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SCIENCE AND VOYAGES OF DISCOVERY

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Natural history and geographical knowledge were transformed in the eighteenth century by means of the systematic analysis of virtually all the accessible parts of the planet. From the 1760s onward, the nature of voyages with a broadly scientific goal underwent a rapid evolution. Although some degree of international cooperation was necessary to achieve this change, the increasing mastery of the Pacific was overshadowed by vigorous competition in the same area among the major European powers. Recently there has been an explosion of interest in this development, in particular among scholars located on the Pacific Rim, and the great voyages of the late eighteenth century have been linked to a number of political, imperial, and commercial contexts. Ostensibly scientific missions were usually accompanied by a set of instructions regarding the discovery of either the Northwest Passage, which was supposed to offer a northern entrance into the Pacific, or of *terra australis incognita,* an area that since classical times had been posited as necessary to "balance" the putative excess of land in the Northern hemisphere. In this chapter I survey the major explorations of the century and analyze their broad achievements in a diversity of scientific fields such as ethnography, botany, cartography, and zoology. I argue that the scientific motives behind these forays were usually bound up with, and often inextricably part of, the strategic concerns of governments in Britain, France, Russia, and Spain.[1]

[1] For the significance of mapping in the period, see J. Brotton, *Trading Territories: Mapping in the Early Modern World* (London: Reaktion, 1997). In general, see V. T. Harlow, *The Founding of the Second British Empire, 1763–93,* 2 vols. (London: Longmans, 1952–64); M. Steven, *Trade, Tactics and Territory: Britain in the Pacific, 1783–1823* (Melbourne: Melbourne University Press, 1983); A. Frost, "Science for Political Purposes: European Exploration of the Pacific Ocean, 1764–1806," in R. MacLeod and P. F. Rehbock (eds.), *Nature in Its Greatest Extent: Western Science in the Pacific* (Honolulu: University of Hawaii Press, 1988), pp. 27–44; D. Baugh, "Seapower and Science: The Motives for Pacific Exploration," in D. Howse (ed.), *Background to Discovery: Pacific Exploration from Dampier to Cook*

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Two sets of voyages epitomize the change in the scale of operations that took place during the century. At the beginning of the period, the British Admiralty equipped Edmond Halley in the *Paramore* between 1698 and 1700 to note variations of the magnetic compass and to find the longitudes of various locations on African and South American ports. Nevertheless, he failed to reach the Pacific, a feat that had been achieved by the buccaneer William Dampier a decade earlier. Dampier's book *A New Voyage Round the World* of 1697, with its important observations on ethnography and natural history in the South Pacific and especially New Holland (Australia), prompted support from the Royal Society and convinced the Royal Navy to make him a civilian captain of an expedition to find *terra australis* in 1699. On the *Roebuck,* which sank at Ascension Island in February 1701, Dampier enjoyed even worse relations with his crew than did the unfortunate Halley, although Dampier's expedition did chart some of the coastline of New Holland and he found an island he called New Britain off the coast of New Guinea. At this time all such enterprises were prey to the vagaries of scurvy, a situation not helped by the glaring inability of sailors to determine longitude to a tolerable degree of accuracy while at sea.[2]

A century after the *Roebuck*'s demise, the very names of the vessels indicated a new approach to exploration. In 1801 the British sent out the *Investigator,* commanded by Matthew Flinders, to establish a presence on the west and south of Australia before a French expedition – commanded by Nicolas Baudin in the corvettes *Le Géographe* and *Le Naturaliste* and already on its way – did the same. Despite the strategic imperial function of each undertaking, both missions were overtly "scientific." Baudin had a team of "philosophical travellers" who had been specially primed with lengthy instructions on physical anthropology and craniometry by Georges Cuvier and on ethnography and anthropology by Joseph-Marie Degérando. Both of them, like Baudin, were members of the newly formed Société des Observateurs de l'Homme, and the expedition's entourage boasted a total of seven of its members. This veritable traveling academy was more than matched by the *Investigator,* whose planning and equipping were organized by Joseph Banks, President of the Royal Society between 1778 and 1820. The best scientific instruments and clocks were ordered, and alongside the most up-to-date charts, Banks included

(Berkeley: University of California Press, 1990), pp. 1–55; G. Williams, "The Achievement of the English Voyages, 1650–1800," in Howse, *Background,* pp. 56–80; P. Petitjean, C. Jami, and A. Moulin (eds.), *Science and Empires: Historical Studies about Scientific Development and European Expansion* (Dordrecht: Reidel, 1992); D. Turnbull, *Mapping the World in the Mind: An Investigation of the Unwritten Knowledge of the Micronesian Navigators* (Geelong: Deakin University Press, 1991).

[2] N. Thrower (ed.), *The Three Voyages of Edmond Halley in the "Paramore," 1698–1701* (London: Hakluyt Society, 1981); Commander D. W. Waters, "Captain Edmond Halley, F.R.S., the Royal Navy and the Practice of Navigation," in N. J. Thrower (ed.), *Standing on the Shoulders of Giants: A Longer View of Newton and Halley* (Berkeley: University of California Press, 1990), pp. 171–202; J. C. Shipman, *William Dampier: Seaman-Scientist* (Lawrence: University of Kansas Libraries, 1962); G. Williams, *The Great South Sea: English Voyages and Encounters 1570–1750* (New Haven, CT: Yale University Press, 1997), pp. 106–30.

his own *pièce de résistance:* a greenhouse that would shelter plants against insects, rats, and seawater. With a broad range of scientific goals, these expeditions had efficacious antiscorbutics and could find their longitude accurately by two different methods. Both were concerned with the *detail* of exploration, and it was arguably this "more minute examination" that would transform discovery into commercial and imperial advantage.[3]

Voyages of discovery unlocked the potential for new sources of wealth and imperial expansion, and they captivated an audience back in Europe that was reassessing its own values by means of philosophical, literary, and ethnographic accounts of the "nature" of humankind. Deist challenges to traditional religion forced a rethinking of the truth of revealed religion and in particular of Christianity, and in the second half of the century, critiques of civilization such as those mounted by Rousseau increasingly raised questions about the depravities of the modern world. From the end of the seventeenth century, print culture spawned astonishing numbers of collections of travels and voyages that owed much to the genre of the Grand Tour narrative. Such tales made heroes of George Anson, James Cook, and Louis Antoine de Bougainville, and the plethora of *Voyages* provided numerous resources for fantasy and cultural self-assessment. In turn, contemporary literature colored the expectations both of the travelers to the South Seas and of the artists who illustrated the *Voyages* that inevitably resulted from them. Eighteenth-century fiction exhausted the possibilities of the exotic, from early castaway narratives to the self-discovery and redemption of Crusoe in 1719, and then to a host of "Robinsonades," which, like *Robinson Crusoe* itself, became extremely popular in France. Nevertheless, Edenic depictions of Noble Savages in the 1760s and 1770s were transformed into more jaundiced views of non-Europeans, hastening the appearance of missionaries in the South Seas at the end of the 1790s.[4]

[3] J. Dunmore, *French Explorers in the Pacific,* 2 vols. (Oxford: Clarendon Press, 1965–9), vol. 2, pp. 9–40; M. Hughes, "Tall Tales or True Stories? Baudin, Péron and the Tasmanians, 1802," in R. MacLeod and P. F. Rehbock (eds.), *Nature in its Greatest Extent: Western Science in the Pacific* (Honolulu: University of Hawaii Press, 1988), 65–86, 67–71; R. Jones, "Images of natural man," in J. Bonnemains, E. Forsyth, and B. Smith (eds.), *Baudin in Australian Waters . . .* (Oxford: Oxford University Press, 1988), pp. 35–64; J.-M. Dégerando, *Considérations sur les diverses méthodes à suivre dans l'observation des peuples sauvages* (1800), trans. F. C. T. Moore as *The Observation of Savage Peoples* (Berkeley: University of California Press, 1969); D. MacKay, *In the Wake of Cook: Exploration, Science and Empire, 1780–1801* (London: Croom Helm, 1981), pp. 3–6.

[4] M. N. Bourguet, "L'explorateur," in M. Vovelle (ed.), *L'Homme des Lumières* (Paris: Seuil, 1996); G. R. Crone and R. A. Skelton, "English Collections of Voyages and Travels, 1625–1846," in E. Lynam (ed.), *Richard Hakluyt and His Successors* (London: Hakluyt Society, 1946), pp. 63–140; P. J. Marshall and G. Williams, *The Great Map of Mankind: British Perceptions of the World in the Age of Enlightenment* (London: Dent, 1982); N. Rennie, *Far-fetched Facts: The Literature of Travel and the Idea of the South Seas* (Oxford: Oxford University Press, 1995); B. M. Stafford, *Voyage into Substance: Art, Science, Nature, and the Illustrated Travel Account, 1760–1840* (Cambridge, MA: MIT Press, 1984); B. Smith, *European Vision and the South Pacific: A Study in the History of Art and Ideas,* 2nd ed. (New Haven, CT: Yale University Press, 1985).

THE BACKGROUND TO SCIENTIFIC VOYAGES

For a number of reasons "voyages of discovery" might be connected to what can loosely be called "scientific expeditions," pioneering examples of which were sponsored by the Académie Royale des Sciences in the seventeenth century to procure information useful for navigation. Under the protection of Colbert and Louis XIV, the Académie actively promoted three voyages between 1668 and 1670 that were undertaken with the explicit intention of testing the feasibility of using clocks or Jupiter's satellites to determine longitude, the perennial problem of the sailor. While cartography prospered in Paris through the work of Gian Domenico Cassini and Jean Picard, Jean Richer traveled to Cayenne in 1672 and made measurements on a pendulum that were used by Newton in his *Principia Mathematica* of 1687 to demonstrate that the earth was flattened at the poles.[5] The Royal Society of London published advice in the early numbers of the *Philosophical Transactions* for sailors and gentlemen travelers to make observations in ethnography and natural history and to report back to both the Society and the Admiralty. This influenced the Narborough expedition of 1669–71, which was supposed to report in detail on the coastlines, minerals, and flora and fauna of the South Pacific, although strategically the affair was disappointing. The *Phil. Trans.* regularly published news from all over the known world, and in 1694 Tancred Robinson, a secretary of the Society, remarked anonymously in his introduction to an *Account of Several Late Voyages and Discoveries* that journals kept at sea should be more detailed and "'tis to be lamented, that the English nation have not sent along with their Navigators some skilful Painters, Naturalists and Mechanists."[6]

Any voyage had to respect the current political climate which might prevent a vessel from continuing or even being given fresh water if it was forced into an unfriendly port. With a sizable presence in Indonesia, the Dutch made it difficult to reach the Pacific via the Cape of Good Hope; to Spain the sea west of the Americas was *mare clausum,* and the latter guarded entry around Cape Horn via the Straits of Magellan. Attempting to enter the Pacific from the north, a number of efforts were made in the early eighteenth century to find the celebrated passage that was supposed to exist between the Atlantic and the Pacific. Attention focused on Hudson Bay and the poorly charted coastal region between the Hudson Bay Company post at Fort Churchill and Southampton Island in the north of the Bay. Because of the height of the tides in Ross Welcome Sound, Luke Foxe had suggested in the 1630s that there might

[5] S. Chapin, "The Men from across La Manche: French Voyages, 1660–1790," in D. Howse (ed.), *Background,* pp. 81–127; J. W. Olmstead, "The Voyage of Jean Richer to Acadia in 1670: A Study in the Relations of Science and Navigation under Colbert," *Proceedings of the American Philosophical Society,* 104 (1960), 612–34; Williams, *Great South Sea,* pp. 115–16.

[6] Williams, *Great South Sea,* pp. 115–16; M. Deacon, *Scientists and the Sea, 1650–1900: A Study of Marine Science,* 2nd ed. (Aldershot: Ashgate, 1997).

be a passage to the west of Southampton Island. Despite a disastrous expedition led by James Knight in 1719, efforts to find a passage were promoted by Arthur Dobbs, who, spurred on by the presence of whales in the Sound, suspected the Company of making an inadequate effort to locate the passage. However, further expeditions, including that of Christopher Middleton in 1741–2, failed to find the mythical route that was supposed to exist, and they ended with a substantial loss of life. Nevertheless, a reward offered by an Act of Parliament of 1745 gave further encouragement to private ventures to find a navigable passage, and interest in the possibility of such a route continued in the 1750s and indeed into the nineteenth century.[7]

THE IMPORTANCE OF VENUS

International cooperation on expeditions had been prominent in the 1730s and 1740s, when the French had worked with Spanish and Swedish personnel near the Equator and in Lapland to determine the nature of the shape of the Earth. As a result of these efforts it became accepted by the end of the 1730s that the Earth was flattened at the poles (that is, an oblate spheroid), as Newton and Christian Huygens had argued. Developing still further the models of scientific cooperation provided by these expeditions, astronomers all over the inhabited parts of the globe prepared for an even more ambitious undertaking in the midst of the Seven Years' War (1756–63). This produced a concerted effort to observe the first of two transits of Venus across the Sun in order to find the mean distance of the Earth from the Sun. As with the cartographic and geodesic measurements of the 1730s and 1740s, observations had to be taken from different parts of the globe in order to determine this value more accurately. Prominent in organizing these expeditions was Joseph-Nicolas Delisle, who had been based in Russia between 1725 and 1747. In 1753 he helped to coordinate international observers to measure a transit of Mercury, and useful experience was gained for the 1761 transit. He produced a *mappemonde* that outlined the precise locations on the globe from which various moments of the 1761 transit could be seen, and he sent it to a number of scientific academies across Europe.[8]

Supported generously by the Crown, French astronomers were dispatched to all parts of the planet. Alexandre-Gui Pingré left France at the beginning of

[7] O. H. K. Spate, *The Pacific since Magellan,* vol. 1: *The Spanish Lake,* vol. 2: *Monopolists and Freebooters* (Canberra: Australian National University Press, 1979, 1983); P. Brioist, *Espaces Maritimes au XVIII^e Siècle* (Paris: Atlande, 1997); G. Williams, *The British Search for the Northwest Passage in the Eighteenth Century* (London: Longmans, 1962), pp. 17–25, 46–72. Middleton, who had published a number of papers on the topic in the *Philosophical Transactions* was made a Fellow of the Royal Society and received the Copley Medal for his investigation of magnetic attraction.

[8] R. Iliffe, "'Aplatisseur du monde et de Cassini': Maupertuis, Precision Instruments and the Shape of the Earth in the 1730s," *History of Science,* 31 (1993), 335–75; H. Woolf, *The Transits of Venus: A Study of Eighteenth Century Science* (Princeton, NJ: Princeton University Press, 1959), pp. 31–4, 48–9.

1761 accompanied by an assistant, Denis Thuillier, who had been instructed by the Comte de Buffon to make some collections in natural history. After some initial problems the astronomers arrived at the Isle Rodrigue in the Mascarenes; although their observations of the transit itself on 6 June were affected by cloud cover, they managed to make accurate assessments of the island's flora and fauna as well as its precise location. After a difficult journey from St. Petersburg, Jean-Baptiste Chappe d'Auteroche had a clear view of the transit from Tobolsk in Siberia. However, drawing from Montesquieu's analysis of the influence of climate on physique and morals, he upset Catherine II with some ill-judged remarks about despotic government and the coarse bodies and unrefined minds of people of Northern Europe. The trip of Guillaume-Hyacinthe-Jean-Baptiste le Gentil de la Galaisière was doomed to failure since the British were blockading his Indian Ocean destination (Pondichery) even as he left France, and he was actually at sea when the transit occurred. Using the Isle de France as a base, he remained in the area for a decade and made important astronomical and cultural observations in the Philippines, Madagascar, and, in particular, India.[9]

Nevil Maskelyne oversaw the organization of instruments for the 1761 transit expeditions organized by the Royal Society to Bencoolen in Sumatra and to the island of St. Helena in the South Atlantic. Maskelyne was chosen as chief observer for the St. Helena expedition, and Charles Mason was made principal observer of the Bencoolen voyage with Jeremiah Dixon as an assistant. Responding to an overtly nationalistic appeal from the Society, the Crown made the unprecedentedly generous award of £800 for each. Maskelyne made a number of important measurements of latitude and longitude, although Mason and Dixon experienced tragedy and then farce on their way to Bencoolen. Their ship, the *Seahorse,* was engaged by the *le Grand* in the Channel with the loss of eleven lives, and Mason in particular was convinced to go on to Bencoolen only when the Royal Society threatened legal action, warning that failure to complete their mission would probably result in their "utter ruin" and "an indelible stain on their character." By the time they reached the Cape of Good Hope, news had arrived that the French had taken Bencoolen. Nevertheless, the observers had a clear view of the transit at Cape Town and made an accurate determination of its longitude. Overall, the results of the 1761 expeditions were inconclusive, not least because there was disagreement about the precise moment at which Venus passed the rim of the Sun in its ingress and egress (the points at which the planet's extremities were first and last seen to touch the rim of the Sun).[10]

Despite the importance of Joseph Banks's botanical interests in assessing

[9] Woolf, *Transits of Venus,* pp. 57–61, 66–8, 97–130; F. Marguet, *Histoire de la Longitude à la Mer au XVIIIe siècle, en France* (Paris: A. Challamet, 1917).

[10] Woolf, *Transits of Venus,* pp. 73–96, 130–4; Howse, *Maskelyne,* pp. 18–38; T. D. Cope and H. W. Robinson, "Charles Mason, Jeremiah Dixon and the Royal Society," *Notes and Records of the Royal Society* 9 (1951), 55–78.

the legacy of the voyage of the *Endeavour,* the ostensible scientific aim of the voyage was to make observations of the 1769 transit of Venus in Tahiti. Other expeditions to observe this transit also tested cures for scurvy and the two basic methods for determining longitude – namely, by lunar distance and chronometer. Although Sweden and Russia sponsored an impressive number of observations, the most significant expeditions were those mounted by Britain and France. Le Gentil went to Pondichery, where he had full cooperation from the British Governor but not from the heavens, and he missed the relevant moment because of cloud cover. With two Dollond achromatic refracting telescopes, Chappe d'Auteroche went to San José del Cabo on the southern tip of Baja California and managed to observe the transit on 3 June before he tragically died soon afterward, along with three-quarters of the disease-ridden town. Pingré went to Cap-François, Saint-Domingue, where his efforts to observe the external and internal moments of contact at ingress were successful. The Royal Society organized four expeditions, sending William Wales to Fort Churchill, Mason to Donegal, Dixon to Hammerfest (an island off the coast of Norway), and Maskelyne's assistant William Bayly on the same voyage to North Cape (eight miles northeast of Hammerfest). The fourth involved sending Charles Green to Tahiti on board the *Endeavour* under Lieutenant James Cook. Although there was still difficulty in obtaining exact accounts of the locations at which observations were made, and disagreement over precise moments of ingress and egress, the range of values was much smaller than that obtained from the 1761 expeditions and gave a figure for the mean distance of the Earth from the Sun that was much closer to the modern value.[11]

IMPERIAL VOYAGING

With the Seven Years' War concluded in its favor, the Admiralty took note of the advice of its First Lord, George Anson, that the Falkland Islands be used as a way station into the Pacific, and it launched an expedition under Commander John Byron in 1764. Byron was to survey the Falklands and then explore New Albion – the American coastline north of San Francisco so named by Francis Drake – for the strait of Juan de Fuca, believed by some to be the Pacific entrance of the Northwest Passage. Instead, having accomplished the Atlantic part of the mission and having rounded Cape Horn, Byron turned west for the Solomons but sailed too far north to find the legendary islands. Not long after his return to England in 1766, his ship, the *Dolphin,* was refitted for another foray around the Horn; the new captain, Samuel Wallis, was given secret instructions to search for land between New Zealand and Cape Horn in more southerly latitudes than Byron had looked. Leaving Plymouth in August 1766, Wallis was accompanied by the *Swallow* under the

[11] Woolf, *Transits of Venus,* pp. 154–70, 190–5.

leadership of Philip Carteret, first lieutenant on Byron's ship. The *Dolphin* was stocked with the latest antiscorbutics and had on board a purser who was able to calculate longitude according to the methods laid down by Maskelyne. The two ships parted company after a fraught trip around the Horn, and the ill-equipped *Swallow* limped back to England in May 1769, exactly a year after Wallis's return. Wallis's voyage was made famous by the discovery of Tahiti in June 1767, although it left behind a legacy of venereal disease that was later blamed on the French. Its most significant impact with respect to the first Cook expedition was the belief of the crew that they had sighted the northern tip of *terra australis.*[12]

Having founded a settlement on the Falkland Islands (Les Malouines) in 1764, Louis Antoine de Bougainville was sent back in the *Boudeuse* at the end of 1766 to formally hand it over to the Spanish, whence it became Las Malvinas. The mission was prompted by Byron's voyage and by Charles de Brosses's book, which made the existence of *terra australis* more likely; a further goal of the mission was to find a base in the South Pacific that could serve as the foundation of imperial expansion. Believing by early 1768 that he had sailed too far north to find *terra australis,* Bougainville methodically dismissed the existence of many lands posited by previous sailors and confessed proudly that he was "a voyager and a sailor, that is to say, a liar and an imbecile in the eyes of that class of slothful and arrogant writers, who speculate the livelong day . . . in the penumbra of their study, thus impertinently submitting nature to their imaginations." In early April they reached Tahiti, where Bougainville and his naturalist, Philibert Commerson, enthused over the innocence of the people while the Tahitians marveled at the fact that Commerson's traveling companion, Jean Bart, was actually a woman, Jeanne Baret. Describing the land as *Nouvelle Cythère* after the home of Aphrodite, Bougainville rhapsodized about the therapeutic qualities of the climate and took a Tahitian, Ahutoru, back to France. This practice was copied on Cook's second voyage by Tobias Furneaux of the *Adventure* when he took another Tahitian, Omai, back to England. In June Bougainville reached the Great Barrier Reef whereupon he sailed north through the Solomons, arriving in Batavia after much hardship. Passing Carteret in February 1769, he reached France in March of the same year.[13]

[12] Williams, *Great South Sea,* pp. 214–58; Frost, *Science for Political Purposes,* pp. 27–31; J. C. Beaglehole, *The Exploration of the Pacific,* 3rd ed. (Stanford, CA: Stanford University Press, 1966), pp. 196–213; W. Eisler (ed.), *The Furthest Shore: Images of Terra Australis from the Middle Ages to Captain Cook* (Cambridge University Press, 1995).

[13] Beaglehole, *Exploration of the Pacific,* pp. 213–28; Stafford, *Voyage into Substance,* pp. 48–9; L-A. de Bougainville, *A Voyage around the World,* trans. J. R. Forster (London, 1772); J. E. Martin-Allanic, *Bougainville,* 2 vols. (Paris: Presses Universitaires de France, 1964); E. Taillemite *Bougainville et ses Compagnons autour du Monde, 1766–1769,* 2 vols. (Paris: Impr. Nationale, 1977); M. Mollat and E. Taillemite (eds.), *L'Importance de l'exploration maritime aux siècle des Lumières (à propos du voyage de Bougainville)* (Paris: CNRS, 1982); C. de Brosses, *Histoire des Navigations aux Terres Australes* (Paris, 1756); E. H. McCormick, *Omai, Pacific Envoy* (Auckland: Oxford University Press, 1977).

Commerson was dropped off at Mauritius on the homeward trip and, although he made significant investigations of the local flora and fauna, he died before he could organize the collections made on the voyage. On Mauritius he continued the work of a number of botanists, many of whom were surgeon-naturalists who, since the early part of the century, had searched for material that could form a part of private collections of the Jardin du Roi. Attention turned in the 1740s and 1750s to the role of climate and to the effects of deforestation on moisture in the atmosphere. When Commerson alighted at Mauritius in November 1768, the results of a vigorous policy of deforestation had already been noted by Pierre Poivre, now commissaire-général-ordonnateur of the island and a key figure in early attempts to develop an ecological understanding of natural habitats. Commerson's report on the nature of the island, and of the South Pacific ambience in general, appeared in the *Mercure de France* of February 1769. This text, along with Rousseau's *Julie, ou La Nouvelle Héloïse* and Bougainville's *Voyage,* was among the most influential writings for forming French public opinion about the beauties of island or garden paradises.[14]

TERRA AUSTRALIS: COOK'S FIRST TWO VOYAGES

Before Cook's first voyage in 1768, natural history was the central reason for long-distance travel, with the Jardin du Roi and the Chelsea Physic Garden functioning as important centers for the reception of exotic materials. From the 1730s, a large number of expeditions was organized for his students by Carl von Linné (Linnaeus), whose binomial system of classification was increasingly being adopted by botanists. A number of these protégés, such as Daniel Solander, Herman Spöring, and Anders Sparrman, were also involved in the Cook voyages, although this extensive travel did not result in the import substitutions of staples that Linnaeus wished would benefit his native Sweden. In Britain, thanks to the protection of men such as Sir Hans Sloane, natural history and especially botany had become highly fashionable by the middle of the century. A great deal of this interest was connected to the vogue for stocking gardens with exotic flowers, and a series of networks was created that facilitated the movement of mineralogical and organic merchandise from the corners of the empire back to London. These networks involved collectors in London such as Peter Collinson, John Fothergill, and John Ellis, and various employees of the East India and West India Companies. They

[14] R. Grove, *Green Imperialism: Colonial Expansion, Tropical Island Edens and the Origins of Environmentalism, 1600–1860* (Cambridge University Press, 1996), pp. 158–65, 179–90, 216–41; J. Roger, *Buffon: un Philosophe au Jardin du Roi* (Paris: Fayard, 1989); Poivre, *Travels of a Philosopher; or, Observations on the Manners of Various Nations in Africa and Asia* (Glasgow, 1770); W. Stearn, "Botanical Exploration to the Time of Linnaeus," *Proceedings of the Linnean Society of London,* 169 (1958), 173–96; Y. Laissus, "Les voyageurs naturalistes du Jardin du roi et du Muséum d'Histoire naturelle: essai de portrait-robot," *Revue d'histoire des sciences,* 34 (1981), 259–317. See also J.-J. Rousseau, *Letters on the Elements of Botany addressed to a Lady,* trans. T. Martyn (London, 1782).

also centered on sites such as the Chelsea Physic Garden – whose chief gardener in the middle of the century was Philip Miller – and Kew Gardens, unofficially run by Joseph Banks after 1772.[15]

Natural history was to constitute one of the major scientific purposes of the voyage of *Endeavour,* although the mission had a number of other goals. The Royal Society initially favored Alexander Dalrymple (an expert on what was then known of the South Seas) as captain, but as a civilian Dalrymple ruled himself out by refusing to go either as a passenger or "in any other capacity than having the total management of the ship." Not long before departure they also had to take into account the news of the existence of Tahiti and the supposed *terra australis* that had been conveyed by Wallis. The King generously authorized £4,000 for the undertaking on 24 March 1768, and Lieutenant James Cook was appointed to the command of the vessel. The decision to go to Tahiti (King George's Island) was made on 9 June, and Cook and Charles Green were appointed official observers. The Council of the Society also told its Secretary to "request that Mr B &c may be permitted to go the voyge [sic] & consequently be receivd on board the Ship with their Baggage." The man in question, Joseph Banks, equipped *Endeavour* lavishly for research in natural history with "all sorts of machines for catching and preserving insects" and "many cases of bottles with ground stoppers, of several sizes to preserve animals in spirits." He and his companions were to play a pivotal role in the expedition's success.[16]

During the Seven Years' War, Cook had surveyed the St. Lawrence River in preparation for the assault on Quebec, and in the first half of the 1760s he had charted the coasts of Nova Scotia and Newfoundland, making a number of impressive measurements of various positions by dint of his skill in astronomy. Although he received "hints" from the President of the Royal Society, the Earl of Morton, on issues such as how to deal with natives, his main instructions for the *Endeavour* mission came from the Admiralty. In an attached packet, Cook also had a list of "secret" instructions that urged him to search for the conceivably massive tract of land to the south of the path taken by the *Dolphin.* From Tahiti he was to go to 40°S and search for *terra australis* between that position and 35°S until hitting either Van Dieman's Land (Tasmania) or New Zealand. If the supposed "Large Continent" were discovered he was to make

[15] L. Koerner, "Purposes of Linnaean Travel: A Preliminary Research Report," in D. D. Miller and H. D. Reill (eds.), *Visions of Empire: Voyages, Botany and Representations of Nature* (Cambridge University Press, 1996), pp. 117–37; H. J. Braunholtz, *Sir Hans Sloane and Ethnology* (London: British Museum, 1970); H. B. Carter, *Sir Joseph Banks 1743–1820* (London: British Museum, 1988); J. Gascoigne, *Joseph Banks and the English Enlightenment: Useful Knowledge and Polite Culture* (Cambridge University Press, 1994), pp. 76–94, 109–10; D. E. Allen, *The Naturalist in Britain: A Social History* (Harmondsworth: Penguin, 1978).

[16] J. C. Beaglehole (ed.), *The Voyage of the Endeavour 1768–1771* (Cambridge University Press, 1968), pp. 512–14; H. T. Fry, "Alexander Dalrymple and Captain Cook: The Creative Interplay of Two Careers," in R. Fisher and H. Johnston (eds.), *Captain James Cook and his Times* (Seattle: University of Washington Press, 1979), pp. 41–58.

all sorts of observations of the local people and flora and fauna, as well as the local minerals, which he was to take back to London along with seeds and grains. Failing that, he was to chart the coastline of New Zealand, enjoining the crew not to breathe a word of what they had seen.[17]

A veteran of a surveying expedition to Newfoundland led by his friend Constantine Phipps in 1766, Banks was connected to the London collectors and a growing number of natural historians. He distrusted armchair speculation and system-building and had a penchant for collecting both artificial and natural objects. Nevertheless, although he believed that there was a major difference between the virtuoso collector and the serious natural historian, he viewed the voyage as a Grand Tour unparalleled in its extent. His hand-picked companions included Daniel Solander, whom he knew from the British Museum, and Herman Spöring; they were to be naturalist and assistant naturalist respectively. Although Cook now had some accomplished draftsmen on board, Banks allowed himself the luxury of two men who were highly skilled in pictorial representation. They were Sydney Parkinson, who had already worked for both Banks and the naturalist Thomas Pennant, and Alexander Buchan, who was to die only a matter of days after arriving at Tahiti. Their drawings, copied by engravers for John Hawkesworth's edition of Cook's *Voyage* in 1773, were profoundly influential in shaping the European visual perception of the South Seas, but, as with many writings on the subject, published etchings of non-Europeans and their surroundings tended to depict them according to neoclassical conventions.[18]

Leaving at the end of August 1768, Cook arrived at Tahiti on 13 April 1769. This gave time for Green to supervise the construction of an observatory (at Point Venus) and for Banks and others to collect flora and fauna and to sample the generous hospitality of the locals. Like Bougainville, Banks described the Tahitians and their culture in classical terms, whereas Cook composed a less florid account. Of seminal importance was the decision to take a Tahitian, Tupaia, with them on the remainder of their journey, for it was he who would prove that Tahitians shared a common language with a range of peoples encompassing a much greater expanse of the globe than had previously been imagined. Completing the observations and failing to sight *terra australis,* Cook turned west to New Zealand, where he discovered that the Maoris and Tupaia could communicate with each other. The existence of a widely dispersed family of languages, implying a single root culture, was one of Cook's greatest discoveries. Later he compiled a comparative vocabulary of Tahitian and Maori

[17] Beaglehole, *Endeavour Journal,* 514–19, pp. cclxxix–cclxxxi, cclxxxii–cclxxxiv.

[18] Gascoigne, *Joseph Banks and the English Enlightenment,* pp. 76–8, 112–15; Smith, *European Visions of the Pacific,* pp. 11–12, 16–18; M. Bowen, *Empiricism and Geographical Thought: From Francis Bacon to Alexander von Humboldt* (Cambridge University Press, 1981); A. M. Lysaght, "Banks's Artists and His Endeavour Collection," in T. C. Mitchell (ed.), *Captain Cook and the South Pacific* (Canberra: National Library of Australia, 1979), pp. 9–80; R. A. Rauschenberg, "Daniel Carl Solander: Naturalist on the *Endeavour,*" *Transactions of the American Philosophical Society,* 58 (1968), 1–66; D. J. Carr (ed.), *Sydney Parkinson, Artist of Cook's Endeavour Voyage* (London: Croom Helm, 1983).

and was extremely impressed by Maori carving, which he thought "very little inferior [to] work of the like kind done by common ship carvers in England." Cook made an extremely accurate chart of the North and South Island in six months, and at the end of March 1770 he sailed west again to New Holland, where he encountered aborigines and allowed Banks and Solander to botanize. However, he nearly came to grief on the wrong side of the Barrier Reef. Having charted the coast of New Holland and claimed much of the territory for the King, Cook proceeded to test Torres's claim to have sailed all the way along the south coast of New Guinea. With a chart of Torres's route given by Dalrymple to Banks, Cook successfully negotiated the strait and thence sailed to Batavia for repairs. The expedition greatly increased the sum total of scientific knowledge about the areas covered, and Linnaeus called the material brought back to Europe "a matchless and truly astonishing collection, such as has never been seen before, nor may ever be seen again."[19]

The voyage prompted a number of strategic undertakings by the French and the Spanish to forestall British presence in the Pacific. In turn, the British organized two new voyages. One of these was determined by the belief that ice could not form in saltwater and that there might be a sea free of ice near the North Pole that could serve as a Northwest Passage. The second voyage was to test the hypothesis that *terra australis* might lurk even farther south than other voyages had explored. The northern expedition, led by Constantine Phipps, reached 80°N in the summer of 1773 before it was almost scuppered by ice and was forced to return to England. For the southern trip the newly promoted Cook was naturally chosen as leader, to be accompanied by Banks. This time Cook requested and received the use of two vessels – *Resolution* and *Adventure* (under Tobias Furneaux) – and for the former Banks organized an even larger team than on *Endeavour.* His entrouage included four portrait painters and draftsmen along with Solander and Joseph Priestley, but the latter's religion proved to be too unorthodox for some and James Lind was chosen instead. However, all these preparations came to naught when Cook became concerned by the structural changes that Banks was proposing to make to *Resolution.* Banks accordingly withdrew, instead making a consolation jaunt to Iceland. The Admiralty now appointed Anders Sparrman, Johann Reinhold Forster, and Forster's son Georg as naturalists, with William Hodges as painter, and it selected William Wales and William Bayly as astronomers.[20]

Cook's extraordinary journey in the Southern Ocean began in July 1772.

[19] Beaglehole, *Exploration of the Pacific,* pp. 231–60; B. Finney, "James Cook and the European Discovery of Polynesia," in R. Fisher and H. Johnston (eds.), *From Maps to Metaphors: The Pacific World of George Vancouver* (Vancouver, BC: UBC Press, 1993), pp. 19–30; W. Shawcross, "The Cambridge University Collection of Maori Artefacts, Made on Captain Cook's First Voyage," *J. Polynesian Society,* 17 (1970), 305–48. Solander later teamed with John Ellis to produce a pioneering work in zoology: J. Ellis and D. Solander, *Natural History of Many Curious and uncommon Zoophytes . . .* (London, 1786), and P. Cornelius, "Ellis and Solander's *zoophytes* 1786: Six Unpublished Plates and Other Aspects," *Bulletin of the British Museum (Natural History), (Historical Series)* 16 (1988), 17–87.

[20] Williams, *Northwest Passage,* pp. 159–66; Smith, *European Visions of the Pacific,* pp. 53–4.

Going eastward around the Cape of Good Hope, the expedition was the first to go south of the Antarctic circle, in January 1773, and, having braved icebergs and extraordinary meteorological conditions, *Resolution* reached New Zealand at the end of March. From here Cook went due east until July, whereupon he sailed north to Tahiti. In October he arrived back in New Zealand, having established the position of a number of islands on the way. Here he stocked up on antiscorbutics and, like the naturalists, made further observations on Maori culture. From New Zealand he set out on the perilously high latitudes of the oceans between New Zealand and Cape Horn; discovering no land in the vicinity, he decided to head north to Easter Island, which was sighted in March 1774. Finding that the islanders spoke a language similar to those of the Tahitians and the Maoris, Cook returned to Tahiti via the Marquesas. He left Tahiti in May and spent time charting New Hebrides and New Caledonia before returning to New Zealand; from here he made the long journey eastward at approximately 55°S, which took him to Cape Horn and then all the way to the Cape of Good Hope.[21]

Cook arrived back as a great hero in England at the end of July 1775, having determined that no large continent existed in temperate southern latitudes in either the Pacific or the Atlantic. In many ways, the scientific importance of the second expedition was greater than that of the first: the two methods for determining longitude were successful, Cook again lost no sailor from scurvy, and the Forsters made exceptionally important ethnological observations of non-Europeans. The elder Forster had taught at the Warrington Academy in the late 1760s and had then earned his living by translating texts such as Bougainville's *Voyages* into English. His wide reading was important in determining his more speculative assessments of the influence of climate upon morals, which made up a large bulk of his *Observations.* The Forsters had difficulty obtaining plates from the Admiralty to publish in their books, but the texts exerted a deep influence, especially on the Continent. Johann Forster explicitly set out to describe "nature in its greatest extent," and in his *Ideas for a Philosophy of the History of Man* (1784–91) Johann Herder described him as the "Ulysses" of the Pacific, praising his work on "philosophico-physical geography." Georg Forster, who was one of the first to recognize and articulate the baneful if inevitable effects of Europeans upon other peoples, had important discussions with Alexander von Humboldt before the latter toured Spanish America in 1799. The painter, Hodges, worked closely with Wales and Cook and made accurate drawings of various coastlines for the captain, and in appealing to the art establishment based around the Royal Academy, he made striking efforts to depict the unusual light effects that were experienced in the Antarctic. Wales and Bayly published their results after their return,

[21] Beaglehole, *Exploration of the Pacific,* pp. 261–84; see also A. Gurney, *Below the Convergence: Voyages towards Antarctica, 1699–1839* (London: Pimlico, 1998), pp. 86–185.

and, although Wales disliked the Forsters, he shared with them an interest in meteorological phenomena.[22]

THE NORTHWEST PASSAGE: COOK'S FINAL VOYAGE

Travels in search of a Northwest Passage were still being keenly promoted by lobbyists such as Daines Barrington, and in 1775 a new Act of Parliament was passed offering a reward of £20,000 to anyone who found it. The Admiralty accordingly made plans for a journey to the northwest coast of America and chose the *Discovery* to partner *Resolution,* which was refitted at Woolwich. In early 1776 Cook retired, accepting a post as captain at Greenwich Hospital but with a proviso that his retirement could be canceled if any work that required his special talents should arise. However, doubtless spurred on by the Act, he was soon convinced that he should command the Pacific voyage, and Charles Clerke was appointed captain of the accompanying ship *Discovery.* Journeying via the Cape of Good Hope, Cook was to search for some islands apparently discovered by previous voyagers in the South Pacific, and having deposited Omai in Tahiti he was to speedily move up the northwest coast of America from 45°N until reaching 65°N, after which a careful and detailed survey of the coastline was to take place. This latitude was chosen because since Samuel Hearne had reached the Arctic Ocean from Fort Churchill in the early 1770s without crossing a saltwater strait, it was now known that there was no passage between Hudson Bay and the Pacific. In that case the best choice for a passage appeared to be one from the Pacific into the Arctic Ocean. A Russian map by J. von Stählin of the St. Petersburg Academy of Sciences had just been published, and it depicted Alaska as a large island.[23]

The Russians were perhaps the best placed to mount exploratory missions into the North Pacific, but, due in the main to the largely impassable terrain and the vast distances involved, the colonization of the Kamchatka peninsula (on the far east of Siberia) did not take place until the early eighteenth century. Under Ivan III the Russians had moved eastward from Moscow in the

[22] Smith, *European Visions of the Pacific,* pp. 55–85; M. Hoare (ed.), *The* Resolution *Journal of Johann Reinhold Forster 1772–1775* (London: Hakluyt Society, 1982); M. Hoare, *The Tactless Philosopher: Johann Reinhold Forster, 1729–98* (Melbourne: Hawthorn Press, 1976); G. Forster, *A Voyage Round the World . . . during the Years 1772, 1773, 1774 and 1775,* 2 vols. (London, 1777); J. R. Forster, *Observations made during a Voyage around the World* (London, 1778); J. G. Herder, *Outlines of a Philosophy of the History of Man,* trans. T. Churchill (London, 1800); H. West, "The Limits of Enlightenment Anthropology: Georg Forster and the Tahitians," *History of European Ideas,* 10 (1989), 147–60; W. Wales and W. Bayly, *Original Astronomical Observations made in the course of a Voyage towards the South Pole* (London, 1777).

[23] Williams, *Northwest Passage,* pp. 173–4, 184–92; Williams, "Myth and Reality: James Cook and the Theoretical Geography of North-West America," in Fisher and Johnston (eds.), *Captain James Cook,* pp. 59–76, especially pp. 66–71; H. R. Wagner, *The Cartography of the Northwest Coast to the Year 1800* (Berkeley: University of California Press, 1937).

late sixteenth century, discovering that Siberia had navigable rivers and large reserves of sable, or "soft gold." After their conquests in the Amur Valley were turned over to the Manchu under the Treaty of Nerchinsk in 1689, many Russians – including the entrepreneur fur traders (*promyshlenniki*) – immediately moved northeast to the difficult but profitable land of the Kamchatka peninsula. Because they repeatedly depleted and extinguished commercially valuable fauna as they went, there was clearly an economic need to search the lands to the far east and to exploit whatever might lie on the northwest coast of the American continent.[24]

The main purpose of the famous Kamchatka Expeditions of 1725–30 and 1733–43 (the first under the Dane Vitus Bering and the second under Bering and Aleksei Il'ich Chirikov) was commercial, since Semon Dezhnev had proved in 1648 that Asia and America were separated. Although the first expedition was not deemed to be a success, the second, prompted by the geographer Ivan Kirilov (who saw it as a way of opening trade to China and Japan) was a massive affair comprising as many as two thousand men and taking ten years. Although it had beneficial long-term trading effects, the naturalist who accompanied the second expedition, Georg Steller, was given only a matter of hours to make some observations. The expedition sighted and charted various parts of the Alaskan coastline and brought back sea otter furs, which prompted the *promyshlenniks* to cross the Aleutian islands and begin hunting on the American mainland. At the same time as the second Bering expedition, another one traveled to the west coast of America. In 1732 Mikhail Gwosdev depicted what is now Cape Prince of Wales, although the map was not made public, and the relationship between the coastlines of Gwosdev and Bering remained unclear until Cook's third voyage.[25]

A number of Russian leaders, beginning with Peter the Great in the early eighteenth century, were keen to procure the services of talented foreign personnel to help with cartography and natural history in the massive empire. For example, J. -N Delisle helped to train many of the astronomers who went on the large number of overland expeditions that were organized in the next decades, with varying sorts of scientific purpose. Scientific travel was often generously supported by the Crown, and in 1767 Catherine the Great authorized the acquisition of twenty-one telescopes for six separate expeditions

[24] J. R. Gibson, "A Notable Absence: the Lateness and Lameness of Russian Discovery and Exploration in the North Pacific, 1639–1803," in Fisher and Johnston (eds.), *Maps to Metaphors,* pp. 85–103, 88–90; G. V. Lantzeff and R. A. Pierce, *Eastward to Empire: Exploration and Conquest on the Russian Open Frontier, to 1750* (Montreal: McGill-Queen's University Press, 1973).

[25] Gibson, *A Notable Absence,* pp. 95–6, 102; Williams, *Myth and Reality* pp. 60–5; G. W. Steller, *Journal of a Voyage with Bering, 1741–1742,* trans., M. A. Engel and D. W. Frost (Stanford, CA: Stanford University Press, 1988), p. 75; R. H. Fisher, *Bering's Voyages: Whither and Why* (London: C. Hurst, 1977); E. G. Kushnarev, *Bering's Search for the Strait: The First Kamchatka Expedition, 1725–1730,* trans. and ed. E. A. P. Crownhart-Vaughan (Portland: Oregon Historical Society, 1990); S. Krasheninnikov, *Explorations of Kamchatka, 1733–1741,* trans. E. A. P. Crownhart-Vaughan (Portland: Oregon Historical Society, 1972); and C. L. Urness, *Bering's First Expedition: A Re-examination Based on Eighteenth Century Books, Maps and Manuscripts* (New York: Garland, 1987).

in connection with the observations of the 1769 transit of Venus, sending letters to a number of foreign academies inviting astronomers to observe on Russian soil. With regard to other areas of science, Peter Simon Pallas made many important observations in Russian natural history and maintained a correspondence with a number of other naturalists such as Thomas Pennant.[26]

Given the difficulty of the overland route, some observers had argued that there would be a number of advantages from reaching Kamchatka by means of a circumnavigation, but the next major expedition in the area followed the same overland route to the east coast. Despatched to chart the Aleutians, this effort set off two years late in 1766, and although it surveyed the tip of the Alaskan peninsula and the Shumagin Islands, all four ships under Pyotr Krenitsyn and Mikhail Levashov were wrecked off the Kamchatkan coast. The *promyshlenniks* had a virtual monopoly of the fur trade until the 1780s and knew parts of the Alaskan coastline extremely well, but news of Cook's third voyage and the forthcoming La Pérouse expedition prompted Pallas to recommend a geographical and astronomical expedition to investigate the northern coasts of Russia. This lasted between 1785 and 1794, and although the ship was commanded by one of Cook's crew, Joseph Billings, its results were deemed to be relatively unsuccessful. The substantial Russian achievements in charting the Kamchatkan, Aleutian, and Alaskan waters remained largely unpublished until William Coxe's book on the subject in 1780. This secrecy was a result of a wish to preserve the fur trade monopoly and to disguise the true state of Russian presence in the east, although the Russians' knowledge of the coastlines in the area was patchy.[27]

Cook sailed in July 1776 just over a week after the American Declaration of Independence; ominously, neither the French nor the Spanish believed this time that the major function of this expedition was any other than strategic. With James King as second lieutenant, William Anderson as surgeon-naturalist, and John Webber as draftsman, Cook completed the first part of his voyage and en route to America made contact with a group of isles he named the Sandwich Islands (Hawai'i) in January 1778. He stopped long enough to allow himself and others to make some observations, and again he marveled at the fact that the people spoke a language closely related to Tahitian. On 7 March the northwest coast of America was sighted at 44° 33'. Coasting northward and unwittingly following in the tracks of recent Spanish voyages, Cook believed that he had disposed of the supposed straits to the Atlantic. However, detailed surveying was not to take place until higher latitudes, and in fact he mistook a number of islands for mainland. He landed at Nootka Sound,

[26] Woolf, *Transits of Venus,* pp. 23–49, 179–80; J. R. Masterton and H. Brower, *Bering's Successors, 1745–1780: Contributions of Peter Simon Pallas to the History of Russian Exploration toward Alaska* (Seattle: University of Washington Press, 1948); and C. L. Urness (ed.), *A Naturalist in Russia: Letters from Peter Simon Pallas to Thomas Pennant* (Minneapolis: University of Minnesota Press, 1967).

[27] Gibson, "A Notable Absence," pp. 91–4, 102; W. Coxe, *Account of the Russian Discoveries between Asia and America* (London, 1780).

and repairs on *Resolution* were carried out until April. Cook continued north and then west along the southern coast of Alaska, filling in the areas that were represented only by dotted lines on older maps. As he traveled, he came to share Bougainville's frustration with speculative geographers as the existence of a navigable strait to the Arctic Ocean became increasingly unlikely. Not for the first time he was to fulfill a mission by proving the nonexistence of the geographical object he had set out to find.[28]

Cook continued up the coast until he reached 70° 44'N and encountered impenetrable walls of ice; not only was there no strait to the Arctic from southern Alaska, but a journey through the Bering Strait and across the Arctic Ocean also appeared to be impossible. *Resolution* traversed the Bering Strait to the Asian coast and then turned south, and after meeting Russian traders at Unalaska Cook headed for the Sandwich Islands. Cook was killed in a skirmish in Kealakekua Bay in January 1779, and the ship left Hawai'i only in March, moving north again to Kamchatka. Heading back along the coast of Asia, the two vessels arrived in England in October 1780. In the realms of botany and zoology, the results of the Cook voyages were astonishing, and a number of people, including Cook himself, continued to collect for Banks on the last two voyages. Using the very latest equipment, Cook's surveys ensured that there would be fewer squiggles on maps and thus fewer calls for attempts to find the Northwest Passage and *terra australis.*[29]

IMPLICATIONS OF COOK'S VOYAGES: LONGITUDE AND SCURVY

Although latitude could be measured reasonably accurately, the inability to locate one's longitude (the distance to the west or to the east of a given or "prime" meridian) was the central source of navigational inaccuracy. A favored method was to sail as far as one could to one side of a target and then, having reached the desired latitude, to sail in the supposed direction of the destination. Complex astronomical techniques for determining longitude by means of the satellites of Jupiter had always proved unworkable at sea given the conventional equipment available to the navigator, and a more precise determination awaited the construction of a more suitable instrument or timepiece. With the latter, one could in principle locate one's own position if one knew

[28] Beaglehole, *Exploration of the Pacific,* pp. 290–300; Williams, *Northwest Passage,* pp. 179–83.

[29] Beaglehole, *Exploration of the Pacific,* pp. 301–15; Williams, *Northwest Passage,* pp. 203–11; W. Stearn, "The Botanical Results of Captain Cook's Three Voyages," *Pacific Studies* 1 (1978), 147–62; P. J. P. Whitehead, "Zoological Specimens from Captain Cook's Voyages," *Journal of the Society for the Bibliography of Natural History* 5 (1969), 161–201; S. P. Dance, "The Cook Voyages and Conchology," *Journal of Conchology* 26 (1971), 354–79; A. Kaeppler, *"Artificial Curiosities": Being an Exposition of Native Manufactures Collected on the Three Voyages of Captain James Cook* (Honolulu: Bishop Museum, 1978); H. Friis, *The Pacific Basin: A History of Its Geographical Exploration* (New York: American Geographical Society, 1967).

the time at the prime meridian, since longitude is also given by the simultaneous difference between local time (which could be found relatively easily) and the time at the prime meridian.[30] As an incentive to develop new instruments for this purpose, a Longitude Act of 1714 offered a large reward for an instrument that could accurately determine longitude at sea, and a Board of Longitude was appointed to oversee the business. An added condition – that the technique be easy for use at sea – was brought closer to realization with the invention of the double-reflection quadrant by John Hadley and the American Thomas Godfrey in 1731 and its transformation into the sextant twenty-five years later. Compared with the quadrant, the sextant doubled the number of days each month in which relevant observations were possible. In addition, one would be able in principle to work out what Greenwich time was at any moment if one knew the motions of the moon in advance, by measuring the angular distances between the moon and the sun or stars (the lunar-distance method). Or one could find out Greenwich time by the simpler method of having a timepiece that kept time to relevant accuracy.[31]

In 1757 Tobias Mayer, using equations provided by Leonhard Euler, sent the Board a set of tables that could be used for the lunar-distance method. The Astronomer Royal James Bradley compared them with his own observations at Greenwich and found them sufficiently accurate to determine the moon's place to 75 arcseconds and thus in principle to within a sufficient degree of precision to win the prize. The Seven Years' War made trial at sea difficult, and the tables were first tested properly when Nevil Maskelyne went to St. Helena to observe the transit of Venus. When he returned from St. Helena he published a description of the lunar-distance method in his *British Mariner's Guide.* Mayer's tables, being more accurate than those of Nicolas-Louis Lacaille utilized in the *Connaissance des Temps* (an earlier and less ambitious version of the *Almanac*), were the basis of Maskelyne's *Nautical Almanac and Astronomical Ephemeris for the Year 1767* and the associated *Tables,* which were published at the start of 1767. The Board decided the the *Almanac* should be published three years in advance, an undertaking that required the work of two full-time "computers." Despite the short-term success of the method, Cook ran out of sheets of the *Almanac* on all three voyages, and the future of longitude determination lay with marine chronometers.[32]

The development of chronometers in Britain into a relatively cheap, accurate, and usable device was due to the work of a number of men, in particular John Harrison. Pioneering techniques for coping with problems of lubrication and for compensating for changes in temperature and barometric pressure, Harrison worked on a number of designs from the 1730s. The third timepiece designated with the prefix "H" was not completed until 1757, eight

[30] D. Howse, "Navigation and Astronomy in the Voyages," in Howse (ed.), *Background,* pp. 160–83.
[31] Howse, *Navigation,* pp. 168–9.
[32] D. Howse, *Maskelyne: The Seaman's Astronomer* (Cambridge University Press, 1989), pp. 14–15, 85–96.

years after he had been recognized by the Royal Society with the award of the Copley Medal. Harrison showed the next and ultimately prize-winning timepiece, H.4, to the Board of Longitude in 1760, and, after some problems, a trial of the machine in Barbados in 1764 was a complete success. Further difficulties ensued with Maskelyne and the Board before Harrison could receive his reward, the most serious being the need to make a complete disclosure of the mechanism to a small selection of watchmakers and scholars. Although this was done in August 1765, the Harrisons remained at loggerheads with various members of the Board, especially Maskelyne, until the second half of the £20,000 prize was granted in 1773.[33]

One of the horologers present at the demonstration, Larcum Kendall, took two and a half years to complete his copy of H.4, and it was this device (K.1) that went with Cook on his second voyage. The watch had maintained a constant going "rate" (that is, the amount of seconds by which a timepiece gains or loses per day) of between 9 and 13 seconds since April 1773, and when this was taken into account it was remarkably accurate; Cook called it his "trusty friend" and "never-failing guide." Three of John Arnold's chronometers went with K.1. on Cook's *Resolution,* whereas Thomas Earnshaw produced the standard design used in the construction of the marine chronometer for the next 150 years. Two of his timepieces would later accompany George Vancouver on the *Discovery,* along with K.3 and two Arnold chronometers.[34] The French had long been developing their own version of the marine chronometer, and Pierre LeRoy's "A" and "S," and Ferdinand Berthoud's No. 6 and No. 8 timepieces were tested on a number of ships between 1768 and 1773, with Berthoud receiving most of the awards. Although some manufacturers such as Earnshaw pioneered the standardization of manufacture for chronometers and built large numbers of them, LeRoy's complex and innovative watches were never built in large quantitites. On the other hand, in 1792 Berthoud remarked that more than fifty of his own timepieces had been used in eighty voyages.[35]

It was generally recognized in the late sixteenth century that oranges and

[33] Howse, *Maskelyne,* pp. 40–1, 46–7, 50–2; H. Quill, *John Harrison: The Man Who Found Longitude* (London: John Baker, 1966); R. T. Gould, *The Mariner's Chronometer: Its History and Development* (London: J. D. Potter, 1923); W. J. H. Andrewes (ed.), *The Quest for Longitude* (Cambridge, MA: Collection of Historical Scientific Instruments, 1996); W. J. H. Andrewes, "Even Newton Could Be Wrong: The Story of Harrison's First Three Sea Clocks," in Andrewes (ed.), *Quest for Longitude,* pp. 189–234, especially pp. 195–6, 206–7, 211.

[34] Quill, *Harrison;* Gould, *Chronometer,* p. 258; J. Betts, "Arnold and Earnshaw: The Practical Solution," in Andrewes (ed.), *Quest for Longitude,* pp. 312–28, especially pp. 320, 326–8; D. Howse, "The Principal Scientific Instruments Taken on Captain Cook's Voyages of Exploration, 1768–1780," *Mariner's Mirror,* 65 (1979), 119–35; A. C. Davies, "Vancouver's Chronometers," in Fisher and Johnston (eds.), *Maps to Metaphors,* pp. 70–84.

[35] Gould, *Chronometer,* p. 83; C. Cardinal, "Ferdinand Berthoud and Pierre Le Roy: Judgement in the Twentieth Century of a Quarrel Dating from the Eighteenth Century," in Andrewes (ed.), *Quest for Longitude,* pp. 281–92, especially pp. 287–8, 292; J. Le Boy, "Pierre le Roy et les horloges marines," in C. Cardinal and J-C Sabrier (eds.), *La Dynastie des Le Roy, Horlogers du Roi* (Tours: Musée de Beaux-Arts, 1987), pp. 43–50; C. Cardinal, *Ferdinand Berthoud, 1727–1807: Horloger Mécanicien du Roi et de la Marine* (La Chaux-de-Fonds, Switzerland: Musée International d'Horlogerie, 1984).

lemons could restore the health of sailors on long voyages, especially combined with dry clothes and clean ship, although citrus fruits were more often than not accompanied by copious amounts of cider. In the eighteenth-century British Royal Navy, scurvy caused more losses than enemy action, and until 1750 there was little progress in relating the onset of the disease to a lack of specific foodstuffs. In 1746 James Lind, who had joined the Navy as a surgeon's mate in 1739, tried an experiment aboard a ship where scurvy had broken out in which six groups of two men with the disease were given different remedies, including oranges and lemons. Those given a diet of oranges and lemons did best, although this information was not seen as conclusive by the Navy.[36]

Lind argued in his treatise of 1753 that scurvy, being unknown in dry places, was caused by moisture that clogged the skin's pores and made the air unfit for breathing. Rather than the ventilation of ships, exercise and some raw onion and garlic would steel the mariner against the vagaries of climate, whereas the best cure was a change of air. However, in the 1772 edition of Lind's work, he was more inclined to recommend regular exercise and a diet "of easy digestion." Significantly for Cook's voyages, the President of the Royal Society, Sir John Pringle, argued that fever among troops and prisoners resulted from air vitiated by filth and sweat, and he recommended the use of "antiseptic" substances such as vinegar, lemon juice, tobacco smoke, and "fixed air" (carbon dioxide). Following this, David MacBride urged the consumption of wort, a malt preparation, as it contained a large amount of fixed air. This was found to be revolting during trials in the early 1760s, but Pringle nevertheless urged that it be tried on long voyages. It was for his attempts to impregnate water with fixed air that Joseph Priestley was awarded the Copley Medal by the Royal Society in 1773, and Cook took some of this specially prepared liquid on the second voyage.[37]

When he took command of *Endeavour* in 1768, Cook was determined that the voyage would constitute a rigorous trial of both new and familiar cures. Although nobody died from the disease on the voyage, he had a hand-picked crew and the vessel was never away from land for more than seventeen weeks. On board were various preventives for scurvy, including sauerkraut, which the sailors initially despised but then ate when they saw Cook and his officers doing the same. Along with this, wort and rob (the boiled essence of oranges and lemons) became favored foods on *Endeavour,* although Joseph Banks continued to praise the antiscorbutic virtues of fixed air and fresh vegetables (despite having "flown" to lemon juice when he thought he had contracted the disease). On his second voyage Banks guarded particularly against the

[36] K. J. Carpenter, *The History of Scurvy and Vitamin C* (Cambridge University Press, 1986), pp. 15–21.

[37] Carpenter, *History of Scurvy,* pp. 51–60, 64–6, 70–1; C. Lawrence, "Disciplining Disease: Scurvy, the Navy, and Imperial Expansion, 1750–1825," in Miller and Reill, *Visions of Empire,* pp. 80–106, especially pp. 86–7; James Lind, *A Treatise of the Scurvy* (Edinburgh, 1753; 3rd ed. London, 1772).

putrefaction of air that could result from dirty bedding and clothing, and he was awarded the Copley Medal in 1776 for a paper on scurvy in which he praised wort and sauerkraut but also the value of proper discipline. Not least because of repeated ignorance of what actually caused scurvy, lemon juice was adopted on a large scale by the British Admiralty only in the late 1790s, and other nations' navies continued to suffer from the disease well into the following century.[38]

AFTER COOK

The Cook expeditions provided a template for the way in which all countries organized similar undertakings before 1800. Of these, the most ambitious was probably that mounted by the French under the leadership of Jean-François Galoup de La Pérouse, which sailed from France at the start of August 1785. This expedition was designed to investigate the American and Asian coastlines and to explore the potential for fur trading and whaling – as well as to assess the degree of Russian, American, and British participation in these activities. However, it was also probably the most extensive scientific expedition mounted to that time, and La Pérouse's *Boussole,* accompanied by the *Astrolabe,* possessed a large number of astronomers, skilled draftsmen and naturalists. La Pérouse was given detailed instructions on how to create a "descriptive catalogue" of "natural curiosities" and on how to collect ethnographic information: "he will order the garments, arms, ornaments, utensils, tools, musical instruments, and everything used by the different people he shall visit to be collected and classed; and each article to be ticketed, and marked with numbers corresponding to that assigned in the catalogue." Traversing most of the Pacific Rim, the expedition tragically foundered on the reef of Vanikoro (off the Santa Cruz islands) in early 1788. However, La Pérouse managed to send back information as he went, and his voyage was influential in reversing the positive view of non-Europeans that was standard at the time – influenced no doubt by the massacre of the captain of the *Astrolabe* and eleven others at Samoa.[39]

After the Revolution in 1789 the French mounted another spectacular voy-

[38] Carpenter, *History of Scurvy,* pp. 77–83; Lawrence, *Disciplining Disease,* pp. 87–8; J. Watt, "Medical Aspects and Consequences of Cook's Voyage," in Fisher and Johnston (eds.), *Captain James Cook,* pp. 129–58, especially pp. 130–5. Of *Endeavour*'s company, forty-one of the original ninety-eight died before Cook returned, the majority dying of malaria and dysentery in Batavia and en route from Batavia to the Cape of Good Hope in early 1771.

[39] Dunmore, *French Explorers,* vol. 1, pp. 250–82; Beaglehole, *Exploration of the Pacific,* pp. 318–19; Smith, *European Visions,* pp. 137–54, especially p. 139; M. L. A. Milet-Mureau, *A Voyage around the World . . . by J.F.G. de La Pérouse,* ed. J. Johnston, 4 vols. (London, 1798); C. Gaziello, *L'Expédition de La Pérouse, 1785–88: Réplique Française aux Voyages de Cook* (Paris: CTHS, 1984); J. Dunmore and M. de Brossard, *La Voyage de Lapérouse, 1785–88: Récit et Documents originaux* (Paris: Imprimerie Nationale, 1985).

age to the Pacific, this time commanded by Bruni d'Entrecasteaux. The two ships – *Recherche* and *Espérance* (under Huon de Kermadec) – went in search of La Pérouse, and, although they did not attain this objective, they made a number of significant discoveries and cartographic corrections in the Australasian region, particularly in charting the correct geography of the Solomons. Their investigation of the southeast corner of Tasmania and of the southwest corner of Australia paved the way for the more extensive charting of the Australian coastline by Baudin, although before that (in 1797) Bass demonstrated that Tasmania and Australia were in fact separate. The undertaking ended when the two captains died within a few months of each other in 1793 and other members of the team were captured and imprisoned at Java – anticipating the fate of Matthew Flinders a decade later when he was detained in Mauritius by the French for seven years. The account of the expedition by *Recherche*'s naturalist, Jacques Julian de Labillardière, offered yet another view of non-Europeans, this time depicting them as stoical, rational, and capable of civilization.[40]

The Spanish invested more money in botanical expeditions over the last few decades of the century than any other nation, but it was the British who were best able to collate and make use of the vast amounts of information (Spanish material largely excepted) pouring back into Europe from the peripheries. Joseph Banks played a pivotal role in organizing the British expeditions that followed Cook, and he built up a series of vast networks that allowed local analysis, minerals, and organic material itself to be sent back to London. As President of the Royal Society, Banks had extremely close connections with powerful institutions such as the Admiralty and the Board of Trade, and he supplied them with information that might prove strategically useful just as they helped serve his real interests in natural history. Banks took it upon himself to continue the style of the explorations begun by Cook, and in 1780 James King (who had taken over command of *Discovery* after Clerke died) told Banks that he looked upon him "as the common Centre of we discoverers."[41]

Aided by his membership in organizations such as the African Association, Banks promoted travels such as those by Mungo Park into the interior of Africa, and he was keenly interested in acquiring useful information that might arise from the Macartney expedition to China in the early 1790s. He also had contact with well over a hundred collectors from China to South America and Africa, and with the help of powerful patrons such as the Duchess of Portland

[40] Dunmore, *French Explorers,* vol. 1, pp. 283–314; J. J. H. de Labillardière, *Voyage in Search of La Pérouse, Performed by Order of the Constituent Assembly during the Years 1791, 1792, 1793 and 1794* (London, 1800).

[41] D. P. Miller, "Joseph Banks, Empire, and 'Centres of Calculation' in Late Hanoverian London," in Miller and Reill, *Visions of Empire,* pp. 21–37, especially p. 29; D. MacKay, "A Presiding Genius of Exploration: Banks, Cook and Empire, 1767–1805," in Fisher and Johnston (eds.), *Captain James Cook,* pp. 21–40.

he sponsored more than twenty individuals on specific collecting missions. These men sent back observations and analysis not merely of flora and fauna of interest to natural history but also of various flowers and crops that might either flourish as exotics in Britain or be transplanted to colonial outposts. Plant specimens were analyzed at Kew, and other "curiosities," reflecting Banks's continuing gentlemanly interest in antiquities and later in anthropology, were kept at his houses in New Burlington St. and (later) Soho Square.[42]

Banks played crucial roles in a number of ventures, such as the colonization of New South Wales and attempts to grow staples there; the efforts to transplant breadfruit from Tahiti to the West Indies to feed slaves; and the voyage led by George Vancouver to survey the northwest coast of America and to consolidate British presence. All these endeavors explicitly entangled scientific knowledge with imperial power and commercial advantage. A number of reasons, such as its strategic benefits and the fear that La Pérouse was going to install a colony in New Zealand, prompted the British to take a serious interest in the imperial potential of New South Wales. The Governor of the colony, Arthur Phillip, was keen to develop the production of cotton, cochineal, and coffee and turned to Banks for advice; Philip reciprocated by sending botanical and zoological exotica back to London. Plans to take breadfruit to West Indian plantations were stalled by the American War of Independence, but when this ended in 1783 the need to bolster the plantations was more pressing than ever. Banks was responsible for the appointment of William Bligh as commander of the *Bounty,* and after the notorious events on that voyage, Banks made the complex botanical arrangements for Bligh's ensuing trip in the *Providence.* This succeeded where the *Bounty,* despite enjoying the specialist skills of the gardener David Nelson, had conspicuously failed. Banks's expertise was crucial in ensuring the success of the breadfruit transplantation, although this did not mean that the foodstuff was readily incorporated into the local diet.[43]

The voyage led by George Vancouver between 1791 and 1795 was the last great exploratory mission launched by the British in the eighteenth century. Its context was both imperial and commercial, and Vancouver's mission had a complex prehistory that was related to the rapid expansion of whalers and fur traders into the Pacific. Initially headed for the South Atlantic, the route to be followed by *Discovery* was suddenly changed in the wake of the Nootka

[42] D. MacKay, "Agents of Empire: the Banksian Collectors and Evaluation of New Lands," in Miller and Reill (eds.), *Visions of Empire,* pp. 38–54, especially pp. 39, 45–6, 49–50; Gascoigne, *Joseph Banks,* pp. 80–2, 149–57; S. Schaffer, "Visions of Empire: Afterword," in Miller and Reill (eds.), *Visions of Empire,* pp. 335–52, especially p. 345.

[43] D. Mackay, *In the Wake of Cook,* pp. 123–40; C. A. Bayly, *Imperial Meridian: The British Empire and the World, 1730–1830* (London: Longman, 1982); A. Frost, *Convicts and Empire: A Naval Question, 1776–1811* (Oxford: Oxford University Press, 1980). Nelson's plants were all thrown overboard during the mutiny, and he died before the *Bounty* returned to England; see also J. Browne, "A Science of Empire: British Biogeography before Darwin," *Revue d'Histoire des Sciences* 45 (1992), 453–75, especially 465.

Sound incident and in the light of new fears about U.S. activity near what is now Vancouver Island. A veteran of the second and third Cook expeditions, Vancouver was made commander, with Banks's choice, Archibald Menzies, as naturalist, although the extent of scientific representation on board was relatively small. Vancouver accurately surveyed the coastlines between 30°N and 60°N (that is, south of where Cook had made his detailed survey) and showed that there was no Northwest Passage hiding behind the large islands. Menzies was given a detailed set of instructions by Banks for observing, collecting, and preserving various specimens he might encounter on his passage, and he was told to pay special attention to the suitability of a location for settlement. Although Vancouver fell out badly with Menzies even before they set out and his rather dull book of the voyage appeared when the vogue for such publications was on the wane, his meticulous enterprise fulfilled the multifunctional roles that had long been the norm for all such travels and paved the way for the voyages of Flinders and his successors.[44]

SPANISH VOYAGES

Like the Russians, the Spanish had a policy of keeping the bulk of their results secret, and rumors of real or false Spanish discoveries on the northwest coast of America galvanized a number of voyages in the eighteenth century. By the beginning of the century, these voyages had amassed a great deal of information relating to the South Pacific and the west coast of South America and New Spain. For example, Luis Vaez de Torres had passed between Papua New Guinea and Australia through the straits named after him in 1606, although this fact long remained secret, leaving a number of geographers for more than a century and a half to believe that Papua New Guinea was actually the northernmost point of *terra australis.* In the eighteenth century, Spanish claims to the Pacific and its coastlines looked increasingly fragile as the French, Russians, and British sought to construct colonies and trading presences in the South Seas and on the coast of North America.[45]

Spaniards accompanied a number of French expeditions to South America in the first half of the eighteenth century, the most significant being the presence of Antonio de Ulloa and Jorge Juan on the journey to Peru between 1735 and 1744. Juan and Ulloa produced a best-selling public version of their extraordinary experiences on the ill-fated voyage, and they also wrote "Noticias secretas de América" for the eyes of the king only. However, serious support for Spanish botanical exploration began in the reign of Carlos III (1759–88).

[44] Mackay, *In the Wake of Cook,* pp. 57–116; J. C. H. King, "Vancouver's Ethnography: A Preliminary Description of Five Inventories from the Voyage of 1791–95," *J. Hist. Collections,* 6 (1994), 35–58.

[45] Beaglehole, *Exploration of the Pacific,* pp. 98–103; W. L. Cook, *Flood Tide of Empire: Spain and the Pacific Northwest, 1543–1819* (New Haven, CT: Yale University Press, 1973).

The monarch sought to promote a Spanish Enlightenment with a strong emphasis on natural knowledge and its practical benefits, and he sponsored the building of a Royal Botanical Garden, a Museum of Natural Science, a Royal Academy of Medicine, and an Astronomical Observatory. With his backing, two naval officers accompanied Chappe d'Auteroche in observing the transit of Venus in 1769, and in 1777 the king supported the expedition through Chile and Peru of the botanists Hipólito Ruiz and José Antonio Pavón and the French naturalist Joseph Dombey, an expedition that lasted until 1788.[46]

When the Spanish heard in 1774 of possible extensions by the Russians from Kamchatka to the American continent, the Viceroy of New Spain, Antonio María Bucareli y Ursúa, was ordered to send exploratory teams up the Pacific coast to determine the extent of Russian involvement and to take formal possession of the coast. The Spanish were more interested in turning the natives to Christianity than were the early French or British expeditions, and there was a strategic interest in a realistic portrayal of peoples who might be significant allies against other European powers. Bucareli chose Juan Peréz, an experienced seaman, to command the first expedition, and the latter sailed in the *Santiago.* Unable to land, Peréz made significant observations of the communities on the northwest coast of America with his second officer, Esteban José Martínez. Since no formal claims of possession had been made, Bucareli sent off another voyage the following year, under Bruno de Hezeta. In the accompanying schooner, the *Sonora,* Juan Francisco de la Bodega y Quadra landed at 57° 2' and took possession of the land for Spain in sight of Mount Edgecombe. When he learned of Cook's intended voyage in 1776, the Minister of the Indies ordered a new expedition; this was led by Ignacio Arteaga on the *Princesa,* accompanied by Bodega on the *Favorita,* and left San Blas in February 1779. It produced detailed cartographic and ethnological accounts of the region around Bucareli Bay on the west coast of Prince of Wales Island.[47]

When news arrived in the mid-1780s of substantial Russian presence as far south as Nootka Sound, the Spanish again responded. This time Martínez was given command of an expedition, which sailed in March 1788, and with the threat of U.S. involvement in the region, yet another undertaking under Martinéz was ordered for 1789 to bolster Spanish claims to sovereignty of the coast. It was Martínez who put James Colnett in irons in July 1789 and sent him, along with his *Argonaut,* down to San Blas, setting in motion the so-called "Nootka Sound incident" that paved the way for negotiations between the Spanish and the British to discuss the sovereignty of the northwest coast

[46] I. H. W. Engstrand, *Spanish Scientists in the New World: The Eighteenth Century Expeditions* (Seattle: University of Washington Press, 1981), pp. 6–8; V. von Hagen, *South America Called Them* (New York: Knopf, 1945), p. 300; A. R. Steele, *Flowers for the King: The Expedition of Ruiz and Pavón and the Flora of Peru* (Durham, NC: Duke University Press, 1964).

[47] C. I. Archer, "The Spanish Reaction to Cook's Third Voyage," in Fisher and Johnston (eds.), *Captain James Cook,* pp. 99–119, especially pp. 100–9. Hezeta discovered the Columbia River and named it the Entrada de Hezeta, although the American Robert Gray renamed it in 1792.

of America. Despite – or because of – their territorial goals, all the Spanish expeditions in the 1770s, 1780s, and 1790s placed a high level of importance on the need to acquire accurate information on mineralogy, meteorology, and ethnography, and the remarkable voyage of Alejandro Malaspina was explicitly devised to rival the scientific achievements of the LaPérouse and Cook expeditions.[48] Having completed a circumnavigation between 1786 and 1788, Malaspina and José Bustamante y Guerra submitted a plan to the Spanish Minister of Marine, Antonio Valdés, for "a Scientific and Political Voyage around the World." Malaspina requested two botanists or naturalists and two artists and was granted the command of the *Descubierta;* Bustamante was given charge of the *Atrevida.* Malaspina selected Lieutenant Antonio Pineda y Ramírez of the Royal Spanish Army as the main natural historian, to be assisted by Luis Née, who had a great deal of experience working for the Royal Botanical Garden. Meanwhile, the newly crowned Carlos IV recommended that the expedition take advantage of the availability of the botanist and naturalist Tadeo Haënke (who became the first person to describe the redwood tree in a European publication).[49]

During 1790 the ships moved slowly up the west coast of South America until they arrived off the coast of Panama, where they went on separate routes. The *Atrevida,* with Arcadio Pineda, Née, the artist José Guío, and the physician-naturalist Pedro María González, sailed on to Acapulco and then on to San Blas. Joining the *Descubierta* in Acapulco in April 1791, Malaspina announced that he had a new brief from Carlos IV to find the Northwest Passage. Accordingly, the ships set sail in May, leaving behind Antonio Pineda and others to explore the local flora and fauna; the personnel at sea had been increased by the addition of the artists José Cardero and Tomás de Suría.[50] Once Malaspina had left, two botanists and an artist from the Royal Scientific Expedition to New Spain (1785–1803), led by Martin de Sessé, accompanied Bodega y Quadra, whose ultimate goal was to sort out territorial issues with Vancouver. The most significant naturalist on board was José Moziño, who made by far the most detailed contemporary linguistic, ethnographic, and historical study of the Nootka Indians. In the meantime the recently returned *Descubierta* and *Atrevida* left Acapulco in December 1791 to explore the Pacific Islands. Leaving the Philippines early in 1792, the expedition toured various sites on the Pacific Rim and finally reached Cadiz in February 1794. Some members enjoyed success: Née collected more than ten thousand plants on his tour and spent a great deal of time ordering his observations in Madrid.

[48] Archer, "Spanish Reaction," pp. 109–12, 114; Cook, *Flood Tide,* pp. 146–99.

[49] Engstrand, *Spanish Scientists,* pp. 44–9; D. C. Cutter, "The Return of Malaspina: Spain's Great Scientific Expedition to the Pacific, 1789–1794," *American West,* 15 (1978), 4–19; M. D. H. Rodriguez, *La Expedición Malaspina 1789–1794* (Madrid: Ministerio de Cultura, 1984); V. G. Claverán, *La Expedición Malaspina en Nueva España (1789–1794)* (Mexico: El Colegio de Mexico, 1988).

[50] Engstrand, *Spanish Scientists,* pp. 50–76; T. Vaughan, E. A. P. Crownhart-Vaughan, and M. P. de Iglesias, *Voyages of Enlightenment: Malaspina on the Northwest Coast 1791/1792* (Portland: Oregon Historical Society, 1976).

Malaspina was more unfortunate, being first compromised at court and then sentenced to ten years' imprisonment.[51]

CONCLUSION

In alliance with imperial and commercial interests, scientific travel extended the bounds of European empires and brought home the effects of European expansion both on the natural world and on fellow human beings. As reading publics became sated with depictions of Others, the culture of collecting that accorded value to items on the grounds of their exotic value was increasingly disparaged. From the 1790s onward, commanders of voyages had specific instructions to make detailed assessments of coastlines, and naturalists were to collect botanical and zoological specimens for *analysis.* The same "analytic" approach applied also to the study of non-Europeans. The collection of ethnographies revealed novel patterns and differences and facilitated the appearance of a value-laden ethnology and anthropology. As indigenous peoples slowly recovered from the ravages of European diseases, they were beset by a scientific racism allied to craniometry. However, it also became clear that the planet was not an inexhaustible resource and that it would require careful management if it was not soon to be ravaged.

By the end of the eighteenth century, navigators and naturalists had at their disposal instruments that were undreamed of a hundred years earlier, capable of measuring phenomena of which their forbears were equally unaware. With a grasp of detail it was now possible to begin the systematic investigation of regional similarities and differences over a planet much diminished in size, and various forces could be linked to form a general science of terrestrial phenomena. Ambitious efforts such as those of Alexander von Humboldt to reveal the "cooperation of physical forces" and hence to display the underlying unity of Nature promised to link all corners of the Earth in a "global physics." Humboldt's narrative of his five-year odyssey to South America depicted what Mary Louise Pratt has called "a dramatic, extraordinary nature, a spectacle capable of overwhelming human knowledge and understanding," and his experiences were made widely available in his popular *Ansichten der Natur.* A new science was necessary to capture the sublime magnificence of such a phenomenon, and Humboldt's study of "vegetation" linked previously disparate areas of research such as botany and geography to form what he called

[51] Engstrand, *Spanish Scientists,* pp. 104–9, 111–18, 123; H. W. Rickett, "The Royal Botanical Expedition to New Spain," *Chronica Botanica,* 11 (1947), 1–81; I. H. Wilson, ed. and trans., *Noticias de Nutka: An Account of Nootka Sound in 1792 by José Mariano Moziño* (Seattle: University of Washington Press, 1970); R. McVaugh, *Botanical Results of the Sessé and Moziño Expedition (1787–1803)* (Ann Arbor: University Herbarium, University of Michigan, 1977), pp. 97–195; X. Lozoya, *Plantas y Luces en Mexico: La Real Expedición Científica a Nueva España, (1787–1803)* (Barcelona: Serbal, 1984).

"earth history." Mapping was central to this enterprise, and an understanding both of historical geology and of zoological regionalization were prolegomena to the transformation of the analysis of the history of the earth and its inhabitants in the following century.[52]

[52] See also M. Nicolson, "Alexander von Humboldt, Humboldtian Science and the Origins of the Study of Vegetation," *History of Science,* 25 (1987), 167–92; M. Dettelbach, "Global Physics and Aesthetic Empire: Humboldt's Physical Portrait of the Tropics," in Miller and Reill (eds.), *Visions of Empire,* pp. 258–92; and M. Louise Pratt, *Imperial Eyes: Travel Writing and Transculturation* (London: Routledge, 1992), pp. 111–43, especially p. 120.

Voyages of discovery. Explore. ADD To collection. Add to new collection. CANCEL.Â Scientists believe sediment cores from beneath the Tasman Sea hold clues to massive changes in tectonic forces that formed the Pacific Ring of Fire and shaped our mostly submerged continent of Zealandia. The researchers are also interested in finding out if these tectonic changes influenced the flow of ocean currents, which may help to explain the pronounced warming of seas around New Zealand at this time. Expeditions #372 and #375 targeted slow-slip earthquakes off the coast of Gisborne, providing a deeper understanding of the Hikurangi plate boundary â€“ New Zealandâ€™s largest fault.