

COMMENT

CLIMATE CHANGE Experts fear permafrost thaw will release more carbon than thought **p.32**

CELL BIOLOGY Time to ditch HeLa lines and move to stem cells **p.34**

NUCLEAR SCIENCE Cold-war defection of an Italian physicist **p.35**



OBITUARY John McCarthy, the father of artificial intelligence **p.40**

H. G. PONTING/POPPERFOTO/GETTY



Terra Nova: Robert Scott's ill-fated 1911 expedition opened up the Antarctic to scientific exploration.

Turning the world upside down

Research, not pole-bagging, was the lasting achievement of Antarctic exploration 100 years ago, says **Edward J. Larson**.

This month, and again in January, hundreds of scientists across Antarctica will set down their tools to mark the 100th anniversaries of the first explorers reaching the South Pole. Most will see the centenaries as simply marking the end of a much-romanticized race between Roald Amundsen's dog-sledging Norwegians and Robert Scott's man-hauling Brits. Yet they should also celebrate those journeys, and the competition involved, for their role in launching Antarctic science.

Competition drove early Antarctic research much as it still drives modern science, but the contest did not begin with Amundsen and Scott's 1911 race to the pole. It had started a decade earlier in the rivalry between Britain and Germany to discover a continent for science. With Britain's Royal Society and Royal Geographic Society and German geophysicist Georg von Neumayer leading the way, a generation of scientists in both countries had lobbied their governments for big-science projects

in the Antarctic. In 1900, scientists in each country used the threat of the other nation gaining the advantage in polar discovery to prod their own to fund what were planned as the first expeditions to winter in the Antarctic. Others rushed in with less ambitious ventures, but the expeditions aboard purpose-built research ships — Britain's *Discovery* and Germany's *Gauss* — launched the heroic age of Antarctic exploration.

What was the science being sought? In 1900, no one knew if Antarctica was ►



Robert Scott, Ernest Shackleton and Edward Wilson (left to right) setting out on the first attempt on the South Pole in 1902.

► a continent or simply a polar ice cap anchored on an archipelago of islands. Yet studies of deep-sea currents and high-altitude weather patterns suggested that the Antarctic governed ocean circulation and influenced the global climate. On the basis of seabed deposits and the fossil record further north, some scientists argued that it must contain a continental landmass, which formerly had been warm enough to support higher plants and had been linked to the other southern continents, serving as a land bridge for species movement. Charles Darwin had proposed the latter hypothesis to account for the abrupt appearance of imprints of *Glossopteris* plants in the fossil record of Africa, South America and Australia. Geophysicists sought reliable data on terrestrial magnetism for deep-southern latitudes and wanted to determine the precise location of the South Magnetic Pole, to which the compass points — a slowly migrating region that, at the time, was located nearly 2,000 kilometres north of the South Geographic Pole.

FIRST STEPS

Commanded by geophysicist Erich von Drygalski, the *Gauss* left Germany in the summer of 1901. It became trapped in pack ice off the little-known Antarctic coast south of the Indian Ocean and its scientists made only limited excursions onshore. They conducted oceanographic, magnetic, meteorological and wildlife research from the vessel for nearly a year before getting out of the ice in February 1903 and heading home prematurely.

Under Scott's command, the *Discovery* expedition also sailed south in 1901. The British team established its winter quarters

on Ross Island in a region already known to contain a coastal mountain range, an active volcano, rich marine life and an ice shelf that some thought might extend to the South Pole. While researchers collected marine and geological specimens, took continual seismic, magnetic and meteorological readings, searched for fossils, discovered the first-known emperor penguin rookery, measured the movement of glaciers and mapped the terrain and coastline, Scott set off for the pole with ship's officer Ernest Shackleton and surgeon Edward Wilson. Although they fell far short of their goal because of poor planning and execution, they marched farther south than any previous party and transformed reaching the pole into a British obsession. Over the next decade, Shackleton and Scott returned to the region with two new expeditions — Shackleton's *Nimrod* expedition (1907–09) and Scott's ill-fated *Terra Nova* expedition (1910–13) — that featured both a polar dash and scientific research.

At a time when the British Empire ruled one-quarter of the world's land area and sought to extend its reach still farther, these British expeditions captured international attention. Newspapers, magazines and book publishers vied for first-hand accounts by Scott and Shackleton. Manufacturers of products ranging from oatmeal and cigarettes to scientific equipment and motor cars supplied their goods free to the explorers in exchange for the chance to tout their use in Antarctica.

Scientists lined up to serve, with Shackleton snagging the distinguished geologist

Edgeworth David as scientific director for his *Nimrod* expedition. Accompanied by his former student Douglas Mawson and others, David climbed the southernmost active volcano and man-hauled heavy sledges more than 1,000 kilometres across sea ice, up a glacier and over the Antarctic Plateau to reach the South Magnetic Pole in January 1909. Such extreme research efforts were typical of the British expeditions.

Stung by Scott's criticism of his physical shortcomings — supposedly a lack of endurance — on *Discovery*'s polar trek, Shackleton had returned south in 1907 with the clear goal of reaching the geographic pole, even as David and the other scientists on his expedition pursued a rich research agenda. Besting the researchers on the *Discovery* expedition on virtually every score, they determined that Antarctica is a continental landmass, plotted the atmospheric patterns radiating from the South Polar Region, found widespread evidence of retreating glaciers, discovered freshwater algae and microorganisms in frozen lakes, and obtained fossil evidence of higher plant life in a land now devoid of it. Antarctica had experienced a temperate climate in earlier epochs, they concluded, and was now warming again. Meanwhile, displaying the determination and survival skills that would make him a legend, Shackleton pioneered a route south across the ice shelf, up the Beardmore Glacier and over the Antarctic Plateau to within 200 kilometres of the South Geographic Pole. It earned him a knighthood on his return home.

SCOTT RETURNS

With the pole still unclaimed, and intent on restoring his pre-eminence in Antarctic exploration, Scott headed south in 1910 aboard the ship *Terra Nova* with more scientists than on any previous polar expedition. "Doubtless there are those who will criticize this provision [for scientific research] in view of its published objectives — that of reaching the South Pole," Scott wrote of his final expedition. "But I believe that the more intelligent section of the community will heartily approve of the endeavour to achieve the greatest possible scientific harvest which the circumstances permit." Scott received more than 8,000 applications for 32 places on the shore party.

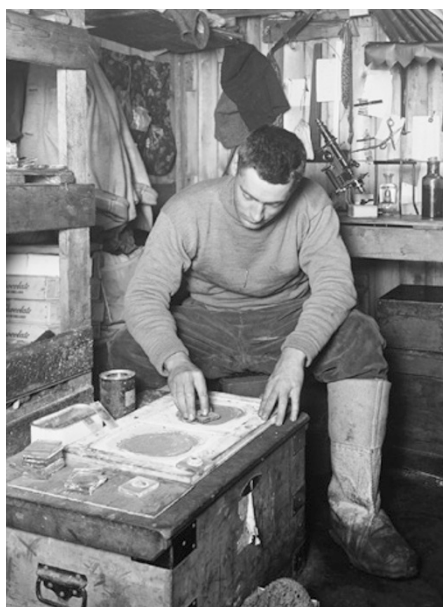
Not knowing of Amundsen's intentions before setting sail, Scott planned a deliberate assault on the pole. Like Amundsen, Scott wintered on the edge of the Ross Sea before embarking in the spring on the arduous trek to the pole. But unlike Amundsen, who travelled light and only with those who would go the entire 1,200-kilometre distance, Scott set off with teams of men, ponies, tractors and dogs that would leave depots of supplies and fall back in stages until only one group remained to man-haul a single sledge over

➔ **NATURE.COM**
For a podcast
on this story,
go to:
go.nature.com/ytfpwk

H. G. PONTING/POPPERFOTO/GETTY



H. G. PONTING/SPRUI, UNIV. CAMBRIDGE (LEFT); H. G. PONTING/POPPERFOTO/GETTY



Terra Nova science (clockwise from top): photographer H. G. Ponting in the Adélie penguin rookery at Cape Royds in 1911; inflating a weather balloon; geologist Frank Debenham grinds rock samples.

the Antarctic Plateau. Scott designed the mission for safety, not speed, and was unable or unwilling to adjust it after learning that Amundsen was also heading south.

Scott's expedition was further burdened with a weighty research agenda. During the first winter, while the Norwegians focused on preparing for their polar dash, the British engaged in a variety of activities. Six men, including geologist Raymond Priestly, a veteran of the Nimrod expedition with proven survival skills, had been dispatched to survey the Ross Sea's northwestern coast, where they spent the winter. The following summer, rather than returning this party to the main base, Scott transferred it to a geologically interesting site farther south on the coast for

a planned month of research, which extended over a second winter when ice blocked the *Terra Nova* ship from extracting the group. Although it made notable findings, the party contributed nothing to the polar dash.

Edward Wilson, the *Terra Nova*'s scientific director, caused another costly diversion by taking a 225-kilometre winter journey to an Emperor penguin rookery. Having visited the site during the Discovery expedition, he wanted to study the birds during the midwinter nesting period. No one had ever tried to travel overland in the dark Antarctic winter, much less haul sledges at temperatures down to -60°C . It nearly killed the three men involved, but two of them, Wilson and H. R. Bowers,

subsequently accompanied Scott to the pole.

A full regime of research continued through the Antarctic winter and into the spring. A month before setting off on the polar journey, Scott himself led a 240-kilometre trek into the Trans-Antarctic Mountains to measure the movement of the Ferrar Glacier. Critics have chided Scott for such actions, which inevitably handicapped him in the race with Amundsen. Two days before departing for Ferrar, however, after reviewing the expedition's scientific work and weighing it against the likelihood of Amundsen beating him to the pole, Scott wrote in his diary: "It is really a satisfactory state of affairs all around. If the [polar] journey comes off, nothing, not even lost priority at the Pole, can prevent the Expedition ranking as one of the most important that ever entered the Polar regions." Science would make it so, and so science must be served.

Of course, the polar journey did not succeed. The Norwegians beat the British to the South Pole and Scott and his four companions died on the way back. The weather was unseasonably cold and the men steadily weakened. Nevertheless, near the end, they stopped to collect fossils from beside the Beardmore Glacier. Wilson had spotted *Glossopteris* impressions, which geologists on all the British expeditions had sought in hopes of proving that the southern continents were once linked to Antarctica. Scott's party hauled these specimens to the final camp, where they were later found with the dead men, their diaries and their field notes.

By the time the findings from the *Terra Nova* expedition had been fully analysed back in Britain, scientists had gained a new appreciation of the Antarctic's global significance. Previously, European and US Earth scientists had given priority to the Northern Hemisphere. With the voyage of the British research ship *Challenger* in the 1870s, they began to realize that undercurrents from the Southern Ocean regulate the marine life and the temperature of the other great oceans, and that air currents from the far south influence the climate farther north. Data collected by Antarctic explorers during the early twentieth century, in large part by scientists travelling with Shackleton and Scott, confirmed that Antarctica's vast glaciers, ice sheets and ice shelves — much more than the Arctic's thin ice cap — influence the global environment. In doing so, they turned the world upside down and put Antarctica on top. ■

Edward J. Larson is university professor of history and law at Pepperdine University, Malibu, California 90263, USA. His most recent book is *An Empire of Ice: Scott, Shackleton, and the Heroic Age of Antarctic Science* (Yale Univ. Press, 2011). e-mail: ed.larson@pepperdine.edu