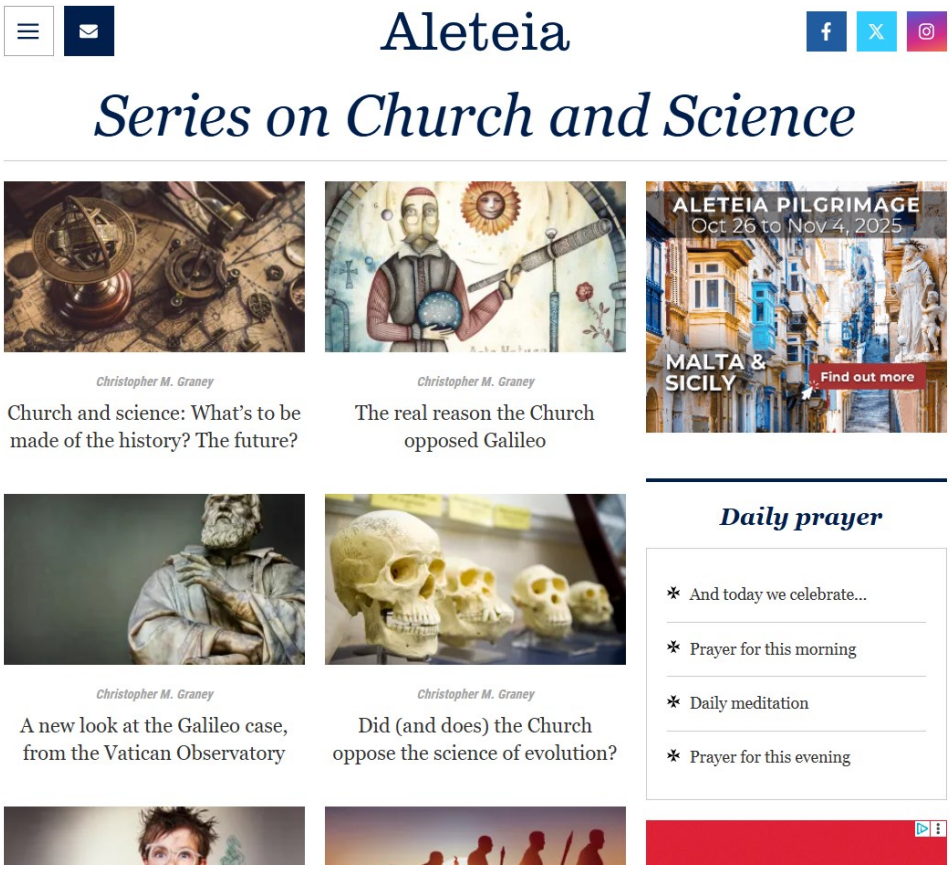

https://aleteia.org/tag/church-and-science

This PDF is a compilation of the "Series on Church and Science" by Christopher M. Graney of the Vatican Observatory and Vatican Observatory Foundation, published by *Aleteia* between November 12, 2024 and February 17, 2025. It has been lightly edited, mainly to remove references to links, and to include some additional figure captions.

> *Aleteia (aleteia.org) is an online publication distributed in five languages (English, French, Spanish, Polish and Slovenian). Since its launch in 2013, it has become one of the world's leading news websites. The Aleteia site offers a Christian vision of the world by providing general and religious content that is free from ideological influences.*
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> *With more than 600,000 subscribers to our newsletter and more than 3.3 million fans on Facebook, Aleteia reaches more than 10 million readers per month.*
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> *Aleteia was created in 2013 in Rome, independently from the Catholic Church but with the support of several of its structures, with the aim of promoting the presence of a Christian point of view in the media landscape for the world's one and a half billion Catholics….*
>
> — *https://aleteia.org/about-us (March 3, 2025)*

Introduction for all articles in the series:

Science is central to modern life. It is because of science that you are reading *Aleteia* on a screen, via the internet, not on paper, by the light of an oil lamp. This series of articles dives deep into the story of the Catholic Church and science. The story goes back a long way. It is still unfolding today. It is not the story you might think you know. But it is a story you *should* know, exactly because science is so central to modern life.

This series is based on the paper "The Vatican and the Fallibility of Science," presented by Christopher M. Graney at the "Unity & Disunity in Science" conference at the University of Notre Dame, April 4-6, 2024. The paper, which is available through ArXiv (https://arxiv.org/abs/2403.05516), contains details and references for the interested reader.

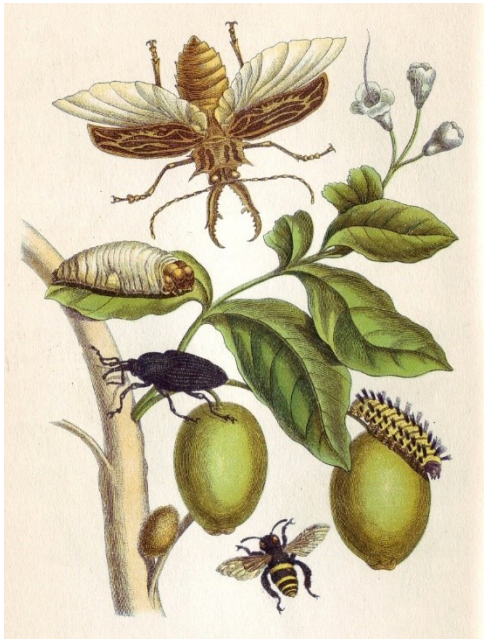
The paper, and this *Aleteia* series, expands on ideas developed by Graney and Vatican Observatory Director Br. Guy Consolmagno, S.J. in their 2023 book, published by Paulist Press, When Science Goes Wrong: The Desire and Search for Truth (click here).

Part 1
Catholic Church and Science: St. Augustine and great lights

With the Vatican Observatory, Aleteia bring you a series on how the Catholic Church relates to science, from the beginnings to today. Here is Part 1.

The story of the Catholic Church and science is usually not one of conflict. The history of science is full of deeply religious scientists who see their work more or less as described in the Catechism of the Catholic Church (CCC 159): "the humble and persevering investigator of the secrets of nature ... being led, as it were, by the hand of God … for it is God, the conserver of all things, who made them what they are." Nevertheless, the points of conflict between science and religion have become famous. Stories of conflict draw our attention. For that reason, this booklet will focus on the conflict stories.

So, when did the Church first find itself faced with a faith-science conflict? The answer to that question is, *a long time ago!* Conflict sprang up between the results of science and the words of Scripture even before the Council of Nicaea in 325 A.D.—even before the Church had formulated essential doctrines on the Trinity and the person of Jesus.



Maria Sibylla Merian is an example of a scientist whose attitude was that of an investigator of the works of the hand of God. Part of one of Merian's hymns of praise:

> ***Lord, of everything Creator,***
> ***all the wonders Thou has wrought,***
> ***in Thy wisdom, I will sing them,***
> ***works that beggar human thought...***

Merian's work is particularly spectacular, as seen in this illustration from her 1705 *Metamorphosis Insectorum Surinamensium*. However, many other scientists across history, from the physicist Isaac Newton to the pioneering microscopist Anthony van Leeuwenhoek, described their work in broadly similar terms. The astronomer Johannes Kepler, like Merian, included hymns of praise to God in his works. Image credit: Wikimedia Commons.

Genesis 1:16 describes the creation of the sun, moon, and stars: "God made the two great lights, the greater one to govern the day, and the lesser one to govern the night, and the stars." What does "great" mean here? If we are thinking of the sky as a simple dome, with these lights on its surface, then "greatness" is merely a matter of sight. The sun, moon, and stars should all be the same distance from Earth; therefore, their relative physical sizes should be simply what appears to the eye. The sun and moon should indeed be "greater"

than the stars, in terms of actual physical bulk as well as in terms of appearance and power of illumination.

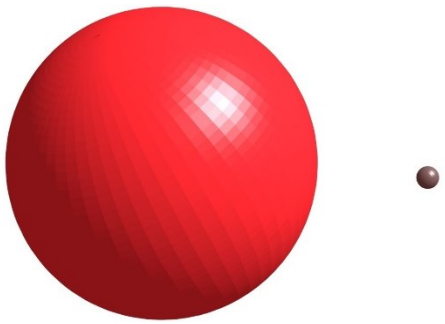
However, careful study of the sky reveals it not to be lights on a dome. The astronomer Ptolemy, of Alexandria in Egypt, worked around 150 A.D. His life overlapped with the lives of people such as St. Polycarp and St. Irenaeus. Ptolemy discussed in his book *Almagest* how the appearance of the stars does not depend on the place on Earth from which they are observed. That means that the size of the Earth is as nothing—it is like a point, he said—compared to the distance to the stars. The stars of Taurus the Bull, for example, look no different when observed from Alexandria than when observed from places much further north or south. That is not true for the moon, meaning that Earth is not merely a point compared to the distance to the moon. The moon must be much closer than the stars.

The moon passing through the stars of Taurus (including the prominent star Aldebaran) in September of 139 A.D., as seen from (left to right), Alexandria in Egypt, central Africa, and northern Europe. The moon's position is slightly different as seen at the same moment in time from each place, showing that the size of the Earth matters in regard to our view of the moon. The appearance of the stars, however, is unchanged in all three, showing that the size of the Earth is as nothing as regards the stars. This simulation, made with the *Stellarium* computer app, shows the stars as having similar apparent sizes (compared to the moon) to what the astronomer Ptolemy measured, or to what anyone with keen eyes (20/20 vision) and experience would see them to be.

Ptolemy's science was persuasive. Anyone who travelled and had good eyesight could confirm what he said. Thus, despite the contradiction between the words of Genesis and the calculations of Ptolemy, St. Severinus Boethius, for example, would cite Ptolemy by name in his *On the Consolation of Philosophy* of 523 A.D. and write,

> *You have learned from astronomy, that this globe of earth is but as a point, in respect to the vast extent of the heavens; that is, the immensity of the celestial sphere is such that ours, when compared with it, is as nothing, and vanishes.*

Ptolemy measured the apparent sizes of stars. Observers everywhere, and over centuries, agreed with his measurements. The vast distance to the stars meant that they actually had to be very large in order to appear even as small as they do. Ptolemy determined the most prominent stars (like Aldebaran in Taurus) to be more than four times the diameter of Earth, while the moon was less than one third of Earth's diameter. A prominent star was therefore far "greater" than the moon.



The size of a star (left) compared to the moon (right) as determined by Ptolemy. Today we know that stars are even larger than this, compared to the moon.

Indeed, every visible star in the night sky would be greater than the moon. Anyone with good eyesight who cared to look could at least approximately confirm Ptolemy's measurements. The stars might *appear* small, but the moon *was* small. The moon was arguably not a "great light"—contrary to Genesis.

How did the Church handle this conflict between Scripture and science?

St. Augustine discussed the matter in his *On the Literal Interpretation of Genesis*. He noted that "many of the stars, however, so they [astronomers] boldly assert, are equal to the sun, or even greater, but they seem small because they have been set further away." After elaborating further on what might be said about the celestial lights, St. Augustine concluded:

> *Let them at least grant this to our eyes, after all, that it is obvious that they [sun and moon] shine more brightly than the rest upon the earth, and that it is only the light of the sun that makes the day bright, and that even with so many stars appearing, the night is never as light when there is no moon, as when it is being illuminated by its presence.*

Centuries later St. Thomas Aquinas addressed the "great lights" question in his *Summa Theologica*, Question LXX ("Of the Work of Adornment, as regards the Fourth Day—In Three Articles"). He considered various objections to the Genesis account of the creation of the celestial lights, including,

> Obj. 5. *Further, as astronomers say, there are many stars larger than the moon. Therefore the sun and the moon alone are not correctly described as the* two great lights.

His answer to this:

> Reply Obj. 5. *As Chrysostom says, the two lights are called great, not so much with regard to their dimensions as to their influence and power. For though the stars be of greater bulk than the moon, yet the influence of the moon is more perceptible to the senses in this lower world. Moreover, as far as the senses are concerned, its apparent size is greater.*

This idea that Genesis speaks to how the stars appear to our eyes, and not to the actual physical sizes of stars, was not only the interpretation of Catholic thinkers. John Calvin made the same general point, but at greater length. He praised the findings of astronomers and claimed that Genesis was written in terms of what we see with our eyes, because "The Holy Spirit had no intention to teach astronomy"; "the Spirit of God here opens a common school for all... adapt[ing] his discourse to common usage" and thus Genesis "does not call us up into heaven... [but] only proposes things which lie open before our eyes".

These three men lived in very different times. St. Augustine lived from 354 to 430 A.D. St. Thomas lived from 1225 to 1274. Calvin lived from 1509 to 1564. All accepted the science that said that the stars are larger than the moon in terms of actual size. All interpreted Genesis as referring to what our eyes perceive.

Others also treated the question of star sizes and Genesis (St. Thomas mentions St. John Chrysostom). Some of these, including St. Robert Bellarmine, were discussing it at the time when Copernicus's hypothesis that the Earth circles around the sun was being debated. Across the centuries, the Church handled this religion-science conflict by accepting the results of science, while noting that Genesis was speaking in terms of how we see the sky. The Church has been accepting persuasive science and figuring out how to interpret faith in light of that persuasive science for almost 2000 years.

Part 2
The Church and evolution, and just one book it condemned

We continue our series on Church and Science, looking today at an example of decided imperfection in the question of how the Vatican dealt with the question of evolution.

The Church has been accepting persuasive science and figuring out how to interpret faith in light of that persuasive science for almost 2000 years, since at least the question of the "two great lights" of Genesis 1. But some of the Church's best minds, St. Augustine and St. Thomas Aquinas, weighed in on that particular question. There is not always an Augustine or Aquinas around. And, things have changed since Augustine, and even since Aquinas.

When there is a conflict between science and the Catholic faith, and there is no Augustine or Aquinas around, what does the Church do? Or, more specifically, what does the Vatican do? How are decisions made and actions taken when the subject is something like science?

There have been few instances where there was significant conflict between science and religion, of the sort where the Vatican got involved. The Church is not really going to have much opinion on most scientific developments. The debates of scientists about the existence of what we now call oxygen, or about bird migration, are unlikely to generate broad conflicts with religion.

One instance where broad conflict did arise and the Vatican got formally involved is the theory of evolution. There is a lot of documentation about the processes the Vatican used during that conflict. That was only about 150 years ago—just yesterday in Church history! The Vatican kept plenty of records that have survived to today. In the late twentieth century, the Vatican opened the archives containing those records so that scholars could study them. Therefore, there is plenty of information available about what went on when the Vatican was confronting the question of evolution.

Scholars have pored over that information and written about what they found. There were six faith-and-science cases involving evolution that reached the Vatican in the later decades of the nineteenth century. All were related to Catholics writing about the theory of evolution.

There were two Vatican groups that could address these sorts of cases. One was the Holy Office (later the Congregation for the Doctrine of the Faith, now the Dicastery for the Doctrine of the Faith). The other was the Congregation of the Index (merged into the Holy Office by Pope Benedict XV in 1917). The Holy Office had a broad role regarding matters of faith and morals. The Congregation of the Index, which published the *Index of Prohibited Books* for more than three centuries, was much less important in function and rank. Its decisions were less important. Its mission was much more concrete and modest.

Nevertheless, when there was Vatican action in the six evolution cases, it was the Congregation of the Index that acted, not the Holy Office.

It turns out that the Congregation of the Index operated like many academic or parish committees—which is to say, imperfectly! The Congregation did not have any set program for reviewing books in general to catch ones the Church might find problematic. There was no plan of action. The Congregation only looked at a book when someone submitted a formal complaint to them about the book.

When that happened, the secretary of the Congregation was required to examine the book and to name book reviewers, called "consultors", who also examined it. Someone in the group would write a report. There would be a meeting of the consultors. Then there would be a meeting of the full Congregation of the member cardinals. They would produce a judgement on the book, to be submitted for the pope's approval. If a book was found to need censure, a decree was published, adding the book to the *Index*. But only that decree of condemnation was made public. The reasons why a book was condemned were not specified.

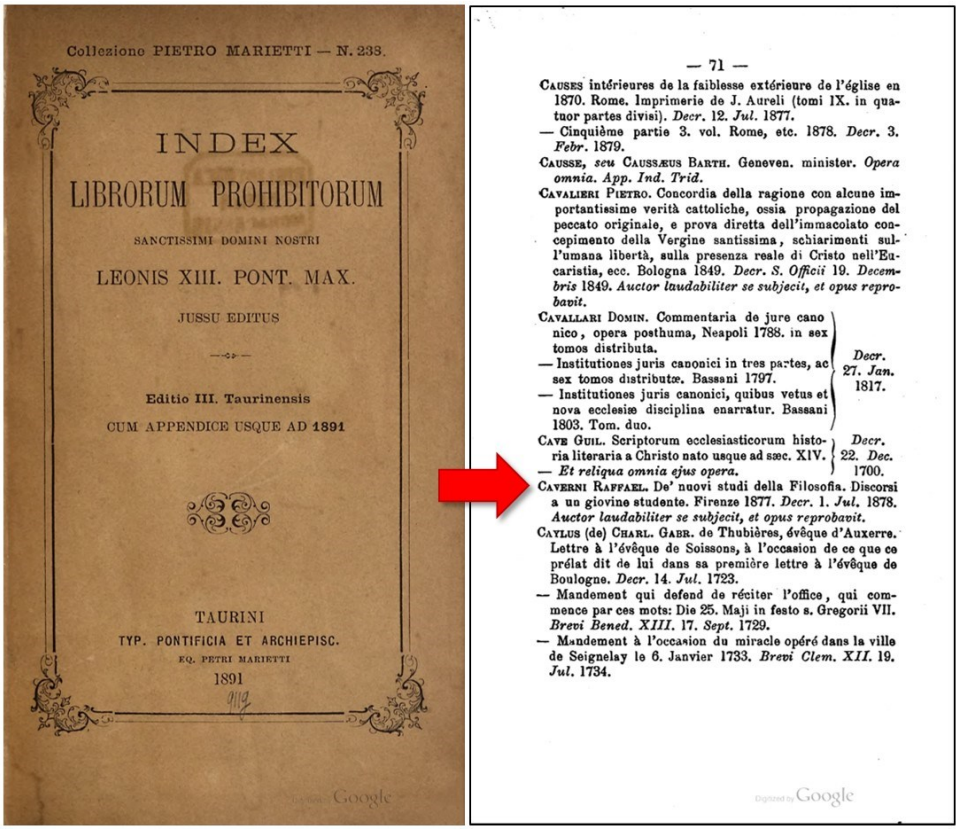
That is how things worked in principle. In reality, new editions of the *Index* were not issued with any regularity. The consultors and cardinals who were members of the Congregation did not attend meetings regularly, either. The Congregation consisted of twenty to thirty cardinals during the evolution discussions, but records show that usually only five or ten cardinals showed up at a meeting! Members of the Congregation had other priorities.

Then there were the reports. There might be multiple reports from different consultors, with the views of the consultors not agreeing with each other at all. In the case of Fr. Dalmace Leroy and his 1891 book *The Evolution of Organic Species*, Congregation consultors wrote six different reports over time! The consultors were not in agreement about Leroy's book. They were not in agreement about evolution.

Consultors themselves recognized the weakness of the process. One of the consultors who reviewed Fr. Leroy's book suggested that the cardinals not prohibit it, but rather just warn Fr. Leroy through his superiors to issue a retraction of the book on his own. Why not prohibit the book? In part because the consultor thought Fr. Leroy had good intentions and was a bright and upright priest. But in part it was because the consultor thought that Fr. Leroy should not be subject to having his book condemned when other writers had similar books in circulation that would not be condemned—not because those books were better somehow than Fr. Leroy's, but simply because no one had complained about them to the Vatican.

Even the overall Congregation might hold back on their opinions. They did not always put a solid effort into their evaluation of evolution (as evidenced by the attendance at meetings), relying on their own efforts rather than consulting a wide group of experts. So sometimes they worried that their decisions were not above criticism from the top minds in theology.

Given the haphazard nature of the Congregation's workings, it is not surprising that in five of those six evolution cases mentioned above, the Congregation took no official action, opting to either privately communicate with authors or to take no action at all. The only book to be publicly condemned as a result of its treatment of evolution was the 1877 book, *New Studies of Philosophy: Lectures to a Young Student* by Fr. Raffaello Caverni,



An 1891 edition of the *Index of Prohibited Books*, which features the *New Studies of Philosophy* of Fr. Raffaello Caverni (arrowed). The note commends the author for agreeing and rejecting the book himself. Image credit: Google Books.

who had served as professor of physics and mathematics in the seminary of Firenzuola. But since the reason for a book's being listed on the *Index* was never given (in keeping with the normal practice of the Congregation), and there was no mention of evolution in the book's title, no one who was not directly involved in the book review process would have ever known what the problem was. People knew Fr. Caverni's book had been prohibited, but not why. Caverni had some criticisms of the ecclesiastical world in his book—for all anyone in the public knew, maybe that was why it was put on the *Index*. Unsurprisingly, the case of Fr. Caverni is usually overlooked in discussions of the Vatican and evolution.

The Vatican, like the Church as a whole, is made up of people—imperfect people. Imperfect people make for imperfect processes, imperfect actions, and imperfect results.

That is important to keep in mind in exploring the story of the Catholic Church and science.

Of course, we might ask—if the Church's processes are so imperfect, why would it ever get involved in a science question in the first place, if there was no heavy hitter like Augustine on hand? Isn't science the best way we have of knowing things?

Part 3
Why would the Vatican meddle in science? To correct it?

Why wouldn't the Vatican just mind its own business? Well, it gets complicated. And offensive. Here's Part 3 of our new Church and Science series, on one of science's blunders.

Why would the Vatican ever decide to meddle in a scientific question? We've just seen in the previous article the imperfection of the Church's processes for evaluating science. Isn't science, by contrast, one of the best ways we have for knowing things? It is self-correcting, always bringing us a truer picture of the universe. Science makes the modern world. Science *works*.

Besides, as we saw in the first article, the ancient matter of Genesis and the "two great lights" is a template for addressing faith-science conflict: the Bible speaks to common understanding, to how the average person might see things; it does not give us a scientific description of the universe. That has been known since St. Augustine's time.

So why wouldn't the Vatican just mind its own business?

The answer to this question gets complicated—and offensive.

Scholars have looked at what was taking place in the later nineteenth century when the evolution question was being discussed within the Church in general, and the Vatican in particular. They have found that various learned people within the Church were emphasizing the importance of the descent of all people from Adam, and the unity of humankind: a provincial council; a bishop; Jesuit critics of evolution; and a Pontifical Biblical Commission.

For example, in 1898 Bishop John Cuthbert Hedley of Newport, Wales wrote a review of four works by of Fr. John Zahm, CSC, a priest and scientist from the University of Notre Dame in the United States who wrote on evolution. In this review, Bishop Cuthbert stated that "there are some matters so clearly revealed as to be out of the field of question or investigation." A bishop was arguing that science had no business studying some things!

What sort of things? "The unity of the human race," was one such thing, the bishop wrote, "as Dr. Zahm himself admits." This unity, Bishop Hedley thought, was one of several subjects, "in which it would be not only a mistake, but also an offence against religious faith, not to start with a firm hold of what is taught by the Church."

As another example, a 1909 Pontifical Biblical Commission did not reject evolution itself, but was concerned about Genesis in terms of the origins of the human race. The commission was concerned about humanity's "monogenistic" origin, such that humanity comprised a single, united family.

The Bible is clearly "monogenistic". All human beings are descendants of the same parents, Adam and Eve. We are thus all of one family.

A competing idea, however, was that different "types" of people had of separate origins. Under this idea there were, supposedly, actually different species of human (-like) creatures, with these different species commonly being called "races". This idea is "polygenism"—multiple origins for the multiple human "types" or "races", with most "races" not being of the line of Adam and Eve.

Polygenism was an ancient idea. It had been bolstered in European minds by voyages of discovery that revealed distant, peopled lands. Polygenism was also considered to be very much heretical.

Giordano Bruno is famous for having been burned at the stake in 1600 as an unrepentant heretic. He advocated many ideas that his contemporaries found offensive. Because he also advocated for the idea of an infinite universe of other suns, all of which were circled by inhabited worlds like Earth, he is sometimes considered a martyr for science. It is a matter of debate among scholars how much his ideas about the universe played in his burning versus, for example, his denial of Christ's divinity. But one Bruno idea that would offend many today was his polygenism. He argued in 1591 that the different "races" could not all have a common origin:

> *For of many colors*
> *Are the species of men, and the black race*
> *Of the Ethiopians, and the yellow offspring of America...*
> *Cannot be traced to the same descent, nor are they sprung*
> *From the generative force of a single progenitor.*

Bruno noted that "it is said in the prophets... that all races of men are to be traced to one first father", but added that "no one of sound judgement can refer the Ethiopian race to that protoplast."

Bruno's singling out "Ethiopians" was typical. It seems it was usually the "black race" that "sound judgement" supposedly indicated was most removed from "true" humans.

Some argued that sound judgement, and indeed science, stood against polygenism. In 1680 Morgan Godwyn published a book called *The Negro's & Indians Advocate, Suing for their Admission into the Church*. In it, he noted that different species do not beget fertile offspring. A horse and an ass, for example, can beget offspring, namely a mule, but that offspring is sterile. Godwyn wrote that, if different races were different species like horses and asses, then the people of mixed race, "must, *like the Mules*... be for ever Barren", unable to procreate. But, Godwyn said, the contrary is seen daily. "Mixed race" people certainly have children. Thus, humans are of one family, whatever "race" they may be. That was just a fact of science. (Godwyn also noted that Catholic missionaries recognized the unity of humankind, and would even portray Jesus as black in their efforts to evangelize all people.)

Polygenists claimed science anyway. For example, J. H. Van Evrie (M.D.) in his 1861 book *Negroes and Negro "Slavery"* claimed that "the inference... that whites and negroes were of the same species, because the mulatto, unlike the mule, did reproduce itself, is simply absurd." Van Evrie argued that people of mixed race were absolutely sterile—the sterility simply showed up over several generations. This was common knowledge among those who dealt in the slave trade, he said.

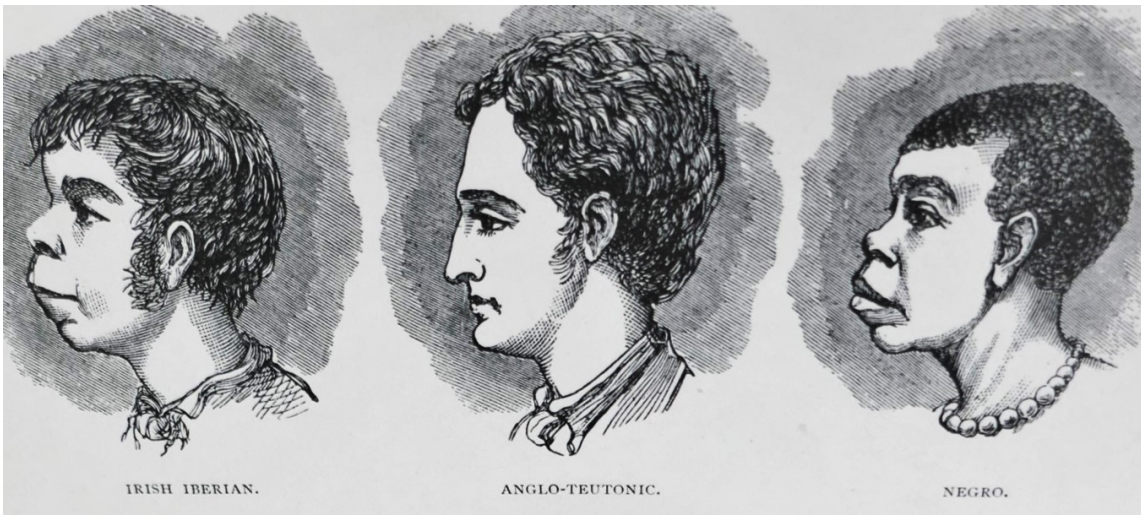
Van Evrie was not alone in his ideas. The 1850 meeting of the American Association for the Advancement of Science featured discussion of how the "types" of human beings were fixed, because "hybrids" were sterile in the long term, and thus died out. The science of polygenism was central to the whole business of racial slavery and oppression. As Van Evrie himself noted,

> *If the Negro had descended from the same parentage, or, except in color merely, was the same being as ourselves.... then it would be [a Christian's] first and most imperative duty... to set an example to others, to labor night and day to elevate this (in that case) wronged and outraged race—indeed, to suffer every personal inconvenience, even martyrdom itself in the performance of a duty so obvious and necessary.*

This sentiment was not limited to Americans tied up with the question of slavery. Others argued that traditional religious ideas about the unity of and nature of human beings should yield to scientific evidence that showed that there were different species of human (-like) beings. Georges Pouchet of the Muséum national d'Histoire naturelle in Paris complained of how, despite the battles "fought and won" by science against religion in astronomy (about Earth's motion) and geology (about Earth's age), "man is a sacred, and, therefore, a forbidden subject." We can study rocks, but not humankind, he groused. Religion treats facts with derision, he said. You can talk about bears and elephants however you want, "but an Esquimaux and a European, a Negro and a Persian, were to be invariably treated as of one species." "The true man" was "the large-brained and small-mouthed Caucasian". Others urged that religious ideas

> *should succumb to the clear demonstrations of inductive science, and racial facts be championed to their appropriate place, as among the most important and reliable data upon which history, more especially that of the earlier ages, can be based.*

Of course, today ugly ideas such as these are not part of science. Modern science is essentially monogenistic; it says that all people are of the same family, and that "racial" variations are quite minor, compared to the variations between individuals, and compared to variations found within other species. The "scientific racism" ideas promoted by Van



The frontispiece from H. S. Constable's 1899 book *Ireland, from One or Two Neglected Points of View*. Constable's caption for this image borrows from evolutionary ideas, discussing how the "Irish Iberians" had roots in Africa and were descendants of a "low type" with a protrusive jaw, "who, in consequence of isolation from the rest of the world, had never been out-competed in the healthy struggle of life, and thus made way, according to the laws of nature, for superior races." Note the portrayal of mouth sizes. Image credit: Wikimedia Commons.

Evrie and Pouchet have been so thoroughly rejected that today you hear them called "pseudo" science, even though they were science in the nineteenth century.

Today it is considered (to paraphrase Bishop Hedley) not only mistaken, but offensive, not to start any scientific investigation with a firm hold of the idea that all human beings, regardless of their "race", are of the same family, and fundamentally equal. Any scientist today who proposed a new polygenistic theory for the origin of human beings, asserting that certain types of people are not truly of the human family, would be roundly condemned.

Today we simply reject the idea that science can tell us that the man or woman standing next to us is not fully human. Those who do not reject it are ranked among the least pleasant kinds of crackpots. Some matters are considered to be so clear (again paraphrasing Bishop Hedley) as to be out of the field of question or investigation.

Therefore, because evolution and polygenism and the idea that certain people were not fully human were all linked together in the nineteenth century, even those today who care little for the Catholic Church might understand why the Vatican would decide to meddle in the evolution question. Even people today who have little interest in discussions of original sin and salvation history might understand why the unity of humankind must be sacrosanct. The example of "scientific racism" urges that science be subject to confrontation and criticism from outside of science. The fact that science is *eventually* self-correcting, *eventually* brings us a truer picture of the universe, and *eventually* works is not good enough when science can go so far wrong, in such a consequential manner.

Part 4
Did (and does) the Church oppose the science of evolution?

A look at the history of the theories and the Church's response shows that some things haven't changed ... Here's the next article in our Series on Church and Science.

We have seen that the Church has been dealing with the question of how scientific discovery impacts faith going all the way back to the time of St. Augustine in the Roman Empire. The question then was Genesis and the astronomer Ptolemy and the "two great lights". We have seen the imperfections of the Vatican's processes for handling such questions. We have also seen, through the question of polygenism and "scientific racism", that science can go so far wrong in such consequential matters that even those who might not support religion might nevertheless agree that some sort of interference from outside of science is warranted. So let's look at a famous case where all of this came together—the Vatican's discussion of evolution at the end of the nineteenth century.

As we saw in Part 2, scholars have identified six cases of the Vatican confronting the evolution question in the late nineteenth century. All six arose from Catholics writing on evolution. In all these cases, the Congregation of the Index handled things. It never took any recognizable public action against evolution—the closest thing being the condemnation of the 1877 book, *New Studies of Philosophy: Lectures to a Young Student*, by Fr. Raffaello Caverni. It was condemned, but since the only decision made public was the prohibition of the book, and the book's title does not mention evolution, there was no way to know why it was condemned. In the other five cases, the Congregation took no public action of any sort, although one scholar has argued that the Vatican's private censuring of various authors effectively amounted to at least a temporary condemnation of evolution.

In the late nineteenth century, evolution was easier to attack on scientific grounds than it is today. Scholars note that the late nineteenth century saw an "eclipse of Darwinism"—scientists at that time did not agree on a mechanism for evolution; Charles Darwin himself retreated a bit on the idea that natural selection was the sole mechanism of evolution; some in the world of British biology were sounding the death knell of Darwinism. Certainly, Darwin's ideas were not so easily confirmed as Ptolemy's ideas about the sizes of stars (Part 1).

And here is something to keep in mind: Ptolemy was right that stars are much farther away and much larger than the moon; but he was wrong about how large and how far. Stars are much larger, and much farther away, than he calculated. Ptolemy did not understand the nature of light like we do today. That threw off his results. Science goes wrong often. Ptolemy's star size science was not so far off base as the scientific racism we encountered in the last article, and certainly not so consequential, but it had real problems.

Scholars have found one Catholic critic after another in the late nineteenth century harping on the real problems they perceived in the theory of evolution, its *scientific* weaknesses. Most of these critics emphasized in some way that we do not abandon the obvious, natural sense of biblical words, unless necessary (like with the "two great lights"), and that there was no such necessity in the case of evolution because of the scientific problems in that theory.

Francesco Salis-Seewis, for example, was one of a group of Jesuits who wrote against evolution in the Roman Jesuit publication *La Civiltà Cattolica*. He argued in the 1890s that evolution must first pass scientific muster. "Only then," he said, "will it merit to face Revelation." Until then, it is pointless "to introduce this failure of science in the sacristy". Salvatore Brandi, another *La Civiltà Cattolica* Jesuit, noted:

> *The first impediment to accepting evolution for educated Catholics comes not from the fear of contradicting the Bible, but from the scientific insufficiency of that system, that is, the absolute lack of evidence that confirms it.*

A scientific idea must be solid before it can be used in interpreting Scripture, Brandi said. "It is certainly required", he wrote, "that the words of eternal Truth not be interpreted and warped on the basis of gratuitous hypotheses, to make [those words] say today in obedience to one theory, what will be said tomorrow in obedience to another".

In other words, the fact that science could influence scriptural interpretation was obvious, thanks to the "two great lights" of Genesis 1. But the science had to be solidly demonstrated. If a theory had weaknesses scientifically, why bother to consider it theologically? After all, the interpretation of Scripture could not be allowed to simply flutter in the changing winds of passing scientific ideas, following one fallible scientific idea today, another tomorrow.

One perceived scientific weakness of evolution was the matter of infertility of hybrids discussed in Part 3. Different species were known to beget offspring; a horse and an ass can beget a mule. But that offspring is sterile. This is not considered relevant to evolution today, but in the late nineteenth century even writers who were enthusiastic about evolution considered it a problem.

Another scientific problem, one that the Jesuits of *La Civiltà Cattolica* found particularly significant, was the problem of the origin of life. Salis-Seewis wrote, "The first postulate with which evolutionism opens its series of imaginative theories is that of the spontaneous generation of the very first organisms." He then went on to point out that the idea of the spontaneous generation of life from inanimate matter, though very ancient, had been repudiated by modern science. Indeed, he said, science had repeatedly pronounced judgement on "this first and fundamental supposition" of evolution, and "primordial spontaneous generation has been declared devoid of any foundation and contrary to the constant induction of facts and to one of the best-established laws of

Nature." Salis-Seewis was correct—while there were still a few advocates for some sort of spontaneous generation even in the late nineteenth century, by the end of that century the idea had been rejected by science. Today the origin of life remains a puzzle, scientifically speaking.

Many Catholic theologians in the late nineteenth century viewed support for evolution as a sort of atheistic ideology based on a scientific theory that lacked any serious foundation. Without such a foundation it was easy to dismiss evolution from a theological point of view. But with time, the changing winds of passing scientific ideas calmed. Science that once seemed all too obviously fallible began to have the kind of persuasive power possessed by Ptolemy's work. And importantly, that science of evolution ceased to be something associated with polygenism that undermined the idea of the unity of the human family.

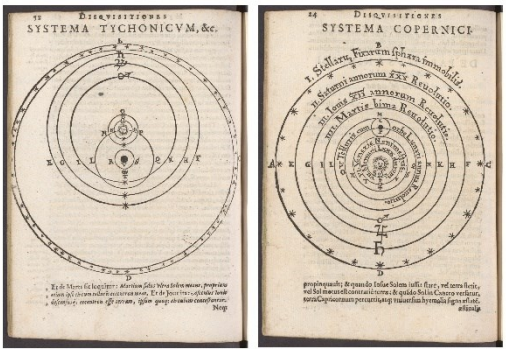
We see, in the Vatican's confrontation of evolution in the late nineteenth century, an effort to wrestle with science that was unsettled and consequential. Evolution was consequential, seen at that time as undermining the unity of humanity and placing some people outside of salvation history. Evolution was unsettled, with Darwinism in "eclipse" and many thinkers having serious scientific questions about it (at least one of which remains unanswered today).

The Vatican's process for wrestling with the idea of evolution was, in essence, a committee of men who lacked the time, expertise and commitment really necessary to address the matter at hand. As imperfect as this process was, it is difficult to envision better processes, or to envision no processes. Many people today view evolution as emblematic of "conflict between science and religion", but if today a scientific idea arose that was promising yet unverified, and that had "race"-based implications for who was fully human and who was not, what would happen? Panels and committees would be formed; reports would be issued; harsh words would be said—outside of religion. There would be consequences to individuals much like what the Vatican could dish out in the late nineteenth century. The process would be imperfect. Modern processes for dealing with consequential scientific ideas, whether they involve the development of weapons or the response to deadly diseases, have been imperfect—like the Vatican's discussion of evolution at the end of the nineteenth century.

But what about back when the Vatican dished out consequences worse than just having a book put on a "prohibited" list? What about Galileo?

Part 5
A new look at the Galileo case, from the Vatican Observatory

In this series on the Church and Science, we can't fail to consider the most famous of the questionable cases. And we find the Vatican following the science.



The models of the universe of Tycho Brahe (left) and Nicolaus Copernicus (right), as illustrated in the 1614 book *Mathematical Disquisitions* by Fr. Christoph Scheiner, S.J. and his student Johann Georg Locher. Copernicus had the Earth and the planets circling the sun, while Brahe had the sun circling an unmoving Earth with the planets circling the sun. Relative motions were identical in both (Venus circled the sun in both, for example); both were compatible with Galileo's discoveries. Under Copernicus, however, the stars had to be very far away—and, it seemed at the time, extremely large—contrary to what is shown in the right-hand diagram. Image credit: ETH-Bibliothek Zürich.

What about the case of Galileo? In the previous article, we saw how much concern there was within the Church regarding the scientific problems with the theory of evolution. We also saw concern regarding any revision of religious thought for the sake of theories that might not withstand the test of time.

Was that what was happening in the Galileo case?

There is less information available about the Galileo case than the evolution case, but it seems likely that the answer to this question is "yes".

You will find it said in many places that Galileo proved Nicolaus Copernicus's "heliocentrism", the idea that the Earth circles the sun. That is not true. Heliocentrism was hard to prove. Earth's motion around the sun was not so easily verified as Ptolemy's claim that the stars were larger than the moon, contrary to the "two great lights" of Genesis (see Part 1).

Those who opposed Galileo focused on a problem involving the sizes of stars in a Copernican universe—in essence, on a variant of the "great lights" question. Ptolemy discussed how the appearance of the stars is independent of the place on *Earth* from which they are observed, with the result that stars must be far larger than the *Earth* (and the moon). That logic, when applied to a moving Earth, where the appearance of the stars becomes independent of the place on *Earth's orbit* from which they are observed, results in stars being far larger than *Earth's orbit*. If Copernicus was right, stars would all utterly dwarf the sun.

This was first pointed out around the turn of the seventeenth century by the astronomer Tycho Brahe. He also produced a new Earth-centered model for the universe that, some years later, turned out to be fully compatible with new telescopic discoveries of Galileo. Some Copernicans, including Johannes Kepler, simply accepted the enormous

stars implied by heliocentrism. Brahe, however, said they were absurd. Brahe's model generally retained Ptolemy's stellar distances and sizes. It did not suffer from the star size problem.

In the first half of the seventeenth century, following the advent of the telescope, Jesuit astronomers such as Frs. Christoph Scheiner, Giovanni Battista Riccioli, and André Tacquet developed Brahe's star size argument further. Scheiner and Tacquet produced brief, elegant versions of the argument (the discussion above of how Earth's orbit in heliocentrism becomes the basis of observation as opposed to the Earth itself, is from Tacquet). Riccioli, by contrast, published large tables containing precise telescopic stellar measurements and the results of calculations made from those measurements, along with pages of discussion—and reached similar conclusions about heliocentrism and star sizes.

Jesuit scientists in the seventeenth century determined that, if Earth rotated like Copernicus said, objects on Earth's surface would move at different speeds (faster toward the equator, slower toward the poles) and this should cause observable effects in objects moving through the air. The diagram at left from Fr. C. F. M. Dechales, S.J. shows a cannonball missing its target owing to this effect. The Jesuits argued that no effects were observed and that was evidence for the immobile Earth of Tycho Brahe. They were right about the effect, but wrong about how obvious it would be. The effect, known today as the "Coriolis Effect", is the cause of the rotation in weather patterns, including hurricanes (right). Image credit: Vatican Observatory Library (left) and NOAA (right).

What this all meant was that Brahe's star size argument, and his model, seemed to grow stronger over time. Science seemed to be backing the idea that Earth *did not* move. In 1674 Robert Hooke, the scientist who clashed with Isaac Newton and who did early work with microscopes, called the star size argument "a grand objection alleged by divers of the great *Anti-copernicans* with great vehemency and insulting; amongst which we may reckon *Ricciolus* and *Tacquet*… hoping to make it [the Copernican universe] seem so improbable, as to be rejected by all parties."

However, by 1674 astronomers including Hooke himself had begun to publish data suggesting problems with measurements of the apparent sizes of stars. These problems indicated that such measurements wildly inflated star sizes, even when done carefully and telescopically. Nevertheless, the sizes of stars remained a difficulty for heliocentrism well into the eighteenth century.

The star size argument was known to some of those involved with the Vatican's actions against heliocentrism, both in 1616 when the subject of heliocentrism was first treated by the Congregation of the Index, and in 1632-33, following publication of Galileo's *Dialogue Concerning the Two Chief Worlds Systems: Ptolemaic and Copernican*. Msgr. Francesco Ingoli, who Galileo believed to have been influential in the rejection of heliocentrism by the Congregation of the Index in 1616, cited the star size argument against Copernicus in his writings. So did Fr. Melchior Inchofer, S.J. who was

selected for a three-person Special Commission formed by Pope Urban VIII to investigate the publication of the *Dialogue*.

Star sizes were not the only scientific problem with heliocentrism. There was nothing to explain how the Earth, a sphere of rock and water of obviously vast weight, could be carried around the sun. Isaac Newton's physics, which would explain it, lay decades in the future. By contrast, an explanation for how the sun and stars might be carried around the Earth dated all the way back to Aristotle. He simply supposed that celestial bodies were made of an ethereal substance that moved naturally. Also, heliocentrism called for a rotating Earth. Such rotation should induce deflections in the observed trajectories of projectiles and falling bodies—deflections that were not observed, as Riccioli and other Jesuits took pains to emphasize. There was, as Salvatore Brandi would later say about evolution (see Part 4), an absolute lack of scientific evidence to confirm heliocentrism.

A full picture of the role that scientific objections played in the Vatican's actions against heliocentrism and Galileo is not yet available. More study is needed to better understand the extent to which scientific arguments such as Brahe's, bolstered by the work of astronomers such as Scheiner, motivated those actions. The parallels between the heliocentrism and evolution cases suggest, however, that what went on in the Galileo case in the early seventeenth century was similar to what went on in the evolution case in the late nineteenth century—when scientific questions, combined with the idea that the natural sense of biblical words should not be abandoned unless necessary, were significant considerations for the Church authorities who were trying to evaluate a complex scientific question. Why would anyone consider reinterpreting Scripture for what seemed at the time to be a weak theory?

Indeed, what would be the implications of reinterpreting Scripture for a weak theory?

Part 6
The real reason the Church opposed Galileo

Looking at the writings of some cardinals—including a saint—and Calvin reveals that the issue wasn't science itself, but a question of good science.

When we talk about the Church and science and the Vatican's actions in the Galileo case, we might ask, "Why would the Vatican care?" We have seen how imperfect its committee-driven processes can be. Yet in March of 1616, the Congregation of the Index declared heliocentrism false and contrary to Scripture, and temporarily prohibited Nicolaus Copernicus's 1543 book *On the Revolutions of Celestial Spheres*. Why do that? With evolution, important ideas like the unity of humankind were involved. What was important about the motion of the Earth? Parallels between the evolution and heliocentrism cases may help to answer these questions.

The reason the Congregation of the Index gave for its declaration, re-iterated in the sentence pronounced against Galileo in 1633, was that the "false" doctrine of heliocentrism needed to be prevented from advancing further "to the prejudice of Catholic truth". Heliocentrism was declared "altogether contrary to Holy Scripture", a "pernicious" doctrine containing "various propositions against the authority and true meaning of Holy Scripture". The idea was to "completely eliminate" heliocentrism, and to "remedy the disorder and the harm which derived from it and which was growing to the detriment of the Holy Faith."

Scripture does speak of the Earth as unmoving—1 Chronicles 16:30, for example: "the world will surely stand fast, never to be moved." Yet the long-standing matter of Genesis 1 and the "two great lights", which we encountered in Part 1, was a template for addressing heliocentrism. Thanks to the science of Ptolemy, the Bible had long been taken as speaking to appearances regarding the apparent *sizes* of celestial bodies. That logic could certainly be applied to the science of Copernicus and the apparent *motions* of celestial bodies.

It was not. Why not? Why did the Vatican decide that a moving Earth was pernicious, but stars greater than the moon were not?

We saw in the evolution case how much concern there was in the Church regarding the descent of all people from Adam, and the unity of humankind. Even people today who care little for the Catholic Church might understand why the Vatican decided to turn loose its imperfect, committee-driven processes on the evolution question. Even people today who have little interest in discussions of original sin and salvation history will understand why the unity of humankind must be sacrosanct.

Well, what was the parallel in the case of heliocentrism? What was sacrosanct then? It seems that what was sacrosanct was reinterpreting Scripture only when *necessary*.

We have seen from the "two great lights" case that Augustine, Aquinas and Calvin all accepted the need to reinterpret Scripture in the light of scientific evidence. Of these three, only Calvin (1509-1564) lived to see the advent of heliocentrism. In the case of the two great lights, he gave a spirited defense of astronomy, even as it contradicted a plain reading of Genesis 1. "Astronomers investigate with great labor whatever the sagacity of the human mind can comprehend," he said. "Astronomy is not only pleasant, but also very useful to be known: it cannot be denied that this art unfolds the admirable wisdom of God." Yet despite his admiration for astronomy, Calvin firmly rejected heliocentrism:

> *We will see some who are so deranged... that they will say that the sun does not move, and that it is the earth which shifts and turns. When we see such minds we must indeed confess that the devil posses them.... So it is with all who argue out of pure malice, and who happily make a show of their imprudence. When they are told: "That is hot," they will reply: "No, it is plainly cold."*

Calvin's logic regarding the two great lights could certainly be applied to heliocentrism. It seems, therefore, that he simply found heliocentrism unpersuasive, lacking evidence. To him, it was a baseless hypothesis, hatched up merely for the sake of being contrary. To reinterpret Scripture to accommodate it would be religiously deranged, or devilish.

Echoes of this can be found in the seventeenth century among those who interacted with Galileo. When Galileo queried Cardinal Carlo Conti about heliocentrism and scripture in 1612, Conti replied that an orbiting Earth was not consistent with Scripture; therefore, heliocentrism could only be reconciled with Scripture by invoking the idea that the Bible was speaking according to common usage of language. But, Conti warned, "*that* mode of interpretation is not to be admitted unless absolutely necessary".

Likewise, Cardinal Robert Bellarmine wrote a few years after Conti:

> *If there were a true demonstration that... the earth circles the sun, then one would have to proceed with great care in explaining the Scriptures that appear contrary, and say rather that we do not understand them than that what is demonstrated is false. But I will not believe that there is such a demonstration, until it is shown me.... and in case of doubt one must not abandon the Holy Scripture as interpreted by the Holy Fathers.*

Bellarmine had applied this logic to his own ideas. When he was a young professor he had argued against the prevailing view of astronomers of his time. They said that celestial bodies like the stars were carried along by complex but ethereal celestial machinery. Various scriptural verses, Bellarmine said, suggested that, no, they moved autonomously, with no machinery to hold them. But, said the young Bellarmine,

> *If then one ascertained with evidence that the motions of the heavenly bodies are not autonomous… one would have to consider a way of interpreting the Scriptures which would put them in agreement with the ascertained truth: for it is certain that the true meaning of Scripture cannot be in contrast with any other truth.*

That is, the interpretation of Scripture must be adapted to science when necessary.

A third example in addition to Conti and Bellarmine is Riccioli. He argued in 1651 that,

> *If the liberty taken by the Copernicans to interpret scriptural texts and to elude ecclesiastic decrees is tolerated, then one would have to fear that it would not be limited to astronomy and natural philosophy and that it could extend to the most holy dogmas; thus, except in cases of manifest necessity, it is important to maintain the rule of interpreting all sacred texts in their literal sense.*

Riccioli then proceeded to argue at length that science showed that there was no manifest necessity. Heliocentrism was false and inconsistent with what was known from physics, astronomy, and mathematics, he said—as seen from, for example, his tables of stellar measurements, calculations, etc. that were discussed in the previous article.

Riccioli did not specify what most holy dogmas he had in mind, but of course the dogma of the unity of humankind comes to mind at this point. "Are we to tolerate the followers of Bruno regarding heliocentrism?" we can imagine Riccioli saying; "If so, what will we do when they start pushing Bruno's ideas about Ethiopians not being true people? [see Part 3]"

Heliocentrism was unsettled science in Galileo's time. There were powerful scientific arguments against it. Heliocentrism certainly seems less consequential to our modern eyes than evolution and the sorts of unity-of-humanity questions associated with it in the nineteenth century. What was considered consequential at Galileo's time was not, it seems, whether scriptural interpretation could be accommodated to heliocentrism, but whether it should be, absent manifest necessity. Scriptural interpretation had long been accommodated to science when necessary, as seen in the "two great lights" case. But to let scriptural interpretation flutter in the changing winds of unsettled and obviously fallible science would put at risk things far more consequential than Earth's fixity.

That seems to be a likely reason for why the Vatican would care about Galileo and heliocentrism.

Part 7
Church and science: What's to be made of the history? The future?

This is the conclusion of a seven-part series that has gone in-depth into three scientific issues in which the church got involved. One is Galileo. The others are less known.

This seven-part series has been a deep dive into the story of the Catholic Church and Science, revealing an ongoing struggle to figure out science. Solid scientific ideas have prompted re-evaluations of interpretations of Scripture. The imperfect process of evaluating and accommodating scientific discovery is almost as old as the Church itself.

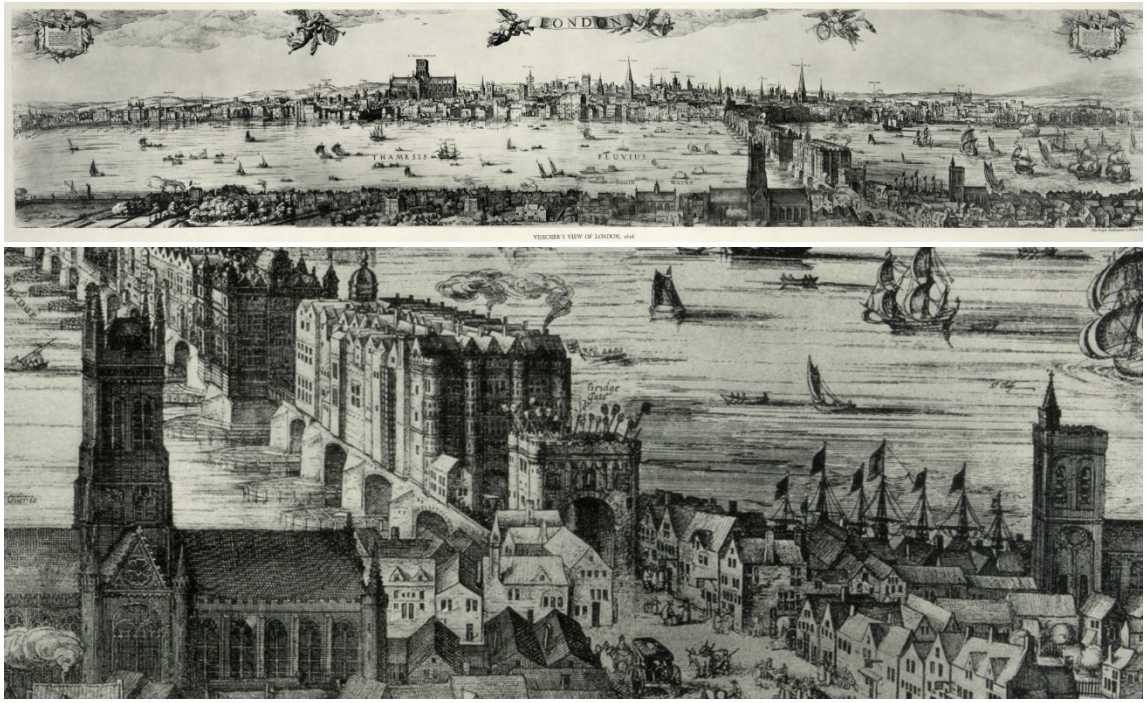
Questions lurk in the background, however. One of these is certainly, *"What about how the Church treated Galileo?"* We have seen how imperfect the Church's processes for dealing with scientific questions can be. We have also seen how science can go wrong in ways so consequential that some sorts of processes for dealing with such questions will be necessary. Because they will involve people, they will be imperfect.

But the processes brought against Galileo were more than just imperfect. The Catholic writers whose work on evolution was the subject of complaints to the Vatican in the late nineteenth century were perhaps unofficially asked to retract their work. Retractions—of, for example, articles in scientific journals—are not uncommon even today. But Galileo was sentenced to prison and then house arrest; he died under house arrest. What of that?

Galileo had the misfortune to run afoul of a powerful man, Pope Urban VIII. At one time, Urban had addressed Galileo "as a brother" and had written poetry praising Galileo's telescopic discoveries. Before the publication of Galileo's *Dialogue*, Urban's powerful nephew had said that Galileo had "no better friend" than Urban, and Urban had granted Galileo an audience. After the *Dialogue's* publication, Urban would explode into anger at Galileo's name.

Urban could deal coldly with things that angered him. Once, he had the birds in the papal garden killed when their noise became a bother. He silenced Galileo, too.

Nothing excuses Urban. Nevertheless, recall that the early seventeenth century of his papacy was a different time than the late nineteenth century when the Vatican was considering the evolution question. Consider the African-American astronomer, Benjamin Banneker, who argued in a letter to Thomas Jefferson that people of African descent were indeed true human beings. The story goes that Banneker had been taught to read and write by his Welsh grandmother. She had fled to the New World to escape a possible death sentence, for petty theft. Consider Claes Visscher's panorama of London in 1616. Visible atop London Bridge are heads, impaled on poles, of executed people. Those grisly heads were there to be seen by even the youngest children crossing the bridge with their parents. Consider that in this same time, people from Africa were first being brought to what is now the USA to be slaves. A pope abusing his power and



unleashing his wrath on a former friend is a reprehensible abuse—one more in a century full of them.

Another question might be, *"Doesn't the Church always lose in these confrontations with science?"* After all, despite the abuse brought to bear against Galileo, the Vatican failed to "completely eliminate" heliocentrism (to borrow the Vatican's language of Galileo's time). Indeed, heliocentrism prevailed. The Earth circles the sun. Scripture has been reinterpreted to accommodate, just like it was with Genesis and the "two great lights".

No, the Church does not always lose.

Consider the situation with evolution. Yes, in many ways, evolution has prevailed much like heliocentrism did. A striking example of the Catholic Church reinterpreting Scripture to accommodate an evolutionary view of *the universe* is the proclamation of "The Nativity of Jesus Christ from the Roman Martyrology", often recited during the celebration of the Liturgy of the Hours on December 24 and before Midnight Mass at Christmas. Traditionally, this text stated that Christ was born in "the year from the creation of the world, when in the beginning God created heaven and earth, five thousand one hundred and ninety-nine". Today, the text states that Christ was born "when ages beyond number had run their course from the creation of the world".

But the evolution that has prevailed is a monogenistic evolution. No reputable scientists today proclaim that there are different species of human (-like) creatures like the scientific racists did in the nineteenth century. The "most holy dogma" of the unity of humankind has prevailed, while the work of those scientists is now called "pseudo" science.

But the unity of humankind did not prevail because of some Vatican decree intended to protect it and to "completely eliminate" polygenism and scientific racism. We might wish that a decree could have squelched those ideas and remedied "the disorder and the harm" (to again borrow the Vatican's language) that derived from them. They and their offspring, eugenics, thrived for decades, to the detriment of many, especially those with the least power. Those with the least power needed the Vatican. They were abused by science gone wrong. Yet scholars who have studied the evolution case suggest that the Vatican's actions were constrained by the shadow of the Galileo case.

The history of the Vatican's efforts to confront evolution reflects the need for a process, a committee, a Congregation, even if imperfect, for confronting fallible science. The history of the Vatican's efforts to confront heliocentrism reflects the need for vigilance in ensuring that process is not abused. Both histories need an understanding of the Church's much older confrontation with the matter of the "two great lights" of Genesis 1.

And that brings us to a third question: *"Hasn't the Vatican apologized for all this already?"* That is unclear. In 1979, the new Pope John Paul II told the Pontifical Academy of Sciences that he hoped that "theologians, scholars, and historians, animated by a spirit of sincere collaboration, will study the *Galileo case* more deeply and, in frank recognition of wrongs from whatever side they come, dispel the mistrust that still opposes, in many minds, a fruitful concord between science and faith". In 1992 he again spoke to the Academy, after a Vatican commission had studied the Galileo case. That speech is often interpreted as a sort of apology to Galileo.

It was not quite that, but the pope did describe the Galileo case as a "tragic mutual incomprehension". He also said that "the new science, with its methods and the freedom of research which they implied, obliged theologians to examine their own criteria of scriptural interpretation. Most of them did not know how to do so."

"Paradoxically," the pope continued, "Galileo, a sincere believer, showed himself to be more perceptive in this regard than the theologians who opposed him." The pope mentioned Galileo's famous letter to Christine de Lorraine (mother of the Grand Duke of Tuscany and occasionally de facto ruler of Tuscany herself). The letter, the pope said, is "like a short treatise on biblical hermeneutics."

The pope did not mention the case of the "two great lights" of Genesis. According to Fr. George V. Coyne, S.J., Director of the Vatican Observatory at the time and a member of the Galileo commission, the commission lacked any historian of science.[*] It seems that the "two great lights" case, widely known in Galileo's time, escaped the notice of the

[*] This last part of the series also draws from George V. Coyne, "The Church's Most Recent Attempt to Dispel the Galileo Myth" in G. Teres (ed.), *Faith and Knowledge: Towards a New Meeting of Science and Theology* (Città del Vaticano: Libreria Editrice Vaticana, 2007), 146-170; partially reprinted in C. M. Graney (ed.), *From the Director: Selected Works of Fr. George V. Coyne, S.J.* (Vatican Observatory Foundation, 2021), 222-239. It also draws from the Vatican Observatory's *Sacred Space Astronomy* blog.

Commission and the pope. Theologians of that time who knew the "two great lights" surely *did* know how "to examine their own criteria of scriptural interpretation."

Even the letter to Christine de Lorraine is a tricky business. Galileo in that letter insisted that astronomers must not be asked to "protect themselves against their own observations and demonstrations", to "do the impossible". He went on to urge that knowledgeable people "should see more clearly that it is not within the power of the practitioners of demonstrative sciences to change opinion at will." Likewise, "no creature has the power of making [the arguments of Copernicus] true or false, contrary to what they happen to be by nature and de facto. So it seems more advisable to first become sure about the necessary and immutable truth of the matter, over which no one has control."

It all sounds very good, but Christine de Lorraine was not doubting Galileo's observations—things that anyone with a good telescope could replicate. She was doubting his interpretation of those observations. Moreover, the scientific racist Van Evrie (see Part 3) used language similar to Galileo's letter: "We cannot believe that which we know to be untrue, and to affect such belief however good the motive may seem, must necessarily debauch and demoralize the whole moral structure.... The fact of distinct races or rather the existence of species of Caucasian, Mongols, Negroes, etc., are physical facts, subject to the senses, and it is beyond the control of the will to refuse assent to their actual presence…. [We must] bow to that fixed and immutable standard of truth which the Eternal has planted in the very heart of things." Galileo's language could be applied even when science was going very wrong.

Imperfection has been central to our story of the Catholic Church and science, so it should not be a surprise to find that even John Paul II's Galileo Commission, the process he put in motion to evaluate the processes of evaluating science, should be imperfect. Thus, the story is still unfolding today as we consider overlooked parts of the story that go way back, like the "two great lights". The Catechism of the Catholic Church states that *true* science "can never conflict with faith, because the things of the world and the things of faith derive from the same God [CCC 159]." With both scientists and Churchmen being imperfect, it is that *"true"* part that is so difficult. Around this matter of science so much of the Church-and-science story has seemed to unfold, and no doubt will continue to unfold.