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The International Indian Ocean Expedition and the Pursuit of Science in the Developing World

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Abstract

Between 2015 and 2020, UNESCO and oceanographers who study the Indian Ocean sponsored an international expedition to pursue current research topics about the region. Known as the Second International Indian Ocean Expedition, the project recapitulated an effort that had begun 56 years earlier. The International Indian Ocean Expedition (IIEO) ran from 1959 to 1965 and was the first major oceanographic expedition to focus on a developing world region. With 22 participating countries, the IIEO pursued large-scale, collaborative science as state formation began after the collapse of European empires. The wave of decolonizations in Africa and Asia after the Second World War was more than just the refusal of alien rule followed by the formation of new nation-states [1]. It was a moment when the citizens of newly independent countries, including India, the most active developing-world participant in the IIOE, sought to recalibrate international hierarchies. As African and Asian politicians and thinkers shaped international institutions to their benefit, including the United Nations, of which UNESCO was a part, developing world scientists also expanded their say in the pursuit of science [2]. Oceanography was a young field, often practiced minimally in wealthy countries, but pursued vigorously by India in the years after independence. This effort occurred in the context of a Cold War pursued by the primary funders of the IIOE, the US and USSR, that eventually undercut international cooperation in science but did not squelch Indian institution-building in oceanography. The IIOE, then, offers a window into the historical geography of science in the postwar period and into the under-recognized agency of scientists outside the West in creating regional science infrastructure.

Introduction: Institutional Setting of the IIOE

The Cold War and the IGY

The IIOE grew from the same set of concerns as had the International Geophysical Year (IGY) from 1957 to 1958. The IGY was the "first major scientific undertaking that reached across the political and ideological borders of the Cold War," involving the US, Soviet Union, and more than 60 other countries [3]. It was an event that not only provided a prototype for potential collaboration across ideological lines but also "shattered the notion that science could rise above politics" [4]. The IGY set off a period of contest in science between the superpowers that included the launch of the Sputnik satellite in 1957, major Antarctic projects, as well as oceanic expeditions such as the IIOE.

Participants in the IGY from Scripps Institution of Oceanography at La Jolla, California, and the Physical Oceanography Lab in Paris probably first proposed the IIOE. While the IGY addressed a number of questions in earth science, including geomagnetism, gravity, geolocation, and oceanography and had a global range, the IIOE focused on oceanography alone and a single, relatively unexplored ocean. The launch of both events stemmed from a "universalist scientific ethos" that drove the growth of internationalism in science and represented a "commitment to science as a body of knowledge generated and validated regardless of national boundaries" [4]. Yet, the labor of producing science revealed the inequalities and national commitments that undercut easy universalism. It also exposed significant differences in the way that non-aligned countries, particularly India, sought to pursue science, encouraging a cooperative approach rather than the competitive mode that tended to characterize science in the developed world. As such, the IIOE was part of a moment when leaders of the developing world, including scientists, asserted their place on the international scene after the collapse of European empires in the Second World War.

The Role of Geography in Science

Scientists who participated in the IIOE were generally not geographers, but problems of geography were central to the mission of the IIOE. These included contests over how to survey the seafloor and who should have access to geolocational equipment that was used to specify the location of ocean currents and movement in water columns. Oceanography, as a field, was at this time institutionally embedded with geology, geography, and zoology. For example, Robert G. Snider, the first administrator of the IIOE, presented the draft prospectus for the expedition in Pakistan in 1960 to the section of the Pan-Indian Ocean Science Congress that grouped together "Oceanography, Geography, and Geophysics" [5]. As such, the IIOE deserves consideration in the growing literature within historical geography that seeks not the conventional, loose use of the term "decolonization," shorn of empirical content, but an understanding of what people "actually said, wrote and did" at the time under conditions of ambiguity and possibility [6].

The IIOE pursued both pure and applied topics in oceanography and so, with the latter, had a role in the push for development of the Indian Ocean region, particularly the expansion of fisheries. Accordingly, it also has a place in the history of economic development. The titles of two books about development capture the essence of recent interpretations of the period after 1945: Adom Getachew's *Worldmaking after Empire: The Rise and Fall of Self-Determination* (2019) and Christy Thornton's *Revolution in Development: Mexico and the Governance of the Global Economy* (2021) [7]. Getachew lays out the ways in which African leaders sought to move the United Nations and associated international bodies toward redistributive practices, while Thornton looks at how Mexico, deeply indebted as it was, played an important and largely forgotten role in the Bretton Woods agreement and the structuring of markets for international sovereign debt. Both books de-emphasize the role of modernization theory in order to describe how modernization played out on the ground in the developing world. In so doing, they give greater importance to those who implemented and lived through attempts to industrialize and to provide adequate sustenance for what were then economies grounded in subsistence agriculture, often subject to famine. For the developing world then, state formation and the politics of economic development are intertwined components in the use of science.

In India, the introduction of European modes of science began during imperialism, when establishment of British rule required assessment of the landscape and its natural resources, from minerals to native plants. Domination required scientific expeditions and surveys: "Next to guns and ships, these were the most potent tools in the hands of a colonizing power" [8]. Botanists from the United Kingdom, for example, furthered the growth of plantations for tea, indigo, coffee and other exports, by engaging in science that advanced European understanding [9]. These investigations relied on local "informants" who played active roles in scientific exploration as collectors of samples and translators of published texts [10]. Although usually denied credit, these local naturalists of the colonial period are more accurately described as "co-producers" of science [11]. In the latter half of the 19th century, Indian naturalists began receiving formal training in institutions set up in India by the British. By the early 20th century, a top student, such as N. Kesava Panikkar, a fish zoologist who went on to lead the Indian component of the IIOE, could get a doctoral degree in India and further training, with a scholarship, in Europe. Even so, recent work in the history of science has understated how quickly India was able to educate a cohort of scientists and build its own science infrastructure, as oceanography in India illustrates, with support from the highest levels of government.

The gap in understanding is, in part, due to the tendency to see industrialization as a prerequisite for modern science, or at least working in tandem with it. In India, the economy continued to be predominately agricultural long after colonization, into the 21st century (a point usually made in contrast to China, where agriculture fell below 50% in the 1990s) [12]. In addition, the simple binaries of center and periphery that often characterize discussion of the history of science efface how intertwined the development of science between center and periphery was from well before decolonization [10]. India, of the countries involved in the IIOE, had longest sought to develop science, including applied oceanography, even before the advent of industrialization. Accordingly, its infrastructure for oceanography, including research facilities for cultivating fisheries, was well in advance of most countries in Asia. Only Japan, where the Tokyo University of Fisheries was set up in 1888, and China, where oceanography was fully subsumed under geography until the Second World War, could claim similarly early institutions devoted to research on the ocean [13]. Such institutions did not exist in the United States until the 20th century. Indeed, the Indian Association for the Cultivation of Science had been founded in 1876 to promote science in India, fully nine years before the creation of the Indian National Congress, the political forum that would achieve Indian independence [8].

Gandhi was suspicious of both science and industrialization. But Jawaharal Nehru, Gandhi's chosen successor, was an ardent proponent of advancing Indian science, particularly for the building of nuclear weapons and for economic development. Nehru met directly with Robert Snider, the initial organizer of the IIOE, as planning for the expedition began; this was in keeping with Nehru's intense interest, including writing for at least one Indian journal on progress in science [14]. After the Second World War, India sought to replace Japan in its former leadership role in Asia, although working from principles of nonalignment, including in the pursuit of science, especially for industrialization and agricultural productivity [15-17]. The history of famine in British India made the question of nutrition pressing [18-20]. Much of the motivation for oceanographic research during the IIOE, then, was to add protein to the Indian diet from fish and to understand, and hopefully predict, the monsoons crucial for agriculture.

The Infancy of Oceanography

As basic as such applied research in oceanography appears today, it is important to remember that infrastructure for applied oceanography in the *developed* world was in its infancy at the same time. In the US, Scripps was founded in 1903, and the Woods Hole Oceanographic Institution (WHOI) in 1930. But oceanography saw its period of greatest growth during the Second World War and continuing after, as the Department of Defense continued to subsidize more than half of oceanographic research, by some estimates, into at least the 1970s [21]. To be sure, oceanographic institutions in the West had access to the much greater scientific resources of the US government, while India struggled to outfit even a handful of ships for sub-surface research (see below). But oceanography as a field only began its greatest advances after the war, once the theory of plate tectonics, first broached by Wegener in 1912, and of mantle convection, advanced by Holmes in 1929, were widely accepted. It was not formally expressed until 1960 that the seafloor was geologically distinct from the continents and functioned, effectively, as a "giant conveyor belt carrying the continents across the globe" [21]. Thus, scientists of the rich and poor worlds began their oceanographic investigations with a playing field more level than for other areas of science such as physics and biology. In developing world investigations, India led the way. This was consonant with the general role that India sought to play in the bipolar world of the Cold War, particularly through its participation in the nonaligned movement, at its peak during the same period as the IIOE.

The Nonaligned Movement and the IIOE

The nonaligned movement had its origins in the realization, prompted by the Japanese military victory over Russia in 1904, that European supremacy in Asia could be successfully challenged. The "explosion of anticolonial agitation" before the First World War launched a growing consciousness of economic and racial oppression among colonized peoples [22]. But the formation of competing Cold War alliances as decolonization got underway made it clear that true independence for countries that had recently achieved separation, including India, required further strategy. India was a leader among nonaligned nations as, after independence in 1947, it refused to side with either superpower from both "calculated self-interest" and from the ambition for "a major peacemaking role" as the international expression of the movement for nonviolent resistance led by Gandhi [22]. By sidestepping alignment with either the US or USSR, Indian leaders sought to "win a leadership role in the nonwhite world" as well as "economic aid from as many sources as possible" [22]. On the latter, US aid depended on priorities set by different presidential administrations. But the Kennedy administration, which was in place for most of the IIOE, generally continued development aid to nonaligned countries even when they criticized the US [22]. At the 1955 conference of nonaligned countries in Bandung, Indonesia, the most important conference of the nonaligned gatherings, there was no agreement on matters of political economy, but "forthright condemnation of the indignity of imperialism's cultural chauvinism" [23].

Science played a major role in India's pursuit of leadership among nonaligned nations. India's post- independence desire to build nuclear weaponry, a sharp break with Gandhi's pacifism, was justified to the public in part as allowing a general advance of science that would aid economic development. Nehru differed with his mentor Gandhi on the value of science in part because of the influence of Meghnad Saha, the internationally recognized astrophysicist, who founded the journal *Science and Culture* in 1935 and who saw science as consonant with traditional Hindu cultural values [8]. Thus, both Saha and Nehru couched their opposition to Gandhian concerns about science, particularly its use in nuclear war, by appealing to a set of principles with which many of Gandhi's followers could agree. In a message in *Science and Culture* in 1938, Nehru noted the potential for science to further "war with all its horrors ravaging the world" [15]. But he went on to argue that "science has made great progress in the West" and "raised the standard of living in some countries to unprecedented heights" [15]. Science today is "in a position…to create conditions of well-being and progress for all humanity" [15]. For Nehru and his supporters in the sciences, who used the IIOE as a platform to construct research institutions for oceanography in India, science and development were intertwined.

Unesco and Science

The agency of the United Nations that acted as the advocate for scientists in the developing world, UNESCO, was housed in Paris. In its early years, UNESCO, whose writ included education and culture as well as science, had close associations with European anticolonial intellectuals. These included Jean-Paul Sartre, Albert Sauvy (who coined the term "Third World"), Alva Myrdal (sometime co-author and wife of Gunnar Myrdal, the Nobel-prize winning economist who wrote *An American Dilemma*, a critique of race relations in the US, in 1944), the anthropologist Claude Lévi-Strauss, and the psychologist Marie Jahoda. The latter two conducted a "crucial study of racism and racial attitudes in different cultural traditions," sponsored by UNESCO, that was published in a series of monographs that shaped the discussion of race at Bandung in 1955, where participating countries denounced "racialism as a means of cultural suppression" [23]. Julian Huxley, the biochemist, became the first director general of UNESCO, and gave a prominent role to science in the new organization. UNESCO had begun in 1946 with the mission of restoring the educational infrastructure of countries devastated by the war [24].

Many schools and scientific facilities had been destroyed during the war in Europe, rendering Europe temporarily on the same level as poorer countries in terms of scientific equipment and educational facilities. Just after the war, for example, UNESCO distributed a book by a London science teacher with the title, *Suggestions for Science Teachers in Devastated Countries,* that was originally intended for British schools. It was subsequently translated into French, Spanish, Chinese, Thai, and Arabic. An historian of UNESCO described the book as "useful for devastated areas" and a "phenomenal success in regions where previously there had been little or no equipment" [25].

Although in general UNESCO did not finance scientific research, it filled an important gap in the marine sciences in coordination among governments when it got responsibility for the Intergovernmental Oceanographic Commission in 1961 [24]. In 1964, the IOC, now housed within UNESCO, published a work titled *Draft of General Scientific Framework for World Ocean Study,* that sought to guide further research in the field [26]. The draft does not appear to have been finalized but that such a document would be produced by UNESCO suggests the unique role oceanography played.

In general, however, UNESCO's early ambitions in science were not fulfilled. The initial motivation for including science under the aegis of UNESCO had been in part to overcome the legacy of the war in establishing "veils of military and commercial secrecy" that "surrounded much of postwar science" [24]. As the Cold War progressed, secrecy on technology with military applications became greater. But the ambition by early UNESCO administrators to have laboratories around the world that would "fly the flag of the United Nations" was never achieved with the notable exception of the European Organization for Nuclear Research (CERN) and the International Centre for Theoretical Physics in Italy [24]. Neither did the IIOE expedition establish labs in which UNESCO played an ongoing role. In India, UNESCO sent technical help for various aspects of the IIOE, including a major operation to classify plankton, but the Indian government funded the creation of scientific facilities.

The Developing World in the Historical Geography of

Science

The role of the global South in the production of science has been important in work that questions idealism, i.e., the assumption that scientific ideas move unchanged through time and space [27]. The now- dominant literature in the sociology of science and technology that grew from the work of Bruno Latour and others in the 1980s, known as actor-network theory (ANT), sees science as a product of the networks that make up all societies [28]. Latour insisted that networks cannot be reduced to social networks but must be understood ontologically as "assemblages" and associations, human and material, that make up society. ANT rejects the "metaphor" of scale in geography (individual, regional, nation-state) and other spatial descriptors ("close and far, up and down, local and global") in favor of analysis of associations and connections, rigorously observed [28]. As a philosophy with its own space-time context, actor-network theory represents a break with the representations of science that prevailed at the time of the IIOE, particularly at UNESCO. ANT works from particular to general (inductively), while UNESCO was the work of European intellectuals who came of age in the 1930s, who saw science in idealist terms, and who went on to see the world as neatly split into global North and global South [29, 30]. However, one important figure, Joseph Needham, the director of natural sciences at UNESCO from its founding in 1946 to 1948, was an early and important bridge to the differences between ANT and the philosophy of science in the immediate postwar period, as well as a strong influence on the creation of efforts to breach science divisions of the Cold War [10].

During the 1950s and 1960s, the growth of science and the growth of industry were assumed to be closely linked, if not indistinguishable. George Basalla, the US historian, published an article in *Science* in 1967 that expressed the assumptions of the role the US assigned to science in foreign affairs during the Cold War and became a widely cited guide for policymakers [31]. In it, Basalla grafted Walt Rostow's five- stage model for economic development, the basis for US aid to forestall Communism, onto the advance of science, predicting that, just as the "United States and the USSR" had "reached, and in some cases surpassed" the "science of the Western European nations," so too could nations that had yet to establish "independent scientific cultures," if a country had, or were given, sufficient resources [32].

Most Western scientists, like Basalla, were not critical of capitalism, but even those who were saw a beneficial role for science. Joseph Needham-initial science director at UNESCO, a Fellow at Cambridge, and a Christian socialist-saw UNESCO as responsible for "extending the bright zones of science from the metropolis to the peripheral countries"--in effect, a position little different from Basalla's [33]. Needham's philosophy of science set the agenda for the active efforts of UNESCO in its early years to shape the pursuit of science globally. Essentially, Needham saw science as a product of a capitalism that tended toward corruption but that provided the foundation for mathematical approaches to science. Math was, according to Needham, "oecumenical," meaning it could be harnessed to advance science by anyone with adequate training [34]. In this sense, he was a typical of the postwar period in talking about scientific ideas as though they were material objects that were portable unchanged across space.

From the outset, the US was suspicious of Needham and his many contacts in China, where he had lived during the Second World War, working for the British government. Eventually, in 1952, his sympathy for China got him blacklisted by the US State Department for lending the weight of his considerable credentials as a Cambridge lecturer to Chinese propaganda accusing the US of biological warfare during the Korean War [35]. Prevented for a time from traveling to the US, a significant hindrance given the rising stature of the US in science, Needham threw his energy into the comparative history of science for the remainder of his career.

Needham produced important work as a biochemist, but he is still read today as an historian of science. Here his work sought to answer a seemingly simple question: Why had modern science evolved first in Europe rather than China? His answer took the form of a work, *Science and Civilisation in China*, initially written with his longtime partner, Wang Ling, that reached seven volumes in his lifetime and continued after his death [36, 37]. *Science and Civilisation* was an analysis and compendium of scientific accomplishment in China versus Europe, highly specific across all fields, from physics to astronomy to mathematics to chemistry to biology to geology to linguistics to logic to cartography to botany, detailing connections between Europe and China (especially through Jesuit missionaries) and independent discoveries.

Needham portrayed differences between China and Western Europe in the advance of science as dating only as far back as the acceptance of heliocentrism at the end of the Renaissance. In general, he argued that differences between the regions had been exaggerated. Prior to Galileo, Needham contended, Chinese accomplishment in science had been equal or superior. Since then, advances in Western math, in particular its emphasis on geometry and development of testable hypotheses, had given Europe an edge. But, even here, according to Needham, Western superiority in the latter drew on global "rivers" of ancient and medieval knowledge from outside Europe [34].

Needham and colleagues accumulated a long list of Chinese "firsts" in science, including the recording of sun spots 1,500 years before their discovery in Europe, the use of mechanical clocks (eighth century in China, the 14th century in Europe), complex soil classifications, and seismology that uncovered the epicenter of earthquakes by the second century. Since then, he argued, with the exception of the periods of upheaval in Chinese society in the 20th century, China had closely tracked the West in science, lagging only for short periods. It had a parallel system of medicine, comprising acupuncture and a highly developed pharmacology, that was effective, including by Western standards [37]. In his analysis of Chinese science, Needham anticipated the geographic turn in the history of science in the 1980s, and his methods--deep empirical research in order to excavate cultural networks of knowledge--anticipate ANT. Needham's work for UNESCO, and his drive to deepen cultural networks in science, were the background to both the IGY and the IIOE.

Predecessors to the IIOE

There were oceanic investigations of the Indian Ocean prior to the IIOE, although few by Western scientists, and these were isolated initiatives. People living in the region, of course, had long had practical knowledge of the northern reaches of the Indian Ocean.

The Harappans of the Indus Valley culture (2500–1700 BCE) were thought to have used the shifting winds during the winter and summer monsoons to navigate the Arabian Sea. Arabic scholars recorded observations of the same sea as early as the ninth century. The geographer Ibn Khordazbeh in 846 AD displayed mastery of navigation of the Arabian Sea, recording that Arab and Persian pilots knew that the currents in the sea reversed twice a year. Another scholar, El Mas'udi, writing in Arabic one hundred years after Ibn Khordazbeh, knew that ocean currents changed in conjunction with the monsoon winds. In the fifteenth century, the navigator Ahmad ibn Magid, who may have served as a pilot to Vasco de Gama, wrote the cycle of winds north and south of the equator in the Indian Ocean as poetry to be memorized by sailors [38]. The Indian Ocean, then, was known in practical terms for sailors of the region centuries before the IIOE.

In terms of modern science, the expeditions of Captain James Cook in the 1760s and 1770s mark the largest sustained ocean investigations to that date. Cook's main objectives were looking for colonies, trading and mapping places unknown to Europeans; these goals married "geographical exploration" and "imperial exploitation" but did so entirely from the surface: "The ocean itself was something to be sailed over and endured" [39]. By the mid-nineteenth century, however, the objectives had shifted. In the 1840s, local investigators began to survey the seafloor and draw specimens via dredging in European seas. The shape of the Earth, topography of the seafloor, magnetic properties of sampled rock, as well as meteorological and atmospheric data were of increasing interest. The result was "thousands" of oceanic expeditions in the past 200 years by every nation that promoted scientific advancement [39].

But the first truly international oceanographic expedition that attempted to survey the oceans was that of the British Ship *Challenger* that circumnavigated the Earth between 1872 and 1876. Led by Charles Wyville Thomson, Professor of Natural History at Edinburgh as chief naturalist, the expedition surveyed the seabed for the purpose of laying cable. Maps from the expedition, published more than two decades after the voyage concluded, were the initial evidence that prompted Alfred Wegener to develop the theory of continental drift [40]. The primary work of the *Challenger*, as for most investigations of the seafloor until after World War II, was dropping cable weights to survey variation in seabed depth and to sample for flora and fauna. From this simple work, the expedition discovered the mid-oceanic ridge in the Atlantic and the difference between the abyssal Atlantic and European continental rock. The expedition also confirmed the robust presence of life against the belief, prior to the mid-nineteenth century, that the oceans were abiotic [39]. Similar work was also part of the IGY in 1957 to 1958. But, as had the *Challenger* expedition, the IGY largely omitted the Indian Ocean.

In both the First and Second World Wars, oceanographers had made contributions to the conduct of the war and developed technology, especially sonar, that would be important in postwar research. As the war began, hiring of oceanographers jumped, outstripping the availability of trained scientists [41]. Most oceanographers in the US were involved in submarine and antisubmarine warfare. Variation in the transmission of sound underwater undermined the use of sonar but gave oceanographers at Scripps and Woods Hole a reason (as well as funding) to study the temperature profile of the upper layers of the ocean and how it influenced sound. Oceanographers also used sonar to expand the US library of navigational charts. Ironically, the wide distribution of Japanese oceanic measurements of temperature and salinity, as well as charts, in the decade before the war, when oceanography had greater support in Japan than in the United States, contributed to improving the use of sonar by the US military as well as to US submarine attacks [42]. From these military efforts came sonar that could increasingly read features on the seafloor, as well as surplus ships that could be repurposed for scientific use. In addition, new techniques of measurement, as well as a US-led push for standardization in scientific measurement, resulted in equipment that did not exist before the war or was not widely used. These newly available types of equipment could measure salinity via electrical conductivity of water, assess currents using floats, detect naturally occurring radioactive substances that indicated circulation of water and mixing, assess the biology and chemistry of sediments, measure heat flow from the earth to the water, and estimate carbon dioxide content and exchanges between atmosphere and ocean [14].

The IIOE: Goals, Organization, Contributors, Outcomes

Scientists participating in the IIOE, then, were uniquely prepared to open novel investigations into seafloor geology, ocean circulation and chemistry, meteorology and marine biology. The Indian Ocean was understudied, although it bordered some of the most densely populated areas in the world along the coasts of the South Asian subcontinent: In 1960, the Indian Ocean region had 30% of the world's population and 20% of the world's ocean area [38]. Yet, "more than 300x as many bath thermographic observations had been taken in the North Atlantic as in the Indian Ocean" [14]. Very little was known about the effects of the monsoon on the currents and organisms in the northern part of the ocean, other than that the ocean was an unproductive fishery, especially in the Bay of Bengal, largely because of the way the Eurasian continent blocks the flow of cold, nutrient-laden waters from the Arctic [14]. In addition, its waters displayed all of the stressors associated with rapidly increasing population-eutrophication, deoxygenation, atmospheric pollution, acidification from surface warming, and overfishing. Finally, evidence from the topography of seafloor would potentially add to the growing consensus on plate tectonics [43-46].

The Proposal of an Expedition for the Indian Ocean

Other major expeditions, starting with the British *Challenger,* had omitted the northern part of the Indian Ocean [38]. The idea to conduct a synoptic study of the Indian Ocean had been proposed too late to be included in the IGY. Paul Tchernia, a physical oceanographer at the Museum of Natural History in Paris, and something of an expert on the Indian Ocean, having conducted research there between between 1948 and 1950, had suggested such a study of the "physical oceanography of the Indian Ocean with emphasis on the season reversal of currents with the monsoon" at a planning meeting for the IGY in 1957 [38]. Although the proposal was not included in the IGY, Tchernia and the director of the Scripps Institution of Oceanography in San Diego, Roger Revelle, approached the chief organizer of the IGY, Lloyd Berkner, the US geophysicist, to suggest a separate international research project, this one regional in scope and exclusively oceanographic, that would become the IIOE [38].

Meanwhile, the International Council of Scientific Unions (ICSU), the NGO dedicated to international cooperation in the advance of science, had formed a working group devoted to oceanography, dubbed the Special Committee on Oceanic Research (SCOR). SCOR, then, was a subcommittee of a non-governmental organization. But it also had close ties to the United Nations because it had been set up by the International Advisory Committee on Marine Sciences, formed by UNESCO in 1955, at the behest of Berkner [38]. Berkner, whose trajectory encapsulated the rise of large scientific effort in the postwar period, was employed for most of his career at institutions established by the US to promote coordinated science, including the Carnegie Institution in Washington and Associated Universities [47]. SCOR met for the first time in August 1957 at Woods Hole Oceanographic Institution on Cape Cod in the US. To SCOR fell the task of organizing the initial stages of the IIOE.

Differing Views of the Same Project: SCOR and the IOC

According to the archives of SCOR, the initial impetus for the expedition in the Indian Ocean came from scientists in nations "experienced in oceanographic research" [14]. In addition to Tchernia, Revelle, and Berkner, other scientists mentioned as originators of the project were Columbus Iselin and Henry Stommel, both of the Woods Hole. These were, in other words, scientists from Europe and "neo-Europes," to use Alfred Crosby's term for the oldest European colonies, especially the US and Australia [48]. In 1960, about half-way through the expedition, administration of the expedition was to shift from SCOR to the Intergovernmental Oceanographic Commission (IOC) of UNESCO by prior arrangement [38]. But, according to the SCOR archives, the origin of the IIOE came from individual Western scientists.

SCOR included scientists from the US, the United Kingdom, Germany, the Soviet Union, and Australia, as well as South Africa, Japan, the Soviet Union, and India. The committee selected the administrator, Snider, a former US Navy officer, who set up a loose organizational structure for the IIOE and used endorsements of the IIOE from Presidents Eisenhower and Kennedy to elicit participation in countries around the world [38]. Eventually, in addition to the membership of SCOR, other countries sent ships (Indonesia, Pakistan, Portugal, and Thailand) and an even larger set of countries sent staff and material (China, Burma, Ethiopia, Israel, Italy, Madagascar, Malaysia, Mauritius, Sri Lanka, and Sudan) [38]. SCOR had initially proposed "as many as 16" ships from different countries, but the expedition ultimately deployed about 40 research vessels from 23 nations [49].

In discussions of the IIOE by the SCOR working group, several tensions emerged among scientists over methods and areas of focus. One debate about how seafloor surveying should be conducted took place between the German scientist, Georg Wüst, who had led the exploration of the South Atlantic in 1925-1927 aboard the *Meteor*, discovering that the deep ocean had strong currents (against prevailing assumptions), and some American scientists: Should the Indian Ocean, as in Wüst's view, be surveyed systematically on a grid, or should it, as in the American view, be surveyed on the fly as experiments were conducted and features of interest discovered on the ocean floor? Ultimately, SCOR sided with the Americans and decided to "plan intensive research for special problems and selected areas instead of a general survey" [38].

The more important debate, however, was over how applied research should be, an issue related to whether a participating scientist hailed from a developing country. Should the expedition focus on the human needs of the region, especially developing fisheries, or should it seek to expand global science, fitting the Indian Ocean into the increasingly accepted theory of plate tectonics? Marine biologists and fisheries scientists were more likely to pursue the applied interests favored by the Indian government and its allies in the developing world, while "pure" topics were favored by physical oceanographers, such as the British scientist George Deacon, although geologists also surveyed the seafloor for mineral exploitation [50]. Applied research on the monsoons that were crucial to Indian agriculture as the country underwent rapid population growth, as well as the exploration of fisheries, were top priorities for Indian scientists and others in the region. It was not that SCOR and Western scientists ignored such topics: Snider had used potential practical results as a method for gaining funding, and individual Western scientists—including William Wooster, an expert on fisheries and climate who would coordinate the expedition after Snider--were committed to applied research.

A perspective on the IIOE different from that of the SCOR archives emerges from those of the Intergovernmental Oceanographic Commission (IOC), created by UNESCO in 1960, and the coordinating body of the expedition after 1962. In a report written by the IOC the year after the conclusion of the IIOE, the authors introduce the expedition as one of the "three large-scale international expeditions" that had been, so far, "coordinated by the IOC," a UNESCO agency [51]. Further on in the report, the authors allow that "SCOR was initiator" of the IIOE "as well as organizer of the First International Oceanographic Conference" in New York where planning had taken place. But they go on to insist that the relationship between SCOR, on the one hand, and IOC and UNESCO, on the other, is "much more complex than simply a giving and taking of advice". SCOR is "non-governmental" and composed of "working scientists"; the IOC represents "useful ideas" coming "from governments," presumably developing countries represented by UNESCO that might not have full representation among the working scientists of SCOR [51]. The report goes on to describe IOC initiatives in management of the IIOE upon its assumption of co-ordination--in data exchange, standardization of measurements and data presentation, and cooperation. As a practical matter, sharing of the data among the many vessels of the IIOE required conscious effort since scientists of a given vessel, most of which were provided by wealthy countries, would repatriate data to their own national institutions.

Without access to data, the expedition would prove of less value to scientists in the region of study. But sharing data required "revision of the rules governing international exchange of oceanographic data as established at the time of the International Geophysical Year" [51]. The change to more open sharing, part of a much broader issue in the availability of the material for the pursuit of science, was a top priority for the IOC, geared as it was to scientists of the Indian Ocean region. The IOC also laid out standards for how data was presented and published that were, again, part of a broader issue of standardizing information in a newly globalized world. As with the increasingly globalized manufacture of industrial components, coordinated science could only happen if measurements adhered to a global standard [52]. Finally, the

IOC report adopted a critical tone on competition among scientists and insisted that co-operation was necessary for research to proceed, particularly for investigations of seasonal or other time-limited phenomena. For countries that could not command fleets with multiple ships, co- ordination among countries was “the only way to accomplish such investigations” [51]. Such concerns with co-operation rather than competition and pooling of resources among nations was consistent with UNESCO’s role in the UN as advocate for developing world countries.

The tone of the 1966 IOC report carries the implication that the need had to be asserted for recognition of the role of developing world countries in the expedition. Indeed, UNESCO and the IOC had done exactly this in print during the expedition itself when an article in *Science* in 1961, still cited in many histories of the IIOE today, failed to mention the imminent transition of the IIOE to coordination by the IOC and UNESCO [53]. The incoming UNESCO administrator who replaced Snider, Warren Wooster, an oceanographer on leave from Scripps, felt compelled to remind readers of the importance of the United Nations in the expedition:

“I have read the recent article on the International Indian Ocean Expedition by Knauss with great interest. One significant omission should be pointed out. This concerns the role of UNESCO, which in addition to sponsoring the Indian Ocean Biological Center in India is also co-sponsor of the expedition. Sponsorship of the expedition by UNESCO has been, and continues to be, more than nominal. Working in close collaboration with [SCOR], organizer of the expedition, UNESCO has provided the financial means for bringing together participating scientists in the fields of marine meteorolog, zoo-planktology, and nutrient chemistry and primary productivity. It should also be noted that at its first session [in 1961] the [IOC] adopted a resolution directing its secretary to assume additional coordinating functions for the expedition” [54].

Both the report and Wooster’s letter suggest there was vexed discussion about who should participate and who should have access to the resulting data.

In addition, some North American scientists interpreted the IIOE, when its focus turned to applied research, as a politicization of science that undercut academic freedom. A satirical chronicle of planning the IIOC, anonymously published at Woods Hole, was titled *The Indian Ocean Bubble*. The first issue likened the expedition to the South Sea Bubble and mixed serious commentary from participants with fictionalized characters such as “Ignatius Donnelly” who proposed meeting to plan the the expedition in a bar. This was an indication, along with the “publication” of the *Bubble* itself, that not all took the IIOE seriously. Both Knauss, the author of the 1961 article on the progress of the expedition, and Wooster, the future UNESCO coordinator of the expedition, were on the distribution list, as well as other oceanographers from Scripps and Woods Hole [55].

In the last edition of the newsletter in 1960, Henry Stommel dropped the satire to complain about how the IIOE involved commitments that went, he felt, beyond the scope of oceanography. Stommel was one of the most productive physical oceanographers then living. Starting in the late 1940s, he had published one of the first theories of the general circulation of the ocean and then went on to develop the first coherent explanation of how variation in the Coriolis effect by latitude explained the westward intensification of wind-driven currents, a topic of considerable relevance for the coast of northeastern Africa that the IIOE was set to explore. He also published a theory of the thermocline, a theory of global abyssal circulation (building on Wüst’s work), and a book on the Gulf Stream, released in 1958, tying all these concepts together. These topics are today taught in introductory physical geography [42].

Stommel's working style was idiosyncratic but highly social “On completing a piece of work, Stommel would go searching for something to take up next; he relied on colleagues to an astonishing degree, given his creativity, to point him in new directions. He roamed the corridors of MIT and WHOI, asking in effect, “what’s interesting?” Often, he would get intrigued, hooked, and would become obsessed with a problem to the point where he was preoccupied with it day and night. More than one collaborator can attest to the late-night or 6:00 a.m. phone call that would start without so much as “hello,” but would come out something like “you know I think the second term in that equation can be neglected, because...” [56].

With regard to the IIOE, Stommel protested the “routine and regimented tasks” more fit for “surveyors” than oceanographers to which (he felt) expedition administrators had committed scientists. Such tasks, he argued, would undermine the “publicly avowed policy of US private institutions” of “academic freedom” for individual scientists. He went on to complain that research on fisheries in the context of the IIOE had only a “very remote chance” of helping to “improve fisheries and alleviate the poverty of the people in many Indian Ocean countries”. Robert Snider had written a prospectus for the expedition, designed in part to solicit funds from development agencies and sympathetic governments, that emphasized the more applied aspects of the effort. This prompted Stommel to launch a critique of what he saw as the politicization of science:

“It is disheartening to see oceanography join the long line of pressure groups acting under the guise of humanitarianism to advance their own interests: in themselves legitimate, but essentially unrelated to the moral and “socio-economic” issues which they pretend to serve. Were the Expedition really motivated to help feed starving populations it would be planned quite differently specifically to subserve these noble ends. But as these ends are palpably not the main goal, would it not be more ethical to refer to them in a place less prominent than the first page of the prospectus? “ [55].

This was, in effect, an appeal to the classic model of universal science that drew a bright line between science and development activities, especially if these were regionally specific. It also indicates an attitudinal difference between an important scientist at one of the main US institutions for oceanography and the lead scientist for the IIOE in India, the developing world country that contributed the largest number of scientists to the IIOE, N. Kesava Panikkar.

N. Kesava Panikkar

Roger Revelle, a leader of the IGY and founder of SCOR, remembered N. Kesava Panikkar as important in efforts to bring developing country scientists into the IIOE. Initially in danger of becoming what Revelle called a “club of rich countries that wanted to do oceanography,” SCOR relied on Panikkar, whom Revelle termed “very sensible and very enthusiastic” to involve developing country scientists [38]. Panikkar, for his part, would later express exasperation in Indian scientific publications with the planning of the expedition, as well as dissatisfaction with the use value of the applied research conducted: If an “enthusiastic” participant, he could also be a critical one [56, 57].

The career of Panikkar from the mid-1940s until his death in 1977 encapsulates the trajectory, to which he was central, of the creation of institutions for oceanographic research in India. Panikkar was born in the southwestern state of Kerala in 1913. As a province, Kerala is isolated from the rest of India by the Western Ghats, the mountainous belt running parallel to the coast. Its social and political contacts have historically stretched across the Arabian Sea to the Persian Gulf region and eastern Africa, including what is today Somalia. He attended university in India, receiving a PhD from Madras University in 1938. In the same year, he won a scholarship that allowed him to travel to Great Britain, where he then worked for five years in London, Plymouth, and Cambridge with prominent biologists. These included the marine biologist and fellow of the Royal Society, Edgar Johnson Allen, and Archibald Hill, winner of the Nobel Prize in Medicine in 1922, known today as a founder of biophysics. While there, Panikkar published significant work on crustaceans in Plymouth [58]. He then returned to India and became head of the Department of Zoology at University College, Trivandrum (now Thiruvananthapuram), in Kerala, a university established in 1866 along British lines. Soon after, he joined Madras University. Eventually, he became head of the Central Marine Fisheries Research Institute, the main oceanographic research institute in India at that point, located in Kerala, in 1950. In 1957, just before planning for the IIOE was to begin, he was appointed Fisheries Development Advisor to the Government of India, responsible for developing the institutions for oceanographic research on fisheries.

Panikkar was, then, a key oceanographer and institution-builder in oceanography for India as a whole. He was central to the creation of what are today its most important oceanographic institutions, and his connections to scientists internationally were extensive, particularly in the United Kingdom and Germany. The initial head of planning for the IIOE in India was the geologist D.N. Wadia, known for his contributions to Himalayan geology and for lending support, based in Indian geology, for Wegener’s idea of continental drift [59]. But from 1962 to 1965, from the point that UNESCO begins administration of the IIOE, Panikkar assumes leadership of the Indian Programme for the expedition, and the emphasis in Indian participation is less on physical oceanography than on ocean productivity. Prior to joining the expedition, Panikkar had conducted a number of voyages in the Indian Ocean for collecting specimens, as well as worked with Eugene C. LaFond, a US physical geographer and early member of SCOR, at Andhra University. During the expedition, he established the Indian Ocean Biological Centre, jointly set up by Indian oceanographers and UNESCO, for analyzing zooplankton samples collected by the IIOE. After the IIOE, he became the founding director of the National Institute of Oceanography (NIO) at Goa, created as a direct outcome of the expedition, serving from 1966 to 1973. In addition, as a result of the IIOE and its plankton operation, UNESCO and an international advisory board set up the Indian Ocean Biological Centre in Cochin, an organization that became an “important nursery for young scientists” [60]. When he died in 1977, Panikkar was vice-chancellor of Cochin University.

Panikkar’s many publications address the full range of oceanic investigations conducted in India, from the most applied questions of fishery locations and monsoon timing to Indian Ocean research that affirmed plate tectonic theory. (One of the outcomes of the IIOE was discovery of a ridge that had previously been thought to be a seamount.) Panikkar’s written work also addressed the material constraints that Indian scientists, often trained in British universities but pursuing careers in a former colony, faced as they pursued their goals.

An article by Panikkar on the state of fisheries in 1954 illustrates the state of oceanography in India in the years not long before the IIOE. The choice of Panikkar to head the Indian component of the IIOE was itself an indication of what the Indian government wanted from the expedition. This applied focus for oceanographic research in the country dated to just after the war. In 1946, the Central Ministry of Agriculture had decided to create fisheries research on “an all-India basis” and to promote research in “mechanized fishing” [61]. Within this area, Panikkar’s description prior to the IIOE indicates the limited scientific equipment, even for applied work, to which any oceanographer in India had access.

India in 1954 relied solely on fishing vessels for research. Such “craft and gear employed by our people remain as they have been for centuries past, both frail and primitive,” and fishing craft continued to rely on wind power, while the “fury of the monsoon winds” limited the fishing season [61]. Even simple surveys of catch were unreliable because fishermen feared having their haul taxed [61]. Yet, working fishermen and their ancient methods were the primary means of scientific work on fisheries, and of oceanography more broadly, in India at the time Panikkar wrote:

“A great handicap in marine fisheries work in India at present is the absence of any fisheries research vessel. Work has necessarily to be restricted 'to the facilities offered by the commercial catches brought by the indigenous vessels. The recent ventures in power fishing have given added facilities for investigations, but it would obviously be difficult to combine the needs of research with purely commercial operations. The Government of India have already planned for the acquisition of a research vessel for marine fisheries investigations, and it is hoped that exploratory surveys and marine investigations could be soon started in our off-shore waters in the same manner as experimental fishing started from Bombay” [61].

The Indian government also sought to promote the development of “mechanized” fishing using commercial nets and to scale up fishing to resemble Japan’s increasingly industrialized methods. Under the circumstances, Panikkar observed, “it is natural that much attention should be paid to studying the biology of our commercially valuable species”. He insisted, however, that “fisheries research” should be “regarded as a social service and not as a business enterprise” [61]. Such a philosophy was consistent with his associations in the Indian government during a period in which the government embraced socialist principles while refusing alignment with communist countries.

In 1966, the year after the expedition ended, Panikkar published an evaluation of the accomplishments of the IIOE for his field of fisheries management in the Indian journal, *Current Science.* Journals of this type, which have European scientific journals as their models, and are generally in English, were long present in India by the time of the IIOE (*Current Science* itself dated to the 1930s). Panikkar was someone who could and did publish in European journals. But, once he returned to India from England, his research became more applied and more focused on South Asia, with the result that his later work appeared mainly in Indian journals. Such journals remain today an underused resource in the history and geography of science, although many are coming to be indexed in Google Scholar and to make archival articles available for free.

With regard to the IIOE, and in contrast to some North American accounts of the expedition, Panikkar was quick to note that most of the findings of the expedition within his expertise were not new. The "fisheries potential" of the IIOE, he observed, was "used as an impressive argument to stimulate interest in the project in the Asian and African countries" where "a quarter of the world's population lives" [61]. But he went on to say, "the actual fisheries work accomplished during the expedition itself has been disappointingly small" [61]. One of the primary scientists from the United Kingdom, Ronald Currie, also a fish biologist, made a similar observation about fisheries research, although he gave more credit to regional knowledge gained: "The expedition did not lead to any new theories in biology but it widened our experience and gave us regional information"[62]. The IIOE found few new fisheries in easy range of India and conditions, especially large azoic zones, that suggested finding new concentrations were unlikely, although better technology was expected to lead to better catch over dispersed zones of productivity. In the end, for India, the most important outcome of the expedition was probably the spur to publication, as well as encouragement to expand Indian institutions for oceanography.

Somalian Upwelling

The discovery of an upwelling that meant nutrients and productive fisheries-off the coast of Somalia was, however, an important finding of the IIOE [62]. Probably because it occurred in an area unlikely to be exploited by India, the government for which Panikkar worked, he did not emphasize the finding in his 1966 evaluation of the IIOE.

During the planning stages of the expedition, the Woods Hole oceanographer, Henry Stommel, had pointed to the potential importance of the "reversing western boundary current" off "Italian Somaliland," a guess directly related to early mathematical modeling of world oceans by Stommel and colleagues. He attributed to "ship observations" the information that the "current flows toward the south during the Northeast monsoon, and toward the north during the Southwest monsoon" and then cited computations by the oceanographer Pierre Welander that indicated that the Somali current "ought to be the world's most strongly oscillating current system". Stommel went on to say that this "strong, intense, and narrow" current should be the subject of "repeated hydrographic sections season by season" during the IIOE [55]. The water column observations that resulted from Stommel's recommendations, combined with ship observations that were probably ancient, resulted in one of the major findings of the IIOE, i.e., a new potential protein source for eastern Africa. As a result, in 1976, there was a project to exploit the upwelling by attempting to transform into fisherman 15,000 nomads driven from their territory in northern Somalia by drought, in a small echo of radical economic transformations attempted in Tanzania, China and the Soviet Union.

Data on the Effect of the Participation of Third World Scientists in the IIOE

After the IIOE, scientists in the US had taken the lead in issuing what they titled, with perhaps false modesty, *A Partial Bibliography of the Indian Ocean,* with 4939 references, covering up until the middle of 1962 [63]. This work was characterized as "exhaustive" by scientists of the Central Marine Fisheries Research Institute in Madras, who nonetheless observed that, of the total references, no fewer than "948 [19.1%] have been published within India" [64]. The Institute went on to issue its own bibliography (*Bibliography of Marine Fisheries and Oceanography of the Indian Ocean, 1962-1967*) that concentrated on more recent years, in which, they noted in the foreword, there were "2738 references listed of which 1351 [49.3%] have been published in this country" [64]. Not only does the discussion of scientific output here indicate rising confidence on the part of Indian oceanographers on their centrality to the field, it shows a real jump in publications for Indian scientists during and just after the IIOE [65, 66].

Conclusion

Panikkar predicted that, by the close of the 20th century, with the help of technological advances in oceanography, the Indian Ocean would produce about 20 million tons of fish annually, by comparison with 2.5 million in 1966 [61]. This prediction remains unfulfilled, an estimate from 2010 puts catches at about 11.3 million tons, but so do neo-Malthusian scenarios about population and extreme famine in India, in part because of the development of fisheries and greater knowledge of the monsoon and its effect on agriculture that were the focus of the IIOE [65, 66]. Today, discussion of fisheries in the Indian Ocean region and throughout the world emphasizes fishing in a sustainable manner, and the major growth area of applied research is in fish farming. Even in the early 1960s, researchers were already warning about the collapse of fisheries in areas with historical data available, and some predicted the same for the Indian Ocean [66].

As an enterprise, the IIOE was the deliberate construction of networks, in line with Needham's work, enshrined later in actor-network theory, for the development of science. Stommel contributed observations, grounded in mathematics, that uncovered the major fishery discovered during the expedition, while Panikkar's insistence, along with that of the Indian government, on applied work during the expedition ultimately shaped what got done and created institutions active today. By 2015, when the Second International Indian Ocean Expedition began, India had become a middle-income country and oceanography, partly as result of the first expedition, played a sizeable role in regional science. The optimism that fueled the IIOE predicted the rise of Asia and left a legacy of science to support development.]

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