

Foote vs Tyndall

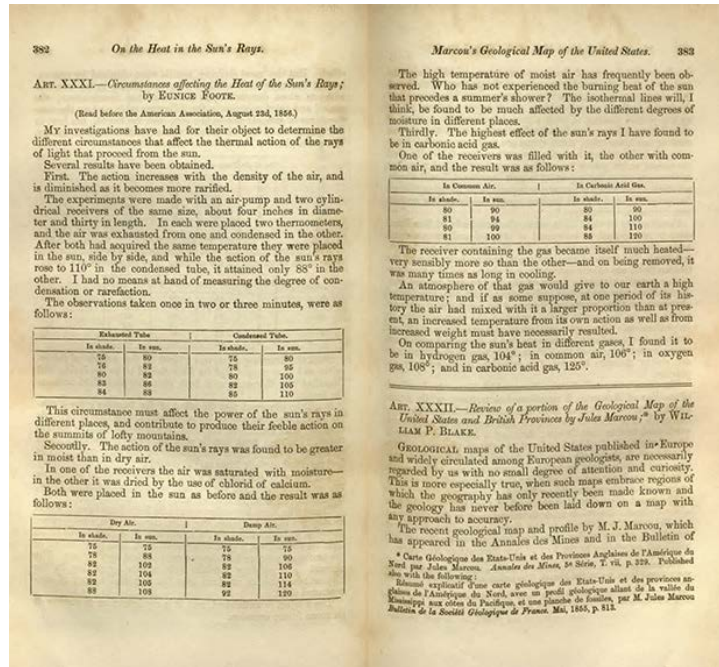
Eunice Newton Foote

In 1856, Eunice Newton Foote, a female American scientist, discovered that carbon dioxide absorbed heat more effectively than other gases. Three years later in 1859, the Irish male physicist John Tyndall arrived at the same conclusion. Though Foote was first to this insight, later known as the greenhouse effect, Tyndall received credit for the discovery. It was not until 2011, 155 years after her experiment, that Foote's work was recognized. To examine why this was the case, we must look at their work in the context of the 19th century.



Illustration of Eunice Newton Foote by Carlyn Iverson. Image courtesy of the artist.

Eunice Newton Foote (1819-1888) was a scientist, inventor, and women's rights activist. She attended an all-girls school and took some classes at a local men's science college. In 1856, Foote published her first paper *Circumstances affecting the heat of the sun's rays* in the *American Journal of Science and Arts*. In this paper she announced her discovery: different gases absorb heat differently. She put different gases in glass jars and left them in the sun as she measured their temperature. The jar with low-density air (like the air found on top of mountains) stayed cooler, while humid air (like the kind you'd find in swamps or jungles) got much hotter. Foote also found that jars with just carbon dioxide in them got much hotter. Carbon dioxide is an invisible gas emitted by cars, exhaled by humans, and expelled by volcanoes. In fact, Eunice discovered that carbon dioxide absorbs heat more efficiently than any other gas she tried. Because of this, she concluded, "an atmosphere of that gas would give to our earth a high temperature." Today, it is well-known that carbon dioxide and other greenhouse gases are causing climate change. Carbon dioxide is called a "greenhouse gas" because of the warming effect that Eunice discovered. Just as a greenhouse traps heat inside it to keep a gardener's plants warm, carbon dioxide traps heat in the earth's atmosphere.



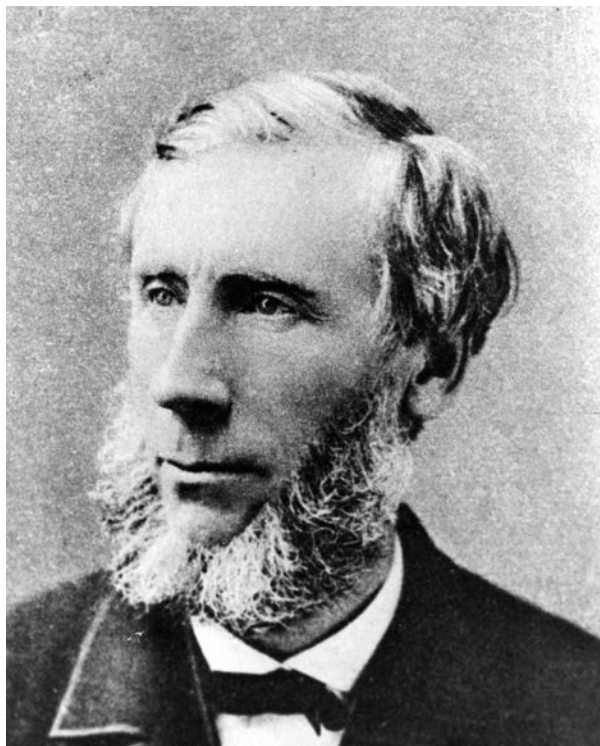
Eunice Foote's work was published in the *American Journal for Sciences and Arts*.

In August 1856, at the 10th meeting of the American Association for the Advancement of Sciences' (AAAS), many scientists presented their research. Eunice Foote's husband Elisha Foote even presented his research and was elected as a member of the society. However, it was not customary for a woman to speak at these meetings. So even though there was no written rule against it, Foote did not present her own work. Instead, Joseph Henry, the Secretary for the Smithsonian Institution, read her work to the society and provided his own commentary on it. He praised her work, but he also failed to understand how significant it was.

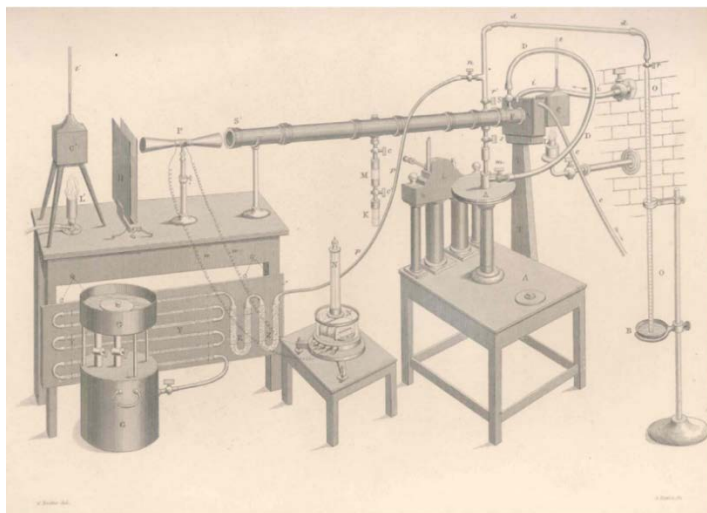
News about Foote's work was published in a few journals in the United States, but it was not mentioned in the AAAS proceedings, the official AAAS record of the meeting. It is unlikely that these reports and her full paper were read much outside of the United States, and her work was mentioned only twice in European journals. Neither of these reports in European journals mentioned her conclusion about carbon dioxide's impact on climate. One publication even referred to her as Mrs. Elisha Foote and miscredited her work! In comparison, her husband's full paper was published by the *Philosophical Magazine*, one of the oldest publications in England, even though his work was less significant than hers.

In contrast, John Tyndall found a lot more publicity for his research than Eunice Foote did. John Tyndall (1820-1893) was already a prominent physicist when he conducted the experiment that revealed carbon dioxide's heat-absorbing power. Tyndall earned his degree in physics while studying under prominent experimental physicists at the University of Marburg. Tyndall became well-known for his work on magnetism and glaciers and was interested in the molecular structures that absorbed heat. For his experiments he had access to cutting-edge technology that Eunice Newton Foote did not. In 1859 when he found that carbon dioxide absorbs heat more than other gasses, he rushed to announce his findings to the Royal Society, and he published outlines of his preliminary work in several European journals. In 1861, he published the major paper with his results but made no mention of its climate

applications. Though Tyndall came to the same conclusion about carbon dioxide as Foote, he was not motivated by the study of climate.



Portrait of John Tyndall, Irish Scientist. Image courtesy of AIP Emilio Segrè Visual Archives, E. Scott Barr Collection



John Tyndall's experimental apparatus.¹

¹ Retrieved from: Jackson, Ronald. "Eunice Foote, John Tyndall and a Question of Priority." *The Royal Institution* 74, no. 1 (February 13, 2019): 105–18. <https://doi.org/10.1098/rsnr.2018.0066>.

It is not known whether Tyndall was aware of Foote's work. There is some evidence he did not know about her conclusions. For instance, he seemed to be surprised by his results on carbon dioxide. He had even initially hypothesized that carbon dioxide *wouldn't* absorb as much heat. In addition, when Tyndall wrote letters to other scientists who were doing similar research, he and the other scientists never mentioned Foote's work. These actions make it seem unlikely that he knew of her work and discovery.

However, there is also some evidence that Tyndall would have known about Foote's work. For instance, one of Tyndall's papers was published in the same journal as Foote's. This indicates that he was aware of the publication and probably read it regularly – maybe he even read the issue where Foote's research was published. Additionally, Tyndall was on the editorial board of *Philosophical Journal*, the publication that selected Foote's husband's work and not hers. The *Philosophical Journal* re-published papers which had already appeared in the *American Journal of Arts and Sciences*. Considering Foote's husband's paper was originally published on the page after Eunice Foote's in the *American Journal of Science and Arts*, whoever selected his work must have also seen, and skipped over, hers. As an editor of the *Philosophical Journal*, Tyndall would have been involved in the selection process. Perhaps Tyndall missed Foote's paper? Perhaps he saw but didn't read her paper? Or perhaps, like Joseph Henry, who read her work for AAAS, he did not understand her results? For now, there is only speculation.

Another reason Eunice Foote did not become as famous as John Tyndall was the poor state of the scientific community in the United States during her lifetime. In the early to mid-19th century, the United States did not have a well-established or globally revered scientific community. Though there had been some internationally regarded scientists in the United States, such as Benjamin Franklin, Europe was still seen as the center of major scientific work. This posed issues for American scientists as it was difficult and uncommon for people to travel across the Atlantic Ocean, and information delivered through the mail moved slowly. To publicize their work across the ocean, American scientists needed connections in Europe, something an amateur, female, scientist like Eunice Foote likely would not have had. Her location and lack of connections would have made it difficult for her to publicize her findings globally.

The United States' international reputation likely impacted the reception of Foote's work, but undoubtedly so did her gender. Most American colleges and universities did not admit women, so she was prevented from receiving a higher level of education. She also lacked the connections with foreign scientific contemporaries and the equipment resources that Tyndall had. She was discouraged from presenting her own work at the AAAS meeting because she was a woman. To add insult to injury, Henry's remarks about her work missed its significance and he was patronizing about her abilities. Tyndall also believed women were less capable scientists than men. Luckily, today we recognize her important contribution to science and give her the credit she deserves.