careful evaluation of *both* witnesses. Yet Ross seems to be the only one here willing to critically question and challenge the scientific witness (although I confess that Sparks's position is one of indifference to the science and thus he has no motivation to question it).

Beyond this superficial agreement, Ross presents a striking essay in what it lacks. Unfortunately, young-age creationists have become known for a type of overconfidence bordering on delusion or dishonesty in their assertion that evolution has no affirming evidence and all the scientific evidence agrees with a young-age creationist perspective. Whether or not this is a fair critique or just a stereotype, Ross displays none of that bluster here. Instead, he affirms that creationism offers "investigative *methods* that address the relevant scientific data" (p. 150, emphasis mine) and that the Bible provides only "a temporal scaffold to guide our investigations of the natural world" (p. 166). He calls his own essay "a rough outline" with "numerous questions, challenges, and problems" (p. 185), and he acknowledges that "current proposals are not the final word" (p. 176). Perhaps in sensitivity to the scoffing creationist stereotype, Ross goes out of his way to emphasize the tentativeness of his own position and the many open questions.

Without overselling his view as more powerful than it is, Ross's essay is uniquely inviting in the present collection. His tentativeness leads him to seek further clarification and discoveries that will confirm or clarify his own ideas. Readers are explicitly invited to join this work of studying the details of God's world and discovering answers to the many open questions. Perhaps this should not be surprising, given he is the only scientist contributing an essay, but his explicit commitment to building community around our search for answers is commendable.

Even with all these positive qualities, Ross's essay notably ignores the genomic evidence, which is sorely missed, given the importance of genomic evidence to the recent renaissance in evolutionary creation. Likewise, the issue of genealogical ancestry, the subject of Loke's essay, also does not appear. Given the assumptions of the genealogical ancestry model (discussed below), it surely is of no use to Ross's model, but how then does Ross account for the demographics of a growing human population arising from a single founding pair? Again, though, we must remember that Ross does not intend to provide comprehensive answers for every question but rather an outline of how scientific evidence might be re-interpreted in ways more agreeable to the biblical witness. And he only has 8,000 words to do it. Perhaps we should be happy with what we have and hope for future opportunities to elaborate the genetic side of the creationist model of human origins.

The other two essays in the book provide perspectives on what Keathley calls dramatic shifts in the debate over the historical Adam (p. 2). As noted, Craig's essay is a condensation of his book, with attention on the interpretation of Genesis 2-3. His position essentially seems to fall into two relatively independent arguments. First, the mytho-historic interpretation of Genesis represents similar positions advocated in the past by the likes of Peter Enns, John Walton, and even Kenton Sparks. Though Craig can (and does) dispute the details of these authors' positions, the central concept that Genesis communicates timeless truths in a non-literal package of fantastic tales is common. Call it narrative theology, mytho-history, or what have you, it does not strike me as a dramatic development in the historical Adam debate.

Much more unique is Craig's approach to the scientific data, the second component of his position. Rather than assuming that humans are *Homo sapiens sapiens*, as most other evolutionary creationist and theistic evolutionist authors have done, Craig examines scientific records and concludes that he cannot deny the humanity of Neandertals and *Homo heidelbergensis*. Evidence he cites for this includes the remarkable Schöningen spears and the curious stone arrangements in Bruniquel Cave.[6] Young-age creationists have claimed Neandertals as human for years,[7] but to my knowledge, this is the first evolutionary creationist to make a similar claim. By extending the category "human" to include other *Homo* species, Craig moves the historical Adam earlier than a half million years ago (on the conventional calendar, which he accepts), much earlier than the Neolithic Adam of more typical evolutionary creationism.

I note that these two components of Craig's view are largely independent, in that one could affirm a mytho-historical view of Genesis without also affirming Neandertals as human (as Sparks does), and one could affirm Neandertals as human without accepting the mytho-historical view (as Ross does). Whether Craig's particular union of these ideas proves durable is anyone's guess, but his vulnerabilities are on full display in this volume. In both his biblical and scientific arguments, Craig proceeds by defining a category according to a list of criteria, and then demonstrating how particular instances fulfill the criteria necessary to be included in the category. On the biblical side, he defines the category *myth* according to ten criteria and purports to show that Genesis meets enough of those criteria to be classified as *myth*. On the scientific side, he defines the category *human* according to four criteria and explains how Neandertals and *Homo heidelbergensis* meet those criteria. Naturally, one could dispute Craig's position by disputing the criteria, and that is exactly how Loke and Ross address him in their responses. Loke disputes his human criteria, and Ross disputes his myth criteria. If Craig's position has any lasting presence, I suspect it will be in the nitpicking of his criteria and their application.

In that spirit then, allow me to express a few nitpicks of my own. I find the myth criteria curiously unequal in importance. For example, his first criterion "myths are narratives" does not identify anything particularly distinctive or useful about a myth. Criteria 5 and 7 are redundant (primordial/primeval setting), as are criteria 3 and 4 (sacred stories of belief). In his book, Craig disputes the relevance of criteria 8 and 9. Ross's conclusion that these criteria essentially can be reduced to two (myths are etiologies and contain fantastic elements) appears mostly correct, despite Craig's protests to the contrary. And since etiologies need not be false, the question of historicity is reduced entirely to the question of the fantastic elements contained within Genesis 1-11. Ironically, even as I affirm the core historicity of Genesis 1-11, I too acknowledge the presence of fantastic elements in the form of miracles. Hence, I agree with Craig that Genesis gives us a fantastic etiology of the world, yet I do not conclude that this constitutes myth. In my case at least, the criteria failed.

On Craig's anthropology, I agree with Ross that his circumscription of humanity is probably too narrow. Based on his book, I think Craig would argue that the lack of significant material culture from *Homo erectus sensu lato* during a million years on the conventional calendar mitigates against their humanity. Yet I wonder at the completeness of the record of *Homo erectus*. There are many fewer skeletal specimens of *H. erectus* compared to Neanderthals. With such a sparse record, should we expect to find much of an archaeological record? Aside from these speculations, what we have of erectine material culture attests to their intellectual sophistication. Sites with evidence of ancient controlled fire are common enough, including Swartkrans,[8] Koobi Fora,[9] and Gesher Benot Ya'aqov.[10] Also at Gesher Benot Ya'aqov, we have rather clear evidence of cooking.[11] Additionally, the presence of Oldowan lithics on Soqotra suggests a considerable seafaring ability.[12] All of these evidences suggest the same level of behavioral sophistication as seen in Neandertals. The puzzle for Craig's model is why more of this evidence does not exist if erectines are human and really did endure for a million years of history.

Loke's genealogical Adam model is simultaneously the most unique and least persuasive essay in the book. Brought to the attention of evangelicals through the work of Joshua Swamidass, the genealogical Adam depends on the surprising discoveries of Joseph T. Chang in 1999 and 2004 that demonstrated that a biparental population of constant size has a surprisingly low number of generations before a common ancestor is reached. In his initial 1999 paper, Chang showed that a population of constant size N has approximately $\log_2(N)$ generations separating it from its most recent common ancestor (MRCA).[13] Chang acknowledged that his model was not directly related to models of genetic ancestry, such that the MRCA need not contribute any genes to the present population, while still appearing in the genealogical family tree. Going back generations before the MRCA, we eventually come to a point where the individuals in the population are either ancestors of all current population members or of no current population members. This generation is reached in approximately $1.77 \log_2(N)$ generations. For a population of a billion people, this would mean the MRCA was only about 30 generations back (at most 1,200 years for humans) and all ancestors become common ancestors about 53 generations back (at most 2,120 years for humans). In a subsequent study, Chang's research group showed that the time to these two ancestral generations remained quite short even with more realistic models of population partitioning and migration.[14]

The relevance of these observations to the existence of a historical Adam will depend entirely on how well one believes this genealogical common ancestor actually fits the description of Genesis. Loke argues for a population of individual *Homo* sp. living at the same time of Adam and Eve. This comes as no surprise. Such proposals have become commonplace from those who seek to reconcile human evolution to the Bible. What distinguishes Loke's model is the detailed description of these people outside the Garden (POGs). In Loke's view, POGs could be biologically, intellectually, and culturally indistinguishable from Adam and Eve but not made in God's image. Thus, the large population of POGs can provide a gene pool to the newly-created people in God's image (PIGIs) with no barrier to mating (and no need to invoke bestiality). For Loke, the image of God readily spreads through the population in subsequent generations by virtue of offspring having at least one PIGI parent. Given Chang's results, the image of God should spread quickly, making Adam and Eve true recent common ancestors of everyone alive while humans still possess a diverse gene pool, the history of which could extend back millions of evolutionary years.

My reaction closely tracks with the responses recorded in the book. With Sparks, I find the model quite implausible, since it does not really fit what the biblical author seems to be saying. The ancient authors of Scripture did not imagine Adam and Eve as two among many. All of the ancient extrabiblical testimony we have (which admittedly is centuries after the composition of Genesis) indicates that Adam and Eve were taken as the absolute progenitors of humanity. The Bible and its earliest interpreters recognize no POGs at all. With Craig, I find Loke's understanding of the image of God to be unworkable. Craig falls back on his own criteria for what makes someone human and therefore in the image of God. I would argue that the best understanding of the image entails *imaging*, namely a relationship to those observing that is at least as important as the relationship to the one being imaged. If POGs cannot be distinguished from PIGIs by any kind of ordinary observation, then PIGIs fail to have the image. Further, if Loke were to respond that the image would be observable in the relationship PIGIs have with God, this too fails to persuade since unrepentant PIGIs would act just like POGs and be therefore indistinguishable from them. The image of God is not a collective that all PIGIs manifest together but an individual feature that every PIGI must possess (hence the prohibition against murder in Gen. 9:6). In this genealogical model, until such time that all people are PIGIs (at least $\log_2(N)$ generations), the image would therefore fail to be the image.

Ross raises the additional chilling conclusion that by spreading the image of God through the POG population, PIGIs also brought death and condemnation, since Adam and Eve had already fallen. Oddly, in his original essay Loke affirms that, like any other animal, POGs could enjoy God's love, comfort, and even an afterlife (p. 130). Ross rightly recognizes that this creates a remarkable moral conundrum. If God does grant some kind of mercy to POGs, surely POGs would have been better off avoiding PIGIs altogether! Loke dismisses this as a "misrepresentation" of his model, yet Loke provides little detail to explain why this rather obvious moral deduction is not a valid consequence of his proposal.

Ultimately, while some people feel a measure of excitement over the genealogical Adam model, I see little value here unless one is already committed to human evolution. For those of us committed to Adam and Eve as sole progenitors like the Bible portrays, the distinction between genetic and genealogical ancestor is unhelpful and unnecessary. For those who allow some form of human evolution, this genealogical ancestry might help resolve tensions over Adam as the ancestor of all people, but given the weaknesses of Loke's model, such scholars still have work to do.

All of these comments on Loke's essay are complicated by his unwillingness to present a straightforward model as the other authors have done. Where Sparks, Craig, and Ross each make a series of assertions and subsequent conclusions, Loke instead tries to present only a *possible* explanation for his claim that human evolution and the Bible could both be true. As a result of this, Loke could simply deny any or all of my concerns by insisting the vulnerabilities only exist for one possible version of his model among many. Such maneuvers smack of special pleading rather than an actual model.

Regarding the book as a whole, what we have here are two essays that take relatively straightforward positions: Sparks sees the Bible as prone to ancient errors and therefore not authoritative on questions of anthropology and origins. Ross affirms the Bible and Christian theology as completely intertwined with recent human creation and therefore concludes that the anthropologists have erred on a number of very consequential matters. Whether or not you accept Ross's scientific discussion is not really relevant to his biblical claims. One could easily imagine many different versions of scientific anthropology that would accord with Ross's perspective on the Bible and theology. To oversimplify then: Sparks concludes that the Bible is an unreliable witness to scientific matters, and Ross contends that the Bible is reliable on the very same questions. Consequently, their essays display a certain simplicity and therefore believability.

In contrast, the proposals of Craig and Loke depend on very complex reasoning about the biblical text and the scientific evidence. In some ways, the biblical proposals floated by these authors are very counterintuitive and sometimes convoluted. Loke admits that the Bible describes the Flood as global but that this is only hyperbole (p. 125). Craig claims that the fantastic elements of Genesis 1-11 cannot be believed as written but instead are indicators of myth, which does not mean that the message of Genesis 1-11 is false, even though false claims are elements needed to recognize myth in the first place. Craig's analysis of the science neglects indicators of humanity in taxa other than *H. sapiens*, Neandertals, and *H. heidelbergensis*. Loke's genealogical model requires you to think of Eve not as the mother of all living but merely the mother of PIGIs. As far as popular ideas go, I see these two models having very little longevity. Their complexity works against them. This is not to argue they are false *per se* but that people are unlikely to favor these ideas in the future.

From my perspective, one lingering question is whether one could advocate both inerrancy and human evolution while insisting that the precise details of the synthesis are currently unknown. I imagine here not of a multiverse of possible models, as Loke argues, but rather a simple insistence that no current model is adequate to answer all the questions. This would be the evolutionary mirror of my own position: That the Bible speaks truth about the detailed history of humanity even if we do not yet fully understand how the science could be consistent with this history. Perhaps here I might note that Craig's effort to distinguish assertorical from illustrative references might be one way to approach this problem of the compatibility of inerrancy and evolution.

Still, even if there were such a position, the larger theological problem of theodicy and the Fall strikes me as an insurmountable barrier to evolution. Ross emphasizes this in his chapter and his response to Sparks, and to his credit, Sparks concedes that he has "more theological work to do" (p. 65). I see multiple difficulties related to the problem of evil. First, natural selection operates by killing countless scores of creatures: The weak and weary and wounded are not loved and cared for, but ruthlessly eliminated in favor of creatures that possess attributes better suited to their environment. This is how evolution proceeds. The idea that God would use natural selection to create the diversity of life including humans and then admonish us to show mercy, turn the other cheek, and care for the suffering seems inconsistent and a frankly monstrous way of creating.

Second, moving beyond natural evil, where should we place the blame for human evil? As Ross points out in his article, evidence of interpersonal human violence is very old, certainly older than the Neolithic. Yet Paul in Romans and 1 Corinthians seems very firm that sin entered the world by Adam. If there are POGs, are they not sinning when they do the very same acts for which PIGIs would be condemned to death? Is this justice? Beyond even that peculiar model, within the evolutionary paradigm, early hominins surely lived in a world of violence, of "kill or be killed." Are we to understand that God created us by this violence but then demanded that we forsake our evolutionary impulses and love one another instead? Did God just set us up to fail?

Third, Paul links the death brought by Adam directly to Jesus' resurrection (1 Cor 15:20-22). In this way, Paul indicates that the death that Adam brought was physical death, since the resurrection of Christ was a physical resurrection. But in these evolutionary scenarios, not only is suffering and death the mechanism by which creation is accomplished, but for physical human death, it is not a consequence of sin. The most common explanation for this discrepancy is to argue that the threat of death in the Garden was a threat of spiritual death, estrangement from God. Yet the Bible speaks of Adam returning to dust, God banishes them from the Garden to prohibit eating the fruit of life and living forever, and Paul connects Adam's death directly to Christ's resurrection. And if Christ be not raised, our faith is in vain.

In my view, this book accomplishes a service primarily by showing us the weakness of the models in the middle. Not only do Craig's and Loke's models suffer from specific weaknesses, but they face profound difficulties reconciling the classical Christian God of mercy and love with the brutal God of natural selection and with explaining the origin of human death by sin. Sparks's model *appears* attractive, yet the price is too high. In his model, we reject a major doctrine with broad biblical support. If we identify the "real truth" of the Bible in repeated claims from the Old and New Testaments, then why would we dispense with the repeated affirmations of the truth and reliability of biblical claims? And if we do not identify the "real truth" of the Bible from repeated claims with broad biblical support, what then is Christian theology at all? The best solution to bring together Christianity and anthropology, as scientifically unlikely as it may seem to some, is a version of Ross's model, a model that offers "a robust path forward" (p. 150).

Regarding Keathley's third assigned question, the implications of these models for Christian ministry, one cannot help but notice the similarity in the three responses given. They are primarily concerned with spreading the gospel and Christian testimony. Sparks, Loke, and Ross tell us that by avoiding wrong beliefs and presenting a rationally sensible gospel message, we can convert nonbelievers. These are unquestionably valid concerns, yet surely the ministry of Christ extends beyond this. Becoming like Christ begins at salvation. It is followed by a lifetime of sanctification and discipleship and culminates in eschatological glorification in Jesus' presence. In what way then does the quest for the historical Adam help us love God or neighbor? How do these disagreements make us more like Jesus? These are questions I have wrestled with myself, as I recognize failures earlier in my career that were very unchristian indeed. Over the past decade, I have found that unexpected relationships with Darrel Falk and others who are ideologically opposed to young-age creationism have sharpened and changed me. Through this crucible of a relationship divided by such differences but united by the Holy Spirit, I have indeed become more like Jesus. Not that I have attained, of course. I still struggle with my own sinfulness, but I have found that remaining isolated in an echo chamber degrades my Christian character and derails my discipleship. By engaging deeply with intellectual opponents, I am constantly challenged to consider what it means to follow Jesus. For me, Keathley's third question is the most important of all. If disputing the details of fossils, genes, or texts does not make us more like Jesus, we need to bring those activities back under the lordship of Christ. If we cannot glorify God or disciple one another with our doctrinal and scientific obsessions, perhaps we should reconsider our priorities.

Notes

[1] Isaac de la Peyrère, *A Theological Systeme upon That Presvpposition, That Men Were before Adam* (London, 1655).

[2] William Lane Craig, *In Quest of the Historical Adam: A Biblical and Scientific Exploration* (Grand Rapids, Michigan: William B. Eerdmans Publishing Company, 2021).

[3] Sally Mcbrearty and Alison S. Brooks, "The Revolution That Wasn't: A New Interpretation of the Origin of Modern Human Behavior," *Journal of Human Evolution* 39, no. 5 (November 1, 2000): 453–563, https://doi.org/10.1006/jhev.2000.0435.

[4] S. Joshua Swamidass, *The Genealogical Adam & Eve: The Surprising Science of Universal Ancestry* (Downers Grove, Illinois: IVP Acdemic, 2019).

[5] Augustine, *Epistula* 82.3.

[6] Hartmut Thieme, "Lower Palaeolithic Hunting Spears from Germany," *Nature* 385, no. 6619 (February 1997): 807–10, https://doi.org/10.1038/385807a0; Jacques Jaubert et al., "Early Neanderthal Constructions Deep in Bruniquel Cave in Southwestern France," *Nature* 534, no. 7605 (June 2016): 111–14, https://doi.org/10.1038/nature18291.

[7] George McCready Price, *The Predicament of Evolution* (Nashville, Tennessee: Southern Publishing Association, 1925), 61.

[8] C. K. Brain and A. Sillent, "Evidence from the Swartkrans Cave for the Earliest Use of Fire," *Nature* 336, no. 6198 (December 1988): 464–66, https://doi.org/10.1038/336464a0.

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[10] Naama Goren-Inbar et al., "Evidence of Hominin Control of Fire at Gesher Benot Ya`aqov, Israel," *Science* 304, no. 5671 (April 30, 2004): 725–27, https://doi.org/10.1126/science.1095443.

[11] Irit Zohar et al., "Evidence for the Cooking of Fish 780,000 Years Ago at Gesher Benot Ya'aqov, Israel," *Nature Ecology & Evolution* 6, no. 12 (December 2022): 2016–28, https://doi.org/10.1038/s41559-022-01910-z.impacting various biological and social aspects, when intentional cooking first began remains unknown. The early Middle Pleistocene site of Gesher Benot Ya'aqov, Israel (marine isotope stages 18–20; ~0.78 million years ago

[12] V.A. Zhukov, *The Results of Research of the Stone Age Sites in the Island of Socotra (Yemen) in 2008-2012* (Moscow: Triada, 2014).

[13] Joseph T. Chang, "Recent Common Ancestors of All Present-Day Individuals," *Advances in Applied Probability* 31, no. 4 (December 1999): 1002–26, https://doi.org/10.1239/aap/1029955256.

[14] Douglas L. T. Rohde, Steve Olson, and Joseph T. Chang, "Modelling the Recent Common Ancestry of All Living Humans," *Nature* 431, no. 7008 (September 2004): 562–66, https://doi.org/10.1038/nature02842.

NEW CREATION STUDIES

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Examining Biostratigraphic Correlation to Post-Flood Survival Bias within Upper Cenozoic Flood Models

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Biostratigraphy provides a scientifically rational, and biblically consistent, method for evaluating post-Flood dispersal and diversification in the natural world (1). Biostratigraphic evaluations of Flood Models have provided strong evidence against Flood/post-Flood boundaries placed in the Upper Cenozoic (2-6). With some variations, Upper Cenozoic Flood Models (UCFM) place the boundary at the Pliocene-Pleistocene boundary.

While most Flood models understand that the Created Kind equates to a minimum of the family taxon (and potentially multi-familial baraminic lineages), the taxonomic boundaries of the Ark Kind depend upon placement of the Flood/post-Flood boundary. Within UCFMs, the Ark Kind is maximally constrained at the genus. There are too many genera within the same families crossing the Plio-Pleistocene boundary (Arment (7) in response to Lightner (8)).

Within a Lower Cenozoic Flood Model (LCFM), genera presence in Cenozoic strata would primarily be interpreted as patterns of dispersal and diversification over time. Within UCFMs, genera presence in strata below the Plio-Pleistocene boundary would be interpreted as existence at the time of the Flood. One biostratigraphic anomaly that has yet to be examined for UCFMs, is increased presence of boundary-crossing genera in highest 'Flood' strata.

Terrestrial mammals (totaling 5,586 genera) were charted for presence across Cenozoic epochs. 640 genera (11.5% of total genera) crossed the Plio-Pleistocene boundary. 476 genera were present in Paleocene deposits, with 0 genera crossing the Plio-Pleistocene boundary. 1,457 genera were present in Eocene deposits, with 5 genera (0.3%) crossing the boundary. 1,004 genera were present in Oligocene deposits, with 26 (2.6%) crossing the boundary. 1,965 genera were present in Miocene deposits, with 338 (17.2%) crossing the boundary. 974 genera were present in Pliocene deposits, with 586 (60.2%) crossing the boundary. Of 640 total boundary crossers, 0% had Paleocene presence, 0.8% had Eocene presence, 4.1% had Oligocene presence, 52.8% had Miocene presence, and 91.6% had Pliocene presence.

On a familial level, out of 463 Cenozoic terrestrial mammal families (all of which, assuming pre-Quaternary presence, would be represented on the Ark within UCFMs), only 172 (37%) have been found above the Plio-Pleistocene boundary. This broad survey of Cenozoic biostratigraphy also lends support for previous research (5,7), as 78 families (45% of those with a Quaternary presence) include multiple genera crossing the Plio-Pleistocene boundary.

The heavy bias towards Miocene-Pliocene presence of boundary-crossing genera is a peculiar problem for those who advocate for UCFMs. All Cenozoic genera should have been present on the Ark. Why would genera found in lower Cenozoic strata be at such a disadvantage surviving the post-Flood landscape? There is no conceivable reason why strata position should offer Ark Kinds any advantageous bias. Rather, these patterns support LCFMs, where baraminic lineages disperse and diversify over time after the Flood. Families and genera that best survived the environmental changes stabilized closer to the Ice Age. Future research should examine bird and terrestrial reptile genera within the Cenozoic to see how they compare to mammal presence.

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A Preliminary Analysis of Lungless Salamander Baraminology (Caudata: Plethodontidae)

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Members of the lungless salamander family (Caudata: Plethodontidae), currently composed of over 500 species in 29 genera, nine tribes, and two subfamilies (1), have been grouped together for almost 200 years. This consistent taxonomic history suggests they form a distinct cognitum and quite possibly an apobaramin. Despite their abundance and diversity, no formal baraminological analyses have been conducted for this family (see Wood (2)). Hennigan (3), however, tentatively defaulted to the genus level for lungless salamander kinds and suggested future research would probably lump them into larger taxonomic groupings. We utilized taxonomic, hybridization, morphological, and molecular data to estimate the number and identity of lungless salamander kinds. A survey of published literature (4-6) suggests that most lungless salamanders share a considerable number of characteristics, several of which are unique to the family. This combination of shared and unique characteristics suggests the family may represent a holobaramin. An investigation of consistent taxonomic groupings over the past 60 years (7-9) identifies seven monobaramins ranging from supergenus to tribe or subfamily level. Records of interspecific hybridization from eight of the 29 recognized genera (10), combined with genetic distance data, reveal eight monobaramins at the genus level ranging in size from 2-23 species. Three monobaramins are evident in DCA, MDS, PAM, and FANNY analyses (11-12) of 30 tongue morphology characters across eight lungless salamander feeding modes/groupings (13): 1) Tribes Plethodontini + Aneidini + Ensatinini + Desmognathini (Subfamily Plethodontinae minus Hydromantini); 2) Tribes Spelerpini + Hemidactyliini; 3) Tribes Bolitoglossini + Hydromantini + Batrachosepini. The [Bolitoglossini + Hydromantini + Batrachosepini] monobaramin is also discontinuous with the [Plethodontini + Aneidini + Ensatinini + Desmognathini] monobaramin in several DCA analyses, indicating these may be separate holobaramins. Analyses of DNA sequences, from two mitochondrial (CYTB, ND4) and one nuclear gene (RAG-1), suggest the presence of five lungless salamander monobaramins that further cluster into two subfamily groupings: 1) Tribe Hemidactyliini; 2) Tribe Spelerpini; 3) Tribe Batrachosepini; 4) Tribe Bolitoglossini; and 5) all five tribes in Subfamily Plethodontinae. Molecular analyses, however, also indicate that these monobaramins cluster into one large family group, separate from all outgroups, and may represent a holobaramin. These DNA sequences, from 50 lungless salamander and outgroup taxa, were gathered from GenBank (**www.ncbi.nlm.nih.gov/genbank**) and aligned using ClustalW in MEGA (**www.megasoftware.net**). Corrected distance matrices for each of these genes, plus a concatenated sequence of all genes combined, were created with the TN93 + Gamma model in R (**www.r-project.org**) and analyzed using hierarchical clustering, MDS, and DCA in R (14-15) and BARCLAY (11-12). Future research may include additional morphological and molecular analyses as well as investigations of fossils, biogeography, and biblical passages related to potential Flood/post-Flood dispersal mechanisms.

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Western Harvester Ant (*Pogonomyrmex* sp.) Disks and Middens Display Designs to Control Nest Temperature, Trap Seeds and Promote Plant Growth, Participating in the Formation of Islands of Fertility in the High Desert

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Western Harvester Ants are known as agricultural pests because they denude vast areas of ranch land by sequestering and consuming seeds. In contrast recent studies show that harvester ants can promote rigorous growth of plants on the edge of their nest creating islands of fertility **(1)**. We predict from a creationist perspective that ants would perform beneficial functions in nature even in a post-Fall environment.

In that light, we note in this study that the construction of the interior surface of the nest promotes trapping and collection of seeds not carried into the subterranean nest galleries. These seeds can germinate under certain conditions also promoting plant growth and acting as a seed reservoir. We predict that this reservoir may be important to re-establishing grasslands and chaparral in the fire-prone high desert of the western United States **(1)**.

Two Western Harvester Ant (*Pogonomyrmex* sp.) nests were observed from June 2023 through May 2024. The entire surface of the Western harvester Ant nest is described as a "disk" typically devoid of plants and mostly composed of small pebbles (1-6mm diameter) that appear to be carefully placed by worker ants (personal observation consistent with Uhey and Hoffstetter **(1)**). Both nests were constructed in the central California high desert at 5100 ft and were established on a slightly down-sloping grade facing southwest on the edge of a dirt highway access road (near the Los Padres National Forest). One nest was roughly 2.5 meters in diameter and the other was 0.5 meters in diameter. Small plants were mostly removed by ants from the disk of the larger nest before winter.

Because temperatures can be above 30o C in the high desert during summer months we noted variations in the nest pebble surface temperatures. We detected temperatures as high as 32o C on the nest surface but the nest opening was typically below 21o C even if it was only a few centimeters away from the warmer temperatures.

We also observed that when the ants closed up the main entrance during winter (Dec 15- Jan 30) that they also placed seed or plant refuge near the opening so the area became a waste-dump or midden **(2)**. Why Harvester Ants place plant material in the midden is not known. We also noted that many seeds and small flower heads were trapped in the pebble surface rubble near the pre-winter main entrance (midden) for both nests. In contrast, the sandy area outside of the nest disk was mostly devoid of plant seeds most likely because of the high winds and heavy rains that occur during the winter months.

We also observed that the ants created new nest entrance openings 5-20 cm away from the original opening in both nests just before the winter closure. After the winter closure the ants reopened one of the summer openings in the larger nest. In the smaller nest two completely new openings were made, roughly 10 cm away from the summer main opening. In both nests seeds had germinated in the midden area with a density of 2 plants/cm in the larger nest. New plants also grew sporadically in other areas on the disk. All newly opened entrances were 5-20 cm away from the highest density of new plant growth.

Our data suggest that the interior of the nest including the middens, not simply the edge of the disk, is a place for plant growth. Even though the plant leaves on the disk are eventually excised by the ants under warm weather conditions, we speculate that the interior of the nest could be an important place for plant growth after a fire event since the pebble surface could also act as a heat shield and seed trap. We believe this represents a new finding as previous studies mentioned only the outside edge of the disk as being a place of new plant growth (1). This would also be consistent with a created design feature beneficial to restoration of plant life in high desert ecosystems.

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Using Biology to Construct an Interpretive Model of History that Informs Young-earth Research and Supports Baraminology

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History, philosophy, and life sciences are all intimately related. Any evaluation of an idea is incomplete without considering its scientific merit, philosophical implications, and history. If young-earth creationism is going to hold its ground in today's academic landscape, it must be historically and philosophically sound. Neo-Darwinists have already discussed the historical merits of evolution (1), while the Intelligent Design movement has discussed history from an "ID perspective" as well (2). With biology as a primary focus, this paper will offer a comprehensive interpretive model of the history of science that will inform and complement young-earth creation research.

Our evaluation of the history of science will begin with the Greeks, though traces of science such as astronomy and mathematics existed earlier. Before the scientific revolution of the 17th century, Greek philosophy dominated thought. The leading "model" for biology was Aristotle's "Chain of Being," which was not a scientific model but a metaphysical explanation of life, and man's place within it. Aristotle organized all species into a ladder, with God, angels, and man at the top and the "lower" organisms at the bottom. The chain of being was somewhat empirical but not scientific; it offered no data or predictions. In many ways, the Chain of Being reflected how the Greeks understood the natural world. There was no systematic study of nature, no scientific model-building, or predictions being tested in the field. For these reasons and others, the Greeks are not considered the founders of modern science (3). Historians generally bestow this honor to the Medieval Europeans, who devised the scientific method in the wake of Copernicus' discovery of the heliocentric solar system (1).

Once the scientific revolution began, biology shifted. Instead of organizing life based on metaphysical worth, Carl Linnaeus proposed a systematic approach to classifying life based on morphology. Once again, the treatment of biology reflects a change in philosophy. Instead of focusing on metaphysical being like the Greeks, the European "natural philosophers" studied nature systematically, using empirical observation rather than philosophical assumptions. The motivation for this change is Medieval Christianity, which incentivized the study of nature in the pursuit of knowing the Creator. The early scientists were creationists who considered Scripture a motivation to do science. This would change with the second shift in thought, which is, once again, most noticeable in the realm of biology.

In the 19th Century, Darwin's theory of evolution by natural selection altered how people understood life. Contrary to Aristotle and Linnaeus, Darwin organized species into a "Tree of Life" which linked all organisms based on biological relationships rather than metaphysics or morphology (4). The shift to evolutionary trees is once again evidence of a philosophical change. Darwin led the way in abandoning special creation, instead believing that descent with modification is the explanation of diversity. This brings us to today's scientific landscape, which holds to a family tree as the best understanding of biology.

Dividing history into phases is more complicated and messier than our generalizations make it seem. Nevertheless, breaking history into the pre-scientific era, the scientific revolution, and the Darwinian revolution accurately reflects ideological trends throughout history. As a result, his model should inform the direction of young-earth creationism, especially in the area of biology. Baraminology, the study of created kinds, inherits the strengths of each stage in the history of biology. It takes into account the Aristotelian belief in the uniqueness of man, Linnaeus' morphological and systematic approach, and Darwin's evolutionary tree. A historian could even consider baraminology as a fourth phase, one that is not a ladder or a tree but an "orchard" **(5)**. Therefore, this three-phase model is not only historically sound, but it also endorses Baraminology as a scientific practice.

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A Preliminary Baraminological and Biostratigraphic Analysis of Giraffoidea

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Previous creationist studies have not reached a consensus on the continuity of Ruminantia **(1-2)**. This study utilized BARCLAY **(3)** to analyze two phylogenetic datasets of ruminants, focusing on giraffoids. Giraffoidea encompasses three families: Climacoceratidae, Giraffidae, and Prolibytheriidae.

The Wang et al. **(4)** dataset contains 45 ruminant taxa and 110 characters. These taxa represent the major groups within Pecora. Baraminic distance correlation graphs (0 relevance cutoff, Pearson correlation) reveal three clusters. The first contains bovids, moschids, and antilocaprids. The second cluster includes all giraffoids. The third contains blastomerycids, cervoids, Hoplitomeryx, and the palaeomerycids. The canthumerycids correlate positively with taxa in the second and third clusters. PAM silhouette plots yielded their highest average silhouette width (0.32) at three groups. FANNY silhouette plots reached a highest average silhouette width (0.29) at two groups. This analysis of the Wang et al.(4) data provides evidence of possible discontinuity surrounding Giraffoidea. A 3D MDS coordinate kinemage of just the giraffoids produces a “y” shape. The taxa fall along this shape in a manner predicted by both their first fossil appearance data and phylogenetic position.

The Ríos, Sánchez, and Morale **(5)** dataset has 25 giraffid taxa, 3 climacoceratid taxa, 3 outgroup taxa, and 111 characters. Baraminic distance correlation graphs (0 relevance cutoff, Pearson correlation) show that most giraffids correlate negatively with outgroup taxa. The average silhouette width of PAM silhouette plots peaks at 0.45 for two groups. FANNY silhouette plots had the highest average silhouette width (0.27) at two groups. A 3D MDS coordinate kinemage yields a trajectory in which taxa roughly appeared where expected given their phylogenetic and stratigraphic position. This could be evidence of a stratomorphic series within Giraffidae.

The Paleobiology Database **(6)** was used to obtain the genus name, coordinates, and radiometric age of fossil giraffoid taxa. They were plotted on a map using ArcGIS Pro **(7)** according to the geological stage in which they occur. This data indicates that giraffoids first appeared throughout Africa, the Middle East, Europe, and East Asia in the lower Miocene. The order of first appearance of giraffoid genera corroborated the series in the 3D MDS coordinates kinemages.

The possible discontinuity of giraffoids with other ruminants suggests that this group may be an apobaramin. The statistical evidence for internal continuity is somewhat conflicting, but the presence of a possible stratomorphic series supports the conclusion that they are continuous. Larger datasets that compare more of the giraffids to the prolibytherids may prove useful in defining these groups. These findings suggest that there may be multiple created kinds within Ruminantia. It remains unclear why giraffoids are not found earlier than the Miocene. We tentatively suggest that the sudden appearance of giraffoids could be related to the expansion of C4 grasslands.

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Citation Ryan C, Brummel P. A Preliminary Baraminological and Biostratigraphic Analysis of Giraffoidea. New Creation Studies. 2025 Jul;1(1):86-87.

Preliminary Analysis of Plesiosaur Baraminology

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Plesiosaurs are an extinct group of Mesozoic marine reptiles belonging to the group Sauropterygia. The recognizable body plans represented in Plesiosauria vary between long and short necks and skulls, but each has four equally sized flippers and a short tail. Although there are discernable groups of plesiosaurs (i.e., Rhomaleosauridae, Pliosauridae, Elasmosauridae, etc.), there is debate over how these groups are related phylogenetically and taxonomically (e.g., O'Keefe **(1)**). Even less is known about the relationships of taxa within Plesiosauria from a creationist viewpoint. We know of only one previous study that considered sauropterygians **(2)**, and its focus was not plesiosaurs. Thus, we conducted a baraminological analysis of plesiosaur data sets to provide a preliminary estimate of the number of created kinds within this group.

Two plesiosaur data sets **(3-4)** were selected for analysis with BARCLAY **(5)**. A character relevance cutoff of 0.75 was chosen for both data sets. From the first data set **(3)**, 28 taxa and 59 characters from the original 32 taxa and 207 characters were used in the analysis. From the second data set **(4)**, 27 taxa and 47 characters were used in BARCLAY from the original 35 taxa and 240 characters. The data sets were analyzed with Pearson and Spearman baraminic distance correlation (BDC), 3D multidimensional scaling (MDS), partition around medoids (PAM) and fuzzy analysis (FANNY).

The Pearson and Spearman correlation coefficients from the first data set yielded nearly identical results, indicating that outgroup taxa were distinct from the plesiosaurs. Plesiosauria itself formed two connected clusters with positive correlations (one cluster containing Rhomaleosauridae and another containing the rest of the plesiosaurs). The 3D MDS results showed a similar pattern with the outgroup taxa. PAM results had the highest average silhouette value at five groups (0.35), whereas FANNY was highest at two groups (0.25). The five PAM groups correlate to: 1) Non-plesiosaur outgroup, 2) Rhomaleosauridae, 3) various plesiosauroids, 4) Microcleididae + *Seeleyosaurus*, and 5) *Hauffiosaurus*.

The second data set focused on rhomaleosaurids, but also included pliosaurid taxa. Here, the Pearson and Spearman BDC results consisted of three main blocks of taxa: 1) outgroup taxa, 2) Pliosauridae, and 3) Rhomaleosauridae + *Hauffiosaurus*. These blocks shared little to no positive correlation between them in the Pearson BDC, whereas the Spearman BDC revealed additional examples of shared positive correlation. The 3D MDS results showed the same three main clusters. The highest PAM average silhouette width was 0.31 at five groups: 1) Non-plesiosaur outgroup, 2) Rhomaleosauridae + some pliosaurids, 3) More rhomaleosaurids + *Nothosaurus* (with a negative silhouette value), 4) *Hauffiosaurus*, and 5) Pliosauridae. The highest FANNY average silhouette value was 0.24 at three groups: 1) Pliosauridae, 2) Outgroup + some rhomaleosaurids, 3) *Hauffiosaurus* + *Thalassiodracon* + some rhomaleosaurids.

Even though the two data sets did not contain identical taxa, there was some consistency as to which groups were separated. There are clear distinctions between the non-plesiosaur outgroups and the plesiosaurs, and most results indicated rhomaleosaurids as separate from other plesiosaur taxa. One exception is that the Sachs et al. (4) data set separated the rhomaleosaurids into two different groups along with some other taxa in the PAM and FANNY analyses. The Sachs et al.(4) results also suggest pliosaurids cluster together, separate from other plesiosaurs. We recognize strong evidence for discontinuity separating Plesiosauria from non-plesiosaurs, and for continuity within both Pliosauridae and Rhomaleosauridae, as well as evidence for discontinuity surrounding each group. Therefore, we propose that Pliosauridae and Rhomaleosauridae might both be holobaramins. *Hauffiosaurus* and *Thalassiodracon* may or may not be continuous with Rhomaleosauridae. These results suggest that there are possibly other plesiosaur holobaramins, but discovering them requires future analyses containing more plesiosaur taxa from Plesiosauroidea.

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Creation Geology Society Annual Conference Abstracts 2024

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Tracking the Trends: Analysis of Over 100 Radiocarbon Measurements in 'Ancient' Fossil Material

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For decades, radiocarbon dating has posed a growing problem to the naturalistic geological timescale. A growing number of endogenous radiocarbon measurements are being documented from dozens of geological samples dated to be far too old for any endogenous C-14 to remain. With the use of accelerated mass spectrometry, dozens of measurements have identified measurable radiocarbon in most forms of fossil material throughout the Phanerozoic. Several studies **(1-2)** have included research components dedicated entirely towards documentation of radiocarbon in samples throughout the Phanerozoic, yet few studies have analyzed this growing dataset in its entirety. Indeed, Giem **(3)** and Baumgardner **(1)** together cite 90 individual radiocarbon ages for 'ancient' geologic samples, yet in most instances these involved non-fossil material such as abiotic calcite spars. As such, the most complete radiocarbon analysis of ancient fossil material was presented by Thomas and Nelson **(2)**, who reported 43 fossil samples with corresponding radiocarbon dates. From these studies, some researchers have speculated on the development of a radiocarbon calibration curve to reinterpret radiocarbon ages to the Biblical Timeline. To test this idea, this study compiled over 100 published radiocarbon measurements from 'ancient' fossil material and evaluated the potential for a future radiocarbon calibration curve. We find that, instead of radiocarbon measurements correlating with geologic age, radiocarbon measurements cluster into specific populations based on the dated fossil material. For instance, petrified wood routinely measures higher radiocarbon values than those in coal regardless of geologic age, while fossilized bone can date even higher values of radiocarbon than those found in petrified wood. Past observations have noted that the same fossil bone may yield multiple radiocarbon values based on the material being tested (e.g. Dahmer et al. **(4)**), which we find from our analysis to vary predictably, with more porous fossil bone commonly yielding higher radiocarbon values than those portions that are less porous. In like manner, the content of uranium found in samples seem to positively correlate with radiocarbon. Samples dating below 20 ka come from sites with uranium content reaching as high as 800 ppm, while coal, averaging C-14 dates of 50 ka, commonly contain only 3-4 ppm. This aligns well with the idea that the decay of U-238 may influence the generation of radiocarbon, thereby creating a measurable radiocarbon signature based on the ability of the sample material to absorb uranium. As such, we suggest that the influence of fossil material and the potential correlation between radiocarbon and uranium must be evaluated before the question of a radiocarbon calibration curve can be addressed.

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A Reassessment of the Timing of Terrestrial Tetrapod Extinction and the Period of Worldwide Submergence During the Flood

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The Period of Worldwide Submergence (PWS) (1) is described in the Flood narrative as a phase where all high mountains were submerged under at least 15 cubits (~7 meters) of water (Genesis 7:21). This period is typically thought to have occurred between Day 40 and Day 150 of the Flood year, coinciding with the demise of the last terrestrial tetrapods not aboard the Ark (2-3). However, the presence of ichnofossils, such as footprints and nests, left by terrestrial vertebrates presents a challenge to this timeline.

Assuming a lower Cenozoic end of the Flood in North America, PWS correlates with sedimentary deposits from the Upper Cretaceous sea level peak (4). The uppermost Cretaceous deposits, a mosaic of marine and terrestrial sedimentation, have been interpreted as the result of late-Flood recession (5). Difficulty for this model arises from the occurrence of terrestrial ichnofossils overlying those formed during PWS (1).

To address this, the author suggests that Day 150 only marks the end of the prevailing Flood phase, not the extinction of the last terrestrial tetrapods. Flood chronologies that place their death prior to Day 150 assume a strictly chronological Flood narrative. But this perspective poses other challenges. For example, it requires that no terrestrial tetrapod could have died prior to Day 40 because their death is not mentioned until after this point in the text (Genesis 7:17, 21). However, recent Comparative Semitics studies propose that much of Genesis 6-9 is thematically rather than strictly chronologically structured in order to emphasize certain theological points (6-7).

This view allows for the survival of some terrestrial tetrapods during PWS, possibly by swimming or floating on vegetation rafts, enabling them to form ichnofossils until they ultimately perished by the time the Ark was vacated. Additional study is necessary to confirm the validity of this model in alignment with the Biblical text, the plausibility of terrestrial tetrapod survival through PWS, and what factors led to their extinction as the

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Is the Paleolithic a True Historical Period?

Developing a Database of Archaeological Sites from the Ancient Near East

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Correlating stratigraphic units in archaeology proves difficult because of regional variation in technocultural development and extremely localized depositional environments. For young-age creationists, a uniquely chronological dimension also challenges our interpretation of the putatively "earliest" stages of archaeology. For example, the roughly 2.5 million radiometric years of the Paleolithic could represent only a few centuries of post-Flood time. Since some patriarchs of the period lived longer than a few centuries, we face the real possibility that the Paleolithic, Mesolithic, Neolithic, and Bronze Age are all approximately contemporaneous and do not record generational development. To further explore this possibility, we need to discern whether there exists a widespread stratigraphic relationship of "stone age" remains occurring in layers overlain by Bronze or Iron Age or whether the chronological "sequence" is largely established from radiometric dating of geographically separated sites. This can only be determined in a geographic context where sites with Paleolithic, Mesolithic, Neolithic, Bronze Age, and Iron Age remains can co-occur and preferably where the chronology can be related to an explicitly biblical framework. We chose to search for sites in southwest Asia (the Levant, Arabian peninsula, Anatolia, and the Caucasus), and northeast Africa (Egypt), where sites have been excavated for decades and copious documentation is available. We are compiling a list of known Paleolithic sites in the region using internet databases and published reviews. The list currently contains 547 sites from seventeen different countries. Most frequent countries in the list are Jordan (101 sites, 18.5%), Israel (89 sites, 16.3%), Iran (85 sites, 15.5%), and Georgia (56 sites, 10.2%), which collectively account for 60.5% of the sites. We are currently classifying the sites as either surface discoveries or excavations, with "excavation" defined as digging at least one test pit. Presently, 467 sites have been classified, with 320 excavated sites (68.5%) and 147 surface discoveries (31.5%). Thus, nearly a third of reported Paleolithic sites represent isolated surface discoveries rather than remains that can be secured to a stratigraphic sequence. Anecdotally, we noted a few sites that do preserve a sequence of Paleolithic or Neolithic under Bronze or Iron Age remains. Such sites include Ubeidiya (Israel), Umm el Tlel (Syria), and Pella (Jordan). A systematic assessment of the stratigraphic sequences of the excavated sites will be necessary to determine if the Paleolithic is best depicted as a stage of history of a regional cultural variation.

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