

# James Cook and the transit of Venus

June 4 2012, By Dr. Tony Phillips

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Portrait of Cook, oil on canvas, Nathaniel Dance, 1735-1811. Credit: National Library of Australia.

*Every ~120 years a dark spot glides across the Sun. Small, inky-black, almost perfectly circular, it's no ordinary sunspot. Not everyone can see it, but some who do get the strangest feeling, of standing, toes curled in the damp sand, on the beach of a South Pacific isle...*

City odors drifted in from Plymouth, across the ship, shoving aside the salt air. Sea gulls fluttered upward, screeching, as the sails snapped taut. The wind had changed and it was time to go.

On August 12, 1768, His Majesty's Bark Endeavour slipped out of harbor, Lt. James Cook in command, bound for Tahiti. The island had been "discovered" by Europeans only a year before in the South Pacific, a part of Earth so poorly explored mapmakers couldn't agree if there was

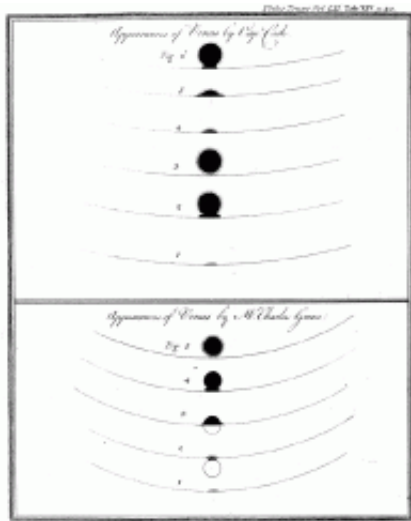
a giant continent there or not. Cook might as well have been going to the Moon or Mars. He would have to steer across thousands of miles of open ocean, with nothing like GPS or even a good wristwatch to keep time for navigation, to find a speck of land only 20 miles across. On the way, dangerous storms could (and did) materialize without warning. Unknown life forms waited in the ocean waters. Cook fully expected half the crew to perish.

It was worth the risk, he figured, to observe a transit of [Venus](#).

"At 2 pm got under sail and put to sea having on board 94 persons," Cook noted in his log. The ship's young naturalist Joseph Banks was more romantic: "We took our leave of Europe for heaven alone knows how long, perhaps for Ever," he wrote.

Their mission was to reach Tahiti before June 1769, establish themselves among the islanders, and construct an astronomical observatory. Cook and his crew would observe Venus gliding across the face of the Sun, and by doing so measure the size of the solar system. Or so hoped England's Royal Academy, which sponsored the trip.

The size of the solar system was one of the chief puzzles of 18th century science, much as the nature of dark matter and dark energy are today. In Cook's time astronomers knew that six planets orbited the sun (Uranus, Neptune, and Pluto hadn't been discovered yet), and they knew the relative spacing of those planets. Jupiter, for instance, is 5 times farther from the Sun than Earth. But how far is that ... in miles? The absolute distances were unknown.



Drawings of the 1769 transit of Venus by James Cook.

Venus was the key. Edmund Halley realized this in 1716. As seen from Earth, Venus occasionally crosses the face of the sun. It looks like a jet-black disk slowly gliding among the sun's true spots. By noting the start-and stop-times of the transit from widely spaced locations on Earth, Halley reasoned, astronomers could calculate the distance to Venus using the principles of parallax. The scale of the rest of the solar system would follow.

But there was a problem. Transits of Venus are rare. They come in pairs, 8 years apart, separated by approximately 120 years. Halley himself would never live to see one. An international team did try to time a Venus transit in 1761, but weather and other factors spoiled most of their data. If Cook and others failed in 1769, every astronomer on Earth would be dead before the next opportunity in 1874.

Cook's expedition is often likened to a space mission. "The Endeavor was not only on a voyage of discovery," writes Tony Horwitz in the Cook travelogue *Blue Latitudes*, "it was also a laboratory for testing the

latest theories and technologies, much as spaceships are today."

In particular, the crew of the Endeavor were to be guinea pigs in the Navy's fight against "the scourge of the sea"--scurvy. The human body can store only about 6 week's worth of vitamin C, and when it runs out seamen experience lassitude, rotted gums, hemorrhaging. Some 18th century ships lost half their crew to scurvy. Cook carried a variety of experimental foods onboard, feeding his crew such things as sauerkraut and malt wort. Anyone who refused the fare would be whipped. Indeed, Cook flogged one in five of his crew, about average in those days, according to Horwitz.

By the time Cook reached Tahiti in 1769, he'd been sailing west for 8 months--about as long as modern astronauts might spend en route to Mars. Five crewmen were lost when the ship rounded stormy Cape Horn, and another despairing marine threw himself overboard during the 10-week Pacific passage that followed. Endeavor was utterly vulnerable as it angled toward Tahiti. There was no contact with "Mission Control," no satellite weather images to warn of approaching storms, no help of any kind. Cook navigated using hourglasses and knotted ropes to measure ship's speed, and a sextant and almanac to estimate Endeavor's position by the stars. It was tricky and dangerous.



The Endeavour is beached in Australia following a collision with the Great Barrier Reef. An engraving from John Hawkesworth's *An Account of the voyages...* Credit: National Library of Australia.

Remarkably, they arrived mostly intact on April 13, 1769, almost two months before the transit. "At this time we had but very few men upon the Sick list ... the Ships compney had in general been very healthy owing in a great measure to the Sour krout," wrote Cook.

Tahiti was as alien to Cook's men as Mars might seem to us today. At least the island was comfortable and well provisioned for human life; the islanders were friendly and eager to deal with Cook's men. Banks deemed it "the truest picture of an arcadia (idyllic and peaceful) ... that the imagination can form." Yet the flora, fauna, customs and habits of Tahiti were shockingly different from those of England; Endeavor's crew was absorbed, amazed.

Perhaps that is why Cook and Banks had so little to say about the transit when it finally happened on June 3, 1769. Venus' little black disk, which could only be seen gliding across the blinding sun through special telescopes brought from England, had a powerful rival: Tahiti itself.

Banks' log entry on the day of the transit consists of 622 words; fewer than 100 of them concern Venus. Mostly he chronicled a breakfast-meeting with Tarróa, the King of the Island, and Tarróa's sister Nuna, and later in the day, a visit from "three handsome women." Of Venus, he says, "I went to my Companions at the observatory carrying with me Tarróa, Nuna and some of their chief attendants; to them we shewd the planet upon the sun and made them understand that we came on purpose to see it. After this they went back and myself with them." Period. If the King or Banks himself was impressed, Banks never said so.

Cook was a little more expansive: "This day prov'd as favourable to our purpose as we could wish, not a Clowd was to be seen ... and the Air was perfectly clear, so that we had every advantage we could desire in

Observing the whole of the passage of the Planet Venus over the Sun's disk: we very distinctly saw an Atmosphere or dusky shade round the body of the Planet which very much disturbed the times of the contacts particularly the two internal ones."

Cook also observed the "black drop effect." When Venus is near the limb of the sun--the critical moment for transit timing--the black of space beyond the sun's limb seems to reach in and touch the planet. This makes it very difficult to say precisely when a transit begins or ends. The effect was not fully understood until 1999 when a team of astronomers led by Glenn Schneider of the University of Arizona studied a similar black drop during a transit of Mercury. They proved<sup>1</sup> the distortion is caused by a combination of solar limb darkening and the point-spread function of the telescope. Cook's observations were clearly affected. Indeed, his measurements disagreed with those of ship's astronomer Charles Green, who observed the transit beside Cook, by as much as 42 seconds.

This was a problem for observers elsewhere, too. When all was said and done, observations of Venus' 1769 transit from 76 points around the globe, including Cook's, were not precise enough to set the scale of the solar system. Astronomers didn't manage that until the 19th century when they used photography to record the next pair of transits.

Cook wouldn't dwell on these matters; there was a lot more exploring to do. Secret orders from the Navy instructed him to leave the island when the transit was done and "search between Tahiti and New Zealand for a Continent or Land of great extent."

For much of the next year Endeavor and her crew scoured the South Pacific, searching for a continent that some 18th century scientists claimed was necessary to balance the great land masses of the northern hemisphere. At one point they were out of sight of land for almost two

months. But the terra australis incognita, the unknown "south land," didn't exist, just as Cook thought all along. Along the way Cook met the fierce Maori of New Zealand and the Aborigines of Australia (encounters both races would lament in later years), explored thousands of miles of Kiwi and Aussie coastline, and had a near-disastrous collision with the Great Barrier Reef.

Later, during a 10-week stopover in Jakarta for repairs, seven seamen died of malaria. The port city was densely populated by people and diseases. Cook left as quickly as possible, but the damage was done. Ultimately 38 of the Endeavour's original company (and 8 who joined later) perished, including astronomer Charles Green. "The ship's 40% casualty rate wasn't considered extraordinary for the day," writes Horwitz. "In fact, Cook would later be hailed for the exceptional concern he showed for the health of his crew."

On July 11, 1771, Cook returned to England at Deal. The survivors had circumnavigated the globe, catalogued thousands of species of plants, insects and animals, encountered new (to them) races of people, and hunted for giant continents. It was an epic adventure.

In the end, the transit was just a tiny slice of Cook's adventure, overshadowed by Tahiti and sabotaged by black drops. But because of the voyage Venus and Cook are linked. In fact, it might be said that the best reason to watch a transit of Venus is history.

Decide for yourself. On June 5-6, 2012, Venus is due to cross the face of the [Sun](#) again. The event will be web cast, broadcast, and targeted by innumerable sidewalk telescopes. In other words, you can't miss it. Look into the inky black disk. It can carry you back to a different place and time: Tahiti, 1769, when much of Earth was still a mystery and the eye at the telescope belonged to a great explorer.

Can you feel the sand between your toes?

Provided by Science@NASA

Citation: James Cook and the transit of Venus (2012, June 4) retrieved 11 May 2024 from <https://phys.org/news/2012-06-james-cook-transit-venus.html>

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